HEWLETT PACKARD

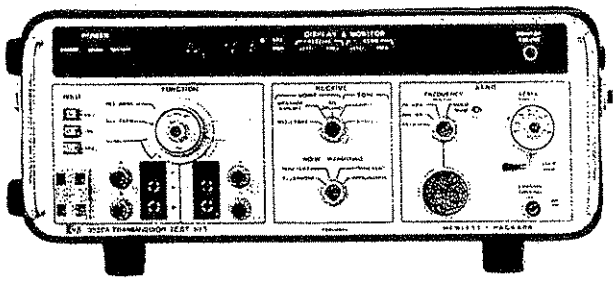
Operating
and
Service
Manual

Model 3552A
Transmisson Test Set

OPERATING AND SERVICE MANUAL

TRANSMISSION TEST SET

3552A



HEWLETT hp PACKARD

OPERATING AND SERVICE MANUAL

MODEL 3552A
TRANSMISSION TEST SET

Serial Number: 1604A00261 and higher
1652U00611 and higher

IMPORTANT NOTICE

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

WARNING

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

Manual Part No. 03552-90004

Microfiche Part No. 03552-90059

Printed: December 1977

HEWLETT hp PACKARD

CERTIFICATION

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

WARRANTY AND ASSISTANCE

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

If this product is sold as part of a Hewlett-Packard integrated instrument system, the above warranty shall not be applicable, and this product shall be covered only by the system warranty.

Service contracts or customer assistance agreements are available for Hewlett-Packard products.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

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SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION.

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

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

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

1-5. SPECIFICATIONS.

1-6. Table 1-1 is a complete list of the critical specifications that are controlled by tolerances. Table 1-2 contains general information that describes the operating characteristics of the Test Set.

1-7. Any changes in specifications due to manufacturing, design or traceability to the U.S. National Bureau of Standards are included in Table 1-1 in this manual. Specifications listed in this manual supersede all previous specifications for the Test Set.

1-8. INSTRUMENT AND MANUAL IDENTIFICATION.

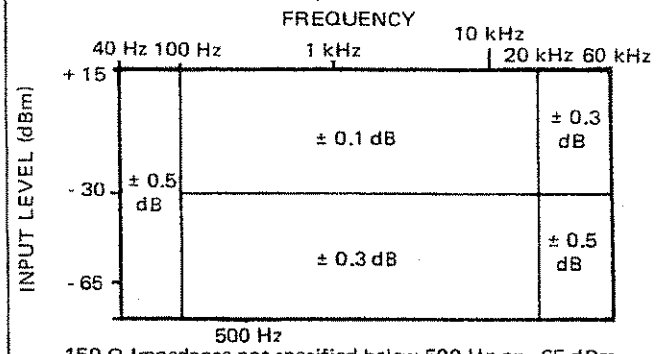
1-9. Instrument identification by serial number is located on the right side. Hewlett-Packard uses a two-section serial number consisting of a four-digit prefix and a five-digit suffix, separated by a letter designating the country in which the instrument was manufactured (A = U.S.A.; G = West Germany; J = Japan; U = United Kingdom).

1-10. This manual applies to instruments having the serial numbers indicated on the title page. It has been updated by page revision to include the latest changes in the instrument at the time of shipment from the factory. Information in Section VIII adapts this manual to instruments with lower serial numbers. Part Numbers for this manual and the microfiche copy of the manual are also shown on the title page.

Table 1-1. Specifications.

RECEIVER:

Level Measurement Accuracy:



150 Ω Impedance not specified below 500 Hz or - 65 dBm
TC ± 0.005 dB/°C at T < 15°C and T > 35°C

Noise Measurement Accuracy:

Message circuit noise:
± 1 dB (- 70 dBm to - 5 dBm).
± 2 dB (- 90 dBm to - 70 dBm)

Noise-with tone:
± 1 dB (- 70 dBm to - 5 dBm)
± 2 dB (- 80 dBm to - 70 dBm)

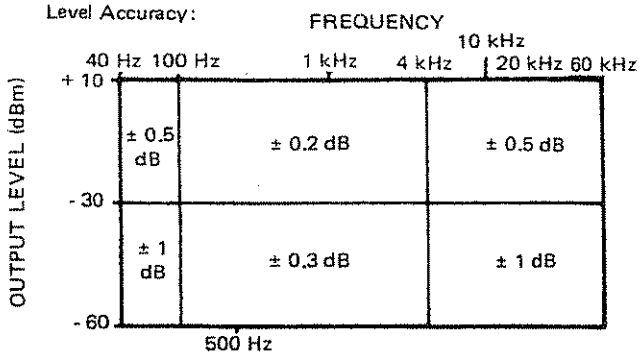
Noise-to-ground:
± 1 dB (- 30 dBm to + 35 dBm)
± 2 dB (- 50 dBm to - 30 dBm)

Frequency Measurement Accuracy:
± 1 count

TRANSMITTER:

Frequency Accuracy:
± 1 count

Level Accuracy:



150 Ω Impedance not specified below 500 Hz
TC ± 0.005 dB/°C at T < 15°C and T > 35°C

Harmonic Distortion:
> - 50 dB (THD 100 Hz to 4 kHz).
> - 40 dB (THD 40 Hz to 100 Hz and 4 kHz to 20 kHz).
> - 55 dB (all harmonics 100 Hz to 4 kHz).
> –30 dB (THD 20 kHz –60 kHz).
> –60 dB (THD 800 Hz Hold Tone).

BRIDGING LOSS:
< 0.2 dB

Table 1-1. Specifications (Cont'd).

RETURN LOSS:

> - 30 dB (150 Ω, 500 Hz to 20 kHz).

> - 30 dB (600 Ω and 900 Ω, 40 Hz to 20 kHz).

LONGITUDINAL BALANCE:

> 100 dB at 800 Hz for Receive mode.

> 50 dB at 6 kHz for Send mode.

Weighting Filters Response:

Programme (CCITT)

FREQUENCY Hz	dB REF to 6300 Hz
63	– 42.1 ± 1.4 dB
100	– 38.0 ± 1.0 dB
200	– 32.0 ± 0.9 dB
400	– 26.0 ± 0.7 dB
800	– 20.1 ± 0.6 dB
1,000	– 18.2 ± 0.5 dB
2,000	– 12.6 ± 0.5 dB
3,150	– 9.2 ± 0.5 dB
4,000	– 7.7 ± 0.5 dB
5,000	– 6.5 ± 0.5 dB
6,300	– 6.0 REF
7,100	– 6.2 ± 0.2 dB
8,000	– 6.8 ± 0.4 dB
9,000	– 8.1 ± 0.6 dB
10,000	– 10.1 ± 0.8 dB
12,500	– 18.2 ± 1.2 dB
14,000	– 23.5 ± 1.4 dB
16,000	– 29.9 ± 1.7 dB
20,000	– 40.4 ± 2.0 dB
31,500	< – 58.1 dBm

15 kHz Flat

FREQUENCY Hz	dB BELOW REF
30	0 ± 2.5
60	0 ± 1.75
250	0 ± 1.0
1000	0
10,000	0.8 ± 1.5
15,000	3.0 ± 3.0
20,000	6.2 ± 3.0
30,000	12.3 ± 3.0
*	

Telephone (CCITT Psophometric)

FREQUENCY Hz	dB REF to 800 Hz
50	- 63.0 ± 2.0 dB
100	- 41.0 ± 2.0 dB
150	- 29.0 ± 2.0 dB
200	- 21.0 ± 2.0 dB
300	- 10.6 ± 1 dB
400	- 6.3 ± 1 dB
500	- 3.6 ± 1 dB
600	- 2.0 ± 1 dB
800	0.0 REF
1000	+ 1.0 ± 1 dB
1200	0.0 REF
1500	- 1.30 ± 1 dB
2000	- 3.0 ± 1 dB
2500	- 4.2 ± 1 dB
3000	- 5.6 ± 2 dB
3500	- 8.5 ± 3 dB
4000	- 15.0 ± 3 dB
5000	- 36.0 ± 3 dB
*	

3 kHz Flat

FREQUENCY Hz	dB BELOW REF
30	0 ± 2.5
60	0 ± 1.75
250	0 ± 1.0
1000	0
2000	0.5 ± 1.75
2500	1.5 ± 2.0
3000	3.0 ± 3.0
*	

*Increases at ≥ a two-pole Butterworth roll-off to 60 dB below reference.

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: - 90 dBm to - 5 dBm
  - Noise-with-tone: - 80 dBm to - 5 dBm (600 Ω, 900 Ω)
  - Noise-to-ground: - 50 dBm to + 35 dBm
- Resolution: 1 dB
- Sample rate: 2/second
- Detector type: Quasi RMS
- Weighting filters: Telephone (CCITT Psophometric), 3 kHz Flat, 15 kHz Flat, Programme (CCITT)

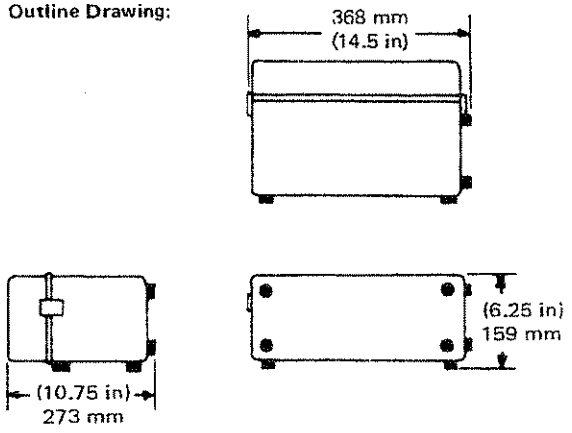
Frequency Measurements:
- Frequency range: 40 Hz to 60 kHz
- Dynamic range: + 15 dBm to - 70 dBm
- Resolution: 1 Hz (40 Hz to 10 kHz)
  10 Hz (10 kHz to 60 kHz)
- Sample rate: 10/second

TRANSMITTER:
- Frequency range: 40 Hz to 60 kHz
- Ranges: 40 Hz to 1 kHz
  200 Hz to 6 kHz
  2 kHz to 60 kHz
  800 Hz fixed (Hold Tone)
- Resolution: 1 Hz (40 Hz to 10 kHz)
  10 Hz (10 kHz to 60 kHz)
- Sample rate: 10/second
- Level range: + 10 dBm to - 60 dBm (40 Hz to 60 kHz)
  + 6 dBm to - 60 dBm (800 Hz fixed) (Hold Tone)
- Resolution: 0.1 dB
- Sample rate: 10/second

HOLD CURRENT:
> 20 mA constant current

GENERAL:
- Monitor: built-in speaker, monitors received or transmitted signal.
- Balanced impedances: 150 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.
- Mains: 100 V, 120 V, 220 V, 240 V ± 10%; 48 Hz to 440 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).

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 CHARGE or MAINS. 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.

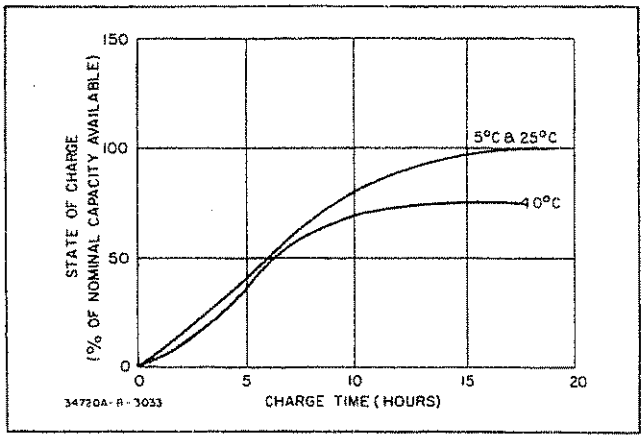


Figure 2-1. Battery Charge Acceptance vs. Temperature.

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 2-8 for recharging procedures. Section V contains information concerning replacement of the batteries.

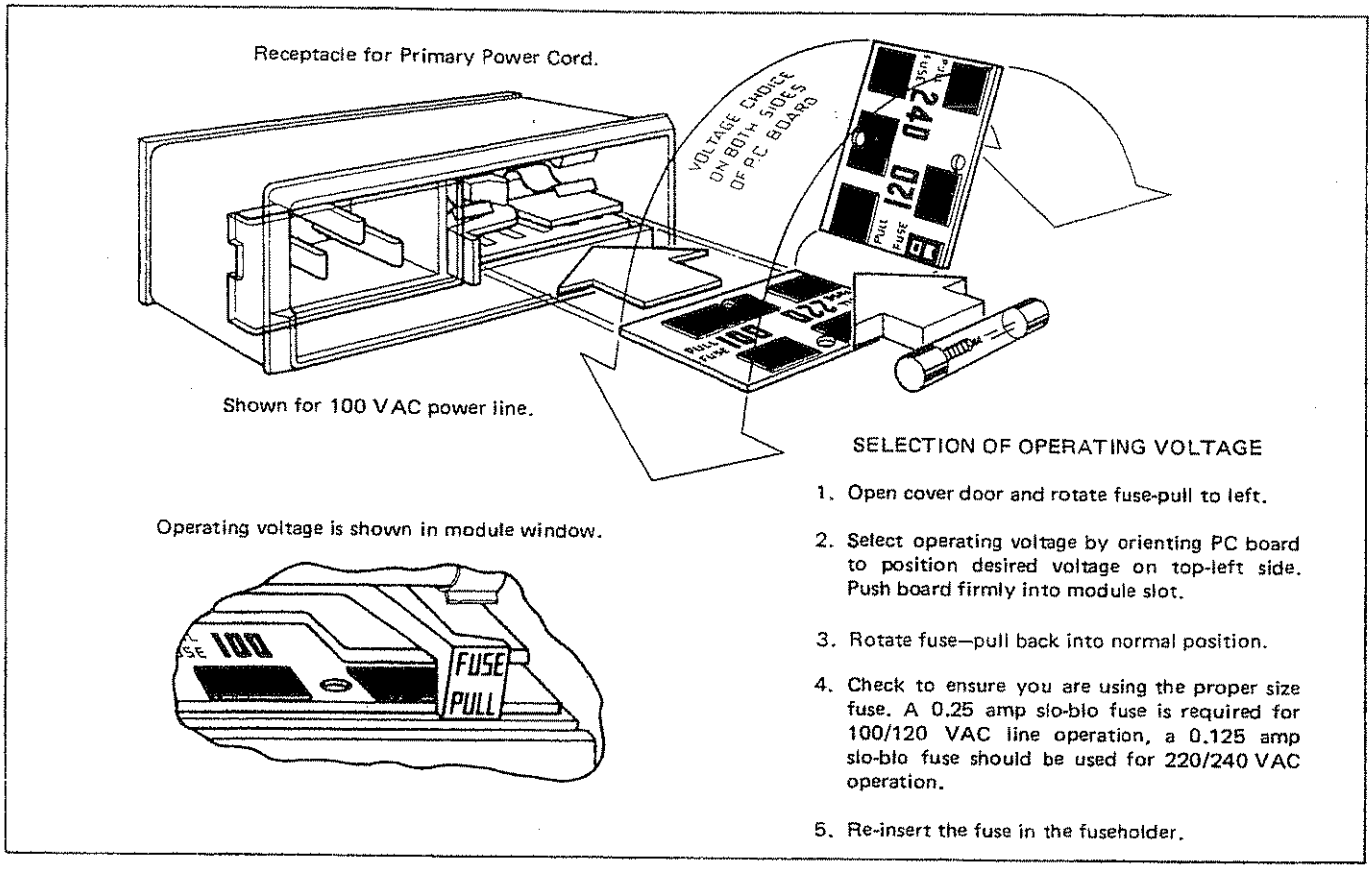


Figure 2-2. Voltage Selection.

2-13. Mains.

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. Check the power module to see if it is set to the correct voltage for your area. 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 below 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.

2-19. ENVIRONMENTAL REQUIREMENTS.

2-20. Operating Temperatures.

2-21. In order for the Test Set to operate within the specifications listed in Table 1-1, the operating temperature

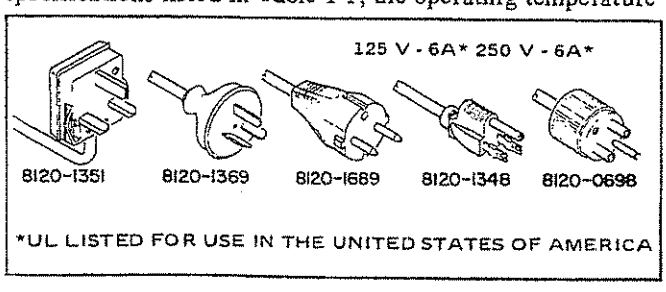


Figure 2-3. Power Cords.

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

2-22. Relative Humidity.

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

2-24. INTERFACE CONNECTIONS.

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

2-26. REPACKAGING FOR SHIPMENT.

NOTE

If the instrument is to be shipped to Hewlett-Packard for service or repair, attach a tag to the instrument identifying the owner and indicating the service or repair to be accomplished. Include the model number and full serial number of the instrument. In any correspondence, identify the instrument by model number and full serial number. If you have any questions, contact your nearest -hp- Sales and Service Office.

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

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

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

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

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

SECTION III
OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

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

3-3. INSTRUMENT CAPABILITIES.

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

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

3-6. 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, unless the audio monitor is on. Use of the audio monitor will discharge the batteries at a much faster rate. The internal power supply contains a sensing circuit, which monitors the battery voltage. If the voltage drops too low for proper operation, the voltage is automatically switched off to all circuitry 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, Figure 2-2.

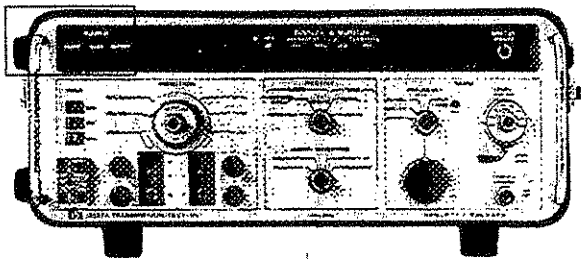
3-8. The Test Set should be allowed to warm up for a minimum of five minutes before use. This allows the instrument to stabilize.

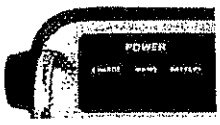
3-9. FRONT PANEL CONTROLS.

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 (CHARGE, MAINS and BATTERY).





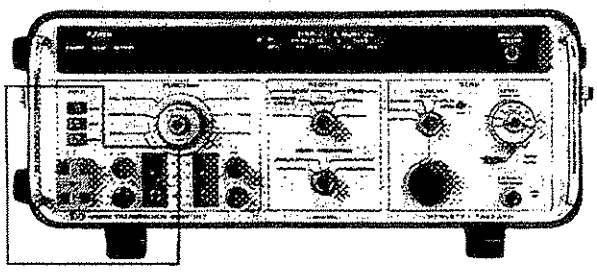
WARNING

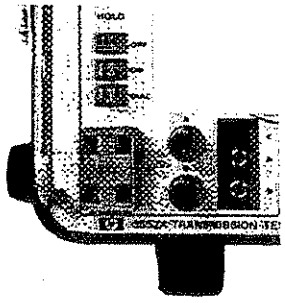
For operator protection connect the front panel ground terminal to earth ground when operating in the battery mode.

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

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 2-13, Section II.



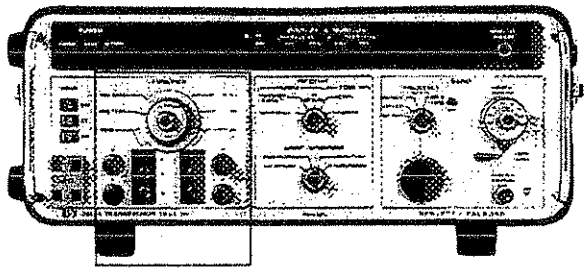


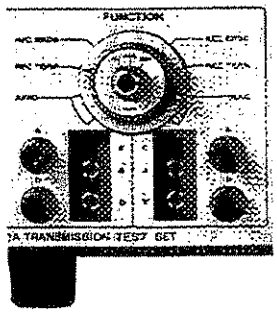
3-13. Dial and Hold.

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 a and b (labeled in black) and the Siemen's 9 REL STP-6AC 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.

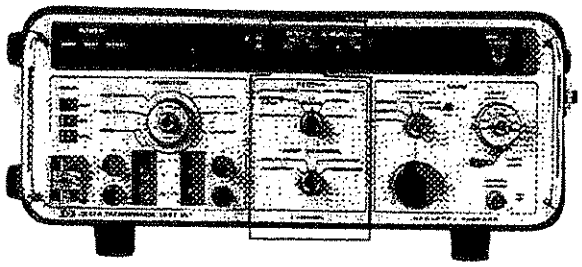
3-17. The Test Set has two sets of input/output terminals. Each set consists of a Siemen's 9 REL STP-6AC jack connected in parallel with two binding posts. The binding posts, labeled a and b, will each accept a standard sized banana plug. The two binding posts for each set are spaced so they will also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

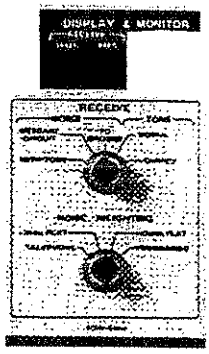
3-18. Either set of the input/output terminals can be used to receive or send. When one set is connected for receiving, the other set is simultaneously connected for sending. The selection of terminals is determined by the position of the input/output function select switch.

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





3-21. Receive.

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

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

3-24. Noise with Tone Mode. Noise measurements with tone may be used to give a measure of the noise encountered by a continuous data signal, or the noise a listener would hear during a speech burst. In the WITH TONE position of the RECEIVE NOISE/TONE switch, a sharp notch filter is switched into the Test Set input

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 (metallic noise). Any of the four weighting filters can be used. Dynamic range for the message circuit noise mode is –90 dBm to –5 dBm.

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

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

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

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

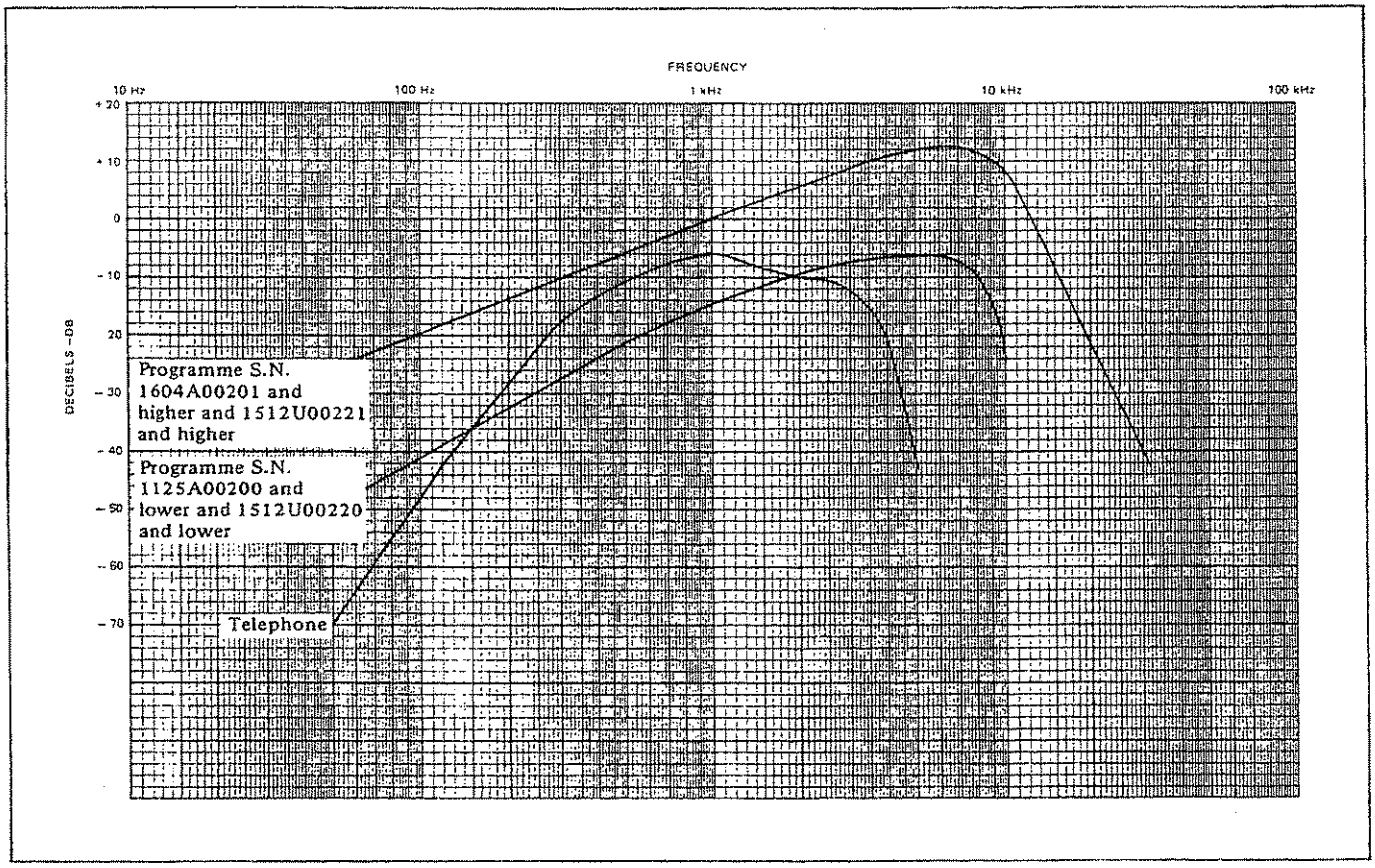


Figure 3-1. Telephone and Programme Weighting Curves.

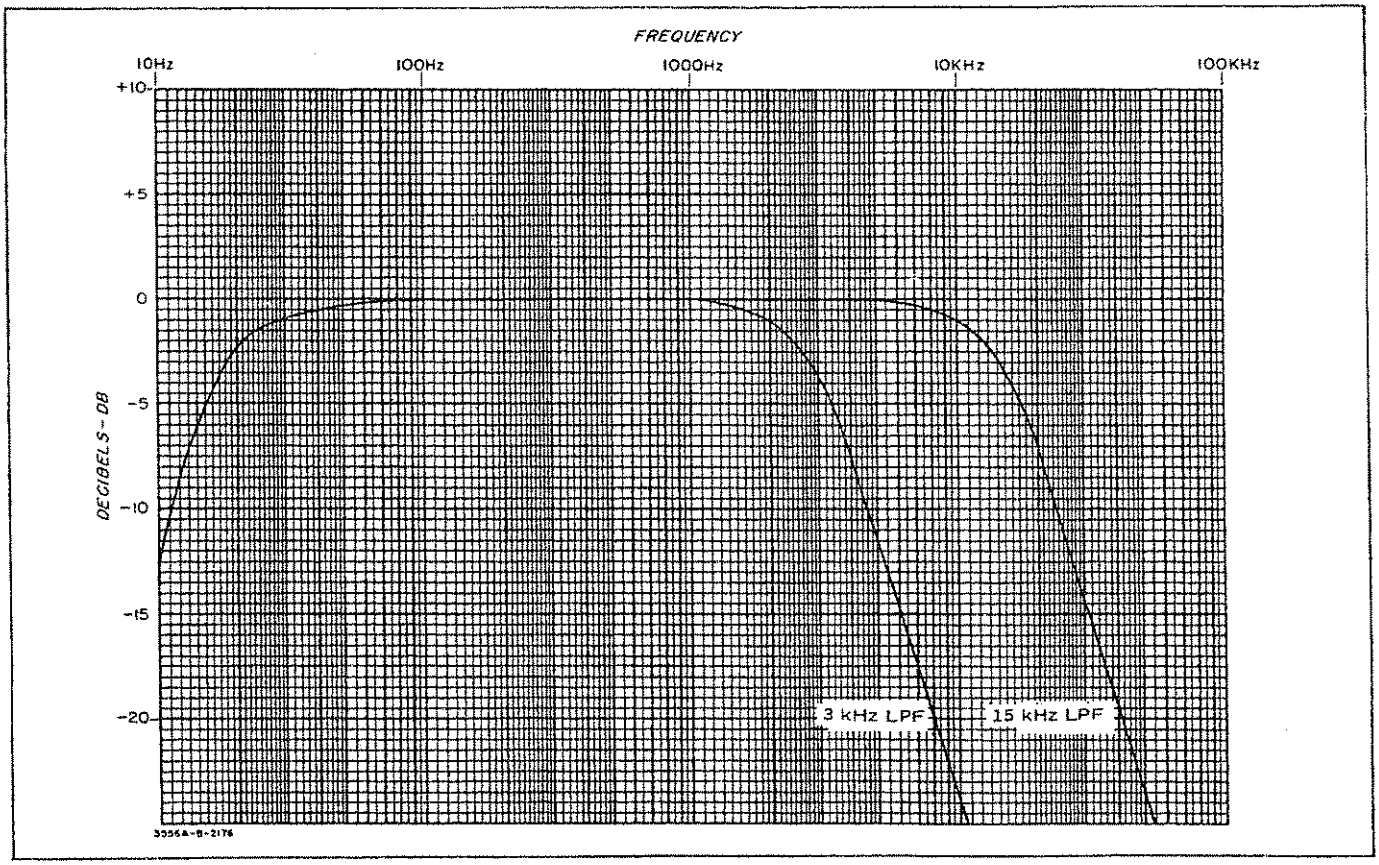


Figure 3-2. 3 kHz FLAT and 15 kHz FLAT Weighting Curves.

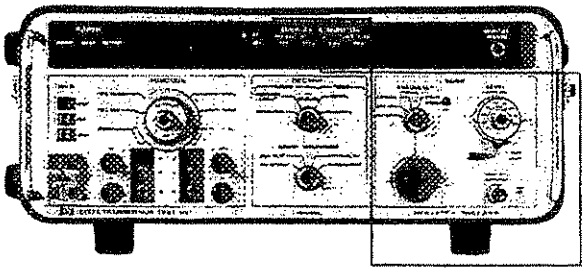
3-30. Telephone (CCITT Psophometric). The Telephone (CCITT Psophometric) filter has a frequency response which simulates the effects of noise on the human ear. This weighting is also used to evaluate the effects of noise on voice-grade data circuits. The frequency response of this filter is shown in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

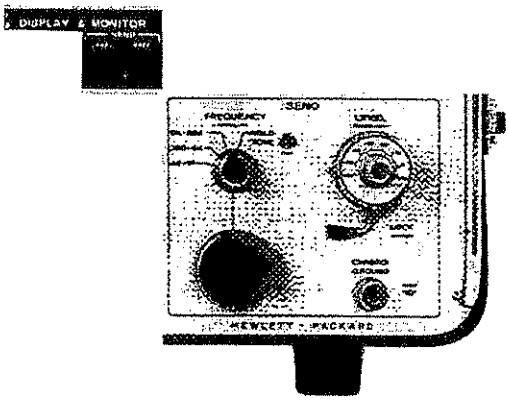
3-31. 3 kHz Flat. The 3 kHz Flat weighting filter is used on voice frequency circuits when investigating low-frequency noise, such as power induction. The frequency response of this filter is shown in Figure 3-2.

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

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

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





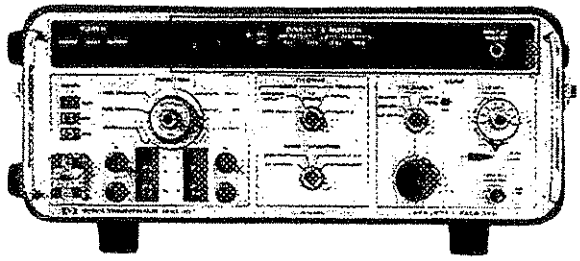
3-35. Send.

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 800 Hz. The amplitude of the test signal is variable from –60 dBm to +10 dBm. Clipping may occur at levels above +10 dBm. Both frequency and amplitude can be monitored.

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

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

3-39. Display Monitor Send. The DISPLAY & MONITOR SEND pushbuttons select the display function desired for the send signal. Two functions, level or frequency, are available. Both level and frequency are fully 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 dBm.

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 the 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.

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

3-47. 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 3-1. Input Levels.

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

Table 3-2. 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 Siemen's 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.

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

Table 3-4. 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.

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

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

Table 3-6. Send Unit Operation.

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

Table 3-7. Balance Measurements.

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

SECTION IV
THEORY OF OPERATION

4-1. INTRODUCTION.

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

4-3. BASIC BLOCK DESCRIPTION.

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

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

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

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

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

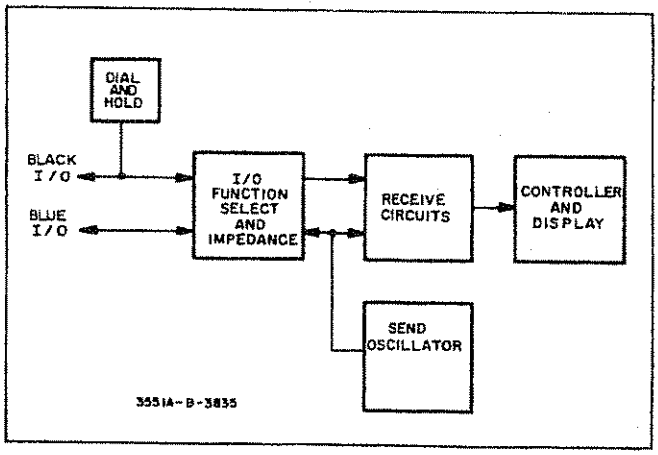


Figure 4-1. Test Set Simplified Block Diagram.

4-9. FUNCTIONAL BLOCK DESCRIPTION.

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

4-11. Dial and Hold.

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

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

4-14. The diode bridge provides the proper biasing polarity of the input/output line connection. A gas discharge tube (V1) provides protection against high voltage transients which may be on the line.

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

NOTE

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

4-16. Function Select.

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

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

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

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

4-21. Send Oscillator.

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

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

4-24. The frequency range of the send oscillator signal is controlled by changing the size of the integrating capacitor with the front panel FREQUENCY RANGE Hz control. The frequency within a range is controlled by varying the amount of current through the current source with the front panel FREQUENCY vernier.

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

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

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

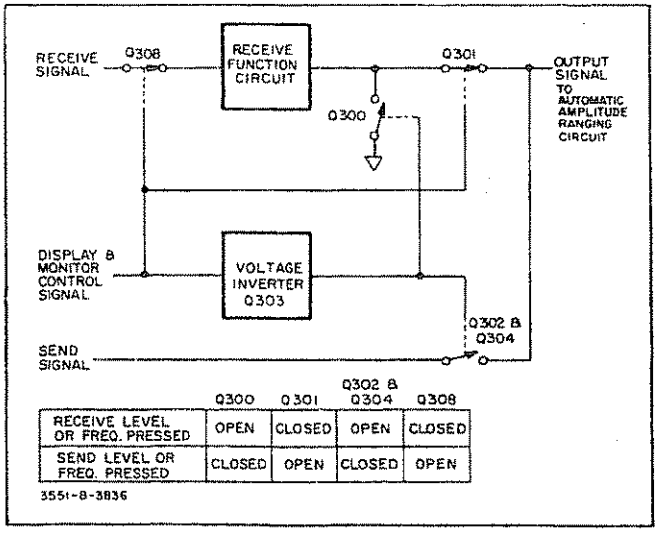
4-28. The Y-AXIS symmetry adjustment is accomplished by monitoring the switching square wave from the comparator. A difference in time for the negative half of the square-wave cycle in respect to the positive half of the square-wave cycle will alter the current from the switching transistors to the integrating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

4-29. Receive Circuits.

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

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

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



	Q300	Q301	Q302 & Q304	Q308
RECEIVE LEVEL OR FREQ. PRESSED	OPEN	CLOSED	OPEN	CLOSED
SEND LEVEL OR FREQ. PRESSED	CLOSED	OPEN	CLOSED	OPEN

Figure 4-2. Receive or Send Signal Switching.

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

at least - 50 dB of signal suppression. The - 50 dB bandwidth is 786 Hz to 810 Hz. The - 3 dB bandwidth is 316 Hz to 1343 Hz.

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

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

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

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

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

NOTE

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

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).

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 - 5 dBm to - 90 dBm dynamic range is 20 dB lower than tone measurements, therefore, the signal must be amplified 20 dB more between the ranging circuit and the logger. There is 15 dB gain in the 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 ..... - 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 Telephone (CCITT Psophometric), 3 kHz Flat, 15 kHz Flat and Programme (CCITT). The filter used is selected by the front panel NOISE WEIGHTING switch. The noise weighting circuitry consists of five active filters and the switching sequence which determines the number of active filters used for each weighting. All active filters are bypassed when the RECEIVE NOISE/TONE switch is in the RECEIVE TONE position or when one of the DISPLAY & 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 150 ohm position of the front panel IMP switch. Since all level indications are in dBm the gain of the amplifier is decreased slightly in the 600 ohm position and again in the 900 ohm position. This is accomplished by increasing the negative feedback by switching in larger resistance to ground in the amplifiers feedback line with the front panel IMP switch.

4-49. 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 a 4 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 7-8, 7-9, and 7-10) 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 ÷ 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).

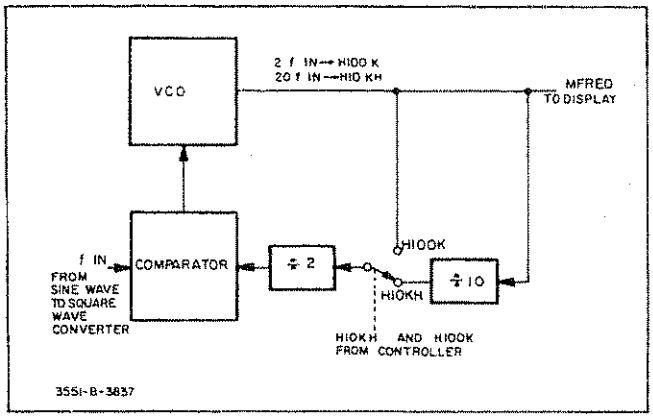


Figure 4-3. Phase-Lock Loop.

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 NCAPD control signal high, closing the FET switch. This will allow the integrating capacitor to charge to the reference voltage. The controller then sets HCAPD low, opening the FET switch (T_1, T_6). The integrating capacitor discharges and the discharge voltage is applied to the comparator. The comparator compares the capacitive discharge signal with the signal from the summer. When these two signals are equal in level, the comparator will output a pulse (HXOVR) to the controller (T_5, T_8).

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

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

4-61. 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

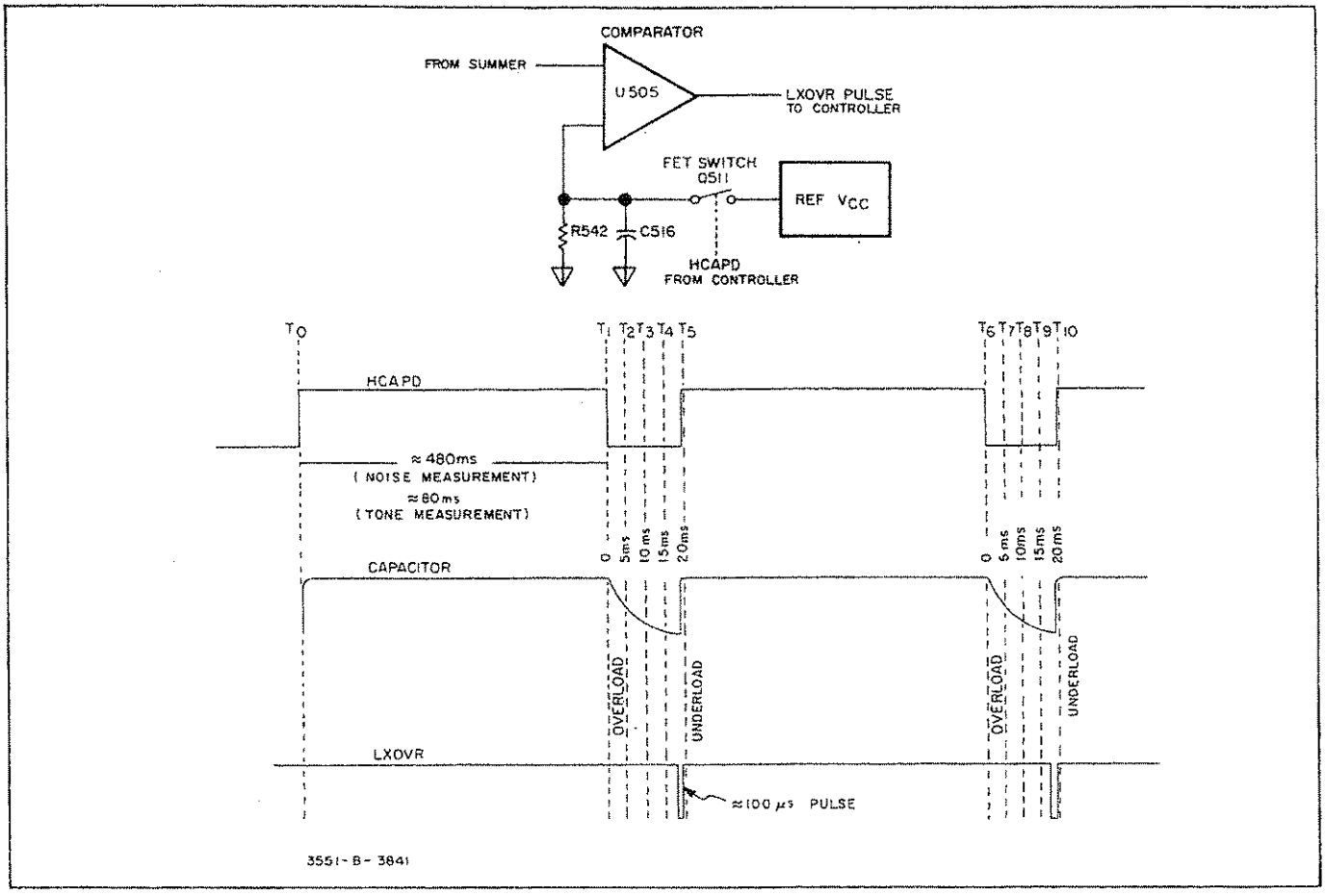


Figure 4-4. Logger.

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 dBm with two digits and a resolution of 1 dBm.

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.

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.

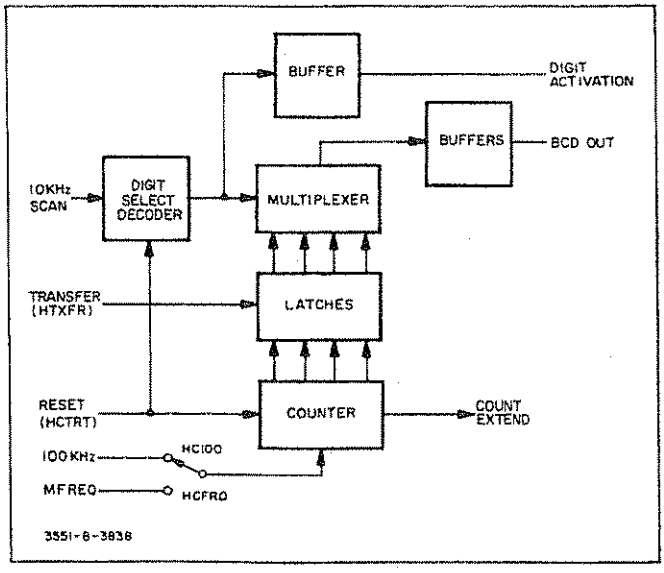


Figure 4-5. Data Accumulator.

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

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

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

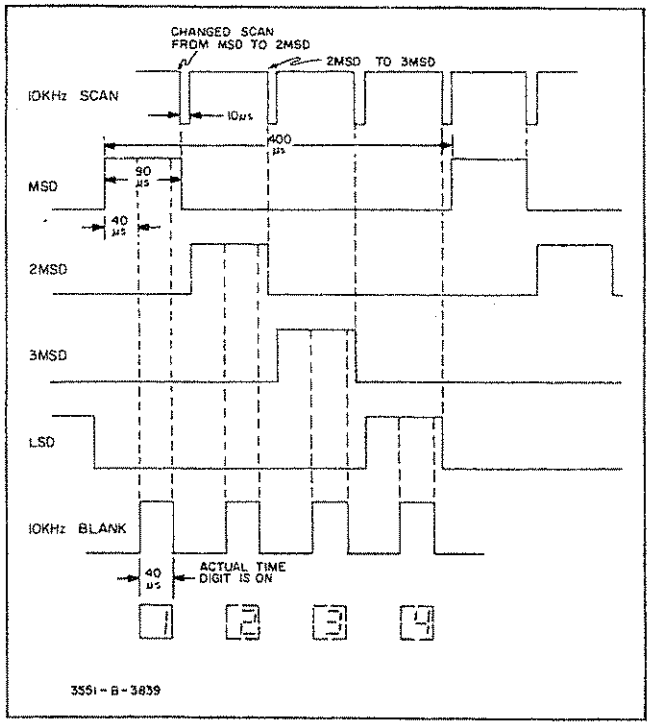


Figure 4-6. Display Timing.

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

4-70. Level Measurements. If the measurement to be made is a level measurement, the controller will set HC100 high (Figure 4-5) and the 100 kHz signal will be input to the counter. This signal will be input until the controller receives HXOVR from the logger circuit (see Paragraph 4-55). As indicated by Paragraph 4-59 and the capacitive discharge curve of Figure 4-4, the controller will accept level information if HXOVR occurs between 5 ms and 20 ms after HCAPD is set low. This time period represents from 500 counts to 2000 counts loaded into the counter (see Figure 4-7).

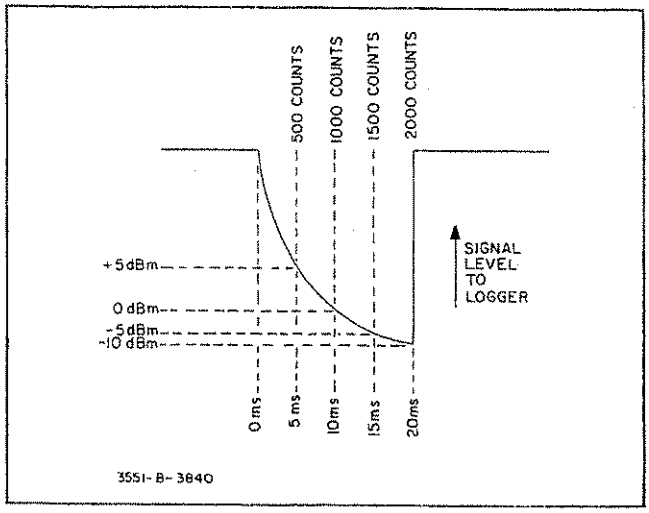


Figure 4-7. Capacitive Discharge Timing and Level Relationship.

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

Example 1:

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

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

Example 2:

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

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

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

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

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

4-74. The display ROM (Figure 7-12) transforms the three least significant digits from negative true logic to positive true logic. These BCD signals are applied to the seven segment decoder where they are decoded as a seven bit binary signal and applied to the display. The most significant digit is decoded in the display ROM according to the range and function qualifier information from the controller. If, as in Example 1 of Paragraph 4-71, the measurement mode is noise level and the automatic range circuit is in range 3, the LNOIS qualifier to the display ROM will be low and the range code on the range qualifier input lines will be 0-1-1 (Table 4-3). The count from the data accumulator will be 1000. The display ROM will decode the most significant digit (1) to a 5. This BCD signal is applied to the seven segment decoder where it is transformed into a seven bit binary code and applied to the display.

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

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

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

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

4-79. Controller.

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

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

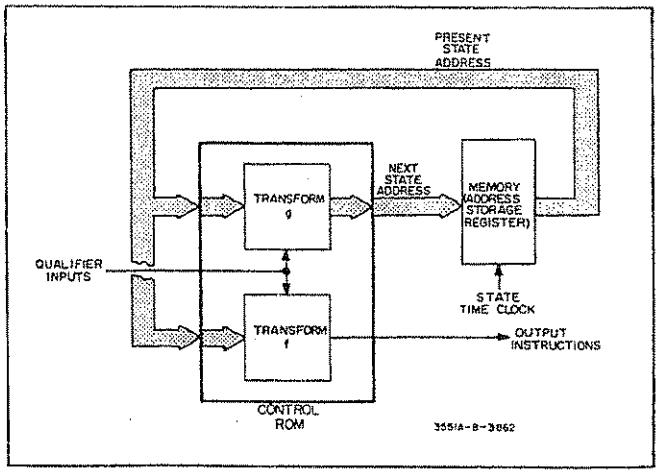


Figure 4-8. ASM Block Diagram.

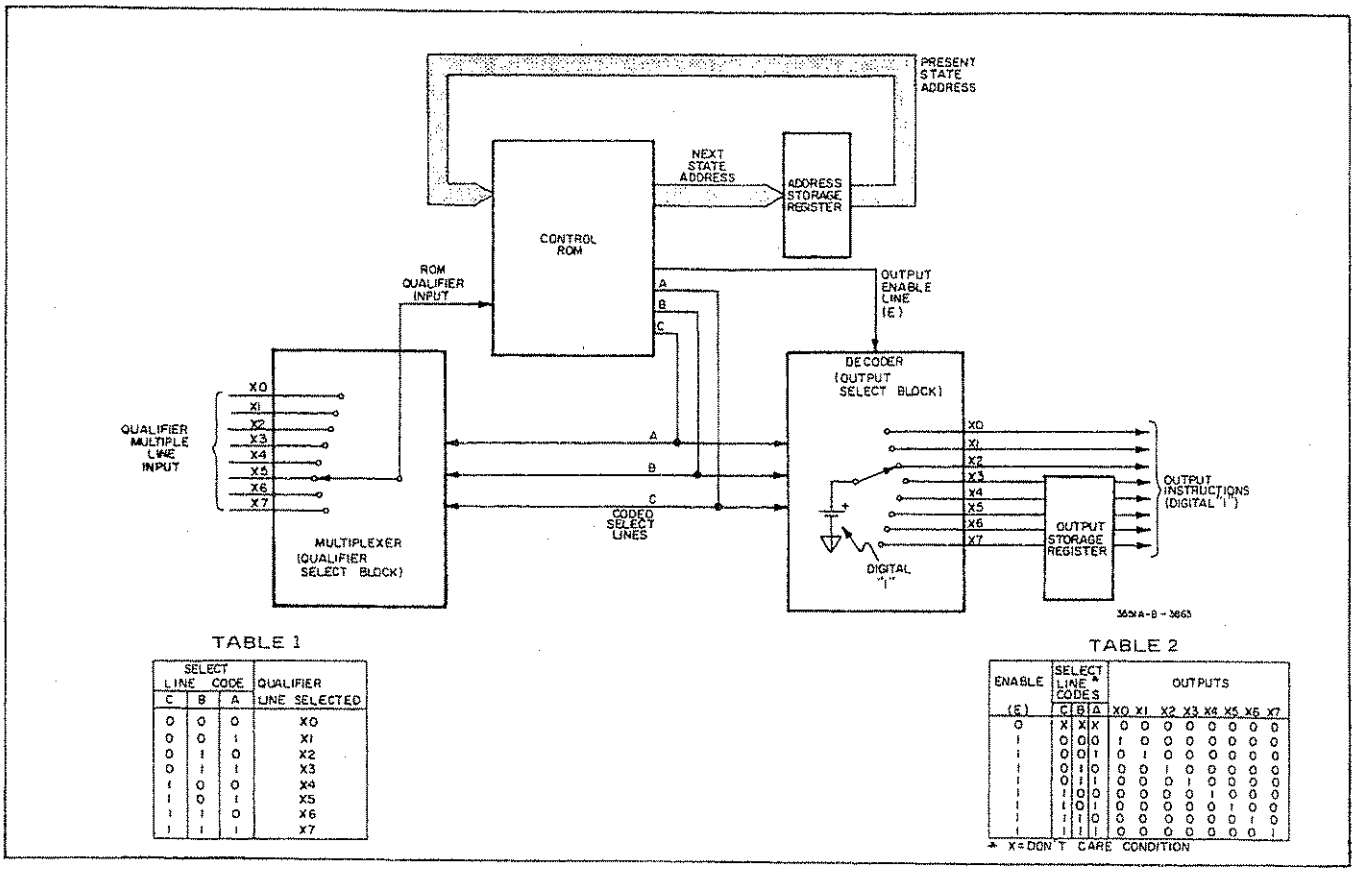


TABLE 1

SELECT LINE CODE C	B	A	QUALIFIER LINE SELECTED
0	0	0	X0
0	0	1	X1
0	1	0	X2
0	1	1	X3
1	0	0	X4
1	0	1	X5
1	1	0	X6
1	1	1	X7

TABLE 2

ENABLE (E)	SELECT LINE CODES C	B	A	OUTPUTS X0	X1	X2	X3	X4	X5	X6	X7
0	X	X	X	0	0	0	0	0	0	0	0
1	0	0	0	1	0	0	0	0	0	0	0
1	0	0	1	0	1	0	0	0	0	0	0
1	0	1	0	0	0	1	0	0	0	0	0
1	0	1	1	0	0	0	1	0	0	0	0
1	1	0	0	0	0	0	0	1	0	0	0
1	1	0	1	0	0	0	0	0	1	0	0
1	1	1	0	0	0	0	0	0	0	1	0
1	1	1	1	0	0	0	0	0	0	0	1

* X = DON'T CARE CONDITION

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

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

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

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

4-85. These added circuits are controlled by coded lines from the ASM. Because it may be desired to input a qualifier and not output an instruction, the output enable line is added to regulate the decoder output. Table 1 (Figure 4-9), lists the select line codes and the input qualifier selected. Table 2 lists the select line codes, the enable line code and the output instruction selected.

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

a. The next address is locked into the address storage register becoming the present address.

b. The input qualifier is clocked into a D Flip-Flop where it is stored and applied to the ROM.

c. If desired, an output instruction is clocked out of the output select block.

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

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

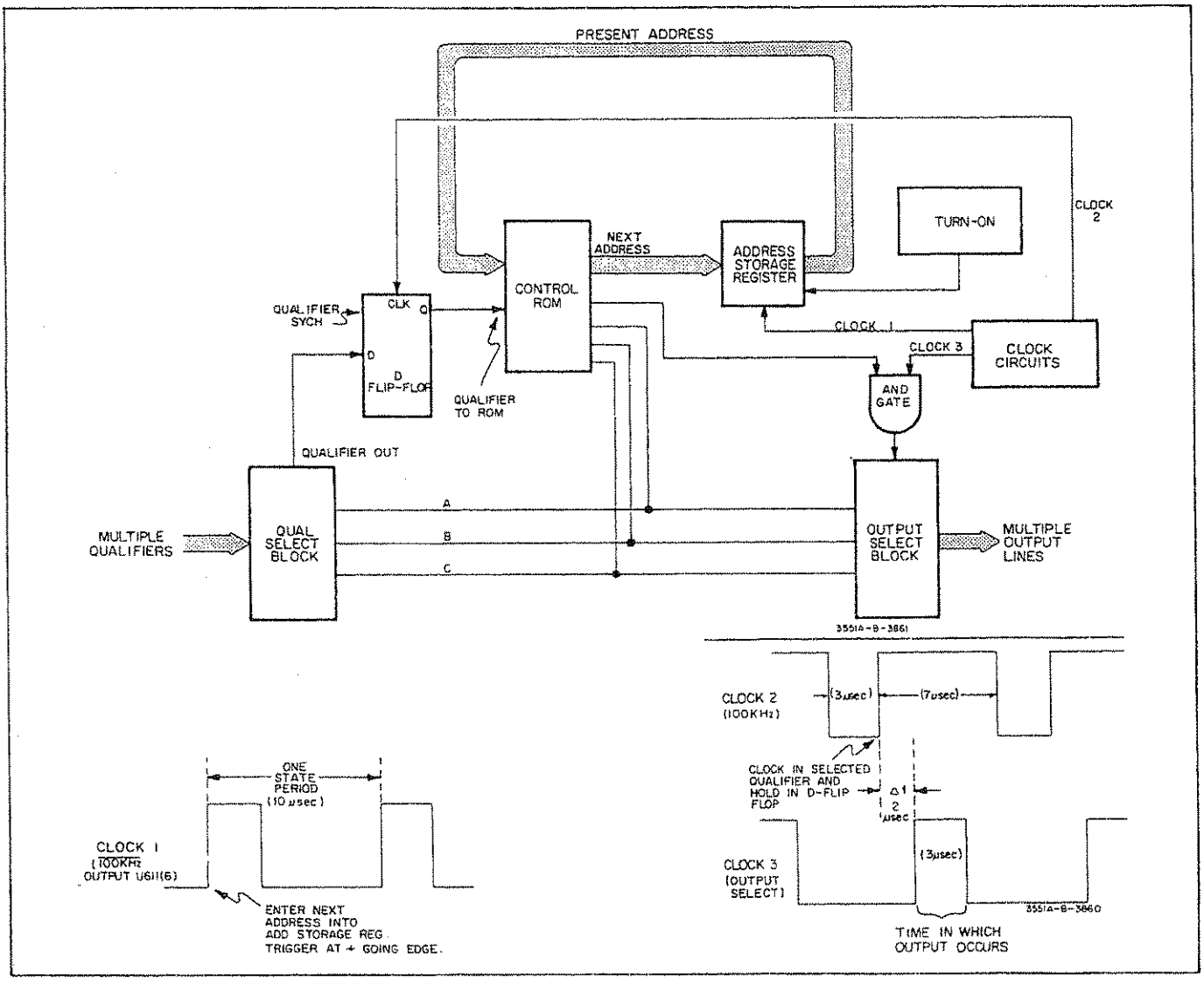


Figure 4-10. ASM Clock Circuits and Timing Diagram.

schematic) and Tables 7-1, 7-2, and 7-3. Tables 7-1, 7-2 and 7-3 contain the definitions for the controller input/output signal mnemonics.

4-89. There are two input qualifier select blocks (U608 and U609) which can select one of 15 input qualifiers. The ROM output (AQSLT) selects which of the two qualifier select blocks will be used. Table 7-1 lists the input qualifiers and their definitions.

4-90. The next state address and present state address are represented by the seven binary signals labeled I0-I6. I0 represents the least significant bit of the address. I6 represents the most significant bit. Two quad D-Flip-Flops (U602 and U603) are used for address storage.

4-91. There is a total of 12 output signals from the output storage registers (U604, U615, U617, and U509). Nine of these signals are selected by the output select block (U606). The remaining three signals are selected directly by the controller. The output select block also activates an up-down counter (U621) which supplies the three amplitude range control signals for the automatic amplitude ranging (see Paragraph 4-36). Table 7-2 lists the output control signals and their definitions.

4-92. The clock and time base circuits, in addition to supplying the timing signals for the controller (100 kHz and OUTPUT SELECT) also provide the display timing pulses (10 kHz SCAN and 10 kHz BLANK, see Paragraph 4-61). ROM input qualifier (ATMBS) provides timing for the frequency and amplitude measurement durations. The ATMBS period is set by controller outputs ATMB1 and ATMB2. Table 4-4 shows the relationship between ATMB1, ATMB2 and ATMBS plus the purpose of the ATMBS time period.

4-93. Power Supply.

4-94. The Test Set can be operated from an external ac power source or from an internal battery pack. Figure 4-11 is a block diagram of the power supply circuits. There are

Table 4-4. Programmable Timebase.

Digital State of Most Significant Time Base Bit	Digital State of Least Significant Time Base Bit	Time Duration of Qualifier	Operation Performed by Controller
(ATMB2)	(ATMB1)	(ATMBS)	
0	0	High for 5 ms	Level Measurement
0	1	High for 50 ms	Frequency Measurement
1	0	High for 500 ms	Noise Measurement
1	1	High for 5000 ms	Internal Test Procedure

three basic voltages supplied by the ac input circuit or the battery pack (+ 5 V dc, + 12 V dc and - 12 V dc). When the instrument is plugged into an external power source, a battery charge circuit supplies charging voltage for the batteries.

4-95. The batteries are protected by a sense circuit which monitors the battery voltage. If the battery voltage drops below a certain level (approximately + 4 V dc for the + 5 V dc battery and ± 10 V dc for the ± 12 V dc batteries), the relay in the relay circuit is opened disconnecting the batteries. The sense circuit also opens the relay if the Test Set is plugged into an external ac source. This prevents the batteries from being used while they are being charged.

