bus

Agilent 75000 Series B

Agilent E1326B
5 1/2-Digit Multimeter

Service Manual

Enclosed is the Service Manual for the Agilent E1326B 5 1/2-Digit Multimeter. Insert this manual, along with any other VXIbus manuals that you have, into the binder that came with your Agilent Technologies mainframe.

Agilent Technologies

Manual Part Number: E1326-90017
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Errata

Agilent References in this manual

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Agilent E1326B 5 1/2-Digit Multimeter Service Manual
Edition 3 Rev 3

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.

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Update 1 (Part Number E1326-90092). . . . . August 1991

Edition 2 (Part Number E1326-90016). . . . . January 1993

Edition 3 (Part Number E1326-90017). . . . . April 1996

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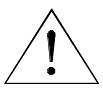
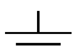
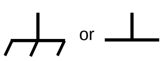
Safety Symbols



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.



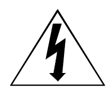
Indicates the field wiring terminal that must be connected to earth ground before operating the equipment—protects against electrical shock in case of fault.



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. Agilent Technologies 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 fuse holders.

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 an Agilent Technologies 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 an Agilent Technologies Sales and Service Office for service and repair to ensure that safety features are maintained.

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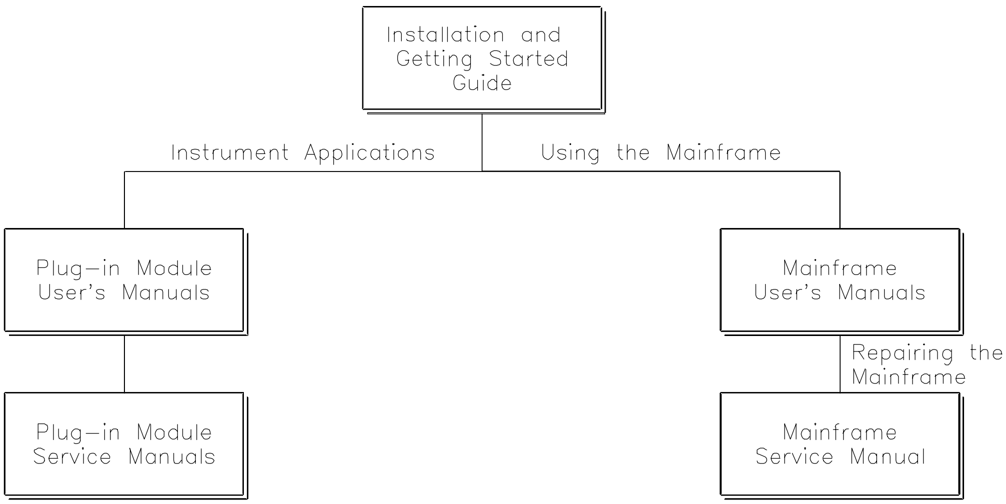
- Go to **http://regulations.corporate.agilent.com/DoC/search.htm** . You can then search by product number to find the latest Declaration of Conformity.
- Alternately, you can go to the product web page **(www.agilent.com/find/E1326B),** click on the Document Library tab then scroll down until you find the Declaration of Conformity link.

Agilent 75000 Series B Service Documentation

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.

Agilent Mainframe User's Manual. Contains programming information for the mainframe, front panel operation information (for the Agilent E1301B mainframe), and general programming information for instruments installed in the mainframe.

Plug-In Module User's Manuals. Contains plug-in module programming and configuration information. These manuals contain examples for the most-used module functions, and a complete SCPI command reference for the plug-in module.

Agilent Mainframe Service Manual. Contains service information for the mainframe. This manual contains information for ordering replaceable parts and exchanging assemblies. Also contains information and procedures for performance verification, adjustment, preventive maintenance, troubleshooting, and repair.

Plug-In Module Service Manuals. Contains plug-in module service information. These manuals contain information for exchanging the module or ordering replaceable parts. Depending on the module, information and procedures for functional verification, operation verification, performance verification, adjustment, preventive maintenance, troubleshooting, and repair is also provided.

What's in this Manual

Manual Overview

This manual shows how to service the Agilent E1326B 5 1/2-Digit Multimeter. Additional manuals which may be required for servicing the multimeter include the *Agilent E1326B/E1411B User's Manual* **which contains multimeter operation, installation, and configuration information, and the appropriate mainframe user's manual(s) for mainframe operation, installation and configuration information.**

Manual Content

Chapter	Title	Content
1	General Information	Provides a basic description, and lists available options and accessories. Also lists the tools and test equipment required for service.
2	Installation	Procedures to install the multimeter, perform initial inspection, prepare for use, and store and ship the multimeter.
3	Operating Instructions	Procedures to operate the multimeter, perform scheduled preventive maintenance, and perform operator's check.
4	Verification Tests	Functional verification, operation verification, and performance verification tests to test the multimeter.
5	Adjustments	Procedures to adjust 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, measurement uncertainty, and test accuracy ratios (TARs) are calculated.

Contents

Chapter 6 - Replaceable Parts

Chapter 7 - Manual Changes

Chapter 8 - Service

Appendix A - Calculating Multimeter Accuracy

Appendix B - Verification Tests - C Programs

1
General Information

Introduction

This Agilent E1326B Service Manual contains information required to test, adjust, troubleshoot, and repair the Agilent E1326B B-Size VXI 5 1/2-Digit Multimeter (multimeter). See the *Agilent E1326B/E1411B User's Manual* for additional information on the Agilent E1326B multimeter. Figure 1-1 shows the Agilent E1326B multimeter and accessories supplied.

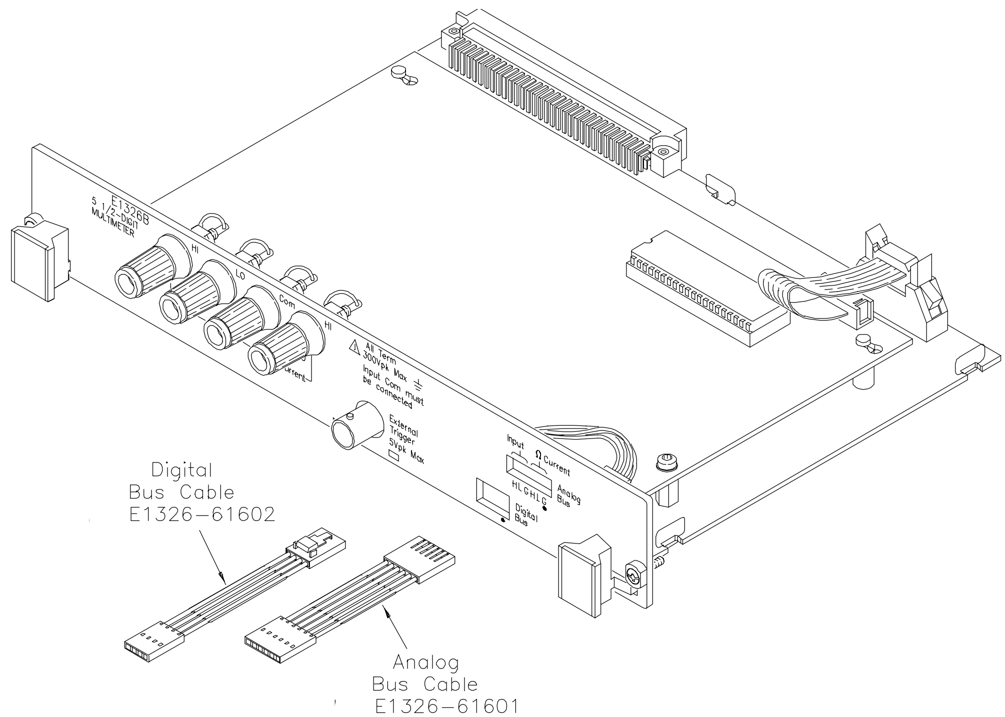


Figure 1-1. Agilent E1326B Multimeter and Accessories

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 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.)

COMMON GROUND. Verify that a common ground exists between the unit under test and the multimeter (via the mainframe) prior to energizing either unit.

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.

REMOVE POWER IF POSSIBLE. Some procedures in this manual may be performed with power supplied to the mainframe while protective covers are removed. Energy available at many points may, if contacted, result in personal injury. (If maintenance can be performed without power applied, the power should be removed.)

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).

WARNING

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

USE PROPER FUSES. For continued protection against fire hazard, replace the line fuse(s) 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 Agilent E1326B multimeter is an "instrument" in the slots of a VXIbus mainframe. As such, it is assigned an error queue, input and output buffers, status registers, and is allocated a portion of mainframe memory for reading storage.

NOTE

Instruments are based on the logical addresses of the plug-in modules. See the Agilent 75000 Series B Installation and Getting Started Guide to set the addresses to create an instrument.

The instrument may consist of the multimeter only (stand-alone operation), or can include relay or FET multiplexers (scanning multimeter operation). The instrument can be operated from the mainframe front panel or from a computer using Standard Commands for Programmable Instruments (SCPI).

In stand-alone operation, input signals are connected to the multimeter's external (faceplate) terminals. In scanning multimeter operation, input signals are connected to the multiplexer channels. The multimeter is linked to relay multiplexers via an analog bus cable. The multimeter is linked to FET multiplexers via an analog bus cable and a digital bus cable.

Multimeter Specifications

Multimeter specifications are listed in *Appendix A* of the *Agilent E1326B/E1411B 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. Agilent 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 Agilent E1326B 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 Agilent Technologies Sales and Service Office for information on Options 1BN and 1BP.

Field Installation Kits

An Agilent E1326B multimeter can be installed inside the Agilent E1300B/E1301B mainframe (using one or two A-size slots). If you have an Agilent E1326B multimeter, order installation kit E1326-80004 and (optionally) installation kit E1326-80005.

As shown in Figure 1-2, the E1326-80004 kit provides the multimeter front panel without binding posts. The E1326-80004 kit also contains required hardware and installation instructions. The E1326-80005 installation kit adds another front panel with binding posts. (If you use the E1326-80005 kit, a second A-size slot is required.)

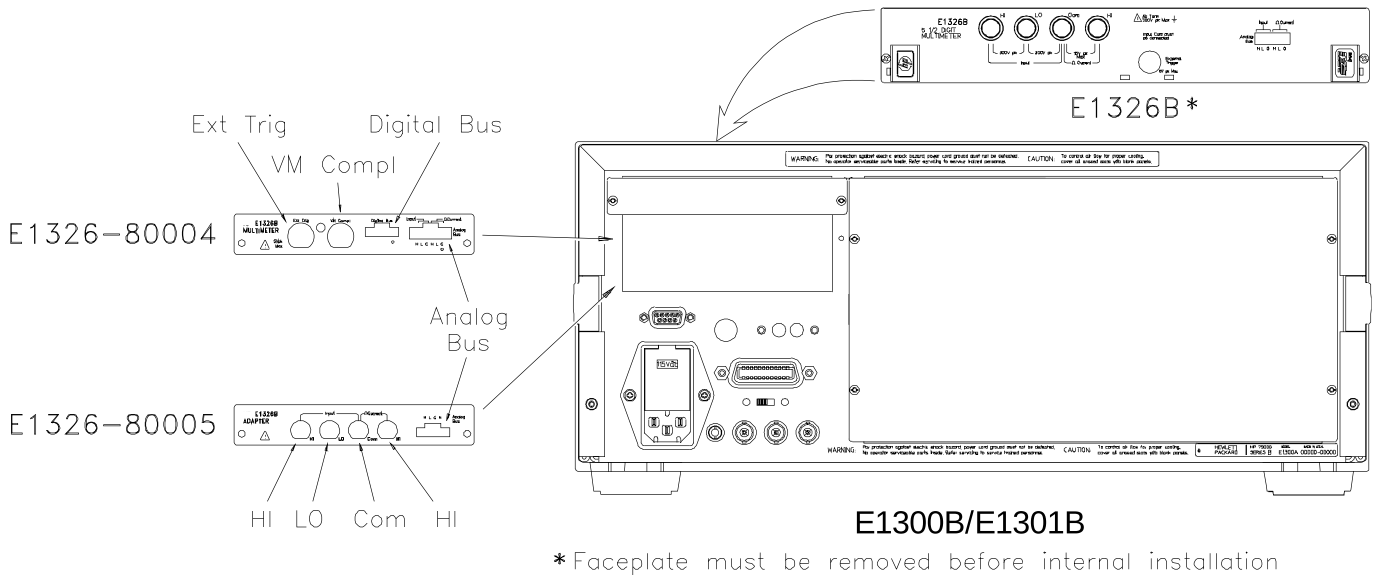


Figure 1-2. Agilent E1326B Field Installation Kits

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, GPIB	GPIB compatibility as defined by IEEE Standard 488-1978 and the identical ANSI Standard MC1.1: SH1, AH1, T2, TEO, L2, LE0, SR0, RL0, PP0, DC0, DT0, and CI, 2, 3, 4, 5	HP Series 300 or IBM compatible PC with BASIC	A,O,F, P,T
Mainframe	Compatible with multimeter	Agilent E1300B, E1301B, E1302A, or E1401B/T, E1421A (requires E1405A/B or E1406A)	A,O,F, P,T
AC Standard	Voltage Range 0.1 V to 300 V	Datron 4708 with Option 20	A,P
DC Standard	Voltage Range 0.07 V to 300 V	Datron 4708 with Option 10	A,P
Resistance Standard	Values 1 kΩ to 1 MΩ	Datron 4708 with Option 30	A,P
Digital Multimeter	General Purpose Voltage and Resistance	Agilent 3458	T

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

NOTES:

2
Installation

Introduction

This chapter provides information to install the Agilent E1326B multimeter, including initial inspection, preparation for use, environment, storage and shipment.

