Agilent 75000 SERIES C

64-Channel 3-Wire Relay Multiplexer Module Agilent E1476A

Service Manual

Enclosed is the Service Manual for the Agilent E1476A 64-Channel Relay Multiplexer Module. Insert this manual, along with any other VXIbus manuals that you may have, into the binder that came with your Agilent Technologies mainframe or command module.

Agilent Technologies

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Agilent E1476A 64-Channel 3-Wire Relay Multiplexer Service Manual
Edition 1 Rev 2

Printing History

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

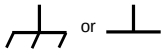
Edition 1 (Part Number E1476-90010). . . . . October 1994

Edition 1 Rev 2 (Part Number E1476-90010) . . . . . May 2006

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

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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.

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Manufacturer's Name: Agilent Technologies, Incorporated
Manufacturer's Address: 815 – 14th St. SW
Loveland, Colorado 80537
USA

Declares, that the product

Product Name: 64 Channel 3 Wire MUX
Model Number: E1476A
Product Options: *This declaration covers all options of the above product(s).*

Conforms with the following European Directives:

The product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC (including 93/68/EEC) and carries the CE Marking accordingly.

Conforms with the following product standards:

EMC	**Standard**	**Limit**
	CISPR 11:1990 / EN 55011:1991	*Group 1 Class A*
	IEC 801-2:1991 / EN 50082-1:1992	*4kV CD, 8kV AD*
	IEC 801-3:1984 / EN 50082-1:1992	*3 V/m*
	IEC 801-4:1988 / EN 50082-1:1992	*0.5kV signal lines, 1kV power lines*
	The product was tested in a typical configuration with Agilent Technologies or Hewlett-Packard Company test systems.	
Safety	*IEC 1010-1:1990+A1:1992 / EN 61010-1:1993* *Canada: CSA C22.2 No. 1010.1:1992* *UL 1244*	

5 June 2001
Date

Ray Corson
Product Regulations Program Manager

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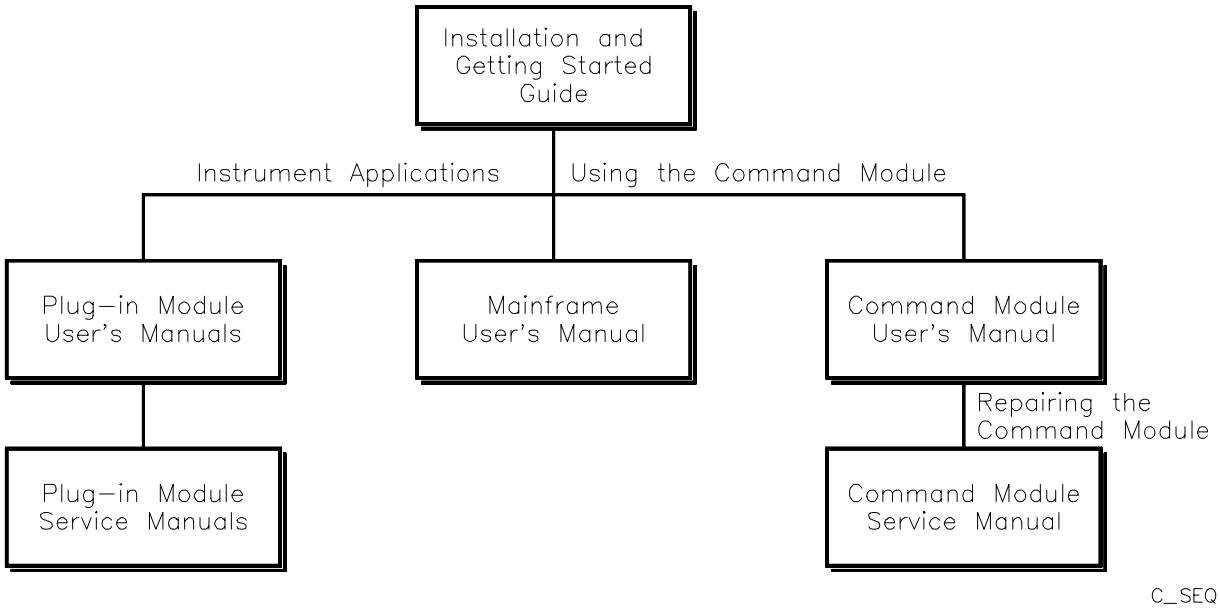
Agilent 75000 Series C Service Documentation

Suggested Sequence for Using the Manuals



Manual Descriptions

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

Command Module User's Manual. This manual contains programming information for the Command Module, and general programming information for instruments installed in the mainframe.

Mainframe User's Manual. This manual contains installation information to prepare the mainframe for use and shows how to install plug-in modules.

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

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

Manual Overview

This manual shows how to service the Agilent E1476A 64-Channel 3-Wire Relay Multiplexer Module. Consult the *Agilent E1476A User's Manual* for additional information on installing, configuring, and operating the module. Consult the appropriate mainframe or command module user's manual for information on configuring and operating the mainframe.

Manual Content

Chapter	Title	Content
1	General Information	Provides a basic description and lists the test equipment required for service.
2	Verification Tests	Functional verification, operation verification, and performance verification tests.
3	Replaceable Parts	Replaceable parts lists and illustrations.
4	Service	Procedures to aid in fault isolation and repair.

Table of Contents

Chapter 3. Replaceable Parts

Chapter 4. Service

Chapter 1

General Information

Introduction

This service manual contains information to test, troubleshoot, and repair the Agilent E1476A 64-Channel 3-Wire Multiplexer Module.

Note

See *Agilent 75000 Series C Service Documentation*, page iv in this manual, for a list of manuals that describe mainframe, command module and hardware operation. The information in this manual assumes you are familiar with Agilent E1476A operation. If incoming inspection is required, see *Inspection/Shipping* later in this manual.

Module Description

The Agilent E1476A is a 64-channel 3-wire Relay Multiplexer. This means it switches both the high, low, and guard signal lines for each channel at the same time. The module is a VXIbus C-size register-based slave device.

Specifications

See *Appendix A - Specifications* in the *Agilent E1476A User's Manual* for complete specifications. These specifications are the performance standards or limits against which the module may be tested.

Environment

The module should be stored in a clean, dry environment. Recommended operating/storage environments for the module are:

	Temperature	Relative Humidity
Operating Environment	0°C to +55°C	<65% (0°C to +40°C)
Storage/Shipment	-40°C to +75°C	<65% (0°C to +40°C)

Safety Information

The module is a Safety Class I instrument with a protective earth terminal when installed in an Agilent E1400 series mainframe. Check the mainframe and all related documentation for safety markings and instructions before operating or servicing the module.

Module Serial Numbers

Figure 1-1 shows the Agilent Technologies serial number structure. Agilent E1476A modules covered by this manual are identified by the serial number prefixes listed on the title page.

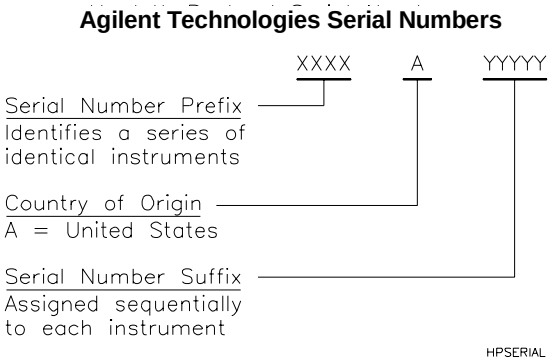


Figure 1-1. Agilent Technologies Serial Numbers

Recommended Test Equipment

Table 1-1 lists test equipment recommended to test and service the module. Essential requirements for each piece of test equipment are listed in the Requirements column. You may substitute other equipment if it meets the requirements in Table 1-1.

Table 1-1. Recommended Test Equipment

Instrument	Requirements	Recommended Model	Use*
Controller, GPIB	GPIB compatibility as defined by IEEE standard 488-1988 and the identical ANSI standard MC1.1: SH1, AH1, T2, TE0, L2, LE0, SR0, RL0, PP0, DC0, DT0, and C1, 2, 3, 4, 5.	HP 9000 Series 300	F, O, P, T
Mainframe	Compatible with relay multiplexer	Agilent E1400B/T Agilent E1401A/T	F, O, P, T
Command Module	Compatible with relay multiplexer with switchbox firmware	Agilent E1405A/B Agilent E1406A	F, O, P, T
Digital Multimeter	4-wire ohms 2-wire ohms (up to 1 GΩ)	Agilent 3458A or Agilent 34401A	O, P, T

*F = Functional Verification Tests, O = Operational Verification Tests, P=Performance Verification Tests, T = Troubleshooting

Schematic Diagram

Figure 1-2 shows the schematic diagram of the Agilent E1476A Relay Multiplexer module. Note that this diagram shows lines not shown in the user manual. These lines are not available on the user terminal block. They are available on the terminal connectors.

