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HP 75000 SERIES C

6 1/2-Digit Multimeter
HP E1410A

Service Manual

Serial Numbers

Attached to the backplane connector of the instrument is a serial number plate. The serial number is in the form: 0000A00000. The first four digits and the letter are the serial number prefix. The last five digits are the suffix. The prefix is the same for identical instruments; it changes only when a configuration change is made to the instrument. The suffix, however, is assigned sequentially and is different for each instrument. This manual applies directly to instruments with serial numbers prefixed with 3002A.

HEWLETT PACKARD

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Zusatzinformation für Mess- und Testgeräte:
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This is to certify that the equipment HP E1410A meets the radio frequency interference requirements of Directive FTZ 1046/84. The German Bundespost has been notified that this equipment was put into circulation and has been granted the right to check the product type for compliance with these requirements.

Additional Information for Test and Measurement Equipment:
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Printing History

The Printing History shown below lists all Editions and Updates of this manual and the printing date(s). The first printing of the manual is Edition 1. The Edition number increments by 1 whenever the manual is revised. Updates, which are issued between Editions, contain replacement pages to correct the current Edition of the manual. Updates are numbered sequentially starting with Update 1. When a new Edition is created, it contains all the Update information for the previous Edition. Each new Edition or Update also includes a revised copy of this printing history page. Many product updates or revisions do not require manual changes and, conversely, manual corrections may be done without accompanying product changes. Therefore, do not expect a one-to-one correspondence between product updates and manual updates.

Edition 1 (Part Number E1410-90010) ..... July 1991

Trademark Information

Safety Symbols



Instruction manual symbol affixed to product. Indicates that the user must refer to the manual for specific Warning or Caution information to avoid personal injury or damage to the product.



Indicates the field wiring terminal that must be connected to earth ground before operating the equipment—protects against electrical shock in case of fault.



Frame or chassis ground terminal—typically connects to the equipment's metal frame.



Alternating current (AC).



Direct current (DC).



Indicates hazardous voltages.

WARNING Calls attention to a procedure, practice, or condition that could cause bodily injury or death.

CAUTION Calls attention to a procedure, practice, or condition that could possibly cause damage to equipment or permanent loss of data.

WARNINGS

The following general safety precautions must be observed during all phases of operation, service, and repair of this product. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the product. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements.

Ground the equipment: For Safety Class 1 equipment (equipment having a protective earth terminal), an uninterruptible safety earth ground must be provided from the mains power source to the product input wiring terminals or supplied power cable.

DO NOT operate the product in an explosive atmosphere or in the presence of flammable gases or fumes.

For continued protection against fire, replace the line fuse(s) only with fuse(s) of the same voltage and current rating and type. DO NOT use repaired fuses or short-circuited fuseholders.

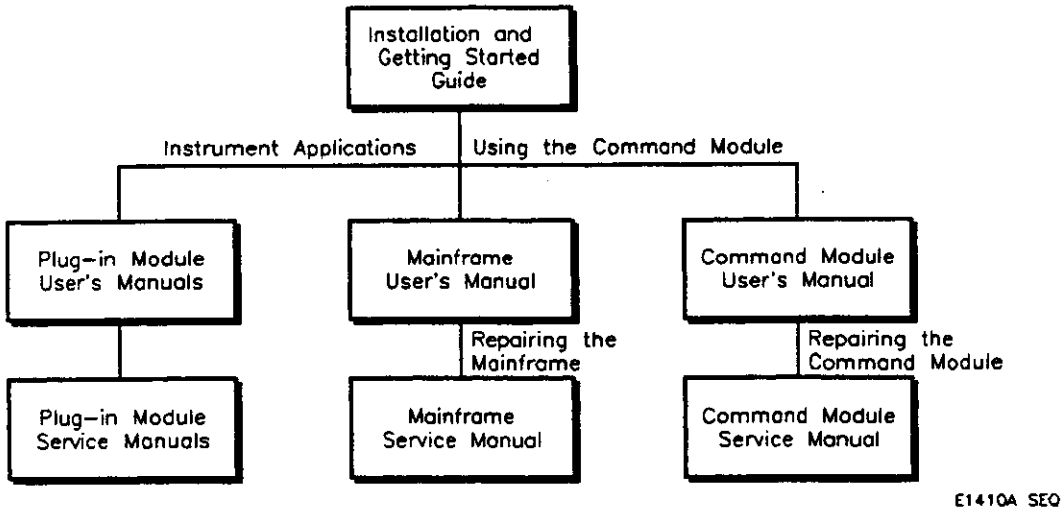
Keep away from live circuits: Operating personnel must not remove equipment covers or shields. Procedures involving the removal of covers or shields are for use by service-trained personnel only. Under certain conditions, dangerous voltages may exist even with the equipment switched off. To avoid dangerous electrical shock, DO NOT perform procedures involving cover or shield removal unless you are qualified to do so.

DO NOT operate damaged equipment: Whenever it is possible that the safety protection features built into this product have been impaired, either through physical damage, excessive moisture, or any other reason, REMOVE POWER and do not use the product until safe operation can be verified by service-trained personnel. If necessary, return the product to a Hewlett-Packard Sales and Service Office for service and repair to ensure that safety features are maintained.

DO NOT service or adjust alone: Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT substitute parts or modify equipment: Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the product. Return the product to a Hewlett-Packard Sales and Service Office for service and repair to ensure that safety features are maintained.

Suggested Sequence to Use Manuals



Manual Descriptions

Installation and Getting Started Guide. Contains step-by-step instructions for all aspects of plug-in module and mainframe installation. This guide also contains introductory programming information and examples.

HP E1405A Command Module User's Guide. Contains programming information for the Command Module, and general programming information for instruments installed in the mainframe.

HP E1400B Mainframe User's Manual. Contains installation information to prepare the mainframe for use and shows how to install plug-in modules.

Plug-In Module User's Manuals. Contain plug-in module programming and configuration information. Each manual contains programming examples and a complete SCPI command reference for the plug-in module.

HP E1400B Mainframe Service Manual. Contains service information for the mainframe, including information for ordering replaceable parts and exchanging assemblies.

Plug-In Module Service Manuals. Contain plug-in module service information. Each manual contains information for exchanging the module and/or ordering replaceable parts. Depending on the module, information and procedures for functional verification, operation verification, performance verification, adjustment, preventive maintenance, troubleshooting, and repair are also provided.

What's in this Manual

Manual Overview

This manual shows how to service the HP E1410A 6 1/2-Digit Multimeter. Consult the *HP E1410A User's Manual* for additional information on installing, configuring, and operating the multimeter. Consult the appropriate user's manuals for information on configuring and operating the mainframe and command module.

Manual Content

Chap	Title	Content
1	General Information	Provides a basic description, and lists available options and accessories. Also lists the test equipment required for service.
2	Installation	Procedures for installation, initial inspection, and shipping.
3	Operating Instructions	Procedures to operate the multimeter, perform scheduled preventive maintenance, and perform the operator's check.
4	Verification Tests	Functional verification, operation verification, and performance verification tests.
5	Adjustments	Procedures for adjusting the multimeter to within its rated specifications.
6	Replaceable Parts	Lists part numbers for user-replaceable parts in the multimeter. Provides information on ordering spare parts and module/assembly exchange.
7	Manual Changes	Information to adapt this manual to instruments whose serial numbers are lower than those listed on the title page.
8	Service	Procedures to aid in fault isolation and repair of the multimeter.
A	Calculating Multimeter Accuracy	Shows how multimeter accuracy is calculated.

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1
General Information

Introduction

This manual contains information required to test, adjust, troubleshoot, and repair the HP E1410A C-Size VXI Digital Multimeter. See the *HP E1410A User's Manual* for additional information. Figure 1-1 shows the HP E1410A multimeter.

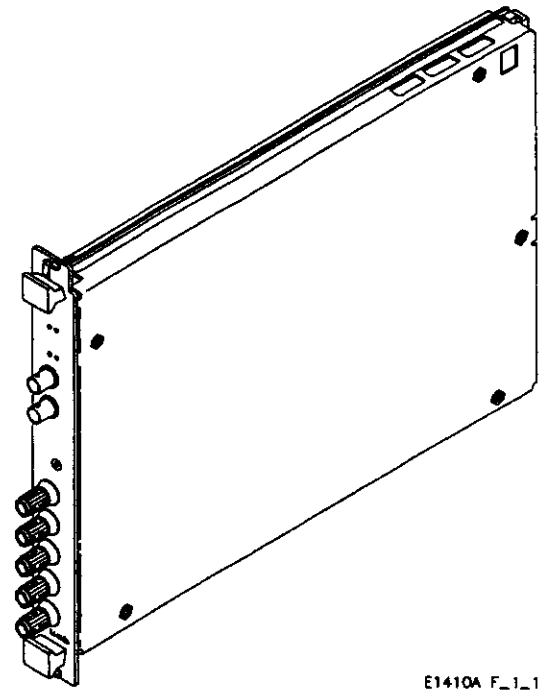


Figure 1-1. HP E1410A Multimeter

Safety Considerations

This product is a Safety Class I instrument that is provided with a protective earth terminal when installed in the mainframe. The mainframe, multimeter, and all related documentation should be reviewed for familiarization with safety markings and instructions before operation or service.

Refer to the WARNINGS page (page iii) in this manual for a summary of safety information. Safety information for preventive maintenance, testing, adjusting, and service follows and is also found throughout this manual.

Warnings and Cautions

This section contains WARNINGS which must be followed for your protection and CAUTIONS which must be followed to avoid damage to the equipment when performing instrument maintenance or repair.

WARNING

SERVICE-TRAINED PERSONNEL ONLY. The information in this manual is for service-trained personnel who are familiar with electronic circuitry and are aware of the hazards involved. To avoid personal injury or damage to the instrument, do not perform procedures in this manual or do any servicing unless you are qualified to do so.

CHECK MAINFRAME POWER SETTINGS. Before applying power, verify that the mainframe setting matches the line voltage and that the correct fuse is installed. An uninterruptible safety earth ground must be provided from the main power source to the mainframe input wiring terminals, power cord, or supplied power cord set.

GROUNDING REQUIREMENTS. Interruption of the protective (grounding) conductor (inside or outside the mainframe) or disconnecting the protective earth terminal will cause a potential shock hazard that could result in personal injury. (Grounding one conductor of a two-conductor outlet is not sufficient protection.)

IMPAIRED PROTECTION. Whenever it is likely that instrument protection has been impaired, the mainframe must be made inoperative and be secured against any unintended operation.

USING AUTOTRANSFORMERS. If the mainframe is to be energized via an autotransformer (for voltage reduction) make sure the common terminal is connected to neutral (that is, the grounded side of the main's supply).

CAPACITOR VOLTAGES. Capacitors inside the mainframe may remain charged even when the mainframe has been disconnected from its source of supply.

WARNING

USE PROPER FUSES. For continued protection against fire hazard, replace the line fuses only with fuses of the same current rating and type (such as normal blow, time delay, etc.). Do not use repaired fuses or short-circuited fuseholders.

CAUTION

Static electricity is a major cause of component failure. To prevent damage to the electrical components in the multimeter, observe anti-static techniques whenever working on the multimeter.

Multimeter Description

The HP E1410A multimeter is a VXIbus C-size, message based instrument. The multimeter can operate in a C-size VXIbus mainframe using an HP E1405A/B Command Module.

Multimeter Specifications

Multimeter specifications are listed in Appendix A of the *HP E1410A User's Manual.* These specifications are the performance standards or limits against which the instrument may be tested.

Multimeter Serial Numbers

Multimeters covered by this manual are identified by a serial number prefix listed on the title page. Hewlett-Packard uses a two part serial number in the form XXXXAYYYYY, where XXXX is the serial prefix, A is the country of origin (A=USA) and YYYYY is the serial suffix. The serial number prefix identifies a series of identical instruments. The serial number suffix is assigned sequentially to each instrument.

If the serial number prefix of your instrument is greater than the one listed on the title page, a Manual Update (as required) will explain how to adapt this manual to your instrument. If the serial number prefix of your instrument is lower than the one listed on the title page, information contained in Chapter 7 (Manual Changes) will explain how to adapt this manual to your instrument.

Multimeter Options

There are no electrical or mechanical options available for the HP E1410A multimeter. However, you can order Option 1BN which provides a MIL-STD-45662A Calibration Certificate, or Option 1BP which provides the Calibration Certificate and measurement data. Contact your nearest Hewlett-Packard Sales and Service Office for information on Options 1BN and 1BP.

Recommended Test Equipment

Table 1-1 lists the test equipment recommended for testing, adjusting, and servicing the multimeter. Essential requirements for each piece of test equipment are described in the Requirements column.

Table 1-1. Recommended Test Equipment

Instrument	Requirements	Recommended Model	Use*
Controller, HP-IB	HP-IB compatibility as defined by IEEE Standard 488-1978 and the identical ANSI Standard MC1.1: SH1, AH1, T2, TE0, L2, LE0, SR0, RL0, PP0, DC0, DT0, and C1, 2, 3, 4, 5.	HP 9000 Series 300	A,O,F, P,T
Mainframe	Compatible with multimeter	E1400B/T	A,O,F, P,T
Slot 0 Command Module	VXI C-size w/HPIB	HP E1405A/B	A,O,F, P,T
AC Standard	Frequency Range: 20 Hz to 1 MHz Voltage Range: 30 mV rms to 300 V rms	Datron 4708 with Option 20	A,O, P,T
DC Standard	Voltage Range: -3 V to +300 V	Datron 4708 with Option 10	A,O, P,T
Resistance Standard	Values: 10 Ω to 10 MΩ	Datron 4708 with Option 30	A,O, P,T
Frequency Standard	Frequency Range: 20 Hz to 1 MHz	HP 3325A/B (with 50 Ω termination)	A,O, P,T
Digital Multimeter**	Resistance Range: 10 Ω to 10 MΩ	HP 3458A	A,O,P
Digital Multimeter	General Purpose	HP 3478A	T

* F = Functional Verification, O = Operation Verification Tests,
P = Performance Verification Tests, A = Adjustments, T = Troubleshooting

** Transfer standard for resistance measurements to meet MIL-STD 45662A requirements.

2
Installation

Introduction

This chapter provides information for installing the HP E1410A multimeter, including:

- initial inspection
- preparation for use
- environment
- shipping

Initial Inspection

Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, keep the container until the shipment contents have been checked and the instrument has been checked mechanically and electrically. See Chapter 4 for procedures to check electrical performance.

WARNING

To avoid possible hazardous electrical shock, do not perform electrical tests if there are signs of shipping damage to any portion of the outer enclosure (covers, panels, etc.).

If the contents are incomplete, if there is mechanical damage or defect, or if the instrument does not pass the electrical performance tests, notify your nearest Hewlett-Packard Sales and Service Office. If the shipping container is damaged or the cushioning material shows signs of stress, notify the carrier as well as Hewlett-Packard, and keep the shipping materials for the carrier's inspection.

Preparation for Use

See Chapter 2 of the *HP E1410A User's Manual* to prepare the HP E1410A multimeter for use. See the appropriate mainframe user's manual to prepare your mainframe. If your mainframe is not manufactured by Hewlett-Packard, consult the manufacturer for a list of available manuals.

Environment

The recommended operating environment for the HP E1410A multimeter is:

Temperature ..... 0°C to +55°C

Humidity ..... <65% relative (0°C to +40°C)

For storage and shipment, the recommended environment is:

Temperature ..... -40°C to +75°C

Humidity ..... <65% relative (0°C to +40°C)

Shipping the Multimeter

If you need to return the HP E1410A multimeter to Hewlett-Packard, first remove any adapters or connectors before packaging the instrument for shipment. When you return the instrument to Hewlett-Packard, attach a tag to the instrument identifying the owner and indicating the service or repair required. In any correspondence, refer to the instrument by model number and full serial number.

When shipping the instrument, we recommend using containers and materials identical to those used in factory packaging, which are available through Hewlett-Packard Sales and Service Offices. Mark the shipping container "FRAGILE" to assure careful handling.

If you use other (commercially available) shipping materials, place the instrument in an anti-static bag, then wrap the instrument in heavy paper or plastic. Use a strong shipping container. A double-wall carton of 2.4 MPa (350 psi) test material is adequate.

Use enough shock-absorbing material (75 to 100 mm layer; 3 to 4 inches) around all sides of the instrument to provide a firm cushion and prevent movement in the container. Protect the front panel with cardboard. Seal the shipping container securely and mark the container "FRAGILE" to assure careful handling.

3
Operating Instructions

Introduction

This chapter provides operating information for the HP E1410A multimeter, including:

- Multimeter operation
- Preventive maintenance
- Operator's check (self-test)

Multimeter Operation

See the *HP E1410A User's Manual* for multimeter operation, including:

- Getting started
- Configuring the multimeter
- Using the multimeter
- Understanding the multimeter
- Multimeter command reference
- Multimeter specifications
- Multimeter error messages

Preventive Maintenance

Preventive maintenance for the HP E1410A multimeter consists of periodically cleaning the front panel of the multimeter and then performing the Operator's Check (*TST? command). You should clean the front panel yearly, or more often if the multimeter is used in a very dusty or humid area. Disassembling the multimeter to clean the inside of the module is not recommended. However, if the multimeter is taken apart (e.g., for repair), the printed circuit assemblies (PCAs) can be blown off with an airgun. See Table 3-1 for recommended cleaning equipment and supplies.

Table 3-1. Recommended Cleaning Equipment

Description	Recommended Use
Airgun (grounded nozzle)	Remove dust from printed circuit boards
Mild soap solution	Clean faceplate panel
Lint-free cloth	Clean faceplate panel

Warnings and Cautions

WARNING

To eliminate possible electrical shock, disconnect AC power from the mainframe and disconnect all inputs to the multimeter before removing the multimeter from the mainframe.

CAUTION

The multimeter printed circuit assemblies (PCAs) contain static-sensitive devices that can be damaged when handling. Use static control devices (wrist straps, static mats, etc.) when handling the instrument. See Chapter 8 for electrostatic discharge (ESD) precautions.

Do not use a vacuum cleaner to remove dust from the multimeter PCAs, as these assemblies have static-sensitive devices that can be damaged by a vacuum cleaner.

Cleaning Procedure

Use the following procedure to clean the multimeter.

1. Disassemble the multimeter. See Chapter 8 for assembly and disassembly instructions.
2. Using an airgun with a grounded nozzle, remove dust from the A1 and A2 PCA surfaces.
3. Reassemble the multimeter.
4. Clean the HP E1410A multimeter faceplate panel with a mild soap solution and a lint-free cloth.

NOTE

Disassembling the multimeter exposes the assemblies to possible ESD damage and is usually unnecessary. Unless you have a good reason to disassemble the multimeter, skip steps 1 through 3 above.

Operator's Check

The Operator's Check for the HP E1410A multimeter consists of sending the self-test (*TST?) command and checking the response. The operator's check can be used at any time to verify that the multimeter is connected properly and is responding to the self-test command.

As required, see the command module user's manual for information on address selection. See the *HP E1410A User's Manual* for information on multimeter SCPI commands.

Self-Test Procedure

1. Verify that the multimeter is properly installed in the mainframe and that the mainframe has passed its power-on test. No input signals should be present at the multimeter inputs.
2. Execute the multimeter self-test using the *TST? command.
3. A "0" returned means no self-test failure, while any other number returned means a failure was detected. See Chapter 8 for troubleshooting information.

NOTE

If an incorrect address is used, the multimeter will not respond. Verify proper address selection before troubleshooting.

