

Errata

Title & Document Type: 4338A Milliohmmeter Service Manual

Manual Part Number: 04338-90031

Revision Date: October 1991

HP References in this Manual

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

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.

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:

www.tm.agilent.com

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.

HP 4338A Milliohmmeter Service Manual

SERIAL NUMBERS

This manual applies directly to instruments with serial number prefix 3148J.

For additional important information about serial numbers, read
"Instruments Covered by This Manual" in Chapter 1 of this manual.



HP Part No. 04338-90031
Microfiche Part No. 04338-90081
Printed in JAPAN October 1991

Notice

The information contained in this document is subject to change without notice.

This document contains proprietary information which is protected by copyright. All rights are reserved. No part of this document may be photocopied, reproduced, or translated to another language without the prior written consent of the Hewlett-Packard Company.

Yokogawa-Hewlett-Packard, LTD.
Kobe Instrument Division
1-3-2, Murotani, Nishi-ku, Kobe-shi
Hyogo, 651-22 Japan

Manual Printing History

The manual printing date and part number indicate its current edition. The printing date changes when a new edition is printed. (Minor corrections and updates which are incorporated at reprint do not cause the date to change.) The manual part number changes when extensive technical changes are incorporated.

October 1991 First Edition

Safety Summary

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific **WARNINGS** given elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument.

The Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements.

Ground The Instrument

To minimize shock hazards, the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three-conductor AC power cable. The power cable must be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and the mating plug of the power cable meet International Electrotechnical Commission (IEC) safety standards.

DO NOT Operate In An Explosive Atmosphere

Do not operate the instrument in the presence of flammable gasses or fumes. Operation of any electrical instrument in such an environment constitutes a safety hazard.

Keep Away From Live Circuits

Operating personnel must not remove instrument cover. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with the power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

DO NOT Service Or Adjust Alone

Do not attempt internal service unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT Substitute Parts Or Modify Instrument

Because of the danger of introducing additional hazards, do not substitute parts or perform unauthorized modifications to the instrument. Return the instrument to a Hewlett-Packard Sales and Service Office for service and repair to ensure the safety features are maintained.

Dangerous Procedure Warnings

Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

Warning



Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting this instrument.

Safety Symbols

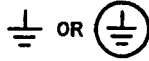
General definitions of safety symbols used on equipment or in manuals.



Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the instrument.



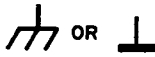
Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 volts must be so marked).



Protective conductor terminal. For protection against electrical shock in case of a fault. Used with wiring terminals to indicate the terminal which must be connected to ground before operating equipment.



Low-noise or noiseless, clean ground (earth) terminal. Used for a signal common, as well as providing protection against electrical shock in case of fault. A terminal marked with this symbol must be connected to ground in the manner described in the installation (Operation) manual, and before operating the equipment.



Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.



Alternating current (power line).



Direct current (power line).



Alternating or direct current (power line).

Warning



Warning denotes a hazard. It calls attention to a procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in injury or death to personnel.

Caution



Caution denotes a hazard. It calls attention to a procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result damage to or destruction of part or all of the product.

Note



Note denotes important information. It calls attention to a procedure, practice, condition or the like, which is essential to highlight.

Documentation Map

Operation Manual

Operation Manual (HP Part Number: 04338-90000 for English edition, 04338-97000 for Japanese edition) explains specifications, basic measurement explanations, and how to verify conformance to published specifications.

Service Manual

Service Manual (HP Part Number: 04338-90031) explains how to adjust, troubleshoot, and repair the HP 4338A.

How To Use This Manual

This is the Service Manual for the HP 4338A Milliohmmeter. This manual contains adjustment and repair information, and consists of the following four chapters.

Chapter 1 General Information

Chapter 1 gives general information for servicing the HP 4338A. This chapter lists the required equipment for adjustment and troubleshooting.

Chapter 2 Adjustment

Chapter 2 describes the adjustment, required to ensure that the HP 4338A is within its published specifications after it has been repaired, or when it fails the performance tests.

Chapter 3 Assembly Replacement

Chapter 3 provides the information on replacing the HP 4338A assemblies. The information includes replaceable assembly lists, and removal and installation procedures.

Chapter 4 Troubleshooting

Chapter 4 provides the information on troubleshooting the HP 4338A. The information includes theory of operation and information on faulty assembly isolation.

Appendix A Manual Changes

Appendix A contains manual changes and provides information for using this manual with HP 4338As manufactured before the printing date of the manual.

Appendix B Default Jumper and Switch Settings

Appendix B describes the settings of the jumpers and switches on the HP 4338A A2 CPU Board Assembly. The information is required when the A2 assembly is replaced.

Contents

1. General Information	
Introduction	1-1
Instruments Covered by This Manual	1-1
Required Equipment	1-2
2. Adjustment	
Introduction	2-1
Safety Consideration	2-1
Required Equipment	2-1
Adjustment Tools	2-2
Adjustable Components	2-2
Factory-Selected Components	2-2
EEPROM Write Protect Switch	2-2
Related Adjustment	2-2
Adjustment Program	2-3
Program Installation	2-4
Making a Working Copy	2-4
Program Execution	2-4
Adjustment Procedure References	2-5
Resistance Measurement Adjustment	2-5
Equipment	2-5
Setup	2-5
3. Assembly Replacement	
Introduction	3-1
Ordering Information	3-1
Restored Exchange Assemblies	3-1
Replacing the A2 CPU Board Assembly	3-2
Replaceable Assembly List	3-2
Replaceable Mechanical Parts List	3-5
Disassembly Procedures	3-9
Tools and Fasteners	3-9
Cover Removal	3-9
A1 Main Board Removal	3-10
Removal Procedure	3-10
A2 CPU Board Assembly Removal	3-10
Removal Procedure	3-10
A5 AC Inlet Board Assembly Removal	3-10
Removal Procedure	3-10
Keyboard Assembly Removal	3-11
Removal Procedure	3-11
LCD Assembly Removal	3-11
Removal Procedure	3-11
BNC Connector Removal	3-11
Removal Procedure	3-11

4. Troubleshooting	
Introduction	4-1
Safety Considerations	4-1
Required Equipment	4-1
After Service Product Safety Checks	4-2
Theory of Operation	4-3
Overall Measurement Theory	4-3
Overall Block Diagram	4-4
Analog Section	4-5
Signal Source Section	4-6
Range Resistor and Current Sense Amplifier Sections	4-7
Voltage Sense Amplifier and Process Amplifier Sections	4-8
Digital Section	4-9
Power Supply Section	4-10
Troubleshooting	4-11
Check Procedure References	4-13
Check 1, DC-DC Converter Output Voltage	4-13
Check 2, LCD Displays Anything?	4-14
Check 3, All LCD Segments Light?	4-14
Check 4, Any Error Message on LCD?	4-14
Check 5, CPU Related Error Message?	4-14
Check 6, CPU Power LED Lights?	4-14
Check 7, Any Error Code on LED?	4-15
Check 8, CPU Fuse High Lead Voltage	4-16
Check 9, Fuse and Line Switch	4-16
Check 10, DC-DC Converter Input Voltage	4-17
Check 11, DC-DC Converter Open Output Voltages	4-18
Check 12, Transformer Secondary Voltage	4-19
A. Manual Changes	
Introduction	A-1
Manual Changes	A-1
B. Default Jumper and Switch Settings	
Introduction	B-1
Jumper and Switch Settings	B-1
Index	

Figures

1-1. Serial Number Label	1-1
2-1. Adjustment Program Flow	2-3
2-2. Range Resistor Adjustment Setup	2-5
3-1. Cover Removal	3-9
4-1. Voltage Current Ratio Measurement Principle	4-3
4-2. HP 4338A Overall Block Diagram	4-4
4-3. Analog Section Block Diagram	4-5
4-4. Signal Source Section Block Diagram	4-6
4-5. Range Resistor and Current Sense Amp. Block Diagram	4-7
4-6. Voltage Sense Amp. and Process Amp. Block Diagram	4-8
4-7. Digital Section Block Diagram	4-9
4-8. Power Supply Section Block Diagram	4-10
4-9. Troubleshooting Flow	4-12
4-10. DC-DC Converter Output Voltage Check	4-13
4-11. CPU Board Assembly LED Light Sequence	4-15
4-12. Location of High Lead of A2F1 Fuse	4-16
4-13. Test Pin Locations	4-17
4-14. DC-DC Converter Output Connector	4-18
4-15. Transformer Secondary Voltage Check	4-19
B-1. Jumper and Switch Settings	B-1

Tables

1-1. Required Equipment	1-2
1-2. Required Language Extensions	1-2
2-1. Related Adjustment	2-2
3-1. Replaceable Major Assembly List	3-3
3-2. A2 CPU Board Assembly, Replaceable Assembly List	3-4
3-3. Replaceable Assembly List	3-4
3-4. Replaceable Mechanical Parts List 1	3-5
3-5. Replaceable Mechanical Parts List 2	3-6
3-6. Replaceable Mechanical Parts List 3	3-7
3-7. Replaceable Mechanical Parts List 4	3-8
4-1. DC-DC Converter Output Voltage (Connected)	4-13
4-2. DC-DC Converter Open Output Voltages	4-18
A-1. Manual Changes by Serial Number	A-1

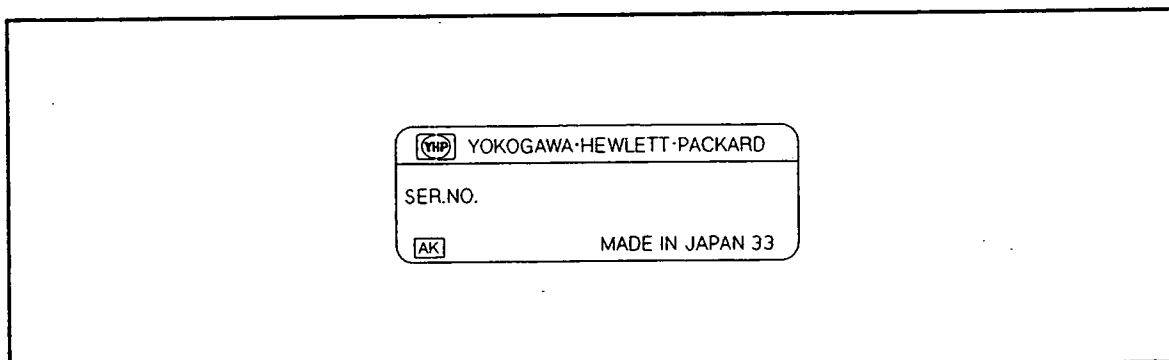
General Information

Introduction

This chapter provides information on instruments covered by this manual and required equipment for the adjustment and troubleshooting.

Instruments Covered by This Manual

Hewlett-Packard uses a two-section, nine character serial number which is printed on the serial number label (Figure 1-1) attached to the instrument's rear panel. The first four digits and a letter are the serial number prefix, and the last five digits are the suffix. The letter placed between the two sections identifies the country where the instrument was manufactured. 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 instruments with the serial number prefix(es) listed under the serial numbers on the title page.



L8501001

Figure 1-1. Serial Number Label

An instrument manufactured after the printing date 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 new instrument may be accompanied by a yellow Manual Changes supplement or have a different manual part number. This sheet contains "change information" that explains how to adapt the manual to the newer instrument.

In addition to change information, the supplement may contain information for correcting errors (Errata) in the manual. To keep this manual as current and accurate as possible, Hewlett-Packard recommends that you periodically request the latest Manual Changes supplement. The supplement for this manual is identified by this manual's printing date and its part number, both of which appear on the manual's title page. Complimentary copies of the supplement are available from Hewlett-Packard. If the serial prefix or number of an instrument

is lower than that on the title page of this manual, see *Appendix A, Manual Changes*. For information concerning, a serial number prefix that is not listed on the title page or in the Manual Change supplement, contact the nearest Hewlett-Packard office.

Required Equipment

Table 1-1 lists the required equipment for adjusting and troubleshooting the HP 4338A. Table 1-2 lists the required language extensions to be used with the adjustment program.

Table 1-1. Required Equipment

Equipment	Requirements	Recommended Model	Qty.	Use
Multimeter	DC V Accuracy: < 1%	HP 3458A	1	T ¹
Standard Resistors	No Substitute	HP 42030A	1	A ²
Open Termination	No Substitute	HP 42090A ³	1	A
Short Termination	No Substitute	HP 42091A ³	1	A
Computer	No Substitute	HP 9000 series 200 or 300 ⁴ RAM ≥ 4M bytes	1	A
Operating System	BASIC 5.1 or higher	HP 98616A	1	A
Adjustment Program	No substitute	HP PN 04338-65002	1	A

1 Troubleshooting

2 Adjustment

3 This model is also included in the HP 42100A, Four Terminal Pair Resistor Set

4 Excluding the HP 9826A

Table 1-2. Required Language Extensions

Name	Ver.	Name	Ver.	Name	Ver.	Name	Ver.
CLOCK	5.0	CS80	5.0 ¹	GRAPH	5.2	KBD	5.1
COMPLEX	5.1	EDIT	5.1	GRAPHX	5.2	MAT	5.1
CRTA	5.1	ERR	5.1	HPIB	5.0	MS	5.1
CRTX	5.1	FHPIB	5.0	IO	5.1	PDEV	5.0

1 This language extension depends on the mass storage type used.

Adjustment

Introduction

This chapter describes the adjustment required to ensure the HP 4338A is within its published specifications after it has been repaired. The adjustment should be performed along with periodic maintenance to keep the HP 4338A in optimum operating condition. If proper performance cannot be achieved after adjustment, proceed to Chapter 4.

Note

To ensure proper results and correct instrument operation, a 30 minute warm-up and stabilization is required before performing the adjustment.