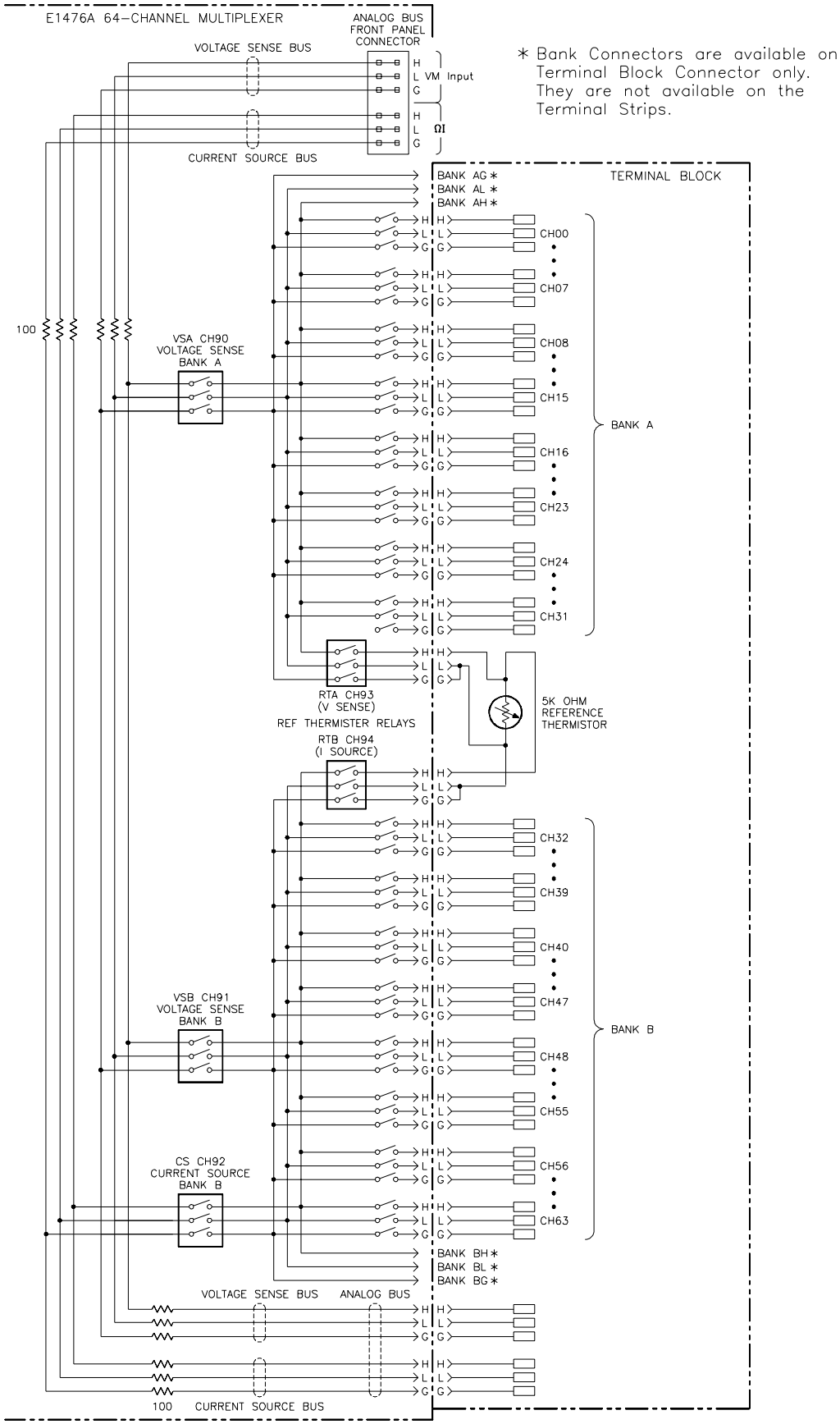


Figure 1-2. Agilent E1476A Schematic Diagram

Relay Life

Electromechanical relays are subject to normal wear-out. Relay life depends on several factors. The effects of loading and switching frequency are briefly discussed below:

Relay Load. In general, higher power switching reduces relay life. In addition, capacitive/inductive loads and high inrush currents (e.g., when turning on a lamp or motor) reduce relay life. ***Exceeding the specified maximum inputs can cause catastrophic failure.***

Switching Frequency. Relay contacts heat up when switched. As the switching frequency increases, the contacts have less time to dissipate heat. The resulting increase in contact temperature reduces relay life.

End-of-Life Detection

A preventive maintenance routine can prevent problems caused by unexpected relay failure. The end of the life of a relay can be determined using one or more of the three methods described below. The best method (or combination of methods), as well as the failure criteria, depends on the application in which the relay is used.

Contact Resistance. As the relay begins to wear out, its contact resistance will increase. When the resistance exceeds a pre-determined value, the relay should be replaced. The end-of-life resistance recommended by Agilent Technologies can be found in Appendix A of the *Agilent E1476A User's Manual*.

Stability of Contact Resistance. The stability of the contact resistance decreases with age. Using this method, the contact resistance is measured several (5-10) times, and the variance of the measurements is determined. An increase in the variance indicates deteriorating performance.

Number of Operations. Alternatively, relays can be replaced after a predetermined number of contact closures. However, this method requires knowledge of the applied load and life specifications for the applied load.

Replacement Strategy

The replacement strategy also depends on the application. If some relays are used more often, or at higher load, than the others, the relays can be individually replaced as needed. If all of the relays see similar loads and switching frequencies, the entire circuit board can be replaced when the end of life approaches. The sensitivity of the application should be weighed against the cost of replacing relays with some useful life remaining.

Note

Relays that wear out normally or fail due to misuse should not be considered defective and are not covered by the product's warranty.

Chapter 2

Verification Tests

Introduction

The two levels of test procedures described in this chapter are used to verify that the relay module:

- is fully functional (Functional Verification);
- meets all testable specifications (Performance Verification).

Test Conditions/ Procedures

See Table 1-1 for test equipment requirements. You should complete the Performance Verification tests at least once a year. For heavy use or severe operating environments, perform the tests more often. It is assumed that the temperature is no greater than 25^{o}C and the relative humidity is no greater than 40%.

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

Performance Test Record

The results of each Performance Verification test may be recorded in the Performance Test Record (Table 2-3). You can make a copy of this form, if desired.

Verification Test Examples

Each verification test procedure includes an example program that performs the test. All example programs assume the following:

- controller is an HP 9000 Series 200/300 computer;
- programming language is BASIC;
- relay module address is 70914 (logical address switches = 112);
- relay module card number is 1;
- DMM is an Agilent 3458A.

Test Fixture

A test fixture is required for the Performance Verification tests. A test fixture can be manufactured from a standard Agilent E1476A terminal module. It is recommended that you order an extra terminal module to use as a test fixture. The terminal module part number is E1476-80001. Figure 2-1 shows how the test fixture should be wired. Use 24AWG wire when making the test fixture.

NOTE: Use 24AWG wire (or smaller) to wire between terminal. Larger gauge wires will not fit in the terminals.

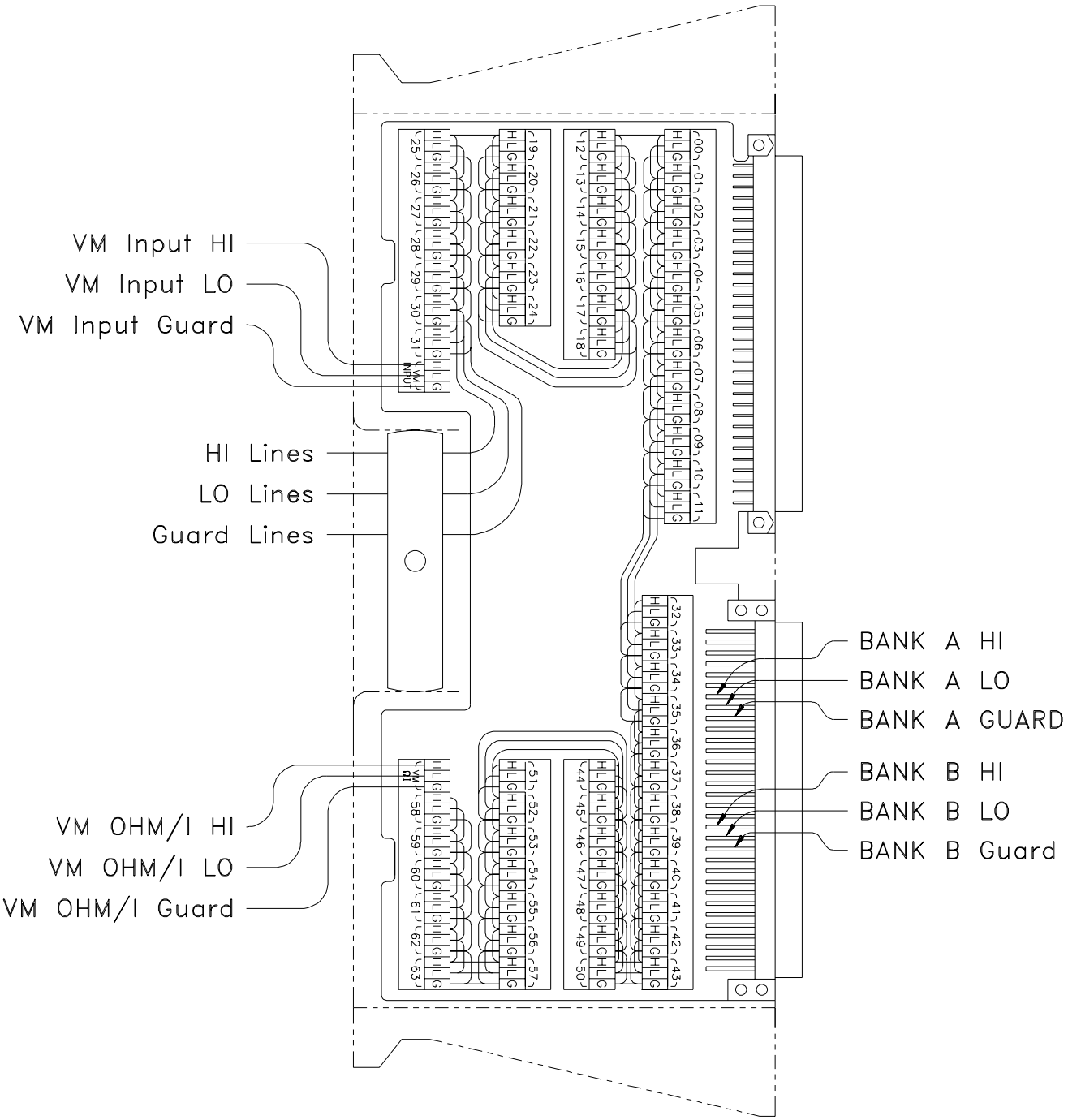


Figure 2-1. Agilent E1476A Test Fixture Wiring

Functional Verification

The Functional Verification Test for the relay module consists of sending the ***IDN?**, **SYST:CDES?**, **SYST:CTYP?**, and ***TST?** commands and checking for appropriate responses. This test can be used at any time to verify that the device is responding to SCPI commands.

Procedure

1. Verify that the relay module is installed in the mainframe and that the mainframe has passed its power-on test.
2. Send the commands to the module (see example following).
3. Enter the responses. After the ***TST** command, the device will return an error code. Any non-zero error code indicates a self-test failure. See Table 2-1 for a description of self-test error codes.

Example

An example follows which uses an HP 9000 Series 300 computer with BASIC and a relay module address of 70914.

```
10      DIM A$[50]
20      OUTPUT 70914;"*RST;*IDN?"   !Module identification
30      ENTER 70914;A$
40      PRINT A$
50      OUTPUT 70914;"SYST:CDES? 1"!Module Description
60      ENTER 70914;A$
70      PRINT A$
80      OUTPUT 70914;"SYST:CTYP? 1"!Module Type
90      ENTER 70914;A$
100     PRINT A$
110     OUTPUT 70914;"*TST?"        !Send the self-test command.
120     ENTER 70914;A               !Get response.
130     PRINT A
140 IF A <>0 THEN
150 REPEAT
160 OUTPUT 70914;"SYST:ERR?"
170 ENTER 70914;A,A$
180 PRINT A,A$
190 UNTIL NOT A
200 END IF
210     END
```

A typical response is:

HEWLETT-PACKARD,SWITCHBOX,0,A.08.00
64 Channel 3 Wire Relay Multiplexer
HEWLETT-PACKARD,E1476A,0,A.08.00
0

Self-test Error Codes

Table 2-1 shows the self-test error codes for the multiplexer module. The meaning of each code is given in the right-hand column. If a self-test failure occurs, cycle power and repeat the test. If the problem reoccurs, the module may need repair.