Example: Self-Test

This example performs a multimeter self-test. Any number other than 0 returned indicates a test failure. See Chapter 8 for self-test error codes.

```
10  OUTPUT 70903;"*TST?"        Send the self-test command
20  ENTER 70903;A               Read self-test result
30  PRINT A                     Display the result
40  END
```

4
Verification Tests

Introduction

The three levels of test procedures described in this chapter are used to verify that the HP E1410A multimeter:

- is fully functional (Functional Verification)
- meets all testable specifications (Performance Verification)
- meets selected testable specifications (Operation Verification)

WARNING

Do not perform any of the following verification tests unless you are a qualified, service-trained technician and have read the WARNINGS and CAUTIONS in Chapter 1.

Test Conditions/ Procedures

For valid tests, the multimeter must have a one hour warm-up with all input signals removed, and the multimeter auto-zero must be ON. An autocalibration should be performed within 24 hours of Performance Verification. For best test accuracy, the ambient temperature of the test area should be between 18°C and 28°C and stable to within ±1°C.

See Table 1-1, *Recommended Test Equipment*, for test equipment requirements. Teflon® cable or other high impedance, low dielectric absorption cable is recommended for all measurements. You should complete the Performance Verification tests at one year intervals. For heavy use or severe operating environments, perform the tests more often.

Line Frequency Reference

For effective normal mode rejection (NMR), the multimeter's line frequency reference should be set to the power line frequency (50, 60, or 400 Hz). The line frequency reference is set to 60 Hz at the factory. The setting is stored in non-volatile memory, and is not affected by cycling power or sending the *RST command. To change the setting, use the CAL:LFR <frequency> command (CAL:LFR 50, for example). See the *HP E1410A User's Manual* for more information.

®Teflon is a registered trademark of E.I. DuPont de Nemours and Company.

Connecting the Guard Terminal

The guard terminal of the multimeter should be connected to divert common mode currents away from the measurement. Some experimenting may be required to find the best guarding method for any particular test setup. Two guarding methods are described below. For further information, see Application Note 123, *Floating Measurements and Guarding* (HP publication number 5952-2153).

Connect guard terminal to multimeter chassis. This connection (see Figure 4-1) gives injected currents in the guard terminal a direct path to ground. However, if the source and instrument grounds are not at exactly the same voltage, a common mode current will be generated that will be coupled into the measurement. This current can be diverted using the method described below, or eliminated by making sure that the two grounds are equal.

Connect guard terminal to source ground. With this connection (see Figure 4-2), common mode currents due to unequal source and instrument grounds are diverted away from the test leads. Injected currents in the guard terminal are also given a path to ground. This method is recommended for most of the adjustments and Performance Verification tests in this manual. For offset measurements, connect the guard terminal directly to the multimeter chassis as described above.

NOTE

To simplify the illustrations in this manual, the guard terminal connection will not be explicitly shown. It is not advisable, however, to leave the guard terminal open.

Performance Test Record

Table 4-1, at the end of this chapter, provides space to enter the results of each Performance Verification test and to compare the results with the upper and lower limits for the test. You can make a copy of this form, if desired.

The value in the "Measurement Uncertainty" column of Table 4-1 is derived from the specifications of the source used for the test, and represents the expected accuracy of the source. The value in the "Test Accuracy Ratio (TAR)" column of Table 4-1 is the ratio of multimeter accuracy to measurement uncertainty.

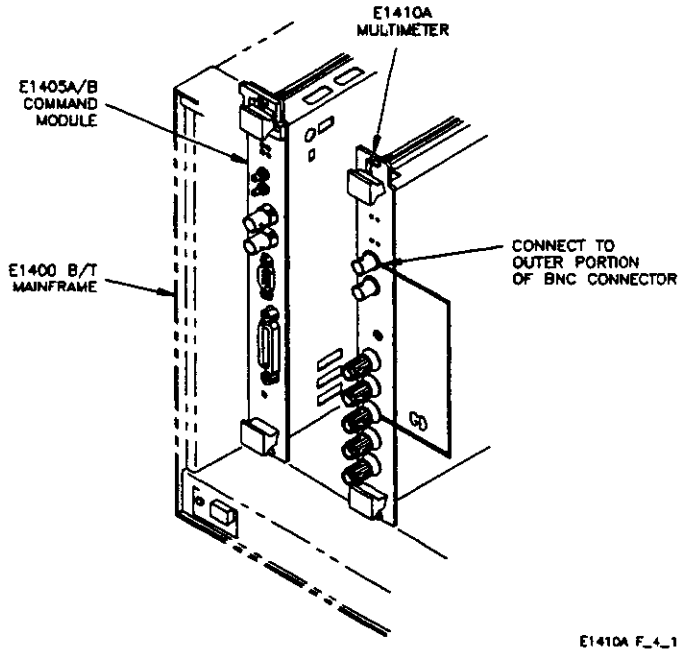


Figure 4-1. Guard Connected to Multimeter Chassis

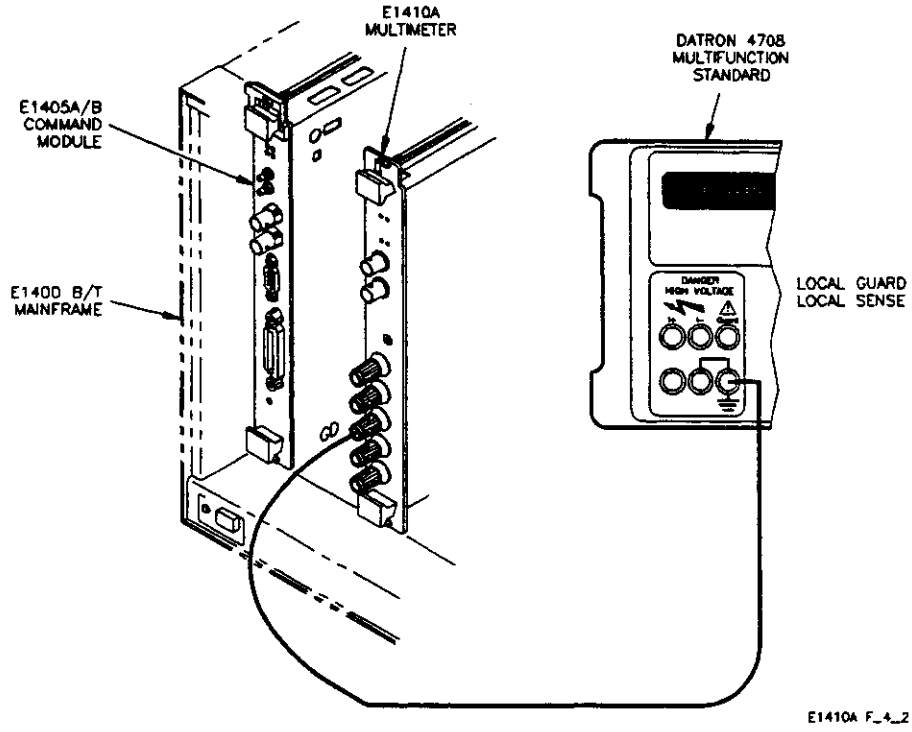


Figure 4-2. Guard Connected to Source Ground

Verification Test Examples

Each verification test procedure includes an example program that performs the test. All example programs assume a multimeter address of 70903, and are written for an HP 9000 Series 200/300 computer running HP BASIC.

NOTE

If necessary, refer to the HP E1405A Command Module User's Manual (or applicable command module manual) for information on address selection.

Functional Verification Test

The procedure in this section is used to quickly verify that the HP E1410A is functioning. This test should be performed anytime the user wants to verify that the HP E1410A is connected properly and is responding to basic commands.

Self-Test Procedure

This test verifies that the multimeter is communicating with the command module, external controller, and/or external terminal by performing a multimeter self-test.

1. Verify that the multimeter and command module are properly installed in the mainframe. No signals should be present at the multimeter inputs.
2. Execute the multimeter self-test using the *TST? command.
3. A "0" returned means no failure, while any other value returned means a failure was detected. See Chapter 8 for troubleshooting information and self-test error codes.

NOTE

If an incorrect address is used, the multimeter will not respond. Verify proper address selection before troubleshooting.

Example: Self-Test

This example performs a multimeter self-test. Any number other than 0 returned indicates a test failure. See Chapter 8 for self-test error codes.

```
10 OUTPUT 70903;"*TST?"        Send the self-test command
20 ENTER 70903;A               Read the test result
30 PRINT A                     Display the result
40 END
```

Performance Verification

The procedures in this section are used to test the electrical performance of the multimeter using the specifications in Appendix A of the *HP E1410A User's Manual* as the performance standards. These tests are suitable for incoming inspection, troubleshooting, and preventive maintenance.

Test 4-1: DC Voltage Test Procedure

The purpose of this test is to verify DC voltage accuracy on all five ranges with inputs at 0 V and at full-scale. Linearity will also be verified at the 3 V range.

DC Voltage Offset Test

1. Connect a low thermal short (copper wire) across the front panel HI and LO input terminals as shown in Figure 4-3.

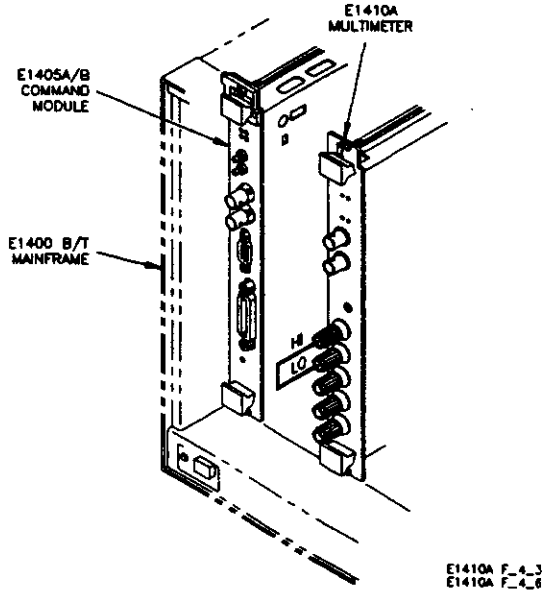


Figure 4-3. DC Voltage Offset Test Setup

2. Set up the HP E1410A as follows:

   - Reset HP E1410A ..... *RST
   - Configure for DC voltage ..... CONF:VOLT:DC
   - NPLC to 10 ..... VOLT:NPLC 10

3. Set the HP E1410A to the 300 V range using the following command:

   - Set range ..... VOLT:RANG 300

4. Perform the measurement using the READ? command.

5. Verify that the result is within specified limits and record the result.

6. Repeat steps 3 through 5 using the following ranges: 30 V, 3 V, 300 mV, and 30 mV.

Example: DCV Offset Test

This example performs a DCV test for a zero volt input.

```
10  OPTION BASE 1
20  DIM Range(5)
30  DATA 300,30,3,.3,.03
40  READ Range(*)
50  OUTPUT 70903;"*RST"                    Reset multimeter
60  OUTPUT 70903;"CONF:VOLT:DC"            Configure for DCV
70  OUTPUT 70903;"VOLT:NPLC 10"            Set to 10 NPLC
80  FOR I=1 TO 5
90    OUTPUT 70903;"VOLT:RANG ";Range(I)   Set multimeter range
100   OUTPUT 70903;"READ?"                 Perform measurement
110   ENTER 70903;Reading
120   PRINT "Range = ";Range(I);"Volts"
130   PRINT "Reading = ";Reading
140   DISP "Press 'Continue' when ready"
150   PAUSE
160 NEXT I
170 DISP
180 END
```

DC Voltage Gain Test

1. Connect the DC Standard across the HP E1410A front panel HI and LO input terminals as shown in Figure 4-4.

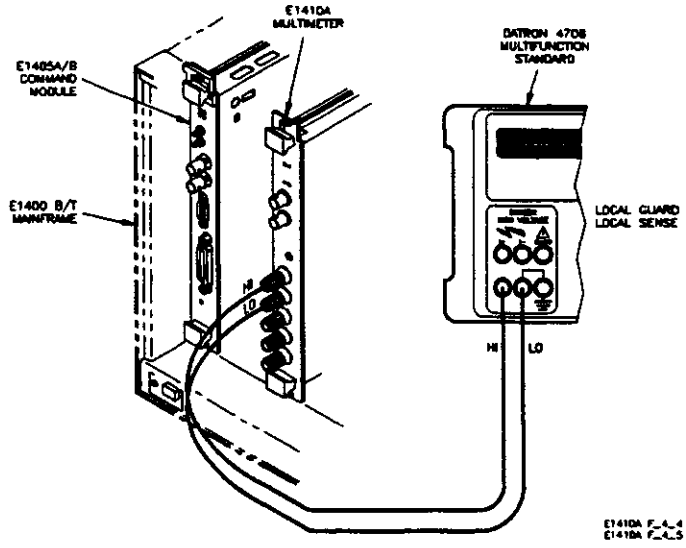


Figure 4-4. DC Voltage Gain Test Setup

2. Set up the HP E1410A as follows:

   - Reset HP E1410A ..... *RST
   - Configure for DC voltage ..... CONF:VOLT:DC
   - NPLC to 10 ..... VOLT:NPLC 10

3. Set the DC Standard output to 30 mV.

4. Set the HP E1410A to the 30 mV range using the following command:

   - Set range ..... VOLT:RANG .03

5. Perform the measurement using the READ? command.

6. Verify that the result is within specified limits and record the result.

7. Repeat steps 3 through 6 using the following ranges and inputs:

E1410A Range	DC Standard Output
30 mV	30 mV
300 mV	300 mV
3 V	3 V
3 V	2 V
3 V	1 V
3 V	-1 V
3 V	-2 V
3 V	-3 V
30 V	30 V
300 V	300 V

Example: DCV Gain Test

This example performs a DCV test for applied inputs.

```
10  OPTION BASE 1
20  DIM Range(10),Voltage(10)
30  DATA .03,.3,3,3,3,3,3,3,30,300
40  READ Range(*)
50  DATA .03,.3,3,2,1,-1,-2,-3,30,300
60  READ Voltage(*)
70  OUTPUT 70903;"*RST"                          Reset multimeter
80  OUTPUT 70903;"CONF:VOLT:DC"                  Configure for DCV
90   OUTPUT 70903;"VOLT:NPLC 10"                 Set to 10 NPLC
100  FOR I = 1 TO 10
110   DISP "Set DC Standard to ";Voltage(I);"Volts"
120   PAUSE
130   OUTPUT 70903;"VOLT:RANG ";Range(I)         Set multimeter range
140   OUTPUT 70903;"READ?"                       Perform measurement
150   ENTER 70903;Reading
160   PRINT "Range = ";Range(I);"Volts"
170   PRINT "Reading = ";Reading
180   DISP "Press 'Continue' when ready"
190   PAUSE
200  NEXT I
210  DISP
220  END
```

Test 4-2: AC Voltage Test Procedure

The purpose of this test is to verify AC voltage accuracy at all five ranges with inputs at full-scale and 10% of full-scale. Frequency response is also tested at the 300 mV and 3 V ranges.

AC Voltage Gain Test

1. Connect the AC Standard across the HP E1410A front panel HI and LO input terminals as shown in Figure 4-5.

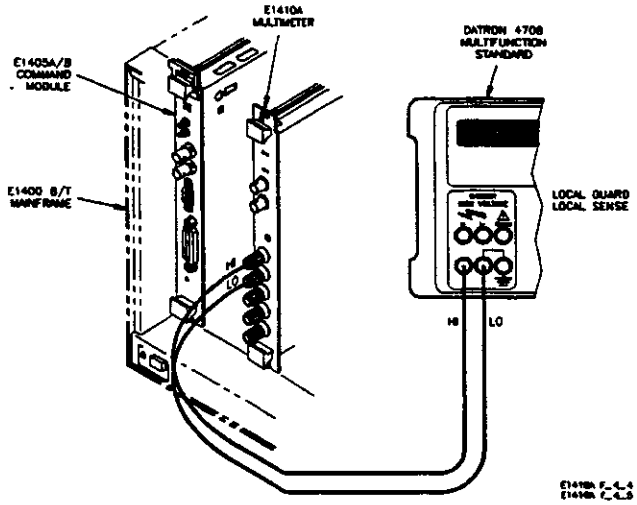


Figure 4-5. AC Voltage Test Setup

2. Set up the HP E1410A as follows:

   - Reset HP E1410A ..... *RST
   - Configure for AC voltage ..... CONF:VOLT:AC
   - NPLC to 10 ..... VOLT:NPLC 10
   - Select AC fast mode ..... BAND:DET 400

3. Set the AC Standard controls as follows:

   - Output ..... 30 mV
   - Frequency 1kHz

4. Set the HP E1410A to the 30 mV range using the following command:

   - Set range ..... VOLT:RANG .03

5. Perform the measurement using the READ? command.
6. Verify that the result is within specified limits and record the result.
7. Repeat steps 3 through 6 using the following ranges and inputs:

E1410A Range	AC Standard Output	
	Voltage	Frequency
30 mV	30 mV	1 kHz
300 mV	300 mV	1 kHz
3 V	1 V	1 kHz
3 V	2 V	1 kHz
3 V	3 V	1 kHz
30 V	30 V	1 kHz
300 V	300 V	1 kHz
300 V	30 V	1 kHz
30 V	3 V	1 kHz
3 V	300 mV	1 kHz
300 mV	30 mV	1 kHz

Example: ACV Gain Test

This example performs an ACV test for gain.

```
10  OPTION BASE 1
20  DIM Range(11),Voltage(11)
30  DATA .03,.3,3,3,3,30,300,300,30,3,.3
40  READ Range(*)
50  DATA .03,.3,1,2,3,30,300,30,3,.3,.03
60  READ Voltage(*)
70  OUTPUT 70903;"*RST"                    Reset multimeter
80  OUTPUT 70903;"CONF:VOLT:AC"            Configure for ACV
90  OUTPUT 70903;"VOLT:NPLC 10"            Set to 10 NPLC
100 OUTPUT 70903;"BAND:DET 400"            Select Fast mode
110  FOR I=1 TO 11
120   DISP "Set AC Standard to ";Voltage(I);"Volts"
130   PAUSE
140   OUTPUT 70903;"VOLT:RANG ";Range(I)   Set multimeter range
150   OUTPUT 70903;"READ?"                 Perform measurement
```

```
160   ENTER 70903;Reading
170   PRINT "Range = ";Range(I);"Volts"
180   PRINT "Reading = ";Reading
190   DISP "Press 'Continue' when ready"
200   PAUSE
210   DISP
220 NEXT I
230 END
```

AC Voltage Frequency Response Test

1. Connect the AC Standard across the HP E1410A front panel HI and LO input terminals as shown in Figure 4-5.

2. Set up the HP E1410A as follows:

   - Reset HP E1410A ..... *RST
   - Configure for AC voltage ..... CONF:VOLT:AC
   - NPLC to 10 ..... VOLT:NPLC 10
   - Select AC fast mode ..... BAND:DET 400

3. Set the AC Standard controls as follows:

   - Output ..... 30 mV
   - Frequency ..... 1 MHz

4. Set the HP E1410A to the 300 mV range using the following command:

   - Set range ..... VOLT:RANG .3

5. Perform the measurement using the READ? command.

6. Verify that the result is within specified limits and record the result.

7. Repeat steps 3 through 6 using the ranges and inputs in the following table. When indicated, set the E1410A AC bandwidth to slow mode using the command: BAND:DET 20.

