# Agilent 75000 SERIES C

# Agilent E1442A
# 64-Channel Form C Switch Module

## Service Manual

Agilent Technologies



E1442-90011
E0706

Manual Part Number: E1442-90011

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# Contents

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*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 E1442A 64-Channel Form C Switch Modules 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 E1442-90010). . . . . October 1994

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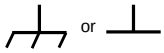
## Safety Symbols

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.

# 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:** 64 Channel Form C or Form A Switch
**Model Number:** E1442A
**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.
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## *Notes*

## *Notes*

## *Notes*

# Chapter 1
# General Information

## Introduction

This service manual contains information to test, troubleshoot, and repair the Agilent E1442A 64-Channel Form C Switch Module.

**Note**

*The information in this manual assumes you are familiar with Agilent E1442A operation. If incoming inspection is required, see Inspection/Shipping later in this manual.*

## Module Description

The Agilent E1442A is a 64-channel Form C Relay Switch Module. This means it switches a common line to either the Normally Closed (NC) or Normally Open (NO) terminal. The module is a VXIbus C-size register-based slave device.

## Module Options

The Agilent E1442A comes standard with a solder lug terminal module providing access to all COM, NO, and NC terminals. In addition, two other terminal modules are available:

- Option 010. A Signal Conditioning Terminal Module for adding passive signal conditioning circuits.
- Option 020. A Screw Terminal Form A Configuration Terminal Module. This terminal module provides access to the COM and NO relay contacts but no connection to the NC relay contacts.

## Specifications

See *Appendix A - Specifications* in the *Agilent E1442A User's Manual* for complete specifications. These specifications are the performance standards or limits against which the module may be tested.

## Environment

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

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

## Safety Information

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

## Module Serial Numbers

Figure 1-1 shows the Agilent Technologies serial number structure. All Agilent E1442A modules are covered by this manual.

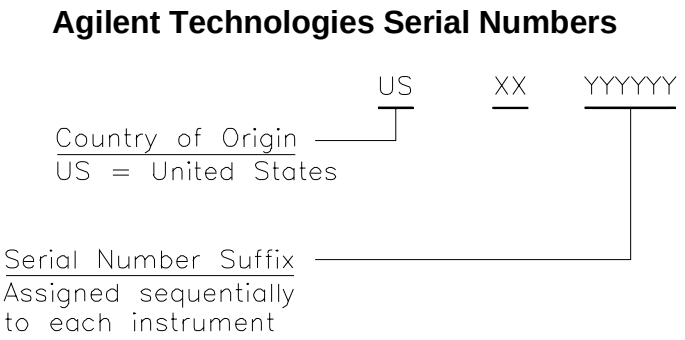



**Figure 1-1. Agilent Technologies Serial Numbers**

# Recommended Test Equipment

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

**Table 1-1. Recommended Test Equipment**

| Instrument | Requirements | Recommended Model | Use* |
|---|---|---|---|
| Controller, GPIB | GPIB compatibility as defined by IEEE standard 488-1988 and the identical ANSI standard MC1.1:<br>SH1, AH1, T2, TE0, L2, LE0, SR0, RL0, PP0, DC0, DT0, and C1, 2, 3, 4, 5. | HP 9000 Series 300<br>or<br>IBM Compatible PC with BASIC | F, O, P, T |
| Mainframe | Compatible with relay multiplexer | Agilent E1401B/T<br>Agilent E1421B | F, O, P, T |
| Command Module | Compatible with relay multiplexer | Agilent E1405A/B<br>Agilent E1406A | F, O, P, T |
| Digital Multimeter | 4-wire ohms<br>2-wire ohms (up to 1 GΩ) | Agilent 3458A or<br>Agilent 34401A | O, P, T |

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

# Schematic Diagram

Figure 1-2 shows the schematic diagram of the Agilent E1442A 64-Channel Form C Switch Module. Note that with the standard terminal block, all lines of all relays are available.

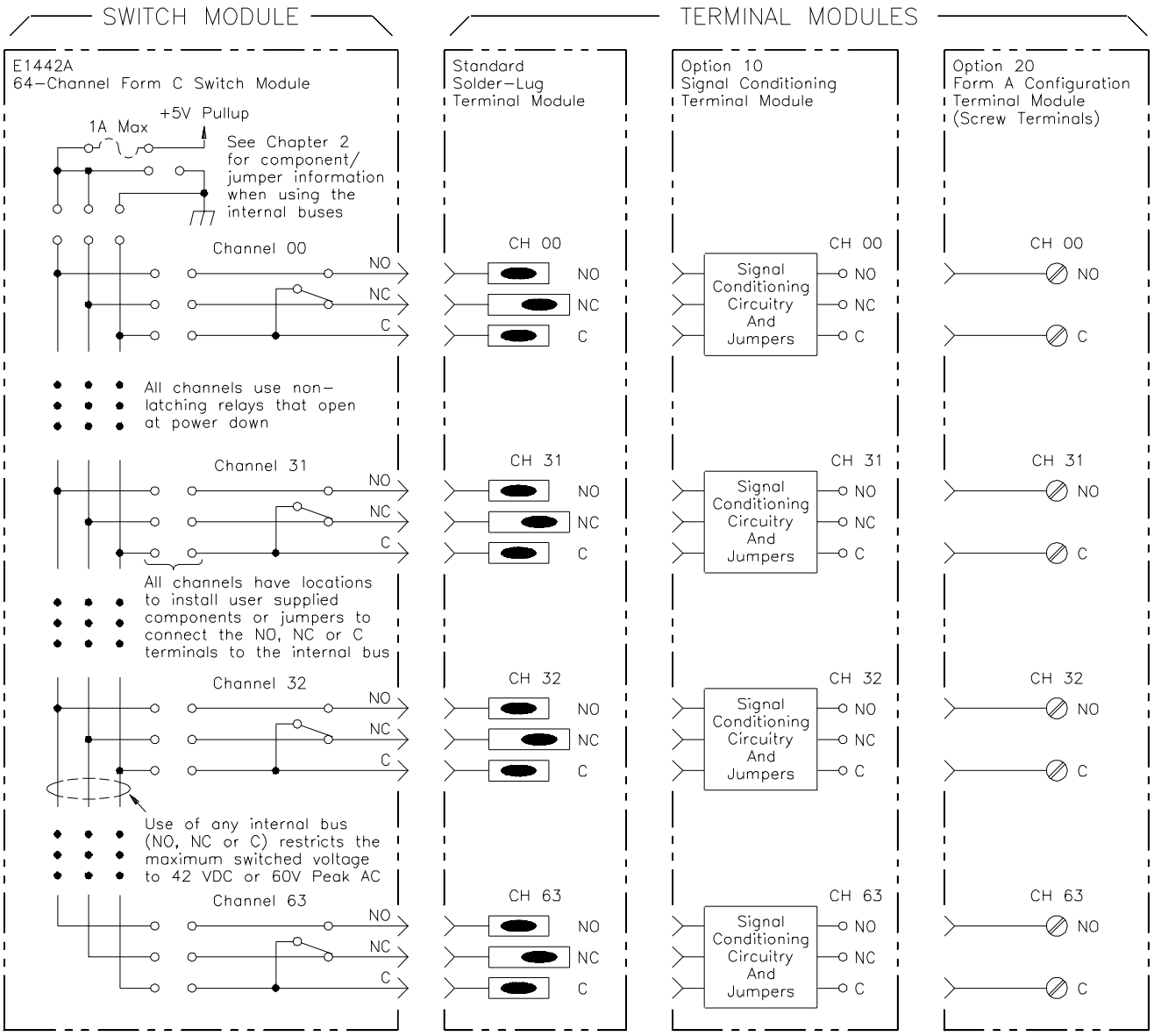



**Figure 1-2. Agilent E1442A Schematic Diagram**

# Relay Life

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

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

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

## End-of-Life Detection

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

**Contact Resistance.** As the relay begins to wear out, its contact resistance will increase. When the resistance exceeds a pre-determined value, the relay should be replaced. The end-of-life resistance recommended by Agilent Technologies can be found in Appendix A of the *Agilent E1442A User's Manual.*

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

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

## Replacement Strategy

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

**Note**

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

# Chapter 2
# Verification Tests

## Introduction

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

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

### Test Conditions/ Procedures

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

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

### Performance Test Record

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

### Verification Test Examples

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

- controller is an HP 9000 Series 200/300 computer;
- programming language is BASIC;
- relay module address is 70915 (logical address switches = 120);
- relay module card number is 1;
- DMM is an Agilent 3458A.