Table 2-1. Self-test Error Codes

Error*	Description,
+0	Self-test passed.
+ss01	Firmware error.
+ss02	Bus error (communications problem with card).
+ss03	Bad ID information in ID register.
+ss05	Hardware and firmware have different relay control register values. Possible hardware fault or module programmed via registers.
+ss10	Interrupt expected but not received.
+ss11	Busy bit was not held ≈9 to 17 msec.,

*ss = card number (with leading zero deleted)

Agilent E1476A Performance Verification

The procedures in this section are used to test the module's electrical performance using the specifications in Appendix A of the *Agilent E1476A User's Manual* as the performance standards. These tests are suitable for incoming inspection, troubleshooting, and preventive maintenance.

Note

In the following procedures, **ss** represents the switch card number (01-99) of the module. A leading zero may be omitted.

Test 2-1: Closed-channel Resistance Test

The purpose of this test is to verify that all channel relay contacts meet the closed-channel resistance specification for the multiplexer. If the closed-channel resistance of any contact is greater than 3.5Ω, the relay should be replaced.

High Lines Test

1. Hardware Connections. See Figures 2-1 and 2-2.
   - For channels 0 - 31, connect the DMM between HI LINES and BANK A HI on the connector.
   - For channels 32 - 64, connect the DMM between HI LINES and BANK B HI on the connector.

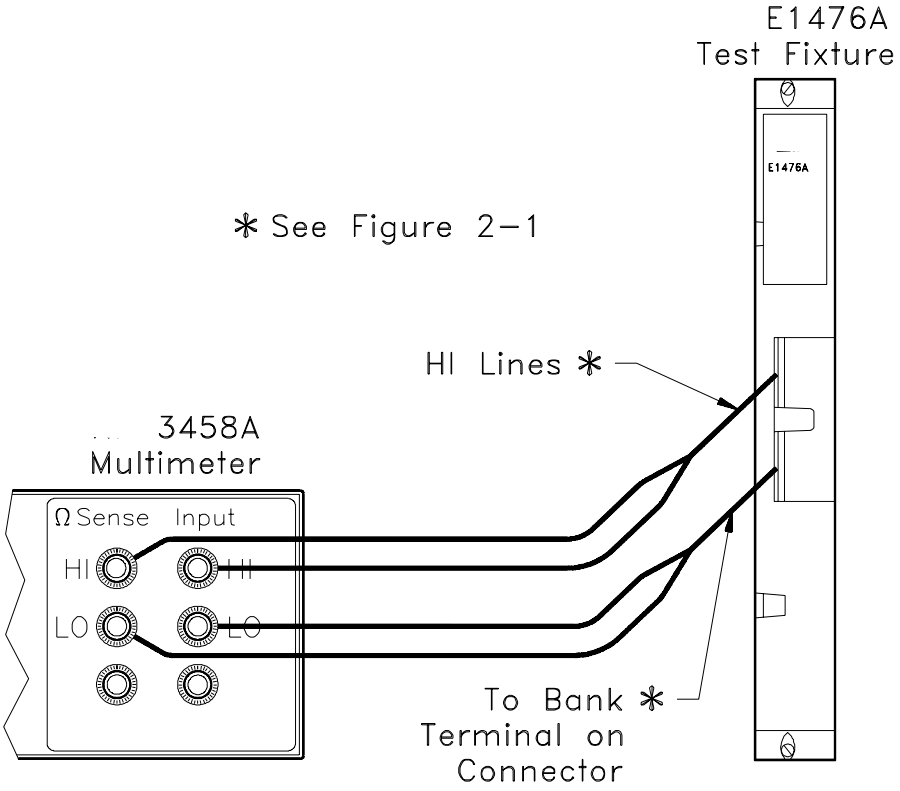


Figure 2-2. Hi Lines Test Connections

2. Equipment Setup
   - Set DMM to: 4-wire ohms, autorange.
   - Send ***RST** to the relay module.
3. Open Channel Reading
   - Trigger the DMM and record the reading.
   - Reading should indicate open circuit indicating all relays are open.
4. Sequentially CLOSE each individual relay
   - Send **CLOSE (@01nn)** to the module to close channel *nn*. *nn* has a range of 00 to 63.
   - Trigger the DMM and verify the relay contact resistance.
   - Record the contact resistance in the Performance Test Table at the end of this chapter.
   - Open that relay and close the next.

Low Lines Test

5. Hardware Connections. See Figures 2-1 and 2-3.
   - For channels 0 - 31, connect the DMM between LO LINES and BANK A LO on the connector.
   - For channels 32 - 64, connect the DMM between LO LINES and BANK B LO on the connector.

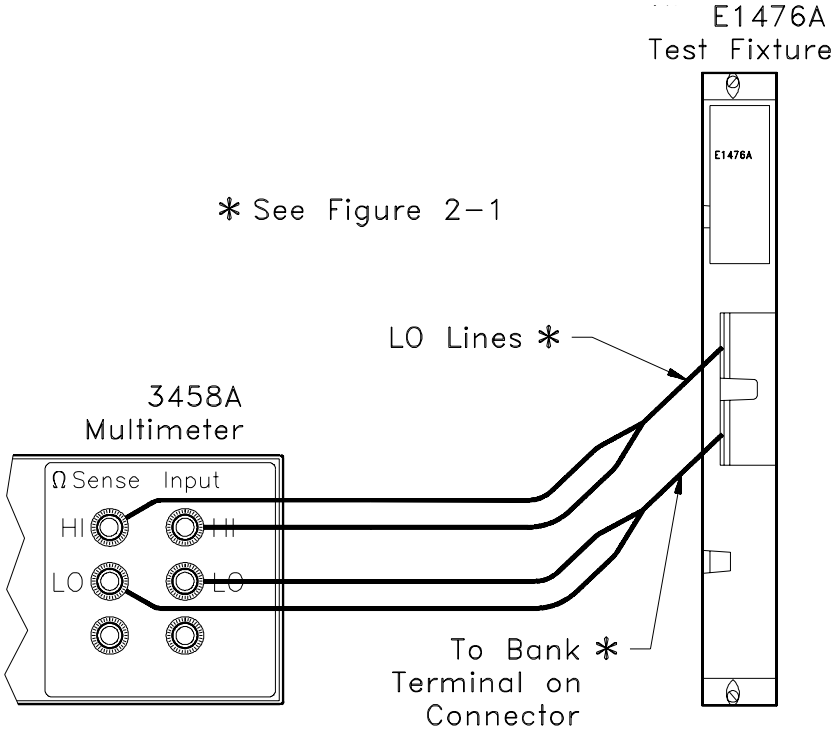


Figure 2-3. Lo Lines Test Connections

6. Equipment Setup
   - Set DMM to: 4-wire ohms, autorange.
   - Send ***RST** to the relay module.
7. Open Channel Reading
   - Trigger the DMM and record the reading.
   - Reading should indicate open circuit indicating all relays are open.
8. Sequentially CLOSE each individual relay
   - Send **CLOSE (@01nn)** to the module to open channel *nn*. *nn* has a range of 00 to 63.
   - Trigger the DMM and verify the relay contact resistance.
   - Record the contact resistance in the Performance Test Table at the end of this chapter.
   - Open that relay and close the next.

Guard Lines Test

9. Hardware Connections. See Figures 2-1 and 2-4.
   - For channels 0 - 31, connect the DMM between GUARD LINES and BANK A GUARD on the connector.
   - For channels 32 - 64, connect the DMM between GUARD LINES and BANK B GUARD on the connector.

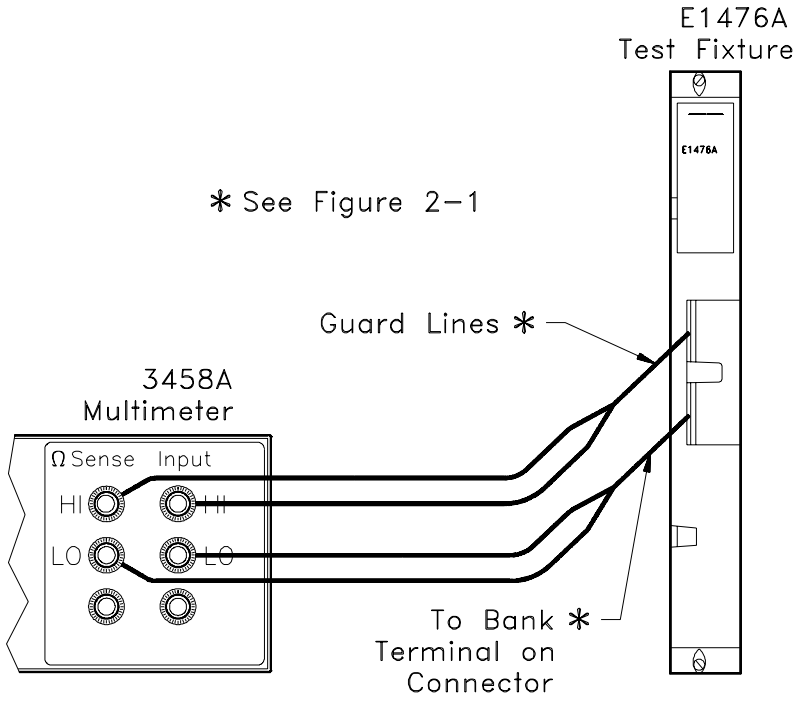


Figure 2-4. Guard Lines Test Connections

10. Equipment Setup
    - Set DMM to: 4-wire ohms, autorange.
    - Send ***RST** to the relay module.
11. Open Channel Reading
    - Trigger the DMM and record the reading.
    - Reading should indicate open circuit indicating all relays are open.
12. Sequentially CLOSE each individual relay
    - Send **CLOSE (@01nn)** to the module to close channel *nn*. *nn* has a range of 00 to 63.
    - Trigger the DMM and verify the relay contact resistance.
    - Record the contact resistance in the Performance Test Table at the end of this chapter.

Note

Guard Relay contacts have either one or two 50Ω resistors in series with the contacts. Consequently the measurement will reflect the value of the resistor(s).