E1410A Range	AC Mode	AC Standard Output	
		Voltage	Frequency
300 mV	Fast	30 mV	1 MHz
300 mV	Fast	30 mV	300 kHz
300 mV	Fast	30 mV	100 kHz
300 mV	Fast	30 mV	20 kHz
300 mV	Fast	30 mV	6.5 kHz
300 mV	Fast	30 mV	400 Hz
300 mV	Fast	300 mV	1 MHz
300 mV	Fast	300 mV	300 kHz
300 mV	Fast	300 mV	100 kHz
300 mV	Fast	300 mV	20 kHz
300 mV	Fast	300 mV	6.5 kHz
300 mV	Fast	300 mV	400 Hz
3 V	Fast	300 mV	1 MHz
3 V	Fast	300 mV	300 kHz
3 V	Fast	300 mV	100 kHz
3 V	Fast	300 mV	20 kHz
3 V	Fast	300 mV	6.5 kHz
3 V	Fast	300 mV	400 Hz
3 V	Fast	3 V	1 MHz
3 V	Fast	3 V	300 kHz
3 V	Fast	3 V	100 kHz
3 V	Fast	3 V	20 kHz
3 V	Fast	3 V	6.5 kHz
3 V	Fast	3 V	400 Hz
3 V	Slow	3 V	100 Hz
3 V	Slow	3 V	45 Hz
3 V	Slow	3 V	20 Hz
300 mV	Slow	300 mV	100 Hz
300 mV	Slow	300 mV	45 Hz
300 mV	Slow	300 mV	20 Hz

Example: ACV Frequency Response Test

This example performs an ACV test for frequency response.

```
10  OPTION BASE 1
20  DIM Range(30),Voltage(30),Freq(30)
30  DATA .3,.3,.3,.3,.3,.3,.3,.3,.3,.3,.3,3,3,3,3,3,3,3
40  DATA 3,3,3,3,3,3,3,3,3,.3,.3,.3
50  READ Range(*)
60  DATA .03,.03,.03,.03,.03,.03,.3,.3,.3,.3,.3,.3,.3,.3,.3,.3,.3,.3
70  DATA 3,3,3,3,3,3,3,3,3,.3,.3,.3
80  READ Voltage(*)
90  DATA 1.E6,3.E5,1.E5,2.E4,6.5E3,400,1.E6,3.E5,1.E5,2.E4,6.5E3,400
100 DATA 1.E6,3.E5,1.E5,2.E4,6.5E3,400,1.E6,3.E5,1.E5,2.E4,6.5E3,400
110 DATA 100,45,20,100,45,20
120 READ Freq(*)
130 OUTPUT 70903;"*RST"                    Reset multimeter
140 OUTPUT 70903;"CONF:VOLT:AC"            Configure for ACV
150  OUTPUT 70903;"VOLT:NPLC 10"           Set to 10 NPLC
160 FOR I=1 TO 30
170  DISP "Set AC Standard to ";Voltage(I);"Volts,";Freq(I);"Hz"
180  PAUSE
190  IF Freq(I) < 400 THEN
200   OUTPUT 70903;"BAND:DET 20"           Select slow mode
210  ELSE
220   OUTPUT 70903;"BAND:DET 400"          Select fast mode
230  END IF
240  OUTPUT 70903;"VOLT:RANG ";Range(I)    Set multimeter range
250  OUTPUT 70903;"READ?"                  Perform measurement
260  ENTER 70903;Reading
270  PRINT "Range = ";Range(I);"Volts"
280  PRINT "Reading = ";Reading
290  DISP "Press 'Continue' when ready"
300  PAUSE
310  DISP
320 NEXT I
330 DISP
340 END
```

Test 4-3: 2-Wire Ohms Test Procedure

The purpose of this test is to verify 2-wire ohms accuracy on all ranges for shorted inputs and applied inputs.

2-Wire Ohms Offset Test

1. Connect a low thermal short (copper wire) across the HP E1410A front panel HI and LO input terminals as shown in Figure 4-6.

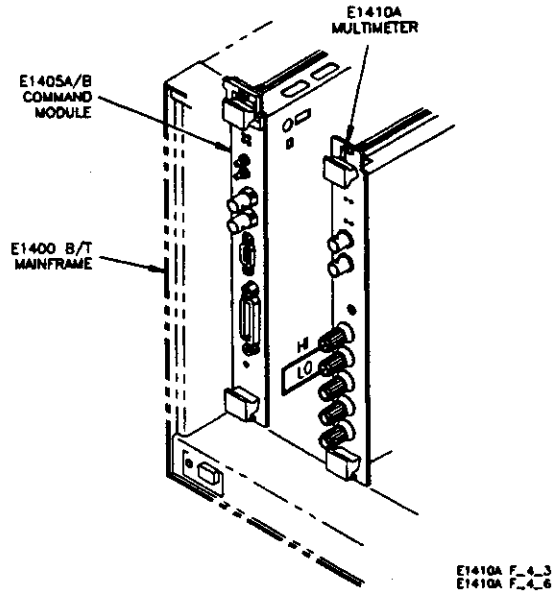


Figure 4-6. 2-Wire Ohms Offset Test Setup

2. Set up the HP E1410A as follows:

   - Reset HP E1410A ..... *RST
   - Configure for 2-wire ohms ..... CONF:RES
   - NPLC to 10 ..... RES:NPLC 10
   - Offset compensation ON ..... RES:OCOM ON
   - Trigger Delay to .5 sec ..... TRIG:DEL .5

3. Set the HP E1410A to the 30 Ω range using the following command:

   - Set range ..... RES:RANG 30

4. Perform the measurement using the READ? command.

5. Verify that the result is within specified limits and record the result.

6. Repeat steps 3 through 5 using the following ranges: 300 Ω, 3 kΩ, 30 kΩ, 300 kΩ, 3 MΩ, and 30 MΩ.

Example: 2-Wire Ohms Offset Test

This example performs a 2-wire ohms test for a shorted input.

```
10  OPTION BASE 1
20  DIM Range(7)
30  DATA 30,300,3000,3.E4,3.E5,3.E6,3.E7
40  READ Range(*)
50  OUTPUT 70903;"*RST"                    Reset multimeter
60  OUTPUT 70903;"CONF:RES"                Configure for 2-wire ohms
70  OUTPUT 70903;"RES:NPLC 10"             Set to 10 NPLC
80  OUTPUT 70903;"RES:OCOM ON"             Offset compensation ON
90  OUTPUT 70903;"TRIG:DEL .5"             Set trigger delay to .5 sec
100 FOR I=1 TO 7
110   OUTPUT 70903;"RES:RANG ";Range(I)    Set multimeter range
120   OUTPUT 70903;"READ?"                 Perform measurement
130   ENTER 70903;Reading
140   PRINT "Range = ";Range(I);"Ohms"
150   PRINT "Reading = ";Reading
160   DISP "Press 'Continue' when ready"
170   PAUSE
180   DISP
190 NEXT I
200 END
```

2-Wire Ohms Gain Test

The following procedure can be performed without using a transfer standard DMM if desired.

1. Set up the HP E1410A as follows:

   - Reset HP E1410A ..... *RST
   - Configure for 2-wire ohms ..... CONF:RES
   - NPLC to 10 ..... RES:NPLC 10
   - Offset compensation ON ..... RES:OCOM ON
   - Trigger Delay to .5 sec ..... TRIG:DEL .5

2. Set the Resistance Standard output to 10 Ω (nominal).

3. Measure the output of the Resistance Standard with the Transfer Standard DMM as shown in Figure 4-7 (optional). The Transfer Standard settings (offset compensation, auto-zero, etc.) and guarding should be identical to those used for the HP E1410A.

NOTE

The Transfer Standard measurement should be taken at the ends of the test leads, as shown in Figure 4-7, so that the resistance of the test leads and the internal resistances of the source are included in the measurement.

---

4. Disconnect the Transfer Standard. Connect the Resistance Standard across the HP E1410A front panel HI and LO input terminals as indicated by the dotted lines in Figure 4-7.

5. Set the HP E1410A to the 30 Ω range using the following command:

   - Set range ..... RES:RANG 30

6. Perform the measurement using the READ? command.

7. Verify that the result is within specified limits and record the result.

8. Repeat steps 2 through 7 using the following ranges and inputs:

E1410A Range	Resistance Standard Output
30 Ω	10 Ω
300 Ω	100 Ω
3 kΩ	1 kΩ
30 kΩ	10 kΩ
300 kΩ	100 kΩ
3 MΩ	1 MΩ
30 MΩ	10 MΩ

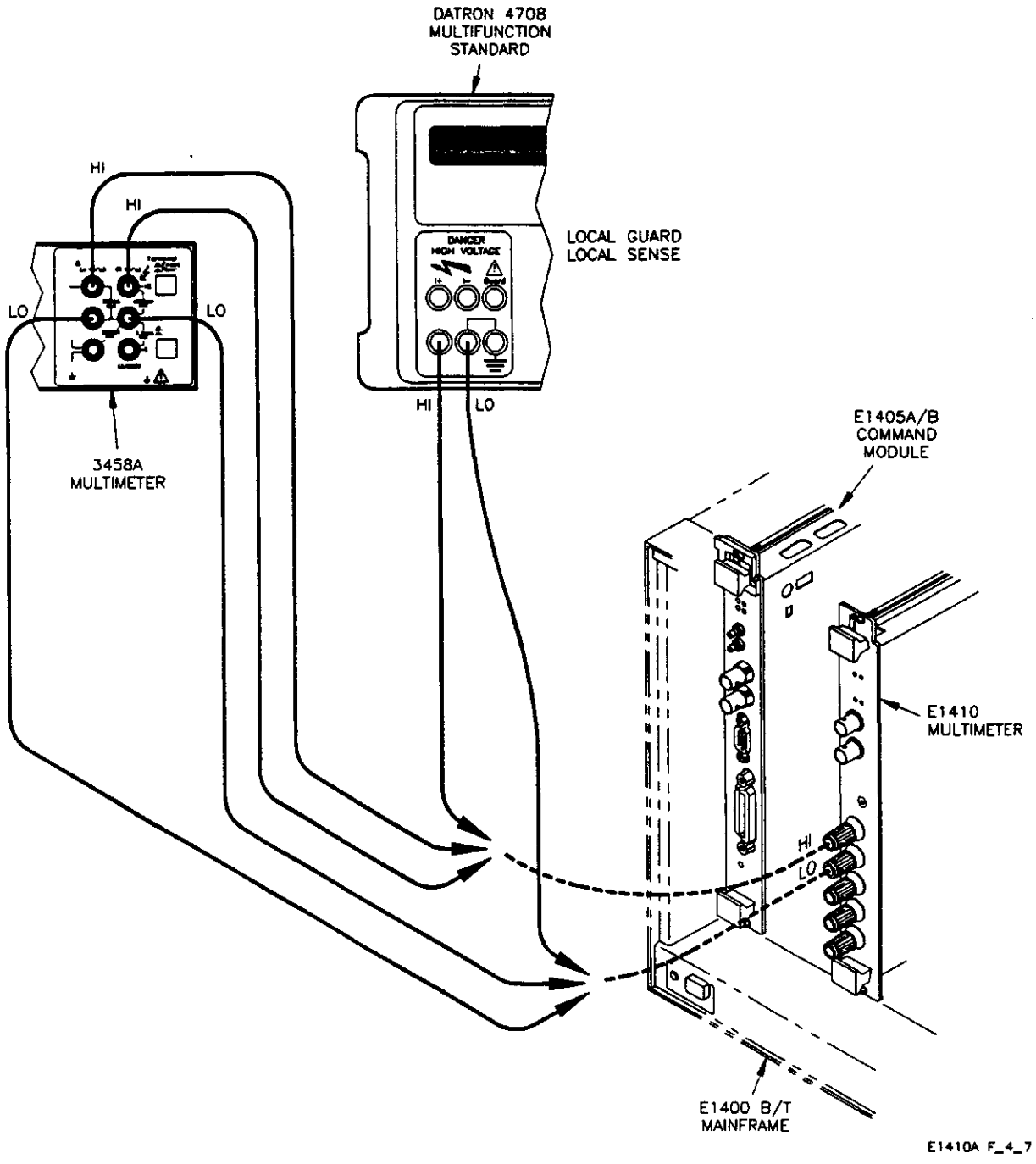


Figure 4-7. 2-Wire Ohms Gain Test Setup

Example: 2-Wire Ohms Gain Test

This example performs a 2-wire ohms test for applied inputs.

```
10  OPTION BASE 1
20  DIM Range(7)
30  DATA 30,300,3000,3.E4,3.E5,3.E6,3.E7
40  READ Range(*)
50  OUTPUT 70903;"*RST"                          Reset multimeter
60  OUTPUT 70903;"CONF:RES"                      Configure for 2-wire ohms
70  OUTPUT 70903;"RES:NPLC 10"                   Set to 10 NPLC
80  OUTPUT 70903;"RES:OCOM ON"                   Offset compensation ON
90  OUTPUT 70903;"TRIG:DEL .5"                   Set trigger delay to .5 sec
100 FOR I = 1 TO 7
110   DISP "Set Resistance Standard to ";Range(I)/3;"Ohms"
120   PAUSE
130   OUTPUT 70903;"RES:RANG ";Range(I)          Set multimeter range
140   OUTPUT 70903;"READ?"                       Perform measurement
150   ENTER 70903;Reading
160   PRINT "Range = ";Range(I);"Ohms"
170   PRINT "Reading = ";Reading
180 NEXT I
190 DISP
200 END
```

Test 4-4: 4-Wire Ohms Test Procedure

The purpose of this test is to verify 4-wire ohms accuracy on all ranges for shorted inputs and applied inputs.

4-Wire Ohms Offset Test

1. Short the E1410A front panel terminals as shown in Figure 4-8.
2. Set up the HP E1410A as follows:

   - Reset HP E1410A ..... *RST
   - Configure for 4-wire ohms ..... CONF:FRES
   - NPLC to 10 ..... RES:NPLC 10
   - Offset compensation ON ..... RES:OCOM ON
   - Trigger Delay to .5 sec ..... TRIG:DEL .5

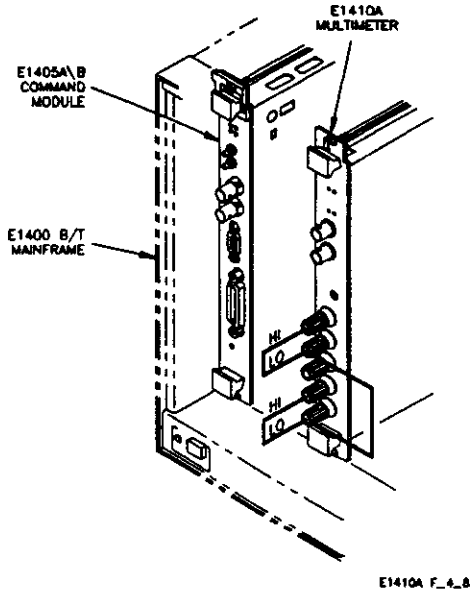


Figure 4-8. 4-Wire Ohms Offset Test Setup

3. Set the HP E1410A to the 30 Ω range using the following command:

   - Set range ..... RES:RANG 30

4. Perform the measurement using the READ? command.
5. Verify that the result is within specified limits and record the result.
6. Repeat steps 3 through 5 using the following ranges: 300 Ω, 3 kΩ, 30 kΩ, 300 kΩ, 3 MΩ, and 30 MΩ.

Example: 4-Wire Ohms Offset Test

This example performs a 4-wire ohms test for a shorted input.

```
10  OPTION BASE 1
20  DIM Range(7)
30  DATA 30,300,3000,3.E4,3.E5,3.E6,3.E7
40  READ Range(*)
50  OUTPUT 70903;"*RST"                      Reset multimeter
60  OUTPUT 70903;"CONF:FRES"                 Configure for 4-wire ohms
70   OUTPUT 70903;"RES:NPLC 10"              Set to 10 NPLC
80  OUTPUT 70903;"RES:OCOM ON"               Offset compensation ON
90  OUTPUT 70903;"TRIG:DEL .5"               Set trigger delay to .5 sec
100  FOR I=1 TO 7
110    OUTPUT 70903;"RES:RANG ";Range(I)      Set multimeter range
120    OUTPUT 70903;"READ?"                   Perform measurement
130    ENTER 70903;Reading
140    PRINT "Range = ";Range(I);"Ohms"
150    PRINT "Reading = ";Reading
160    DISP "Press 'Continue' when ready"
170    PAUSE
180    DISP
190  NEXT I
200  END
```

4-Wire Ohms Gain Test

The following procedure can be performed without using a transfer standard DMM if desired.

1. Set up the HP E1410A as follows:

   - Reset HP E1410A ..... *RST
   - Configure for 4-wire ohms ..... CONF:FRES
   - NPLC to 10 ..... RES:NPLC 10
   - Offset compensation ON ..... RES:OCOM ON
   - Trigger Delay to .5 sec ..... TRIG:DEL .5

2. Set the Resistance Standard output to 10 Ω (nominal).

3. Measure the output of the Resistance Standard with the Transfer Standard DMM as shown in Figure 4-9(a) (optional). The Transfer Standard settings (offset compensation, auto-zero, etc.) and guarding should be identical to those used for the HP E1410A.

4. Disconnect the Transfer Standard. Using the same test leads, connect the Resistance Standard to the HP E1410A front panel input terminals as shown in Figure 4-9(b).

5. Set the HP E1410A to the 30 Ω range using the following command:

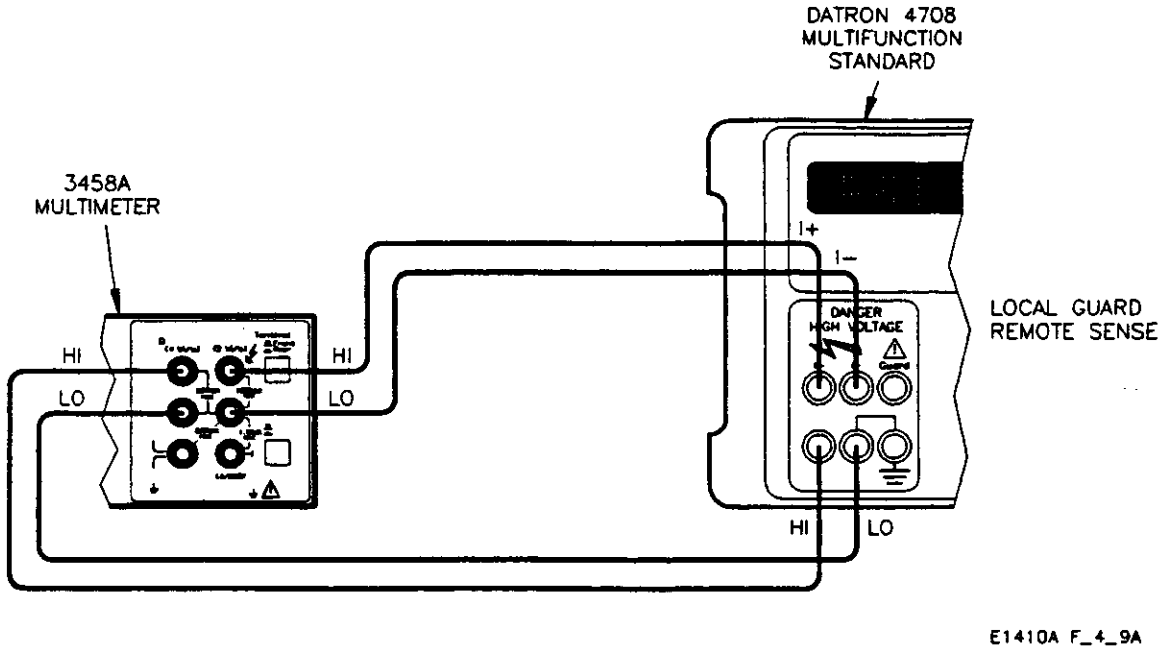
   - Set range ..... RES:RANG 30

6. Perform the measurement using the READ? command.

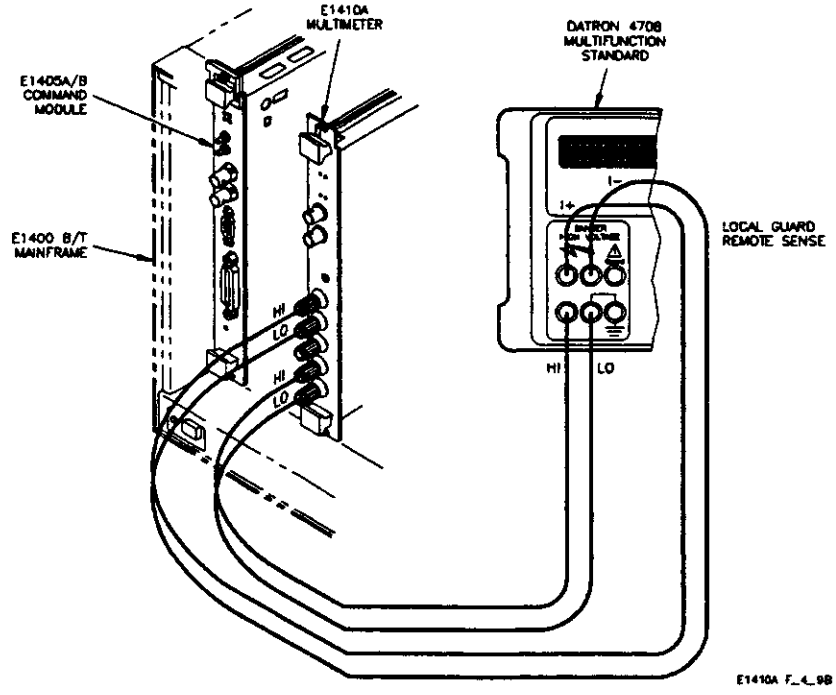
7. Verify that the result is within specified limits and record the result.

