Agilent Technologies E8481A 2-Wire 4x32 Relay Matrix Switch Module Service Manual

Serial Numbers

This manual applies directly to Agilent E8481A 2-Wire 4x32 Relay Matrix Switch modules with serial numbers US41000101 and above.

Agilent Technologies

Manual Part Number: E8481-90010
Printed in U.S.A. E0601

Contents

Agilent E8481A Service Manual

AGILENT TECHNOLOGIES WARRANTY STATEMENT

AGILENT PRODUCT: E8481A 2-wire 4x32 Relay Matrix Switch Module **DURATION OF WARRANTY:** 3 years

1. Agilent Technologies warrants Agilent hardware, accessories and supplies against defects in materials and workmanship for the period specified above. If Agilent receives notice of such defects during the warranty period, Agilent will, at its option, either repair or replace products which prove to be defective. Replacement products may be either new or like-new.

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3. Agilent does not warrant that the operation of Agilent products will be interrupted or error free. If Agilent is unable, within a reasonable time, to repair or replace any product to a condition as warranted, customer will be entitled to a refund of the purchase price upon prompt return of the product.

4. Agilent products may contain remanufactured parts equivalent to new in performance or may have been subject to incidental use.

5. The warranty period begins on the date of delivery or on the date of installation if installed by Agilent. If customer schedules or delays Agilent installation more than 30 days after delivery, warranty begins on the 31st day from delivery.

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Agilent Technologies

E8481A 2-Wire 4x32 Relay Matrix Switch Module Service Manual
Edition 1

Documentation History

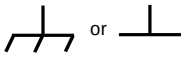
All Editions and Updates of this manual and their creation date are listed below. The first Edition of the manual is Edition 1. The Edition number increments by 1 whenever the manual is revised. Updates, which are issued between Editions, contain replacement pages to correct or add additional information to the current Edition of the manual. Whenever a new Edition is created, it will contain all of the Update information for the previous Edition. Each new Edition or Update also includes a revised copy of this documentation history page.

Edition 1 . . . . . June, 2001

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.

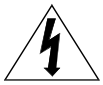
Indicates the field wiring terminal that must be connected to earth ground before operating the equipment — protects against electrical shock in case of fault.



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

Alternating current (AC)

Direct current (DC).



Warning. Risk of electrical shock.

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 Agilent 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 Agilent for service and repair to ensure that safety features are maintained.

DECLARATION OF CONFORMITY

According to ISO/IEC Guide 22 and CEN/CENELEC EN 45014

CE

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

Declares, that the product

Product Name: 2-Wire 4x32 Relay Matrix Switch Module
Model Number: E8481A
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**
	IEC 61326-1:1997+A1:1998 / EN 61326-1:1997+A1:1998	
	CISPR 11:1990 / EN 55011:1991	*Group 1 Class A*
	IEC 61000-4-2:1995+A1:1998 / EN 61000-4-2:1995	*4kV CD, 8kV AD*
	IEC 61000-4-3:1995 / EN 61000-4-3:1995	*3 V/m, 80-1000 MHz*
	IEC 61000-4-4:1995 / EN 61000-4-4:1995	*0.5kV signal lines, 1kV power lines*
	IEC 61000-4-5:1995 / EN 61000-4-5:1995	*0.5 kV line-line, 1 kV line-ground*
	IEC 61000-4-6:1996 / EN 61000-4-6:1996	*3V, 0.15-80 MHz*
	IEC 61000-4-11:1994 / EN 61000-4-11:1994	*Dips: 30% 10ms; 60% 100ms* *Interrupt > 95%@5000ms*
	Canada: ICES-001:1998 *Australia/New Zealand: AS/NZS 2064.1*	
	The product was tested in a typical configuration with Agilent Technologies test systems.	
Safety	*IEC 61010-1:1990+A1:1992+A2:1995 / EN 61010-1:1993+A2:1995* *Canada: CSA C22.2 No. 1010.1:1992* *UL 3111-1: 1994*	

14 June 2001
Date

Ray Corson
Product Regulations Program Manager

For further information, please contact your local Agilent Technologies sales office, agent or distributor.
Authorized EU-representative: Agilent Technologies Deutschland GmbH, Herrenberger Strabe 130, D 71034 Böblingen, Germany

Notes:

Chapter 1
General Information

Introduction

This manual contains information required to test, troubleshoot, and repair the Agilent E8481A 2-Wire 4x32 Relay Matrix Switch module (see Figure 1-1). For more information on the matrix module operation, see the *Agilent E8481A 2-Wire 4x32 Relay Matrix Switch Module User's Manual.*

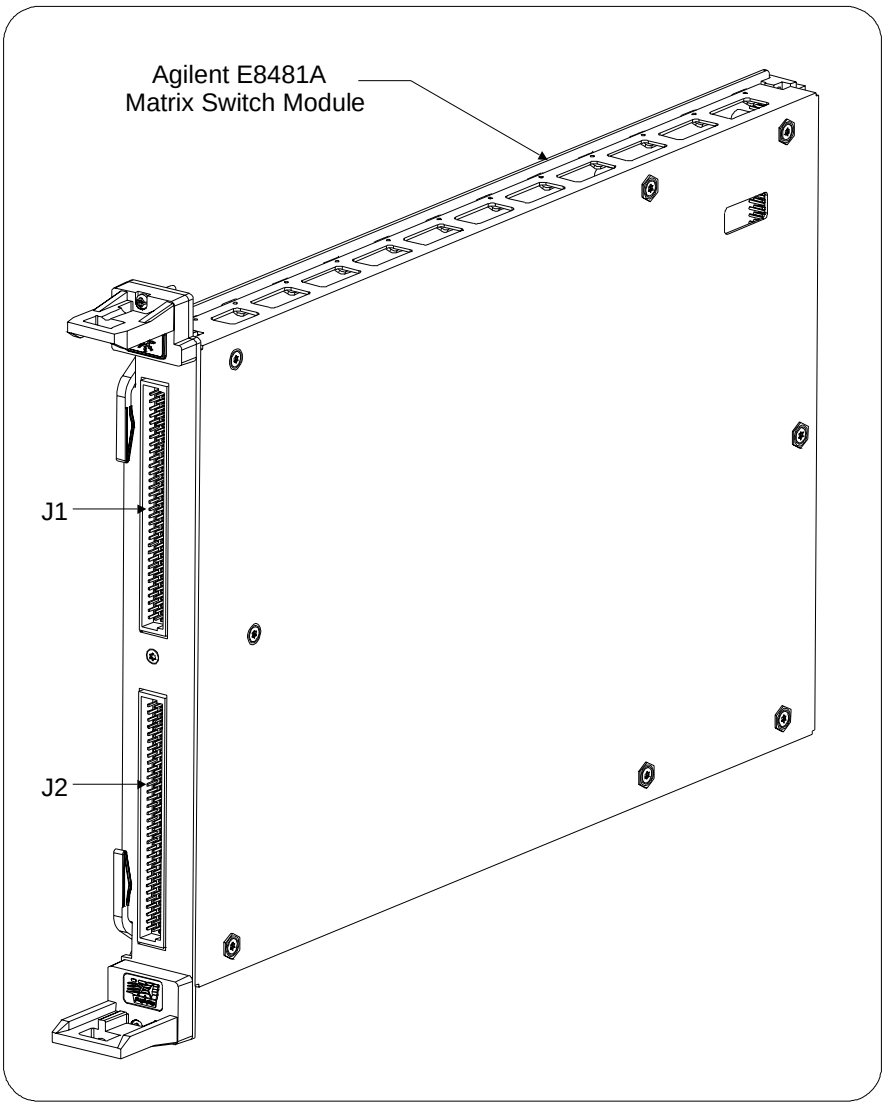


Figure 1-1. Agilent E8481A Matrix Switch Module

Contacting Agilent Technologies

Any maintenance or repair of this product must be performed by qualified personnel. Contact your customer engineer through your local Agilent Technologies Service Center for repair and service.

- To find a list of your local Sales and Service Offices, go to the main Agilent Customer web site (http://www.agilent.com/find/assist).
- The Agilent Calibration and Repair Services web site (http://www.agilent.com/find/repair) describes Agilent calibration and repair services.
- The Agilent Parts web site (http://www.parts.agilent.com/) shows how to order replacement parts from Agilent.

Safety Considerations

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

Refer to the WARNINGS page (page 6) in this manual for a summary of safety information. Safety information for testing and service follows and is also found throughout this manual.

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

WARNING

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

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

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

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

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.)

WARNING

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

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

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

SHOCK HAZARD. Only service-trained personnel who are aware of the hazards involved should install, remove, or configure the Matrix Switch module. Before you remove any installed module, disconnect AC power from the mainframe and from other modules that may be connected to the Matrix.

CHANNEL WIRING INSULATION. All channels that have a common connection must be insulated so that the user is protected from electrical shock. This means wiring for all channels must be insulated as though each channel carries the voltage of the highest voltage channel.

CAUTION

MAXIMUM INPUTS. The maximum voltage that can be applied to any terminal of the matrix switch module is 42 V dc or 30 V ac rms. The maximum current that can be applied to any terminal is 0.5 A dc or ac peak. The maximum power that can be applied to any terminal is 5 W or 5 VA (resistive). Exceeding any limit may damage the Matrix Switch module.

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

Inspection/Shipping

This section contains initial (incoming) inspection and shipping guidelines for the matrix switch module.

Initial Inspection

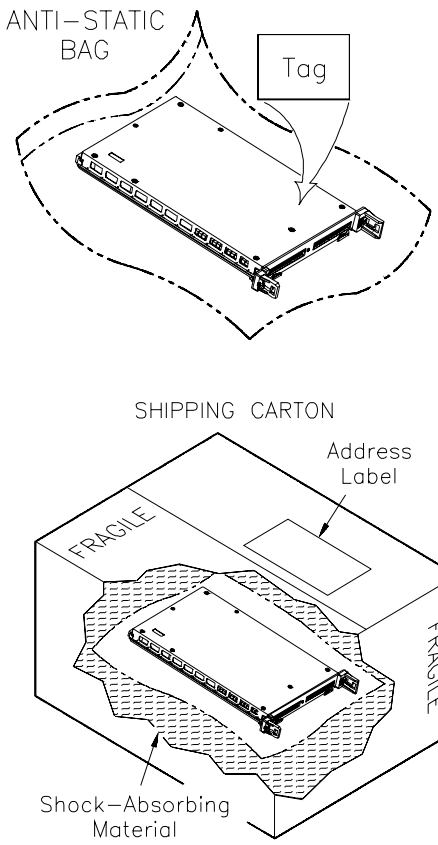
Use the following steps as guidelines to perform initial (incoming) inspection for the E8481A matrix switch module.