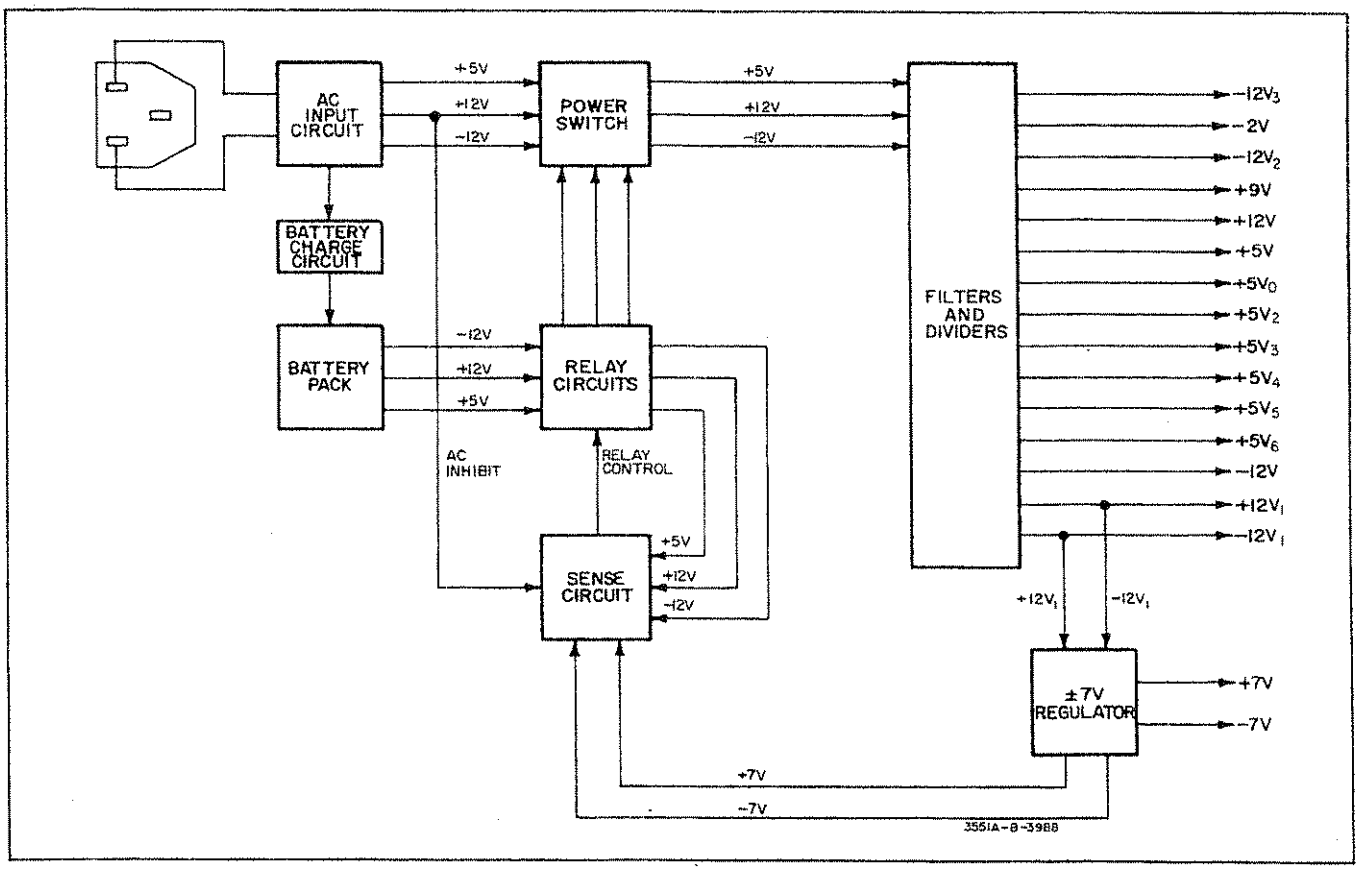


Figure 4-11. Power Supply Block Diagram.

WARNING

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

Table 5-1. Test Equipment Required.

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

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

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

5-3. RECOMMENDED TEST EQUIPMENT.

5-4. The equipment required for the maintenance of the Test Set is listed in Table 5-1. If the recommended model is not available, use a substitute that meets the required specifications given in the table.

5-5. TEST RECORD.

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

PERFORMANCE TESTS

5-7. PERFORMANCE TESTS.

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

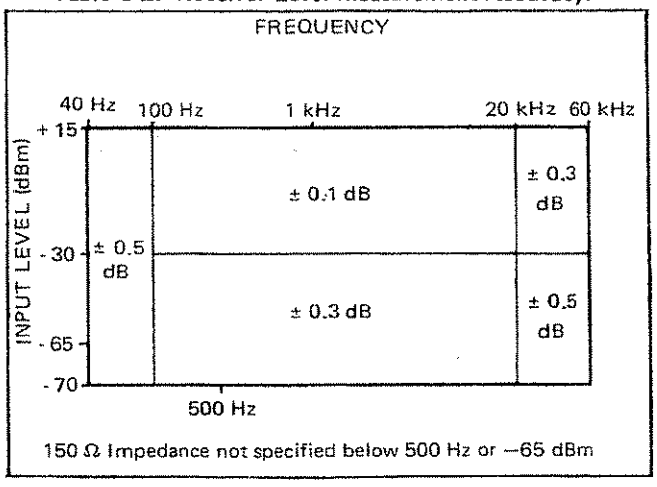
NOTE

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

5-9. Receiver Level Accuracy.

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

Table 5-2. Receiver Level Measurement Accuracy.



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

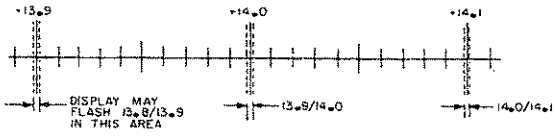
HOLD . . . . . OFF
FUNCTION
  Left Terminals (black) . . . . . .REC BRDG
RECEIVE/TONE . . . . . .NORMAL
(or 40 to 60 kHz)
DISPLAY & MONITOR . . . RECEIVE LEVEL
IMP 150
SEND FREQUENCY . . . . . 40 – 1 K
(or 40 – 600)
FREQUENCY
  VERNIER . . . . . Fully counterclockwise
SEND LEVEL RANGE . . . . . –60 to –50
SEND LEVEL
  VERNIER . . . . . Fully counterclockwise
POWER . . . . . .MAINS

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

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

+14 dBm Test Test Set Input Levels 150 ohms = 1.9411 V 600 ohms = 3.882 V 900 ohms = 4.755 V				−35 dBm Test Test Set Input Levels 150 ohms = 6.887 mV 600 ohms = 13.77 mV 900 ohms = 16.87 mV			
Test Frequencies			Test Set	Test Frequencies			Test Set
150 Ω	600 Ω	900 Ω	Display (dBm)	150 Ω	600 Ω	900 Ω	Display (dBm)
	40 Hz	40 Hz	+13.4/13.5 to +14.4/14.5		40 Hz	40 Hz	−34.4/34.5 to −35.4/35.5
500 Hz	100 Hz	100 Hz	+13.8/13.9 to +14.0/14.1	500 Hz	100 Hz	100 Hz	−34.6/34.7 to −35.2/35.3
1 kHz	1 kHz	1 kHz	+13.8/13.9 to +14.0/14.1	1 kHz	1 kHz	1 kHz	−34.6/34.7 to −35.2/35.3
10 kHz	10 kHz	10 kHz	+13.8/13.9 to +14.0/14.1	10 kHz	10 kHz	10 kHz	−34.6/34.7 to −35.2/35.3
20 kHz	20 kHz	20 kHz	+13.8/13.9 to +14.0/14.1	20 kHz	20 kHz	20 kHz	−34.6/34.7 to −35.2/35.3
40 kHz	40 kHz	40 kHz	+13.6/13.7 to +14.2/14.3	40 kHz	40 kHz	40 kHz	−34.4/34.5 to −35.4/35.5
60 kHz	60 kHz	60 kHz	+13.6/13.7 to +14.2/14.3	60 kHz	60 kHz	60 kHz	−34.4/34.5 to −35.4/35.5

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



d. Proceed to test the receiver level accuracy at the frequencies, impedances, and levels shown in Table 5−3. Be sure to change the ac calibrator output to the correct level for each impedance. The Test Set display should be as indicated for each test.

e. Set the Test Set IMP to 600.

f. Adjust the ac calibrator frequency to 1 kHz and set the output level to 3.882 V. The Test Set display should be +13.8/13.9 to +14.0/14.1. This is the first test in Table 5−4.

g. Proceed to test the Test Set receiver level accuracy at the input levels shown in Table 5−4. The Test Set display should be as indicated in each case.

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

Test Set Input Level (ac rms)	Test Set Display (dBm)
3.882 V	+13.8/13.9 to +14.0/14.1
2.449 V	+ 9.8/9.9 to +10.0/10.1
1.546 V	+ 5.8/5.9 to + 6.0/6.1
.7746 V	− 0.0/0.1 to + 0.0/0.1
.4887 V	− 3.8/3.9 to − 4.0/4.1
.1546 V	−13.8/13.9 to −14.0/14.1
48.87 mV	−23.8/23.9 to −24.0/24.1
15.46 mV	−33.6/33.7 to −34.2/34.3
4.887 mV	−43.6/43.7 to −44.2/44.3
1.546 mV	−53.6/53.7 to −54.2/54.3
.4887 mV	−63.6/63.7 to −64.2/64.3

h. Connect a 10 dB 50 ohm attenuator (Model 355C set to −10), a 50 ohm feed−thru termination (Model 11048C), and an ac voltmeter (Model 3490A) to the ac calibrator and the Test Set as shown in Figure 5−1. The ac voltmeter accuracy must be ± (0.12% of reading + 0.035% of range) or better at 1 kHz.

i. Set the ac calibrator output voltage to .8691 V (1 V range). (Frequency is still 1 kHz; Test Set in REC BRDG: IMP 600.) If the ac voltmeter reading is not 0.2748 V, adjust the ac calibrator output to obtain this reading.

j. Change the ac calibrator to the 1 mV range (do not make any other changes). The Test Set display should be between (flashing) −68.6/68.7 and −69.2/69.3 dBm.

CAUTION

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

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

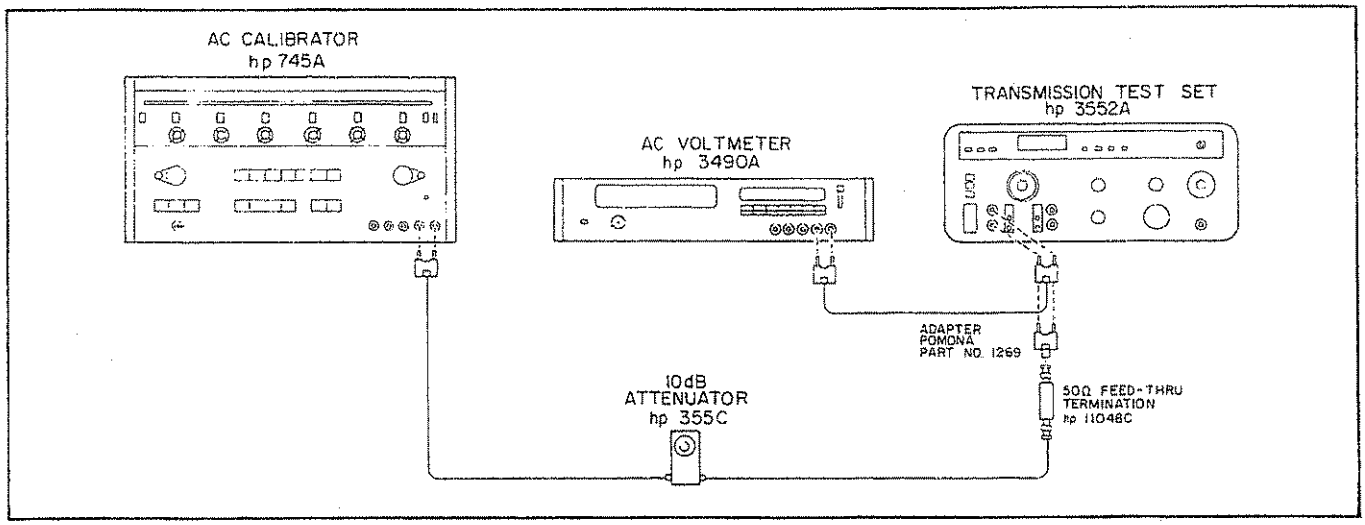
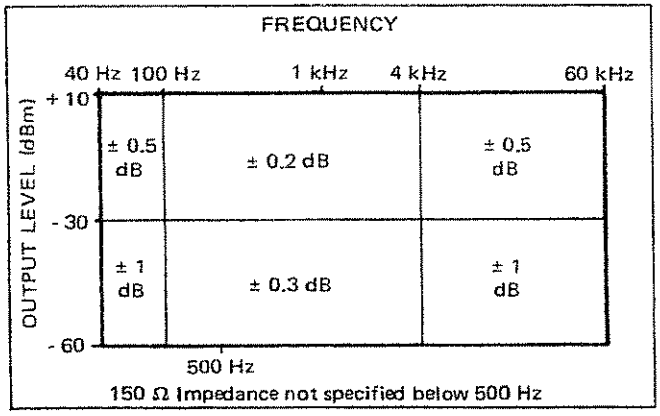


Figure 5-1. Receiver Low Level Accuracy Test.

display 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 an ac voltmeter to monitor the Test Set output signal at +10 dBm over the specified frequency range. The range of the output level controls is then checked using the Test Set display.

Table 5-5. Transmitter Level Measurement Accuracies.



a. Connect an ac voltmeter to the blue input/output terminals. Connect a 150 ohm resistor across these terminals.

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

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

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 ac voltmeter indication should be from 1.1969 to 1.2533 V rms. This is the first test in Table 5–6.

g. Repeat Step e at the remaining frequencies in Table 5–6 under 150 ohms. The ac voltmeter indication should be within the limits shown in each case.

h. Change the Test Set IMP control to 600 and repeat Step c through Step g at the frequencies listed under 600 ohms in Table 5–6. The ac voltmeter reading should be within the limits indicated for each frequency.

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

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

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

l. Set the Test Set front panel SEND LEVEL vernier fully CCW and the SEND LEVEL RANGE control to the –60 to –50 position. The Test Set display indication should be less than –60.0 dBm.

m. Set the Test Set front panel SEND LEVEL RANGE

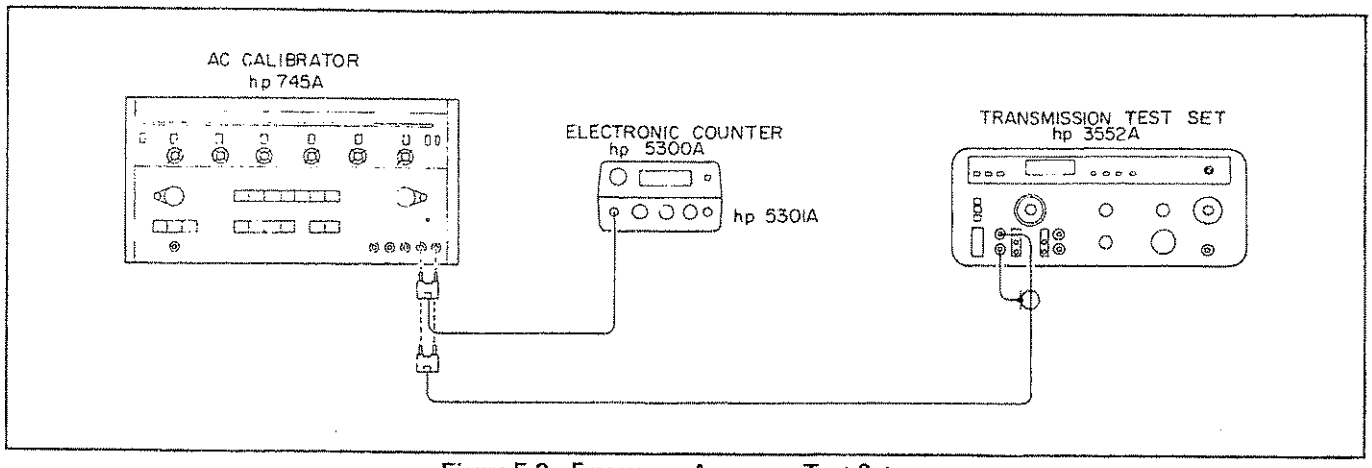


Figure 5-2. Frequency Accuracy Test Setup.

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

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

Table 5-6. Transmitter Level Accuracy.

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

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.

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
IMP 600
RECEIVE
NOISE/TONE . . . . . .TONE NORMAL
(or 40 Hz – 60 kHz)
DISPLAY & MONITOR . . . .RECEIVE FREQ
POWER . . . . . .MAINS

c. Set the ac calibrator frequency to 40 Hz, .7746 V.

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 5-7.

Table 5-7. 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
(or 40 – 600)
SEND LEVEL RANGE dBm . . . . . .0 to +10
DISPLAY & MONITOR . . . . . .SEND FREQ
POWER . . . . . .MAINS

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

NOTE

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

c. Adjust the Test Set SEND FREQUENCY vernier fully CW. The Test Set display indication should be greater than 1.000 kHz (or 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.

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

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

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

WARNING

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

NOTE

In order to test the Noise Weighting Filters Response accuracy to one decimal place, it is necessary to move a jumper within the instrument. With the 3552A disconnected from mains, release the cover as shown in Figure 5–12 and slide the cover back approximately three inches. Change the position of "Jumper for dBrn Resolution" (see Figure 5–16) from the N position to the 3 position. Be sure to return this jumper to the N position after completing the Noise Weighting Filter tests. Some instruments with serial number suffix below 00111 do not have this jumper, and consequently can be tested only to integer number resolution. For these instruments, use the following tables marked "For 2–Digit Display". For instruments in which the jumper is moved for these tests, use the tables marked "For Expanded Display".

a. Connect the AC Calibrator output to the Test Set left (black) input/output terminals as shown in Figure 5–2. using an electronic counter to monitor the calibrator frequency.

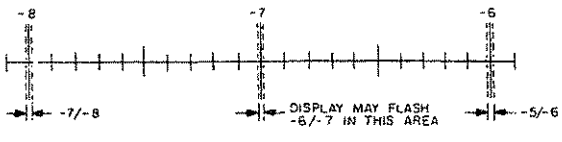
b. Set the Test Set front panel controls as follows:

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

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

1. If the Test Set display has been expanded for this test, adjust the AC Calibrator output voltage so that the Test Set display alternates –6.9/–7.0 dBm. This sets the reference point as near as possible to –7.0 dBm. Then adjust the AC Calibrator to the frequencies shown in Table 5–8. Do not readjust the output voltage. The Test Set display should be as shown for each frequency.

2. If the Test Set does not have an expanded display, adjust the AC Calibrator output voltage so that the Test Set display alternates between –6 and –7 dBm. This sets the reference point as near as possible to –7.0 dBm. The display may flash –6/–7 at any point from –6.99 through –7.01. Therefore, if the specification were –7.0 dBm ± 1 dB, for example, the display limits would be flashing –5/–6 to flashing –7/–8 as illustrated below.



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

Table 5-8. Noise Weighting Filter, Telephone. (For Expanded Display)

Frequency (Hz)	Test Set Display Limits (dBm)
800	– 6.9/ 7.0 dBm REF
50	–67.9/68.0 to –71.9/72.0
100	–45.9/46.0 to –49.9/50.0
150	–33.9/34.0 to –37.9/38.0
200	–25.9/26.0 to –29.9/30.0
300	–16.5/16.6 to –18.5/18.6
400	–12.2/12.3 to –14.2/14.3
500	– 9.5/ 9.6 to –11.5/11.6
600	– 7.9/ 8.0 to – 9.9/10.0
1000	– 4.9/ 5.0 to – 6.9/ 7.0
1200	– 5.9/ 6.0 to – 7.9/ 8.0
1500	– 7.2/ 7.3 to – 9.2/ 9.3
2000	– 8.9/ 9.0 to –10.9/11.0
2500	–10.1/10.2 to –12.1/12.2
3000	–10.5/10.6 to –14.5/14.6
3500	–12.4/12.5 to –18.4/18.5
4000	–18.9/19.0 to –24.9/25.0
5000	–39.9/40.0 to –45.9/46.0
10,000	⩾12 dB below 5 kHz reading
20,000	⩾24 dB below 5 kHz reading

voltage determined at 800 Hz must be increased by .0122 V. This is determined as follows:

At 400 Hz, the display must be 6.3 dB ± 1 dB below the –7.0 dBm reference (see Table 1–1), or –13.3 dBm ± 1 dB. If the input (reference) is increased by 0.3 dB, then the display should be between –11/–12 (flashing) and –13/–14 (see Table 5–9). Converting dBm (600 Ω) to volts;

Reference +0.3 dB =	–6.7 dBm	= .3582
Reference	= –7.0 dBm	= .3460
Difference		= .0122 V

Therefore, to increase the input (and consequently the display) by 0.3 dB, the reference voltage must be increased by .0122 V.

Perform this test at the frequencies listed in Table 5–9, changing the input voltage as necessary at each frequency. The display should be within the limits shown in each case.

Table 5-9. Noise Weighting Filter, Telephone. (For 2- Digit, Non Expanded Display)

Frequency (Hz)	Test Set Input	Test Set Display Limits (dBm)
800	REF*	– 6/ 7 dBm REF
50	REF	–67/68 to –71/72
100	REF	–45/46 to –49/50
150	REF	–33/34 to –37/38
200	REF	–25/26 to –29/30
300	REF –.0156 V	–16/17 to –18/19
400	REF +.0122 V	–11/12 to –13/14
500	REF –.0156 V	– 9/10 to –11/12
600	REF	– 7/ 8 to – 9/10
1000	REF	– 4/ 5 to – 6/ 7
1200	REF	– 5/ 6 to – 7/ 8
1500	REF + .0122 V	– 6/ 7 to – 8/ 9
2000	REF	– 8/ 9 to –10/11
2500	REF + .0081 V	– 9/10 to –11/12
3000	REF –.0156 V	- 10/11 to –14/15
3500	REF + .0205 V	–11/12 to –17/18
4000	REF	–18/19 to –24/25
5000	REF	–39/40 to –45/46
10,000	REF	⩾12 dB below 5 kHz reading
20,000	REF	⩾24 dB below 5 kHz reading

*REF voltage determined in Paragraph 5–18, Step c (2).

d. Set the Test Set front panel NOISE WEIGHTING control to the 3 kHz FLAT position.

e. Adjust the ac calibrator frequency to 1 kHz and the output voltage to .3084 V.

1. If the Test Set display has been expanded for this test, adjust the ac calibrator output voltage for a Test Set display of –7.9/8.0 dBm. Then adjust the calibrator to the frequencies shown under "3 kHz Flat" in Table 5–10. Do not readjust the output voltage level. The Test Set display should be as shown for each frequency.

2. If the Test Set does not have an expanded display, adjust the ac calibrator output voltage so that the Test Set display alternates between –7 and –8 dBm. This sets the reference point as near as possible to –8 dBm. Perform the tests indicated in Table 5–11 for "3 kHz Flat". The display should be within the limits shown for each frequency.

f. Repeat Step e for the 15 kHz FLAT filter control position.

Table 5-10. Noise Weighting Filter, 3 kHz Flat, 15 kHz Flat. (For Expanded Display)

3 kHz Flat			15 kHz Flat		
Frequency (Hz)	Test Set Input	Display Limits (dBm)	Frequency (Hz)	Test Set Input	Display Limits (dBm)
1000	REF*	–7.9/8.0 dBm REF	1000	REF*	– 7.9/ 8.0 dBm REF
60	REF –.0088 V	–6.4/6.5 to –9.9/10.0	60	REF –.0088 V	– 6.4/ 6.5 to – 9.9/10.0
250	REF	–6.9/7.0 to –8.9/9.0	250	REF	– 6.9/ 7.0 to – 8.9/ 9.0
2000	REF –.0088 V	–6.9/7.0 to –10.4/10.5	10,000	REF	– 7.2/ 7.3 to –10.2/10.3
2500	REF	–7.4/7.5 to –11.4/11.5	15,000	REF	– 7.9/ 8.0 to –13.9/14.0
3000	REF	–7.9/8.0 to –13.9/14.0	20,000	REF	–11.1/11.2 to –17.1/17.2
6000	REF	⩾9 dB below 3 kHz reading	30,000	REF	–17.2/17.3 to –23.2/23.3
60,000	REF	⩾52 dB below 3 kHz reading	60,000	REF	⩾12 dB below 30 kHz reading

*REF voltage determined in Paragraph 5-18, Step e (1).

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

3 kHz Flat			15 kHz Flat		
Frequency (Hz)	Test Set Input	Display Limits (dBm)	Frequency (Hz)	Test Set Input	Display Limits (dBm)
1000	REF*	−7/8 dBm REF	1000	REF*	−7/8 dBm REF
60	REF	−5/6 to − 9/10	60	REF	− 5/ 6 to − 9/10
250	REF	−6/7 to − 8/9	250	REF	− 6/ 7 to − 8/9
2000	REF −.0173 V	−6/7 to −10/11	10,000	REF + .0108 V	− 6/ 7 to − 9/10
2500	REF −.0173 V	−7/8 to −11/12	15,000	REF	− 7/ 8 to −13/14
3000	REF	−7/8 to −13/14	20,000	REF + .0072 V	−10/11 to −16/17
30,000	REF	⩾40 dB below 3 kHz	30,000	REF + .0108 V	−16/17 to −22/23
60,000	REF	⩾52 dB below 3 kHz	60,000	REF + .0108 V	⩾12 dB below 30 kHz

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

5-19. Programme Noise Weighting Filter Response. (Serial No. 1604A00201 and higher) (Serial No. 1512U00221 and higher)

5-20. This performance test determines if the Test Set meets the specifications listed in Table 1−1 for the Programme Noise Weighting Filter. The specifications conform to the standards adopted by the Consultive Committee on International Telephone and Telegraph (CCITT) Recommendation P53. This performance test uses a 745A AC Calibrator to provide the signal and the Test Set display is used to monitor the filter accuracies.

a. Connect the ac calibrator output to the Test Set left (black) input/output terminals.

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

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

c. Adjust the ac calibrator frequency to 6.3 kHz, and set the output level to 94.48 mV. If the Test Set display is not −5.9/6.0 dBm adjust the ac calibrator output voltage to obtain this reading.

d. Adjust the ac calibrator to the frequencies shown in Table 5−12. Do not readjust the voltage. The Test Set display should be as shown for each frequency.

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

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

5-21. Programme Noise Weighting Filter Response. (Serial No. 1125A00200 and lower) (Serial No. 1512U00220 and lower)

5-22. This performance test determines if the Test Set meets the Programme Noise Weighting Filter specifications for instruments Serial No. 1125A00200 and lower. These specifications are shown in Section VIII, Backdating. This performance test uses a 745A AC Calibrator to provide the signal and the Test Set display is used to monitor the filter accuracies.

a. Connect the ac calibrator to the Test Set left (black) input/output terminals.

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

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

c. Adjust the ac calibrator frequency to 1 kHz and the output voltage to .1377 V.

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

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

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

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

WARNING

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

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

5-23. Receiver Noise Accuracy.

5-24. 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 (−70 dBm to −5 dBm).
± 2 dB (−90 dBm to −70 dBm).

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

Frequency (Hz)	Test Set Input	Test Set Display Indication and Tolerances (dBm)
1000	REF*	−14/15 dBm REF
60	REF −.0047 V	−45/46 to −48/49
100	REF −.0062 V	−39/40 to −42/43
200	REF −.0031 V	−30/31 to −33/34
400	REF +.0048 V	−21/22 to −24/25
800	REF +.0065 V	−14/15 to −17/18
2000	REF +.0032 V	− 7/ 8 to −10/11
4000	REF +.0048 V	− 4/ 5 to − 7/ 8
5000	REF +.0016 V	− 4/ 5 to − 7/ 8
6000	REF +.0048 V	− 4/ 5 to − 7/ 8
7000	REF +.0032 V	− 5/ 6 to − 8/ 9
8000	REF +.0065 V	− 7/ 8 to −10/11
9000	REF +.0048 V	−11/12 to −17/18
10,000	REF −.0047 V	−21/22 to −27/28
20,000	REF −.0047 V	⩾12 dB below 10 kHz reading
40,000	REF −.0047 V	⩾24 dB below 10 kHz reading
60,000	REF −.0047 V	⩾31 dB below 10 kHz reading

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

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

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

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

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 . . . . . .MAINS

c. Adjust the ac calibrator output to 1 kHz and .6920 V (Test Set input of .3460 V). The Test Set display should be between −5/6 dBm (flashing) and −7/8 dBm. This is the first test in Table 5−15.

d. Proceed with the remaining tests in Table 5−15 at the input levels listed. The display should be as shown in each case.

Table 5-15. Receiver Noise Level Test.

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

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

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

g. Adjust the ac calibrator frequency to 316 Hz.

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

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

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

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

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

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

n. Repeat Step n for a frequency of 932 Hz.

5-25. Transmitter Harmonic Distortion.

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

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

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

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

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

c. Adjust the Test Set SEND LEVEL vernier for +10.0 dBm.

d. Press SEND FREQ and adjust the Test Set SEND FREQUENCY vernier for a Test Set display indication of 40 Hz.

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

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

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

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

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

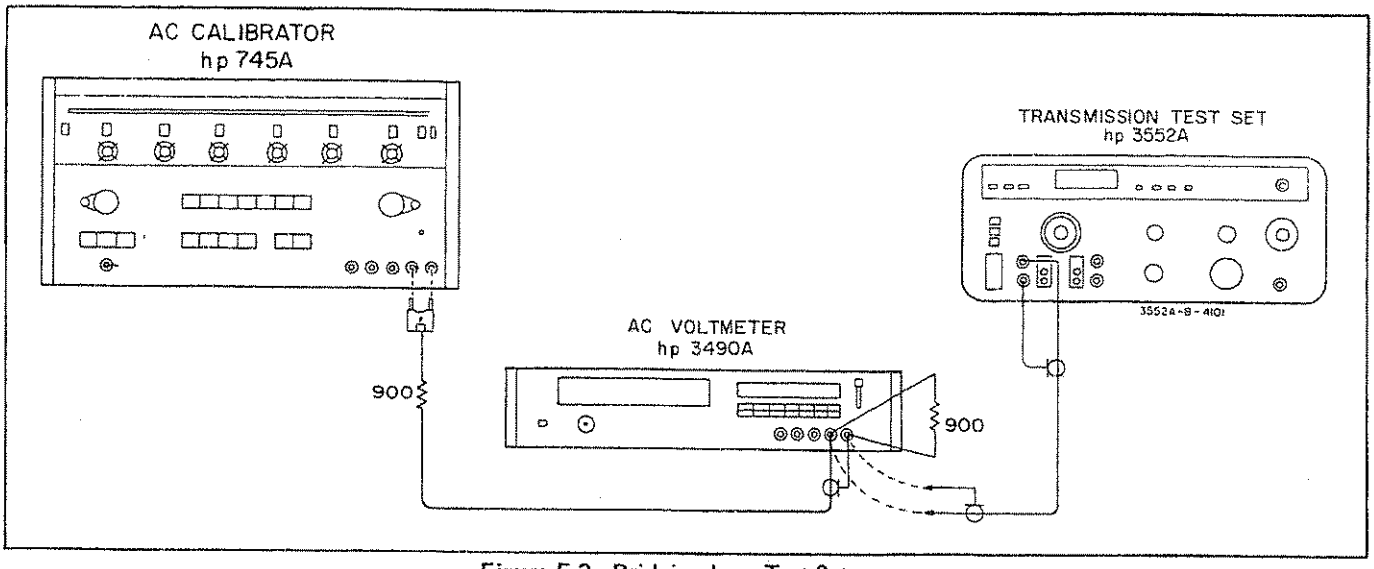


Figure 5-3. Bridging Loss Test Setup.

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

100 Hz
500 Hz
1 kHz
2 kHz
4 kHz

5-28. Bridging Loss.

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

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

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

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

c. Adjust the ac calibrator output for 100 Hz and an ac voltmeter indication of 1.000 V ac.

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

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

f. Repeat the procedure at 60 kHz. The voltmeter indication should not vary more than 20 mV ac.

5-30. Return Loss.

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

Receiver:

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

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

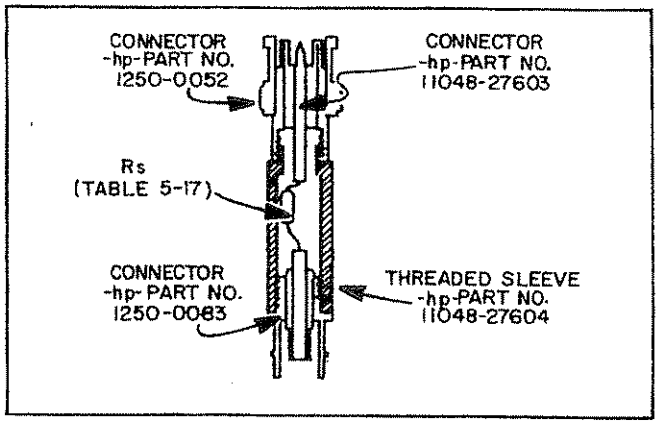


Figure 5-4. Return Loss Test Adapter.

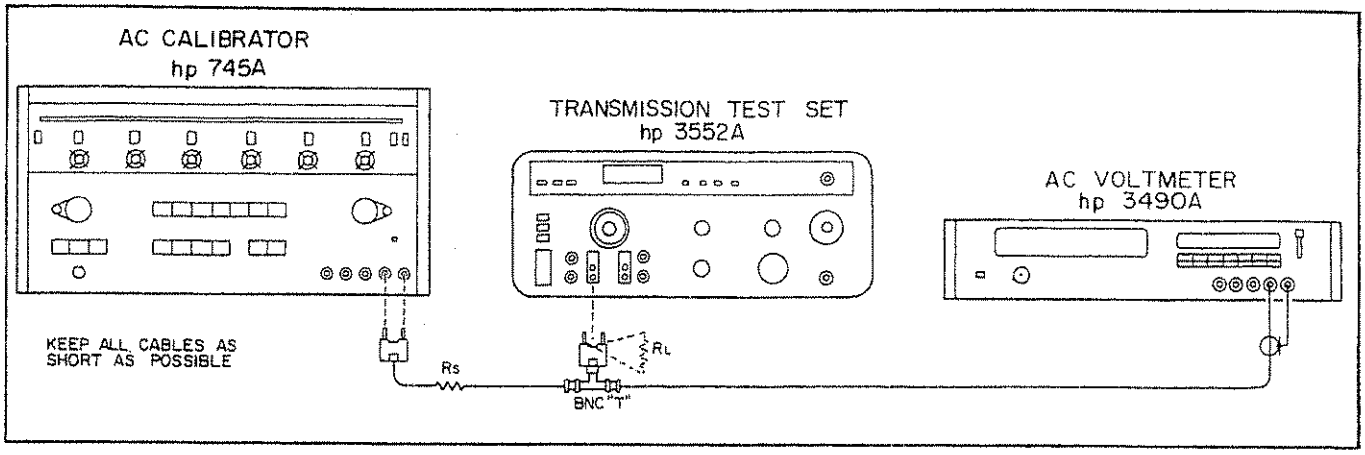


Figure 5-5. Return Loss Test Setup.

When R_1 is the source resistance, V_1 is its open circuit voltage, R_2 is the load resistance, and V_2 is the voltage across the load.

b. Connect the equipment as shown in Figure 5–5. Do not connect the 3552A or R_L at this time. Make R_S = 150 ohms (see Table 5–17). Set the ac voltmeter to the 1 V range.

c. Set the ac calibrator output to 1 V at 20 kHz. Record the ac voltmeter reading. This is V_1.

d. Connect a 150 ohm resistor (Table 5–17) to the dual banana plug (R_L in Figure 5-5). Record the ac voltmeter reading. This is V_2.

e. Calculate the return loss of the test equipment, using the formula in Step a. Return loss must be greater than 40 dB in order to be accurate enough to test the 3552A. If it is not, check R_S, the ac calibrator, and the interconnecting wiring.

NOTE

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

f. Set the 3552A controls as follows:

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

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

h. Disconnect the 3552A and measure the open circuit voltage at both frequencies recorded in Step g.

i. Calculate the return loss for both cases where V_1 is the voltage from Step h and V_2 is the voltage from Step g. The Return Loss must be greater than 30 dB.

j. Change R_S to 600 ohms and the 3552A IMP to 600 ohms. Repeat Steps c through i, using a 600 ohm resistor for R_L and sweeping from 40 Hz to 20 kHz. The return loss must be greater than 30 dB.

k. Change R_S to 900 ohms and the 3552A IMP to 900 ohms. Repeat Steps c through i, using a 900 ohm resistor for R_L and sweeping from 40 Hz to 20 kHz. The return loss must be greater than 30 dB.

NOTE

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

Table 5-17. Return Loss Test Resistors.

3552A Impedance	R_S/R_L –hp– Part No.
150	150 Ω ± 0.1% 0698–6774
600	600 Ω ± 0.1% 0698–7408
900	900 Ω ± 0.1% 0698–5453

Transmitter:

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

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

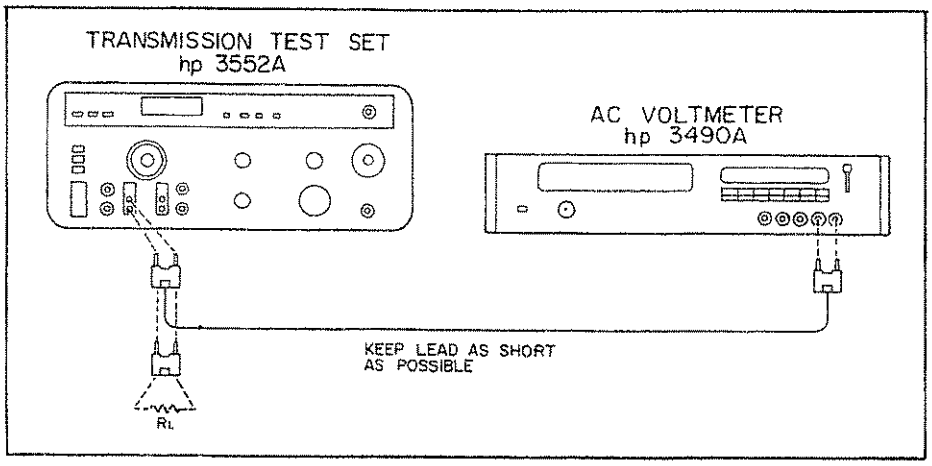


Figure 5-6. Transmitter Return Loss Test.

Where V_1 is the open circuit voltage at the Test Set output and V_2 is the output voltage with R_L connected (See Figure 5-6).

m. Connect the equipment as shown in Figure 5-6. Connect a 150 Ω ± 0.1%. Resistor (R_L) across the Test Set left–hand (black) terminals.

n. Set the Test Set controls as follows:

HOLD . . . . . OFF
FUNCTION (Black Input/
Output Terminals) . . . . . SEND
IMP 150
SEND FREQUENCY . . . . . 40 – 1 K
(or 40 – 600)
SEND LEVEL . . . . . –10 to 0
POWER . . . . . ~ AC

o. Press DISPLAY & MONITOR SEND FREQ and adjust the FREQUENCY VERNIER for a display of 0.500 kHz.

p. Press DISPLAY & MONITOR SEND LEVEL and adjust the SEND LEVEL VERNIER for a display of –10.0 dBm.

q. Return the display to SEND FREQ. Sweep the Test Set output frequency from 500 Hz to 20 kHz, and record the highest and lowest voltages measured on the ac voltmeter, along with the frequencies at which these voltages were measured. (This is V_2 in the equation.)

r. Disconnect R_L and measure the open circuit voltage at both frequencies recorded in Step f. (This is V_1 in the equation.)

s. Calculate the return loss for both cases, using the equation in Step l. V_2 is the voltage measured in Step q, and V_1 is the voltage measured in Step r. The return loss must be greater than 30 dB.

t. Change R_L to 600 ohms and the Test Set IMP to 600. Repeat Steps p through s, sweeping the frequency from 40 Hz to 20 kHz. The return loss must be greater than 30 dB.

u. Change R_L to 900 ohms and the Test Set IMP to 900. Repeat Steps p through s, sweeping the frequency from 40 Hz to 20 kHz. The return loss must be greater than 30 dB.

5-32. Longitudinal Balance.

5-33. This performance test determines if the Test Set meets the Longitudinal Balance specification listed in Table 1–1. The specification is greater than 60 dB below reference at 6 kHz for the receive mode and greater than 50 dB below the reference at 6 kHz for the send mode. Both the receiver balance and the transmitter balance are checked.

5-34. The procedure for the receiver balance uses a 745A ac calibrator to supply an unbalanced signal to the Test Set balanced input. This supplies the Test Set with a maximum unbalance for a reference. The same signal is then applied equally between the Test Set input terminals and referenced to the Test Set ground. The difference between these signals as read on the Test Set display is the receiver balance.

5-35. The transmitter balance is tested in the same way except the Test Set serves as the oscillator and an external ac voltmeter serves as the monitor.

Receiver:

a. Connect the equipment as shown in Figure 5-7(a).

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

HOLD . . . . . OFF
FUNCTION (Black Input/
Output Terminals) . . . . . REC BRDG
IMP 600
RECEIVE
NOISE/TONE . . . . . TONE NORMAL
(or 40 – 60 K)
DISPLAY & MONITOR . . . RECEIVE LEVEL
POWER . . . . . MAINS

c. Adjust the ac calibrator output for 6 kHz and a Test Set display indication of –6.0dBm (approximately 1.549V).

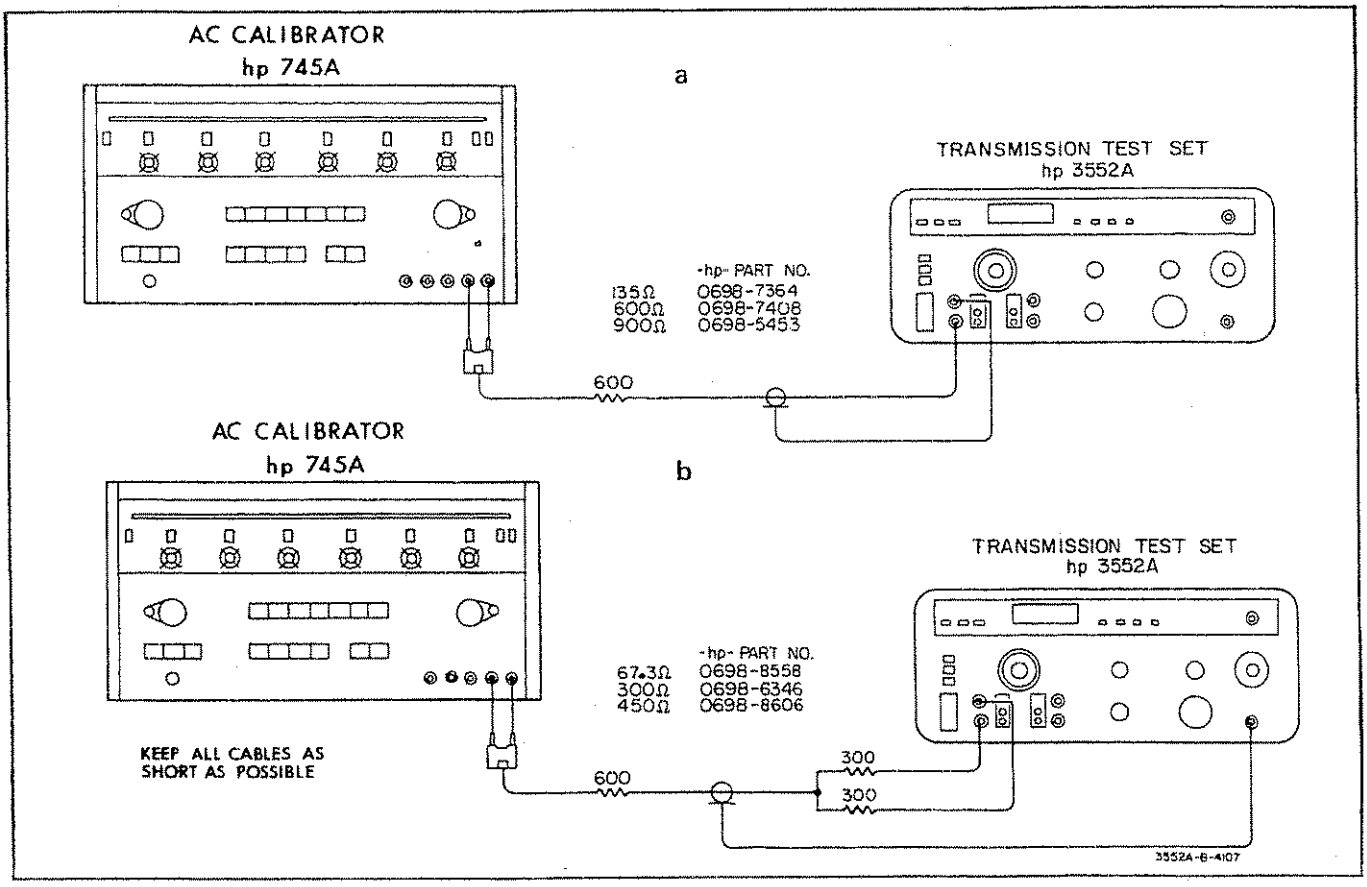


Figure 5-7 (a,b). Receiver Balance Test Setup.

d. Connect the test equipment as shown in Figure 5–7(b).

e. The Test Set display indication should be greater than 60 dB below the –6.0 dBm reference of Step c.

f. Repeat Steps c through e with IMP set to 150. Substitute a 150 ohm resistor for the 600 ohm resistor in Figure 5–7, and two 75 ohm resistors for the 300 ohm resistors. (AC calibrator output approximately .7746 V.)

g. Repeat Steps c through e with IMP set to 900. Substitute a 900 ohm resistor for the 600 ohm resistor in Figure 5–7, and two 450 ohm resistors for the 300 ohm resistors. (AC calibrator output approximately 1.897 V.)

Transmitter:

h. Connect the ac voltmeter to the Test Set blue input/output terminals. Connect a 150 ohm resistor across the Test Set terminals.

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

HOLD . . . . . OFF
FUNCTION (Blue Input/
Output Terminals) . . . . . SEND
IMP 150
SEND FREQUENCY RANGE Hz. . 2 K – 60 K
SEND LEVEL RANGE dBm . . . . . 0 to +10
DISPLAY & MONITOR . . . . . SEND FREQ
POWER . . . . . MAINS

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

k. Adjust the Test Set SEND LEVEL for a 1.00 V ac indication on the ac voltmeter (≈ +8.7 dBm).

l. Connect the equipment as shown in Figure 5–8. Use two 75 ohm resistors for R1 and R2.

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

n. Repeat Steps h through m for the 600 and 900 positions of the Test Set IMP control. For the 600 position, use a 600 ohm resistor in Step h and two 300 ohm resistors in Figure 5–8 for R1 and R2, and SEND LEVEL of 1 V (≈ +2.2 dBm). For the 900 position use a 900 ohm resistor in Step h and two 450 ohm resistors in Figure 5–8 for R1 and R2, and SEND LEVEL of 1 V (≈ +0.5 dBm).

5-36. Hold Current.

5-37. This test determines whether the hold circuit is operating correctly. Hold current absolute value and tolerances are not part of the 3552A specifications.

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

HOLD . . . . . OFF
FUNCTION (Left Terminals). . . . .REC TERM
IMP 900

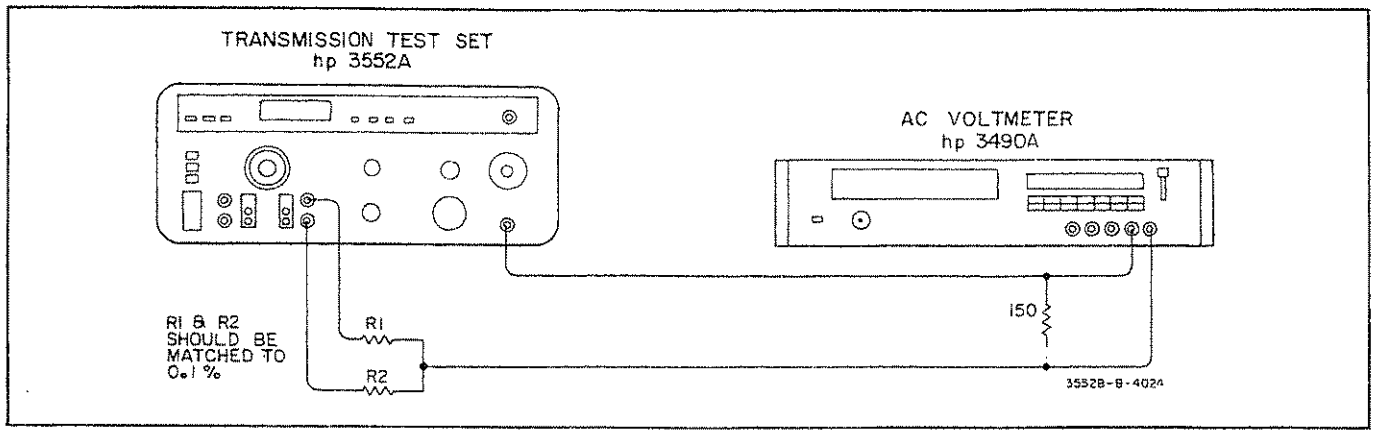


Figure 5-8. Transmitter Balance Test Setup.

DISPLAY & MONITOR . . . RECEIVE LEVEL
RECEIVE NOISE/TONE . . . . . .NORMAL
(40 – 60 kHz)
SEND FREQUENCY RANGE . . . . .200 – 6 K
SEND LEVEL RANGE . . . . . –10 to 0 dBm
POWER. . . . . .MAINS

b. Connect the left (receive) terminals to the right (send) terminals, and connect a dc voltmeter to the left terminals as indicated in Figure 5–9.

c. Connect a dc power supply capable of supplying 30 mA at 60 V to the Test Set left terminals through a 100 ohm series resistor.

d. Adjust the dc power supply until the dc voltmeter indicates 53 V dc. Note the indication on the Test Set display.

NOTE

The DISPLAY & MONITOR RECEIVE LEVEL must be selected for this test. The display will not be the same if SEND LEVEL is selected, because the 100 ohm resistor and power supply are in parallel with the Test Set internal 900 ohm termination.

e. Press the Test Set HOLD ON pushbutton. The Test Set display should not change more than ± 0.1 dBm. (A switching transient may be observed. This is normal.) If the reading changes more than 0.1 dBm, the hold circuit is defective.

f. Decrease the dc power supply voltage and verify that when HOLD is turned on and off the display reads the same (± 0.1 dBm, excluding switching transients) for any voltage greater than 6 V.

g. Set HOLD to OFF and adjust the dc power supply for a dc voltmeter reading of 12 V.

h. Set HOLD to ON and note the dc voltmeter reading, V_1. The hold current = $\frac{12 - V_1}{100}$. (V_1 is in volts.) This current should be approximately 20 mA. In some instruments below Serial No. 1125A00170 the hold current may be about 27 mA (see Appendix B).

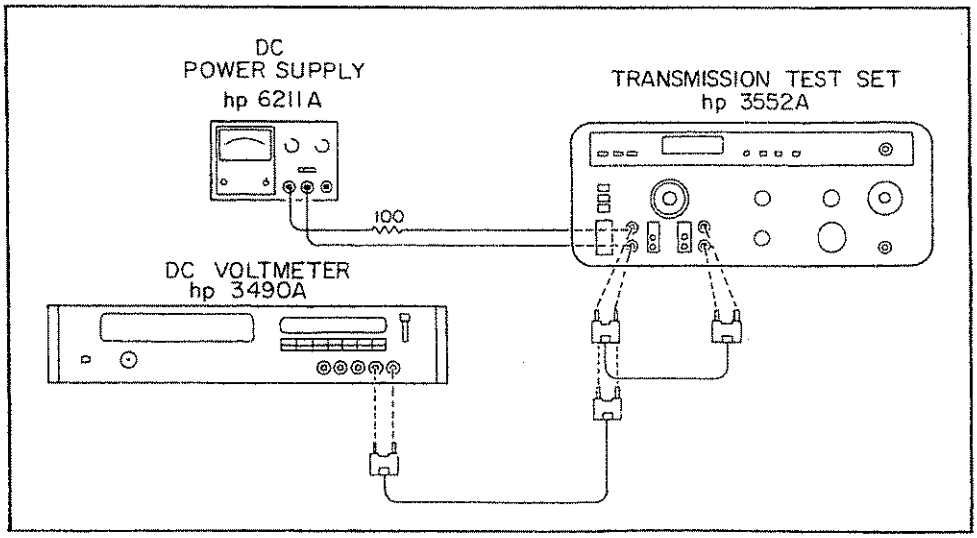


Figure 5-9. Hold Circuit Test.

ADJUSTMENT PROCEDURES

5-38. ADJUSTMENT PROCEDURES.

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

NOTE

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

5-40. To remove the Test Set from the case refer to Paragraph 5-62. Figure 5-16 shows the adjustment locations for A1, A3 and A4.

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

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 current revision boards, they will be given in parentheses.

5-42. Receive Level Adjustment.

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

a. Connect an ac calibrator (745A) to the Test Set black input/output terminals. Refer to Figure 5-10 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
(40 – 60 K)
DISPLAY & MONITOR . . . RECEIVE LEVEL
POWER . . . . . .MAINS

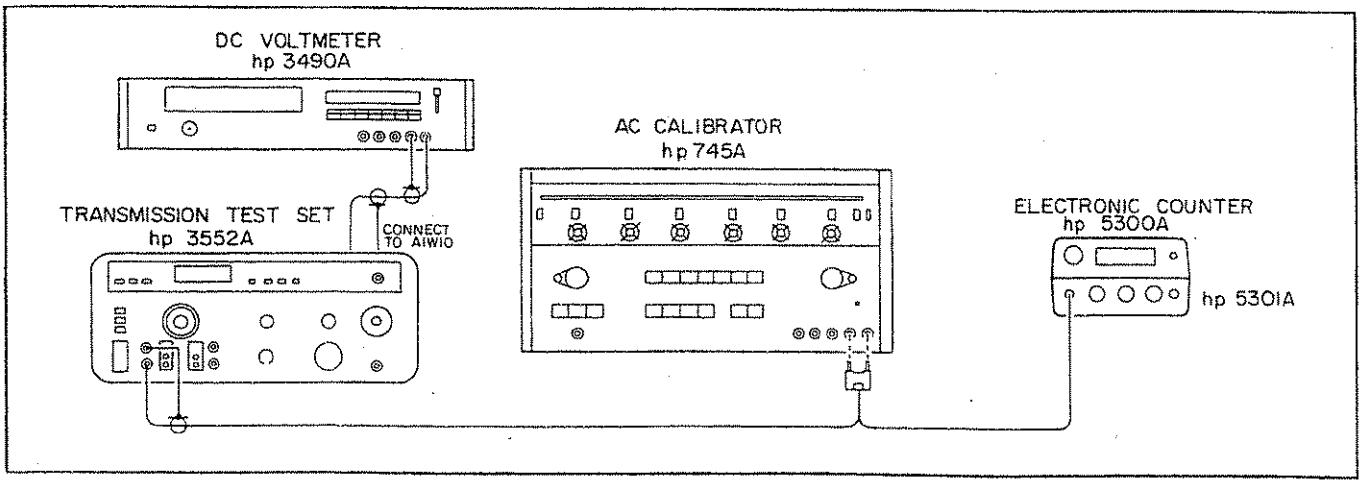


Figure 5-10. Receive Level and Noise Weighting Filters Adjustment.

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

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

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

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

g. Set the ac calibrator to 1.2274 V.

h. Adjust A1R801 on the Test Set for a display flashing between + .401 and + .399 dBm (4.01/3.99 or 40/39).

NOTE

If + .399 to + .401 dBm cannot be reached, adjust A3R505 for a reading of + .410 dBm (4.10 or 4.1).

i. Set the ac calibrator to .3083 V.

j. Adjust A1R524 on the Test Set for a display of −.800 ± .002 dBm (−8.00 ± 0.02 or 8.0/7.9).

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

l. Set the ac calibrator to .7533 V.

m. Switch the 3552A IMP selector to 900 ohm.

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

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 ac calibrator to .3076 V.

p. Switch the 3552A front panel IMP selector to 150 ohm.

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

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 ac calibrator to 60 kHz.

s. Remove A1TP8 short and observe the Test Set display for a reading of −.201 ± .02 dBm (2.0).

NOTE

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

t. Set the ac calibrator to 29.18 mV and observe the Test Set for a display of −2.201 ± .02 dBm (22.01 or 2.20).

NOTE

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

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

v. Set the ac calibrator to 2.918 V and observe the Test Set for a display of −4.201 ± .1 dBm (42.0).

NOTE

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

Table 5-18. 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 0F	0160−2198	68 pF	0140−0192
510 pF	0160−0362				
560 pF	0140−0178				
620 pF	0160−0363				

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

NOTE

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

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

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

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

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

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

d. Short A1TP8 to ground.

e. Adjust A4R430 (TEL) for a Test Set display of −1.600 ± .005 (or −16.00 ± .05).

f. Remove short from A1TP8.

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

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

i. Short A1TP8 to ground.

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

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

l. Adjust A4R410 (3/15) for a Test Set display of −1.600 ± .05 (or −16.00 ± .5).

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

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

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

p. Adjust A4R402 (PR) for a Test Set display of −2.200 ± .005 (or −22.00 ± .05).

q. Change the synthesizer frequency to 6.3 kHz and adjust A4R445 (P6.3) for a Test Set display of 0.980 ± .005.

r. Remove short from A1TP8.

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

NOTE

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

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

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

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

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

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

d. Short A1TP8 to ground.

e. Adjust A4R430 (TEL ADJ) for a Test Set display of −1.600 ± .005 (or −16.00 ± .05).

f. Remove short from A1TP8.

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

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

i. Short A1TP8 to ground.

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

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

l. Adjust A4R410 (3 and 15 kHz ADJ) for a Test Set display of −1.600 ± .05 (or −16.00 ± .5).

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

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

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

p. Adjust A4R402 (PROG ADJ) for a Test Set display of −1.600 ± .005 (or −16.00 ± .05).

q. Remove short from A1TP8.

5-48. Notch Filter Calibration.

NOTE

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

5-49. This adjustment procedure sets the corner frequencies and the center of the Notch filters. An ac calibrator is used to supply precise frequencies and amplitudes to the test set input.

a. Connect the ac calibrator to the 3552A Test Set as shown in Figure 5−10. Monitor the frequency with an electronic counter.

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

HOLD . . . . . OFF
NOISE WEIGHTING . . . . . .15 kHz Flat
FUNCTION (Black Input/
Output Terminals) . . . . . .REC TERM
IMP 600
RECEIVE
NOISE/TONE . . . . . .NOISE WITH TONE
DISPLAY & MONITOR . . . RECEIVE LEVEL
POWER. . . . . .MAINS

c. Adjust the ac calibrator frequency for 200 Hz at an amplitude of .1228 V.

d. Short A1TP8 to ground, then power OFF, power ON the 3552A Test Set.

e. Center pots (1 turn pots) A3R306, A3R321, A3R336, and A3R351. Refer to A3 adjustment locations shown in Figure 5−16.

f. Adjust A3R315 for a Test Set display −1.590 to −1.601 (flashing between −15/−16).

g. Adjust the ac calibrator frequency to 804 Hz.

h. Connect an ac voltmeter to A3TP13.

i. Set A3R306, A3R321 fully CW.

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

k. Disconnect the ac voltmeter 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 ac calibrator frequency to 936 Hz.

n. Adjust A3R351 fully CCW, and adjust A3R306 for a display of −1.590 to −1.601 (flashing between) −15/−16).

o. Adjust the ac calibrator frequency to 682 Hz.

p. Verify display of −1.725 ± .125 (−16 to −18).

q. Remove the short at A1TP8.

5-50. Receiver Balance Adjustment.

5-51. The adjustment procedure sets the Test Set input balance. The ac calibrator is used to supply the Test Set with a signal appliedequally between the Test Set terminals and referenced to the Test Set ground. The Test Set is then

5-51. The adjustment procedure sets the Test Set input balance. The ac calibrator 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 5−7(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
(40 − 60 K)
DISPLAY & MONITOR . . . RECEIVE LEVEL
POWER. . . . . .MAINS

c. Adjust the ac calibrator output frequency to 800 Hz at an amplitude of 6.153 V.

d. Adjust A3C102 (Balance) 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 5-19 for padding values):*

1. *If A3C102 is a 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.*

5-52. Transmitter Impedance Adjustment.

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

Table 5-19. Capacitor Padding Lists.

A3C103		A3C104, A3C107	
Value	Part No.	Value	Part No.
220 pF	0160–2198	120 pF	0160–2205
39 pF	0140–0190	200 pF	0140–0198
56 pF	0140–0191		
68 pF	0160–0376		
82 pF	0140–0193		
100 pF	0160–2204		
A3C108		**A3C323, A3C327**	
Value	Part No.	Value	Part No.
33 pF	0160–2150	200 pF	0140–0198
43 pF	0160–2200	240 pF	0140–0199
		270 pF	0140–0206
		300 pF	0160–2207
		330 pF	0160–0207
		360 pF	0160–2209
		390 pF	0140–0200
		430 pF	0160–0939
		470 pF	0140–0149
		510 pF	0160–0362

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

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

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

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

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

e. Adjust A3R121 (150 Output IMP) for an ac volt meter indication of 1.000 V ac ± 0.005 V ac.

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

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

5-54. High Frequency Symmetry Adjustment.