8. Repeat steps 2 through 7 using the following ranges and inputs:

E1410A Range	Resistance Standard Output
30 Ω	10 Ω
300 Ω	100 Ω
3 kΩ	1 kΩ
30 kΩ	10 kΩ
300 kΩ	100 kΩ
3 MΩ	1 MΩ
30 MΩ	10 MΩ



(a)



(b)

Figure 4-9. 4-Wire Ohms Test Setup

Example: 4-Wire Ohms Gain Test

This example performs a 4-wire ohms test for applied inputs.

```
10  OPTION BASE 1
20  DIM Range(7)
30  DATA 30,300,3000,3.E4,3.E5,3.E6,3.E7
40  READ Range(*)
50  OUTPUT 70903;"*RST"                          Reset multimeter
60  OUTPUT 70903;"CONF:FRES"                     Configure for 4-wire ohms
70  OUTPUT 70903;"RES:NPLC 10"                   Set to 10 NPLC
80  OUTPUT 70903;"RES:OCOM ON"                   Offset compensation ON
90  OUTPUT 70903;"TRIG:DEL .5"                   Set trigger delay to .5 sec
100 FOR I=1 TO 7
110   DISP "Set Resistance Standard to ";Range(I)/3;"Ohms"
120   PAUSE
130   OUTPUT 70903;"RES:RANG ";Range(I)          Set multimeter range
140   OUTPUT 70903;"READ?"                       Perform measurement
150   ENTER 70903;Reading
160   PRINT "Range = ";Range(I);"Ohms"
170   PRINT "Reading = ";Reading
180 NEXT I
190 DISP
200 END
```

Test 4-5: Frequency Test Procedure

The purpose of this test is to verify frequency accuracy at 20 Hz and 1 MHz.

1. Connect the Frequency Standard across the HP E1410A front panel HI and LO terminals as shown in Figure 4-10.

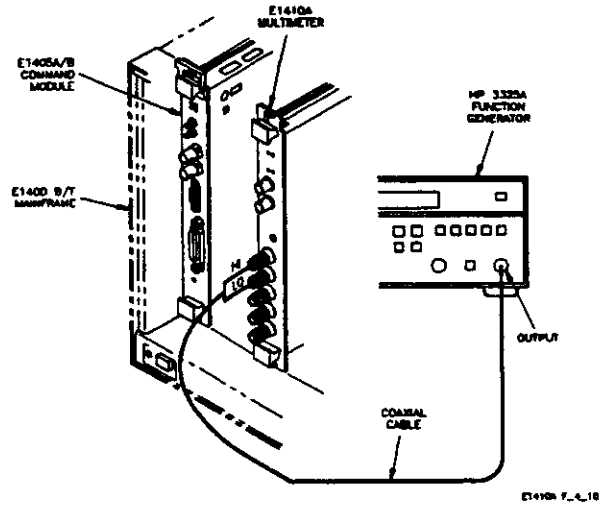


Figure 4-10. Frequency Test Setup

2. Set up the HP E1410A as follows:

   - Reset HP E1410A ..... *RST
   - Configure for frequency ..... CONF:FREQ

3. Set the Frequency Standard controls as follows:

   - Output ..... 1 V
   - Frequency ..... 20 Hz

4. Perform the measurement using the READ? command.

5. Verify that the result is within specified limits and record the result.

6. Repeat steps 4 and 5 with the Frequency Standard set to 1 MHz.

Example: Frequency Accuracy Test

This example performs a frequency test.

```
10  OUTPUT 70903;"*RST"                    Reset multimeter
20  OUTPUT 70903;"CONF:FREQ"               Configure for frequency
30  DISP "Set Frequency Standard to 1 V, 20 Hz sinewave"
40  PAUSE
50  OUTPUT 70903;"READ?"                   Perform measurement
60  ENTER 70903;Reading
70  PRINT "Reading = ";Reading
80  DISP "Set Frequency Standard to 1 V, 1 MHz sinewave"
90  PAUSE
100 OUTPUT 70903;"READ?"                   Perform measurement
110 ENTER 70903;Reading
120 PRINT "Reading = ";Reading
130 END
```

Operation Verification Tests

The procedures in this section are used when only a subset of the Performance Verification procedures is required. These tests are designed to provide a moderate level of confidence that the instrument is meeting specifications.

Operation Verification is performed by completing the following portions of the Performance Verification tests:

Test Name	Test Point	
	DMM Range	DMM Input
DC Volts		
Offset Test	30 V	short
	3 V	short
	300 mV	short
Gain Test	300 mV	300 mV
	3 V	3 V
	30 V	30 V
AC Volts		
Gain Test	300 mV	300 mV, 1 kHz
	3 V	3 V, 1 kHz
	30 V	30 V, 1 kHz
Frequency Response Test	3 V	300 mV, 20 kHz
	3 V	3 V, 20 kHz
	3 V	3 V, 100 Hz
	3 V	3 V, 20 Hz
2-Wire Ohms		
Offset Test	3 kΩ	short
	30 kΩ	short
	300 kΩ	short
Gain Test	3 kΩ	1 kΩ
	30 kΩ	10 kΩ
	300 kΩ	100 kΩ
4-Wire Ohms		
Offset Test	3 kΩ	short
	30 kΩ	short
	300 kΩ	short
Gain Test	3 kΩ	1 kΩ
	30 kΩ	10 kΩ
	300 kΩ	100 kΩ
Frequency	Auto	1 V, 20 Hz
	Auto	1 V, 1 MHz

Performance Test Record

Table 4-1, *Performance Test Record for the HP E1410A Multimeter*, is a form you can copy and use to record performance verification test results for the multimeter. Pages 3, 4, and 5 of Table 4-1 show multimeter accuracy, measurement uncertainty, and test accuracy ratio (TAR) values.

NOTE

The accuracy, measurement uncertainty, and TAR values shown in Table 4-1 are valid ONLY for the specific test conditions, test equipment, and assumptions described. If you use different test equipment or change the test conditions, you will need to compute the specific values for your test setup.

Multimeter Accuracy

Accuracy is defined for DC voltage, AC voltage, 2-wire ohms, 4-wire ohms, and frequency measurements using the 1-year specifications in Appendix A of the *HP E1410A User's Manual*. In Table 4-1, the "High Limit" and "Low Limit" columns represent the multimeter accuracy for the specified test conditions.

Measurement Uncertainty

For the performance verification tests in this manual, measurement uncertainties are calculated assuming an HP 3325A/B as the source for frequency measurements, and a Datron 4708 as the source for all other measurements. For 2-wire and 4-wire ohms measurements, an HP 3458A multimeter is used as a transfer standard. In other words, the Datron 4708 output should be measured by the HP 3458A (in 4-wire mode) before being measured by the HP E1410A. The measurement uncertainty then becomes equivalent to the accuracy of the HP 3458A. Measurement uncertainties in Table 4-1 are based on 90-day accuracy specifications for the Datron 4708 and the HP 3458A, and 1-year accuracy specifications for the HP 3325A/B.

Test Accuracy Ratio (TAR)

In Table 4-1, the "Test Accuracy Ratio (TAR)" is calculated from (high limit - expected measurement)/measurement uncertainty. "N/A" means measurement uncertainty and TAR do not apply to the measurement. For the specified conditions and test equipment, all measurements have TAR's that are greater than 4:1.

Table 4-1. Performance Test Record for the HP E1410A Multimeter (Page 1 of 5)

Test Facility:

Name _____ Report No. _____

Address _____ Date _____

City/State _____ Customer _____

Phone _____ Tested by _____

Model _____ Ambient temperature _____ °C

Serial No. _____ Relative humidity _____ %

Options _____ Line frequency _____ Hz (nominal)

Firmware Rev. _____

Special Notes:

Table 4-1. Performance Test Record for the HP E1410A Multimeter (Page 2 of 5)

Model _____ Report No. _____ Date _____

Test Equipment Used: Description	Model No.	Trace No.	Cal Due Date
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			
16.			
17.			
18.			
19.			
20.			

Table 4-1. Performance Test Record for the HP E1410A Multimeter (Page 3 of 5)

Model _____ Report No. _____ Date _____

1-year Specifications

Test No.	Test Input	DMM Range	Low Limit	Measured Reading	High Limit	Meas Uncert	Test Acc Ratio
DC Voltage Test (Values in Vdc)							
4-1	0	300	-.000700	_____	.000700	N/A	N/A
	0	30	-.000200	_____	.000200	N/A	N/A
	0	3	-.000007	_____	.000007	N/A	N/A
	0	.3	-.000004	_____	.000004	N/A	N/A
	0	.03	-.0000039	_____	.0000039	N/A	N/A
	.03	.03	.02999475	_____	.03000525	.0000006	9:1
	.3	.3	.2999855	_____	.3000145	.0000020	7:1
	3	3	2.999918	_____	3.000082	.0000105	8:1
	2	3	1.999943	_____	2.000057	.000008	7:1
	1	3	.999968	_____	1.000032	.0000048	7:1
	-1	3	-1.000032	_____	-.999968	.0000048	7:1
	-2	3	-2.000057	_____	-1.999943	.000008	7:1
	-3	3	-3.000082	_____	-2.999918	.0000105	8:1
	30	30	29.9986	_____	30.0014	.000171	8:1
	300	300	299.9828	_____	300.0172	.002	9:1
AC Voltage Gain Test (1 kHz) (Values in Vac)							
4-2	.03	.03	.02990079	_____	.03009921	.0000124	8:1
	.3	.3	.2992479	_____	.3007521	.000025	>10:1
	1	3	.996479	_____	1.003521	.000060	>10:1
	2	3	1.994479	_____	2.005521	.000200	>10:1
	3	3	2.992479	_____	3.007521	.00025	>10:1
	30	30	29.92479	_____	30.07521	.0028	>10:1
	300	300	299.0679	_____	300.9321	.056	>10:1
	30	300	29.7699	_____	30.2301	.0028	>10:1
	3	30	2.97879	_____	3.02121	.00025	>10:1
	.3	3	.297879	_____	.302121	.000025	>10:1
	03	.3	.0297879	_____	.0302121	.0000124	>10:1

Table 4-1. Performance Test Record for the HP E1410A Multimeter (Page 4 of 5)

Model _____ Report No. _____ Date _____

1-year Specifications

Test No.	Test Input	Test Freq	DMM Range	Low Limit	Measured Reading	High Limit	Meas Uncert	Test Acc Ratio
AC Voltage Frequency Response Test (Values in Vac)								
4-2 (Cont.)	.03	1 MHz	.3	.020193	_____	.039807	.00018	>10:1
	.03	300 kHz	.3	.0279699	_____	.0320301	.000057	>10:1
	.03	100 kHz	.3	.0295338	_____	.0304662	.000028	>10:1
	.03	20 kHz	.3	.0297879	_____	.0302121	.000017	>10:1
	.03	6.5 kHz	.3	.0297879	_____	.0302121	.0000124	>10:1
	.03	400 Hz	.3	.0297879	_____	.0302121	.0000124	>10:1
	.28	1 MHz	.3	.244168	_____	.315832	.00079	>10:1
	.3	300 kHz	.3	.2888169	_____	.3111831	.00018	>10:1
	.3	100 kHz	.3	.2975898	_____	.3024102	.000053	>10:1
	.3	20 kHz	.3	.2992479	_____	.3007521	.000025	>10:1
	.3	6.5 kHz	.3	.2992479	_____	.3007521	.000025	>10:1
	.3	400 Hz	.3	.2992479	_____	.3007521	.000025	>10:1
	.3	1 MHz	3	.20193	_____	.39807	.00082	>10:1
	.3	300 kHz	3	.279699	_____	.320301	.00018	>10:1
	.3	100 kHz	3	.295338	_____	.304662	.000053	>10:1
	.3	20 kHz	3	.297879	_____	.302121	.000025	>10:1
	.3	6.5 kHz	3	.297879	_____	.302121	.000025	>10:1
	.3	400 Hz	3	.297879	_____	.302121	.000025	>10:1
	2.8	1 MHz	3	2.44168	_____	3.15832	.0079	>10:1
	3	300 kHz	3	2.888169	_____	3.111831	.0018	>10:1
	3	100 kHz	3	2.975898	_____	3.024102	.00053	>10:1
	3	20 kHz	3	2.992479	_____	3.007521	.00025	>10:1
	3	6.5 kHz	3	2.992479	_____	3.007521	.00025	>10:1
	3	400 Hz	3	2.992479	_____	3.007521	.00025	>10:1
	3	100 Hz	3	2.992779	_____	3.007221	.00038	>10:1
	3	45 Hz	3	2.990379	_____	3.009621	.00038	>10:1
	3	20 Hz	3	2.979879	_____	3.020121	.00060	>10:1
	.3	100 Hz	.3	.2992779	_____	.3007221	.000038	>10:1
	.3	45 Hz	.3	.2990379	_____	.3009621	.000038	>10:1
	.3	20 Hz	.3	.2979879	_____	.3020121	.000060	>10:1

Table 4-1. Performance Test Record for the HP E1410A Multimeter (Page 5 of 5)

Model _____ Report No. _____ Date _____

1-year Specifications

Test No.	Test Input	DMM Range	Low Limit	Measured Reading	High Limit	Meas Uncert	Test Acc Ratio
2-Wire Ohms Test (Values in ohms)							
4-3	0	30	-.2034	_____	.2034	N/A	N/A
	0	300	-.2035	_____	.2035	N/A	N/A
	0	3000	-.207	_____	.207	N/A	N/A
	0	30000	-.27	_____	.27	N/A	N/A
	0	300000	-1	_____	1	N/A	N/A
	0	3000000	-14.2	_____	14.2	N/A	N/A
	0	30000000	-830.2	_____	830.2	N/A	N/A
	10	30	9.79585	_____	10.20415	.0002	>10:1
	100	300	99.791	_____	100.209	.0015	>10:1
	1000	3000	999.743	_____	1000.257	.0085	>10:1
	10000	30000	9999.23	_____	10000.77	.085	9:1
	100000	300000	99994	_____	100006	.85	7:1
	1000000	3000000	999920.8	_____	1000079	14	6:1
	10000000	30000000	9995170	_____	10004830	600	8:1
4-Wire Ohms Test (Values in ohms)							
4-4	0	30	-.0034	_____	.0034	N/A	N/A
	0	300	-.0035	_____	.0035	N/A	N/A
	0	3000	-.007	_____	.007	N/A	N/A
	0	30000	-.07	_____	.07	N/A	N/A
	0	300000	-.8	_____	.8	N/A	N/A
	0	3000000	-14	_____	14	N/A	N/A
	0	30000000	-830	_____	830	N/A	N/A
	10	30	9.99585	_____	10.00415	.0002	>10:1
	100	300	99.991	_____	100.009	.0015	6:1
	1000	3000	999.943	_____	1000.057	.0085	7:1
	10000	30000	9999.43	_____	10000.57	.085	7:1
	100000	300000	99994.2	_____	100005.8	.85	7:1
	1000000	3000000	999921	_____	1000079	14	6:1
	10000000	30000000	9995170	_____	10004830	600	8:1
Frequency Test (Values in Hz)							
4-5	20	Auto	19.99	_____	20.01	.0000036	>10:1
	1000000	Auto	999900	_____	1000100	.18	>10:1

5 Adjustments

Introduction

This chapter contains procedures for adjusting the HP E1410A multimeter. For best performance, the instrument should be adjusted after repair. All adjustments are performed electrically, so manual adjustment of the multimeter is not necessary.

WARNING

Do not perform any of the following adjustments unless you are a qualified, service-trained technician, and have read the WARNINGS and CAUTIONS in Chapter 1.

NOTE

Adjustment procedures should be performed in the order shown in this manual.

Adjustment Conditions/ Procedures

For valid adjustments, the HP E1410A multimeter must have at least a 60 minute warm-up. For best accuracy, the temperature of the area where adjustments are made should be between 18°C and 28°C and stable to within ±1°C. Consult Chapter 4 for information on setting the line frequency reference and connecting the guard terminal. See Table 1-1, *Recommended Test Equipment*, for test equipment requirements.

Calibration Number (CAL:NUMB?)

The CAL:NUMB? command provides you with a method of monitoring the number of adjustments performed. The instrument will respond to the CAL:NUMB? command by returning the number of calibration RAM entries completed since factory initialization. The calibration number increments for each adjustment point. The adjustment procedure described in this chapter will increase the calibration number by 45. Note that the autocal commands (CAL:INT? and *CAL?) do not affect the calibration number.

Calibration Security

Calibration security must be disabled before the multimeter will accept any adjustment. The following command disables calibration security: CAL:SEC OFF, <security code>. The security code is set to '1410' at the factory.

Calibration security is enabled by cycling power or by sending either of the following commands:

- CAL:SEC ON,<security code>
- *RST

NOTE *The security code is optional for the CAL:SEC ON command.*

Overriding Calibration Security

Calibration security can also be disabled by shorting R202 to ground on assembly A1 (see Figure 5-1). Calibration will remain unsecured as long as the jumper is present. Since it is not advisable to disassemble the multimeter, the jumper should usually only be used if the security code is not known. See Chapter 8 for disassembly/reassembly instructions.

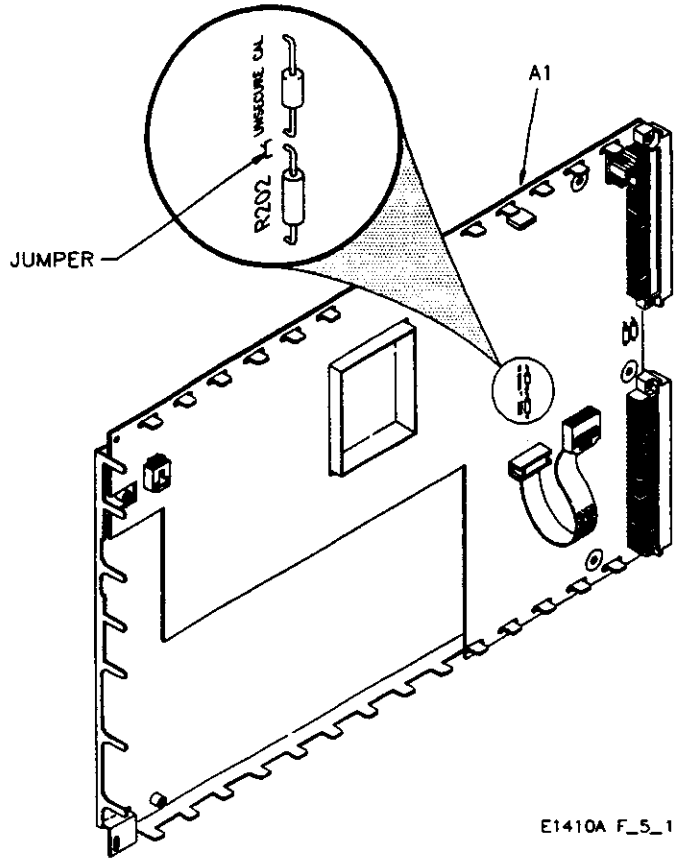


Figure 5-1. Overriding Calibration Security

Checking Calibration Security State

The current state of calibration security can be found by using the CAL:SEC? command. A '1' is returned if calibration security is enabled, and a '0' is returned if calibration security is disabled.

