Agilent 75000 SERIES C

Relay Matrixes
Agilent E1468A and E1469A

Service Manual

Enclosed is the Service Manual for the the Agilent E1468A/E1469A Relay Matrices. Insert this manual, along with any other VXIbus manuals that you have, into the binder that came with your Agilent mainframe or command module.

Agilent Technologies

E1468-90010
E0406

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Certification

Agilent Technologies certifies that this product met its published specifications at the time of shipment from the factory. Agilent Technologies further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology (formerly National Bureau of Standards), to the extent allowed by that organization's calibration facility, and to the calibration facilities of other International Standards Organization members.

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Agilent E1468A and E1469A Relay Matrixes Service Manual
Edition 2 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 E1460-90010). . . . . February 1992

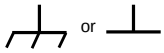
Edition 2 (Part Number E1468-90010). . . . . April 1994

Edition 2 Rev 2 (Part Number E1468-90010) . . . . . April 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

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

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

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

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

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

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

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

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

DECLARATION OF CONFORMITY

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

Manufacturer's Name: Agilent Technologies, Incorporated
Manufacturer's Address: *Measurement Product Generation Unit*
815 14th ST. S.W.
Loveland, CO 80537 USA

Declares, that the product

Product Name: Relay Matrix Switch
Model Number: E1468A/E1469A
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 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 11:1997 +A1:1997 / EN 55011:1998	*Group 1 Class A [1]*
	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	*I cycle, 100%*
	Canada: ICES-001:1998	
	Australia/New Zealand: AS/NZS 2064.1	
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	

Supplemental Information:

[1] The product was tested in a typical configuration with Agilent Technologies test systems.

September 5, 2000
Date

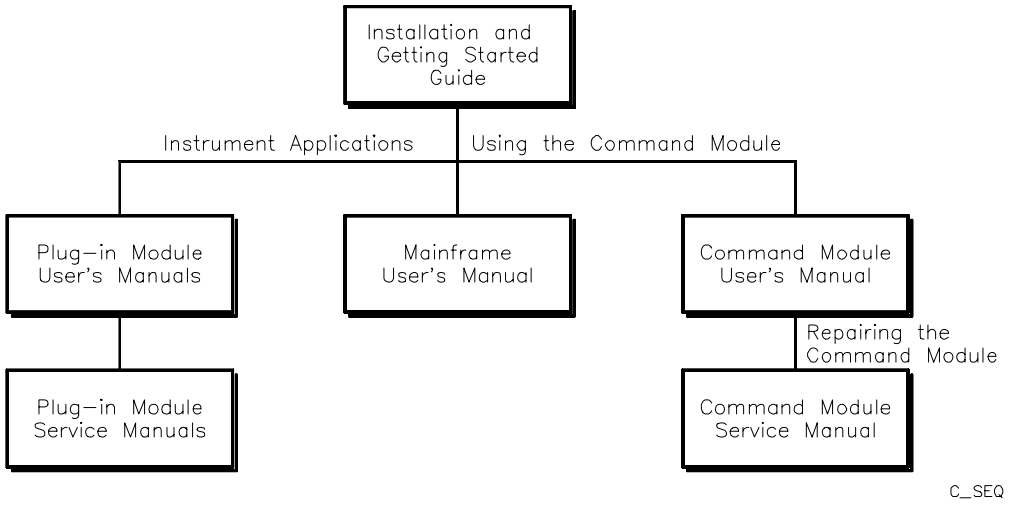
Jim White
Name

Quality Manager
Title

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

Agilent 75000 Series C Service Documentation

Suggested Sequence to Use 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.

What's in this Manual

Manual Overview

This manual shows how to service the Agilent E1468A and E1469A relay matrixes. Consult the *Agilent E1468A/E1469A User's Manual* for additional information on installing, configuring, and operating the modules. Consult the appropriate mainframe or command module user's manual for information on configuring and operating the mainframe.

Manual Content

Chap	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.

Contents

Agilent E1468A and E1469A Relay Matrixes Module Service Manual

Chapter 4 - Service

Chapter 1
General Information

Introduction

This manual contains information required to test, troubleshoot, and repair the Agilent E1468A and E1469A relay matrixes (see Figure 1-1). Note that both instruments use the E1460-66201 relay module.

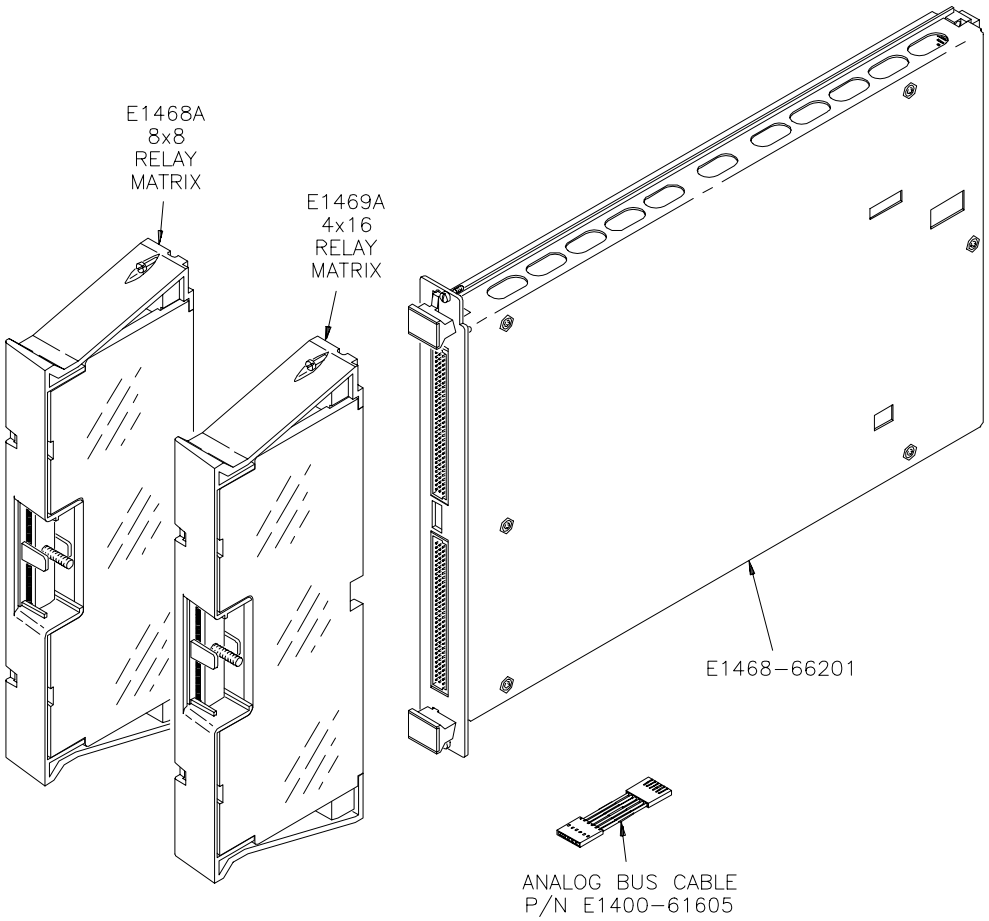


Figure 1-1. Agilent E1468A/69A Matrixes

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 can be found in Appendix A of the *Agilent E1468A/ E1469A 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.

Safety Considerations

This product is a Safety Class I product 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 ii) in this manual for a summary of safety information. Safety information for testing and service follows and is also found throughout this manual.

Warnings and Cautions

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

WARNING

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

CHECK MAINFRAME POWER SETTINGS. Before applying power, verify that the mainframe setting matches the line voltage and that the correct fuse is installed. An uninterruptible safety earth ground must be provided from the main power source to the supplied power cord set. Note: the Agilent E1401A mainframe automatically selects the correct line frequency.

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. 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 is 220Vdc/250Vrms. The maximum current that can be applied to any terminal is 1 A at <30Vdc/Vrms, or 0.3 A at <220Vdc/250Vrms. The maximum power that can be applied to any terminal is 40 VA.

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

Incoming Inspection

Use the following steps as guidelines to perform initial (incoming) inspection for the Agilent E1468A or E1469A.

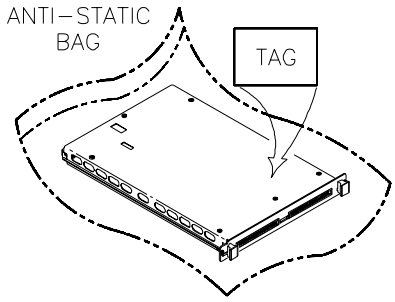
WARNING

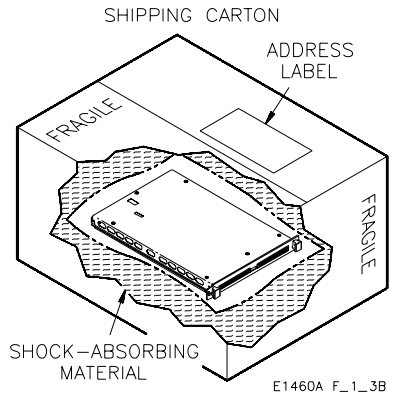
To avoid possible hazardous electrical shock, do not perform electrical tests if there are signs of shipping damage to the shipping container or to the instrument.

1. If the Agilent E1468A/E1469A is damaged, contact Agilent Technologies and contact the carrier.
2. Install the Agilent E1468A/E1469A in a VXI mainframe. Refer to the *Agilent E1468A/E1469A 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 1-2 to return one of the matrix modules to an 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.

** A list of Sales and Support offices can be found at the back of this manual.

Figure 1-2. Packaging/Shipping Guidelines

Environment

The recommended operating environment for the matrix is:

Environment	Temperature	Humidity
Operating	0^{o}C to $+55^{o}$C	<65% relative (0^{o}C to $+40^{o}$C)
Storage and Shipment	-40^{o}C to $+75^{o}$C	<65% relative (0^{o}C to $+40^{o}$C)

Matrix Description

The Agilent E1468A and E1469A matrix modules are "instruments" in the slots of a VXIbus mainframe. Each module is assigned an error queue, input and output buffers, and a status register. The Agilent E1468A and Agilent E1469A are 8x8 and 4x16 relay matrixes, respectively. Both devices use the same relay module (E1460-66201).

