Errata

Title & Document Type: **4938A Network Circuit Access Test Set Operating and Service Manual**

Manual Part Number: **04938-90003**

Revision Date: **September 1984**

About this Manual

We've added this manual to the Agilent website in an effort to help you support your product. This manual provides the best information we could find. It may be incomplete or contain dated information, and the scan quality may not be ideal. If we find a better copy in the future, we will add it to the Agilent website.

HP References in this Manual

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

Support for Your Product

Agilent no longer sells or supports this product. You will find any other available product information on the Agilent Test & Measurement website:

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Search for the model number of this product, and the resulting product page will guide you to any available information. Our service centers may be able to perform calibration if no repair parts are needed, but no other support from Agilent is available.

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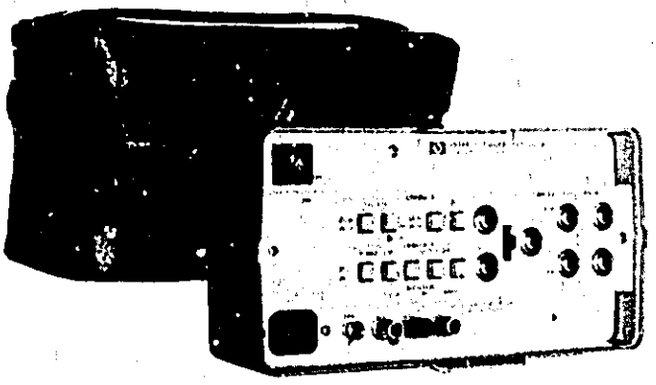
OPERATING AND SERVICE MANUAL

4938A

NETWORK CIRCUIT ACCESS TEST SET



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SAFETY

This product has been designed and tested according to International Safety Requirements. To ensure safe operation and to keep the product safe, the information, cautions, and warnings in this manual must be heeded Refer to Section I for general safety considerations applicable to this product.

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard 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

This Hewlett-Packard instrument product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, HP will, at its options, either repair or replace products which prove to be defective.

For Warranty service or repair, this product must be returned to a service facility designated by HP. Buyer shall prepay shipping charges to HP and HP shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to HP from another country.

HP warrants that its software and firmware designed by HP for use with an instrument will execute its programming instructions when properly installed on that instrument. HP does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance. No other warranty is expressed or implied. HP specifically disclaims the implied warranties of merchantability and fitness for a particular purpose.

EXCLUSIVE REMEDIES

The remedies provided herein are buyer's sole and exclusive remedies. HP shall not be liable for any direct, indirect, special, incidental, or consequential damages, whether based on contract, tort, or any other legal theory.

ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products. For any assistance, contact your nearest Hewlett-Packard Sales and Service Office.

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OPERATING AND SERVICE MANUAL

HEWLETT-PACKARD MODEL 4938A
Network Circuit Access Test Set

SERIAL NUMBERS

This manual applies directly to instruments with serial numbers prefixed 2432A.

For additional important information about serial numbers, see INSTRUMENTS COVERED BY MANUAL in Section 1.

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MANUAL PART NO. 04938-90003
MICROICHE PART NO. 04938-90004

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WARNING

SAFETY

If this instrument is to be energized via an autotransformer for voltage reduction, make sure the common terminal is connected to the earthed pole of the power source.

BEFORE SWITCHING ON THIS INSTRUMENT, the protective earth terminals of this instrument must be connected to the protective conductor of the (mains) power cord. The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action must not be negated by use of an extension cord (power cable) without a protective conductor (grounding).

Make sure that only fuses with the required rated current and of the specified type (normal blow, time delay, etc.) are used for replacement. The use of repaired fuses and the short-circuiting of fuse holders must be avoided.

Whenever it is likely that the protection offered by fuses has been impaired, the instrument must be made inoperative and be secured against any unintended operation.

GROUNDING

Any interruption of the protective (grounding) conductor (inside or outside the instrument) or disconnecting the protective earth terminal can make this instrument dangerous. Intentional interruption is prohibited.

HIGH VOLTAGE

Any adjustment, maintenance, and repair of the opened instrument under voltage should be avoided as much as possible and, when inevitable, should be carried out only by a skilled person who is aware of the hazard involved.

Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.

Adjustments and service described herein are performed with power supplied to the instrument while protective covers are removed. Energy available at many points, if contacted, result in personal injury.

CAUTION

LINE VOLTAGE

BEFORE SWITCHING ON THIS INSTRUMENT, make sure instrument requirements match the voltage of the power source.

GROUNDING

BEFORE SWITCHING ON THIS INSTRUMENT, ensure that all devices connected to this instrument are connected to the protective (earth) ground.

BEFORE SWITCHING ON THIS INSTRUMENT, ensure that the line power (mains) plug is connected to a three-conductor line power outlet that has a protective (earth) ground. (Grounding one conductor of a two-conductor outlet is not sufficient.)

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IEC SYMBOLS

The following is a list of key IEC symbols used by Hewlett-Packard. All symbols are normally applied adjacent to the device requiring the symbol. They shall not be placed on removable parts likely to be detached or lost.

Instruction Manual symbol: If necessary, to preserve the apparatus from damage it is necessary for the user to refer to the instruction manual, then shall the apparatus be marked with this symbol (IEC 348,16a).

Terminal devices fed from the interior by live voltages that may be dangerous when connecting to or disconnecting from those devices shall be marked with the flash shown when the voltage exceeds 1 KV: The flash shall be red (IEC 348,18c)

Earth Terminals. If the use of this symbol for the protective earth terminal is not permitted by National Standards, it may be modified, for example, by being placed inside a circle (IEC 348,18a).

AC current (IEC 117-1, symbol No. 3).

DC current (IEC 117-1, symbol No. 2).

AC or DC current (IEC 117-1, symbol No. 8).

Frame or chassis connection. The hatching may be completely or partly omitted if there is no ambiguity. If the hatching is omitted, the line representing the frame or chassis shall be thicker (IEC 117-1, symbol No. 87).

A — Ampere (IEC 117-4, symbol No. 356).

V — Volt (IEC 117-4, symbol No. 357).

VA — Voltampere (IEC 117-4, symbol No. 358).

W — Watt (IEC 117-4, symbol No. 360).

Wh — Watthour (IEC 117-4, symbol No. 361).

VAh — Voltamperehour (IEC 117-4, symbol No. 362).

Hz — Hertz (IEC 117-4, symbol No. 365).

Contactor, normally closed. In order to avoid confusion with the symbol for a capacitor, the distance between the horizontal (as drawn here) lines should be at least equal to the length of those lines (IEC 117-3, symbol No. 215-2).

In addition the following describes the use of Warnings, Cautions and Notes used in HP Automatic Test System Manuals.

Warnings, cautions and notes. (All) Warnings and cautions shall precede the text to which each applies but notes may precede or follow applicable text depending on the material to be highlighted. Warnings, cautions, and notes shall not contain procedural steps nor shall they be numbered. When a warning, caution, or note consists of two or more paragraphs, the heading WARNING, CAUTION, NOTE, shall not be repeated above each paragraph. If it is ever necessary to precede a paragraph by both a warning and a note, or a caution and a note, etc, they shall appear in the sequence as noted, namely, warnings, cautions, notes. Such inserts in the text shall be short and concise and be used to emphasize important and critical instructions.

WARNING

An operating procedure, practice, etc, which, if not correctly followed, could result in personal injury or loss of life.

CAUTION

An operating procedure, practice, etc. which, if not strictly observed, could result in damage to, or destruction of, equipment.

NOTE: An operating procedure, condition, etc. which it is essential to highlight.

Health hazards precaution data. (All) When hazardous chemicals or adverse health factors, in the environment or use of the equipment cannot be eliminated, appropriate precautionary requirements shall be included

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Table of Contents

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Table of Contents (con't)

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List of Illustrations

List of Tables

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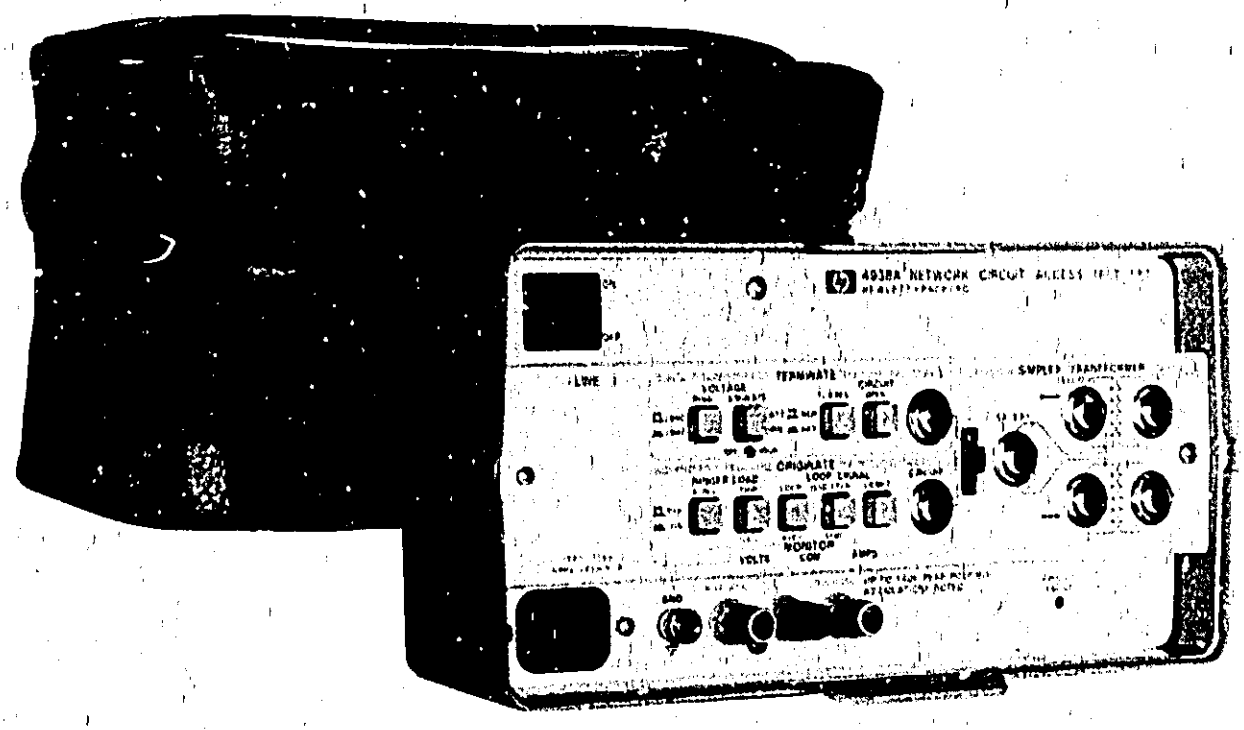

Figure 1-1. *Model 4938A Network Circuit Access Test Set*

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SECTION I

GENERAL INFORMATION

1-1. INTRODUCTION

1-2. This Operating and Service Manual contains information required to install, operate, test, adjust, and service the Hewlett-Packard Model 4938A Network Circuit Access Test Set (NCATS). Figure 1-1 shows the instrument and accessories supplied. Throughout the remainder of this manual the Model 4938A will be referred to as HP 4938A or the instrument.

1-3. The Manual part number is listed on the title page. Also listed on the title page of this manual is a Microfiche part number. This number can be used to order 4 X 6 inch microfilm transparencies of the manual. Each microfiche contains up to 96 photo-duplicates of the manual pages. The microfiche package also includes the latest Manual Changes supplement as well as pertinent Service Notes.

1-4. SPECIFICATIONS

1-5. Instrument specifications are listed in table 1-1. These specifications are the performance standards or limits against which the instrument is tested.

1-6. SAFETY CONSIDERATIONS

1-7. This product is a Safety Class 1 instrument (provided with a protective earth terminal). The instrument and manual should be reviewed for safety markings and instructions before operation.

1-8. INSTRUMENTS COVERED BY THIS MANUAL

1-9. Attached to the instrument is a serial number plate. The serial number is in the form: 0000A00000. It is in two parts; the first four digits and the letter are the serial prefix and the last five digits are the suffix. The prefix is the same for all identical instruments; it changes only when a change is made to the instrument. The suffix however, is assigned sequentially and is different for each instrument. The contents of this manual apply to the instruments with the serial number prefix(s) listed under SERIAL NUMBERS on the title page.

1-10. An instrument manufactured after the printing of this manual may have a serial number prefix that is not listed on the title page. This unlisted serial number prefix indicates the instrument is different from those described in this manual. The manual for this newer number is accompanied by a yellow Changes Sheet supplement. This supplement contains "change information" that explains how to adapt the manual to the newer instrument.

1-11. For information concerning a serial number prefix that is not listed on the title page or in the Manual Changes supplement, contact your nearest Hewlett-Packard sales office.

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1-12. DESCRIPTION

1-13. The HP 4938A is a test set that, when used in conjunction with the HP 4937 Transmission Impairment Measuring Set, provides the capability to perform all the required signaling and transmission tests or measurements on telephone voice and voiceband data circuits.

1-14. The HP 4938A is an ac powered, portable test set that is installed in a front panel dust cover that fits the HP Models 4935A and 4937A Transmission Impairment Measuring Sets.

1-15. The HP 4938A features can be divided into four main categories:

1. Ring testing
2. Loop signal margin testing
3. Battery Simulation
4. 4 wire network access

1-16. **Ring Testing**--this feature provides two functions:

1. Ringing voltage generator
2. Ringer termination

1-17. The Ringing Voltage Generator is a telephone company specified source of ringing used for verifying the operation of a ringer or ringing detector in an Off Premises Extension (OPX). The generator provides 86 Vrms at either 20 or 30 Hz superimposed on -48 Vdc with a 2-second on and a 4-second off duty cycle. When the OPX goes off-hook or a loop closure is sensed, the ringing will stop (ring trip). The OFF-HOOK indicator is illuminated to show this condition.

1-18. The Ringer Termination is a terminating impedance that simulates the load of 3 ringers, which is a Ring Equivalent Number 3 (REN-3). A test jack is provided to measure the ringing voltage from a remote generator. A ring trip closure is also provided to simulate an off hook condition to the remote generator.

1-19. **Loop Signal Margin Testing**--Loop Signaling margin tests are performed using a dc loop-closure network, which is internal to the HP 4938A NCATS. Using an externally connected multimeter, the network circuit-loop current can be verified. The HP 4938A can initiate either a Loop Start or Ground Start line seizure on a 2-wire circuit.