Example

This example checks calibration security status.

```
10 OUTPUT 70903;"CAL:SEC?"          Query cal security state
20 ENTER 70903;A
30 PRINT A
40 END
```

Changing the Security Code

The security code can be changed with the following procedure. The code must be a signed 32-bit integer, that is, between -2147483648 and +2147483647.

1. Disable calibration security:

   CAL:SEC OFF, <security code>

   where <security code> = current value.

2. Set security code to new value:

   CAL:SEC:CODE <security code>

   where <security code> = new value.

3. Enable calibration security:

   CAL:SEC ON, <security code>

Example

The following example changes the security code from '1410' to '0141'.

```
10 OUTPUT 70903;"*RST"
20 OUTPUT 70903;"CAL:SEC OFF,1410"     Disable cal security
30 OUTPUT 70903;"CAL:SEC:CODE 0141"    Change code to 0141
40 OUTPUT 70903;"CAL:SEC ON,0141"      Enable cal security
50 END
```

Protected User Data (*PUD)

The E1410A has a 63 byte Protected User Data (PUD) storage location that allows the user to store up to 63 characters of information pertaining to this instrument. To read the information, send the command: *PUD?. To load new information, disable the calibration security feature as described above. Then send the command: *PUD <block>, where <block> is the information to be stored.

Since the E1410A does not know how many bytes of information to expect, it must be told when to terminate. In HP BASIC, this can be accomplished by either of the following methods:

Precede the data with '#0' and follow the data with ',END'. For example:

```
OUTPUT 70903;"*PUD #0LAST CAL 11/19/90 AT 25degC",END
```

Precede the data by '#NL', where L is the number of characters (including spaces) to be sent, and N is the number of digits in L. For example:

```
OUTPUT 70903;"*PUD #227LAST CAL 11/19/90 AT 25degC"
```

Example

The following example writes a string to Protected User Data (PUD) storage. The PUD contents are read before and after the string is sent.

```
10  DIM A$[100],B$[100]
20  OUTPUT 70903;"*RST"
30  OUTPUT 70903;"*PUD?"                    Read current PUD contents
40  ENTER 70903;A$
50  PRINT A$
60  !
70  OUTPUT 70903;"CAL:SEC OFF,1410"         Disable security
80  OUTPUT 70903;"*PUD #227LAST CAL 11/19/90 AT 25degC"
90  OUTPUT 70903;"CAL:SEC ON,1410"          Enable security
100 !
110 OUTPUT 70903;"*PUD?"                    Read new PUD contents
120 ENTER 70903;B$
130 PRINT B$
140 END
```

DC Voltage Adjustment Procedure

This procedure sets the DC voltage offset and gain calibration constants for each range. The adjustments should be performed in the order given, with offset adjustments starting at the high range and gain adjustments starting at the low range.

Calibration values sent to the multimeter should meet the following conditions:

- For offset adjustments, the calibration value must be less than +/- 0.0033% of full-scale. For example, at the 3 V range, the value sent must be less than +/- 99 μV. For a good low thermal short, the value should be 0.
- For gain adjustments, the calibration value should be no less than 1/3 of full-scale and no greater than 101% of full-scale. For best results, set the calibration value to full-scale.

DC Voltage Offset Adjustment

1. Connect a low thermal short across the HI and LO terminals of the E1410A (Figure 5-2).

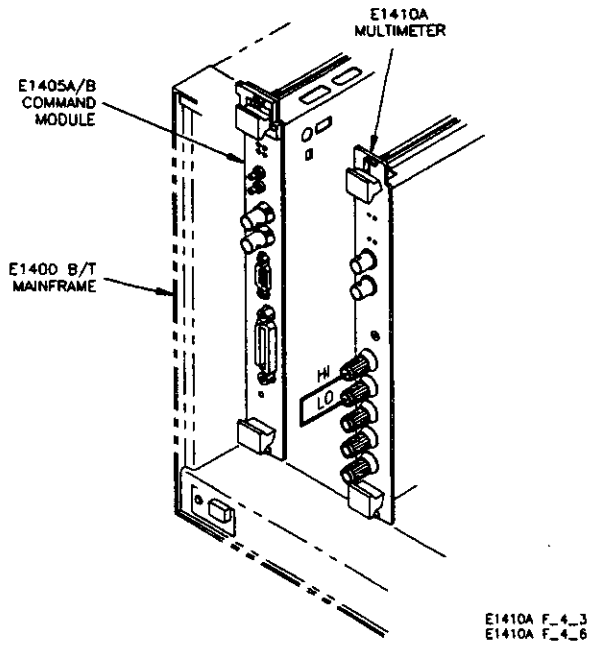


Figure 5-2. DC Voltage Offset Adjustment Setup

2. Set up the HP E1410A as follows:

   - Reset the multimeter ..... *RST
   - Set the function ..... FUNC:VOLT:DC

3. Prepare the HP E1410A for calibration:

   - Set the range ..... VOLT:RANG 300
   - Enable cal ..... CAL:SEC OFF, <security code>
   - Send input value ..... CAL:VALUE 0

4. Check to see if the last command has been completed using the *OPC? command. Read the result; a 1 indicates that the operation has been completed.

5. Perform the adjustment by sending the CAL? command and reading the result.

   - A zero indicates that the adjustment was accepted.
   - A non-zero result indicates that an error has occurred. Send the SYST:ERR? command and read the result. See Chapter 5 of the *HP E1410A User's Manual* for details.

NOTE

The CAL? command may take 30 seconds or more to execute for some ranges.

---

6. Repeat steps 3 through 5 for the following ranges: 30 V, 3 V, 300 mV, and 30 mV.

DC Voltage Gain Adjustment

1. Connect the DC Standard output across the HI and LO terminals of the E1410A as shown in Figure 5-3.

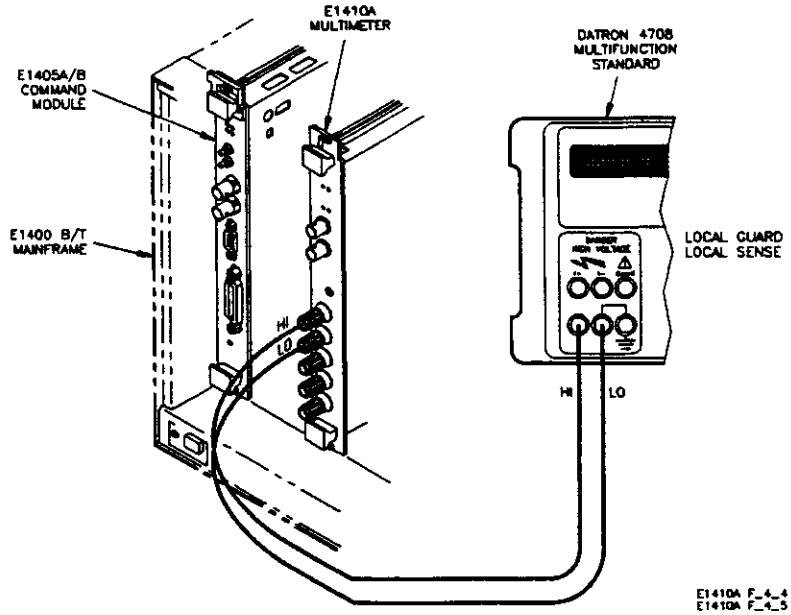


Figure 5-3. DC Voltage Gain Adjustment Setup

2. Set up the HP E1410A as follows:

   - Reset the multimeter ..... *RST
   - Set the function ..... FUNC:VOLT:DC

3. Set the DC Standard output to 30 mV.

4. Prepare the HP E1410A for calibration:

   - Set the range ..... VOLT:RANGE .03
   - Enable cal ..... CAL:SEC OFF, <security code>
   - Send input value .... CAL:VALUE <input voltage>

5. Check to see if the last command has been completed using the *OPC? command. Read the result; a 1 indicates that the operation has been completed.

6. Perform the adjustment by sending the CAL? command and reading the result.

   - A zero indicates that the adjustment was accepted.
   - A non-zero result indicates that an error has occurred. Send the SYST:ERR? command and read the result. See Chapter 5 of the *HP E1410A User's Manual* for details.

NOTE

The CAL? command may take 30 seconds or more to execute for some ranges.

7. Repeat steps 3 through 6 for the ranges and inputs given below.

E1410A Range	DC Standard Output
30 mV	30 mV
300 mV	300 mV
3 V	3 V
3 V	-3 V
30 V	30 V
300 V	300 V

NOTE

The -3 V adjustment sets the calibration constant for A/D conversion. For this step, the input must be EXACTLY equal and opposite to the preceding input. To ensure this condition, reverse the leads going into the HI and LO terminals of the E1410A, rather than setting the source to the negative voltage.

Example: DC Voltage Adjustments

This example performs DCV offset and gain adjustments on all ranges. Change the values in line 60 if you are using different input voltages.

```
10  OPTION BASE 1
20  DIM Range(11),Cal_input(11)
30  DIM Message$[256]
40  DATA 300,30,3,.3,.03,.03,.3,3,3,30,300
50  READ Range(*)
60  DATA 0,0,0,0,0,.03,.3,3,-3,30,300
70  READ Cal_input(*)
80  OUTPUT 70903;"*RST"                    Reset multimeter
90  OUTPUT 70903;"FUNC:VOLT:DC"            Set to DCV
100 DISP "Connect low thermal short to E1410A terminals"
```

```
110 PAUSE
120 FOR I=1 TO 11
130  IF I=6 THEN
140   DISP "Set DC Standard to";Cal_input(I);"Volts"
150   PAUSE
160  END IF
170  OUTPUT 70903;"VOLT:RANG ";Range(I)   Set multimeter range
180  OUTPUT 70903;"CAL:SEC OFF,1410"   Enable calibration
190  OUTPUT 70903;"CAL:VALUE ";Cal_input(I)   Enter input value
200  OUTPUT 70903;"*OPC?"   Wait for operation complete
210  ENTER 70903;A
220  OUTPUT 70903;"CAL?"   Perform adjustment
230  ENTER 70903;Cal_result
240  IF Cal_result=0 THEN
250   PRINT "Calibration successful on";Range(I);"Volt range."
260  ELSE
270   REPEAT
280    OUTPUT 70903;"SYST:ERR?"
290    ENTER 70903;Code,Message$
300    PRINT Code,Message$
310   UNTIL Code=0
320   OUTPUT 70903;"*CLS"
330  END IF
340  DISP "Press 'Continue' when ready"
350  PAUSE
360  DISP
370 NEXT I
380 END
```

AC Voltage Adjustment Procedure

This procedure sets the AC voltage gain calibration constants for each range, as well as the common offset calibration constant. The adjustments should be performed in the order given. The 3 V range must be done first, because the offset calibration constant for all AC voltage ranges is calculated at the 3 V range.

Calibration values sent to the multimeter should meet the following conditions:

- For gain adjustments, the calibration value should be between 80% of full-scale and 108.3% of full-scale. For best results, set the calibration value to full-scale.
- The source frequency should be 1 kHz +/- 100 Hz.
- CAL:INT? AC or CAL:INT? ALL should be performed within 1 hour of any AC voltage adjustments.

AC Voltage Gain Adjustment

1. Connect the AC Standard output across the HI and LO terminals of the E1410A as shown in Figure 5-4.
2. Set up the HP E1410A as follows:
   - Reset the multimeter ..... *RST
   - Set the function ..... FUNC:VOLT:AC

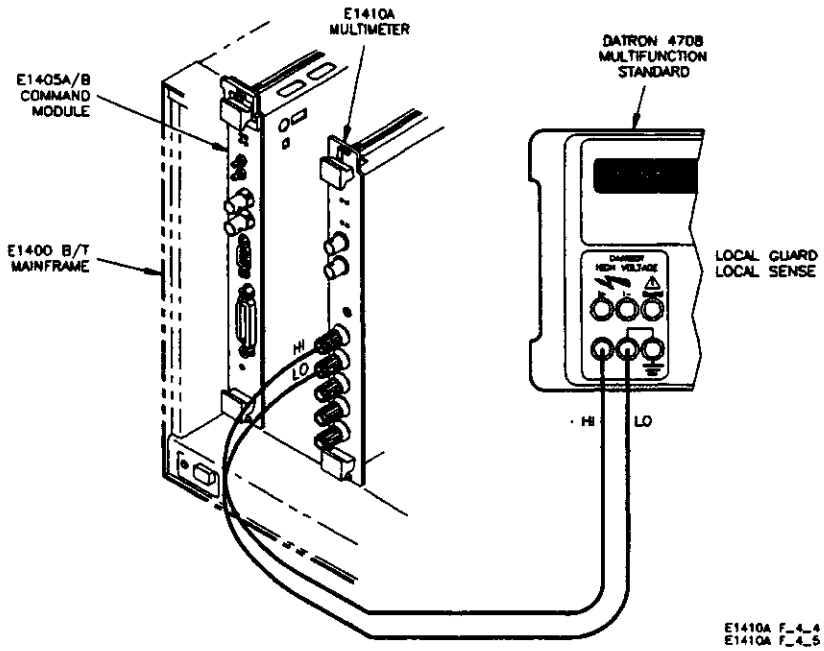


Figure 5-4. AC Voltage Adjustment Setup

3. Set the AC Standard output to 3 V.

4. Prepare the HP E1410A for calibration:

   - Set the range ..... VOLT:RANG 3
   - Enable cal ..... CAL:SEC OFF,<security code>
   - Send input value ..... CAL:VALUE <input voltage>

5. Check to see if the last command has been completed using the *OPC? command. Read the result; a 1 indicates that the operation has been completed.

6. Perform the adjustment by sending the CAL? command and reading the result.

   - A zero indicates that the adjustment was accepted.
   - A non-zero result indicates that an error has occurred. Send the SYST:ERR? command and read the result. See Chapter 5 of the *HP E1410A User's Manual* for details.

NOTE *The CAL? command may take 30 seconds or more to execute for some ranges.*

---

7. Repeat steps 3 through 6 for the ranges and inputs given below.

E1410A Range	AC Standard Output	
	Voltage	Frequency
3 V	3 V	1 kHz
30 mV	30 mV	1 kHz
300 mV	300 mV	1 kHz
30 V	30 V	1 kHz
300 V	300 V	1 kHz

Example: AC Voltage Adjustments

This example performs ACV adjustments on all ranges. Change the values in line 60 if you are using different input voltages.

```
10  OPTION BASE 1
20  DIM Range(5),Cal_input(5)
30  DIM Message$[256]
40  DATA 3,.03,.3,30,300
50  READ Range(*)
60  DATA 3,.03,.3,30,300
70  READ Cal_input(*)
80  OUTPUT 70903;"*RST"                    Reset multimeter
90  OUTPUT 70903;"CAL:INT? AC"             Perform AC autocal
100 ENTER 70903;Acal_result
110 IF Acal_result < >0 THEN
120   PRINT "Autocal error: ";Acal_result
130 END IF
140 OUTPUT 70903;"FUNC:VOLT:AC"            Set to ACV function
150 FOR I = 1 TO 5
160   DISP "Set AC Standard to";Cal_input(I);"Volts"
170   PAUSE
180   DISP
190   OUTPUT 70903;"VOLT:RANG ";Range(I)   Set multimeter range
200   OUTPUT 70903;"CAL:SEC OFF,1410"      Enable calibration
210   OUTPUT 70903;"CAL:VALUE ";Cal_input(I)  Enter input value
220   OUTPUT 70903;"*OPC?"                 Wait for operation complete
230   ENTER 70903;A
240   OUTPUT 70903;"CAL?"                  Perform adjustment
250   ENTER 70903;Cal_result
260   IF Cal_result = 0 THEN
270     PRINT "Calibration successful on";Range(I);"Volt range."
280   ELSE
290     REPEAT
300       OUTPUT 70903;"SYST:ERR?"
310       ENTER 70903;Code,Message$
320       PRINT Code,Message$
330     UNTIL Code = 0
340     OUTPUT 70903;"*CLS"
350   END IF
360   DISP "Press 'Continue' when ready"
370   PAUSE
390 NEXT I
400 END
```

2-Wire Ohms Adjustment Procedure

This procedure sets the 2-wire ohms offset and gain calibration constants for each range. The adjustments should be performed in the order given, with offset adjustments starting at the high range and gain adjustments starting at the low range.

Calibration values sent to the multimeter should meet the following conditions:

- For offset adjustments, the calibration value must be less than +/- 0.0033% of full-scale. For example, at the 3 kΩ range, the value sent should be less than +/- 99 mΩ. For a good low thermal short, the value should be 0.
- For gain adjustments, the calibration value should be between 1/3 of full-scale and full-scale. If full-scale inputs are used, make sure that the total resistance (including lead resistance and internal source resistances) does not exceed 101% of full-scale.
- CAL:INT? RES or CAL:INT? ALL should be performed within 1 hour of any resistance adjustments.

2-Wire Ohms Offset Adjustment

1. Connect a low thermal short across the HI and LO terminals of the E1410A (Figure 5-5).

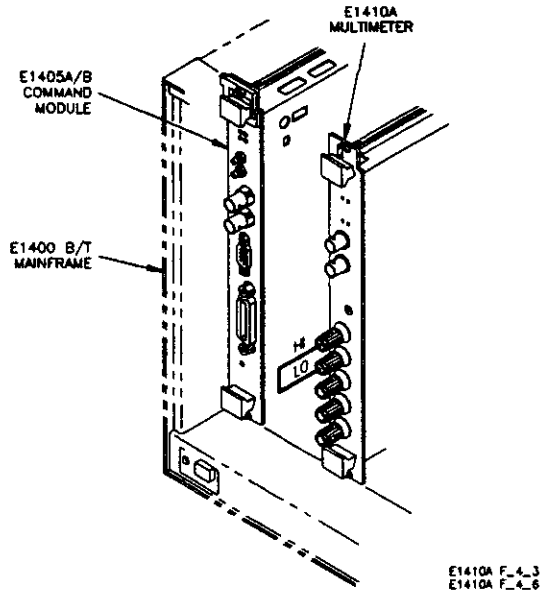


Figure 5-5. 2-Wire Ohms Offset Adjustment Setup

2. Set up the HP E1410A as follows:

   - Reset the multimeter ..... *RST
   - Set the function ..... FUNC:RES
   - Disable offset compensation ..... RES:OCOM OFF
   - Set trigger delay ..... TRIG:DEL .5

3. Prepare the HP E1410A for adjustment:

   - Set the range to 30 MΩ ..... RES:RANG 3E7
   - Enable cal ..... CAL:SEC OFF,<security code>
   - Send input value ..... CAL:VALUE 0

4. Check to see if the last command has been completed using the *OPC? command. Read the result; a 1 indicates that the operation has been completed.