NOTE

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

Matrix Specifications

Specifications are listed in Appendix A of the *Agilent E1468A/E1469A User's Manual*. These specifications are the performance standards or limits against which the modules may be tested.

Matrix Serial Numbers

Devices covered by this manual are identified by a serial number prefix listed on the title page. Agilent uses a two-part serial number in the form XXXXAYYYYY, where XXXX is the serial prefix, A is the country of origin (A=USA), and YYYYY is the serial suffix. The serial number prefix identifies a series of identical instruments. The serial number suffix is assigned sequentially to each instrument. The serial number plate is located on the right-hand shield near the backplane connectors.

Matrix Options

There are no electrical or mechanical options available for the modules.

Schematics/ Component Locators

Component locators and schematics for the modules are included in this manual. Clear plastic sleeves are included for storage.

Recommended Test Equipment

Table 1-1 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 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 matrixes	E1400B/T	F,O,P,T
Command Module	Compatible with matrixes	E1405A/B 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, O = Operation Verification Tests, P = Performance Verification Tests, T = Troubleshooting			

Chapter 2
Verification Tests

Introduction

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

- 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.

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 25^{o}C and the relative humidity is no greater than 40%. For the Agilent E1468A/E1469A, it is assumed that all relay card jumpers have been removed as recommended in the *Agilent E1468A/E1469A User's Manual*.

Performance Test Record

The results of each Performance Verification test may be recorded in the Performance Test Record (Tables 2-1 and 2-2). Use the table that corresponds to the terminal card that you are using. 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
- Switch address is 70914
- Switch 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 the terminal block from either the Agilent E1468A or Agilent E1469A (the relay module is the same for both devices).

It is recommended that you order an extra terminal block to use as a test fixture, so that you do not have to re-wire the terminal block each time these tests are performed. The terminal block part numbers are E1468-80001 and E1469-80001. Figures 2-1 and 2-2 show how each test fixture should be wired.

Note

You can also use the terminal block (part number E1460-80001)from the Agilent E1460A Relay Multiplexer. Refer to the Agilent E1460A Service Manual for specific information on using that terminal block. You must use the Agilent E1460A terminal block if you want to test the control relays on the Agilent E1460-66201 Relay Module. These relays are not used in the Agilent E1468A or E1469A Relay Matrixes but can be tested.

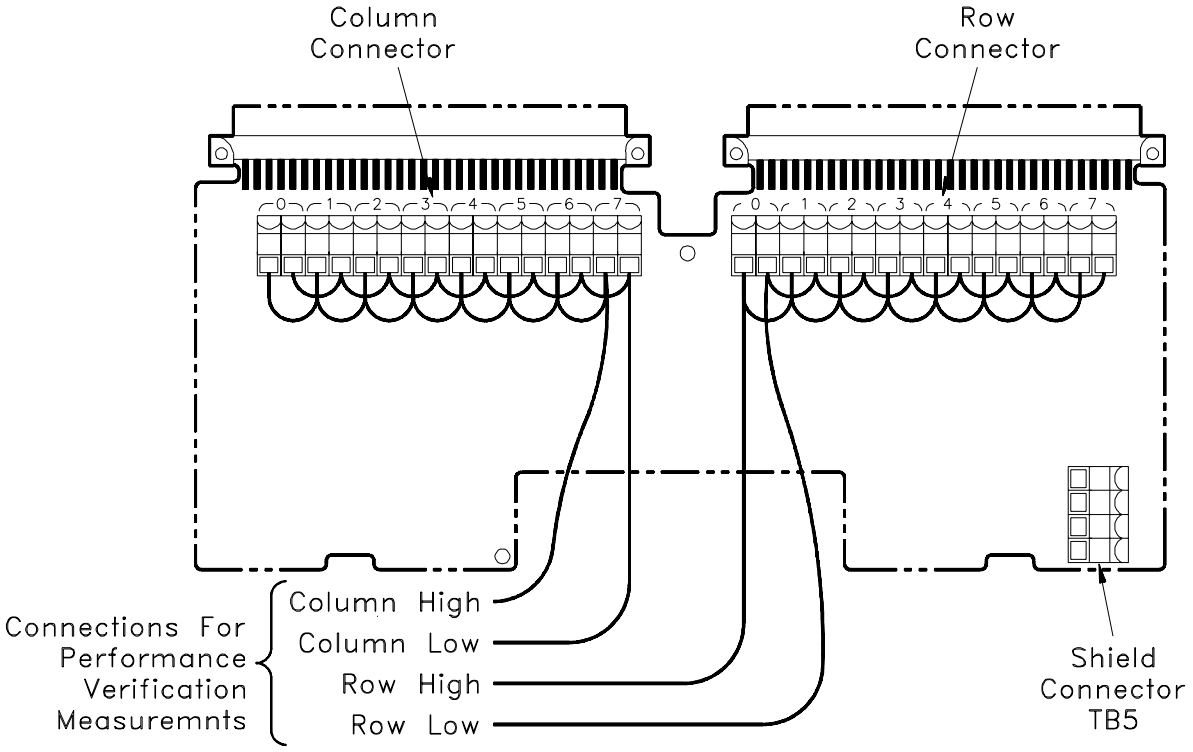


Figure 2-1. Agilent E1468A Test Fixture

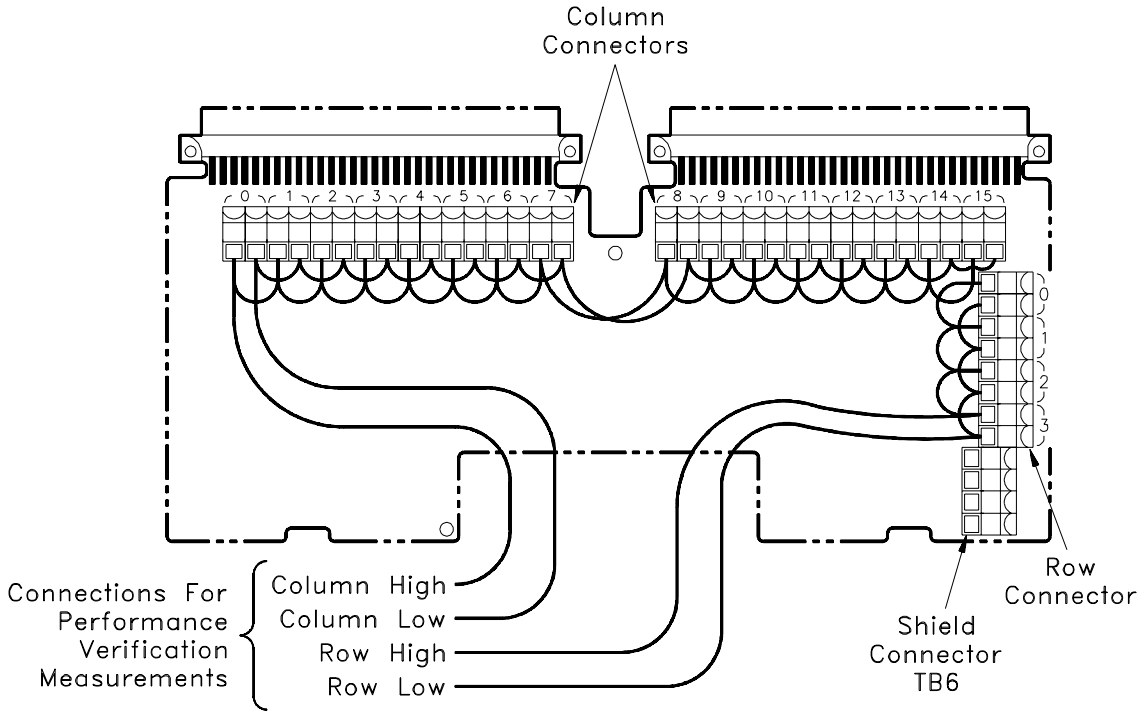


Figure 2-2. Agilent E1469A Test Fixture

Functional Verification

The Functional Verification Test for the matrix consists of sending the *TST? command 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.

