Agilent 75000 Series B

Agilent E1346A
48-Channel Relay Multiplexer

Service Manual

Enclosed is the Service Manual for the Agilent E1346A 48-Channel Relay Multiplexer. Insert this manual, along with any other VXIbus manuals that you have, into the binder that came with your Agilent Technologies mainframe.

Agilent Technologies

Manual Part Number: E1346-90011
Printed in Malaysia E0706

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 E1346A 48-Channel Relay Multiplexer Module 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.

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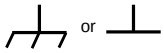
Safety Symbols

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

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



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

Alternating current (AC).

Direct current (DC).

Indicates hazardous voltages.

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

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

WARNINGS

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

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

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

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

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

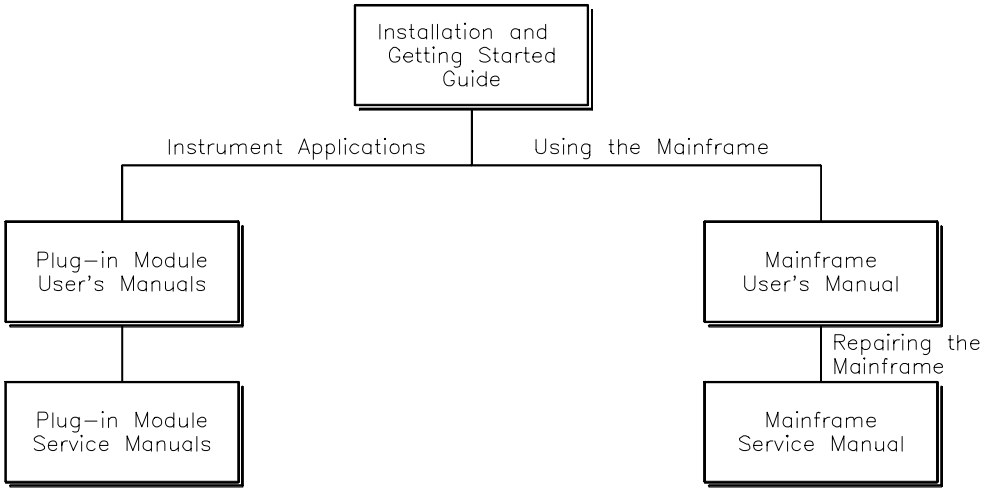
DO NOT operate damaged equipment: Whenever it is possible that the safety protection features built into this product have been impaired, either through physical damage, excessive moisture, or any other reason, REMOVE POWER and do not use the product until safe operation can be verified by service-trained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

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

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

Agilent 75000 Series B Service Documentation

Suggested Sequence to Use Manuals



Manual Descriptions

Installation and Getting Started Guide. This manual contains step-by-step instructions for all aspects of plug-in module and mainframe installation. Introductory programming information and examples are also included.

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

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

Mainframe Service Manual. This manual contains service information for the mainframe. It contains information for ordering replaceable parts and exchanging assemblies. Information and procedures for performance verification, adjustment, preventive maintenance, troubleshooting, and repair are also included.

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, preventive maintenance, troubleshooting, and repair are also provided.

What's in this Manual

Manual Overview

This manual shows how to service the Agilent E1346A Single Ended Relay Multiplexer. Consult the *Agilent E1346A User's Manual* for additional information on installing, configuring, and operating the Agilent E1346A. Consult the appropriate mainframe 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	Lists replaceable parts for the multiplexers.
4	Service	Procedures to aid in fault isolation and repair of the multiplexers.

Contents

1
General Information

Introduction

This manual contains information required to test, troubleshoot, and repair the Agilent E1346A Single Ended Relay Multiplexer. See the *Agilent E1346A User's Manual* for additional information on the Agilent E1346A.

Figure 1-1 shows the Agilent E1346A Single Ended Relay Multiplexer. Each multiplexer consists of a component assembly and a terminal block.

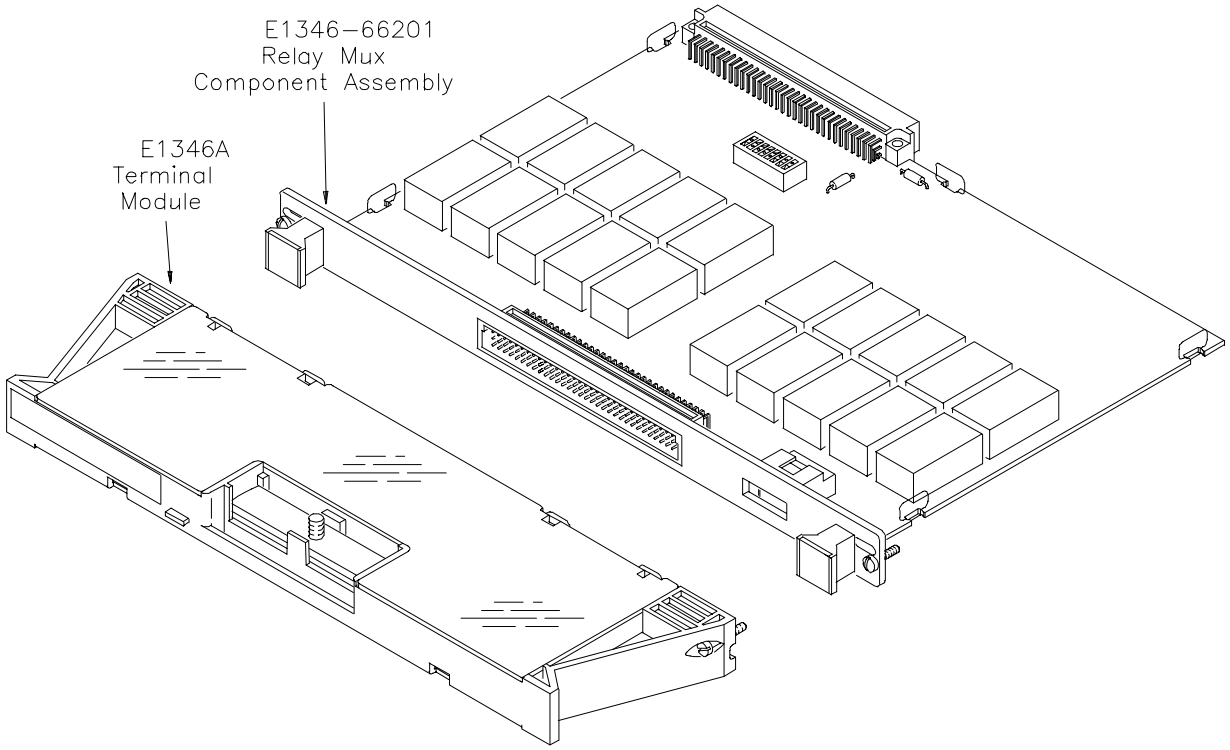


Figure 1-1. Agilent E1346A Single Ended Relay Multiplexer

Safety Considerations

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

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

Warnings

This section contains WARNINGS which must be followed for your protection when performing equipment 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.

WIRING INSULATION. To prevent electrical shock, all wires to the channel connections must be insulated to at least 120 V rms (170 V peak).

Cautions

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

CAUTION

MAXIMUM VOLTAGE/CURRENT. The maximum voltage that may be applied between High (H), Low (L), and Guard (G) terminals is 120 V dc or 120 V rms (170 V peak). The maximum current is 50 mA (non-inductive) per channel. The maximum power per channel is 1 VA.

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

Relay Life

Electromagnetic relays are subject to normal wear-out. Relay life depends on several factors. Two factors are loading and switching frequency.

Loading and Switching Frequency Effects

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 following methods. The best method (or combination of methods), as well as the failure criteria, depends on the application in which the relay is used.

Check Contact Resistance. As a relay begins to wear out, its contact resistance will increase. When the resistance exceeds a pre-determined value, the relay should be replaced. Typically, a relay for the Agilent E1346A Multiplexer should be replaced when the contact resistance exceeds 2.0 Ω.

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

Replace Relays after Defined Number of 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. For the Agilent E1346A Single Ended Relay Multiplexer, maximum relay life is specified to be 10^8 operations at no load or 10^7 operations at rated 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.

Multiplexer Description

The Agilent E1346A Single Ended Relay Multiplexer is an "instrument" in a VXIbus mainframe. As such, the multiplexer 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 the Agilent 75000 Series B Installation and Getting Started Guide to set the addresses to create an instrument.

E1346A Description

The Agilent E1346A Single Ended Relay Multiplexer provides switching (multiplexing) of up to 48 channels (i.e., channels 00 to 47). Each channel switches only a High (H) connection. The Low (L) and Guard (G) connections are common for all channels. The multiplexer module can only close one channel at a time.

Multiplexer Specifications

See *Appendix A* of the *Agilent E1346A User's Manual* for Agilent E1346A specifications. These specifications are the performance standards or limits against which the instrument may be tested.

Multiplexer Environment

The recommended operating environment for the Agilent E1346A Single Ended Relay Multiplexer 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)

Multiplexer Serial Numbers

Multiplexers covered by this manual are identified by a serial number prefix listed on the title page. Agilent Technologies 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 backplane connector. If the serial number prefix of your instrument is greater than the one listed on the title page, a Manual Update (as required) will explain how to adapt this manual to your instrument.

Multiplexer Options

There are no electrical or mechanical options available for the Agilent E1346A Single-Ended Relay Multiplexer.

Schematics/ Component Locators

Component locators and schematics for the multiplexers are packaged with this manual. Clear plastic sleeves are included for storage.

Recommended Test Equipment

Table 1-1 lists the test equipment recommended for testing, adjusting, and servicing the relay multiplexer. 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 488-1987 and the identical ANSI Standard MC1.1: SH1, AH1, T2, TE0, L2, LE0, SR0, RL0, PP0, DC0, DT0, and C1, 2, 3, 4, 5.	HP 9000 Series 300 or IBM Compatible PC with BASIC	F,O, P,T
Mainframe	Compatible with multiplexer	Agilent E1300B, E1301B, E1302A or E1401B/T, E1421A/B (requires E1405A/B)	F,O, P,T
Digital Multimeter	2-wire ohms (up to 1 GΩ) 4-wire ohms	Agilent 3458A or Agilent 34401A	O,P,T

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

Inspection/ Shipping

This section contains initial (incoming) inspection and shipping guidelines for the multiplexer.

Initial Inspection

Use the steps in Figure 1-2 as guidelines to perform initial inspection of a relay multiplexer. Performance Verification tests are optional.

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.

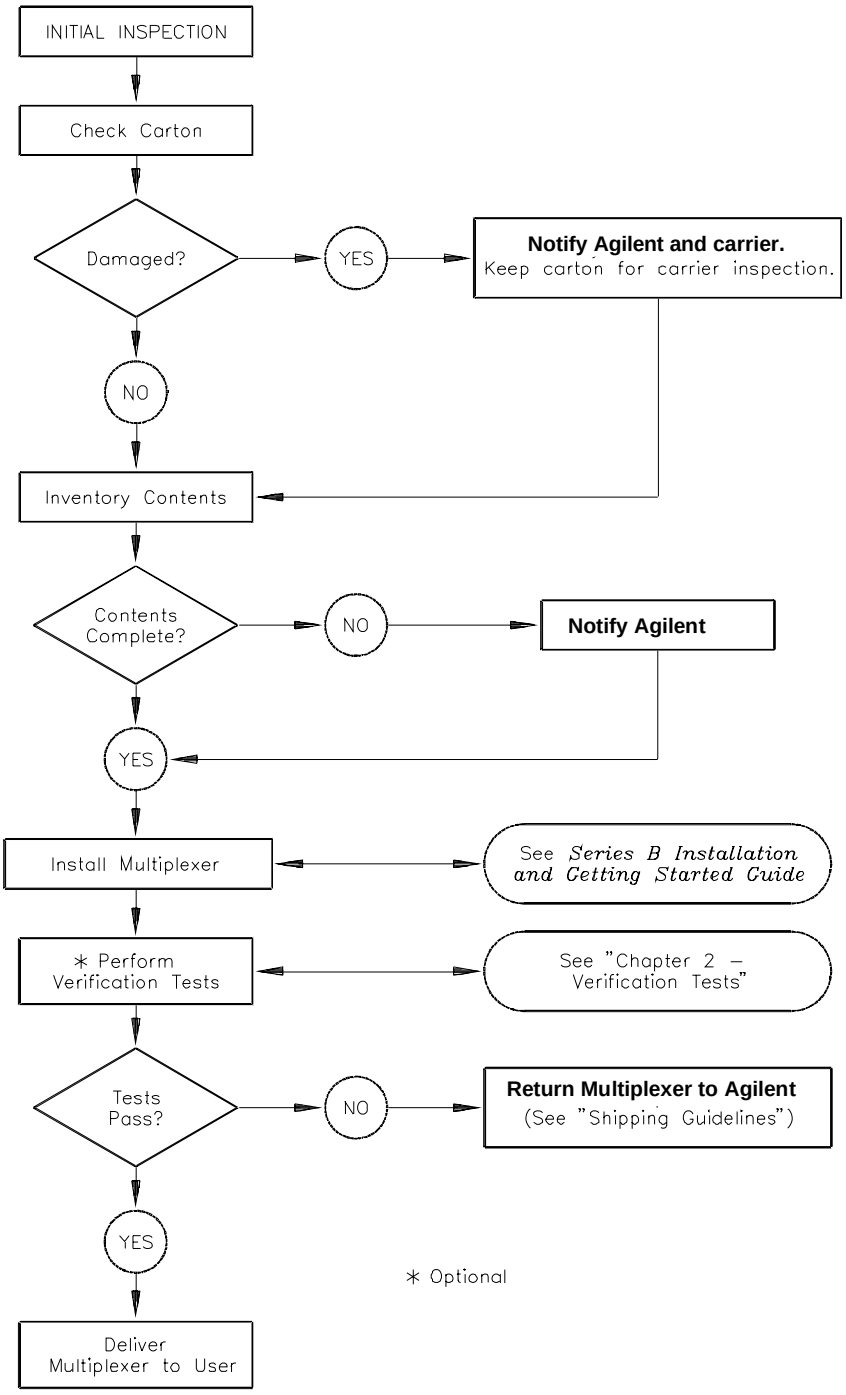
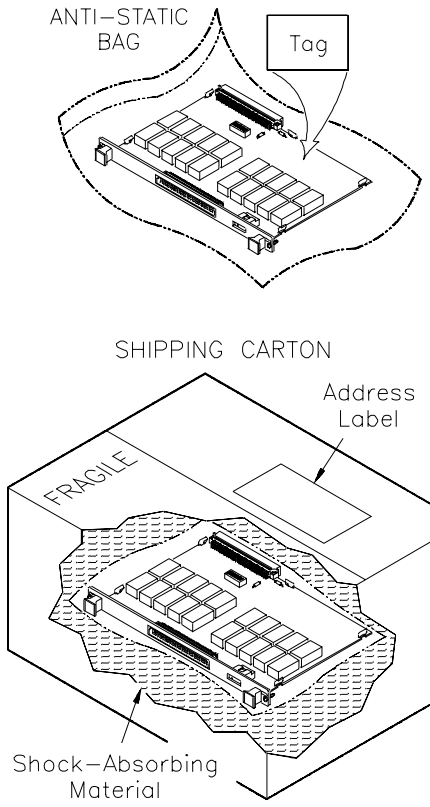


Figure 1-2. Initial (Incoming) Inspection Guidelines

Shipping Guidelines

Follow the steps in Figure 1-3 to return a relay multiplexer to a Agilent Technologies Sales and Support Office or Service Center.