### Test Fixture

A test fixture is required for the Performance Verification tests. A test fixture can be manufactured from a standard Agilent E1442A solder-lug terminal module. It is recommended that you order an extra terminal module to use as a test fixture. The terminal module part number is E1442-64401. Figure 2-1 shows how the test fixture should be wired. Solder all the COM contacts together, then solder all the NC contacts together, then the NO contacts.

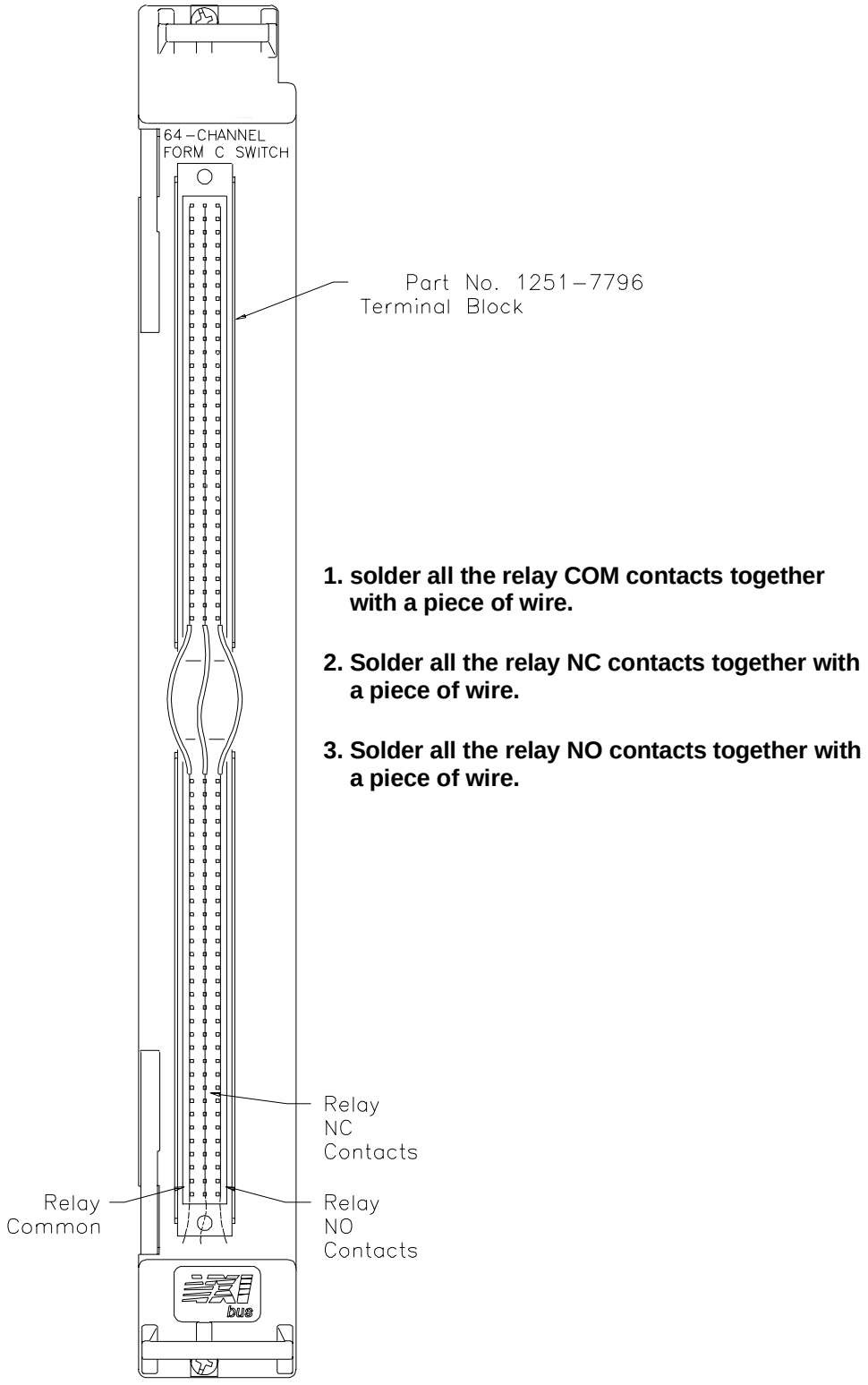



**Figure 2-1. Agilent E1442A Test Fixture Wiring**

# Functional Verification

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

## Procedure

1. Verify that the relay module is installed in the mainframe and that the mainframe has passed its power-on test.

2. Send the commands to the module (see example following).

3. Enter the responses. After the *TST command, the device will return an error code. Any non-zero error code indicates a self-test failure. See Table 2-1 for a description of self-test error codes.

## Example Program

An example follows which uses an HP 9000 Series 300 computer with BASIC and a relay module address of 70915.

```
10DIM A$[50]
20OUTPUT 70915;"*RST;*IDN?"          !Module identification
30ENTER 70915;A$
40PRINT A$
50OUTPUT 70915;"SYST:CDES? 1"        !Module Description
60ENTER 70915;A$
70PRINT A$
80OUTPUT 70915;"SYST:CTYP? 1"        !Module Type
90ENTER 70915;A$
100PRINT A$
110OUTPUT 70915;"*TST?"              !Self-test command.
120ENTER 70915;A                     !Get response.
130PRINT A
140 IF A <>0 THEN
150 REPEAT
160 OUTPUT 70915;"SYST:ERR?"
170 ENTER 70915;A,A$
180 PRINT A,A$
190 UNTIL NOT A
200 END IF
210END
```

A typical response is:

```
HEWLETT-PACKARD,SWITCHBOX,0,A.08.00
64-Channel General Purpose Switch
HEWLETT-PACKARD,E1442A,0,A.08.00
0
```

## Self-test Error Codes

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

**Table 2-1. Self-test Error Codes**

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

*ss = card number (with leading zero deleted)

# Performance Verification

The procedures in this section are used to test the module's electrical performance using the specifications in Appendix A of the *Agilent E1442A User's Manual* as the performance standards. These tests are suitable for incoming inspection, troubleshooting, and preventive maintenance.

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

**Note**

*All internal-bus jumpers should be removed prior to testing. As shipped from the factory, these jumpers are not installed. Refer to Chapter 1 of the Agilent E1442A User's Manual for additional information.*

## Test 2-1: Closed-channel Resistance Test

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

### COM to Normally Open (NO) Lines Test

1. **Hardware Connections.** See Figure 2-2.

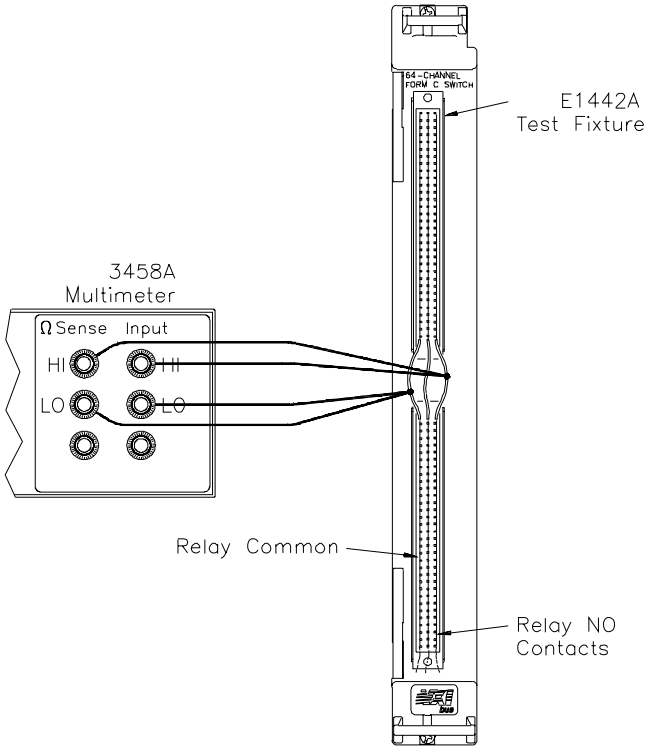



**Figure 2-2. COM to NO Lines Test Hardware Setup**

2. **Equipment Setup**

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

3. **Open Channel Reading**

   - Trigger the DMM and record the reading.
   - Reading should indicate open circuit indicating all relays are open.