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

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

HOLD . . . . . OFF
SEND FREQUENCY RANGE . . . 200 –6 kHz
SEND FREQUENCY vernier . . . . . MAX CW

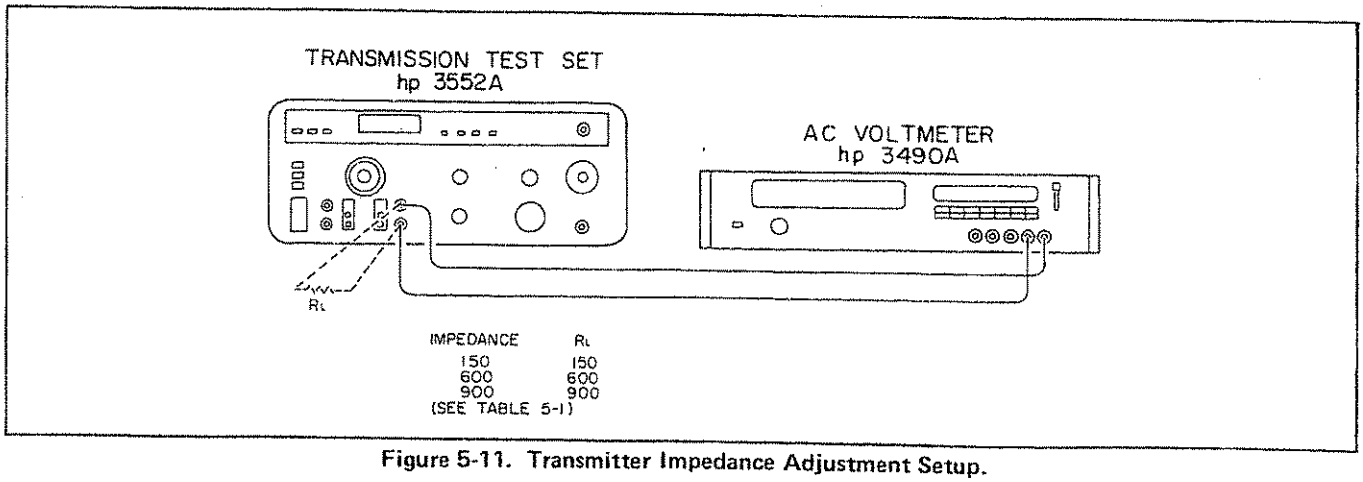


Figure 5-11. Transmitter Impedance Adjustment Setup.

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

NOTE

On earlier instruments that do not have A3TP8, connect the DCVM to the collector of A3Q211 or the end of A3R223 nearest the front of the instrument.

c. Switch the frequency range control to 2 kHz to 60 kHz.

d. Adjust A3C211 for the reading in Step b, ± 30 mV.

5-56. Harmonic Distortion and Hold Tone Calibration.

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

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

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

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

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

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

NOTE

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

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

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

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

NOTE

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

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

Table 5-20. Resistor Padding List.

A3R244		A3R256, A3R284	
Value	Part No.	Value	Part No.
2000 ohm	0757–0283	29.4 K	0698–4490
2320 ohm	0698–4434	30.9 K	0698–4491
2490 ohm	0698–4435	32.4 K	0698–4492
2670 ohm	0698–3492	34.0 K	0698–4493
2870 ohm	0698–3151	35.7 K	0698–4494
3160 ohm	0757–0279	37.4 K	0698–4495
3320 ohm	0757–0433	39.2 K	0757–0124
3480 ohm	0698–3152	41.2 K	0698–3582
		42.2 K	0698–3450
		43.2 K	0757–0456

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

NOTE

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

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

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

5-58. Transmitter Balance Adjust.

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

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

NOTE

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

5-60. Transmitter Level Display Adjustment.

NOTE

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

5-61. This adjustment procedure sets the level of the Test Set send oscillator to the Test Set display. The ac voltmeter is used to monitor the send oscillator output level and the signal to the Test Set display is adjusted for a display indication equal to the ac voltmeter indication.

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. . . . . .MAINS

c. Connect the Test Set chassis to the "b" 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 ± .001 dBm (non–expandable display flashing ± 0.0).

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

h. Adjust the Test Set front panel SEND LEVEL vernier for an ac voltmeter indication of 0.3873 V ac ± 0.001 V ac.

i. Adjust A3R397 (Send Level) for a Test Set display indication of .000 dBm ± .001 dBm (non–expandable display flashing ± 0.0).

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

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 (± 0.0 on non–expandable display). If not, adjust A3R377 until the reading is just within the specifications. Recheck the 600 ohm display level for .000 ± .005 dBm (± 0.0).

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 .7746 V ac ± 0.001 V. The Test Set display should be .000 dBm ± .02 dBm (between –0.2/0.1 and +0.1/0.2 on non–expandable display). If not, pad A3C323 or A3C327 until the display is within specifications. Refer to Table 5–19 for capacitor padding values.

NOTE

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

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

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

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

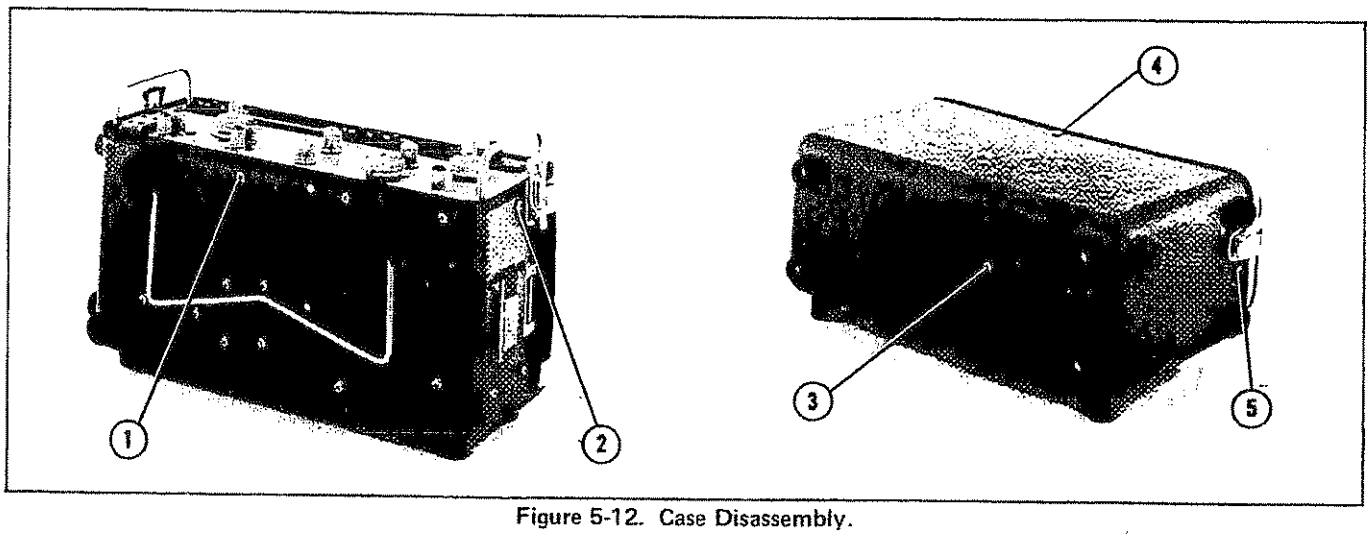


Figure 5-12. Case Disassembly.

5-62. DISASSEMBLY INFORMATION.

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

WARNING

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

5-64. Test Set Case Removal.

a. To remove the case for access to the internal parts, remove the five phillips head screws shown in Figure 5-12.

b. Slide the front panel out from the case, disconnect the internal power cable and monitor plug cable. The power cable must be disconnected at the power supply assembly, which remains in the case (see Figure 5–15).

WARNING

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

5-65. Printed Circuit Card Removal.

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

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 5–13. Then remove the board assembly so as not to damage the POWER and DISPLAY & MONITOR switches.

b. Turn the unit over to obtain access to the component side of the A3 board and remove the five phillips head screws shown in Figure 5–14. The shield should now be loose and can be easily removed.

NOTE

No further disassembly of the Test Set is recommended.

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

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

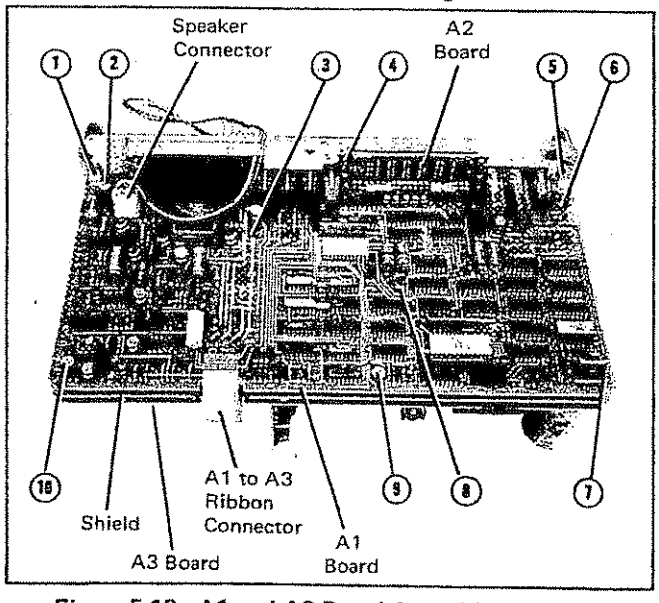


Figure 5-13. A1 and A2 Board Assembly Removal.

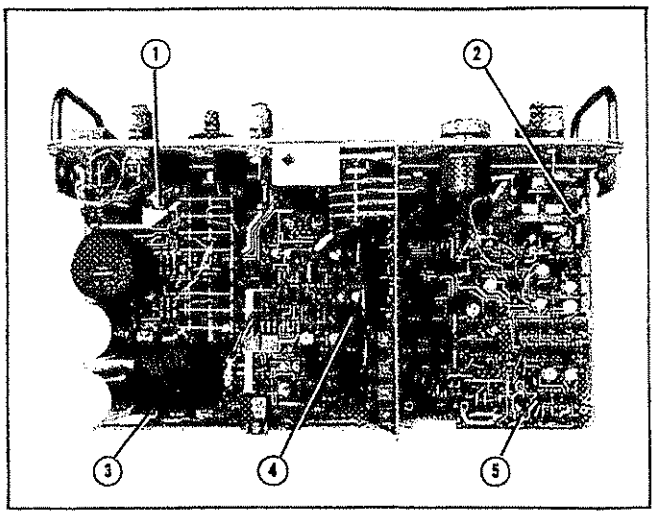


Figure 5-14. Shield Removal.

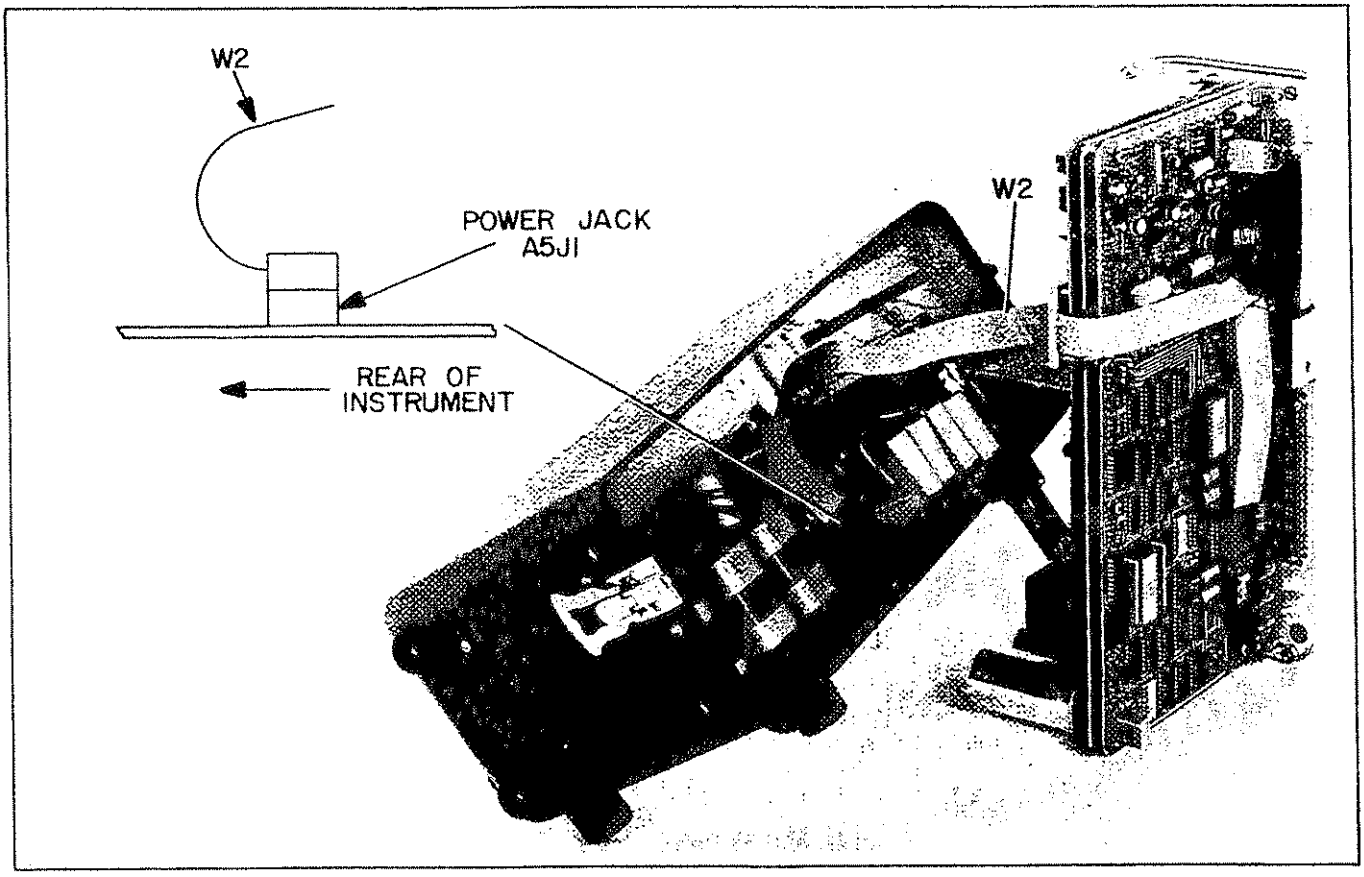
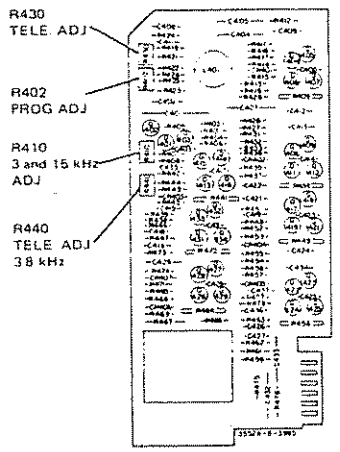
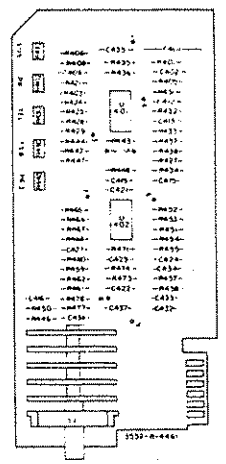


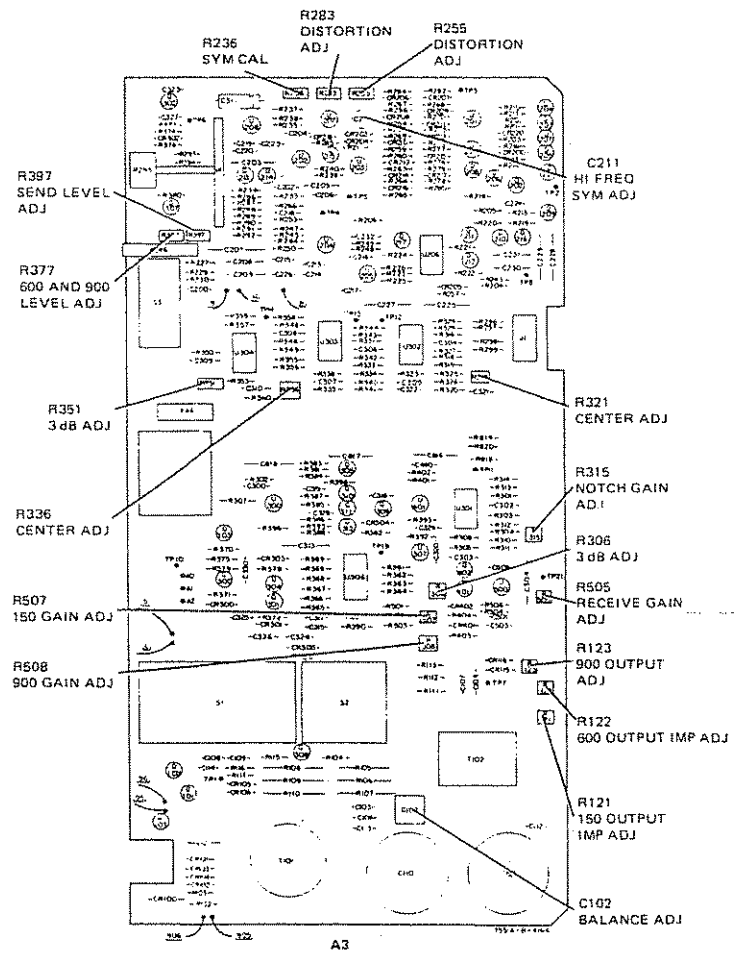
Figure 5-15. Power Cable Installation.



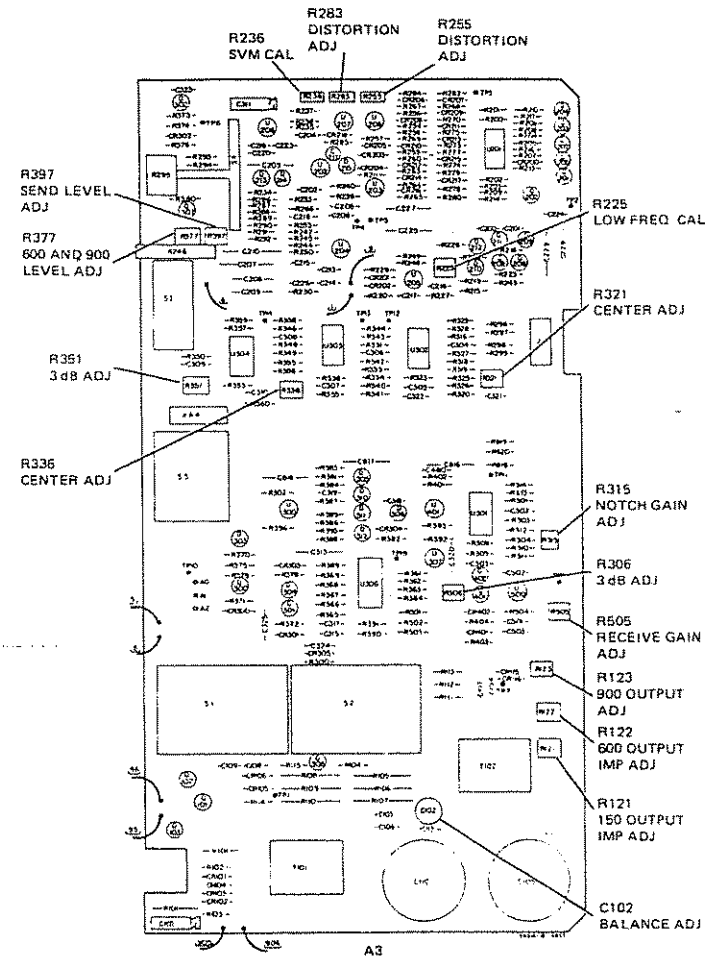
A4
-hp- Part No. 03552-66504
Rev B.
Serial No. 1125A00200 and lower



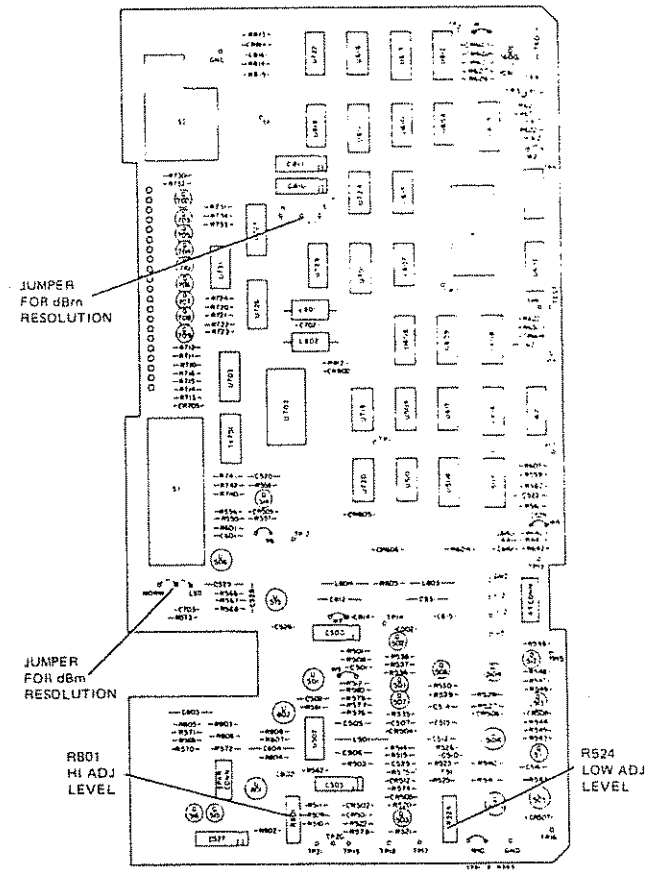
A4
—hp— Part No. 03552—66514
Rev. A
Serial No. 1604A00201 and higher



A3
- hp— Part No. 03552—66513
Serial No. 1125A00141 and higher



A3
—hp— Part No. 03552—66503
Serial No. 1435A00140 and lower



A1
—hp— Part No. 03551—66501

Figure 5-16. Location of Adjustments.

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-3 lists parts in alphameric order of their reference designators and indicates the description, -hp- Part Number of each part, together with any applicable notes, and provides the following:

a. Total quantity used in the instrument (Qty column). The total quantity of a part is given the first time the part number appears.

b. Description of the part. (See list of abbreviations below.)

c. Typical manufacturer of the part in a five-digit code. (See Table 6-2 for list of manufacturers.)

d. Manufacturers part number.

6-3. Miscellaneous parts are listed at the end of Table 6-3.

6-4. ORDERING INFORMATION.

6-5. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Field Office. (See Appendix A for list of office locations.) Identify parts by their Hewlett-Packard part numbers. Include instrument model and serial numbers.

6-6. NON-LISTED PARTS.

6-7. To obtain a part that is not listed, include:

a. Instrument model number.
b. Instrument serial number.
c. Description of the part.
d. Function and location of the part.

6-8. PARTS CHANGES.

6-9. Components which have been changed are so marked by one of three symbols; ie., Δ, Δ with a letter subscript, eg., Δ_a, or Δ with a number subscript eg., Δ_{10}. A Δ with no subscript indicates the component listed is the preferred replacement for an earlier component. A Δ with a letter subscript indicates a change which is explained in a note at the bottom of the page. A Δ with a number subscript indicates the related change is discussed in backdating (Section VIII). The number of the subscript indicates the number of the change in backdating which should be referred to.

6-10. PROPRIETARY PARTS.

6-11. Items marked by a dagger (†) in the reference designator column are available only for repair and service of Hewlett-Packard instruments.

Table 6-1. Standard Abbreviations.

ABBREVIATIONS

Ag	silver	Hz	hertz (cycle(s) per second)	NPO	negative positive zero (zero temperature coefficient)	sl	slide
Al	aluminum					SPDT	single-pole double-throw
A	ampere(s)	ID	inside diameter	ns	nanosecond(s) = 10^{-9} seconds	SPST	single-pole single-throw
Au	gold	impg	impregnated	nsr	not separately replaceable		
		incd	incandescent			Ta	tantalum
C	capacitor	ins	insulation(ed)	Ω	ohm(s)	TC	temperature coefficient
cer	ceramic			obd	order by description	TiO_2	titanium dioxide
coef	coefficient	kΩ	kilohm(s) = 10^{+3} ohms	OD	outside diameter	tog	toggle
com	common	kHz	kilohertz = 10^{+3} hertz			tol	tolerance
comp	composition			p	peak	trim	trimmer
conn	connection	L	inductor	pA	picoampere(s)	TSTR	transistor
		lin	linear taper	pc	printed circuit		
dep	deposited	log	logarithmic taper	pF	picofarad(s) 10^{-12} farads	V	volt(s)
DPDT	double-pole double-throw			piv	peak inverse voltage	vacw	alternating current working voltage
DPST	double-pole single-throw	mA	milliampere(s) = 10^{-3} amperes	p/o	part of	var	variable
		MHz	megahertz = 10^{+6} hertz	pos	position(s)	vdcw	direct current working voltage
elect	electrolytic	MΩ	megohm(s) = 10^{+6} ohms	poly	polystyrene		
encap	encapsulated	met film	metal film	pot	potentiometer	W	watt(s)
		mfr	manufacturer	p-p	peak-to-peak	w/	with
F	farad(s)	ms	millisecond	ppm	parts per million	wiv	working inverse voltage
FET	field effect transistor	mtg	mounting	prec	precision (temperature coeffient, long term stability and/or tolerance)	w/o	without
fxd	fixed	mV	millivolt(s) = 10^{-3} volts			ww	wirewound
		μF	microfarad(s)				
GaAs	gallium arsenide	μs	microsecond(s)	R	resistor		
GHz	gigahertz = 10^{+9} hertz	μV	microvolt(s) = 10^{-6} volts	Rh	rhodium		
gd	guard(ed)	my	Mylar®	rms	root-mean-square	*	optimum value selected at factory, average value shown (part may be omitted)
Ge	germanium			rot	rotary	**	no standard type number assigned selected or special type
gnd	ground(ed)	nA	nanoampere(s) = 10^{-9} amperes				
		NC	normally closed	Se	selenium		
H	henry(ies)	Ne	neon	sect	section(s)		® Dupont de Nemours
Hg	mercury	NO	normally open	Si	silicon		

DESIGNATORS

A	assembly	FL	filter	Q	transistor	TS	terminal strip
B	motor	HR	heater	QCR	transistor-diode	U	microcircuit
BT	battery	IC	integrated circuit	R	resistor	V	vacuum tube, neon bulb, photocell, etc.
C	capacitor	J	jack	RT	thermistor	W	cable
CR	diode	K	relay	S	switch	X	socket
DL	delay line	L	inductor	T	transformer	XDS	lampholder
DS	lamp	M	meter	TB	terminal board	XF	fuseholder
E	misc electronic part	MP	mechanical part	TC	thermocouple	Y	crystal
F	fuse	P	plug	TP	test point	Z	network

Table 6-2. Code List of Manufacturers.

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

Table 6-3. Replaceable Parts

REFERENCE DESIGNATOR	-hp- PART NO.	DESCRIPTION	MFR.	MFR. PART NO.
A1	03551-66501	PC ASSY, LOGIC	28480	03551-66501
A1C500	0180-1800	CAPACITOR-FXD; 100UF+100-10% 6VDC AL	28480	0180-1800
A1C501	0160-0763	CAPACITOR-FXD; 5PF +-10% 500WVDC MICA 0+	28480	0160-0763
A1C502 Δ3	0180-1701	CAPACITOR-FXD; 6.8UF +-20% 6VDC	56289	1500685X0006A2
A1C503	0180-1800	CAPACITOR-FXD; 100UF +100 -10% 6VDC AL	28480	0180-1800
A1C505 Δ1	0160-0298	CAPACITOR-FXD; 1500PF +-10% 200WVDC	56289	292P15292
A1C506 Δ1	0160-0156	CAPACITOR-FXD; 3900PF +-10% 200WVDC	56289	292P39292
A1C507 Δ3	0160-0127	CAPACITOR-FXD; 1UF +-20% 25WVDC	28480	0160-0127
A1C508	0150-0093	CAPACITOR-FXD; .01UF +80 -20% 100WVDC CER	28480	0150-0093
A1C510	0160-3622	CAPACITOR-FXD; .1UF +80 -20% 100WVDC CER	28480	0160-3622
A1C511	0160-3622	CAPACITOR-FXD; .1UF +80 -20% 100WVDC CER	28480	0160-3622
A1C512	0160-0127	CAPACITOR-FXD; 1UF +-20% 25WVDC CER	28480	0160-0127
A1C513	0160-3501	CAPACITOR-FXD; 4UF +-10% 50WVDC	28480	0160-3501
A1C514	0160-0127	CAPACITOR-FXD; 1UF +-20% 25WVDC CER	28480	0160-0127
A1C515	0160-0128	CAPACITOR-FXD; 2.2UF +-20% 25WVDC CER	28480	0160-0128
A1C516	0160-3548	CAPACITOR-FXD; .01UF +-1% 100WVDC MICA	28480	0160-3548
A1C520	0180-0309	CAPACITOR-FXD; 4.7UF +-20% 10VDC TA	56289	150D475X0010A2
A1C521	0160-2214	CAPACITOR-FXD; 100PF +-5% 300WVDC MICA	28480	0160-2214
A1C522 Δ1	0180-1701	CAPACITOR-FXD; 6.8UF +-20% 6VDC	56289	1500685X0006A2
A1C525	0180-0376	CAPACITOR-FXD; .47UF +-10% 35VDC TA	56289	150D474X9035A2
A1C526	0160-2204	CAPACITOR-FXD; 100PF +-5% 300WVDC MICA	28480	0160-2204
A1C527	0180-0303	CAPACITOR-FXD; 100UF +75 -10% 3VDC AL	56289	30D107G003C82
A1C528 Δ3	0150-0014	CAPACITOR-FXD; 5000PF +100 -0% 500WVDC	28480	0150-0014
A1C529 Δ3	0160-0127	CAPACITOR-FXD; 1UF +-20% 25WVDC	28480	0160-0127
A1C601 Δ1	0160-0128	CAPACITOR-FXD; 2.2UF +-20% 25WVDC	28480	0160-0128
A1C610*	0160-2198	CAPACITOR-FXD; 20PF +-5% 300WVDC MICA 0+ *FACTORY SELECTED PART	28480	0160-2198
A1C611	0160-3622	CAPACITOR-FXD; .1UF +80 -20% 100WVDC CER	28480	0160-3622
A1C612*	0160-2198	CAPACITOR-FXD; 20PF +-5% 300WVDC MICA 0+ *FACTORY SELECTED PART	28480	0160-2198
A1C620	0180-0195	CAPACITOR-FXD; .33UF +-20% 35VDC TA	56289	150D334X0035A2
A1C640	0150-0093	CAPACITOR-FXD; .01UF +80 -20% 100WVDC CER	28480	0150-0093
A1C641	0150-0093	CAPACITOR-FXD; .01UF +80 -20% 100WVDC CER	28480	0150-0093
A1C642	0150-0093	CAPACITOR-FXD; .01UF +80 -20% 100WVDC CER	28480	0150-0093
A1C702, C703 Δ3	0160-2204	CAPACITOR-FXD; 100PF +-5% 300WVDC	28480	0160-2204
A1C704	0180-1702	CAPACITOR-FXD; 180UF +-20% 6VDC TA-SOLID	56289	150D187X0006R2
A1C801	0180-0374	CAPACITOR-FXD; 10UF +-10% 20VDC TA-SOLID	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	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	DIODE-SCHOTTKY	28480	1901-0518
A1CR502	1901-0518	DIODE-SCHOTTKY	28480	1901-0518
A1CR504 Δ3	1901-0040	DIODE-SWITCHING 30V 50NA 2NS	28480	1901-0040
A1CR505	1901-0040	DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A1CR506	1902-3062	DIODE-ZNR 3.92V 5% DO-7 PD= .4W TC=	04713	SZ 10939-65
A1CR507	1902-0041	DIODE-ZNR 5.11V 5% DO-7 PD= .4W TC=	04713	SZ 10939-65
A1CR508	1901-0040	DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A1CR509	1901-0040	DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A1CR512 Δ3	1901-0040	DIODE-SWITCHING 2NS 30V 50MA		
A1CR601	1901-0040	DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A1CR602	1901-0040	DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A1CR603	1901-0040	DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A1CR604	1901-0040	DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A1CR605, CR606 Δ3	1901-0040	DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A1CR705	1901-0518	DIODE-SCHOTTKY	28480	1901-0518
A1CR801	1902-3182	DIODE-ZNR 12.1V 5% DO-7 PD= .4W	04713	SZ 10939-206
A1CR802	1902-3149	DIODE-ZNR 9.09V 5% DO-7 PD= .4W	04713	SZ 10939-170

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

REFERENCE DESIGNATOR	-hp- PART NO.	DESCRIPTION	MFR.	MFR. PART NO.
A1J2	1200—0423	SOCKET—IC BLK 16 CONTACT	23880	CSA2900—16B
A1J3	1251—3305	CONNECTOR—4 - CONT, MALE, POST TYPE	27264	09—65—1041(2244—4A)
A1L501 Δ_1	9100—1665	COIL—FXD; 3.3MH 5%	24226	22/334
A1L704	9140—0083	COIL—FXD; MOLDED RF CHOKE; 400UH 10%	0004A	S—400J—I
A1L801	9140—0083	COIL—FXD; MOLDED RF CHOKE; 400UH 10%	0004A	S—400J—I
A1L802	9140—0083	COIL—FXD; MOLDED RF CHOKE; 400UH 10%	0004A	S—400J—I
A1L803	9140—0137	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	TRANSISTOR PNP SI CHIP PD= 300MW	28480	1853—0020
A1Q502	1854—0071	TRANSISTOR NPN SI PD= 300MW FT= 200MHZ	28480	1854—0071
A1Q503	1855—0378	TRANSISTOR J—FET N—CHAN, D—MODE SI	28480	1855—0378
A1Q504	1853—0066	TRANSISTOR PNP SI CHIP TO—92 PD= 200MW	28480	1853—0066
A1Q506	1855—0081	TRANSISTOR J—FET N—CHAN, D—MODE SI	01295	2N5245
A1Q507	1854-0071	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q508	1855-0308	TRANSISTOR; JFET;DUAL; N-CHAN D-MODE SI	28480	1855-0308
A1Q511	1855-0412	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	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 N—CHAN, D—MODE SI	28480	1855—0216
A1R501 Δ_3	0698—3274	RESISTOR 10K 1% .125W F TUBULAR	24546	NE55
A1R503 Δ_3	0757—0465	RESISTOR 100K 1% .125W	24546	C4—1/8—TO—1003—F
A1R508	0698—6630	RESISTOR 20K .1% .125W F TUBULAR	19701	MF4C1/8—T9—2002—B
A1R509	0698—7163	RESISTOR 2.0081K .1% .125W F TUBULAR	19701	MF4C1/8—T9—2008R1—B
A1R510 Δ_3	0757—0283	RESISTOR 2K 1% .125W F	24546	C4—1/8—TO—2001—F
A1R511	0698—6965	RESISTOR 505 OHM .1% .125W F TUBULAR	19701	MF4C1/8—T9—505R—B
A1R512 Δ_1	0698—4465	RESISTOR 931 1% .125W F	24546	C4—1/8—TO—931R—F
A1R513 Δ_1				
A1R514 Δ_3	0698—3152	RESISTOR 3.48K 1% .125W F	16299	C4—1/8—TO—3481—F
A1R515 Δ_3	0757—0472	RESISTOR 200K 1% .125W F	24546	C4—1/8—TO—2003—F
A1R520	0683—1055	RESISTOR 1M 5% .25W CC TUBULAR	01121	CB1055
A1R521 Δ_3	0757—0453	RESISTOR 30.1K 1% .125W F	24546	C4—1/8—TO—3012—F
A1R522 Δ_3	0698—7880	RESISTOR 28.7K 1% .125W F	19701	MF4C1/8—T9—2872—F
A1R523	0698-6630	RESISTOR 20K .1% .125W F TUBULAR	19701	MF4C1/8-T9-2002-B
A1R524	2100-3095	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 Δ_3	0698—7082	RESISTOR 100K 1% .125W F	24546	NE55
A1R525	0698-6630	RESISTOR 20K .1% .125W F TUBULAR	19701	MF4C1/8-T9-2002-B
A1R526	0698-6977	RESISTOR 30K .1% .125W F TUBULAR	19701	MF4C1/8-T9-4172-B
A1R527	0757-0289	RESISTOR 13.3K 1% .125W F TUBULAR	30983	MF4C1/8-T0-1332-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	RESISTOR 4.7K 5% .25W CC TUBULAR	01121	CB4725
A1R535	0683-4735	RESISTOR 47K 5% .25W CC TUBULAR	01121	CB4735
A1R536	0683-1035	RESISTOR 10K 5% .25W CC TUBULAR	01121	CB1035
A1R537	0683-1035	RESISTOR 10K 5% .25W CC TUBULAR	01121	CB1035
A1R538	0683-1035	RESISTOR 10K 5% .25W CC TUBULAR	01121	CB1035
A1R540	0683-1035	RESISTOR 10K 5% .25W CC TUBULAR	01121	CB1035
A1R541	0683-1035	RESISTOR 10K 5% .25W CC TUBULAR	01121	CB1035
A1R542	0698-5358	RESISTOR 866K .125	28480	0698-5358
A1R543	0683-1055	RESISTOR 1M 5% .25W CC TUBULAR	01121	CB1055
A1R544*	0698—3274	RESISTOR 10K 1% .125W F *FACTORY SELECTED PART	24546	NE55
A1R545	0698-6977	RESISTOR 30K .1% .125W F TUBULAR	19701	MF4C1/8-T9-4172-B
A1R546	0683-1035	RESISTOR 10K 5% .25W CC TUBULAR	01121	CB1035
A1R547	0683-1035	RESISTOR 10K 5% .25W CC TUBULAR	01121	CB1035
A1R548	0683-1035	RESISTOR 10K 5% .25W CC TUBULAR	01121	CB1035
A1R549	0683-1035	RESISTOR 10K 5% .25W CC TUBULAR	01121	CB1035
A1R555	0683—1035	RESISTOR 10K 5% .25W CC TUBULAR	01121	CB1035
A1R556 Δ_1	0698—4453	RESISTOR 402 1% .125W F	24546	C4—1/8—TO—402R—F
A1R557	0683-1035	RESISTOR 10K 5% .25W CC TUBULAR	01121	CB1035
A1R558	0683-1035	RESISTOR 10K 5% .25W CC TUBULAR	01121	CB1035
A1R559	0757-0465	RESISTOR 100K 1% .125W F TUBULAR	24546	C4-1/8-TO-1003-F

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

REFERENCE DESIGNATOR	-hp- PART NO.	DESCRIPTION	MFR.	MFR. PART NO.
A1R560	0698-4123	RESISTOR 499 OHM 1% .125W F TUBULAR	16299	C4-1/8-TO-499R-F
A1R561*	0683-2235	RESISTOR 22K 5% .25W CC TUBULAR *FACTORY SELECTED PART	01121	CB2235
A1R566 Δ3	0698-4435	RESISTOR 2.49K 1% .125W F	16299	C4-1/8-TO-2491-F
A1R567	0698-4510	RESISTOR 84.5K 1% .125W F TUBULAR	24546	C4-1/8-TO-8452-F
A1R568	0757-0459	RESISTOR 56.2K 1% .125W F TUBULAR	24546	C4-1/8-TO-5622-F
A1R569	0757-0416	RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-TO-511R-F
A1R570	0698-4435	RESISTOR 2.49K 1% .125W F TUBULAR	16299	C4-1/8-TO-2491-F
A1R571	0757-0416	RESISTOR 511 OHM 1% .125W F TUBULAR	24546	C4-1/8-TO-511R-F
A1R572	0698-4435	RESISTOR 2.49K 1% .125W F TUBULAR	16299	C4-1/8-TO-2491-F
A1R573 Δ3	0698-4435	RESISTOR 2.49K 1% .125W F	16299	C4-1/8-TO-2491-F
A1R574 Δ3	1757-0472	RESISTOR 200K 1% .125W F	24546	C4-1/8-TO-2003-F
A1R575 Δ3	0698-3152	RESISTOR 3.48K 1% .125W F	16299	C4-1/8-TO-3481-F
A1R576 Δ3	0698-3228	RESISTOR 49.9K 1% .125W F	03888	PME55S
A1R577 Δ3	0757-0465	RESISTOR 100K 1% .125W F	24546	C4-1/8-TO-1003-F
A1R578 Δ3	0698-4486	RESISTOR 24.9K 1% .125W F	24546	C4-1/8-TO-2492-F
A1R579 Δ3	0683-1015	RESISTOR 100 5% .25W	01121	CB1015
A1R580 Δ3	0757-0465	RESISTOR 100K 1% .125W F	24546	C4-1/8-TO-1003-F
A1R581, 582 Δ3	0698-3228	RESISTOR 49.9K 1% .125W F	03888	PME55S
A1R601	0757-0280	RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-TO-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 Δ3	0683-4735	RESISTOR 47K 5% .25W FC	01121	CB473
A1R605 Δ3	0683-5145	RESISTOR 510K 5% .25W FC	01121	CB5145
A1R610	1810-0055	CIRCUIT; PSIV; NON-RPRABLE IN	28480	1810-0055
A1R611	1810-0055	CIRCUIT; PSIV; NON-RPRABLE IN	28480	1810-0055
A1R613	0683-1035	RESISTOR 10K 5% .25W CC TUBULAR	01121	CB1035
A1R620	0683-1865	RESISTOR 18M 5% .25W CC TUBULAR	01121	CB1865
A1R621	0683-1265	RESISTOR 12M 5% .25W CC TUBULAR	01121	CB1265
A1R622	0683-2435	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	RESISTOR 22M 5% .25W CC TUBULAR	01121	CB2265
A1R640	0683-1045	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-TO-1001-F
A1R701	1810-0055	CIRCUIT; PSIV; NON-RPRABLE IN	28480	1810-0055
A1R710	0757-0381	RESISTOR 15 OHM 1% .125W F TUBULAR	30983	MF4C1/8-TO-15R0-F
A1R711	0757-0381	RESISTOR 15 OHM 1% .125W F TUBULAR	30983	MF4C1/8-TO-15R0-F
A1R712	0757-0381	RESISTOR 15 OHM 1% .125W F TUBULAR	30983	MF4C1/8-TO-15R0-F
A1R713	0757-0381	RESISTOR 15 OHM 1% .125W F TUBULAR	30983	MF4C1/8-TO-15R0-F
A1R714	0757-0381	RESISTOR 15 OHM 1% .125W F TUBULAR	30983	MF4C1/8-TO-15R0-F
A1R715	0757-0381	RESISTOR 15 OHM 1% .125W F TUBULAR	30983	MF4C1/8-TO-15R0-F
A1R716	0757-0381	RESISTOR 15 OHM 1% .125W F TUBULAR	30983	MF4C1/8-TO-15R0-F
A1R720	0683-2015	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	RESISTOR 16 OHM 5% .25W CC TUBULAR	01121	CB1605
A1R731	0683-5105	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	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	RESISTOR 10 OHM 5% .25W CC TUBULAR	01121	CB1005
A1R804	0757-0273	RESISTOR 3.01K 1% .125W F TUBULAR	24546	C4-1/8-TO-3011-F
A1R805	0698-6360	RESISTOR 10K .1% .125W F TUBULAR	19701	MF4C1/8-T9-1002-B
A1R806	0698-3279	RESISTOR 4.99K 1% .125W F TUBULAR	16299	C4-1/8-TO-4991-F
A1R807	0698-6360	RESISTOR 10K .1% .125W F TUBULAR	19701	MF4C1/8-T9-1002-B
A1R808	0683-1015	RESISTOR 100 OHM 5% .25W CC TUBULAR	01121	CB1015
A1R812	0683-1025	RESISTOR 1K 5% .25W CC TUBULAR	01121	CB1025
A1R813	0757-0277	RESISTOR 49.9 OHM 1% .125W F TUBULAR	24546	C4-1/8-TO-49R9-F
A1R814	0698-3519	RESISTOR 12.4K 1% .125W F TUBULAR	16299	C4-1/8-TO-1242-F
A1R815	0698-3279	RESISTOR 4.99K 1% .125W F TUBULAR	16299	C4-1/8-TO-4991-F
A1S1	3101-1848	SWITCH, PUSHBUTTON :DISPLAY & MONITOR	28480	3101-1848
A1S2	3101-1847	SWITCH, PUSHBUTTON :POWER	28480	3101-1847

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

REFERENCE DESIGNATOR	-hp- PART NO.	DESCRIPTION	MFR.	MFR. PART NO.
A1U501	1826-0109	IC LIN AMPLIFIER	34371	HA2-2625-80593
A1U502 Δ3	1826-0323	IC LIN HA 4741	28480	1826-0323
A1U503 Δ3				
A1U504	1826-0043	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	IC DGTL CD4046AE PHASE LOCK LOOP	02735	CD4046AE
A1U508	1820-1189	IC DGTL MC14510CP COUNTER	04713	MC14510CP
A1U509	1820-0939	IC DGTL CD4013AE FLIP-FLOP	86684	CD4013AE
A1U510	1820-0949	IC;DGTL;GATE	86684	CD4011AE
A1U515	1820-0223	IC LIN LM301AH AMPLIFIER	27014	LM301AH
A1U601	1818-2239	IC 4K ROM NMOS	28480	1818-2239
A1TX601	1200-0423	SOCKET: ELEC; IC 16-CONT DIP SLDR TERM	28480	1200-0423
A1U602	1820-1190	IC DGTL MM74C173N FLIP-FLOP	27014	MM74C173N
A1U603	1820-1190	IC DGTL MM74C173N FLIP-FLOP	27014	MM74C173N
A1U604	1820-0939	IC DGTL CD4013AE FLIP-FLOP	86684	CD4013AE
A1U606	1820-0927	IC DGTL CD4028AE DECODER	02735	CD4028AE
A1U607	1820-0949	IC;DGTL;GATE	86684	CD4011AE
A1U608	1820-1241	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	IC;DGTL;BUFFER/DRIVER/LINE DRIVER	02735	CD4049AE
A1U612	1820-1123	IC DGTL MK 5009P	50088	MC5009P
A1U613	1820-1122	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	IC DGTL MC14516CL COUNTER	04713	MC14516CL
A1U701	1820-1239	IC DGTL MK 5007P COUNTER	50088	MK5007P
A1TX701	1200-0423	SOCKET; ELEC; IC 16-CONT DIP SLDR TERM	28480	1200-0423
A1U702	1818-2240	ROM, MOS	28480	1818-2240
A1U703	1820-1233	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	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	IC LIN REGULATOR	07263	723HC
A1U802	1826-0043	IC LIN LM307H AMPLIFIER	27014	LM307H
A1W1	03551-61601	CABLE ASSY, FLAT	28480	03551-61601
A1Y601	0410-0561	CRYSTAL	28480	0410-0561
A1A2	03551-66502	PC ASSY, DISPLAY	28480	03551-66502
A1A2CR701	1990-0416	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
A1A2CR708	1901-0040	DIODE-SWITCHING 2NS 30 V 50 MA	28480	1901-0040
A1A2R701	0757-0401	RESISTOR 100 OHM 1% .125W F TUBULAR	24546	C4-1/8-TO-101-P
A1A2U701	1990-0491	DISPLAY AN SEG 1 CHAR .28 IN HIGH	28480	1990-0491
A1A2U702	1990-0490	DISPLAY NUM SEG 1 CHAR .3 IN HIGH	28480	1990-0490
A1A2U703	1990-0490	DISPLAY NUM SEG 1 CHAR .3 IN HIGH	28480	1990-0490
A1A2U704	1990-0490	DISPLAY NUM SEG 1 CHAR .3 IN HIGH	28480	1990-0490
A1A2U705	1990-0490	DISPLAY NUM SEG 1 CHAR .3 IN HIGH	28480	1990-0490
		D Brightness		
A2		SEE A1A2		
A3 Δ1	03552-66513	PC ASSY, INPUT AMPLIFIER	28480	03552-66513
A3C101 Δ2				
A3C102	0121-0147	CAPACITOR; VAR; TRMR; CER; 2/19.3PF	74970	189-507-5
A3C103*		NORMALLY NOT LOADED *FACTORY SELECTED PART		
A3C104*	0160-2206	CAPACITOR-FXD 18PF +-5% 300WVDC MICA *FACTORY SELECTED PART	28480	0160-2206
A3C105	0183-0543	CAPACITOR-FXD; 75UF+100-20% 300VDC AL	90201	SPG 32-8428
A3C106	0150-0050	CAPACITOR-FXD 1000PF +80-20% 1000WVDC	28480	0150-0050
A3C107*		NORMALLY NOT LOADED		
A3C108*	0140-0190	CAPACITOR-FXD 39PF +-5% 300WVDC MICA	72136	DM15E390J0300WV1CR

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

REFERENCE DESIGNATOR	-hp- PART NO.	DESCRIPTION	MFR.	MFR. PART NO.
A3C109	0150-0050	CAPACITOR-FXD 1000PF +80-20% 100WVDC	28480	0150-0050
A3C110	0180-0543	CAPACITOR-FXD: 75UF+100-20% 300VDC AL	90201	SPG 32-8428
A3C112	0150-0050	CAPACITOR-FXD 1000PF +80-20% 100WVDC	28480	0150-0050
A3C113				
A3C200	0150-0093	CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A3C201				
A3C202	0150-0093	CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A3C203	0160-0156	CAPACITOR-FXD 3900PF +-10% 200WVDC POLYE	56289	292P39292
A3C204	0160-0938	CAPACITOR-FXD 1000PF +-5% 100WVDC MICA	53021	D15C1E102J
A3C205	0180-1743	CAPACITOR-FXD .1UF +-20% 25WVDC CER	56289	150D104X9035A2
A3C206	0160-0938	CAPACITOR-FXD 1000PF +-5% 100WVDC MICA	53021	D15C1E102J
A3C207	0160-3188	CAPACITOR-FXD .27UF +-5% 50WVDC MET	28480	0160-3188
A3C208	0160-4232	CAPACITOR-FXD .047UF +5-0% 50WVDC MET	28480	0160-4232
A3C209	0160-4231	CAPACITOR-FXD 4700PF +-5% 50WVDC MET	28480	0160-4231
A3C210				
A3C211	0121-0060	CAPACITOR-VAR 2-8PF	73899	DV11PS8A
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 *FACTORY SELECTED PART	72136	DM15F101G0300WV1CR
A3C216	0160-3094	CAPACITOR-FXD; .1UF +-10% 100 WVDC CER	28480	0160-3094
A3C217	0160-0938	CAPACITOR-FXD; 1000PF +-5% 100 WVDC MICA	53021	D15C1E102J
A3C218*	0150-0045	CAPACITOR-FXD; 8.2PF +-5% 500WVDC *FACTORY SELECTED PART	95121	TYPE QC
A3C219	0150-0093	CAPACITOR-FXD; .01UF +80 -20% 100WVDC CER	28480	0150-0093
A3C220	0160-2150	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	CAPACITOR-FXD; 33UF+-10% 15VDC 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	CAPACITOR-FXD; 22UF+-10% 15VDC TA-SOLID	56289	150D226X9015B2
A3C229	0180-0228	CAPACITOR-FXD; 22UF+-10% 15VDC TA-SOLID	56289	150D226X9015B2
A3C230 Δ_2	0150-0093	CAPACITOR-FXD; .01UF +80 -20% 100WVDC	28480	0150-0093
A3C231 Δ_2	0150-0093	CAPACITOR-FXD; .01UF +80 -20% 100WVDC	28480	0150-0093
A3C232	0160-0127	CAPACITOR-FXD; 1UF +-20% 25WVDC	28480	0160-0127
A3C233, 234	0160-0127	CAPACITOR-FXD; 1UF +-20% 25WVDC	28480	0160-0127
A3C300	0160-2204	CAPACITOR-FXD; 100PF +-5% MICA 300WVDC	28480	0160-2204
A3C302-306	0160-3548	CAPACITOR-FXD; .01UF +-1% 100WVDC MICA	28480	0160-3548
A3C307	0160-3548	CAPACITOR-FXD .01UF +-1% 100WVDC MICA	28480	0160-3548
A3C308	0160-3548	CAPACITOR-FXD .01UF +-1% 100WVDC MICA	28480	0160-3548
A3C309	0160-3548	CAPACITOR-FXD .01UF +-1% 100WVDC MICA	28480	0160-3548
A3C310	0160-0127	CAPACITOR-FXD 1UF +-20% 25WVDC CER	28480	0160-0127
A3C311	0180-0161	CAPACITOR-FXD; 3.3UF +-20% 35VDC	56289	150D335X0035B2
A3C313	0180-0106	CAPACITOR-FXD; 60UF +-20% 6VDC TA-SOLID	56289	150D606X0006B2
A3C315	0140-0149	CAPACITOR-FXD; D 470PF +-5% 300WVDC	72136	DM15F471J0300WV1CR
A3C317	0160-0205	CAPACITOR-FXD; 10PF +-5% 500WVDC MICA 0+	28480	0160-0205
A3C318*	0160-2201	CAPACITOR-FXD; 51PF +-5% 300 WVDC MICA	28480	0160-2201
A3C319	0160-0205	CAPACITOR-FXD; 10PF +-5% 500 WVDC 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		NORMALLY NOT LOADED		
A3C325	0160-2199	CAPACITOR-FXD; 30PF +-5% 300WVDC MICA	28480	0160-2199
A3C326	0160-0269	CAPACITOR-FXD; .1UF +-20% 500WVDC	28480	0160-0269
A3C327	0140-0149	CAPACITOR-FXD; 470PF +-5% 300WVDC	72136	Dm15F471J0300WV1CR
A3C328	0160-2204	CAPACITOR-FXD; 100PF +-5% 300WVDC MICA	28480	0160-2204
A3C330	0160-3622	CAPACITOR-FXD; .1UF +80 -20% 100WVDC CER	28480	0160-3622
A3C335	0160-2035	CAPACITOR-FXD; 750PF +-5% 300 WVDC MICA	28480	0160-2035
A3C480*	0140-0199	CAPACITOR-FXD; 240PF +-5% 300 WVDC	72136	DM15F241J0300WV1CR
A3C501	0150-0093	CAPACITOR-FXD; .01UF +80 -20% 100WVDC CER	28480	0150-0093
A3C502	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	0180-0100	CAPACITOR-FXD; 4.7UF 10% 35VDC TA	56289	150D475X903582
A3C316	0180-0228	CAPACITOR-FXD; 22UF +-10% 15VDC TA-SOLID	56289	150D226X901582
A3C317	0180-1704	CAPACITOR-FXD; 47UF +-10% 6VDC TA-SOLID	56289	150D476X900682
A3C818	0180-1835	CAPACITOR-FXD; 68UF +-20% 15VDC	56289	150D686X0015R2
A3CR100 Δ_2	1901-0758	DIODE	28480	1901-0758

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

REFERENCE DESIGNATOR	-hp- PART NO.	DESCRIPTION	MFR.	MFR. PART NO.
A3CR101	1901-0028	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	DIODE-SWITCHING 2NS 80V 200MA	28480	1901-0050
A3CR106	1901-0050	DIODE-SWITCHING 2NS 80V 200MA	28480	1901-0050
A3CR115	1902-0554	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	DIODE-ZNR 6.81V 5% DO-7 PD=.4W	28480	1902-0048
A3CR201				
A3CR202				
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	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
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 DLK 16 CONTACT	23880	DSA2900-168
A3Q101	1854-0234	TRANSISTOR NPN 2N3440 SI PD=1W	02735	2N3440
A3Q102	1854-0234	TRANSISTOR NPN 2N3440 SI PD=1W	02735	2N3440
A3Q103	1854-0071	TRANSISTOR SI NPN	28480	1854-0071
A3Q201	1853-0086	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	1853-0086	TRANSISTOR PNP SI CHIP PD=310MW	28480	1853-0086
A3Q212	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	1853-0086	TRANSISTOR PNP SI	28480	1853-0086
A3Q217	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	1854-0071	TRANSISTOR NPN SI PD=300MW FT=200MHz	28480	1854-0071
A3Q302	1855-0410	TRANSISTOR: J-FET N-CHAN, D-MODE SI	28480	1855-0410
A3Q303	1854-0233	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	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 Δ_2 A3R102*	0698-3433	RESISTOR- 28.7K 1% .125W F TC = 0 +-100	03888	PME55-1/8-TO-2BR7-F
A3R103	0683-2275	RESISTOR 2.7 OHM 5% .25W CC TUBULAR	01121	CB27G5
A3R104	0757-0472	RESISTOR 200K 1% .125W F TUBULAR	24546	C4-1/8-TO-2003-F
A3R105*	0698-8560	RESISTOR 74.8 OHM 1% .5W F TUBULAR *FACTORY SELECTED PART	28480	0698-8560
A3R106*	0698-8559	RESISTOR 302 OHM 1% .5W F TUBULAR *FACTORY SELECTED PART	28480	0698-8559
A3R107*	0698-8561	RESISTOR 454.6 OHM 1% .5W F TUBULAR *FACTORY SELECTED PART	28480	0698-8561
A3R108*	0698-8560	RESISTOR 74.8 OHM 1% .5W F TUBULAR *FACTORY SELECTED PART	28480	0698-8560

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

REFERENCE DESIGNATOR	-hp- PART NO.	DESCRIPTION	MFR.	MFR. PART NO.
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	0757-0402	RESISTOR 110 OHM 1% .125W F TUBULAR	24546	C4-1/8-TO-111-F
A3R112	0698-4419	RESISTOR 210 OHM 1% .125W F TUBULAR	24546	C4-1/8-TO-210R-F
A3R113	0698-4451	RESISTOR 340 OHM 1% .125W F TUBULAR	24546	C4-1/8-TO-340R-F
A3R114				
A3R115	0757-0472	RESISTOR 200K 1% .125W F TUBULAR	24546	C4-1/8-TO-2003-F
A3R116, R117	0698-6965	RESISTOR 505 .1% .125W F	24546	NE55
A3R121	2100-3426	RESISTOR-VAR 20 OHM .10	28480	2100-3426
A3R122	2100-0552	RESISTOR-VAR TRMR 50 OHM 20% C TOP ADJ	73138	72XR50M
A3R123	2100-0552	RESISTOR-VAR TRMR 50 OHM 20% C TOP ADJ	73138	72XR50M
A3R200				
A3R201	0757-0442	RESISTOR 10K 1% .125W	24546	C4-1/8-TO-1002-F
A3R202	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	0698-3228	RESISTOR 49.9K 1% 125W F TUBULAR	03888	PME55S
A3R205	0698-3228	RESISTOR 49.9K 1% .125W F TUBULAR	03888	PME55S
A3R206	0757-0442	RESISTOR 10K 1% 125W	24546	C4-1/8-TO-1002-F
A3R207				
A3R208				
A3R209				
A3R210	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	0698-3258	RESISTOR 5.36K 1% .125W F	16299	C4-1/8-TO-5361-F
A3R214	0757-0273	RESISTOR 3.01K 1% .125W F TUBULAR	24546	C4-1/8-TO-3011-F
A3R215	0698-7880	RESISTOR 28.7K 1% .125W F TUBULAR	30983	MF4C1/8-T9-2872-F
A3R216	0698-4473	RESISTOR 8.06K 1% .125W F	24546	C4-1/8-TO-4022-F
A3R217*	0757-0273	RESISTOR 3.01K 1% .125W F TUBULAR *FACTORY SELECTED PART	24546	C4-1/8-TO-3011-F
A3R218	0698-4470	RESISTOR 6.98K 1% .125W F TUBULAR	24546	C4-1/8-TO-6981-F
A3R219	0757-0453	RESISTOR 82.5K 1% .125W F TUBULAR	24546	C4-1/8-TO-8252-F
A3R220	0698-7880	RESISTOR 28.7K 1% .125W F TUBULAR	30983	MF4C1/8-T9-2872-F
A3R221, R222	0757-0427	RESISTOR 1500OHM 1% .125W	24546	C4-1/8-TO-1501-F
A3R223	0757-0476	RESISTOR 301K 1% .125W F TUBULAR	24546	C4-1/8-TO-3013-F
A3R224	0757-0453	RESISTOR 30.1K 1% .125W F TUBULAR	24546	C4-1/8-TO-3012-F
A3R225	0698-3279	RESISTOR 4990 OHM 1% .125W F TUBULAR	16299	C4-1/8-TO-4991-F
A3R226	0698-3279	RESISTOR 4990 OHM 1% .125W F TUBULAR	16299	C4-1/8-TO-4991-F
A3R227	0757-0457	RESISTOR 47.5K 1% .125W F TUBULAR	24546	C4-1/8-TO-4752-F
A3R229	0698-4520	RESISTOR 143K 1% .125W F TUBULAR	24546	C4-1/8-TO-1433-F
A3R230	0757-0426	RESISTOR 1300 OHM 1% .125W F TUBULAR	24546	C4-1/8-TO-1301-F
A3R233	0683-1045	RESISTOR 100K 5% .25W CC TUBULAR	01121	CB1045
A3R234	0698-4504	RESISTOR 69.8K 1% .125W F TUBULAR	24546	C4-1/8-TO-6982-F
A3R235	0698-7880	RESISTOR 28.7K 1% .125W F TUBULAR	30983	MF4C1/8-T9-2872-F
A3R236	2100-3273	RESISTOR-VAR TRMR 2KOHM 10% C SIDE ADJ	73138	72XR2K
A3R237	0698-7880	RESISTOR 28.7K 1% .125W F TUBULAR	30983	MF4C1/8-T9-2872-F
A3R238	0698-7956	RESISTOR 99K 1% .125W F TUBULAR	30983	MF4C1/8-T9-9902-F
A3R239	0698-7360	RESISTOR 398.5K 1% .125W F TUBULAR	30983	MF4C1/8-T2-3985Z-8
A3R240	0698-4539	RESISTOR 402K 1% .125W F TUBULAR	19701	MF4C1/8-TC-4023-F
A3R243	0698-3228	RESISTOR 49.9K 1% .125W F TUBULAR	03888	PME55S
A3R244*	0698-0085	RESISTOR 2.61K 1% .125W F *FACTORY SELECTED PART	16299	C4-1/8-TO-2611-F
A3R245	0757-0447	RESISTOR 16.2K 1% .125W F TUBULAR	24546	C4-1/8-TO-1622-F
A3R246	2100-1656	RESISTOR-VAR TRMR 500 OHM 5% MW SIDE ADJ	32997	3057P-1-501
A3R247	0757-0440	RESISTOR 7.5K 1% .125W F TUBULAR	24546	C4-1/8-TO-7501-F
A3R248	0757-0465	RESISTOR 100K 5% .125W CC TUBULAR	24546	C4-1/8-TO-1003-F
A3R249	0757-0465	RESISTOR 100K 5% .125W CC TUBULAR	24546	C4-1/8-TO-1003-F
A3R250	0698-3154	RESISTOR 4.22K 1% .125W F	16299	C4-1/8-TO-4221-F
A3R253	0757-0283	RESISTOR 2K 1% .125W F TUBULAR	24546	C4-1/8-TO-2001-F
A3R254	0698-3499	RESISTOR 40.2K 1% .125W F TUBULAR	16299	C4-1/8-TO-4022-F
A3R255	2100-3273	RESISTOR-VAR TRMR 2K OHM 10%	73138	72XR2K
A3R256	0757-0124	RESISTOR- 39.2K 1% .125 W F TC = 0 +-100	24546	C5-1/4-TO-3922-F
A3R257	0757-0438	RESISTOR 5.11K 1% .125W F TUBULAR	24546	C4-1/8-TO-5111-F
A3R258	0757-0413	RESISTOR 392 OHM 1% .125W F TUBULAR	24546	C4-1/8-TO-392R-F
A3R259	0757-0410	RESISTOR 301 OHM 1% .125W F TUBULAR	24546	C4-1/8-TO-301R-F
A3R260	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-TO-475R-F
A3R263	0757-0421	RESISTOR 825 OHM 1% .125W F TUBULAR	24546	C4-1/8-TO-825R-F
A3R264	0757-0411	RESISTOR 332 OHM 1% .125W F TUBULAR	24546	C4-1/8-TO-332R-F
A3R265	0757-0280	RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-TO-1001-F
A3R266	0757-0467	RESISTOR 121K 1% .125W F TUBULAR	24546	C4-1/8-TO-1213-F
A3R267	0757-0422	RESISTOR 909 OHM 1% .125W F TUBULAR	24546	C4-1/8-TO-909R-F
A3R268	0757-0413	RESISTOR 392 OHM 1% .125W F TUBULAR	24546	C4-1/8-TO-392R-F
A3R269	0698-3493	RESISTOR 4.12K 1% .125W F TUBULAR	16299	C4-1/8-TO-4121-F
A3R270	0757-0410	RESISTOR 301 OHM 1% .125W F TUBULAR	24546	C4-1/8-TO-301R-F
A3R273	0757-0436	RESISTOR 4.32K 1% .125W F TUBULAR	24546	C4-1/8-TO-4321-F
A3R274	0757-0447	RESISTOR 16.2K 1% .125W F TUBULAR	24546	C4-1/8-TO-1622-F
A3R275	0757-0415	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-TO-475R-F
A3R277	0757-0421	RESISTOR 825 OHM 1% .125W F TUBULAR	24546	C4-1/8-TO-825R-F
A3R278	0698-3157	RESISTOR 19.6K 1% .125W F TUBULAR	16299	C4-1/8-TO-1962-F
A3R279	0757-0411	RESISTOR 332 OHM 1% .125W F TUBULAR	24546	C4-1/8-TO-332R-F
A3R280	0757-0280	RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-TO-1001-F
A3R282	0698-3499	RESISTOR 40.2K 1% .125W F TUBULAR	16299	C4-1/8-TO-4022-F