1-20. The loop network can be connected to the SIMPLEX TRANSFORMER jacks. This 4-wire access transformer provides 4-wire Loop or Ground Start signaling. This allows the HP 4937A, and the HP 4935A Transmission Impairment Measuring Sets to perform 4-wire transmission tests.

1-21. **Battery Simulation.** The HP 4938A provides a source of 48 volts for simulation of the Central Office Battery. The battery simulator will detect the presence of a loop closure greater than 17 mA and will indicate the closure by illuminating the OFF HOOK led.

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1-22. Four wire network access--A 4-wire transformer with Simplex leads is provided for signaling and for transmission tests in 4 wire environments on the network side of the network interface (NI). Loop Start and Ground Start Signaling or busy conditions may be enforced using the internal loop signaling network or the internal battery simulator respectively.

1-23. This feature also allows simultaneous 4 wire network access and 4 wire transmission testing when used in conjunction with the HP 4937A, and the HP 4935A Transmission Impairment Measuring Sets.

1-24. WARRANTY

1-25. Instrument warranty is as listed inside the front cover of this manual.

1-26. ACCESSORIES AVAILABLE

1. Test Cord w/310 male to alligator clips, 60 inches, HP P/N 18182A
2. Test Cord w/310 male at both ends, 36 inches, HP P/N 15513A
3. Power Cord, HP P/N 8120-1378

1-27. RECOMMENDED TEST EQUIPMENT

1-28. Equipment required to maintain the Model 4938A is listed in table 1-2. Other equipment may be substituted if it meets or exceeds the critical specifications listed in the table.

1-29. OPERATING TEMPERATURE

1-30. Normal operating temperature of the HP 4938A should be between 0 degrees C and +55 degrees C (+32 degrees F and +131 degrees F).

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Table 1-1. *Specifications*

Ringing Voltage Generator

Output	
Level	86 volts rms (typical)
Frequencies	20 Hz +/-3 Hz 30 Hz +/-3 Hz
Waveform	Shaped squarewave
Duty cycle	2 seconds on and 4 seconds off
DC offset	-48 volts dc Tip to Ring (typical)
Impedance	220 ohms in series with Tip and with Ring Tip is grounded
Ring Trip	
Threshold	17 mA (typical)
Time to trip	< 200 ms

Ringer Termination

REN-3 load impedance	2330 ohms +/-1% in series with 0.45 uF +/-10%
Ring trip closure	330 ohms +/-1%, 5 watts

Loop Signaling Network

Loop start	430 ohms +/-1%, 5 watts
Ground start	550 ohms +/-1%, 5 watts momentary contact

Four Wire Network Access

Simplex transformer	Dual center tapped Insertion loss: <1dB at 1004 Hz Flatness (relative to 1004Hz): +/-0.5 dB, 200 Hz to 4 kHz

Battery Simulator

Output	
Level	48 volts dc typical
Maximum current	100 mA
Impedance	220 ohms in series with Tip and with Ring Tip is grounded

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Table 1-1. *Specifications (cont'd)*

General

Power Requirements
108 to 126 Vac
60 Hz

Temperature Range
0 C to +55 C (+32 F to +131 F)

Dimensions
Width 127 mm (5.0 inches)
Length 260 mm (10.3 inches)
Depth 91 mm (3.6 inches)

Weight 1.6 kg (3.2 pounds)

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Table 1-2. *Recommended Test Equipment*

Instrument	Critical Specifications	Recommended Model	Use
Multimeter	dc current	HP 3478A	P,T
Oscilloscope	Dual Chan: 5mV/div	HP 1740A	P
Power Supply	50 volt	HP 6200B	P
Signal Generator		HP 3336B	p
Voltmeter		HP 3456A	p
310 to Dual Bannana Connector		Pamona Electronics 2112	P

Note:
P=Performance Test
T=Troubleshooting

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SECTION II

INSTALLATION

2-1. INTRODUCTION

2-2. This section provides installation instructions for the Model 4938A NCATS. This section also includes information about initial inspection and damage claims, preparation for use, power requirements, storage and shipment.

2-3. INITIAL INSPECTION

2-4. Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the instrument has been checked mechanically and electrically. The contents of the shipment should be as shown in figure 1-1. The procedures for checking electrical performance are given in Section IV. If the contents are incomplete, if there is mechanical damage or defect, or if the instrument does not pass the performance tests, notify the nearest Hewlett-Packard sales and support office. If the shipping container is damaged, or the cushioning material shows signs of stress, notify the carrier as well as the Hewlett-Packard sales and support office.

2-5. PREPARATION FOR USE

2-6. Power Requirements

2-7. This instrument requires a power source of 108 to 128 Vac, single phase 48 to 66 Hz.

2-8. Power Cable

WARNING

Any interruption of the protective (grounding) conductor (inside or outside the instrument) or disconnecting the protective earth terminal can make this instrument dangerous to electrical shock.

2-9. This instrument is supplied with a three-wire power cable. When connected to an appropriate three-wire ac power receptacle, the cable grounds the instrument. See table 2-1 for available power cables.

2-10. OPERATING ENVIRONMENT

2-11. Temperature

2-12. This instrument may be operated in temperatures from 0 degrees C to +55 degress C (+32 degrees F to +131 degrees F).

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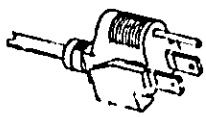
Table 2-1. *Power Cables Available*

Plug Type	Cable HP Part Number	C D	Plug Description	Cable Length (inches)	Cable Color	For Use In Country
125V 	8120-1348	5	Straight *NEMA5-15P	80	Black	United States, Canada, Japan (100V or 200V), Mexico, Philippines, Taiwan
	8120-1398	5	90°	80	Black	
	8120-1754	7	Straight *NEMA5-15P	36	Black	
	8120-1378	1	Straight *NEMA5-15P	80	Jade Gray	
	8120-1521	6	90°	80	Jade Gray	
	8120-1676	2	Straight *NEMA5-15P	36	Jade Gray	

*Part number shown for plug is industry identifier for plug only. Number shown for cable is HP Part Number for complete cable including plug.
E = Earth Ground, L = Line, N = Neutral

2-13. Humidity

2-14. This instrument may be operated in environments with humidity from 5 percent to 95 percent relative humidity at +40 degrees C (+104 degrees F). However, the instrument should be protected from temperature extremes that can cause condensation within the instrument.

2-15. STORAGE AND SHIPMENT

2-16. Environment

2-17. The instrument may be stored and shipped within the following environmental limits:

- Temperature..... -20 to +65 degrees C (-4 to +149 degrees F)
- Humidity..... Up to 90% Relative at +65 degrees C (+149 degrees F)

2-18. Packaging

2-19. Tagging for Service.--If the instrument is being returned to Hewlett- Packard for service, please complete one of the blue repair tags located at the back of this manual and attach it to the instrument.

2-20. Original Packaging.--Containers and materials identical to those used in factory packaging are available through Hewlett-Packard sales and support offices. If the instrument is being returned for servicing, attach a tag indicating the type of service required, return address, model number, and full serial number. Also mark the container FRAGILE to ensure careful handling. In any correspondence, refer to the instrument by model number and full serial number.

2-21. Other Packaging.--The following general instructions should be used for repacking with commerically available materials:

a. Wrap the instrument in heavy paper or plastic. (If shipping to Hewlett- Packard office or service center, attach a tag indicating type of service required, return address, model number, and full serial number.)

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b. Use strong shipping container. A double-walled carton made of 350-pound test material is adequate.

c. Use a layer of shock-absorbing material 70 to 100 mm (3 to 4 inches) thick around all sides of the instrument to provide firm cushioning and to prevent movement inside the container. Protect the control panel with cardboard.

d. Seal the shipping container securely.

e. Mark shipping container FRAGILE to ensure careful handling.

f. In any correspondence, refer to instrument by model number and full serial number.

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OPERATION

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SECTION III
OPERATION

3-1. INTRODUCTION

3-2. This section contains an explaination of the HP 4938A operating modes and describes the function of the front panel controls.

3-3. OPERATING CHARACTERISTICS

3-4. The HP 4938A provides four major functions:

- Ring Testing
- Loop Signal Margin Testing
- Battery Simulation
- Four Wire Network Access Simplex Signaling

3-5. The HP 4935A, HP 4937A, and the HP 4945A Transmission Impairment Measuring Sets can perform four wire circuit testing with the use of the HP 4938A. This method of testing four wire circuits is described later in this section.

3-6. PANEL FEATURES

3-7. Figure 3-1 identifies the front panel features and includes a brief description as to the function of each feature. The numbers used to reference these functions are also used in the procedural steps next to the control name.

1. LINE switch: Applies power to the instrument when in the ON position.

2. RING: Selects frequency of ringer voltage; Up is 20 Hz and Down is 30 Hz.

3. OFF HOOK: Indicates that a dc loop has been closed across the TERMINATE CIRCUIT Jack and that a current of at least 17 mA typically is flowing.

4. SIMULATE: Selects function; Up is -48 volt battery simulator (-48 volts Tip to Ring); Down is 20 or 30 Hz ring voltage superimposed on -48 volts.

5. T/R REV: Tip/Ring Reverse; Up position the Tip and Ring are connected to the TERMINATE CIRCUIT Jack in normal polarity. Down position the Tip and Ring are connected to the TERMINATE CIRCUIT Jack in reverse polarity.

6. OPEN: Opens circuit; Up position the TERMINATE CIRCUIT Jack is connected. Down position the TERMINATE CIRCUIT Jack is disconnected.

7. TERMINATE CIRCUIT Jack: Provides connection between the TERMINATE CIRCUIT functions and the circuit under test.

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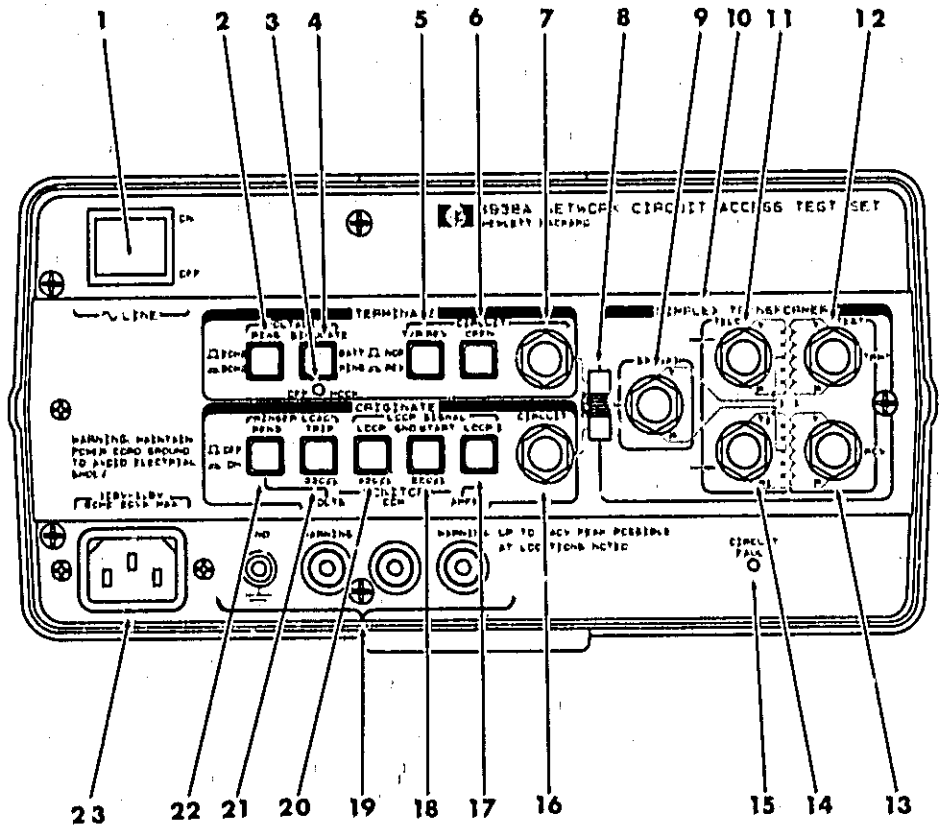

Figure 3-1. *Front Panel Controls, Connectors, and Indicators.*

8. Simplex Lead Patch Switch: provides an internal connection between either the TERMINATE or ORIGINATE functions and the SIMPLEX TRANSFORMER. The slide switch positions are:

   - Up position connects the TERMINATE functions to the SIMPLEX TRANSFORMER.
   - Middle position disconnects the SIMPLEX TRANSFORMER from both the TERMINATE and the ORIGINATE functions.
   - Down position connects the ORIGINATE function to the SIMPLEX TRANSFORMER.

9. SX/SX1 Jack: Simplex lead SX is the Tip and lead SX1 is the Ring.

10. SIMPLEX TRANSFORMER: Provides 4 wire network access with Simplex leads, SX/SX1. The front panel graphics show the internal connections.

11. TELCO Jack: Output from transformer to telephone company circuits.

12. TEST TRMT Jack: Input to transformer from test equipment.

13. TEST RCV Jack: Output from transformer to test equipment.

14. TELCO Jack: Input to transformer from telephone company circuits.

15. CIRCUIT FAULT LED: Indicates that a circuit fault (a short or a high foreign voltage) exists on the circuit being tested. The internal protection circuit will automatically disconnect the instrument from the faulty circuit. The fault must be cleared before continuing with the testing.

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16. ORIGINATE CIRCUIT Jack: Provides connection between the ORIGINATE CIRCUIT functions and the circuit under test.

17. LOOP I: Momentary switch that, when pressed interrupts the Tip/Ring loop closure and places the MONITOR COM and AMPS binding posts in series with the loop for measuring loop current.

18. GND START: Momentary switch that, when pressed grounds the ring through a load of 550 ohms.

19. Monitor binding posts.

- VOLTS: Access to monitor ring voltage from far end generator or to monitor dial tone after affecting loop closure.
- COM: Common connection for voltage or current monitor.
- AMPS: Access to monitor loop current.
- GND: Chassis ground.

20. LOOP: Push/push switch that, when pressed in, connects 430 ohms across the loop circuit.

21. TRIP: Push/push switch that, when pressed in, connects 330 ohms across the loop circuit.

22. REN3: Push/push switch that, when pressed in, applies a load to the circuit that is equivalent to the load of three ringers. The voltage can be measured across the VOLTS and COM binding post.

23. Connection for power cord.

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3-8. OPERATING INSTRUCTIONS

3-9. POWER ON AND SET UP

3-10. Make sure all front panel pushbuttons are in the up position before connecting LINE power to the instrument.

3-11. Connect power cord to the front panel connector.