1 Prepare the Multiplexer

- Remove user wiring from terminal block
- 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 Multiplexer

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

3 Ship the Multiplexer 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 a minimum 2.4 MPa (350 psi) test.

Figure 1-3. Packaging/Shipping Guidelines

2
Verification Tests

Introduction

This chapter describes the verification tests for the Agilent E1346A Single Ended Relay Multiplexer. The three levels of test procedures described in this chapter are used to verify that the Agilent E1346A:

- is functional (Functional Verification Test)
- meets selected testable specifications (Operation 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 multiplexers, and the specified test equipment. The test procedures do not specify equipment settings for test equipment except in general terms. It is assumed that a qualified, service-trained technician will select and connect the cables, adapters, and probes required for the test.

Performance Test Record

The results of each Performance Verification test may be recorded in Table 2-2, *Performance Test Record*, at the end of this chapter. 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 configuration:

- HP 9000 Series 200/300 computer
- BASIC programming language
- Multiplexer address 70914
- Multiplexer card number 1
- Agilent 3458A Digital Multimeter (DMM)

Functional Verification Test

The Functional Verification Test for the Agilent E1346A Single Ended Relay Multiplexer consists of sending the *IDN? command and checking the response. This test can be used to verify that the multiplexer is connected properly and is responding to a basic command.

Procedure

1. Verify that the multiplexer is properly installed in mainframe
2. Verify that the mainframe has passed its power-on test.
3. Send *IDN? to the multiplexer (see example following)
4. The return should be as follows (revision number may vary):

HEWLETT-PACKARD,SWITCHBOX,0,A.06.00

NOTE

If the primary address setting, secondary address setting, or the interface select code is set incorrectly, the multiplexer will not respond. Verify proper address selection before troubleshooting.

Example

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

```
10 DIM A$[100]
20 OUTPUT 70914;"*IDN?"          !Send the ID command
30 ENTER 70914;A$                !Get response
40   PRINT A$
50 END
```

Operation Verification Test

The procedures in this section are used to provide a high level of confidence that the multiplexer is meeting published specifications.
The Operation Verification test is a subset of the Performance Verification tests and is suitable for checkout after performing repairs.

The Operation Verification Test is performed by completing the Closed Channel Resistance Test (Test 2-1) as described in the Performance Verification test procedures. This test is usually sufficient to verify that the multiplexer is meeting its specifications.

Performance Verification Tests

The procedures in this section are used to test the multiplexer's electrical performance using the specifications in *Appendix A - Specifications* of the *Agilent E1346A Single Ended Relay Multiplexer User's Manual* as the performance standard.

There are two performance verification tests for the relay multiplexers: *Test 2-1: Closed-Channel Resistance Test* and *Test 2-2: DC Isolation Test*. These tests are suitable for incoming inspection, troubleshooting, and preventive maintenance.

Wiring the Test Fixture

A test fixture is required for the performance verification tests. Figure 2-1 shows typical connections using an Agilent E1346A terminal block for the test fixture. You may want to order an extra terminal block to use as a test fixture, so that you don't have to re-wire each time the tests are performed. The Agilent E1346A terminal block part number is E1346-80001.

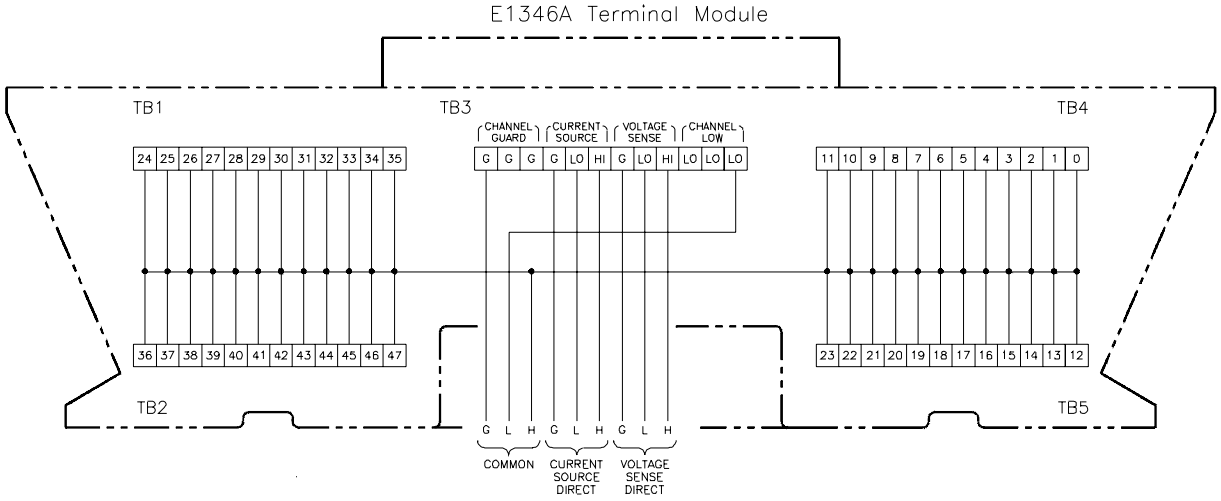


Figure 2-1. Test Fixture Connections

Test 2-1: Closed Channel Resistance Test

This test verifies that all relay contacts meet the closed-channel resistance specification for the multiplexer. When making the Closed Channel Resistance Test, the path measured always includes: a tree relay, a channel relay, and one or more protection resistors. This test uses the test fixture (see Figure 2-1).

The Closed Channel resistance specification for each relay is 2 Ω. Since all HI path measurements include both a channel relay and a tree relay, the closed channel specification is set to 2 Ω to detect any failure. It is possible that a channel resistance greater than 2 Ω is not a failure. Further troubleshooting, as described in Chapter 4, is required to verify a true HI path Closed Channel Resistance Test failure.

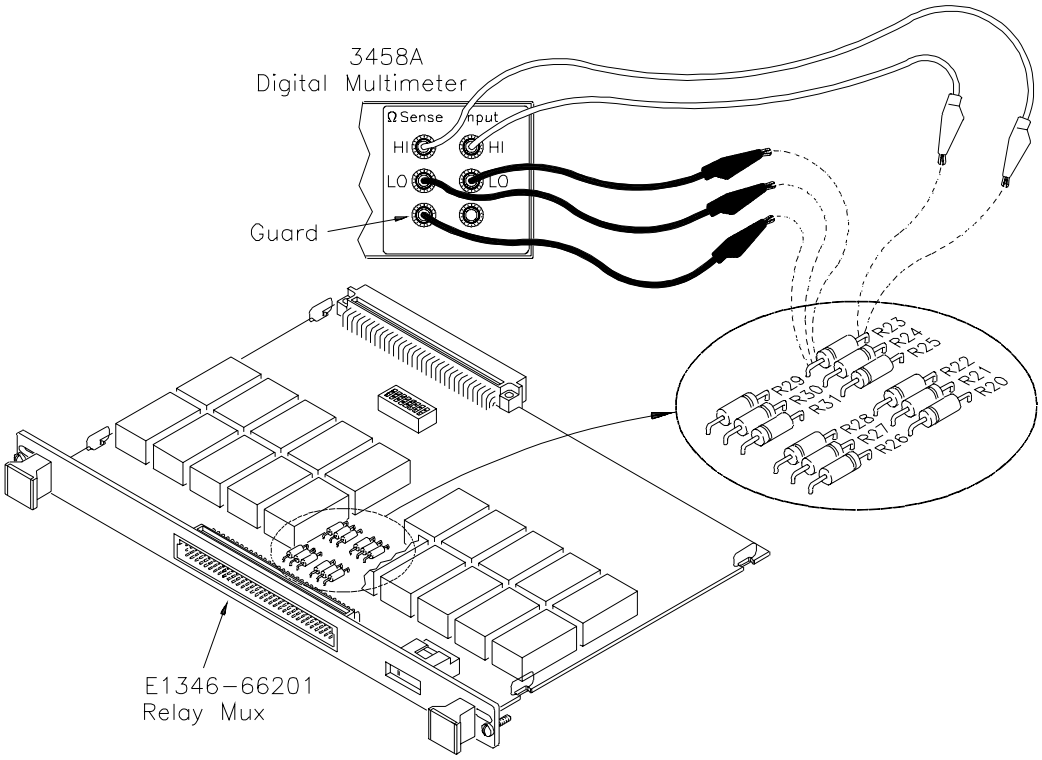


Figure 2-2. Protection Resistor Measurement Connection

Measuring Protection Resistors

Since there are 100 Ω protection resistors (R38 through R43) in the relay paths, measure the protection resistor values to begin this test. The values of the protection resistors are then subtracted from the measured path resistance to determine the relay contact resistance. To measure the protection resistor values, set the Agilent 3458A DMM to 4-wire ohms, autorange and measure each resistor value with the DMM (see Figure 2-2). Record the measured values in Table 2-1.

Table 2-1. Measured Protection Resistor Values

Resistor	Measured Value (Ω)	Resistor	Measured Value (Ω)
R38	_____	R41	_____
R39	_____	R42	_____
R40	_____	R43	_____

Chs 00-47 and 90-92 HI Measurements

1. **Make Hardware Connections**

- Turn mainframe power OFF
- Connect DMM leads as shown in Figure 2-3
- Turn mainframe power ON

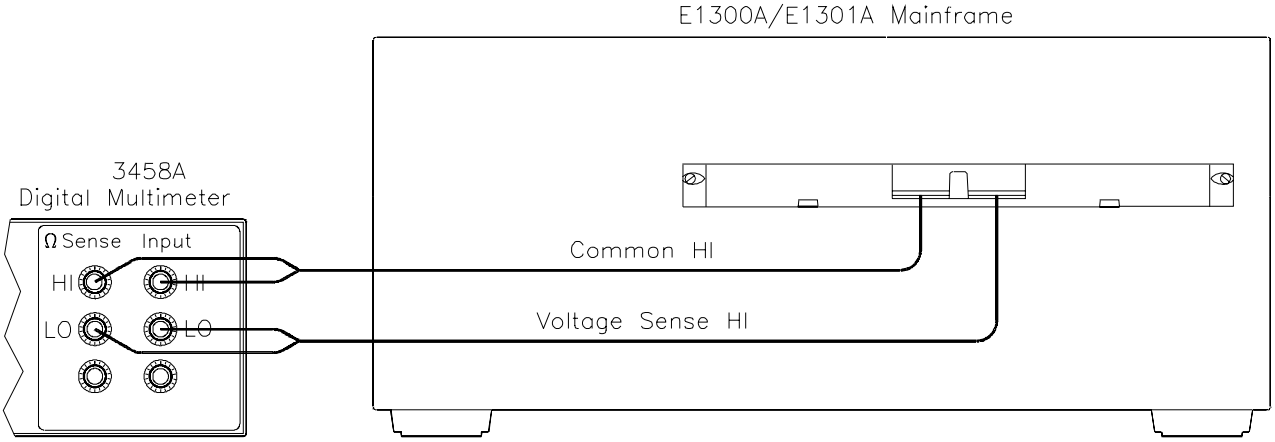


Figure 2-3. Ch 00-47 HI Measurement Connections

2. **Measure Channel 00 HI Resistance**

- Send *RST to multiplexer
- Send CLOS (@*nn*00) to close chan 00, where *nn* = card #
- Trigger the DMM with TRIG SGL and note reading
- Send OPEN (@*nn*00) to open channel 00
- Subtract measured value of R43 from DMM reading
- Enter the result in Table 2-2 for Channel 00 HI

3. **Repeat for Channels 01 - 47 HI**

- Repeat step 2 for channels 01 - 47 HI
- Use CLOS (@*nncc*) and OPEN (@*nncc*), where *nn* = card # and *cc* = channel # (omit leading zeroes in *nn*)

Ch 90-92 LO Measurements

1. **Make Hardware Connections**

- Turn mainframe power OFF
- Connect DMM leads as shown in Figure 2-4
- Turn mainframe power ON

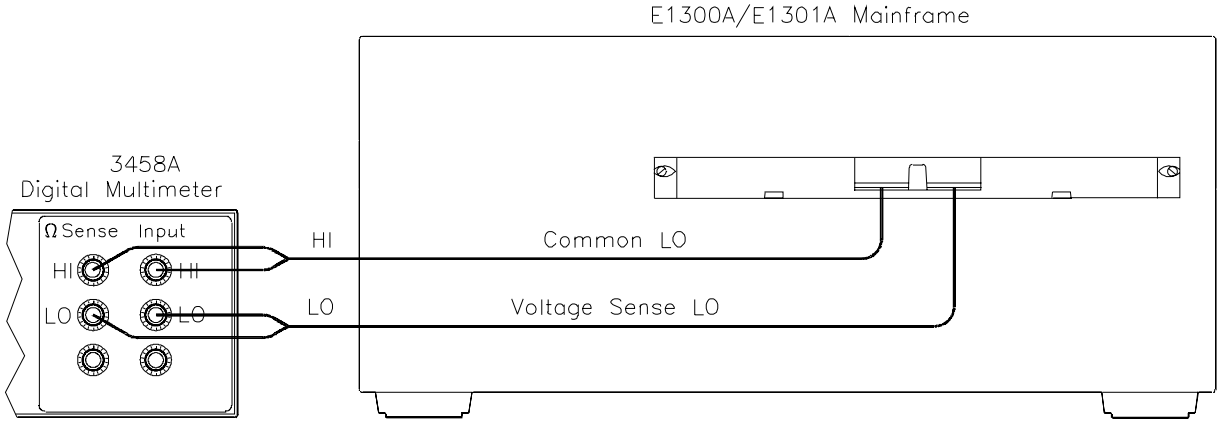


Figure 2-4. Ch 90 LO Measurement Connections

1. **Measure Channel 90 LO Resistance**

- Send *RST to multiplexer
- Send CLOS (@*nn*00) to close chan 90 and 00, where *nn* = card # (omit leading zeroes in *nn*).
- Trigger the DMM with TRIG SGL and note reading
- Send OPEN (@*nn*00) to open channel 90 and 00
- Subtract measured value of R42 from DMM reading
- Enter the result in Table 2-2 for Channel 90 LO

2. **Repeat for Channels 91 and 92 LO**

- Repeat steps 1 and 2 for channels 91 and 92 LO
- Use CLOS (@*nncc*) and OPEN (@*nncc*), where *nn* = card # and *cc* = channel # (omit leading zeroes in *nn*). Use 08 for channel 91 and 16 for channel 92.