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. Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, contact Agilent Technologies (see page 10).
2. Check the shipping contents and verify they are complete. Normally, the module you ordered (see Figure 1-1) and a User's Manual should be included. If the contents are incomplete or with mechanical damage/defect, contact Agilent Technologies (see page 10).
3. Install the matrix module in a VXI mainframe. Refer to the *Agilent E8481A 2-Wire 4x32 Relay Matrix Switch Module User's Manual* for more information.
4. Perform the Functional Verification test and the Performance Verification tests (optional). Refer to *Chapter 2* of this manual.
5. If any of the tests do not pass, refer to page 41 in *Chapter 3* for troubleshooting. If the instrument is to be shipped to Agilent for service or repair, see Figure 1-2 for instructions on repackaging the module for shipment.
6. If all verification tests pass, the module is ready for use.

Shipping Guidelines

If the instrument is to be shipped to Agilent for service or repair, follow the procedures in Figure 1-2.



1. Prepare the Module

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

2. Package the Module

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

3. Ship the Module to Agilent

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

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

** See "Contacting Agilent Technologies" on page 10 for the address to which you can return the module.

Figure 1-2. Packaging/Shipping Guidelines

Matrix Switch Module Description

The Agilent E8481A is a single-slot VXIbus C-Size register-based module which can operate in a C-Size VXIbus mainframe. It is supplied with an E1406A command module driver and a *VXIplug&play* driver. These drivers make the E8481A appear as an "instrument" in the slot of a VXIbus mainframe. Each module is assigned an error queue, input and output buffers, and a status register.

NOTE *Instruments are based on the logical addresses of the plug-in modules. See Agilent E8481A 2-Wire 4x32 Relay Matrix Switch Module User's Manual to set the logical address for the matrix module to create an instrument.*

Matrix Module Block Diagram

As shown in Figure 1-3, the Agilent E8481A 2-wire 4x32 Matrix Switch module offers 128 2-wire channels. Each channel uses two Form-A non-latching relays to switch both High (H) and Low (L) signals. The channels can be individually controlled or can be scanned. By closing or opening the appropriate channel relays, the row is connected to or disconnected from the column. Multiple channel relays can be closed at a time, allowing any combination of rows connected to columns. Since the relays are non-latching, the channel relays are all open following a power-on or a reset command.

When shipped from the factory, the E8481A is configured as a 4x32 2-wire matrix switch module. All columns (00-31) are switched to rows (00-03) of Group A with 50 MHz bandwidth. The E8481A can also be easily reconfigured as two independent 4x16 matrixes (see *Agilent E8481A 2-Wire 4x32 Relay Matrix Switch Module User's Manual for details*). In such case, columns 00-15 are switched to rows 00-03 of Group A, and columns 16-31 are switched to rows 00-03 of Group B with bandwidth up to 70 MHz.

NOTE *DO NOT make connections on the rows 00-03 connectors of Group B when in the 4x32 configuration. Rows connectors of Group B are used only when in the Dual 4x16 configuration.*

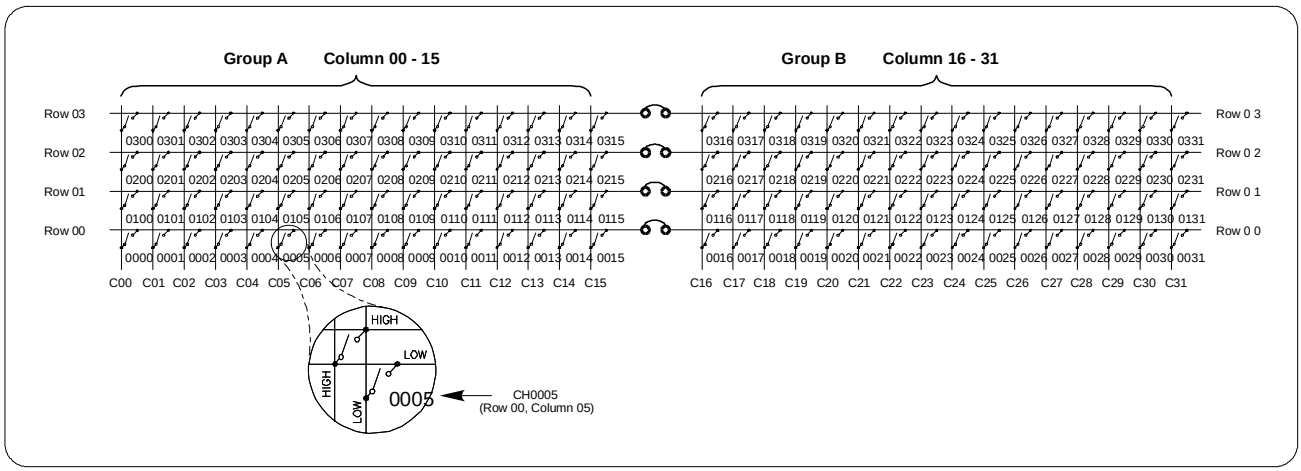


Figure 1-3. Agilent E8481A Block Diagram

Matrix Module Specifications

Specifications are listed in Appendix A of this manual. These specifications are the performance standards or limits against which the modules may be tested.

Matrix Module Serial Numbers

Devices covered by this manual are identified by Agilent Technologies product number E8481A followed with a ten-character serial number (as listed on the title page). Agilent uses a two-part serial number in the form US00000000. The first 2-letter indicates the country in which the product was manufactured (US = United States). The last 8-digit is unique and assigned sequentially for that particular product number. The serial number plate is located on the right-hand shield near the backplane connectors.

Matrix Module Options

The Agilent E8481A matrix module comes without a terminal module. However, two optional terminal modules (see Figure 1-4) are available for the matrix module. Order option 105 if an SMB-type terminal module is desired or order option 106 if a screw-type terminal module is desired. See *Agilent E8481A 2-Wire 4x32 Relay Matrix Switch Module User's Manual* for more information on these terminal modules.

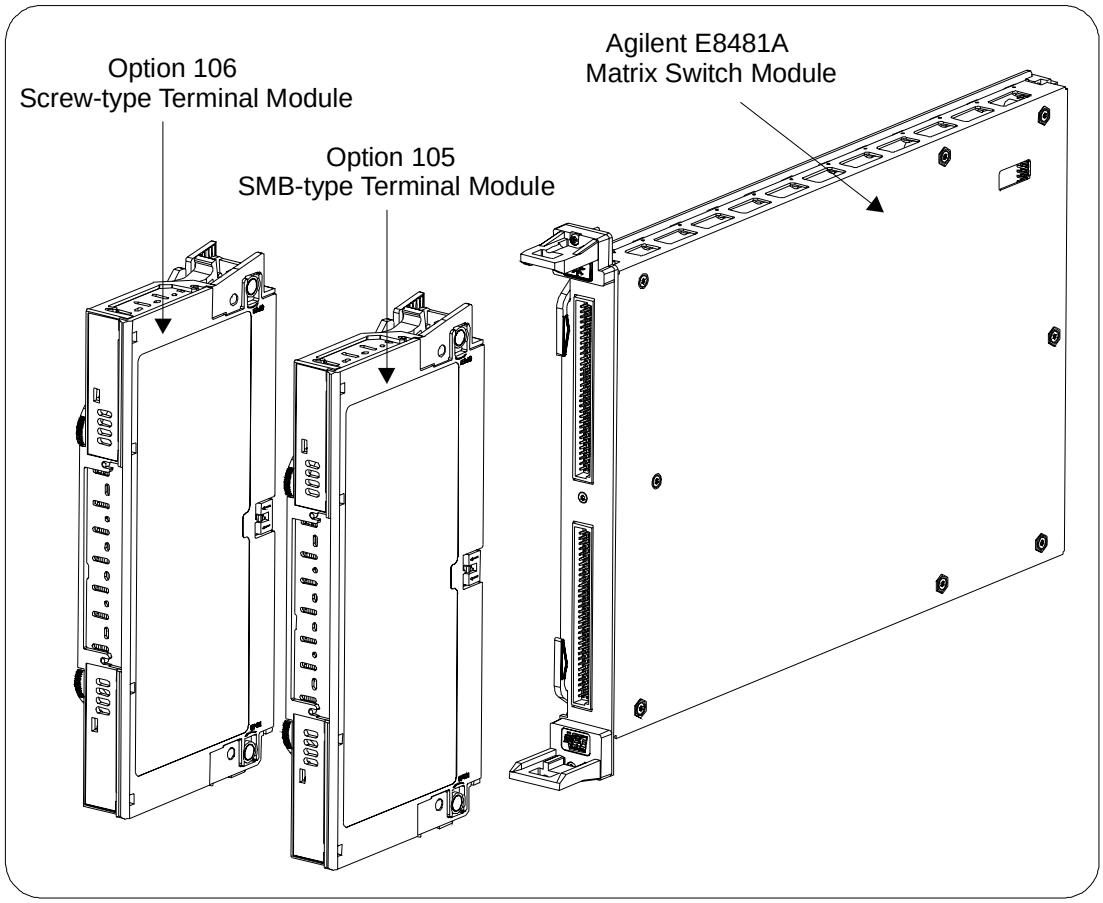


Figure 1-4. Option 105/106 Terminal Module

Chapter 2
Verification Tests

Introduction

The purpose of the functional verification tests described in this chapter is to provide a relatively fast and easy way to determine that the Agilent E8481A 2-Wire 4x32 Relay Matrix Switch module is operational. For more in-depth, higher confidence level test procedures, use the two performance verification tests in this chapter. The verification tests are:

- Functional Verification Test: Self-Test
- Performance Verification Test: Closed-Channel Resistance Test
- Performance Verification Test: DC Isolation Test

General Test Requirements

Before performing the verification tests, you should check the requirements and assumptions in this section.

Recommended Test Equipment

Table 2-1 lists the test equipment recommended for testing and servicing the module. Essential requirements for each piece of test equipment are described in the Requirements column.

Table 2-1. Recommended Test Equipment

Instrument	Requirements	Recommended Model	Use [a]
Controller, GPIB	GPIB compatibility as defined by IEEE Standard 488-1987 and the identical ANSI Standard MC1.1: SH1, AH1, T2, TE0, L2, LE0, SR0, RL0, PP0, DC0, DT0, and C1, 2, 3, 4, 5.	IBM Compatible PC with Agilent 82350 GPIB card installed	F, P, T
Mainframe	Compatible with matrix module	Agilent E8401A/03A/04A/08A	F, P, T
Command Module	Compatible with matrix module	Agilent E1406A	F, P, T
Digital Multimeter	4-wire Ohms 2-wire Ohms (up to 1 GΩ)	Agilent 3458A or Agilent 34401A	P, T

a. F = Functional Verification Tests, P = Performance Verification Tests, T = Troubleshooting

NOTE *The performance tests, troubleshooting and repair procedures are written for the recommended test equipment. Substituting alternate test equipment may require that some procedures be modified.*

Test Conditions/ Procedures

You should complete 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 that the person performing the tests understands how to operate the mainframe, the matrix, 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.