Safety Consideration

This chapter contains *NOTES*, *CAUTIONS*, and *WARNINGS* which must be followed to ensure operator safety and to maintain the instrument in a safe and serviceable condition. The adjustment covered in this chapter should be performed only by a qualified person who is aware of the hazards.

Warning

Any interruption of the protective ground conductor (inside or outside the instrument) or disconnection of the protective ground terminal can make the instrument dangerous. Intentional interruption of the protective ground system for any reason is prohibited.



Required Equipment

Table 1-1 lists the equipment required to perform the adjustment. Use only calibrated standards when adjusting the HP 4338A.

Adjustment Tools

No hand tools are required for the adjustment.

Adjustable Components

There are no adjustable components, such as variable capacitors or variable resistors, in the HP 4338A. Adjustment is performed by updating the adjustment data stored in the EEPROM.

Factory-Selected Components

No factory-selected components are used in the HP 4338A

EEPROM Write Protect Switch

There are no EEPROM write protect switches in the HP 4338A.

Related Adjustment

There is only one adjustment for the HP 4338A. Table 2-1 lists the adjustment that must be performed if an assembly has been replaced.

Table 2-1. Related Adjustment

Assembly Replaced	Required Adjustment
A1 Main Board Assy	Resistance Measurement Adjustment
A2 CPU Board Assy without EEPROM	None ¹
A5 AC Inlet Board Assy	None
LCD Assembly	None
DC-DC Converter Unit	None
Keyboard Assembly	None

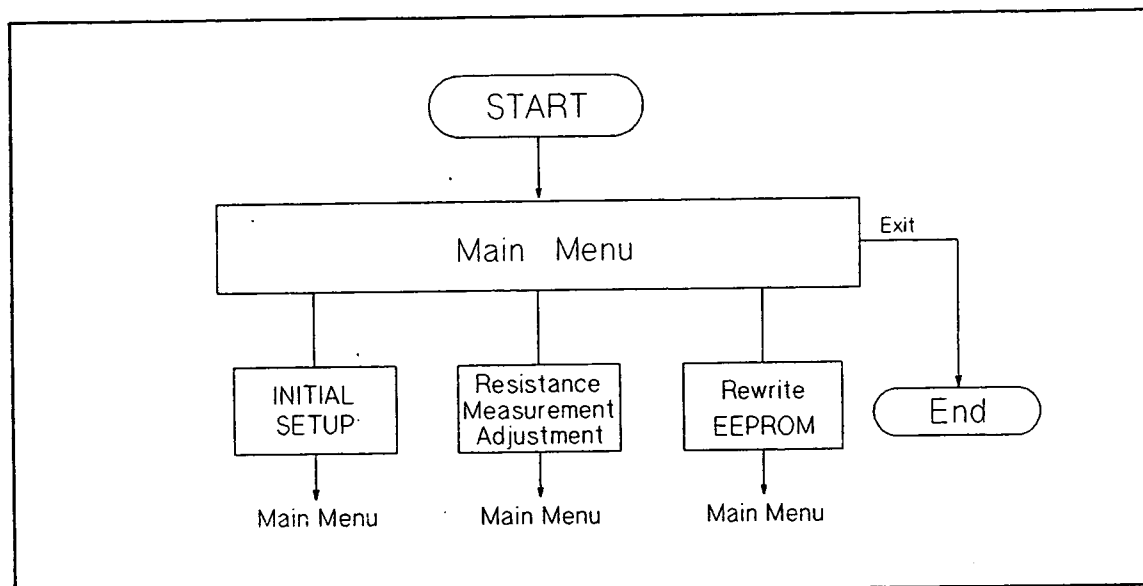
¹ If the EEPROM, A2U10, is replaced, the Resistance Measurement Adjustment is required.

Adjustment Program

The adjustment program listed in Table 1-1 is required for the adjustment. Using the program, the computer controls the HP 4338A to obtain the adjustment data, and stores the data in the HP 4338A internal EEPROM, A2U10.

The adjustment program runs on the computer listed in Table 1-1. The program should be installed into your computer according to the procedure described in "Program Installation". To start the program after it has been installed, refer to "Program Execution".

Figure 2-1 shows the adjustment program flow. The following lists the brief explanation for each menu item.



1.6502001

Figure 2-1. Adjustment Program Flow

INITIAL SETUP defines the standards' calibration values. Update the standard's calibration values if necessary.

Resistance Measurement Adjustment obtains the data to adjust the actual measurement resistance to the standards' value, and writes the data both to the HP 4338A internal EEPROM and to the unit-serial-number dependent file on the disk. This adjustment should be performed if the Impedance Measurement Accuracy performance test fails.

Rewrite EEPROM writes the adjustment data, which is stored in the unit-serial-number dependent file, to the EEPROM.

Note



Make sure that the correct line frequency (50 or 60Hz) has been selected in the "UUT: HP4338A" window preceding the Main Menu. This selection will improve the adjustment data accuracy.

Program Installation

The adjustment program must be installed in the computer using the following procedures.

Making a Working Copy

Copy the content of the adjustment program disk to a working disk or to the harddisk to prevent the program file from accidental deletion or destruction. Use the working disk or harddisk and store the original disk in a safe place.

Program Execution

Perform the following steps to start the adjustment program.

Note Install the program prior to execution. Refer to "Program Installation".



-
1. Turn on the computer and bring up the BASIC system. Refer to the Table 1-2 for the required language extensions.
 2. Set the Mass Storage Unit Specifier to the drive/directory where the adjustment program exists using the MSI command.
 3. Load the program, "ADJ4338A" by pressing LOAD "ADJ4338A" **Return** (or **Enter**).
 4. Execute the program by pressing RUN.

Note In the program, the HP 4338A is referred as "UUT".



Note If the adjustment being performed follows right after EEPROM replacement, change switch A2SW1-1 to "CLOSE", so that the HP 4338A will ignore the self test errors at power-on. (Return the switch to "OPEN" when the adjustment has been completed.) Refer to Figure B-1 for the switch location.

Adjustment Procedure References

This section provides supplemental information for the adjustment which is performed by the program. Connection instructions and some additional explanations are provided. Use this chapter as a reference when performing the adjustment.

Resistance Measurement Adjustment

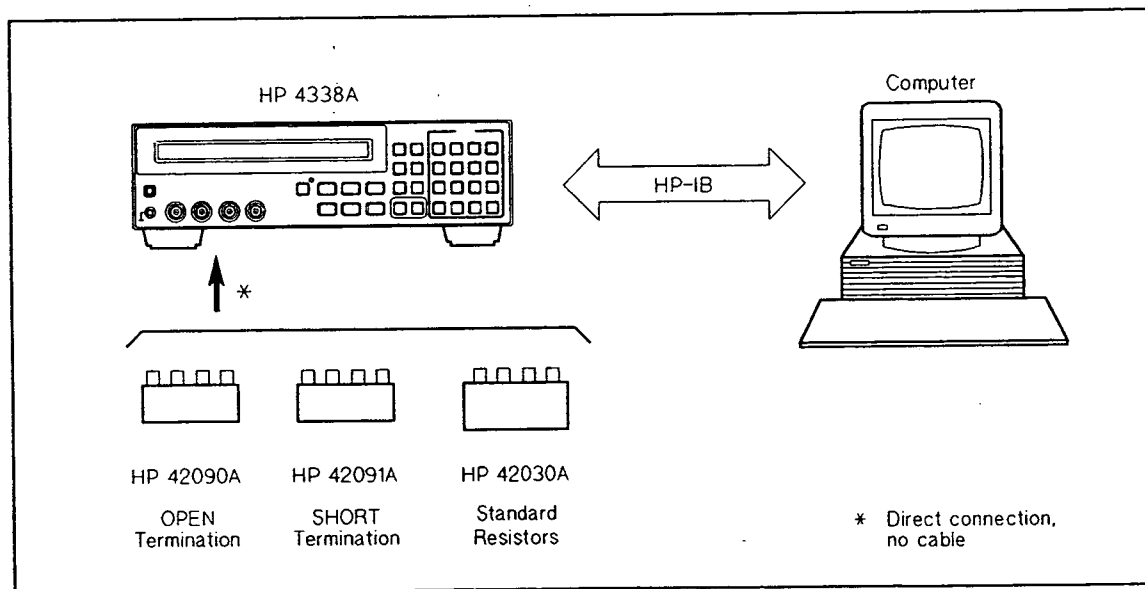
This adjustment updates the data to adjust the measurement resistance to the standard values.

Equipment

Standard Resistors	HP 42030A
Open Termination	HP 42090A
Short Termination	HP 42091A

Setup

This setup obtains the range resistor adjustment data and the process amplifier attenuator adjustment data.



L6S02002

Figure 2-2. Range Resistor Adjustment Setup

Perform the following steps as the program instructs.

1. Connect the specified termination or standard resistor directly to the HP 4338A UNKNOWN Connectors.
2. Repeat step 1 as instructed.

Assembly Replacement

Introduction

This chapter provides the HP 4338A replaceable parts lists, and the step by step disassembly procedures for the major assemblies. Table 3-1 to Table 3-7 describe all the HP 4338A replaceable parts. The figure section of Table 3-7 also shows the cable connections.

Ordering Information

To order a part listed in the replaceable parts lists, quote the Hewlett-Packard part number, indicate the quantity required, and address the order to the nearest Hewlett-Packard office.

To order a part that is not listed in the replaceable parts list, include the instrument model number, complete instrument serial number, the description and function of the part, and the quantity of parts required. Address the order to the nearest Hewlett-Packard office.

Restored Exchange Assemblies

Some replacement assemblies are available as either new or restored assemblies. The restored assembly is more economical than a new assembly and, as with new assemblies, a 90-day warranty applies through the instrument's support life. The defective assembly must be returned for credit. For this reason, new assemblies must be ordered for spare parts. The part numbers for both new and restored assemblies are given in the replaceable parts lists.

Note

The Exchange Program may not apply in your country. Contact the nearest Hewlett-Packard office for further details.



Replacing the A2 CPU Board Assembly

The A2 CPU Board Assembly has a ROM for the firmware and an EEPROM for the adjustment data and user data. Both ROM and EEPROM are mounted in sockets for easy replacement. If the A2 assembly is replaced, the ROM and EEPROM may be transferred from the defective assembly to the new assembly as long as the ROM and EEPROM are not defective. The ROM transfer reduces parts cost for the repair, and the EEPROM transfer saves time from readjusting the HP 4338A. For this purpose, the A2 assembly can only be ordered without ROM and EEPROM.

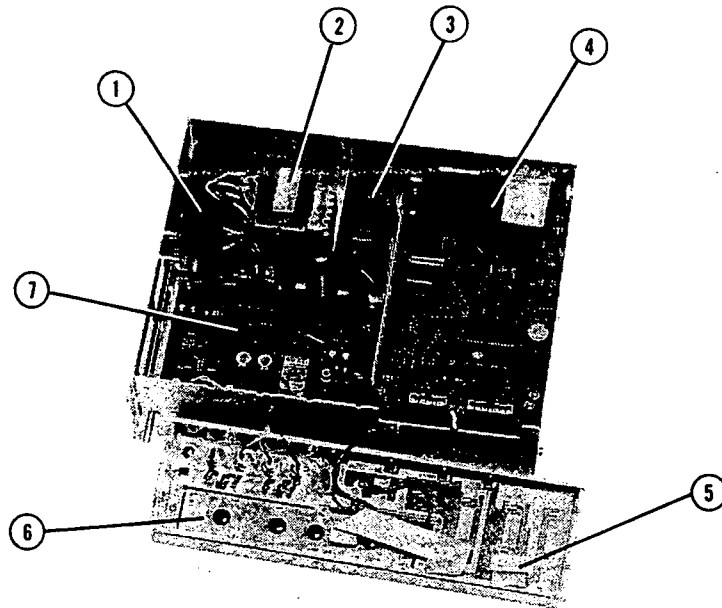
When the A2 assembly is replaced, the shield case should be transferred from the defective assembly to the new assembly. The A2 assembly can only be ordered without the shield case so the old shield case should be used.

When the A2 assembly is replaced, make sure that the jumpers and switches on the A2 assembly are in the default position as shown in Appendix B.

Replaceable Assembly List

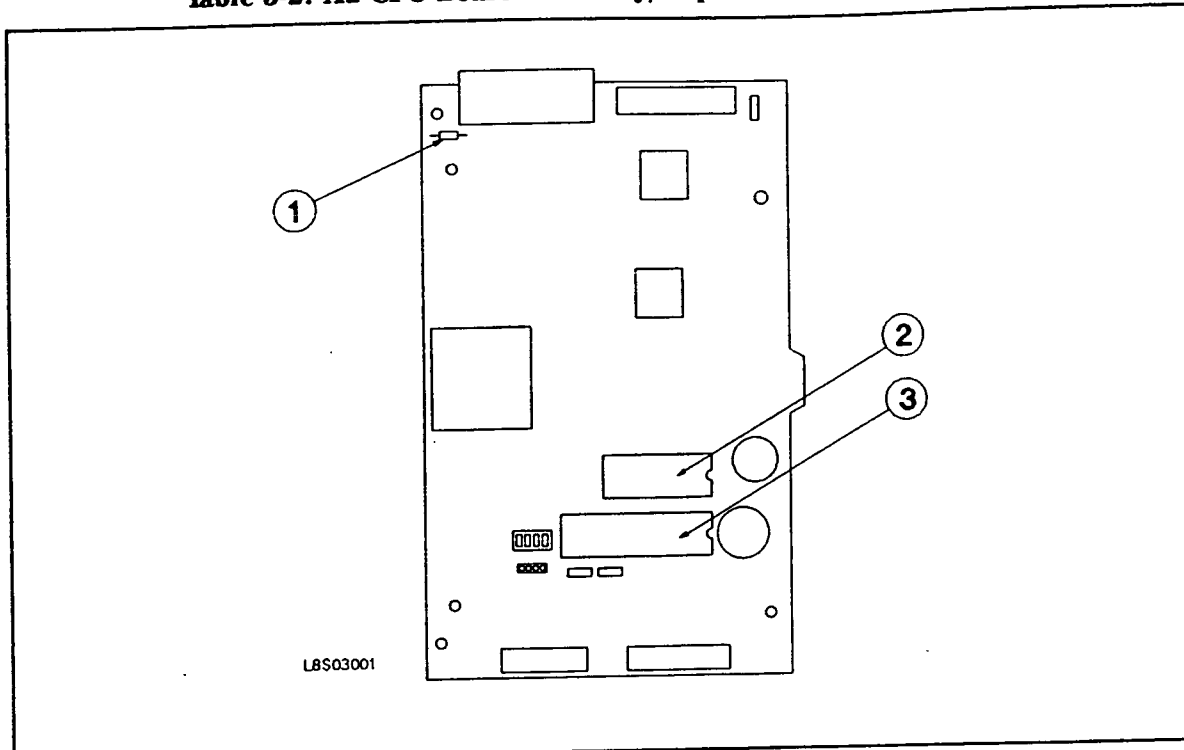
The replaceable electrical assemblies are listed in Table 3-1 and Table 3-3.