Ch 90-92 GU Measurements

1. **Make Hardware Connections**

- Turn mainframe power OFF
- Connect DMM leads as shown in Figure 2-5
- Turn mainframe power ON

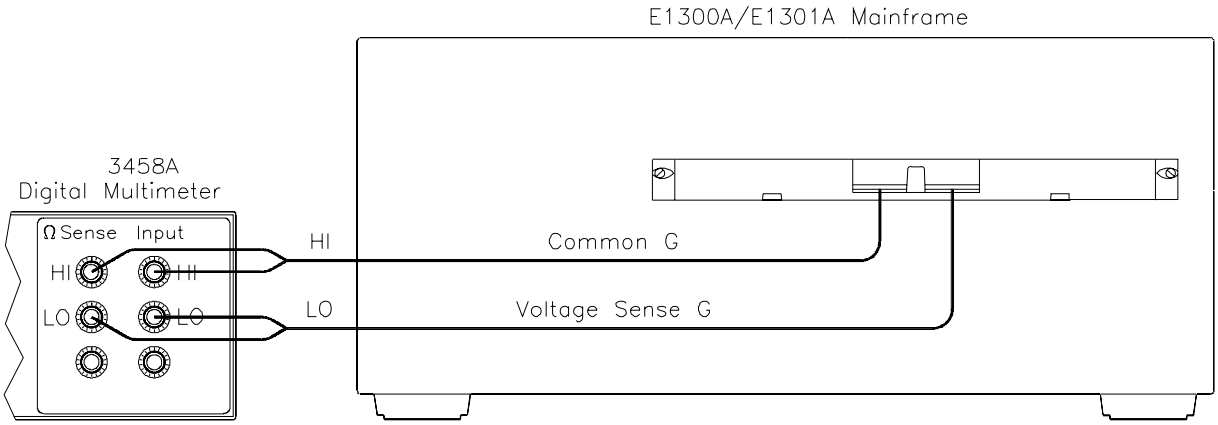


Figure 2-5. Ch 90 GU Measurement Connections

2. **Measure Channel 90 GU Resistance**

- Send *RST to multiplexer
- Send CLOS (@*nn*00) to close chan 90 and 00, where *nn* = card # (omit leading zeroes in *nn*).
- Trigger the DMM with TRIG SGL and note reading
- Send OPEN (@*nn*00) to open channel 90 and 00
- Subtract measured value of R41 from DMM reading
- Enter the result in Table 2-2 for Channel 90 GU

3. **Repeat for Channels 91 and 92 GU**

- Repeat steps 1 and 2 for channels 91 and 92 GU
- Use CLOS (@*nncc*) and OPEN (@*nncc*), where *nn* = card # and *cc* = channel # (omit leading zeroes in *nn*) Use 08 for channel 91 and 16 for channel 92.

Ch 93 HI Measurement

1. **Make Hardware Connections**

- Turn mainframe power OFF
- Connect DMM leads as shown in Figure 2-6
- Turn mainframe power ON

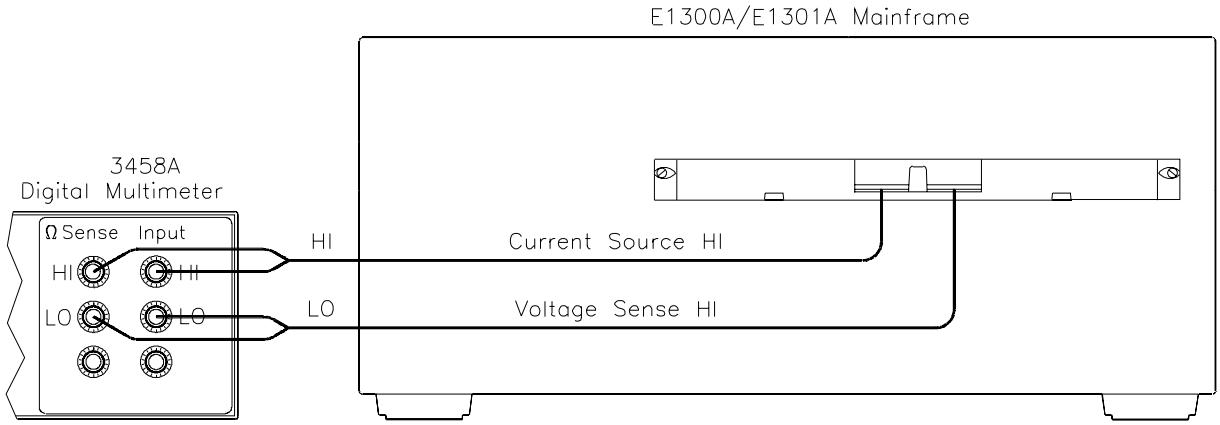


Figure 2-6. Ch 93 HI Measurement Connections

2. **Measure Channel 93 HI Resistance**

- Send *RST to multiplexer
- Send CLOS (@*nn*93) to close chan 93, where *nn* = card # (omit leading zeroes in *nn*)
- Trigger the DMM with TRIG SGL and note reading
- Send OPEN (@*nn*93) to open channel 93
- Subtract measured value of (R38 + R43) from DMM reading
- Enter the result in Table 2-2 for Channel 93 HI

Ch 93 LO Measurement

1. **Make Hardware Connections**

- Turn mainframe power OFF
- Connect DMM leads as shown in Figure 2-7
- Turn mainframe power ON

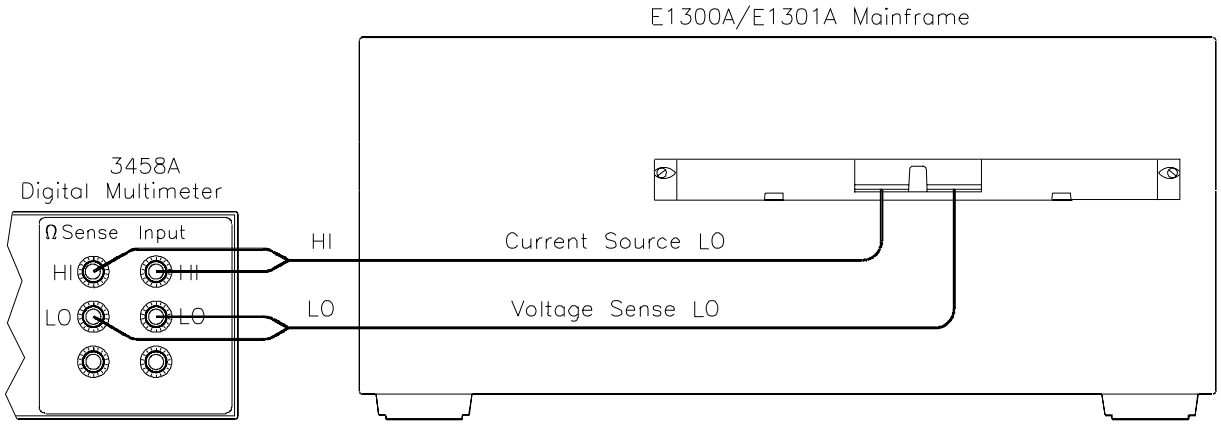


Figure 2-7. Ch 93 LO Measurement Connections

2. **Measure Channel 93 LO Resistance**

- Send *RST to multiplexer
- Send CLOS (@*nn*93) to close chan 93, where *nn* = card #
- Trigger the DMM with TRIG SGL and note reading
- Send OPEN (@*nn*93) to open channel 93
- Subtract measured value of (R39 + R42) from DMM reading
- Enter the result in Table 2-2 for Channel 93 LO

Ch 93 GU Measurement

1. **Make Hardware Connections**

- Turn mainframe power OFF
- Connect DMM leads as shown in Figure 2-8
- Turn mainframe power ON

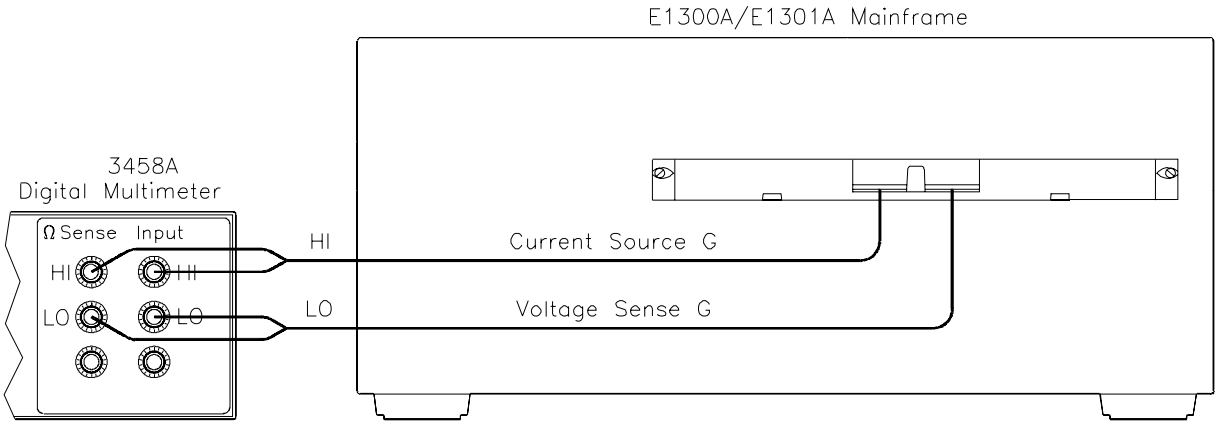


Figure 2-8. Ch 93 GU Measurement Connections

2. **Measure Channel 93 GU Resistance**

- Send *RST to multiplexer
- Send CLOS (@*nn*93) to close chan 93, where *nn* = card #
- Trigger the DMM with TRIG SGL and note reading
- Send OPEN (@*nn*93) to open channel 93
- Subtract measured value of (R40 + R41) from DMM reading
- Enter the result in Table 2-2 for Channel 93 GU

Example: Closed Channel Resistance Test

This example performs a Closed Channel Resistance Test to measure Channels 00 - 47, Channels 90-92 and Channel 93 HI, LO, and GU relay contact resistances. If the relay contact resistance for a channel is >2.0 Ω the program prints a message indicating which channel has failed the test. Use this list in chapter 4 when troubleshooting a failing relay.