5. Perform the adjustment by sending the CAL? command and reading the result.

   - A zero indicates that the adjustment was accepted.
   - A non-zero result indicates that an error has occurred. Send the SYST:ERR? command and read the result. See Chapter 5 of the *HP E1410A User's Manual* for details.

NOTE

The CAL? command may take 30 seconds or more to execute for some ranges.

---

6. Repeat steps 1 through 3 for the following ranges: 3 MΩ, 300 kΩ, 30 kΩ, 3 kΩ, 300 Ω, 30 Ω.

2-Wire Ohms Gain Adjustment

This procedure can be performed without using a transfer standard DMM, if desired.

1. Set up the HP E1410A as follows:

   - Reset the multimeter ..... *RST
   - Set the function ..... FUNC:RES
   - Enable offset compensation ..... RES:OCOM ON
   - Set trigger delay ..... TRIG:DEL .5

2. Set the Resistance Standard output to 10 Ω (nominal).

3. Measure the output of the Resistance Standard with the Transfer Standard DMM as shown in Figure 5-6 (optional). The Transfer Standard settings (offset compensation, auto-zero, etc.) and guarding should be identical to those used for the HP E1410A.

NOTE

The Transfer Standard measurement should be taken at the ends of the test leads, as shown in Figure 5-6, so that the resistance of the test leads and the internal resistances of the source are included in the measurement.

---

4. Disconnect the transfer standard. Connect the Resistance Standard output across the HI and LO terminals of the E1410A as indicated by the dotted lines in Figure 5-6.

5. Prepare the HP E1410A for adjustment:

   - Set the range to 30 Ω ..... RES:RANG 30
   - Enable cal ..... CAL:SEC OFF,<security code>
   - Send input value ..... CAL:VALUE <resistance>

6. Check to see if the last command has been completed using the *OPC? command. Read the result; a 1 indicates that the operation is completed.

7. Perform the adjustment by sending the CAL? command and reading the result.

   - A zero indicates that the adjustment was accepted.
   - A non-zero result indicates that an error has occurred. Send the SYST:ERR? command and read the result. See Chapter 5 of the *HP E1410A User's Manual* for details.

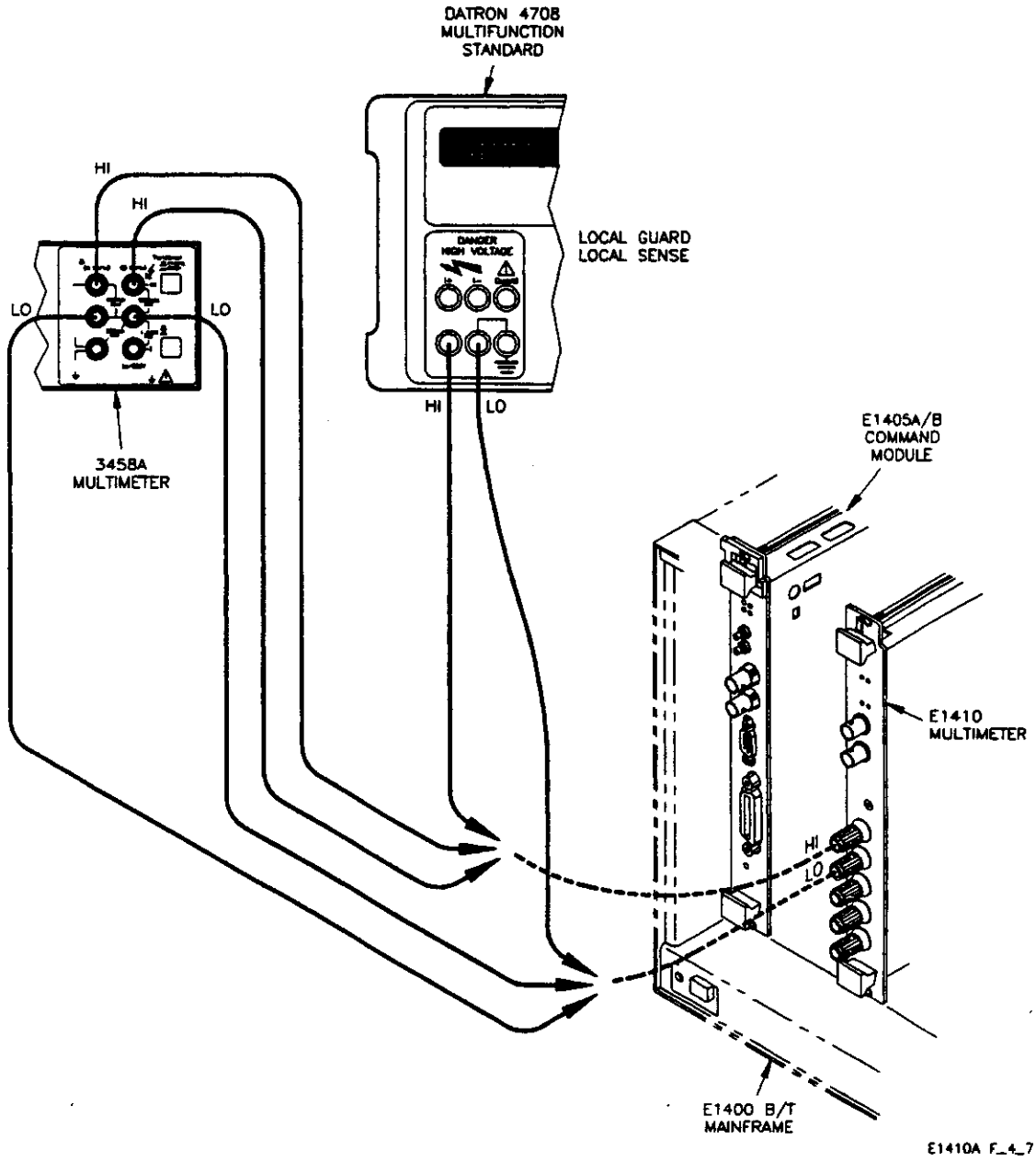


Figure 5-6. 2-Wire Ohms Gain Adjustment Setup

NOTE

The CAL? command may take 30 seconds or more to execute for some ranges.

8. Repeat steps 2 through 7 for the ranges and inputs given below.

E1410A Range	Resistance Standard Output
30 Ω	10 Ω
300 Ω	100 Ω
3 kΩ	1 kΩ
30 kΩ	10 kΩ
300 kΩ	100 kΩ
3 MΩ	1 MΩ
30 MΩ	10 MΩ

9. Perform a CAL:INT? RES or a CAL:INT? ALL immediately after the 30 MΩ range adjustment in order to automatically adjust the 300 MΩ and 3 GΩ ranges.

Example: 2-Wire Ohms Adjustments

This example performs 2-wire ohms offset and gain adjustments on all ranges. Change the values in line 80 if you are using different input resistances.

```
10  OPTION BASE 1
20  DIM Range(14),Cal_input(14)
30  DIM Message$[256]
40  DATA 3.E7,3.E6,3.E5,3.E4,3.E3,300,30
50  DATA 30,300,3.E3,3.E4,3.E5,3.E6,3.E7
60  READ Range(*)
70  DATA 0,0,0,0,0,0,0
80  DATA 10,100,1.E3,1.E4,1.E5,1.E6,1.E7
90  READ Cal_input(*)
100 OUTPUT 70903;"*RST"                    Reset multimeter
110 OUTPUT 70903;"CAL:INT? ALL"            Perform autocal
120 ENTER 70903;Acal_result
130 IF Acal_result< >0 THEN
140   PRINT "Autocal error: ";Acal_result
150 END IF
160 OUTPUT 70903;"FUNC:RES"                Select 2-wire ohms
170 OUTPUT 70903;"TRIG:DEL .5"             Set trigger delay to .5 sec
180 DISP "Connect two-wire low thermal short to E1410A terminals"
190 PAUSE
200 DISP
```

```
210  FOR I=1 TO 14
220   IF I=8 THEN
230    OUTPUT 70903;"RES:OCOM ON"        Turn offset comp ON
240    DISP "Set Resistance Standard to";Cal_input(I);"Ohms"
250    PAUSE
260    DISP
270   END IF
280   OUTPUT 70903;"RES:RANG ";Range(I)      Set multimeter range
290   OUTPUT 70903;"CAL:SEC OFF,1410"    Enable calibration
300   OUTPUT 70903;"CAL:VALUE ";Cal_input(I)    Enter input value
310   OUTPUT 70903;"*OPC?"               Wait for operation complete
320   ENTER 70903;A
330   OUTPUT 70903;"CAL?"                Perform adjustment
340   ENTER 70903;Cal_result
350   IF Cal_result=0 THEN
360    PRINT "Calibration successful on";Range(I);"Ohm range."
370   ELSE
380    REPEAT
390     OUTPUT 70903;"SYST:ERR?"
400     ENTER 70903;Code,Message$
410     PRINT Code,Message$
420    UNTIL Code=0
430    OUTPUT 70903;"*CLS"
440   END IF
450   DISP "Press 'Continue' when ready"
460   PAUSE
470   DISP
480  NEXT I
490  DISP "Disconnect source from E1410A terminals, press 'Continue'"
500  PAUSE
510  OUTPUT 70903;"CAL:INT? ALL"        Adjust extended ranges
520  ENTER 70903;Acal_result
530  IF Acal_result<>0 THEN
540   PRINT "Autocal error: ";Acal_result
550  END IF
560  DISP
570  END
```

4-Wire Ohms Adjustment Procedure

This procedure sets the 4-wire ohms offset and gain calibration constants for each range. The adjustments should be performed in the order given, with offset adjustments starting at the high range and gain adjustments starting at the low range.

Calibration values sent to the multimeter should meet the following conditions:

- For offset adjustments, the calibration value must be less than +/- 0.0033% of full-scale. For example, at the 3 kΩ range, the value sent must be less than +/- 99 mΩ. For a good low thermal short, the value should be 0.
- For gain adjustments, the calibration value should be no less than 1/3 of full-scale and no greater than 101% of full-scale.
- A CAL:INT? RES or CAL:INT? ALL should be performed within 1 hour of any resistance adjustments.

4-Wire Ohms Offset Adjustment

1. Connect a 4-wire low thermal short across the terminals of the E1410A as shown in Figure 5-7.

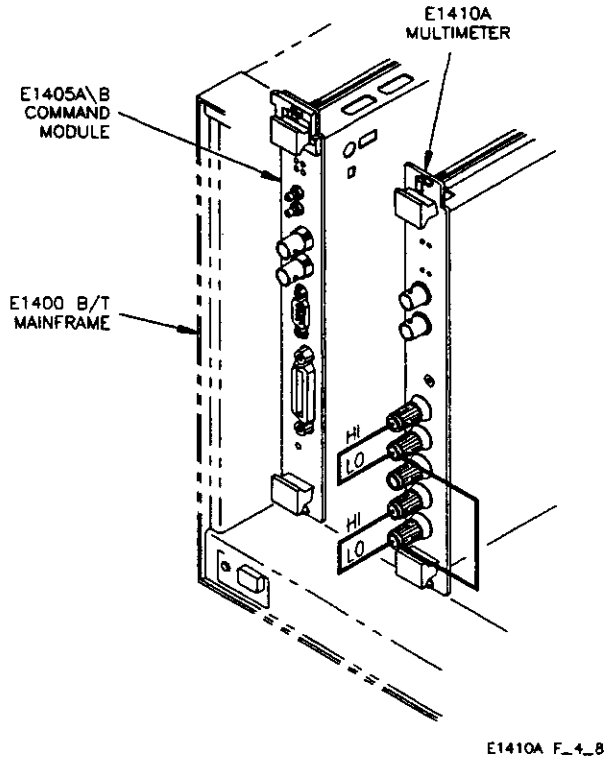


Figure 5-7. 4-Wire Ohms Offset Adjustment Setup

2. Set up the HP E1410A as follows:

   - Reset the multimeter ..... *RST
   - Set the function ..... FUNC:FRES
   - Disable offset compensation ..... RES:OCOM OFF
   - Set trigger delay ..... TRIG:DEL .5

3. Prepare the HP E1410A for adjustment:

   - Set the range to 30 MΩ ..... RES:RANG 3E7
   - Enable cal ..... CAL:SEC OFF,<security code>
   - Send input value ..... CAL:VALUE <resistance>

4. Check to see if the last command has been completed using the *OPC? command. Read the result; a 1 indicates that the operation is completed.

5. Perform the adjustment by sending the CAL? command and reading the result.

   - A zero indicates that the adjustment was accepted.
   - A non-zero result indicates that an error has occurred. Send the SYST:ERR? command and read the result. See Chapter 5 of the *HP E1410A User's Manual* for details.

NOTE

The CAL? command may take 30 seconds or more to execute for some ranges.

---

6. Repeat steps 3 through 5 for the following ranges: 3 MΩ, 300 kΩ, 30 kΩ, 3 kΩ, 300 Ω, 30 Ω.

4-Wire Ohms Gain Adjustment

This procedure can be performed without using a transfer standard DMM, if desired.

1. Set up the HP E1410A as follows:

   - Reset the multimeter ..... *RST
   - Set the function ..... FUNC:FRES
   - Enable offset compensation ..... RES:OCOM ON
   - Set trigger delay ..... TRIG:DEL .5

2. Set the Resistance Standard output to 10 Ω (nominal).

3. Measure the output of the Resistance Standard with the Transfer Standard DMM as shown in Figure 5-8(a) (optional). The Transfer Standard settings (offset compensation, auto-zero, etc.) and guarding should be identical to those used for the HP E1410A.

4. Disconnect the Transfer Standard. Using the same test leads, connect the Resistance Standard output to the terminals of the E1410A as shown in Figure 5-8(b).

5. Prepare the HP E1410A for adjustment:

   - Set the range to 30 Ω ..... RES:RANG 30
   - Enable cal ..... CAL:SEC OFF,<security code>
   - Send input value ..... CAL:VALUE <resistance>

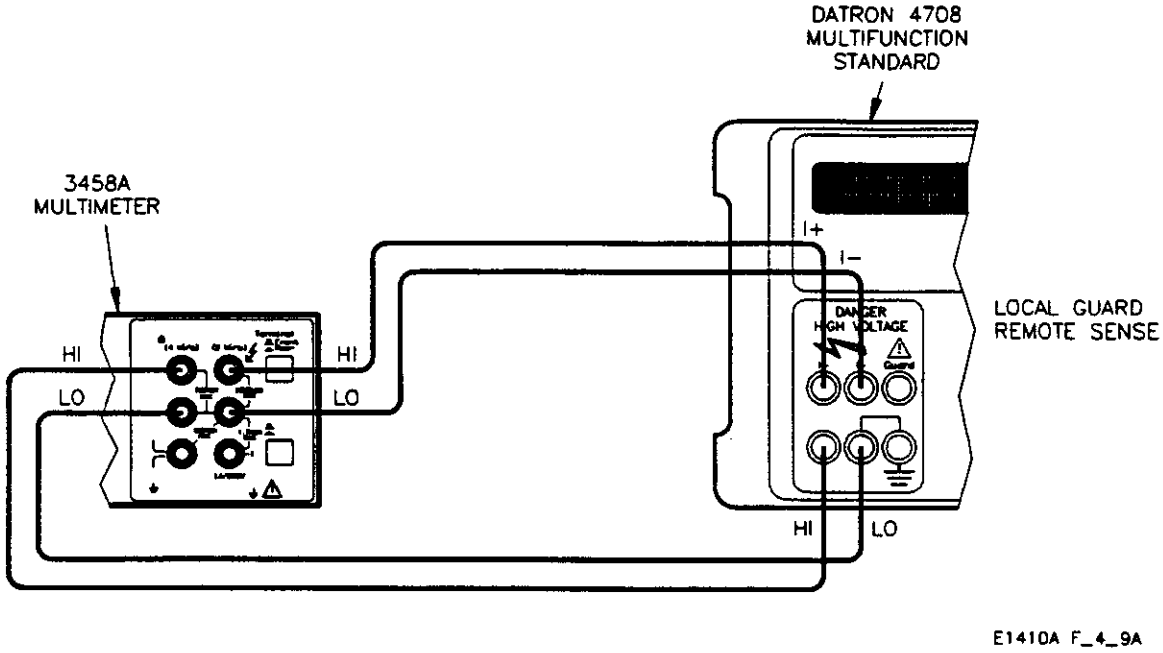
6. Check to see if the last command has been completed using the *OPC? command. Read the result; a 1 indicates that the operation has been completed.

7. Perform the adjustment by sending the CAL? command and reading the result.

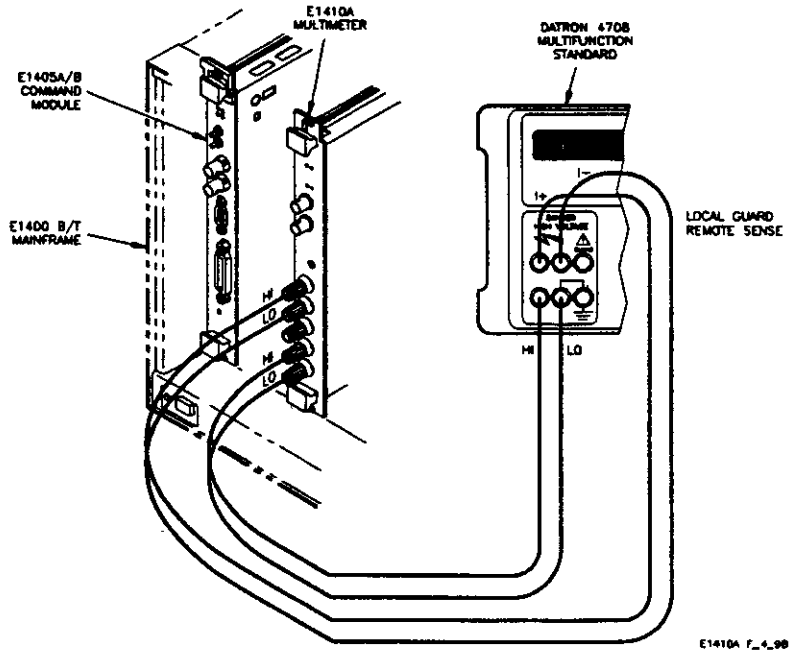
   - A zero indicates that the adjustment was accepted.
   - A non-zero result indicates that an error has occurred. Send the SYST:ERR? command and read the result. See Chapter 5 of the *HP E1410A User's Manual* for details.

NOTE

The CAL? command may take 30 seconds or more to execute for some ranges.