Table 3-1. Replaceable Major Assembly List



Reference Designation	HP Part Number	Qty.	Description
1	04263-66505	1	A5 AC Inlet Board Assembly
2	04263-60004	1	Transformer Assembly
3	04263-80901	1	DC-DC Converter Unit
4	04263-66602	1	A2 CPU Board Assembly w/o ROM and EEPROM
	04263-00604	1	Case Shield
	0515-1550	4	Screw M3
	04263-69602		A2 CPU Board Assembly w/o ROM and EEPROM (Exchange Assembly)
5	04338-66504	1	A4 Keyboard Assembly
	04338-25101	1	Rubber Key
	0515-1550	1	Screw M3
6	5062-0601	1	LCD Assembly
	04263-25002	1	Filter Transparent
	0515-1550	2	Screw M3
7	04338-66501	1	A1 Main Board Assembly
	04338-69501		A1 Main Board Assembly (Exchange Assembly)

Table 3-2. A2 CPU Board Assembly, Replaceable Assembly List



Reference Designation	HP Part Number	Qty.	Description
1	2110-0716	1	A2F1, Fuse .5 A
2	1818-5146	1	A2U10, EEPROM
3	04338-85001	1	A2U11, ROM Rev. 1.00

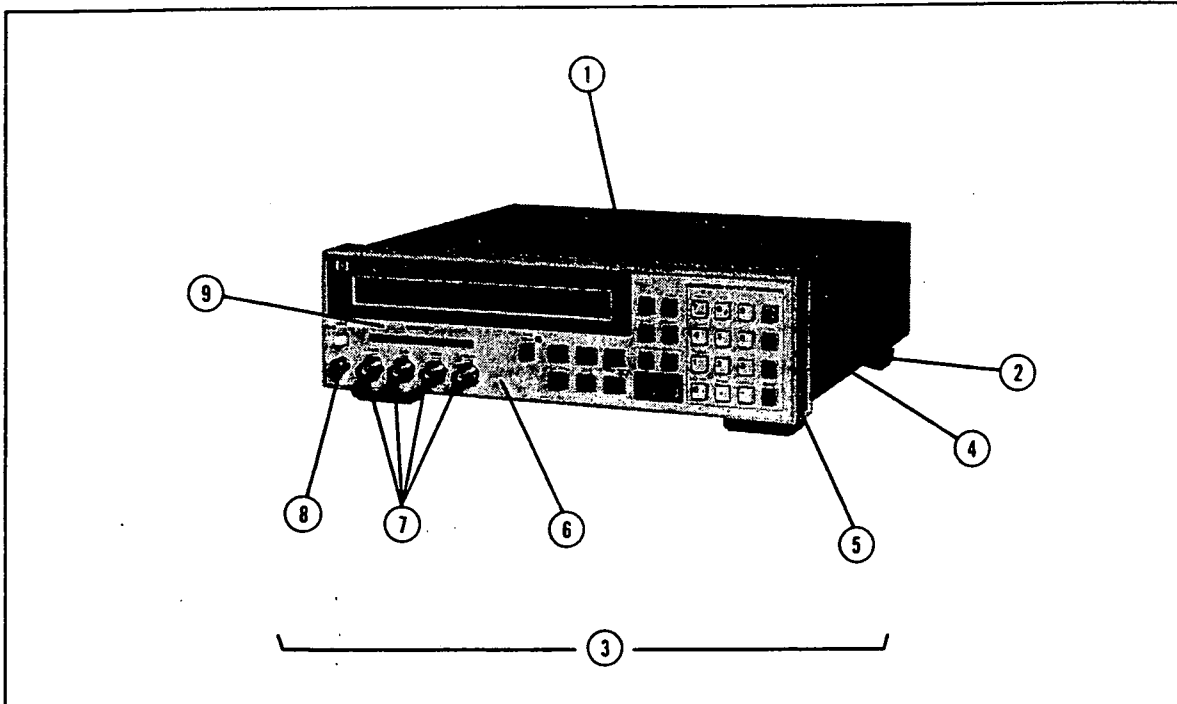
Table 3-3. Replaceable Assembly List

Reference Designation	HP Part Number	Qty.	Description
A1F500	2110-0712	1	Fuse 4 A (for power supply)
A1C500	0180-4334	1	Capacitor, 22000 μ F (for power supply)
A1C501	0180-4334	1	Capacitor, 22000 μ F (for power supply)
A5SW1	3101-3171	1	Line Switch
A5VR1	0837-0237	1	Varistor
A5VR2	0837-0237	1	Varistor

Replaceable Mechanical Parts List

The replaceable mechanical parts are listed in Table 3-4 to Table 3-7.

Table 3-4. Replaceable Mechanical Parts List 1

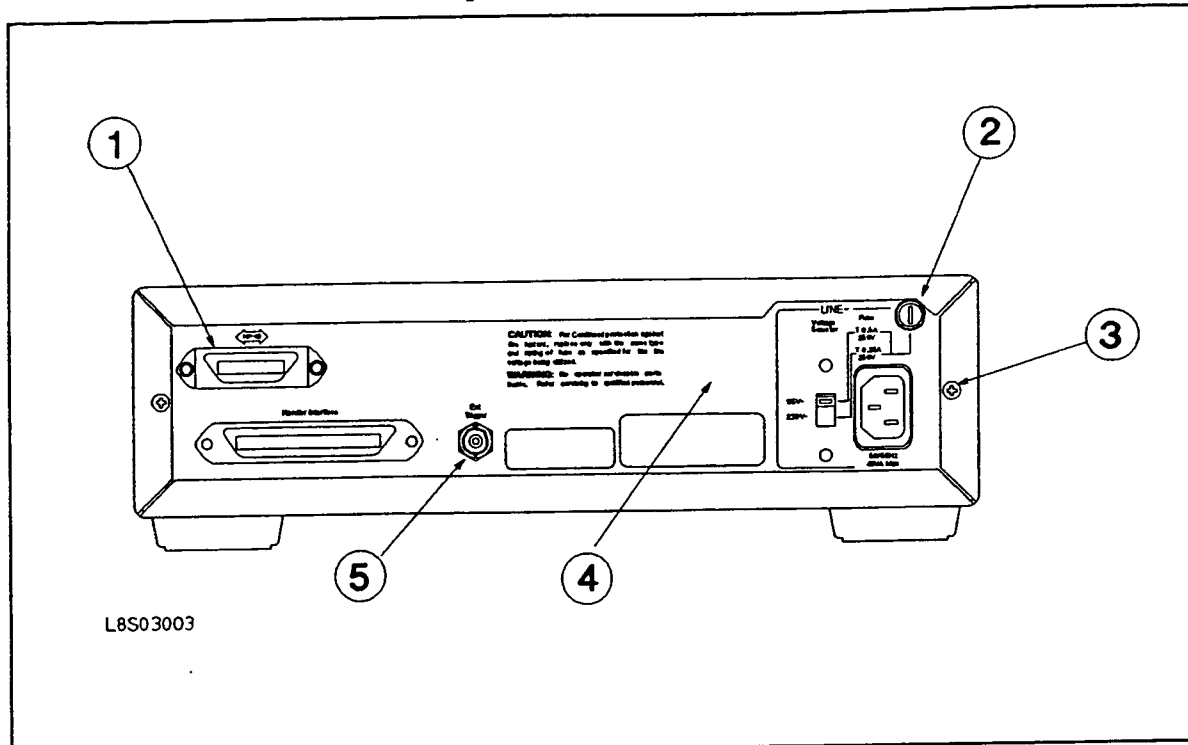


Reference Designation	HP Part Number	Qty.	Description
1	04263-60001	1	Cover
2	5041-8801	4	Foot
	1460-1345	2	Tilt Stand
3	04338-65010	1	Front Panel Assembly ¹
4	5001-0538	2	Trim Side
	0515-0914	4	Screw M3 (Hidden)
5	04339-40001	1	Front Bezel ²
6	04263-00605	1	Sub Panel (Hidden) ²
	0515-0914	4	Screw M3 (Hidden) ²
	0515-1550	2	Screw M3 (Hidden) ²
	0160-4808	4	Capacitor 470 pF (Hidden) ²
	1901-1250	8	Diode (Hidden) ²
7	1250-0252	4	BNC Connector ²
	2950-0035	4	Nut ²
	5040-3324	4	Insulator ²
	5040-3325	4	Insulator (Hidden) ²
	04263-01221	4	Lug Terminal (Hidden) ²
8	1510-0130	1	Binding Post ²
	2190-0067	1	Washer (Hidden) ²
	2950-0006	1	Nut (Hidden) ²
9	04338-87101	1	Panel Label ²

¹ The assembly consists of the parts designated by 5 through 9.

² This part is included in the Front Panel Assembly, 3.

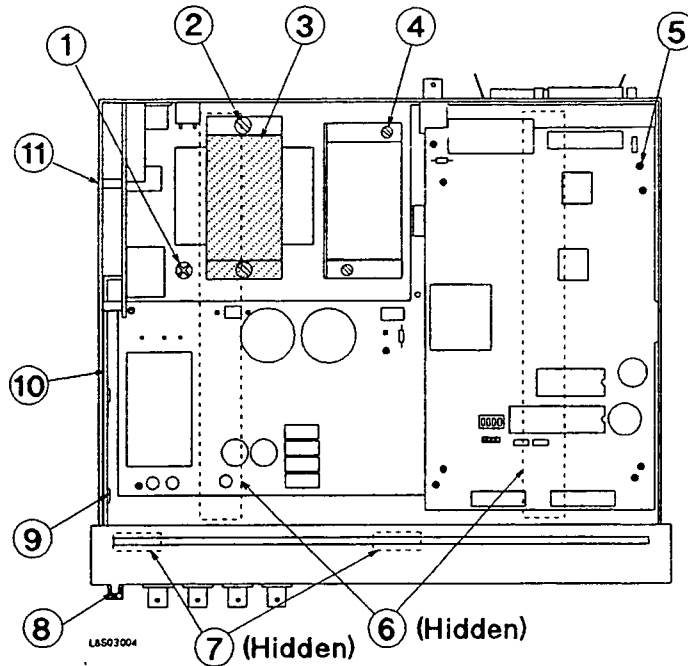
Table 3-5. Replaceable Mechanical Parts List 2



Reference Designation	HP Part Number	Qty.	Description
1	04263-61603	1	HP-IB Connector with flatcable ¹
2	2110-0565	1	Fuse Holder
	2110-0202	1	Fuse 0.25 A, Slow Blow (230V)
	2110-0201		Fuse 0.5 A, Slow Blow (115V)
3	0515-1551	2	Screw M3
4	04338-00101	1	Chassis
5	2190-0054	1	Washer
	2950-0054	1	Nut

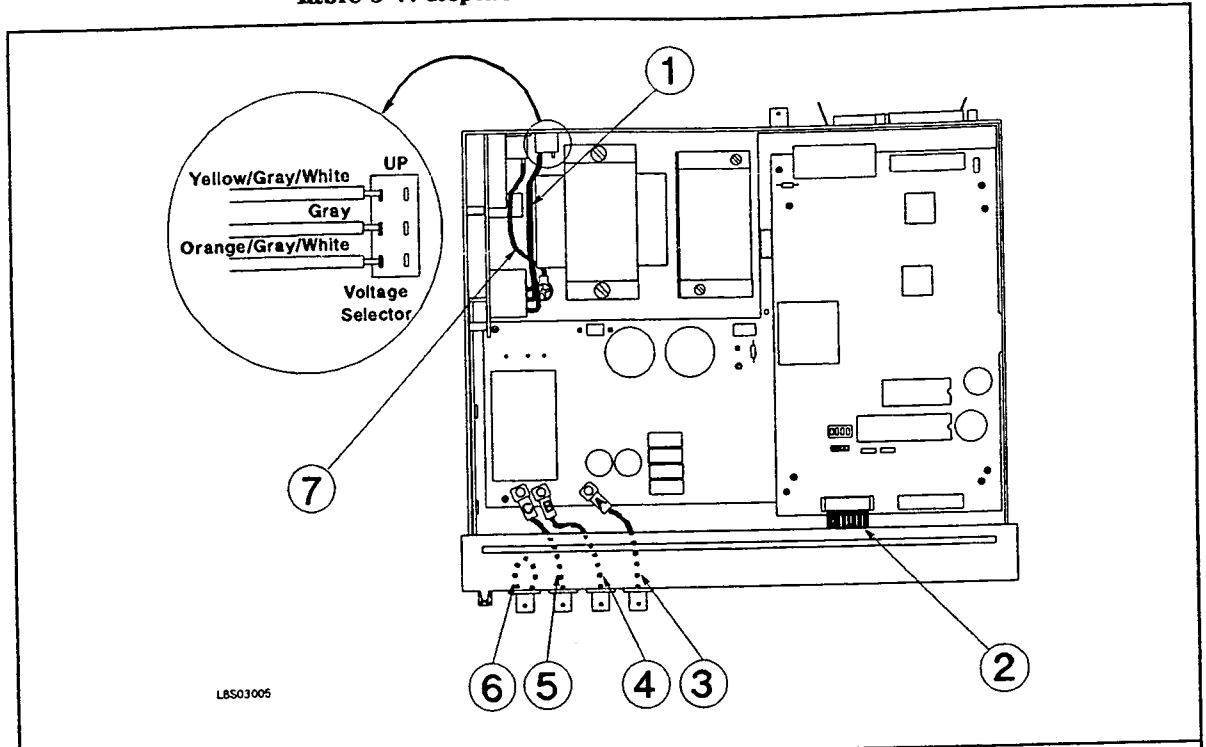
¹ Includes two sets of screw, washer, and nut.