NOTE

Since small measurement variations may occur when measuring the protection resistors, the program returns "0.00" if the calculated resistance is <0 Ω .

```
10!    RE-SAVE "CLOS_TEST"
20     ASSIGN @Dmm TO 722
30     ASSIGN @Mux TO 70914
40     DISP CHR$(129)
50     DIM R(38:43),Value0(47),Value1(3,3),Result0(47),Result1(3,3),
Path$(2)[2]
60     DATA HI,LO,G
70     READ Path$(*)
80     !
90     !Measure protection resistors
100    !
110    PRINT "Measure Protection Resistors R38 - R43 "
120    PRINT TABXY(1,3),"  1. Turn mainframe power OFF"
130    PRINT TABXY(1,4),"  2. Remove E1346A Component Assembly from
mainframe"
140     PRINT TABXY(1,5),"  3. Set DMM for 4-wire ohms (OHMF) function "
150    DISP " Press Continue when ready to measure protection resistors "
160    PAUSE
170    CLEAR SCREEN
180    FOR I=38 TO 43
190      PRINT TABXY(1,4),"Connect DMM leads (4-wire) to resistor R";I
200      PRINT TABXY(1,5),"Measure resistor R";I;"value (in Ohms)"
210      INPUT " Enter resistor value (in Ohms), and press Return ",R(I)
220    NEXT I
230    CLEAR SCREEN
240    PRINT "Install Component Assembly and Test Fixture "
250   PRINT
260    PRINT "  1. Turn Mainframe AND Agilent 3458a DMM power OFF"
270    PRINT "  2.  Connect GPIB Cable between mainframe and DMM"
280    PRINT "  3.  Install E1346A Component Assembly into Mainframe"

290    PRINT "  4. Attach Test Fixture to Component Assembly"
```

```
300    PRINT "  5. Turn Mainframe power ON "
310    PRINT "  5. Press Continue when ready to begin testing "
320    PAUSE
330    CLEAR SCREEN
340    !
350    ! Measure Channels 00-47 and  90-92 (HI, LO, and G)
360    !
370    OUTPUT @Dmm;"PRESET NORM;FUNC OHMF"
380    OUTPUT @Mux;"*RST"
390    J=100    ! Address offset
400    K=0
410    PRINT TABXY(1,1),"Channel 00-47 and 90-92";Path$(K);" Measurements"
420    PRINT TABXY(1,3),"Connect DMM Sense and Input HI leads to COMMON ";Path$(K)
430    PRINT TABXY(1,4),"Connect DMM Sense and Input LO leads to VOLTAGE SENSE ";Path$(K)
440    DISP " Press Continue when connections are complete "
450    PAUSE
460    CLEAR SCREEN
470    FOR I=0 TO 47
480       OUTPUT @Mux;"CLOS (@"&VAL$(J+I)&")"
490       OUTPUT @Dmm;"TRIG SGL"
500       ENTER @Dmm;Value0(I)
510       OUTPUT @Mux;"OPEN (@"&VAL$(J+I)&")"
520       Result0(I)=Value0(I)-R(43)
530       IF Result0(I)<0. THEN Result0(I)=0
540       IF Result0(I)>2.0 THEN
550          PRINT "Resistance for Channel";I;" ";Path$(K);"Path is >2.0 Ohms"
560       END IF
570    NEXT I
580    PRINT "Measurements complete for Channels 00 - 47 and 90-92 ";Path$(K)
590    DISP " Press Continue for Channels 90 - 92 ";Path$(K+1);" measurements "
600    PAUSE
610    !
620    ! Measure channels 90-92 LO and G
630    !
640    OUTPUT @Mux;"*RST"
650    FOR K=1 TO 2
660       CLEAR SCREEN
```

```
670       PRINT TABXY(1,1),"Channels 90-92 ";Path$(K);" Measurements"
680       PRINT TABXY(1,3),"Connect DMM Sense and Input HI leads to COMMON ";Path$(K)
690       PRINT TABXY(1,4),"Connect DMM Sense and Input LO leads to VOLTAGE SENSE ";Path$(K)
700       DISP " Press Continue when connections are complete "
710       PAUSE
720       CLEAR SCREEN
730       J=100   ! Address Offset
740       FOR I=0 TO 2
750         OUTPUT @Mux;"CLOS (@"&VAL$(J)&")"
760         OUTPUT @Dmm;"TRIG SGL"
770         ENTER @Dmm;Value1(I,K)
780         OUTPUT @Mux;"OPEN (@"&VAL$(J)&")"
790         Result1(I,K)=Value1(I,K)-R(43-K)
800         IF Result1(I,K)<0. THEN Result1(I,K)=0.
810         IF Result1(I,K)>2.0 THEN
820           PRINT "Resistance for Channel ";(I+90);" ";Path$(K);"Relay is >2.0 Ohms"
830         END IF
840       J=J+8
850       NEXT I
860       PRINT "Measurements complete for Channels 90-92";Path$(K)
870      IF K=1 THEN
880         DISP " Press Continue for Channels 90 - 92 ";Path$(K+1);" measurements "
890         PAUSE
900       END IF
910     NEXT K
920     !
930     ! Measure channel 93 HI, LO, and G
940     !
950     DISP " Press Continue for Channel 93 HI, LO, and G measurements "
960     PAUSE
970     CLEAR SCREEN
980     J=193   ! Address offset
990     FOR K=0 TO 2
1000      PRINT TABXY(1,1),"Channel 93 HI, LO, and G Contact Resistance Test"
1010      PRINT TABXY(1,3),"1.  Connect DMM Sense and Input HI leads to VOLTAGE SENSE ";Path$(K)
1020      PRINT TABXY(1,4),"2.  Connect DMM Sense and Input LO leads to CURRENT SOURCE ";Path$(K)
1030      DISP " Press Continue when connections are complete "
```

```
1040    PAUSE
1050    CLEAR SCREEN
1060    OUTPUT @Mux;"CLOS (@"&VAL$(J)&")"
1070    OUTPUT @Dmm;"TRIG SGL"
1080    ENTER @Dmm;Value1(K,3)
1090    OUTPUT @Mux;"OPEN (@"&VAL$(J)&")"
1100    Result1(K,3)=Value1(K,3)-(R(38+K)+R(43-K))
1110    IF Result1(K,3)<0 THEN Result1(K,3)=0.
1120    IF Result1(K,3)>2.0 THEN
1130      PRINT "Resistance for Channel";(J-100);" ";Path$(K);"Relay is
>2.0 Ohms"
1140    END IF
1150  NEXT K
1160  PRINT "Closed Contact Resistance Measurements complete
1170  DISP " Press Continue to display measurement results "
1180  PAUSE
1190  CLEAR SCREEN
1200  !
1210  !  Print measurement results
1220  !
1230  Format:    IMAGE 2(5X,"CH ",DD," & ",DD,3X,DD.DDDD," Ohms",5X)
1240  PRINT TABXY(1,3),"Channels 00-47 & 90-92 HI Contact Resistance"
1250  PRINT
1260  PRINT
1270  FOR I=0 TO 23
1280    SELECT I
1290        CASE <8
1300            K=90
1310         CASE <16
1320            K=91
1330        CASE ELSE
1340            K=92
1350    END SELECT
1360    PRINT USING Format;I,K,Result0(I),I+24,K,Result0(I+24)
1370  NEXT I
1380  PRINT
1390  Form2:      IMAGE 3(2X,"CH ",DD," ",2A,2X,DD.DDDD," Ohms",2X)
1400  PRINT "Channels 90-92 LO and G Contact Resistance"
1410  PRINT
1420  FOR K=1 TO 2
1430    PRINT USING
Form2;90,Path$(K),Result1(0,K),91,Path$(K),Result1(1,K),92,Path$(K),Resu
lt1(2,K)
```

```
1440  NEXT K
1450  PRINT
1460  PRINT "Channel 93 Contact Resistance"
1470  PRINT
1480  FOR K=0 TO 2
1490     PRINT "Channel 93  ";Path$(K);"  ";Result1(K,3);"  Ohms"
1500  NEXT K
1510  END
```

Typical Result

Channel 00-47 and Channels 90-92 HI Contact Resistance

CH 0 & 90	1.6785	Ohms	CH 24 & 90	.5995	Ohms
CH 1 & 90	.6885	Ohms	CH 25 & 90	.7865	Ohms
CH 2 & 90	.6725	Ohms	CH 26 & 90	.6578	Ohms
CH 3 & 90	.6785	Ohms	CH 27 & 90	1.865	Ohms
CH 4 & 90	1.6785	Ohms	CH 28 & 90	1.72225	Ohms
CH 5 & 90	1.4785	Ohms	CH 29 & 90	.7865	Ohms
CH 6 & 90	1.5785	Ohms	CH 30 & 90	.59005	Ohms
CH 7 & 90	1.6785	Ohms	CH 31 & 90	.7865	Ohms
CH 8 & 91	.6785	Ohms	CH 32 & 91	.4566	Ohms
CH 9 & 91	.6785	Ohms	CH 33 & 91	.7865	Ohms
CH 10 & 91	.8685	Ohms	CH 34 & 91	.7222	Ohms
CH 11 & 91	1.256	Ohms	CH 35 & 91	.9885	Ohms
CH 12 & 91	.8555	Ohms	CH 36 & 91	.7865	Ohms
CH 13 & 91	.6785	Ohms	CH 37 & 91	1.2265	Ohms
CH 14 & 91	.7865	Ohms	CH 38 & 91	.9995	Ohms
CH 15 & 91	.6785	Ohms	CH 39 & 91	.7555	Ohms
CH 16 & 92	.6785	Ohms	CH 40 & 92	.5996	Ohms
CH 17 & 92	1.6785	Ohms	CH 41 & 92	.7865	Ohms
CH 18 & 92	1.6785	Ohms	CH 42 & 92	.9595	Ohms
CH 19 & 92	.6785	Ohms	CH 43 & 92	.5566	Ohms
CH 20 & 92	.6780	Ohms	CH 44 & 92	.9865	Ohms
CH 21 & 92	.4485	Ohms	CH 45 & 92	.7865	Ohms
CH 22 & 92	.6785	Ohms	CH 46 & 92	.6785	Ohms
CH 23 & 92	1.6785	Ohms	CH 47 & 92	.7865	Ohms

Channels 90-92 LO and G Contact Resistance

.	CH 90 LO .1023 Ohms	CH 91 LO .1125 Ohms	CH 92 LO .2011 Ohms
.	CH 90 G .1113 Ohms	CH 91 G .1985 Ohms	CH 92 G .0955 Ohms

Channel 93 HI, LO and G Contact Resistance

CH 93 HI	1.6785	Ohms
CH 93 LO	1.0005	Ohms
CH 93 G	0.1785	Ohms

Test 2-2: DC Isolation Test

This test verifies that sufficient DC isolation exists at various points on the multiplexer. DC Isolation is checked from HI to Chassis, HI to LO, and HI to GU (GUARD). This test uses the test fixture (see Figure 2-1).

NOTE

The DMM used should be capable of measuring at least 1 G. Ω. 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, a typical return for an overload is 1.E+38 and the entry in Table 2-2 should be >1.2 G Ω.

HI to Chassis Isolation

1. Make hardware connections as shown in Figure 2-9
2. Set DMM to 2-wire ohms, 1 G Ω range
3. Send CLOS (@100,108,116,193) to close all Tree relays
4. Trigger the DMM with TRIG SGL
5. Record the DMM reading on Table 2-2 (HI to CHASSIS)

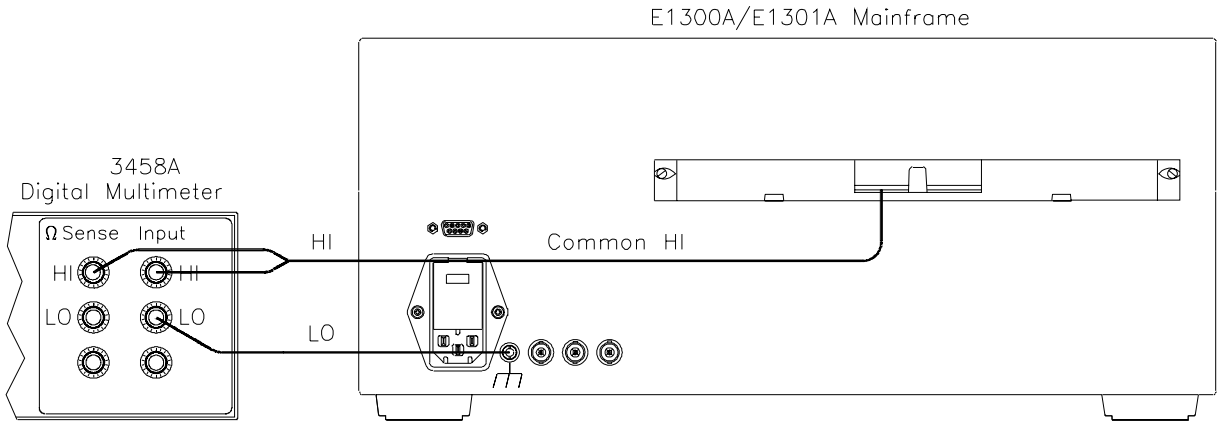


Figure 2-9. HI to Chassis Isolation Connections

HI to LO Isolation

1. Make hardware connections as shown in Figure 2-10
2. Trigger the DMM with TRIG SGL
3. Record the DMM reading on Table 2-2 (HI to LO)

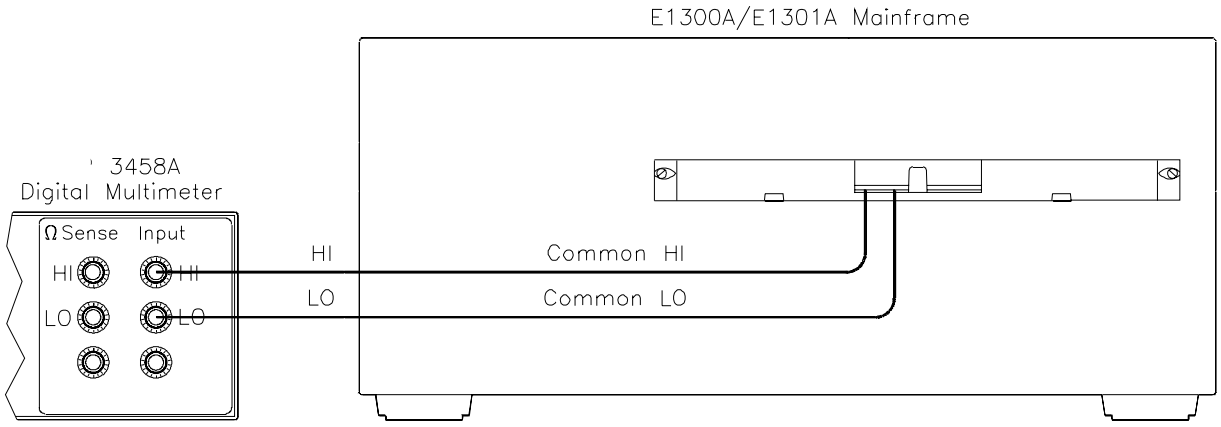


Figure 2-10. HI to LO Isolation Connections

HI to GU Isolation

1. Make hardware connections as shown in Figure 2-11
2. Trigger the DMM with TRIG SGL
3. Record the DMM reading on Table 2-2 (HI to GU)