4. **Sequentially CLOSE each individual relay**

   - Send **CLOSE (@01nn)** to the module to close channel *nn*. *nn* has a range of 00 to 63.
   - Trigger the DMM and verify the relay contact resistance.
   - Record the contact resistance in the Performance Test Table at the end of this chapter.
   - Open that relay and close the next. Send **OPEN (@01nn)** to open the relay and then send **CLOSE (@01nn)** to close the next relay.

### COM to Normally Closed (NC) Lines Test

1. **Hardware Connections.** See Figure 2-3.

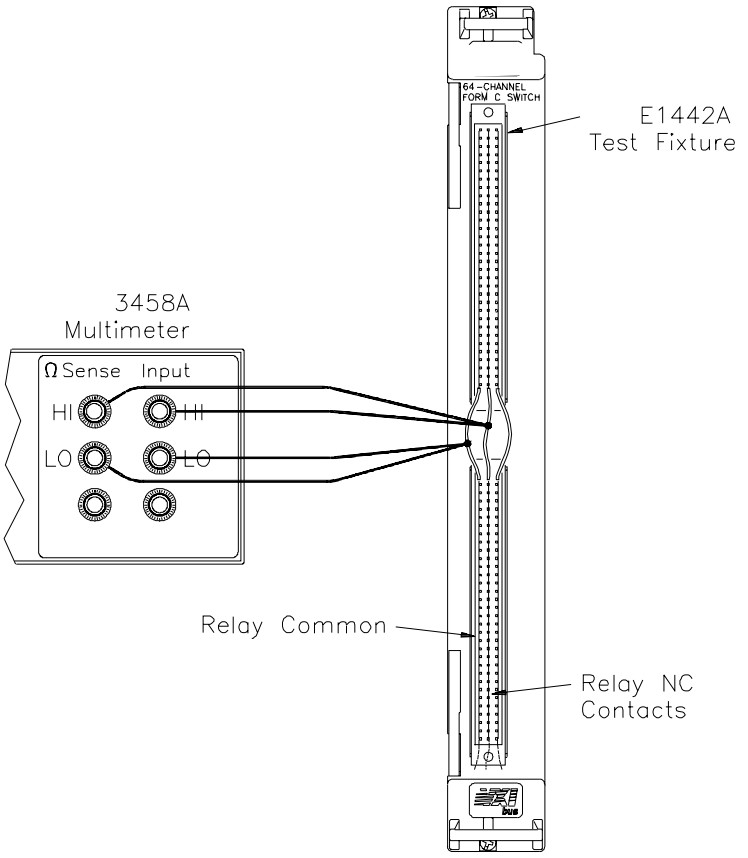



**Figure 2-3. COM to NC Lines Test Hardware Setup**

2. **Reset the Module then open all relays.**

   - Send ***RST** to the module.
   - Send **CLOSE (@0100:0163)**.

3. **Open Channel Reading**

   - Trigger the DMM and record the reading.
   - Reading should indicate open circuit indicating all relays are open.

4. **Sequentially OPEN each individual relay**

   - Send **OPEN (@01nn)** to the module to open channel *nn*. *nn* has a range of 00 to 63.
   - Trigger the DMM and verify the relay contact resistance.
   - Record the contact resistance in the Performance Test Table at the end of this chapter.
   - Close that relay and open the next. Send **CLOSE (@01nn)** to close the relay and then send **OPEN (@01nn)** to open the next relay.

**Example: Closed Channel Resistance Test Program**

This example performs the Closed-channel Resistance Test for the Agilent E1442A. This example can be used to test the High or Low lines of the module.

```
10 !   RE-STORE "E1442APERF"
20     ASSIGN @Sw TO 70915
30     ASSIGN @Dmm TO 722
40     !
50    OUTPUT @Dmm;"RESET"
60     OUTPUT @Dmm;"PRESET NORM;TRIG HOLD"      !Set DMM to 4-wire
70     OUTPUT @Dmm;"FUNC OHMF;RANGE AUTO"       !ohms, autorange
80     !
90     OUTPUT @Sw;"*RST"                        !Reset Switch
100     WAIT 1
110     !
120     PRINT "Common to Normally Open Test"
130     PRINT
140     PRINT "Connect DMM 4-Wire connections to Module COM and NO terminals."
150     PRINT
160     PRINT "Press 'CONTINUE' when ready to proceed."
170     PAUSE
180     OUTPUT @Dmm;"TRIG SGL"                   !Trigger DMM
190     ENTER @Dmm;Rdg
200     IF Rdg < 1.E+6 THEN
210         PRINT "At least one relay is stuck in the Normally Open state."
220         PRINT "Discontinue test and isolate defective relay(s). Repair module."
230          STOP
240          END IF
250    FOR Ch=0 TO 63
260     IF Ch < 10 THEN
270       Ch$ = "0"&VAL$(Ch)
280       ELSE
290       Ch$ = VAL$(Ch)
300       END IF
310    OUTPUT @Sw;"ROUT:CLOS (@01"&Ch$&")"       !Close relay
320    OUTPUT @Dmm;"TRIG SGL"                    !Trigger DMM
330    ENTER @Dmm;Rdg
340    PRINT "Channel: ";Ch;"  NO resistance is ";DROUND(Rdg,4);" ohms."
350    OUTPUT @Sw;"ROUT:OPEN (@01"&Ch$&")"       !Open Relay
360     IF Rdg > 3.5 THEN
370       PRINT "CHANNEL: ";Ch;" RESISTANCE IS OUT OF TOLERANCE."
380       PRINT "Press 'CONTINUE' to proceed with test."
390        PAUSE
```

**Closed-channel Resistance Test Program**

```
400      END IF
410    NEXT Ch
420    OUTPUT @Sw;"ROUT:CLOS (@100:0163)"          !Close all relays
430    PRINT "End of COM to NO Test. Press 'CONTINUE' to proceed."
440     PAUSE
450    CLEAR SCREEN
460    PRINT "Common to Normally Closed Test"
470    PRINT
480    PRINT "Connect DMM 4-Wire connections to Module COM and NC terminals."
490    PRINT
500    PRINT "Press 'CONTINUE' when ready to proceed."
510    PAUSE
520         OUTPUT @Dmm;"TRIG SGL"                 !Trigger DMM
530         ENTER @Dmm;Rdg
540    IF Rdg < 1.E+6 THEN
550        PRINT "At least one relay is stuck in the Normally Closed state."
560        PRINT "Discontinue test and isolate defective relay(s). Repair module."
570        STOP
580        END IF
590    FOR Ch=0 TO 63
600      IF Ch < 10 THEN
610      Ch$ = "0"&VAL$(Ch)
620       ELSE
630      Ch$ = VAL$(Ch)
640      END IF
650  OUTPUT @Sw;"ROUT:OPEN (@01"&Ch$&")"           !Close relay
660  OUTPUT @Dmm;"TRIG SGL"                        !Trigger DMM
670  ENTER @Dmm;Rdg
680  PRINT "Channel: ";I;"  NC resistance is ";DROUND(Rdg,4);" ohms"
690  OUTPUT @Sw;"ROUT:CLOS (@01"&Ch$&")"           !Open Relay
700  IF Rdg > 3.5 THEN
710    PRINT "CHANNEL: ";I;" RESISTANCE IS OUT OF TOLERANCE.
720    PRINT "Press 'CONTINUE' to proceed with test."
730    PAUSE
740    END IF
750  NEXT Ch
760  OUTPUT @Sw;"*RST"
770  PRINT "End of COM to NC test.
780  END
```

## Test 2-2: DC Isolation

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

### Common to NO/NC

1. **Hardware Connections**. See Figure 2-4.

   - Connect the DMM LO to the relay module's COM terminals.
   - Connect the DMM HI to the relay module's NO terminals.