It is assumed that the temperature is no greater than 25ºC and the relative humidity is no greater than 40% (within the specifications as shown in *Appendix A)*.

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.

Recommended System Configuration

All verification tests in this chapter assume the following:

- An E1406A command module and an E8481A matrix module are installed in the mainframe.
- The Agilent SICL Library, VISA extensions, and an Agilent 82350 GPIB card had been installed and properly configured in your computer.
- The computer is connected to the E1406A command module via GPIB interface. The GPIB select code is 7, the GPIB primary address is 09, and the E8481A module is at logical address 112 (secondary address = 112/8 = 14).
- The E8481A SCPI driver (Revision A.11.01 or later) had been downloaded into the E1406A command module. For access to the most up to date instrument drivers, go to the web site (http://www.agilent.com/find/inst_drivers).
- DMM is an Agilent 3458A.

NOTE *You may need to change the module's address and/or command syntax to perform the tests for your setup. However, substituting alternate configuration may require that some procedures be modified. See the Agilent E8481A 2-Wire 4x32 Relay Matrix Switch Module User's Manual for information on address selection, cabling guidelines, and the related SCPI commands.*

Functional Verification Test

The Functional Verification Test for the Agilent E8481A matrix switch module consists of sending the self-test command (*TST?) and checking the response. This test can be used at any time to verify that the device is connected properly and is responding to basic commands. However, it does not ensure module's switching operability.

Test Procedure

1. Verify that the E8481A matrix switch module is properly installed in the mainframe and the mainframe has passed its power-on sequence test.

2. Verify that the computer is properly connected to the mainframe via GPIB interface.

3. Send the *TST? command to the module (GPIB primary address is 09 and secondary address is 112/8 = 14) from *Agilent VISA Assistant* application program.

4. A "+0" returned means no self-test failure, while any non-zero error code returned indicates a self-test failure. See Table 2-2 for the description of self-test error codes.

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. As required, see the Agilent E8481A 2-Wire 4x32 Relay Matrix Switch Module User's Manual for more information on module installation, address selection, and the related SCPI commands.*

Corrective Action

An non-zero error code is returned when the module self-test fails. The meaning of each code is given in Table 2-2. If a self-test failure occurs, recycle power and repeat the self-test as shown above. If the problem reoccurs, the module may require to be repaired. Contact Agilent Technologies for repair and service (see page 10).

Table 2-2. Self-test Error Codes

Error [a]	Description (probable Causes)
+0	Self-test passes.
+ss01	Firmware error.
+ss02	Bus error (communications problem with card).
+ss03	Incorrect ID information in ID register.
+ss05	Card data register incorrect (hardware and firmware with different values).
+ss10	Interrupt expected but not received.
+ss11	Card busy time incorrect.

a. ss = card number (with leading zero deleted, the typical is 1)

Wiring the Test Fixture for Performance Tests

To simplify the following performance verification tests, a test fixture is required to act as an interface between the module and a multimeter. Figure 2-1 shows typical connections using the Option 106 Screw-type terminal module as the test fixture.

NOTE *We recommend to use wire sizes (AWG 20-26) when wiring the test fixture. Wire ends should be stripped 6mm (0.25 inch) and tinned to prevent single strands from shorting to adjacent terminals. See Agilent E8481A 2-Wire 4x32 Relay Matrix Switch Module User's Manual for more wiring information.*

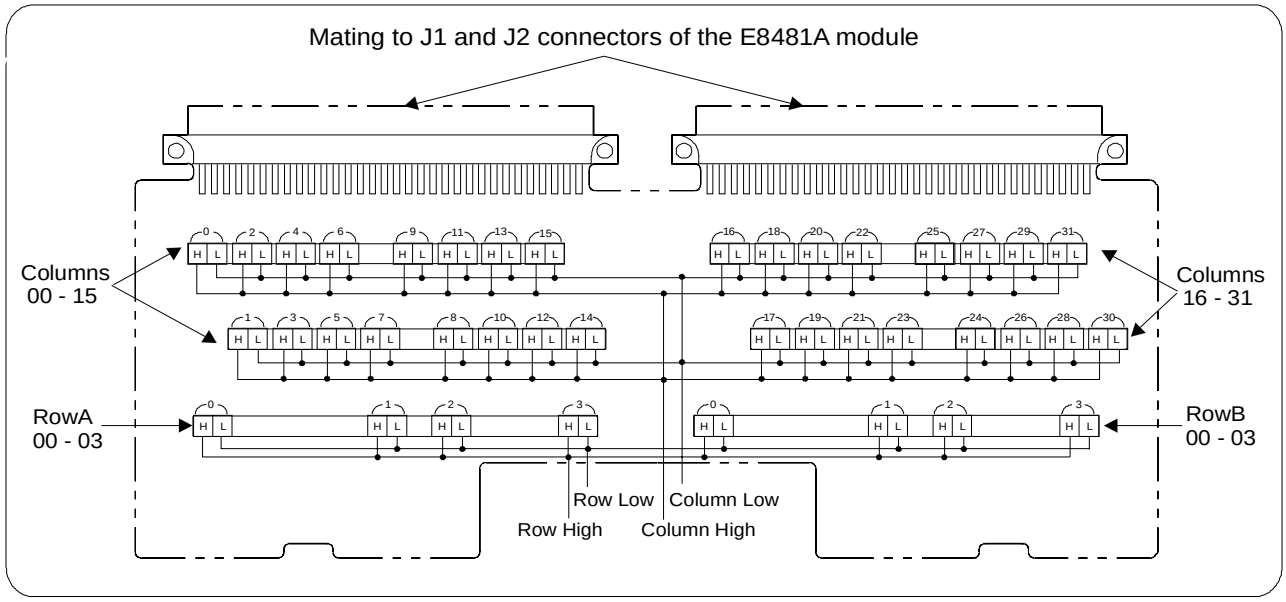


Figure 2-1. Agilent E8481A Test Fixture

Performance Test: Closed-Channel Resistance Test

The purpose of this test is to verify all relay contacts of the E8481A matrix module. It is suitable for identifying a damaged relay.

In general, a new relay should have a contact resistance of 2 Ω or less. Relays with contact resistance in excess of 3 Ω should be replaced. Performance of a relay will deteriorate with use.

NOTE *In the following procedures, **ss** represents the card number (01-99) of the matrix module. The typical value is 1. A leading zero may be omitted. rr represents matrix row number (00-03) and cc represents matrix column number (00-31).*

NOTE *In the following procedures, all commands sending to the matrix module (GPIB primary address is 09 and secondary address is 112/8 = 14) are from the VISA Assistant Application Program.*

Test Procedure

1. Verify that the E8481A matrix switch module is properly installed in the mainframe and the mainframe has passed its power-on sequence test.

2. Verify that the computer is properly connected to the mainframe via GPIB interface.

3. Make hardware connections as shown in Figure 2-2 to perform the closed-channel resistance test for Row High to Column High. See Figure 2-1 for details on the test fixture.

4. Power on the DMM (Agilent 3458A), and set the DMM to 4-wire Ohms, autorange.

NOTE *As required, see the Agilent 3458A Multimeter Operating, Programming, and Configuration Manual for more configuration information.*

5. Measure closed-channel resistance for channel 0000.
   (Row 00 High to Column 00 High)

   -- Send *RST to the matrix module to open all channel relays.
   -- Send CLOS (@ss0000) to the matrix module to close channel 0000 (row 00, column 00).
   -- Read the DMM display and record the reading in Table 2-3.
   -- Send OPEN (@ss0000) to the matrix module to open channel 0000 (row 00, column 00).
   -- Read the DMM display and verify that an open circuit is indicated (>500 MΩ).

6. Repeat Step 5 for all channels with the following change:

   -- Use CLOS (@ssrrcc) and OPEN (@*ssrrcc*), where *ss* = card number, *rr* = row numbers (00-03) and *cc* = column numbers (01-31).

7. Repeat steps 3 through 6 to perform the closed-channel resistance test for Row Low to Column Low with the following change:

   -- In step 3, make hardware connection as shown in Figure 2-3.

Corrective Action

As shown in *Appendix A*, the initial closed-channel resistance for any relay contact of the E8481A module should be less than 2.0 Ω. However, the electromechanical relays are subject to normal wear-out (see *Appendix B*). As the relay begins to wear out, its contact resistance increases. When the resistance exceeds 3.0 Ω or the end of relay life approaches, the relay should be replaced.

According to the repair strategy for the E8481A module (see page 37), you may need to replace entire printed circuit assembly (PCA) if any relay channel's performance is out of the specification limit. However, the sensitivity of the application should be weighted against the cost of replacing the entire PCA board (P/N E8481-60001) with some useful life remaining.