Procedure

1. Verify that the matrix is installed in the mainframe and that the mainframe has passed its power-on test.
2. Send the *TST? command to the device (see example following).
3. 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 matrix 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 END
```

A typical response is:

HEWLETT-PACKARD,SWITCHBOX,0,A.04.00
4X16 2-WIRE MATRIX
HEWLETT-PACKARD,E1469A,0,A.04.00
+0

Self-test Error Codes

Table 2-1 shows the self-test error codes for the matrix modules. 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 device may need repair.

Table 2-1. Self-test Error Codes

Error*	Description
+0	Self-test passes
+ss01	Firmware error
+ss02	Bus error (communications problem with card)
+ss03	Bad ID information in ID register
+ss10	Interrupt expected but not received
+ss11	Busy bit was not held ≈9 to 17 msec,

*ss = card number (with leading zero deleted)

E1468A/E1469A Performance Verification

The procedures in this section are used to test the matrix's electrical performance using the specifications in Appendix A of the *Agilent E1468A/69A 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 matrix. A leading zero may be omitted.*

Test 2-1: Closed-channel Resistance Test

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

High Lines Test

1. Hardware Connections

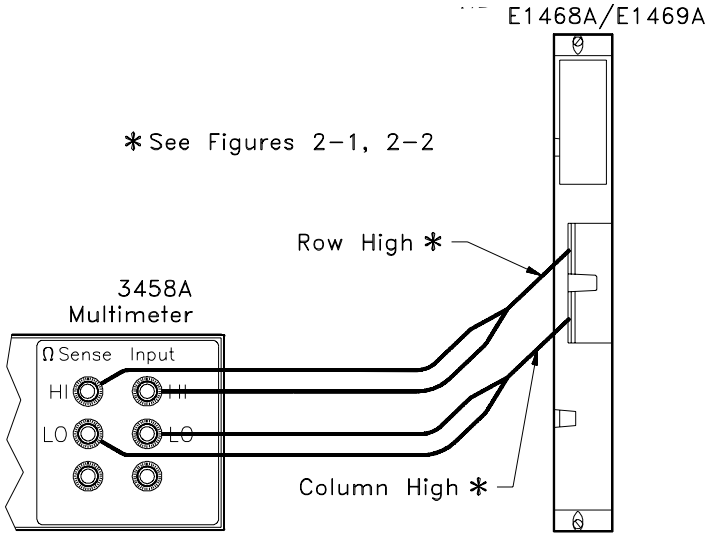


Figure 2-3. Closed-channel Resistance (High lines)

2. Equipment Setup

   - Set DMM to: 4-wire ohms, autorange
   - Send ***RST** to the matrix.

3. Closed-channel Reading (row 0, column 0)

   - Send **CLOS (@ss00)** (for the E1468A) or **CLOS (@ss0000)** (for the E1469A) to the matrix to close row 0, column 0.
   - Trigger the DMM and record the reading.

4. Open-channel Reading (row 0, column 0)

   - Send **OPEN (@ss00)** (for the E1468A) or **OPEN (@ss0000)** (for the E1469A) to the matrix to open row 0, column 0.
   - Trigger the DMM and verify that an open circuit is indicated (>500 MΩ).

5. Closed- and Open-channel Readings (remaining channels)

   - Repeat steps 3 and 4 for all 64 relays listed in the Performance Test Record for the Agilent E1468A (Table 2-2) or the Agilent E1469A (Table 2-3).

     For the E1468A, use **CLOS (@ssrc)** and **OPEN (@ssrc)**, where

     ss = card number (01-99, leading zero not necessary)
     r = row number (0-7)
     c = column number (0-7)

     For the E1469A, use **CLOS (@ssrrcc)** and **OPEN (@ssrrcc)**, where

     ss = card number (01-99, leading zero not necessary)
     rr = row number (00-03)
     cc = column number (00-15)

Low Lines Test

6. Hardware Connections

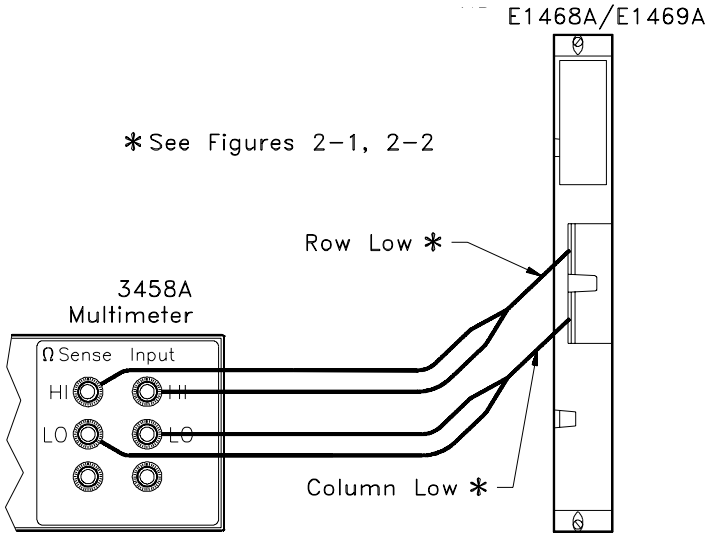


Figure 2-4. Closed-channel Resistance (Low lines)

7. Repeat steps 1 through 5.

Example: Closed-channel Resistance Test

This example performs the Closed-channel Resistance Test for the Agilent E1468A. To use this program with the Agilent E1469A, modify lines 150, 160, and 170 as follows:

```
150   FOR I=0 TO 3
160   FOR J=0 TO 15
170   Channel$=VAL$(Sw_card*10000+100*I+J)
```

If the switch card number is not 1, change the value in line 40 to the correct number. This example can be used to test the High or Low lines of the module.

```
10 !  RE-STORE "CCR_1468"
20    ASSIGN @Matrix TO 70914
30    ASSIGN @Dmm TO 722
40    Sw_card=1
50    !
60    OUTPUT @Dmm;"PRESET NORM;TRIG HOLD"      !Set DMM to 4-wire
70    OUTPUT @Dmm;"FUNC OHMF;RANGE AUTO"       !ohms, autorange
80    !
90    OUTPUT @Matrix;"*RST"                    !Reset matrix
100    WAIT 1
110    !
120    PRINT "CHANNEL","CLOSED","OPEN"
130    PRINT
140    !
150    FOR I=0 TO 7
160      FOR J=0 TO 7
170        Channel$=VAL$(Sw_card*100+10*I+J)
180        OUTPUT @Matrix;"CLOS (@"&Channel$&")"   !Close relay
190        OUTPUT @Dmm;"TRIG SGL"            !Trigger DMM
200        ENTER @Dmm;Rdg
210        PRINT Channel$,VAL$(DROUND(Rdg,4)),
220        !
230        OUTPUT @Matrix;"OPEN (@"&Channel$&")"   !Open relay
240        OUTPUT @Dmm;"TRIG SGL"            !Trigger DMM
250        ENTER @Dmm;Rdg
260        PRINT VAL$(DROUND(Rdg,4))
270      NEXT J
280    NEXT I
290    !
300    !
310    OUTPUT @Dmm;"RESET"
320    LOCAL @Dmm
330    OUTPUT @Matrix;"*RST"
340    END
```

Test 2-2: DC Isolation Test

This test verifies that sufficient DC isolation exists between various points on the matrix module. If the DMM indicates an overload, record the reading as ">R_{max}", where R_{max} is the highest resistance that the DMM can measure. If the DMM is an Agilent 3458A, for example, the reading should be written as ">1.2 GΩ".

Column High to Column Low

1. Hardware Connections (Column lines)

   - Connect the DMM as shown by the solid lines in Figure 2-5.

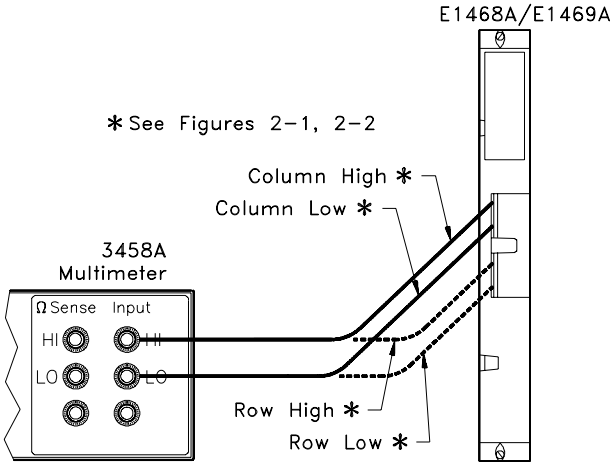


Figure 2-5. High to Low Isolation

2. Equipment Setup

   - Set DMM to: 2-wire ohms, 1 GΩ range.
   - Send ***RST** to the module to open all channel relay contacts.

3. DC Isolation Reading

   - Trigger the DMM and record the reading.

Row High to Row Low

4. Hardware Connections (Row lines)

   - Connect the DMM as shown by the dashed lines in Figure 2-5.

5. DC Isolation Reading

   - Trigger the DMM and record the reading.

Column High & Low to Chassis

6. Hardware Connections (Column lines)

   - Connect the DMM as shown by the solid lines in Figure 2-6.

NOTE

Use any convenient chassis connection. The illustration shows the DMM LO terminal connected to the outside of the Trig Out BNC on the E1406 Command Module.

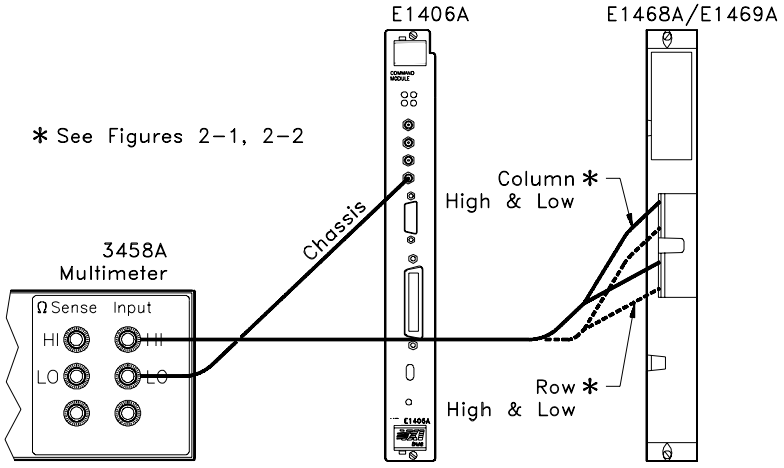


Figure 2-6. High & Low to Chassis Isolation

7. DC Isolation Reading

   - Trigger the DMM and record the reading.

Row High & Low to Chassis

8. Hardware Connections (Row lines)

   - Connect the DMM as shown by the dashed lines in Figure 2-6.

9. DC Isolation Reading

   - Trigger the DMM and record the reading.

Example: DC Isolation Test

This example performs the DC Isolation Test for the Agilent E1468A or E1469A. If the switch card number is not 1, change the value in line 40 to the correct number.