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 1 (Figure 1-1) for shipment contents. 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 Agilent Technologies Sales and Service Office. If the shipping container is damaged or the cushioning material shows signs of stress, notify the carrier as well as Agilent, and keep the shipping materials for the carrier's inspection.

Preparation for Use

See Chapter 2 of the *Agilent E1326B/E1411B User's Manual* to prepare the Agilent E1326B multimeter for use. See the appropriate mainframe user's manual(s) to prepare your mainframe. If your mainframe is not manufactured by Agilent, consult the manufacturer for a list of available manual(s).

Recommended operating environment for the Agilent E1326B multimeter is 0^{o}C to + 55^{o}C with humidity < 65% relative (0 ^{o}C to + 40^{o}C). The instrument should be stored in a clean, dry environment. For storage and shipment, the temperature range is -40^{o}C to + 75^{o}C with humidity < 65% relative (0^{o}C to + 40^{o}C).

Shipping the Multimeter

If you need to return the Agilent E1326B multimeter to Agilent Technologies, first remove any adapters or connectors before packaging the instrument for shipment. When you return the instrument to Agilent, attach a tag to the instrument identifying the owner and indicating 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 Agilent Sales and Service Offices. Mark the shipping container "FRAGILE" to assure careful handling.

If you use other (commercially available) shipping materials, 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 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 lists operating information for the Agilent E1326B multimeter, including:

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

Multimeter Operation

See the *Agilent E1326B/E1411B 5 1/2-Digit Multimeter 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
- Register-based programming

Operator's Check

The Operator's Check for the Agilent E1326B multimeter consists of sending the self-test (*TST?) command and checking the return. The operator's check can be used at any time to verify the multimeter is connected properly and is responding to the self-test command.

As required, see the mainframe user's manual for information on address selection. See the *Agilent E1326B/E1411B User's Manual* for information on multimeter SCPI commands.

Self-Test Procedure

1. Verify the multimeter is properly installed in the mainframe and the mainframe has passed its power-on sequence test.

2. Execute the multimeter functional test using the *TST? command (see example following).

3. A "0" returned means no self-test failure, while "1", "2", "3", or "4" returned means a failure was detected. See *Chapter 8 - Service* for troubleshooting information (see NOTE following).

NOTE

Test failures can be caused by improper cabling, improper selection of the interface select code, primary, and/or secondary address setting. Verify proper connection and address selection before troubleshooting.

Example: Multimeter Self-Test

An example follows which uses an HP 9000 Series 300 computer with BASIC and a multimeter address of 70903.

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

4
Verification Tests

Introduction

The three levels of test procedures described in this chapter are used to verify that the Agilent E1326B multimeter:

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

WARNING

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

Test Conditions/ Procedures

For valid tests, all test equipment and the multimeter must have a one hour warmup, the line voltage must be 115/230 Vac ± 10%, and multimeter Auto Zero must be set. See Table 1-1, *Recommended Test Equipment* for test equipment requirements.

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. You should perform the Performance Verification tests at least once a year. For heavy use or severe operating environments, perform the tests more often.

The verification tests assume the person performing the tests understands how to operate the mainframe, multimeter and specified test equipment. The test procedures do not specify equipment settings for test equipment, except in general terms. It is assumed a qualified, service-trained person will select and connect the cables, adapters, and probes required for the test.

Performance Test Record

Table 4-1, *Agilent E1326B Performance Test Record,* 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.

NOTE

The upper and lower limits in the Performance Test Record assume the test equipment used is calibrated and operating at peak performance. If this is not the case, problems can occur. For example, an uncalibrated source may cause what seems to be an inaccurate measurement. This condition must be considered when observed measurements do not agree with the performance test limits.

The value in the "Measurement Uncertainty" column of Table 4-1 is derived from the specifications for 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, rounded to the nearest integer.

Verification Test Examples

Each Performance Verification Test includes an example program to perform the test. Each example uses address 70903 for the multimeter, and an HP 9000 Series 200/300 computer running BASIC commands. You may need to change the multimeter address and/or command syntax to perform the examples for your setup.

As required, see the mainframe user's manual for information on address selection and cabling guidelines. See the *Agilent E1326B/E1411B User's Manual* for information on multimeter Standard Commands for Programmable Instruments (SCPI) commands.

Functional Verification Test

The functional verification test for the Agilent E1326B multimeter consists of the multimeter self-test. You can perform this test any time to verify the multimeter is functional and is communicating with the mainframe, external computer and/or external terminal.

Self-Test Procedure

This test verifies the multimeter is communicating with the mainframe, external controller, and/or external terminal by performing a multimeter self-test. Do the following steps to perform the self-test:

1. Verify the multimeter is correctly installed in the mainframe.

2. Connect a power cable to the mainframe and set mainframe power ON. Verify proper mainframe power-up sequence. (See the mainframe user's manual for additional information.) If correct, proceed with step 3. If incorrect, troubleshoot the problem before proceeding.

3. Execute the multimeter functional verification test using the *TST? command. See the following example which uses an HP 9000 Series 300 computer with BASIC and a multimeter address of 70903.

4. A "0" returned means no failure, while "1", "2", "3" or "4" returned means a failure was detected. See *Chapter 8 - Service* for troubleshooting information.

NOTE *Test failures can be caused by improper selection of the interface select code, primary address setting, and/or secondary address setting. Verify proper address selection before troubleshooting.*

Example: Self-Test

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

Operation Verification Tests

There are no operation verification tests for the Agilent E1326B multimeter. Use the Performance Verification tests for post-repair checkout.

Performance Verification Tests

Performance verification tests are used to check the multimeter's electrical performance against the specifications in *Appendix A - Specifications* of the *Agilent E1326B/E1411B User's Manual* as the performance standards. These tests are suitable for incoming inspection, troubleshooting, and preventive maintenance.

NOTE *When an Agilent E1326B is installed internal to the Agilent E1300B/E1301B mainframe, the (optional) Agilent E1326-80005 panel with binding posts is recommended to do the performance verification tests and adjustments. The binding posts provide a way to connect an external standard source directly to the internally-installed multimeter.*

Test 4-1: DC Voltage Test (Zero Volt Input)

This test verifies DC Voltage accuracy on all five ranges with a zero volt input.

Equipment Setup

1. Connect the equipment as shown in Figure 4-1.

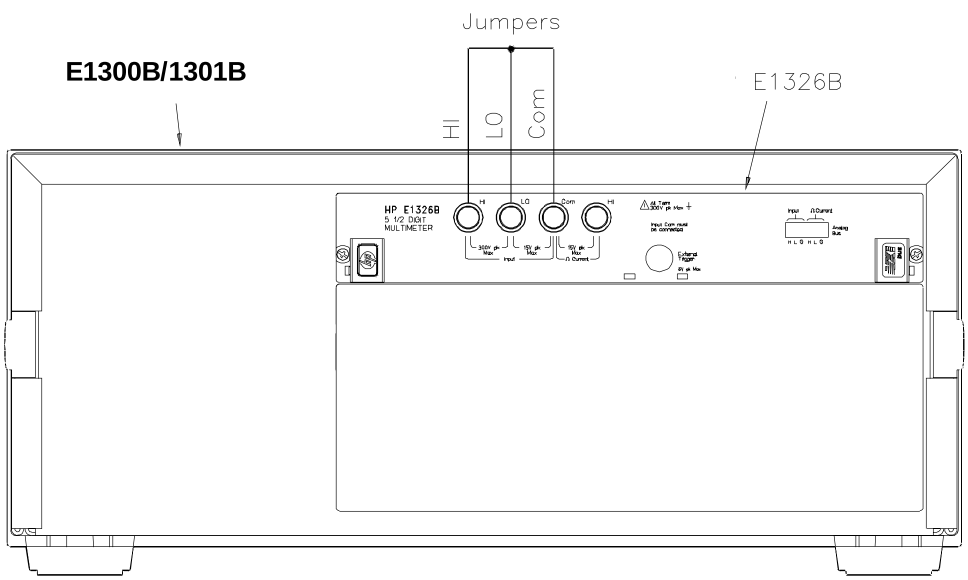


Figure 4-1. DC Voltage (Zero Volt Input) Setup

2. Set the Agilent E1326B multimeter as follows:

- Reset Multimeter ....*RST
- Auto Zero ....ON
- Power Line Cycles (PLC) 1
- Line Freq Reference (CAL:LFR) .... 50Hz or 60Hz

NOTE

**RST sets Auto Zero to ON and Power Line Cycles to 1.*

Test Procedure

1. Set the Agilent E1326B range to 0.113 V (0.125 V with 10% overrange) with MEAS:VOLT:DC? 0.1

2. Measure the input and verify the results are within specified limits (at the range selected for 1 PLC).

3. Repeat steps 1 and 2 for the following ranges:

E1326B Range	10% Overrange	Input
0.91 V	1 V	0 V
7.27 V	8 V	0 V
58.1 V	64 V	0 V
300 V	N/A	0 V

4. Remove power and disconnect test equipment.

Example: Zero Volt DCV Test

This example performs a DCV test for zero volts input and a power line reference frequency of 60 Hz. Change line 20 to OUTPUT 70903;"CAL:LFR 50" for 50 Hz operation.

```
10   OUTPUT 70903;"*RST"                  Resets and sets autozero
                                          ON and PLC to 1
20   OUTPUT 70903;"CAL:LFR 60"            Sets line reference to 60 Hz
30   OUTPUT 70903;"MEAS:VOLT:DC? .1"      Measure 0.113 V range
40   ENTER 70903;A
50   PRINT A
60   OUTPUT 70903;"MEAS:VOLT:DC? .9"      Measure 0.91 V range
70   ENTER 70903;B
80   PRINT B
90   OUTPUT 70903;"MEAS:VOLT:DC? 7"       Measure 7.27 V range
100  ENTER 70903;C
110  PRINT C
120  OUTPUT 70903;"MEAS:VOLT:DC? 58"      Measure 58.1 V range
130  ENTER 70903;D
140  PRINT D
150  OUTPUT 70903;"MEAS:VOLT:DC? 300"     Measure 300 V range
160  ENTER 70903;E
170  PRINT E
180  END
```

Test 4-2: DC Voltage Test (DCV Input)

This test verifies DC Voltage accuracy on all five ranges with DC voltage inputs.

Equipment Setup

1. Connect the equipment as shown in Figure 4-2. You can connect to the E1326B OR the E1326-80005 terminals, but not to both.

WARNING **The DC Standard (Datron 4708, Option 10) can produce dangerous voltages which are present on the terminals. Do not touch the front (or rear) panel terminals unless you are sure no dangerous voltage is present.**

---

2. Set the Agilent E1326B multimeter as follows:

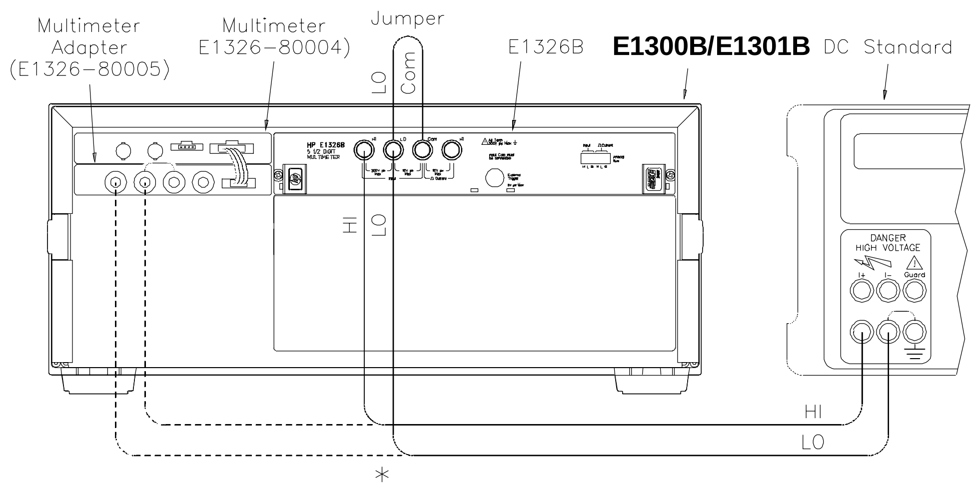


Figure 4-2. DC Voltage (DCV Input) Setup

- Reset Multimeter ....*RST
- Auto Zero ....ON
- Power Line Cycles (PLC) 1
- Line Freq Reference (CAL:LFR) ....50Hz or 60Hz

NOTE **RST sets Auto Zero to ON and Power Line Cycles to 1.*

Test Procedure

1. Set the DC Standard (Datron 4708, Option 10) Output to 0.1 DCV.

2. Set the Agilent E1326B range to 0.113 V (0.125 V with 10% overrange) with CONF:VOLT:DC 0.1.

3. Measure the input with READ? and verify the results are within specified limits (at the range selected for 1 PLC).

4. Repeat steps 1 through 3 for the following DC Standard voltage settings and Agilent E1326B ranges:

E1326B Range	10% overrange	DC Std Output
0.91 V	1 V	0.9 V
7.27 V	8 V	7.0 V
58.1 V	64 V	58.0 V
300 V	N/A	300.0 V

5. Remove power and disconnect test equipment.

Example: DC Voltage Test (DCV Input)

This example performs a DCV test for DC volts input and a power line reference frequency of 60 Hz. Change line 80 to OUTPUT 70903;"CAL:LFR 50" for 50 Hz operation.