WARNING

Always connect power cord to a properly grounded 3-wire power outlet. Any interruption of the protective earth grounding will cause a potential shock hazard that could result in personal injury.

3-12. Connect the line under test to the instrument as described in the measurement procedures in this section.

3-13. Set LINE switch to ON.

3-14. The HP 4938A has the following signaling and measuring capabilities:

a. Ring Simulator

- Send ring voltage
- Terminate and measure ring voltage
- Test for ring trip

b. Loop Simulator

- Loop start
- Measuring loop current
- Ground start

c. Battery Simulator

d. Four Wire Circuit Testing

- 4-wire access
- Ring simulation on 4-wire circuits
- Battery simulation on 4-wire circuits
- 4-wire transmission testing

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3-15. OPERATING PROCEDURES

3-16. Ring Simulator (see figure 3-1)

3-17. The ringing voltage generator is used to verify the operation of a ringer or ringing detector in an Off Premises Extension (OPX). The generator provides 86 Vrms, at either 20 Hz or 30 Hz, superimposed on -48 Vdc with a 2 second on and 4 second off duty cycle. When the OPX goes off hook or a loop closure is sensed, the ringing will stop (ring trip) and the OFF HOOK indicator will be lighted.

3-18. Sending Ring Voltage

WARNING

The TERMINATE CIRCUIT Jack has live ring voltage on it when the circuit is being tested.

a. Connect the circuit under test to the TERMINATE CIRCUIT Jack (7).

b. Select the RING VOLATGE (2) frequency of either 20 or 30 Hz.

c. Press the VOLTAGE SIMULATE (4) pushbutton to begin ringing.

1. Ring voltage will be impressed on the circuit under test if that circuit is open for dc current.
2. The OFF HOOK LED (3) should be off until a dc loop is closed on the far end.
3. When a dc loop is closed on the circuit and the loop current is greater than 17 mA, the OFF HOOK LED (3) will light and ring voltage will stop within 200 ms. Battery will remain on the circuit.
4. Ringing will not restart if the dc loop is removed.
5. To restart the ring, release the VOLTAGE SIMULATE (4) pushbutton to the up position. Then, press the pushbutton to the down position.
6. Ringing will not restart if the dc loop is still closed.

3-19. Terminating and Measuring Ring Voltage

3-20. The ringer termination is a terminating impedance that simulates the load of three ringers or Ring Equivalent Number 3. The load is used when measuring the ringing voltage from a remote generator. This voltage can be measured across the VOLTS and COM binding posts.

a. Connect the circuit under test to the ORIGINATE CIRCUIT Jack(16).

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3-20. (cont'd)

b. Press the REN3 (22) pushbutton.

1. This will terminate the circuit with ring equivalent number 3 load.

WARNING

The Voltage Monitor may have live ring voltage.

2. The MONITOR VOLTS (19) binding posts are also placed across the REN3 load.

c. To measure ring voltage, connect a multimeter across the MONITOR VOLTS (19) binding post and the MONITOR COM (19) binding post.

3-21. Testing for Ring Trip

a. With the circuit under test terminated with REN3 and ring voltage present from the far end, press the TRIP (21) pushbutton to cause a ring trip closure

b. If ring trip capability of the far end generator is operational, the ring voltage being measured in step 3-20, c will stop.

3-22. Loop Simulator

3-23. Loop signaling margin tests are performed using a dc loop closure network internal to the HP 4938A. The circuit loop current can be measured across the AMPS and COM binding post using a multimeter. The HP 4938A can originate either loop start or ground start on both two-wire and four-wire circuits. The four-wire circuit must be connected to the Simplex Transformer.

3-24. Loop Start Originate

a. Connect the circuit under test to the ORIGINATE CIRCUIT (16) Jack.

b. Press the LOOP (20) pushbutton to cause a loop closure on the circuit.

c. The circuit can be monitored for a dial tone by connecting a lineman's handset (butt-in) across the line.

Note

The loop circuit can momentarily be broken by pressing the LOOP I pushbutton. The multimeter must not be connected to the Current Monitor binding posts.

The TRIP pushbutton may be used to affect the loop closure. The loop resistance in this case is 330 ohms.

The TRIP and the LOOP pushbuttons may be used together for loop closure. The resistance in this case is 187 ohms.

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3-25. Measuring Loop Current

a. Connect a multimeter across the MONITOR COM (19) and AMPS (19) binding posts.

b. Set the multimeter for dc current, 100 mA range.

c. Press the LOOP (20) pushbutton to cause a loop closure on the circuit.

d. Press the LOOP I (17) pushbutton. The MONITOR COM (19) and AMPS (19) binding posts are placed in series with the circuit while the LOOP I (17) pushbutton is held down.

3-26. Ground Start Originate

a. Connect the circuit under test to the ORIGINATE CIRCUIT (16) Jack.

b. Press the LOOP (20) pushbutton.

c. Momentarily press the GND START (18) pushbutton.

Note

A ground will be placed on the ring conductor of the ORIGINATE CIRCUIT Jack through the margin test resistance.

d. The circuit can be monitored for dial tone by connecting a linesman's handset (butt-in) across the line.

3-27. Battery Simulator

a. Connect circuit under test to the TERMINATE CIRCUIT (7) Jack.

b. With the SIMULATE (4) pushbutton in the up position (BATT), -48 Vdc will be applied to the TERMINATE CIRCUIT (7) Jack.

- The OFF HOOK LED (3) should be off until a dc loop is closed on the far end.
- When a dc loop is closed on the circuit and the loop current is greater than 17 mA, the OFF HOOK LED (3) will go on.

c. The battery simulator can be reversed by pressing the T/R REV (5) pushbutton switch.

d. The battery simulator may be removed from the circuit by pressing the OPEN (6) pushbutton switch.

PERFORMANCE TESTS

12. Continuous 20 Hz Ringing (cont'd)

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3-28. Four Wire Circuit Testing

3-29. The Simplex Transformer leads provide connections for signaling and transmission testing in four wire circuits on the network side of the network interface. Loop start signaling and ground start signaling can be enabled using the internal loop signaling network. Busy conditions can be enabled by using the internal battery simulator.

3-30. 4 Wire Loop Start - Originate

a. Move the Simplex Lead Patch Switch (8) to the down position.

b. Connect the 4 wire circuit under test to T/R (11) and T1/R1 (14) jacks on the TELCO side of the SIMPLEX TRANSFORMER (10).

c. Press the LOOP (20) pushbutton to cause a loop closure on SX/SX1 (9) jack.

Note

The loop circuit may be momentarily broken by pressing the LOOP I pushbutton. The multimeter must not be connected to the COM and AMPS binding posts.

The TRIP pushbutton may be used to affect the loop closure. The loop resistance in this case is 330 ohms

The TRIP and the LOOP push buttons may be used together for loop closure. The resistance in this case is 187 ohms.

3-31. Measuring Loop Current Across SX/SX1

a. Move the Simplex Lead Patch Switch (8) to the down position.

b. Connect the 4 wire circuit under test to T/R (11) and T1/R1 (14) jacks on the TELCO side of the SIMPLEX TRANSFORMER (10).

c. Connect a Multimeter across the MONITOR COM (19) and AMPS (19) binding posts.

d. Set the Multimeter for dc current, 100 mA range.

e. With the LOOP (20) pushbutton pressed in, press the LOOP I (17) pushbutton. The COM and AMPS (19) binding posts will be placed in series with the circuit.

Note

Note that if a linemen's handset (butt-in) is used to monitor dial tone through the AMPS and COM binding posts, the dial tone will be interrupted while the LOOP I switch is held down.

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3-32. 4 Wire Ground Start - Originate

a. Move the Simplex Lead Patch Switch (8) to the down position.

b. Connect the 4 wire circuit under test to T/R (11) and T1/R1 (14) jacks on the TELCO side of the SIMPLEX TRANSFORMER (10).

c. Press the LOOP (20) pushbutton.

d. Press the GND START (18) pushbutton momentarily. A ground will be placed on the ring conductor or SX1 lead of the SX/SX1 (9) jack through the margin test resistance.

3-33. Other 4 Wire Access

a. 4-wire access using signaling not available in the HP 4938A can be accomplished by connecting the source of external signaling to the SX/SX1 (9) jack.

b. Move the Simplex Lead Patch Switch (8) to the OPEN (middle) position to disconnect the terminate or originate functions from the Simplex Leads.

3-34. Ring Simulation on 4 Wire Circuits

a. Move the Simplex Lead Patch Switch (8) to the up position.

b. Repeat steps 3-16 through 3-21.

3-35. Battery Simulation on 4 Wire Circuits

a. Move the Simplex Lead Patch Switch (8) to the up position.

b. With the SIMULATE (4) pushbutton in the up position, -48 Vdc will be applied to the SX/SX1 (9) jack.

Note

The OFF HOOK LED will be off until a dc loop is closed on the far end. When a dc loop is closed on the circuit and the loop current is greater than 17 mA, the OFF HOOK LED will go on.

c. The battery simulator may be reversed by pressing the T/R REV (5) pushbutton.

d. The battery simulator may be removed from the circuit by pressing the OPEN (6) pushbutton.

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3-36. 4 Wire Transmission Testing

a. Connect the 4 wire circuit under test to T/R (11) and T1/R1 (14) jack on the TELCO side of the SIMPLEX TRANSFORMER (10).

b. Connect the Transmission Impairment Measuring Set to TRMT and RCV jacks on the test side of the Simplex Transformer.

c. To use loop start signaling perform step 3-24.

d. To use ground start signaling perform step 3-26.

e. When signaling is complete, perform the necessary transmission tests.

3-37. SYSTEM CONFIGURATIONS

Note

The HP 4935A, HP 4937A, and the HP 4945A Transmission Impairment Measuring Sets (TIMS) can be used in a 4 wire environment with the aid of the HP 4938A. Because signaling with the TIMS requires the use of one of the two circuit jacks, combining the TIMS with the signaling and 4 wire access capabilities of the HP 4938A, frees both of the TIMS's circuit jacks for transmission testing.

3-38. Using the HP 4938A with the HP 4937A TIMS

3-39. 4 Wire Transmission Testing Using the HP 4938A with the HP 4937A TIMS.

a. Connect the 4 wire circuit under test to T/R (11) and T1/R1 (14) jack on the TELCO side of the SIMPLEX TRANSFORMER (10).

b. Connect the HP 4937A TIMS to TRMT (12) and RCV (13) jacks on the test side of the SIMPLEX TRANSFORMER (10).

c. To use loop start signaling perform step 3-24.

d. To use ground start signaling perform step 3-26.

e. When signaling is complete, perform the necessary transmission tests.

3-40. Using the HP 4938A with the HP 4935A TIMS or the HP 4945A TIMS

3-41. 4 Wire Transmission Testing Using the HP 4938A with the HP 4935A or HP 4945A.

a. Connect the 4 wire circuit under test to T/R (11) and T1/R1 (14) jack on the TELCO side of the SIMPLEX TRANSFORMER (10).

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3-41. (cont'd)

b. Connect the HP 4935A or HP 4945A TIMS to TRMT (12) and RCV (13) jacks on the test side of the SIMPLEX TRANSFORMER (10).

c. To use loop start signaling perform step 3-24.

d. To use ground start signaling perform step 3-26.

e. When signaling is complete, perform the necessary transmission tests.

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PERFORMANCE CHECK

ADJUSTMENTS

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SECTION IV
PERFORMANCE TESTS
AND
TROUBLESHOOTING

4-1. INTRODUCTION

4-2. The procedures in this section test the instrument's electrical performance using the specifications in table 1-1 as the performance standards. All tests can be performed without access to the interior of the instrument. These tests can be used for incoming inspection verification. If the instrument should fail any test, the suspected fault or troubleshooting aid are also included along with the test procedure. There are no internal adjustments in the HP 4938A.

4-3. EQUIPMENT REQUIRED

4-4. Equipment required for the performance tests is listed in the Recommended Test Equipment table in Section I. Any equipment that satisfies the critical specifications given in the table may be subsituted for the recommended model(s).

4-5. TEST RECORD

4-6. Results of the performance test may be tabulated on the Test Record at the end of the procedures. The Test Record lists all of the tested specifications and their acceptable limits. The results recorded at incoming inspection can be used for comparison in periodic maintenance and troubleshooting and after repair or adjustment.

4-7. CALIBRATION CYCLE

4-8. This instrument requires perodic verfication of performance. Depending on the use and environmental conditions, the instrument should be checked using the performance test every six months. Performance tests should also be made following repair.

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4-9. PERFORMANCE TESTS

4-10. Reset

EQUIPMENT:

none

1. On the HP 4938A set:

```
Set LINE..................... ON
```

2. The red CIRCUIT FAULT indicator should be on for less than 1 second, then turn off.

Troubleshooting aid

1. If the CIRCUIT FAULT indicator remains on check the following:

   a. Cable A4W1 to A2J3 (see figure 6-1) connection is not making proper contact and the power supplies are not properly loaded.

   b. An external voltage is connected to the TEST RCV jack that is greater than 30 volts.

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4-11. Power Supply Voltage Checks

EQUIPMENT:

Digital Multimeter HP 3478A

1. On the HP 4938A set:

```
VOLTAGE SIMULATE..... BATT
```

2. On the Digital Multimeter set:

```
POWER..... ON
FUNCTION..... DC VOLTS
```

3. Connect the digital multimeter across the HP 4938A test points and verify the voltages as listed in table 4-1.

Table 4-1. *Power Supply Voltage Measurements*

TEST POINT CONNECTION	DC VOLTAGE SHOULD BE	TYPICAL RIPPLE
2 and 3	48 +/-2 volts	< 0.5 Vrms
2 and 7	48 +/-2 volts	< 0.5 Vrms
6 and 7	40 +/-2 volts	< 0.5 Vrms
5 and 8	5 +/-0.5 volts	< 0.5 Vrms
5 and 9	-5 +/-0.5 volts	< 0.5 Vrms
4 and 5	5 +/-0.5 volts	< 0.5 Vrms

Troubleshooting aid

1. The typical ripple (with loading or with 10k load across voltmeter) on these power supplies is less than 0.5 Vrms and is usually 0.1 to 0.2 Vrms.