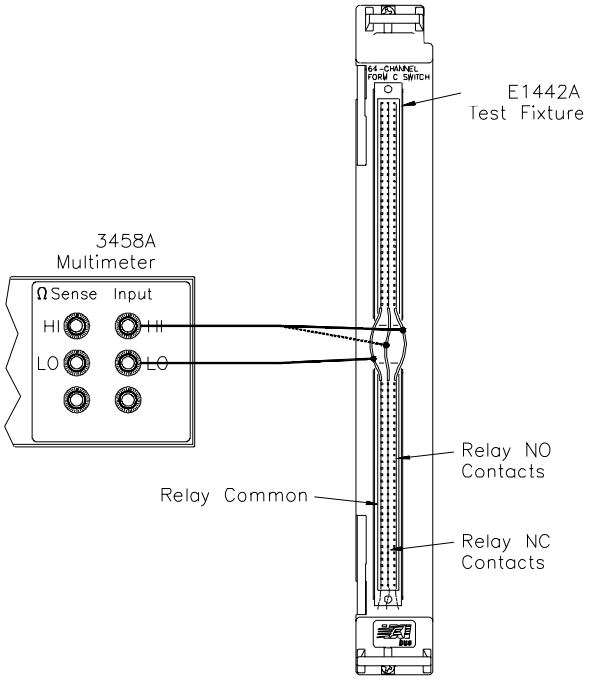



**Figure 2-4. COMmon to NO DC Isolation Hardware Setup**

2. **Equipment Setup**

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

3. **DC Isolation Reading**

   - Trigger the DMM and record the reading.

4. **Change the Hardware Connections.** See Figure 2-4.

   - Connect the DMM LO to the relay module's COM terminals.
   - Connect the DMM HI to the relay module's NC terminals.

5. **Module Setup**

   - Send **CLOSE (@0100:0163)** to open the Normally Closed contacts on all relays on the module**.**

6. **DC Isolation Reading**

   - Trigger the DMM and record the reading.

### NC/NO/COM to Chassis

1. **Hardware Connections.** See Figure 2-5.

   - Connect the DMM HI to the relay module's NC/NO/COM terminals.
   - Connect the DMM LO to any available chassis connection.

---

**Note**

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

---

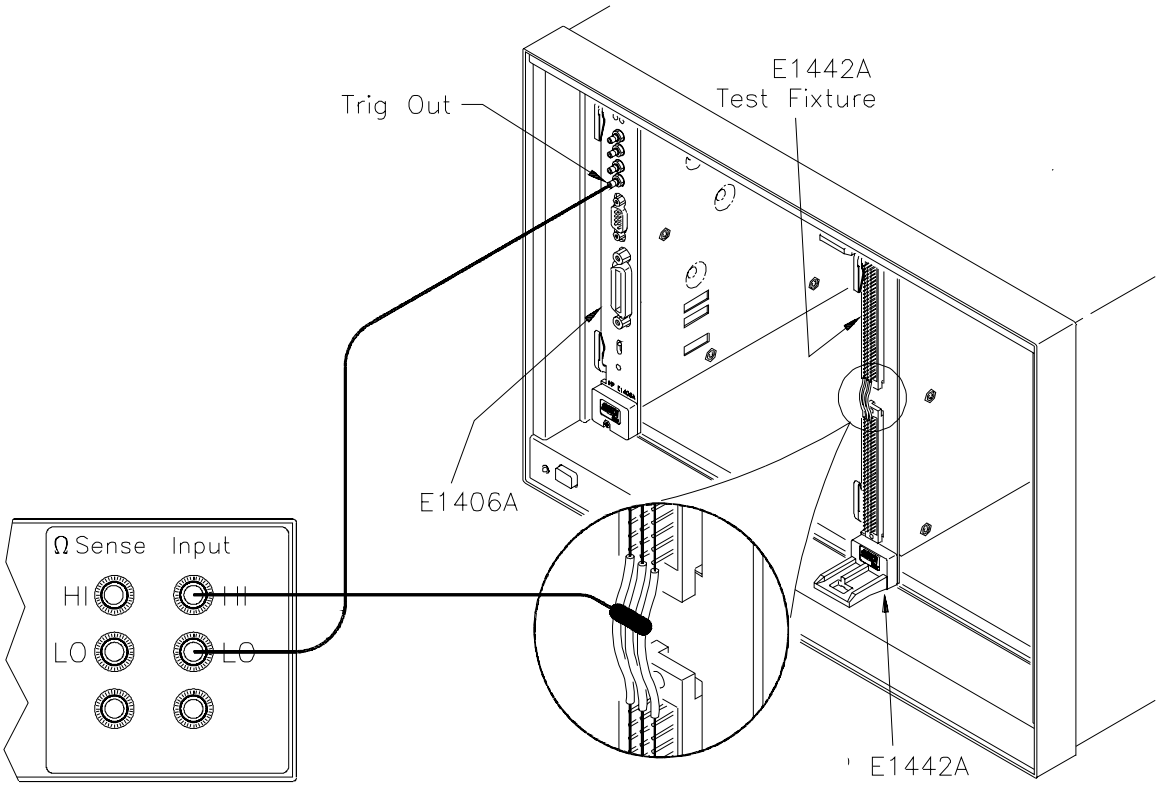



**Figure 2-5. COM, HI, LO to Chassis DC Isolation Hardware Setup**

2. **Equipment Setup**

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

3. **DC Isolation Reading**

   - Trigger the DMM and record the reading.

**Example: DC Isolation Test Program**

The following program example performs the DC Isolation test for the relay module.

```
10 !  RE-STORE "DC_E1442A"
20    ASSIGN @Sw TO 70915
30    ASSIGN @Dmm TO 722
50    OUTPUT @Dmm;"RESET"
60     OUTPUT @Dmm;"PRESET NORM;TRIG HOLD"      !Set DMM to 4-wire
70     OUTPUT @Dmm;"FUNC OHMF;RANGE  1E9"       !ohms, 1GΩ Range
90     OUTPUT @Sw;"*RST"                        !Reset Switch
100    WAIT 1
110    !
120    ! Common to NO/NC Isolation
130    PRINT "Connect DMM Lo to relay module's COM terminals."
140    PRINT "Connect DMM Hi to relay module's NO terminals."
150    PRINT
160    PRINT "Press 'CONTINUE' when ready to proceed."
170    PAUSE
180     OUTPUT @Dmm;"TRIG SGL"                  !Trigger DMM
190     ENTER @Dmm;Rdg
200    PRINT "COM to NO DC Isolation passes. ";Rdg;" ohms."
210     PRINT
220    PRINT "Connect DMM Hi to relay module's NC terminals."
230    PRINT
240    PRINT "Press 'CONTINUE' when ready to proceed."
250    OUTPUT @Sw;"CLOS (@100:0163)"            !Close all relays
260    PAUSE
270     OUTPUT @Dmm;"TRIG SGL"                  !Trigger DMM
280     ENTER @Dmm;Rdg
290    PRINT "COM to NC DC Isolation passes. ";Rdg;" ohms."
310            ! NC/NO/COM to chassis isolation test
320    PRINT "Connect DMM HI to relay module's COM/NO/NC terminals."
330    PRINT "Connect DMM LO to mainframe chassis connection."
340    PRINT
350    PRINT "Press 'CONTINUE' when ready to proceed."
360    PAUSE
370     OUTPUT @Dmm;"TRIG SGL"                  !Trigger DMM
380     ENTER @Dmm;Rdg
390    PRINT "COM/NO/NC to Chassis DC Isolation passes. ";Rdg;" ohms."
400    OUTPUT @Sw;"*RST"
410    END
```

# Performance Test Record

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

## Test Limits

Test limits are defined for closed-channel contact resistance and DC isolation using the specifications in Appendix A of the *Agilent E1442A 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 2-3. Performance Test Record for Agilent E1442A (Page 1 of 5)**

Test Facility:

Name _____

Address_____

City/State_____

Phone_____

Report No._____

Date_____

Customer_____

Tested by_____

Model_____

Serial No._____

Options_____

Firmware Rev._____

Ambient temperature_____$^{o}$C

Relative humidity_____%

Line frequency _____ Hz (nominal)

Special Notes:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

**Table 2-3. Performance Test Record for Agilent E1442A (Page 2 of 5)**

Model _____ Report No. _____ Date _____

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

**Table 2-3. Performance Test Record for Agilent E1442A (Page 3 of 5)**

Model _____ Report No. _____ Date_____

| Channel* | Minimum** | COM to NO Reading | COM to NC Reading | Maximum | Meas Uncert | TAR |
|---|---|---|---|---|---|---|
| **Test 2-1. Closed-channel Resistance Test (Values in ohms)** | | | | | | |
| ss00 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss01 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss02 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss03 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss04 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss05 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss06 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss07 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss08 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss09 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss10 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss11 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss12 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss13 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss14 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss15 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss16 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss17 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss18 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss19 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss20 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss21 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss22 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss23 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss24 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss25 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss26 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss27 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss28 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss29 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |

