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HEWLETT-PACKARD WARRANTY STATEMENT

HP PRODUCT: HP E8462A 256-Channel Relay Multiplexer **DURATION OF WARRANTY:** 3 years

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

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Edition 1
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Documentation History

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

Edition 1 . . . . . April 1998

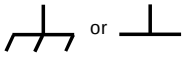
Safety Symbols



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 equipmentÅprotects against electrical shock in case of fault.



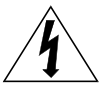
Frame or chassis ground terminal—typically connects to the equipment's metal frame.



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. Hewlett-Packard Company 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 a Hewlett-Packard 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 a Hewlett-Packard Sales and Service Office for service and repair to ensure that safety features are maintained.

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Manufacturer's Name: Hewlett-Packard Company
Loveland Manufacturing Center

Manufacturer's Address: 815 14th Street S.W.
Loveland, Colorado 80537

declares, that the product:

Product Name: 256-Channel Relay Multiplexer, VXI C-Size

Model Number: HP E8462A

Product Options: All

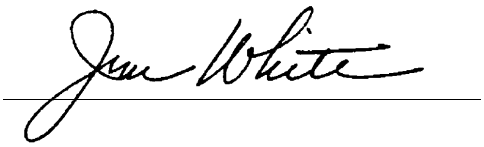
conforms to the following Product Specifications:

Safety: IEC 1010-1 (1990) Incl. Amend 2 (1996)/EN61010-1 (1993)
CSA C22.2 #1010.1 (1992)
UL 3111-1 (1994)

EMC: CISPR 11:1990/EN55011 (1991): Group 1 Class A
EN61000-3-2:1995 Class A
EN61000-3-3:1995
EN50082-1:1992
IEC 1000-4-2:1995: 4kVCD, 8kVAD
IEC 1000-4-3:1995: 3 V/m
IEC 1000-4-4:1995: 1kV Power Line 0.5kV Signal Lines
ENV50141:1993/prEN50082-1 (1995): 3 Vrms
EN 61000-4-5:1995 1kV CM, 0.5kV DM
EN61000-4-8:1993/prEN50082-1 (1995): 3 A/M
EN61000-4-11:1994/prEN50082-1 (1995): 30%, 10mS 60%, 100mS

Supplementary Information: 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" mark accordingly.

Tested in a typical configuration in an HP C-Size VXI mainframe.



March 3, 1998 **Jim White, QA Manager**

European contact: Your local Hewlett-Packard Sales and Service Office or Hewlett-Packard GmbH, Department HQ-TRE, Herrenberger Straße 130, D-71034 Böblingen, Germany (FAX +49-7031-14-3143)

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• The documentation is clearly written.	O	O	O	O	O
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Chapter 1
Configuring the HP E8462A Multiplexer

Using This Chapter

This chapter provides general module information, vital WARNINGS and CAUTIONS, and the tasks you must perform to configure and install the HP E8462A Relay Multiplexer. It also provides information to verify module installation. Chapter contents are:

- Module Description. . . . . Page 11
- Warnings and Cautions . . . . . Page 12
- Configuring the Multiplexer Module . . . . . Page 15
- Installing the Multiplexer in a Mainframe . . . . . Page 17
- Connecting Field Wiring. . . . . Page 18
- Terminal Cards . . . . . Page 24
- Programming the Multiplexer. . . . . Page 29
- Initial Operation . . . . . Page 32

Module Description

Figure 1-1 shows the HP E8462A armature relay multiplexer simplified block diagram, Option 014 or 015 Terminal Card, and a simple measurement application. Notice the sixteen 100Ω protection resistors; one in series with each bank line. Refer to Figure 1-1 for the following description.

Relay Organization

The 256 channels of the HP E8462A Relay Multiplexer are organized into 8 banks with 32 channels per bank. The channels in each bank are as follows:

Bank	Channels
0	000 - 015 and 032 - 047
1	016 - 031 and 048 - 063
2	064 - 079 and 096 - 111
3	080 - 095 and 112 - 127
4	128 - 143 and 160 - 175
5	144 - 159 and 176 - 191
6	192 - 207 and 224 - 239
7	208 - 223 and 240 - 255

The default configuration is 128 channels of 2-wire switches (128 x 2).

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Tree relays T0 through T21 (Channel 9000 through Channel 9021) configure the module to the desired operating mode: 1-wire, 2-wire, 3-wire or 4-wire mode. You use the tree relays to manually configure this module in one of the following configurations (or in a combination of these configurations). Using the ROUTe:FUNCtion command sets the tree switches automatically for any one of the following configurations (e.g., 2-64x2).

Quantity	Switch Topology
1	256 x 1or 128 x 2 or 64 x 3 or 64 x 4
2	128 x 1 or 64 x 2 or 32 x 4
4	64 x 1 or 32 x 2 or 16 x 4
8	32 x 1 or 16 x 2

Relays AB200 through AB204 (Channels 9200 through 9204) are the analog bus connection control relays which connect the terminal busses to the front panel analog bus connector.