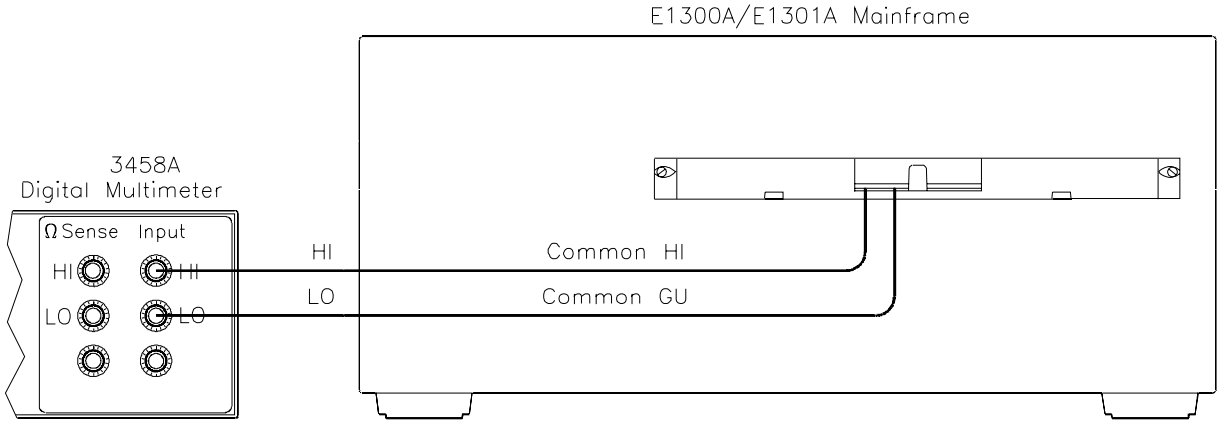


Figure 2-11. HI to GU Isolation Connections

Example: DC Isolation Test

This example performs DC Isolation Tests for HI to Chassis, HI to LO, and HI to GU (GUARD).

```
10!  RE-SAVE "DC_ISOL"
20   ASSIGN @Dmm TO 722
30   ASSIGN @Mux TO 70914
40   DISP CHR$(129)
50   DIM Conn$(5)[10]
60   DATA CHASSIS, LO, G , CHASSIS, COMMON LO, COMMON G
70   READ Conn$(*)
80   OUTPUT @Dmm;"OHM 1E9"
90   PRINT "Equipment Connections "
100  PRINT
110  PRINT " 1.  Turn Mainframe and Agilent 3458A DMM power OFF"
120  PRINT " 2.  Connect GPIB Cable between mainfrmae and DMM"
130  PRINT " 3.   Install Agilent E1346A Component Assembly into
Mainframe "
140  PRINT " 4.  Attach Test Fixture to Component Assembly"
150  PRINT " 5.  Turn Mainframe power ON"
160  DISP  "Press Continue when ready to begin testing "
170  PAUSE
180  CLEAR SCREEN
190  !
200  ! Measure DC Isolation (HI to Chassis, HI to LO, HI to G)
210  !
220  OUTPUT @Mux;"*RST"
230  OUTPUT @Mux;"CLOS (@193,100,108,116)
240  FOR I=0 TO 2
250     PRINT TABXY(1,1),"DC Isolation HI to ";Conn$(I);" Measurements  "
260     PRINT TABXY(1,3),"1. Connect DMM INPUT HI lead to COMMON
HI"
270     PRINT TABXY(1,4),"2. Connect DMM INPUT LO to ";Conn$(I+3)
280     DISP " Press Continue when connections are complete "
290     PAUSE
300     CLEAR SCREEN
310     OUTPUT @Dmm;"TRIG SGL"
320     ENTER @Dmm;Value(I)
330  NEXT I
340  OUTPUT @Mux;"OPEN (@193,100,108,116)
350  DISP " Press Continue to print measurement results "
```

```
360  PAUSE
370  CLEAR SCREEN
380  PRINT TABXY(1,1),"DC Isolation Tests "
390  PRINT TABXY(1,3),"HI to CHASSIS (Ohms)";Value(0)
400  PRINT TABXY(1,4),"HI to LO (Ohms)          ";Value(1)
410  PRINT TABXY(1,5),"HI to GUARD (Ohms)   ";Value(2)
420  END
```

Typical Result A typical result for an overload on all three measurements is :

```
DC Isolation Tests

HI to CHASSIS (Ohms) 1.E+38
HI to LO (Ohms)          1.E+38
HI to GUARD (Ohms)    1.E+38
```

Performance Test Record

Table 2-2, *Performance Test Record*, is a form you can copy and use to record performance verification test results for the multiplexers. Table 2-2 shows multiplexer test limits, DMM measurement uncertainty, and test accuracy ratio (TAR) values.

Test Limits

Test limits are defined for relay closed channel resistance and DC isolation using the specifications in *Appendix A - Specifications* of the *Agilent E1346A Single Ended Relay Multiplexers User's Manual* . The relay contact resistance and DC isolation specifications are single-ended, meaning that there is an upper limit OR a lower limit, but not both. In Table 2-2, the Minimum or Maximum column is blank for a single-sided test.

Measurement Uncertainty

For the performance verification tests in this manual, measurement uncertainties are calculated based on the Agilent 3458A Digital Multimeter. The measurement uncertainty shown in Table 2-2 is the accuracy of the Agilent 3458A using 90-day specifications. The calculations follow.

Closed Channel Resistance Test

Conditions:

- 4-wire ohms function, 10 Ω range
- 90-day specifications
- Worst-case reading = 2.0 Ω

M.U. = (15 *ppm of Reading* + 5 *ppm of Range*)

$= (15 \times 10^{-6} * 2.0 + 5 \times 10^{-6} * 10)\ \Omega$

$= 8.0 \times 10^{-5}\ \Omega$

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)

M.U. = (0.5% *of Reading* + 10*ppm of Range*)

$= (0.005 * 1.2 \times 10^{9} + 10 \times 10^{-6} * 1 \times 10^{9})\ \Omega$

$= 6.0 \times 10^{6}\ \Omega$

Test Accuracy Ratio (TAR)

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

Table 2-2. Performance Test Record (Page 1 of 3)

General Information

Test Facility:

Name _____ Report No. _____

Address _____ Date _____

City/State _____ Customer _____

Phone _____ Tested by _____

Special Notes:

_____

_____

_____

_____

_____

_____

Test Equipment Record

Model _____ Report No. _____ Date _____

Test Equipment Used: Description	Model No.	Trace No.	Cal Due Date
1. _____	_____	_____	_____
2. _____	_____	_____	_____
3. _____	_____	_____	_____
4. _____	_____	_____	_____
5. _____	_____	_____	_____

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

Test No/Description	Minimum* Value	Measured Value (V)	Maximum Value **	Meas Uncert	Test Acc Ratio (TAR)
2-1. Closed Channel Resistance (Values in Ohms)					
HI Path Resistance					
Channel 00 & 90		_____	2.0	8.00E-5	NA
Channel 01 & 90		_____	2.0	8.00E-5	NA
Channel 02 & 90		_____	2.0	8.00E-5	NA
Channel 03 & 90		_____	2.0	8.00E-5	NA
Channel 04 & 90		_____	2.0	8.00E-5	NA
Channel 05 & 90		_____	2.0	8.00E-5	NA
Channel 06 & 90		_____	2.0	8.00E-5	NA
Channel 07 & 90		_____	2.0	8.00E-5	NA
Channel 08 & 91		_____	2.0	8.00E-5	NA
Channel 09 & 91		_____	2.0	8.00E-5	NA
Channel 10 & 91		_____	2.0	8.00E-5	NA
Channel 11 & 91		_____	2.0	8.00E-5	NA
Channel 12 & 91		_____	2.0	8.00E-5	NA
Channel 13 & 91		_____	2.0	8.00E-5	NA
Channel 14 & 91		_____	2.0	8.00E-5	NA
Channel 15 & 91		_____	2.0	8.00E-5	NA
Channel 16 & 92		_____	2.0	8.00E-5	NA
Channel 17 & 92		_____	2.0	8.00E-5	NA
Channel 18 & 92		_____	2.0	8.00E-5	NA
Channel 19 & 92		_____	2.0	8.00E-5	NA
Channel 20 & 92		_____	2.0	8.00E-5	NA
Channel 21 & 92		_____	2.0	8.00E-5	NA
Channel 22 & 92		_____	2.0	8.00E-5	NA
Channel 23 & 92		_____	2.0	8.00E-5	NA
Channel 24 & 90		_____	2.0	8.00E-5	NA
Channel 25 & 90		_____	2.0	8.00E-5	NA
Channel 26 & 90		_____	2.0	8.00E-5	NA
Channel 27 & 90		_____	2.0	8.00E-5	NA
Channel 28 & 90		_____	2.0	8.00E-5	NA
Channel 29 & 90		_____	2.0	8.00E-5	NA
Channel 30 & 90		_____	2.0	8.00E-5	NA
Channel 31 & 90		_____	2.0	8.00E-5	NA
Channel 32 & 91		_____	2.0	8.00E-5	NA
Channel 33 & 91		_____	2.0	8.00E-5	NA
Channel 34 & 91		_____	2.0	8.00E-5	NA
Channel 35 & 91		_____	2.0	8.00E-5	NA

*Single-sided specification - Minimum value does not apply

**Value listed is for a single relay contact. All channels measured include two relay contacts. Refer to Chapter 4 for troubleshooting information.

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

Test No/Description	Minimum* Value	Measured Value (V)	Maximum Value **	Meas Uncert	Test Acc Ratio (TAR)
2-1. Closed Channel Resistance (Values in Ohms) (cont'd)					
HI Path Resistance					
		_____	2.0	8.00E-5	NA
Channel 36 & 91		_____	2.0	8.00E-5	NA
Channel 37 & 91		_____	2.0	8.00E-5	NA
Channel 38 & 91		_____	2.0	8.00E-5	NA
Channel 39 & 91		_____			
Channel 40 & 92		_____	2.0	8.00E-5	NA
Channel 41 & 92		_____	2.0	8.00E-5	NA
Channel 42 & 92		_____	2.0	8.00E-5	NA
Channel 43 & 92		_____	2.0	8.00E-5	NA
Channel 44 & 92		_____	2.0	8.00E-5	NA
Channel 45 & 92		_____	2.0	8.00E-5	NA
Channel 46 & 92		_____	2.0	8.00E-5	NA
Channel 47 & 92		_____	2.0	8.00E-5	NA
LO Path Resistance					
Channel 90		_____	2.0	8.00E-5	NA
Channel 91		_____	2.0	8.00E-5	NA
Channel 92		_____	2.0	8.00E-5	NA
G Path Resistance					
Channel 90		_____	2.0	8.00E-5	NA
Channel 91		_____	2.0	8.00E-5	NA
Channel 92		_____	2.0	8.00E-5	NA
Channel 93 Path Resistance					
Channel 93 HI		_____	2.0	8.00E-5	NA
Channel 93 LO		_____	2.0	8.00E-5	NA
Channel 93 G		_____	2.0	8.00E-5	NA
2-2. DC Isolation (Values in Ohms) ***					
HI to CHASSIS	1E9	_____		6.0E6	NA
HI to LO	1E9	_____		6.0E6	NA
HI to G	1E9	_____		6.0E6	NA

*Single-sided specification - Minimum value does not apply.

**Value listed is for a single relay contact. All channels measured include two relay contacts. Refer to Chapter 4 for troubleshooting information.

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

3
Replaceable Parts

Introduction

This chapter contains information to order replaceable parts for Agilent E1346A Single Ended Relay Multiplexers with serial number prefixes 2934A and below. Table 3-1 lists assembly and terminal block part numbers for the multiplexer, Table 3-2 lists replaceable parts for the multiplexer, Table 3-3 shows reference designators for parts in Table 3-2, and Table 3-4 shows the manufacturer code list for these parts.

To order a part listed in Table 3-2, specify the Agilent Technologies part number and the quantity required. Send the order to your nearest Agilent Technologies Sales and Support Office.

Replaceable Parts List

Table 3-2, *Agilent E1346A Replaceable Parts*, lists replaceable parts for the Agilent E1346A Single Ended Relay Multiplexer with serial number prefix 2934A. See Figures 3-1 and 3-2 for locations of selected mechanical parts.

See the Component Locator diagrams at the end of *Chapter 4 - Service* for locations of electrical components. See Table 3-1 for replacement part number for E1346A Component Assembly and Terminal Block. A relay multiplexer consists of the E1346-66201 Component Assembly and a Terminal Block.

A Terminal Block consists of a Terminal Card and a Terminal Case Assembly. For example, to order an E1346A Terminal Block, use E1346-80001. To order only the Terminal Card, use E1346-66510. To order only the Terminal Case Assembly, use E1300-84401.

Table 3-1. Relay Multiplexer Assembly/Terminal Block Part Numbers

Multiplexer	Component Assembly	Terminal Block	Terminal Card	Terminal Case Assy
E1346A SE Relay Mux	E1346-66201	E1346-80001	E1346-66510	E1300-84401

Table 3-2. Agilent E1346A Replaceable Parts

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr. Code	Mfr. Part Number
			ASSEMBLIES/CABLES/MANUALS (See Figure 3-1)		
A1	E1346-66201	1	MOD RLY MUXR 48CH SE	28480	E1346-66201
	E1400-61605	1	CABLE RIBBON ASSEMBLY FOR E1400A	28480	E1400-61605
BRK1-BRK2	0050-2183	2	CASTING-ZINC P.C. BOARD HOLDER	28480	0050-2183
	9220-4727	1	PAD	28480	9220-4727
	9220-4728	1	PAD	28480	9220-4728
LBL1	E1300-84308	1	LBL LOGO AGILENT B SIZE	28480	E1300-84308
LBL2	E1300-84309	1	LBL LOGO VXI B SIZE	28480	E1300-84309
MNL1	E1346-90004	1	USER'S MANUAL	28480	E1346-90004
MP1-MP2	1400-1546	2	BRACKET PC BOARD HOLDER; BLACK; EXTRUDED	28480	1400-1546
PNL1	E1346-00202	1	PNL-RR RLY MUXR	28480	E1346-00202
SCR1-SCR2	0515-0444	2	SCREW-MACHINE M2.5 X 0.45 8MM-LG PAN-HD	28480	0515-0444
SCR3-SCR4	0515-1968	2	SCREW PHM 2.5 X 11	28480	0515-1968
SHD1	E1300-80601	1	SHIELD SAFETY	28480	E1300-80601
W1	E1300-61605	1	CABLE ASSEMBLY, B-Size	28480	E1300-61605
			COMPONENT ASSEMBLY		
A1	E1346-66501	1	PRINTED CIRCUIT ASSEMBLY 48 CHANNEL RELAY	28480	E1346-66501
A1C1	0180-1746	2	CAPACITOR-FXD 15uF +-10% 20 V TA	56289	150D156X9020B2-DYS
A1C2-C3	0160-4822	3	CAPACITOR-FXD 1000pF +-5% 100 V CER C0G	04222	SA201A102JAAH
A1C5	0160-4801	4	CAPACITOR-FXD 100pF +-5% 100 V CER C0G	04222	SA102A101JAAH
A1C6	0160-4822		CAPACITOR-FXD 1000pF +-5% 100 V CER C0G	04222	SA201A102JAAH
A1C7-C9	0160-4801		CAPACITOR-FXD 100pF +-5% 100 V CER C0G	04222	SA102A101JAAH
A1C11	0160-3334	1	CAPACITOR-FXD 0.01uF +-10% 50 V CER X7R	04222	SA105C103KAAH
A1C17	0160-4835	9	CAPACITOR-FXD 0.1uF +-10% 50 V CER X7R	04222	SA105C104KAAH
A1C38-C42	0160-4835		CAPACITOR-FXD 0.1uF +-10% 50 V CER X7R	04222	SA105C104KAAH
A1C44	0180-1746		CAPACITOR-FXD 15uF +-10% 20 V TA	56289	150D156X9020B2-DYS
A1C45-C46	0160-4835		CAPACITOR-FXD 0.1uF +-10% 50 V CER X7R	04222	SA105C104KAAH
A1C48	0160-4835		CAPACITOR-FXD 0.1uF +-10% 50 V CER X7R	04222	SA105C104KAAH
A1CR1	1902-0554	1	DIODE-ZENER 10V 5% PD=1W IR=10UA	04713	1N4740ARL