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

REFERENCE DESIGNATOR	-hp- PART NO.	DESCRIPTION	MFR.	MFR. PART NO.
A3R283	2100-3273	RESISTOR-VAR TRMR 2K OHM 10%	73138	72XR2K
A3R284	0698-3499	RESISTOR 40.2K 1% .125W F	16299	C4-1/8-TO-4022-F
A3R285	0757-0438	RESISTOR 5.11K 1% .125W F TUBULAR	24546	C4-1/8-TO-5111-F
A3R286	0757-0452	RESISTOR 27.4K 1% .125W F TUBULAR	24546	C4-1/8-TO-2742-F
A3R287	0698-3498	RESISTOR 8.66K 1% .125W F TUBULAR	16299	C4-1/8-TO-8661-F
A3R288	0757-0281	RESISTOR 2.74K 1% .125W F TUBULAR	24546	C4-1/8-TO-2741-F
A3R289	0698-3495	RESISTOR 866 OHM 1% .125W F TUBULAR	16299	C4-1/8-TO-8661-F
A3R290	0757-0409	RESISTOR 274 OHM 1% .125W F TUBULAR	24546	C4-1/8-TO-274R-F
A3R291	0698-4398	RESISTOR 86.6 OHM 1% .125W F TUBULAR	16299	C4-1/8-TO-86R6-F
A3R292	0698-3262	RESISTOR 40.2 OHM 1% .125W F TUBULAR	16299	C4-1/8-TO-4022-F
A3R293	0757-0426	RESISTOR 1.3K 1% .125W F	24546	C4-1/8-TO-1301-F
A3R294	0698-4463	RESISTOR 845 OHM 1% .125W F TUBULAR	03888	PME55-1/8-TO-8450-F
A3R295	2100-3477	RESISTOR-VAR 10K	28480	2100-3477
A3R296	0683-2405	RESISTOR 24 OHM 5% .25W CC TUBULAR	01121	CB2405
A3R297	0683-2405	RESISTOR 24 OHM 5% .25W CC TUBULAR	01121	CB2405
A3R298	0683-2405	RESISTOR 24 OHM 5% .25W CC TUBULAR	01121	CB2405
A3R299	0683-2405	RESISTOR 24 OHM 5% .25W CC TUBULAR	01121	CB2405
A3R300	0683-5145	RESISTOR 510K 5% .25W CC TUBULAR	01121	CB5145
A3R301	0757-0449	RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R302	0683-1055	RESISTOR 1M 5% .25W CC TUBULAR	01121	CB1055
A3R303	0757-0473	RESISTOR 221K 1% .125W F TUBULAR	24546	C4-1/8-TO-2213-F
A3R304	0698-4482	RESISTOR 17.4K 1% .125W F TUBULAR	03888	PME55-1/8-TO-1742-F
A3R305	0698-4481	RESISTOR 16.5K 1% .125W F TUBULAR	24546	C4-1/8-TO-1652-F
A3R306	2100-0567	RESISTOR-VAR TRMR 2KOHM 10% C TOP	73138	72PR2K
A3R307 Δ1	0757-0449	RESISTOR 20K 1% .125W	24546	C4-1/8-TO-2002-F
A3R308	0757-0449	RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R310	0757-0449	RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R311	0698-4510	RESISTOR 84.5K 1% .125W F TUBULAR	24546	C4-1/8-TO-8452-F
A3R312	0757-0473	RESISTOR 221K 1% .125W F TUBULAR	24546	C4-1/8-TO-2213-F
A3R313	0757-0449	RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R314	0698-4483	RESISTOR 18.7K 1% .125W F TUBULAR	24546	C4-1/8-TO-1872-F
A3R315	2100-0567	RESISTOR-VAR TRMR 2KOHM 10% C TOP	73138	72PR2K
A3R316	0757-0449	RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R318	0698-4510	RESISTOR 84.5K 1% .125W F TUBULAR	24546	C4-1/8-TO-8452-F
A3R319	0698-4483	RESISTOR 18.7K 1% .125W F TUBULAR	24546	C4-1/8-TO-1872-F
A3R320	0698-4482	RESISTOR 17.4K 1% .125W F TUBULAR	03888	PME55-1/8-TO-1742-F
A3R321	2100-0567	RESISTOR-VAR TRMR 20KOHM 10% C TOP	73138	72PR2K
A3R323	0757-0449	RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R325	0757-0449	RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R326	0698-3243	RESISTOR 178K 1% .125W F TUBULAR	16299	C4-1/8-TO-1783-F
A3R327	0698-4510	RESISTOR 84.5K 1% .125W F TUBULAR	24546	C4-1/8-TO-8452-F
A3R328	0757-0449	RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R329	0757-0449	RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R331	0757-0449	RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R333	0698-4507	RESISTOR 76.8K 1% .125W F TUBULAR	24546	C4-1/8-TO-7682-F
A3R334	0698-3245	RESISTOR 20.5K 1% .125W F TUBULAR	16299	C4-1/8-TO-2052-F
A3R335	0698-3157	RESISTOR 19.6K 1% .125W F TUBULAR	16299	C4-1/8-TO-1962-F
A3R336	2100-0567	RESISTOR-VAR TRMR 2KOHM 10% C TOP	73138	72PR2K
A3R338	0757-0449	RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R340	0757-0449	RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R341	0698-4529	RESISTOR 226K 1% .125W F TUBULAR	24546	C4-1/8-TO-2263-F
A3R342	0698-4507	RESISTOR 76.8K 1% .125W F TUBULAR	24546	C4-1/8-TO-7682-F
A3R343	0757-0449	RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R344	0757-0449	RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R346	0757-0449	RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R348	0698-4524	RESISTOR 174K 1% .125W F TUBULAR	24546	C4-1/8-TO-1743-F
A3R349	0757-0199	RESISTOR 21.5K 1% .125W F TUBULAR	24546	C4-1/8-TO-2152-F
A3R350	0757-0349	RESISTOR 22.6K 1% .125W F TUBULAR	24546	C4-1/8-TO-2262-F
A3R351	2100-0567	RESISTOR-VAR TRMR 2KOHM 10% C TOP	73138	72PR2K
A3R353	0757-0449	RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R355	0757-0449	RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R356	0698-4507	RESISTOR 76.8K 1% .125W F TUBULAR	24546	C4-1/8-TO-7682-F
A3R357	0698-4524	RESISTOR 174K 1% .125W F TUBULAR	24546	C4-1/8-TO-1743-F
A3R358	0757-0449	RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R359	0757-0449	RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R360	0757-0465	RESISTOR 100K 1% .125W F TUBULAR	24546	C4-1/8-TO-1003-F
A3R361	0698-6323	RESISTOR 100 OHM .1% .125W F TUBULAR	19701	MF4C1/8-T9-100R-B
A3R362	0698-6448	RESISTOR 216.2 OHM .1% .125W F TUBULAR	03888	PME55,T-9
A3R363	0698-6447	RESISTOR 683.8 OHM .1% .125W F TUBULAR	03888	PME55,T-9
A3R364	0698-6446	RESISTOR 2.162K .1% .125W F TUBULAR	03888	PME55,T-9
A3R365	0698-7330	RESISTOR 96.84K .1% .125W F TUBULAR	30983	MF4C1/8-T2-9684I-B

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

REFERENCE DESIGNATOR	-hp- PART NO.	DESCRIPTION	MFR.	MFR. PART NO.
A3R366	0698-7574	RESISTOR 31.62 OHM .1% .125W F TUBULAR	30983	MF4C1/8-T9-31R62-B
A3R367	0698-6449	RESISTOR 68.38 OHM .1% .125W F TUBULAR	03888	PME55,T-9
A3R368	0698-6448	RESISTOR 216.2 OHM .1% .125W F TUBULAR	03888	PME55,T-9
A3R369	0698-6447	RESISTOR 681.8 OHM .1% .125W F TUBULAR	03888	PME55,T-9
A3R370	0698-3511	RESISTOR 665 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-665R-F
A3R371	0683-5145	RESISTOR 510K 5% .25W CC TUBULAR	01121	CB5145
A3R372	0683-5145	RESISTOR 510K 5% .25W CC TUBULAR	01121	CB5145
A3R373	0698-3275	RESISTOR 2.5K 1% .125W F TUBULAR	19701	MF4C1/8-T9-2501-F
A3R374	0683-5145	RESISTOR 510K 5% .25W CC TUBULAR	01121	CB5145
A3R375	0757-0472	RESISTOR 200K 1% .125W F TUBULAR	24546	C4-1/8-T0-2003-F
A3R376	0698-3275	RESISTOR 2.5K 1% .125W F TUBULAR	19701	MF4C1/8-T9-2501-F
A3R377	2100-3212	RESISTOR-VAR TRMR 200 OHM 10% C SIDE ADJ	32997	3389P-1-201
A3R378	0683-5145	RESISTOR 510K 5% .25W CC TUBULAR	01121	CB5145
A3R379	0683-1045	RESISTOR 100K 5% .25W CC TUBULAR	01121	CB1045
A3R380	0757-1094	RESISTOR 1.47K 1% .125W F TUBULAR	24546	C4-1/8-T0-1471-F
A3R381	0683-5145	RESISTOR 510K 5% .25W CC TUBULAR	01121	CB5145
A3R382	0683-1045	RESISTOR 100K 5% .25W CC TUBULAR	01121	CB1045
A3R383	0683-3945	RESISTOR 390K 5% .25W CC TUBULAR	01121	CB3945
A3R384	0683-1055	RESISTOR 1M 5% .25W CC TUBULAR	01121	CB1055
A3R385	0698-6362	RESISTOR 1K .1% .125W F TUBULAR	19701	MF4C1/8-T9-1001-B
A3R386	0698-6446	RESISTOR 2.162K .1% .125W F TUBULAR	03888	PME55,T-9
A3R387	0757-0438	RESISTOR 5.11K 1% .125W F TUBULAR	24546	C4-1/8-T0-5111-F
A3R388	0757-0446	RESISTOR 15K 1% .125W F TUBULAR	24546	C4-1/8-T0-1502-F
A3R389	0698-4123	RESISTOR 499 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-499R-F
A3R390	0683-4735	RESISTOR 47K 5% .25W CC TUBULAR	01121	CB4735
A3R391	0683-4735	RESISTOR 47K 5% .25W CC TUBULAR	01121	CB4735
A3R392	0698-6801	RESISTOR 3.48K 1% .125W F TUBULAR	19701	MF4C1/8-T9-3481-F
A3R393	0698-8182	RESISTOR 2.21K 1% .125W F TUBULAR	30983	MF4C1/8-T9-2211-F
A3R394	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	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
A3R402	0757-0439	RESISTOR- 6.8K 1% .125 W F TC = 0 +-100	24546	C4-1/8-TO-6811-F
A3R403, 404	0683-5145	RESISTOR- 510K 5% .25 W CC TUBULAR	01121	CB5145
A3R501	0698-5394	RESISTOR 105.5 OHM.1% .125W F TUBULAR	28480	0698-5394
A3R502	0698-6448	RESISTOR-FXD 216.2 .001 .125W	24546	NE55
A3R503	0698-5369	RESISTOR-FXD 262.4 .001	28480	0698-5369
A3R504	0698-3274	RESISTOR 10K 1% .125W F TUBULAR	19701	MF4C1/8-T9-1002-F
A3R505	2100-3351	RESISTOR-VAR TRMR 500OHM 10% C SIDE ADJ	73138	72XR500
A3R506	0757-0284	RESISTOR-FXD 150OHM 1% .125W	24546	C4-1/8-TO-151-F
A3R507, 508	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	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	SWITCH, ASSEMBLY ROTARY:FUNCTION AND IMP	28480	03551-61901
A3S3	3100-2753	SWITCH, ROTARY: FREQ RANGE HZ	28480	3100-2753
A3S4	3100-3351	SWITCH, ROTARY: LEVEL RANGE DBM	28480	3100-3351
A3S5 Δ_3	3100-3377	SWITCH, ROTARY: RECEIVE NOISE/TONE	28480	3100-3377
A3T101 Δ_2	9100-3489	TRANSFORMER, RECEIVE	28480	9100-3489
A3T102	9100-3449	TRANSFORMER, SEND	28480	9100-3449
A3U201	1826-0218	IC LIN AMPLIFIER	02735	CA3100T
A3U202	1820-0478	IC LIN LM308H AMPLIFIER	27014	LM308H
A3U203	1820-0478	IC LIN LM308H AMPLIFIER	27014	LM308H
A3U204	1826-0109	IC LIN AMPLIFIER	34371	HA2-2625-80593
A3U205	1820-0478	IC LIN LM308H AMPLIFIER	27014	LM308H
A3U206	1826-0222	IC LIN RC4136CP AMPLIFIER	0059R	RC4136DP
A3U207	1826-0043	IC LIN LM307H AMPLIFIER	27014	LM307H
A3U208	1826-0109	IC LIN AMPLIFIER	34371	HA2-2625-80593
A3U209	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	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	HA2-2625-80593
A3V101	1970-0073	DIODE	28480	1970-0073
A3XA4	1251-1941	CONNECTOR: PC EDGE: 6-CONT: DIP SOLDER	71785	252-06-30-310
		A3 MISCELLANEOUS		
	03551-01203	BRACKET, ANALOG SWITCH	28480	03551-01203
	03551-26503	PC BOARD, INPUT AMPLIFIER	28480	03551-26503
	03551-61602	CABLE ASSY	28480	03551-61602
	03551-61604	CABLE ASSY	28480	03551-61604
	03551-61603	CABLE ASSY	28480	03551-61603
	1200-0043	INSULATOR: XSTR: TO- 3: .02 THK	28480	1200-0043
	1205-0250	THERMAL-LINK: SGL: TO-5 PKG	28480	1205-0250

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

REFERENCE DESIGNATOR	-hp- PART NO.	DESCRIPTION	MFR.	MFR. PART NO.
A4 Δ_3	03552—66514	PC ASSY—NOISE FILTER	28480	03552—66514
A4C401	0160—0166	CAPACITOR—FXD; 8200PF +—10% 200WVDC	56289	292P82292
A4C402	0180—0197	CAPACITOR—FXD; 2.2UF +—10% 20VDC	56289	150D225X9020A2
A4C408	0160—2387	CAPACITOR—FXD; 1000PF +—1% 500WVDC	28480	0160—2387
A4C412, 413	0140—0163	CAPACITOR—FXD; 4751PF +—1% 300WVDC	72136	DM20F4751F0300WV1CR
A4C415, 416	0160—3024	CAPACITOR—FXD; 1700PF +—1% 100WVDC	28480	0160—3024
A4C419	0160—3024	CAPACITOR—FXD; 1700PF +—1% 100WVDC	28480	0160—3024
A4C421, 422	0160—3024	CAPACITOR—FXD; 1700PF +—1% 100WVDC	28480	0160—3024
A4C424	0140—0184	CAPACITOR—FXD; 8200PF +—1% 100WVDC	72136	DM20F822F0100WV1CR
A4C427	0160—3024	CAPACITOR—FXD; 1700PF +—1% 100WVDC	28480	0160—3024
A4C429	0160—2387	CAPACITOR—FXD; 1000PF +—1% 500WVDC	28480	0160—2387
A4C432, 433	0150—0093	CAPACITOR—FXD; .01UF +80 —20% 100WVDC	28480	0150—0093
A4C434	0140—0184	CAPACITOR—FXD; 8200PF +—1% 100WVDC	72136	DM20F822F0100WV1Cr
A4C435	0180—0197	CAPACITOR—FXD; 2.2UF +—10% 20VDC	56289	150D225X9020A2
A4C436	0160—0128	CAPACITOR—FXD; 2.2UF +—20% 25WVDC	28480	0160—0128
A4C437	0150—0093	CAPACITOR—FXD; .01UF +80 —20% 100WVDC	28480	0150—0093
A4R401	0698—4498	RESISTOR 53.6K 1% .125W F	24546	C4—1/8—TO—5362—F
A4R402	2100—3354	RESISTOR—VAR 50K OHM 10%	73138	72XR50K
A4R403	0757—0476	RESISTOR 301K 1% .125W F	24546	C4—1/8—TO—3013—F
A4R405	0698—3499	RESISTOR 40.2K 1% .125W F	16299	C4—1/8—TO—4022—F
A4R406	0757—0442	RESISTOR 10K 1% .125W F	24546	C4—1/8—TO—1002—F
A4R408	0757—0442	RESISTOR 10K 1% .125W F	24546	C4—1/8—TO—1002—F
A4R410	2100—3274	RESISTOR—TRMR 10K 10%	73138	72XR10K
A4R421	0698—8724	RESISTOR—FXD; 16.06K	28480	0698—8724
A4R424	0757—0470	RESISTOR 162K 1% .125W F	24546	C4—1/8—TO—1623—F
A4R425	0757—0465	RESISTOR 100K 1% .125W F	24546	C4—1/8—TO—1003—F
A4R427	0698—8039	RESISTOR 8.87D .1% .125W F	19701	MF4C1/8—T9—8871—B
A4R428	0757—0427	RESISTOR 1.5K 1% .125W F	24546	C4—1/8—TO—1501—F
A4R429	0698—3279	RESISTOR 4.99K 1% .125W F	16299	C4—1/8—TO—4991—F
A4R430	2100—3274	RESISTOR—TRMR 10K 10%	73138	72XR10K
A4R431	0698—7671	RESISTOR 47.96K .1% .125W F	19701	MF4C1/8—T2—47961—B
A4R432, 433	0698—7673	RESISTOR 49.39K .1% .125W F	19701	MF4C1/8—T2—49391—B
A4R434	0698—8039	RESISTOR 8.87K .1% .125W F	19701	MF4C1/8—T9—8871—B
A4R435	0698—7674	RESISTOR 13.19K .1% .125W F	19701	MF4C1/8—T2—13191—B
A4R436	0698—6943	RESISTOR 20K .1% .125W F	24546	NC55
A4R437	0698—7675	RESISTOR 24.06K .1% .125W F	19701	MF4C1/8—T2—24061—B
A4R438	0698—7670	RESISTOR— 23.69K .1% .125 W F	19701	MF4C1/8—T2—23691—B
A4R440	2100—3354	RESISTOR—VAR TRMR 50K OHM 10%	73138	72XR50K
A4R442	0698—6629	RESISTOR 60K .1% .125W F	24546	NE55
A4R443	0698—6943	RESISTOR 20K .1% .125W F	24546	NC55
A4R444	0698—8723	RESISTOR—FXD; 13.95K	28480	0698—8723
A4R445	2100—3207	RESISTOR—TRMR 5K 10%	32997	86X—1—502
A4R446	0698—6407	RESISTOR 32.8K .1% .1W F	07716	MAR5/HP023
A4R447	0757—0123	RESISTOR 34.8K 1% .125W F	24546	C5—1/4—TO—3482—F
A4R448	0698—7668	RESISTOR 39.91K .1% .125W F	19701	MF4C1/8—T2—39911—B
A4R450	0698—8722	RESISTOR—FXD; 13.58K	28480	0698—8722
A4R451	0698—7668	RESISTOR 39.91 K .1% .125W F	19701	MF4C1/8—T2—39911—B
A4R452	0698—7682	RESISTOR 52.98K .1% .125W F	19701	MF4C1/8—T2—52981—B
A4R454, 455	0698—7680	RESISTOR 59.41K .1% .125W F	19701	MF4C1/8—T2—59411—B
A4R457	0698—7679	RESISTOR 19.41K .1% .125W F	19701	MF4C1/8—T2—19411—B
A4R458	0698—6943	RESISTOR 20K .1% .125W F	24546	NC55
A4R459	0698—6407	RESISTOR 32.8K .1% .1W F	07716	MAR5/HP023
A4R460	0698—7376	RESISTOR 11.39K .1% .125W F	19701	MF4C1/8—T2—11397R—B
A4R461	0698—4488	RESISTOR 26.7K 1% .125W F	24546	C4—1/8—TO—2672—F
A4R462	0698—3258	RESISTOR— 5.36K 1% .125 W F TC = 0 +—100	16299	C4—1/8—TO—5361—F
A4R465	0698—6943	RESISTOR— 20K .1% .125 W F	24546	NC55
A4R466	0698—4307	RESISTOR 14.3K 1% .125W F	16299	C4—1/8—TO—1432—F
A4R467	0698—4473	RESISTOR 8.06K 1% .125W F	24546	C4—1/8—TO—8061—F
A4R468	0698—3268	RESISTOR 11.5K 1% .125W F	16299	C4—1/8—TO—1152—F
A4R471	0698—8721	RESISTOR—FXD; 38.1K	28480	0698—8721

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

REFERENCE DESIGNATOR	-hp- PART NO.	DESCRIPTION	MFR.	MFR. PART NO.
A4R473	0757—0451	RESISTOR— 24.3K 1% .125 W F C = 0 +—100	24546	C4—1/8—TO—2432—F
A4R474	0698—6943	RESISTOR— 20K .1% .125 W F	24546	NC55
A4R477	0684—1011	RESISTOR 100 10% .125W	01121	CB1011
A4R478	0684—1041	RESISTOR 100K 10% .25W	01121	CB1041
A451	3100—2755	SWITCH—ROTARY 1.031 IN CTR SPCG	28480	3100—2755
A4U401, 402	1826—0323	IN—LINEAR	28480	1826—0323
A5	03551—66515	PC ASSY, POWER SUPPLY	28480	03551—66515
A5C801	0180-2563	CAPACITOR-FXD; 2600UF+75-10% 12VDC AL	28480	0180-2563
A5C802	0180-2563	CAPACITOR-FXD; 2600UF+75-10% 12VDC AL	28480	0180-2563
A5C803	0180-2511	CAPACITOR-FXD; 370UF+100-10% 20VDC AL	90201	MTV377N020E1JP
A5C804	0180-2511	CAPACITOR-FXD; 370UF+100-10% 20VDC AL	90201	MTV377N020E1JP
A5C805	0180-2511	CAPACITOR-FXD; 370UF+100-10% 20VDC AL	90201	MTV377N020E1JP
A5C806	0180-2511	CAPACITOR-FXD; 370UF+100-10% 20VDC AL	90201	MTV377N020E1JP
A5C810	0180-2511	CAPACITOR-FXD; 370UF+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	CAPACITOR-FXD; 47UF+-10% 35VDC TA-SOLID	56289	150D476X9035S2
A5CR801	1901-0158	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, 814	1901—0040	DIODE—SWITCHING 30 V 50 MA 2NS	28480	1901—0040
A5CR815	1901—0158	DIODE—PWR RECT 200 V 750 MA	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	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
A5CR822	1901—0158	DIODE—PWR RECT 200 V 750 MA	04713	SR1358—3
A5CR823, 824	1901—0040	DIODE—SWITCHING 30 V 50 MA 2NS	28480	1901—0040
A5CR825	1901—0158	DIODE—PWR RECT 200 V 750 MA	04713	SR1358—3
A5F801	2110-0046	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	1251—3751	CONNECTOR: 8—PIN	27264	09—65—1081
A5J3	1251-3745	CONNECTOR PLUG: +5V INCLUDES THE FOLLOWING:	28480	1251-3745
	1251-3746	CONTACT CONNECTOR	28480	1251-3746
A5J4	1251-3745	CONNECTOR PLUG: +12V INCLUDES THE FOLLOWING:	28480	1251-3745
	1251-3747	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	RELAY	28480	0490-0569
A5Q11	1853—0233	TRANSISTOR PNP SI PD = 40 W FT = 3 MHz	28480	1853—0233
A5Q12	1854—0402	TRANSISTOR NPN SI PD = 30 W FT = 3 MHz	28480	1854—0402
A5R804	0683—1305	RESISTOR 13K 5% .25 W FC TC = —400/+500	01121	CB1305
A5R805	0757—0427	RESISTOR 1.5K 1% .125 W F TC = +—100	24546	C4—1/8—TO—1501—F
A5R806	0813—0009	RESISTOR 125K 3% 4 W PW TC = 0 +—20	07088	KM—350
A5R807	0811—0939	RESISTOR 100 OHM 3% 5† PW TC = 0 +—20	07088	KM—500
A5R809	0698—4494	RESISTOR 35.7 K 1% .125W F TUBULAR	24546	C4—1/8—TO—3572—F
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	RESISTOR 20 OHM 5% 5W PW TUBULAR	91637	CW5-2-5W-T2-20R-J
A5R805	0812-0070	RESISTOR 10 OHM 5% 5W PW TUBULAR	91637	CW5-2-5W-T2-10R-J
A5R806	0811-3114	RESISTOR 75 OHM 3% 5W PW TUBULAR	00213	1500S
A5R807	0811-1854	RESISTOR 50 OHM 5% 5W PW TUBULAR	56289	243E50R5
A5R809	0698-4494	RESISTOR 35.7K 1% .125W F TUBULAR	24546	C4-1/8-TO-3572-F
A5R810	0698-3451	RESISTOR 133K 1% .125W F TUBULAR	16299	C4-1/8-TO-1333-F
A5R811	0698-4489	RESISTOR 28K 1% .125W F TUBULAR	24546	C4-1/8-TO-2802-F
A5R812	0698-3162	RESISTOR 46.4K 1% .125W F TUBULAR	16299	C4-1/8-TO-4642-F
A5R813	0698-4502	RESISTOR 64.9K 1% .125W F TUBULAR	24546	C4-1/8-TO-6492-F
A5R814	0698-3451	RESISTOR 133K 1% .125W F TUBULAR	16299	C4-1/8-TO-1333-F
A5R815	0698-4494	RESISTOR 35.7K 1% .125W F TUBULAR	24546	C4-1/8-TO-3572-F
A5R816	0683-1045	RESISTOR 100K 5% .25W CC TUBULAR	01121	CB1045
A5R817	0683-1045	RESISTOR 100K 5% .25W CC TUBULAR	01121	CB1045
A5R818	0683-1045	RESISTOR 100K 5% .25W CC TUBULAR	01121	CB1045
A5R819	0683-1045	RESISTOR 100K 5% .25W CC TUBULAR	01121	CB1045

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

REFERENCE DESIGNATOR	-hp- PART NO.	DESCRIPTION	MFR.	MFR. PART NO.
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
A5R827	0683-1305	RESISTOR 13K 5% .25 W FC TC = -400/+500	01121	CB1305
A5R828	0757-0427	RESISTOR 1.5K 1% .125 W F TC = +-100	24546	C4-1/8-TO-1501-F
A5U801	1820-0430	IC LIN LM309K REGULATOR	27014	LM309K
A5U802	1826-0117	IC LIN REGULATOR	07263	7812KC
A5U803	1826-0123	IC LIN LM320K-12 REGULATOR	27014	LM320K-12
		A5 MISCELLANEOUS		
	03551-01205	BRACKET, BATTERY CONNECTOR	28480	03551-01205
	0380-0160	STANDOFF	28480	0380-0160
	0490-0541	RETAINER, SOCKET	28480	0490-0541
	0490-0570	SOCKET, RELAY	28480	0490-0570
	1251-2551	CONNECTOR, SINGLE CONTACT	00779	332070
		CHASSIS PARTS		
BT1	1420-0220	BATTERY PACK: 5 V	28480	1420-0220
BT2	1420-0221	BATTERY PACK: 12 V	28480	1420-0221
BT3	1420-0221	BATTERY PACK: 12 V	28480	1420-0221
C901, 902	0160-0195	CAPACITOR-FXD; 1000PF +-20% 250 WVAC	28480	1060-0195
F1	2110-0201	FUSE .25A 250V SLO-BLO	75915	313.2505
J3	1510-0091	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	1251-2533	CONNECTOR; TEL; 3-CKT JACK .25 SHK DIA	28480	1251-2533
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	1251-2533	CONNECTOR; TEL; 3-CKT JACK .25 SHK DIA	28480	1251-2533
J9	1510-0087	BINDING-POST, SINGLE,6-32,JGK/BLK	28480	1510-0087
L1-L4 Δ_1	9100-3551	COIL-FXD; 1UH 5%	24226	9493
PM1	0960-0444	LINE MODULE	28480	0960-0444
R200	2100-0669	RESISTOR-VAR 50K 10% CC	12697	SERIES 63H
R500	2100-0352	RsVAR 50K-5K OHM 5% 2W	28480	2100-0352
S1	3101-1869	SWITCH: PUSHBUTTON, HOLD	28480	3101-1869
T1	9100-3882	TRANSFORMER: POWER	28480	9100-3882
W2	03570-61625	CABLE ASSY	28480	03570-61625
		MISCELLANEOUS PARTS		
Δ_1 Δ_3	03552-00221	PANEL, FRONT	28480	03552-00221
Δ_1	03552-00212	PANEL, FRONT, SUB	28480	03552-00212
	03551-01201	BRACKET, PRIMARY POWER MOUNTING	28480	03551-01201
	03551-01202	CLAMP, CABLE	28480	03551-01202
	03551-04101	INSULATOR, LINE V	28480	03551-04101
	03551-04301	PLATE, PC BOARD MOUNTING	28480	03551-04301
	03551-23701	ROD, AUTO OFF	28480	03551-23701
	03552-64101	COVER ASSY	28480	03552-64101
	03552-64501	CASE ASSY	28480	03552-64501
	0370-1003	KNOB, MONITOR VOLUME	28480	0370-1003
	0370-1005	KNOB, IMP & SEND LEVEL RANGE	28480	0370-1005
	0370-1099	KNOB, SEND FREQUENCY RANGE KNOB, RECEIVE NOISE TONE KNOB, NOISE WEIGHTING	28480	0370-1099
	0370-1303	KNOB, SEND FREQUENCY VERNIER	28480	0370-1303
	0370-1318	KNOB, FUNCTION	28480	0370-1318
	0370-2486	PUSHBUTTON, COVER HOLD	28480	0370-2486
	0370-2497	PUSHBUTTON, COVER;POWER, DISPLAY & MONIT	28480	0370-2497
	0370-2627	KNOB ASSY, SEND LEVEL VERNIER	28480	0370-2627
	1251-3167	CONNECTOR; 4-CONT; FEM; POST TYPE	27264	09-50-3061
	1251-3301	CONNECTOR; 8-CONT; FEM; POST TYPE	28480	1251-3301
	1460-1341	SPRING WFRM STL	28480	1460-1341
	4040-1092	LENS DISPLAY	28480	4040-1092
	5040-7695	MOUNT, SPEAKER	28480	5040-7695
	5060-7452	DIAL CONT ASSY	28480	5060-7452
	525C-49A	HANDLES	28480	525C-49A
	8120-1348	CABLE, POWER	28480	8120-1348
	9160-0229	SPEAKER	28480	9160-0229
Δ_2	03551-65001	LOCK	28480	03551-65001

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

REFERENCE DESIGNATOR	-hp- PART NO.	DESCRIPTION	MFR.	MFR. PART NO.
		HANDLE, CARRYING (CONSISTS OF THE FOLLOWING PARTS):		
	1440-0071	HANDLE-PLSTC 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 .094-THK	28480	2260-0001
	2190-0004	WASHER-LK INTL T NO. 4 .115 IN ID .27 IN	U1453	1904
Δ_1	03551-24710	HOUSING, LOCK	28480	03551-24710
Δ_1	03551-24901	HANDLE, LOCK	28480	03551-24901
Δ_1	03551-27901	SCREW, LOCK	28480	03551-27901
Δ_1	0370-1810	KNOB, LEVER SW, JADE GRAY (STD)	28480	0370-1810

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 . . . . . MAINS

b. Connect a 745A ac calibrator to the Test Set input terminals.

c. Adjust the ac calibrator to 1 kHz at a level of .7746 V.

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 an oscilloscope. The oscilloscope should indicate an 85 mV p-p sine wave at 1 kHz. If the reading is bad refer to the analog troubleshooting section. The malfunction is most likely to have occurred on the A3 board.

g. Measure A1TP12 with the 180C Oscilloscope. The oscilloscope should indicate a 1 kHz square wave 4 V p-p. If

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

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

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

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

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

NOTE

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

NOTE

In order to test the Noise Weighting Filters Response accuracy to one decimal place, it is necessary to move a jumper within the instrument. With the 3552A disconnected from mains, release the cover as shown in Figure 5-12 and slide the cover back approximately three inches. Change the position of "Jumper for dBrn Resolution" (see Figure 5-16) from the N position to the 3 position. Be sure to return this jumper to the N position after completing the Noise Weighting Filter tests. Some instruments with serial number suffix below 00111 do not have this jumper, and consequently can be tested only to integer number resolution.

Table 7-1. Receive Tone Test Points.

Test Point	Reading AC	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	

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

b. Set the Test Set front panel controls to:

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

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

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

NOTE

If incorrect voltage readings are obtained at the test points, refer to Schematics 4 and 5 for component level troubleshooting. Correct readings at all tested points indicated that the problem is most likely to be found in the logic section of the A1 board. Refer to the Digital Troubleshooting Section.

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 r, 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

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

NOTE

The NOISE WEIGHTING FILTERS should check good before proceeding.

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

b. Set the Test Set controls as follows:

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

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

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

NOTE

If incorrect voltage readings are obtained at any test points, refer to Schematic 3 for component level troubleshooting. Correct readings indicate a problem existing on the A1 board, logic section. Refer to the Digital Troubleshooting sections.

Table 7-3. Notch Filters Test Points.

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

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

7-13. Noise to Ground.

NOTE

The NOISE WEIGHTING FILTERS should check good before proceeding.

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

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

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

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

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

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

NOTE

If the initial display readings are flashing between - 22 to - 23 dBm the A1 board is most likely to be bad. If incorrect voltage readings are obtained at any test points, refer to schematics 1 and 3 for component level troubleshooting. Correct voltage readings indicate a problem existing on the A1 board, logic section. Refer to the Digital Troubleshooting section.

7-14. Send Circuits, Troubleshooting Level Problems.

NOTE

The RECEIVE TONE LEVEL should check good before proceeding.

Table 7-4. Noise to Ground Test Points.

Test Point	Reading AC	Reading DC
1. Shorted input terminals	7.768 V	
2. A1W10		+ 1.336 V
3. Input to Attenuator	50.83 mV	
4. A3TP10	0.23 mV	
5. R370 (signal side)	50.85 mV	
6. Q301 Source	50.85 mV	
7. A3TP21	80 mV	
8. A1TP18		- 1.69 V
9. A1TP19	605 mV	- 338 mV

7-15. The Send circuits can be functionally divided into three areas consisting of the (1) Send Oscillator, (2) Send Level Display and (3) the Send Level Output. The troubleshooting procedure first concentrates on isolating the malfunction to one of these three areas, then to isolating the problem within that particular area. A basic block diagram is shown in Figure 7-1.

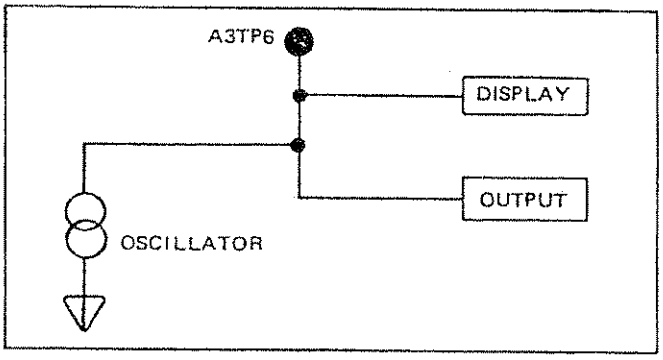


Figure 7-1. Block Diagram of Send Circuitry.

7-16. Isolating the Malfunction to a Specific Area of the Send Circuits.

a. Set the Test Set controls as follows:

FUNCTION
(Black input/output terminals). . . . . SEND
IMP 600
DISPLAY & MONITOR . . . . . .SEND FREQ
HOLD. . . . . OFF
FREQUENCY . . . . . 200 - 6 K range

b. Connect an ac voltmeter to the Test Set left (black) input terminals through a 600 ohm precision load.

c. Adjust the Test Set output frequency to 1 kHz at a level of .775 ± .002 V rms as displayed on the voltmeter.

NOTE

If the output level of .775 V ± .002 V rms cannot be obtained, measure the ac voltage at A3TP6. Adjust the voltage using the Level Vernier for greater than 5 V rms. Then refer to the section on Send Level Output troubleshooting for additional procedures. If the correct voltage at A3TP6 cannot be obtained, refer to the Send Oscillator troubleshooting section for additional procedures.

d. Press the Send Level switch on the Test Set and observe the display for 0 dB ± .1 dB. If the reading is not in tolerance, measure the voltage at A3TP21 for 129 mV rms.

NOTE

A correct measurement at A3TP21 indicates a problem in the Receive Tone Circuitry. If the measurement is out of tolerance, refer to the Send Level Display Troubleshooting section.

7-17. Send Oscillator Troubleshooting.

a. Refer to Paragraph 7-16 for Test Set Setup.

b. Verify the test point voltages and waveforms shown in Table 7-5. Refer to Schematic 2 for component level troubleshooting.

Table 7-5. Send Oscillator Test Points.

Test Point	Reading ACV rms	Reading Oscilloscope p-p
1. A3TP4	2.9 V	10 V p-p (triangular wave)
2. A3W1	570.5 mV	1.7 V p-p (sine wave)
3. A3TP5	2.3 V	6.6 V p-p (sine wave)
4. Pin 2, U201	1.03 V	3.8 V p-p (triangular wave)
5. Pin 3, U204	417 mV	1.5 V p-p (triangular wave)

7-18. Send Level Output Troubleshooting.

a. Refer to Paragraph 7-16 for the 3552A setup.

b. Using the level control, adjust the voltage at A3TP6 for a 1.04 V rms output on the ac voltmeter.

c. Measure the voltages at the test points shown in Table 7-6. Refer to Schematic 2 for component level troubleshooting when a measurement is out of tolerance.

Table 7-6. Send Oscillator Level Test Points.

Test Point	Reading AC
1. R210	2 V
*2. Pin 3 to Pin 4	775 mV
3. A3TP7	1.04 V

*These pins are connected to wires 95 and 96 located on top center of the function switch.

7-19. Send Level Display Troubleshooting.

a. Refer to Paragraph 7-16 for the 3552A setup.

b. Using the level control, adjust the voltage at A3TP6 for a 1.04 V rms reading on the ac voltmeter.

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	540 mV
2. Q304 Source	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 . . . . . .MAINS

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

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

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 A3Q21 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

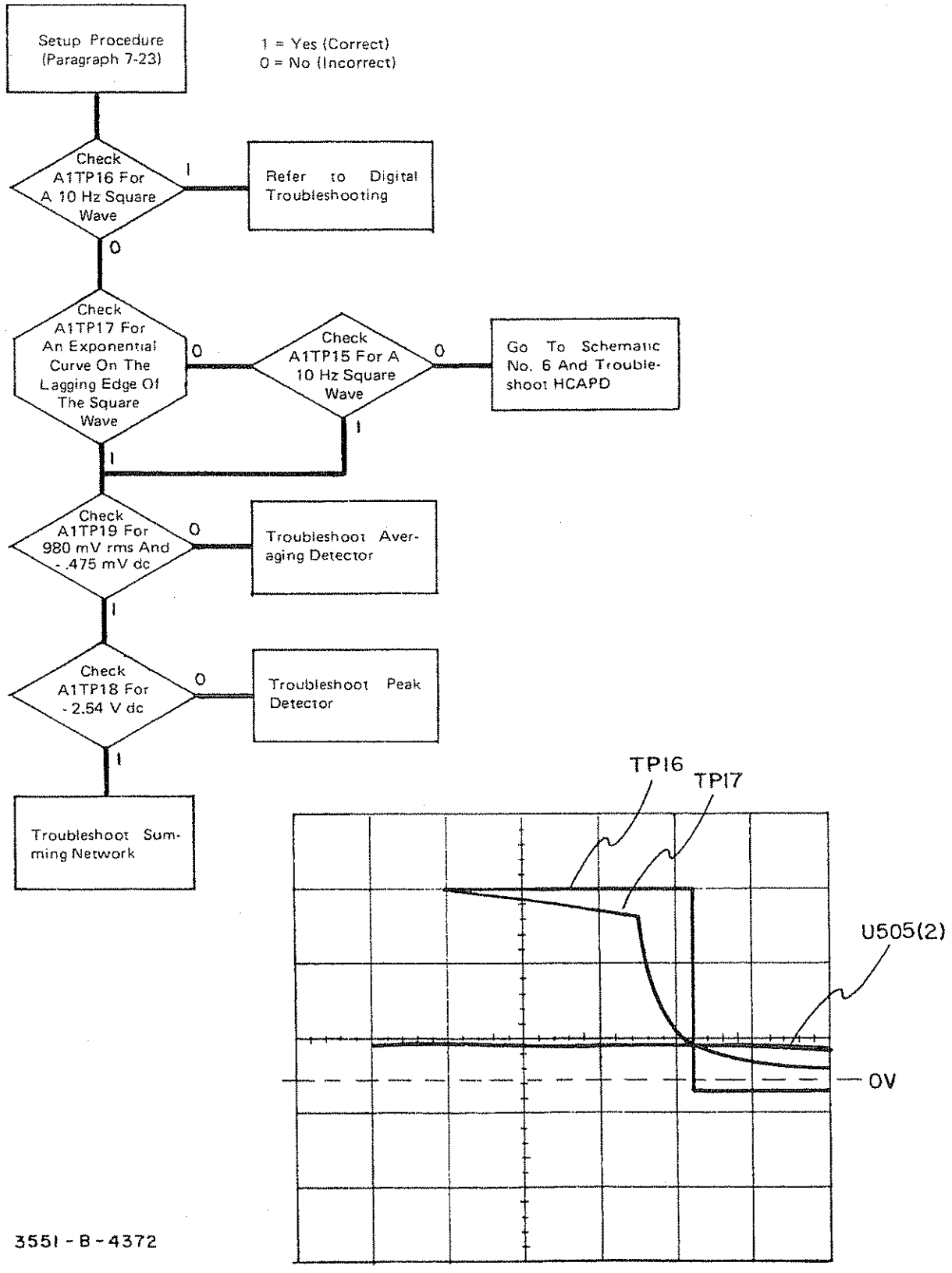


Figure 7-2. Measure Circuit Troubleshooting Flow Chart.

period). The instructions performed are listed inside the box. The diamond signifies a decision made during the state. The information which the decision is based upon is written in the diamond. The decision is represented by a binary "1" or "0". In the example "1" signifies a yes decision and "0" signifies a no decision.

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

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

Example No. 1.

Octal Code 001

0	0	1	octal
0	000	001	binary
	binary equivalent		0000001

Example No. 2.

Octal Code 156

1	5	6	octal
1	101	110	binary
	binary equivalent		1101110

Example No. 3.

Octal Code 077

0	7	7	octal
0	111	111	binary
	binary equivalent		0111111

Example No. 4.

Binary Number 1010101

1	010	101	binary
1	2	5	octal
	octal equivalent		125

Example No. 5.

Binary Number 0101010

0	101	010	binary
0	5	2	octal
	octal equivalent		052

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

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

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

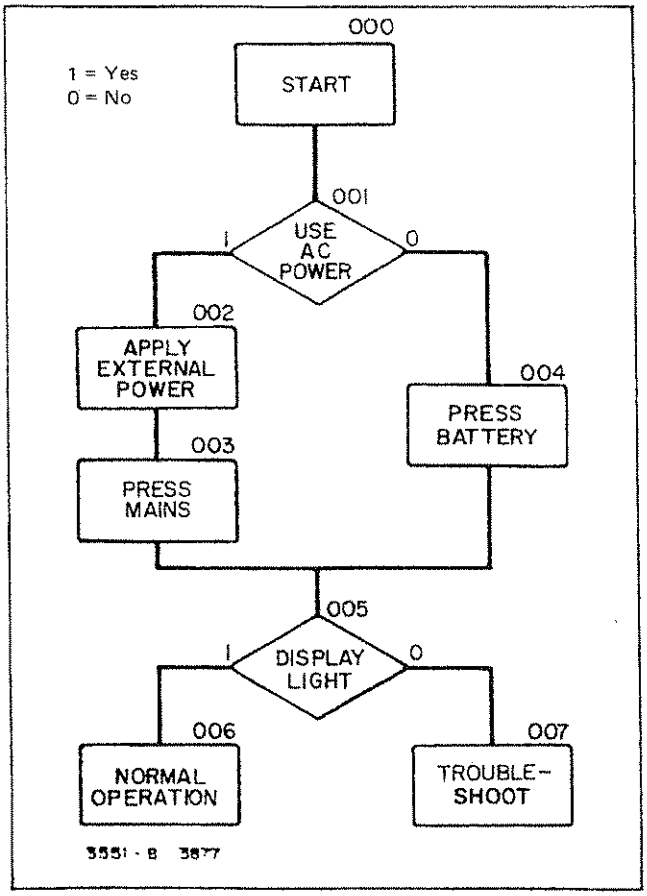


Figure 7-3. Hypothetical Flow Chart.

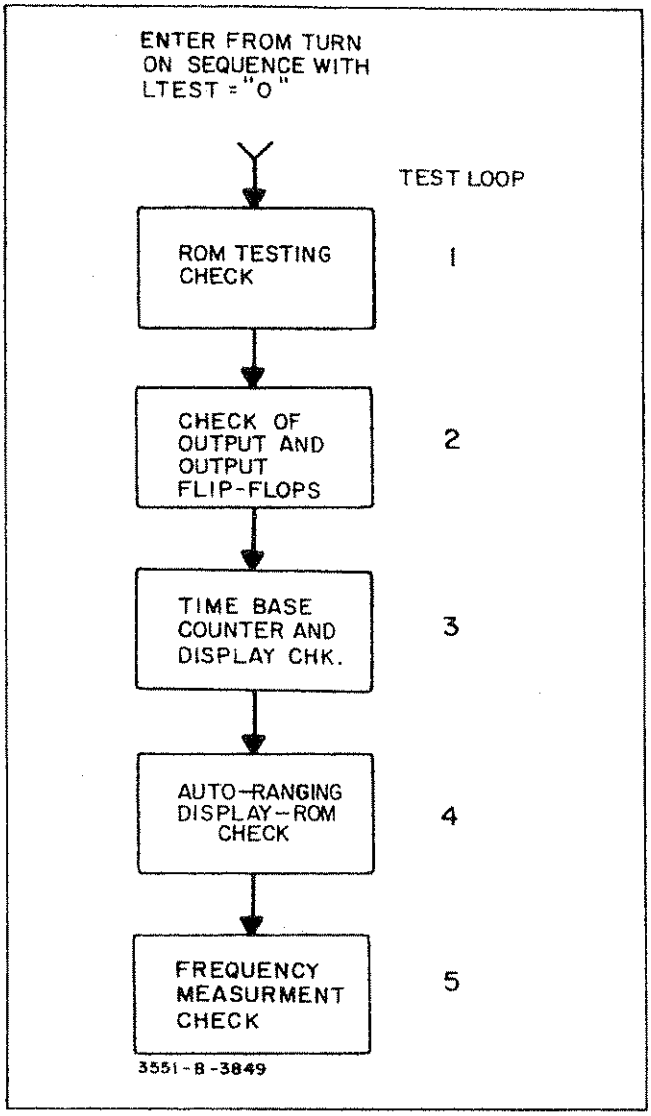


Figure 7-4. Basic Test Loop Block Flow Chart.

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

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

a. Connect the 180C/1601A Logic State Analyzer 6 Bit Data Probes, Part No. 10231A, to A1U602 and A1U603 as shown below.

NOTE

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

Data Probe	IC	IC Pin No.
Bit 0	A1U602	6
Bit 1	A1U602	5
Bit 2	A1U602	4
Bit 3	A1U602	3
Bit 4	A1U603	3
Bit 5	A1U603	4
Bit 6	A1U603	5
Bit 7		TP7

b. Connect the 180C/1601A clock probe to A1TP4.

c. Set the 180C/1601A trigger word to the selected octal code for the 3552A Test Loops.

Table 7-8. Qualifier Signals to Control ROM.

Qualifier	Meaning	Origin
*LFREQ	(L)FREQ = 0, display in frequency mode	Display select switches
LNGND	(L)NGND = 0, receive section in noise to gnd	Receive function switch
ARNG0	Least significant range bit	
ARNG1	Second most significant range bit	Range counter A1U621.
ARNG2	Most significant range bit	
HOVFW	Counter overflow	A1U618
HXOVR	Crossover, logger circuit comparison	A1U614 (12)
HSIGN	Polarity sign on if HSIGN = "1"	Flip flop A1U617
ATMBS	Time base.	Clock circuit A1U612
L1000	Counts in counter less than 1 K	Display section A1U612
L<900	Counts in counter less than 900	
H10KH	Freq counter in 10 kHz range	Flip flop A1U509
LTEST	Instrument in test mode	Board Jumper Point TP8 Held high in 3551A
LREMT	Instrument in remote operation	
L3552	For European design, held high in U.S. version 3551A	

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

NOTE

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

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

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

Signal	Meaning	Origin
HCAPD	Logger capacitor charge signal	A1U603
HFLAG	ROM general control signal	A1U601
ATMB1	Least significant time base programming bit	A1U611 B2 B1 Time 0 0 5 ms 0 1 50 ms 1 0 500 ms 1 1 5000 ms
ATMB2	Most significant time base programming bit	
HSRST	Set reset controls HTBRT and HCTRT	A1U606
HTBRT	Time base reset	A1U611
HCTRT	Counter reset	
HSCLK	Set clock controls HC100 and HCFRQ	A1U606
HC100	Selects 100 kHz clock to counter U701	A1U615
HCFRQ	Selects measured frequency to counter U701	
HTXFR	Data transfer pulse to counter U701	A1U606
HRNGC	Clocks or steps autorange counter U621	A1U606
HFRQC	Clocks or steps frequency range U509	A1U606
H10KH	10 kHz freq range	A1U509
H100K	100 kHz freq range	A1U509
HSBLK	Set blank controls LBLNK	A1U606
HBLNK	Blanks display	A1U611 (2)
HSPOL	Set polarity, polarity control	A1U606
HENAB	ROM output enable	A1U601 (13)
AQSLT	Qualifier block select "1" - U608 "0" - U609	A1U601 (11)
ASELA ASELB ASELC	Coded ROM output and qualifier select lines	A1U601 pins (18, 12, 17)

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

7-38. Operational Troubleshooting Procedure. The operational troubleshooting procedure is designed for troubleshooting the Test Set while it is in normal operating conditions. This procedure uses the normal operating flow charts and a logic analyzer such as the -hp- Model 1601A. The logic analyzer will monitor the operation of the controller step-by-step as outlined on the flow charts.

NOTE

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

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

Table 7-10. Other Control Signals.

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

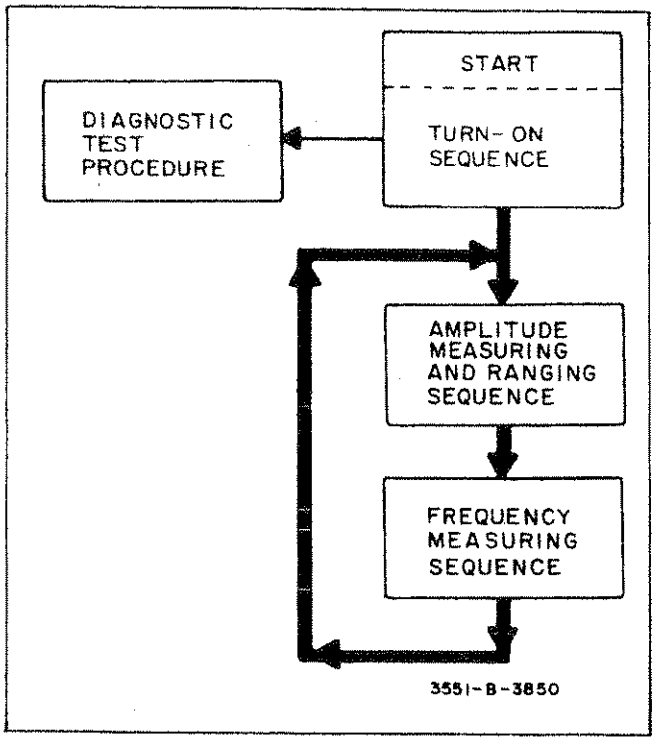


Figure 7-6. Operational Block Flow Chart.

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

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

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

7-43. Connect the logic analyzer as follows:

Logic Analyzer Inputs	Test Set Signals
Bit 0	Address bit I_0
Bit 1	Address bit I_1
Bit 2	Address bit I_2
Bit 3	Address bit I_3
Bit 4	Address bit I_4
Bit 5	Address bit I_5
Bit 6	Address bit I_6
Bit 7	Address bit I_7
grnd	grnd
clock	100 kHz TX601 pin 10 U602 pin 7

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

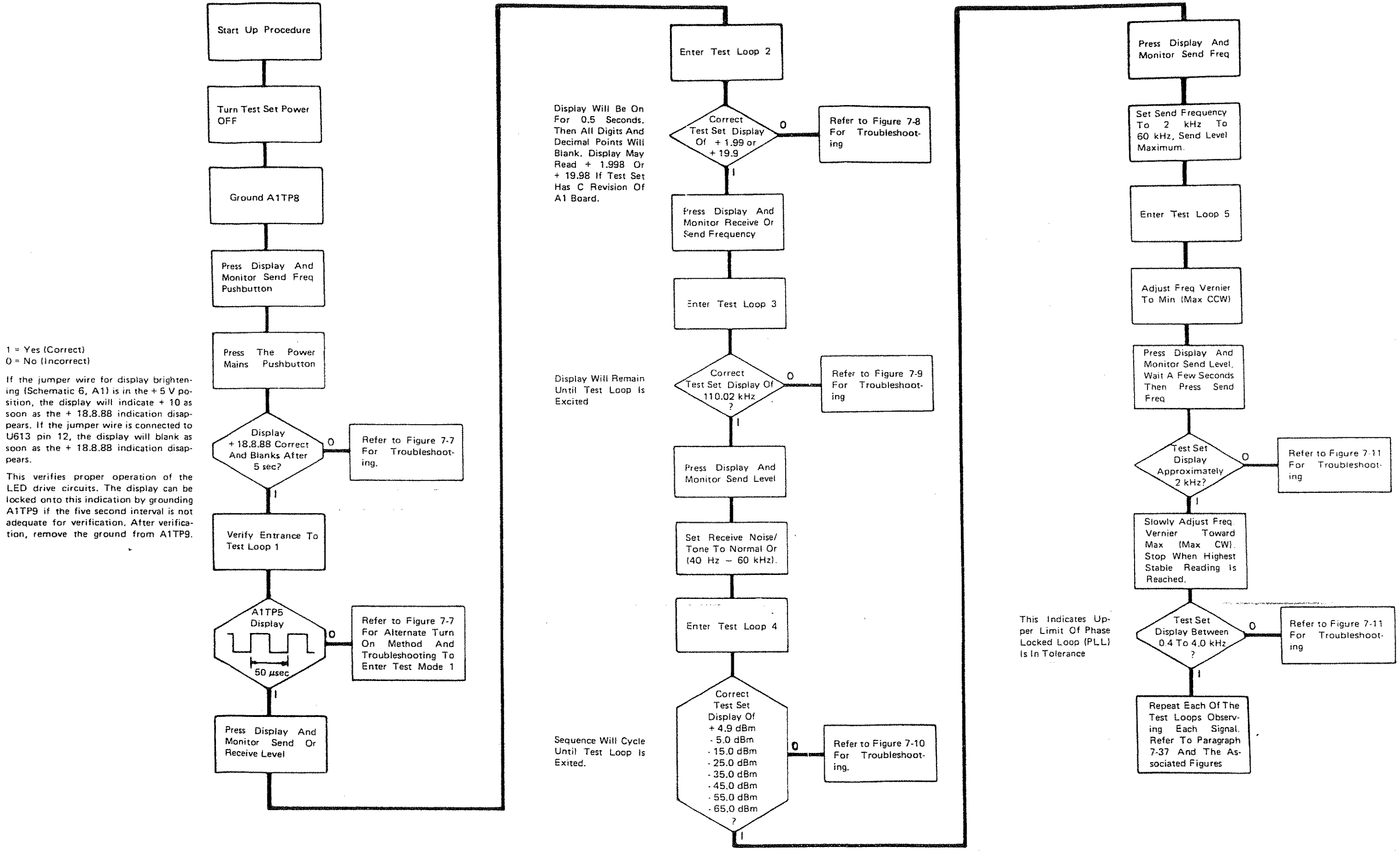


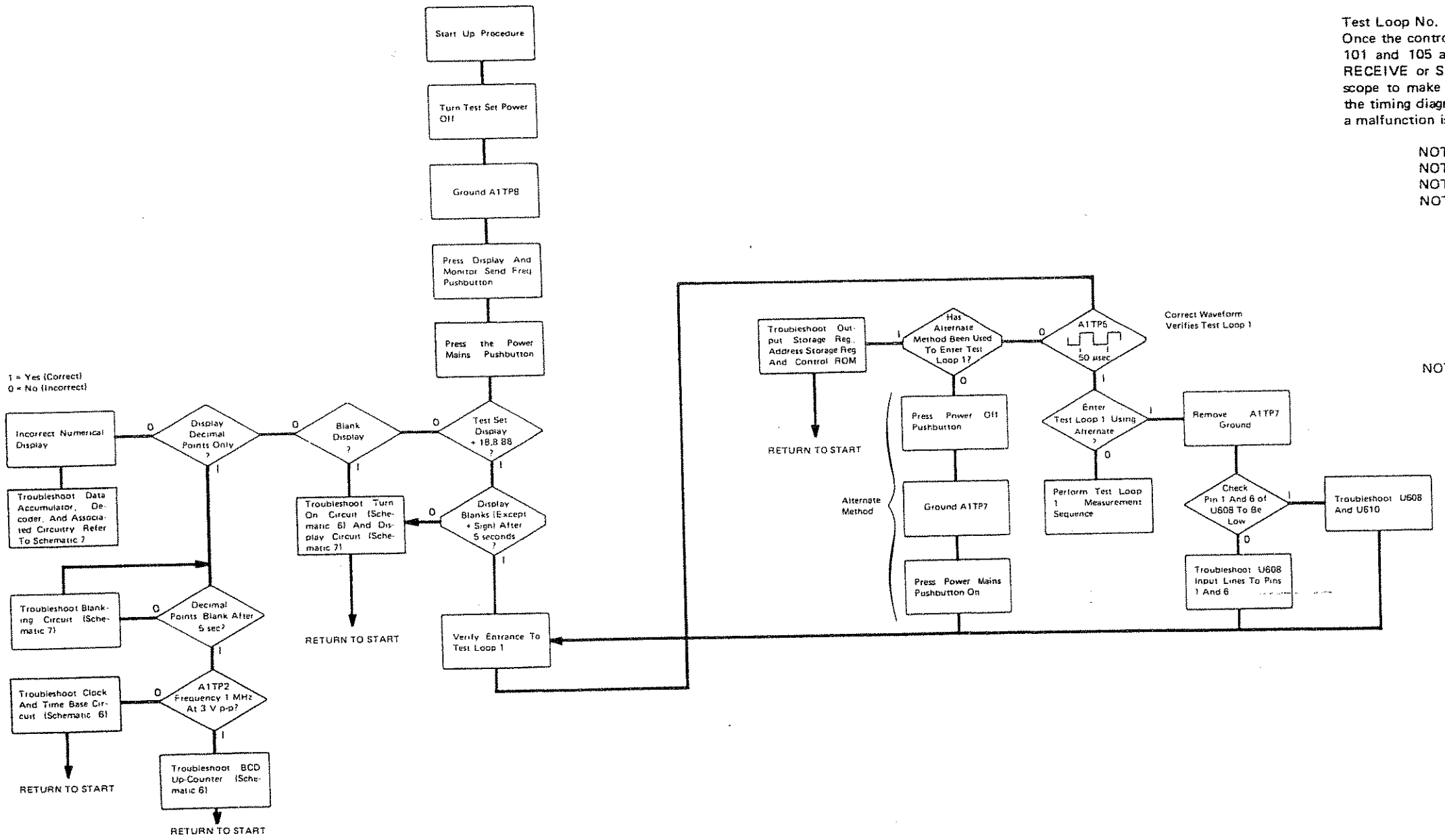
Figure 7-5. Simplified Test Loop Flow Chart.