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

**Table 2-3. Performance Test Record for Agilent E1442A (Page 4 of 5)**

| Channel* | Minimum** | COM to NO Reading | COM to NC Reading | Maximum | Meas Uncert | TAR |
|---|---|---|---|---|---|---|
| **Test 2-1. Closed-channel Resistance Test (Values in ohms)** | | | | | | |
| ss30 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss31 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss32 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss33 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss34 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss35 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss36 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss37 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss38 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss39 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss40 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss41 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss42 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss43 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss44 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss45 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss46 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss47 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss48 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss49 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss50 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss51 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss52 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss53 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss54 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss55 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss56 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss57 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss58 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss59 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss60 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss61 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss62 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |
| ss63 | | _____ | _____ | 3.5Ω | 1.03E-4 | NA |

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

**Table 2-3. Performance Test Record for Agilent E1442A (Page 5 of 5)**

| Test Description | Minimum | Reading | Maximum* | Meas Uncert | TAR |
|---|---|---|---|---|---|
| **Test 2-2. DC Isolation Test (Values in ohms)** | | | | | |
| COM to NO | 5E8Ω | _____ | | 6.0E6 | NA |
| COM to NC | 5E8Ω | _____ | | 6.0E6 | NA |
| COM/NO/NC to Chassis | 5E8Ω | _____ | | 6.0E6 | NA |

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

# Chapter 3
# Replaceable Parts

## Introduction

This chapter contains information for ordering replaceable parts for the Agilent E1442A 64 Channel Form C Switch Module.

### Ordering Information

To order a part listed in this chapter, 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 3-1 lists replaceable parts for the Agilent E1442A . See "Component Locators" (Figure 3-1) for locations of parts in Table 3-1. Table 3-4 shows reference designators for parts in Table 3-1, and Table 3-5 shows the manufacturer code list for the parts.

**NOTE**

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

**Table 3-1. Agilent E1442A Replaceable Parts**

| Reference Designator | Agilent Part Number | Qty | Part Description | Mfr. Code | Mfr. Part Number |
|---|---|---|---|---|---|
| | E1442-66202† | 1 | E1442A Relay Module Assembly | 28480 | E1442-66202† |
| | E1442-60101† | 1 | Standard Terminal Module | 28480 | E1442-60101† |
| | E1442-60102† | 1 | Option 010 Terminal Module | 28480 | E1442-60102† |
| | E1442-60103† | 1 | Option 020 Terminal Module | 28480 | E1442-60103† |
| A1 | E1442-66501 | 1 | Relay Module PC Assembly | 28480 | E1442-66501 |
| F1 | 2110-0712 | 1 | Fuse - Subminiature 4A 125V NTD AX | 28480 | 2110-0712 |
| F2 | 2110-0698 | 1 | Fuse Subminiature 2.5A 125V NTD AX | 28480 | 2110-0698 |
| J1, J4, J5 | 1252-1596 | 3 | Connector Post Type 2.54 Pin Spcg 96 Cont. | 28480 | 1252-1596 |
| J2 | 1252-4743 | 1 | Connector Post Type 2.54 Pin Spcg 64 Cont. | 28480 | 1252-4743 |
| K0 - K63 | 0490-1778 | 64 | Relay 2C 12VDC-Coil, 3A 250VAC | 28480 | 0490-1778 |
| HDL1 | E1400-45102† | 1 | Handle Bottom - Metal Injection | 28480 | E1400-45102† |
| HDL2 | E1400-45101† | 1 | Handle Top - Metal Injection | 28480 | E1400-45101† |
| MP3 | 8160-0686 | 1 | RFI Strip - fingers BE-CU Tin plated | 30817 | 00786-185 |
| PNL1 | E1442-00202† | 1 | Front Panel | 28480 | E1442-00201† |
| SCR1 - SCR2 | E1400-00610† | 2 | Shoulder Screw Assembly | 28480 | E1400-00610† |
| SCR3 - SCR8 | 0515-1135 | 8 | Screw - M3 x 0.5 25mm long Flat Head | 28480 | 0515-1135 |
| SCR20 - SCR21 | 0515-1135 | | Screw - M3 x 0.5 25mm long Flat Head | 28480 | 0515-1135 |
| SHD1 | E1442-00601 | 1 | Shield, Top | 28480 | E1442-00601 |
| SHD2 | E1442-00602 | 1 | Shield, Bottom | 28480 | E1442-00602 |
| SP1 | 3101-2094 | 1 | Switch DIP Rocker 8-1A0.15A 30VDC | 28480 | 3101-2094 |
| **†NOTE: For modules with serial numbers less than US34000972, the following parts must be used for replacement (see inset in figure 3-1).** | | | | | |
| | E1442-66201 | 1 | E1442A Relay Module Assembly | 28480 | E1442-66201 |
| | E1442-64401 | 1 | Standard Terminal Module | 28480 | E1442-64401 |
| | E1442-64402 | 1 | Option 010 Terminal Module | 28480 | E1442-64402 |
| | E1442-64403 | 1 | Option 020 Terminal Module | 28480 | E1442-64403 |
| *PNL1 | E1442-00201 | 1 | Front Panel | 28480 | E1442-00201 |
| *MP1 | E1400-84105 | 1 | External Handle Kit - Bottom | 28480 | E1400-84105 |
| *MP2 | E1400-84106 | 1 | External Handle Kit - Top | 28480 | E1400-84106 |
| *SCR1-SCR2 | 0515-0368 | 2 | Screw - M2.5 x 0.45 12mm long Pan Head | 28480 | 0515-0368 |
| *SCR9-SCR10 | 0515-1375 | 2 | Screw - M2.5 x 0.45 6mm long Flat Head | 28480 | 0515-1375 |
| *SCR11-SCR12 | 0515-1968 | 2 | Screw - M2.5 x 0.45 11mm long Pan Head | 28480 | 0515-1968 |