WARNING **Any maintenance and repair of the module must be performed by qualified personnel. Contact Agilent Technologies (see page 10) for repair and service.**

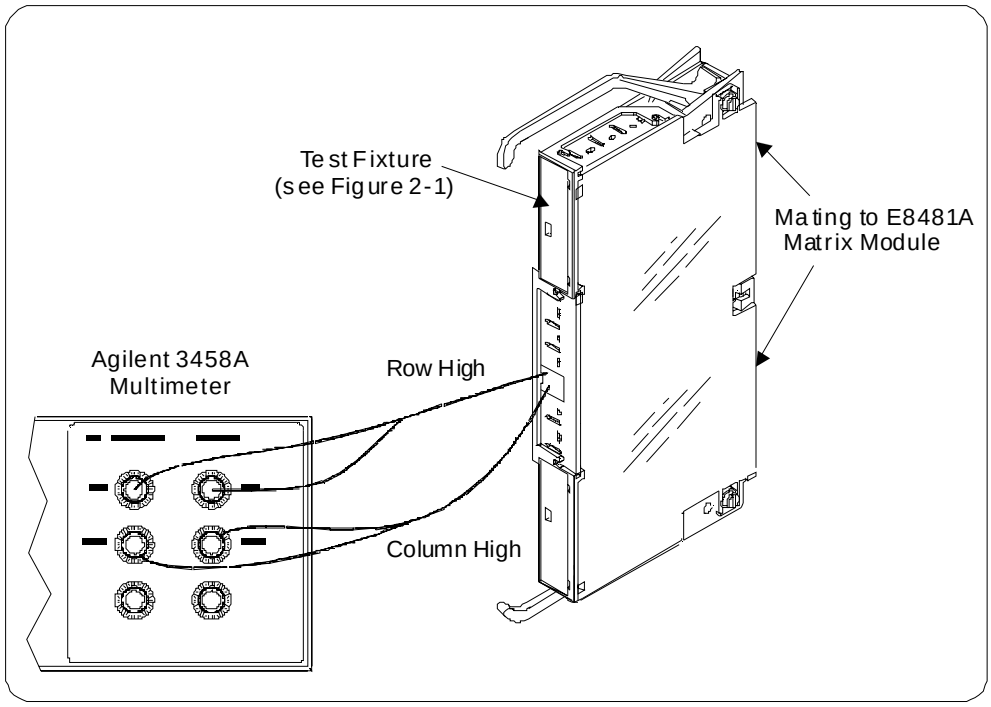


Figure 2-2. Closed-channel Resistance (High Lines)

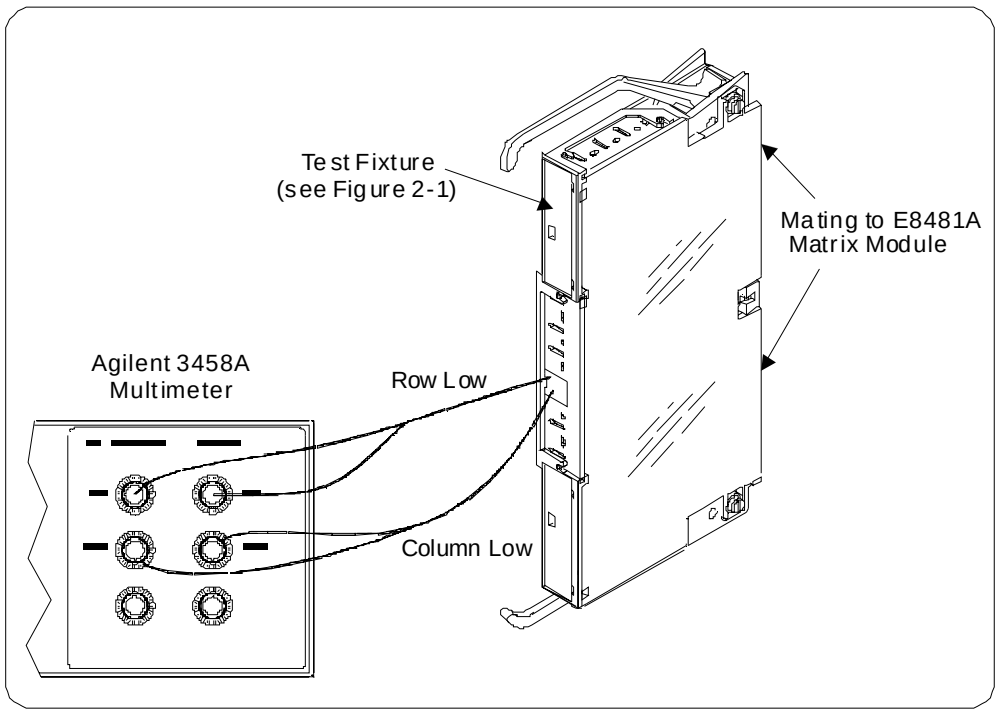


Figure 2-3. Closed-channel Resistance (Low Lines)

Performance Test: DC Isolation Test

The purpose of this test is to verify that sufficient DC isolation (> 1.0 GΩ) exists between various points on the matrix module. The DC isolation test is checked from Column High to Column Low, Row High to Row Low, Column High & Low to Chassis, and Row High & Low to Chassis.

NOTE *The DMM should be capable of measuring at least 1 GΩ. If the DMM indicates an overload, record the reading as ">Rmax", where Rmax is the highest resistance that the DMM can measure. For example, if the DMM is an Agilent 3458A, the reading should be recorded as ">1.2 GΩ" in Table 2-3.*

NOTE *In the following procedures, all commands sending to the matrix module (GPIB primary address is 09 and secondary address is 112/8 = 14) are from the VISA Assistant Application Program.*

Test Procedure

1. Verify that the E8481A matrix module is properly installed in the mainframe and the mainframe has passed its power-on sequence test.
2. Verify that the computer is properly connected to the mainframe via GPIB interface.
3. Make hardware connections as shown in Figure 2-4 to measure the DC isolation resistance for Column High to Column Low. See Figure 2-1 for details on the test fixture.
4. Power on the DMM (Agilent 3458A), and set the DMM to 2-wire Ohms, 1 GΩ range.

NOTE *As required, see the Agilent 3458A Multimeter Operating, Programming, and Configuration Manual for more configuration information.*

5. Send *RST to the matrix module to open all channel relay contacts.
6. Read the DMM display and record the reading in Table 2-3 as required.
7. Repeat steps 3 through 6 to measure DC isolation resistance for Row High to Row Low with the following change:

   -- In step 3, make hardware connection as shown in Figure 2-5.

8. Repeat steps 3 through 6 to measure DC isolation resistance for Column High & Low to Chassis with the following change:

   -- In step 3, make hardware connection as shown in Figure 2-6.

9. Repeat steps 3 through 6 to measure DC isolation resistance for Row High & Low to Chassis with the following change:

   -- In step 3, make hardware connection as shown in Figure 2-7.

Corrective Action

As shown in *Appendix A*, the DC Isolation resistance between any two points of the E8481A module should be greater than 1.0 GΩ when the temperature is no greater than 25°C and the relative humidity is no greater than 40%. The DC Isolation Test failure is most likely caused by the damage relay(s).

When a test failure occurs, it may indicate that some relay(s) on the board are defective. According to the repair strategy for the E8481A module (see page 37), you need to replace entire printed circuit assembly (PCA) if any relay on the board is defective. However, the sensitivity of the application should be weighted against the cost of replacing the entire PCA board (P/N E8481-60001) with some useful life remaining.

WARNING **Any maintenance and repair of the module must be performed by qualified personnel. Contact Agilent Technologies (see page 10) for repair and service as required.**