Analog Bus

The “Analog Bus Front Panel Connector” on the module allows you to connect this Multiplexer to to a VXI Multimeter (such as the HP E1411A/B and/or E1326A/B) directly. Either of these Multimeter’s allow you to configure the Multimeter and one or more E8462A Multiplexers in a “Scanning Voltmeter” configuration. See Chapter 4 for information on using the E8462A in a scanning voltmeter.

Optional Terminal Cards

The E8462A has three optional terminal cards which you may purchase from Hewlett-Packard:

- Option 012 Crimp & Insert Terminal Card is provided with the same terminal connector described above but does not provide the crimp-and-insert contacts. Additionally, you must order the quantity of contacts your application requires. This terminal card provides strain relief and a housing to protect the contacts. Refer to Option 012 Crimp-and- Insert Terminal Block on page 24.

- Option 014 Fault Tolerant Terminal Card and Option 015 Ribbon Cable Terminal Card provides nine ribbon-cable header connectors (P101-P109). P101 through P108 contain 16 terminals (Ter0 through Ter15) and all the 256 channels (CH000-CH255) and P109 is the analog bus connector. Option 014 has PTC resistors; Option 015 does not. Refer to Option 014 Fault Tolerant Terminal Block on page 24.

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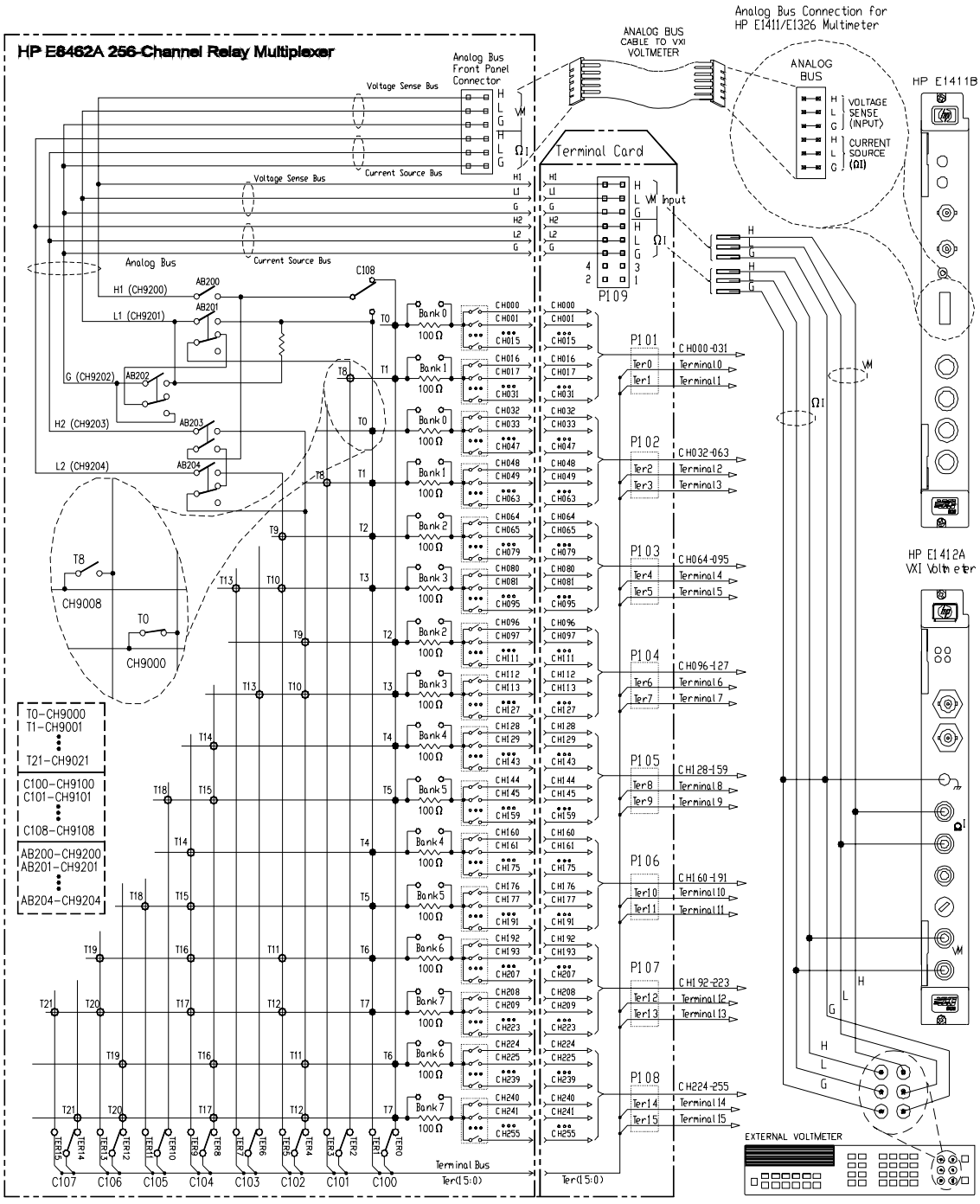