NOTE

When connected to the Agilent E1326B multimeter, some DC Standards may exhibit voltage variations at the start of a measurement. The WAIT 1 statement (line 150) provides a one second wait before measurement to allow settling of the DC Standard output.

```
1    ! DC Voltage Performance Verification
2    !
10   OPTION BASE 1
20   DIM Range(5), Volts(5), Read_meas(5)
30   DATA 0.113, 0.91, 7.27, 58.1, 300.0
40   READ Range(*)
50   DATA 0.1, 0.9, 7.0, 58.0, 300.0
60   READ Volts(*)
70   OUTPUT 70903;"*RST"              Set autozero on and PLC 1
80   OUTPUT 70903;"CAL:LFR 60"        Set 60 Hz line frequency
90   FOR I= 1 TO 5
```

```
100    PRINT "Set DC Standard to ";Volts(I);" VDC"
110    PRINT "Press Continue when ready"
120    PAUSE
130    CLEAR SCREEN
140    OUTPUT 70903;"CONF:VOLT:DC ";Range(I) Set DCV, range
150    WAIT 1                                  Wait for settling
160    OUTPUT 70903;"READ?"
170    ENTER 70903;Read_meas(I)                Enter DC voltage
180  NEXT I
190  FOR I= 1 TO 5
200    PRINT "Voltage on";Range(I);"V range = ";Read_meas(I); "VDC"
210  NEXT I
220  END
```

Test 4-3: AC Voltage Test

This test verifies AC voltage accuracy on the 87.5 mV and 300 V ranges using sine wave input at ≥ 50% of full scale. The input frequency varies from 60 Hz to 10 kHz. The DC component must be < 10% of the AC component.

NOTE

The DC Voltage Performance test must be performed prior to the AC Voltage test to check the A/D accuracy on all ranges. If the DC Voltage test has not been performed, the AC voltage must be checked on all ranges.

Equipment Setup

1. Connect the equipment as shown in Figure 4-3. You can connect to the E1326B OR the E1326-80005 terminals, but not to both.

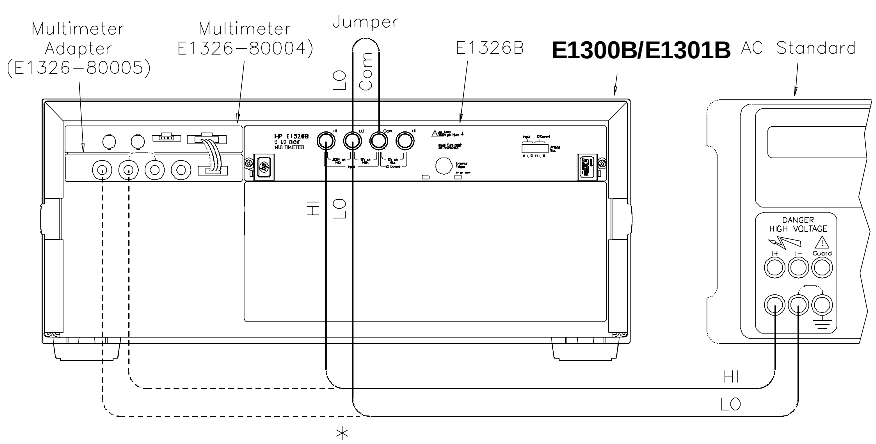


Figure 4-3. AC Voltage Setup

WARNING

The AC Standard (Datron 4708, Option 20) can produce dangerous voltages which are present on the terminals. Do not touch the front (or rear) panel terminals unless you are sure no dangerous voltage is present.

2. Set the Agilent E1326B multimeter as follows:

- Reset Multimeter ....*RST
- Auto Zero ....ON
- Power Line Cycles (PLC) 1
- Line Freq Reference (CAL:LFR) .... 50Hz or 60Hz

NOTE

**RST sets Auto Zero to ON and Power Line Cycles to 1.*

Test Procedure

1. Set the AC Standard (Datron 4708, Option 20) Output to 0.07 Vac at 60 Hz sine wave.

2. Set the Agilent E1326B range to 79.5 mV (87.5 mV with 10% overrange) using CONF:VOLT:AC .07.

3. Measure the AC input voltage with READ? and verify the results are within specified limits (at the range selected for1 PLC).

4. Repeat steps 1 through 3 using the following AC Standard voltage and frequency settings, and Agilent E1326B ranges:

E1326B Range	10% overrange	AC Standard Output	
		Voltage (Vac)	Frequency (Hz)
79.5 mV	87.5 mV	0.07 V	5 kHz
79.5 mV	87.5 mV	0.07 V	10 kHz
300 V	N/A	300 V	5 kHz

5. Remove power and disconnect test equipment.

Example: AC Voltage Test

This example performs an ACV test for a power line reference frequency of 60 Hz. Change line 80 to OUTPUT 70903;"CAL:LFR 50" for 50 Hz operation.

NOTE

When connected to the Agilent E1326B multimeter, some AC Standards may exhibit voltage variations at the start of a measurement. The WAIT 1 statement (line 160) allows settling time for the AC Standard output.

```
1    ! AC Voltage Performance Verification
2    !
10   OPTION BASE 1
20   DIM Read_meas(4),Source_volts(4),Source_freq(4)
30   DATA  0.07, 0.07, 0.07, 300.0
40   READ Source_volts(*)
50   DATA 60, 5000, 10000, 5000
60   READ Source_freq(*)
70   OUTPUT 70903;"*RST"                      Set autozero on, PLC 1
80   OUTPUT 70903;"CAL:LFR 60"                Set 60 Hz line ref freq
90   FOR I= 1 TO 4
100    PRINT " 1. Set AC Standard output to";Source_volts(I);"Vac"
110    PRINT " 2. Set AC Standard frequency to";Source_freq(I);"Hz"
120    PRINT " 3. Press Continue when ready"
130    PAUSE
140    CLEAR SCREEN
150    OUTPUT 70903;"CONF:VOLT:AC ";Source_volts(I)
160    WAIT 1                                 One second settling time
170    OUTPUT 70903;"READ?"
180    ENTER 70903;Read_meas(I)
190  NEXT I
200  FOR I= 1 TO 4
210    PRINT "Voltage for";Source_volts(I);" Vac range @";
Source_freq(I);"Hz = ";Read_meas(I);"Vac"
220  NEXT I
230  END
```

Test 4-4: Resistance Test (4-Wire Ohms)

This test verifies the 4-wire resistance accuracy of the 2kΩ, 131kΩ, and 1MΩ ranges.

NOTE

The DC Voltage performance test must be performed prior to the Resistance Test to check the A/D accuracy on all ranges. If the DC Voltage test has not been performed, resistance must be checked on all ranges at 0 and at 50% of full scale.

Equipment Setup

1. Connect the equipment as shown in Figure 4-4. You can connect to the E1326B OR to the E1326-80005, but not to both.

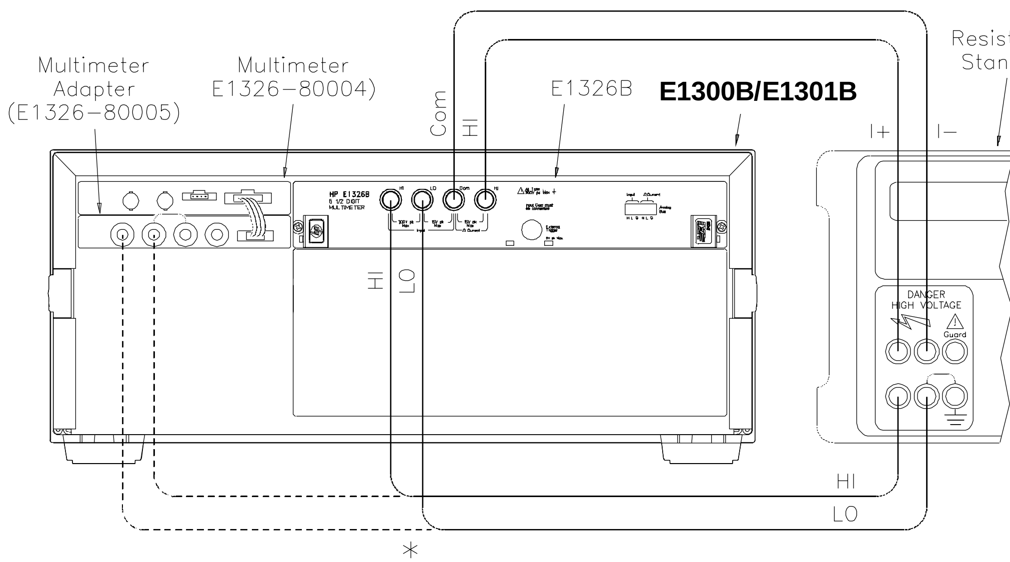


Figure 4-4. Resistance Test Setup

2. Set the Agilent E1326B multimeter as follows:

- Reset Multimeter ....*RST
- Auto Zero ....ON
- Power Line Cycles (PLC) 1
- Line Freq Reference (CAL:LFR) .... 50 Hz or 60 Hz

NOTE

**RST sets Auto Zero to ON and Power Line Cycles to 1.*

Test Procedure

1. Set the Resistance Standard (Datron 4708, Option 30) to 1 kΩ setting.

2. Set the Agilent E1326B range to 1861Ω (2048Ω with 10% overrange) with CONF:FRES 1861.

3. Measure the input resistance and verify the results are within specified limits (at the range selected for 1 PLC).

NOTE

For best measurement accuracy, you may want to measure the ACTUAL Resistance Standard value. You can do this by recording the front panel display of the resistance value, or measure the resistance with an Agilent 3458A multimeter or equivalent.

For example, suppose the ACTUAL resistance value for the 1 kΩ setting is 1001.3 Ω. Then, the Lower Limit for this value = 1000.9 Ω and the Upper Limit = 1001.7 Ω. These limits would replace the existing limits of 999.6 Ω and 1000.4 Ω shown in Table 4-1. If the measured value falls within the ***revised*** *limits, the test passes.*

---

4. Repeat steps 1 through 3 using the following Resistance Standard settings.

E1326B Range	10% overrange	Resistance Std Setting
119,156Ω 1,048,576Ω	131,052Ω N/A	100 kΩ 1 MΩ

5. Remove power and disconnect test equipment.

Example: 4-Wire Ohms Test

This example performs a 4-wire ohms resistance test for a power line reference frequency of 60 Hz. Change line 80 to OUTPUT 70903;"CAL:LFR 50" for 50 Hz operation.

The program also calculates the Upper Limit and Lower Limit values for the ACTUAL Resistance Standard resistance value (lines 170 -190). If the actual Resistance Standard value is different than 1 kΩ, 100 kΩ, or 1 MΩ, replace the Lower Limit and Upper Limit values shown in Table 4-1, *Performance Test Record*, with the values computed by the program.

```
1    ! 4-Wire Ohms Performance Verification
2    !
10   OPTION BASE 1
20   DIM Range(3),Source(3),Read_meas(3),Limit(3),Ohms(3)
30   DATA 1861, 119156, 1048576
40   READ Range(*)
50   DATA 1000, 100000, 1000000
60   READ Source(*)
70   OUTPUT 70903;"*RST"                    Sets autozero on and PLC 1
80   OUTPUT 70903;"CAL:LFR 60"              Set 60 Hz line ref freq
90   FOR I= 1 TO 3
100    PRINT "1. Set Resistance Standard to";Source(I);"Ohms"
110    PRINT "2. Measure ACTUAL Resistance Standard value (in Ohms)"
120    INPUT " Enter ACTUAL Resistance Standard value (in Ohms) ",Ohms(I)
130    CLEAR SCREEN
140    OUTPUT 70903;"CONF:FRES ";Range(I)      Set 4-wire ohms, range
150    OUTPUT 70903;"READ?"
160    ENTER 70903;Read_meas(I)
170    IF I= 1 THEN Limit(I)= .0004*Ohms(I)+ 2.0E-2   2 kOhm limits
180    IF I= 2 THEN Limit(I)= .0004*Ohms(I)+ 1.       131 kOhm limits
190    IF I= 3 THEN Limit(I)= .0004*Ohms(I)+ 10.      1 MOhm limits
200  NEXT I
210  PRINT " Measured      Source        Low Limit      High Limit"
220  PRINT " Resistance    Resistance     (Ohms)         (Ohms)"
230  PRINT
240 Format:IMAGE 7D.3D,6X,7D.3D,6X,7D.3D,6X,7D.3D
250  FOR I= 1 TO 3
260    PRINT USING Format;Read_meas(I),Ohms(I), Ohms(I)-Limit(I),Ohms(I)+ Limit(I)
270  NEXT I
280  END
```

Performance Test Record

Table 4-1, *Performance Test Record for the Agilent E1326B Multimeter*, is a form you can copy and use to record performance verification test results for the multimeter. Page 3 of Table 4-1 shows multimeter accuracy, measurement uncertainty and test accuracy ratio (TAR) values. See *Appendix A - Calculating Multimeter Accuracy* for example calculations of Table 4-1 entries.

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 and/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, and 4-Wire Resistance measurements using the 1-year specifications in *Appendix A - Specifications* in the *Agilent E1326B/E1411B 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 a Datron 4708 source for inputs to the multimeter. Measurement uncertainties in Table 4-1 are calculated for the 90-day accuracy specifications in the *Datron 4708 User's Handbook*.

Test Accuracy Ratio (TAR)

In Table 4-1, the "Test Accuracy Ratio (TAR)" is calculated from (high limit - expected measurement)/measurement uncertainty. (To meet MIL-STD-45662A requirements, the TAR must be 4:1 or greater.) "N/A" means measurement uncertainty and TAR do not apply to the measurement. Although all TAR values are > 10:1, the entry for each value is > 10:1.