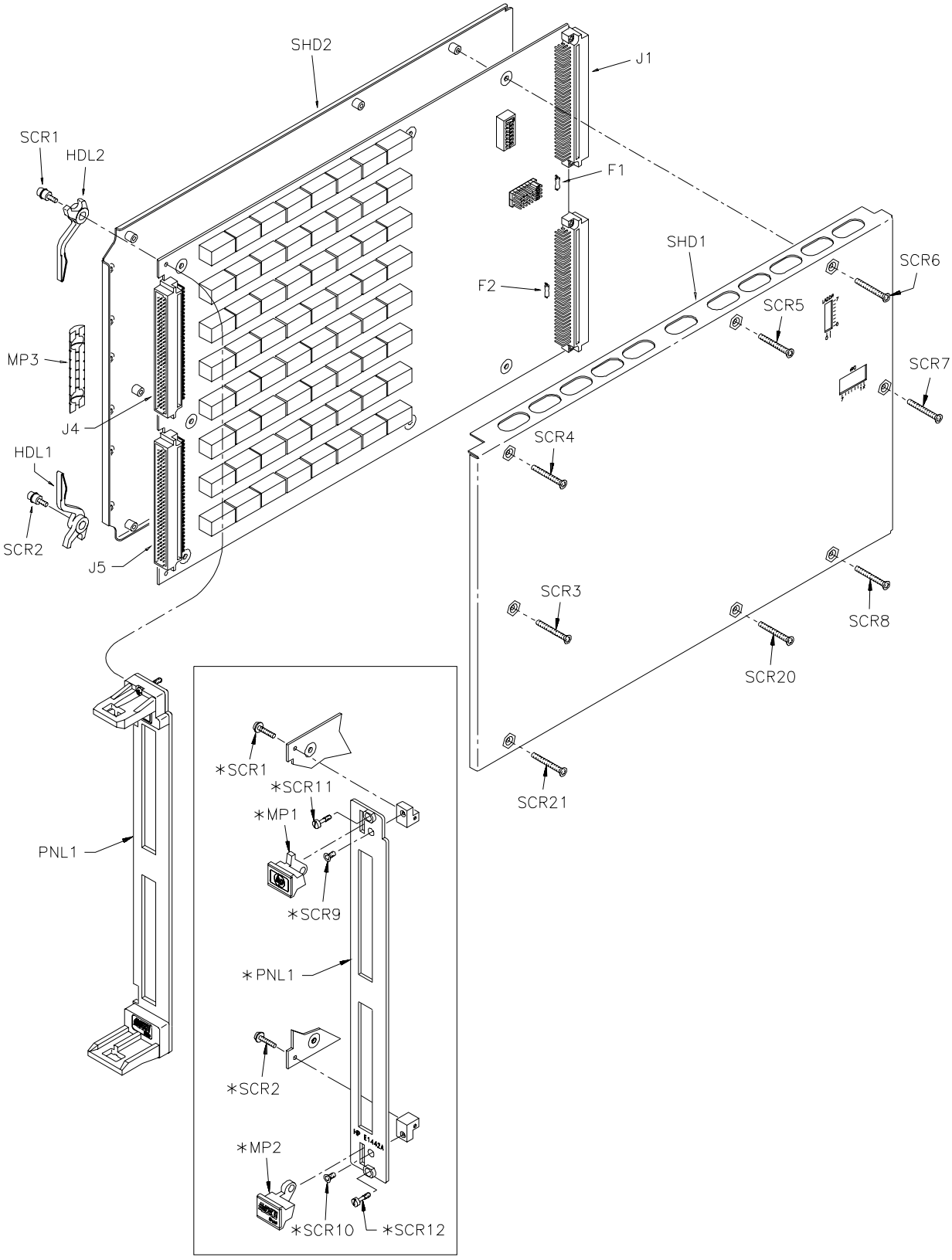



**Figure 3-1. Agilent E1442A Component Locator**

**Table 3-2. Agilent E1442A Terminal Module Assembly Replaceable Parts (for modules with serial numbers greater than US34000973)**

| Reference Designator | Agilent Part Number | Qty. | Part Description | Mfr. Code | Mfr. Part Number |
|---|---|---|---|---|---|
| 1 | E1400-84405 | 1 | Case Assembly - Terminal | 28480 | E1400-84405 |
| 2 | E1400-45103 | 1 | Top Lever | 28480 | E1400-45103 |
| 3 | E1400-45104 | 1 | Bottom Lever | 28480 | E1400-45104 |
| 4 | 1460-2552 | 1 | Torsion Spring - Left Hand Wound | 28480 | 1460-2552 |
| 5 | 1460-2553 | 1 | Torsion Spring - Right Hand Wound | 28480 | E1460-2553 |
| 6 | 1390-1027 | 2 | Receptical Quick Fastener | 28480 | 1390-1027 |
| PCA | **Standard:** | | **Terminal Blocks:** | | |
| | 1252-4326 | 2 | Connector 3 X 32 Pin F Din | 28480 | 1252-4326 |
| | E1400-21204 | 4 | Crimp & Insert Connector Support | 28480 | E1400-21204 |
| | 0515-0905 | 4 | Screw Pan Head Machine 2.5 X 06PZ | 28480 | 0515-0905 |
| | **Opt 010:** | | | | |
| | Z2403-66510 | 1 | PCA Assembly | 28480 | Z2403-66510 |
| | **Opt 020:** | | | | |
| | Z2413-66510 | 1 | PCA Assembly | 28480 | Z2413-66510 |

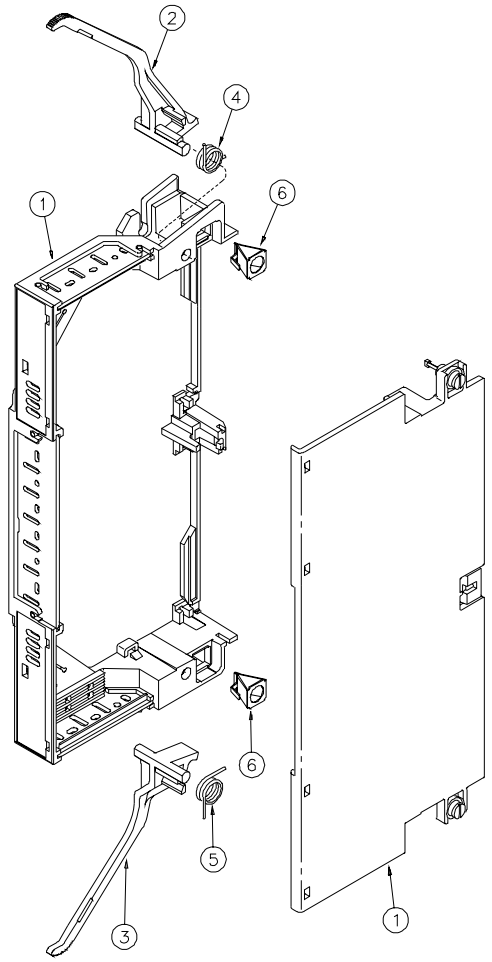



**Figure 3-2. Agilent E1442A Terminal Module Assembly**

**Table 3-3. Agilent E1442A Terminal Module Assembly Replaceable Parts (for modules with serial numbers less thanUS34000972)**

| Reference Designator | Agilent Part Number | Qty. | Part Description | Mfr. Code | Mfr. Part Number |
|---|---|---|---|---|---|
| 1 | 03852-01201 | 1 | Clamp | 28480 | 03852-01201 |
| 2 | 03852-86701 | 1 | Pad - Clamp | 28480 | 03852-86701 |
| 3 | 0515-2109 | 1 | Screw - Mach. 10-24 0.625in long Pan Head | 28480 | 0515-2109 |
| 4 | 1390-0846 | 2 | Fastener - Captive screw M2.5 x 0.45 | 28480 | 1390-0846 |
| 5 | E1300-01202 | 1 | Clamp - Strain Relief | 28480 | E1300-01202 |
| 6 | E1400-44104 | 1 | Terminal Housing - bottom | 28480 | E1400-44104 |
| 7 | E1400-44105 | | Terminal Housing - top | 28480 | E1400-44105 |
| PCA | **Standard:** | | **Terminal Blocks:** | | |
| | 1252-4326 | 2 | Connector 3 X 32 Pin F Din | 28480 | 1252-4326 |
| | E1400-21204 | 4 | Crimp & Insert Connector Support | 28480 | E1400-21204 |
| | 0515-0905 | 4 | Screw Pan Head Machine 2.5 X 06PZ | 28480 | 0515-0905 |
| | **Opt 010:** | | | | |
| | Z2403-66510 | 1 | PCA Assembly | 28480 | Z2403-66510 |
| | **Opt 020:** | | | | |
| | Z2413-66510 | 1 | PCA Assembly | 28480 | Z2413-66510 |

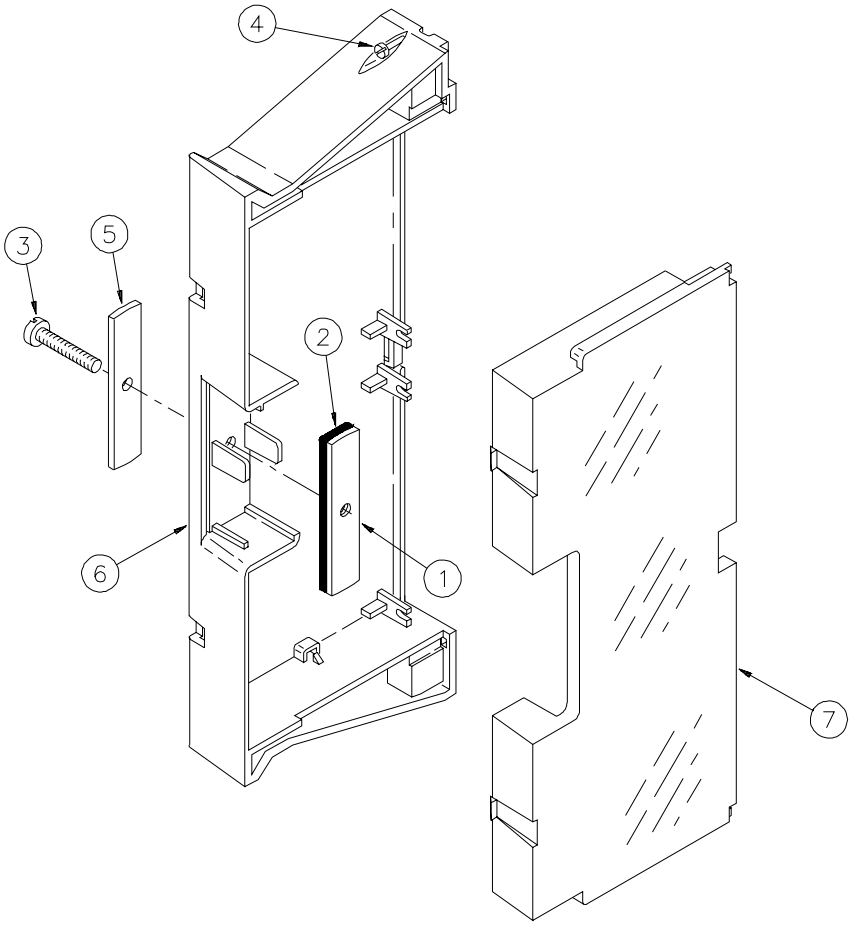



**Figure 3-3. Agilent E1442A Terminal Module Assembly**

**Table 3-4. Agilent E1442A Reference Designators**

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

**Table 3-5. Code List of Manufacturer's**

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

# Chapter 4
# Service

## Introduction

This chapter contains service information for the Agilent E1442A 64-Channel Form C Relay Module, including troubleshooting techniques and repair/maintenance guidelines.