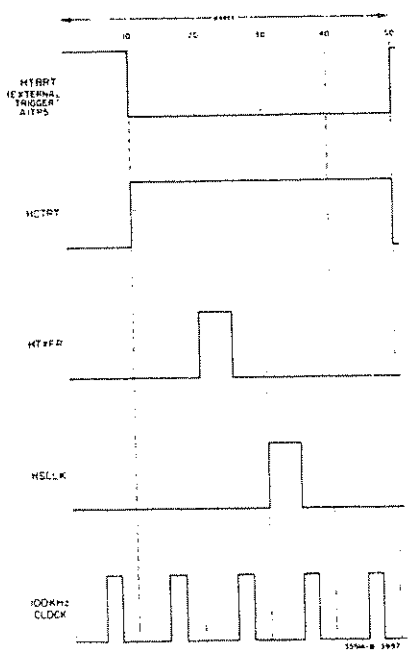
INTRODUCTION.

Test Loop No. 1 verifies the occurrence of the ROM timing signals. Once the controller has entered the loop, it will run between states 101 and 105 as long as LFREQ is low (DISPLAY & MONITOR RECEIVE or SEND FREQ pushbutton is pressed). Use an oscilloscope to make the checks listed in Notes 1 through 4 as shown in the timing diagram. Externally trigger the oscilloscope at A1TP5. If a malfunction is discovered, it must be corrected before continuing.

NOTE 1. Verify the signal (HTBRT) at A1TP5.
NOTE 2. Verify the signal (HCTRT) at A1U611 pin 4.
NOTE 3. Verify the signal (HTXFR) at A1U606 pin 2.
NOTE 4. a. Verify the signal (HSCLK) at A1U606 pin 3.
b. Verify a 100 kHz clock signal at A1U701 pin 7. If all signals have been verified at this point, exiting Test Loop No. 1 can be achieved by pressing DISPLAY & MONITOR RECEIVE or SEND LEVEL pushbutton. If the alternate entrance procedure was used in Paragraph 7-20, remove the ground from A1TP7.

NOTE 5. The ATMBS 500 state is a 500 msec delay (50,000 clock pulses) between exiting Test Loop No. 1 and entering Test Loop No. 2.





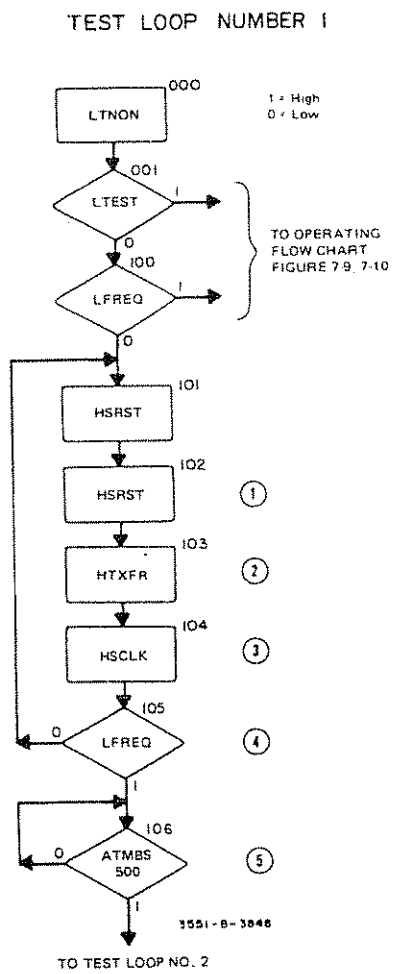


Figure 7-7. Test Loop Number 1.

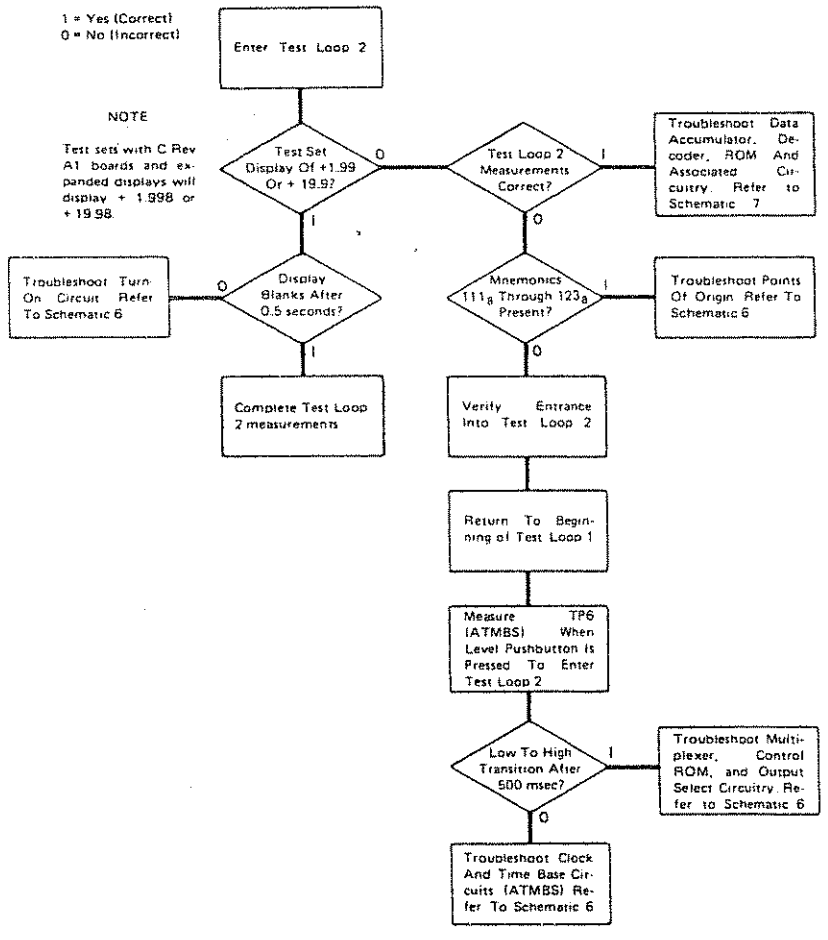
INTRODUCTION.

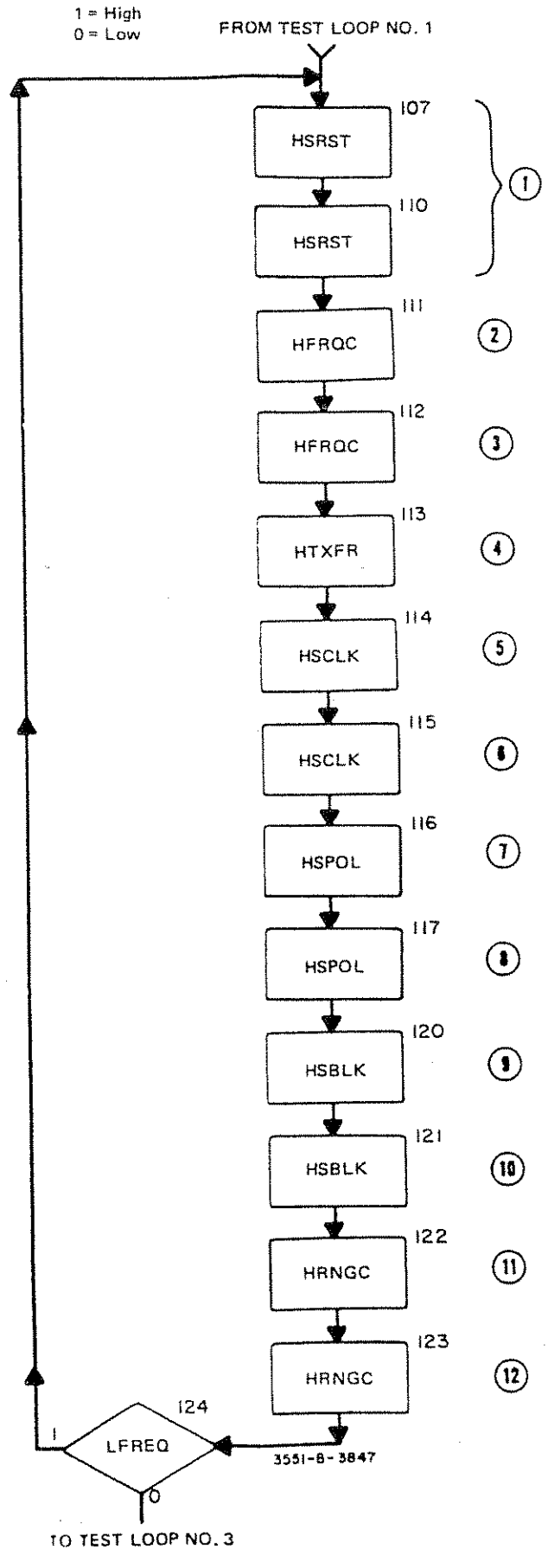
Test Loop No. 2 verifies the operation of the ROM output and the output storage registers. Once the controller has entered the loop, it will run between states 107 and 124 as long as LFREQ is high (DISPLAY & MONITOR RECEIVE LEVEL or SEND LEVEL pushbutton is pressed). There are 13 instruction-states in 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. The troubleshooting flow chart shown in this figure provides possible solutions to problems encountered in Test Loop 2. If a malfunction is discovered, it must be corrected before entering Test Loop 3.

NOTE 1. Signals were verified in Test Loop No. 1.
NOTE 2. Verify HFRQC at A1U606 pin 1.
NOTE 3. Verify H10KH at A1U509 pin 13.
NOTE 4. Verify HTXFR at A1U701 pin 5.
NOTE 5. Verify HSCLK at A1U606 pin 3.
NOTE 6. Verify HC100 at A1U615 pin 1.
NOTE 7. Verify HSPOL at A1U606 pin 4.
NOTE 8. Verify HSIGN at A1U617 pin 1.
NOTE 9. Verify HSBLK at A1U606 pin 6.
NOTE 10. Verify pulse at A1U617 pin 13.
NOTE 11. Verify HRNGC at A1U606 pin 15.
NOTE 12. Verify ARNG0 at A1U621 pin 6.

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





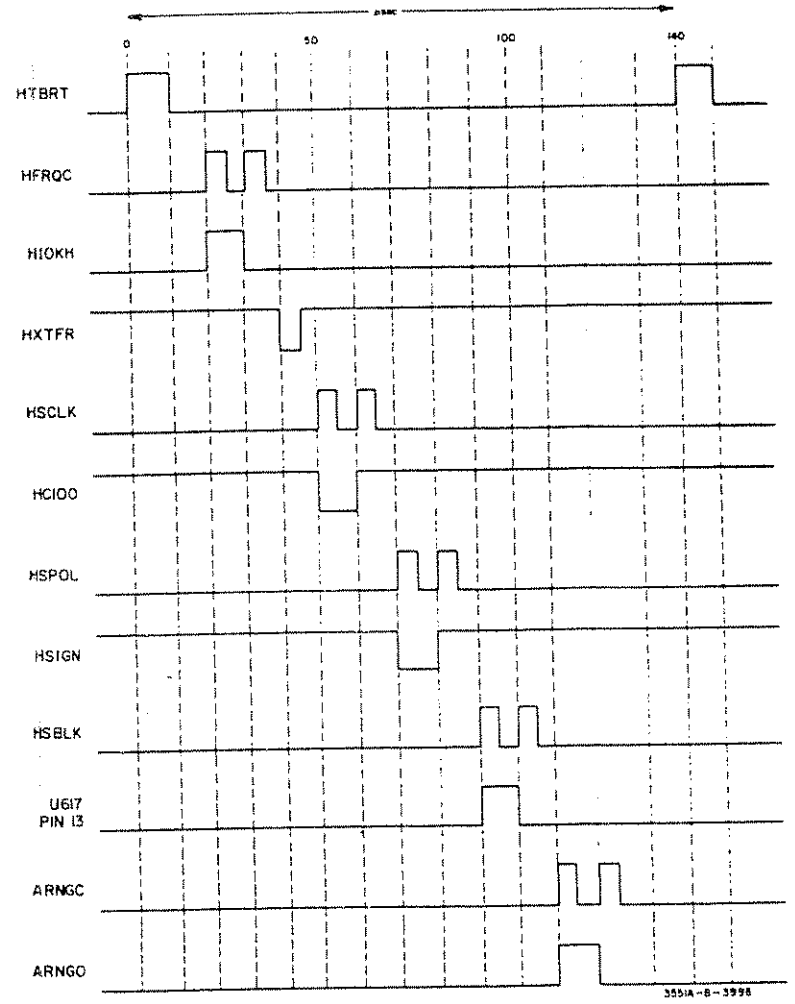


Figure 7-8. Test Loop Number 2.

INTRODUCTION.

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

NOTE 1. Signals were verified in Test Loop No. 1.

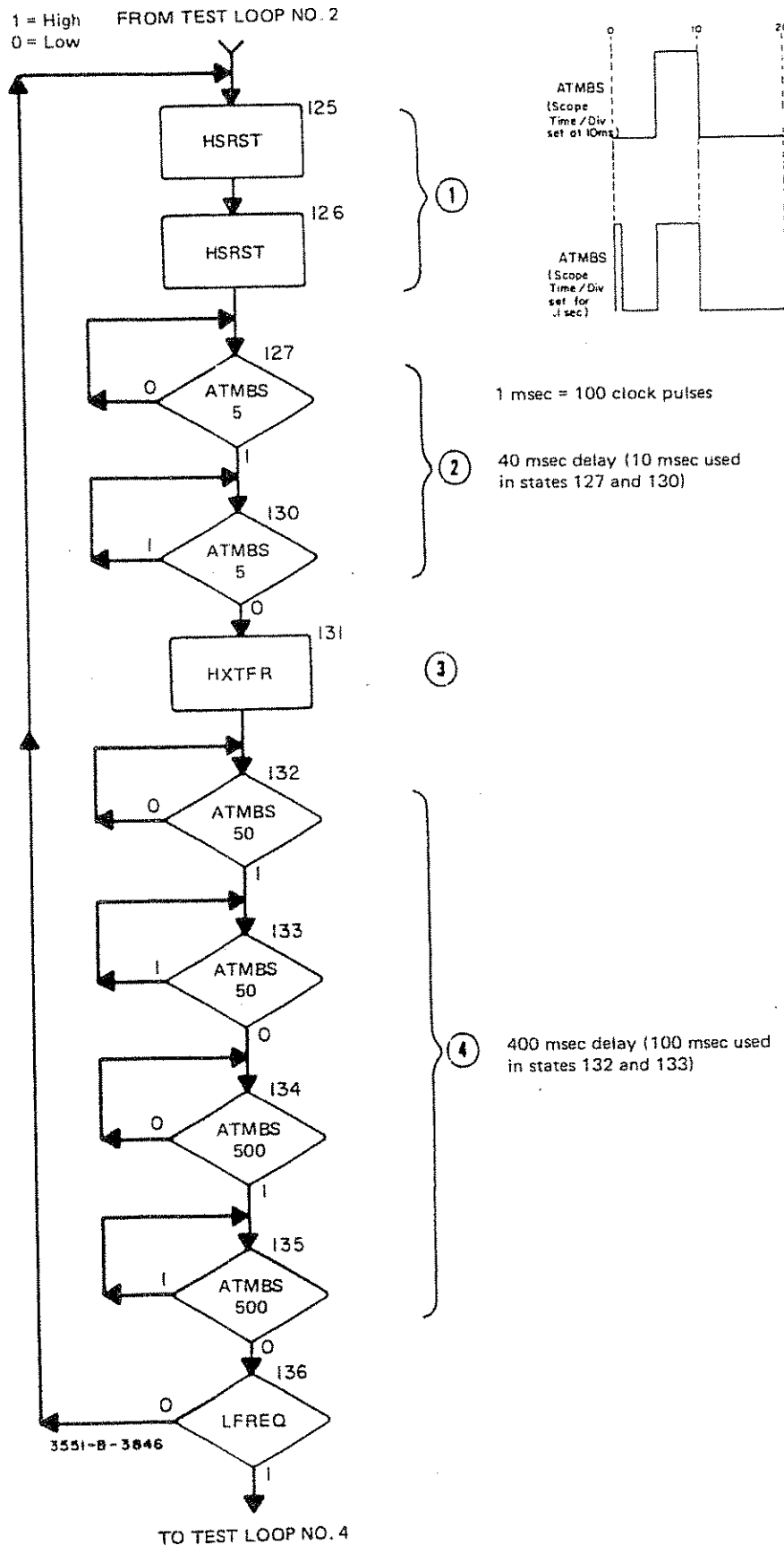
NOTE 2. In states 127 and 130 the controller will exercise HTMB1 and HTMB2 from A1U604. These signals program the programmable time base A1U612. During this exercise the 100 kHz signal will be loaded into the Data Accumulator A1U701 for a 10 msec period (1000 counts).

NOTE 3. a. The HXTFR pulse transfers the 1000 counts to the display. The display indication should be + 110.02.

b. If the display indication is incorrect, verify the ATMBS signal at A1TP6. If this signal is not correct, troubleshoot the time base circuitry. If this signal is correct and the display indication in Step a was incorrect, troubleshoot the display circuitry.

NOTE 4. 1.1 second delay.

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



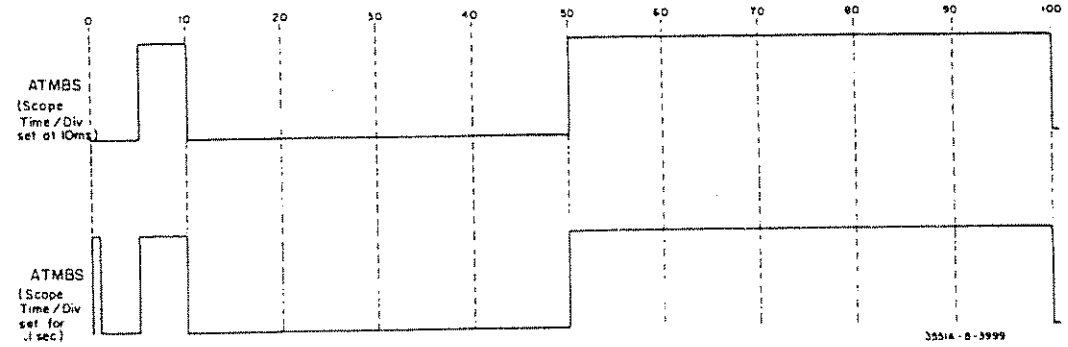


Figure 7-9. Test Loop Number 3.

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.

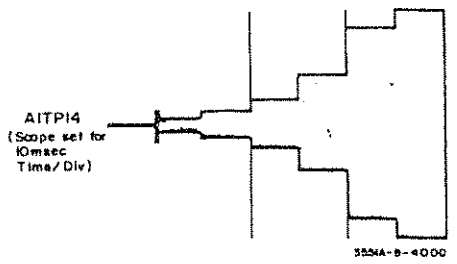
NOTE 3. Connect an oscilloscope to A1U606 pin 15 and verify the signal (HRNGC). Verify ARNG0, ARNG1 and ARNG2 at A1U621 pins 6, 11 and 14 respectively.

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

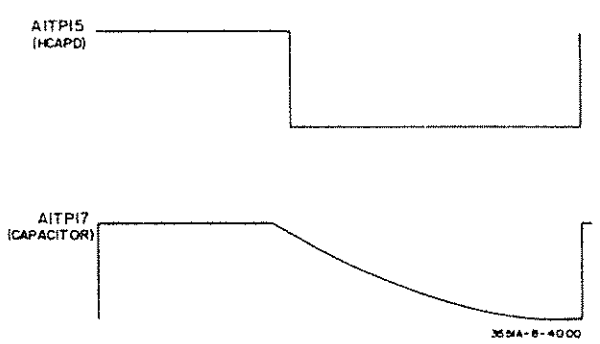
This sequence should repeat as long as LFREQ is high (DISPLAY & MONITOR SEND LEVEL is pressed).

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:

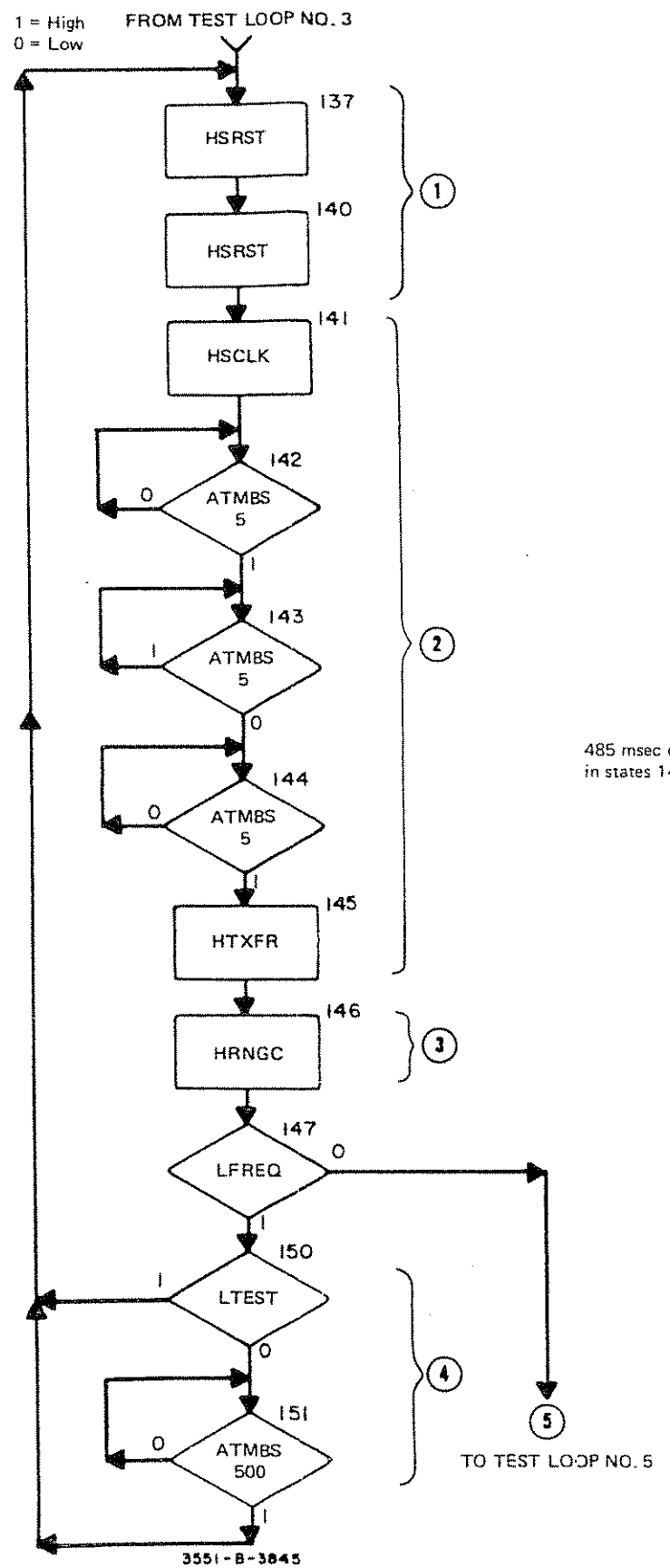


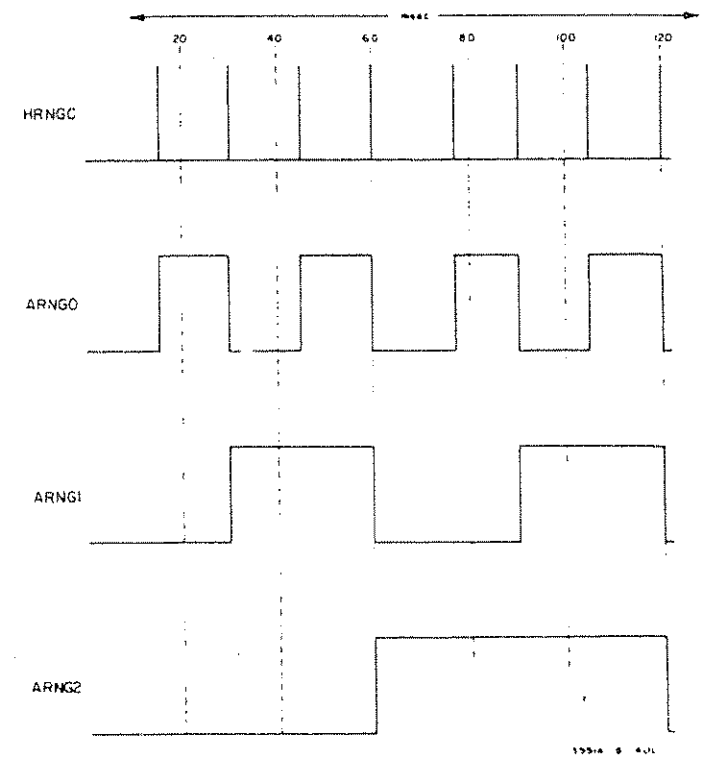
This verifies proper operation of the Range Select Block A3U306.

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.





485 msec delay (15 msec used in states 142 - 144)

Figure 7-10. Test Loop Number 4.

INTRODUCTION.

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

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

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

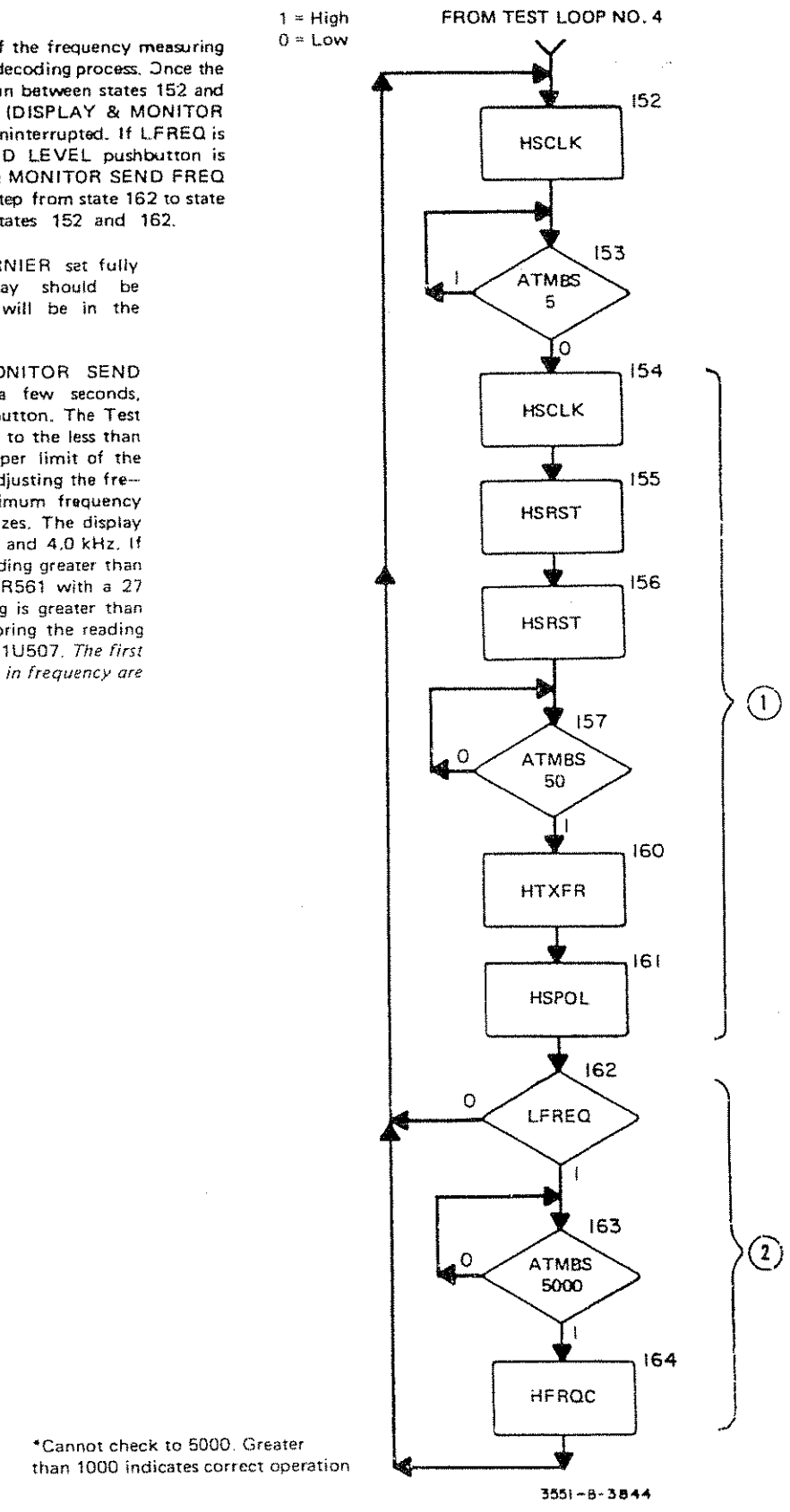


Figure 7-11. Test Loop Number 5.

PROCEDURE:

a. Set POWER to CHARGE (OFF).

b. Set 3552A controls as follows:

HOLD	OFF
FUNCTION LEFT	
TERMINALS	REC TERM
DISPLAY & MONITOR	RECEIVE LEVEL
RECEIVE	TONE/NORMAL
	(40 Hz –60 kHz)
NOISE WEIGHTING	TELEPHONE
SEND FREQUENCY	200 –6 K
FREQUENCY VERNIER	Fully clockwise
LEVEL RANGE	0 to +10
LEVEL VERNIER	Fully counterclockwise
MONITOR	
VOLUME	Fully counterclockwise

c. Set 1601A Trigger Word to 001 (Bit 7 OFF).

d. Connect 1601A inputs as follows:

Bit 0	A1U602 Pin 6
Bit 1	A1U602 Pin 5
Bit 2	A1U602 Pin 4
Bit 3	A1U602 Pin 3
Bit 4	A1U603 Pin 3
Bit 5	A1U603 Pin 4
Bit 6	A1U603 Pin 5
Bit 7 (Qualifier)	A1TP7
Clock (Positive)	A1U603 Pin 7

e. Set 3552A POWER to MAINS.

(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 HXOVR
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) Downrange path for level measurements.

(7) Uprange path for level measurements.

NOTE 1. LREMT should always be High. Not used in 3552A.

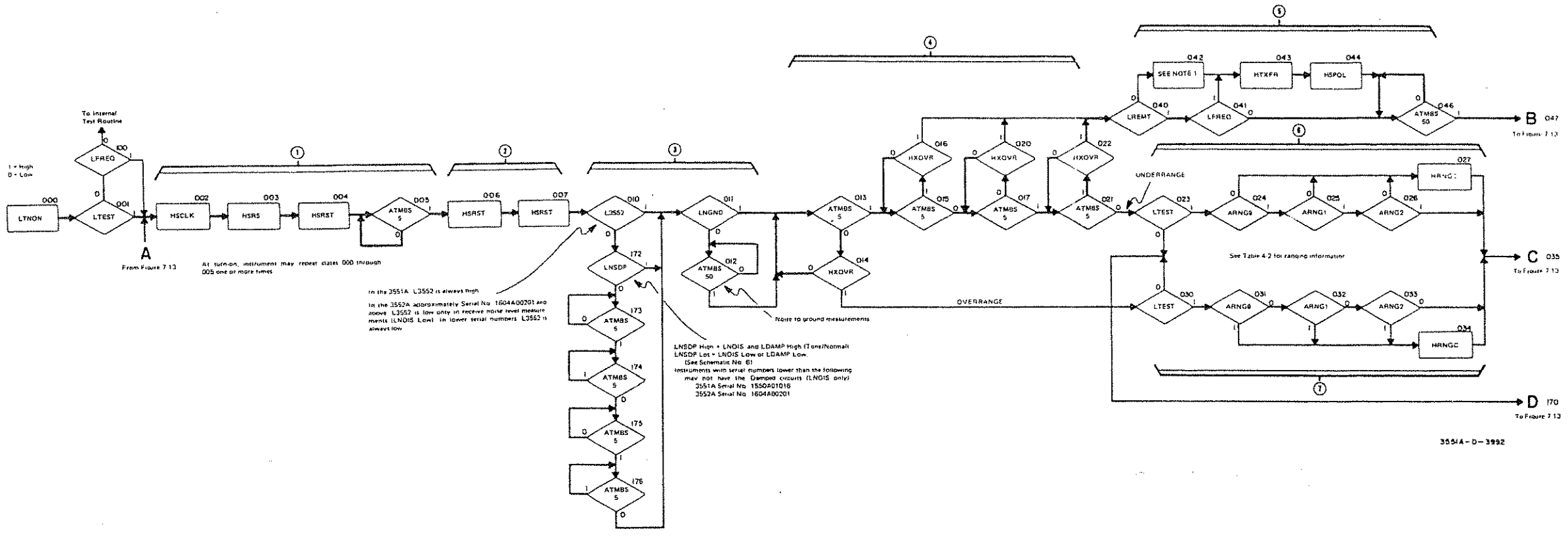


Figure 7-12. p/o Operational Flow Chart.
7-23/7-24

Figure 7-12. p/o Operational Flow Chart.
7-23/7-24

(1) Set counter in Data Accumulator to count input frequency

(2) Wait period of 50 ms for frequency count

(3) LREMT always high in 3552A

(4) Transfer count for frequency measurement.

(5) Detection for frequency downranging.

(6) Detection for frequency upranging.

(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)

NOTE 1 LREMT should always be High. Not used in 3552A

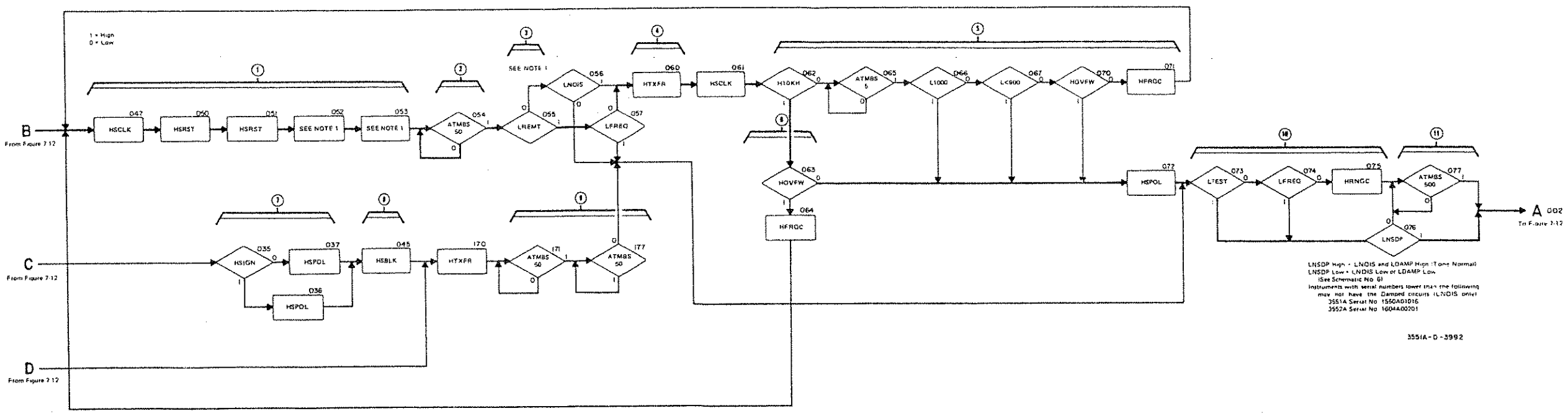


Figure 7-13. p/o Operational Flow Chart.

GENERAL SCHEMATIC NOTES

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.

2. COMPONENT VALUES ARE SHOWN AS FOLLOWS UNLESS OTHERWISE NOTED.
   RESISTANCE IN OHMS
   CAPACITANCE IN MICROFARADS
   INDUCTANCE IN MILLIHENRYS

3. DENOTES EARTH GROUND.
   USED FOR TERMINALS WITH NO LESS THAN A NO. 18 GAUGE WIRE CONNECTED BETWEEN TERMINAL AND EARTH GROUND TERMINAL OR AC POWER RECEPTACLE.

4. DENOTES FRAME GROUND.
   USED FOR TERMINALS WHICH ARE PERMANENTLY CONNECTED WITHIN APPROXIMATELY 0.1 OHM OF EARTH GROUND.

5. DENOTES GROUND ON PRINTED CIRCUIT ASSEMBLY. (PERMANENTLY CONNECTED TO FRAME GROUND).

6. DENOTES FLOATABLE CIRCUIT GROUND.

7. SCREWDRIVER GROUND.

8. DENOTES ASSEMBLY.

9. DENOTES FEEDBACK PATH.

10. DENOTES FRONT PANEL MARKING.

11. DENOTES REAR PANEL MARKING.

12. DENOTES SCREWDRIVER ADJUST.

13. ✳ AVERAGE VALUE SHOWN, OPTIMUM VALUE SELECTED AT FACTORY. THE VALUE OF THESE COMPONENTS MAY VARY FROM ONE INSTRUMENT TO ANOTHER.

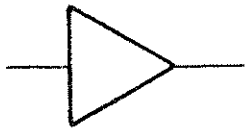
14. DENOTES SECOND APPEARANCE OF A CONNECTOR PIN.

15. \924/ DENOTES WIRE COLOR: COLOR CODE SAME AS RESISTOR COLOR CODE. FIRST NUMBER IDENTIFIES BASE COLOR, SECOND NUMBER IDENTIFIES WIDER STRIP, THIRD NUMBER IDENTIFIES NARROWER STRIP. (e.g. \924/ = WHITE, RED, YELLOW.)

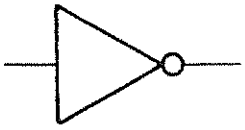
16. ALL RELAYS ARE SHOWN DEENERGIZED.

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

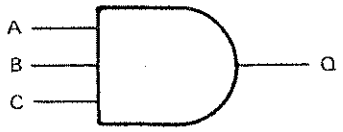
18. DC VOLTAGE LEVELS WERE MEASURED WITH RESPECT TO CIRCUIT GROUND USING A VTVM WITH 10 MEGOHM INPUT IMPEDANCE. THE VOLTAGE LEVELS SHOWN ARE NOMINAL AND MAY VARY FROM ONE INSTRUMENT TO ANOTHER DUE TO CHANGE IN TRANSISTOR CHARACTERISTICS. A VARIATION OF ± 10 % SHOULD BE ALLOWED.



DENOTES BUFFER

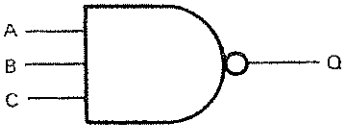


DENOTES INVERTER



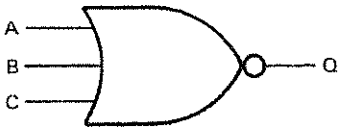
DENOTES AND GATE

A	B	C	Q
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1



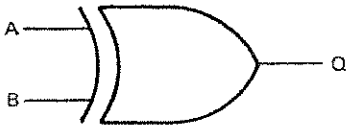
DENOTES NAND GATE

A	B	C	Q
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0



DENOTES NOR GATE

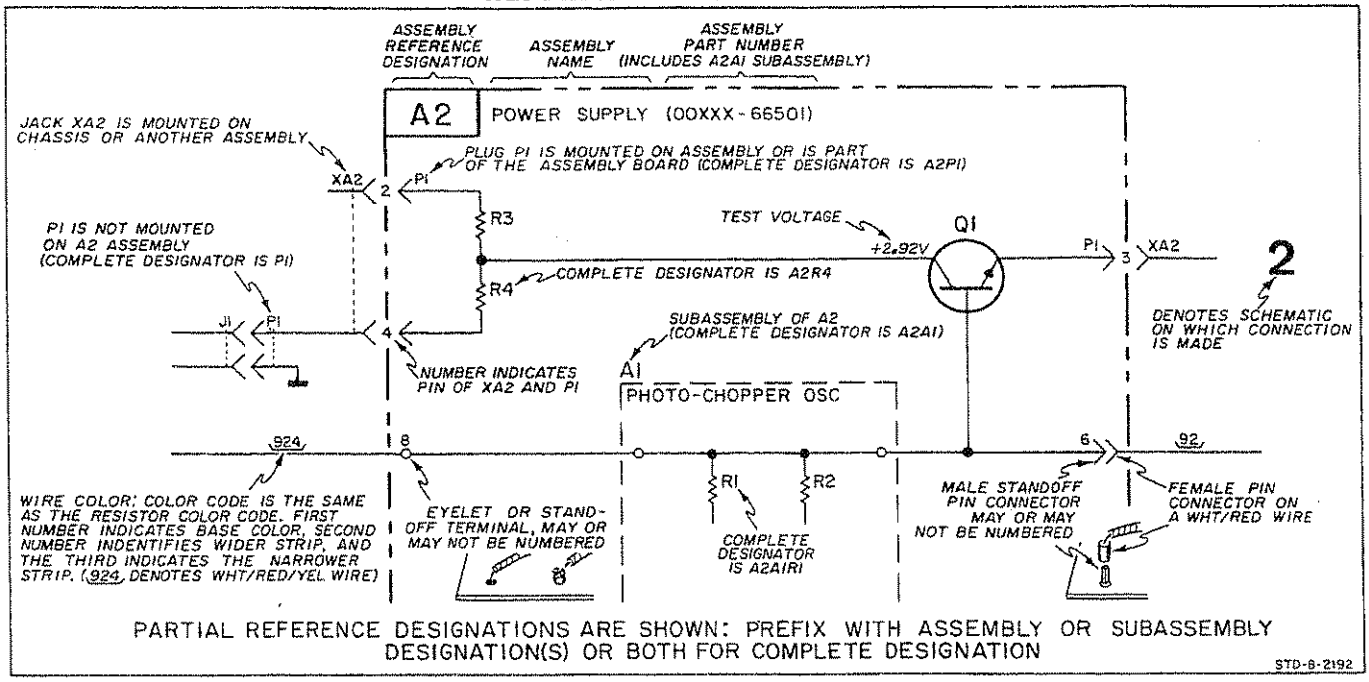
A	B	C	Q
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0



DENOTES EXCLUSIVE OR GATE

A	B	Q
0	0	0
0	1	1
1	0	1
1	1	0

REFERENCE DESIGNATIONS



Set the Test Set front panel controls as follows:

HOLD	OFF
FUNCTION (black input/output terminals)	RFC BRDG
IMP	150
RECEIVE NOISE/TONE	NORMAL
NOISE WEIGHTING	C-MESSAGE
SEND FREQUENCY RANGE Hz	HOLD TONE
SEND LEVEL RANGE dBm	0 to +10
SEND LEVEL vernier	CCW
DISPLAY & MONITOR	RECEIVE FREQ
POWER	MAINS

Apply an input signal of 5 V p-p amplitude into 150 ohms and a frequency of 2000 Hz.

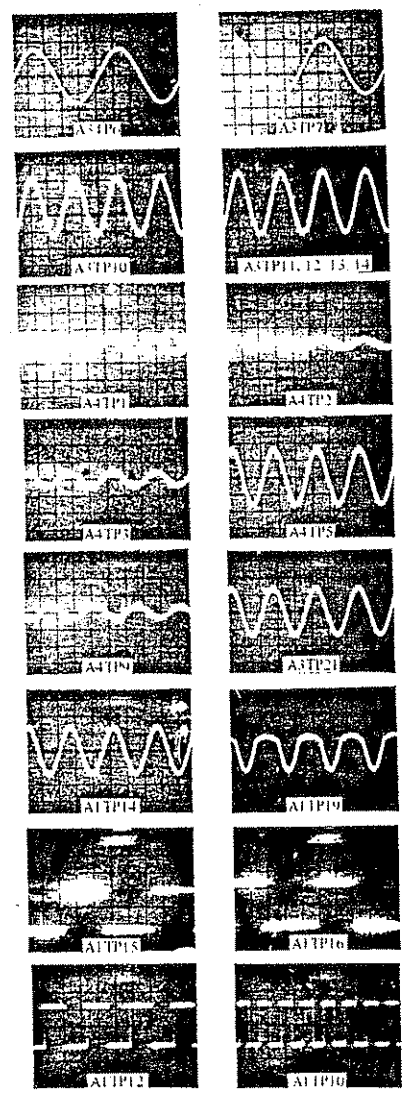
Test Point	Oscilloscope Time/Div	Volts/Div
A3TP2	.2 msec	.5
A3TP3	.2 msec	.5
A3TP4	.2 msec	1
A3TP5	.2 msec	.5
A3TP6	.2 msec	.5
A3TP7	.2 msec	.5

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

A3TP10	.2 msec	1
A3TP11, 12, 13, 14	.2 msec	1

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

A4TP1	.2 msec	.05
A4TP2	.2 msec	.5
A4TP3	.2 msec	1
A4TP5	.2 msec	.05
A4TP8	.2 msec	.05
A3TP21	.2 msec	1
A1TP14	.2 msec	1
A1TP19	.2 msec	1
A1TP15	20 msec	1
A1TP16	20 msec	1
A1TP12	.2msec	1
A1TP10	20 μsec	1



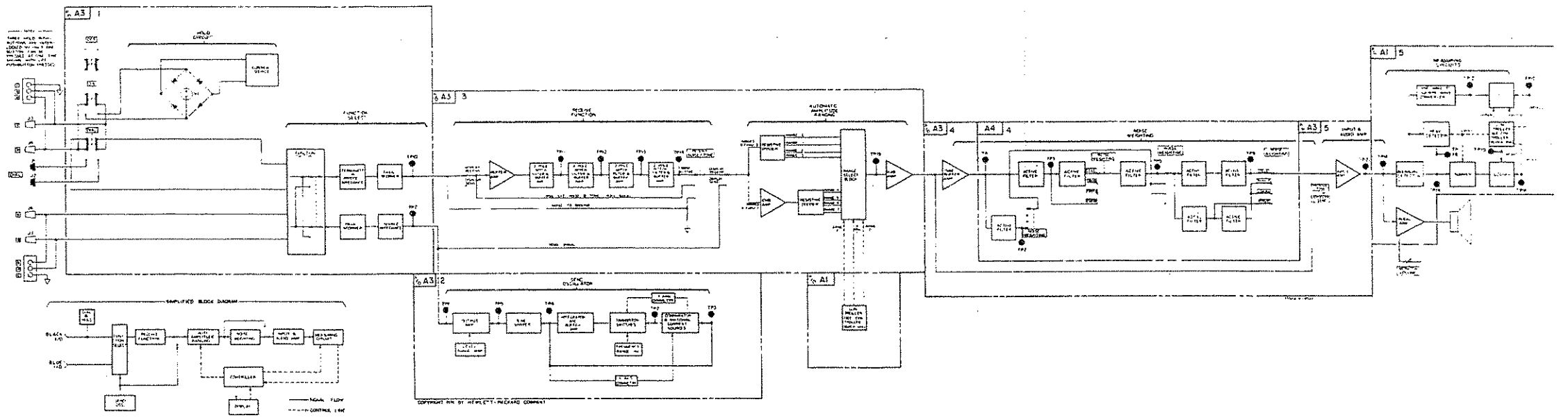


Figure 7-14. Analog Block Diagram.

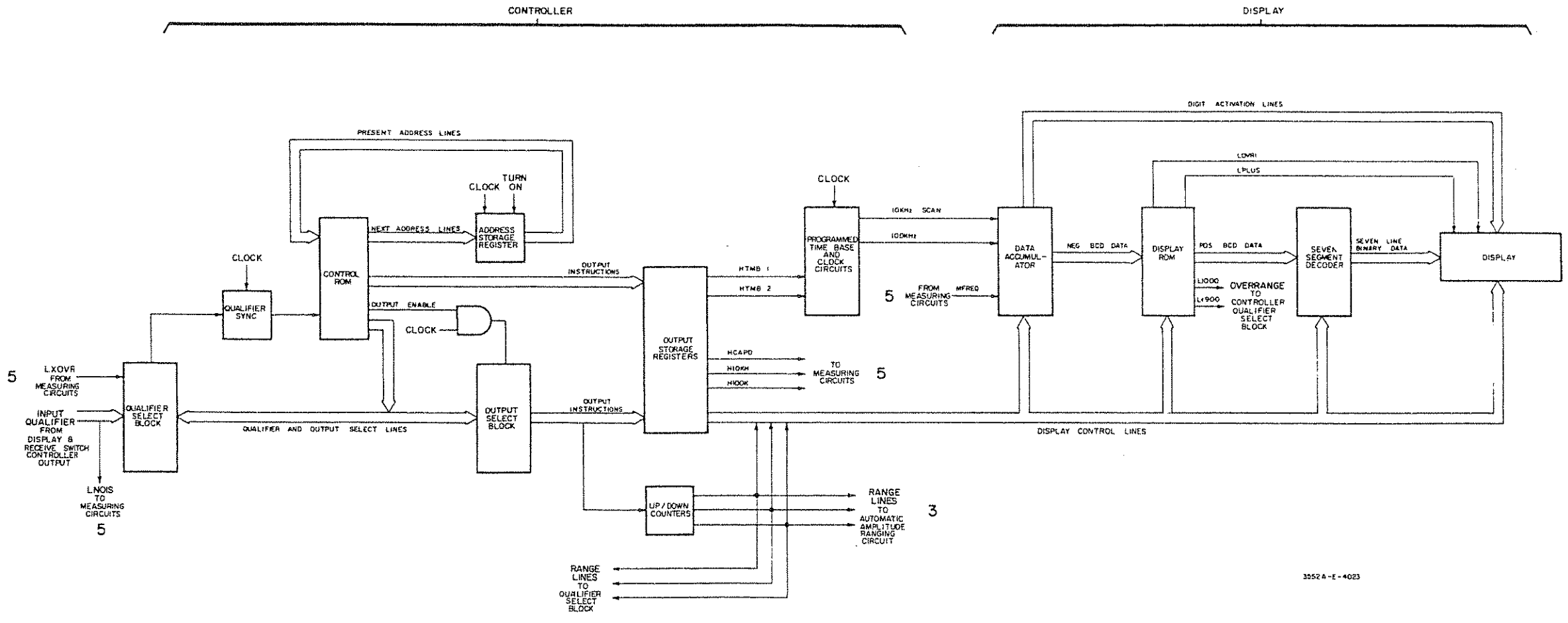
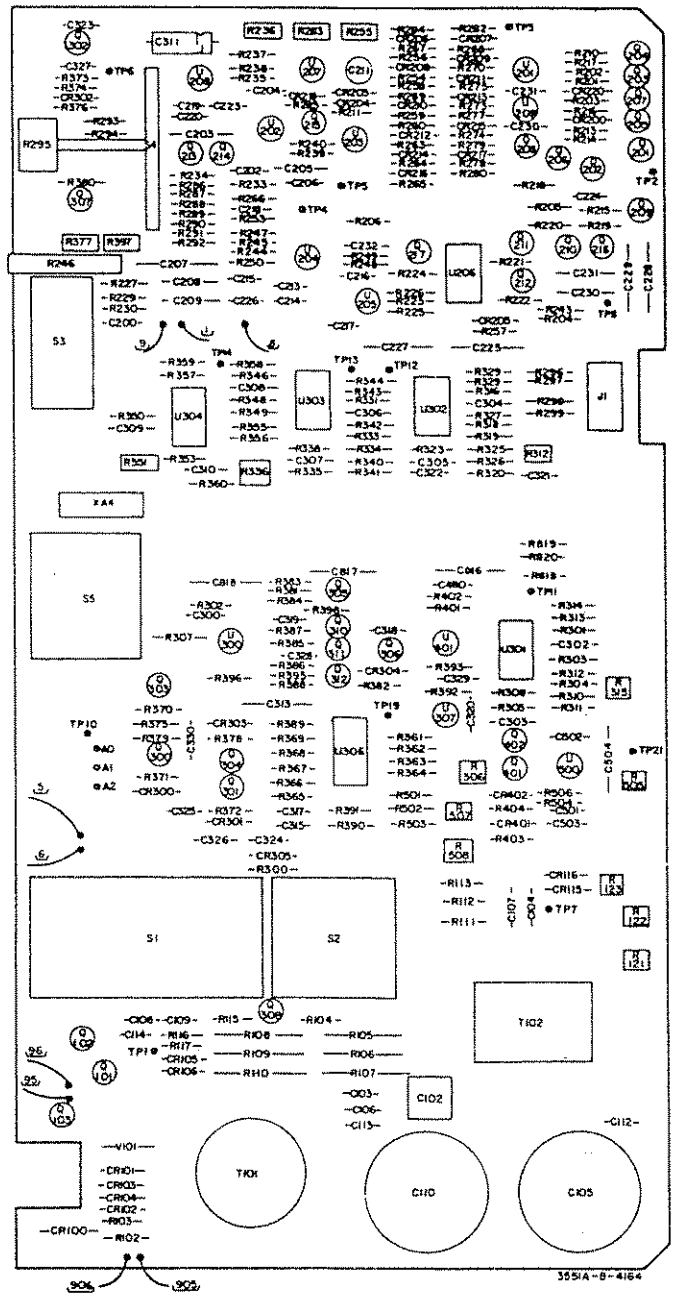


Figure 7-15. Controller and Display Block Diagram.



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-hp- Part No. 03551-66513
Rev B

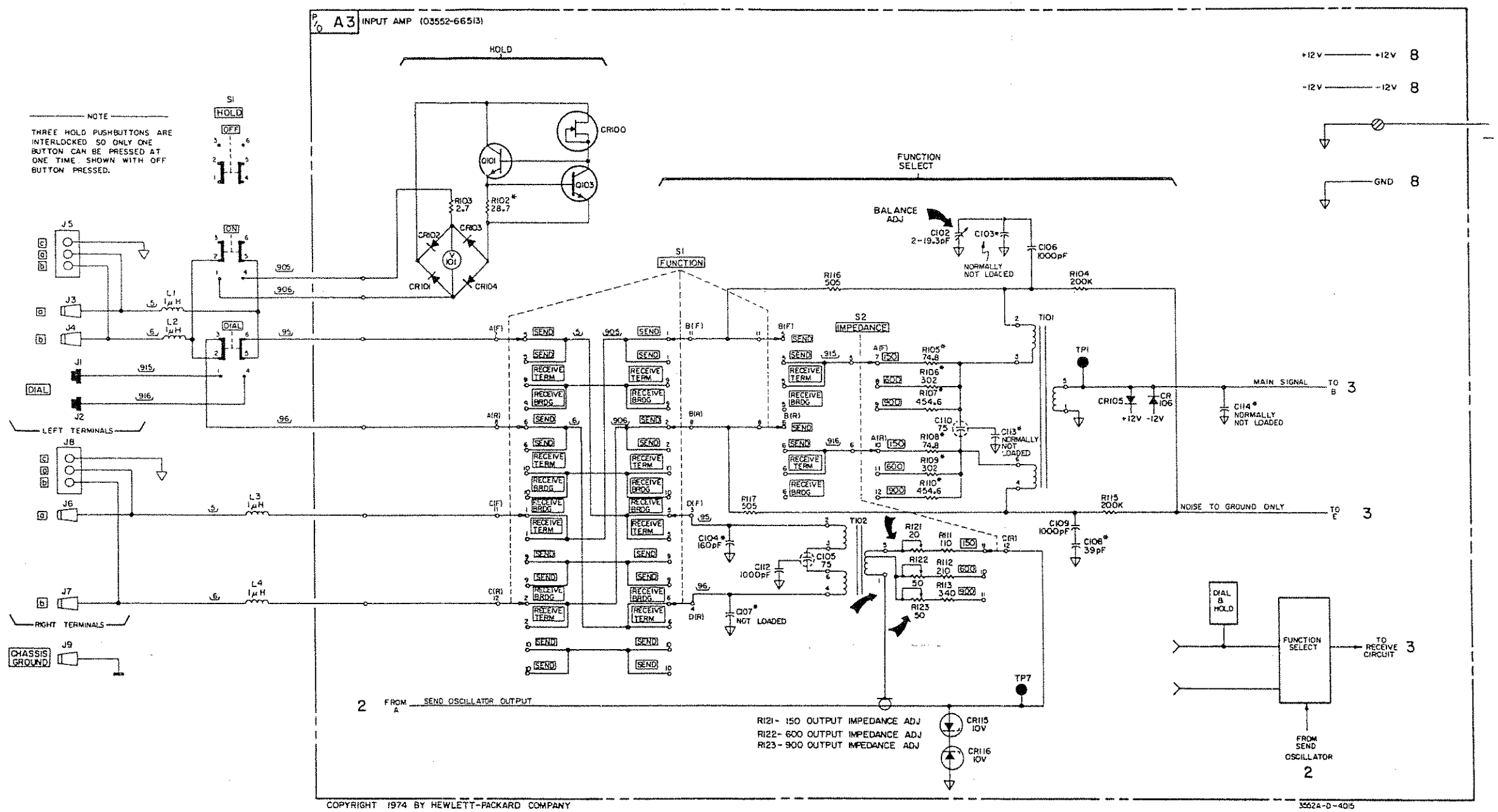
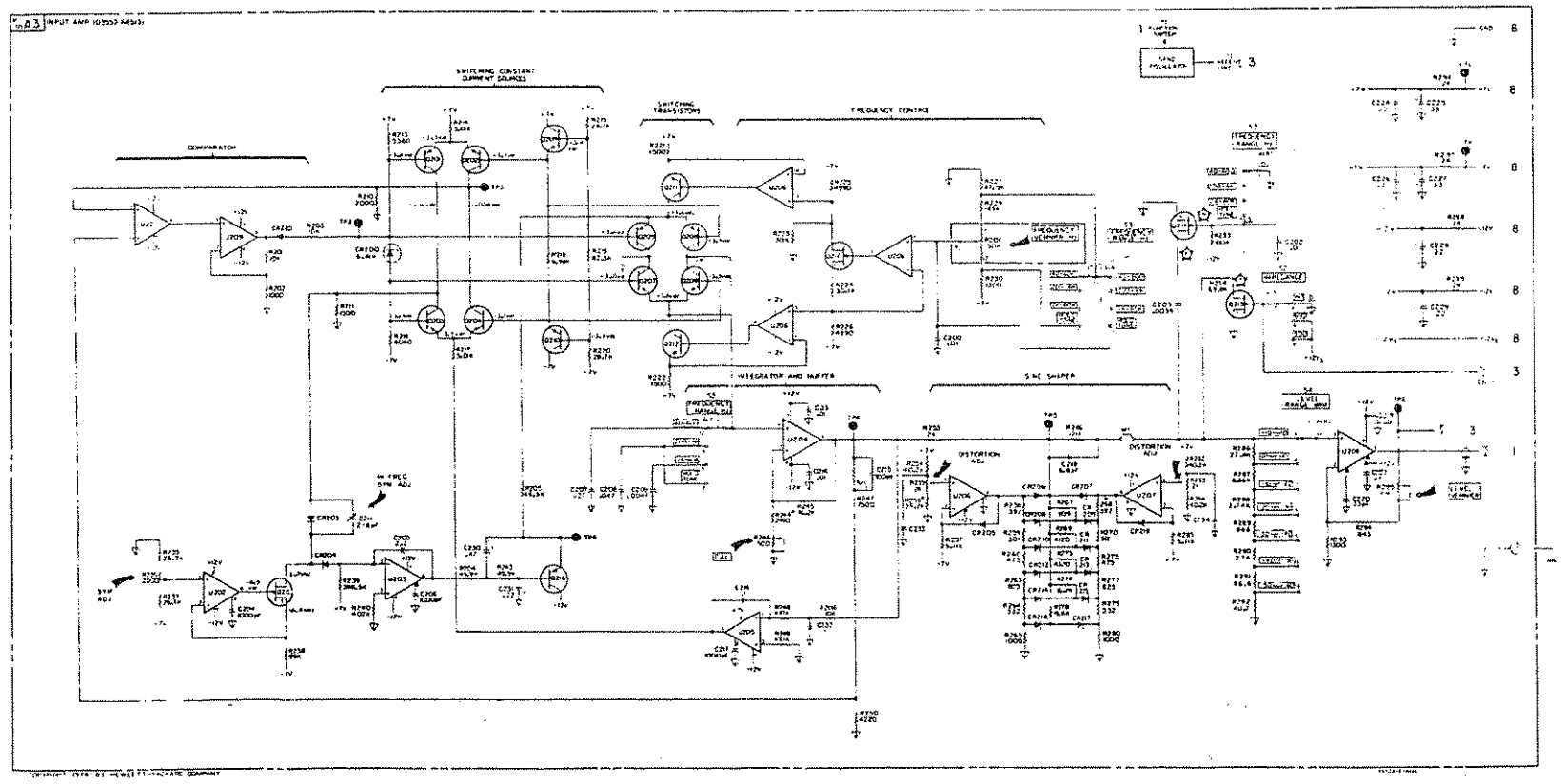
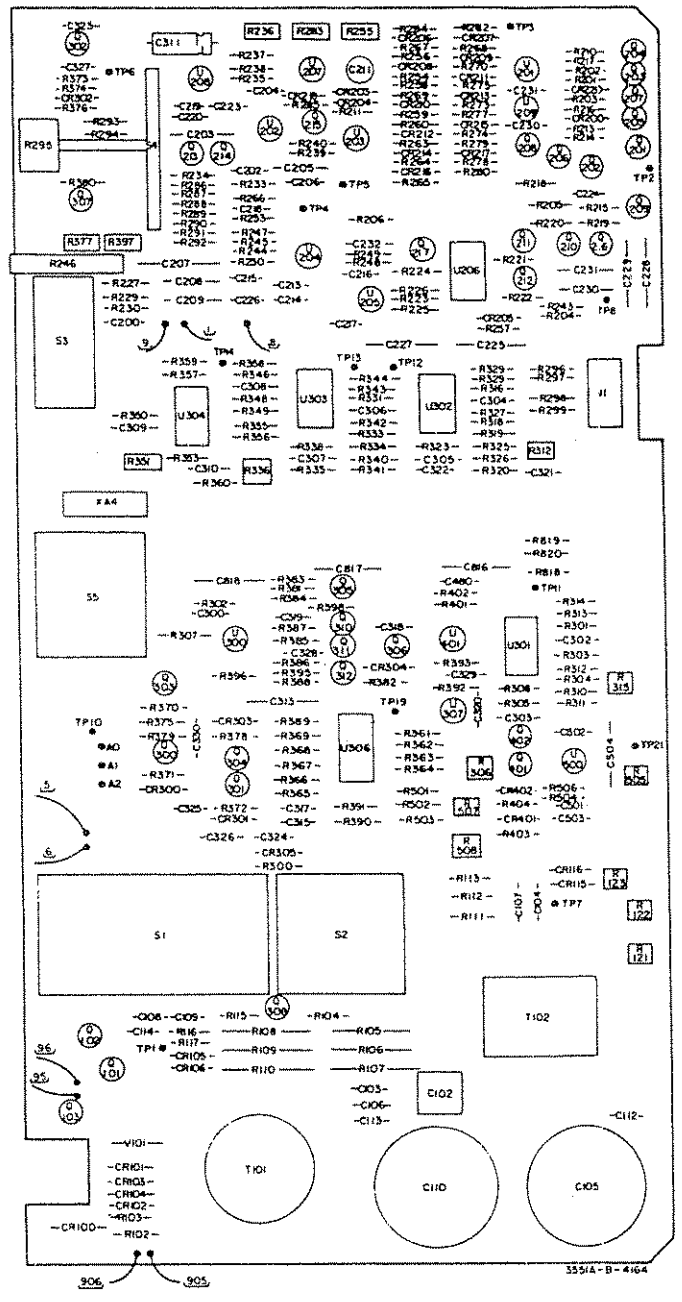


Figure 7-16. Dial and Hold, Function Select, A3.
7-33/7-34





A3
-hp- Part No. 03551-66513
Rev B

① 0 V dc
- 12 V dc

② 0 V dc
- 0.5 V dc

Top voltage measured with FREQUENCY RANGE Hz in HOLD TONE position. Bottom voltage measured with FREQUENCY RANGE Hz in all other positions.