Table 3-2. E1346A Replaceable Parts (Continued)

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr. Code	Mfr. Part Number
A1CR2	8150-4086	1	WIRE 22AWG-WHITE TEFLON 1X22 105C	28480	8150-4086
A1F1	2110-0712	1	FUSE-SUBMINIATURE 4A 125V NTD AX	75915	R251004T1
A1F2	2110-0665	1	FUSE-SUBMINIATURE 1A 125V NTD AX UL CSA	75915	R251001T1
A1J1	1252-1596	2	CONNECTOR-POST TYPE 2.54-PIN-SPCG 96-CONTACT	06776	DIN-96CPC-SRI-TR
A1J2	1252-3712	1	CONNECTOR-POST TYPE .100-PIN-SPCG 12-CONTACT	18873	68668-004
A1JM1-JM7	7175-0057	9	RESISTOR 0 MFS	28480	7175-0057
A1JM15-JM16	7175-0057		RESISTOR 0 MFS	28480	7175-0057
A1K0-K15	0490-1707	20	RELAY-REED 3A 500MA 110VAC 5VDC-COIL 5VA	71707	3600-0022
A1K90-K93	0490-1707		RELAY-REED 3A 500MA 110VAC 5VDC-COIL 5VA	71707	3600-0022
A1P1	1252-1596		CONNECTOR-POST TYPE 2.54-PIN-SPCG 96-CONTACT	06776	DIN-96CPC-SRI-TR
A1PCB1	E1346-26501	1	PC BOARD - BLANK	28480	E1346-26501
A1Q1	8150-4083	1	WIRE 22AWG-WHITE TEFLON 1X22 105C	28480	8150-4083
A1R2	0757-0453	1	RESISTOR 30.1K +-1% .125W TF TC=0+-100	24546	CT4-1/8-T0-3012-F
A1R9	0757-0417	1	RESISTOR 562 +-1% .125W TF TC=0+-100	24546	CT4-1/8-T0-562R-F
A1R10	0757-0442	1	RESISTOR 10K +-1% .125W TF TC=0+-100	24546	CT4-1/8-T0-1002-F
A1R38-R43	0698-8768	6	RESISTOR 100 +-5% .25W CC TC=-400/+500	28480	0698-8768
A1RP1-RP3	1810-0265	3	NETWORK-RES 16-DIP 680.0 OHM X 8	32997	4116R-1B0-681
A1RP25-RP26	1810-0279	3	NETWORK-RES 10-SIP 4.7K OHM X 9	56289	256CK472X2PD
A1RP32	1810-0279		NETWORK-RES 10-SIP 4.7K OHM X 9	56289	256CK472X2PD
A1SW1	3101-3066	1	SWITCH-DIP ROCKER 8-1A 0.15A 30VDC	81073	76YY22968S
A1U1-U3	1858-0069	3	TRANSISTOR ARRAY 18-LEAD PLASTIC DIP	56289	ULN-2803-A
A1U5	1820-4057	1	IC BUFFER TTL/F NAND QUAD 2-INP	18324	74F38N
A1U6	1820-6731	1	IC-ASIC GATE-ARRAY CMOS	27014	SCX6B04ACE/N9
A1U7-U8	1820-3079	2	IC DECODER CMOS/HC BIN 3-TO-8-LINE	04713	MC74HC138N
A1U9	1820-3081	1	IC FF CMOS/HC D-TYPE POS-EDGE-TRIG	04713	MC74HC74N
A1U10-U11	1820-3975	2	IC DRIVER CMOS/HC LINE OCTL	01295	SN74HC541N
A1U12	1820-4590	1	IC MV CMOS/HC MONOSTBL RETRIG DUAL	27014	MM74HC423AN
A1U15	1820-4147	1	IC LATCH CMOS/HCT TRANSPARENT OCTL	27014	MM74HCT573N
A1U16	1820-3714	2	IC TRANSCEIVER TTL/ALS BUS OCTL	01295	SN74ALS245A-1N

Table 3-2. E1346A Replaceable Parts (Continued)

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr. Code	Mfr. Part Number
A1U17-U18	1820-3631	2	IC COMPARATOR CMOS/HCT MAGNITUDE 8-BIT	27014	MM74HCT688N
A1U19	1820-3664	1	IC GATE CMOS/HCT NAND QUAD 2-INP	27014	MM74HCT00N
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
A1U25	1820-4086	3	IC FF CMOS/HCT D-TYPE POS-EDGE-TRIG	18324	74HCT273N
A1U30	1820-4086		IC FF CMOS/HCT D-TYPE POS-EDGE-TRIG	18324	74HCT273N
A1U35	1820-3714		IC TRANSCEIVER TTL/ALS BUS OCTL	01295	SN74ALS245A-1N
A1U38	1820-4086		IC FF CMOS/HCT D-TYPE POS-EDGE-TRIG	18324	74HCT273N

Table 3-2. E1346A Replaceable Parts (Continued)

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr. Code	Mfr. Part Number
			TERMINAL MODULE (See Figure 3-2)		
A3	E1346-66510	1	THERMNL MODULE PC	28480	E1346-66510
A3P1	1252-1593	1	CONNECTOR-POST TYPE 2.54-PIN-SPCG 96-CONTACT	91662	20-8577-096-002-025
A3PCB1	E1346-26510	1	PC BOARD - BLANK	28480	E1346-26510
A3TB1-TB5	0360-2391	5	TERMINAL BLOCK 12 P. POLYAMIDE	28480	0360-2391
			TERMINAL CASE ASSEMBLY (See Figure 3-2)		
CS	E1300-84401	1	CASE ASSEMBLY FOR MULTIPLEXER	28480	E1300-84401
CS1	03852-01201	1	CLAMP	28480	03852-01201
CS2	03852-86701	1	PAD-CLAMP	28480	03852-86701
CS3	0515-2109	1	SCREW-MACHINE 10-24 .625-IN-LG PAN-HD-SLT	28480	0515-2109
CS4	1390-0846	2	FASTENER-CAPTIVE SCREW M2.5 X 0.45	28480	1390-0846
CS5	E1300-01202	1	CLAMP STRAIN RELIEF	28480	E1300-01202
CS6	E1300-44101	1	COVER-TOP TERMINAL HOUSING MOLDED	28480	E1300-44101
CS7	E1300-44102	1	COVER-BOTTOM TERMINAL HOUSING	28480	E1300-44102

Table 3-3. Agilent E1346A Reference Designators

Agilent E1346A Reference Designators	
A ..... assembly	PCB ..... printed circuit board
BRK ..... bracket	PNL ..... panel
C ..... capacitor	Q ..... transistor
CR ..... diode	R ..... resistor
CS .....case	RP ..... resistor pack
LBL ..... label	RT ..... thermistor probe
F ..... fuse	SCR.....screw
J ..... electrical connector (jack)	SHD ..... shield
JM ..... jumper	SW ..... switch
K ..... relay	TB ..... terminal block
MP .....mechanical part	U ..... integrated circuit
P ..... electrical connector (plug)	

Table 3-4. Agilent E1346A Code List of Manufacturers

Mfr. Code	Manufacturer's Name	Manufacturer's Address	Zip Code
01295	TEXAS INSTRUMENTS INC	DALLAS TX US	75265
04222	AVX CORP	GREAT NECK NY US	11021
04713	MOTOROLA INC	ROSELLE IL US	60195
06776	ROBINSON NUGENT INC	NEW ALBANY IN US	47150
12014	CHICAGO RIVET & MACHINE CO	NAPERVILLE IL US	60540
18324	SIGNETICS CORP	SUNNYVALE CA US	94086
18873	DUPONT E I DE NEMOURS & CO	WILMINGTON DE US	19801
24546	CORNING GLASS WORKS	CORNING NY US	14830
27014	NATIONAL SEMICONDUCTOR CORP	SANTA CLARA CA US	95052
28480	AGILENT TECHNOLOGIES - CORPORATE	PALO ALTO CA US	94304
32997	BOURNS NETWORKS INC	RIVERSIDE CA US	92507
56289	SPRAGUE ELECTRIC CO	LEXINGTON MA US	02173
71707	COTO WABASH	PROVIDENCE RI US	02907
71983	DOW CHEMICAL CO	MIDLAND MI US	48674
75915	LITTELFUSE INC	DES PLAINES IL US	60016
81073	GRAYHILL INC	LA GRANGE IL US	60525
91662	ELCO CORP	NEWPORT BEACH CA	92660

Mechanical Parts Locators

Figures 3-1 and 3-2 show locations of selected mechanical parts for the Agilent E1346A Single Ended Relay Multiplexer. See the Component Locators at the end of *Chapter 4 - Service* for locations of electrical components.