```
10 !   RE-STORE "DC_1468"
20     ASSIGN @Matrix TO 70914
30     ASSIGN @Dmm TO 722
40     Sw_card=1
50     !
60     OUTPUT @Dmm;"PRESET NORM;TRIG HOLD"       !Set DMM to 2-wire
70     OUTPUT @Dmm;"FUNC OHM;RANGE MAX"          !ohms, max range
80     !
90     OUTPUT @Matrix;"*RST"                     !Reset matrix
100    WAIT 1
110    !
120    ! / / / / / / / / / /  Column High to Column Low Isolation / / / / / / / / / /
130    PRINT "Connect DMM HI to Column High line."
140    PRINT "Connect DMM LO to Column Low line."
150    PRINT
160    PAUSE
170    DISP "Press 'Continue'"
180    OUTPUT @Dmm;"TRIG SGL"
190    ENTER @Dmm;Rdg
200    PRINT "DC Isolation -- Column High to Column Low = ";Rdg
210    PRINT
220    !
230    ! / / / / / / / / / /  Row High to Row Low Isolation / / / / / / / / / /
240    PRINT "Connect DMM HI to Row High line."
250    PRINT "Connect DMM LO to Row Low line."
260    PRINT
270    PAUSE
280    DISP "Press 'Continue'"
290    OUTPUT @Dmm;"TRIG SGL"
300    ENTER @Dmm;Rdg
310    PRINT "DC Isolation -- Row High to Row Low = ";Rdg
320    PRINT
330    !
```

Continued on Next Page