Table 4-1. Performance Test Record for the Agilent E1326B Multimeter (Page 1 of 3)

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:

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Table 4-1. Performance Test Record for the Agilent E1326B Multimeter (Page 2 of 3)

Model ______________________________	Report No. __________________	Date _______________

Test Equipment Used: Description	Model No.	Trace No.	Cal Due Date
1. DATRON 4708	____________	____________	____________
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 Agilent E1326B Multimeter (Page 3 of 3)

Model ______________________________	Report No. __________________________	Date____________

1-Year Specifications

Test No.	Test Input	DMM Range	Low Limit	Measured Reading	High Limit	Meas Uncert*	Test Acc Ratio (TAR)**
DC Voltage (Zero Volts Input) (Values in Vdc)							
4-1	0	0.113	-.000005	__________	+ .000005	N/A	N/A
	0	0.91	-.000015	__________		N/A	N/A
	0	7.27	-.00005	__________	+ .000015	N/A	N/A
	0	58.1	-.001	__________		N/A	N/A
	0	300	-.005	__________	+ .00005	N/A	N/A
					+ .001		
					+ .005		
DC Voltage (DCV Input) (Values in Vdc)							
4-2	0.1	0.113	0.09996	__________	0.10004	.0000030	> 10:1
	0.9	0.91	0.89978	__________	0.90022	.0000046	> 10:1
	7.0	7.27	6.9986	__________	7.0014	.0000115	> 10:1
	58.0	58.1	57.98	__________	58.02	.0001680	> 10:1
	300.0	300	299.9	__________	300.1	.0011770	> 10:1
AC Voltage (60 Hz, 5 kHz, 10 kHz, 5 kHz) (Values in Vac)							
4-3	0.07	0.0875	.0693	__________	.0707	.000044	> 10:1
	0.07	0.0875	.0676	__________	.0724	.000044	> 10:1
	0.07	0.0875	.0676	__________	.0724	.000044	> 10:1
	300.00	300	269.1	__________	330.9	.038030	> 10:1
4-Wire Resistance (Values in Ohms)							
4-4	1000	2000	999.6	__________	1000.4	0.003	> 10:1
	100000	131000	99959	__________	100041	0.3	> 10:1
	1000000	1000000	999590	__________	1000410	10.0	> 10:1

* Measurement Uncertainty of Datron 4708 source for 90 days since calibration and $23^{o}C \pm 1^{o}C$.
** TAR = multimeter accuracy/measurement uncertainty, shown as > 10:1.

NOTES:

5
Adjustments

Introduction

This chapter contains procedures to adjust the Agilent E1326B multimeter for peak performance. 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 person, and have read the WARNINGS and CAUTIONS in Chapter 1.

NOTE

ALL adjustment procedures MUST be performed in the order shown in this manual (DC Voltage, then AC Voltage, and then Resistance).

Adjustment Conditions/ Procedures

For valid adjustments, the Agilent E1326B multimeter and test equipment used must have at least a 60 minute warm-up, and the line voltage must be 115/230 Vac ± 10%. 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. See Table 1-1, *Recommended Test Equipment*, for test equipment requirements.

The adjustment procedures assume the person performing the adjustments understands how to operate the mainframe, multimeter and specified test equipment. The adjustment procedures do not specify test equipment settings, except in general terms. It is assumed a qualified, service-trained person will select and connect the cables and jumpers required for the adjustments.

DC Voltage Adjustments

This procedure adjusts Agilent E1326B DC voltage measurement accuracy.

Equipment Setup

1. Connect the equipment as shown in Figure 5-1. You can connect to the E1326B OR the E1326-80005 terminals, but not to both.

WARNING

The DC Standard (Datron 4708, Option 10) can produce dangerous voltages whch are present on the terminals. Do not touch the front (or rear) panel terminals unless you are sure no dangerous voltage is present.

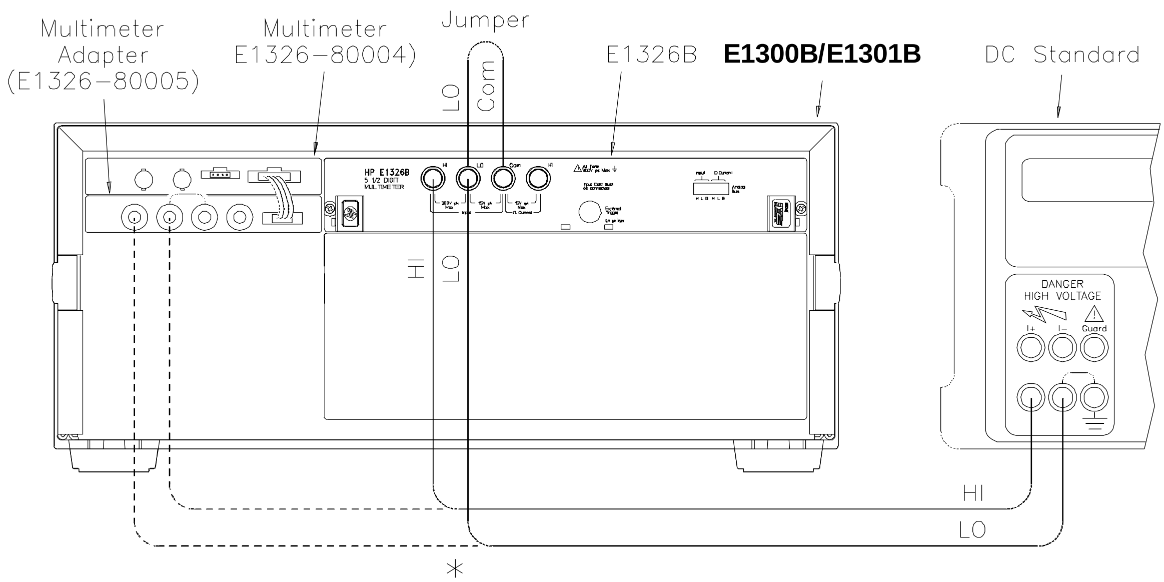

Figure 5-1. DC Voltage Adjustment Setup

2. Set the Agilent E1326B as follows:

- Reset Multimeter ....*RST
- Auto Zero ....ON
- Power Line Cycles (PLC) 1
- Line Freq Reference (CAL:LFR) .... 50 Hz or 60 Hz

NOTE **RST sets Auto Zero to ON and Power Line Cycles to 1.*

Adjustment Procedure

1. Set the DC Standard output to 7.7 V.

2. Set the Agilent E1326B range to 8 V, and adjust the multimeter at + 7.7 V using:

```
FUNC:VOLT:DC
VOLT:DC:RANGE 8
CAL:VAL 7.7
CAL?
```

3. Verify that the returned calibration error code is 0 (no error). If not 0, see Table 5-1 for a list of calibration errors and codes. The calibration error is displayed on the Agilent E1301B front panel, or can be returned to an external computer using ENTER.

4. Repeat steps 1 through 3 using the following Agilent E1326B (and VOLT:DC:RANG) voltage ranges, and DC Standard (and CAL:VAL) settings:

Agilent E1326B range/ VOLT:DC:RANG < >	DC Standard Output/ CAL:VAL < >
8 V	- 7.7 V
0.125 V	+ 0.121 V
0.125 V	- 0.121 V
1 V	+ 0.97 V
1 V	- 0.97 V
64 V	+ 62.0 V
64 V	-62.0 V
300 V	+ 300 V
300 V	-300 V

5. Remove power and disconnect test equipment.

Example: DC Voltage Adjustments

This example performs DC voltage adjustments for a power line reference frequency of 60 Hz. Change line 80 to OUTPUT 70903;"CAL:LFR 50" for 50 Hz operation.

If no calibration error occurs (Cal_code = 0 in line 210), the program displays an "adjustment complete" message. If a calibration error occurs, the program displays the calibration error and prompts you to repeat the adjustment (see Table 5-1 for a list of calibration errors).

When connected to the Agilent E1326B multimeter, some DC Standards may exhibit voltage variations at the start of a measurement. TRIG:DEL .05 (line 190) adds a 0.8 second wait before calibration begins to allow settling time for the DC Standard output. TRIG:DEL .05 is used since the input is sampled 16 times before the calibration is performed. Thus, total added delay = 0.05 seconds x 16 = 0.8 second.

```
1    ! DC Voltage Adjustments
2    !
10   OPTION BASE 1
20   DIM Range(10),Volts(10)
30   DATA 8.0, 8.0, 0.125, 0.125, 1.0, 1.0, 64.0, 64.0, 300.0, 300.0
40   READ Range(*)
50   DATA 7.7, -7.7, .121, -.121, .97, -.97, 62.0, -62.0, 300.0, -300.0
60   READ Volts(*)
70   OUTPUT 70903;"*RST"                      Set autozero on and PLC 1
80   OUTPUT 70903;"CAL:LFR 60"                Set 60 Hz line ref frequency
90   FOR I= 1 TO 10
100 Re_try:   !
110    CLEAR SCREEN
120    PRINT "Set DC Standard to ";Volts(I);" VDC"
130    PRINT "Press Continue when ready"
140    PAUSE
150    CLEAR SCREEN
160    OUTPUT 70903;"FUNC:VOLT:DC"            Set DCV function
170    OUTPUT 70903;"VOLT:RANG ";Range(I)     Set E1326B range
180    OUTPUT 70903;"CAL:VAL ";Volts(I)       Set CAL:VAL value
190    OUTPUT 70903;"TRIG:DEL .05"            Wait for settling
200    OUTPUT 70903;"CAL?"                    Perform calibration
210    ENTER 70903 USING "K";Cal_code         Return cal error code
220    IF Cal_code< > 0 THEN
230      PRINT "Calibration Error";Cal_code;"for ";Volts(I);"VDC input."
240      PRINT "Check source value/connections, then"
250      PRINT "press Continue to retry this adjustment"
260      PAUSE
270      GOTO Re_try
280    ELSE
290      PRINT "Adjustment complete for ";Volts(I);"VDC input"
300    END IF
```

```
310    PRINT "Press Continue for the next adjustment"
320    PAUSE
330    CLEAR SCREEN
340   NEXT I
350   END
```

AC Voltage Adjustments

This procedure adjusts the Agilent E1326B AC voltage measurement accuracy.

NOTE

The DC Voltage adjustment MUST be performed before the AC Voltage adjustment.

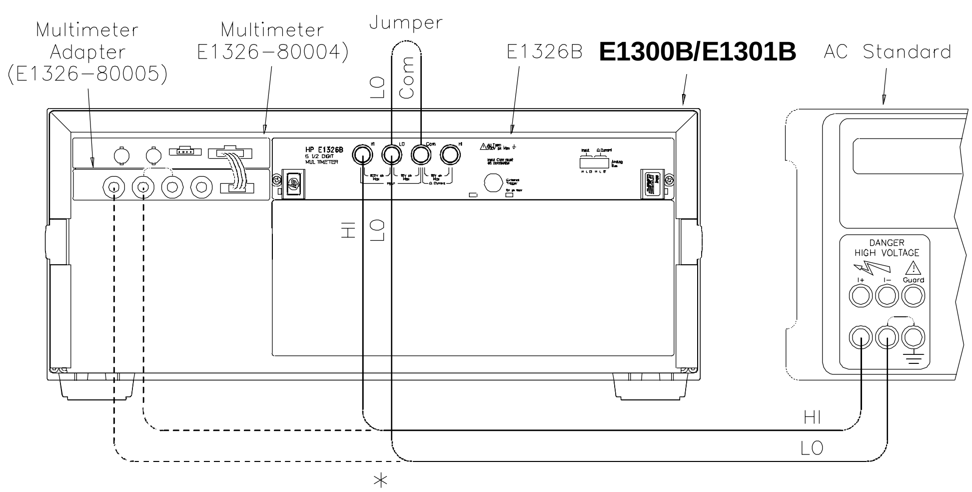

Figure 5-2. AC Voltage Adjustment Setup

Equipment Setup

1. Connect the equipment as shown in Figure 5-2. You can connect to the E1326B OR the E1326-80005 terminals, but not to both.

2. Set the Agilent E1326B as follows:

- Reset Multimeter ....*RST
- Auto Zero .... ON

- Power Line Cycles (PLC) 1
- Line Freq Reference (CAL:LFR) .... 50 Hz or 60 Hz

NOTE **RST sets Auto Zero to ON and Power Line Cycles to 1.*

Adjustment Procedure

1. Set the AC Standard output to 5.6 Vac at 1 kHz.

2. Set the Agilent E1326B range to 5.6 V, and adjust the multimeter at 5.6 V using:

```
FUNC:VOLT:AC
VOLT:AC:RANG 5.6
CAL:VAL 5.6
CAL?
```

3. Verify that the returned calibration error code is 0 (no error). If not 0, see Table 5-1 for a list of calibration errors and codes.

4. Remove power and disconnect test equipment.

Example: AC Voltage Adjustments

This example performs an AC voltage adjustment for a power line reference frequency of 60 Hz and an input of 5.6 Vac @ 1 kHz. Change line 20 to OUTPUT 70903;"CAL:LFR 50" for 50 Hz operation.

If no calibration error occurs (Cal_code = 0 in line 130), the program displays an "adjustment complete" message. If a calibration error occurs, the program displays the calibration error (see Table 5-1 for a list of calibration errors).

When connected to the Agilent E1326B multimeter, some AC Standards may exhibit voltage variations at the start of a measurement. TRIG:DEL .05 (line 110) adds a 0.8 second wait before calibration begins to allow settling time for the AC Standard output. TRIG:DEL .05 is used since the input is sampled 16 times before the calibration is performed. Thus, total added delay = 0.05 seconds x 16 = 0.8 second.

```
1    ! AC Voltage Adjustments
2    !
10   OUTPUT 70903;"*RST"              Set autozero on and PLC 1
20   OUTPUT 70903;"CAL:LFR 60"        Set 60 Hz line ref frequency
```

```
30 Re_try:    !
40     PRINT "Set AC Standard to 5.6 Vac at 1.0 kHz"
50     PRINT "Press Continue when ready"
60     PAUSE
70     CLEAR SCREEN
80     OUTPUT 70903;"FUNC:VOLT:AC"        Set ACV function
90     OUTPUT 70903;"VOLT:RANG 5.6"       Set 5.6 Vac range
100    OUTPUT 70903;"CAL:VAL 5.6"         Set 5.6 Vac cal value
110    OUTPUT 70903;"TRIG:DEL .05"        Wait for settling
120    OUTPUT 70903;"CAL?"                Perform calibration
130    ENTER 70903 USING "K";Cal_code
140    IF Cal_code< > 0 THEN
150      PRINT "Calibration Error";Cal_code;"on 5.6 Vac range"
160      PRINT "Check source value/connections, then"
170      PRINT "press Continue to retry this adjustment"
180       PAUSE
190       CLEAR SCREEN
200        GOTO Re_try
210    ELSE
220      PRINT "AC Voltage adjustment complete"
230    END IF
240    END
```

Resistance Adjustments

This procedure adjusts 4-wire resistance measurement accuracy.