---

13. Open that relay and close the next.

Example: Closed-channel Resistance Test

This example performs the Closed-channel Resistance Test for the Agilent E1476A. This example can be used to test the High, Low, and Guard lines of the module.

```
10 !   RE-STORE "E1476APERF"
20   ASSIGN @Mux TO 70914                    ! Multiplexer GPIB address
30   ASSIGN @Dmm TO 722!                     ! DMM GPIB address
40   !
50   OUTPUT @Dmm;"RESET"                     ! Reset the DMM
60   OUTPUT @Dmm;"TRIG HOLD"                 ! Set DMM to trigger hold
70   OUTPUT @Dmm;"FUNC OHMF;RANGE AUTO"      ! 4-wire ohms
80    !
90   OUTPUT @Mux;"*RST"                      ! Reset the multiplexer
100   PRINT "Testing Channels 0 thru 31"     ! Test Bank A channels
110   PRINT
120   PRINT "HI Lines Test "
130   PRINT "Connect DMM 4-wire connections to test fixture HI and  BANK A HI"
140   GOSUB Cont_prog
150   GOSUB Meas                              ! Open ch. test
160   IF Rdg< 1E+6 THEN PRINT "A relay is stuck closed. Troubleshoot  separately"
170   Resist=3.5                              ! Resistance not to exceed 3.5Ω
180   GOSUB Lo_chans
190   OUTPUT @Mux;"*RST"
200   PRINT
210   PRINT "LO Lines Test "
220   PRINT "Connect DMM 4-wire connections to Test Fixture LO and  BANK A LO"
230   GOSUB Cont_prog
240   GOSUB Meas                              ! Open ch. test
250   IF Rdg<1 E+6 THEN PRINT "A relay is stuck closed. Troubleshoot  separately"
260   GOSUB Lo_chans
270   OUTPUT @Mux;"*RST"
280   PRINT
290   PRINT "GUARD Lines Test "
300   PRINT "Connect DMM 4-wire connections to Test Fixture GUARD  and BANK A
Guard"
310   GOSUB Cont_prog
320   GOSUB Meas                              ! Open ch. test
330   IF Rdg<1 E+6 THEN PRINT "A relay is stuck closed. Troubleshoot  separately"
340   Resist=103                              ! Guard relay resistance
350   GOSUB Lo_chans
360   OUTPUT @Mux;"*RST"                      ! Reset the multiplexer
370   PRINT
380   PRINT
390   PRINT "Testing Channels 32 thru 63"     ! Test Bank B channels
400   PRINT
```

Closed-channel Resistance Test (continued)

```
410   PRINT "HI Lines Test "
420   PRINT "Connect DMM 4-wire connections to test fixture HI and  BANK B HI"
430   GOSUB Cont_prog
440   GOSUB Meas                                          ! Open ch. test
450   IF Rdg<l E+6 THEN PRINT "A relay is stuck closed. Troubleshoot  separately"
460   Resist=3.5                                          ! Resistance not to exceed 3.5Ω
470   GOSUB Hi_chans
480   OUTPUT @Mux;"*RST"
490   PRINT
500   PRINT "LO Lines Test "
510   PRINT "Connect DMM 4-wire connections to Test Fixture LO and  BANK B LO"
520   GOSUB Cont_prog
530   GOSUB Meas                                          ! Open ch. test
540   IF Rdg<l E+6 THEN PRINT "A relay is stuck closed. Troubleshoot  separately.
550   GOSUB Hi_chans
560   OUTPUT @Mux;"*RST"
570   PRINT
580   PRINT "GUARD Lines Test "
590   PRINT "Connect DMM 4-wire connections to Test Fixture GUARD  and BANK B
Guard"
600   GOSUB Cont_prog
610   GOSUB Meas                                          ! Open ch. test
620   IF Rdg<l E+6 THEN PRINT "A relay is stuck closed. Troubleshoot separately"
630   Resist=103
640   GOSUB Hi_chans
650   OUTPUT @Mux;"*RST"                                  ! Reset the multiplexer
660   PRINT
670   PRINT
680   !
690   !
700   STOP
710 Chan_tst:    ! Close ch, measure it, open ch
720           OUTPUT @Mux;"ROUT CLOS (@1"&Ch$&")"
730           GOSUB Meas
740           PRINT "Channel ";Ch;" resistance is ";VAL$(DROUND(Rdg,4))
750           IF Rdg > Resist THEN PRINT "*** Channel ";Ch;" FAILED the resistance
test"
760           OUTPUT @Mux;"ROUT:OPEN (@1"&Ch$&")"
770           RETURN
780           !
790 Meas:  ! Have DMM Measure Resistance
800      OUTPUT @Dmm;"TRIG SGL"                           ! Trigger DMM 1 reading
810      ENTER @Dmm;Rdg                                   ! Enter the reading
820      RETURN
```

Closed-channel Resistance Test (continued)

```
830 Cont_prog: ! Pause and continue the program when ready
840            PRINT
850            PRINT "Press 'CONTINUE' when ready to proceed"
860            PAUSE
870            RETURN
880 Lo_chans:                                   ! Test channels 0 to 31
890            FOR Ch-0 TO 9
900            Ch$="0"&VAL$(Ch)
910            GOSUB Chan_tst
920            NEXT Ch
930            FOR Ch=10 TO 31
940            Ch$=VAL$(Ch)
950            GOSUB Chan_tst
960            NEXT Ch
970            RETURN
980 Hi_chans:                                   ! Test Channels 32 to 63
990            FOR Ch=32 TO 63
1000           Ch$=VAL$(Ch)
1010           GOSUB Chan_tst
1020           NEXT Ch
1030           RETURN
1040       END
```

Test 2-2: Bank Control Relays (optional test)

The E1476A relay module has three bank control relays (numbered 90 to 92). There is no simple method for testing these control relays because there are 100Ω resistors in series with the HI, LO and GUARD relay contacts (see Figure 1-2). This test is optional because these relays are unlikely to wear out under normal use. However, if you need to test these relays, use the following procedure. Remember to subtract 100Ω's from the measured value to get the contact resistance. The 100Ω resistors are 1% tolerance resistors.

The Reference Thermistor is used for thermocouple compensated measurements. Refer to the *Agilent E1476A User's Manual* for more information. The approximate value of the thermistor is 5kΩs, the actual value depends on the ambient temperature and self-heating caused by the ohmmeter current source. The relays used for measuring the thermistor are very unlikely to wear out under normal use. The test simply verifies that the thermistor value is approximately 5kΩs and the two control relays (numbered 93 and 94) are functional.

The DMM can be used in two-wire mode for a functional check, or in four-wire mode for a more accurate measurement. Use the following procedure to check the bank control relays.

Bank Control Relays Test

1. Hardware Connections. See Figures 2-1 and 2-5. Table 2-2 lists the connections to make.

Table 2-2. Bank Control Relays Test Connections

Relay	90	91	92
HI Contacts	VM INPUT HI BANK A HI	VM INPUT HI BANK B HI	VM Ω/I HI BANK B HI
LO Contacts	VM INPUT LO BANK A LO	VM INPUT LO BANK B LO	VM Ω/I LO BANK B LO
Guard Contacts	VM INPUT GUARD BANK A GUARD	VM INPUT GUARD BANK B GUARD	VM Ω/I GUARD BANK B GUARD

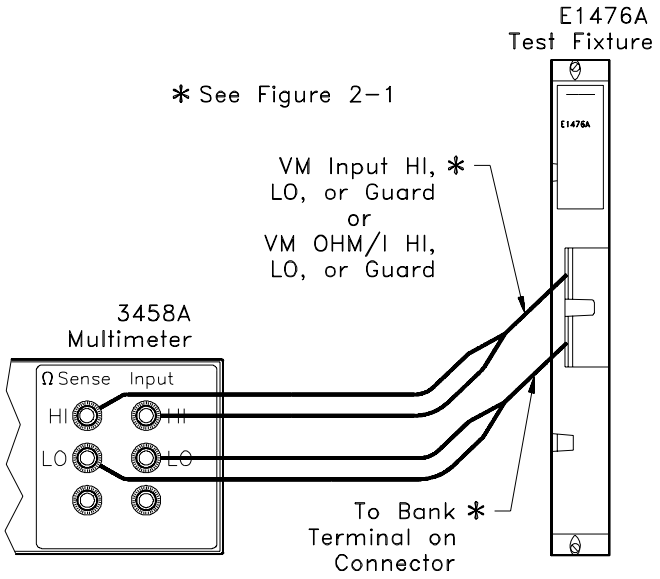


Figure 2-5. Bank Control Relays Test Connections

2. Equipment Setup
   - Set DMM to: 4-wire ohms, autorange.
   - Send ***RST** to the relay module.
3. Sequentially CLOSE each individual relay
   - Send **CLOSE (@01nn)** to the module to close channel *nn*. *nn* is either 90, 91, or 92.
   - Trigger the DMM and verify the relay contact resistance.
   - Measure the HI, LO, and Guard contacts of each relay.
   - Record the contact resistance in the Performance Test Table at the end of this chapter.
4. Open that relay and close the next.

Reference Thermistor Test

5. Hardware Connections. See Figures 2-1 and 2-6.
   - To test relay 93, connect the DMM between VM INPUT HI and VM INPUT LO. The guard contacts are not tested.
   - To test Relay 94, connect the DMM between VM Ω/I HI and VM Ω/I LO. The guard contacts are not tested.
6. Equipment Setup

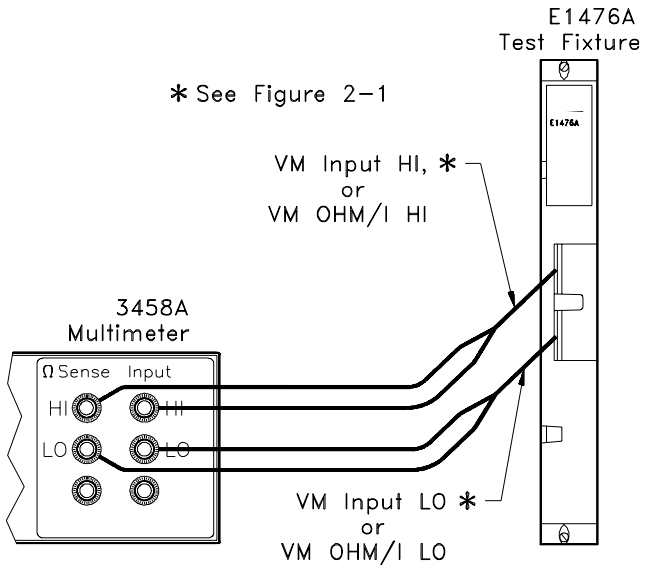


Figure 2-6. Reference Thermistor Test connections

   - Set DMM to: 4-wire ohms, autorange.
   - Send ***RST** to the relay module.
7. Close relay 93 and measure the reference thermistor.
8. Open relay 93 and close both relays 92 and 94. Measure the reference thermistor.

Example: Bank Control Relays Resistance Test

The following program measures the contact resistance of the bank control relays and automatically subtracts 100Ωs from each reading. The program also measures the reference thermistor through the two control relays. The program listing begins on the next page.