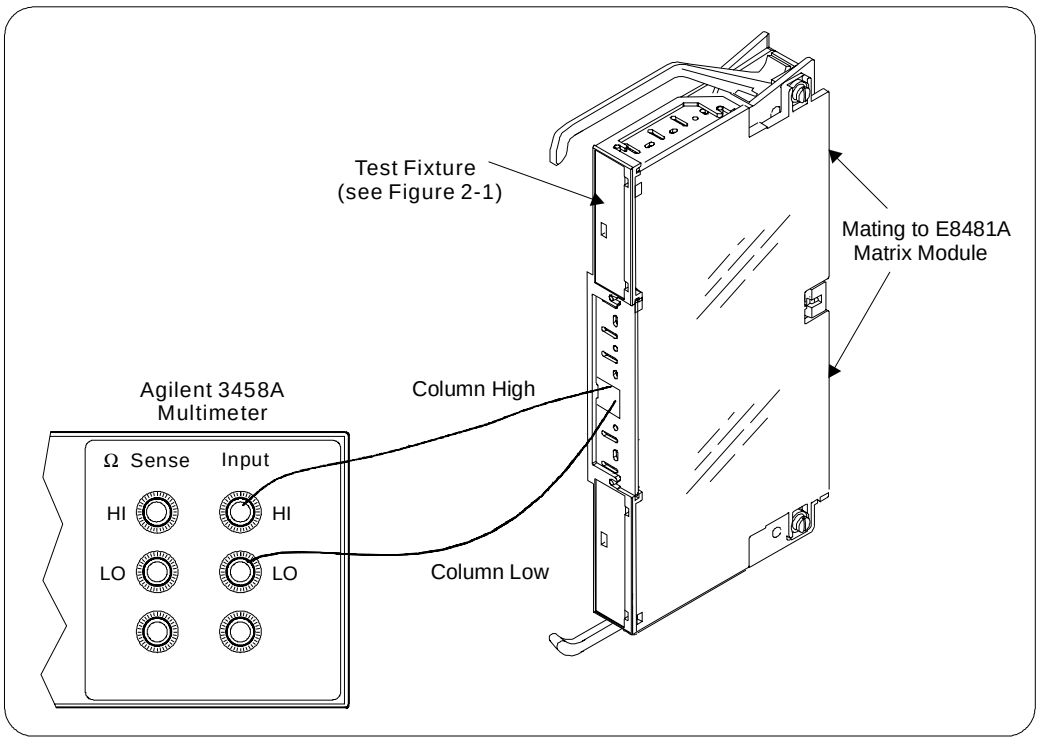


Figure 2-4. Column High to Column Low DC Isolation Test

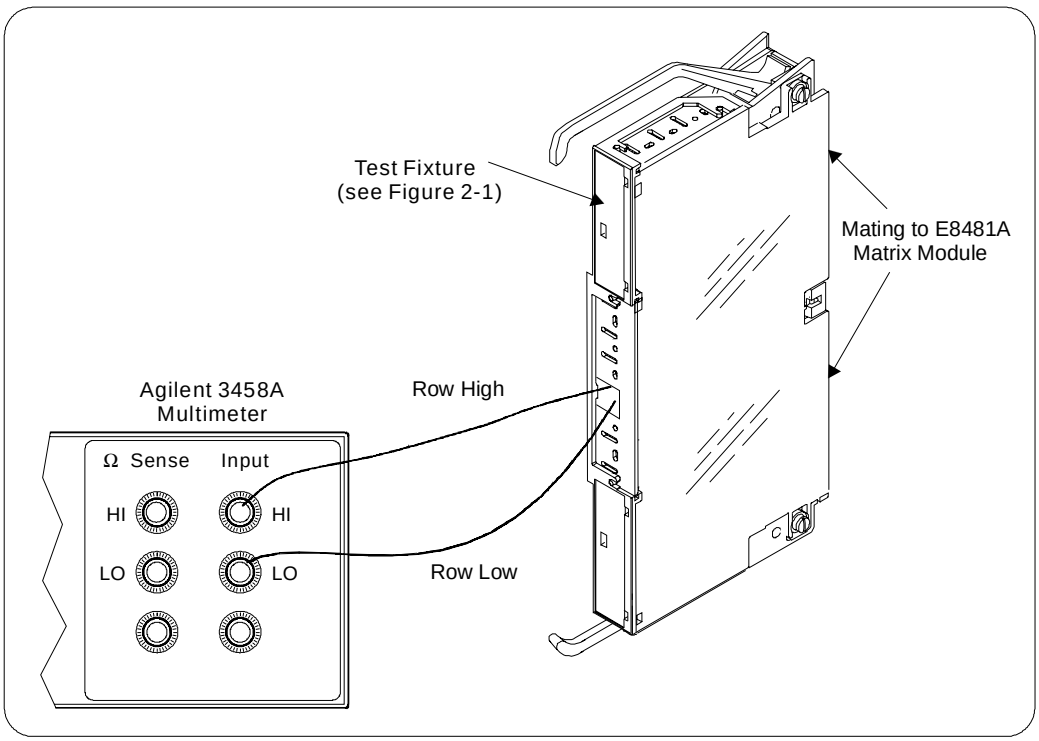


Figure 2-5. Row High to Row Low DC Isolation Test

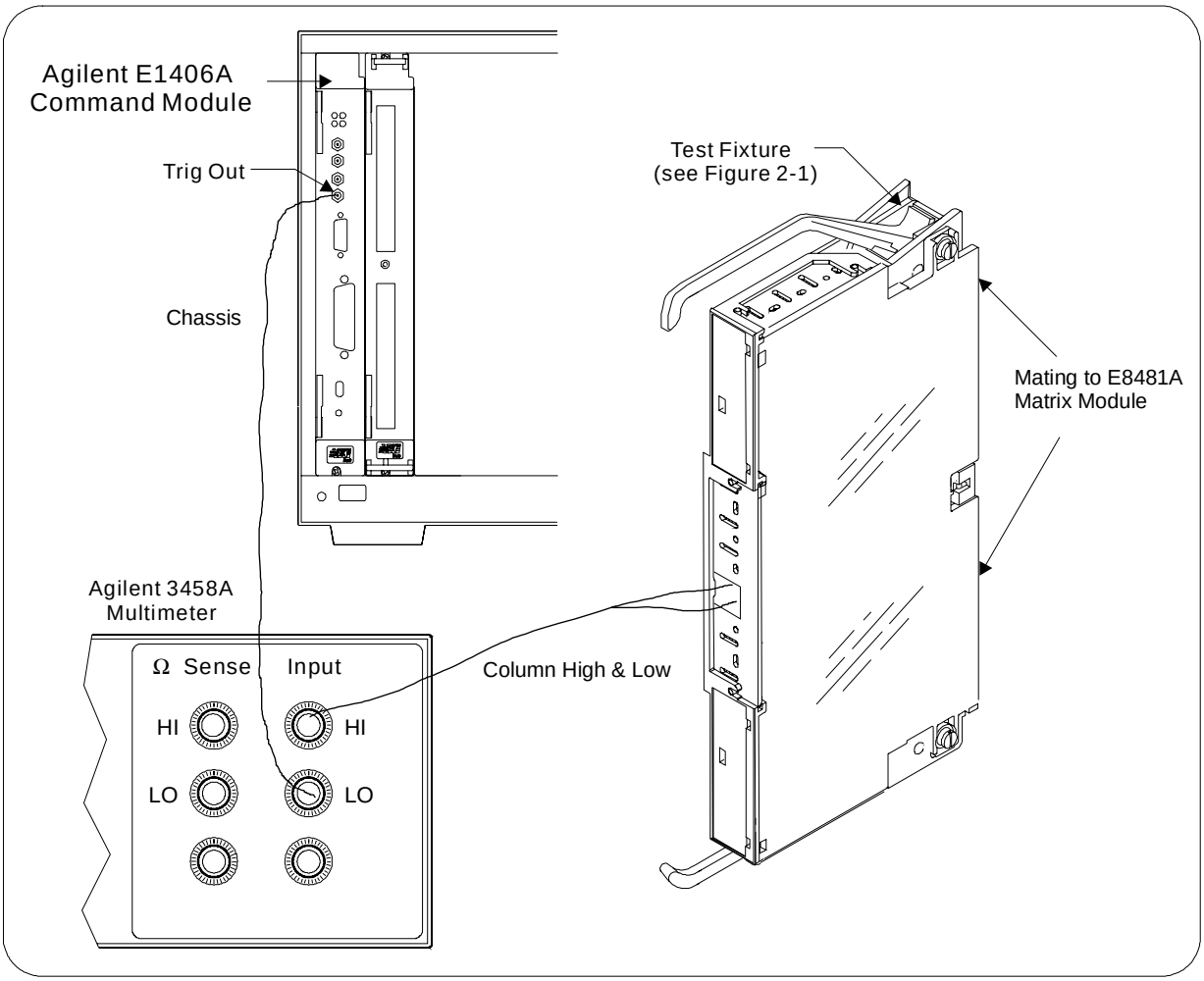


Figure 2-6. Column High & Low to Chassis DC Isolation Test

NOTE *Use any convenient chassis connection. The illustration shows the DMM LO terminal connected to the outside of the Trig Out BNC on the E1406A command module.*

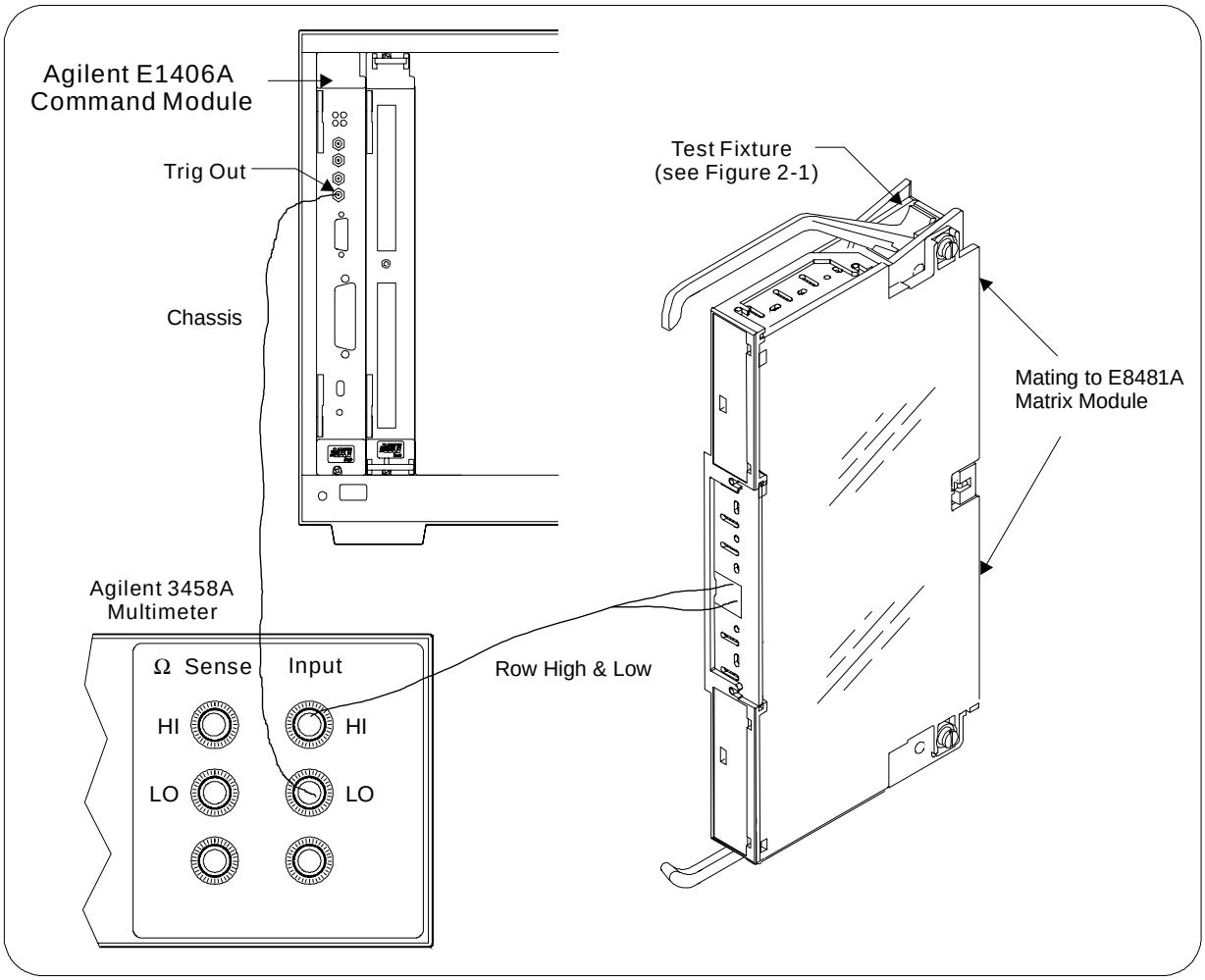


Figure 2-7. Row High & Low to Chassis DC Isolation Test

NOTE *Use any convenient chassis connection. The illustration shows the DMM LO terminal connected to the outside of the Trig Out BNC on the E1406A command module.*

Performance Test Record

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

NOTE *The accuracy, measurement uncertainty, and TAR values shown in* Table 2-3 *are valid ONLY for the specific test conditions, test equipment, and assumption described. If you use test equipment and/or change the test conditions, you will need to compute the specific values for your test setup.*

Test Limits

Test limits are defined for Closed-Channel Resistance Test and DC Isolation Test using the specifications in Appendix A of this manual. The 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 = 3.0 Ω

M.U. = (15 *ppm of Reading* + 5 *ppm of Range*)
= $(15 \times 10^{-6} * 3.0) + (5 \times 10^{-6} * 10)$ Ω
= 9.5×10^{-5} Ω

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)

M.U. = (0.5% *of Reading* + 10 *ppm of Range*)
= $(0.005 * 1.2 \times 10^{9}) + (10 \times 10^{-6} * 1 \times 10^{9})$ Ω
= 6.1×10^{6} Ω

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 (Page 1 of 6)

Model _____ **Report Number** _____ **Date** _____

General Information

Test Facility	
Name _____	Phone _____
Address _____	Fax _____
City, State, ZIP _____	e-Mail _____
Customer _____	Tested by _____
Notes	
_____	
_____	
_____	
_____	
_____	
_____	
_____	

Test Equipment Used

Description	***Model No.***	***Trace No.***	***Cal Due Date***
1. _____	_____	_____	_____
2. _____	_____	_____	_____
3. _____	_____	_____	_____
4. _____	_____	_____	_____
5. _____	_____	_____	_____
6. _____	_____	_____	_____

Table 2-3. Performance Test Record (Page 2 of 6)