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4-12. Simplex Transformer

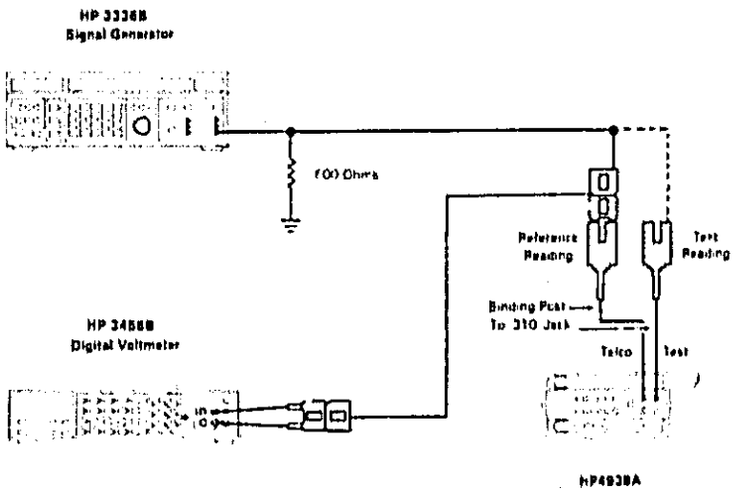

Figure 4-1. *Simplex Transformer Test Setup*

EQUIPMENT:

Signal Generator HP 3336B
Digital Voltmeter HP 3456A
600-ohm termination

1. Connect equipment as shown in figure 4-1.

2. Set HP 4938A LINE power to ON.

3. On the Signal Generator set:

POWER	ON
FREQUENCY	1004 Hz
AMPLITUDE	0 dBm

4. On the Digital Voltmeter set:

POWER	ON
FUNCTION	AC volts
AUTOZERO	ON
RANGE	AUTO
TRIGGER	INTERNAL

5. Connect the digital voltmeter across the signal generator output. Press the STORE Y (8) pushbutton and the math (9) 20 LOG X/Y pushbutton.

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4-12. Simplex Transformer (cont'd)

6. Disconnect the digital voltmeter from the signal generator (at the HP 4938A connection) and reconnect to the HP 4938A TRMT tip and ring jack. The insertion loss at 1004 Hz should be less than 1.0 dB.

7. Sweep the signal generator from 200 Hz to 4000 Hz. The difference in level should be less than 0.5 dB.

8. Connect the digital voltmeter across the signal generator output. Press the STORE Y (8) pushbutton and the math (9) 20 LOG X/Y pushbutton.

9. Disconnect the digital voltmeter from the signal generator and reconnect to the HP 4938A TELCO RCV tip and ring jack. The insertion loss at 1004 Hz should be less than 1.0 dB.

10. Sweep the signal generator from 200 Hz to 4000 Hz. The difference in level should be less than 0.5 dB.

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4-13. Continuous 20 Hz Ringing

EQUIPMENT:

Oscilloscope HP 1740A
Digital Voltmeter HP 3456A
Digital Multimeter HP 3478A

1. On the HP 4938A connect the TERMINATE CIRCUIT jack to the ORIGINATE CIRCUIT jack.

2. Connect the digital voltmeter to the VOLTS and COM binding posts on the HP 4838A.

3. Connect the oscilloscope to the HP 4938A TERMINATE CIRCUIT jack ring (tip is a reference).

4. Connect the digital multimeter across the HP 4938A TERMINATE CIRCUIT tip to ring.

5. On the Oscillocope set:

```
INPUT..... 10 TO 1 probe
VERTICAL..... 5 V/DIV
HORIZONTAL..... 10 ms/DIV
```

6. On the Digital Multimeter set:

```
POWER..... ON
FUNCTION..... DC volts
```

7. On the Digital Voltmeter set:

```
FUNCTION..... AC volts
AUTOZERO..... ON
RANGE..... AUTO
TRIGGER..... INTERNAL
```

8. On the HP 4938A set:

```
Power..... ON
VOLTAGE..... RING
RING..... 20 Hz
CIRCUIT..... NOT
RINGER LOAD..... REN3
```


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4-13. Continuous 20 Hz Ringing (cont'd)

9. Set the HP 4938A Ring jumper (JU1) into the continuous ring position (T).

10. The amplitude of the signal displayed on the digital voltmeter should be from 82.7 to 90.3 Vrms.

11. Change the mode on the digital voltmeter from AC volts to DC volts. The amplitude of the signal displayed on the digital voltmeter should be < 50 mV.

12. The amplitude of the signal as shown on the digital multimeter should be 48.0 +/- 2.0 volts.

13. The ON/OFF signal time as seen on the oscilloscope should be 25.0 +/-2.5 ms.

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PERFORMANCE TESTS

4-14. Continuous 30 Hz Ringing

EQUIPMENT:

Oscilloscope HP 1740A
Digital Voltmeter HP 3456A
Digital Multimeter HP 3478A

1. On the HP 4938A connect the TERMINATE CIRCUIT jack to the ORIGINATE CIRCUIT jack.

2. Connect the digital voltmeter to the VOLTS and COM binding posts on the HP 4838A.

3. Connect the oscilloscope to the HP 4938A TERMINATE CIRCUIT jack tip (ring is a reference).

4. Connect the digital multimeter across the HP 4938A TERMINATE CIRCUIT tip to ring.

5. On the Oscilloscope set:

INPUT..... 10 TO 1 probe
VERTICAL..... 5 V/DIV
HORIZONTAL..... 10 ms/DIV

6. On the Digital Multimeter set:

POWER..... ON
FUNCTION..... DC volts

7. On the Digital Voltmeter set:

FUNCTION..... AC volts
AUTOZERO..... ON
RANGE..... AUTO
TRIGGER..... INTERNAL

8. On the HP 4938A set:

Power..... ON
VOLTAGE..... RING
RING..... 30 Hz
CIRCUIT..... NOR
RINGER LOAD..... REN3

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4-14. Continuous 30 Hz Ringing Check (cont'd)

9. Set the HP 4938A Ring jumper (JU1) into the continuous ring position (T).

10. The amplitude of the signal displayed on the digital voltmeter should be from 82.7 to 90.3 Vrms.

11. Change the mode on the digital voltmeter from AC volts to DC volts. The amplitude of the signal displayed on the digital voltmeter should be < 50 mV.

12. The amplitude of the signal as shown on the digital multimeter should be 48.0 +/- 2.0 volts.

13. The ON/OFF signal time as seen on the oscilloscope should be 16.7 +/-1.0 ms.

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4-15. Trip Point Voltage

EQUIPMENT:

Power Supply HP 6200B
2.38k ohm Termination
2.756k ohm Termination

1. On the HP 4938A set:

```
Power..................... ON
SIMULATE.................. BATTERY
CIRCUIT................... NORM
RINGER LOAD............... REN3
```

2. On the HP 4938A connect the TERMINATE CIRCUIT jack to the ORIGINATE CIRCUIT jack.

3. Jumper JU1 should be in the normal position (N).

4. Connect the 2.756k ohm termination into the HP 4938A TERMINATE CIRCUIT. The TRIP indicator should not light.

5. Connect the 2.38k ohm termination into the HP 4938A TERMINATE CIRCUIT. The TRIP indicator should be lighted.

6. Diconnect all leads and press the SIMULATE RING pushbutton on the HP 4938A.

7. Connect the Power Supply from the TERMINATE CIRCUIT tip to the GND connection.

8. Increase the output voltage on the power supply until the FAULT indicator is lighted. The voltage indicated should be > 30 volts.

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4-16. Duty Cycle

EQUIPMENT:

Oscilloscope HP 1740A

1. On the HP 4938A set:

Power	ON
SIMULATE	RING

2. On the Oscilloscope set:

INPUT	10 to 1 probe
VERTICAL	5 V/div
HORIZONTAL	1 sec/div

3. Connect the HP 4938A TERMINATE CIRCUIT Ring to the oscilloscope for signal and Tip as reference.

4. Observe that the ring signal displayed on the oscilloscope is ON for 2 seconds and OFF for 4 seconds.

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Table 4-2. Performance Test Record

Hewlett-Packard Model 4938A Network Circuit Access Test Set

Serial No.

Tested By

Repair Order No.

Recommended Calibration Interval 6 Month Interval

Date

Paragraph Number	Test	Minimum	Results Actual	Maximum
4-12	Simplex Transformer Transmit side Insertion loss at 1004 Hz	0.0 dB	———	1.0 dB
	Flatness (difference 200 Hz to 4000 Hz)	0.0 dB	———	0.5 dB
	Simplex Transformer Receive side Insertion loss at 1004 Hz	0.0 dB	———	1.0 dB
	Flatness (difference 200 Hz to 4000 Hz)	0.0 dB	———	0.5 dB
4-13	Continuous 20 Hz Ringing	82.7 Vrms	———	90.3 Vrms
	Continuous 20 Hz dc Offset	0.0 mV	———	50.0 mV
	On/Off Signal Time	22.5 ms	———	27.5 ms
4-14	Continuous 30 Hz Ringing	82.7 Vrms	———	90.3 Vrms
	Continuous 30 Hz dc Offset	0.0 mV	———	50.3 mV
	On/Off Signal Time	15.7 ms	———	17.7 ms
4-15	Trip Point Voltage	0.0 V	———	30.0 V

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SECTION V
ADJUSTMENTS

5-1. INTRODUCTON

5-2. The HP 4938A is adjusted and calibrated at the factory. The instrument does not contain any operator adjustments.

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PARTS LIST

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SECTION VI

REPLACEABLE PARTS

6-1. INTRODUCTION

6-2. This section contains information for ordering parts. Table 6-1 lists the abbreviations used in table 6-3, table 6-2 is the Manufacturer's Code List, and table 6-3 lists the replaceable parts. Figures 6-1 is illustrated parts breakdown.

6-3. REPLACEABLE PARTS LIST

6-4. Table 6-3 lists the replaceable parts in alphanumerical order. Included is the description, quantity (total number used in the instrument), the HP Part Number and the manufacturer's part number.

6-5. ORDERING INFORMATION

6-6. To order a part listed in the replaceable parts table, quote the Hewlett- Packard part number, indicate the quantity required, and address the order to the nearest Hewlett-Packard Sales Office.

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Table 6-1. *Reference Designations and Abbreviations*

REFERENCE DESIGNATIONS

A	= assembly	J	= electrical connector (stationary portion); jack	TB	= terminal board
B	= fan; motor	L	= coil; inductor	TP	= test point
BT	= battery	MP	= misc. mechanical part	U	= integrated circuit; microcircuit
C	= capacitor	P	= electrical connector (movable portion); plug	V	= electron tube; glow lamp
CR	= diode; diode thyristor; varactor	Q	= transistor; SCR; triode thyristor	VR	= voltage regulator; breakdown diode
DL	= delay line	R	= resistor	W	= cable
DS	= annunciator; lamp; LED	RT	= thermistor	X	= socket
E	= misc electrical part	S	= switch; jumper	Y	= crystal unit (piezo-electric or quartz)
F	= fuse	T	= transformer		
FL	= filter				
H	= hardware				

ABBREVIATIONS

A	= amperes	DIA	= diameter	K	= kilo (10^3), kilohm
AC	= alternating current	DIP	= dual in-line package	LED	= light emitting diode
ADD	= address	DPDT	= double-pole, double-throw	LFT	= left
ADJ	= adjust, adjustment	DPST	= double-pole, single-throw	LG	= long
AL	= aluminum	DR	= drive	LH	= lefthand
AR	= as required	DRVR	= driver	LKWR	= lockwasher
ASM	= algorithmic state machine	DSPL	= display	LP	= low pass
ASSY	= assembly	DTL	= diode-transistor logic	LS	= low power Schottky
				LSB	= least significant bit
B	= base	E	= emitter		
BCD	= binary coded decimal	ECL	= emitter-coupled logic	M	= milli (10^{-3}), male, mega (10^6), megohm
BeCu	= beryllium copper	ELECT	= electrolytic	MET FLM	= metal film
BIN	= binary	ENCAP	= encapsulated	MET OX.	= metal oxide
BLK	= black	EXT	= external	MHZ	= megahertz
BLU	= blue	EXTR	= extractor	MFR	= manufacturer
BP	= band pass			MINTR	= miniature
BRN	= brown	F	= female; farads	MISC	= miscellaneous
BRS	= brass	FF	= flip-flop	MOM	= momentary
BTU	= British thermal unit	FLM	= film	MOS	= metal oxide semiconductor
		FRNT	= front	MSB	= most significant bit
C	= collector	FXD	= fixed	MTCHD	= matched
CATH	= cathode			MTG	= mounting
CCW	= counterclockwise	G	= giga (10^9)	MTLC	= metallic
CD PL	= cadmium plate	GE	= germanium		
CER	= ceramic	GL	= glass	N	= nano (10^{-9})
CERMET	= ceramic met flm	GND	= ground(ed)	N.C.	= normally closed, no connection
CKTS	= circuits	GP	= General Purpose	NE	= neon
C FLM	= carbon film	GRA	= gray	NO.	= number
CLK	= clock	GRN	= green	N.O.	= normally open
CLR	= clear			NP	= No Polarity
CMOS	= complementary metal oxide semiconductor logic	H	= henries	NPN	= negative-positive-negative
		HDW	= hardware	NPO	= negative-positive zero (zero temperature coefficient)
COM	= common	HEX	= hexagon, hexagonal, six		
COML	= commercial	HP	= high pass	NRFR	= not recommended for field replacement
COMP	= composition	HR	= hour(s)		
COMPL	= complete	HZ	= Hertz	NS	= normally shorting; nanosecond
COND	= conductor				
CONN	= connector	IC	= integrated circuit	NSR	= not separately replaceable
CONT	= contact	ID	= inside diameter	NYL	= nylon
CPPSN	= compression	IF	= intermediate frequency		
CTL	= complementary-transistor logic	IN.	= inch, inches	OBD	= order by description
		INCAND	= incandescent	OD	= outside diameter
CW	= clockwise	INCL	= include(s)	ORN	= orange
		INSUL	= insulation, insulated		
D	= diameter	INT	= internal		
DC	= direct current	INTL	= internal		
DEPC	= deposited carbon				

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Table 6-1. *Reference Designations and Abbreviations (Continued)*