Bank Control Relays Resistance Test

```
10   !
20   CLEAR SCREEN
30   ASSIGN @Mux TO 70914
40   ASSIGN @Dmm TO 722
50    !
60   OUTPUT @Dmm;"RESET"
70   OUTPUT @Dmm;"TRIG HOLD"
80   OUTPUT @Dmm;"FUNC OHMF;RANGE AUTO"
90    !
100   OUTPUT @Mux;"*RST"
110   PRINT "Testing Agilent E1476A Bank Control Relays"
120   PRINT
130   PRINT "Testing Relay 90 HI"
140   PRINT "Connect DMM 4-wire connections to Test Fixture VM Input  HI and BANK A
HI"
150   OUTPUT @Mux;"ROUT CLOS (@190)"
160   GOSUB Meas
170   PRINT "Testing Relay 90 LO"
180   PRINT "Connect DMM 4-wire connections to Test Fixture VM Input  LO and BANK
A LO"
190   GOSUB Meas
200   PRINT "Testing Relay 90 Guard"
210   PRINT "Connect DMM 4-wire connections to Test Fixture VM Input Guard and
BANK A Guard"
220   GOSUB Meas
230   OUTPUT @Mux;"*RST"
240   PRINT
250   PRINT "Testing Relay 91 HI"
260   PRINT "Connect DMM 4-wire connections to Test Fixture VM Input  HI and BANK B
HI"
270   OUTPUT @Mux;"ROUT CLOS (@191)"
280   GOSUB Meas
290   PRINT "Testing Relay 91 LO"
300   PRINT "Connect DMM 4-wire connections to Test Fixture VM Input  LO and BANK
B LO"
310   GOSUB Meas
320   PRINT "Testing Relay 91 GUARD"
330   PRINT "Connect DMM 4-wire connections to Test Fixture VM Input Guard and
BANK B Guard"
340   GOSUB Meas
350   OUTPUT @Mux;"*RST"
360   PRINT
370   PRINT "Testing Relay 92 HI"
380   PRINT "Connect DMM 4-wire connections to Test Fixture VM Ohm/I  HI and BANK
B  HI"
390   OUTPUT @Mux;"ROUT CLOS (@192)"
```

Bank Control Relays Resistance Test (continued)

```
400   GOSUB Meas
410   PRINT "Testing Relay 92 LO"
420   PRINT "Connect DMM 4-wire connections to Test Fixture VM Ohm/I  LO and BANK
B  LO"
430   GOSUB Meas
440   PRINT "Testing Relay 92 GUARD"
450   PRINT "Connect DMM 4-wire connections to Test Fixture VM Ohm/I Guard and
BANK B GUARD"
460   GOSUB Meas
470   OUTPUT @Mux;"*RST"
480   !
490   PRINT "Testing Reference Thermistor and Relays"
500   PRINT
510   PRINT "Connect DMM 4-wire connections to Test Fixture VM Input  HI and VM
Input LO"
520   PRINT "Press 'CONTINUE' when ready to proceed"
530   OUTPUT @Mux;"ROUT CLOS (@193)"
540   PAUSE
550   OUTPUT @Dmm "TRIG SGL"
560   ENTER @Dmm;Rdg
570   PRINT "Reference Thermistor Reading and Relay 93 is
";VAL$(DROUND(Rdg,4));" Ohms"
580   PRINT
590   PRINT "Connect DMM 4-wire connections to Test Fixture VM Ohm/I  HI and VM
Ohm/I LO"
600   PRINT "Press 'CONTINUE' when ready to proceed"
610   OUTPUT @Mux;"*RST;ROUT CLOS (@192,194)"
620   PAUSE
630   OUTPUT @Dmm;"TRIG SGL"
640   ENTER @Dmm;Rdg
650   PRINT "Reference Thermistor Reading and Relay 94 is
";VAL$(DROUND(Rdg,4));" Ohms"
660   PRINT
670   PRINT "End of testing Bank Control Relays"
680 STOP
690 Meas !
700     PRINT "Press 'CONTINUE' when ready to proceed"
710     PAUSE
728     OUTPUT @Dmm;"TRIG SGL"
730     ENTER @Dmm;Rdg
740     PRINT "Contact resistance = Measured Resistance - 100 Ohms =
";VAL$(DROUND(Rdg-100,4));" Ohms "
750       PRINT
760       RETURN
770   END
```

Test 2-3: DC Isolation

This test verifies that sufficient DC isolation exists between various points on the relay module. The DMM used should be capable of measuring up to at least 1 GΩ. If the DMM indicates an overload, record the reading as ">R_{max}", where R_{max} is the highest resistance that the DMM can measure. For example, if the DMM is an Agilent 3458A, the reading should be recorded as ">1.2GΩ".

High to Low

1. Hardware Connections (see Figure 2-7)
   - Connect the DMM LO to the test fixture's LO lines.
   - Connect the DMM HI to the test fixture's HI lines.

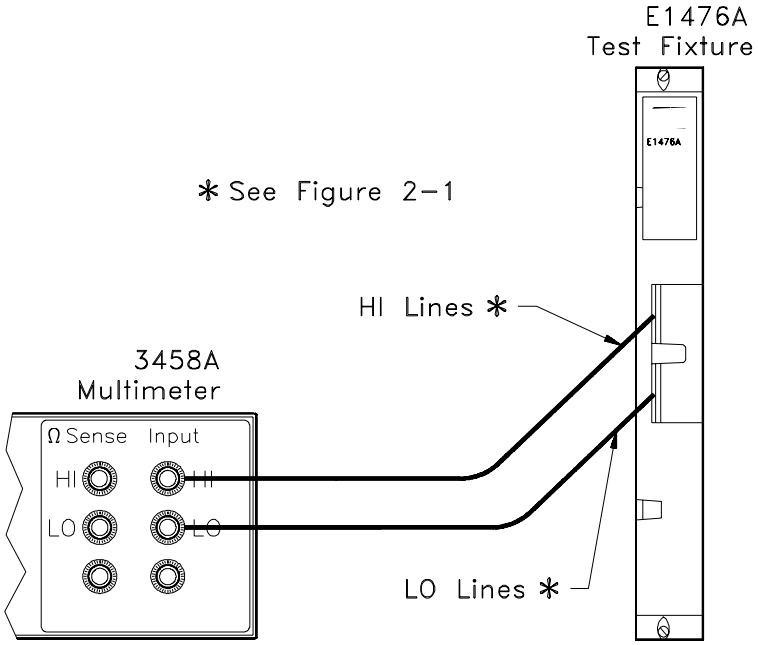


Figure 2-7. DC Isolation Test Connections

2. Equipment Setup
   - Set DMM to: 2-wire ohms, 1GΩ range
   - Send ***RST** to the module to open all relays.
3. DC Isolation Reading
   - Trigger the DMM and record the reading.

HI/LO to Chassis

4. Hardware Connections (see Figure 2-8)
   - Connect the DMM HI to the test fixture's HI and LO lines..
   - Connect the DMM LO to any available chassis connection.

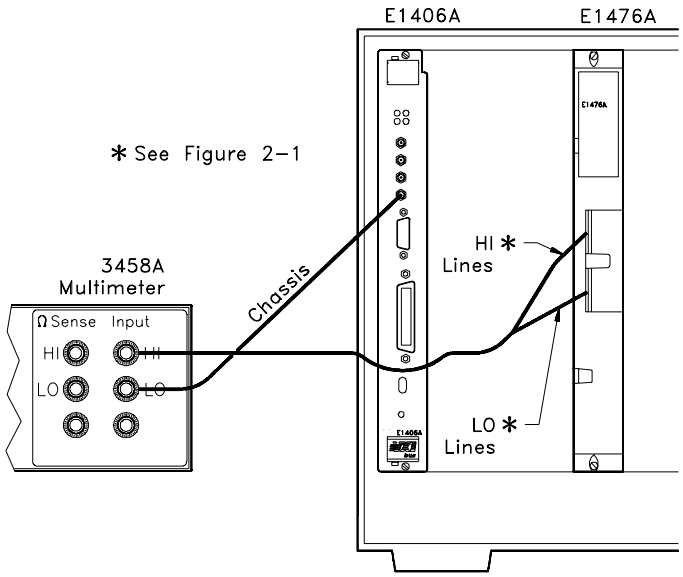


Figure 2-8. HI/Lo to Chassis Isolation Test Connections

Note

Use any convenient chassis connection. The illustration shows the DMM LO terminal connected to the the outside of the TRIG OUT SMB on the Agilent E1406A Command Module.

5. DC Isolation Reading
   - Trigger the DMM and record the reading.

Performance Test Record

Table 2-3 is a form you can copy and use to record performance verification test results for the relay multiplexer. Information concerning test limits, measurement uncertainty, and test accuracy ratio (TAR) is provided below.

Test Limits

Test limits are defined for closed-channel contact resistance and DC isolation using the specifications in Appendix A of the *Agilent E1476A User's Manual*. The closed-channel resistance and DC isolation specifications are single-sided, (i.e., there is an upper limit or a lower limit, but not both). In the Performance Test Record, either the Minimum or Maximum column will be blank.

Measurement Uncertainty

For the performance verification tests in this manual, the measurement uncertainties are based on 90-day accuracy specifications for the Agilent 3458A Digital Multimeter. The calculations are shown below.

Closed-channel Resistance Test

Conditions:

- 4-wire ohms function
- 10 Ω range
- 90-day specifications
- Worst-case reading = 3.5 Ω

$$\begin{aligned} \text{M.U.} &= (15\textit{ppm of Reading} + 5\textit{ppm of Range}) \\ &= (15\times10^{-6} \cdot 3.5 \; + \; 5\times10^{-6} \cdot 10) \quad (\Omega) \\ &= \underline{1.03\times10^{-4}\ \Omega} \end{aligned}$$

DC Isolation Test

Conditions:

- 2-wire ohms function
- 1 GΩ range
- 90-day specifications
- Worst-case reading = 1.2 GΩ (highest resistance that can be measured with the Agilent 3458A)

$$\begin{aligned} \text{M.U.} &= (0.5\% \textit{ of Reading} + 10\textit{ppm of Range}) \\ &= (0.005 \cdot 1.2\times10^{9} \; + \; 10\times10^{-6} \cdot 1\times10^{9}) \quad (\Omega) \\ &= \underline{6\times10^{6}\ \Omega} \end{aligned}$$

Test Accuracy Ratio (TAR)

Test Accuracy Ratios are not defined for single-sided measurements, so all closed-channel resistance and DC isolation measurements have 'NA' (Not Applicable) in the TAR column.