```
340   ! / / / / / / / / / /  Column High & Low to Chassis Isolation / / / / / / / / / /
350   PRINT "Connect DMM HI to Column High and Column Low line."
360   PRINT "Connect DMM LO to Chassis."
370   PRINT
380   PAUSE
390   DISP "Press 'Continue'"
400   OUTPUT @Dmm;"TRIG SGL"
410   ENTER @Dmm;Rdg
420   PRINT "DC Isolation -- Column Lines to Chassis = ";Rdg
430   PRINT
440   !
450   ! / / / / / / / / / /  Row High & Low to Chassis Isolation / / / / / / / / / /
460   PRINT "Connect DMM HI to Row High and Row Low line."
470   PRINT "Connect DMM LO to Chassis."
480   PRINT
490   PAUSE
500   DISP "Press 'Continue'"
510   OUTPUT @Dmm;"TRIG SGL"
520   ENTER @Dmm;Rdg
530   PRINT "DC Isolation -- Row Lines to Chassis = ";Rdg
540   PRINT
550   !
560   OUTPUT @Dmm;"RESET"
570   LOCAL @Dmm
580   OUTPUT @Matrix;"*RST"
590   END
```

Performance Test Record

Tables 2-2 and 2-3 are forms you can copy and use to record performance verification test results for the matrix. Use the table that corresponds to the terminal block you are using. 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 E1468A/69A 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

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

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)

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

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 2-2. Performance Test Record for the Agilent E1468A (Page 1 of 5)

Test Facility:

Name _____ Report No. _____

Address _____ Date _____

City/State _____ Customer _____

Phone _____ Tested by _____

Model _____ Ambient temperature _____ ^{o}C

Serial No. _____ Relative humidity _____%

Options _____ Line frequency _____ Hz (nominal)

Firmware Rev. _____

Special Notes:

_____

_____

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_____

Table 2-2. Performance Test Record for the Agilent E1468A (Page 2 of 5)

Model _____ Report No. _____ Date _____

Test Equipment Used: Description	Model No.	Trace No.	Cal Due Date
1.			
2.			
3.			
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Table 2-2. Performance Test Record for the Agilent E1468A (Page 3 of 5)

Model _____ Report No. _____ Date_____

Channel*	Minimum**	Low Lines Reading	High Lines Reading	Maximum	Meas Uncert	TAR
Test 2-1. Closed-channel Resistance Test (Values in ohms)						
ss00		_____	_____	3.5	1.03E-4	NA
ss01		_____	_____	3.5	1.03E-4	NA
ss02		_____	_____	3.5	1.03E-4	NA
ss03		_____	_____	3.5	1.03E-4	NA
ss04		_____	_____	3.5	1.03E-4	NA
ss05		_____	_____	3.5	1.03E-4	NA
ss06		_____	_____	3.5	1.03E-4	NA
ss07		_____	_____	3.5	1.03E-4	NA
ss10		_____	_____	3.5	1.03E-4	NA
ss11		_____	_____	3.5	1.03E-4	NA
ss12		_____	_____	3.5	1.03E-4	NA
ss13		_____	_____	3.5	1.03E-4	NA
ss14		_____	_____	3.5	1.03E-4	NA
ss15		_____	_____	3.5	1.03E-4	NA
ss16		_____	_____	3.5	1.03E-4	NA
ss17		_____	_____	3.5	1.03E-4	NA
ss20		_____	_____	3.5	1.03E-4	NA
ss21		_____	_____	3.5	1.03E-4	NA
ss22		_____	_____	3.5	1.03E-4	NA
ss23		_____	_____	3.5	1.03E-4	NA
ss24		_____	_____	3.5	1.03E-4	NA
ss25		_____	_____	3.5	1.03E-4	NA
ss26		_____	_____	3.5	1.03E-4	NA
ss27		_____	_____	3.5	1.03E-4	NA
ss30		_____	_____	3.5	1.03E-4	NA
ss31		_____	_____	3.5	1.03E-4	NA
ss32		_____	_____	3.5	1.03E-4	NA
ss33		_____	_____	3.5	1.03E-4	NA
ss34		_____	_____	3.5	1.03E-4	NA
ss35		_____	_____	3.5	1.03E-4	NA
ss36		_____	_____	3.5	1.03E-4	NA
ss37		_____	_____	3.5	1.03E-4	NA

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

Table 2-2. Performance Test Record for the Agilent E1468A (Page 4 of 5)

Model _____ Report No. _____ Date_____

Channel*	Minimum**	Low Lines Reading	High Lines Reading	Maximum	Meas Uncert	TAR
Test 2-1. Closed-channel Resistance Test (Values in ohms)						
ss40		_____	_____	3.5	1.03E-4	NA
ss41		_____	_____	3.5	1.03E-4	NA
ss42		_____	_____	3.5	1.03E-4	NA
ss43		_____	_____	3.5	1.03E-4	NA
ss44		_____	_____	3.5	1.03E-4	NA
ss45		_____	_____	3.5	1.03E-4	NA
ss46		_____	_____	3.5	1.03E-4	NA
ss47		_____	_____	3.5	1.03E-4	NA
ss50		_____	_____	3.5	1.03E-4	NA
ss51		_____	_____	3.5	1.03E-4	NA
ss52		_____	_____	3.5	1.03E-4	NA
ss53		_____	_____	3.5	1.03E-4	NA
ss54		_____	_____	3.5	1.03E-4	NA
ss55		_____	_____	3.5	1.03E-4	NA
ss56		_____	_____	3.5	1.03E-4	NA
ss57		_____	_____	3.5	1.03E-4	NA
ss60		_____	_____	3.5	1.03E-4	NA
ss61		_____	_____	3.5	1.03E-4	NA
ss62		_____	_____	3.5	1.03E-4	NA
ss63		_____	_____	3.5	1.03E-4	NA
ss64		_____	_____	3.5	1.03E-4	NA
ss65		_____	_____	3.5	1.03E-4	NA
ss66		_____	_____	3.5	1.03E-4	NA
ss67		_____	_____	3.5	1.03E-4	NA
ss70		_____	_____	3.5	1.03E-4	NA
ss71		_____	_____	3.5	1.03E-4	NA
ss72		_____	_____	3.5	1.03E-4	NA
ss73		_____	_____	3.5	1.03E-4	NA
ss74		_____	_____	3.5	1.03E-4	NA
ss75		_____	_____	3.5	1.03E-4	NA
ss76		_____	_____	3.5	1.03E-4	NA
ss77		_____	_____	3.5	1.03E-4	NA

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

Table 2-2. Performance Test Record for the Agilent E1468A (Page 5 of 5)

Model _____ Report No. _____ Date_____

Test Description	Minimum	Reading	Maximum*	Meas Uncert	TAR
Test 2-2. DC Isolation Test (Values in ohms)					
Column High to Column Low	5E8	_____		6.0E6	NA
Row High to Row Low	5E8	_____		6.0E6	NA
Column High & Low to	5E8	_____		6.0E6	NA
Chassis	5E8	_____		6.0E6	NA
Row High & Low to Chassis					

* Single-sided specification -- Maximum does not apply.

Table 2-3. Performance Test Record for the Agilent E1469A (Page 1 of 5)

Test Facility:

Name _____ Report No. _____

Address _____ Date _____

City/State _____ Customer _____

Phone _____ Tested by _____

Model _____ Ambient temperature _____ ^{o}C

Serial No. _____ Relative humidity _____%

Options _____ Line frequency _____ Hz (nominal)

Firmware Rev. _____

Special Notes:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Table 2-3. Performance Test Record for the Agilent E1469A (Page 2 of 5)

Model _____ Report No. _____ Date _____

Test Equipment Used: Description	Model No.	Trace No.	Cal Due Date
1.			
2.			
3.			
4.			
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7.			
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Table 2-3. Performance Test Record for the Agilent E1469A (Page 3 of 5)

Model _____ Report No. _____ Date_____

Channel*	Minimum**	Low Lines Reading	High Lines Reading	Maximum	Meas Uncert	TAR
Test 2-1. Closed-channel Resistance Test (Values in ohms)						
ss0000		_____	_____	3.5	1.03E-4	NA
ss0001		_____	_____	3.5	1.03E-4	NA
ss0002		_____	_____	3.5	1.03E-4	NA
ss0003		_____	_____	3.5	1.03E-4	NA
ss0004		_____	_____	3.5	1.03E-4	NA