Table 3-6. Replaceable Mechanical Parts List 3



Reference Designation	HP Part Number	Qty.	Description
1	0515-2079	1	Screw M4 (on the Chassis)
2	04263-24001	2	Nut Rod (for Transformer)
	2190-0586	2	Washer Spring M4
3	04263-00607	1	Plate Shield
4	04263-24002	2	Nut Rod (for DC-DC Conv.)
	2190-0584	2	Washer Spring M3
5	0515-1550	7	Screw M3 (for A1 and A2)
	04339-24006	4	Standoff (Hidden, for A1)
6	04263-25001	2	Plate (Hidden, Chassis Reverse side)
	0460-0616	150 mm x 2	Adhesive Tape (for Plate)
7	04263-07001	2	Gasket
	0515-1550	4	Screw M3
8	0370-2862	1	Button, Line Switch
	04339-23001	1	Shaft, Line Switch
	0535-0031	1	Nut (for Shaft)
9	04339-25002	2	Support, Line Switch Plate
	0515-1076	2	Screw M3L4 Flat Head
10	04263-01201	1	Plate, Line Switch
11	0515-0914	5	Screw M3 (for A5)

Table 3-7. Replaceable Mechanical Parts List 4



Reference Designation	HP Part Number	Qty.	Description
1	04263-61608	1	Wire Assy (V Selector)
2	04339-61603	1	Flat Cable Assy (LCD Assy)
3	04263-61602	1	Cable Assembly, "A"- "A"
	04339-25004	1	Core Holder
	0515-1550	1	Screw M3
4	04263-61604	1	Cable Assembly, "B"- "B"
	04339-25004	1	Core Holder
	0515-1550	1	Screw M3
5	04263-61605	1	Cable Assembly, "C"- "C"
	04339-25004	1	Core Holder
	0515-1550	1	Screw M3
6	04338-61603	1	Cable Assembly
7	04263-61611	1	Wire Assy (Binding Post)

Disassembly Procedures

This section provides the procedures to disassemble the HP 4338A's major assemblies. Tools and fasteners required for the replacement are described.

Caution

SUSCEPTIBLE TO DAMAGE FROM ESD.



Perform the following procedures only at a static-safety workstation and wear a grounding strap.

Tools and Fasteners

The HP 4338A mechanical components are secured using metric threaded fasteners. Many fasteners in the HP 4338A may appear to be Phillips type, but they are in fact, Pozidrive type. To avoid damaging them, use only pozidrive screwdrivers to remove or tighten pozidrive type fasteners.

Cover Removal

The following procedure is common for gaining access to any of the assemblies.

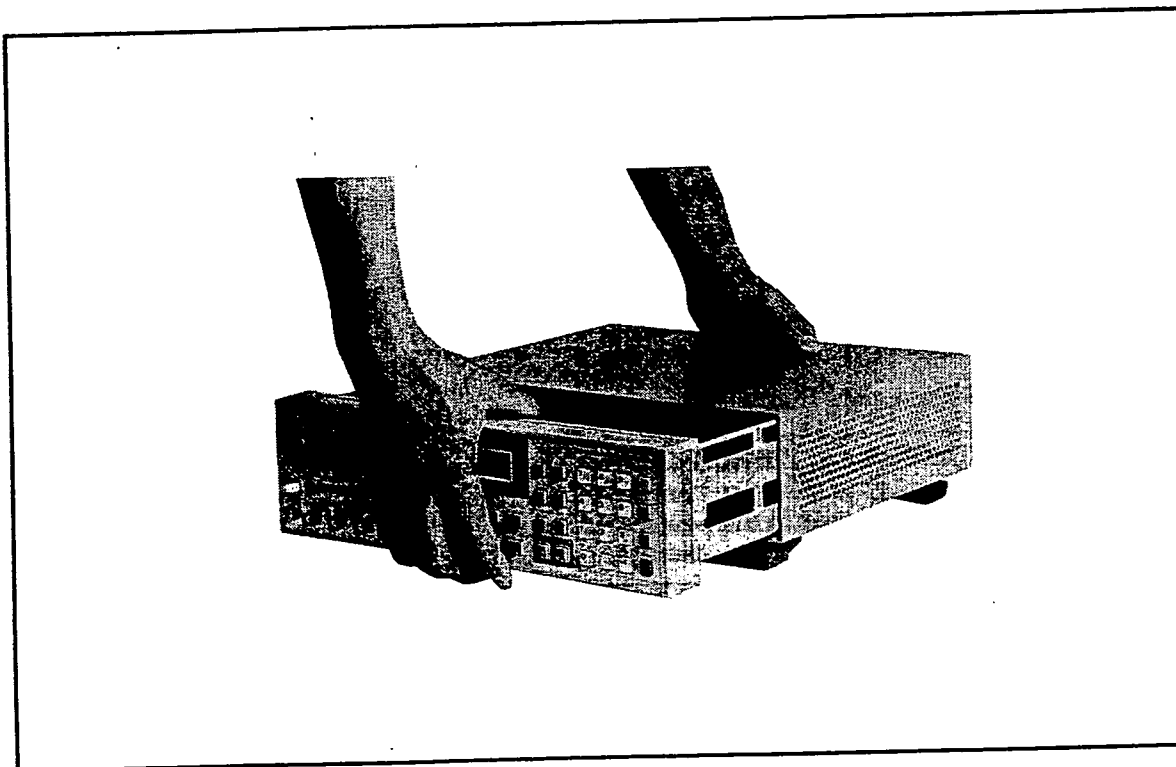


Figure 3-1. Cover Removal

1. Remove the two screws which fasten the cover to the chassis rear panel.
2. Slide the cover toward the rear while holding the front panel bezel as shown in Figure 3-1.

A1 Main Board Removal

Removal Procedure

1. Remove the A2 CPU Board Assembly referring to "A2 CPU Board Assembly Removal".
2. Disconnect the following cable assemblies and wire assemblies from the A1 assembly.
 - a. The three cable assemblies marked "A", "B", and "C" which are connected to the UNKNOWN connectors on the Front Panel
 - b. The wire assembly which is connected to the transformer
 - c. The two wire assemblies which are connected to the DC-DC Converter
3. Remove the nut which fasten the Ext Trigger connector to the rear panel.
4. Remove the four studs, that secure the A1 assembly to the chassis, by rotating them with a flat bladed screwdriver.
5. Remove the three screws that secure the A1 assembly to the chassis.
6. Remove the A1 assembly from the chassis by sliding the assembly toward forward before lifting.

A2 CPU Board Assembly Removal

Removal Procedure

1. Remove the cover referring to "Cover Removal".
2. Disconnect two flatcable assemblies from the front side of the A2 assembly.
3. Disconnect the flatcable assembly, which is connected to the HP-IB connector on the rear panel, from the rear right side of the A2 assembly.
4. Remove the four screws that secure the A2 assembly to the stud.
5. Remove the flat cable assembly which is connected to the A1 main board assembly on the bottom, while sliding the A2 assembly toward front.
6. Remove the A2 assembly from the chassis.

Note



The ROM and EEPROM on the A2 assembly may be transferred to the new assembly to minimize the repair time and parts cost. The shield case should be transferred to the new assembly. Refer to "Replacing the A2 CPU Board Assembly" for more information.

A5 AC Inlet Board Assembly Removal

Removal Procedure

1. Disconnect the cable assembly with the 4 pin connector from the A5 assembly.
2. Disconnect the cable assembly with the 3 pin connector from the A5 assembly.
3. Remove the screw which fixes the green and yellow wire connected to the neutral terminal of the power cable connector to the chassis bottom.
4. Remove the five screws which secure the A5 assembly to the chassis, from the side.
5. Slide the A5 assembly toward the right to remove the switch on the A5 assembly from the line switch plate slot.

6. Remove the A5 assembly from the chassis.

Keyboard Assembly Removal

Removal Procedure

1. Remove the cover referring to "Cover Removal".
2. Disconnect the flatcable assembly from the front right side of the A2 assembly.
3. Remove the two flat head screws that secure the front panel from the bottom.
4. Remove the side trim label from both sides of the front bezel.
5. Remove four screws that secure the front panel bezel to the chassis from both sides.
6. Place the front panel assembly, so that the front panel faces down.
7. Remove the screw that secures the keyboard to the front panel bezel.
8. Remove the keyboard assembly from the front panel bezel.

LCD Assembly Removal

Removal Procedure

1. Remove the cover referring to "Cover Removal".
2. Disconnect the two flatcable assemblies from the front side of the A2 assembly.
3. Remove the two flat head screws that secure the front panel from the bottom.
4. Remove the side trim label from both sides of the front bezel.
5. Remove the four screws that secure the front panel bezel to the chassis from both sides.
6. Place the front panel assembly, so that the front panel faces down.
7. Remove the two screws that secure the LCD to the front panel bezel.
8. Remove the LCD assembly from the front panel bezel.

BNC Connector Removal

Removal Procedure

1. Remove the cover referring to "Cover Removal".
2. Disconnect the two flatcable assemblies from the front side of the A2 assembly.
3. Remove the two flat head screws that secure the front panel from the bottom.
4. Remove the side trim label from both sides of the front bezel.
5. Remove four screws that secure the front panel bezel to the chassis from both sides.
6. Place the front panel assembly, so that the panel faces down.
7. Disconnect the cable assembly which is connected to the BNC being replaced connector from the A1 main board assembly.
8. Remove the core holder which holds the cable assembly which is connected to the BNC connector being replaced, by unscrewing the screw secures the holder from the front side.

9. Disconnect the cable from the BNC connector housing being replaced, by unscrewing the nut which fastens, from the back of the front panel, the cable to the BNC connector.
10. Unscrew the nut which connects the BNC connector housing to the sub panel.
11. Remove the BNC connector.

Troubleshooting

Introduction

This chapter provides assembly level troubleshooting information for the HP 4338A. The information includes theory of operation, and troubleshooting.

Safety Considerations

This chapter contains *WARNINGS* and *CAUTIONS* that must be followed for your protection and to avoid damaging the equipment.

Warning



The servicing procedures described herein are performed when power is supplied to the instrument and its protective covers are removed. This type of servicing must be performed only by service trained personnel who are aware of the hazards involved (for example, fire, and electrical shock). When servicing can be performed without power applied to the instrument, remove power from the instrument. Before any repair is completed, ensure that all safety features are intact and functioning, and that all necessary parts are properly connected to the protective grounding system.

Required Equipment

Table 1-1 lists the equipment required for troubleshooting.

After Service Product Safety Checks

Warning



Whenever it appears likely that protective safety provisions have been impaired, the apparatus shall be marked as inoperative and should be secured against any unintended operation. The protection provisions will have likely been compromised if, for example:

- The instrument shows visible signs of damage.
 - The instrument fails to perform the intended measurement.
 - The unit has undergone prolonged storage under unfavorable conditions.
 - The instrument was severely stressed in transport.
-

Perform the following five safety checks to verify the safety condition of the HP 4338A (these checks may also be used for safety checks after troubleshooting and repair).

1. Visually inspect the interior of the instrument for any signs of abnormal internally generated heat, such as discolored printed circuit boards and components, damaged insulation, or evidence of arcing. Determine the cause, and repair.
2. Use an ohmmeter which can accurately measure 0.1Ω to check the resistance from the instrument enclosure to the power cord's ground pin. The resistance must be less than 0.1Ω . Flex the power cord while making this measurement to determine if any intermittent discontinuities exist.
3. Unplug the HP 4338A's power plug from the power source. Set the line switch to ON. Tie the line and neutral pins of the power connector together and check the resistance between them and enclosure. The minimum acceptable resistance is $5 M\Omega$. Find and replace any component which causes the instrument to fail this test.
4. Verify that the correct fuse is installed.
5. Verify that the grounding wire (green and yellow) is secured to the chassis by a screw and washer.

Theory of Operation

This section describes the general overall operation of the HP 4338A and the operation of each assembly.

Overall Measurement Theory

The HP 4338A measures the resistance of the Device Under Test (DUT) by measuring vector voltage to current ratio. A vector is a value which consists of a magnitude and a phase. The DUT resistance is the real part of vector impedance which is determined by the vector ratio between the voltage across the DUT and the current flowing through the DUT.