Table 2-3. Performance Test Record for the E1476A (Page 1 of 5)

Test Facility:

Name _____

Address_____

City/State_____

Phone_____

Report No._____

Date_____

Customer_____

Tested by_____

Model_____

Serial No._____

Options_____

Firmware Rev._____

Ambient temperature_____^{o}C

Relative humidity_____%

Line frequency _____ Hz (nominal)

Special Notes:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Table 2-3. Performance Test Record for the E1476A (Page 2 of 5)

Model _____ Report No. _____ Date _____

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

Table 2-3. Performance Test Record for the E1476A (Page 3 of 5)

Model ________________________ Report No. _________________________ Date____________

Channel*	Min**	Hi Lines Test	Lo Lines Test	Guard Lines Test	Maximum	Meas Uncert	TAR
Test 2-1. Closed-channel Resistance Test (Values in ohms)							
ss00		__________	__________	__________	3.5Ω	1.03E-4	NA
ss01		__________	__________	__________	3.5Ω	1.03E-4	NA
ss02		__________	__________	__________	3.5Ω	1.03E-4	NA
ss03		__________	__________	__________	3.5Ω	1.03E-4	NA
ss04		__________	__________	__________	3.5Ω	1.03E-4	NA
ss05		__________	__________	__________	3.5Ω	1.03E-4	NA
ss06		__________	__________	__________	3.5Ω	1.03E-4	NA
ss07		__________	__________	__________	3.5Ω	1.03E-4	NA
ss08		__________	__________	__________	3.5Ω	1.03E-4	NA
ss09		__________	__________	__________	3.5Ω	1.03E-4	NA
					3.5Ω		
ss10		__________	__________	__________	3.5Ω	1.03E-4	NA
ss11		__________	__________	__________	3.5Ω	1.03E-4	NA
ss12		__________	__________	__________	3.5Ω	1.03E-4	NA
ss13		__________	__________	__________	3.5Ω	1.03E-4	NA
ss14		__________	__________	__________	3.5Ω	1.03E-4	NA
ss15		__________	__________	__________	3.5Ω	1.03E-4	NA
ss16		__________	__________	__________	3.5Ω	1.03E-4	NA
ss17		__________	__________	__________	3.5Ω	1.03E-4	NA
ss18		__________	__________	__________	3.5Ω	1.03E-4	NA
ss19		__________	__________	__________	3.5Ω	1.03E-4	NA
					3.5Ω		
ss20		__________	__________	__________	3.5Ω	1.03E-4	NA
ss21		__________	__________	__________	3.5Ω	1.03E-4	NA
ss22		__________	__________	__________	3.5Ω	1.03E-4	NA
ss23		__________	__________	__________	3.5Ω	1.03E-4	NA
ss24		__________	__________	__________	3.5Ω	1.03E-4	NA
ss25		__________	__________	__________	3.5Ω	1.03E-4	NA
ss26		__________	__________	__________	3.5Ω	1.03E-4	NA
ss27		__________	__________	__________	3.5Ω	1.03E-4	NA
ss28		__________	__________	__________	3.5Ω	1.03E-4	NA
ss29		__________	__________	__________	3.5Ω	1.03E-4	NA
					3.5Ω		

* ss = switch card number (leading zero may be omitted)
** Single-sided specification -- Minimum does not apply.

Table 2-3. Performance Test Record for the E1476A (Page 4 of 5)

Channel*	Min**	Hi Lines Test	Lo Lines Test	Guard Lines Test	Maximum	Meas Uncert	TAR
Test 2-1. Closed-channel Resistance Test (Values in ohms)							
ss30		_____	_____	_____	3.5Ω	1.03E-4	NA
ss31		_____	_____	_____	3.5Ω	1.03E-4	NA
ss32		_____	_____	_____	3.5Ω	1.03E-4	NA
ss33		_____	_____	_____	3.5Ω	1.03E-4	NA
ss34		_____	_____	_____	3.5Ω	1.03E-4	NA
ss35		_____	_____	_____	3.5Ω	1.03E-4	NA
ss36		_____	_____	_____	3.5Ω	1.03E-4	NA
ss37		_____	_____	_____	3.5Ω	1.03E-4	NA
ss38		_____	_____	_____	3.5Ω	1.03E-4	NA
ss39		_____	_____	_____	3.5Ω	1.03E-4	NA
					3.5Ω		
ss40		_____	_____	_____	3.5Ω	1.03E-4	NA
ss41		_____	_____	_____	3.5Ω	1.03E-4	NA
ss42		_____	_____	_____	3.5Ω	1.03E-4	NA
ss43		_____	_____	_____	3.5Ω	1.03E-4	NA
ss44		_____	_____	_____	3.5Ω	1.03E-4	NA
ss45		_____	_____	_____	3.5Ω	1.03E-4	NA
ss46		_____	_____	_____	3.5Ω	1.03E-4	NA
ss47		_____	_____	_____	3.5Ω	1.03E-4	NA
ss48		_____	_____	_____	3.5Ω	1.03E-4	NA
ss49		_____	_____	_____	3.5Ω	1.03E-4	NA
					3.5Ω		
ss50		_____	_____	_____	3.5Ω	1.03E-4	NA
ss51		_____	_____	_____	3.5Ω	1.03E-4	NA
ss52		_____	_____	_____	3.5Ω	1.03E-4	NA
ss53		_____	_____	_____	3.5Ω	1.03E-4	NA
ss54		_____	_____	_____	3.5Ω	1.03E-4	NA
ss55		_____	_____	_____	3.5Ω	1.03E-4	NA
ss56		_____	_____	_____	3.5Ω	1.03E-4	NA
ss57		_____	_____	_____	3.5Ω	1.03E-4	NA
ss58		_____	_____	_____	3.5Ω	1.03E-4	NA
ss59		_____	_____	_____	3.5Ω	1.03E-4	NA
					3.5Ω		
ss60		_____	_____	_____	3.5Ω	1.03E-4	NA
ss61		_____	_____	_____	3.5Ω	1.03E-4	NA
ss62		_____	_____	_____	3.5Ω	1.03E-4	NA
ss63		_____	_____	_____	3.5Ω	1.03E-4	NA

* ss = switch card number (leading zero may be omitted)
** Single-sided specification -- Minimum does not apply.

Table 2-3. Performance Test Record for the E1476A (Page 5 of 5)

Channel*	Min**	Hi Lines Test	Lo Lines Test	Guard Lines Test	Maximum	Meas Uncert	TAR
Test 2-2. Bank Control Relay Closed-channel Resistance Test (Values in ohms)							
ss90		_____	_____	_____	3.5Ω	1.03E-4	NA
ss91		_____	_____	_____	3.5Ω	1.03E-4	NA
ss92		_____	_____	_____	3.5Ω	1.03E-4	NA
ss93		_____	_____	_____	typ. 5.0 kΩ	1.03E-4	NA
ss94		_____	_____	_____	typ. 5.0 kΩ	1.03E-4	NA

* ss = switch card number (leading zero may be omitted)
** Single-sided specification -- Minimum does not apply.

Test Description	Minimum	Reading	Maximum*	Meas Uncert	TAR
Test 2-3. DC Isolation Test (Values in ohms)					
HI to LO	5E8Ω	_____		6.0E6	NA
HI/LO to Chassis	5E8Ω	_____		6.0E6	NA

* ss = switch card number (leading zero may be omitted)
** Single-sided specification -- Maximum does not apply.

Chapter 3

Replaceable Parts

Introduction

This chapter contains information for ordering replaceable parts for the Agilent E1476A 64-Channel 3-Wire Multiplexer Module.

Ordering Information

To order a part listed in this chapter, specify the Agilent part number and the quantity required. Send the order to your nearest Agilent Technologies Sales and Support Office.

Replaceable Parts List

Table 3-1 lists replaceable parts for the Agilent E1476A . See "Component Locators" (Figure 3-1) for locations of parts in Table 3-1. Table 3-3 shows reference designators for parts in Table 3-2, and Table 3-4 shows the manufacturer code list for the parts.

NOTE

If defect can be traced to a fuse or replaceable mechanical part, replace the fuse and/or part and retest the module. If the defect cannot be traced to a fuse or replaceable mechanical part, replace the entire module. Individual printed circuit assemblies (PCAs) cannot be returned for replacement or exchange.

Table 3-1. Agilent E1476A Replaceable Parts

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr. Code	Mfr. Part Number
	E1476-66501	1	E1476A Relay Module Assembly	28480	E1476-66501
	E1476-80000	1	Std. Terminal Module	28480	E1476-80000
A1	E1476-66501	1	Relay Module PC Assembly	28480	E1476-66501
F801	2110-0712	1	Fuse - Subminiature 4A 125V NTD AX	28480	2110-0712
F802	2110-0665	1	Fuse Subminiature 1A 125V NTD AX	28480	2110-0665
J1	1252-1596	2	Connector Post Type 2.54 Pin Spcg 96 Cont.	28480	1252-1596
J2	1252-4743	1	Connector Post Type 2.54 pin spcg 64 Cont	28480	1252-4743
J4	12521596		Connector Post Type 2.54 Pin Spcg 96 Cont.	28480	1252-1596
J5	1252-6031	1	Connector Post Type 2.54 Pin Spcg	28480	1252-6031
K300 - K315 K416 - K431 K532 - K547 K648 - K663 K790 - K794	0490-1674	69	Relay Low Thermal	28480	0490-1674
MP1	E1400-84105	1	External Handle Kit - Bottom	28480	E1400-84105
MP2	E1400-84106	1	External Handle Kit - Top	28480	E1400-84106
MP3	8160-0686	1	RFI Strip - fingers BE-CU Tin plated	30817	00786-185
PNL1	E1476-00201	1	Front Panel	28480	E1476-00201
SCR1 - SCR2	0515-0368	2	Screw - M2.5 x 0.45 12mm long Pan Head	28480	0515-0368
SCR3 - SCR8	0515-1135	8	Screw - M3 x 0.5 25mm long Flat Head	28480	0515-1135
SCR9 - SCR10	0515-1375	2	Screw - M2.5 x 0.45 6mm long Flat Head	83486	343-300-02506
SCR11-SCR12	0515-1968	2	Screw - M2.5 x 0.45 11mm long Pan Head	28480	0515-1968
SCR20-SCR21	0515-1135		Screw - M3 x 0.5 25mm long Flat Head	28480	0515-1135
SHD1	E1476-00601	1	Shield, Top	28480	E1476-00601
SHD2	E1476-00602	1	Shield, Bottom	28480	E1476-00602
SP101	3101-3142	1	Switch DIP Surface SPST 0.025A 24VDC	28480	3101-3142
SP102	3101-3279	1	Switch DIP Rotary 8 pos. 0.03A 30VDC	28480	3101-3279