(a)



(b)

Figure 5-8. 4-Wire Ohms Gain Adjustment Setup

8. Repeat steps 2 through 7 for the ranges and inputs given below.

E1410A Range	Resistance Standard Output
30 Ω	10 Ω
300 Ω	100 Ω
3 kΩ	1 kΩ
30 kΩ	10 kΩ
300 kΩ	100 kΩ
3 MΩ	1 MΩ
30 MΩ	10 MΩ

Example: 4-Wire Ohms Adjustments

This example performs 4-wire ohms offset and gain adjustments on all ranges. Change the values in line 80 if you are using different input resistances.

```
10  OPTION BASE 1
20  DIM Range(14),Cal_input(14)
30  DIM Message$[256]
40  DATA 3.E7,3.E6,3.E5,3.E4,3.E3,300,30
50  DATA 30,300,3.E3,3.E4,3.E5,3.E6,3.E7
60  READ Range(*)
70  DATA 0,0,0,0,0,0,0
80  DATA 10,100,1.E3,1.E4,1.E5,1.E6,1.E7
90  READ Cal_input(*)
100  OUTPUT 70903;"*RST"                    Reset multimeter
120  OUTPUT 70903;"CAL:INT? ALL"            Perform autocal
130  ENTER 70903;Acal_result
140  IF Acal_result< >0 THEN
150   PRINT "Autocal error: ";Acal_result
160  END IF
170  OUTPUT 70903;"FUNC:FRES"               Select 4-wire ohms
180  OUTPUT 70903;"TRIG:DEL .5"             Set trigger delay to .5 sec
190  DISP "Connect a 4-wire low thermal short to E1410A terminals"
200  PAUSE
210  DISP
220  FOR I=1 TO 14
230   IF I=8 THEN
240    OUTPUT 70903;"RES:OCOM ON"           Turn offset comp ON
250    DISP "Set Resistance Standard to";Cal_input(I);"Ohms"
260    PAUSE
270    DISP
280   END IF
```

```
290  OUTPUT 70903;"RES:RANG ";Range(I)      Set multimeter range
300  OUTPUT 70903;"CAL:SEC OFF,1410"   Enable calibration
310  OUTPUT 70903;"CAL:VALUE ";Cal_input(I)     Enter input value
320  OUTPUT 70903;"*OPC?"                  Wait for operation complete
330  ENTER 70903;A
340  OUTPUT 70903;"CAL?"                   Perform adjustment
350  ENTER 70903;Cal_result
360  IF Cal_result=0 THEN
370   PRINT "Calibration successful on";Range(I);"Ohm range."
380  ELSE
390   REPEAT
400    OUTPUT 70903;"SYST:ERR?"
410    ENTER 70903;Code,Message$
420    PRINT Code,Message$
430   UNTIL Code=0
440   OUTPUT 70903;"*CLS"
450  END IF
460  DISP "Press 'Continue' when ready"
470  PAUSE
480 NEXT I
490 END
```

Frequency Adjustment Procedure

This procedure sets the frequency calibration constant for the multimeter.

For best results, keep the following guidelines in mind:

- The calibration value must be between 900 Hz and 1 MHz.
- The source voltage should be between 80% of full-scale and full-scale. Any voltage range may be used, but the 3 V range produces the best results.
- CAL:INT? AC or CAL:INT? ALL must be performed within 1 hour of any Frequency adjustments.

Frequency Gain Adjustment

1. Connect the Frequency Standard output across the HI and LO terminals of the E1410A as shown in Figure 5-9.

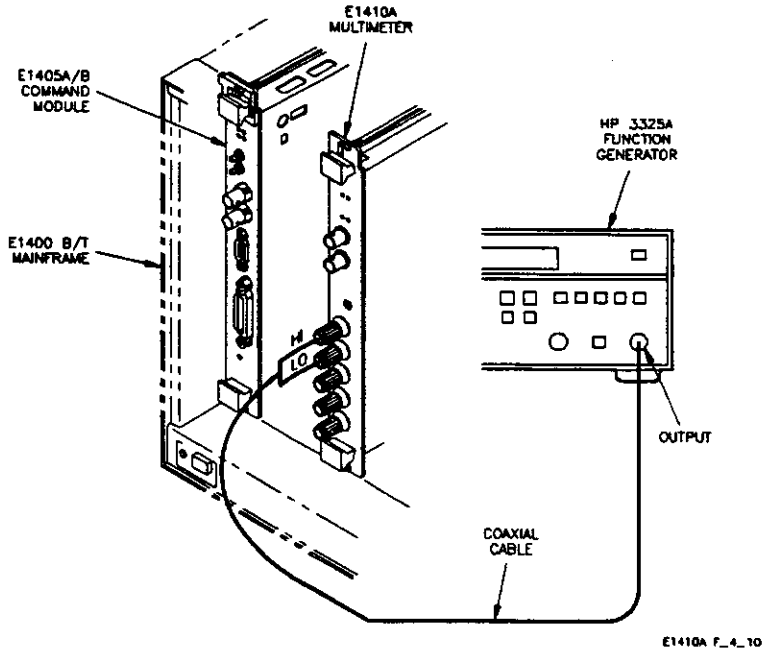


Figure 5-9. Frequency Counter Adjustment Setup

2. Set the Frequency Standard as follows:

- Set the voltage ..... 3 V sinewave
- Set the frequency ..... 1 kHz

NOTE

Other input frequencies and voltages may be used, as long as they meet the requirements listed at the beginning of this section.

3. Set up the HP E1410A as follows:

   - Reset the multimeter ..... *RST
   - Set the function ..... FUNC:FREQ

4. Prepare the HP E1410A for adjustment using the following commands:

   - Set the range to 3 V ..... VOLT:RANGE 3
   - Enable cal ..... CAL:SEC OFF,<security code>
   - Send input value ..... CAL:VALUE <frequency>

5. Check to see if the last command has been completed using the *OPC? command. Read the result; a 1 indicates that the operation has been completed.

6. Perform the adjustment by sending the CAL? command and reading the result.

   - A zero indicates that the adjustment was accepted.
   - A non-zero result indicates that an error has occurred. Send the SYST:ERR? command and read the result. See Chapter 5 of the *HP E1410A User's Manual* for details.

NOTE

The CAL? command may take 30 seconds or more to execute for some ranges.

Example: Frequency Adjustment

This example adjusts the multimeter's frequency counter. Change the value in line 140 if you are using a different input frequency.

```
10  DIM Message$[256]
20  OUTPUT 70903;"*RST"                          Reset multimeter
30  OUTPUT 70903;"CAL:INT? AC"                   Perform AC autocal
40  ENTER 70903;Acal_result
50  IF Acal_result< >0 THEN
60   PRINT "Autocal error: ";Acal_result
70  END IF
80  DISP "Connect 3 V rms, 1 kHz sinewave to E1410A terminals"
90  PAUSE
100 DISP
110 OUTPUT 70903;"FUNC:FREQ"                     Select frequency function
120 OUTPUT 70903;"VOLT:RANG 3"                   Set multimeter range
130 OUTPUT 70903;"CAL:SEC OFF,1410"              Enable calibration
140 OUTPUT 70903;"CAL:VALUE 1000"                Enter input frequency
150 OUTPUT 70903;"*OPC?"                         Wait for operation complete
160 ENTER 70903;A
170 OUTPUT 70903;"CAL?"                          Perform adjustment
180 ENTER 70903;Cal_result
190 IF Cal_result=0 THEN
200  PRINT "Calibration successful"
210 ELSE
220  REPEAT
230   OUTPUT 70903;"SYST:ERR?"
240   ENTER 70903;Code,Message$
250   PRINT Code,Message$
260  UNTIL Code=0
270  OUTPUT 70903;"*CLS"
280 END IF
290 END
```

6
Replaceable Parts

Introduction

This chapter contains information for ordering replaceable parts for the HP E1410A multimeter.

Exchange Assemblies

Table 6-1 lists assemblies that may be replaced on an exchange basis (EXCHANGE ASSEMBLIES). Exchange, factory-repaired and tested assemblies are available only on a trade-in basis. Defective assemblies must be returned for credit. Assemblies required for spare parts stock must be ordered by the new assembly part number. Contact your nearest Hewlett-Packard Sales and Service Office for details.

Ordering Information

To order a part listed in Table 6-1, specify the Hewlett-Packard part number and the quantity required. Send the order to your nearest Hewlett-Packard Sales and Service Office.

Replaceable Parts List

Table 6-1 lists the replaceable parts for the HP E1410A multimeter. See Figure 6-1 for locations of parts listed in Table 6-1.

Table 6-1. HP E1410A Replaceable Parts

Reference* Designator	HP Part Number	Qty	Description	Mfr** Code	Mfr Part Number
			EXCHANGE ASSEMBLIES		
	E1410-66201	1	MULTIMETER MODULE (NEW)	28480	E1410-66201
	E1410-69201	1	MULTIMETER MODULE (EXCHANGE)	28480	E1410-69201
A1	E1410-66501	1	PC ASSY-DIGITAL [a]	28480	E1410-66501
A1F101	2110-0698	2	FUSE-SUBMINIATURE 2.5A 125V NTD AX	75915	R25102.5T1
A1F102	2110-0698		FUSE-SUBMINIATURE 2.5A 125V NTD AX	75915	R25102.5T1
A1J100	1251-4756	1	CONN-POST TYPE .100-PIN-SPCG 12-CONT	00779	87227-6
A1J100A	1258-0141	3	JUMPER-REMOVABLE	18873	65474-004
A1J100B	1258-0141		JUMPER-REMOVABLE	18873	65474-004
A1J100C	1258-0141		JUMPER-REMOVABLE	18873	65474-004

Reference* Designator	HP Part Number	Qty	Description	Mfr** Code	Mfr Part Number
A1J101	1251-4756	1	CONN-POST TYPE .100-PIN-SPCG 12-CONT	00779	87227-6
A1J101A	1258-0141	3	JUMPER-REMOVABLE	18873	65474-004
A1J101B	1258-0141		JUMPER-REMOVABLE	18873	65474-004
A1J101C	1258-0141		JUMPER-REMOVABLE	18873	65474-004
A1J400	1252-3664	1	CONN-POST TYPE .100-PIN-SPCG 4-CONT	76381	CHE-1004-U01A10-KKE
A1J411	1252-1874	1	CONN-POST TYPE .100-PIN-SPCG 3-CONT	27264	705-55-0072
A1P1	1252-1596	1	CONN-POST TYPE 2.54-PIN-SPCG 96-CONT	06776	DIN-96CPC-SRI-TR
A1P2	1251-7892	1	CONN-POST TYPE 2.54-PIN-SPCG 64-CONT	18873	75882-364
A1W701	44702-61603	1	CABLE-RBN 10 PIN,65MM LONG	28480	44702-61603
A2	E1410-66502	1	PC ASSY-ANALOG [a]	28480	E1410-66502
A2J801	1252-1920	1	CONN-POST TYPE .100-PIN-SPCG 10-CONT	76381	3654-5002
A2P501	1251-5394	1	CONN-POST TYPE .100-PIN-SPCG 4-CONT	27264	22-10-2041
A3	03456-66525	1	NATL REF ASSY	28480	03456-66525
			MECHANICAL PARTS		
CBL1	E1410-61601	1	CBL ASSY 2 WIRE	28480	E1410-61601
HDW1	3050-0593	5	WASHER-SPR CRVD 3/8 IN .379-IN-ID	28480	3050-0593
HDW2	3050-0593		WASHER-SPR CRVD 3/8 IN .379-IN-ID	28480	3050-0593
HDW3	3050-0593		WASHER-SPR CRVD 3/8 IN .379-IN-ID	28480	3050-0593
HDW4	3050-0593		WASHER-SPR CRVD 3/8 IN .379-IN-ID	28480	3050-0593
HDW5	3050-0593		WASHER-SPR CRVD 3/8 IN .379-IN-ID	28480	3050-0593
HDW6	2950-0144	5	NUT-3/8-32-THD .188-IN-THK .5-A/F	26365	913-891
HDW7	2950-0144		NUT-3/8-32-THD .188-IN-THK .5-A/F	26365	913-891
HDW8	2950-0144		NUT-3/8-32-THD .188-IN-THK .5-A/F	26365	913-891
HDW9	2950-0144		NUT-3/8-32-THD .188-IN-THK .5-A/F	26365	913-891
HDW10	2950-0144		NUT-3/8-32-THD .188-IN-THK .5-A/F	26365	913-891
HDW11	2950-0030	2	NUT-HX-DBL-CHAM 3/8-32-THD .094-IN-THK	73734	9003
HDW12	2950-0030		NUT-HX-DBL-CHAM 3/8-32-THD .094-IN-THK	73734	9003
J1	1510-0111	4	BINDING POST SGL SGL-TUR JGK RED	28480	1510-0111
J2	1510-0111		BINDING POST SGL SGL-TUR JGK RED	28480	1510-0111
J3	1510-0111		BINDING POST SGL SGL-TUR JGK RED	28480	1510-0111
J4	1510-0111		BINDING POST SGL SGL-TUR JGK RED	28480	1510-0111
J5	1510-0091	1	BINDING POST SGL SGL-TUR JGK RED	28480	1510-0091
J10	1250-0118	2	CONNECTOR-RF 50-OHM	24931	28JR128-1
J11	1250-0118		CONNECTOR-RF 50-OHM	24931	28JR128-1
MP1	E1400-84105	1	EXT HNDL KIT-BTM	28480	E1400-84105
MP2	E1400-84106	1	EXT HNDL KIT-TOP	28480	E1400-84106
PNL1	E1410-00201	1	FRONT PANEL	28480	E1410-00201
SCR15	0515-0368	2	SCREW- X 12MM-LG -HD	28480	0515-0368
SCR16	0515-0368		SCREW- X 12MM-LG -HD	28480	0515-0368
SCR21	0515-1135	5	SCREW- X 25MM-LG -HD	28480	0515-1135
SCR44	0515-1135		SCREW- X 25MM-LG -HD	28480	0515-1135
SCR45	0515-1135		SCREW- X 25MM-LG -HD	28480	0515-1135
SCR46	0515-1135		SCREW- X 25MM-LG -HD	28480	0515-1135
SCR47	0515-1135		SCREW- X 25MM-LG -HD	28480	0515-1135

Reference* Designator	HP Part Number	Qty	Description	Mfr** Code	Mfr Part Number
SCR48	0515-1968	2	DESCRIPTION SCR PHM2.5X11TX	28480	0515-1968
SCR49	0515-1968		DESCRIPTION SCR PHM2.5X11TX	28480	0515-1968
SHD1	E1410-00601	1	SHLD-TOP	28480	E1410-00601
SHD2	E1410-00602	1	SHIELD-BOTTOM	28480	E1410-00602
SHD3	E1410-00603	1	SHLD-FLEX,GUARD	28480	E1410-00603
SHD4	E1410-00604	1	SHIELD-FLEX LO	28480	E1410-00604
SHD6	E1410-00606	1	SHIELD-FLEX	28480	E1410-00606
W1	E1410-61602	5	WIRE KIT	28480	E1410-61602
W2	E1410-61602		WIRE KIT	28480	E1410-61602
W3	E1410-61602		WIRE KIT	28480	E1410-61602
W4	E1410-61602		WIRE KIT	28480	E1410-61602
W5	E1410-61602		WIRE KIT	28480	E1410-61602

* See Table 6-2 for Reference Designator definitions

** See Table 6-3 for Code List of Manufacturers

[a] Repair limited to replacement of parts listed - see Introduction for ordering information

Table 6-2. HP E1410A Reference Designators

HP E1410A REFERENCE DESIGNATORS	
A ..... assembly	P ..... electrical connector (plug)
CBL ..... cable	PNL ..... panel
F ..... fuse	SCR.....screw
HDW ..... hardware	SHD ..... shield
J ..... electrical connector (jack)	W .....cable, wire
MP ..... misc. mechanical part	

Table 6-3. HP E1410A Code List of Manufacturers

Mfr Code	Manufacturer Name	Address
00000	Any satisfactory supplier	
00779	AMP Inc	Harrisburg, PA 17111
18873	DuPont E I De Nemours & Co	Wilmington, DE 19801
24931	Specialty Connector Co	Franklin, IN 46131
26365	Gries/Dynacast Co	New Rochelle, NY 10802
27264	Molex Inc	Lisle,IL 60532
28480	Hewlett-Packard Company	Palo Alto, CA 94304
73734	Federal Screw Products Co	Chicago, IL 60618
75915	Littelfuse Inc	Des Plaines, IL 60016
76381	3M Co	St. Paul, MN 55144

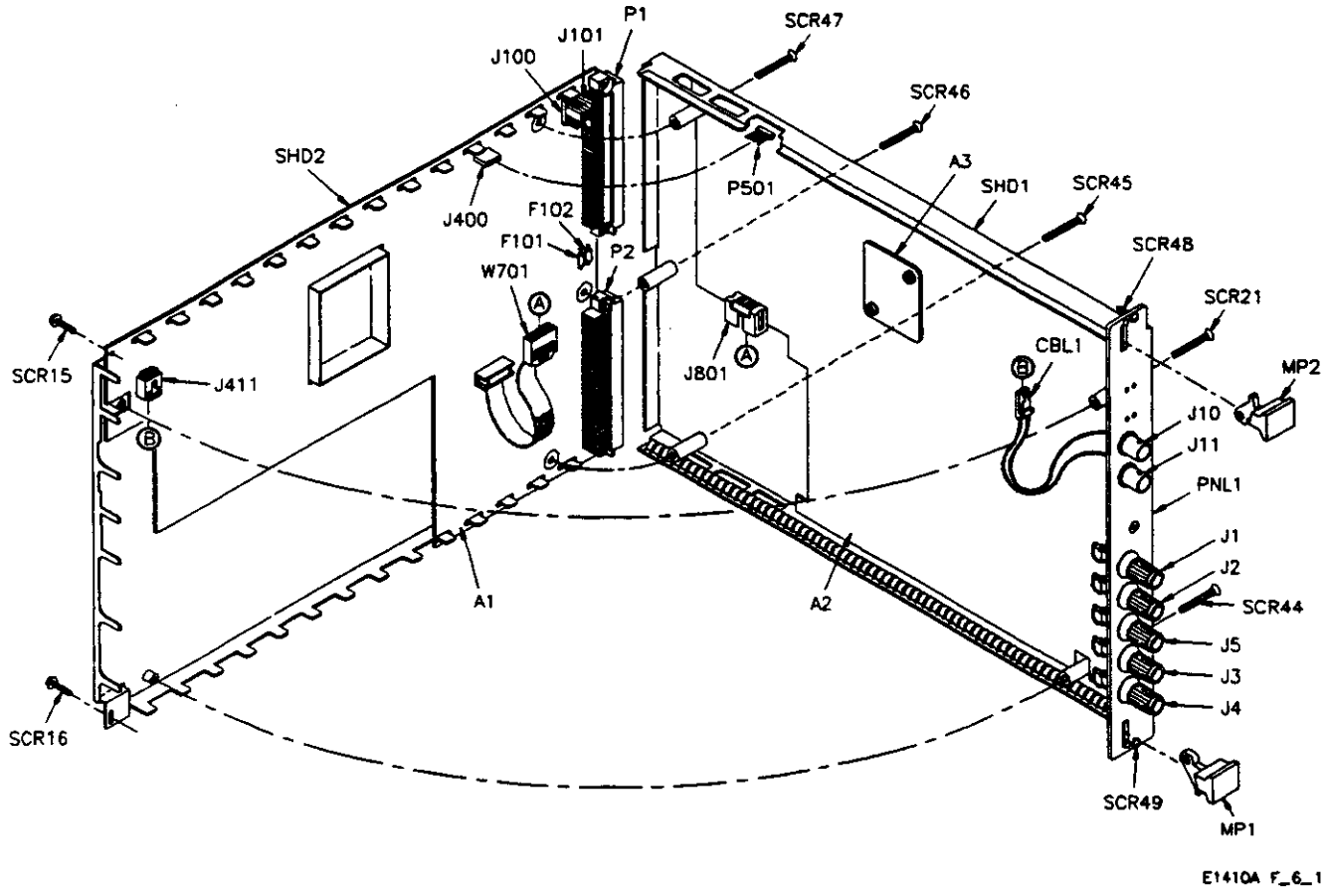


Figure 6-1. HP E1410A Replaceable Parts

7
Manual Changes

Introduction

This chapter contains information to adapt this manual to instruments for which the content does not directly apply. Since this manual applies directly to instruments with serial numbers listed on the title page, change information is not required. See *Multimeter Serial Numbers* in Chapter 1 for HP E1410A multimeter serial number information.

8
Service

Introduction

This chapter contains information for servicing the HP E1410A multimeter, including troubleshooting guidelines and repair/ maintenance guidelines.

WARNING

Do not perform any of the service procedures shown unless you are a qualified, service-trained technician, and have read the WARNINGS and CAUTIONS in Chapter 1.