ss0005		_____	_____	3.5	1.03E-4	NA
ss0006		_____	_____	3.5	1.03E-4	NA
ss0007		_____	_____	3.5	1.03E-4	NA
ss0008		_____	_____	3.5	1.03E-4	NA
ss0009		_____	_____	3.5	1.03E-4	NA
ss0010		_____	_____	3.5	1.03E-4	NA
ss0011		_____	_____	3.5	1.03E-4	NA
ss0012		_____	_____	3.5	1.03E-4	NA
ss0013		_____	_____	3.5	1.03E-4	NA
ss0014		_____	_____	3.5	1.03E-4	NA
ss0015		_____	_____	3.5	1.03E-4	NA
ss0100		_____	_____	3.5	1.03E-4	NA
ss0101		_____	_____	3.5	1.03E-4	NA
ss0102		_____	_____	3.5	1.03E-4	NA
ss0103		_____	_____	3.5	1.03E-4	NA
ss0104		_____	_____	3.5	1.03E-4	NA
ss0105		_____	_____	3.5	1.03E-4	NA
ss0106		_____	_____	3.5	1.03E-4	NA
ss0107		_____	_____	3.5	1.03E-4	NA
ss0108		_____	_____	3.5	1.03E-4	NA
ss0109		_____	_____	3.5	1.03E-4	NA
ss0110		_____	_____	3.5	1.03E-4	NA
ss0111		_____	_____	3.5	1.03E-4	NA
ss0112		_____	_____	3.5	1.03E-4	NA
ss0113		_____	_____	3.5	1.03E-4	NA
ss0114		_____	_____	3.5	1.03E-4	NA
ss0115		_____	_____	3.5	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 Agilent E1469A (Page 4 of 5)

Model _____ Report No. _____ Date_____

Channel*	Minimum**	Low Lines Reading	High Lines Reading	Maximum	Meas Uncert	TAR
Test 2-1. Closed-channel Resistance Test (Values in ohms)						
ss0200		_____	_____	3.5	1.03E-4	NA
ss0201		_____	_____	3.5	1.03E-4	NA
ss0202		_____	_____	3.5	1.03E-4	NA
ss0203		_____	_____	3.5	1.03E-4	NA
ss0204		_____	_____	3.5	1.03E-4	NA
ss0205		_____	_____	3.5	1.03E-4	NA
ss0206		_____	_____	3.5	1.03E-4	NA
ss0207		_____	_____	3.5	1.03E-4	NA
ss0208		_____	_____	3.5	1.03E-4	NA
ss0209		_____	_____	3.5	1.03E-4	NA
ss0210		_____	_____	3.5	1.03E-4	NA
ss0211		_____	_____	3.5	1.03E-4	NA
ss0212		_____	_____	3.5	1.03E-4	NA
ss0213		_____	_____	3.5	1.03E-4	NA
ss0214		_____	_____	3.5	1.03E-4	NA
ss0215		_____	_____	3.5	1.03E-4	NA
ss0300		_____	_____	3.5	1.03E-4	NA
ss0301		_____	_____	3.5	1.03E-4	NA
ss0302		_____	_____	3.5	1.03E-4	NA
ss0303		_____	_____	3.5	1.03E-4	NA
ss0304		_____	_____	3.5	1.03E-4	NA
ss0305		_____	_____	3.5	1.03E-4	NA
ss0306		_____	_____	3.5	1.03E-4	NA
ss0307		_____	_____	3.5	1.03E-4	NA
ss0308		_____	_____	3.5	1.03E-4	NA
ss0309		_____	_____	3.5	1.03E-4	NA
ss0310		_____	_____	3.5	1.03E-4	NA
ss0311		_____	_____	3.5	1.03E-4	NA
ss0312		_____	_____	3.5	1.03E-4	NA
ss0313		_____	_____	3.5	1.03E-4	NA
ss0314		_____	_____	3.5	1.03E-4	NA
ss0315		_____	_____	3.5	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 Agilent E1469A (Page 5 of 5)

Model _____ Report No. _____ Date_____

Test Description	Minimum	Reading	Maximum*	Meas Uncert	TAR
Test 2-2. DC Isolation Test (Values in ohms)					
Column High to Column Low	5E8	_____		6.0E6	NA
Row High to Row Low	5E8	_____		6.0E6	NA
Column High & Low to	5E8	_____		6.0E6	NA
Chassis	5E8	_____		6.0E6	NA
Row High & Low to Chassis					

* Single-sided specification -- Maximum does not apply.

Chapter 3
Replaceable Parts

Introduction

This chapter contains information for ordering replaceable parts for the Agilent E1468A and E1469A matrix modules.

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

See the table below for the contents of each table in this chapter. Any applicable illustrations are listed in the right-hand column.

Table	Description	Illustrations
3-1	E1468A replaceable parts	Figure 3-1 (terminal module pc board) Figure 3-3 (terminal module case assembly) Figure 3-4 (relay module mechanical parts) Component Locator (relay module elect. parts)*
3-2	E1469A replaceable parts	Figure 3-2 (terminal module pc board) Figure 3-3 (terminal module case assembly) Figure 3-4 (relay module mechanical parts) Component Locator (relay module elect. parts)*
3-3	E1400-84401 terminal module case assembly replaceable parts	Figure 3-3
3-4	E1460-66201 relay module replaceable parts	Figure 3-4 (relay module mechanical parts) Component Locator (relay module elect. parts)*
3-5	Code List of Manufacturers	N.A.
3-6	Reference Designators	N.A.

* Component locator for the E1460-66201 relay module is included with schematics packaged with this manual.

Table 3-1. Agilent E1468A Replaceable Parts

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr. Code	Mfr. Part Number
A1	**E1400-84401**	**1**	**CASE, TERMINAL BLOCK ASSY (SEE TABLE 3-3)**	**28480**	**E1400-84401**
A2	**E1460-66201**	**1**	**MODULE-64 CHANNEL MUX (SEE TABLE 3-4)**	**28480**	**E1460-66201**
A3	**E1468-66510**	**1**	**PCA-8X8 TERMINAL CARD**	**28480**	**E1468-66510**
A3J1-J4	1252-3963	4	CONNECTOR-POST TYPE .100-PIN-SPCG 24-CONTACT	55322	TSW-108-08-S-T-LA
A3JM1-JM10	8150-3405	10	WIRE JUMPER 22AWG WHITE TEFLON 1X22 105C	28480	8150-3405
A3P1-P2	1252-1593	2	CONNECTOR-POST TYPE 2.54-PIN-SPCG 96-CONTACT	06776	DIN-96RSC-SR1-TR
A3TB1-TB4	0360-2502	4	TERMINAL BLOCK 8 POS. POLYESTER	30035	BB-125-08
A3TB5	0360-2390	1	TERMINAL BLOCK 4 POS. SCREW TYPE	28480	0360-2390
CBL1	E1400-61605	1	ANALOG BUS CABLE FOR E1400B/T	28480	E1400-61605

*The part number for a complete terminal module (assemblies A1 and A2) is E1468-80001.

Table 3-2. Agilent E1469A Replaceable Parts

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr. Code	Mfr. Part Number
A1	**E1400-84401**	**1**	**CASE, TERMINAL BLOCK ASSY (SEE TABLE 3-3)**	**28480**	**E1400-84401**
A2	**E1460-66201**	**1**	**MODULE-64 CHANNEL MUX (SEE TABLE 3-4)**	**28480**	**E1460-66201**
A3	**E1469-66510**	**1**	**PCA-4X16 TERMINAL CARD**	**28480**	**E1469-66510**
A3J1-J5	1252-3963	5	CONNECTOR-POST TYPE .100-PIN-SPCG 24-CONTACT	55322	TSW-108-08-S-T-LA
A3JM1-JM12	8150-3405	12	WIRE JUMPER 22AWG WHITE TEFLON 1X22 105C	28480	8150-3405
A3P1-P2	1252-1593	2	CONNECTOR-POST TYPE 2.54-PIN-SPCG 96-CONTACT	06776	DIN-96RSC-SR1-TR
A3TB1-TB5	0360-2502	5	TERMINAL BLOCK 8 POS. POLYESTER	30035	BB-125-08
A3TB6	0360-2390	1	TERMINAL BLOCK 4 POS. SCREW TYPE	28480	0360-2390
CBL1	E1400-61605	1	ANALOG BUS CABLE FOR E1400B/T	28480	E1400-61605

*The part number for a complete terminal module (assemblies A1 and A2) is E1469-80001.

Table 3-3. E1400-84401 Terminal Module Case Assembly Replaceable Parts

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr. Code	Mfr. Part Number
A1	**E1400-84401**	**1**	**CASE, TERMINAL BLOCK ASSY**	**28480**	**E1400-84401**
	03852-01201	1	CLAMP	28480	03852-01201
	03852-86701	1	PAD-CLAMP	28480	03852-86701
	0515-2109	1	SCREW-MACHINE 10-24 .625-IN-LG PAN-HD-SLT	28480	0515-2109
	1390-0846	2	FASTENER-CAPTIVE SCREW M2.5 X 0.45	28480	1390-0846
	E1300-01202	1	CLAMP STRAIN RELIEF	28480	E1300-01202
	E1400-44104	1	TERMINAL HOUSING - BOTTOM	28480	E1400-44104
	E1400-44105	1	TERMINAL HOUSING - TOP	28480	E1400-44105