③ 0 V dc
- 4 mV dc

Top voltage measured with IMP in 150 position. Bottom voltage measured with IMP in 600 and 900 position.

④ + 2.6 V dc
- 1.6 V dc
0 V dc
- 2.5 V dc

⑤ + 2.0 V dc
- 2.1 V dc
0 V dc
- 2.5 V dc

Top voltage measured with FREQUENCY RANGE Hz in all but HOLD TONE position and FREQUENCY vernier CCW. For second voltage, set FREQUENCY vernier CW. Third voltage measured with FREQUENCY RANGE Hz in HOLD TONE position and FREQUENCY vernier CCW. For fourth voltage, set FREQUENCY vernier CW.

⑥ - 2.1 V dc
0 V dc
- 2.5 V dc

⑦ - 2.5 V dc
0 V dc
- 2.5 V dc

Top voltage measured with FREQUENCY RANGE Hz in all but HOLD TONE position. Second voltage measured with FREQUENCY RANGE Hz in HOLD TONE position and FREQUENCY vernier CCW. For third voltage, set FREQUENCY vernier CW.

Because of the closed-loop nature of the Input Amplifier, the following troubleshooting procedure is suggested.

a. Adjust the front panel Frequency Vernier fully clockwise.

b. Unsolder one end of A3R205.

c. Unsolder the end of A3R217 that connect to A3U205 Pin 6. Connect - 7 V dc (from -7 Test Point) to the open end of A3R217.

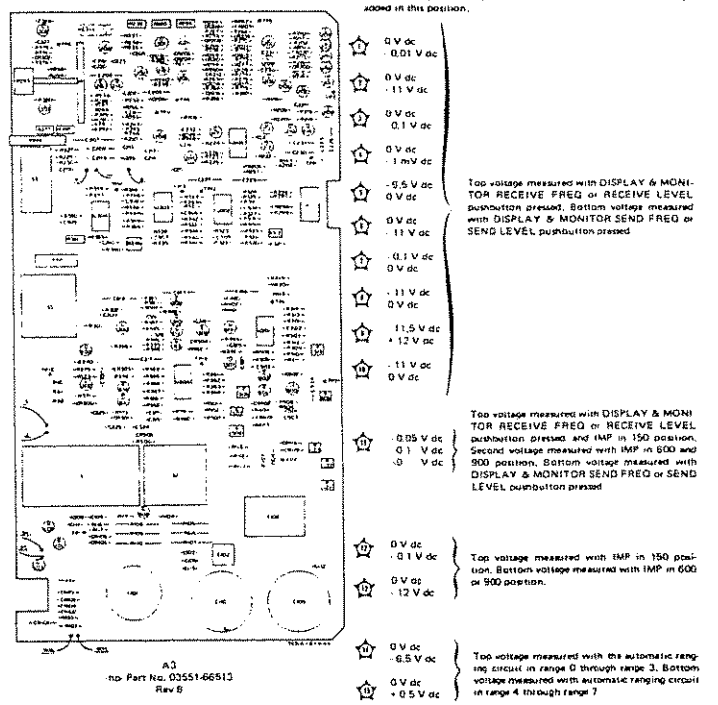
d. Unsolder the end of A3R247 that connects to A3TP4. Apply a 1 kHz sine wave at 2.24 V rms from an ac calibrator to the open end of A3R247.

e. The signals at the following points should be approximately the levels shown below, measured with an oscilloscope.

A3U201 Pin 2	4.6 V p-p sine wave
A3TP2	2.6 V p-p square wave
A3TP3	3.4 V p-p square wave
A3TP4	18 V p-p square wave
A3TP5	7 V p-p square wave
A3TP6	≥17 V p-p square wave
A3U205 Pin 6	200 mV p-p sine wave

f. Also check A3U206 in the Frequency Control circuit.

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



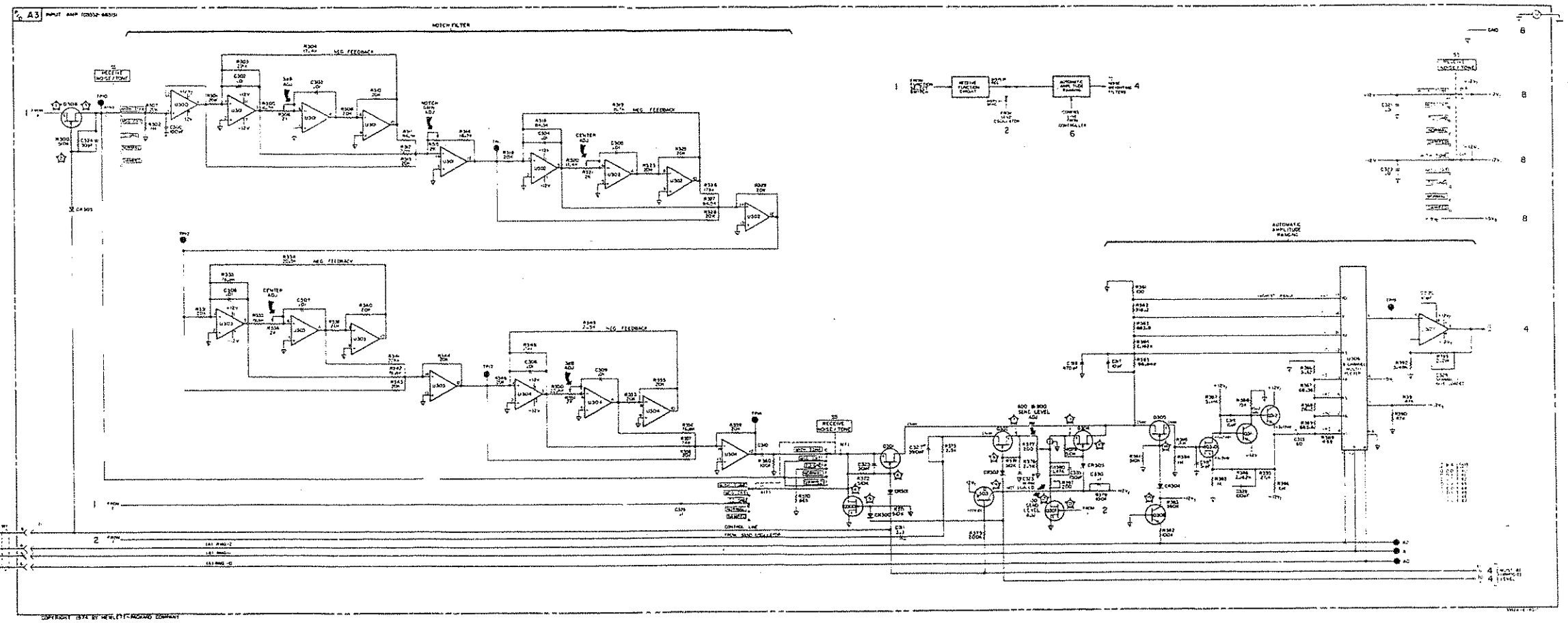
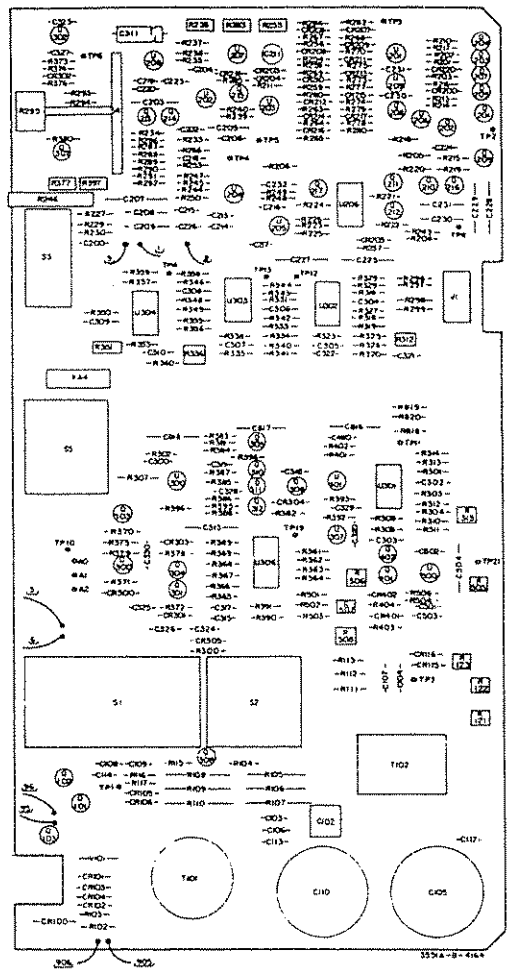
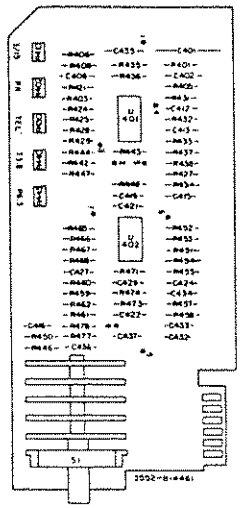


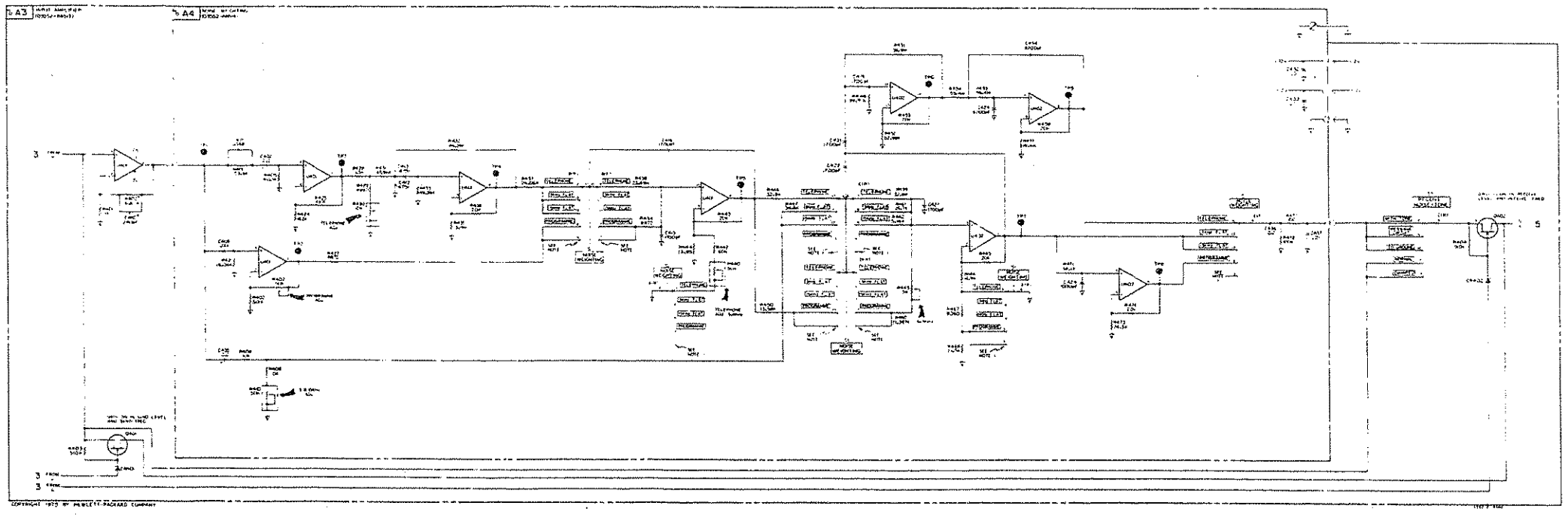
Figure 7-18. Receive Circuit and Automatic Amplitude Ranging, A3.



A3
-hp- Part No. 03551-66513
Rev B

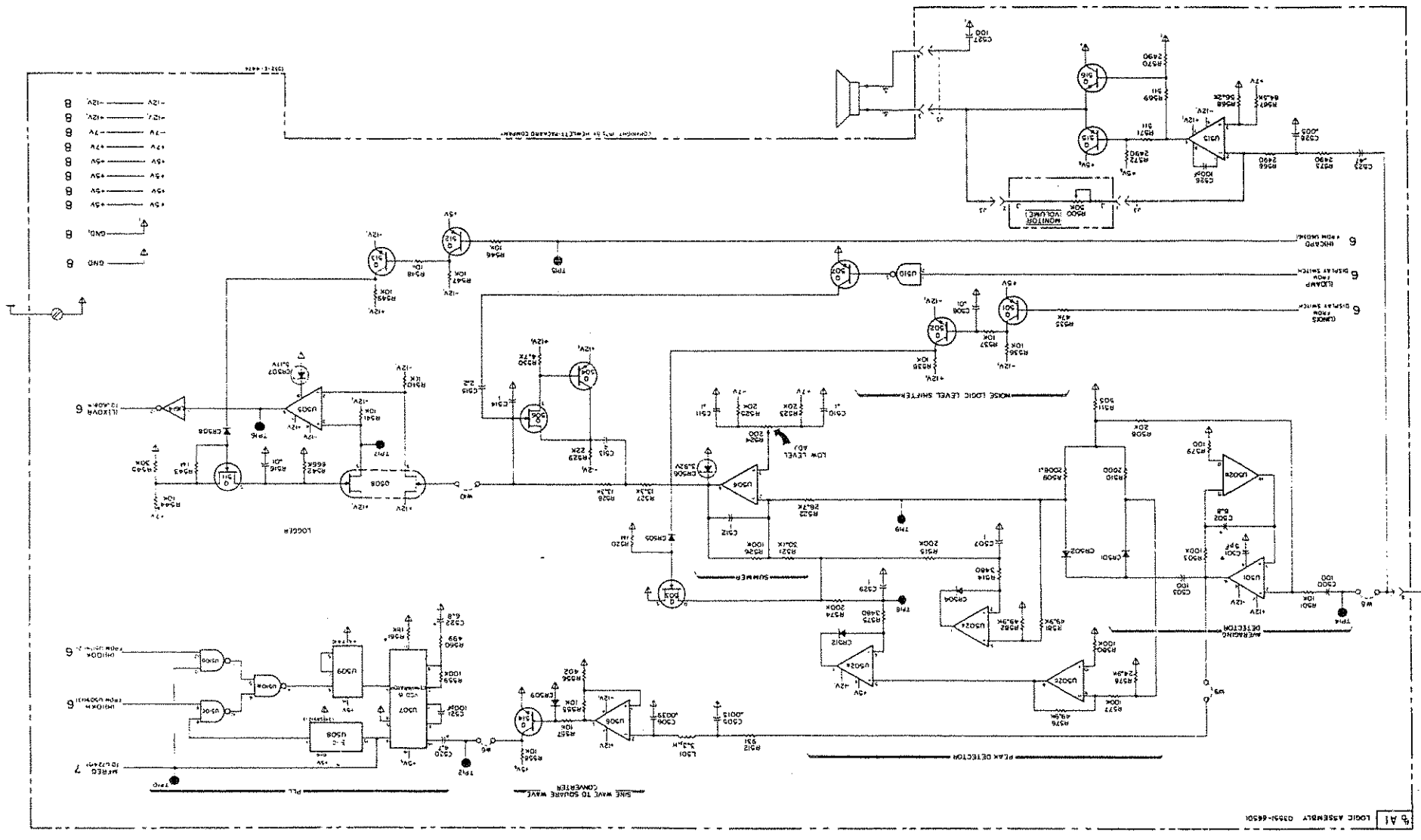


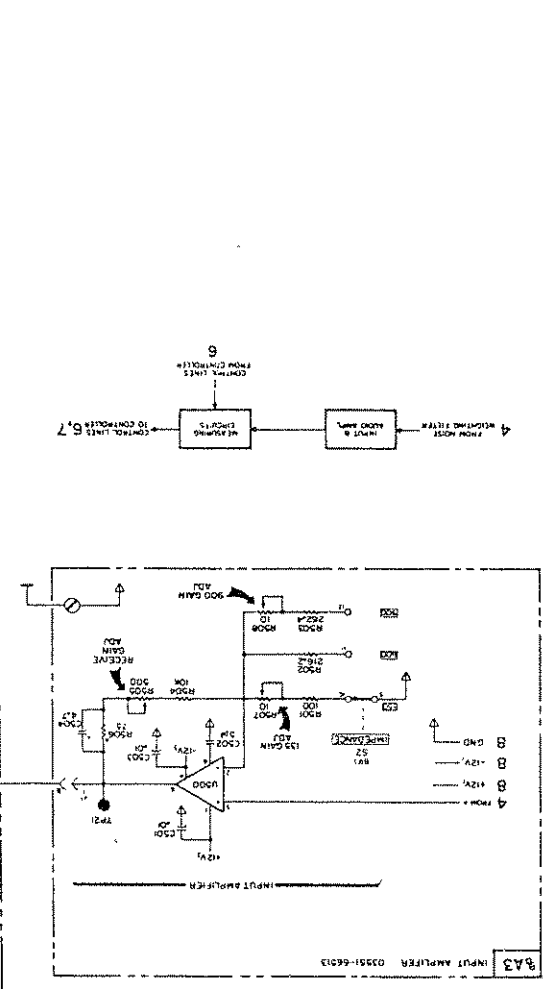
A4
-hp- Part No. 03552-66514
Rev B

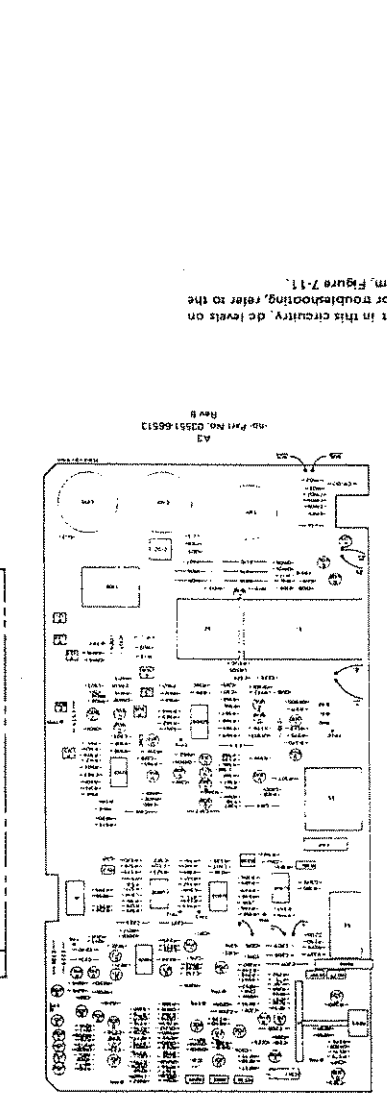


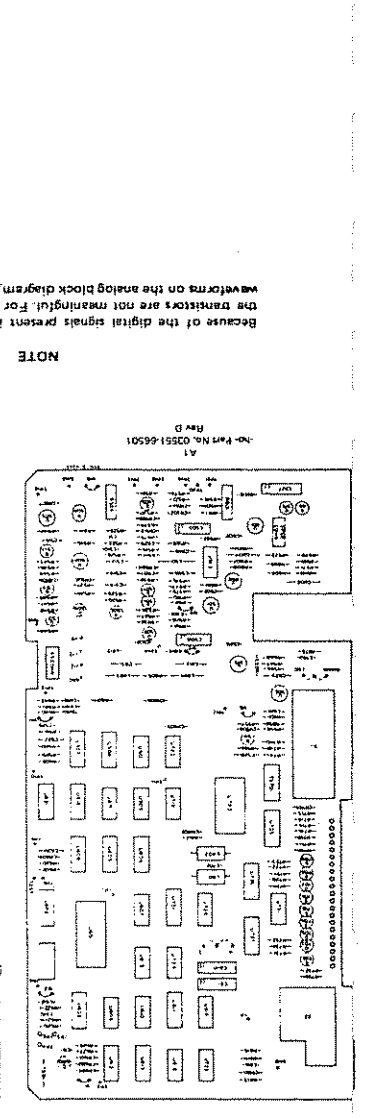
1	-0.87 -5.5	Top voltage measured with NOISE WEIGHTING in the TELEPHONE position. Bottom voltage measured in any other NOISE WEIGHTING position.
2	-0.3 -0.02 -0.01 -7 mV	Top voltage measured with NOISE WEIGHTING in TELEPHONE position. Second voltage measured with NOISE WEIGHTING in 3 kHz FLAT position. Third voltage measured with NOISE WEIGHTING in 15 kHz FLAT position. Bottom voltage measured with NOISE WEIGHTING in PROGRAMME position.
3	-0.65 -2.5 3 -0.55	Top voltage measured with the NOISE WEIGHTING in the TELEPHONE position. Second voltage measured with the NOISE WEIGHTING in 3 kHz FLAT or 15 kHz FLAT position. Bottom voltage measured with NOISE WEIGHTING in the PROGRAMME position.
4	-0.1 -2.2 -0.3	
5	+9.5 +10.1 +9.5	
6	+0.8 -2.5 +1.0	
7	-0.12 -1.98 -0.04	
8	+0.24 -3.0 +0.46	
9	+0.25 +1.0	
10	-0.3 -0.03	Top voltage measured with NOISE WEIGHTING in the TELEPHONE position. Bottom voltage measured in any other NOISE WEIGHTING position.
11	-0.3 +0.5	
12	-1.36 -0.6	
13	-0.82 -0.07 -0.05 -0.04	Top voltage measured with NOISE WEIGHTING in TELEPHONE position. Second voltage measured with NOISE WEIGHTING in 3 kHz FLAT position. Third voltage measured with NOISE WEIGHTING in 15 kHz FLAT position. Bottom voltage measured with NOISE WEIGHTING in PROGRAMME position.
14	-1.2 +0.86 +0.91 +0.94	
15	-0.84 -0.084 -0.067 -0.057	
16	-1.7 +0.30 +0.36 +0.39	

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





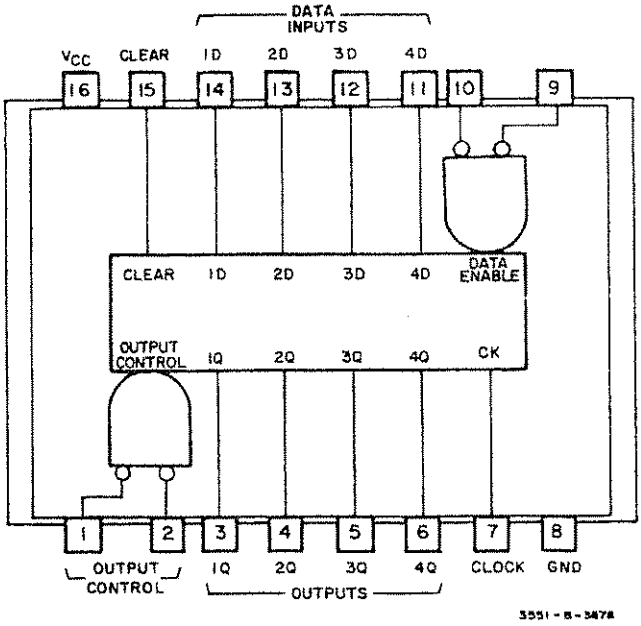




NOTE

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

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



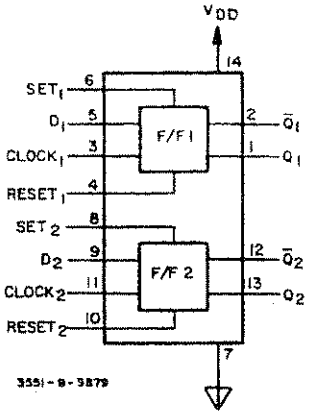
FUNCTION TABLE

INPUTS					
CLEAR	CLOCK	DATA ENABLE G1	DATA ENABLE G2	DATA D	OUTPUT G
H	X	X	X	X	L
L	L	X	X	X	Q_0
L	↑	L	L	L	L
L	↑	L	L	H	H

When pin 1 is high the output is disabled to the high-impedance state; however sequential operation of the flip-flops is not affected.

H = high level (steady state)
L = low level (steady state)
↑ = irrelevant (any input including transistions)
Q_0 = the level of Q before the indicated steady-state input conditions were established.

U602 and U603

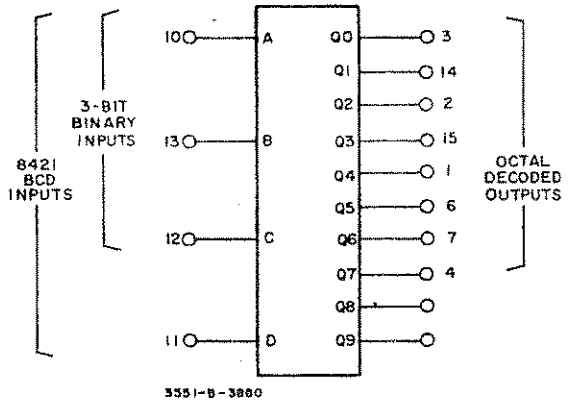


TRUTH TABLE (Each FF)

CL+	D	R	S	Q	Q̄	
	0	0	0	0	1	NO CHANGE
	1	0	0	1	0	
	x	0	0	Q	Q̄	
x	x	1	0	0	1	
x	x	0	1	1	0	
x	x	1	1	*	*	

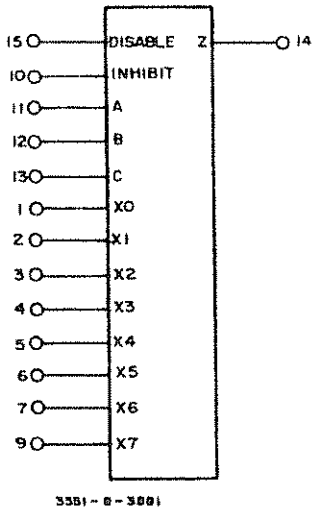
* = INVALID CONDITION
+ = LEVEL CHANGE
x = DON'T CARE CASE

U604



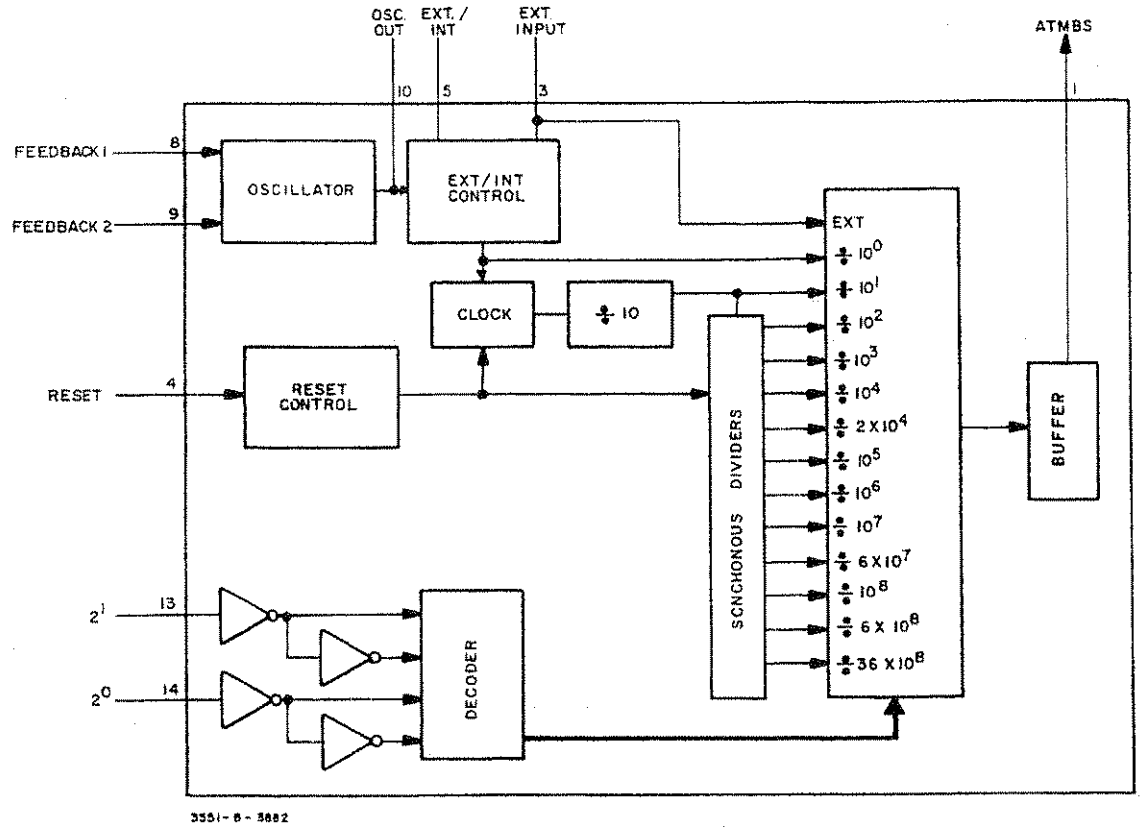
INPUT				OUTPUT									
D	C	B	A	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0	0	0	0	0	1
0	0	0	1	0	0	0	0	0	0	0	0	1	0
0	0	1	0	0	0	0	0	0	0	0	1	0	0
0	0	1	1	0	0	0	0	0	0	1	0	0	0
0	1	0	0	0	0	0	0	0	1	0	0	0	0
0	1	0	1	0	0	0	0	1	0	0	0	0	0
0	1	1	0	0	0	0	1	0	0	0	0	0	0
0	1	1	1	0	0	1	0	0	0	0	0	0	0
1	0	0	0	0	1	0	0	0	0	0	0	0	0
1	0	0	1	1	0	0	0	0	0	0	0	0	0
1	0	1	0	0	0	0	0	0	0	0	0	0	0
1	0	1	1	0	0	0	0	0	0	0	0	0	0
1	1	0	0	0	0	0	0	0	0	0	0	0	0
1	1	0	1	0	0	0	0	0	0	0	0	0	0
1	1	1	0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	0	0	0	0	0	0	0	0	0	0

U606



C	B	A	DISABLE	OUT
0	0	0	0	X0
0	0	1	0	X1
0	1	0	0	X2
0	1	1	0	X3
1	0	0	0	X4
1	0	1	0	X5
1	1	0	0	X6
1	1	1	0	X7

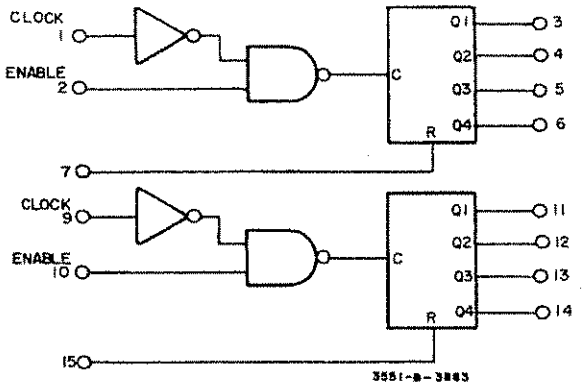
U608 and U609



2^1	2^0	ATMBS
0	0	$\div 10^4$
0	1	$\div 10^5$
1	0	$\div 10^6$
1	1	$\div 10^7$

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

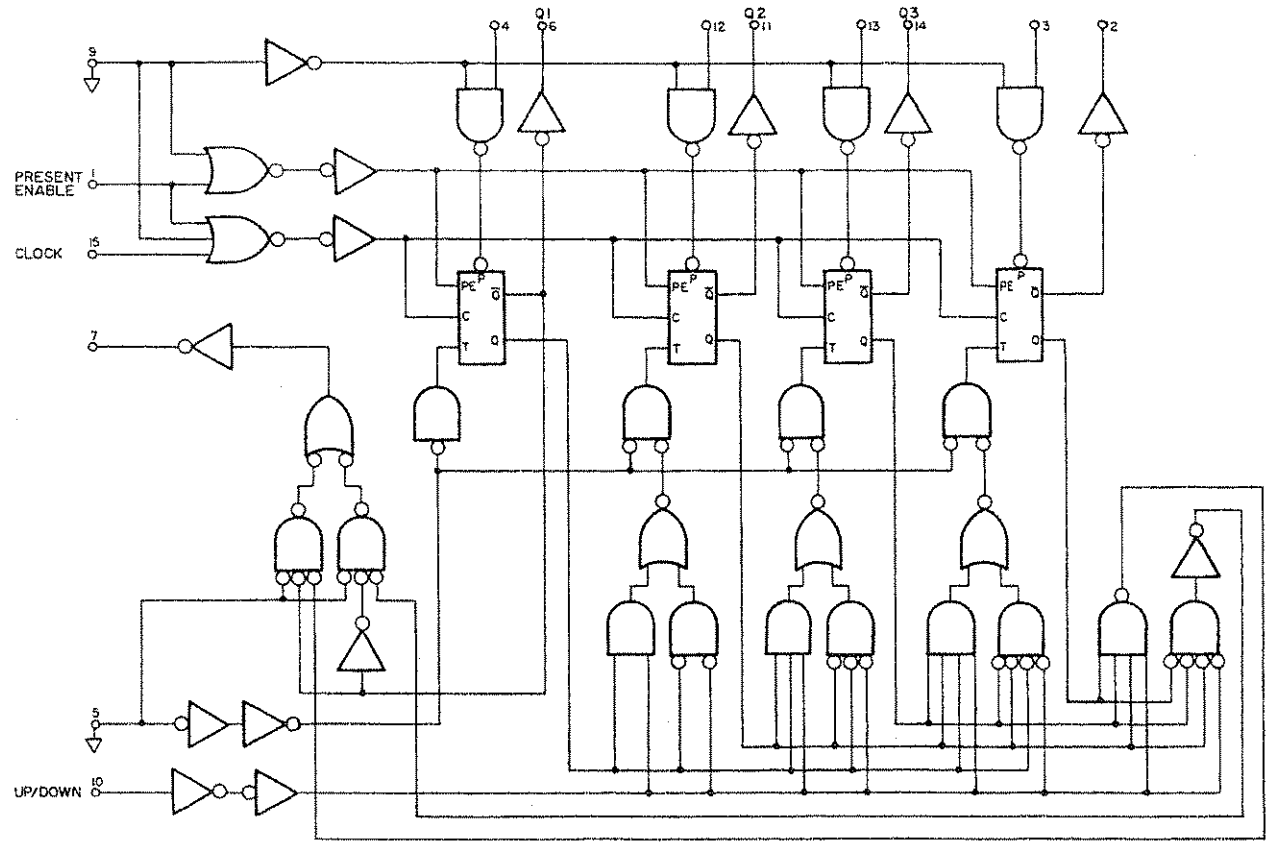
U612

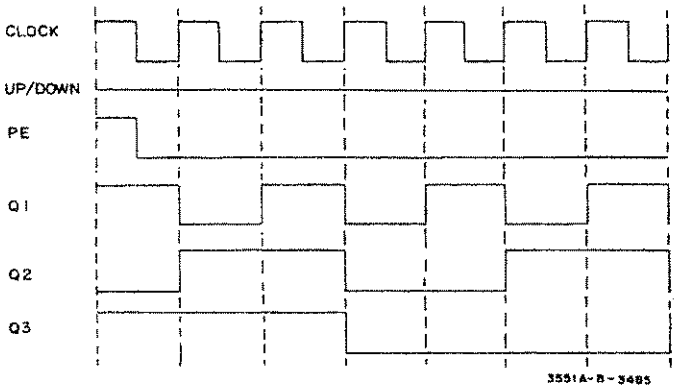


CLOCK	ENABLE	RESET	ACTION
⎍	1	0	Increment Counter
X	X	1	Q1 thru Q4= 0

X = Don't Care

U613





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

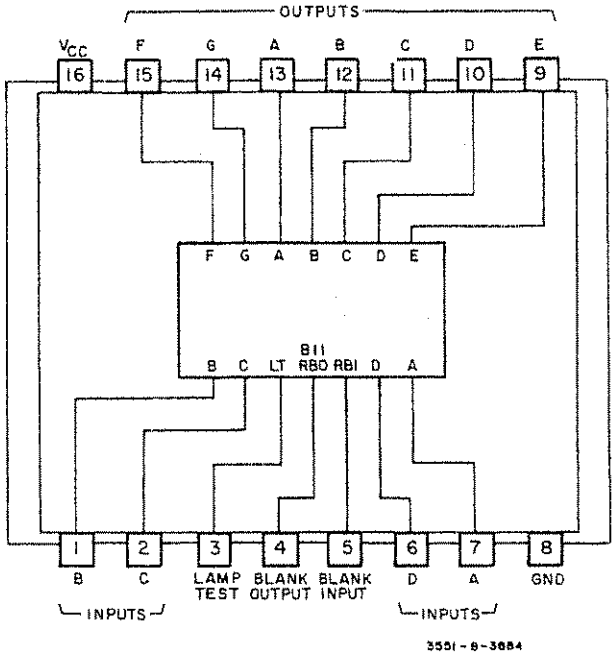
OUTPUT TRUTH TABLES					
		BCD OUTPUTS			
Scan	Digit	MSB	2^2	2^1	LSB
1	0	1	1	1	1
1	1	1	1	1	0
1	2	1	1	0	1
1	3	1	1	0	0
1	4	1	0	1	1
1	5	1	0	1	0
1	6	1	0	0	1
1	7	1	0	0	0
1	8	0	1	1	1
1	9	0	1	1	0
0	0	1	1	1	1

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

U621

A1
-hp- Part No. 03551-66501
Rev D

Figure 7-21. Controller, A1, A3.
7-47/7-48



FUNCTION TABLE

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

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

NOTES: 1. The blanking input must be open or high if blanking of a decimal zero is not desired.

2. When blanking input and inputs A, B, C, and D are at a low level with the lamp test input high, all segment outputs go off and the blanking output goes to a low level (response condition).

3. When the blanking output is open or held high and a low is applied to the lamp-test input, all segment outputs are on.

U703

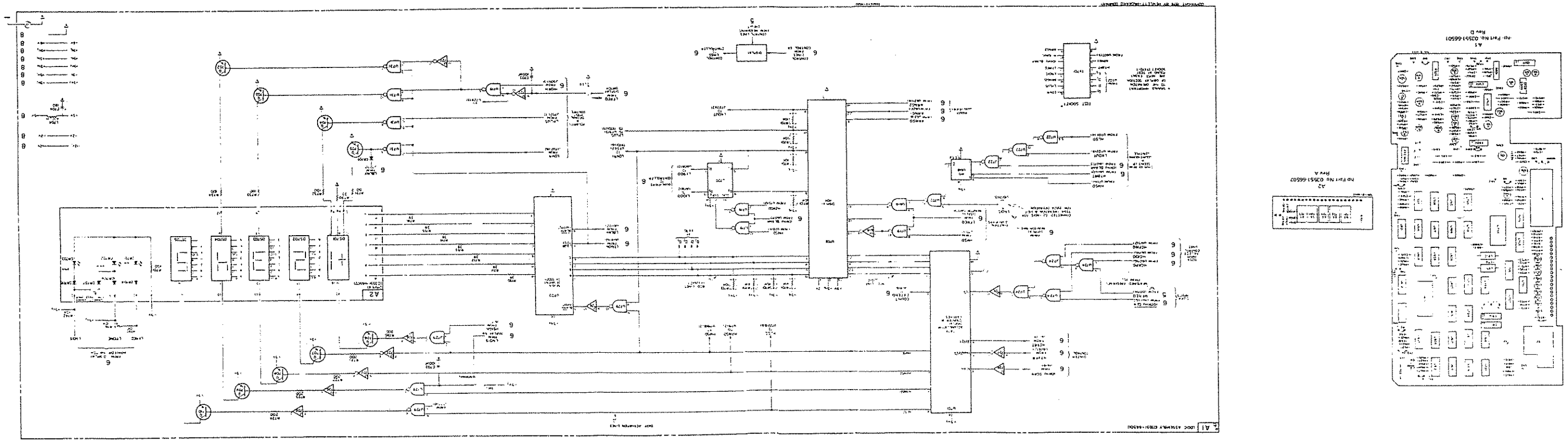
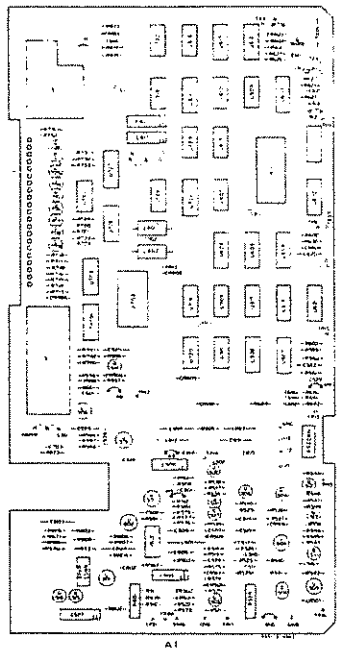
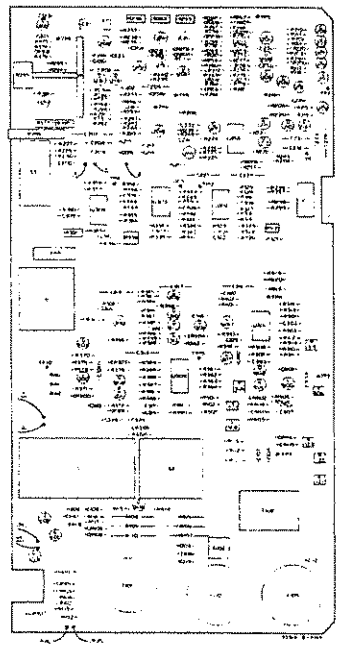


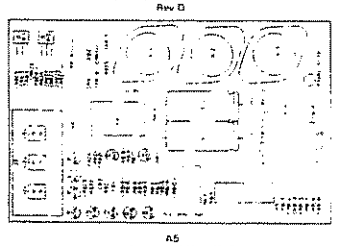
Figure 7-22. Display, A1, A2.



A1
hp Part No. 03551-66501
Rev D



A3
hp Part No. 03551-66513
Rev B



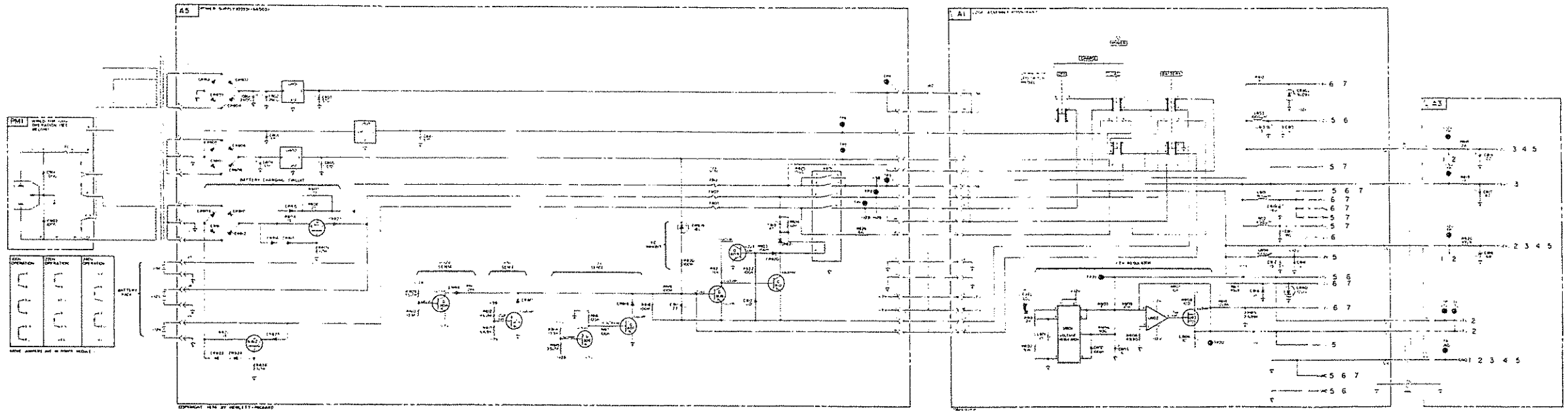
A5
hp Part No. 03551-66515
Rev A

NOTE 1

Fuses F801 - F803 are plug-in fuses. A spare fuse located on the A5 assembly is supplied. To exchange fuse remove K801 (plug-in) remove fuse and replace with spare fuse.

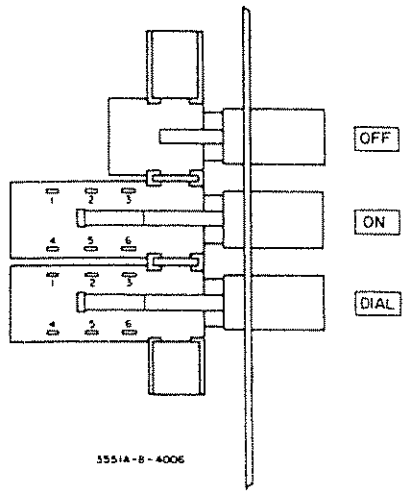
NOTE 2

For dc level troubleshooting, remove battery cables, outl board out as far as T1 cable will allow troubleshoot in ac mode

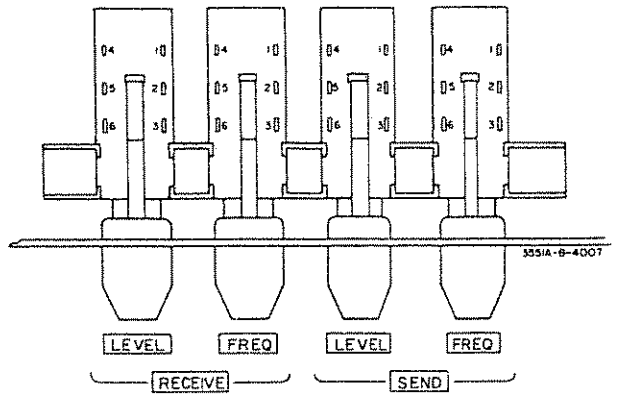


8

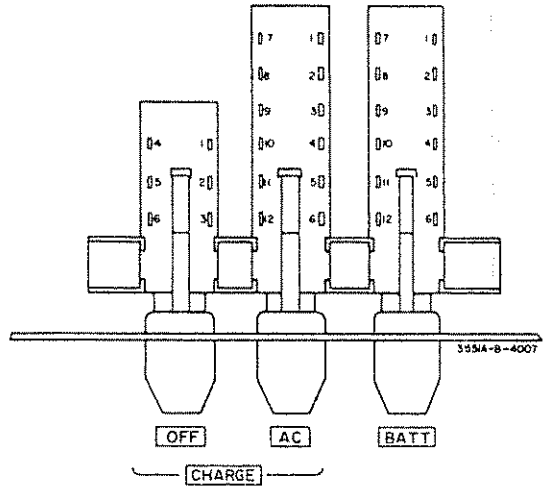
Figure 7-23. Power Supply A1, A3, A5.
7-53/7-54



HOLD
S1



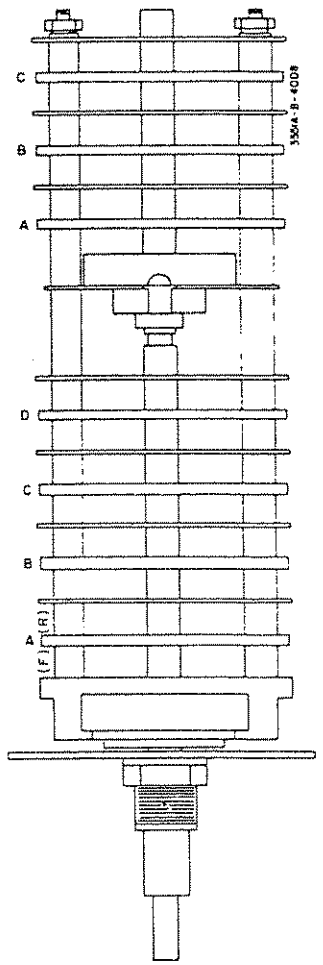
DISPLAY—MONITOR
A1S1

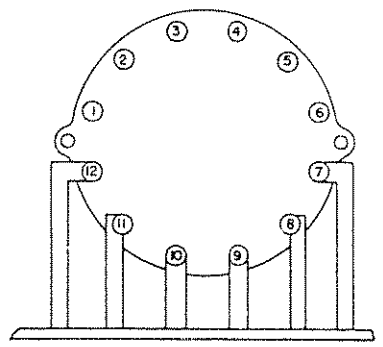


POWER
A1S2

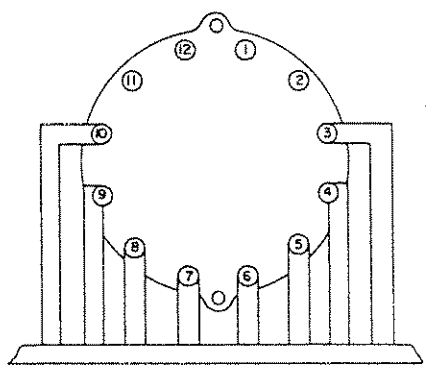
IMP
A3S2

FUNCTION
A3S1

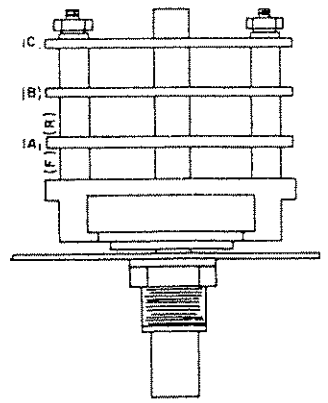




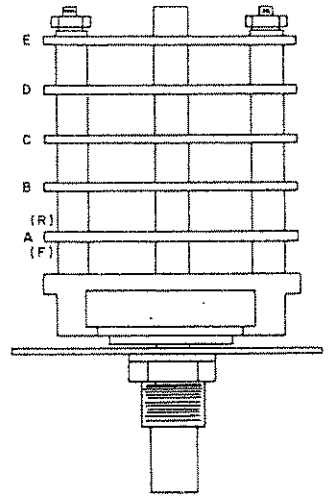
A3S3 and wafers for all rotary switches except A3S4. Front view of wafer shown.



A3S4



RECEIVE
NOISE/TONE
A3S5



NOISE
WEIGHTING
A4S1

Figure 7-24. Switch Drawings.

SECTION VIII
BACKDATING

8-1. INTRODUCTION.

8-2. This section, in conjunction with the integrated backdating, makes this manual applicable to earlier instruments. Where practical, the backdating change has been integrated into the text, parts list or schematic. This type of change is denoted by an open delta or a lettered delta (Δ or Δ_B). The delta refers to the corresponding backdating note on that page. If the backdating change is too long or otherwise impractical to incorporate into the text, the entry will be denoted by a numbered delta (Δ_1). The numbered delta refers to the corresponding numbered delta in this section.

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

8-4. BACKDATING CHANGES.

Δ_1 8-5. Serial No. 1435A00140 and Lower.

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

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

Delete: Housing, Lock, 03551-24710
Handle, Lock, 03551-24901
Screw, Lock, 03551-27901
Knob, Lever, 0370-1810
L1 through L4, Coil-Fxd, 1 μH, 9100-3551
A1L501, Coil-Fxd, 3.3 mH, 9100-1665

Add: A1R513, R-Fxd, 3 K, 0683-3025
A4R475, R-Fxd, 470 Ω, 0684-4711

Change: Panel, Front, 03552-00201
Panel, Front-Sub, 03552-00202
A1C505, C-Fxd, 1000 pF, 0160-0153
A1C506, C-Fxd, 1000 pF, 0160-0153
A1C522, C-Fxd, 4.7 μF, 0180-0309
A1C601, C-Fxd, .01 μF, 0150-0093
A1R512, R-Fxd, 3 K, 0683-3025
A1R556, R-Fxd, 100 Ω, 0757-0401

Δ_2 8-8. Serial No. 1125A00170 and Lower. Serial No. 1604U00260 and Lower.

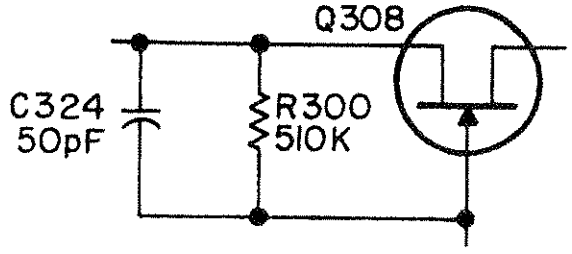
8-9. Make the following changes in Table 6-3, Replaceable Parts:

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

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

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

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



Δ_3 8-10. Serial No. 1125A00200 and Lower. Serial No. 1512U00220 and Lower.

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

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

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

Delete: A1C528,529,702,703
A1CR512, 605, 606
A1R573 through 582,604,605

Add: A1U503, 1C-Op Amp, 1820-0233

Change: A1C502, C-Fxd, 2.2 μF, 0160-0128
A1C507, C-Fxd, 2.2 μF, 0160-0128
A1CR504, Diode, 1901-0518
A1R501, R-Fxd, 7870 Ω, 0698-7960
A1R503, R-Fxd, 1 M, 0683-1055
A1R510, R-Fxd, 1500 Ω, 0757-0427
A1R514, R-Fxd, 9090 Ω, 0757-0288
A1R515, R-Fxd, 143 K, 0698-4520
A1R521, R-Fxd, 30 K, 0698-6977
A1R522, R-Fxd, 10 K, 0698-6360
A1R526, R-Fxd, 30 K, 0698-6977
A1R566, R-Fxd, 4990 Ω, 0698-3279
A1U502, IC-Op Amp, 1826-0043

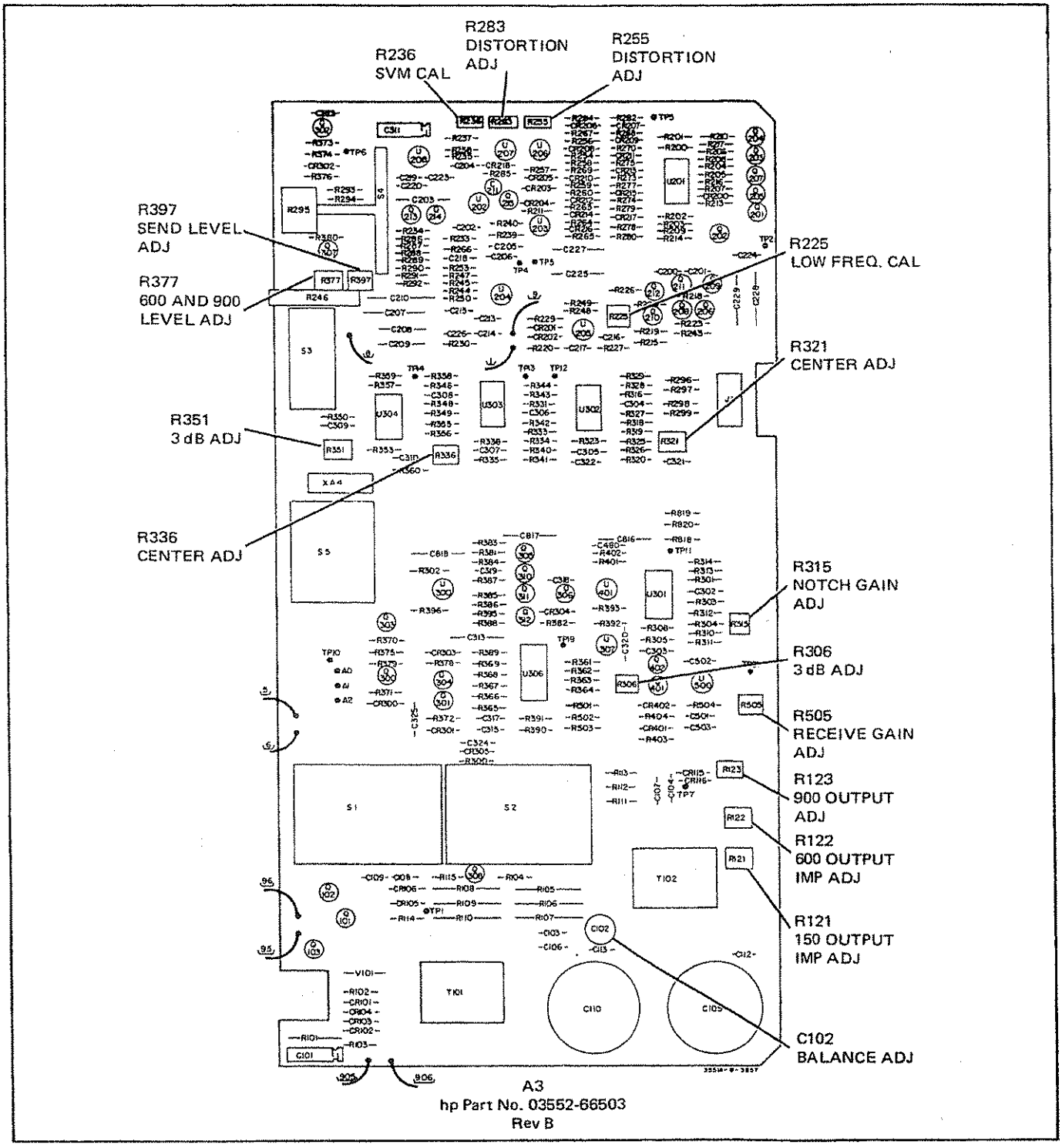


Figure 8-1. A3 Adjustment Locator, S/N 1435A00140 and Lower.