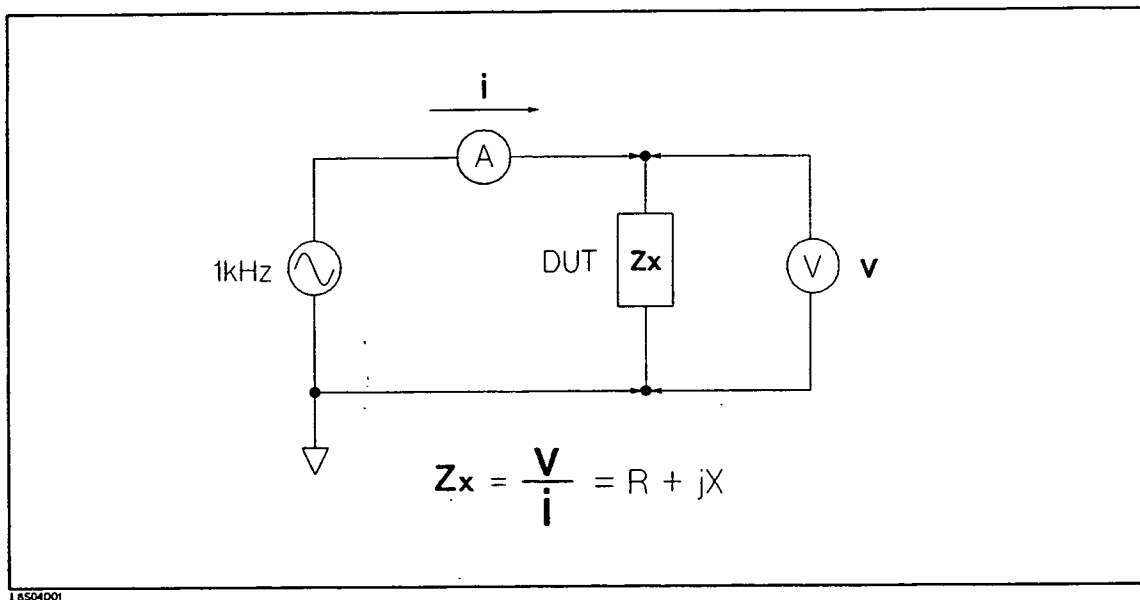


Figure 4-1. Voltage Current Ratio Measurement Principle

In Figure 4-1, a DUT is connected in series with a signal source, voltmeter V, and ammeter A. If the ammeter measures i amperes when the source voltage is v volts, the DUT's impedance Z_x is expressed by:

$$Z_x = \frac{v}{i}$$

The DUT resistance, R , is the real part of Z_x expressed in the complex real-imaginary number format:

$$Z_x = R + jX$$

where, j is the imaginary unit and X is the reactance.

Note For accurate and stable low-resistance-measurement, the HP 4338A employs an ac voltage source, rather than a dc voltage source.



The HP 4338A essentially consists of a signal source, a vector voltmeter, and a vector current meter.

Overall Block Diagram

Figure 4-2 shows the overall block diagram of the HP 4338A.

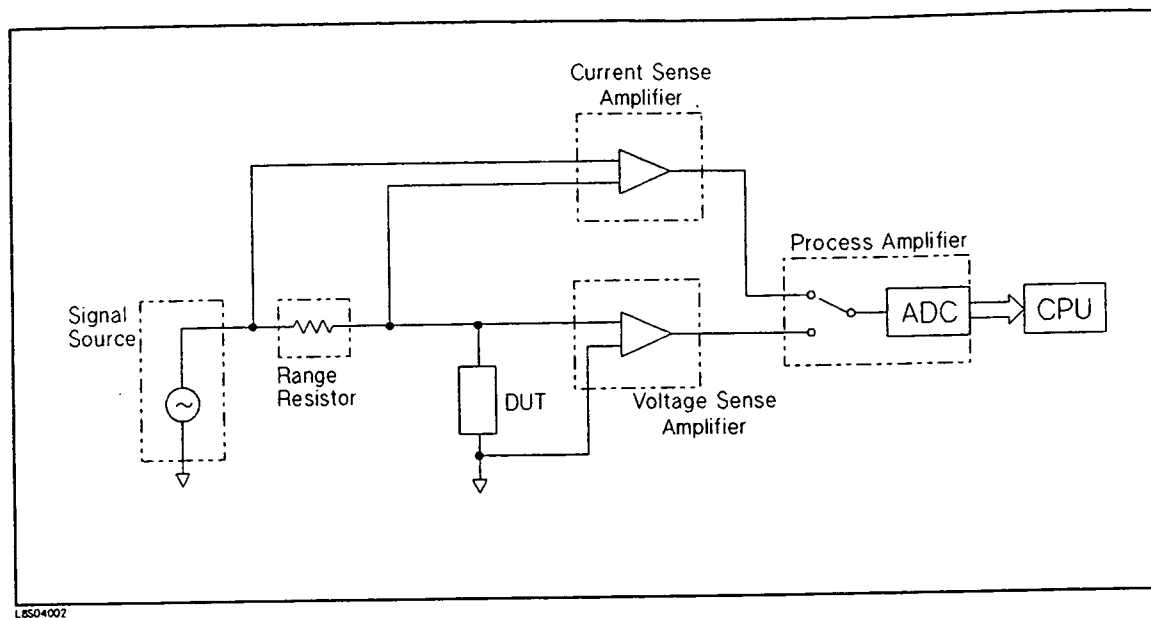


Figure 4-2. HP 4338A Overall Block Diagram

The signal source section applies measurement signal to the range resistor and DUT in series. The current sense amplifier measures the voltage across the range resistor, which is proportional to the current flowing through the DUT. The voltage sense amplifier measures the voltage across the DUT. The process amplifier switches these two voltages to be converted into digital data. The CPU calculates DUT resistance, derived from impedance, from the vector ratio of these two voltages, and displays the result on the LCD.

Analog Section

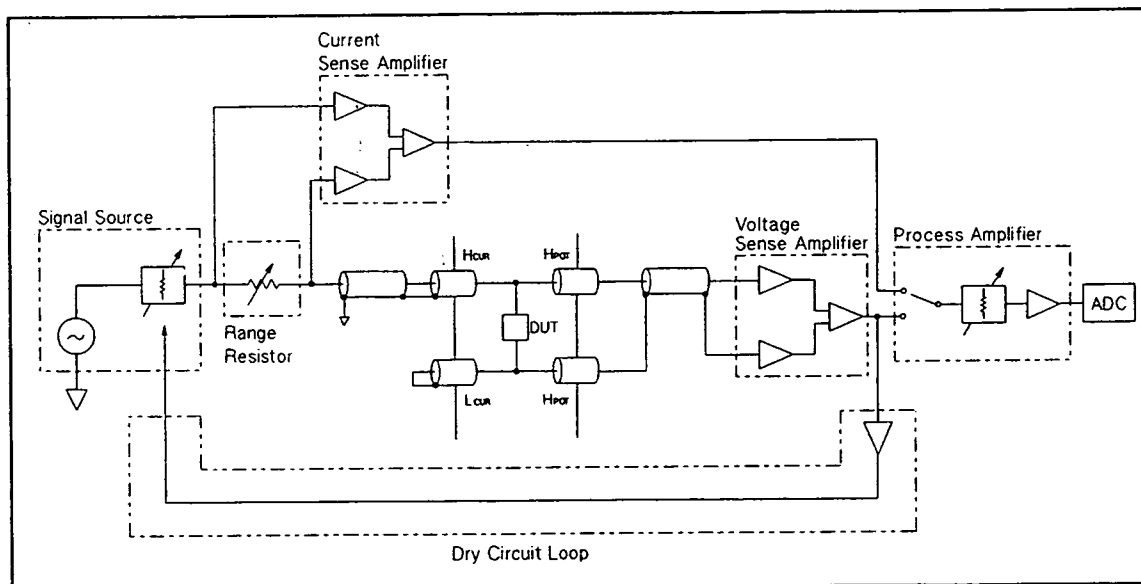
Figure 4-3 shows the analog section block diagram. The HP 4338A analog section can be divided in six sections, the signal source, range resistor, current sense amplifier, voltage sense amplifier, process amplifier, and dry circuit loop.

The signal source generates a 1 kHz signal of which level is set from the keyboard or by HP-IB commands. The signal is applied to the range resistor and to the DUT via the High-Current (H_{CUR}) connector. The current flowing through the DUT flows into the ground via the Low-Current (L_{CUR}) connector and outer shield of the H_{CUR} connector.

The vector current flowing through the DUT is measured by the current sense amplifier in terms of the vector voltage across the range resistor. The vector voltage across the DUT is measured by the voltage sense amplifier.

The process amplifier selects one of the above two vector voltages. The selected voltage is processed according to measurement conditions, such as signal source level and measurement range, and is converted into digital data by the Analog-to-Digital Converter (ADC).

The dry circuit loop attains the dry circuit mode by limiting the signal source output, so that the voltage across the DUT is not more than 20 mV.



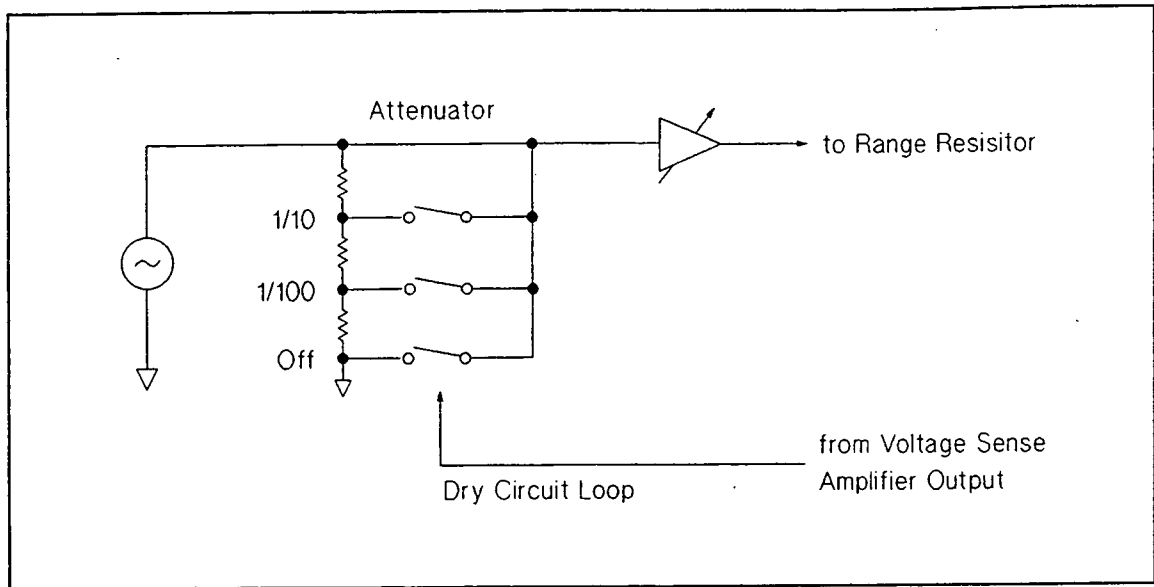
LE504005

Figure 4-3. Analog Section Block Diagram

Signal Source Section

The signal source generates a 1 kHz signal of which output current is selected from among 1 μA , 10 μA , 100 μA , 1 mA, and 10 mA (in rms).

The output current is determined by the attenuator and the following amplifier. The dry circuit loop controls the attenuation, so that the voltage across the DUT is not more than 20 mV.



L6504013

Figure 4-4. Signal Source Section Block Diagram

Range Resistor and Current Sense Amplifier Sections

These sections measure current flowing through the DUT. Figure 4-5 shows this section's block diagram.

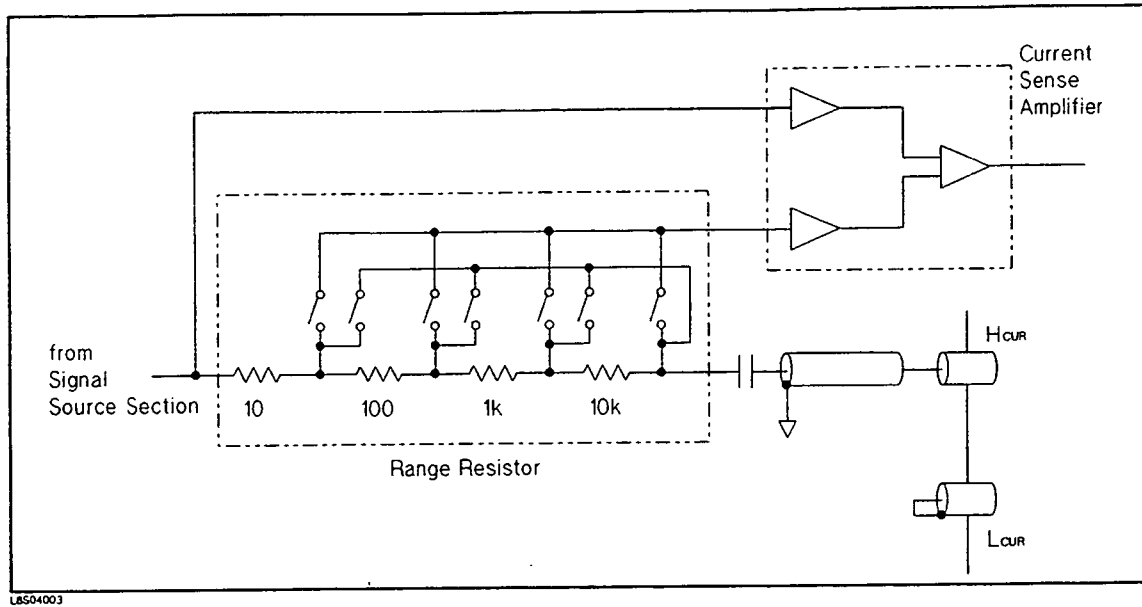


Figure 4-5. Range Resistor and Current Sense Amp. Block Diagram

The range resistor converts the current to a proportional voltage which is measured. The range resistor consists of four resistors, which are switched according to the signal source output level.

The current sense amplifier, which is a differential amplifier, amplifies the voltage across the range resistor.

Voltage Sense Amplifier and Process Amplifier Sections

These sections measure the voltage across the DUT and processes the outputs from the voltage sense amplifier and the current sense amplifier. Figure 4-6 shows this section's block diagram.