Model _____ **Report Number** _____ **Date** _____

Channel	Minimum Value [a]	Low LInes Measured Value	High LInes Measured Value	Maximum Value	Measurement Uncertainty	Test Accuracy Ratio (TAR)
Closed-channel Resistance Test (*Values in Ohms****)***						
ss0000		_____	_____	3.0	9.5E-5	NA
ss0001		_____	_____	3.0	9.5E-5	NA
ss0002		_____	_____	3.0	9.5E-5	NA
ss0003		_____	_____	3.0	9.5E-5	NA
ss0004		_____	_____	3.0	9.5E-5	NA
ss0005		_____	_____	3.0	9.5E-5	NA
ss0006		_____	_____	3.0	9.5E-5	NA
ss0007		_____	_____	3.0	9.5E-5	NA
ss0008		_____	_____	3.0	9.5E-5	NA
ss0009		_____	_____	3.0	9.5E-5	NA
ss0010		_____	_____	3.0	9.5E-5	NA
ss0011		_____	_____	3.0	9.5E-5	NA
ss0012		_____	_____	3.0	9.5E-5	NA
ss0013		_____	_____	3.0	9.5E-5	NA
ss0014		_____	_____	3.0	9.5E-5	NA
ss0015		_____	_____	3.0	9.5E-5	NA
ss0016		_____	_____	3.0	9.5E-5	NA
ss0017		_____	_____	3.0	9.5E-5	NA
ss0018		_____	_____	3.0	9.5E-5	NA
ss0019		_____	_____	3.0	9.5E-5	NA
ss0020		_____	_____	3.0	9.5E-5	NA
ss0021		_____	_____	3.0	9.5E-5	NA
ss0022		_____	_____	3.0	9.5E-5	NA
ss0023		_____	_____	3.0	9.5E-5	NA
ss0024		_____	_____	3.0	9.5E-5	NA
ss0025		_____	_____	3.0	9.5E-5	NA
ss0026		_____	_____	3.0	9.5E-5	NA
ss0027		_____	_____	3.0	9.5E-5	NA
ss0028		_____	_____	3.0	9.5E-5	NA
ss0029		_____	_____	3.0	9.5E-5	NA
ss0030		_____	_____	3.0	9.5E-5	NA
ss0031		_____	_____	3.0	9.5E-5	NA

a. Single-sided specification - Minimum Value does not apply.

Table 2-3. Performance Test Record (Page 3 of 6)

Model _____ **Report Number** _____ **Date** _____

Channel	Minimum Value [a]	Low LInes Measured Value	High LInes Measured Value	Maximum Value	Measurement Uncertainty	Test Accuracy Ratio (TAR)
Closed-channel Resistance Test (*Values in Ohms****)***						
ss0100		_____	_____	3.0	9.5E-5	NA
ss0101		_____	_____	3.0	9.5E-5	NA
ss0102		_____	_____	3.0	9.5E-5	NA
ss0103		_____	_____	3.0	9.5E-5	NA
ss0104		_____	_____	3.0	9.5E-5	NA
ss0105		_____	_____	3.0	9.5E-5	NA
ss0106		_____	_____	3.0	9.5E-5	NA
ss0107		_____	_____	3.0	9.5E-5	NA
ss0108		_____	_____	3.0	9.5E-5	NA
ss0109		_____	_____	3.0	9.5E-5	NA
ss0110		_____	_____	3.0	9.5E-5	NA
ss0111		_____	_____	3.0	9.5E-5	NA
ss0112		_____	_____	3.0	9.5E-5	NA
ss0113		_____	_____	3.0	9.5E-5	NA
ss0114		_____	_____	3.0	9.5E-5	NA
ss0115		_____	_____	3.0	9.5E-5	NA
ss0116		_____	_____	3.0	9.5E-5	NA
ss0117		_____	_____	3.0	9.5E-5	NA
ss0118		_____	_____	3.0	9.5E-5	NA
ss0119		_____	_____	3.0	9.5E-5	NA
ss0120		_____	_____	3.0	9.5E-5	NA
ss0121		_____	_____	3.0	9.5E-5	NA
ss0122		_____	_____	3.0	9.5E-5	NA
ss0123		_____	_____	3.0	9.5E-5	NA
ss0124		_____	_____	3.0	9.5E-5	NA
ss0125		_____	_____	3.0	9.5E-5	NA
ss0126		_____	_____	3.0	9.5E-5	NA
ss0127		_____	_____	3.0	9.5E-5	NA
ss0128		_____	_____	3.0	9.5E-5	NA
ss0129		_____	_____	3.0	9.5E-5	NA
ss0130		_____	_____	3.0	9.5E-5	NA
ss0131		_____	_____	3.0	9.5E-5	NA

a. Single-sided specification - Minimum Value does not apply.

Table 2-3. Performance Test Record (Page 4 of 6)

Model _____ **Report Number** _____ **Date** _____

Channel	Minimum Value [a]	Low LInes Measured Value	High LInes Measured Value	Maximum Value	Measurement Uncertainty	Test Accuracy Ratio (TAR)
Closed-channel Resistance Test (*Values in Ohms****)***						
ss0200		_____	_____	3.0	9.5E-5	NA
ss0201		_____	_____	3.0	9.5E-5	NA
ss0202		_____	_____	3.0	9.5E-5	NA
ss0203		_____	_____	3.0	9.5E-5	NA
ss0204		_____	_____	3.0	9.5E-5	NA
ss0205		_____	_____	3.0	9.5E-5	NA
ss0206		_____	_____	3.0	9.5E-5	NA
ss0207		_____	_____	3.0	9.5E-5	NA
ss0208		_____	_____	3.0	9.5E-5	NA
ss0209		_____	_____	3.0	9.5E-5	NA
ss0210		_____	_____	3.0	9.5E-5	NA
ss0211		_____	_____	3.0	9.5E-5	NA
ss0212		_____	_____	3.0	9.5E-5	NA
ss0213		_____	_____	3.0	9.5E-5	NA
ss0214		_____	_____	3.0	9.5E-5	NA
ss0215		_____	_____	3.0	9.5E-5	NA
ss0216		_____	_____	3.0	9.5E-5	NA
ss0217		_____	_____	3.0	9.5E-5	NA
ss0218		_____	_____	3.0	9.5E-5	NA
ss0219		_____	_____	3.0	9.5E-5	NA
ss0220		_____	_____	3.0	9.5E-5	NA
ss0221		_____	_____	3.0	9.5E-5	NA
ss0222		_____	_____	3.0	9.5E-5	NA
ss0223		_____	_____	3.0	9.5E-5	NA
ss0224		_____	_____	3.0	9.5E-5	NA
ss0225		_____	_____	3.0	9.5E-5	NA
ss0226		_____	_____	3.0	9.5E-5	NA
ss0227		_____	_____	3.0	9.5E-5	NA
ss0228		_____	_____	3.0	9.5E-5	NA
ss0229		_____	_____	3.0	9.5E-5	NA
ss0230		_____	_____	3.0	9.5E-5	NA
ss0231		_____	_____	3.0	9.5E-5	NA

a. Single-sided specification - Minimum Value does not apply.

Table 2-3. Performance Test Record (Page 5 of 6)

Model _____ **Report Number** _____ **Date** _____

Channel	Minimum Value [a]	Low LInes Measured Value	High LInes Measured Value	Maximum Value	Measurement Uncertainty	Test Accuracy Ratio (TAR)
Closed-channel Resistance Test (*Values in Ohms****)***						
ss0300		_____	_____	3.0	9.5E-5	NA
ss0301		_____	_____	3.0	9.5E-5	NA
ss0302		_____	_____	3.0	9.5E-5	NA
ss0303		_____	_____	3.0	9.5E-5	NA
ss0304		_____	_____	3.0	9.5E-5	NA
ss0305		_____	_____	3.0	9.5E-5	NA
ss0306		_____	_____	3.0	9.5E-5	NA
ss0307		_____	_____	3.0	9.5E-5	NA
ss0308		_____	_____	3.0	9.5E-5	NA
ss0309		_____	_____	3.0	9.5E-5	NA
ss0310		_____	_____	3.0	9.5E-5	NA
ss0311		_____	_____	3.0	9.5E-5	NA
ss0312		_____	_____	3.0	9.5E-5	NA
ss0313		_____	_____	3.0	9.5E-5	NA
ss0314		_____	_____	3.0	9.5E-5	NA
ss0315		_____	_____	3.0	9.5E-5	NA
ss0316		_____	_____	3.0	9.5E-5	NA
ss0317		_____	_____	3.0	9.5E-5	NA
ss0318		_____	_____	3.0	9.5E-5	NA
ss0319		_____	_____	3.0	9.5E-5	NA
ss0320		_____	_____	3.0	9.5E-5	NA
ss0321		_____	_____	3.0	9.5E-5	NA
ss0322		_____	_____	3.0	9.5E-5	NA
ss0323		_____	_____	3.0	9.5E-5	NA
ss0324		_____	_____	3.0	9.5E-5	NA
ss0325		_____	_____	3.0	9.5E-5	NA
ss0326		_____	_____	3.0	9.5E-5	NA
ss0327		_____	_____	3.0	9.5E-5	NA
ss0328		_____	_____	3.0	9.5E-5	NA
ss0329		_____	_____	3.0	9.5E-5	NA
ss0330		_____	_____	3.0	9.5E-5	NA
ss0331		_____	_____	3.0	9.5E-5	NA

a. Single-sided specification - Minimum Value does not apply.

Table 2-3. Performance Test Record (Page 6 of 6)

Model _____ **Report Number** _____ **Date** _____

Test Description	Minimum Value	Measured Value	Maximum Value [a]	Measurement Uncertainty	Test Accuracy Ratio (TAR)
DC Isolation Test (*Values in Ohms****)***					
Column High to Column Low	1.2E9	_____		6.1E6	NA
Row High to Row Low	1.2E9	_____		6.1E6	NA
Column High & Low to Chassis	1.2E9	_____		6.1E6	NA
Row High & Low to Chassis	1.2E9	_____		6.1E6	NA

a. Single-sided specification - Maximum Value does not apply.

Notes:

Chapter 3
Service

Introduction

This chapter contains service information for the Agilent E8481A 2-Wire 4x32 Matrix Switch module, including repair strategy, ordering replaceable parts, repair/maintenance guidelines, as well as troubleshooting techniques.

WARNING **Do not perform any of the service procedures shown unless you are a qualified, service-trained technician, and have read the "Safety Considerations" in Chapter 1.**

NOTE *The performance tests, troubleshooting and repair procedures are written for the recommended test equipment as shown in Table 2-1 on page 17 of this manual. Substituting alternate test equipment may require that some procedures be modified.*

Repair Strategy

Agilent recommends replacement of the entire printed circuit assembly (PCA) for the E8481A matrix module when any of the relay fails or the end of relay life approaches. However, the sensitivity of the application should be weighed against the cost of replacing the entire circuit board with some useful life remaining. The repair to the Option 105/106 terminal modules is also limited to the replacement of the PCAs. Table 3-1 shows the ordering information for the user-replaceable assemblies. See Figure 3-1 for the PCA diagram of the E8481A matrix switch module. See Figure 3-2 for the PCA diagrams of the Option 105/106 SMB-type/Screw-type terminal modules. For more repair information, contact Agilent Technologies (see page 10).