Equipment Required

Equipment required for multimeter troubleshooting is listed in Table 1-1, *Recommended Test Equipment.* Any equipment that satisfies the requirements listed in the table may be substituted. To avoid damage to the screw head slots, use Torx drivers as specified in the instructions. The Torx drivers needed are T8 and T10 (HP part numbers 8710-1673 and 8710-1284, respectively).

Service Aids

Service aids on printed circuit boards include pin numbers, some reference designations, and assembly part numbers. See Chapter 6 for descriptions and locations of HP E1410A replaceable parts.

Service notes, manual updates, and service literature for the HP E1410A multimeter may be available through Hewlett-Packard. For information, contact your nearest Hewlett-Packard Sales and Service Office.

Troubleshooting Techniques

There are two main steps in troubleshooting an HP E1410A multimeter problem: (1) identifying the problem, and (2) isolating the cause to a user-replaceable component.

Identifying the Problem

Multimeter problems can be divided into four general categories:

- Self-test errors
- Operator errors
- Catastrophic failures
- Performance out of specification

Self-Test Errors

An error number is returned when the multimeter self-test fails. If a self-test error occurs, cycle power and repeat the self-test. If the error repeats, see "Testing Assemblies" to troubleshoot the multimeter. Self-test error codes are listed in the following table.

Error	Description
0	All tests passed
1	Inguard UART failure
2	Inguard CPU failure
4	Inguard link failure
8	Integrator convergence failure
16	Front end zero measurement error
32	Gain test error
128	AC amplifier's DC offset test failure
256	AC flatness check failure
512	Ohms precharge failure
4096	Calibration RAM checksum failure
8192	Autocalibration RAM checksum failure
16384	ROM checksum failure

If error code 8192 is returned, the following procedure may clear the error:

1. Perform a complete autocalibration (CAL:INT? ALL or *CAL)
2. Perform a self-test (TEST:ALL? or *TST?) and verify that the error is no longer present.
3. Cycle power and perform the self-test again to verify that non-volatile memory is working.

Operator Errors

Apparent failures may result from operator errors. See Appendix B - *Error Messages* in the *HP E1410A User's Manual* for information on operator errors.

Catastrophic Failure

If a catastrophic failure occurs, see "Testing Assemblies" to troubleshoot the multimeter.

Performance Out of Specification

If the multimeter performance is out of specification limits, use the adjustment procedures in Chapter 5 to correct the problem. If the condition repeats, see "Testing Assemblies" to troubleshoot the multimeter.

Testing Assemblies

You can use the tests and checks in Table 8-1 to isolate the problem to a user-replaceable part. See Figure 6-1 for locations of user-replaceable parts.

NOTE

If the problem cannot be traced to a user-replaceable part listed in Table 6-1, return the multimeter to Hewlett-Packard for exchange.

Table 8-1. HP E1410A Tests/Checks

Test/Check	Check:
Heat Damage	Discolored PC boards Damaged insulation Evidence of arcing
Switch/Jumper Settings	IRQ Level setting LADDR setting
Frame	Cable contact damage Panel binding posts Panel BNC connectors
PCAs	Fuse continuity Connector contacts IC contact/connections

Checking for Heat Damage

Inspect the multimeter for signs of abnormal internally generated heat such as discolored printed circuit boards or components, damaged insulation, or evidence of arcing. If there is damage, do not operate the multimeter until you have corrected the problem.

Switches/ Jumpers

Verify that the logical address setting is set correctly (factory set at 24). Verify that the interrupt priority jumpers are set correctly (factory set at level 1). See the *HP E1410A User's Manual* for information.

Multimeter Frame

To test the multimeter frame, see Table 8-1 for guidelines to check binding posts, BNC connectors, and cables. If you need to remove and/or replace the binding posts or BNC connectors, see the appropriate section in this chapter.

A1/A2 PCAs

To check the A1 and A2 PCAs, remove mainframe power and remove the multimeter from the mainframe. Then, disassemble the multimeter (see "Disassembly/Reassembly" for instructions). See Table 8-1 for guidelines to isolate the problem to a user-replaceable part.

Repair/ Maintenance Guidelines

This section provides guidelines for repairing and maintaining the HP E1410A multimeter, including:

- ESD precautions
- Disassembly/Reassembly
- Removing binding posts
- Removing BNC connectors
- Soldering printed circuit boards
- Post-repair safety checks

ESD Precautions

Electrostatic discharge (ESD) may damage MOS, CMOS, and other static sensitive devices in the HP E1410A multimeter. This damage can range from slight parameter degradation to catastrophic failure. When handling multimeter assemblies, follow these guidelines to avoid damaging multimeter components:

- Always use a static-free work station with a pad of conductive rubber or similar material when handling multimeter components.
- After you remove an assembly from the multimeter, place the assembly on a conductive surface to guard against ESD damage. Do not stack assemblies.

Disassembly/ Reassembly

Perform the following steps to disassemble and reassemble the multimeter. Refer to Figure 8-1 as necessary.

CAUTION

It is especially important to use anti-static procedures during the following procedure.

Disassembly

1. Place the module on its right side and remove the front panel handles by removing the T8 torx screw next to each handle. Be careful not to lose the spacers when you remove the screws.
2. Place the module on its left side and remove the five T10 torx screws on the right panel.
3. Loosen the T10 torx screw on the front panel, but do not remove it.
4. Separate the two assemblies far enough to disconnect the cables that run between them (connector J411 and cable W701).

Reassembly

1. Tuck the flexible shields under the cables that run to the front panel.
2. Lower the left panel onto the right panel until they are close enough to reattach the cables that were removed earlier.
3. Align P501 with J400.
4. Press down firmly on the left panel until the two assemblies snap together.
5. Place the module on its left side and replace the T10 torx screws that were removed from the right panel earlier.
6. Reattach the handles.
7. Tighten the front panel T10 torx screw.

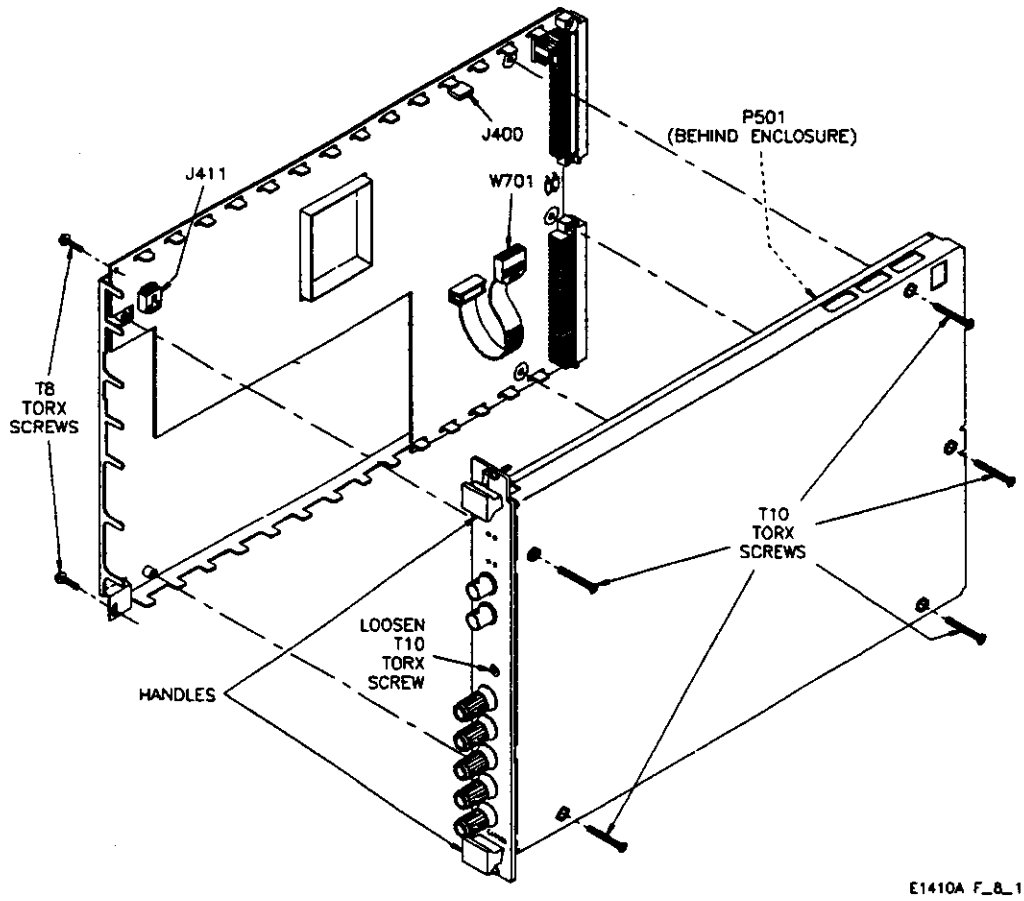


Figure 8-1. Disassembly/Reassembly of HP E1410A

Removing Binding Posts

Use the following steps to remove the HP E1410A faceplate binding posts.

1. Unsolder the wire.
2. Remove the 3/8-32 nut and spring washer.
3. Remove the binding post.
4. Reverse the order to reinstall the binding post.

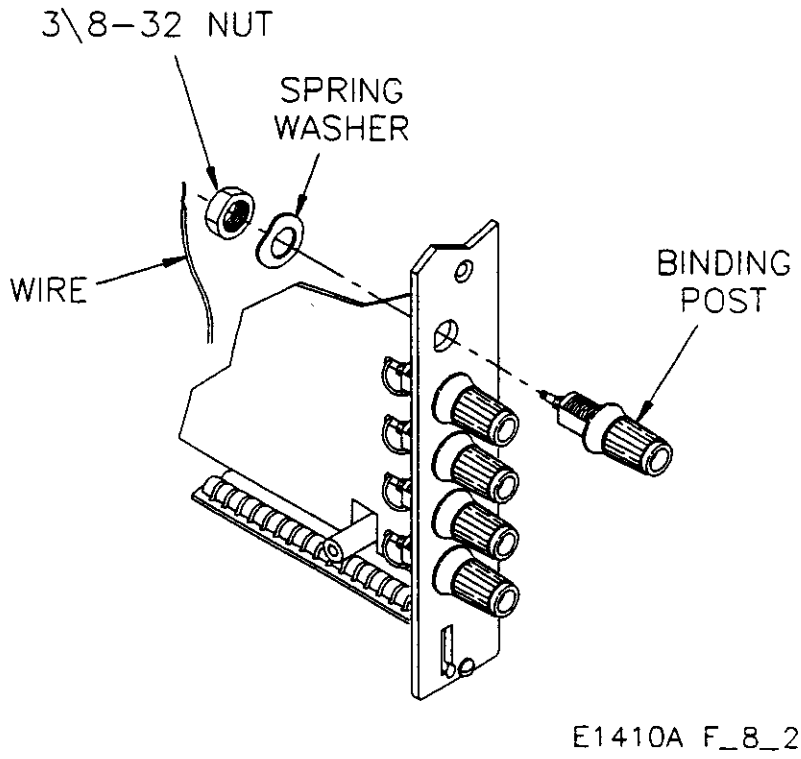


Figure 8-2. Removal of Binding Posts

Removing BNC Connectors

Use the following steps to remove the HP E1410A faceplate BNC connectors.

1. Unsolder the wire.
2. Remove the 3/8-32 nut on the inside of the front panel.
3. Remove the BNC connector.
4. Reverse the order to reinstall the connector.

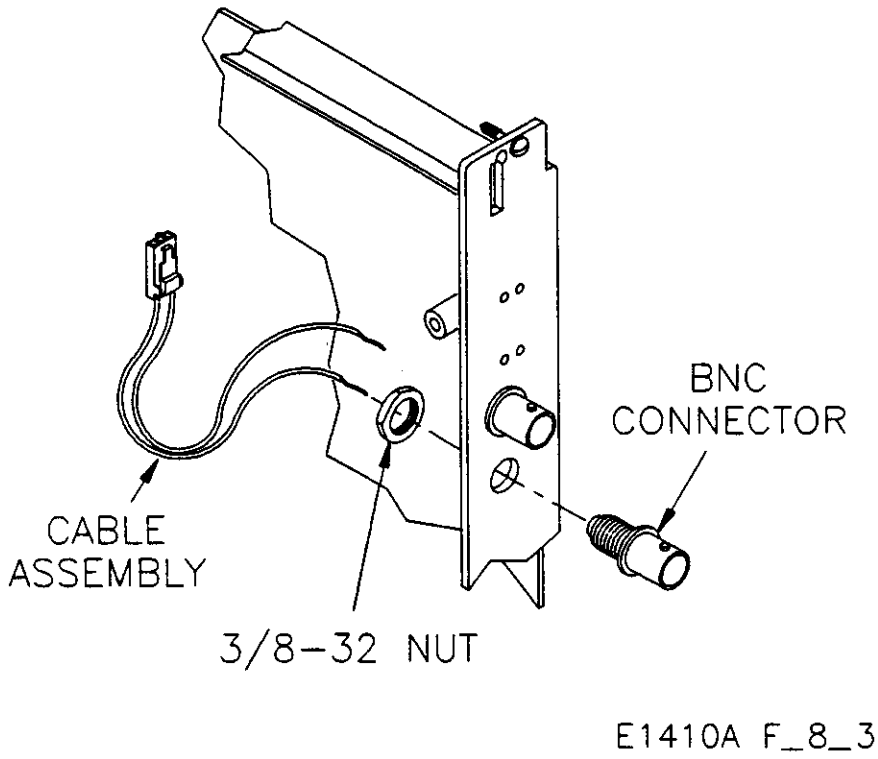


Figure 8-3. Removal of BNC Connectors

Soldering Printed Circuit Boards

The etched circuit boards in the multimeter have plated-through holes that allow a solder path to both sides of the insulating material. Soldering can be done from either side of the board with equally good results. When soldering to any circuit board, keep in mind the following guidelines.

- Do not use a sharp metal object such as an awl or twist drill, since sharp objects may damage the plated-through conductor.
- Avoid unnecessary component unsoldering and soldering. Excessive replacement can result in damage to the circuit board and/or adjacent components.
- Do not use a high power soldering iron on etched circuit boards, as excessive heat may lift a conductor or damage the board.
- Use a suction device or wooden toothpick to remove solder from component mounting holes. When using a suction device, be sure the equipment is properly grounded to prevent electrostatic discharge from damaging CMOS devices.

Post-Repair Safety Checks

After making repairs to the HP E1410A multimeter, inspect the multimeter for any signs of abnormal internally generated heat, such as discolored printed circuit boards or components, damaged insulation, or evidence of arcing. Determine and correct the cause of the condition. Then run the self-test (*TST? command) to verify that the multimeter is functional.

A
Calculating Multimeter Accuracy

Introduction

This appendix shows how multimeter accuracy is calculated for the HP E1410A multimeter.

See Table 4-1, "Performance Test Record for the HP E1410A Multimeter" for 1-year specification values of multimeter accuracy, measurement uncertainty, and test accuracy ratios (TARs).

NOTE

Multimeter accuracy, measurement uncertainty, and test accuracy ratios in Table 4-1 are valid ONLY for the specified test conditions and assumptions described in this manual.

Multimeter Accuracy Definition

Multimeter accuracy is the expected accuracy of the measurement considering ONLY the multimeter. The "Low Limit" entry in Table 4-1 is the lower (-) value of multimeter accuracy, while the "High Limit" entry is the upper (+) value of multimeter accuracy.

Multimeter Accuracy Calculations

For the HP E1410A multimeter performance verification tests, multimeter accuracy is defined for DC voltage, AC voltage, 2-wire ohms, 4-wire ohms, and frequency measurements using the 1-year specifications in Appendix A of the *HP E1410A User's Manual.* The **assumed** test conditions are:

- One hour warm-up
- Aperture = 167 msec (60 Hz) or 200 msec (50 Hz)
- Autozero ON
- Temperature within ± 5°C of calibration temperature and between 18°C and 28°C

DC Voltage Accuracy Equations

From Appendix A of the *HP E1410A User's Manual*, DC voltage 1-year accuracy = ±(% of reading + volts). The accuracy equations for the ranges and apertures used in the performance verification tests are:

Range	Accuracy [±(% of reading + Volts)]
30 mV	0.0045% + 3.9 μV
300 mV	0.0035% + 4.0 μV
3 V	0.0025% + 7.0 μV
30 V	0.0040% + 200 μV
300 V	0.0055% + 700 μV

Example: Calculate DC Voltage Accuracy

For a 3.0 V input to the multimeter, using the 3 V range and 167/200 msec aperture, multimeter accuracy (1-year) = ±(.0025% reading + 7.0 μV) = ±(.000025 x 3.0 + 7.0 x 10^{-6}) = ±82 μV. Thus, for a 3.0 V input the High Limit in Table 4-1 = 3.000082 Volts and the Low Limit = 2.999918 Volts.

AC Voltage Accuracy Equations

From Appendix A of the *HP E1410A User's Manual*, AC voltage 1-year accuracy (AC-coupled) = ±(% of reading + % of range). The accuracy equations for the ranges, frequencies and apertures used in the performance verification tests are:

Range	Frequency	Accuracy [±(% of reading + % of range)]
30 mV	400 Hz - 20 kHz	0.20% + 0.1307%
.3 V to 30 V	20 Hz - 45 Hz	0.62% + 0.0507%
	45 Hz - 100 Hz	0.27% + 0.0507%
	400 Hz - 20 kHz	0.20% + 0.0507%
	20 kHz - 100 kHz	0.72% + 0.0834%
	100 kHz - 300 kHz	3.39% + 0.3377%
	300 kHz - 1 MHz	10.41% + 2.228%
300 V	400 Hz - 20 kHz	0.26% + 0.0507%

Example: Calculate AC Voltage Accuracy

For a 3.0 V input to the multimeter, using the 3 V range, 1 kHz frequency, and 167/200 msec aperture, multimeter accuracy (1-year) = ±(0.20% reading + 0.0507% range) = ±(.0020 x 3.0 + 0.000507 x 3.0) = ±0.007521 Volts. Thus, for a 3.0 V input the High Limit in Table 4-1 = 3.007521 Volts and the Low Limit = 2.992479 Volts.

4-Wire Ohms Accuracy Equations

From Appendix A of the *HP E1410A User's Manual*, 4-wire ohms 1-year accuracy = ±(% of reading + Ohms). The accuracy equations for the ranges and apertures used in the performance verification tests are:

Range	Accuracy [±(% of reading + ohms)]
30 Ω	0.0075% + 3.4 mΩ
300 Ω	0.0055% + 3.5 mΩ
3 kΩ	0.0050% + 7 mΩ
30 kΩ	0.0050% + 70 mΩ
300 kΩ	0.0050% + 800 mΩ
3 MΩ	0.0065% + 14 Ω
30 MΩ	0.0400% + 830 Ω

Example: Calculate 4-Wire Ohms Accuracy

For a 1 kΩ input to the multimeter, using the 3 kΩ range and 167/200 msec aperture, multimeter accuracy (1-year) = ±(.0050% reading + 7 mΩ) = ±(.000050 x 1000 + 7 x 10^{-3}) = ±0.057 Ω. Thus, for a 1 kΩ input the High Limit in Table 4-1 = 1000.057 Ω and the Low Limit = 999.943 Ω.

2-Wire Ohms Accuracy

For 2-wire ohms calculations, simply add ±200 mΩ to all 4-wire specifications. For the previous example, the 2-wire ohms accuracy would be ±(0.057 Ω + 200 mΩ), or ± 0.257 Ω.

Frequency Accuracy

For frequency measurements in the 10 Hz - 400 Hz range, multimeter accuracy = ±(0.05% of reading). For measurements in the 400 Hz - 1.5 MHz range, multimeter accuracy = ±(0.01% of reading). For example, at 1 MHz, multimeter accuracy = ±(0.0001 x 1.0 x 10^{6}) = ± 100 Hz.

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