**WARNING**

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

### Equipment Required

Equipment required for module 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 E1442A replaceable parts. Service notes, manual updates, and service literature for the modules may be available through Agilent Technologies. For information, contact your nearest Agilent Technologies Sales and Support Office.

## Troubleshooting

To troubleshoot an Agilent E1442A module problem, you should first identify the problem, and then isolate the cause using the component locators and schematics in this manual.

### Identifying the Problem

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

**Table 4-1. Agilent E1442A Common Problems**

| Problem Type | Symptom | Possible Solutions |
|---|---|---|
| Self-test Errors | Non-zero error code in response to the *TST? command. | See Table 2-1 for information on self-test errors. |
| Operator Errors | Non-zero error code in response to the SYST:ERR? command. | See the *Agilent E1442A User's Manual* for multiplexer errors and causes. |
| | | See Appendix B of the *Agilent E1405 User's Manual* or *Agilent E1406 User's Manual* for additional information on operator errors. |
| Catastrophic Failures | Not responding to commands. | Check logical address setting. |
| | | Check GPIB cables and connections. |
| | | See "Testing the Assembly" in this chapter. |
| Performance Out of Specification | Failing Closed-channel Resistance Test (see Test 2-1 in Chapter 2). | Check user wiring and test connections. |
| | | Replace relays that correspond to the channels that are failing (see Table 4-3). |
| | | If many of the channels are near or above the test limit (3.5 Ω), replace the entire module. |
| | 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 Chapter 3 for locations of mechanical parts.

**Table 4-2. Agilent E1442A Tests/Checks**

| Test/Check | Reference Designator | Check: |
|---|---|---|
| Heat Damage | - - - - - - - - - - | Discolored PC boards<br>Damaged insulation<br>Evidence of arcing |
| Switch Settings | SP1<br>SP2 | LADDR setting<br>IRQ Level setting |
| Multiplexer PCA | F1, F2<br>J1 - J5<br>K1, K2, ..., K64 | Fuse continuity<br>Connector contacts<br>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 120). Verify that the interrupt priority switch is set correctly (factory set at level 1).

### Checking the Module PCA

Use the component locators in 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 determine the relay that corresponds to a failing channel.
- Check connectors P1 and J1 for damage.

---

**Note**

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

---

## Matching Relays to Channels

Use Table 4-3 to find the reference designator of any relay on the Agilent E1442-66501 relay module.

**Table 4-3. Channel Relays/Reference Designators**

| Channel | Relay Component Locator | Channel | Relay Component Locator | Channel | Relay Component Locator | Channel | Relay Component Locator |
|---|---|---|---|---|---|---|---|
| 0 | K0 | 16 | K16 | 32 | K32 | 48 | K48 |
| 1 | K1 | 17 | K17 | 33 | K33 | 49 | K49 |
| 2 | K2 | 18 | K18 | 34 | K34 | 50 | K50 |
| 3 | K3 | 19 | K19 | 35 | K35 | 51 | K51 |
| 4 | K4 | 20 | 20 | 36 | K36 | 52 | K52 |
| 5 | K5 | 21 | K21 | 37 | K37 | 53 | K53 |
| 6 | K6 | 22 | K22 | 38 | K38 | 54 | K54 |
| 7 | K7 | 23 | K23 | 39 | K39 | 55 | K55 |
| 8 | K8 | 24 | K24 | 40 | K40 | 56 | K56 |
| 9 | K9 | 25 | K25 | 41 | K41 | 57 | K57 |
| 10 | K10 | 26 | K26 | 42 | K42 | 58 | K58 |
| 11 | K11 | 27 | K27 | 43 | K43 | 59 | K59 |
| 12 | K12 | 28 | K28 | 44 | K44 | 60 | K60 |
| 13 | K13 | 29 | K29 | 45 | K45 | 61 | K61 |
| 14 | K14 | 30 | K30 | 46 | K46 | 62 | K62 |
| 15 | K15 | 31 | K31 | 47 | K47 | 63 | K63 |

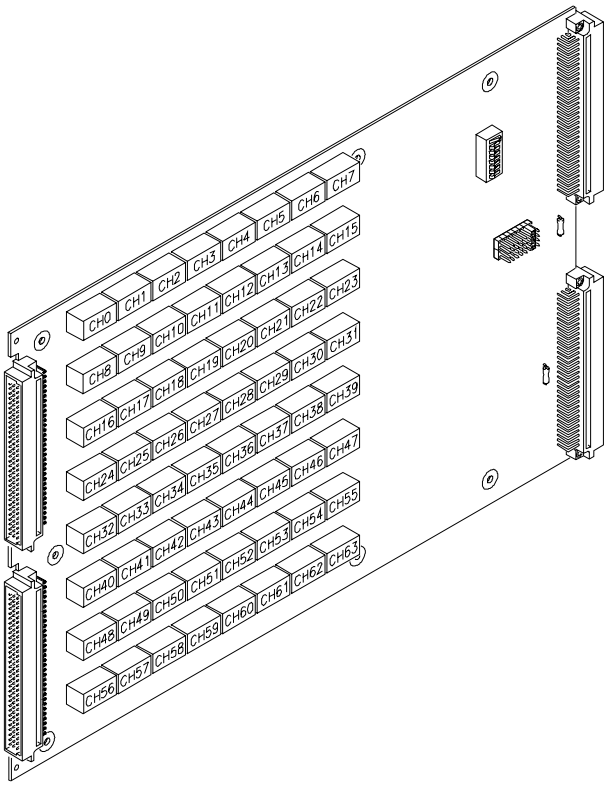



**Figure 4-4. Agilent E1442A Relay Locations**

# Repair/ Maintenance Guidelines

This section provides guidelines for repairing and maintaining the Agilent E1442A module, including:

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

## ESD Precautions

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

- Always use a static-free work station with a pad of conductive rubber or similar material when handling electronic components.
- Do not use pliers to remove a MOS or CMOS device from a high-grip socket. Instead, use a small screwdriver to pry the device up from one end. Slowly lift the device up, one pair of pins at a time.
- After you remove a MOS or CMOS device from a module, place the device onto a pad of conductive foam or other suitable holding material.
- If a device requires soldering, be sure the assembly is placed on a pad of conductive material. Also, be sure that you, the pad, and the soldering iron tip are grounded to the assembly.

## Soldering Printed Circuit Boards

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

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

## Post-Repair Safety Checks

After making repairs to the module, inspect the device for any signs of abnormal internally generated heat, such as discolored printed circuit boards or components, damaged insulation, or evidence of arcing. Determine and correct the cause of the condition. Then perform the Functional Verification Test described in Chapter 2 to verify that the device is functional.

# Incoming Inspection

Use the following steps as guidelines to perform initial (incoming) inspection of the Agilent E1442A.

**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 E1442A is damaged, contact Agilent Technologies and the carrier.

2. Install the Agilent E1442A in a VXI mainframe. Refer to the *Agilent E1442A User's Manual* and the *C-Size VXIbus Systems Configuration Guide* for additional information.

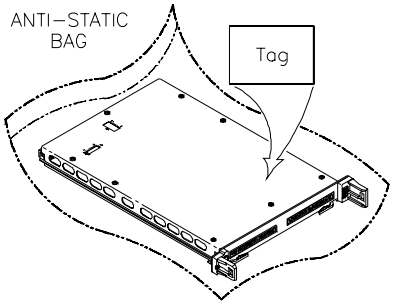
3. Perform the Functional Verification test and (optionally) the Performance Verification tests. Refer to Chapter 2 in this manual.