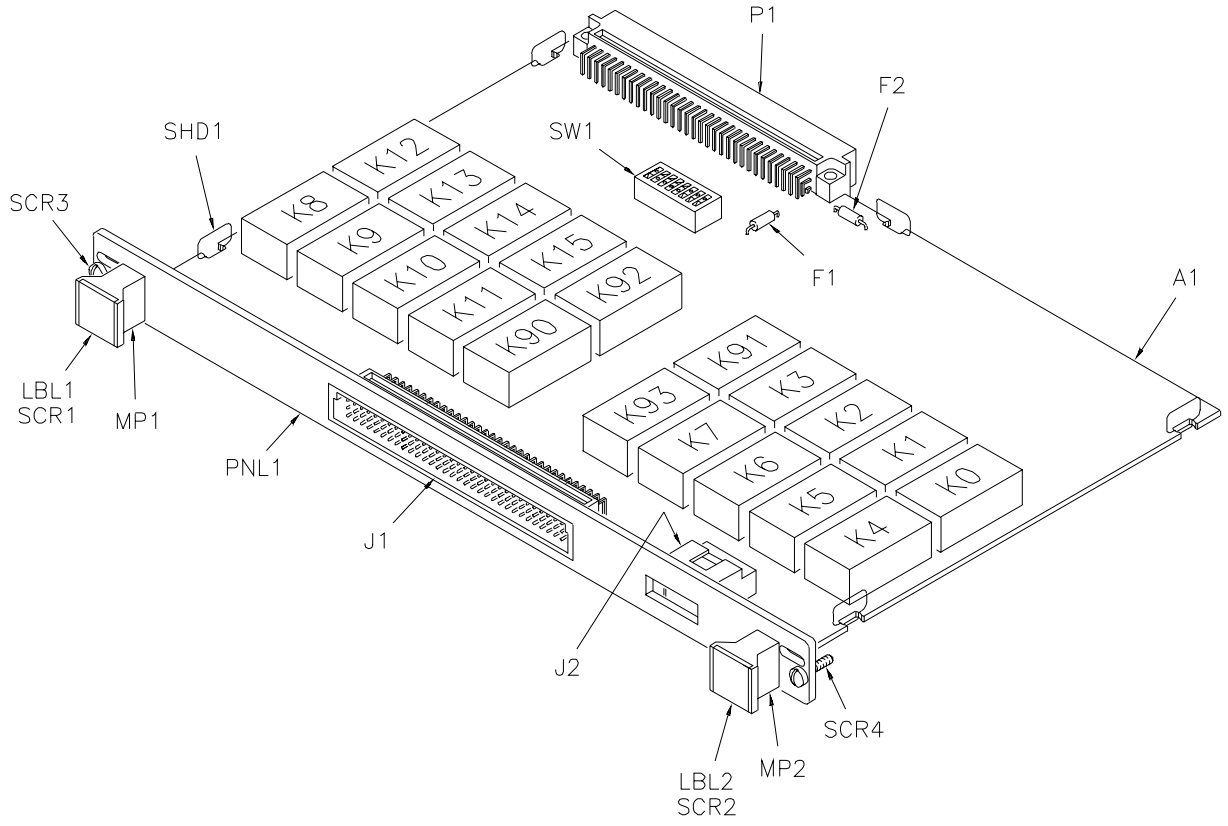


Figure 3-1. Component Assy Mechanical Parts

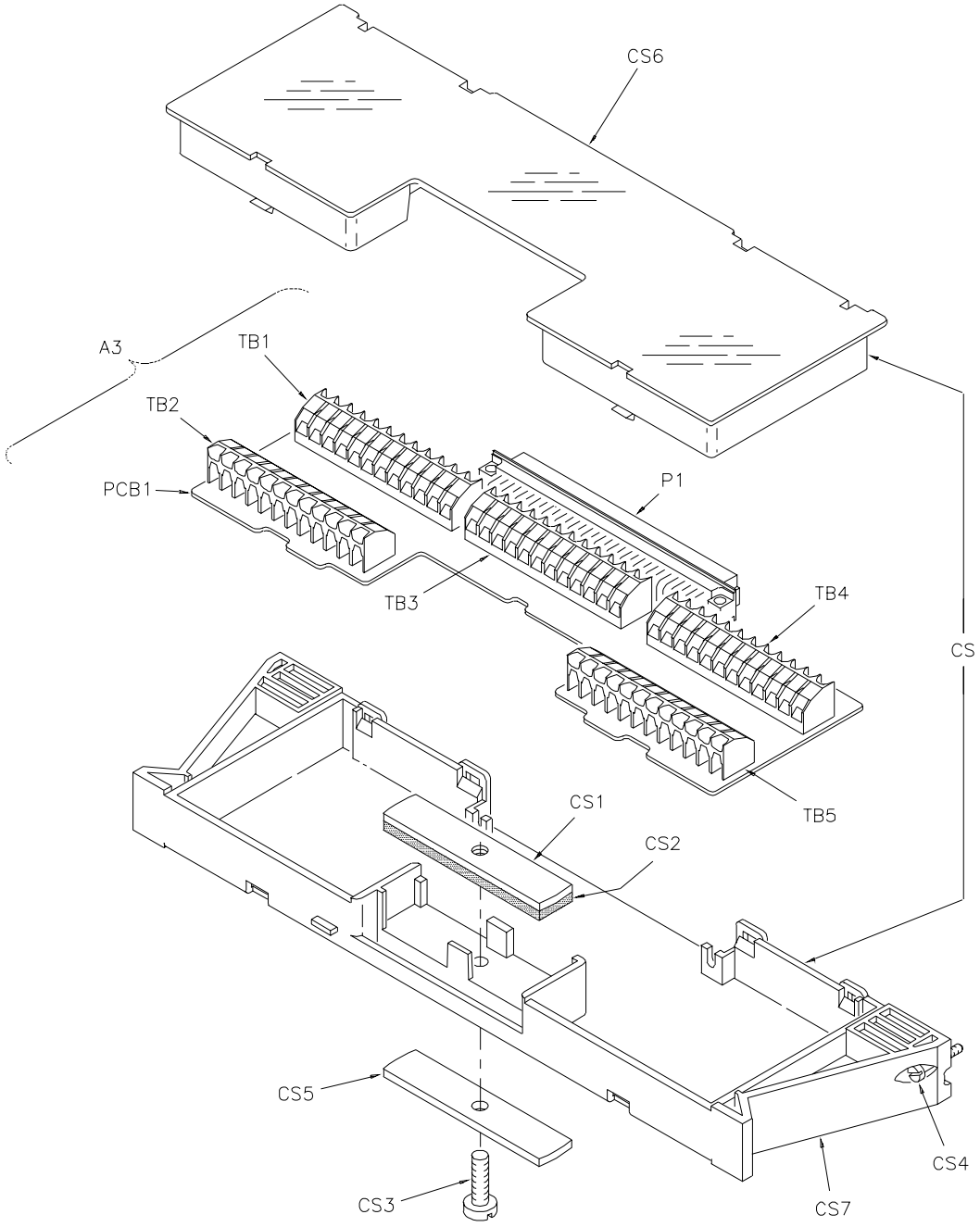


Figure 3-2. Terminal Block Mechanical Parts

4
Service

Introduction

This chapter contains service information for the Agilent E1346A multiplexer. Also included are troubleshooting, repair, and maintenance guidelines. Component locators and schematic diagrams for the multiplexer are located at the end of this chapter.

WARNING

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

Equipment Required

Equipment required for multiplexer 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.

Service Aids

See *Chapter 3 - Replaceable Parts* for descriptions and locations of Agilent E1346A replaceable parts. Service notes, manual updates, and service literature for the multiplexers may be available through Agilent Technologies. For information, contact your nearest Agilent Technologies Sales and Service Office.

Agilent E1346A Multiplexer Description

The Agilent E1346A 48-Channel Single Ended Relay Multiplexer consists of an E1346A component assembly (E1346-66201) and a terminal block. The multiplexer provides switching (multiplexing) for 48 channels (channels 00 to 47). Each channel switches only a high (HI) connection. The Low (LO) and Guard (G) connections are common for all channels. The Low and Guard are switched, however, by the tree switches. See Figure 4-1 for a block diagram of these modules.

Component Assembly Description

The E1346A Component Assembly consists of 16 channel relays and four tree switch relays. Each channel relay switches three HI channels to the tree switch relays.

The AT, BT, and CT Tree Switch relays control which of the three channels connected by a channel relay are connected to the Voltage Sense common terminals and the Analog Bus Connector. Additionally, the Tree Switches connect LO and G to common. HI, LO, and G are all provided 100 Ω protection resistors on the component assembly.

The DT Tree Switch relay connects the Current Source terminals to the Voltage Sense Terminals and Analog Bus connector. HI, LO, and G are switched and provided with 100 Ω protection resistors on the component assembly.

Terminal Block Description

The terminal block provides connections from user devices to the multiplexer. The terminal block also provides connections for multimeters, voltmeters, counters, and other measuring devices.

The Terminal Block has:

- 48 terminals for channel HI
- three terminals for channel LO
- three terminals for channel G
- three terminals for Current Source HI, LO ,and G
- three terminals for Voltage Sense HI, LO, and G.

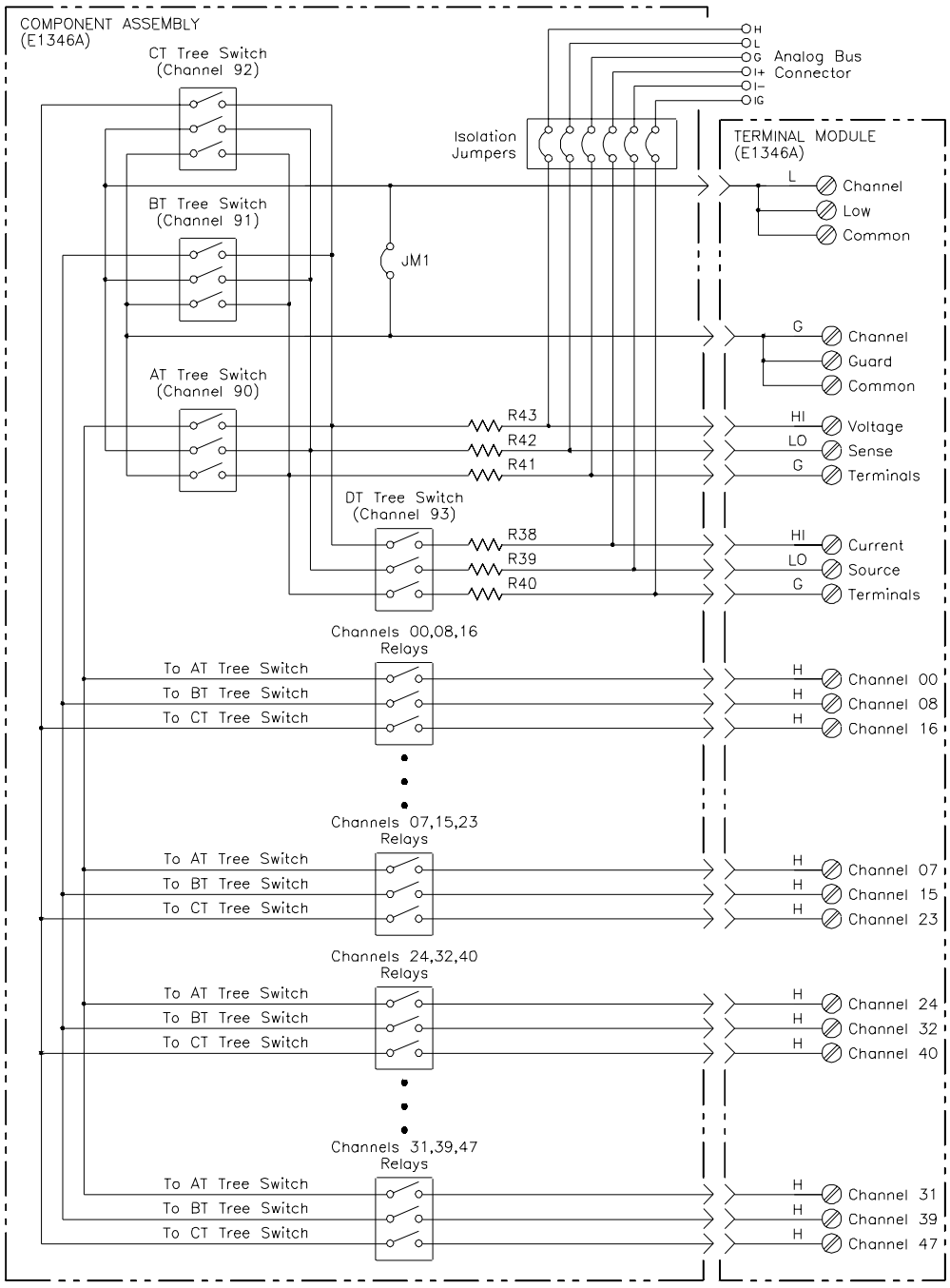


Figure 4-1. Agilent E1346A Block Diagram

Troubleshooting Techniques

To troubleshoot a relay multiplexer problem you must first identify the problem and then isolate the cause of the problem to a replaceable part. See *Chapter 3 - Replaceable Parts* for descriptions and locations of Agilent E1346A replaceable parts.

NOTE

If the problem cannot be isolated to a user-replaceable part shown in Table 3-1 and/or Table 3-2 we suggest you troubleshoot to the component level and then return the multiplexer to Agilent Technologies for repair. See Chapter 3 - Replaceable Parts for procedures to return multiplexers to Agilent Technologies.

Identifying the Problem

Table 4-1 lists some common symptoms for the relay multiplexers and some possible solutions. If the problem cannot be identified using these steps, perform component-level troubleshooting using the component locator diagram and schematics at the end of this chapter.

Table 4-1. Agilent E1346A Typical Problems

Symptom	Possible Solutions
Non-zero error code in response to SYST:ERR?	See Appendix C of the *Agilent E1346A Relay Multiplexers User's Manual*.
Multiplexer not responding to commands.	See "Making Visual Checks" in this chapter
Multiplexer fails Closed Channel Resistance Test (Test 2-1) Multiplexer fails DC Isolation Test (Test 2-2)	See "Testing the Multiplexer" in this chapter Check user wiring and test fixture connections.

Making Visual Checks

Visual checks for the Agilent E1346A multiplexer include the following. See Table 4-2 for typical symptoms/actions.

- Check switches/jumpers
- Check for heat damage
- Checking terminal block connections

NOTE

See the Agilent E1346A Single Ended Relay Multiplexer User's Manual for information on logical address and IRQ settings. If there are no apparent problems following the visual checks, run the Performance Verification Tests in Chapter 2 to see if a relay or other component is defective.

Table 4-2. Agilent E1346A Visual Tests/Checks

Test/Check	Reference Designator	Check	Action/Notes
Heat Damage	- - - - - - - - - - - - - - -	Discolored PC boards Damaged insulation Evidence of arcing	If there is damage, do not operate the multiplexer until you have corrected the problem.
Switch/Jumper Settings	- - - - - SW1	IRQ Level setting Logical address setting	Factory set at 1 Factory set at 112
Component Assembly	F1, F2 J1, J2 P1	Fuse continuity Dirty or bent connector pins Dirty or bent connector pins	Check fuses with ohmmeter Straighten/clean pins Straighten/clean pins
Terminal Block	P1 TB1 - TB5	Dirty or bent connector pins Loose screw connections	Straighten/clean pins Check/tighten connections

Testing the Multiplexer

You can use the tests and checks in *Chapter 2 - Verification Tests* and the information in Table 4-3 to isolate the problem to a relay, to a component, or to both. See *Chapter 3 - Replaceable Parts* for locations of mechanical parts. See the component locator diagram at the end of this chapter for locations of electrical components.

Table 4-3 shows the relationship between the failing channel number and the associated channel relay, tree relay, and driver/decoder. Because the closed channel resistance test always includes two relay contacts, use Table 4-3 to determine if failures of the closed contact resistance test are in logical groupings. For example, if *Test 2-1. Closed Channel Resistance Test* failed for channel 00 alone, replace relay K0, if the test failed for channels 24 through 31, replace relay K90.

Table 4-3. Troubleshooting

Channel Number	Channel Relay	Tree Relay	Channel Relay Driver/Decoder
00	K0	K90	U1, U38
01	K1		
02	K2		
03	K3		
04	K4		
05	K5		
06	K6		
07	K7		
08	K0	K91	
09	K1		
10	K2		
11	K3		
12	K4		
13	K5		
14	K6		
15	K7		
16	K0	K92	
17	K1		
18	K2		
19	K3		
20	K4		
21	K5		
22	K6		
23	K7		
24	K8	K90	U2, U30
25	K9		
26	K10		
27	K11		
28	K12		
29	K13		
30	K14		
31	K15		
32	K8	K91	
33	K9		
34	K10		
35	K11		
36	K12		
37	K13		
38	K14		
39	K15		
40	K8	K92	
41	K9		
42	K10		
43	K11		
44	K12		
45	K13		
46	K14		
47	K15		
90		K90	U3, U25
91		K91	
92		K92	
93		K93	

Repair and Maintenance Guidelines

This section provides guidelines for repairing and maintaining the Agilent E1346A Single Ended Relay Multiplexer including:

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

ESD Precautions

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

- Always use a static-free work station with a pad of conductive rubber or similar material when handling multiplexer components.
- 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 of the multiplexer modules have plated-through holes that provide 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:

- Avoid unnecessary component unsoldering and soldering. Excessive replacement can result in damage to the circuit board, adjacent components, or both.
- 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 multiplexer, inspect the multiplexer 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 tests as described in *Chapter 2 - Verification Tests* to verify that the multiplexer is functional.

Component Locators and Schematic Diagrams

Table 4-4 lists Component Locator Diagrams and Schematic Diagrams for the Agilent E1346A relay multiplexer.