NOTE *The detailed diagrams for the schematics and component locators are not included with the electronic version of this manual. Please order a paper copy of this manual (P/N E8481-90010) if you wish for a paper copy of the schematics and component locators.*

Replaceable Parts

The only replaceable parts for the Agilent E8481A Matrix Switch module and the Option 105/106 terminal modules are the PCA boards (as shown in Figure 3-1 and Figure 3-2). To order a replaceable PCA board, specify the Agilent part number listed in Table 3-1 and the quantity required. Send your

order to Agilent Technologies. See "Contact Agilent Technologies" in *Chapter 1* for details.

Table 3-1. Agilent E8481A and Option 105/106 Replaceable PCAs

Reference Designator	Part Number	Quantity	Description
A1	E8481-60001	1	E8481A Relay Matrix Module PCA
A2	E8481-60002	1	Option 105 SMB-type Terminal Module PCA
A3	E8481-60003	1	Option 106 Screw-type Terminal Module PCA

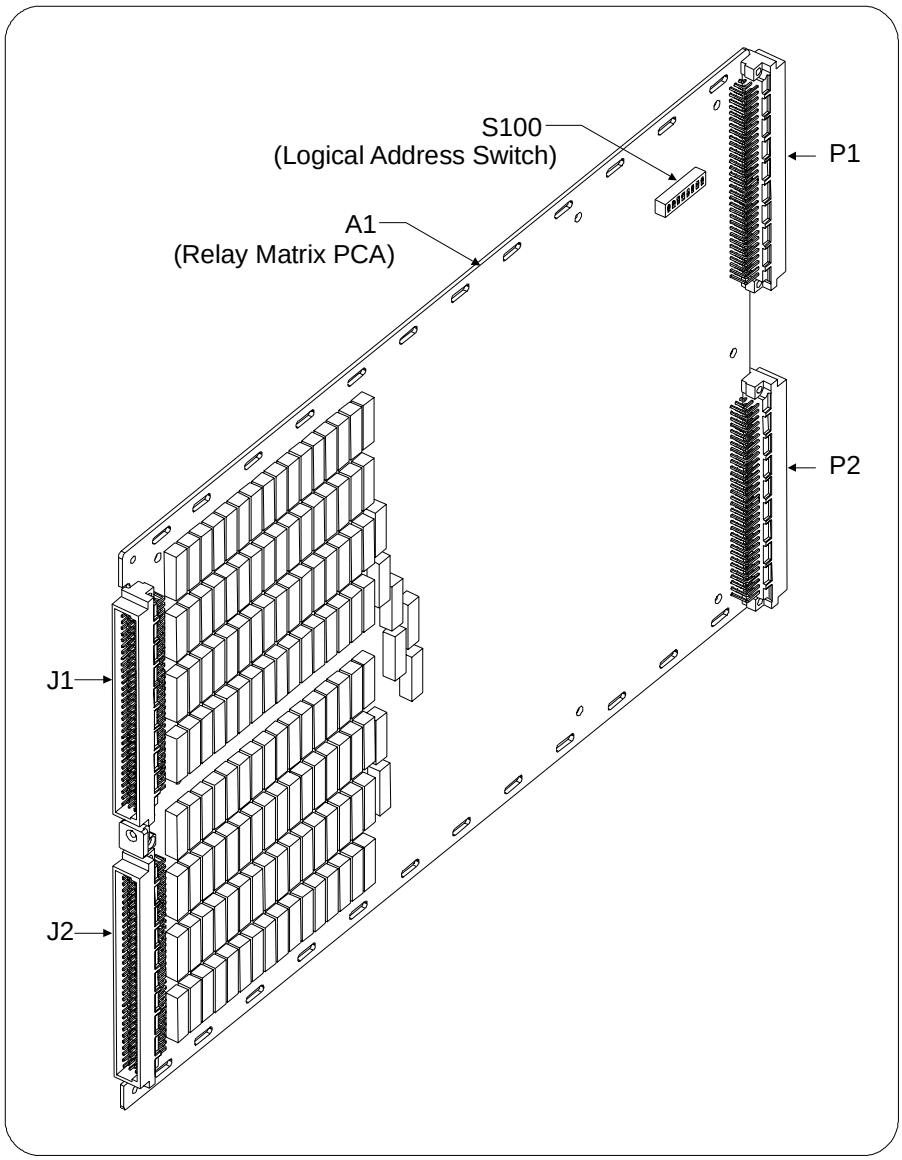


Figure 3-1. Agilent E8481A Matrix Switch Module PCA

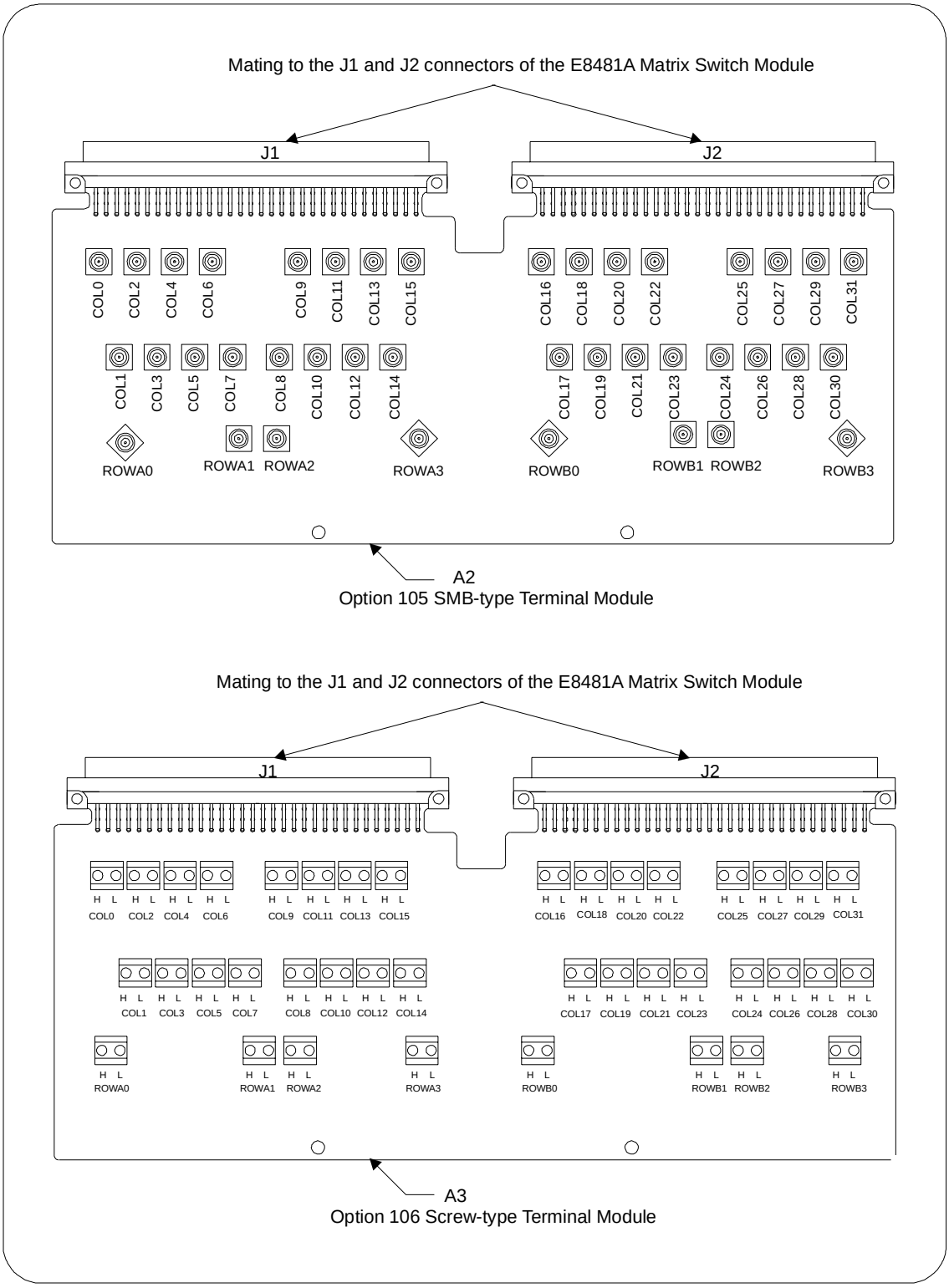


Figure 3-2. Option 105/106 Terminal Module PCAs

Repair/Maintenance Guidelines

This section provides guidelines for repairing and maintaining the Agilent E8481A matrix module, including:

- ESD precautions
- Cleaning Requirements

ESD Precautions

Electrostatic discharge (ESD) may damage static-sensitive devices in the matrix modules. This damage can range from slight parameter degradation to catastrophic failure. When handling matrix 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.
- After you remove an assembly from the module, place the assembly on a conductive surface to guard against ESD damage. Do not stack assemblies.

Cleaning Requirements

Preventive maintenance for the Agilent E8481A consists of periodically cleaning the module to remove dust and debris that will build up over time. The cleaning interval is dependent on the environment conditions and application. For best results, you should clean the module once a year or more often if the module is used in extremely dusty or very humid area. The front panel and the top/bottom covers can be cleaned with a dry cloth or one slightly dampened with water.

WARNING **To prevent electrical shock, disconnect any AC power from the mainframe and from other modules that may be connected to the matrix module before cleaning.**

Troubleshooting

To troubleshoot an Agilent E8481A matrix module problem, you should first identify the problem, and then isolate the cause to a user-replaceable assembly.

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. As required, see the Agilent E8481A 2-Wire 4x32 Relay Matrix Switch Module User's Manual for information on address selection and cabling guidelines.*

Identifying the Problem

Table 3-2 lists some common problems, along with symptoms and possible solutions.

NOTE *If the problem can not be identified or traced to a user-replaceable assembly with the following procedures, contact Agilent Technologies for repair and service (see page 10).*

Table 3-2. Agilent E8481A Common Problems

Problem Type	Symptom	Recommended Actions [a]
Self-test Errors	Non-zero error code in response to the *TST? command.	See page 19 in *Chapter 2*.
Operator Errors	Non-zero error code in response to the SYST:ERR? command.	See *Appendix C - Error Messages* in *the Agilent E8481A 2-Wire 4x32 Relay Matrix Switch Module User's Manual* for matrix errors and causes.
Catastrophic Failures	Not responding to commands.	See "Testing the Assembly" later in this chapter.
Performance Out of Specification	Failing Closed-channel Resistance Test	See page 22 in *Chapter 2*.
	Failing DC Isolation Test	See page 25 in *Chapter 2*.

a. Verify proper connections and correct logical address setting before troubleshooting.