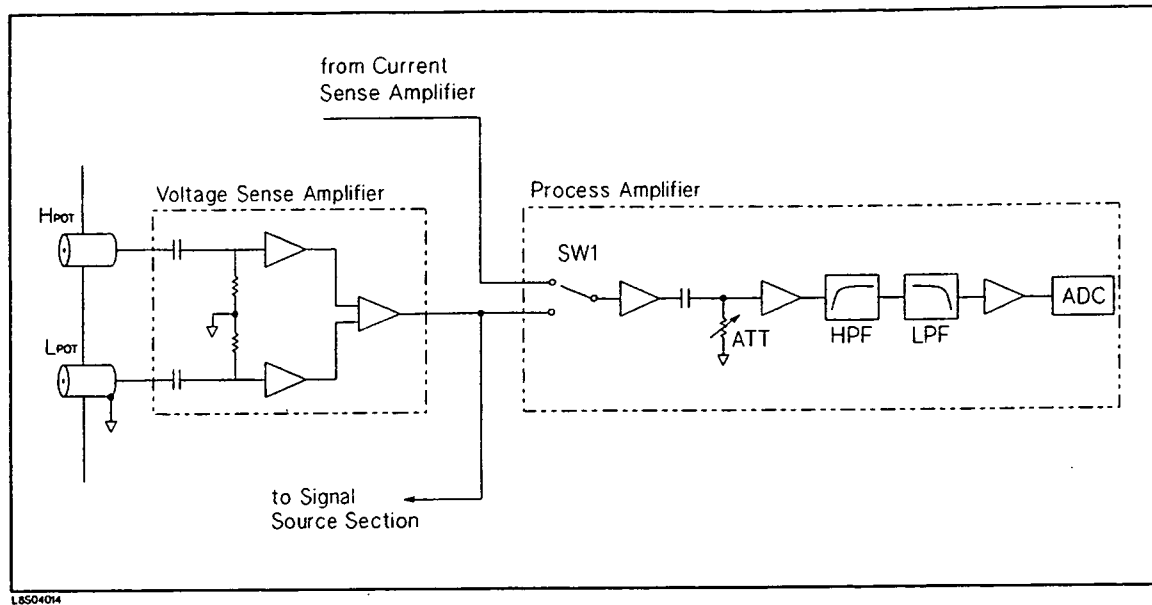


Figure 4-6. Voltage Sense Amp. and Process Amp. Block Diagram

The voltage sense amplifier, which is a differential amplifier, measures the vector voltage across the DUT via the High-Potential (HPOT) and Low-Potential (LPOT) connectors.

The output of the voltage sense amplifier is fed back to the signal source section for dry circuit measurement.

SW1 in the process amplifier selects the inputs from the voltage sense amplifier and current sense amplifier to be processed. The selected signal is attenuated according to the range resistor setting. The filter passes the fundamental signal (1 kHz) in order to purify the signal for accurate and stable measurement. The filtered signal is converted into digital data to be processed by the digital section.

Digital Section

Figure 4-7 shows the Digital Section block diagram.

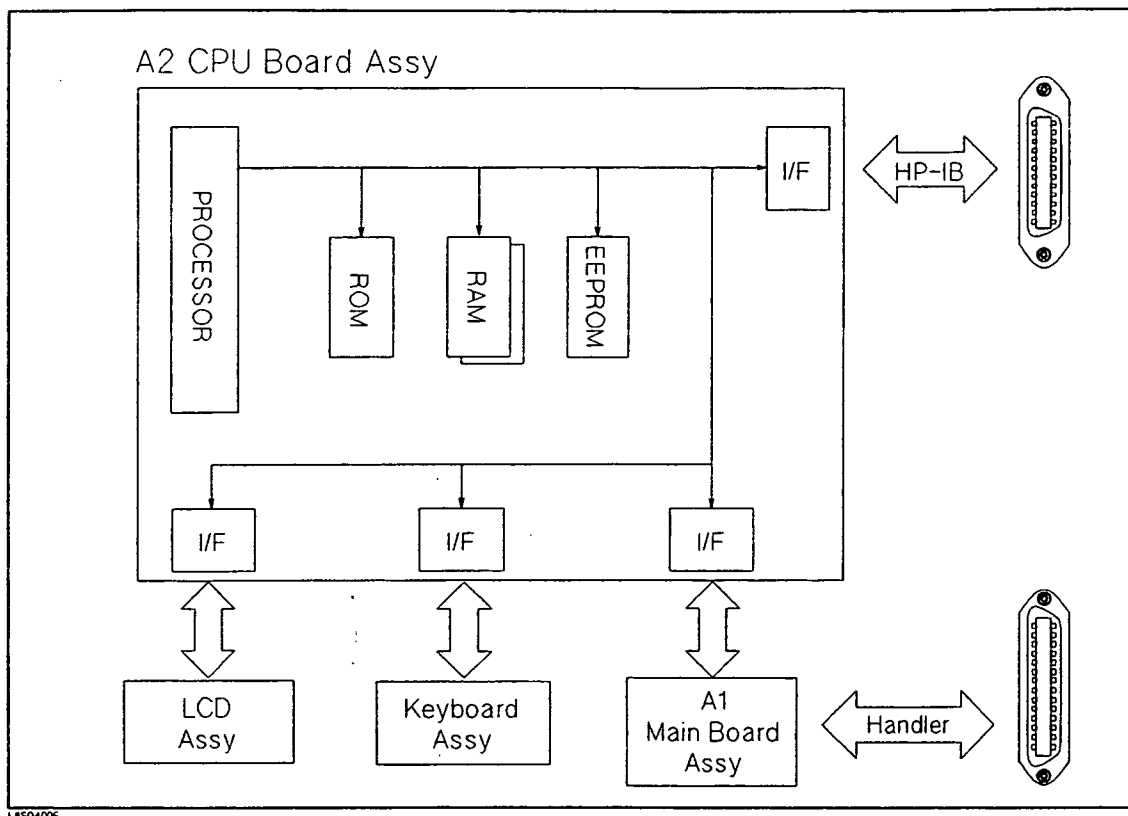


Figure 4-7. Digital Section Block Diagram

The digital section consists of the A2 CPU Board Assembly and other peripheral assemblies such as the keyboard and LCD. The section communicates with the A1 Main Board Assembly in order to control the latches, switches, and other components on the A1 assembly and receive the measurement data. The HP-IB interface on the A2 Assembly allows the HP 4338A communicate with a controller. A handler interface on the A1 Assembly allows the HP 4338A communicate with an external handler.

The A2 CPU Board Assembly includes a processor, ROM, EEPROM, jumpers, switches, and LEDs.

ROM (A2U11) stores the firmware which controls all the HP 4338A's operation and functions. The ROM is mounted in a socket for easy replacement.

The EEPROM (A2U10) stores the unit unique data, such as the adjustment data and the operator unique data, such as the operator saved measurement setup condition. The EEPROM will not lose its data when power is turned off. The EEPROM is mounted in a socket for easy replacement.

Jumpers and switches set the HP 4338A's conditions. Refer to Appendix B for more information.

Power Supply Section

Figure 4-8 shows the power supply section block diagram.

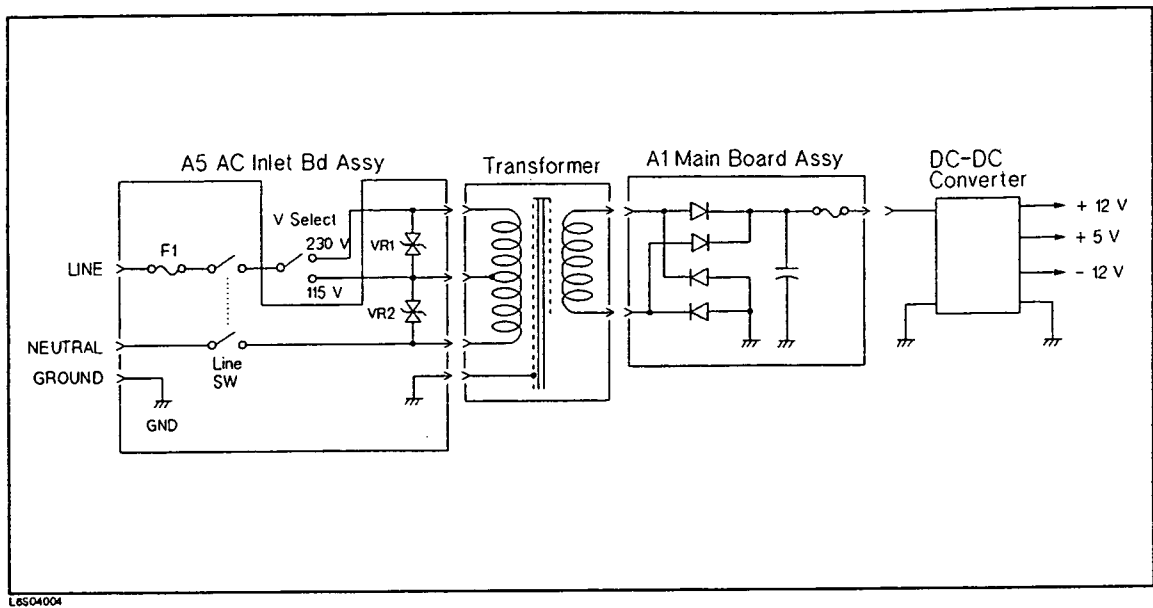


Figure 4-8. Power Supply Section Block Diagram

The ac line power is connected to the A5 AC Inlet Board Assembly, which consists of the fuse, line switch, and varistors. The voltage selection switch on the rear panel selects the ac line voltage from 230V or 115V. According to the selection, the ac line power is connected to the corresponding primary tap of the transformer. Varistor, VR1 protects the circuit from surge voltage on the line power. VR2 blows fuse F1 if the HP 4338A is turned on with the wrong line voltage setting selection, for example, 115V selection when using a 230V line.

The transformer secondary voltage is approximately 14 V. The ac voltage is rectified and filtered by circuitry on the A1 Main Board Assembly, and produces approximately 14V dc. The dc voltage is applied to the DC-DC Converter to produce regulated +12V, +5V, and -12V dc. The dc voltages are supplied to all assemblies, either directly or indirectly via the A1 assembly.

Troubleshooting

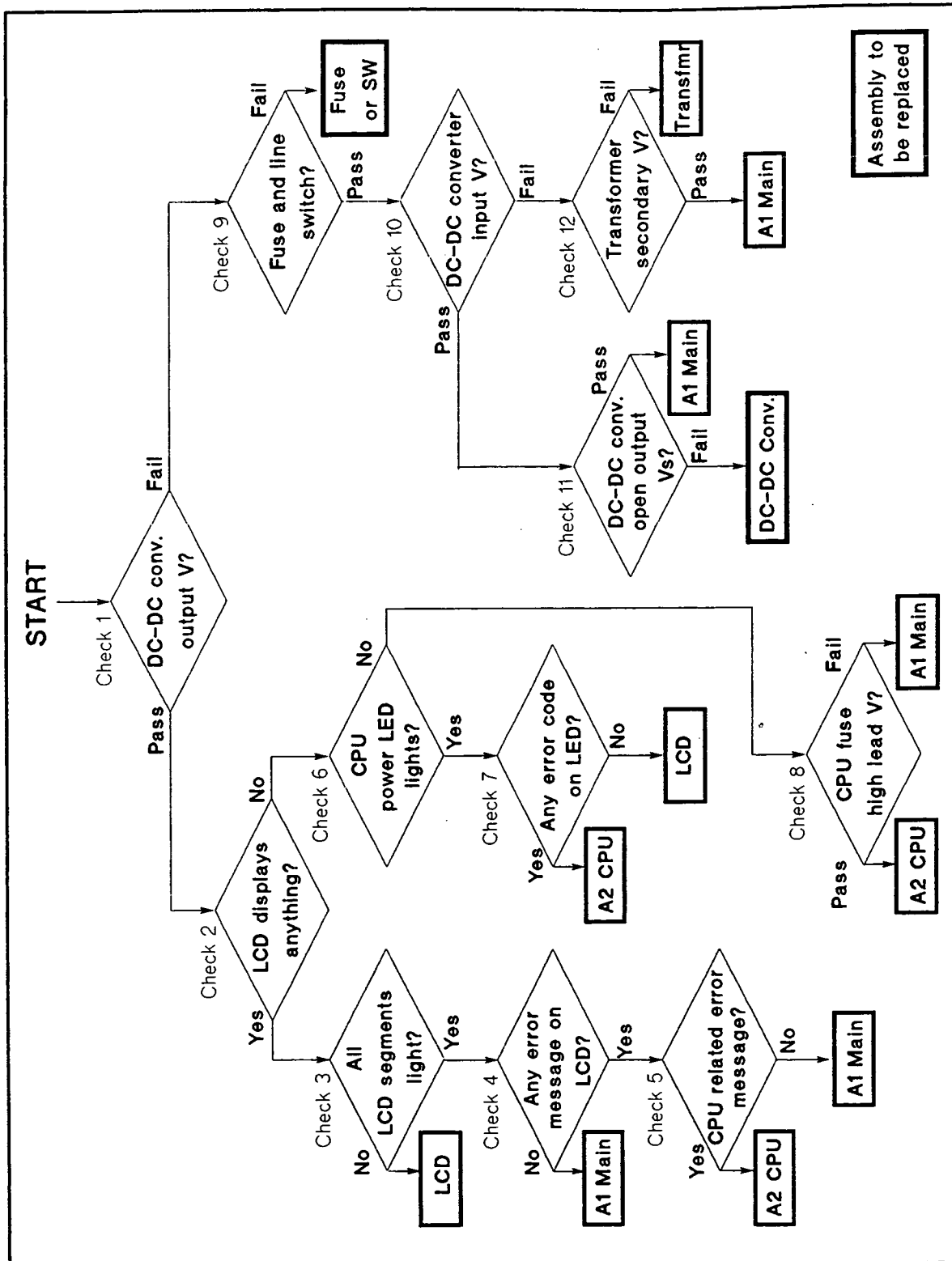
Figure 4-9 shows the overall troubleshooting flowchart to find the defect assembly. Follow the flowchart when troubleshooting. Refer to the "Check Procedure References" for the detailed procedure to check each item.