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

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

Programme (CCITT)	
FREQUENCY Hz	dB REF to 1000 Hz
50	- 34.3 ± 1.5 dB
60	- 32.2 ± 1.5 dB
100	- 26.1 ± 1.5 dB
200	- 17.3 ± 1.5 dB
400	- 8.8 ± 1.5 dB
800	- 1.9 ± 1.5 dB
1000	0 REF
2000	+ 5.3 ± 1.5 dB
4000	+ 8.2 ± 1.5 dB
5000	+ 8.4 ± 1.5 dB
6000	+ 8.2 ± 1.5 dB
7000	+ 7.3 ± 1.5 dB
8000	+ 5.1 ± 1.5 dB
9000	- 0.3 ± 3.0 dB
10,000 *	- 9.7 ± 3.0 dB

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

Δ4 **8-14. Serial No. 1604A00260 and Lower. Serial No. 1635U00440 and Lower.**

8-15. Make the following changes in Table 6-3, Page 6-13 and 6-14.

Change: A5, Power Supply Assembly to 03551-66505
A5CR813, CR814 to 1901-0158 Diode: S 1.75 A 200 V
A5R804 to 0813-0040 R: fxd 20.5 Ω 5 W
A5R805 to 0812-0070 R: fxd 10 Ω ½ W
A5R806 to 0811-3114 R: fxd 75 Ω 5 W
A5R807 to 0811-1854 R: fxd 50 Ω ½ W

Delete: A5CR822 thru CR825; A3Q811, Q812; A3R827, 828

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

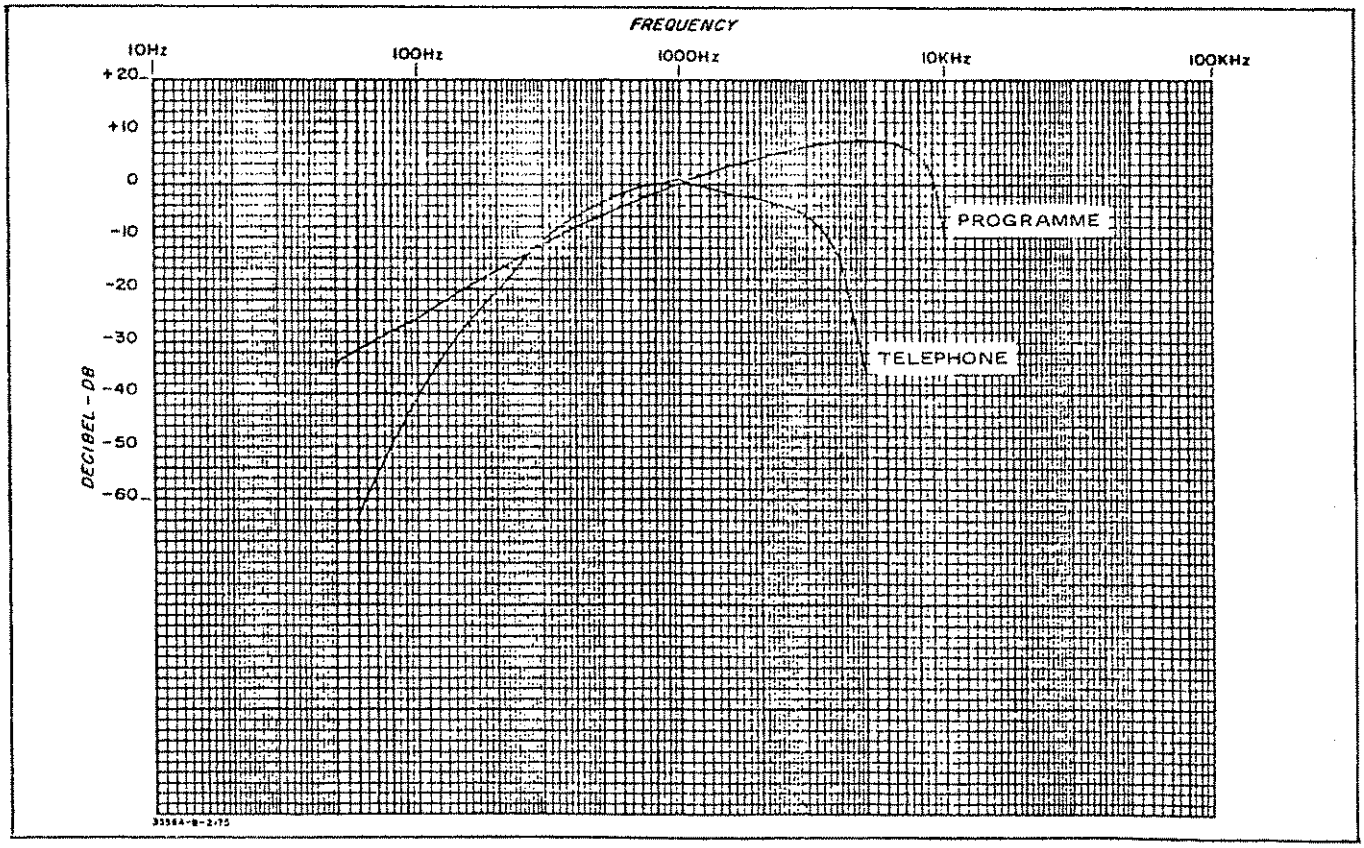


Figure 8-2. Programme Noise Weighting Curve, S/N 1125A00200 and Lower and 1152U00220 and Lower.

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

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A3	03552—66503	1	PC ASSY, INPUT AMPLIFIER	28480	03552—66503
A3C101	0180-0106	2	CAPACITOR-FXD; 60UF +/-20% 6VDC AL	56289	150D606X000682
A3C102	0121-0046	1	CAPACITOR; VAR; TRMR; CER; 9/35PF	73899	DV11PS350
A3C103*	0140-0191	1	CAPACITOR-FXD 56PF +-5% 300WVDC MICA *FACTORY SELECTED PART	72136	DM15E560J03ODWV1CR
A3C104*	0160-2206	1	CAPACITOR-FXD 160PF +-5% 300WVDC MICA *FACTORY SELECTED PART	28480	0160-2206
A3C105	0183-0543	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*		0	NORMALLY NOT LOADED		
A3C108*			NORMALLY NOT LOADED		
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	0150-0050		CAPACITOR-FXD 1000PF +80-20% 1000WVDC	28480	0150-0050
A3C200	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A3C201	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
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	0160-0128		CAPACITOR-FXD 2.2UF +-20% 25WVDC CER	28480	0160-0128
A3C206	0160-0938		CAPACITOR-FXD 1000PF +-5% 100WVDC MICA	53021	D15C1E102J
A3C207	0160-4233	1	CAPACITOR-FXD .47UF +-5% 50WVDC MET	28480	0160-4233
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	0160—2856	1	CAPACITOR—FXD .33UF +—10%50WVDCMET	84411	X663F33452W2
A3C211	0121—0063	1	CAPACITOR—VAR 2—8PF	73899	DV11A8A

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

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
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	0160-2199	3	CAPACITOR-FXD 30PF +-5% 300WVDC MICA	28480	0160-2199
A3C216	0163-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A3C217	0160-0938		CAPACITOR-FXD 1000PF +-5% 100WVDC MICA	53021	DISC1E102J
A3C218	0150-3043	1	CAPACITOR-FXD 6.8PF +-5% 500WVDC TI DIDX	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
A3C302	0160-3548		CAPACITOR-FXD .01UF +-1% 100WVDC MICA	28480	0160-3548
A3C303	0160-3548		CAPACITOR-FXD .01UF +-1% 100WVDC MICA	28480	0160-3548
A3C304	0160-3548		CAPACITOR-FXD .01UF +-1% 100WVDC MICA	28480	0160-3548
A3C305	0160-3548		CAPACITOR-FXD .01UF +-1% 100WVDC MICA	28480	0160-3548
A3C306	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	0180-0224		CAPACITOR-FXD; 10UF+75-10% 16VDC AL	56289	30D106G016BA2
A3C313	0180-0106	1	CAPACITOR-FXD; 60UF+-20% 6VDC TA-SOLID	56289	150D606X0006B2
A3C317	0160-0205	4	CAPACITOR-FXD 10PF +-5% 500WVDC MICA D+	28480	0160-0205
A3C318	0160-0356	1	CAPACITOR-FXD 18PF +-5% 300WVDC MICA D+	28480	0160-0356
A3C319	0160-0205		CAPACITOR-FXD 10PF +-5% 500WVDC MICA D+	28480	0160-0205
A3C320	0160-0205		CAPACITOR-FXD 10PF +-5% 500WVDC MICA D+	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*	0160-2207		CAPACITOR-FXD 300PF +/-5% 300WVDC *FACTORY SELECTED PART	28480	0160-2207
A3C324	0160-2199		CAPACITOR-FXD 30PF +-5% 300WVDC MICA	28480	0160-2199
A3C325	0160-2199		CAPACITOR-FXD 30PF +-5% 300WVDC MICA	28480	0160-2199
A3C480*	0140-0149		CAPACITOR-FXD 470PF +/-5% 300V *FACTORY SELECTED PART	72136	DM10F471J0300WV1CR
A3C501	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A3C502	0160-0205		CAPACITOR-FXD 10PF +-5% 500WVDC MICA D+	28480	0160-0205
A3C503	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
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	0180-0228		CAPACITOR-FXD; 22UF+-10% 15VDC TA-SOLID	56289	150D226X9015B2
A3CR101	1901-3028	4	DIODE-PWR RECT 400V 750MA	04713	SR1358-9
A3CR102	1901-3028		DIODE-PWR RECT 400V 750MA	04713	SR1358-9
A3CR103	1901-3028		DIODE-PWR RECT 400V 750MA	04713	SR1358-9
A3CR104	1901-3028		DIODE-PWR RECT 400V 750MA	04713	SR1358-9
A3CR105	1901-0050	4	DIODE-SWITCHING 2NS 80V 200MA	28480	1901-0050
A3CR106	1901-3050		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	1902-3048	1	DIODE-ZNR 6.81V 5% DO-7 PD=.4W	28480	1902-0048
A3CR201	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
A3CR202	1901-0040		DIODE-SWITCHING 2NS 30V 50MA	28480	1901-0040
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
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

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

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
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	CSA2900-168
A3Q101	1854-0234	2	TRANSISTOR NPN 2N3440 SI PD=1W	02735	2N3440
A3Q102	1854-0234		TRANSISTOR NPN 2N3440 SI PD=1W	02735	2N3440
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	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A3Q212	1853-0086		TRANSISTOR PNP SI CHIP PD=310MW	28480	1853-0086
A3Q213	1855-0410	6	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
A3Q300	1855-0414	5	TRANSISTOR; J-FET N-CHAN, D-MODE SI	17856	2N4393
A3Q301	1855-0414		TRANSISTOR; J-FET N-CHAN, D-MODE SI	17856	2N4393
A3Q301	1854-0071		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
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	0683-1045	1	RESISTOR 100K 5% 1/4W CC TUBULAR	01121	CB1045
A3R102*	0698-3431	2	RESISTOR 23.7 OHM 1% .125W F TUBULAR	03888	PME55-1/8-TO-23R7-F
A3R103	0683-0275	1	RESISTOR 2.7 OHM 5% .25W CC TUBULAR	01121	CR27G5
A3R104	0757-0472	3	RESISTOR 200K 1% .125W F TUBULAR	24546	C4-1/8-TO-2003-F
A3R105*	0698-8560	2	RESISTOR 74.8 OHM 1% .5W F TUBULAR *FACTORY SELECTED PART	28480	0698-8560
A3R106*	0698-8559	2	RESISTOR 302 OHM 1% .5W F TUBULAR *FACTORY SELECTED PART	28480	0698-8559
A3R107*	0698-8561	2	RESISTOR 464.6 OHM 1% .5W F TUBULAR *FACTORY SELECTED PART	28480	0698-8561
A3R108*	0698-8560		RESISTOR 74.8 OHM 1% .5W F TUBULAR *FACTORY SELECTED PART	28480	0698-8560
A3R109*	0698-8559		RESISTOR 302 OHM 1% .5W F TUBULAR *FACTORY SELECTED PART	28480	0698-8559
A3R110*	0698-8561		RESISTOR 464.6 OHM 1% .5W F TUBULAR *FACTORY SELECTED PART	28480	0698-8561
A3R111	0757-0402	1	RESISTOR 110 OHM 1% .125W F TUBULAR	24546	C4-1/8-TO-111-F
A3R112	0698-4419	1	RESISTOR 210 OHM 1% .125W F TUBULAR	24546	C4-1/8-TO-210R-F
A3R113	0698-4451	1	RESISTOR 340 OHM 1% .125W F TUBULAR	24546	C4-1/8-TO-340R-F
A3R114	0698-4123		RESISTOR 499 OHM 1% .125W F TUBULAR	16299	C4-1/8-TO-499R-F
A3R115	0757-0472		RESISTOR 200K 1% .125W F TUBULAR	24546	C4-1/8-TO-2003-F
A3R121	2100-3426	1	RESISTOR-VAR 20 OHM .10	28480	2100-3426
A3R122	2100-0552	2	RESISTOR-VAR TRMR 50 OHM 20% C TOP ADJ	73138	72XR50M
A3R123	2100-0552		RESISTOR-VAR TRMR 50 OHM 20% C TOP ADJ	73138	72XR50M
A3R200	0757-0439	2	RESISTOR 6.81K 1% .125W F TUBULAR	24546	C4-1/8-TO-6811-F
A3R201	0698-4474	4	RESISTOR 8.45K 1% .125W F TUBULAR	24546	C4-1/8-TO-8451-F
A3R202	0698-4474		RESISTOR 8.45K 1% .125W F TUBULAR	24546	C4-1/8-TO-8451-F
A3R203	0757-0439		RESISTOR 6.81K 1% .125W F TUBULAR	24546	C4-1/8-TO-6811-F
A3R204	0757-0442	4	RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-TO-1002-F
A3R205	0757-0442		RESISTOR 10K 1% .125W F TUBULAR	24546	C4-1/8-TO-1002-F
A3R206	0757-0468	3	RESISTOR 18.2K 1% .125W F TUBULAR	24546	C4-1/8-TO-1822-F
A3R207	0698-4474		RESISTOR 8.45K 1% .125W F TUBULAR	24546	C4-1/8-TO-8451-F
A3R208	0698-4474		RESISTOR 8.45K 1% .125W F TUBULAR	24546	C4-1/8-TO-8451-F
A3R209	0757-0468		RESISTOR 18.2K 1% .125W F TUBULAR	24546	C4-1/8-TO-1822-F
A3R210	0757-0424	1	RESISTOR 1.1K 1% .125W F TUBULAR	24546	C4-1/8-TO-1101-F
A3R211	0757-0427		RESISTOR 1.5K 1% .125W F TUBULAR	24546	C4-1/8-TO-1501-F
A3R213	0698-3492	1	RESISTOR 2.67K 1% .125W F TUBULAR	16299	C4-1/8-TO-2671-F

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

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A3R214	0757-0273		RESISTOR 3.01K 1% .125W F TUBULAR	24546	C4-1/8-T0-3011-F
A3R215	0698-7880	4	RESISTOR 28.7K 1% .125W F TUBULAR	30983	MF4C1/8-T9-2872-F
A3R216	0698-3558	1	RESISTOR 4.02K 1% .125W F TUBULAR	16299	C4-1/8-T0-4021-F
A3R217*	0757-0273	4	RESISTOR 3.01K 1% .125W F TUBULAR	24546	C4-1/8-T0-3011-F
			*FACTORY SELECTED PART		
A3R218	0698-4470	1	RESISTOR 6.98K 1% .125W F TUBULAR	24546	C4-1/8-T0-6981-F
A3R219	0757-0463	1	RESISTOR 82.5K 1% .125W F TUBULAR	24546	C4-1/8-T0-8252-F
A3R220	0698-7880		RESISTOR 28.7K 1% .125W F TUBULAR	30983	MF4C1/8-T9-2872-F
A3R223	0698-0084		RESISTOR 2.15K 1% .125W F TUBULAR	16299	C4-1/8-T0-2151-F
A3R224	0698-4435		RESISTOR 2.49K 1% .125W F TUBULAR	16299	C4-1/8-T0-2491-F
A3R225	2100-3211	1	RESISTOR-VAR TRMR 1KOHM 10% C SIDE ADJ	32997	3389P-1-102
A3R226	0757-0279	1	RESISTOR 3.16K 1% .125W F TUBULAR	24546	C4-1/8-T0-3161-F
A3R227	0698-4496	2	RESISTOR 45.3K 1% .125W F TUBULAR	24546	C4-1/8-T0-4532-F
A3R229	0698-4464	1	RESISTOR 887 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-887R-F
A3R230	0698-4496		RESISTOR 45.3K 1% .125W F TUBULAR	24546	C4-1/8-T0-4532-F
A3R233	0683-1045		RESISTOR 100K 5% .25W CC TUBULAR	01121	CB1045
A3R234	0698-4504	1	RESISTOR 69.8K 1% .125W F TUBULAR	24546	C4-1/8-T0-6982-F
A3R235	0698-7880		RESISTOR 28.7K 1% .125W F TUBULAR	30983	MF4C1/8-T9-2872-F
A3R236	2100-3352	2	RESISTOR-VAR TRMR 1KOHM 10% C SIDE ADJ	73138	T2XR102
A3R237	0698-7880		RESISTOR 28.7K 1% .125W F TUBULAR	30983	MF4C1/8-T9-2872-F
A3R238	0698-7956	1	RESISTOR 99K 1% .125W F TUBULAR	30983	MF4C1/8-T9-9902-F
A3R239	0698-7360	1	RESISTOR 398.5K 1% .125W F TUBULAR	30983	MF4C1/8-T2-3985Z-8
A3R240	0698-4539	1	RESISTOR 402K 1% .125W F TUBULAR	19701	MF4C1/8-T0-4023-F
A3R243	0698-4487	1	RESISTOR 25.5K 1% .125W F TUBULAR	24546	C4-1/8-T0-2552-F
A3R244*	0757-0273		RESISTOR 3.01K 1% .125W F TUBULAR	24546	C4-1/8-T0-3011-F
			*FACTORY SELECTED PART		
A3R245	0757-0447	2	RESISTOR 16.2K 1% .125W F TUBULAR	24546	C4-1/8-T0-1622-F
A3R246	2100-1656	1	RESISTOR-VAR TRMR 500 OHM 5% MW SIDE ADJ	32997	3057P-1-501
A3R247	0757-0440	1	RESISTOR 7.5K 1% .125W F TUBULAR	24546	C4-1/8-T0-7501-F
A3R248	0683-1055		RESISTOR 1M 5% .25W CC TUBULAR	01121	CB1055
A3R249	0683-1055		RESISTOR 1M 5% .25W CC TUBULAR	01121	CB1055
A3R250	0698-4429	1	RESISTOR 1.87K 1% .125W F TUBULAR	16299	C4-1/8-T0-1871-F
A3R253	0757-0283	1	RESISTOR 2K 1% .125W F TUBULAR	24546	C4-1/8-T0-2001-F
A3R254	0698-3499	2	RESISTOR 40.2K 1% .125W F TUBULAR	16299	C4-1/8-T0-4022-F
A3R255	2100-3274	2	RESISTOR-VAR TRMR 10KOHM 10% C SIDE ADJ	32997	3389H
A3R256	0757-0453	2	RESISTOR 30.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-3012-F
A3R257	0757-0438	3	RESISTOR 5.11K 1% .125W F TUBULAR	24546	C4-1/8-T0-5111-F
A3R258	0757-0413	2	RESISTOR 392 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-392R-F
A3R259	0757-0410	2	RESISTOR 301 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-301R-F
A3R260	0757-0415	2	RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R263	0757-0421	2	RESISTOR 825 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-825R-F
A3R264	0757-0411	2	RESISTOR 332 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-332R-F
A3R265	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A3R266	0757-0467	1	RESISTOR 121K 1% .125W F TUBULAR	24546	C4-1/8-T0-1213-F
A3R267	0757-0422	1	RESISTOR 909 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-909R-F
A3R268	0757-0413		RESISTOR 392 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-392R-F
A3R269	0698-3493	1	RESISTOR 4.12K 1% .125W F TUBULAR	16299	C4-1/8-T0-4121-F
A3R270	0757-0410		RESISTOR 301 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-301R-F
A3R273	0757-0436	1	RESISTOR 4.32K 1% .125W F TUBULAR	24546	C4-1/8-T0-4321-F
A3R274	0757-0447		RESISTOR 16.2K 1% .125W F TUBULAR	24546	C4-1/8-T0-1622-F
A3R275	0757-0415		RESISTOR 475 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-475R-F
A3R277	0757-0421		RESISTOR 825 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-825R-F
A3R278	0698-3157	1	RESISTOR 19.6K 1% .125W F TUBULAR	16299	C4-1/8-T0-1962-F
A3R279	0757-0411		RESISTOR 332 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-332R-F
A3R280	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-T0-1001-F
A3R282	0698-3499		RESISTOR 40.2K 1% .125W F TUBULAR	16299	C4-1/8-T0-4022-F
A3R283	2100-3274		RESISTOR-VAR TRMR 10KOHM 10% C SIDE ADJ	32997	3389H
A3R284	0757-0453		RESISTOR 30.1K 1% .125W F TUBULAR	24546	C4-1/8-T0-3012-F
A3R285	0757-0438		RESISTOR 5.11K 1% .125W F TUBULAR	24546	C4-1/8-T0-5111-F
A3R286	0757-0452	1	RESISTOR 27.4K 1% .125W F TUBULAR	24546	C4-1/8-T0-2742-F
A3R287	0698-3498	1	RESISTOR 8.66K 1% .125W F TUBULAR	16299	C4-1/8-T0-8661-F
A3R288	0757-0281	1	RESISTOR 2.74K 1% .125W F TUBULAR	24546	C4-1/8-T0-2741-F
A3R289	0698-3495	1	RESISTOR 866 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-8661-F
A3R290	0757-0409	1	RESISTOR 274 OHM 1% .125W F TUBULAR	24546	C4-1/8-T0-274R-F
A3R291	0698-4398	1	RESISTOR 86.6 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-86R6-F
A3R292	0698-3262	1	RESISTOR 40.2 OHM 1% .125W F TUBULAR	16299	C4-1/8-T0-4022-F
A3R293	0698-3225	1	RESISTOR 1.43K 1% .125W F TUBULAR	16299	C4-1/8-T0-1431-F
A3R294	0698-4463	1	RESISTOR 845 OHM 1% .125W F TUBULAR	03888	PME55-1/8-T0-845R-F
A3R295	2100-3394	1	RESISTOR-VAR 10K	28480	2100-3394
A3R296	0683-2405	5	RESISTOR 24 OHM 5% .25W CC TUBULAR	01121	CB2405
A3R297	0683-2405		RESISTOR 24 OHM 5% .25W CC TUBULAR	01121	CB2405
A3R298	0683-2405		RESISTOR 24 OHM 5% .25W CC TUBULAR	01121	CB2405
A3R299	0683-2405		RESISTOR 24 OHM 5% .25W CC TUBULAR	01121	CB2405
A3R300	0683-5145	8	RESISTOR 510K 5% .25W CC TUBULAR	01121	CB5145
A3R301	0757-0449	19	RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-T0-2002-F
A3R302	0683-1055		RESISTOR 1M 5% .25W CC TUBULAR	01121	CB1055

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

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A3R303	0757-0473		RESISTOR 221K 1% .125W F TUBULAR	24546	C4-1/8-TO-2213-F
A3R304	0698-4482		RESISTOR 17.4K 1% .125W F TUBULAR	03888	PME55-1/8-TO-1742-F
A3R305	0698-4481		RESISTOR 16.5K 1% .125W F TUBULAR	24546	C4-1/8-TO-1652-F
A3R306	2100-0567		RESISTOR-VAR TRMR 2KOHM 10% C TOP	73138	72PR2K
A3R308	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R310	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R311	0698-4510		RESISTOR 84.5K 1% .125W F TUBULAR	24546	C4-1/8-TO-8452-F
A3R312	0757-0473		RESISTOR 221K 1% .125W F TUBULAR	24546	C4-1/8-TO-2213-F
A3R313	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R314	0698-4483		RESISTOR 18.7K 1% .125W F TUBULAR	24546	C4-1/8-TO-1872-F
A3R315	2100-0567		RESISTOR-VAR TRMR 2KOHM 10% C TOP	73138	72PR2K
A3R316	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R318	0698-4510		RESISTOR 84.5K 1% .125W F TUBULAR	24546	C4-1/8-TO-8452-F
A3R319	0698-4483		RESISTOR 18.7K 1% .125W F TUBULAR	24546	C4-1/8-TO-1872-F
A3R320	0698-4482		RESISTOR 17.4K 1% .125W F TUBULAR	03888	PME55-1/8-TO-1742-F
A3R321	2100-0567		RESISTOR-VAR TRMR 20KOHM 10% C TOP	73138	72PR2K
A3R323	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R325	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R326	0698-3243		RESISTOR 178K 1% .125W F TUBULAR	16299	C4-1/8-TO-1783-F
A3R327	0698-4510		RESISTOR 84.5K 1% .125W F TUBULAR	24546	C4-1/8-TO-8452-F
A3R328	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R329	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R331	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R333	0698-4507		RESISTOR 76.8K 1% .125W F TUBULAR	24546	C4-1/8-TO-7682-F
A3R334	0698-3245		RESISTOR 20.5K 1% .125W F TUBULAR	16299	C4-1/8-TO-2052-F
A3R335	0698-3157		RESISTOR 19.6K 1% .125W F TUBULAR	16299	C4-1/8-TO-1962-F
A3R336	2100-0567		RESISTOR-VAR TRMR 2KOHM 10% C TOP	73138	72PR2K
A3R338	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R340	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R341	0698-4529		RESISTOR 226K 1% .125W F TUBULAR	24546	C4-1/8-TO-2263-F
A3R342	0698-4507		RESISTOR 76.8K 1% .125W F TUBULAR	24546	C4-1/8-TO-7682-F
A3R343	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R344	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R346	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R348	0698-4524		RESISTOR 174K 1% .125W F TUBULAR	24546	C4-1/8-TO-1743-F
A3R349	0757-0199		RESISTOR 21.5K 1% .125W F TUBULAR	24546	C4-1/8-TO-2152-F
A3R350	0757-0349		RESISTOR 22.6K 1% .125W F TUBULAR	24546	C4-1/8-TO-2262-F
A3R351	2100-0567		RESISTOR-VAR TRMR 2KOHM 10% C TOP	73138	72PR2K
A3R353	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R355	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R356	0698-4507		RESISTOR 76.8K 1% .125W F TUBULAR	24546	C4-1/8-TO-7682-F
A3R357	0698-4524		RESISTOR 174K 1% .125W F TUBULAR	24546	C4-1/8-TO-1743-F
A3R358	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R359	0757-0449		RESISTOR 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A3R360	0757-0465		RESISTOR 100K 1% .125W F TUBULAR	24546	C4-1/8-TO-1003-F
A3R361	0698-6323	2	RESISTOR 100 OHM .1% .125W F TUBULAR	19701	MF4C1/8-T9-100R-B
A3R362	0698-6448	2	RESISTOR 216.2 OHM .1% .125W F TUBULAR	03888	PME55,T-9
A3R363	0698-6447	2	RESISTOR 683.8 OHM .1% .125W F TUBULAR	03888	PME55,T-9
A3R364	0698-6446	2	RESISTOR 2.162K .1% .125W F TUBULAR	03888	PME55,T-9
A3R365	0698-7330	1	RESISTOR 96.84K .1% .125W F TUBULAR	30983	MF4C1/8-T2-9684I-B
A3R366	0698-7574	1	RESISTOR 31.62 OHM .1% .125W F TUBULAR	30983	MF4C1/8-T9-31R62-B
A3R367	0698-6449	1	RESISTOR 68.38 OHM .1% .125W F TUBULAR	03888	PME55,T-9
A3R368	0698-6448		RESISTOR 216.2 OHM .1% .125W F TUBULAR	03888	PME55,T-9
A3R369	0698-6447		RESISTOR 683.8 OHM .1% .125W F TUBULAR	03888	PME55,T-9
A3R370	0698-3511	1	RESISTOR 665 OHM 1% .125W F TUBULAR	16299	C4-1/8-TO-665R-F
A3R371	0683-5145		RESISTOR 510K 5% .25W CC TUBULAR	01121	CB5145
A3R372	0683-5145		RESISTOR 510K 5% .25W CC TUBULAR	01121	CB5145
A3R373	0698-3275	2	RESISTOR 2.5K 1% .125W F TUBULAR	19701	MF4C1/8-T9-2501-F
A3R374	0683-5145		RESISTOR 510K 5% .25W CC TUBULAR	01121	CB5145
A3R375	0757-0472		RESISTOR 200K 1% .125W F TUBULAR	24546	C4-1/8-TO-2003-F
A3R376	0698-3275		RESISTOR 2.5K 1% .125W F TUBULAR	19701	MF4C1/8-T9-2501-F
A3R377	2100-3212	2	RESISTOR-VAR TRMR 200 OHM 10% C SIDE ADJ	32997	3386P-1-201
A3R378	0683-5145		RESISTOR 510K 5% .25W CC TUBULAR	01121	CB5145
A3R379	0683-1045		RESISTOR 100K 5% .25W CC TUBULAR	01121	CB1045
A3R380	0757-1094	1	RESISTOR 1.47K 1% .125W F TUBULAR	24546	C4-1/8-TO-1471-F
A3R381	0683-5145		RESISTOR 510K 5% .25W CC TUBULAR	01121	CB5145
A3R382	0683-1045		RESISTOR 100K 5% .25W CC TUBULAR	01121	CB1045
A3R383	0683-3945	1	RESISTOR 390K 5% .25W CC TUBULAR	01121	CB3945
A3R384	0683-1055		RESISTOR 1M 5% .25W CC TUBULAR	01121	CB1055
A3R385	0698-6362	1	RESISTOR 1K .1% .125W F TUBULAR	19701	MF4C1/8-T9-1001-B
A3R386	0698-6446		RESISTOR 2.162K .1% .125W F TUBULAR	03888	PME55,T-9
A3R387	0757-0438		RESISTOR 5.11K 1% .125W F TUBULAR	24546	C4-1/8-TO-5111-F
A3R388	0757-0446		RESISTOR 15K 1% .125W F TUBULAR	24546	C4-1/8-TO-1502-F
A3R389	0698-6123		RESISTOR 499 OHM 1% .125W F TUBULAR	16299	C4-1/8-TO-499R-F
A3R390	0683-4735		RESISTOR 47K 5% .25W CC TUBULAR	01121	CB4735

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

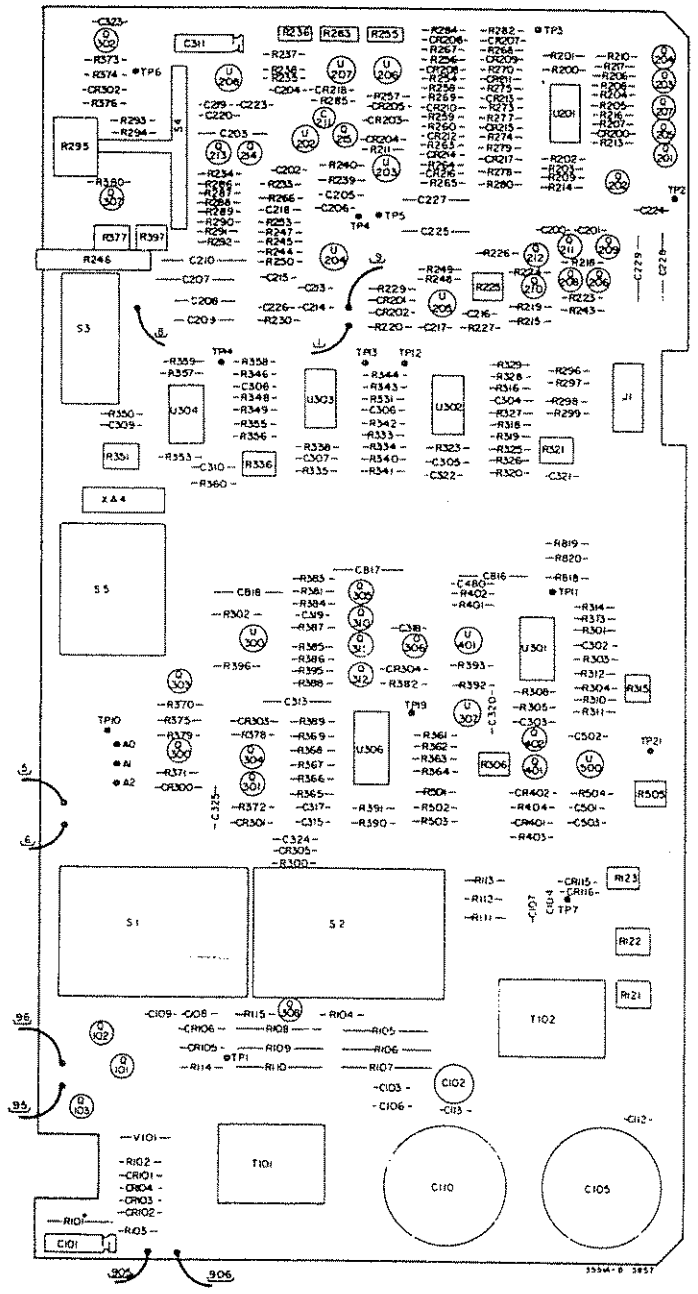
REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A3R391	0683-4735		RESISTOR 47K 5% .25W CC TUBULAR	01121	CB4735
A3R392	0698-6801	1	RESISTOR 3.48K 1% .125W F TUBULAR	19701	MF4C1/8-T9-3481-F
A3R393	0698-8162	1	RESISTOR 2.21K 1% .125W F TUBULAR	30983	MF4C1/8-T9-2211-F
A3R395	0757-0387		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	32997	3389P-1-201
A3R401	0757-0280		RESISTOR 1K 1% .125W F TUBULAR	24546	C4-1/8-TO-1001-F
A3R402	0757-0439	1	RESISTOR 6.81K 1% .125W F TUBULAR	24546	C4-1/8-TO-6811-F
A3R403	0683-5145		RESISTOR 510K 5% .25W CC TUBULAR	01121	CB5145
A3R404	0683-5145		RESISTOR 510K 5% .25W CC TUBULAR	01121	CB5145
A3R501	0698-5394		RESISTOR 105.5 OHM 1% .125W F TUBULAR	28480	0698-5394
A3R502	0698-5371	1	RESISTOR-FXD 213.2 .001	28480	0698-5371
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	2100-3352		RESISTOR-VAR TRMR 1KOHM 10% C SIDE ADJ	73138	72XR102
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-T0-4992-F
A3S1, A3S2	03551-61901		SWITCH, ASSEMBLY ROTARY:FUNCTION AND IMP	28480	03551-61901
A3S3	3100-2753	1	SWITCH, ROTARY: FREQ RANGE HZ	28480	3100-2753
A3S4	3100-2754	1	SWITCH, ROTARY: LEVEL RANGE DBM	28480	3100-2754
A3S5	3100-2751	1	SWITCH, ROTARY: RECEIVE NOISE/TONE	28480	3100-2751
A3T101	9100-3450	1	TRANSFORMER, RECEIVE	28480	9100-3450
A3T102	9100-3449	1	TRANSFORMER, SEND	28480	9100-3449
A3U201	1821-0001	1	IC LIN CA3046 TRANSISTOR ARRAY	02735	CA3046
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	HA2-2625-80593
A3U205	1820-0478		IC LIN LM308H AMPLIFIER	27014	LM308H
A3U206	1826-0043		IC LIN LM307H AMPLIFIER	27014	LM307H
A3U207	1826-0043		IC LIN LM307H AMPLIFIER	27014	LM307H
A3U208	1826-0109		IC LIN AMPLIFIER	34371	HA2-2625-80593
A3U300	1826-0013	2	IC LIN AMPLIFIER	28480	1826-0013
A3U301	1826-0222	4	IC LIN RC4136CP AMPLIFIER	00598	RC4136DP
A3U302	1826-0222		IC LIN RC4136CP AMPLIFIER	00598	RC4136DP
A3U303	1826-0222		IC LIN RC4136CP AMPLIFIER	00598	RC4136DP
A3U304	1826-0222		IC LIN RC4136CP AMPLIFIER	00598	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	HA2-2625-80593
A3V101	1970-0052	1	TUBE, ELCTRN, B1-C90, SURGE V PTCTR	28480	1970-0052
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
A4	03552-66504	1	PC ASSY-NOISE FILTER	28480	03552-66504
A4C401	0160-3468		CAPACITOR-FXD .12UF 10% 80WVDC	56289	292P1249R8
A4C402	0180-0197		CAPACITOR-FXD 2.2UF 10% 20VDC	56289	150D225X9020A2
A4C403	0160-2199		CAPACITOR-FXD 30PF 300WVDC 5%	28480	0160-2199
A4C404	0160-0164		CAPACITOR-FXD .039UF 10% 200WVDC	56289	292P39392
A4C405	0160-0166		CAPACITOR-FXD .068 µF 10% 15VDC	56289	292P68392
A4C406	0160-2199		CAPACITOR-FXD 30PF 5% 300WVDC	28480	0160-2199
A4C407	0160-2192		CAPACITOR-FXD .082UF 5% 200WVDC	84411	HEW238T
A4C408	0160-0192		CAPACITOR-FXD 525PF 5% WVDC	28480	0160-0192
A4C409, C411	0160-2221		CAPACITOR-FXD 1300PF 5% 300WVDC	28480	0160-2221
A4C412, C413	0140-0163		CAPACITOR-FXD 4751PF 1% 300WVDC	72136	DM20F4751F0300WV1CR
A4C414	0160-2199		CAPACITOR-FXD 30PF 5% 300WVDC	28480	0160-2199
A4C415, C416	0160-3024		CAPACITOR-FXD 1700PF 1% 100WVDC	28480	0160-3024
A4C417	0160-2199		CAPACITOR-FXD 30PF 5% 300WVDC	28480	0160-2199
A4C418, C419	0160-3024		CAPACITOR-FXD 1700PF 1% 100WVDC	28480	0160-3024
A4C421, C422	0160-3024		CAPACITOR-FXD 1700PF 1% 100WVDC	28480	0160-3024
A4C423	0160-2199		CAPACITOR-FXD 30PF 5% 300WVDC	28480	0160-2199
A4C424	0140-0184		CAPACITOR-FXD 8200PF 1% 100WVDC	72136	DM20F822F0100WV1CR
A4C425	0160-2199		CAPACITOR-FXD 30PF 5% 300WVDC	28480	0160-2199

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

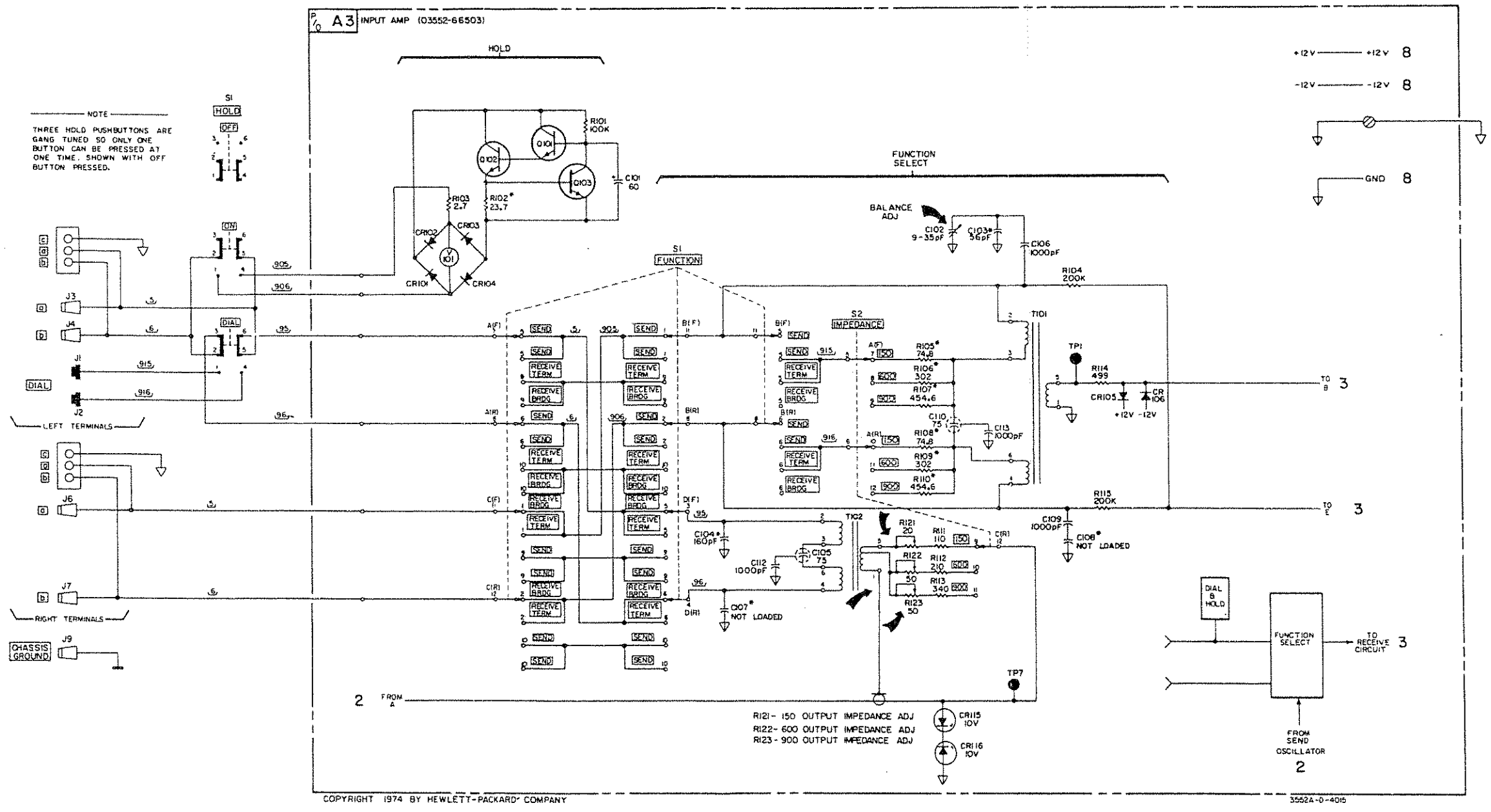
REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A4C426, C427	0160-3024		CAPACITOR-FXD 1700PF 1% 100WVDC	28480	0160-3024
A4C428	0160-2199		CAPACITOR-FXD 30PF 5% 300WVDC	28480	0160-2199
A4C429	0160-2414		CAPACITOR-FXD .022UF 5% 200WVDC	56289	292P22352
A4C431	0160-2199		CAPACITOR-FXD 30PF 5% 300WVDC	28480	0160-2199
A4C432, C433	0180-0228		CAPACITOR-FXD 22UF 10% 15VDC	56289	150D226X901582
A4C434	0140-0184		CAPACITOR-FXD 8200PF 1% 100WVDC	72136	DM20F822F0100WV1CR
A4C435	0180-0197		CAPACITOR-FXD 2.2UF 10% 20VDC	56289	150D225X9020A2
A4C436	0160-0128		CAPACITOR-FXD 2.2UF 20% 25WVDC	28480	0160-0128
A4C437	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC	28480	0150-0093
A4CR401	1902-3085		DIO-BKDN 4.75V	05713	SZ10939-89
A4CR402-407	1901-0025		DIO-SI 100V 200MA	28480	1901-0025
A4L401	9100-3211		INDUCTOR 255MH	28480	9100-3211
A4Q401, 402	1854-0071		XSTR-SI NPN	28480	1854-0071
A4Q403	1853-0086		XSTR-SI PNP	28480	1853-0086
A4Q404	1854-0071		XSTR-SI NPN	28480	1854-0071
A4Q405	1853-0086		XSTR-SI PNP	28480	1853-0086
A4Q406-408	1854-0071		XSTR-SI NPN	28480	1854-0071
A4Q409	1853-0086		XSTR-SI PNP	28480	1853-0086
A4Q411-413	1854-0071		XSTR-SI NPN	28480	1854-0071
A4Q414	1853-0086		XSTR-SI PNP	28480	1853-0086
A4Q415-417	1854-0071		XSTR-SI NPN	28480	1854-0071
A4Q418	1853-0086		XSTR-SI PNP	28480	1853-0086
A4Q419, 421	1854-0071		XSTR-SI NPN	28480	1854-0071
A4Q422	1854-0071		XSTR-SI NPN	28480	1854-0071
A4Q423	1853-0086		XSTR-SI PNP	28480	1853-0086
A4Q424-426	1854-0071		XSTR-SI NPN	28480	1854-0071
A4Q427	1853-0086		XSTR-SI PNP	28480	1853-0086
A4Q428, Q29	1854-0071		XSTR-SI NPN	28480	1854-0071
A4Q431	1854-0071		XSTR-SI NPN	28480	1854-0071
A4Q432	1853-0086		XSTR-SI PNP	28480	1853-0086
A4Q433, Q434	1854-0071		XSTR-SI NPN	28480	1854-0071
A4R401	0698-4498	1	R-FXD 53.6K 1% .125W F TUBULAR	24546	C4-1/8-TO-5362-F
A4R402	2100-3354	4	R-VAR 50K 10% F TUBULAR	73138	72XR104
A4R403	0698-4497	1	R-FXD 48.7K 1% .125W F TUBULAR	24546	C4-1/8-TO-4872-F
A4R404	0757-0460	1	R-FXD 61.9K 1% .125W F TUBULAR	24546	C4-1/8-TO-6192-F
A4R405	0698-4514	1	R-FXD 105K 1% .125W F TUBULAR	24546	C4-1/8-TO-1053-F
A4R406	0757-0442	4	R-FXD 10K 1% .125W F TUBULAR	24546	C4-1/8-TO-1002-F
A4R407	0757-0452	1	R-FXD 27.4K 1% .125W F TUBULAR	24546	C4-1/8-TO-2742-F
A4R408	0757-0123	2	R-FXD 34.8K 1% .125W F TUBULAR	24546	C5-1/8-TO-3482-F
A4R409	1810-0027	7	R-NETWORK	28480	1810-0027
A4R410	2100-3354		R-VAR 50K 10% F TUBULAR	73138	72XR104
A4R411	0757-0449	2	R-FXD 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A4R412, 413	0698-4207	2	R-VAR 44.2K 1% .125W F TUBULAR	16299	C4-1/8-TO-4422-F
A4R414	0757-0161	1	R-FXD 604 OHM 1% .125W F TUBULAR	24546	C4-1/8-TO-604R-F
A4R415	0757-0349	1	R-FXD 22.6K 1% .125W F TUBULAR	24546	C4-1/8-TO-2262-F
A4R416	0757-0449		R-FXD 20K 1% .125W F TUBULAR	24546	C4-1/8-TO-2002-F
A4R417, 418	0757-0442		R-FXD 10K 1% .125W F TUBULAR	24546	C4-1/8-TO-1002-F
A4R419	0684-4751	1	R-FXD 4.7M 10% 1/4W	01121	CB4751
A4R421	0698-4483	1	R-FXD 18.7K 1% .125W F TUBULAR	24546	C4-1/8-TO-1872-F
A4R422	0684-6821	1	R-FXD 6800 OHM 10% 1/4W CC TUBULAR	01121	CB6821
A4R423	0698-3228	1	R-FXD 49.9K 1% .125W F TUBULAR	07716	CEA1/8-TO4991-F
A4R424	0757-0470	1	R-FXD 162K 1% .125W F TUBULAR	24546	C4-1/8-TO-1623-F
A4R425	0757-0465	2	R-FXD 100K 1% .125W F TUBULAR	24546	C4-1/8-TO-1003-F
A4R426	0757-0442		R-FXD 10K 1% .125W F TUBULAR	24546	C4-1/8-TO-1002-F
A4R427	0698-8191	1	R-FXD 12.5K 1% .125W F TUBULAR	24546	C4-1/8-TO-1212-F
A4R428	0757-0427	1	R-FXD 1500 OHM 1% .125W F TUBULAR	24546	C4-1/8-TO-1501-F
A4R429	0757-0283	1	R-FXD 2K 1% .125W F TUBULAR	24546	C4-1/8-TO-1502-F
A4R430	2100-3354		R-VAR 50K 10%	73138	72XR104
A4R431	0698-7671	1	R-FXD 47.96K .1% .125W F TUBULAR	30983	MF4C1/8-T2-47961-B
A4R432, 433	0698-7673	2	R-FXD 49.39K .1% .125W F TUBULAR	30983	MF4C1/8-T2-49391-B
A4R434	1810-0027		R-NETWORK	28480	1810-0027
A4R435	0698-7674	1	R-FXD 13.19K .1% .125W F TUBULAR	30983	MF4C1/8-T2-13191-B
A4R436	0698-6943	5	R-FXD 20K .1% .125W F TUBULAR	19701	MF4C1/8-T2-2002-B
A4R437	0698-7675	1	R-FXD 24.06K .1% .125W F TUBULAR	30983	MF4C1/8-T2-24061-B
A4R438	0698-7670	1	R-FXD 23.69K .1% .125W F TUBULAR	30983	MF4C1/8-T2-23691-B
A4R439	0698-3519	1	R-FXD 12.4K 1% .125W F TUBULAR	16299	C4-1/8-TO-1242-F
A4R440	2100-3354		R-VAR 50K 10%	73138	72XR104
A4R441	1810-0027		R-NETWORK	28480	1810-0027
A4R442	0757-0469	1	R-FXD 150K 1% .125W F TUBULAR	24546	C4-1/8-TO-8662-F
A4R443	0698-6943		F-FXD 20K .1% .125W F TUBULAR	19701	MF4C1/8-T2-2002-B
A4R444	0698-3519	1	R-FXD 12.4K 1% .125W F TUBULAR	24546	C4-1/8-TO-1302-F

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

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A4R445	0757-0465		R-FXD 100K 1% .125W F TUBULAR	24546	C4-1/8-TO-1003-F
A4R446	0698-7669	2	R-FXD 32.35K .1% .125W F TUBULAR	30983	MF4C1/8-T2-32351-B
A4R447	0757-0123		R-FXD 34.8K 1% .125W F TUBULAR	24546	C5-1/8-TO-3482-F
A4R448	0698-7668	2	R-FXD 39.91K .1% .125W F TUBULAR	30983	MF4C1/8-T2-39911-B
A4R449	1810-0027		R-NETWORK	28480	1810-0027
A4R451	0698-7668		R-FXD 39.91K .1% .125W F TUBULAR	30983	MF4C1/8-T2-39911-B
A4R452	0698-7682	1	R-FXD 52.98K .1% .125W F TUBULAR	30983	MF4C1/8-T2-52981-B
A4R453	0698-6943		R-FXD 20K .1% .125W F TUBULAR	19701	MF4C1/8-T2-2002-B
A4R454, 455	0698-7680	2	R-FXD 59.41K .1% .125W F TUBULAR	30983	MF4C1/8-T2-59411-B
A4R456	1810-0027		R-NETWORK	28480	1810-0027
A4R457	0698-7679	1	R-FXD 19.41K .1% .125W F TUBULAR	30983	MF4C1/8-T2-19411-B
A4R458	0698-6943		R-FXD 20K .1% .125W F TUBULAR	19701	MF4C1/8-T2-2002-B
A4R459	0698-7669		R-FXD 32.35K .1% .125W F TUBULAR	30983	MF4C1/8-T2-32351-B
A4R462	0757-0290	1	R-FXD 6190 OHM 1% .125W F TUBULAR	30983	MF4C1/8-TO-6191-F
A4R463	0757-0454	1	R-FXD 33.2K 1% .125W F TUBULAR	24546	C4-1/8-TO-3322-F
A4R464	1810-0027		R-NETWORK	28480	1810-0027
A4R465	0698-6943		R-FXD 20K .1% .125W F TUBULAR	19701	MF4C1/8-T2-2002-B
A4R466	0698-4307	1	R-FXD 14.3K .1% .125W F TUBULAR	19701	MF4C1/8-T2-1492-B
A4R467	0698-7681	1	R-FXD 15.33K .1% .125W F TUBULAR	30983	MF4C1/8-T2-15331-B
A4R468	0757-0434	1	R-FXD 3650 OHM 1% .125W F TUBULAR	24546	C4-1/8-TO-3651-F
A4R469	0698-4492	1	R-FXD 32.4K 1% .125W F TUBULAR	24546	C4-1/8-TO-3242-F
A4R471	0757-0459	1	R-FXD 56.2K 1% .125W F TUBULAR	24546	C4-1/8-TO-5622-F
A4R472	1810-0027		R-NETWORK	28480	1810-0027
A4R473	0698-4482	1	R-FXD 17.4K 1% .125W F TUBULAR	03888	PME55-1/8-TO-1742-F
A4R474	0698-4489	1	R-FXD 28K 1% .125W F TUBULAR	24546	C4-1/8-TO-2802-F
A4R476	0683-4715	1	R-FXD 470 OHM 5% .25W CC TUBULAR	01121	CB4711
A4R477	0684-1011	1	R-FXD 100 OHM 10% .25W CC TUBULAR	01121	CB1011
A4R478	0684-1041	1	R-FXD 100K 10% .25W CC TUBULAR	01121	CB1041
A4S1	3100-2755	1	SWITCH-ROTARY	28480	3100-2755

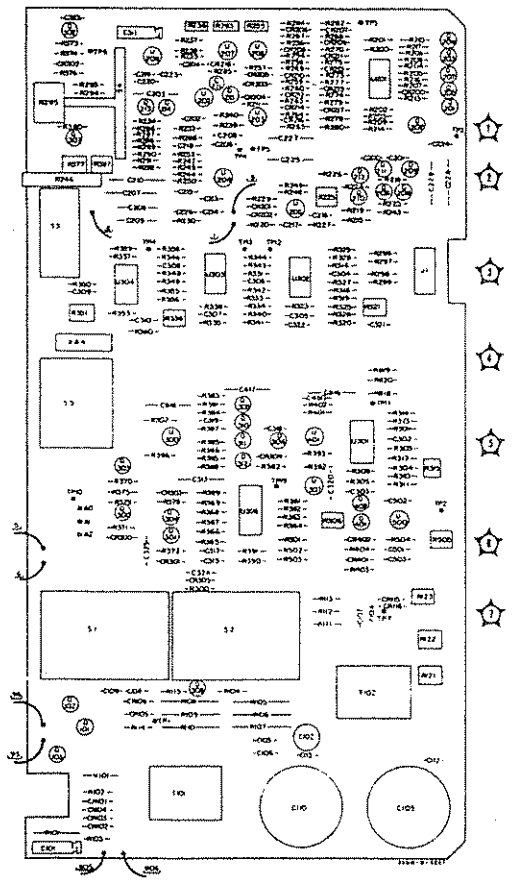


A3
hp Part No. 03552-66503
Rev B



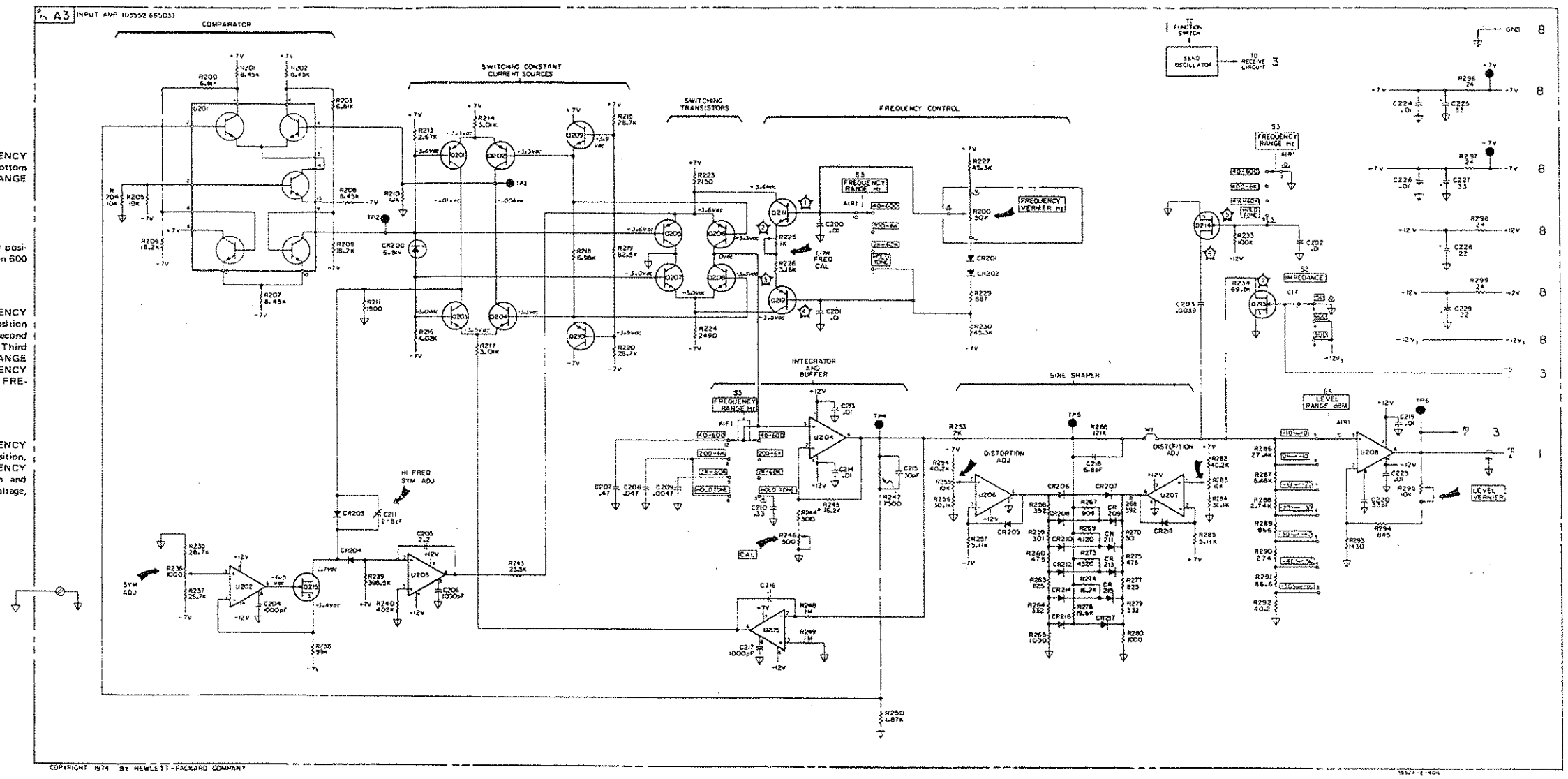
For Serial Numbers 1435A00140 and below **1**

Figure 8-3. Dial and Hold, Function Select, A3.
8-13/8-14



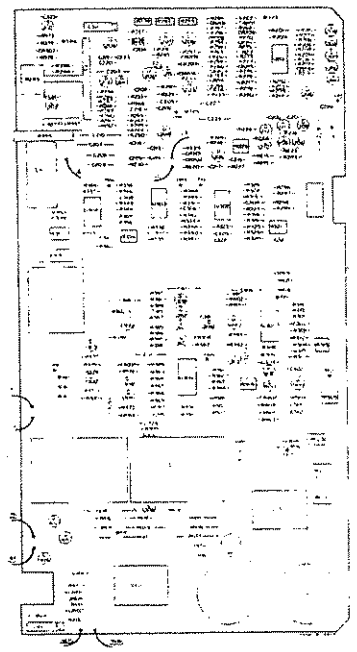
0 V dc - 12 V dc	Top voltage measured with FREQUENCY RANGE Hz in HOLD TONE position. Bottom voltage measured with FREQUENCY RANGE Hz in all other positions.
0 V dc - 0.5 V dc	
0 V dc - 4 mV dc	Top voltage measured with IMP in 150 position. Bottom voltage measured with IMP in 600 and 900 position.
+ 2.6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

A3
hp Part No. 03552-66503
Rev B



For Serial Numbers 1435A00140 and below **2**

Figure 8-4. Send Oscillator, A3.



A3
hp Part No. 03552-66503
Rev B

All dc levels are with RECEIVE NOISE/TONE in all but the WITH TONE position. In the WITH TONE position, dc levels shown will be lower (approximately 10%) because of the additional filtering added in this position.

0 V dc	- 0.01 V dc
0 V dc	11 V dc
0 V dc	0.1 V dc
0 V dc	1 mV dc
9.5 V dc	0 V dc
0 V dc	11 V dc
0.1 V dc	0 V dc
11 V dc	0 V dc
11.5 V dc	- 12 V dc
11 V dc	0 V dc

Top voltage measured with DISPLAY & MONITOR RECEIVE FREQ or RECEIVE LEVEL pushbutton pressed. Bottom voltage measured with DISPLAY & MONITOR SEND FREQ or SEND LEVEL pushbutton pressed.