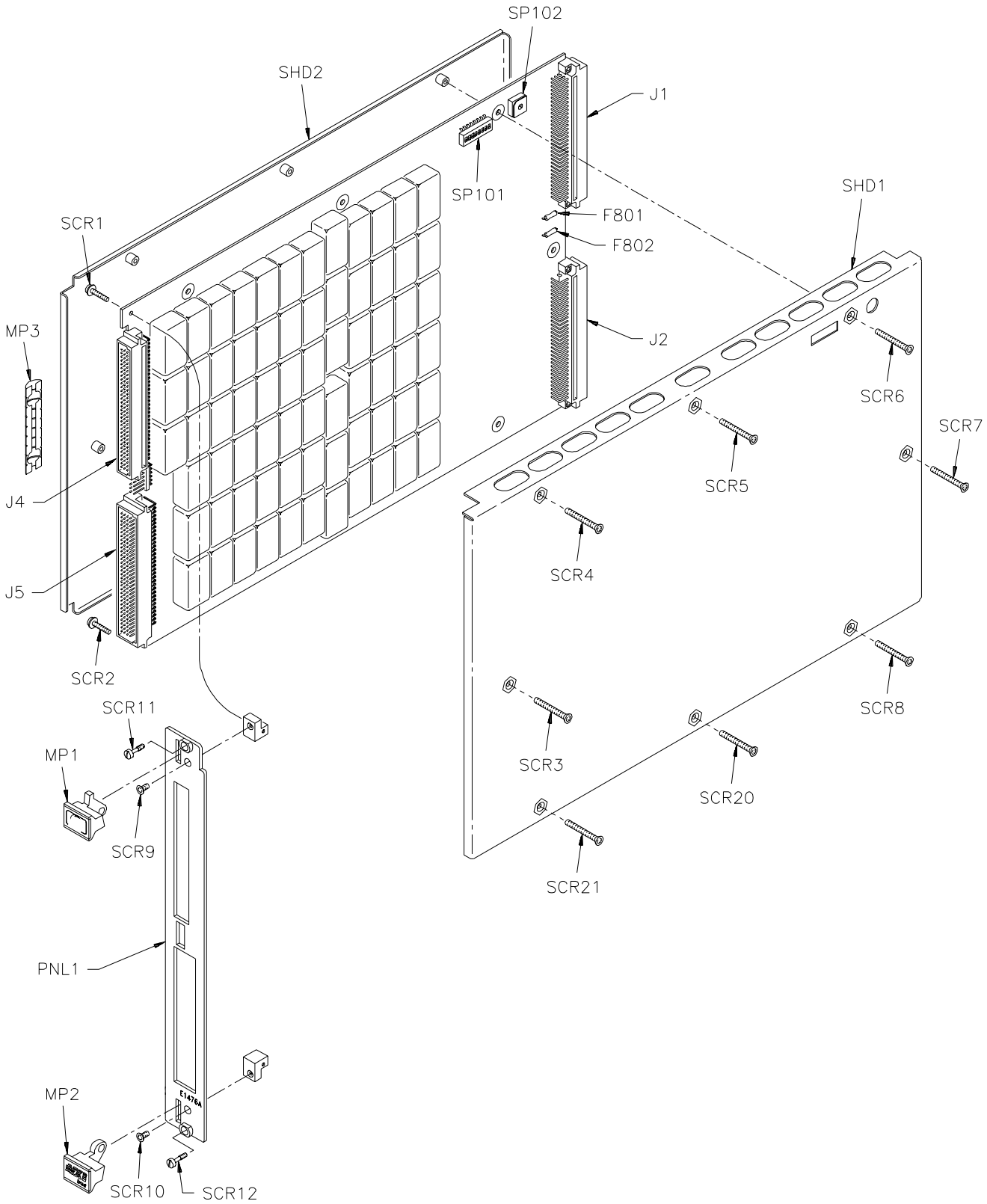


Figure 3-1. Agilent E1476A Component Locator

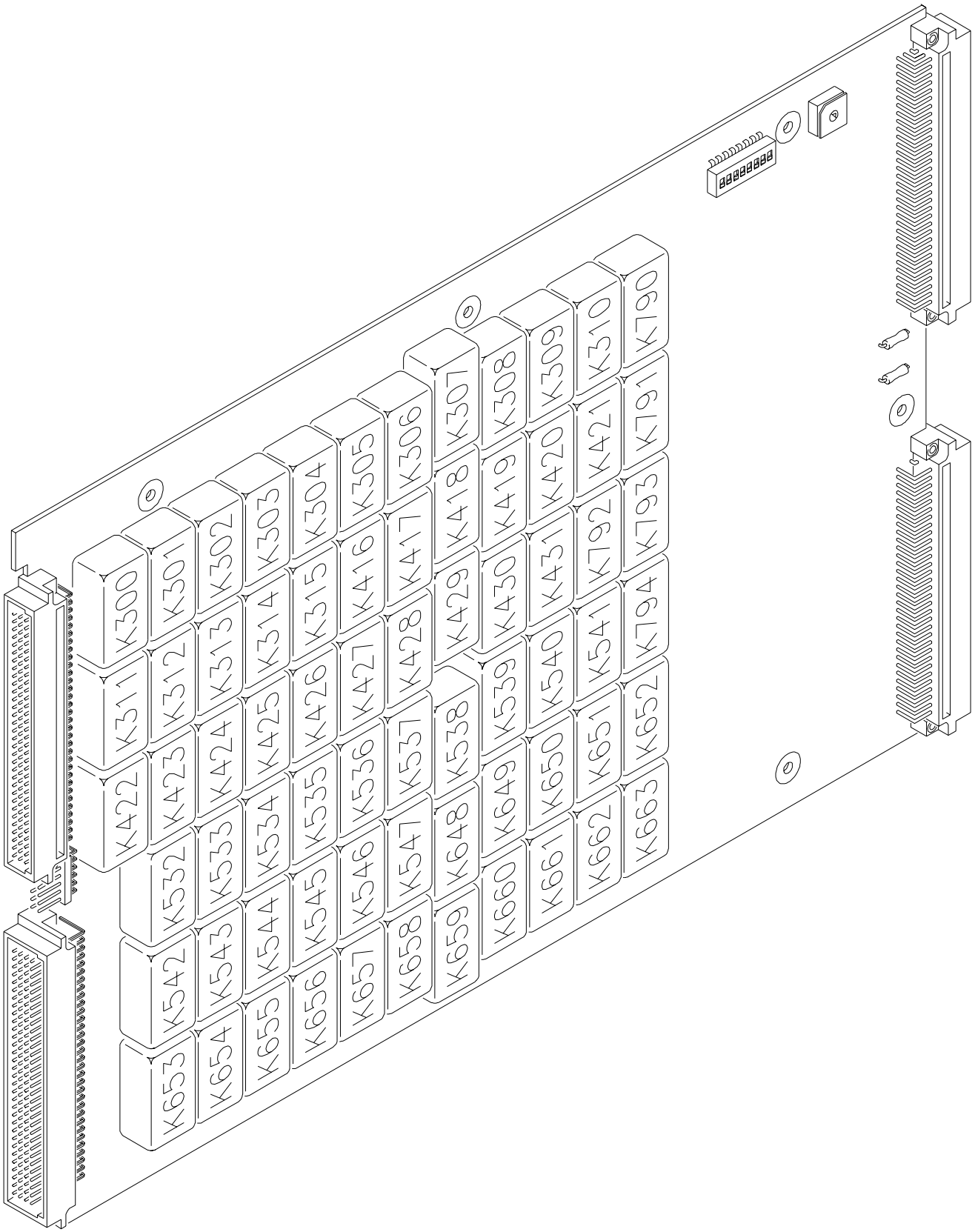


Figure 3-2. Agilent E1476A Relay Locations

3-4 Replaceable Parts

Table 3-2. Agilent E1476A Terminal Module Assembly Replaceable Parts

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr. Code	Mfr. Part Number
1	03852-01201	1	Clamp	28480	03852-01201
2	03852-86701	1	Pad - Clamp	28480	03852-86701
3	0515-2109	1	Screw - Mach. 10-24 0.625in long Pan Head	28480	0515-2109
4	1390-0846	2	Fastener - Captive screw M2.5 x 0.45	28480	1390-0846
5	E1300-01202	1	Clamp - Strain Relief	28480	E1300-01202
6	E1400-44108	1	Terminal Housing - bottom	28480	E1400-44108
7	E1400-44105	1	Terminal Housing - top	28480	E1400-44105