Table 4-4. Relay Multiplexer Component Locator and Schematic Diagram Drawings

	Part Number	Drawing Number	Drawing Title
Component Locator Diagrams	E1346-66501	L-E1346-66501	Relay Multiplexer Component Assembly
	E1346-66510	L-E1346-66510	48-Channel Relay Multiplexer Terminal Card
Schematic Diagrams	E1346-66501	S-E1346-66501 (pg 1)	Relay Multiplexer Component Assembly - VXI Interface #1
	E1346-66501	S-E1346-66501 (pg 2)	Relay Multiplexer Component Assembly - VXI Interface #2
	E1346-66501	S-E1346-66501 (pg 3)	Relay Multiplexer Component Assembly - Relay Drivers
	E1346-66501	S-E1346-66501 (pg 4)	Relay Multiplexer Component Assembly - Relays
	E1346-66510	S-E1346-66510	48-Channel Relay Multiplexer Terminal Card

Appendix A
Verification Tests - C Programs

Functional Verification Test

This program is designed to do the Functional Verification Test found in *Chapter 2 - Verification Tests.*

Example: Self Test

The self test for Agilent E1346A Single Ended Relay Multiplexer consists of sending the *IDN? command and checking the response. This test can be used to verify that the multiplexer is connected properly and is responding to a baxic command.

NOTE

This program assumes a primary address of 09 and a secondary address of 14. If your Multiplexer address does not match this, you must either change the Multiplexers address setting or change the program line # define ADDR "hpib7,9,14" *to match your Multiplexers address setting.*

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

# define ADDR "hpib7,9,14"                /* Address of device */

void main (void)
{
  INST id;                                /* Define id as an instrument */
 char a[256] =  {0};                      /* Result variable */
 int i;
ionerror (I_ERROR_EXIT);
 id =  iopen (ADDR);                      /* Open instrument session */
 iprint(id, "*IDN?\ n");                  /* Send *IDN? command */
  iscanf(id, "%t", a);                    /* Get response */
  printf("\ n %s", a);                    /* Print result */
  getchar();                              /* Pause */

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

Performance Verification Test

This program is designed to do the Performance Verification Test found in *Chapter 2 - Verification Tests.*

NOTE

These programs assume a primary address of 09 and a secondary address of 14. If your Multiplexer address does not match this, you must either change the Multiplexers address setting or change the program lines # define ADDR "hpib7,9,14" *to match your Multiplexers address setting.*

Example: Closed Channel Resistance Test

This example performs a Closed Channel Resistance Test to measure Channels 00 - 47, Channels 90 - 92, cna Channel 93 HI, LO, and GU relay contact resistances. If the relay contact resistance for a channel is > 2.0W, the program prints a message indicating which channel has failed the test. on all channels in the RF Multiplexer. If a channel is out of specification, the program prints a message and pauses.

```
/*  Closed-channel Resistance Test          E1346A  */

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

# define ADDR "hpib7,9,14"              /* Address of device */
# define DMM "hpib7,22"                 /* Address of multimeter */

void main (void)
{
  INST id, dm;                          /* Define id and dm as an instrument */
  int channel, i, j;
  double ohm, R[6], result[48], result1[3][3], value1[3][3];
  char cr[256] =  {0};

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

  ionerror(I_ERROR_EXIT);

  id =  iopen (ADDR);                   /* Open instrument session */
  itimeout (dm, 10000);

  printf (dm, "PRESET NORM\ n");
  printf (dm, "END ALWAYS\ n");
  printf (dm, "TRIG HOLD\ n");
  printf (dm, "FUNC OHMF\ n");
```

```
/*----------Measure Protection Resistors ----------*/

  printf ("\ n\ nMeasure Protection Resistors R38 - R43");
  printf ("\ n\ n 1. Turn mainframe power OFF.");
  printf ("\ n 2. Remove E1346A component assembly from mainframe.");
  printf ("\ n 3. Press ENTER when ready to measure protection resistors.");
  getchar ();
  printf ("\ n\ n");

for (i =  0; i < =  5; i+ + )
{
printf ("\ nConnect DMM leads (4-wire) to resistor R%u", i+ 38);
printf ("\ nPress ENTER when ready to measure resistance");
getchar ();

iprintf (dm, "TRIG SGL\ n");
iscanf (dm, "%lf', &R[i]);
iscanf (dm, "%t", cr);
printf ("\ nResistance of R%u =  %lf', i+ 38, R[i]);
}

printf ("\ n\ n\ nInstall Component Assembly and Test Fixture");
printf ("\ n\ n 1. Turn Mainframe AND Agilent 3458a DMM power OFF.");
printf ("\ n 2. Connect GPIB Cable between mainframe and DMM.");
printf ("\ n 3. Install E1364A Component Assembly into Mainframe.");
printf ("\ n 4. Attach Test Fixture to Component Assembly.");
printf ("\ n 5. Turn Mainframe and DMM power ON");
printf ("\ n 6. Press ENTER when ready to begin testing.");
getchar ();

/*.............Measure Channels 00-47 and 90-92 (HI, Lo, and G).....*/

id =  iopen(ADDR);
iprintf (id, "*RST\ n");
iprintf (dm, "PRESET NORM;TRIG HOLD\ n");
iprintf (dm, "END ALWAYS\ n");
iprintf (dm, "FUNC OHMF\ n");

j =  100;
printf ("\ n\ nChannel 00-47 and 90-92 HI measurements");
printf ("\ n\ n 1. Connect DMM Sense and Input HI leads to COMMON HI.");
printf ("\ n 2. Connect DMM Sense and Input LO leads to VOLTAGE SENSE HI.");
printf ("\ n 3. Press ENTER when connections are complete.");
getchar 0;

for (i =  0;i < =  47; i+ + )
{
iprintf (id, "CLOS (@%u)\ n", j+ i);
iprintf (dm, "TRIG SGL\ n");
iscanf (dm, "%lf", &value[i]);
iscanf (dm, "%t", cr);
iprintf (id, "OPEN (@%u)\ n", j+ i);
result[i] =  value[i] - R[5];
```

```
if (result[i] <  0) result[i] =  0;
if (result[i] >  2.0) printf ("\ n*** Resistance for Channel %u HI path is 2.0 Ohms
*** %lf", i, result[i]);
}

printf ("\ n\ nMeasurements complete for Channels 00-47 and 90-92 HI");
printf ("\ nPress ENTER for Channels 90-92 LO measurements");
getchar ();

/*.....Measure Channels 90-92 LO.....*/

iprintf (id, "*RST\ n");

printf ("\ n\ n\ nChannels 90-92 LO measurements");
printf ("\ n\ n 1. Connect DMM Sense and Input HI leads to COMMON LO.");
printf ("\ n 2. Connect DMM Sense and Input LO leads to VOLTAGE SENSE
LO.");
printf ("\ n 3. Press ENTER when connections are complete.");
getchar ();

j =  100;
for (i =  0;i < =  2; i+ + )

{
iprintf (id, "CLOS (@%u)\ n", j);
iprintf (dm, "TRIG SGL\ n");
iscanf (dm, "%lf", &value1[i][1]);
iscanf (dm, "%t", cr);
iprintf (id, "OPEN (@%u)\ n", i*8);
result1[i][1] =  value1[i][1] - R[42];

if (resultl[i][1] <  0) resultl[i][1] =  0;
if (resultl[i][1] >  2.0) printf ("\ n*** Resistance for Channel %u LO Relay is 2.0
Ohms", i+ 90);

j =  j +  8;
}

printf ("\ n\ nMeasurements complete for Channels 90-92 LO.");
printf ("\ nPress ENTER for Channel 90-92 G measurements.");
getchar ();

/*.....Measure Channels 90-92 G.....*/

printf ("\ n\ n\ nChannels 90-92 G measurements");
printf ("\ n\ n 1. Connect DMM Sense and Input HI leads to COMMON G.");
printf ("\ n 2. Connect DMM Sense and Input LO leads to VOLTAGE SENSE G.");
printf ("\ n 3. Press ENTER when connections are complete.");
getchar ();

j =  100;
```

```
for (i =  0; i < =  2; i+ + )
{

iprintf (id, "CLOS (@°/0u)\ n", j);
iprintf (dm, "TRIG SGL\ n");
iscanf (dm, "%lf", &value1[i][2]);
iscanf (dm, "%t", cr);
iprintf (id, "OPEN (@%u)\ n", i*8);
resultl[i][2] =  value1[i][2] - R[42];

if (resultl[i][2] <  0) resultl[i][2] =  0;
if (resultl[i][2] >  2.0) printf ("\ n*** Resistance for Channel %u G Relay is 2.0
Ohms", i+ 90);

j =  j +  8;
}

printf ("\ n\ nMeasurements complete for Channels 90-92 G.");
printf ("\ nPress ENTER for Channel 93 HI, LO, and G measurements.");
getchar ();

/*.....Measure Channel 93 HI, LO, and G.....*/

j =  193;
printf ("\ n\ n\ nChannel 93 HI, LO, and G measurements");
printf ("\ n\ n 1. Connect DMM Sense and Input HI leads to VOLTAGE SENSE
HI.");
printf ("\ n 2. Connect DMM Sense and Input LO leads to CURRENT SOURCE
HI.");
printf ("\ n 3. Press ENTER when connections are complete.");
getchar ();

iprintf (id, "CLOS (@%u)\ n", j);
iprintf (dm, "TRIG SGL\ n");
iscanf (dm, "%lf", &value1[0][3]);
iscanf (dm, "%t", cr);
resultl[0][3] =  value1[0][3] - R[38] - R[43];
iprintf (id, "open (@%u)\ n", j);

if (result1[0][3] <  0) result1[0][3] =  0;
if (result1[0][3] >  2.0) printf ("\ n*** Resistance for Channel 93 HI Relay is 2.0
Ohms");

printf ("\ n\ n 1. Connect DMM Sense and Input HI leads to VOLTAGE SENSE
LO.");
printf ("\ n 2. Connect DMM Sense and Input LO leads to CURRENT SOURCE
LO.");
printf ("\ n 3. Press ENTER when connections are complete.");
getchar();

iprintf (id, "CLOS (©%u)\ n", j);
iprintf (dm, "TRIG SGL\ n");
iscanf (dm, "%lf", &valuel[1][3]);
```

```
iscanf (dm, "%t", cr);
resultl[1][3] =  valuel[1][3] - R[39] - R[42];
iprintf (id, "open (@%u)\ n", j);

if (result1[1][3] <  0) result1[1][3] =  0;
if (result1[1][3] >  2.0) printf ("\ n*** Resistance for Channel 93 LO Relay is 2.0
Ohms");

printf ("\ n\ n 1. Connect DMM Sense and Input HI leads to VOLTAGE SENSE
G.");
printf ("\ n 2. Connect DMM Sense and Input LO leads to CURRENT SOURCE
G.");
printf ("\ n 3. Press ENTER when connections are complete.");
getchar ();

iprintf (id, "CLOS (@%u)\ n", j);
iprintf (dm, "TRIG SGL\ n");
iscanf (dm, "%lf", &value1[2][3]);
iscanf (dm, "%t", cr);
result1[2][3] =  value1[2][3] - R[40] - R[41];
iprintf (id, "open (@%u)\ n", j);

if (result1[2][3] <  0) result1[2][3] =  0;
if (result1[2][3] >  2.0) printf (An*** Resistance for Channel 93 G Relay is 2.0
Ohms");

printf ("\ n\ nMeasurements complete for Channel 93 HI, LO, and G.");
printf ("\ nPress ENTER to display measurement results.");
getchar ();

/*.....Display Measurement Results.....*/

printf ("\ n\ n\ nChannels 00-47 & 90-92 HI Contact Resistance\ n");
for (i =  0;i < =  23; i+ + )
{

printf ("\ n CH %u & %u %6.4lf Ohms CH %u & %u %6.4lf
Ohms",i,90+ (i/8),result[i],i+ 24,90+ (i/8),result[i+ 24]);
}

printf ("\ n\ nChannels 90-92 LO and G Contact Resistance\ n");
printf ("\ n CH 90 LO %6.41f Ohms CH 91 LO %6.4lf Ohms CH 92 LO %6.4lf
Ohms", result1[0][1],result1[1][1],result1[2][1]);
printf ("\ n CH 90 G %6.4lf Ohms CH 91 G (706.41f Ohms CH 92 G %6.41f
Ohms", result1[0][2],result1[1][2],result1[2][2]);
printf ("\ n\ nChannel 93 HI, LO, and G Contact Resistance\ n");

printf ("\ n CH 93 HI %6.4lf Ohms\ n CH 93 LO %6.4lf Ohms\ n CH 93 G %6.41f
Ohms\ n",result1[0][3],result1[1][3],result1[2][3]);

iclose (id);
```

Example: DC Isolation Test

This example performs DC Isolation Tests for HI to Chassis, HI to LO, and HI to GU (Guard).

```
/* DC Isolation Test          E1346A */

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

# define ADDR "hpib7,9,14"          /* Address of device */
# define DMM "hpib7,22"             /* Address of multimeter*/

void main (void)
{
INST id, dm;
char reading[256]=  {0};            /* Define id and dm as instruments */
char cr[256]=  {0};                 /* Result variable */

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

ionerror(I_ERROR_EXIT);

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

iprintf (dm, "PRESET NORM;TRIG HOLD\ n");
iprintf (dm, "FUNC OHM;RANGE 1E9\ n");
iprintf (dm, "END ALWAYS\ n");

iprintf (id, "*RST\ n");
iprintf (id, "CLOS (@193,100,108,116)\ n");

/*.....HI to CHASSIS.....*/

printf ("\ n\ nConnect DMM HI and LO to E1346A COMMON HI and CHASSIS");
getchar ();
iprintf (dm, "TRIG SGL\ n");
iscanf (dm, "%t", reading);
printf ("\ nDC Isolation - HI to CHASSIS ");
printf (" R =  %s Ohms", reading);

/*.....HI to LO.....*/

printf ("\ n\ nConnect DMM HI and LO to E1346A COMMON HI and COMMON LO");
getchar 0;
iprintf (dm, "TRIG SGL\ n");
iscanf (dm, "%t", reading);
printf ("\ nDC Isolation - HI to LO ");
printf (" R =  %s Ohms", reading);

/*.....HI to GUARD.....*/
```

```
/*.........HI to GUARD.........*/

printf ("\ n\ nConnect DMM HI and LO to E1346A COMMON HI and COMMON G");
getchar ();
iprintf (dm, "TRIG SGL\ n");
iscanf (dm, "%t", reading);
printf ("\ nDC Isolation - HI to GUARD ");
printf (" R =   %s Ohms", reading);

/*.........................................*/

iprintf (id, "OPEN (@193,100,108,116)\ n");

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

iclose (dm);
}
```