ABBREVIATIONS

P = pico (10-12)	RVT = rivet	TRN = turn
PC = printed circuit	RWV = reverse working voltage	TTL = transistor-transistor logic
PCA = printed-circuit assembly		TYP = typical
PF = picofarad	S = second	
PIV = Peak Inverse Voltage	SB = slow blow	U (μ) = micro (10-6)
PK = peak	SCR = silicon controlled rectifier	UF = microfarad
PNL = panel	SE = selenium	US = microseconds
PNP = positive-negative-positive	SGL = single	
P-P = peak-to-peak	SI = silicon	V = volt(s)
PPM = parts per million	SHK = shank	VAR = variable
POLYC = polycarbonate	SIP = single in-line package	VCO = voltage controlled oscillator
POLYE = polyethylene	SKT = socket	
POLYSTY = polystyrene	SLDR = solder	VDCW = direct current working volts
PORC = porcelain	SPCG = spacing	VIO = violet
POSN = position(s)	SPDT = single-pole, double-throw	VNP = no polarity voltage
POZI = pozidrive	SPST = single-pole, single-throw	
PRV = peak reverse voltage	SST = stainless-steel	W = watts
PWV = peak working voltage	STL = steel	WT = weight
P/O = part of	SZ = size	WW = wirewound
		WHT = white
R = ring	T = tip	WIP = wiper
RAM = random access memory	TA = tantalum	WIV = working inverse voltage
ROM = read only memory	TEL = telephone	WSHR = washer
RECT = rectifier	T.C. = Temp. Compensated, temp. coefficient	X = times, multiple
RF = radio frequency	THKNS = thickness	
RH = right hand	TI = titanium	YEL = yellow
RMS = root-mean-square	TGL = toggle	
RND = round	THD = thread	ZNR = zener
RT = right hand,	THK = thick	
RTL = resistor-transistor logic	TOL = tolerance	ϕ = phi, phase
RTNT = retainer	TRMR = trimmer	
RTRY = rotary		

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Table 6-2. *Manufacturer Code List*

MFR NO.	MANUFACTURER NAME	ADDRESS	ZIP CODE
C0633	RIFA	BROMA	
00000	ANY SATISFACTORY SUPPLIER		
01121	ALLEN-BRADLEY CO	MILWAUKEE WI	53204
01295	TEXAS INSTR INC SEMICOND CMPNT DIV	DAL'AS TX	75222
04713	MOTOROLA SEMICONDUCTOR PRODUCTS	PHOENIX AZ	85008
07263	FAIRCHILD SEMICONDUCTOR DIV	MOUNTAIN VIEW CA	95042
19701	MEPCO/ELECTRA CORP	MINERAL WELLS TX	76067
24546	CORNING GLASS WORKS (BRADFORD)	BRADFORD PA	16701
27014	NATIONAL SEMICONDUCTOR CORP	SANTA CLARA CA	95051
28480	HEWLETT-PACKARD CORP HQ	PALO ALTO CA	94304
56289	SPRAGUE ELECTRIC CO	NORTH ADAMS MA	01247
82389	SWITCHCRAFT INC	CHICAGO IL	60630

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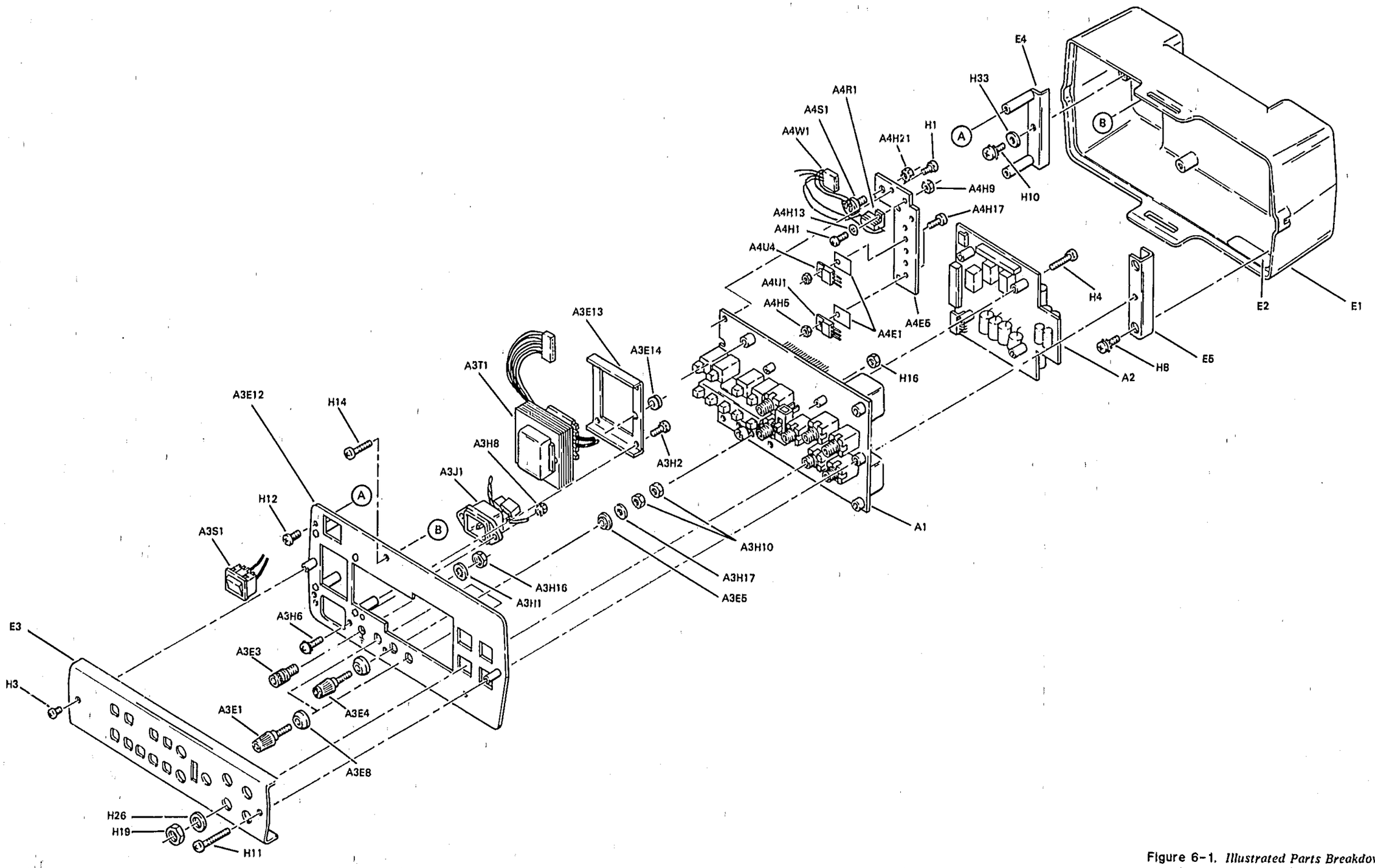

Figure 6-1. *Illustrated Parts Breakdown*

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Table 6-3. *Replaceable Parts*

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1	04938-60001	A	2	MAIN PC BD ASSY	28480	04938-60001
A1C1	0160-0576	5	18	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C2	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C3	0160-3870	6	2	CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3870
A1C4	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C5	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C6	0180-0197	8	3	CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A1C7	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C8	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C9	0160-6141	2	1	CAPACITOR-FXD .45UF 10% 200V	28480	0160-6141
A1C10	0180-2015	1	1	CAPACITOR-FXD 100UF+-20% 10VDC TA	28480	0180-2015
A1C11	0160-4663	9	2	CAPACITOR-FXD 0.2UF +80-20% 100VDC CER	28480	0160-4663
A1C12	0160-3879	7	7	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A1C13	0160-4663	9		CAPACITOR-FXD 0.2UF +80-20% 100VDC CER	28480	0160-4663
A1C14	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C15	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C16	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C17	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C18	0180-0374	3	1	CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A1CR1	1901-0050	3	5	DIODE SWITCHING 80V 200MA DNG DO-35	28480	1901-0050
A1DS201	1990-0485	5	1	LED-LAMP LUM-INT=800UCD IF=30MA-MAX	28480	5082-4984
A1DS409	1990-0486	6	1	LED-LAMP LUM-INT=1MCD IF=20MA-MAX DVR=5V	28480	5082-4684
A1J1	1251-7095	9	1	CONN POST TYPE .100-PIN-SPCG 40 CONT	28480	1251-7095
A1J205	1251-3677	7	6	CONNECTOR-TEL JACK 2-CKT .25 SHK DIA	28480	1251-3677
A1J208	1251-5798	9	1	CONNECTOR-TEL JACK 2 CKT	02389	M-1140
A1J209	1251-3677	7		CONNECTOR-TEL JACK 2-CKT .25-SHK-DIA	28480	1251-3677
A1J210	1251-3677	7		CONNECTOR-TEL JACK 2-CKT .25-SHK-DIA	28480	1251-3677
A1J305	1251-3677	7		CONNECTOR-TEL JACK 2-CKT .25-SHK-DIA	28480	1251-3677
A1J309	1251-3677	7		CONNECTOR-TEL JACK 2-CKT .25-SHK-DIA	28480	1251-3677
A1J310	1251-3677	7		CONNECTOR-TEL JACK 2-CKT .25-SHK-DIA	28480	1251-3677
A1R1	0698-3155	1	6	RESISTOR 4.64K 1% .125W F TC=0+-100	24546	CA 1/8-T0 4641-F
A1R2	0698-3155	1		RESISTOR 4.64K 1% .125W F TC=0+-100	24546	CA-1/8-T0-4641-F
A1R3	0757-0442	9	4	RESISTOR 10K 1% .125W F TC=0+-100	24546	CA-1/8-T0-1002-F
A1R4	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	CA-1/8-T0-1002-F
A1R5	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	CA-1/8-T0-1002-F
A1R6	0757-0465	6	1	RESISTOR 100K 1% .125W F TC=0+-100	24546	CA-1/8-T0-1003-F
A1R7	0698-3447	4	1	RESISTOR 422 1% .125W F TC=0+-100	24546	CA 1/8-T0-422R-F
*A1R8	0811-3688	7	1	RESISTOR 550 OHMS 5W	28480	0811-3688
A1R9	0698-3441	8	1	RESISTOR 215 1% .125W F TC=0+-100	24546	CA-1/8-T0 215R F
A1R10	0698-0331	5	1	RESISTOR 2.33K .5% .25W F TC=0+-50	19701	MF5C1/4-T0-2331-D
A1R11	0811-2151	7	1	RESISTOR 430 1% 5W PW TC=0+-20	28480	0811-2151
A1R12	0811-3687	6	1	RESISTOR 330 OHMS 5W	28480	0811-3687
A1S200	3101-2124	2	4	SWITCH-PB DPDT ALTNG .25A 115VAC	28480	3101-2124
A1S201	3101-2124	2		SWITCH-PB DPDT ALTNG .25A 115VAC	28480	3101-2124
A1S203	3101-2124	2		SWITCH-PB DPDT ALTNG .25A 115VAC	28480	3101-2124
A1S204	3101-2124	2		SWITCH-PB DPDT ALTNG .25A 115VAC	28480	3101-2124
A1S207	3101-2767	9	1	SWITCH-SLIDE	28480	3101-2767
A1S300	3101-2766	8	1	SWITCH PB 6 DIA	28480	3101-2766
A1T110	9100-4403	8	2	TRANSFORMER	28480	9100-4403
A1T410	9100-4403	8		TRANSFORMER	28480	9100-4403
A1U100	1820-3001	4	3	IC FF CMOS/74HC D-TYPE POS-EDGE TRIG	28480	1820-3001
A1U102	1820-2922	0	1	IC GATE CMOS/74HC NAND QUAD 2-INP	28480	1820-2922
A1U103	1820-3001	4		IC FF CMOS/74HC D-TYPE POS EDGE TRIG	28480	1820-3001
A1U105	1820-3184	0	1	IC GATE CMOS/74HC AND TPL 3 INP	28480	1820-3184
A1U107	1820-3185	9	1	IC SCHMITT-TRIG CMOS/74HC INV HEX	28480	1820-3185
A1U108	1820-3001	4		IC FF CMOS/74HC D-TYPE POS EDGE TRIG	28480	1820-3001
A1U405	1820-3199	5	2	IC CNTR CMOS/74HC BIN ASYNCHRO	28480	1820-3199
A1U406	1820-3603	2	1	IC CNTR CMOS/74HC DECD SYNCHRO	28480	1820-3603
A1U407	1820-3199	5		IC CNTR CMOS/74HC BIN ASYNCHRO	28480	1820-3199
A1U408	1820-2924	2	1	IC-MC74HC02N	28480	1820-2924
	0380-1255	5	5	SPACER PRESS-IN 0.250 IN LG; 0.143 IN	28480	0380-1255
	0380-1264	7	4	STANDOFF PRESS-IN .250 IN LG; 4-40 THD	00000	ORDER BY DESCRIPTION
	0380-1326	1	2	STANDOFF-PRESS-IN .500 IN LONG; 4-40	00000	ORDER BY DESCRIPTION
	1251-5439	3	1	CONNECTOR 12 PIN M POST TYPE	28480	1251-5439
	1258-0141	0	1	JUMPER-WIRE	28480	1258-0141
	0941-0300	6	9	PUSH BUTTON KNOB	28480	0941-0300
	04938-20001	8	1	PC BOARD MAIN	28480	04938-20001

See introduction to this section for ordering information
*Indicates factory selected value

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Table 6-3. *Replaceable Parts (Continued)*