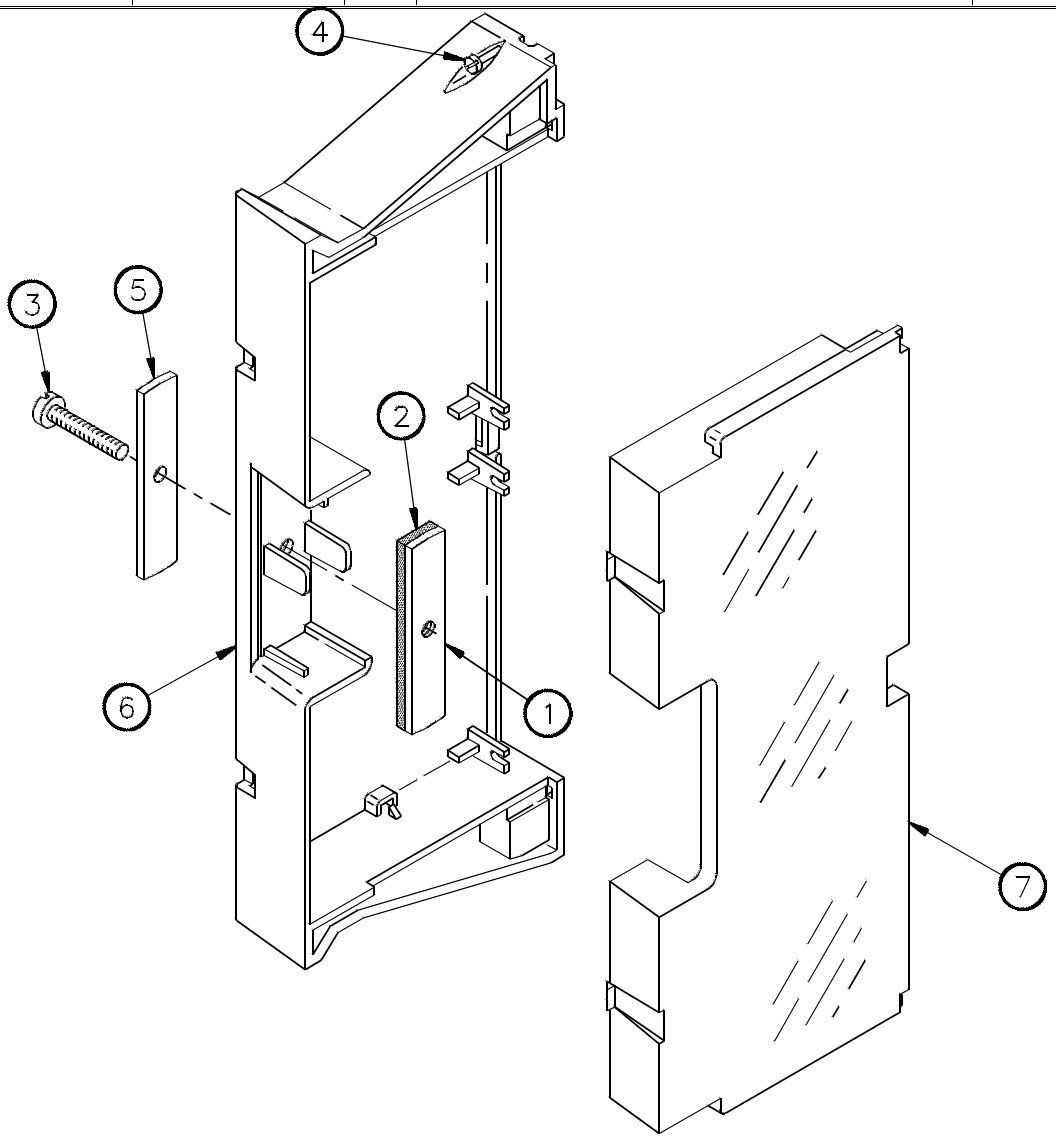


Figure 3-3. Agilent E1476A Terminal Module Assembly

Table 3-5. Agilent E1476A Reference Designators

Reference Designators	
A assembly	P electrical connector (plug)
BRK bracket	PNL panel
C capacitor	Qtransistor
CR diode	R resistor
CVR cover	RP resistor pack
F fuse	SCR screw
J electrical connector (jack)	SHD shield
JM jumper	SW switch
K relay	TB terminal block
Linductor	U integrated circuit
MP mechanical part	XJMremovable jumper

Table 3-6. Code List of Manufacturer's

Mfr. Code	Manufacturer's Name	Manufacturer's Address	Zip Code
28480	Agilent Technologies, Inc. - Corporate	Palo Alto, CA	94304
30817	Instrument Specialties Co. Inc.	Del Water Gap, PA	18327
83486	Elco Tool and Screw Corp.	Rockford, IL	61125

Chapter 4

Service

Introduction

This chapter contains service information for the Agilent E1476A 64-Channel 3-Wire Relay Multiplexer module, including troubleshooting techniques and repair/maintenance guidelines.

WARNING

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

Equipment Required

Equipment required for multiplexer/matrix troubleshooting and repair is listed in Table 1-1, *Recommended Test Equipment*. Any equipment that satisfies the requirements given in the table may be substituted. To avoid damage to the screw head slots, use a T8 Torx driver to remove the front panel handles and a T10 Torx driver to remove the shields.

Service Aids

See Chapter 3 for descriptions and locations of Agilent E1476A replaceable parts. Service notes, manual updates, and service literature for the modules may be available through Agilent Technologies. For information, contact your nearest Agilent Technologies Sales and Support Office.

Troubleshooting

To troubleshoot an Agilent E1476A multiplexer problem, you should first identify the problem, and then isolate the cause using the component locators and schematics in this manual.

Identifying the Problem

Table 4-1 lists some common problems, along with symptoms and possible solutions. If the problem persists, perform component-level troubleshooting using the component locators and schematics.

Table 4-1. Agilent E1476A Common Problems

Problem Type	Symptom	Possible Solutions
Self-test Errors	Non-zero error code in response to the *TST? command.	See Table 2-1 for information on self-test errors.
Operator Errors	Non-zero error code in response to the SYST:ERR? command.	See the *Agilent E1476A User's Manual* for multiplexer errors and causes. See Appendix B of the *Agilent E1405 User's Manual* or *Agilent E1406 User's Manual* for additional information on operator errors.
Catastrophic Failures	Not responding to commands.	Check logical address setting. Check GPIB cables and connections. See "Testing the Assembly" in this chapter.
Performance Out of Specification	Failing Closed-channel Resistance Test (see Test 2-1 and Test 2-2 in Chapter 2).	Check user wiring and test connections. Replace relays that correspond to the channels that are failing (see Table 4-3). If most of the channels are near or above the test limit (3.5 Ω), replace the entire printed circuit board (Agilent part number E1476-66501).
	Failing DC Isolation Test (see Test 2-3 in Chapter 2).	Check user wiring and test connections. Remove dust from relay module and terminal module printed circuit boards.

Testing the Assembly

You can use the tests and checks in Table 4-2 to isolate the problem. See Figures 3-1 and 3-2 in Chapter 3 for locations of mechanical parts.

Table 4-2. Agilent E1476A Tests/Checks

Test/Check	Reference Designator	Check:
Heat Damage	- - - - - - - - - -	Discolored PC boards Damaged insulation Evidence of arcing
Switch Settings	SP1 SP2	LADDR setting IRQ Level setting
Multiplexer PCA	F801, F802 J1 - J4 K300 - K315 K416 - K431 K532 - K547 K648 - K663 K790 - K794	Fuse continuity Connector contacts Relay contact resistance

Checking for Heat Damage

Inspect the assembly for signs of abnormal internally generated heat such as discolored printed circuit boards or components, damaged insulation, or evidence of arcing.

Checking Switches/Jumpers

Verify that the logical address switch is set correctly (factory set at 112). Verify that the interrupt priority jumpers are set correctly (factory set at level 1).

Checking the Multiplexer PCA

Use the component locators in this manual to check the following:

- Verify that fuses F801 and F802 are good.
- Check the closed-channel resistance of all channel relays using the procedure in Chapter 2. Replace any bad relays. Use Table 4-3 to isolate the relay that corresponds to each failing channel.
- Check connectors P1 and J1 for damage.

Note

If the preceding steps fail to isolate the problem, replace the module.

Matching Relays to Channels

Use Table 4-3 to find the reference designator of any relay on the E1476A relay module.

Table 4-3. Channel Relays/Reference Designators

E1476A Channel	PCA Reference Designator		E1476A Channel	PCA Reference Designator
0	K300		34	K534
1	K301		35	K535
2	K302		36	K536
3	K303		37	K537
4	K304		38	K538
5	K305		39	K539
6	K306			
7	K307		40	K540
			41	K541
8	K308		42	K542
9	K309		43	K543
10	K310		44	K544
11	K311		45	K545
12	K312		46	K546
13	K313		47	K547
14	K314			
15	K315		48	K648
			49	K649
16	K416		50	K650
17	K417		51	K651
18	K418		52	K652
19	K419		53	K653
20	K420		54	K654
21	K421		55	K655
22	K422			
23	K423		56	K656
			57	K657
24	K424		58	K658
25	K425		59	K659
26	K426		60	K660
27	K427		61	K661
28	K428		62	K662
29	K429		63	K663
30	K430			
31	K431		90	K790
			91	K791
32	K532		92	K792
33	K533		93	K793
			94	K794

Repair/Maintenance Guidelines

This section provides guidelines for repairing and maintaining the Agilent E1476A multiplexer module, including:

- ESD precautions
- Soldering printed circuit boards
- Post-repair safety checks

ESD Precautions

Electrostatic discharge (ESD) may damage static-sensitive devices in the multiplexer module. This damage can range from slight parameter degradation to catastrophic failure. When handling multiplexer assemblies, follow these guidelines to avoid damaging components:

- Always use a static-free work station with a pad of conductive rubber or similar material when handling electronic components.
- 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 a module, 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 that you, the pad, and the soldering iron tip are grounded to the assembly.

Soldering Printed Circuit Boards

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

- Do not use a high-power soldering iron on etched circuit boards, as excessive heat may lift a conductor or damage the board.
- Use a suction device or wooden toothpick to remove solder from component mounting holes. When using a suction device, be sure that the equipment is properly grounded.

Post-Repair Safety Checks

After making repairs to the module, inspect the device 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 perform the Functional Verification Test described in Chapter 2 to verify that the device is functional.

Incoming Inspection

Use the following steps as guidelines to perform initial (incoming) inspection of the Agilent E1476A.

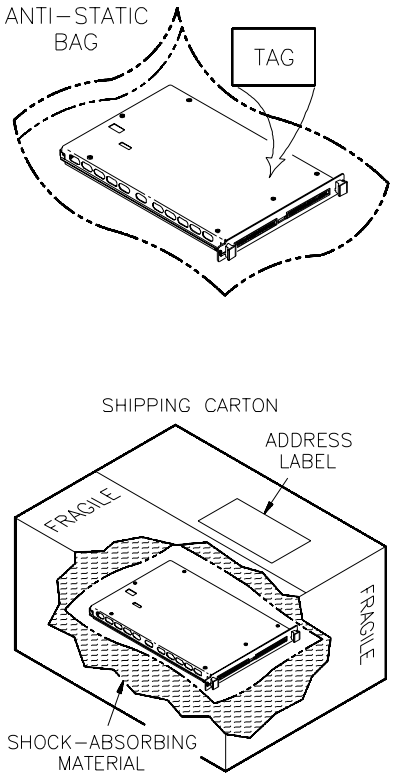
WARNING

To avoid possible hazardous electrical shock, do not perform electrical tests if there are signs of shipping damage to the shipping container or to the instrument.

1. If the Agilent E1476A is damaged, contact Agilent Technologies and the carrier.
2. Install the Agilent E1476A in a VXI mainframe. Refer to the *Agilent E1476A User's Manual* and the *Agilent Series C Installation and Getting Started Guide* for additional information.
3. Perform the Functional Verification test and (optionally) the Performance Verification tests. Refer to Chapter 2 in this manual.
4. If any of the tests do not pass, return the module to Agilent Technologies. See *Shipping Guidelines* later in this chapter.
5. If all verification tests pass, the module is ready to use.

Shipping Guidelines

Follow the steps in Figure 4-1 to return the relay multiplexer module to a Agilent Technologies Sales and Support Office or Service Center.



1 Prepare the module

- Remove any user wiring.
- Attach tag to device that identifies:
  - Owner
  - Model Number/Serial Number
  - Service Required
- Place tagged device in approved anti-static bag.

2 Package the module

- Place packaged device in shipping carton.*
- Place 75 to 100 mm (3 to 4 inches) of shock-absorbing material around the module.
- Seal the shipping container securely.
- Mark the shipping container FRAGILE.

3 Ship the module to Agilent Technologies

- Place address label on shipping carton.
- Send carton to Agilent Technologies.

* We recommend that you use the same shipping materials as those used in factory packaging (available from Agilent Technologies). For other (commercially available) shipping materials, use a double-wall carton with minimum 2.4 MPa (350 psi) test.

Figure 4-1. Packaging/Shipping Guidelines