Refer to Chapter 3 for assembly replacement.

Note



Because of each assembly's high SMD (surface mount device) ratio, the repair should be done by assembly replacement. The troubleshooting procedure, therefore, only isolates the defective assembly.



L8S04007

Figure 4-9. Troubleshooting Flow

Check Procedure References

Refer to the corresponding check procedure. Each check procedure is numbered the same as in Figure 4-9 for quick reference.

Check 1, DC-DC Converter Output Voltage

1. Remove the cover referring to "Cover Removal" in Chapter 3.
2. Turn on the HP 4338A.
3. Using a multimeter, check to see if the voltages between the test pads and the ground (TP500), shown in Table 4-1, on A1 Main Board Assembly are in the ranges shown.
4. If passed, proceed to "Check 2, LCD Displays Anything?", otherwise proceed to "Check 9, Fuse and Line Switch".

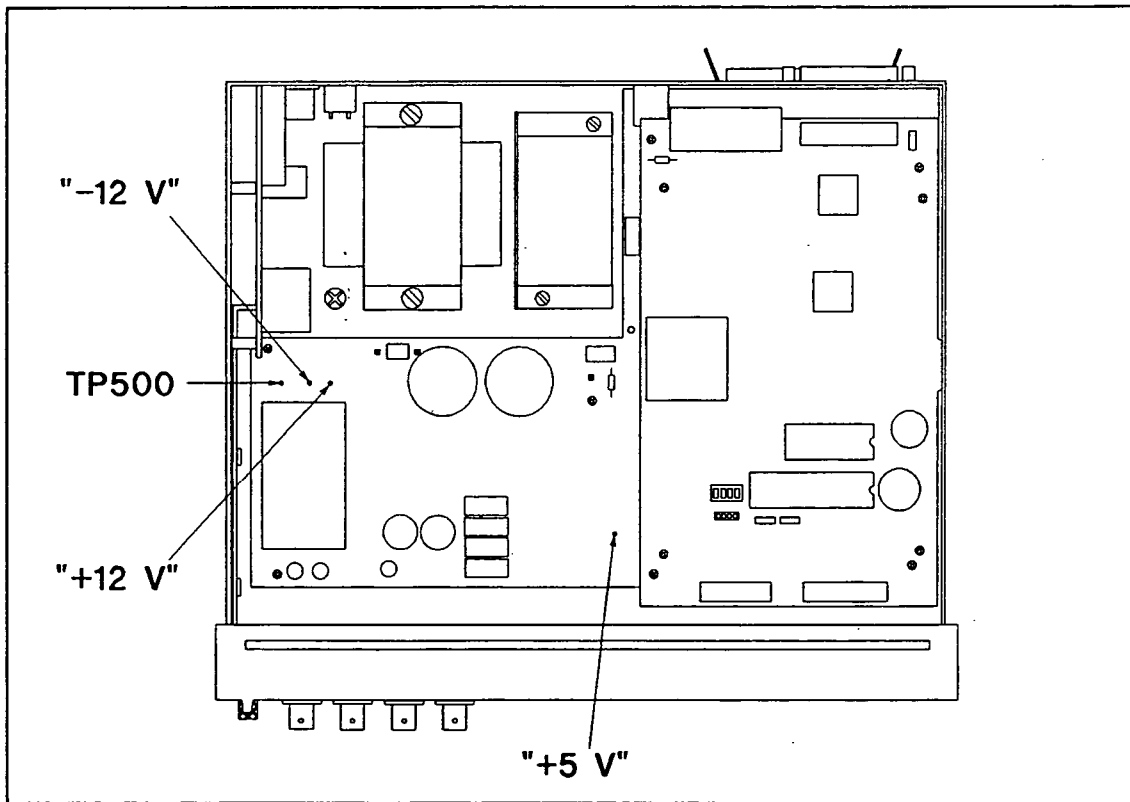


Figure 4-10. DC-DC Converter Output Voltage Check

Table 4-1. DC-DC Converter Output Voltage (Connected)

Test Pad (+)	Test Pin (-)	Range
" +5 V"	500	5.1±0.2 V
" +12 V"	500	12±0.6 V
" -12 V"	500	-12±0.6 V

Check 2, LCD Displays Anything?

1. Turn off the HP 4338A.
2. Turn on the HP 4338A while watching the LCD.
3. Check for a beep sound for a moment and if you see anything is displayed on the LCD.
4. If beep sounds and LCD displays something, proceed to "Check 3, All LCD Segments Light?", otherwise proceed to "Check 6, CPU Power LED Lights?".

Check 3, All LCD Segments Light?

1. Turn off the HP 4338A.
2. Turn on the HP 4338A while watching the LCD.
3. Check if you see all the LCD segments light for a while. If you didn't have enough time to look at all the segments, repeat from the procedure 1 until you could.
4. If all the segments light, proceed to "Check 4, Any Error Message on LCD?", otherwise replace the LCD Assembly.

Check 4, Any Error Message on LCD?

1. Turn off the HP 4338A.
2. Turn on the HP 4338A while watching the LCD.
3. Check if the LCD displays any error message.
4. If an error has NOT occurred, replace the A1 Main Board Assembly, otherwise proceed to "Check 5, CPU Related Error Message?".

Check 5, CPU Related Error Message?

1. If the error message is one of the following replace the A2 CPU Board Assembly, otherwise replace the A1 Main Board Assembly.
 - a. ROM TEST FAILED
 - b. RAM TEST FAILED
 - c. EEPROM R/W FAILED

Note



When replacing the A2 CPU Board Assembly, refer to "Replacing the A2 CPU Board Assembly" in Chapter 3 for handling the ROM and EEPROM on the A2 Assembly.

Check 6, CPU Power LED Lights?

1. Turn on the HP 4338A.
2. Check if the LED "+5 V" of DS1 on the A2 CPU Board Assembly lights. Refer to Figure 4-11 for DS1 location.
3. If the LED lights, proceed to "Check 7, Any Error Code on LED?", otherwise proceed to "Check 8, CPU Fuse High Lead Voltage".

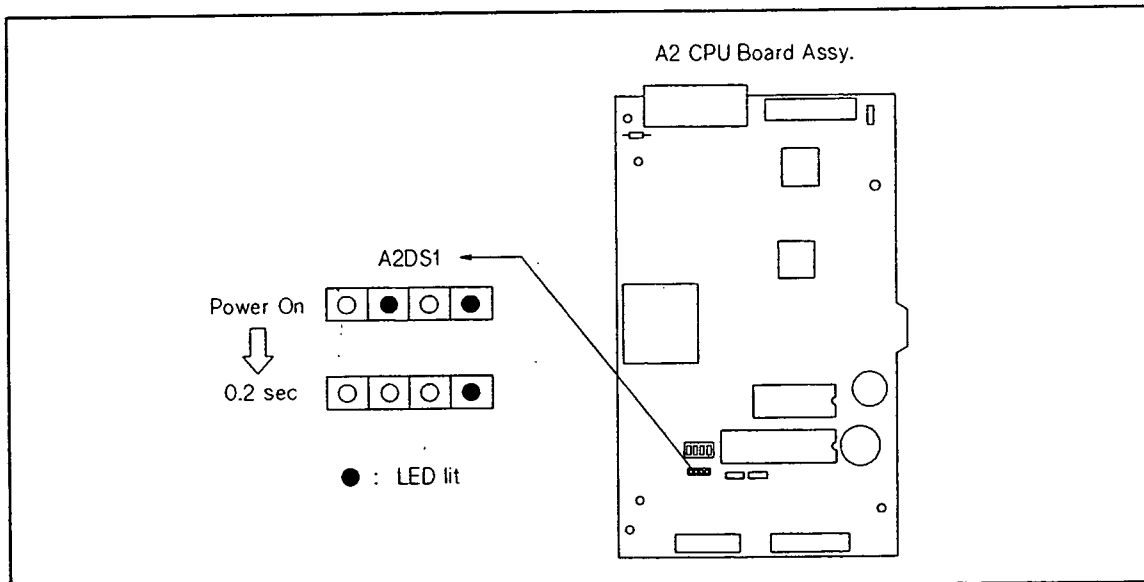
Check 7, Any Error Code on LED?

1. Turn off the HP 4338A.
2. Turn on the HP 4338A while watching LEDs on the A2 CPU Board Assembly.
3. Check if the LEDs light in the sequence shown in Figure 4-11.
4. If LEDs light as the sequence, replace the LCD Assembly, otherwise (possibly, "HALT" doesn't turn off or "BERR" lights) replace the A2 CPU Board Assembly.

Note



When replacing the A2 CPU Board Assembly, refer to "Replacing the A2 CPU Board Assembly" in Chapter 3 for handling the ROM and EEPROM on the A2 Assembly.



16504009

Figure 4-11. CPU Board Assembly LED Light Sequence

Check 8, CPU Fuse High Lead Voltage

1. Turn on the HP 4338A.
2. Using a multimeter, check if the dc voltage at the high lead of the fuse F1 on the CPU Board shown in Figure 4-12 is $+5\pm 0.2$ V.
3. If the voltage is in the range, replace the A2 CPU Board Assembly, otherwise replace the A1 Main Board Assembly.

Note



If the multimeter reading is correct, fuse F1 on the A2 CPU Board Assembly is most suspicious. Replacing only the fuse may fix the problem.

Note



When replacing the A2 CPU Board Assembly, refer to "Replacing the A2 CPU Board Assembly" in Chapter 3 for handling the ROM and EEPROM on the A2 Assembly.

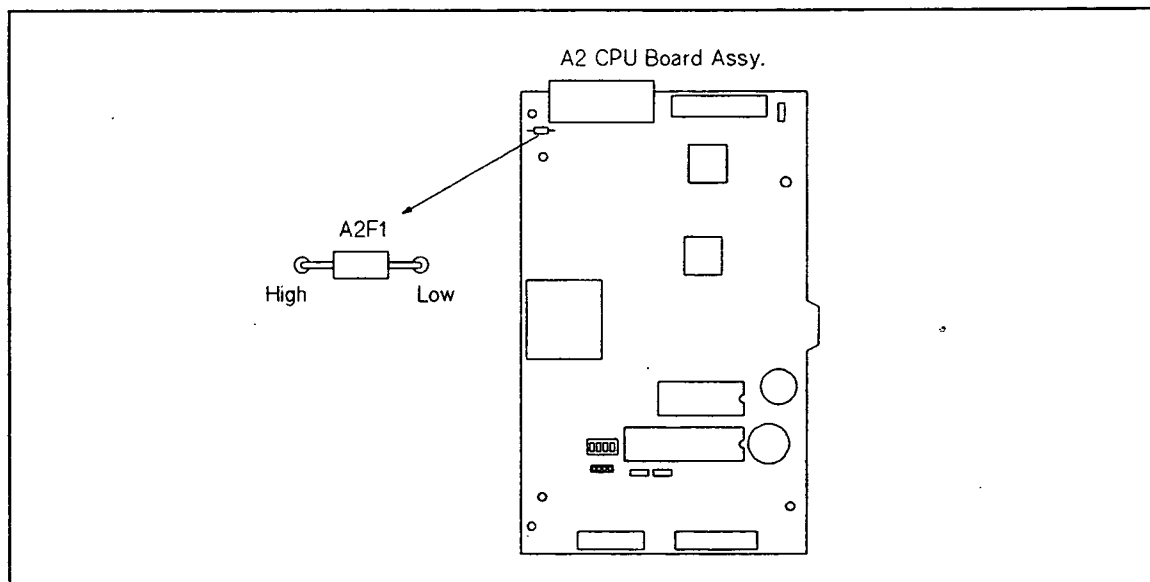


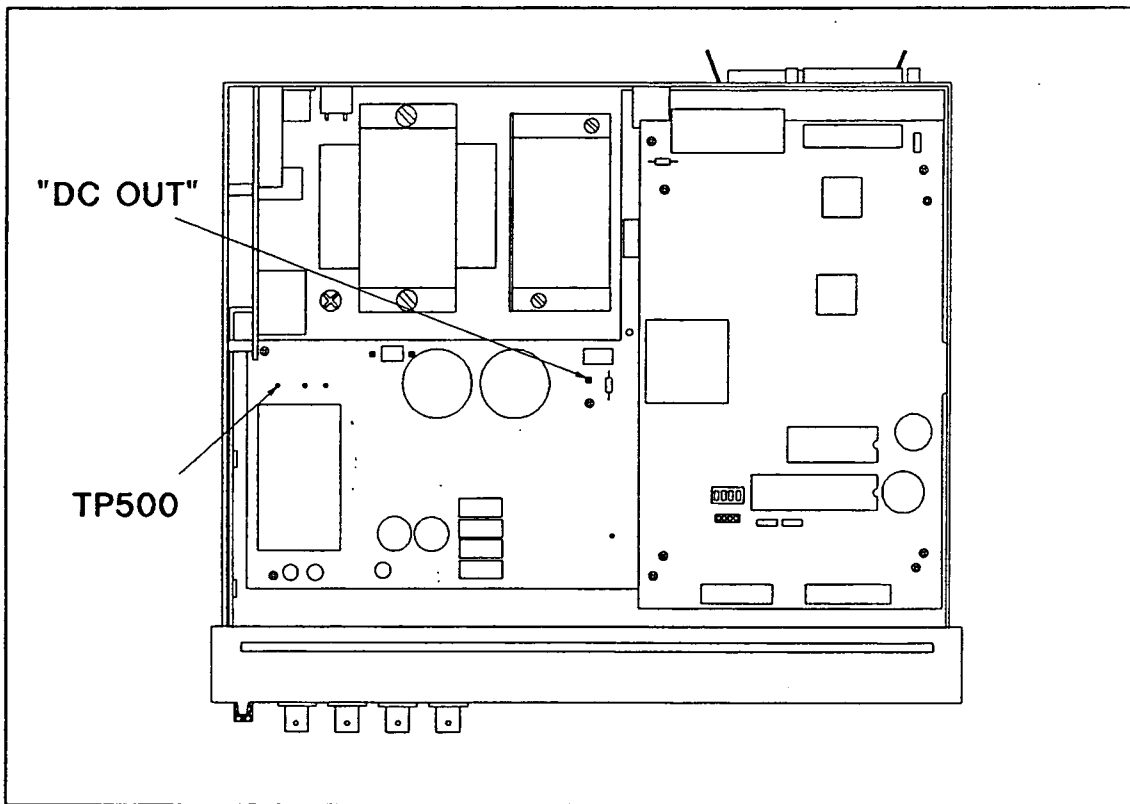
Figure 4-12. Location of High Lead of A2F1 Fuse

Check 9, Fuse and Line Switch

1. Check that the fuse on the HP 4338A rear panel is not blown.
2. Check that the line switch on the A5 AC Inlet Board Assembly is not defective.
3. If passed, proceed to "Check 10, DC-DC Converter Input Voltage", otherwise replace the defective line switch or blown fuse.