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A2	04938-60002	5	2	PC PC BOARD ASSY	28480	04938-60002
A2C1	0160-0161	4	2	CAPACITOR-FXD .01UF +-10% 200VDC POLYE	28480	0160-0161
A2C2	0160-0161	4		CAPACITOR-FXD .01UF +-10% 200VDC POLYE	28480	0160-0161
A2C3	0130-3280	8	1	CAPACITOR-FXD 1000UF +50-10% 16VDC AL	28480	0130-3280
A2C4	0160-3508	7	2	CAPACITOR-FXD 1UF +80-20% 50VDC CER	28480	0160-3508
A2C5	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A2C6	0180-0197	0		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A2C7	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A2C8	0180-0197	0		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A2C9	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A2C10	0160-3508	7		CAPACITOR-FXD 1UF +80-20% 50VDC CER	28480	0160-3508
A2C11	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A2C12	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A2C13	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A2C14	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A2C15	0180-3508	1	3	CAPACITOR-FXD 100UF 100V	28480	0180-3508
A2C16	0180-2207	5	2	CAPACITOR-FXD 100UF+-10% 10VDC TA	56289	150D107X9010R2
A2C17	0180-2207	5		CAPACITOR-FXD 100UF+-10% 10VDC TA	56289	150D107X9010R2
A2C18	0180-3508	1		CAPACITOR-FXD 100UF 100V	28480	0180-3508
A2C19	0180-3661	6	3	CAP FXD ELCTLT	28480	0180-3661
A2C20	0180-3661	6		CAP FXD ELCTLT	28480	0180-3661
A2C21	0180-3661	6		CAP FXD ELCTLT	28480	0180-3661
A2C22	0180-3043	9	1	CAPACITOR-FXD 100UF+50-10% 25VDC AL	28480	0180-3043
A2C23	0160-3079	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3079
A2C24	0160-3077	7		CAPACITOR-FXD .001UF +-20% 100VDC CER	28480	0160-3079
A2C25	0160-3079	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3079
A2C26	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A2C27	0160-3079	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3079
A2C28	0160-3079	7		CAPACITOR FXD .01UF +-20% 100VDC CER	28480	0160-3079
A2C29	0160-3079	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3079
A2C30	0160-3078	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3078
A2C31	0180-3508	1		CAPACITOR-FXD 100UF 100V	28480	0180-3508
A2CR1	1901-0704	4	7	DIODE-PWR RECT 1N4002 100V 1A DO-41	01295	1N4002
A2CR2	1901-0704	4		DIODE-PWR RECT 1N4002 100V 1A DO-41	01295	1N4002
A2CR3	1901-0704	4		DIODE-PWR RECT 1N4002 100V 1A DO-41	01295	1N4002
A2CR4	1901-0704	4		DIODE-PWR RECT 1N4002 100V 1A DO-41	01295	1N4002
A2CR5	1901-0050	3		DIODE SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A2CR6	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A2CR7	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A2CR8	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A2CR9	1902-0579	3	1	DIODE-ZNR 5.1V 5% PD=1W IR=10UA	28480	1902-0579
A2CR10	1901-0704	4		DIODE-PWR RECT 1N4002 100V 1A DO-41	01295	1N4002
A2CR11	1901-0704	4		DIODE-PWR RECT 1N4002 100V 1A DO-41	01295	1N4002
A2CR12	1901-0704	4		DIODE-PWR RECT 1N4002 100V 1A DO-41	01295	1N4002
A2CR13	1901-0731	7	3	DIODE-PWR RECT 400V 1A	28480	1901-0731
A2CR14	1901-0731	7		DIODE-PWR RECT 400V 1A	28480	1901-0731
A2CR15	1901-0731	7		DIODE-PWR RECT 400V 1A	28480	1901-0731
A2CR16	1901-0704	4		DIODE-PWR RECT 1N4002 100V 1A DO-41	01295	1N4002
A2CR17	1901-0704	4		DIODE PWR RECT 1N4002 100V 1A DO-41	01295	1N4002
A2CR18	1901-0535	9	1	DIODE-SM SIG SCHOTTKY	28480	1901-0535
A2DB1	1901-0363	1	4	DIODE-FW BRDG 100V 1A	28480	1901-0363
A2DB2	1901-0363	1		DIODE-FW BRDG 100V 1A	28480	1901-0363
A2DB3	1901-0363	1		DIODE FW BRDG 100V 1A	28480	1901-0363
A2DB4	1901-0363	1		DIODE-FW BRDG 100V 1A	28480	1901-0363
A2J1	1252-0222	4	1	CONN MALE 9 PIN	28480	1252-0222
A2J2	1251-0757	4	1	CONN-POST TYPE 2.5-PIN-SPCG 18-CONT	28480	1251-0757
A2J3	1252-0221	3	1	CONN MALE 6 PIN	28480	1252-0221
A2K101	0490-1409	4	1	RELAY DC 5VDC-COIL 2A 250VAC	28480	0490-1409
A2K103	0490-1354	0	1	RELAY DC 5VDC-COIL 2A 250VAC	28480	0490-1354
A2K200	0490-104193	9	1	RELAY	28480	0490-104193
A2L1	9140-0210	1	2	INDUCTOR RF-CH-MLD 100UH 5% .166DX.305LG	28480	9140-0210
A2L2	9140-0210	1		INDUCTOR RF-CH-MLD 100UH 5% .166DX.305LG	28480	9140-0210
A2MOV1	0837-0116	4	2	VARISTOR VIN=250VAC ENERGY=20JOULES	28480	0837-0116
A2MOV2	0837-0116	4		VARISTOR VIN=250VAC ENERGY=20JOULES	28480	0837-0116
A2P1	1252-0223	5	1	CONN-FEMALE 40 PIN	28480	1252-0223
A2R1	0698-8020	7	2	RESISTOR 4.64 1% .125W F TC=0+-100	28480	0698-8020
A2R2	0698-8020	7		RESISTOR 4.64 1% .125W F TC=0+-100	28480	0698-8020
A2R3	0757-0416	7	2	RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A2R4	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A2R5	0757-1094	9	1	RESISTOR 1.47K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1471-F

See introduction to this section for ordering information.
*Indicates factory selected value

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Table 6-3. *Replaceable Parts (Continued)*

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A2R6	0757-0459	8	1	RESISTOR 56.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5622-F
A2R7	0757-0279	0	1	RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4 1/8-T0-3161-F
A2R8	0698-3155	1		RESISTOR 4.64K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4641-F
A2R9	0698-3155	1		RESISTOR 4.64K 1% .125W F TC=0+-100	24546	C4 1/8-T0-4641-F
A2R10	0698-3155	1		RESISTOR 4.64K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4641-F
A2R11	0698-3132	4	2	RESISTOR 261 1% .12[illegible] TC=0+-100	24546	C4 1/8-T0-2610-F
A2R12	0698-3132	4		RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A2R13	0698-3444	1	1	RESISTOR 316 1% .125W F TC=0+-100	24546	C4-1/8-T0-316R-F
A2R14	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A2R15	0757-0440	7	2	RESISTOR 7.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7501-F
A2R16	0757-0424	7	2	RESISTOR 1.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1101-F
A2R17	0757-0440	7		RESISTOR 7.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7501-F
A2R18	0757-0424	7		RESISTOR 1.1K 1% .125W F TC=0+-100	24546	C4 1/8-T0-1101-F
A2R19	0686 8776	7	3	RESISTOR 10 5% .25W FC TC=-400/+500	28480	0686 8776
A2R20	0686 8776	7		RESISTOR 10 5% .25W FC TC=-400/+500	28480	0686 8776
A2R21	0686 8776	7		RESISTOR 10 5% .25W FC TC=-400/+500	28480	0686 8776
A2R22	0764-0005	5	3	RESISTOR 10K 5% 2W MO TC=0+-200	28480	0764-0005
A2R23	0764-0005	5		RESISTOR 10K 5% 2W MO TC=0+-200	28480	0764-0005
A2R24	0764-0005	5		RESISTOR 10K 5% 2W MO TC=0+-200	28480	0764-0005
A2R25	0757-0280	3	1	RESISTOR 1K 1% .125W F TC=0+-100	24546	C4 1/8-T0-1001-F
A2R26	0757-0283	6	1	RESISTOR 2K 1% .125W F TC=0+-100	24546	C4 1/8-T0-2001-F
A2R27	0698-3155	1		RESISTOR 4.64K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4641-F
A2U203	1820-3209	4	1	IC DRVR CMOS PRPHL OP LATCH INPUT QUAD	28480	1820-3209
A2U302	1826-0785	1	1	IC OP AMP LOW DIAS-B-IMPD DUAL 8-DIP-C	01295	TL072ACJG
A2U304	1826-0412	1	1	IC COMPARATOR PRCN DUAL 8 DIP-P PKG	27014	LM392N
A2U404	1826-0205	6	1	IC V RGLTR TO-92	04713	MC79L05C
A2U504	1826-0276	6	1	IC 79L05A V RGLTR TO-92	04713	MC79L05ACP
	0380-1716	3	4	SPACER PRESS-IN 0.500 IN LG) 0.116 IN ID	28480	0380-1716
	04938 [illegible]0002	1	1	PB PC BOARD	28480	04938-20002
A3	04938-62601	4	2	SUBPANEL ASSY	28480	04938-62601
A3C1	0160-4048	4	2	CAPACITOR-FXD .022UF +-20% 250VAC(RMS)	C0633	PME 271 M 522
A3C2	0160-4048	4		CAPACITOR-FXD .022UF +-20% 250VAC(RMS)	C0633	PME 271 M 522
A3E1	1510-0076	4	2	BINDING POST SGL SGL-TUR JGK	28480	1510-0076
A3E2	1510-0076	4		BINDING POST SGL SGL-TUR JGK	28480	1510-0076
A3E3	1510-0038	8	1	BINDING POST ASSY SGL THD-STUD	28480	1510-0038
A3E4	1510-0007	7	1	BINDING POST SGL THD-STUD JGK BLK	28480	1510-0007
A3E5	0340-0719	0	3	INSULATOR-BDG POST ABS JADE-GRA	28480	0340-0719
A3E6	0340-0719	0		INSULATOR-BDG POST ABS JADE-GRA	28480	0340-0719
A3E7	0340-0719	0		INSULATOR-BDG POST ABS JADE-GRA	28480	0340-0719
A3E8	0340-0732	7	3	INSULATOR-BDG POST POLYC	28480	0340-0732
A3E9	0340-0732	7		INSULATOR-BDG POST POLYC	28480	0340-0732
A3E10	0340-0732	7		INSULATOR-BDG POST POLYC	28480	0340-0732
A3E11	0360-0816	2	1	TERMINAL-SLDR LUG LK-MTG FOR-#4-SCR	28480	0360-0816
A3E12	04938-00002	9	1	FT PNL LOWER	28480	04938-00002
A3E13	04938-00005	2	1	BRKT XFMR	28480	04938-00005
A3E14	0400-0009	9	1	GROMMET-RND .125-IN-ID .25 IN-GRV-DD	28480	0400-0009
A3E15	0890-0304	4	1	TUBING-NS .155 D/.062-RCVD .02-WALL PVC	00000	ORDER BY DESCRIPTION
A3H1	2190-0027	6	1	WASHER-LK INTL T 1/4 IN .256-IN-ID	28480	2190-0027
A3H2	2200-0103	2	7	SCREW-MACH 4-40 .25-IN-LG PAN-HD-POZI	28480	2200-0103
A3H3	2200-0103	2		SCREW-MACH 4-40 .25-IN-LG PAN-HD-POZI	28480	2200-0103
A3H4	2200-0103	2		SCREW-MACH 4-40 .25-IN-LG PAN-HD-POZI	28480	2200-0103
A3H5	2200-0103	2		SCREW-MACH 4-40 .25-IN-LG PAN-HD-POZI	28480	2200-0103
A3H6	2200-0107	6	2	SCREW-MACH 4-40 .375-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A3H7	2200-0107	6		SCREW-MACH 4-40 .375-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A3H8	2260-0089	3	2	NUT-HEX-W/LKWR 4 40-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
A3H9	2260-0007	3		NUT-HEX-W/LKWR 4 40-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
A3H10	2420-0003	7	6	NUT-HEX-DBL-CHAM 6-32-THD .094-IN-THK	28480	2420 0003
A3H11	2420-0003	7		NUT-HEX-DBL-CHAM 6-32-THD .094-IN-THK	28480	2420-0003
A3H12	2420-0003	7		NUT-HEX-DBL-CHAM 6-32-THD .094-IN-THK	28480	2420-0003
A3H13	2420-0003	7		NUT HEX-DBL CHAM 6-32 THD .094-IN THK	28480	2420-0003
A3H14	2420-0003	7		NUT HEX-DBL-CHAM 6-32-THD .094-IN-THK	28480	2420-0003
A3H15	2420-0003	7		NUT HEX-DBL-CHAM 6-32-THD .094 IN THK	28480	2420-0003
A3H16	2950-0016	3	1	NUT-HEX-DBL-CHAM 1/4-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
A3H17	3050-0227	3	4	W SHER-FL MTLC NO. 6 .149-IN-ID	28480	3050-0227
A3H18	3050-0227	3		WASHER-FL MTLC NO. 6 .149 IN-ID	28480	3050 0227
A3H19	3050-0227	3		WASHER-FL MTLC NO. 6 .149-IN-ID	28480	3050-0227
A3J1	1251-2357	8	1	CONNECTOR-AC PWR HP-9 MALE FLG-MTG	28480	1251-2357
A3S1	3101-0420	5	1	SWITCH PWR BASIC DPDT 6A 250SLDR-LUG	28480	3101-0420
A3T1	9100-4395	7	1	PWR XFMR	28480	9100 4395

See introduction to this section for ordering information
*Indicates factory selected value

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Table 6-3. *Replaceable Parts (Continued)*