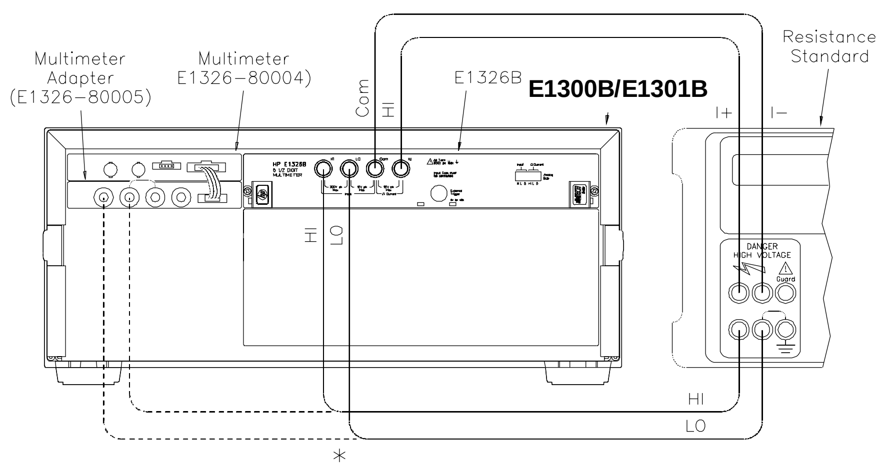

Figure 5-3. Resistance Adjustments Setup

NOTE

The DC Voltage adjustment and the AC Voltage adjustment MUST be performed before the Resistance adjustment.

Equipment Setup

1. Connect the equipment as shown in Figure 5-3. You can connect to the E1326B OR the E1326-80005 terminals, but not to both.

2. Set the Agilent E1326B as follows:

   - Reset Multimeter .... *RST
   - Auto Zero .... ON
   - Power Line Cycles (PLC) 1
   - Line Freq Reference (CAL:LFR) .... 50 Hz or 60 Hz

NOTE

**RST sets Auto Zero to ON and Power Line Cycles to 1.*

Adjustment Procedure

1. Set the Resistance Standard to 1 kΩ.

2. Set the Agilent E1326B range to 2 kΩ, and adjust the multimeter at 1 kΩ using:

```
FUNC:FRES
FRES:RANG 2000
CAL:VAL 1000
CAL?
```

NOTE

For best adjustment accuracy, you may want to measure the ACTUAL resistance value of the Resistance Standard and use this value in the CAL:VAL command. You can read the actual resistance value from the Datron front panel or you can measure the value with an Agilent 3458A multimeter or equivalent.

3. Verify that the returned calibration error code is 0 (no error). If not 0, see Table 5-1 for a list of calibration errors and codes. The calibration error is displayed on the Agilent E1301B front panel, or can be returned to the computer using an ENTER statement.

4. Repeat steps 1 through 3 using the following Agilent E1326B (and FRES:RANG) ranges, and Resistance Standard (and CAL:VAL) values.

Agilent E1326B Range/ FRES:RANG < >	Resistance Standard/ CAL:VAL < >
16000Ω 1048576Ω	10000Ω 1000000Ω

5. Remove power and disconnect test equipment.

Example: 4-Wire Resistance Adjustments

This example performs a 4-wire ohms resistance adjustment for a power line reference frequency of 60 Hz. Change line 80 to OUTPUT 70903;"CAL:LFR 50" for 50 Hz operation. If a calibration error occurs, the program displays the calibration error and prompts you to repeat the adjustment (see Table 5-1 for a list of calibration errors).

```
10   OPTION BASE 1
20   DIM Range(3),Source(3)
30   DATA  2000, 16000, 1048576
40   READ Range(*)
50   DATA 1000, 10000, 1000000
60   READ Source(*)
70   OUTPUT 70903;"*RST"                         Set autozero on and PLC 1
80   OUTPUT 70903;"CAL:LFR 60"                   Set 60 Hz line ref freq
90   FOR I= 1 TO 3
100 Re_try:   !
110     PRINT "1. Set Resistance Standard to";Source(I);"Ohms"
120     PRINT "2. Measure ACTUAL Resistance Standard value (in
Ohms)"
130     INPUT " Enter ACTUAL Resistance Standard value (in Ohms)
",Ohms_actual
140     CLEAR SCREEN
150     OUTPUT 70903;"FUNC:FRES"                 Set 4-wire ohms
160     OUTPUT 70903;"FRES:RANG ";Range(I) Set resistance range
170     OUTPUT 70903;"CAL:VAL ";Ohms_actual Set cal value
180     OUTPUT 70903;"CAL?"                      Perform calibration
190     ENTER 70903 USING "K";Cal_code
200     IF Cal_code< > 0 THEN
210       PRINT "Calibration Error";Cal_code;"with";Source(I);"Ohms
input"
220       PRINT "Check source value/connections, then"
230       PRINT "Press Continue to repeat this adjustment"
240       PAUSE
```

```
250     CLEAR SCREEN
260     GOTO Re_try
270   ELSE
280     PRINT "Adjustment complete with";Source(I);"Ohms source"
290     PRINT "Press Continue for the next adjustment"
300     PAUSE
310     CLEAR SCREEN
320    END IF
330  NEXT I
340  PRINT "Resistance adjustments completed"
350  END
```

Calibration Errors

Table 5-1 summarizes calibration error numbers, titles and descriptions for the Agilent E1326B multimeter. Note that an error is returned if the adjustment (calibration) standard used is outside the calibration range of the multimeter (between ± (0.5 full scale and full scale)).

Table 5-1. Agilent E1326B Multimeter Calibration Errors

Error	Title	Description	Code*
0	No Error	No error has occurred since last time the error code was read.	
4	Reading Overrun	The FIFO memory was still full at the time the new reading was ready, or a new command was received while in the middle of outputting a reading. TRIGGER ARM is disabled and the multimeter waits for a new command.	U
6	Calibration Error	An error occurred when computing a calibration constant, probably due to an improper input or a defective Unit Under Test (UUT). Calibration cycle aborted.	U/H
7	Checksum Error	The non-volatile RAM contains a checksum error. The data is assumed to be corrupted.	H
8	Invalid CAL Request	Calibration requested for an invalid combination of multimeter range and function.	U
9	Bad CAL Target	The target value for the calibration was outside the range of ± (0.5 full scale to full scale).	U
11	No Inguard Response	No response from inguard (expected data and got nothing). Timed out instead.	H
13	Linearity CAL Error	An error has occurred during a linearity calibraton sequence. Probably a hardware failure of the A/D inguard section.	H

14	Pacer Overrun Error	The pacer is in use and the pacer rate is faster than the maximum A/D conversion rate based on integration time, autorange setting, autozero setting, and interrupts enabled.	U
15	Input Overload	A potentially damaging overload has been applied to the multimeter terminals and the multimeter has disconnected from the input. A new SET RANGE command is necessary to restore normal operation. A damaging overload is defined as: 1. Applying > ± 40 volts HI to LO or HI to COMMON while in manual range with RANGE ≤ 8 volts. 2. Applying > ± 40 volts between LO and COMMON under any circumstances.	U

* U = improper operation, H = hardware failure

6
Replaceable Parts

Introduction

This chapter contains information to order replaceable parts for the Agilent E1326B 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 Agilent Technologies Sales and Service Office for details.

Ordering Information

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

Replaceable Parts List

Table 6-1, *Agilent E1326B Replaceable Parts*, lists the replaceable parts for the Agilent E1326B multimeter. See Figure 6-1 (page 6-3) for locations of parts listed in Table 6-1.

Table 6-1. Agilent E1326B Replaceable Parts

Reference* Designator	Agilent Part Number	Qty	Description	Mfr** Code	Mfr Part Number
			EXCHANGE ASSEMBLIES		
	E1326-66202	1	Multimeter Module (New)	28480	E1326-66202
	E1326-69202	1	Multimeter Module (Exchange)	28480	E1326-69202
A1	E1326-66511	1	**OUTGUARD PRINTED CIRCUIT ASSY [a]**	28480	E1326-66511
A1F1-F2	2110-0712	2	Fuse - Sub Miniature 4A 125V	75915	R251004T1
A1J1	1252-3416	1	Connector - 4 Pin Right Angle	27264	705-53-0108
A1J2	1250-1846	1	Connector - Right Angle BNC	24931	28JR342-1
A1J3	1251-5222	1	Connector - Post 2X5 10 Pin	18873	65863-265
A1JM1	1251-4927	2	Connector - Header 16 Pin	18873	67997-616
A1JM3	1251-4927		Connector - Header 16 Pin	18873	67997-616
A1P1	1252-1596	1	Connector - Right Angle 96 Pin	06776	DIN-96CPC-SRI-TR
A1P3	1258-0247	1	4-Position Jumper	18873	69146-204
A1SW1	3101-3066	1	Switch - Rocker 8 Position 5 V 0.1 A	81073	76YY22968S
A1XU23	1200-0817	1	Socket - 40 Pin Integrated Circuit	00779	2-640379-1

(Continued on next page)

Reference* Designator	Agilent Part Number	Qty	Description	Mfr** Code	Mfr Part Number
A2	E1326-66502	1	**INGUARD PRINTED CIRCUIT ASSY [a]**	28480	E1326-66502
A2J101	44702-61603	1	Cable Assembly - Ribbon 10 Conductor	28480	44702-61603
A2J102	1252-3712	1	Connector - Right Angle 2X6 12 Pin	18873	68668-004
A2J103	1252-3416	1	Connector - Right Angle 4 Pin	27264	705-53-0108
A2K104-K105	0490-1556	2	Relay - Reed 2A 250MA 400VDC 5VDC-Coil	71707	3500-0050
A2K106	0490-1555	1	Relay - Reed 2A 250MA 400VDC 5VDC-Coil	71707	3500-0051
A2XU104	1200-0817	1	Socket - 40 Pin Integrated Circuit	00779	2-640379-1
			CABLE ASSEMBLIES		
CBL1	E1326-61605	1	Cable Assembly - 4 Conductor	28480	E1326-61605
CBL2	E1326-61601	1	Cable Assembly - 6 Conductor	28480	E1326-61601
CBL3	E1326-61606	1	Cable Assembly - 4 Conductor Ribbon	28480	E1326-61606
			MECHANICAL PARTS		
LBL1	E1326-84302	1	Label - Serial Number	28480	E1326-84302
MP1	E1300-45101†	2	HNDL-KIT TOP, Agilent†	28480	E1300-45101†
MP2	E1300-45102†	4	HNDL-KIT BTM, VXI †	28480	E1300-45102†
MP3-MP6	1510-0091	2	Binding Post - Red	28480	1510-0091
MP9-MP10	1400-1567	1	Wire Saddle - Nylon	28480	1400-1567
PNL1	E1326-00208†	1	PNL-EXTERNAL VM†	28480	E1326-00208†
SHD1	E1300-80601		Shield - Safety	28480	E1300-80601
			COMMON HARDWARE		
	0515-0372	1	SCR Pan-Head M3.0 X .5 Torx T10	28480	0515-0372
SCR1-SCR2	0515-2140	2	SCR-THD-RLG M2.5 X0.45 14mm	28480	0515-2140
SCR3-SCR4	0515-1968	2	SCR Pan-Head M2.5 X 11 Pozidriv	28480	0515-1968
SCR9-SCR10	0515-2743	2	SCR-FH M2.5 X 8 THREAD ROLLING	28480	0515-2743
	2950-0001	4	Nut-Hex-DBL Chamfer 3/8-32 THD	28480	2950-0001
	3050-0593	4	Washer-Spring NO. 3/8	28480	3050-0593

* 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
† These parts are not compatible with older version fixed handles or their corresponding front panels. To replace one or more of these old parts, you must order all three new parts (Top and Bottom Handle Kits AND External Panel).