Testing the Assembly

You can use the tests and checks in Table 3-3 to identify the problem on the user-replaceable assembly. If there are no apparent problems following the typical checks, run the Verification Tests in Chapter 2 to see if the module is defective. See Figures 3-1 for the locations of the checked components on the E8481A printed circuit assembly (E8481-60001). The typical checks for the matrix module include.

- Checking for heat damage
- Checking logical address switch setting
- Checking connectors contacts

Table 3-3. Agilent E8481A Tests/Checks

Test/Check	Reference Designator	Check:
Heat Damage	N.A.	Discolored PC boards Damaged insulation Evidence of arcing
Logical Address Switch	S100	Logical address setting
Connectors	P1, P2, J1 and J2	Bent or damaged connectors

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. If there is damage, do not operate the module until you have corrected the problem.

Checking Logical Address Switch

Verify that the logical address switch (S100) is set correctly (factory set at 112). See *Agilent E8481A 2-Wire 4x32 Relay Matrix Switch Module User's Manual* for information on address setting.

Checking Connectors

Check all connectors (P1, P2, J1 and J2) for bent pins or damaged contacts. If any of them is damaged, you may have to replace the entire PCA (P/N E8481-60001).

WARNING **Any maintenance and repair of the module must be performed by qualified personnel. Contact Agilent Technologies (see page 10) for repair and service.**

Matrix Module Disassembly

Use the following procedures to disassemble the E8481A matrix module (see Figure 3-3).

NOTE *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 top/bottom cover.*

1. To remove the top and bottom covers:

   -- Remove the eight T10 Torx screws from the top cover as shown.
   -- Lift the top cover off the module.
   -- Turn the A1 assembly over and lift off the bottom cover.

2. To remove the front panel:

   -- Remove the two T8 Torx screws from the front panel handles as shown.
   -- Remove the one T8 Torx screw from the front panel as shown.
   -- Remove the front panel off the A1 assembly.

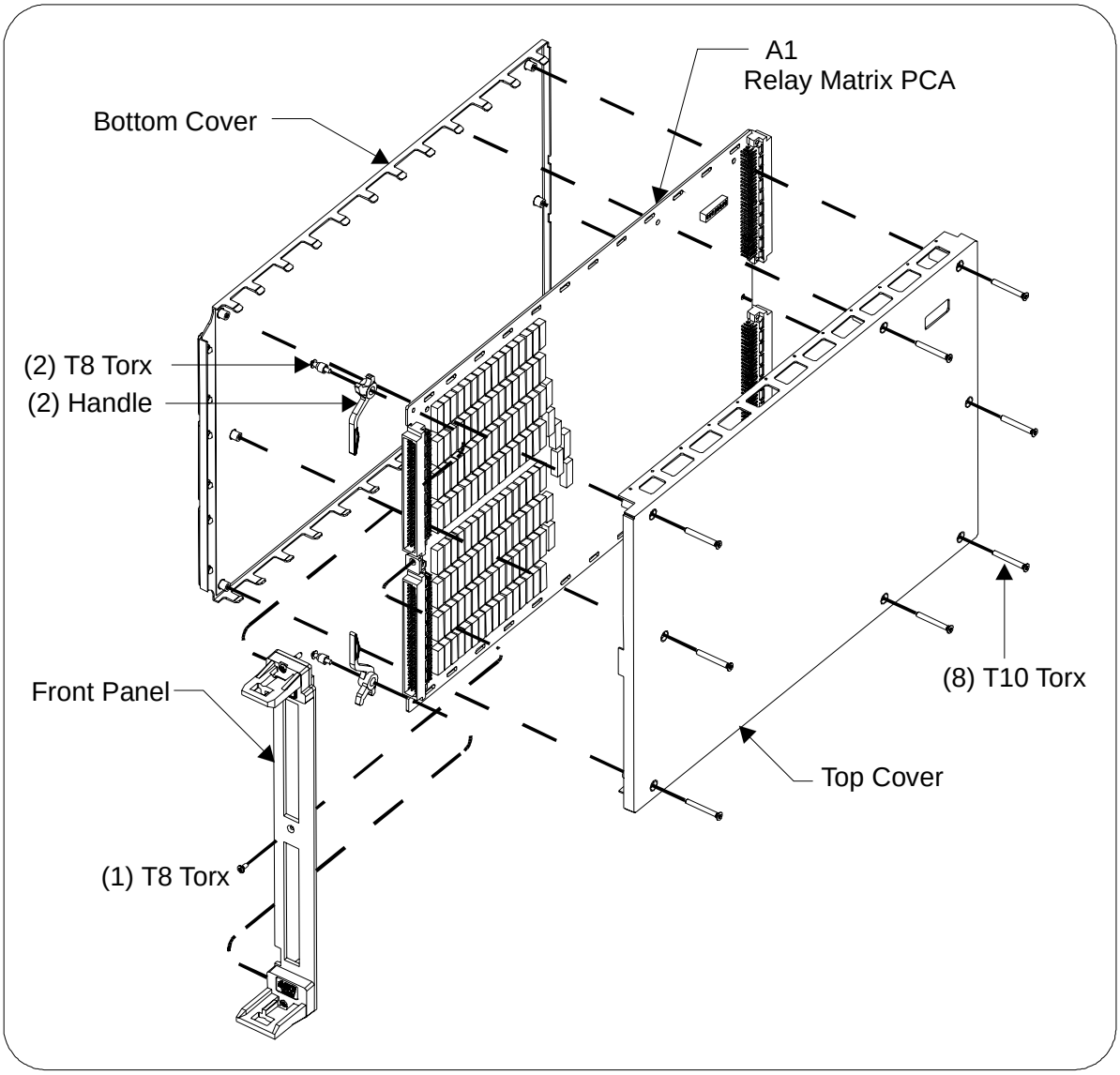


Figure 3-3. Agilent E8481A Module Disassembly

Appendix A
E8481A Specifications

Table A-1. E8481A Specifications

ITEMS		SPECIFICATIONS
GENERAL CHARACTERISTICS		
Module Size/Device Type:		C-Size 1-Slot, Register based, A16, slave only, P1 and P2 Connectors
Total Channels:		Single 4x32 Matrix; or Dual 4x16 matrixes
Relays Type:		Form-A, Non-latching Reed
Typical Relay Life:	At Rated Load: [a]	1×10^9
Power Requirements:	Peak Module Current: Dynamic Module Current:	2.21 A @ +5 V 0.1 A @ +5 V
Watts/slot:	With 8 Crosspoints Closed: [b]	13 W
Cooling/slot:	With 8 Crosspoints Closed: [b]	0.1 mm H_2O @ 1.1 Liter/sec for 10^oC rise
Operating Temperature:		0 - 55^oC
Operating Humidity:		65% RH, 0 - 40^oC
INPUT CHARACTERISTICS		
Maximum Voltage:	Terminal to Terminal:	42 Vdc, 30 Vac rms
Maximum Transient Impulse:		500 V peak
Maximum Current:	Per Channel (non-inductive):	0.5 A dc, 0.5 A ac peak
Maximum Power:	Per Channel (resistive load): Per Module (resistive load):	5 VA ac 40 VA ac
DC ISOLATION / PERFORMANCE		
Closed Channel Resistance:	**Per channel:**	< 2 Ω (initial)
Isolation resistance: **(between any two points, single module)**	< (40^oC, 65% RH): < (25^oC, 40% RH):	$> 10^8$ Ω $> 10^9$ Ω
Thermal Offset:	Per Channel:	< 50 μV

(*continued on the next page*)

Table A-1. E8481A Specifications

ITEMS		SPECIFICATIONS
AC ISOLATION / PERFORMANCE (*4x32 Configuration,* $Z_I = Z_S = 50\ \Omega$, **< (40°C, 65% RH):*)***		
Closed Channel Capacitance:	Hi to Lo:	< 160 pF
	Hi to Chassis:	< 160 pF
	Lo to Chassis:	< 550 pF
Bandwidth (-3dB):	4 x 32 Configuration:	50 MHz
Crosstalk Within a Card:	< 100 KHz:	< -65 dB
(Channel-Channel with 50Ω termination)	< 5 MHz:	< -50 dB
	< 50 MHz:	< -27 dB
AC ISOLATION / PERFORMANCE (*Dual 4x16 Configuration,* $Z_I = Z_S = 50\ \Omega$, **< (40°C, 65% RH):*)***		
Closed Channel Capacitance:	Hi to Lo:	< 100 pF
	Hi to Chassis:	< 100 pF
	Lo to Chassis:	< 300 pF
Bandwidth (-3dB):	4 x 16 Configuration:	70 MHz
Crosstalk Within a Card:	<100 KHz:	< -65 dB
(Channel-Channel with 50Ω termination)	< 5 MHz:	< -50 dB
	< 50 MHz:	< -27 dB

a. 10 mA, 1 Vdc resistive load.
b. When more than 8 crosspoints are closed, add 0.34 W per crosspoint to the specified power dissipation (13 W), and 0.027 liter/sec to the air flow (1.1 Liter/sec).

Appendix B
Relay Life

Replacement Strategy

Electromechanical relays are subject to normal wear-out. Relay life depends on several factors as shown below. The recommended repair strategy for the E8481A matrix switch is PCA-level replacement. User repairs to the E8481A matrix module are limited to replacement of the entire circuit board (P/N E8481-60001) when any of the relay fails or the end of relay life approaches. The sensitivity of the application should be weighed against the cost of replacing the entire circuit board with some useful life remaining. For more information, contact Agilent Technologies (see page 10).

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.*

Relay Life Factors

Some effects of loading and switching frequency on relay life follow.

- **Relay Load.** In general, higher power switching reduces relay life. In addition, capacitive/inductive loads and high inrush currents (for example, turning on a lamp or starting a motor) reduces relay life. *Exceeding 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 also reduces relay life.

End-of-Life Determination

A preventive maintenance routine can prevent problems caused by unexpected relay failure. The end of the life of the relay can be determined by 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 Maximum Value.** As the relay begins to wear out, its contact resistance increases. When the resistance exceeds a predetermined value, the relay should be replaced.

- **Contact Resistance Variance.** 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 Relay Operations.** 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.

Agilent Technologies

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