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3W1	8150-2640	5	1	WIRE 22AWG W/GY 600V PVC 7X30 105C	28400	8150-2640
A3W2	8150-2641	6	1	WIRE 22AWG W/BR/GY 600V PVC 7X30 105C	28400	8150-2641
A3W3	8150-3284	5	1	WIRE 18AWG G/Y 600V PVC 19X30 105C	28400	8150-3284
A4	04938-62602	5	2	HT SPREADER ASSY	28400	04938-62602
A4E1	0340-0949	8	4	INSULATOR-XSTR THRM-CNDCT	28400	0340-0949
A4E2	0340-0949	8		INSULATOR-XSTR THRM-CNDCT	28400	0340-0949
A4E3	0340-0949	8		INSULATOR-XSTR THRM-CNDCT	28400	0340-0949
A4E4	0340-0949	8		INSULATOR-XSTR THRM-CNDCT	28400	0340-0949
A4E5	04938-00006	3	1	HT SPREADER	28400	04938-00006
A4H1	0520-0120	7	4	SCREW-MACH 2-56 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A4H2	0520-0120	7		SCREW-MACH 2-56 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A4H3	0520-0120	7		SCREW-MACH 2-56 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A4H4	0570-0120	7		SCREW-MACH 2-56 .25-IN-LG PAN-HD POZI	00000	ORDER BY DESCRIPTION
A4H5	0590-0018	1	4	NUT-HEX-DBL-CHAM 4-40-THD .124-IN-THK	00000	ORDER BY DESCRIPTION
A4H6	0590-0018	1		NUT-HEX-DBL-CHAM 4-40-THD .124-IN-THK	00000	ORDER BY DESCRIPTION
A4H7	0590-0018	1		NUT-HEX-DBL-CHAM 4-40-THD .124-IN-THK	00000	ORDER BY DESCRIPTION
A4H8	0590-0018	1		NUT-HEX-DBL-CHAM 4-40-THD .124-IN-THK	00000	ORDER BY DESCRIPTION
A4H9	0610-0081	6	4	NUT-HEX-DBL-CHAM 2-56-THD .062-IN-THK	00000	ORDER BY DESCRIPTION
A4H10	0610-0081	6		NUT-HEX-DBL-CHAM 2-56-THD .062-IN THK	00000	ORDER BY DESCRIPTION
A4H11	0610-0081	A		NUT-HEX-DBL-CHAM 2-56-THD .062-IN-THK	00000	ORDER BY DESCRIPTION
A4H12	0610-0081	6		NUT-HEX-DBL-CHAM 2-56-THD .062-IN-THK	00000	ORDER BY DESCRIPTION
A4H13	2190-0014	1	4	WASHER-LK INTL T NO. 2 .009-IN-ID	28480	2190-0014
A4H*14	2190-0014	1		WASHER-LK INTL T NO. 2 .009-IN-ID	28480	2190-0014
A4H15	2190-0014	1		WASHER-LK INTL T NO. 2 .009 IN-ID	28480	2190-0014
A4H16	2190-0014	1		WASHER-LK INTL T NO. 2 .009-IN-ID	28480	2190-0014
A4H17	2200-0720	7	4	SCREW-MACH 4-40 .312-IN-LG PAN-HD-SLT	00000	ORDER BY DESCRIPTION
A4H18	2200-0720	7		SCREW-MACH 4-40 .312-IN-LG PAN-HD-SLT	00000	ORDER BY DESCRIPTION
A4H19	2200-0720	7		SCREW-MACH 4-40 .312-IN-LG PAN HD-SLT	00000	ORDER BY DESCRIPTION
A4H20	2200-0720	7		SCREW-MACH 4-40 .312-IN-LG PAN HD SLT	00000	ORDER BY DESCRIPTION
A4H21	2420-0023	1	4	NUT-HEX-W/LKWR 6-32-THD .109-IN-THK	28480	2420-0023
A4H22	3103-0015	9	1	SWITCH-THRM FXD +75C 6A DPN-ON-RISE	28480	3103-0015
A4R1	0811-3689	B	2	RESISTOR 21C OHMS 5W	28480	0811-3689
A4R2	0811-3689	0		RESISTOR 210 OHMS 5W	28480	0811-3689
A4U1	1826-0527	9	3	IC 337 V RGLTR TO-220	27014	LM337T
A4U2	1826-0527	9		IC 337 V RGLTR TO-220	27014	LM337T
A4U3	1826-0527	9		IC 337 V RGLTR TO-220	27014	LM337T
A4U4	1826-0122	8	1	IC 7805 V RGLTR TO-220	07263	7805UC
A4W1	04938-61601	2	1	CABLE ASSY	28480	04938-61601
				CHASSIS PARTS		
A1	04938-60001	A		MAIN PC BD ASSY	28480	04938-60001
A2	04938-60002	5		PS PC BOARD ASSY	28480	04938-60002
A3	04938-62601	4		SUBPANEL ASSY	28480	04938-62601
A4	04938-62602	5		HT SPREADER ASSY	28480	04938-62602
E1	4040-2171	D	1	HOUSING	28480	4040-2171
E2	7120-4104	2	1	LABEL-IDENTIFICATION 1-IN-WD 2.5-IN LG	28480	7120-4104
E3	04938-00001	B	1	FT PNL UPPER	28480	04938-00001
E4	04938-00003	0	1	LEFT BRKT	28480	04938-00003
E5	04938-00004	1	1	RIGHT BRKT	28480	04938-00004
H1	2200-0103	2		SCREW-MACH 4-40 .25-IN-LG PAN-HD POZI	28480	2200-0103
H2	2200-0103	2		SCREW-MACH 4-40 .25 IN-LG PAN-HD-POZI	28480	2200-0103
H3	2200-0103	2		SCREW-MACH 4-40 .25-IN-LG PAN-HD POZI	28480	2200-0103
H4	2200-0117	B	4	SCREW-MACH 4-40 .875 IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
H5	2200-0117	B		SCREW-MACH 4-40 .875-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
H6	2200-0117	B		SCREW-MACH 4-40 .875-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
H7	2200-0117	B		SCREW-MACH 4-40 .875-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
H8	2360-0115	4	3	SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
H9	2360-0115	4		SCREW-MACH 6-32 .312-IN-LG PAN-HD POZI	00000	ORDER BY DESCRIPTION
H10	2360-0115	4		SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
H11	2360-0131	4	1	SCREW MACH 6-32 1.125-IN-LG PAN-HD POZI	00000	ORDER BY DESCRIPTION
H12	2380-0195	0	2	SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI	28480	2380-0195
H13	2380-0195	0		SCREW-MACH 6-32 .312-IN-LG PAN-HD POZI	28480	2380-0195
H14	2360-0203	1	2	SCREW-MACH 6-32 .625-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
H15	2360-0203	1		SCREW-MACH 6-32 .625 IN LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
H16	2420-0023	1		NUT-HEX-W/LKWR 6-32-THD .109 IN-THK	28480	2420-0023
H17	2420-0023	1		NUT-HEX-W/LKWR 6-32-THD .109 IN THK	28480	2420-0023
H18	2420-0023	1		NUT-HEX-W/LKWR 6-32-THD .109-IN THK	28480	2420-0023
H19	2950-0001	B	7	NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN THK	00000	ORDER BY DESCRIPTION
H20	2950-0001	B		NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN THK	00000	ORDER BY DESCRIPTION
H21	2950-0001	B		NUT-HEX-DBL-CHAM 3/8-32 THD .094-IN THK	00000	ORDER BY DESCRIPTION
H22	2950-0001	B		NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN THK	00000	ORDER BY DESCRIPTION
H23	2950-0001	B		NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN THK	00000	ORDER BY DESCRIPTION
H24	2950-0001	B		NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN THK	00000	ORDER BY DESCRIPTION
H25	2950-0001	B		NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN THK	00000	ORDER BY DESCRIPTION

See introduction to this section for ordering information
*Indicates factory selected value

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Table 6-3. *Replaceable Parts (Continued)*

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
H26	3050-0067	9	7	WASHER-FL MTLC 5/16 IN .375-IN-ID	28480	3050-0067
H27	3050-0067	9		WASHER-FL MTLC 5/16 IN .375-IN-ID	28480	3050-0067
H28	3050-0067	9		WASHER-FL MTLC 5/16 IN .375-IN-ID	28480	3050-0067
H29	3050-0067	9		WASHER-FL MTLC 5/16 IN .375-IN-ID	28480	3050-0067
H30	3050-0067	9		WASHER-FL MTLC 5/16 IN .375-IN-ID	28480	3050-0067
H31	3050-0067	9		WASHER-FL MTLC 5/16 IN .375-IN-ID	28480	3050-0067
H32	3050-0067	9		WASHER-FL MTLC 5/16 IN .375-IN-ID	28480	3050-0067
H33	3050-0227	3		WASHER-FL MTLC NO. 6 .149-IN-ID	28480	3050-0227
W1	8120-1378	1	1	CABLE ASSY 18AWG 3-CNDCT JCK-JKT	28480	8120-1378
	9211-4500	1	1	CARTON-CORR RSC 12-IN-LG 12-IN-WD	28480	9211-4500
	9211-4501	2	2	CARTON-CORR RSC 290-MM-LG 144-MM-WD	28480	9211-4501
	9220-4120	3	1	PAD-CORR RCT 390MM-LG 260MM-WD	28480	9220-4120
	9222-0667	6	1	BAG-ASTAT POLYETH FLM ENV 13.5X8-IN OPNG	28480	9222-0667
	04936-29001	3	2	CUSHION-END CAP	28480	04936-29001
	04930-80001	6	1	SERIAL TAG	28480	04930-80001
	04936-90003	9	1	OP & SERVICE MAN	28480	04936-90003
	04936-90006	2	1	QUICK REF GUIDE	28480	04936-90006

See introduction to this section for ordering information
*Indicates factory selected value

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BACK DATING MANUAL CHANGES

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SECTION VII
MANUAL CHANGES

7-1. INTRODUCTION

7-2. This section normally contains information for adapting this manual to instruments for which the content does not apply directly. Because this manual does apply directly to instruments having serial numbers listed on the title page, no change information is given here. Refer to INSTRUMENTS COVERED BY THIS MANUAL in Section I for additional important information about this serial number coverage.

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SCHEMATIC DIAGRAMS

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SECTION VIII

SERVICE

8-1. INTRODUCTION

8-2. This section contains service information for the HP 4938A NCATS. Included are the circuit descriptions, component locators, and schematics.

8-3. SAFETY CONSIDERATIONS

8-4. This section contains warnings and cautions that must be followed for your protection and to avoid damage to the equipment.

8-5. Before any repair is completed, ensure that all safety features are intact and functioning, and that all necessary parts are connected to their protective grounding means. Safety markings displayed inside the instrument must be adhered to.

8-6. CIRCUIT DESCRIPTION

8-7. The HP 4938A contains four main sections. They are the mechanical, simplex transformers, originate circuitry, and the terminate circuitry. See figures 6-1, 8-2, and 8-4.

8-8. Mechanical

8-9. Most of the originate circuitry, terminate circuitry, and the simplex transformer circuitry is located on the upper circuit board (A1). The power supply and relays are located on the lower circuit board (A2). The series regulators in the power supply and the 5-watt load resistors are located on a heat spreader (A4). The thermal rise of the heat spreader bracket is controlled by a thermal cutout switch, A4TS1 . The switch is activated at 55 degrees C surface temperature. When the thermal cutout switch is activated the CIRCUIT FAULT indicator will light.

8-10. Simplex Transformers

8-11. There are two simplex transformers (A1T110 and A1T410) in the instrument. The transformers allow the conversion between 2-wire and 4-wire circuits. The transformers have a one to one turns ratio with the secondary center tapped. The center tap allows for a dc signal to be applied to the circuit without imbalancing the line. The loop dc resistance is also reduced to half because the tip and ring are, in effect, in parallel.

8-12. The transformers can be connected to the terminate circuitry or the originate circuitry, or they can be disconnected from both, through switch A1S207. Also, the transformers are automatically disconnected from the terminate and originate circuitry when a 310 jack is inserted into the SX/SX1 jack, A1J208.

Note

By convention, the transmit side of a 4-wire termination set is carried on T and R leads. The receive direction is carried on T1 and R1 leads.

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8-13. Two wires of a 4-wire input circuit are connected to jack A1J309, T1 and R1. The other two wires are connected to jack A1J209, T and R. The center tap of each transformer becomes one conductor of the internal two-wire bidirectional circuit. This circuit becomes the conducting path for loop closure, ring trip closure, loop current measurement, and the 3-ringer load.

8-14. Originate Circuitry

8-15. The originate circuitry allows margin testing to be performed on the line from the originate end. The circuitry is wired to function as either a ringer load or as a loop closure for the circuit under test.

8-16. When the originate circuit is to function as a ringer load, the input must be connected to the ORIGINATE CIRCUIT jack, A1J305. There are two ringer loads available; A1R10, 2330 ohms (REN3) or A1R12, 330 ohms (TRIP). The signal flows from A1J305 to the LOOP I, A1S300 switch. The LOOP I switch, when in the normal position (out), is wired through to REN 3, A1S300 switch. When LOOP I switch is pressed in, the signal flows to the front panel COM and AMP MONITOR binding posts. The monitor binding posts are ac coupled to the line by two 2.2 uF capacitors, A1C11 and A1C13.

8-17. When REN 3 switch is closed A1R10, 2330 ohms ringing load, is connected into the signal flow circuit. This load is the equivalent to three ringers. The ringing voltage (>55 Vrms) can be measured by connecting a voltmeter across the VOLTS and COM MONITOR binding post.

8-18. When initiating a loop start the input must be connected to the ORIGINATE CIRCUIT jack, A1J305. The signal flows through the LOOP I switch to the LOOP, A1S300 switch. Closing the LOOP switch inserts a 430-ohm load into the circuit. This provides a dc current path (about 20 mA) for the loop closure.

8-19. When in the loop start signaling mode a ground start can be simulated by pressing the GND START pushbutton. This places an additional 550 ohms, A1R8 into the circuit.

8-20. The loop current can also be measured by connecting a current meter to the AMPS and COM MONITOR binding posts and pressing the LOOP I pushbutton.

8-21. Terminate Circuitry

8-22. The terminate circuitry consists of the power supply, digital control logic, and the analog sensing circuitry. The terminate circuitry provides a ringing voltage at either 20 Hz or 30 Hz, at -48 Vdc battery. The ringing voltage can be applied to the SX/SX1 jack by setting the front panel switch to the up position.

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8-23. The power supply consists of five different voltage supplies. There are two supplies rated at -48 volts, one at -38 volts, one at +5 volts, and one at -5 volts.

8-24. The +/- 5 volt supplies are used to power the digital logic, operating amplifiers, and relays. These supplies are standard full-wave rectifiers with three terminal regulators. The +5 volt supply uses two of the regulators to keep relay noise from interfering with the digital logic.

8-25. One of the -48 volt supplies is used as the battery simulator. The other -48 volt supply is added to the -38 volt supply to provide 86 V rms. Relay A2K101 is used to select either the -48 volts for battery simulation or the output of relay A2K103, which is the ringing voltage. The ringing voltage is generated by switching A2K103 between +48 volts and -134 volts. Relay driver A2U203 toggles relay A2K103 at a rate of either 20 Hz or 30 Hz depending on the selected ringing frequency.

8-26. The digital logic controls the operation of the ringer. The clock is taken from the power line by full wave rectifying it. This voltage is then sent to the Schmitt trigger A1U105 where it is shaped into a square wave. The output frequency from A2U105 is 120 Hz. The clock signal is then sent to A1U100 and A1U108 where the frequency (120 Hz) is divided by 6 or 4 respectively. This gives the 20 Hz or 30 Hz ringing frequency. The output of the dividers is then used to drive A1U203 and A1U408, which toggles relay A2K103 at the correct rate.

8-27. A1U405 and A1U406 are used to generate the two second on four second off ringing time. The clock turns the frequency generator on for 2 seconds and off 4 seconds. Placing jumper JU1 in the T position the ring generator will run continuously.

8-28. The analog sensing circuit consists of A2U302, A2U304 and a thermal switch A4TS1. If the temperature in the instrument exceeds 55 degrees C the switch will open and disconnect the ringer.

8-29. A1U302 is used to determine if dc current is flowing in the loop. The average voltage is sensed across A2R2. If the average voltage is above 74 mV (about 16 mA) A1U107 will trip and stop the ringing generator and the OFF HOOK LED will light. A2U304 is an overvoltage/current detector. When the current flow in the ring exceeds 138 mA, A2U304 will open relay A2K200.