Check 10, DC-DC Converter Input Voltage

1. Turn on the HP 4338A.
2. Using a multimeter, check if the voltage between "DC OUT" test pad and TP500 (DC-DC Converter input voltage) is between 12 V and 15 Vdc. Refer to Figure 4-13 for test pad and pin locations.
3. If the voltage is in range, proceed to the "Check 11, DC-DC Converter Open Output Voltages", otherwise proceed to the "Check 12, Transformer Secondary Voltage".

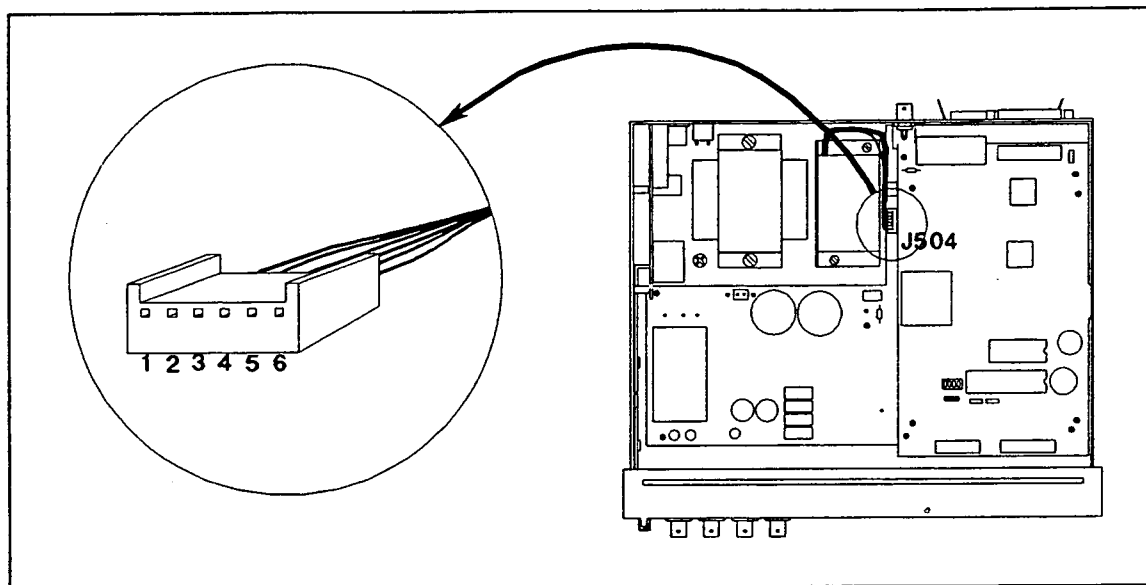


L6504012

Figure 4-13. Test Pin Locations

Check 11, DC-DC Converter Open Output Voltages

1. Turn off the HP 4338A.
2. Disconnect the DC-DC Converter Output Cable shown in Figure 4-14 from connector "J504" on the A1 Main Board Assembly.
3. Turn the HP 4338A on.
4. Using the multimeter, check if the DC-DC Converter open output voltages on the output connector pins shown in Figure 4-14 are in the ranges shown in Table 4-2.
5. If passed, replace the A1 Main Board Assembly, otherwise replace the DC-DC Converter Assembly.



L6504011

Figure 4-14. DC-DC Converter Output Connector

Table 4-2. DC-DC Converter Open Output Voltages

Pin (+)	Pin (-)	Voltage Range
1	2	5.1 ± 0.1 V
4	3	12 ± 0.6 V
5	3	-12 ± 0.6 V

Check 12, Transformer Secondary Voltage

1. Turn off the HP 4338A.
2. Disconnect the transformer secondary connector from connector "J501" on the A1 Main Board Assembly. Refer to Figure 4-15 for the connector location.
3. Turn the HP 4338A on.
4. Using a multimeter, check if the transformer secondary voltage is between +13 V and +17Vac.
5. If passed, replace the A1 Main Board, otherwise replace the transformer.

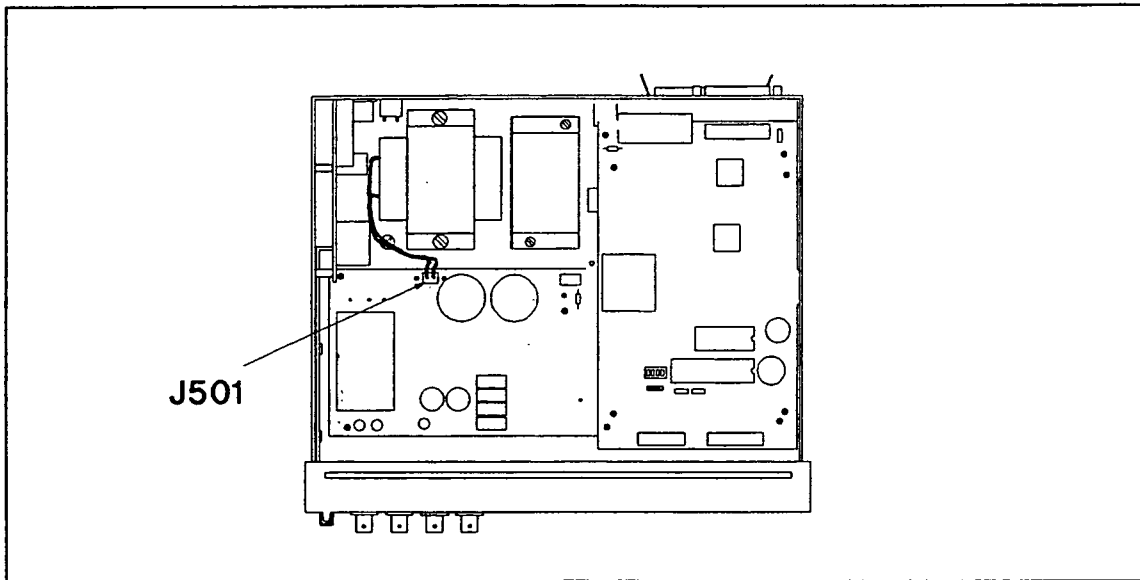


Figure 4-15. Transformer Secondary Voltage Check

Manual Changes

Introduction

This appendix contains the information required to adapt this manual to earlier versions or configurations of the HP 4338A than the current printing date of this manual. The information in this manual applies directly to HP 4338A Milliohmmeter whose serial number prefix is listed on the title page of this manual.

Manual Changes

To adapt this manual to your HP 4338A, refer to Table A-1, and make all of the manual changes listed opposite your instrument's serial number.

Instruments manufactured after the printing of this manual may be different from those documented in this manual. Later instrument versions will be documented in a manual changes supplement that will accompany the manual shipped with that instrument. If your instrument serial number is not listed on the title page of this manual or in Table A-1, it may be documented in a *yellow MANUAL CHANGES* supplement.

For additional information on serial number coverage, refer to HP 4338A Operation manual.

Table A-1. Manual Changes by Serial Number

Serial Prefix or Number	Make Manual Changes
	There are no earlier configurations than the printing date of this manual.

Default Jumper and Switch Settings

Introduction

This appendix describes the setting of the jumpers and switches on the A2 CPU Board Assembly. Use this information when the A2 Assembly is replaced.

Jumper and Switch Settings

Figure B-1 shows the default Jumper and Switch settings. When the A2 CPU Board Assembly is replaced, set the jumpers and switches to the default sides as shown in the figure.

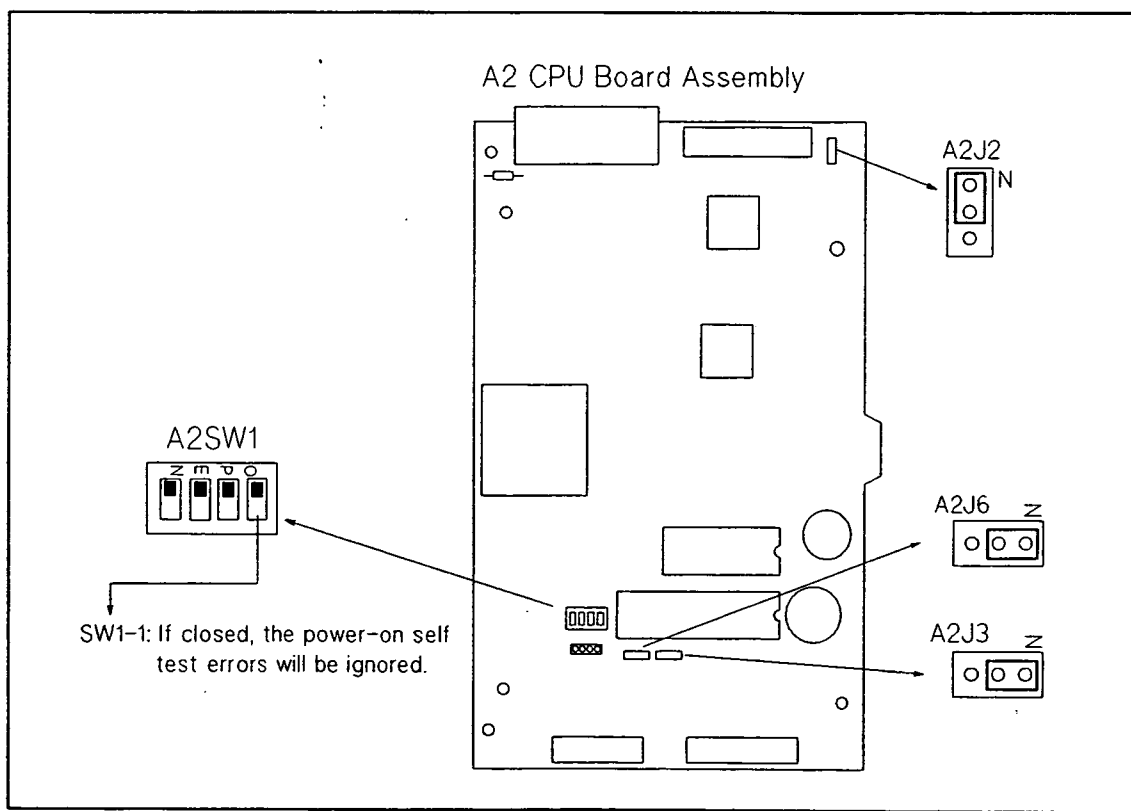


Figure B-1. Jumper and Switch Settings

Index

A

A1 Main Board Removal, 3-10
A2 CPU Board Assembly Removal, 3-10
A5 AC Inlet Board Assembly Removal, 3-10
Adjustable Components, 2-2
Adjustment, 2-1
Adjustment Procedure References, 2-5
Adjustment Program, 2-3
Adjustment Tools, 2-2
After Service Product Safety Checks, 4-2
Analog Section, 4-5
Assembly Replacement, 3-1
Assistance, ii

B

BNC Connector Removal, 3-11

C

Certification, ii
Check Procedure References, 4-13
Cover Removal, 3-9

D

Digital Section, 4-9
Disassembly Procedures, 3-9
Documentation Map, vii

E

EEPROM Write Protect Switch, 2-2
Exclusive Remedies, ii

F

Factory-Selected Components, 2-2

G

General Information, 1-1

H

How To Use This Manual, vii

I

Instruments Covered by This Manual, 1-1

K

Keyboard Assembly Removal, 3-11

L

LCD Assembly Removal, 3-11
Limitation of Warranty, ii

M

Manual Changes, A-1

O

Ordering Information, 3-1
Overall Block Diagram, 4-4
Overall Measurement Theory, 4-3

P

Power Supply Section, 4-10
Program Installation, 2-4

R

Range Resistor Adjustment, 2-5
Range Resistor and Current Sense Amplifier
Sections, 4-7
Related Adjustment, 2-2
Replaceable Assembly List, 3-2
Replaceable Mechanical Parts List, 3-5
Replacing A2 CPU Board Assembly, 3-2
Required Equipment, 1-2
Restored Exchange Assemblies, 3-1

S

Safety Summary, v
Safety Symbols, vi
Signal Source Section, 4-6

T

Theory of Operation, 4-3
Tools and Fasteners, 3-9
Troubleshooting, 4-11

V

Voltage Sense Amplifier and Process Amplifier
Sections, 4-8

W

Warranty, ii