Table 6-2. Agilent E1326B Reference Designators

Agilent E1326B Reference Designators	
A .... assembly	MP .... misc. mechanical part
CBL .... cable	P .... electrical connector (plug)
F .... fuse	PNL .... panel
J .... electrical connector (jack)	SCR .... screw
JM .... electrical connector (header)	SHD .... shield
K ....relay	SW .... switch
LBL .... label	XU .... socket, integrated circuit

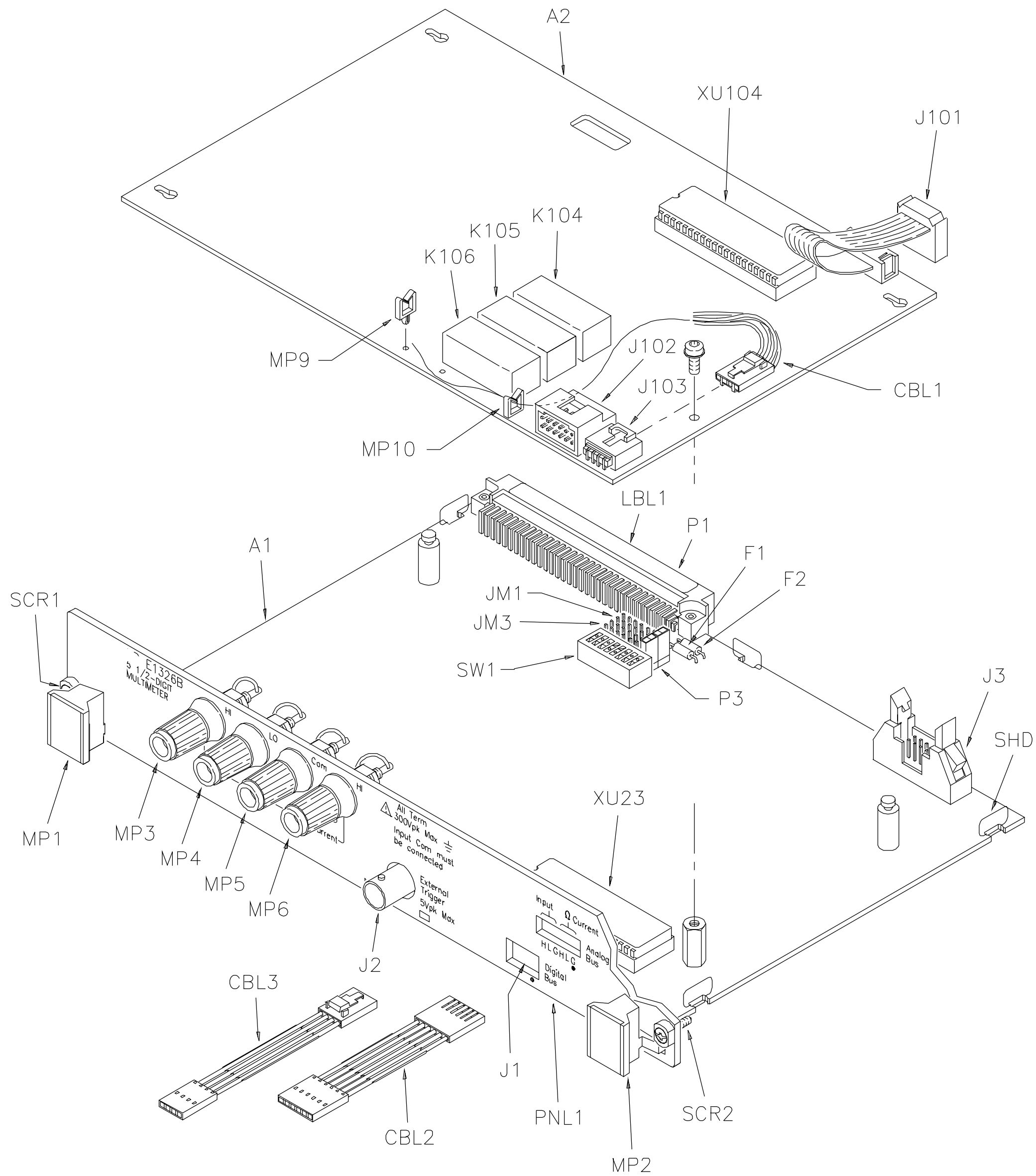

Figure 6-1. Agilent E1326B Replaceable Parts

Table 6-3. Agilent E1326B Code List of Manufacturers

Mfr Code	Manufacturer Name	Address
00000	Any satisfactory supplier	
00779	AMP Inc	Harrisburg, PA US 17111
06776	Robinson Nugent Inc	New Albany, IN US 47150
18873	Dupont E I De Nemours & Co	Wilmington, DE US 19801
24931	Specialty Connector Co	Franklin, IN US 46131
27264	Molex Inc	Lisle, IL US 60532
28480	Agilent Technologies	Palo Alto, CA US 94304
71707	Coto Wabash	Providence, RI US 02907
75915	Littelfuse Inc	Des Plaines, IL US 60016
81073	Grayhill Inc	La Grange, IL US 60525

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 Agilent E1326B multimeter serial number information.

8

Service

Introduction

This chapter contains information to service the Agilent E1326B multimeter, including:

- recommended repair strategy
- troubleshooting techniques
- repair/maintenance guidelines

WARNING

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

Equipment Required

See Table 1-1, *Recommended Test Equipment* for equipment required for multimeter troubleshooting and repair. To avoid damage to screw head slots, user Posidriv or TORX drivers as specified. See Table 8-1 for driver numbers.

Table 8-1. Pozidriv/Torx Drivers

Description	Agilent Part Number
No. 1 Pozidriv No. 2 Pozidriv	8710-0899 8710-0900
Size T-8 Torx Size T-10 Torx Size T-15 Torx	8710-1673 8710-1284 8710-1816

Service Aids

There are no test points or manual adjustment locations for the Agilent E1326B multimeter. Service aids on printed circuit boards may include pin numbers, some reference designations, and assembly part numbers. See *Chapter 6 - Replaceable Parts* for descriptions and locations of Agilent E1326B multimeter replaceable parts.

Service notes and other service literature for the Agilent E1326B multimeter may be available through Agilent. For information, contact your nearest Agilent Sales and Service Office.

Recommended Repair Strategy

The recommended repair strategy for the Agilent E1326B multimeter is assembly-level repair. User repairs to the Agilent E1326B multimeter are limited to replacement of the parts shown in Table 6-1 *Agilent E1326B Replaceable Parts.*

If the fault cannot be traced to a user-replaceable part in Table 6-1, return the entire Agilent E1326B multimeter to Agilent for exchange or replacement (see *Chapter 6 - Replaceable Parts* for details.) Individual A1 or A2 printed circuit assemblies (PCAs) cannot be returned for exchange or replacement.

Troubleshooting Techniques

There are two main steps to troubleshoot an Agilent E1326B multimeter problem: (1) identify the problem, and (2) test assemblies to isolate 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 (1, 2, 3, or 4) is returned when the multimeter self-test fails. If a self-test error occurs, recycle power and repeat the self-test. If the error repeats, see "Testing Assemblies" to troubleshoot the multimeter. Table 8-2 shows some typical causes of self-test errors.

Table 8-2. Self-Test Errors

Error	Description	Typical Causes
1	Multimeter does not respond to self-test	. Bad connections/settings . Incorrect operation . Hardware failure (exchange)
2	Invalid communication between A1 and A2 processors	. Bad A1/A2 connection . Hardware failure (exchange)
3	Data line test between multimeter and mainframe failed	. Bad connections/settings . Incorrect operation . Hardware failure (exchange)
4	Invalid communication between multimeter and mainframe	. Bad connections/settings . Incorrect operation . Hardware failure (exchange)

Operator Errors

Apparent failures may result from operator errors. See *Appendix B - Error Messages* in the *Agilent E1326B/E1411B 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 - Adjustments* 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 8-3 to isolate the problem to a user-replaceable part on the multimeter frame, to the A1 Outguard PCA, or to the A2 Inguard PCA. See Figure 6-1 in *Chapter 6 - Replaceable Parts* 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 Agilent for exchange. See Chapter 6 - Replaceable Parts for procedures.

Table 8-3. Agilent E1326B Tests/Checks

Test/Check	Reference Designator	Check:
Heat Damage	- - - - - - - - - -	Discolored PC boards Damaged insulation Evidence of arcing
Switch/Jumper Settings	JM1, JM3 SW1	IRQ Level setting LADDR setting
Frame	CBL1, CBL2, CBL3 MP3, MP4, MP5, MP6	Cable contact damage Panel binding posts
A1 Outguard PCA	F1, F2 J1, J2, J3 P1, P3 XU23	Fuse continuity Mating connector contacts Connector contacts IC contact/connections
A2 Inguard PCA	J101, J102, J103 K104, K105, K106 XU104	Cable connector contacts Relay opening/closure IC contact/connections

Checking 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 correct the problem.

Checking Switches/Jumpers

Verify the logical address setting is set correctly (factory set at 24). Verify the interrupt priority jumpers are set correctly (factory set at level 1). See the *Agilent E1326B/E1411B User's Manual* for information.

Testing Multimeter Frame

To test the multimeter frame, see Table 8-3 for guidelines to check binding posts MP3, MP4, MP5, and MP6, and cables CBL1, CBL2, and CBL3. If you need to remove and/or replace the binding posts, see "Removing Binding Posts" in this chapter.

Testing A1/A2 PCAs

To test the A1 Outguard PCA and the A2 Inguard PCAs, remove mainframe power and remove the multimeter from the mainframe. Then, remove the A2 Inguard PCA (see "Removing A2 Inguard PCA" for instructions). Then, see Table 8-3 for guidelines to isolate the problem to a user-replaceable part.

Repair/ Maintenance Guidelines

This section gives guidelines to repair and maintain the Agilent E1326B multimeter, including:

- ESD precautions
- Removing A2 inguard PCA
- Removing binding posts
- Soldering printed circuit boards
- Post-repair safety checks

ESD Precautions

Electrostatic discharge (ESD) may damage MOS, CMOS and other static sensitive devices in the Agilent E1326B 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

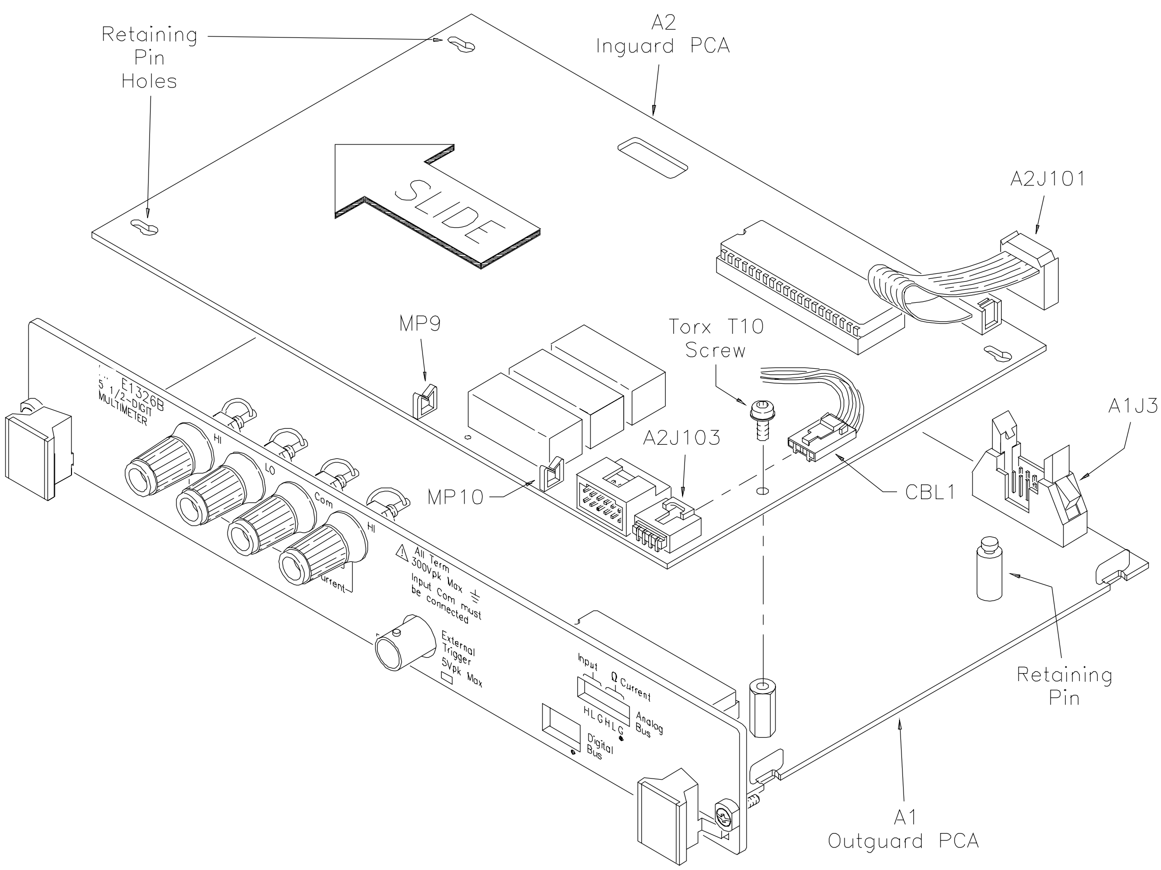

Figure 8-1. Removing A2 Inguard PCA

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.

- Do not use pliers to remove a MOS or CMOS device from a high-grip socket. Instead, use a small screwdriver to pry the device up from one end. Slowly lift the device up, one pair of pins at a time.

- After you remove a MOS or CMOS device from an assembly, place the device onto a pad of conductive foam or other suitable holding material.

- If a device requires soldering, be sure the assembly is placed on a pad of conductive material. Also, be sure you, the pad, and the

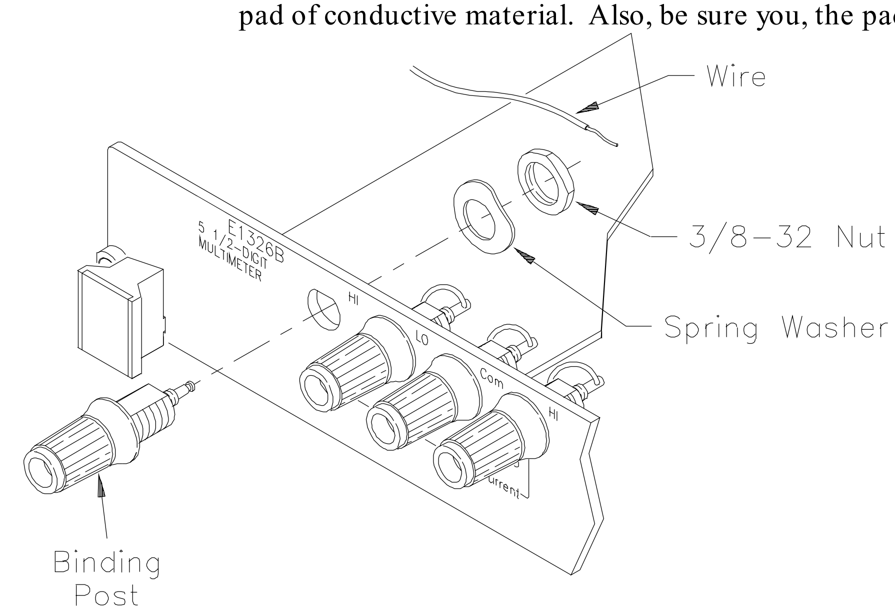

Figure 8-2. Removing Binding Posts

soldering iron tip are grounded to the assembly. Apply as little heat as possible when soldering.