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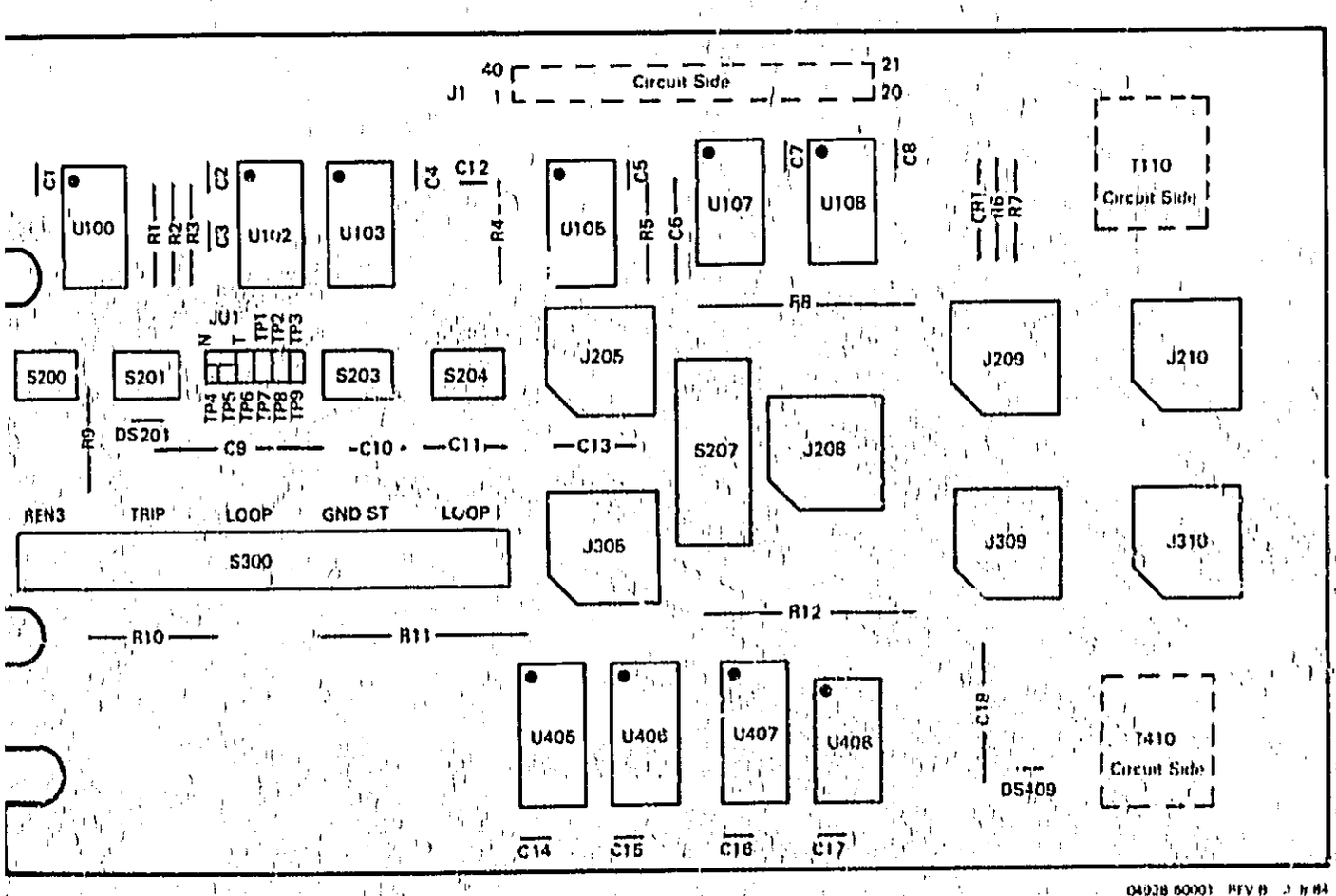

Figure 8-1. *Main Assembly A1 Component Locator*

8-4

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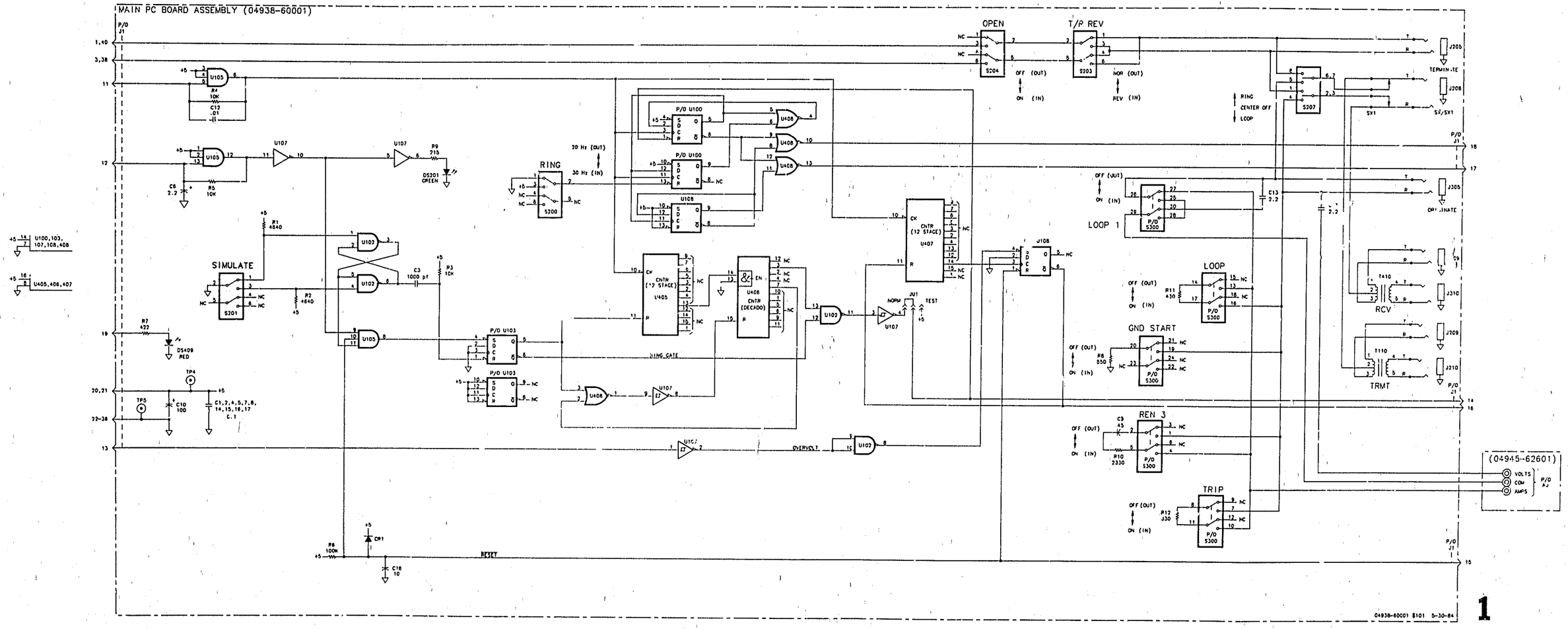

Figure 8-2. Main Assembly A1 Schematic

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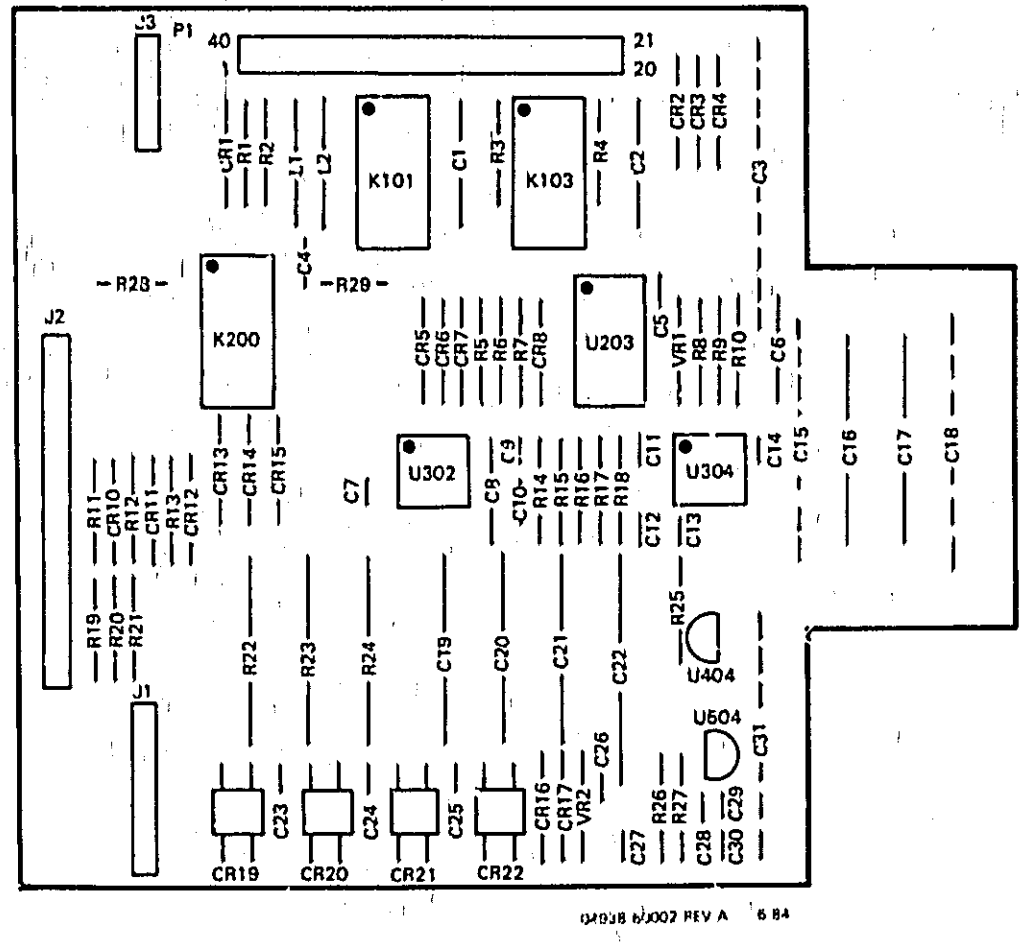

Figure 8-3. *Power Supply Assembly A2 Component Locator*

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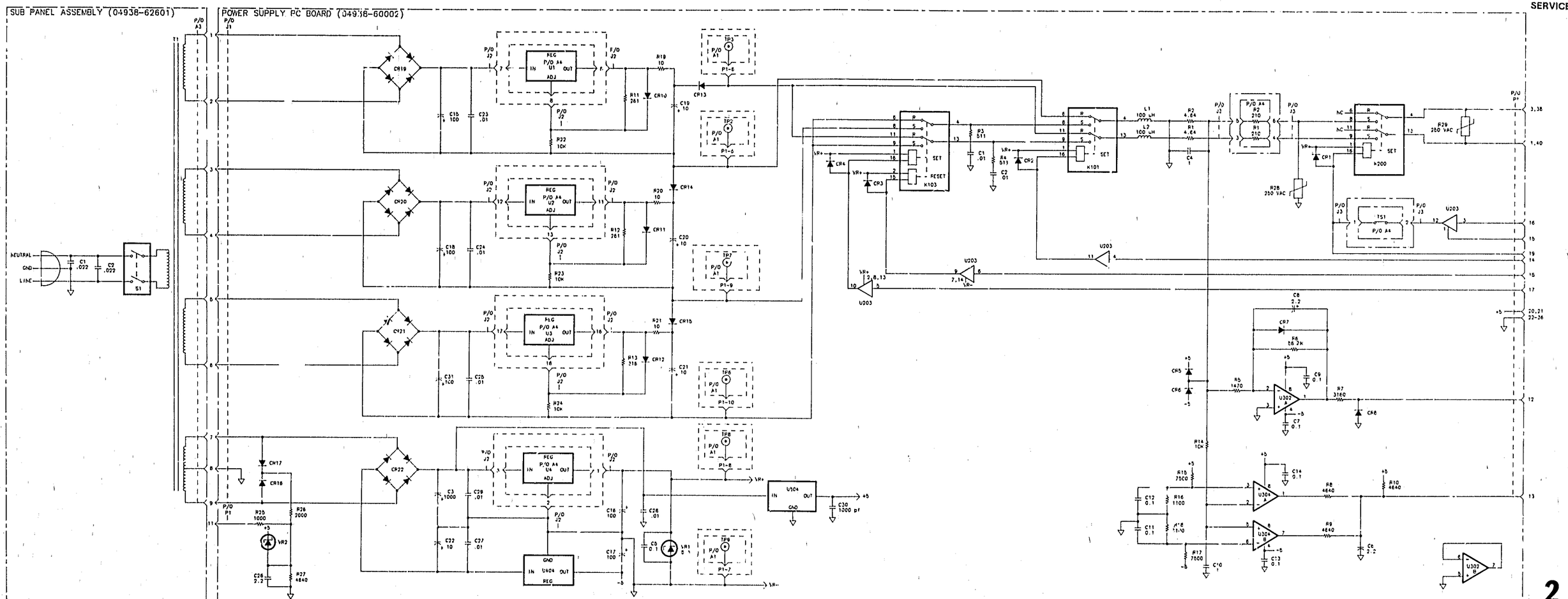

2

Figure 8-4. Power Supply Assembly A2 Schematic

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MANUAL CHANGES

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HEWLETT hp PACKARD

MANUAL CHANGES

------ MANUAL DESCRIPTION -----	CHANGE DATE 14 December 1984
INSTRUMENT: 4938A	(This change supersedes all earlier dated changes)
SERIAL PREFIX: 2432A	* Make all changes listed as ERRATA.
DATE PRINTED: September 1984	* Check the following table for your instrument's serial prefix or serial number and make listed change(s) to manual.
HP PART NO: 04938-90003-B	
MICROFICHE NO: 04938-90004-B	

If your Instrument has serial prefix or serial number	Make these changes to your manual	If your instrument has serial prefix or serial number	Make these changes to your manual
2450A	1		

ERRATA

Title Page:
Change: serial numbers prefixed from 2432A to 2431A

Change 1

Section I Page 1-4, Ringer Termination
Change REN-3 load impedance to:
1780 ohms +/-1% in series with 5 uF +/-20% nonpolar

Section IV Page 4-7
Change step 10 to read
10. The amplitude of the signal display on the digital voltmeter should be from 69 to 81 Vrms.

Change step 13 to read
13. The ON/OFF signal time as seen on the oscilloscope should be 50 ms +/-6 ms.

Section IV Page 4-9
Change step 10 to read
10. The amplitude of the signal display on the digital voltmeter should be from 69 to 81 Vrms.

Change step 13 to read
13. The ON/OFF signal time as seen on the oscilloscope should be 33 ms +/-6 ms.

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Change 1 (cont'd)

Section VI Page 6-7
Change A1C9 to Part Number 0180-3645 CAPACITOR-FXD 5 uF 20 % 200V
A1R10 to Part Number 0811-3721 RESISTOR 1.78 k, 1%, 3W

Section VIII Page 8-5
Change A19C from .45 to 5
A1R10 from 2330 to 1780

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