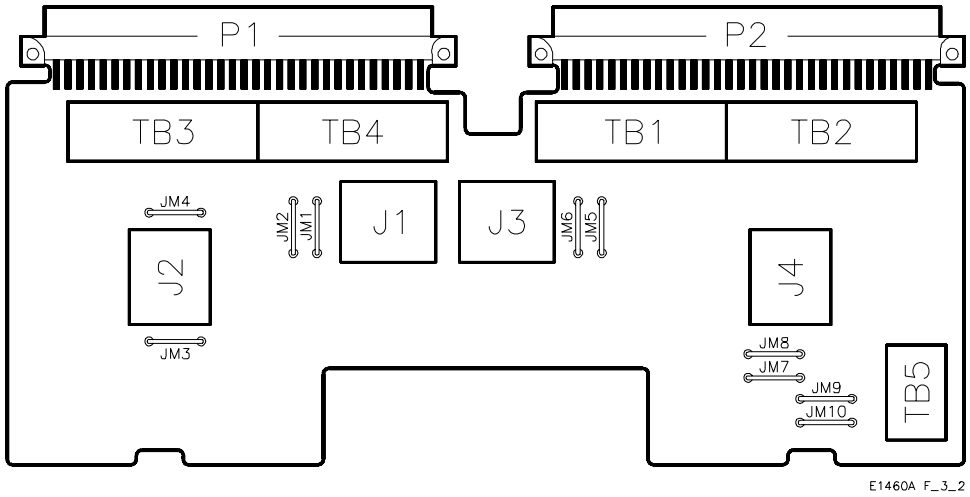

Figure 3-1. E1468A Terminal Module (E1468-66510)

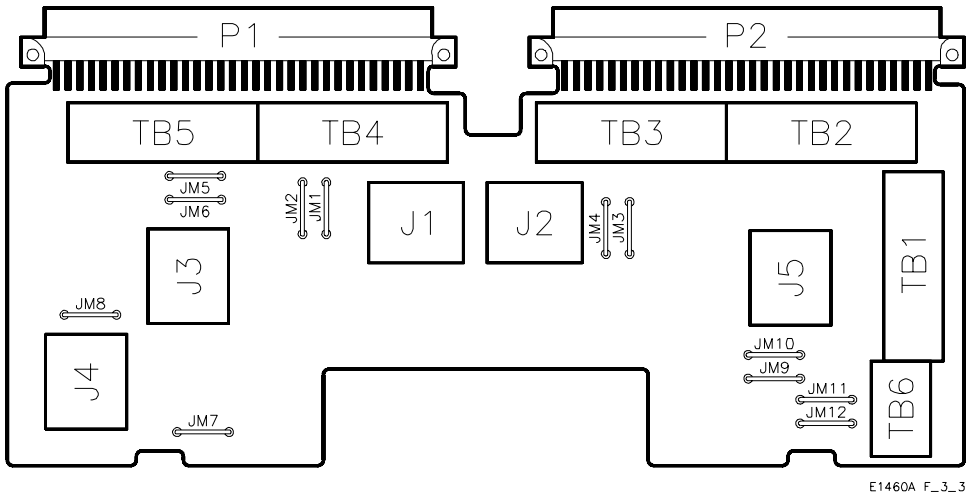

Figure 3-2. E1469A Terminal Module (E1469-66510)

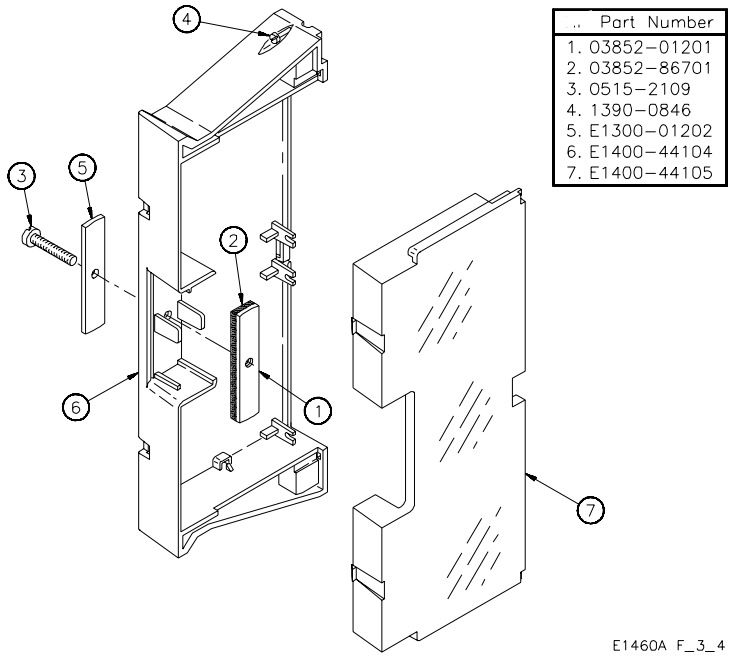

Figure 3-3. E1400-84401 Terminal Module Case Assembly

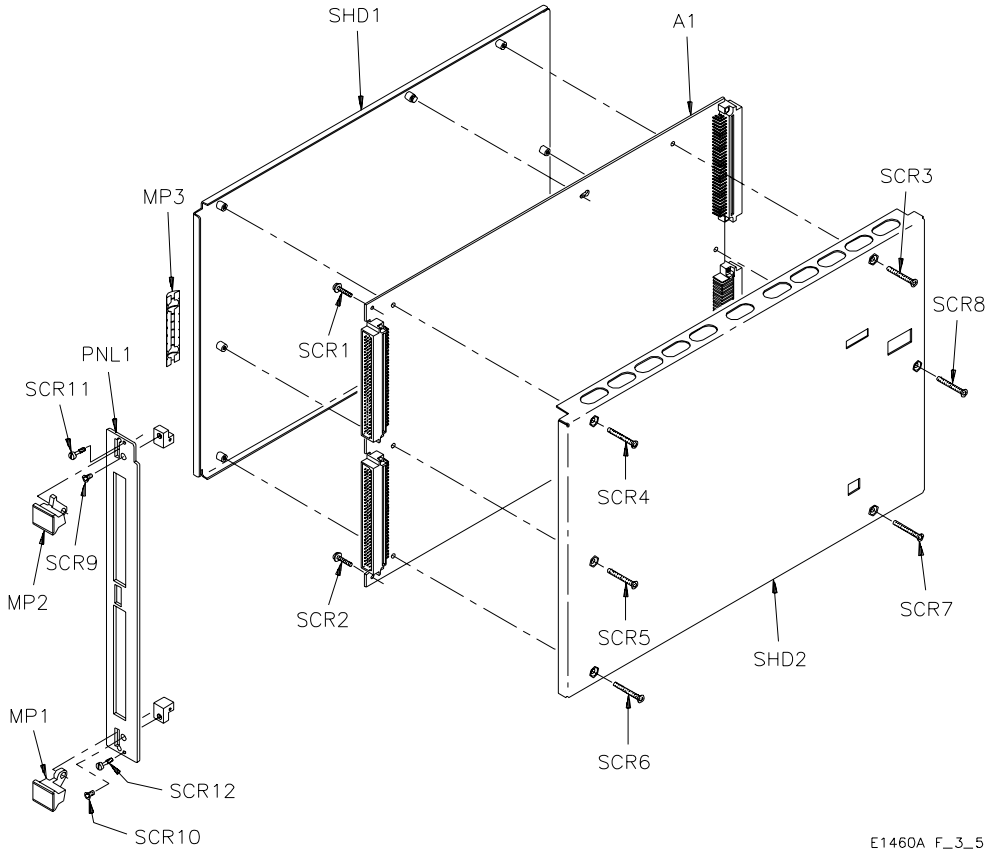

Figure 3-4. E1460-66201 Relay Module Mechanical Parts

Table 3-4. E1460-66201 Relay Module Replaceable Parts

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr. Code	Mfr. Part Number
A1	**E1460-66502**	**1**	**MULTIPLEXER PRINTED CIRCUIT ASSEMBLY**	**28480**	**E1460-66501**
A1C1	0160-4801	1	Capacitor-fxd 100pF +-5% 100 V CER C0G	04222	SA102A101JAAH
A1C2-C12	0160-4835	16	Capacitor-fxd 0.1uF +-10% 50 V CER X7R	04222	SA105C104KAAH
A1C15-C16	0180-1746	2	Capacitor-fxd 15uF +-10% 20 V TA	56289	150D156X9020B2-DYS
A1C17	0160-7318	1	Capacitor-fxd 0.22uF +-2% 100 V POLYC-MET	28480	0160-7318
A1C18	0160-4832	5	Capacitor-fxd 0.01uF +-10% 100 V CER X7R	04222	SA101C103KAAH
A1C19	0180-0291	1	Capacitor-fxd 1uF +-10% 35 V TA	56289	150D105X9035A2-DYS
A1C20	0160-4832		Capacitor-fxd 0.01uF +-10% 100 V CER X7R	04222	SA101C103KAAH
A1C21-C25	0160-4835		Capacitor-fxd 0.1uF +-10% 50 V CER X7R	04222	SA105C104KAAH
A1C26-C28	0160-4832		Capacitor-fxd 0.01uF +-10% 100 V CER X7R	04222	SA101C103KAAH
A1C29-C30	0180-0100	2	Capacitor-fxd 4.7uF +-10% 35 V TA	56289	150D475X9035B2-DYS
A1CR1	1901-1098	1	Diode-switching 50V 200MA 4NS	27014	1N4150
A1CR2	1901-0743	1	Diode-power rectifier 400V 1A DO-41	71744	1N4004
A1CR3-CR159	1902-0594	157	Diode-zener 18V 5% PD=1W IR=5UA	28480	1902-0594
A1CR160-CR169	1901-1164	10	Diode-switching 80V 200MA 2NS DO-35	28480	1901-1164
A1F1-F2	2110-0712	2	Fuse-subminiature 4A 125V NTD AX	75915	R251004T1
A1J1-J2	1252-1596	3	Connector-post type 2.54-pin-spcg 96-contact	06776	DIN-96CPC-SRI-TR
A1J3	1252-0776	1	Connector-post type .100-pin-spcg 12-contact	00779	102979-6
A1J4-J5	1251-4927	2	Connector-post type .100-pin-spcg 16-contact	18873	67997-616
A1JM1-JM5	7175-0057	13	Resistor 0 MFS	28480	7175-0057
A1JM10-JM17	7175-0057		Resistor 0 MFS	28480	7175-0057
A1K1-K7	0490-1912	71	Relay 2C 12VDC-coil 2A 250VDC	28480	0490-1651
A1K10-K73	0490-1912		Relay 2C 12VDC-Coil 2A 250VDC	28480	0490-1651
A1L1-L2	9140-1354	2	Inductor-fixed 47uH +-15% .453D-IN X .9LG-IN	91637	IHD-3-01 47 uH 15%
A1P1	1252-1596		Connector-post type 2.54-pin-spcg 96-contact	06776	DIN-96CPC-SRI-TR
A1P2	1252-4743	1	Connector-post type 2.54-pin-spcg 64-contact	00779	650945-5
A1Q1-Q3	1854-1028	3	Transistor NPN SI PD=350MW FT=300MHZ	04713	2N3904
A1Q4-Q12	1855-0567	9	Transistor MOSFET P-CHAN E-MODE SI	9M011	IRFD9123
A1R1	0757-0417	1	Resistor 562 +-1% .125W TF TC=0+-100	24546	CT4-1/8-T0-562R-F
A1R2	0757-0421	1	Resistor 825 +-1% .125W TF TC=0+-100	24546	CT4-1/8-T0-825R-F
A1R3	0698-3228	1	Resistor 49.9K +-1% .125W TF TC=0+-100	28480	0698-3228
A1R4	0757-0465	1	Resistor 100K +-1% .125W TF TC=0+-100	24546	CT4-1/8-T0-1003-F
A1R5	0698-0085	1	Resistor 2.61K +-1% .125W TF TC=0+-100	24546	CT4-1/8-T0-2611-F
A1R6	0698-3442	1	Resistor 237 +-1% .125W TF TC=0+-100	24546	CT4-1/8-T0-237R-F
A1R7-R8	0757-0442	6	Resistor 10K +-1% .125W TF TC=0+-100	24546	CT4-1/8-T0-1002-F
A1R9	0757-0452	1	Resistor 27.4K +-1% .125W TF TC=0+-100	24546	CT4-1/8-T0-2742-F
A1R10	0698-4444	1	Resistor 4.87K +-1% .125W TF TC=0+-100	24546	CT4-1/8-T0-4871-F
A1R11	0757-0453	1	Resistor 30.1K +-1% .125W TF TC=0+-100	24546	CT4-1/8-T0-3012-F
A1R12-15	0757-0442		Resistor 10K +-1% .125W TF TC=0+-100	24546	CT4-1/8-T0-1002-F
A1R16-R19	0757-0472	4	Resistor 200K +-1% .125W TF TC=0+-100	24546	CT4-1/8-T0-2003-F

(*Continued on next page*)

Table 3-4. E1460-66201 Replaceable Parts (Cont.)

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr. Code	Mfr. Part Number
A1RP1-RP3	1810-0279	3	Network-res 10-SIP 4.7K OHM X 9	56289	256CK472X2PD
A1RP4-RP6	1810-0265	3	Network-res 16-DIP 680.0 OHM X 8	32997	4116R-001-681
A1RP7-RP10	1810-0280	4	Network-res 10-SIP 10.0K OHM X 9	01121	210A103
A1SP1	3101-3066	1	Switch-DIP Rocker 8-1A 0.15A 30VDC	81073	76YY22968S
A1SP2	3101-2063	1	Switch-DIP Rocker 4-1A 0.15A 30VDC	81073	76YY22968S
A1U1	1820-6731	1	IC-ASIC GATE-ARRAY CMOS Plastic DIP	27014	SCX6B04ACE/N9
A1U2	1820-3184	1	IC Gate CMOS/HC and TPL 3-INP	27014	MM74HC11N
A1U3	1820-4147	1	IC Latch CMOS/HCT Transparent OCTL	34371	CD74HCT573E
A1U4	1820-4057	1	IC Buffer TTL/F NAND QUAD 2-INP	18324	74F38N
A1U5-U8	1820-3079	4	IC Decoder CMOS/HC BIN 3-TO-8-LINE	04713	MC74HC138N
A1U9-U10	1820-3081	2	IC FF CMOS/HC D-TYPE POS-EDGE-TRIG	04713	MC74HC74N
A1U11	1820-3146	4	IC FF CMOS/HC D-TYPE POS-EDGE-TRIG COM	04713	MC74HC175N
A1U12-U14	1820-3975	3	IC Driver CMOS/HC Line OCTL	01295	SN74HC541N
A1U15	1820-4590	1	IC Multivibrator CMOS/HC Monostable retrig dual	27014	MM74HC423AN
A1U16-U17	1820-3714	2	IC Transceiver TTL/ALS BUS OCTL	01295	SN74ALS245A-1N
A1U18-U19	1820-3631	2	IC Comparator CMOS/HCT Magnitude 8-Bit	27014	MM74HCT688N
A1U20	1820-4242	1	IC Schmitt-TRIG CMOS/HCT INV HEX	18324	74HCT14N
A1U21-U22	1820-4643	2	IC Gate CMOS/HCT NOR QUAD 2-INP	18324	74HCT02N
A1U23	1820-4586	1	IC Driver/receiver CMOS/HCT Bus OCTL	01295	SN74HCT541N
A1U24	1826-0393	1	IC V Regulator-Adj-Pos 1.2/37V TO-220 Pkg	27014	LM317T
A1U25	1820-3146		IC FF CMOS/HC D-TYPE POS-EDGE-TRIG COM	04713	MC74HC175N
A1U26	1858-0069	1	Transistor array 18-Pin plastic DIP	56289	ULN-2803A
A1U27-U28	1820-3146		IC FF CMOS/HC D-TYPE POS-EDGE-TRIG COM	04713	MC74HC175N
A1U29-U32	1820-4599	4	IC-Interface driver misc/Unknown NAND	56289	UDN-2543B
A1XJM3	1258-0247	1	Jumper 4-pos	22526	69146-204
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	E1460-00201	1	Front panel	28480	E1460-00201
SCR1-SCR2	0515-0368	2	Screw-machine Assy M2.5 X 0.45 12MM-LG Pan-hd	28480	0515-0368
SCR3-SCR8	0515-1135	6	Screw-machine M3 X 0.5 25MM-LG Flat-hd	28480	0515-1135
SCR9-SCR10	0515-1375	2	Screw-machine M2.5 X 0.45 6MM-LG Flat-hd	83486	343-300-02506
SCR11-SCR12	0515-1968	2	Screw PHM 2.5 X 11	28480	0515-1968
SHD1	E1460-00602	1	Shield; bottom shield for multiplexer	28480	E1460-00602
	0590-1741	6	Threaded insert-STDF M3 X 0.5 5.5-MM-LG	46384	YC3-5321
	0590-1901	2	Threaded insert-STDF-KEYHL 5.5-MM-LG	28480	0590-1901
SHD2	E1468-00601	1	Shield; top shield for multiplexer	28480	E1468-00601
	0590-1899	6	Threaded insert-SPCE-TH, NO THD 21-MM-LG	28480	0590-1899

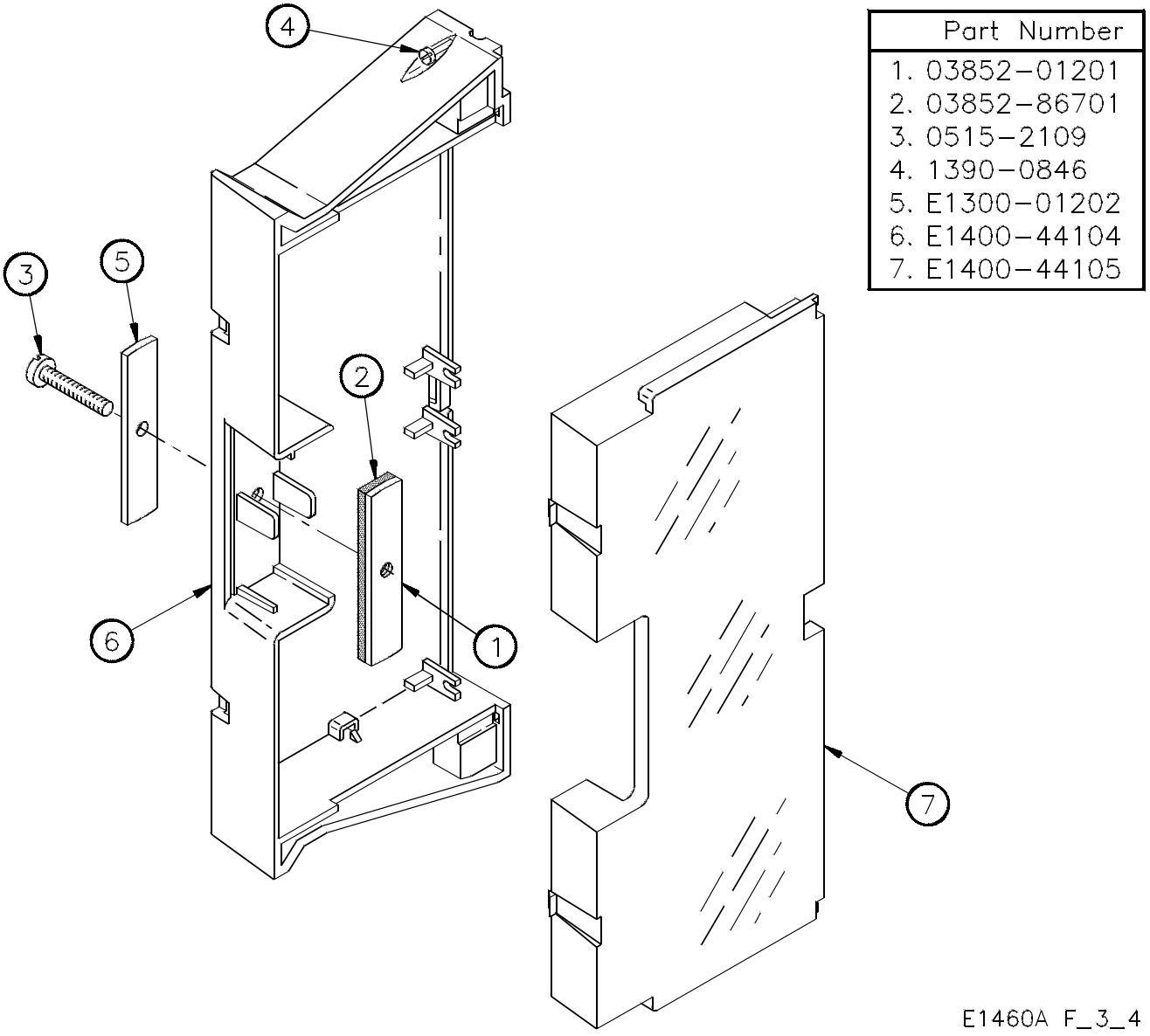

Figure 3-5. Relay Module Component Locator

Table 3-5. Code List of Manufacturers

Mfr. Code	Manufacturer's Name	Manufacturer's Address	Zip Code