- When you replace a MOS or CMOS device, ground the foam to the multimeter before removing the device from the foam.

Removing A2 Inguard PCA

Use the following steps to remove the A2 A/D Inguard printed circuit assembly (PCA) from the A1 Outguard PCA. See Figure 8-1 for component locations.

1. Disconnect the four-conductor cable (CBL1) from A2J103.

2. Remove CBL1 from the two plastic retainers (MP9 and MP10) on the A2 Inguard PCA.

3. Disconnect the 10-pin ribbon cable (A2J101) from A1J3.

4. Remove the Torx T10 screw, using a T10 Torx driver.

5. Slide the A2 Inguard PCA to align with the large holes on the retaining pins.

6. Lift and remove the A2 Inguard PCA from the A1 Outguard PCA.

7. Reverse Steps 1 through 6 to reinstall the A2 Inguard PCA onto the A1 Outguard PCA.

NOTE

When reinstalling the A2 Inguard PCA, verify that the holes are aligned with the retainers. Then, slide the PCA into place.

Removing Binding Posts

Use the following steps to remove the Agilent E1326B faceplate binding posts (MP3, MP4, MP5, and MP6) (see Figure 8-2).

1. Unsolder 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.

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.

CAUTION

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 (a 38-watt soldering iron is recommended), 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 Agilent E1326B 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.

NOTES:

A
Calculating Multimeter Accuracy

Introduction

This appendix shows how multimeter accuracy, measurement uncertainty, and test accuracy ratio (TAR) values are defined and calculated for the performance verification tests for the Agilent E1326B multimeter.

See Table 4-1, "Performance Test Record for the Agilent E1326B 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. For the test conditions described, all TARs exceed the 4:1 requirements of MIL-STD-45662A.

Multimeter Accuracy Definition

Multimeter accuracy is the expected accuracy of the measurement due ONLY to 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.

Measurement Uncertainty Definition

Measurement Uncertainty is the expected accuracy of the source used to input signals to the multimeter. Since the Datron 4708 Autocal Multifunction Standard is the source used for measurements in this manual, the measurement uncertainty of the source is that of the Datron 4708.

This value is shown in the "Measurement Uncertainty" column of Table 4-1. See the *Datron 4708 User's Handbook* for additional information on calculating measurement uncertainty for the Datron 4708 source.

NOTE

Measurement Uncertainty does not apply to the DC Voltage (Zero Volts Input) test, since no input is applied.

Test Accuracy Ratio (TAR) Definition

Test Accuracy Ratio (TAR) is the ratio of multimeter accuracy to measurement uncertainty. For the Agilent E1326B multimeter performance tests, test accuracy ratio = (High Limit value - Test Input value)/
Measurement Uncertainty value. This value is shown in the "Test Accuracy Ratio (TAR)" column of Table 4-1.

NOTE

Test accuracy ratio does not apply to the DC Voltage (Zero Volts Input) test, since no measurement uncertainty value applies.

Multimeter Accuracy Calculations

For the Agilent E1326B multimeter performance verification tests, multimeter accuracy is defined for DC Voltage, AC Voltage, and 4-Wire Resistance measurements using the 90-day specifications in *Appendix A - Specifications* of the *Agilent E1326B/E1411B User's Manual*. The **assumed** test conditions are:

- One year since the last calibration
- Temperature within ± 5^{o}C of calibration temperature
- Module calibration temperature 18^{o}C to 28^{o}C
- One hour warmup
- 4-wire ohms resistance measurements
- Aperture = 16.7 msec (60 Hz) or 20 msec (50 Hz)
- Autozero ON

DC Voltage Accuracy Equations

From *Appendix A* of the *Agilent E1326B /E1411B 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)]
125 mV	0.023 + 5.0 µV
1 V	0.013 + 15.0 µV
8 V	0.010 + 50.0 µV
64 V	0.015 + 1.0 mV
300 V	0.015 + 5.0 mV

Example: Calculate DC Voltage Accuracy

For a 7.0 DCV input to the multimeter, using the 8 V range and 16.7/20 msec aperture, multimeter accuracy (1-year) = ±(.020% reading + 50.0 µV) = ±(.0002 x 7.0 + 50 x 10^{-6}) = ±0.0014 Volts. Thus, for a 7.0 DCV input the Low Limit in Table 4-1 = 6.9986 Volts and the High Limit = 7.0014 Volts.

AC Voltage Accuracy Equations

From *Appendix A* of the *Agilent E1326B/E1411B User's Manual*, AC voltage 1-year accuracy = ±(% of reading + volts). The accuracy equations for the ranges, frequencies and apertures used in the performance verification tests are:

Range	Frequency	Accuracy [± (% of reading + Volts)]
87.5 mV	60 Hz	0.695 + 200 μV
87.5 mV	5 kHz	3.195 + 200 μV
87.5 mV	10 kHz	3.195 + 200 μV
300 V	5 kHz	10.14 + 500 mV

Example: Calculate AC Voltage Accuracy

For a 0.07 ACV input to the multimeter, using the 87.5 mV range, 60 Hz frequency, and 16.7/20 msec aperture, multimeter accuracy (1-year) = ±(0.695% reading + 200 μV) = $\pm(.00695 \times 0.07 + 200 \times 10^{-6})$ = ±0.0007 Volts. Thus, for a 0.07 ACV input the Low Limit in Table 4-1 = 0.0693 Volts and the High Limit = 0.0707 Volts.

4-Wire Ohms Accuracy Equations

From *Appendix A* of the *Agilent E1326B/E1411B User's Manual*, 4-Wire resistance 90-day accuracy = ±(% of reading + Ohms). The accuracy equations for the ranges and apertures used in the performance verification tests are:

Range	Accuracy [± (% of reading + Ohms)]
2 kΩ	0.04 + 20 mΩ
131 kΩ	0.04 + 1 Ω
1 MΩ	0.04 + 10 Ω

Example: Calculate 4-Wire Resistance Accuracy

For a 1 kΩ input to the multimeter, using the 2 kΩ range and 16.7/20 msec aperture, multimeter accuracy (1-year) = ±(.04% reading + 20 mΩ) = $\pm(.0004 \times 1000 + 20 \times 10^{-3})$ = ±0.4 Ω. Thus, for a 1 kΩ input the Low Limit in Table 4-1 = 999.6 Ω and the High Limit = 1000.4 Ω.

Measurement Uncertainty Calculations

Measurement uncertainties for the Datron 4708 source are calculated using the 90-day accuracy specifications in the *Datron 4708 User's Handbook:*

Measurement Uncertainty = Datron Accuracy + Calibration Uncertainty, where Datron Accuracy (ppm) = Accuracy Relative to Calibration Standards = ± (ppm OUTPUT + ppm FS)

and FS = 2 x range for all ranges except 1000V
FS = 1100 for the 1000V range

The **assumed** test conditions are:

- Temperature of $23^{o}C \pm 1^{o}C$
- 90 days since last calibration
- 4-wire sense function for ohms measurements

Calculate DCV Measurement Uncertainty

From *Section 6 - Specifications* of the *Datron 4708 User's Handbook*, DC Voltage (Option 10) Accuracy (90 days since calibration and $23^{o}C \pm 1^{o}$ C) follows, where Datron Accuracy = ± (ppm OUTPUT + ppm FS).

Datron OUTPUT (DCV)	Datron Range (Volts)	Datron Accuracy (ppm)	Calibration Uncertainty (ppm)
0.1	1.0000000V	2 + 0.4	2
0.9	1.0000000V	2 + 0.4	2
7.0	10.000000V	1 + 0.15	1.5
58.0	100.00000V	2 + 0.25	2
300.0	1000.0000V	3 + 0.25	2

Example: Calculate DC Voltage Measurement Uncertainty

Since Measurement Uncertainty = Datron Accuracy + Calibration Uncertainty, for a 7.0 DCV OUTPUT and the Datron 4708 range set to 10.000000 V, Measurement Uncertainty (µV) = ± [(1.0 x 7.0) + (2 x 0.15 x 10)] + 1.5 = ± 11.5 µV = ± 0.0000115 V.

Or, with a 300 DCV OUTPUT and the 1000.0000V range, Measurement Uncertainty (µV) = ± [(3.0 x 300) + (0.25 x 1100)] + 2.0 = ± 1177 µV = ± 0.001177 V.

Calculate ACV Measurement Uncertainty

From *Section 6 - Specifications* of the *Datron 4708 User's Handbook*, AC Voltage (Option 20) Accuracy (90 days since last calibration and $23^{o}C \pm 1^{o}$ C) where Datron Accuracy = ± (ppm OUTPUT + ppm FS).

Datron Output (ACV)	Datron Range	Datron Freq	Datron Accuracy (ppm)	Calibration Uncertainty (ppm)
0.07	100 mV	20 Hz	110 + 20 + 5 µV	30 + 1 µV
0.07	100 mV	60 Hz	60 + 20 + 5 µV	30 + 1 µV
0.07	100 mV	5 kHz	50 + 20 + 5 µV	30 + 1 µV
0.07	100 mV	10 kHz	50 + 20 + 5 µV	30 + 1 µV
300.0	1000 V	5 kHz	90 + 10	30

Example: Calculate AC Voltage Measurement Uncertainty

Since Measurement Uncertainty = Datron Accuracy + Calibration Uncertainty, for a 0.07 ACV OUTPUT to the multimeter and the Datron 4708 range set to 100 mV at 60 Hz, Measurement Uncertainty (µV)= ± [(60.0 x 0.07) + (2 x 20 x .1) + 5] + [(30 + 1)] = ± 44.2 µV = ± 0.000044 V.

Or, for a 300 ACV OUTPUT to the multimeter and the Datron 4708 range set to 1000 V at 5 kHz, Measurement Uncertainty (µV) = ± [(90.0 x 300.0) + (10 x 1100)] + 30 = ± 38030 µV = ± 0.038030 V.

Calculate Resistance Measurement Uncertainty

From *Section 6 - Specifications* of the *Datron 4708 User's Handbook*, 4-Wire Resistance (Option 30) Accuracy (90 days since last calibration and $23^{o}C \pm 1^{o}$ C) follows, where Datron Accuracy = ± (ppm OUTPUT + ppm FS).

Datron Range (Ohms)	Datron Accuracy (ppm)	Calibration Uncertainty (ppm)
1.0000000k	3	5
100.00000k	3	6
1.0000000M	10	12

Example: Calculate 4-Wire Ohms Measurement Uncertainty

For the 100k Ω range, measurement uncertainty = $[(3 \times 10^{-6} \times 10^{5}) + (6 \times 10^{-6})]\ \Omega = (0.3 + 0.000006)\ \Omega = 0.300\ \Omega$.

Test Accuracy Ratio (TAR) Calculations

For the Agilent E1326B multimeter **Test Accuracy Ratio (TAR)** = [High Limit - Input Value]/Measurement Uncertainty where the source input value is in DCV, ACV, or Ohms.

Example: Calculate DCV Test Accuracy Ratio

For a 7.0 DCV measurement if the High Limit value = 7.000750 DCV and the Measurement Uncertainty = .0000115 DCV, Test Accuracy Ratio (TAR) = (7.000750 V - 7.0000000 V)/.0000115 V = 65:1 (rounded to the nearest integer value). Since this value is >10:1, the entry in Table 4-1 is ">10:1".

B
Verification Tests - C Programs

Functional Verification Test

This program is designed to do the Functional Verification Test found in *Chapter 4 - Verification Tests*.

Example:Self Test

This example performs a multimeter self-test to ensure that the multimeter is communicating with the mainframe, external controller, and/or external terminal.

```
#include <stdio.h>
#include <sicl.h>

#define ADDR "hpib7,9,03"             /* Address of device */

void main ()
{
   INST id;                            /* Define id as an instrument */
   char a[256] = {0};                  /* Result variable */

   id = iopen (ADDR);                  /* Open instrument session */

   ipromptf(id, "*TST?\n", "%t", a);   /* Self test command */

   printf("\n %s", a);                 /* Print result */

   getchar();                          /* Pause */

   iclose (id);                        /* Close instrument session */
}
```

Performance Verification Tests

These programs are designed to do the Performance Verification Tests found in *Chapter 4 - Verification Tests*.