- 0.05 V dc	
0.1 V dc	
0 V dc	

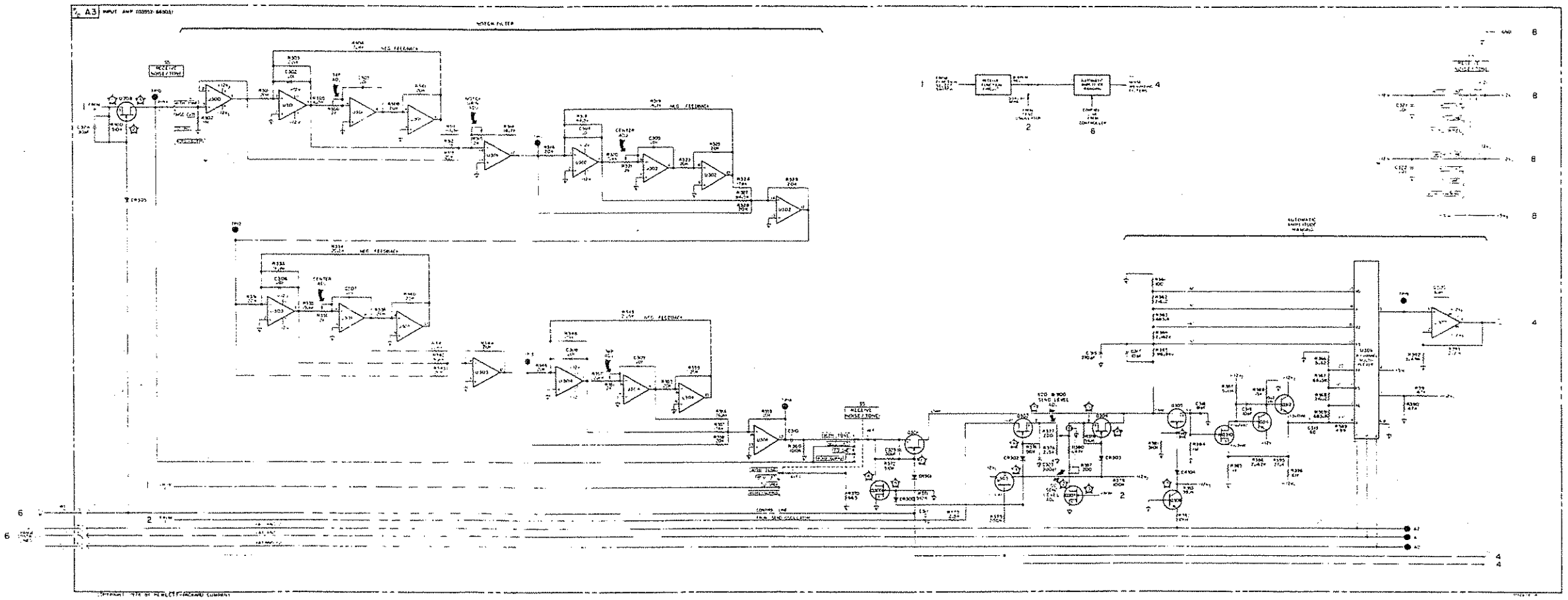
Top voltage measured with DISPLAY & MONITOR RECEIVE FREQ or RECEIVE LEVEL pushbutton pressed and IMP in 150 position. Second voltage measured with IMP in 600 and 900 position. Bottom voltage measured with DISPLAY & MONITOR SEND FREQ or SEND LEVEL pushbutton pressed.

0 V dc	0.1 V dc
0 V dc	- 12 V dc

Top voltage measured with IMP in 150 position. Bottom voltage measured with IMP in 600 or 900 position.

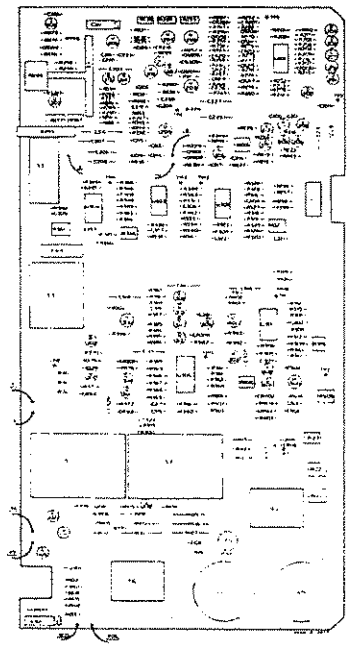
0 V dc	- 6.5 V dc
0 V dc	- 0.5 V dc

Top voltage measured with the automatic ranging circuit in range 0 through range 2. Bottom voltage measured with automatic ranging circuit in range 4 through range 7.



For Serial Numbers 1435A00140 and Below

Figure 8-5. Receive Circuit and Automatic Amplitude Ranging, A3.



A3
hp Part No. 03552-66503
Rev B

A4
hp Part No. 03552-66504
Rev B

☆ 0.87 / 5.5 — Top voltage measured with NOISE WEIGHTING in the TELEPHONE position. Bottom voltage measured in any other NOISE WEIGHTING position.

☆ 0.3 / 0.02 / 0.01 / 3 mV — Top voltage measured with NOISE WEIGHTING in TELEPHONE position. Second voltage measured with NOISE WEIGHTING in 3 kHz FLAT position. Third voltage measured with NOISE WEIGHTING in 15 kHz FLAT position. Bottom voltage measured with NOISE WEIGHTING in PROGRAMME position

☆ +0.25 / +1.0 — Top voltage measured with NOISE WEIGHTING in the TELEPHONE position. Bottom voltage measured in any other NOISE WEIGHTING position.

☆ 0.3 / 0.03

☆ 0.3 / +0.5

☆ 1.36 / 0.6

☆ 0.65 / 2.5.3 / 0.55 — Top voltage measured with the NOISE WEIGHTING in the TELEPHONE position. Second voltage measured with the NOISE WEIGHTING in 3 kHz FLAT or 15 kHz FLAT position. Bottom voltage measured with NOISE WEIGHTING in the PROGRAMME position.

☆ 0.1 / 2.2 / 0.3

☆ +9.5 / +10.1 / +9.5

☆ +0.8 / 2.5 / +1.0

☆ 0.12 / 1.98 / 0.04

☆ +0.24 / 3.0 / +0.46

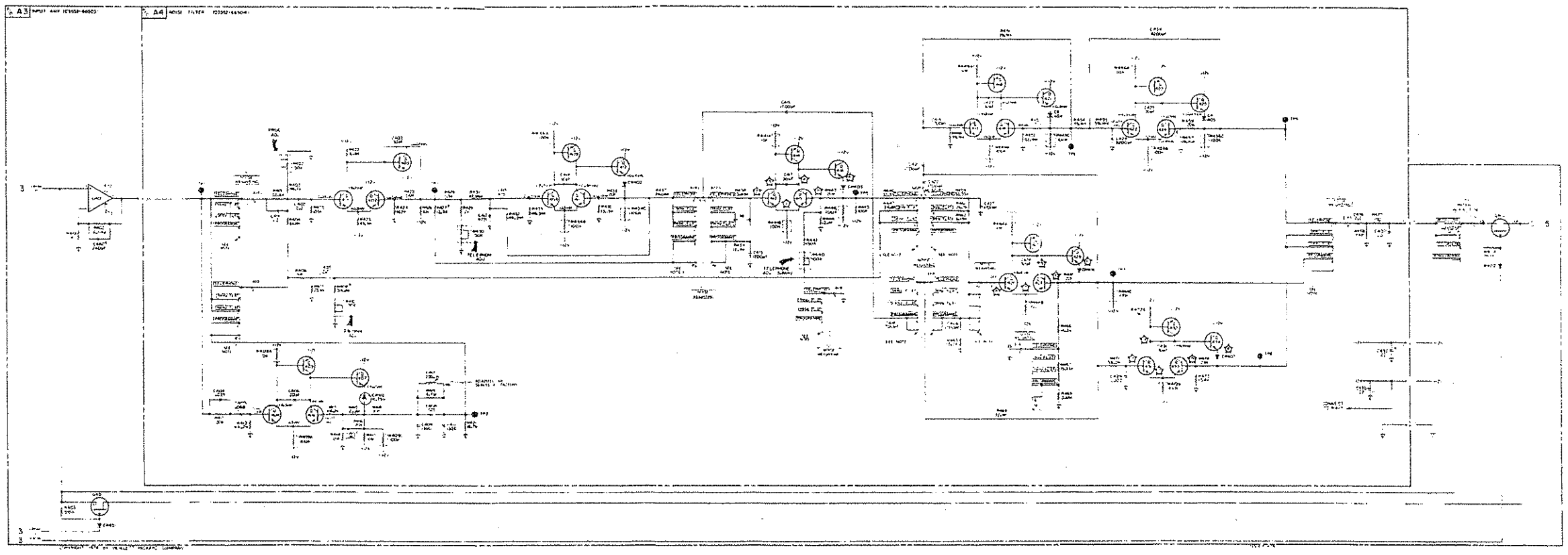
☆ 0.87 / 0.07 / 0.05 / 0.04 — Top voltage measured with NOISE WEIGHTING in TELEPHONE position. Second voltage measured with NOISE WEIGHTING in 3 kHz FLAT position. Third voltage measured with NOISE WEIGHTING in 15 kHz FLAT position. Bottom voltage measured with NOISE WEIGHTING in PROGRAMME position

☆ 1.2 / +0.85 / +0.91 / +0.94

☆ 0.84

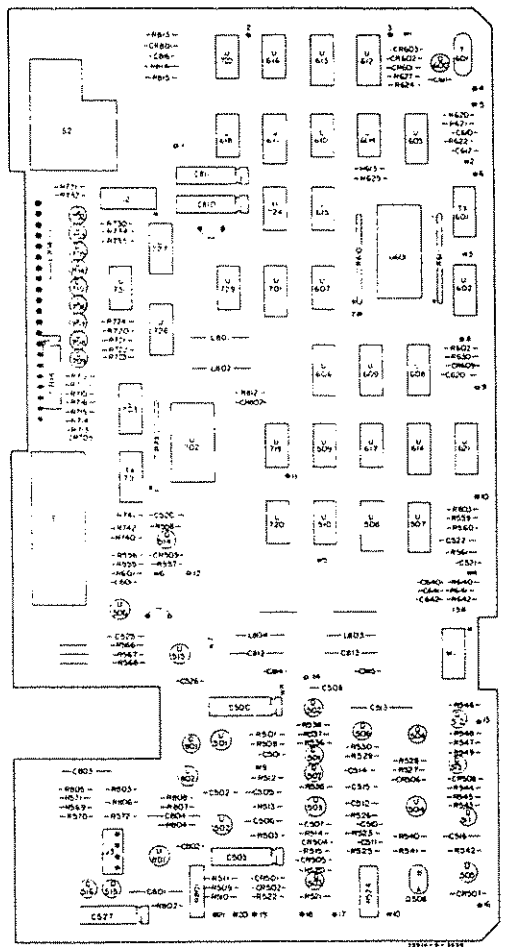
☆ 0.084 / 0.067 / 0.057

☆ 1.7 / +0.30 / +0.36 / +0.38

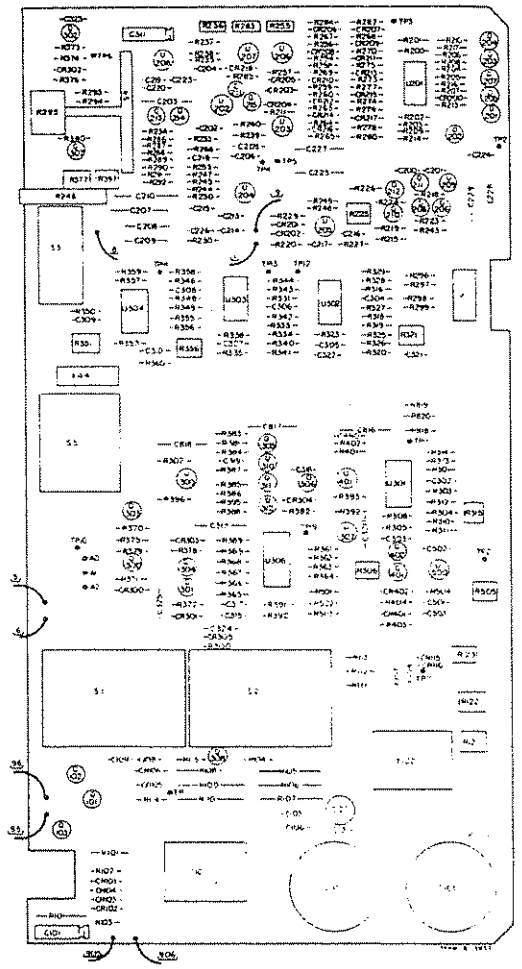


For Serial Numbers 1125A00200 and lower
and 1512U00220 and lower

Figure 8-6. Noise Weighting Filters, A3, A4.



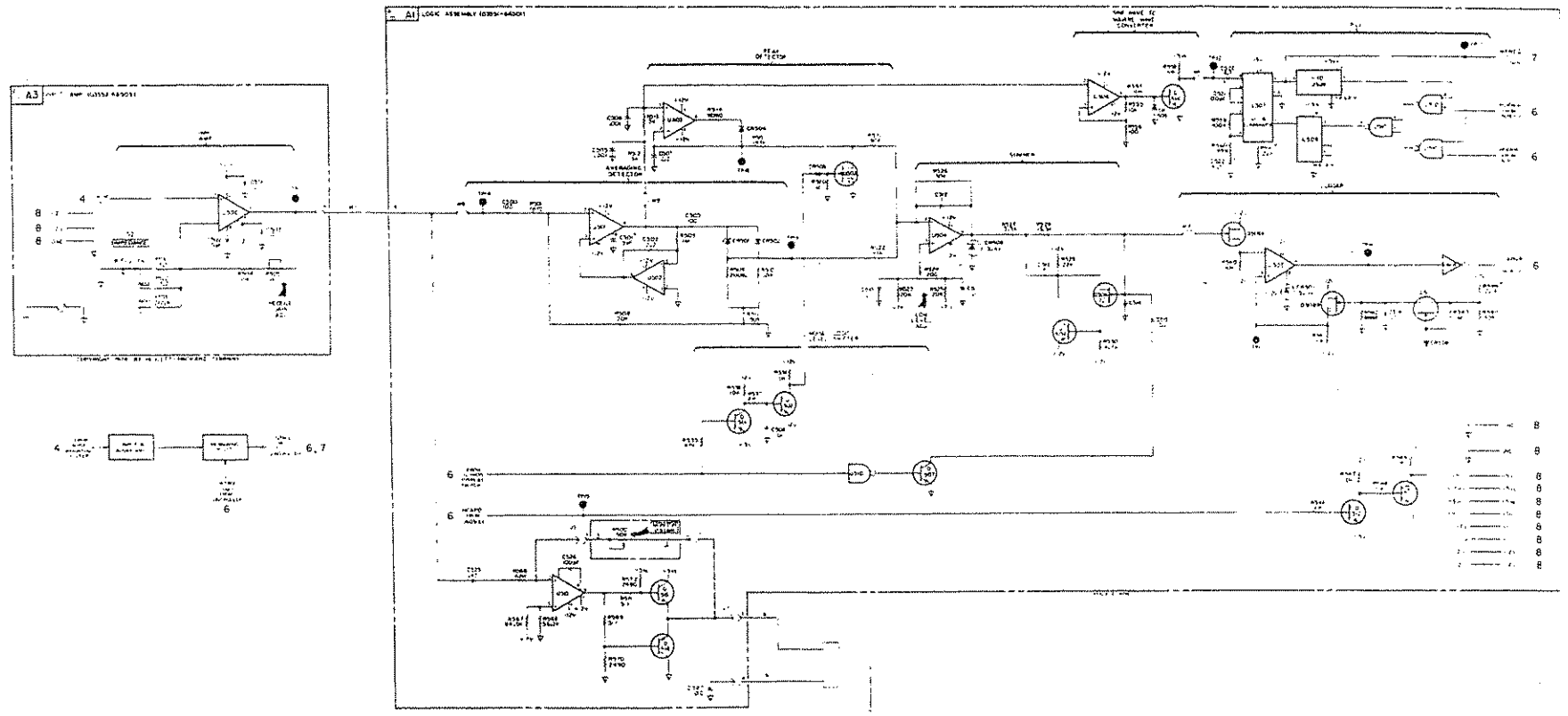
A1
hp Part No. 03551-66501
Rev B



A3
hp Part No. 03552-66503
Rev B

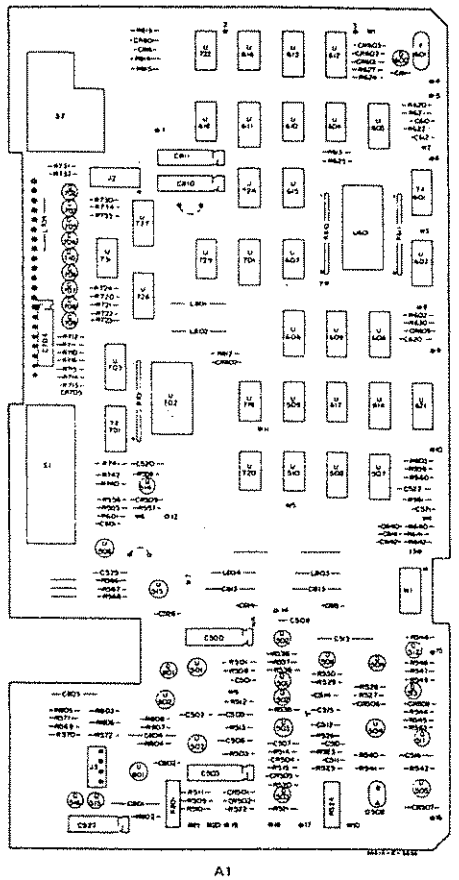
NOTE

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

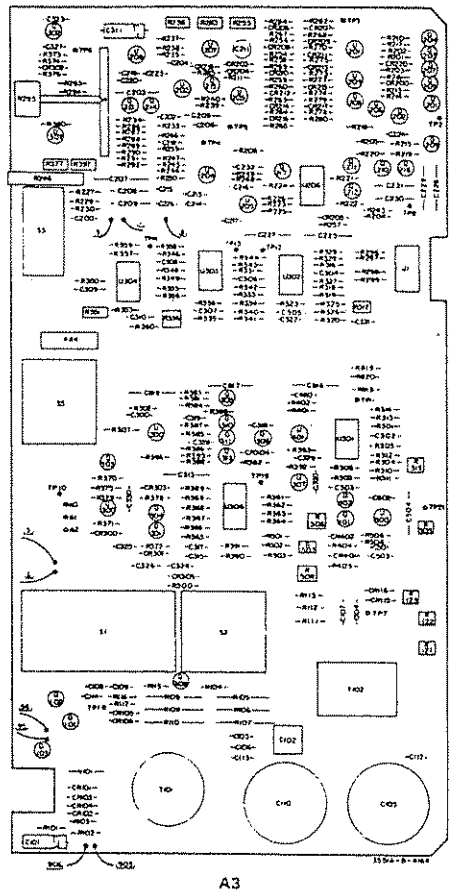


For Serial Numbers 1435A00140 and Below

Figure 8-7. Input and Audio Amp, Measuring Circuits, A1, A3.



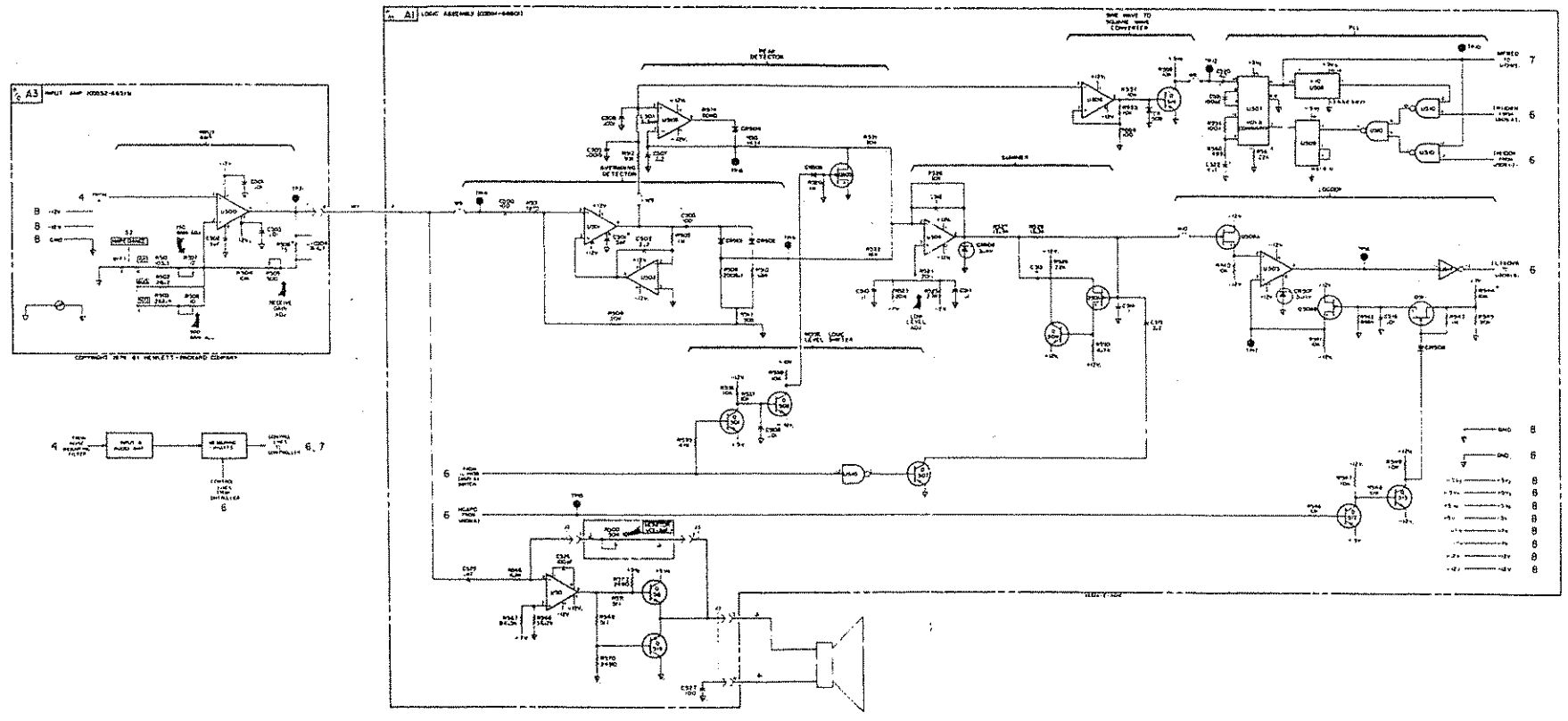
A1
hp Part No. 03551-66501
Rev B



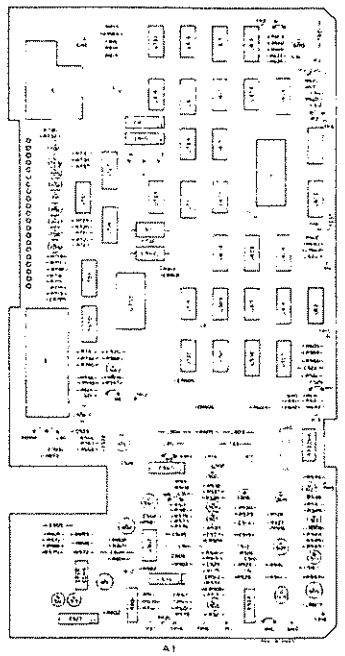
A3
hp Part No. 03552-66513
Rev A

NOTE

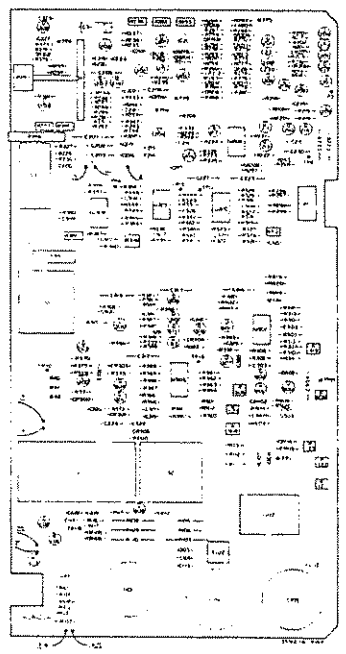
Because of the digital signals present in this circuitry, dc levels on the transistors are not meaningful. For troubleshooting, refer to the waveforms on the analog block diagram, Figure 7-11.



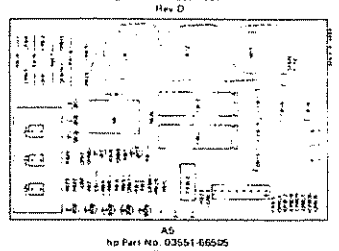
For Serial Numbers 1125A00200 and lower
and 1152U00220 and lower
Figure 8-8. Input and Audio Amp, Measuring Circuits, A1, A3.



A1
hp Part No. 03551-66501
Rev D



A3
hp Part No. 03551-66513
Rev B



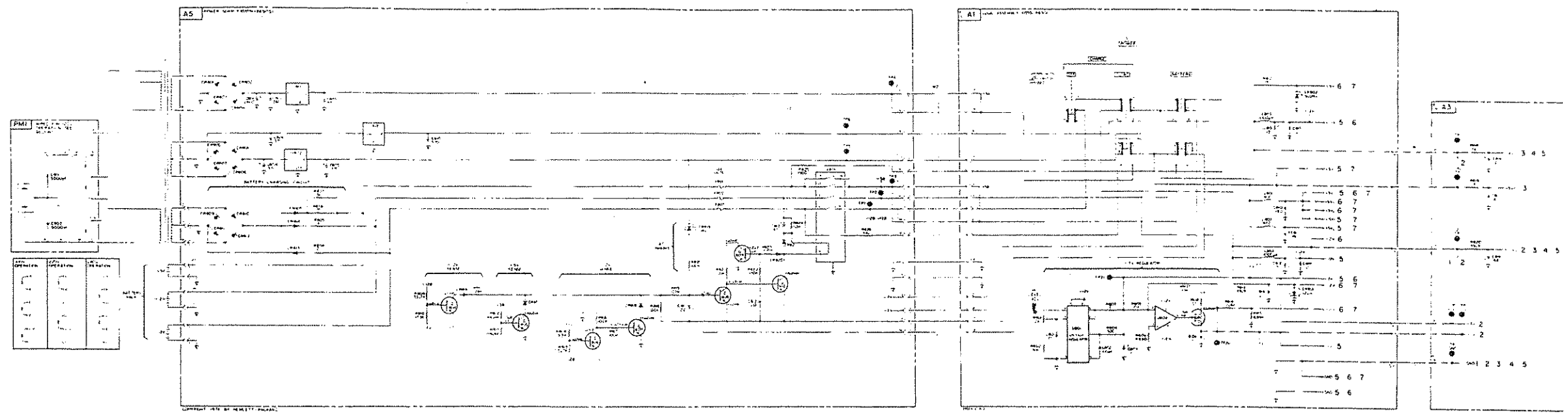
A5
hp Part No. 03551-66505
Rev A

NOTE 1

Fuses F801 - F803 are plug-in fuses. A spare fuse located on the A5 assembly is supplied. To exchange fuse: remove K801 (plug) and remove fuse and replace with spare fuse.

NOTE 2

For dc level troubleshooting, remove battery cables, pull board out at least 7 inches (cable will allow troubleshoot in ac mode).



For Serial Numbers 1604A00260 and lower
and 1635U00440 and lower

Figure 8-9. Power Supply A1, A3, A5.

APPENDIX B

B-1. Radio Frequency Interference.

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

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

IMPORTANT

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

Make the following changes in Table 6-3.

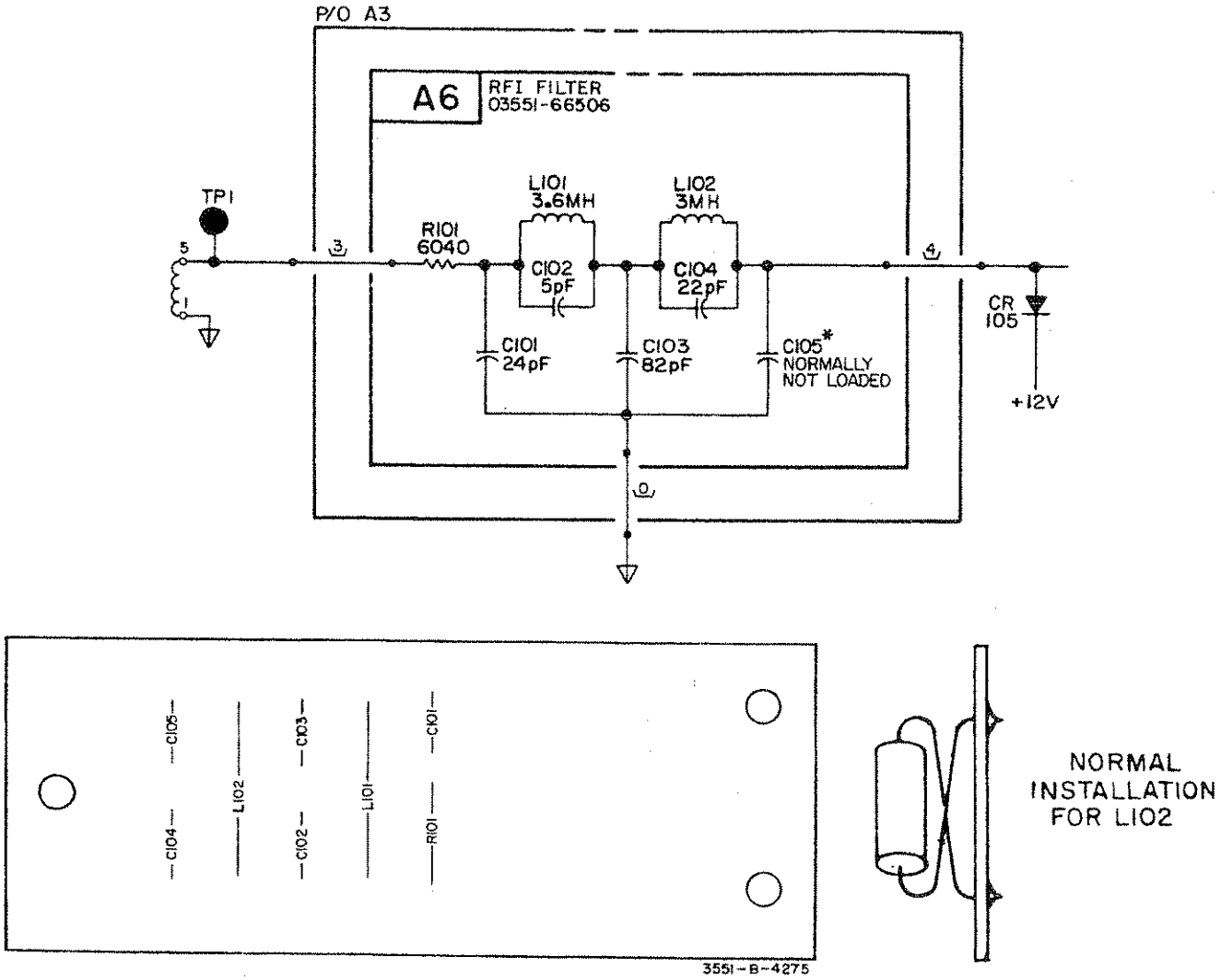
A3R376 changed to 2.162 kΩ .1% .125W, 0698-6446
A3R380 changed to 1.37 kΩ 1% .125W, 0698-4423
A1C813 changed to 68 μF 15 V, 0180-1835
A3C103* (starred value) is typically not loaded
A3C108* (starred value) is typically a 470 pF

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

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

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

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



A6

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

B-2. Replacement of A3 Assembly in Instruments Serial No. 1435A00140 and lower.

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

NOTE

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

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

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

panels. These front and front sub-panels are not interchangeable with old style instruments prior to this change. Old style front sub-panels and front panels are available on a special order basis.

If you have any questions, contact your nearest -hp- Sales and Service Office (Appendix A). In addition, the new assembly will require updated adjustment information.

B-3. Hold Circuit Modification.

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

MODIFICATION 1.

Hold Circuit Drops E.S.S. Lines.

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

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

Parts Needed For Modification

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

a. Remove A3C101 and discard.

b. Remove A3V101 and install new protector tube in its place.

c. Remove A3R101 and discard. Install the current regulator in place of R101. The dotted end of the "diode" goes towards the front of the instrument.

d. Correct your manual schematic and parts list.

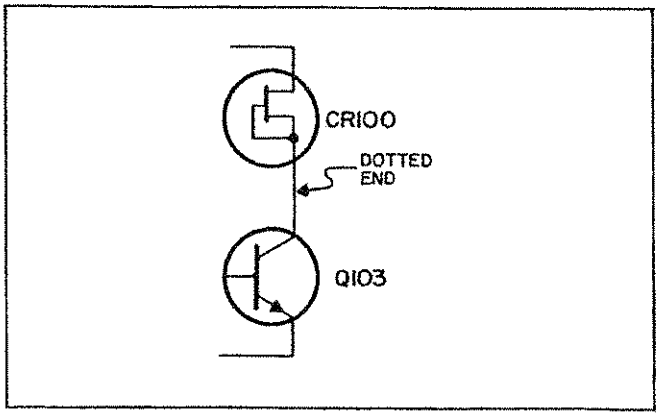


Figure 1. Schematic Representation.

MODIFICATION 2.

Hold Circuit Causes Erroneous Readings.

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

When the above instruments are operated on fringe lines the high (≅ 27 milliamps) current sunk by the hold circuit may cause problems. Lowering the value of the current will decrease the probability of problems.

Parts Needed For Modification

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

a. Remove A3R102, ususally a 20.5 Ω resistor, and discard.

b. Install new resistor, 28.7 Ω, in place of A3R102.

NOTE

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

c. Correct your manual schematic and parts list.

PERFORMANCE TEST.

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

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

POWER . . . . . ~ AC (MAINS)
FUNCTION (Black Input/
Output Terminals . . . . . .REC TERM
IMP 900
SEND FREQUENCY RANGE . . . 200 –6 kHz
SEND LEVEL RANGE . . . . . –10 to 0 dBm
DISPLAY & MONITOR . . . RECEIVE LEVEL
RECEIVE NOISE/TONE . . . . . TONE
HOLD . . . . . OFF

b. Connect the SEND output to the RECEIVE input with a cable.

c. Connect a DC Voltmeter (-hp- 3490A) in parallel with the RECEIVE input.

d. Connect a DC power supply capable of supplying 30 mA at 60 volts to the TEST SET'S RECEIVE input thru a 100 ohm series resistor.

e. Adjust the power supply voltage until the voltmeter indicates 53 V dc. Note the indication on the TEST SET display.

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

g. Decrease the input voltage and assure that when HOLD is turned on and off the display reads the same (± .1 dBm) for any dc voltage greater than 6 volts. See note in Step f.

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

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

APPENDIX C

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

The contents of this appendix are as follows:

Section — Page

C–1. GENERAL INFORMATION C–1
Table of board revisions and approximate serial number breaks C–1
Quick check list of known problems C–2

C–2. WARRANTY ALWAYS MODIFICATIONS . . .C–1
These modifications may be made at any time the instrument is returned to an –hp– Sales and Service Office for maintenance. The cost of modification will be borne by –hp–

C–3. WARRANTY ALWAYS IF OUT OF SPECIFICATION. C–4
These modifications should be made if the instrument is out of specifications. The cost of modification will be borne by –hp–

C–4. WARRANTY NEVER MODIFICATIONS C–8
Modification which improve ease of calibration or enable surpassing a given specification by a greater margin. Hewlett–Packard will NOT bear the cost of these modifications

Section C-1. GENERAL INFORMATION.

Table C–2 is meant to be used as a quick overview of problems which may exist on the 3552A. Column one indicates the part number of the board which may need modification while column two gives the board revision. Both the part number and the revision are printed on every board. Column three gives a very brief description of the problem which may exist. Information given later in this Appendix (the section column indicates where) indicates the necessary action to be taken if this problem exists. The status column indicates who pays for the cost of modification. WA means the modification will be done by any –hp– Sales and Service Office at no charge, no matter how old the instrument is.

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

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

Section C-2. WARRANTY ALWAYS.

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

IMPORTANT

Perform the modifications only on the given

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

Serial Prefix with 'A'

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

Serial Prefix with 'U'

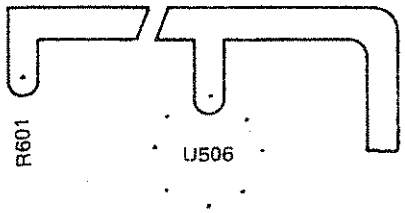
Serial No.	Board				
	A4	A1	A3	A2	A5
101	66504 REV A	66501 REV B	66513 REV A	66502 REV A	66505 REV A
121					
150		REV C	REV B		
221	66514 REV A			REV B	REV B
281		REV D			

Table C–2. Quick Checklist.

Board	Revision	Fault	Status	Section
03552–66501	B & C	Short between front end of A1R601 and A1U506 pin 4	WA	C–2A
03552–66501	D	Open from left side of A1C528 to ground	WA	C–2B
03552–66501	D	A1U502 pin 4 at +5 V	WA	C–2C
03552–66501	D	No holddown on A1Y601 crystal	WA	C–2D
03552–66503 03552–66513	A & B A & B	A3C502 is 10 pF	WA	C–2E
03552–66513	A & B	A3R213 is 26.7 K and/or A3R216 is 40.2 K and/or A3C216 is blue or red in color	WA	C–2F
03552–66501	A & B & C	Crosstalk between Send and Receive too high	WA*	C–3A
03552–66501	A & B & C	Racking of display when measuring a HOLD TONE	WA*	C–3B
03552–66503 03552–66513	A & B A & B	Inability to obtain +10 dBm output or maximum level overranges (blanks) display	WA*	C–3C
03552–66513	A & B	Received level at 100 Hz out of spec	WA*	C–3D
03552–66513	A & B	Send oscillator distortion out of spec	WA*	C–3E
Mainframe 3552A	——	FM Interference, coils on input jacks missing	WA*	C–3F
General 3552A	——	Display brightness uneven	WA*	C–3G
03552–66503 03552–66513	A & B A	A3R236 at its endstop	WN	C–4A
03552–66503 03552–66513	A & B A & B	Displayed send level not actual output at 60 kHz and 135 ohm IMP	WN	C–4B
03552–66503 03552–66513	A & B A	Difficulty in adjusting send oscillator distortion	WN	C–4C
03552–66513	A & B	Marginal Longitudinal Balance	WN	C–4D
Case 3552A	——	RFI Interference – AM	WN	C–4E

*Modification to be performed only if a problem exists.

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



C–2A
03552–66501 REV B & C

a. Check the resistance from A1U506 pin 4 to the front end (viewed from the front of the instrument) of A1R701. If a short (less than 2 ohms) is measured, perform Step b. If about 14 ohms is measured, the modification is unnecessary.

b. A trace shorting A1L804 should be cut. This trace is on the back side (non–component side) of the A1 board between A1U506 pin 4 and A1R601.

C–2B
03552–66501 REV D

a. Check the resistance from the left side (as viewed from the top front) of A1C528 to ground. If there is continuity, the modification is already installed. If there is no continuity, continue.

b. Remove left side of A1C528 from the board and install a terminal post Part No. 0360–1716 in the resulting

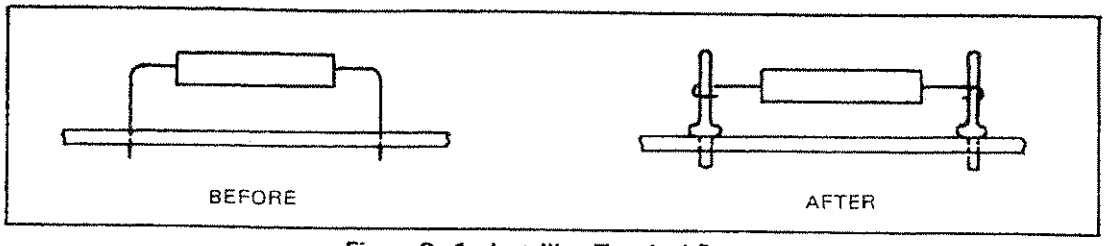


Figure C–1. Installing Terminal Posts.

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

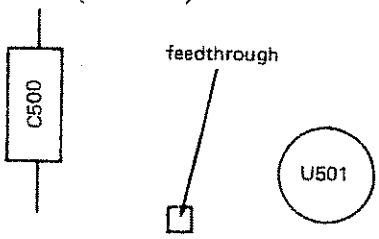
c. Run a fine wire from the terminal post to the "LSD" post (ground) on the non–component side of the board (see Figure C–2).

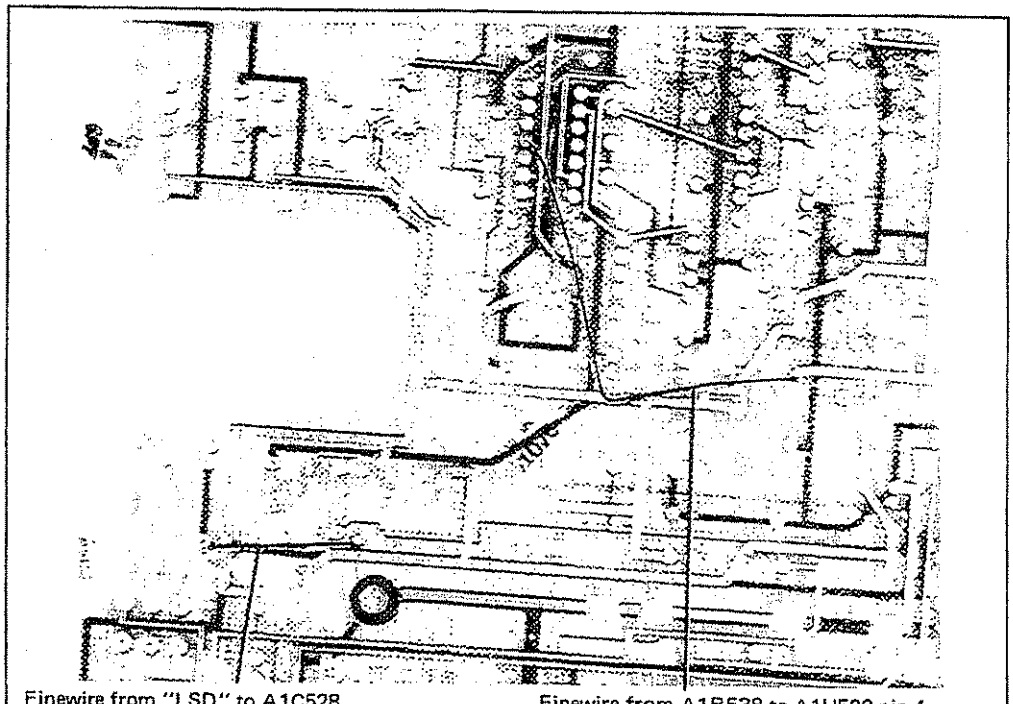
d. Attach the finewire to the board as shown with a thin coating of epoxy.

C–2C
03552–66501 REV D

a. Check the voltage on pin 4 of A1U502. If it is approximately +5 volts (as opposed to +12 volts), install the following modification.

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





A thin coating of clear Epoxy Part No. 0470-0585 should be put over the entire length of the finewire (except where soldered). Finewire should not touch any pads which may require unsoldering at a later date. The recommended finewire is 24 gauge solid round copper magnet wire with polyurethene insulation. Part No. 8180-2124 is a spool of this wire (about 3000 feet). Approximately one foot is needed for these modifications.

Figure C–2. Running Finewires.

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

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

e. Check for an open between A1U502 IC socket pin 4 and +5 volt supply (use +5 TP under A3 connector). If shorted, recheck "drilled out" feedthrough.

f. Run a finewire on the non–component side of the board from the new terminal post (on A1R538) to pin 4 of A1U502 IC socket (see Figure C–2).

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

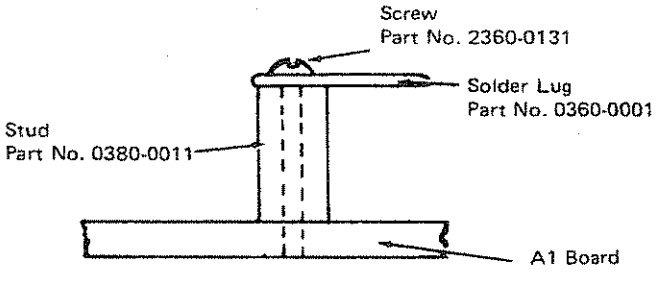
h. Reinstall A1U502. Use a new IC Part No. 1826–0323 (to avoid intermittents due to solder on IC legs).

C–2D
03552–66501 REV D

a. Locate the crystal A1Y601 and see if it is soldered in or plugged in. If it is plugged in, there should be a solder lug over the top of the crystal holding the crystal in place. If there is not, proceed with Step b.

b. Remove the A1 board mounting screw adjacent to the crystal.

c. Install a spacer stud and a solder lug over the hole as shown below. Position the solder lug over the top of the crystal (A1Y601) can to hold it in the socket. Tighten the screw.



d. Remove the A1 board mounting screw adjacent to TP16. Install a spacer stud and screw as shown above (delete the solder lug).

C–2E
03552–66503 REV A & B
03552–66513 REV A & B

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

C–2F
03552–66513 REV A & B

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

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

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

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

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

IMPORTANT

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

C–3A
03552–66501 REV A & B & C

PERFORMANCE CHECK

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

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

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

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

IMPORTANT

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

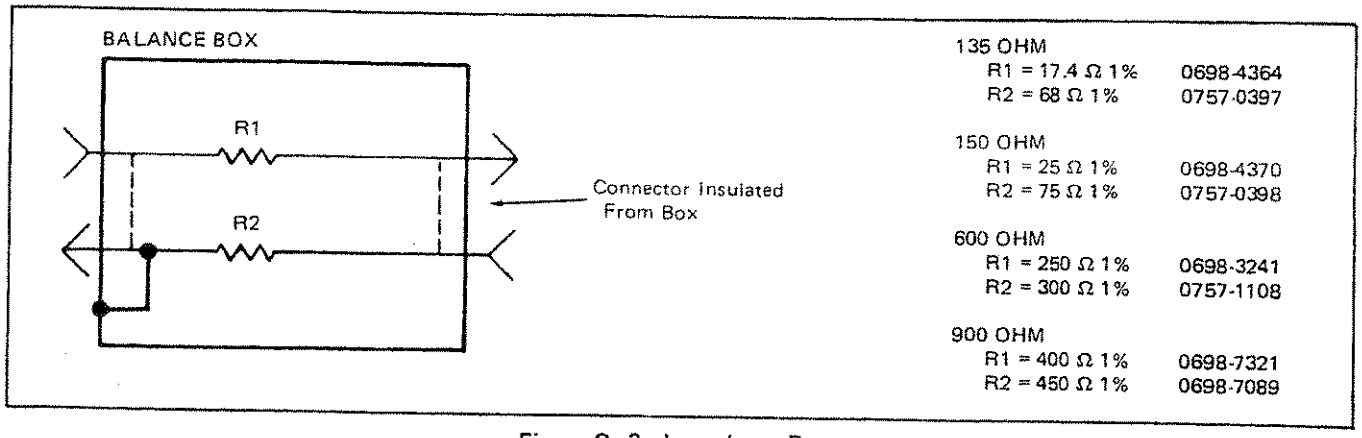


Figure C–3. Impedance Box.

e. Press RECEIVE FREQ and check the reading (≈ 40 Hz). If it is incorrect, perform the following modification. If the reading is correct, proceed to Step f.

f. Set SEND FREQ to 40 Hz and send LEVEL to minimum (< –60 dBm).

g. Set the synthesizer to 60 kHz at a level of +20 dBm (3552A input of 4.46 V).

h. Set the FUNCTION switch to REC BRDG and press the SEND FREQ monitor button. If the reading is incorrect, perform the following modification.

MODIFICATION

a. Change A1C522 from 4.7 microfarad to 6.8 microfarad Part No. 0180–1701.

b. Change A1C601 from .04 microfarad to 2.2 microfarad Part No. 0160–0128.

c. Change A1C505 from .001 microfarad to .0015 microfard Part No. 0160–0298.

d. Change A1C506 from .001 microfarad to .0039 microfarad Part No. 1060–0156.

e. Change A1R513 from 3 kilohm to a 3.3 microhenry coil (L501) Part No. 9011–1665.

f. Change A1R512 from 3 kilohm to 931 ohm Part No. 0698–4465.

g. Change A1R556 from 100 ohm to 402 ohm Part No. 0698–4453.

h. Measure the resistance between the case of A3T101 and ground. If it is over one ohm, remove T101 and solder a wire from pin 1 of the transformer to the case or outer can. Reinstall T101.

i. Dress all wires in the vicinity of the function switch away from the transformer.

j. If the instrument has a 03552–66503 board, continue with Step k; otherwise, the modification is complete.

k. Check for a .1 microfarad capacitor across A3R379. If none is present:

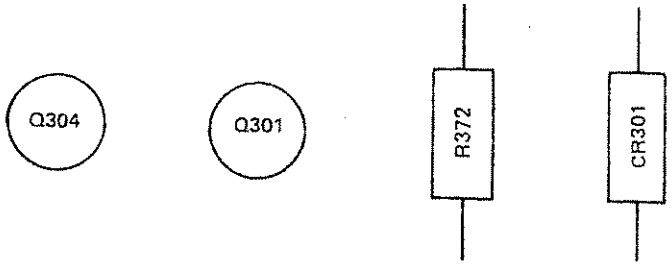
1. Remove A3R379 and install terminal posts (Part No. 0360–1716) in the board at both ends (see Figure C–1).

2. Reconnect A3R379 between the posts and add a .1 microfarad capacitor Part No. 0150–0084 between the posts in parallel with A3R379.

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

m. Remove A3R372 and install terminal posts (Part No. 0360–1716) in the board at both ends (see Figure C–1).

n. Install A3C324, either the one removed in Step m or if none was present, a new 30 pF capacitor (Part No. 0160–2199), between the posts in parallel with R372.



o. Check for a 30 or 33 pF capacitor across A3R300. If none is present, remove R300 and install terminal posts (Part No. 0360–1716) in the board at both ends (see Figure C–1).

p. Reinstall R300 and add a 30 pF capacitor (Part No. 0160–2199) between the posts in parallel with R300.

C–3B
03552–66501 REV A & B & C

PROBLEM

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

MODIFICATION

NOTE

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

a. Check the values of A1C502 and A1R503. If they are 6.8 microfarad and 100 kilohm respectively, then the racking is already suppressed and the modification should NOT be installed.

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

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

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

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

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

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

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

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

j. Select A1R503 for a test set display of –.4 dBm. Typically a 120 to 150 kilohm resistor is needed.

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

C–3C
03552–66503 REV A & B
03552–66513 REV A & B

PERFORMANCE CHECK

a. Depress the SEND LEVEL button and adjust the SEND LEVEL control for a maximum output (> +10 dBm).

b. Set the IMP switch to 900 ohms and the FREQUENCY switch to HOLD TONE.

c. The display should indicate a minimum of +10 dBm (any value over +10 is acceptable).

d. Set the IMP switch to 600 ohms and the FREQUENCY control to 10 kHz.

e. The display should indicate a minimum of +10 dBm but should not indicate overrange (blanked display).

f. If either Step c or Step e does not work as stated, perform the following modification.

MODIFICATION

a. Change A3R293 to a starred value (newer schematic indicates this change).

b. Select A3R293 for proper readings, typically a 1.33 kilohm to 1.5 kilohm resistor is needed. Higher values of R293 will lower the output reading.

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

C–3D
03552–66513 REV A & B

PERFORMANCE CHECK

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

b. Set the synthesizer for a +8.79 dB output at 1 kHz (3552A input of .6152 V).

c. Press the RECEIVE LEVEL button and note the reading (≈ –2 dBm).

d. Set the synthesizer frequency to 100 Hz.

e. The received level should be within ± .1 dB of that noted in Step 3. If this level is not obtained, perform the following modification.

MODIFICATION

a. Change A3R506 to a starred value.

b. Typically a 75 ohm resistor, Part No. 0757–0398, will be needed.

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

C–3E
03552–66513 REV A & B

PERFORMANCE CHECK

a. Check the send oscillator distortion as outlined in the Operating and Service Manuals Performance Tests section. Pay particular attention to 20 kHz (> –40 dB) and 4 kHz (> –50 dB).

b. If the distortion is not within specifications, the following modification should be made.

MODIFICATION

Parts Needed for Modification

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

a. Change A3C215 to 100 pF.

b. Lift the end of A3R284 closest to the rear of the instrument and install a terminal post in the board. Reconnect R284 to the post (see Figure C–1).

c. Lift the end of A3R282 closest to the front of the instrument and install a post in the board. Reconnect R282.

d. Connect a 1 μF capacitor between the posts installed in Steps b and c.

e. Lift the end of A3R254 closest to the front of the instrument and install a post in the board. Reconnect R254.

f. Lift the end of A3R211 closest to the rear of the instrument and install a post in the board. Reconnect R211.

g. Connect a 1 μF capacitor between the posts installed in Steps e and f.

h. Correct the manual schematic to show the new value of A3C215 and to add a 1 μF capacitor from the junction of R283 and R282 to ground. Also, add a 1 μF capacitor from the junction of R254 and R255 to ground.

C–3F
MAINFRAME

PROBLEM

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

MODIFICATION

Parts Needed for Modification

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

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

a. Unsolder the two wires attached to the rear of one of the front panel banana jacks.

b. Unscrew the plastic mounting nut and remove the flat saddle washer (see Figure C–4). Discard saddle washer.

c. Reinstall and tighten the plastic mounting nut. Then add the solder lug, lockwasher, and nut (Part No. 2950–0043) in that order to the rear of the banana jack (see Figure C–4).

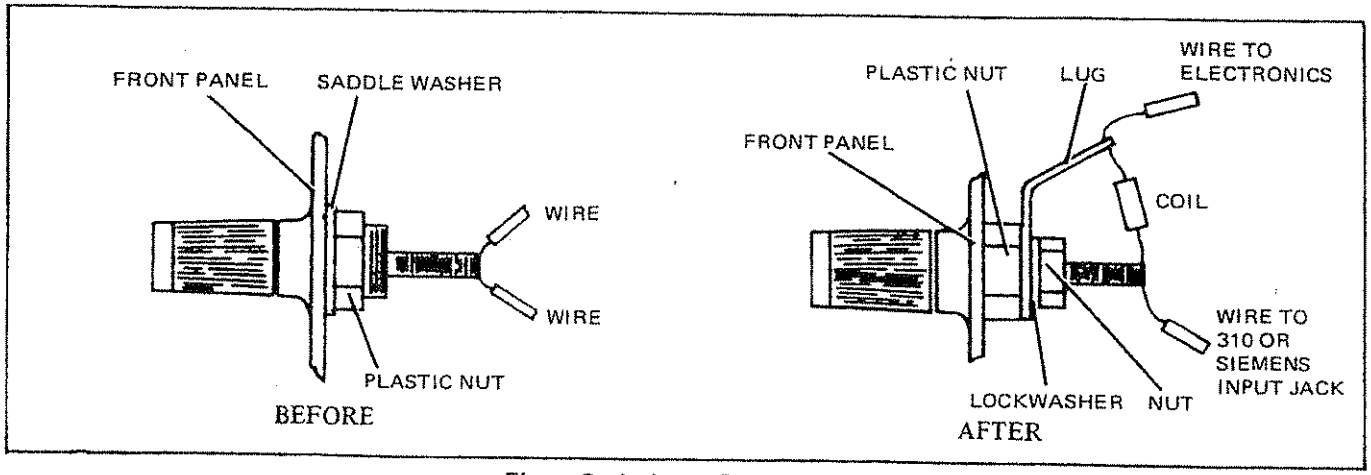


Figure C–4. Input Banana Jack.

d. Connect a coil between the solder lug and the rear of the banana jack.

e. Reconnect the wires as shown in Figure C–4.

f. Redo Steps a to e on the three remaining banana jacks.

C–3G
GENERAL

DISPLAY BRIGHTNESS UNEVEN

3552A Serial Numbers 1435A00140 and below

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

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

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

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

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

Section C–4. WARRANTY NEVER MODIFICATIONS.

The following modifications provide improved performance in the manner indicated. These modifications must NOT BE charged to warranty (WN).

IMPORTANT

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

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

RESULT

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

MODIFICATION (WN)

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

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

RESULT

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

MODIFICATION (WN)

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

b. Reconnect A3R380 between the terminal posts.

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

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

RESULT

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

MODIFICATION (WN)

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

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

C–4D
03552–66513 REV A & B

RESULT

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

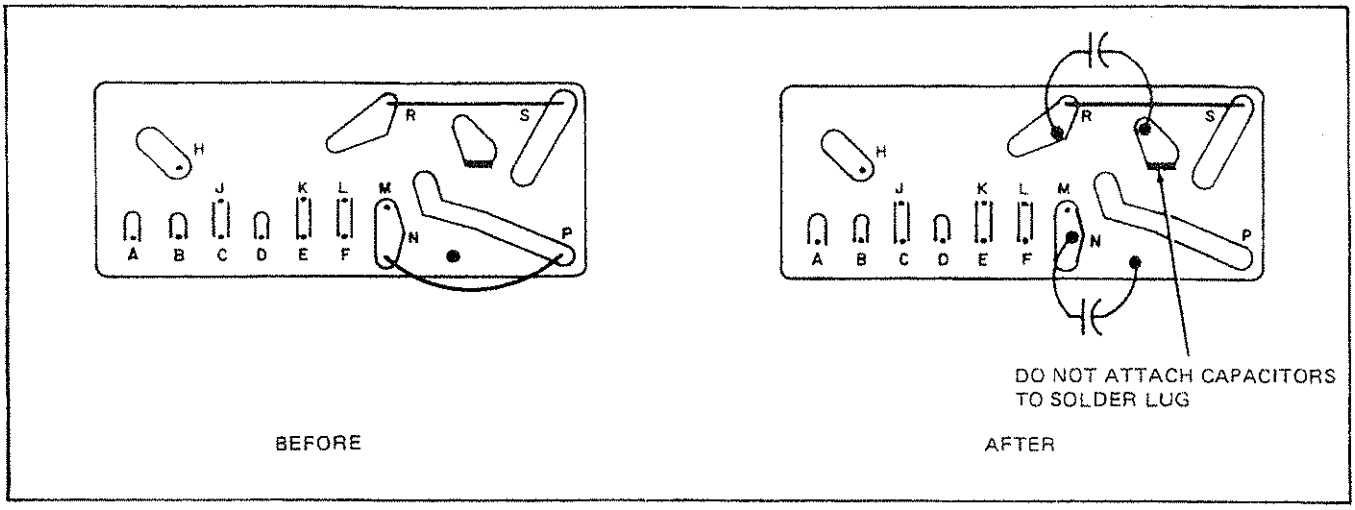


Figure C–5. Pictorial Representation.

MODIFICATION (WN)

Change A3R116 and A3R117 from 499 ohm to 505 ohm .1% Part No. 0698–6965.

C–4E
CASE

PROBLEM, RFI INTERFERENCE – AM

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

If the interference is coming through the line power cord and presents a problem, the following modification should help. This modification may not be charged to warranty (WN) since battery operation is recommended where extremely noisy power lines exist.

MODIFICATION (WN)

Parts Needed for Modification

Quantity	Description	–hp– Part No.
2	Capacitor, .001 μF	0160–0195
1	Label	7120–5361

a. Remove line module from case.

b. Add capacitors as shown in Figure C–5 and C–6.

NOTE

Some units are in the field with terminal posts and capacitors added in a slightly different manner. This is acceptable and remodification is not required. Be sure the label is present and correct.

c. Reassemble instrument.

d. Attach label to outside of case under AC input plug over existing label.

e. Add parts used to the manual's parts list and correct the manual schematic to show a capacitor from R to ground and a capacitor from N to ground. Change the AC line input frequency in Table 1–2 to 48 to 66 Hz.

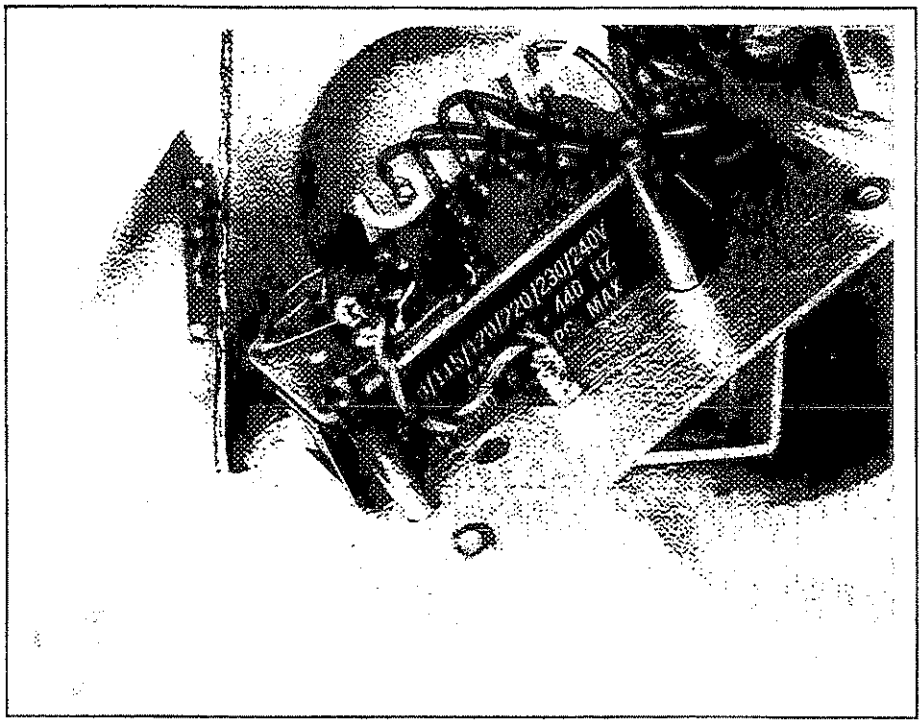


Figure C–6. Physical Parts Locator.

HEWLETT PACKARD

Reorder No. or
Manual Part No.

03552-90004

03552-90004