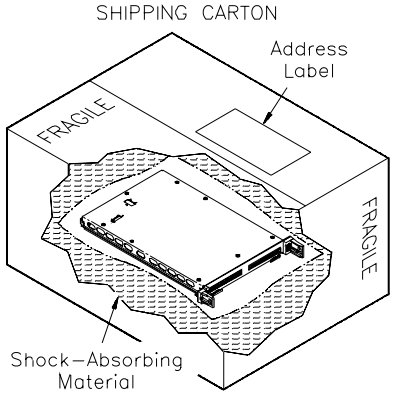
4. If any of the tests do not pass, return the module to Agilent Technologies. See *Shipping Guidelines* later in this chapter.

5. If all verification tests pass, the module is ready to use.

## Shipping Guidelines

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




**1 Prepare the module**

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

**2 Package the module**

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

**3 Ship the module to Agilent Technologies**

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

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

**Figure 4-5. Packaging/Shipping Guidelines**

# Appendix A
# Verification Tests - C Programs

**Note**

*These examples assume a Relay Module logical address setting of 70915. If your Module has a different address, see the Agilent E1442A User's Manual to change the logical address or change the program line* #define ADDR "hpib7,9,15" *to match your address setting.*

## Functional Verification Test

This example is designed to do the Functional Verification Test found in *Chapter 2 - Verification Tests*. The test for the relay module consists of sending the *IDN?, SYST:CDES?, SYST:STYP?, and *TST? commands and checking for appropriate responses.

```
/* Self Test                                                    E1442A
      This program performs the Self Test found
      in the E1442A Service Manual
      Program Rev. A.01.00  7/1/96  */

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

#define ADDR "hpib7,9,15"                          /* Address of device */

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

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

      ipromptf(id, "*RST;*IDN?\n", "%t", a);       /* Self test command */
      printf("\n %s", a);
      ipromptf(id, "SYST:CDES? 1\n", "%t", a);     /* Module description */
      printf ("\n %s", a);
      ipromptf(id, "SYST:CTYP? 1\n", "%t", a);     /* Module type */
      printf ("\n %s", a);
      ipromptf(id, "*TST?\n", "%t", a);            /* Self test */
      printf ("\n %s", a);

      if (a[1] != '0')
      {
         do
         {
           ipromptf (id, "SYST:ERR?\n", "%t", a);
           printf ("\n %s", a);
         }
         while (a[1] != '0');
      }

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

# Performance Verification Tests

These programs are designed to do the Performance Verification Tests found in *Chapter 2 - Verification Tests*.

## Test 2-1: Closed Channel Resistance

The purpose of this test is to verify that all channel relay contacts meet the closed channel resistance specification for the module. If the closed channel resistance of any contact is greater than 3.5Ω, the relay should be replaced. See Chapter 2 for hardware connections and equipment setup.

```
/*  Closed-channel Resistance Test          E1442A
      This program performs the Closed Channel Resistance Test found
      in the E1442A Service Manual
      Program Rev. A.01.00  7/1/96  */

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

#define ADDR "hpib7,9,15"                                   /* Address of device */
#define DMM "hpib7,22"

void main (void)
{
      INST id, dm;                                          /* Define id and dm as an instrument */
      int channel;
      double result;
      char cr[256];

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

      ionerror(I_ERROR_EXIT);

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

      itimeout (dm, 10000);

      printf ("\n\n\nInstall Component Assembly and Test Fixture");
      printf ("\n\n 1. Turn Mainframe AND 3458a DMM power OFF.");
      printf ("\n 2. Connect GPIB Cable between mainframe and DMM.");
      printf ("\n 3. Install Agilent E1442A 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 Closed Channel Resistance.....*/

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

      printf ("\n\nNO to Common Measurements");
      printf ("\n\n 1. Connect DMM Input HI lead to NO terminal");
      printf ("\n 2. Connect DMM Input LO lead to COM Terminal");
      printf ("\n 3. Press ENTER when connections are complete");
      getchar ();
```

```
/*-------Check for stuck channels------*/

iprintf (id, "*RST\n");
iprintf (dm, "TRIG SGL\n");
iscanf  (dm, "%lf", &result);
iscanf  (dm, "%t", cr);

if (result < 1000000)
{
  printf ("\n\n***** Measurement indicates a stuck channel *****");
  printf ("\n***** Correct the problem before proceeding *****");
  goto EXIT;
}

for (channel = 0;channel <= 63; channel++)
{
  if (channel < 10)   iprintf (id, "ROUT:CLOS (@010%u)\n", channel);
  else                iprintf (id, "ROUT:CLOS (@01%u)\n", channel);

  iprintf (dm, "TRIG SGL\n");
  iscanf  (dm, "%lf", &result);
  iscanf  (dm, "%t", cr);
  printf ("\nchannel %u resistance = %6.4lf", channel, result);

  if (channel < 10)  iprintf (id, "ROUT:OPEN (@010%u)\n", channel);
  else               iprintf (id, "ROUT:OPEN (@01%u)\n", channel);


  if (result > 3.5) printf ("\n*** Resistance for Channel %u is > 3.5 Ohms ***  %6.4lf Ohms",
                             channel, result);

}

printf ("\n\nMeasurements complete for NO terminals.");
printf ("\nPress ENTER for NC measurements");
getchar ();

printf ("\n\nNC to Common Measurements");
printf ("\n\n 1. Connect DMM Input HI lead to NC terminal");
printf ("\n 2. Connect DMM Input LO lead to COM Terminal");
printf ("\n 3. Press ENTER when connections are complete");
getchar ();

/*-------Check for stuck channels------*/

iprintf (id, "ROUT:CLOS (@0100:0163)\n");
iprintf (dm, "TRIG SGL\n");
iscanf (dm, "%lf", &result);
iscanf (dm, "%t", cr);

if (result < 1E6)
{
  printf ("\n\n***** Measurement indicates a stuck channel *****");
  printf ("\n***** Correct the problem before proceeding *****");
  goto EXIT;
 }

for (channel = 0;channel <= 63; channel++)
{
  if (channel < 10)   iprintf (id, "ROUT:OPEN (@010%u)\n", channel);
  else                iprintf (id, "ROUT:OPEN (@01%u)\n", channel);

  iprintf (dm, "TRIG SGL\n");
  iscanf  (dm, "%lf", &result);
  iscanf  (dm, "%t", cr);
  printf ("\nchannel %u resistance = %6.4lf", channel, result);
```

```
        if (channel < 10)  iprintf (id, "ROUT:CLOS (@010%u)\n", channel);
        else               iprintf (id, "ROUT:CLOS (@01%u)\n", channel);

        if (result > 3.5) printf ("\n*** Resistance for Channel %u is > 3.5 Ohms ***  %6.4lf Ohms",
                                  channel, result);

      }

      printf ("\n\nMeasurements complete for NC terminals.");

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

## Test 2-2: DC Isolation

This test verifies that sufficient DC isolation exists between various points on the relay module. See Chapter 2 for hardware connections and equipment setup.

```
/*  DC Isolation Test          E1442A
      This program performs the DC Isolation Test found
      in the E1442A Service Manual
      Program Rev. A.01.00  7/1/96  */

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

#define ADDR "hpib7,9,15"                                   /* Address of device */
#define DMM "hpib7,22"

void main (void)
{
      INST id, dm;                                          /* Define id and dm as an instrument */
      char reading[256] = {0};                              /* Result variable */
      int channel, i;

      #if defined(__BORLANDC__) && !defined(__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 (id, "*RST\n");

      printf ("\n\nConnect DMM HI and LO to E1442A NO and C lines");
      getchar ();

      ipromptf (dm, "TRIG SGL\n", "%t", reading);
      printf ("\nDC Isolation -- Normally Open Channels to Common");
      printf ("\n  R = %s Ohms", reading);

      printf ("\n\nConnect DMM HI and LO to E1442A NC and C lines");
      iprintf (id, "CLOS (@0100:0163)\n");
      getchar ();

      ipromptf (dm, "TRIG SGL\n", "%t", reading);
```

```
        printf ("\nDC Isolation -- Normally Closed Channels to Common");
        printf ("\n  R = %s Ohms", reading);

        printf ("\n\nConnect DMM HI and LO to E1442A NO/NC/COM lines and mainframe chassis");
        getchar ();
        ipromptf (dm, "TRIG SGL\n", "%t", reading);
        printf ("\nDC Isolation -- NO/NC/COM Channels to Chassis");
        printf ("\n  R = %s Ohms", reading);

        iprintf (id, "*RST\n");
        iclose (id);                                        /* Close instrument session */
        iclose (dm);
}
```