Example: Zero Volt DCV Test

This example performs a DCV test for zero volts input and a power line reference frequency of 60 Hz.

```
/*  Zero Volt DCV Test     E1326B  */

#include <stdio.h>
#include <sicl.h>

#define ADDR "hpib7,9,03"            /* Address of Agilent E1326B */

void main (void)
{
  INST id;                               /* Define id as an instrument */
  char volt[256] = {0};                  /* Result variable */

  #if defined(__BORLANDC__) && !defined(__WIN32__)
    _InitEasyWin();
  #endif

  ionerror(I_ERROR_EXIT);

  id = iopen (ADDR);                     /* Open instrument session */

  iprintf (id, "*RST\n");                /* Resets and set autozero
                                              ON and PLC to 1 */
  iprintf (id, "CAL:LFR 60\n");          /* Sets line reference to 60 Hz */

  ipromptf (id, "MEAS:VOLT:DC? .1\n", "%t", volt);
                                         /* Measure 0.113 V range */
  printf ("Voltage for 0.113 V range = %s\n", volt);

  ipromptf (id, "MEAS:VOLT:DC? .9\n", "%t", volt);
                                         /* Measure 0.91 V range */
  printf ("Voltage for 0.91 V range = %s\n", volt);

  ipromptf (id, "MEAS:VOLT:DC? 7\n", "%t", volt);
                                         /* Measure 7.27 V range */
  printf ("Voltage for 7.27 V range = %s\n", volt);

  ipromptf (id, "MEAS:VOLT:DC? 58\n", "%t", volt);
                                          /* Measure 58.1 V range */
  printf ("Voltage for 58.1 V range = %s\n", volt);

  ipromptf (id, "MEAS:VOLT:DC? 300\n", "%t", volt);
                                          /* Measure 300 V range */
  printf ("Voltage for 300 V range = %s\n", volt);

  iclose (id);                            /* Close instrument session */
}
```

Example: DC Voltage Test

This test performs a DC Voltage test for positive input DC volts and a power line reference frequency of 60 Hz.

```
/*  DC Voltage Test (DCV Input)     E1326B  */

#include <stdio.h>
#include <sicl.h>

#define ADDR "hpib7,9,03"        /* Address of Agilent E1326B */

void main ()
{
   INST id;                            /* Define id as an instrument */
   float range[5] = {0.113, 0.910, 7.270, 58.10, 300.0};
   float volts[5] = {0.1, 0.9, 7.0, 58.0, 300.0};
   char measurement[5][256], complete[256];  /* Result variable */
   int i;

   #if defined(__BORLANDC__) && !defined(__WIN32__)
      _InitEasyWin();
   #endif

   ionerror(I_ERROR_EXIT);      /* Exit on error */

   id = iopen (ADDR);                 /* Open instrument session */

   iprintf (id, "*RST\n");              /* Resets and set autozero
                                          ON and PLC to 1 */
   iprintf (id, "CAL:LFR 60\n");      /* Sets line reference to 60 Hz */

   for(i = 0; i < 5; i++)                /* Take voltage measurements */
   {
      printf("\n Set DC Standard to %.1f VDC", volts[i]);
      printf("\n press ENTER when ready\n");
      getchar ();
      iprintf(id, "CONF:VOLT:DC %f\n", range[i]);  /* Voltage range */
      ipromptf(id, "*OPC?\n", "%s", complete);      /* Wait for settling */
      ipromptf(id, "READ?\n", "%t", measurement[i]);  /* Read voltage */
   }

   for (i=0; i < 5; i++)                 /* Print voltage measurements */
     printf("\n Voltage on %4f V range = %s ", range[i], measurement[i]);

   iclose (id);                          /* Close instrument session */
}
```

Example: AC Voltage Test

This example performs an AC voltage test for a power line reference frequency of 60 Hz.

```
/*  AC Voltage Test          E1326B  */

#include <stdio.h>
#include <sicl.h>

#define ADDR "hpib7,9,03"               /* Address of Agilent E1326B */

void main ()
{
   INST id;                            /* Define id as an instrument */
   float source_volts[4] = {0.07, 0.07, 0.07, 300.0};
   float source_freq[4] = {60, 5000, 10000, 5000};
   char measurement[4][256], complete[256];  /* Result variable */
   int i;

   #if defined(__BORLANDC__) && !defined(__WIN32__)
     _InitEasyWin();
   #endif

   ionerror(I_ERROR_EXIT);     /* Exit on error */

   id = iopen (ADDR);              /* Open instrument session */

   iprintf (id, "*RST\n");             /* Resets and set autozero
                                          ON and PLC to 1 */
   iprintf (id, "CAL:LFR 60\n");   /* Sets line reference to 60 Hz */

   for(i = 0; i < 4; i++)              /* Take voltage measurements */
   {
     printf("\n 1. Set AC Standard output to %.2f VAC",
             source_volts[i]);
     printf("\n 2. Set AC Standard frequency to %.1f
              Hz",source_freq[i]);
     printf("\n 3. Press ENTER when ready\n");
     getchar ();
     iprintf(id, "CONF:VOLT:AC %f\n", source_volts[i]);
                                          /* Set voltage range */
     ipromptf(id, "*OPC?\n", "%s", complete);
     ipromptf(id, "READ?\n", "%t", measurement[i]);
                                          /* Read voltage */
   }

   for (i=0; i < 4; i++)                 /* Print voltage measurements */
   printf("\n Voltage for %4f V range at %.1f Hz = %s ", source_volts[i],
          source_freq[i], measurement[i]);

   iclose (id);                          /* Close instrument session */
}
```

Example: Resistance Test

This example performs a 4-wire ohms resistance test. The program also calculates the Upper and Lower Limit values for the ACTUAL resistance values. Use these values in Table 4-1 if they differ from the given values.

```
/*  Resistance Test (4-wire Ohms)     E1326B  */

#include <sdtio.h>
#include <sicl.h>

#define ADDR "hpib7,9,03"        /* Address of Agilent E1326B */

void main ()
{
  INST id;                                /* Define id as an instrument */
  float range[3] = {1861, 119156, 1048576};
  float source[3] = {1000, 100000, 1000000};
  char measurement[3][256], complete[256];
  float limit[3], actual[3];
  int i;

  #if defined(__BORLANDC__) && !defined(__WIN32__)
    _InitEasyWin();
  #endif

  ionerror(I_ERROR_EXIT);       /* Exit on error */

  id = iopen (ADDR);                  /* Open instrument session */

  iprintf (id, "*RST\n");              /* Resets and set autozero
                                          ON and PLC to 1 */
  iprintf (id, "CAL:LFR 60\n");      /* Sets line reference to 60 Hz */

  for(i = 0; i < 3; i++)                 /* Take measurements */
  {
    printf("\n 1. Set Resistance Standard to %.1f Ohms", source[i]);
    printf("\n 2. Measure ACTUAL resistance standard value (in
           Ohms)");
    printf("\n 3. Enter ACTUAL resistance standard (in Ohms): ");
    scanf("%f", &actual[i]);

    iprintf(id, "CONF:FRES %f\n", range[i]);
                                        /* Set resistance range */
    ipromptf(id, "*OPC?\n", "%s", complete);     /* Wait for settling */
    ipromptf(id, "READ?\n", "%t", measurement[i]);
                                        /* Read resistance */

    if (i == 0)
       limit[i] = .0004*actual[i] + 0.02;      /* 2kOhm limits */
    if (i == 1)
       limit[i] = .0004*actual[i] + 1.0;       /* 131 kOhm limits */
    if (i == 2)
       limit[i] = .0004*actual[i] + 10;        /* 1 MOhm limits */
  }

  printf("\nMeasured     Source     Low Limit     High Limit");
  printf("\nResistance     Resistance     (Ohms)     (Ohms)\n");

  for (i=0; i < 3; i++)                  /* Print measurements and limits */
    printf("\n%s     %10.2f          %10.2f         %10.2f",
           measurement[i],actual[i],  actual[i]-limit[i], actual[i]+limit[i]);

  iclose (id);                            /* Close instrument session */
}
```

Adjustments

These programs are designed to do the adjustments found in *Chapter 5 - Adjustments*.

DC Voltage Adjustments

This example performs DC Voltage adjustments for a power line reference frequency of 60 Hz. If no calibration error occurs, the program displays an "adjustment complete" message. If a calibration error occurs, the program displays the calibration error and prompts you to repeat the adjustment (see Table 5-1 for a list of calibration errors).

```
/*  DC Voltage Adjustments     E1326B  */

#include <stdio.h>
#include <sicl.h>

#define ADDR "hpib7,9,03"           /* Address of device */

void main ()
{
   INST id;                                    /* Define id as an instrument */
   float range[10] = {8.0, 8.0, 0.125, 0.125, 1.0, 1.0, 64.0, 64.0,
                               300.0, 300.0};
   float volts[10] = {7.7, -7.7, .121, -.121, .97, -.97, 62.0, -62.0,
                             300.0, -300.0};
   char cal_code[5][256];
   int i;
#if defined(__BORLANDC__) && !defined(__WIN32__)
  _InitEasyWin();
#endif
   ionerror(I_ERROR_EXIT);          /* Exit on error */
   id = iopen (ADDR);                    /* Open instrument session */
   iprintf (id, "*RST\n");               /* Resets and set autozero
                                                   ON and PLC to 1 */
   iprintf (id, "CAL:LFR 60\n");       /* Sets line reference to 60 Hz */
   for(i = 0; i  10; i++)                 /* Take voltage measurements */
   {
    retry:
      printf("\n Set DC Standard to %.1f VDC", volts[i]);
      printf("\n press ENTER when ready\n");
      getchar ();
      iprintf(id, "FUNC:VOLT:DC\n");               /* Set DCV function */
      iprintf(id, "VOLT:RANG %f\n", range[i]);   /* Set E1326B range */
      iprintf(id, "CAL:VAL %f\n", volts[i]);           /* Set CAL:VAL value */
      iprintf(id, "TRIG:DEL .05\n");                  /* Wait for settling */
      ipromptf(id, "CAL?\n", "%t", cal_code[i]);  /* Read voltage */

      if (cal_code != 0)
      {
         printf ("\nCalibration Error %s for %f Vdc input", cal_code,
                     volts[i]);
         printf ("\nCheck source value/connections, then");
         printf ("\npress ENTER to retry this adjustment");
         getchar ();
         goto retry;
      }
      else
         printf ("\nAdjustment complete for %f Vdc input", volts[i]);
   }
   iclose (id);                                 /* Close instrument session */
}
```

AC Voltage Adjustments

This example performs an AC Voltage adjustment for a power line reference frequency of 60 Hz and an input of 5.6 Vac at 1 kHz. If no calibration error occurs, the program displays an "adjustment complete" message. If a calibration error occurs, the program displays the calibration error and prompts you to repeat the adjustment (see Table 5-1 for a list of calibration errors).

```
/*  AC Voltage Adjustments     E1326B  */

#include <sdtio.h>
#include <sicl.h>

#define ADDR "hpib7,9,03"           /* Address of device */

void main ()
{
   INST id;                         /* Define id as an instrument */
   char cal_code[256];

#if defined(__BORLANDC__) && !defined(__WIN32__)
   _InitEasyWin();
#endif

   ionerror(I_ERROR_EXIT);          /* Exit on error */

   id = iopen (ADDR);               /* Open instrument session */

   iprintf (id, "*RST\n");          /* Resets and set autozero
                                       ON and PLC to 1 */
   printf (id, "CAL:LFR 60\n");     /* Sets line reference to 60 Hz */

   retry:
   printf("\n Set AC Standard to 5.6 Vac at 1.0 kHz");
   printf("\n press ENTER when ready\n");
   getchar ();   iprintf(id, "FUNC:VOLT:AC\n");   /* Set DCV function */
   iprintf(id, "VOLT:RANG 5.6\n");                 /* Set E1326B range */
   iprintf(id, "CAL:VAL 5.6\n");                   /* Set CAL:VAL value */
   iprintf(id, "TRIG:DEL .05\n");                  /* Wait for settling */
   ipromptf(id, "CAL?\n", "%t", cal_code[i]);    /* Read voltage */

   if (cal_code != 0)
   {
      printf ("\nCalibration Error %s on 5.6 Vac range", cal_code);
      printf ("\nCheck source value/connections, then");
      printf ("\npress ENTER to retry this adjustment");
      getchar ();
      goto retry;
   }
   else
      printf ("\nAdjustment complete for %f Vdc input", volts[i]);

   iclose (id);                     /* Close instrument session */
}
```

Resistance Adjustments

This example performs a 4-wire ohms resistance adjustment for a power line reference frequency of 60 Hz. If a calibration error occurs, the program displays the calibration error and prompts you to repeat the adjustment (see Table 5-1 for a list of calibration errors).

```
/*  4-wire Resistance Adjustments     E1326B  */

#include <stdio.h>
#include <sicl.h>

#define ADDR "hpib7,9,03"            /* Address of device */

void main ()
{
   INST id;                              /* Define id as an instrument */
   float range[3] = {2000, 16000, 1048576};
   float source[3] = {1000, 10000, 1000000};
   char cal_code[5][256];
   float actual[3];
   int i;

#if defined(__BORLANDC__) && !defined(__WIN32__)
   _InitEasyWin();
#endif

   ionerror(I_ERROR_EXIT);          /* Exit on error */

   id = iopen (ADDR);                    /* Open instrument session */

   iprintf (id, "*RST\n");                /* Resets and set autozero
                                            ON and PLC to 1 */
   iprintf (id, "CAL:LFR 60\n");        /* Sets line reference to 60 Hz */

   for(i = 0; i  3; i++)                  /* Take voltage measurements */
   {
     retry:
      printf("\n Set Resistance Standard to %.1f Ohms", source[i]);
      printf("\n Measure ACTUAL Resistance Standard value (in
             Ohms):");
      scanf ("%f", &actual[i]);

      iprintf(id, "FUNC:FRES\n");                     /* Set DCV function */
      iprintf(id, "FRES:RANG %f\n", range[i]);   /* Set E1326B range */
      iprintf(id, "CAL:VAL %f\n", actual[i]);        /* Set CAL:VAL value */
      ipromptf(id, "CAL?\n", "%t", cal_code[i]);  /* Read voltage */

      if (cal_code != 0)
      {
         printf ("\nCalibration Error %s for %f Ohms", cal_code,
                source[i]);
         printf ("\nCheck source value/connections, then");
         printf ("\npress ENTER to retry this adjustment");
         getchar ();
         goto retry;
      }
      else
          printf ("\nAdjustment complete with %f Ohms source\n",
                 source[i]);

   }

   iclose (id);                              /* Close instrument session */
}
```