00779	AMP INC	HARRISBURG, PA	17111
01121	ALLEN-BRADLEY CO INC	EL PASO, TX	79935
01295	TEXAS INSTRUMENTS INC	DALLAS, TX	75265
04222	AVX CORP	GREAT NECK, NY	11021
04713	MOTOROLA INC	ROSELLE, IL	60195
06776	ROBINSON NUGENT INC	NEW ALBANY, IN	47150
18324	SIGNETICS CORP	SUNNYVALE, CA	94086
18873	DUPONT E I DE NEMOURS & CO	WILMINGTON, DE	19801
24546	CORNING GLASS WORKS	CORNING, NY	14830
27014	NATIONAL SEMICONDUCTOR CORP	SANTA CLARA, CA	95052
28480	AGILENT TECHNOLOGIES - CORPORATE	PALO ALTO, CA	94304
30035	JOLO INDUSTRIES	SANTA ANA, CA	92643
30817	INSTRUMENT SPECIALTIES CO INC	DEL WATER GAP, PA	18327
32997	BOURNS NETWORKS INC	RIVERSIDE, CA	92507
34371	HARRIS CORP	MELBOURNE, FL	32901
46384	PENN ENGINEERING & MFG CORP	DOYLESTOWN, PA	18901
55322	SAMTEC	NEW ALBANY, IN	47150
56289	SPRAGUE ELECTRIC CO	LEXINGTON, MA	02173
71744	GENERAL INSTRUMENT CORP	CLIFTON, NJ	07012
71983	DOW CHEMICAL CO	MIDLAND, MI	48674
75915	LITTELFUSE INC	DES PLAINES, IL	60016
81073	GRAYHILL INC	LA GRANGE, IL	60525
83486	ELCO INDUSTRIES INC	ROCKFORD, IL	61125
91637	DALE ELECTRONICS INC	COLUMBUS, NE	68601
9M011	INTL RECTIFIER CORP	LOS ANGELES, CA	90069

Table 3-6. Agilent E1468A/E1469A Reference Designators

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

Chapter 4
Service

Introduction

This chapter contains service information for the Agilent E1468A/69A matrix modules, 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 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 E1468A/69A replaceable parts. A component locator and schematics are included with this manual. 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 E1468A/69A matrix problem, you should first identify the problem, and then isolate the cause using the component locator and schematics included with 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 locator and schematics.

Table 4-1. Agilent E1468A/69A 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 Appendix C of the *Agilent E1468A/E1469A User's Manual* for matrix errors and causes. • See Appendix B of the *Agilent E1405 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 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 E1460-66502).
	Failing DC Isolation Test (see Test 2-2 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 through 3-5 in Chapter 3 for locations of mechanical parts. See the component locator included with this manual for locations of electrical components.

Table 4-2. Agilent E1468A/69A Tests/Checks

Test/Check	Reference Designator	Check:
Heat Damage	- - - - - - - - - -	Discolored PC boards Damaged insulation Evidence of arcing
Switch/Jumper Settings	J4, J5 SP1	IRQ Level setting LADDR setting
Matrix PCA	F1, F2 P1, J1 K1, K2, ..., K7 K10, K11, ..., K73	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 Matrix PCA

Use the component locator included with this manual to check the following:

- Verify that fuses F1 and F2 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, use the schematics included with this manual to perform component-level troubleshooting.

Matching Relays to Channels

Use Table 4-3 to find the reference designator of any relay on the E1460-66201 relay module. Table 4-3 shows all 64 channel relays

Table 4-3. Channel Relays/Reference Designators

E1468A Channel Relay		E1469A Channel Relay		Reference Designator
Row	Column	Row	Column	
00	00	00	00	K10
00	01	00	01	K11
00	02	00	02	K12
00	03	00	03	K13
00	04	00	04	K14
00	05	00	05	K15
00	06	00	06	K16
00	07	00	07	K17
01	00	00	08	K25
01	01	00	09	K24
01	02	00	10	K23
01	03	00	11	K22
01	04	00	12	K21
01	05	00	13	K20
01	06	00	14	K19
01	07	00	15	K18
02	00	01	00	K41
02	01	01	01	K40
02	02	01	02	K39
02	03	01	03	K38
02	04	01	04	K37
02	05	01	05	K36
02	06	01	06	K35
02	07	01	07	K34
03	00	01	08	K33
03	01	01	09	K32
03	02	01	10	K31
03	03	01	11	K30
03	04	01	12	K29
03	05	01	13	K28
03	06	01	14	K27
03	07	01	15	K26
04	00	02	00	K57
04	01	02	01	K56
04	02	02	02	K55
04	03	02	03	K54
04	04	02	04	K53
04	05	02	05	K52
04	06	02	06	K51
04	07	02	07	K50

(Continued on Next Page)

Table 4-3. Channel Relays and Reference Designators (cont.)

E1468A Channel Relay		E1469A Channel Relay		Reference Designator
Row	Column	Row	Column	
05	00	02	08	K49
05	01	02	09	K48
05	02	02	10	K47
05	03	02	11	K46
05	04	02	12	K45
05	05	02	13	K44
05	06	02	14	K43
05	07	02	15	K42
06	00	03	00	K73
06	01	03	01	K72
06	02	03	02	K71
06	03	03	03	K70
06	04	03	04	K69
06	05	03	05	K68
06	06	03	06	K67
06	07	03	07	K66
07	00	03	08	K65
07	01	03	09	K64
07	02	03	10	K63
07	03	03	11	K62
07	04	03	12	K61
07	05	03	13	K60
07	06	03	14	K59
07	07	03	15	K58

Disassembly

Use the following procedures to disassemble the E1460-66201 relay module (see Figure 4-1):

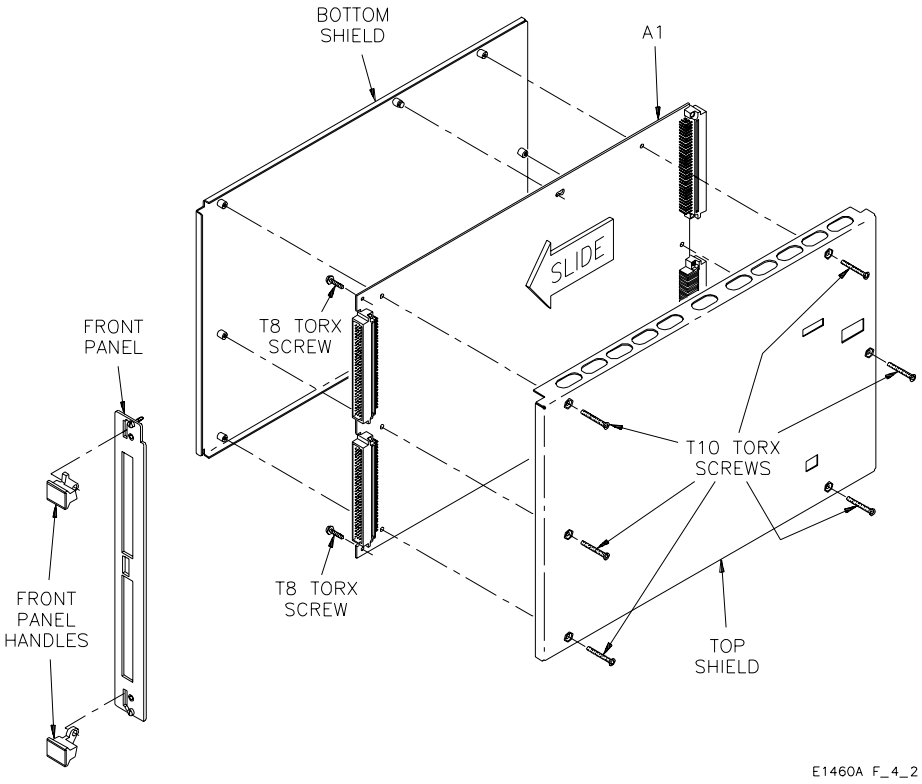

Figure 4-1. E1460-66201 Relay Module Disassembly

To remove the top shield:

- Remove the six T10 Torx screws as shown.
- Lift the top shield off of the module.

To remove the bottom shield:

- Slide A1 in the direction shown until the retaining pins on the shield align with the larger holes on A1.
- Lift A1 off of the bottom shield.

To remove the front panel and front panel handles:

- Remove the two T8 Torx screws as shown.

Repair/ Maintenance Guidelines

This section provides guidelines for repairing and maintaining the Agilent E1468A/69A matrix modules, including:

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

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

- Do not use a 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.

Component Locators and Schematic Diagrams

Table 4-4 lists Component Locator Diagrams and Schematic Diagrams for the Agilent E1468A and E1469A relay matrixes.

Table 4-4. Component Locators and Schematics Diagrams

	Part Number	Drawing Number	Drawing Title
Component Locator Diagram	E1460-66502	L-E1460-66502	Relay Matrixes Component Assembly
Schematic Diagrams	E1460-66502	S-E1460-66502(1)	Component Assembly - VXI P1,P2 Connectors & Power
	E1460-66502	S-E1460-66502(2)	Component Assembly - VXI Interface Logic Part 1
	E1460-66502	S-E1460-66502(3)	Component Assembly - VXI Interface Logic Part 2
	E1460-66502	S-E1460-66502(4)	Component Assembly - Relay Interface & Drive
	E1460-66502	S-E1460-66502(5)	Component Assembly - Analog & Configuration Bus
	E1460-66502	S-E1460-66502(6)	Component Assembly - Channels 00-37
	E1460-66502	S-E1460-66502(7)	Component Assembly - Channels 40-77
	E1468-66510	S-E1468-66510	8 x 8 Relay Matrix Terminal Card
	E1469-66510	S-E1469-66510	4 x 16 Relay Matrix Terminal Card