Figure 1-1. HP E8462A Simplified Schematic

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Warnings and Cautions



WARNING **SHOCK HAZARD. Only qualified, service-trained personnel who are aware of the hazards involved should install, configure, or remove the Multiplexer Module. Disconnect all power sources from the mainframe, the Terminal Cards, and installed modules before installing or removing a module.**

WARNING **When handling user wiring connected to the Terminal Card, consider the highest voltage present accessible on any terminal. Use only wire with an insulation rating greater than the highest voltage which will be present on the Terminal Card. Do not touch any circuit element connected to the Terminal Card if any other connector to the Terminal Card is energized to more than 30VACRMS or 60VDC.**

Caution **MAXIMUM VOLTAGE/CURRENT. Maximum allowable voltage per channel, terminal-to-terminal or terminal-to-chassis for the Multiplexer is 200 VDC, 140 VACrms, or 200VACpeak. Maximum switching current per channel is 500 mA (non-inductive). Maximum transient voltage is 1200V peak. Exceeding any limit may damage the Multiplexer Module.**

Caution **WIRING THE TERMINAL CARD. When wiring to the terminal connectors on the HP E8462A Terminal Card, be sure not to exceed a 5mm strip back of insulation to prevent the possibility of shorting to other wiring on adjacent terminals.**

Caution **STATIC ELECTRICITY. Static electricity is a major cause of component failure. To prevent damage to the electrical components in the Multiplexer, observe anti-static techniques whenever removing, configuring, and installing a module. The Multiplexer is susceptible to static discharges. Do not install the Multiplexer Module without its metal shield attached.**

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Configuring the Multiplexer Module

The Multiplexer module can be configured to the operating modes through the VXI*plug&play* driver or via SCPI commands. These drivers are located on the supplied CD-ROM. Before installing the module into a VXIbus mainframe (e.g. HP E1401A), you need to set the Multiplexer's logical address.

Setting the Logical Address

The factory default logical address switch setting is 112. Valid addresses are from 1 to 254 for static configuration and address 255 for dynamic configuration. The HP E8462A supports dynamic configuration of the address. This means the address is set programmatically by the resource manager when it encounters a module with address 255.

The logical address must be a multiple of eight (e.g., 112, 120, 128, etc.) when using a VXIbus command module. An instrument must have a unique secondary address which is the logical address divided by eight. When multiple modules are used for form a "switchbox", the logical addresses must be sequential with the first module address being a multiple of eight. See Figure 1-13. "Card Numbers in a Multiple-module Configuration" on page 30 for more information.

Refer to the *C-Size VXIbus System Installation and Getting Started Guide* for addressing information. Figure 1-2 shows the logical address switch position. You access the address switch through the air hole on the edge of the module. The label on the side cover identifies the switch location.

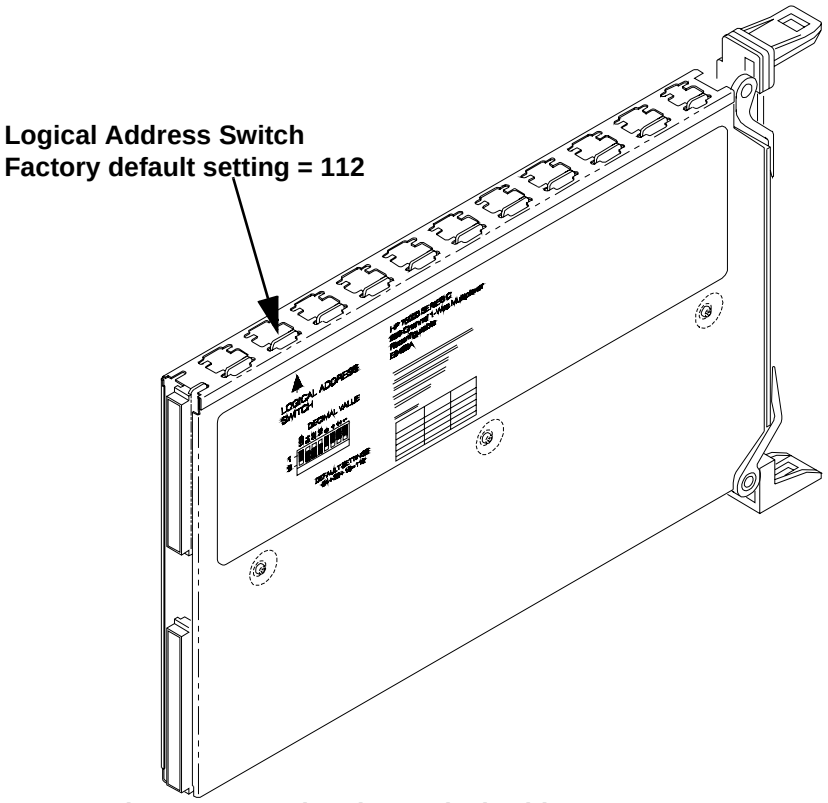


Figure 1-2. Setting the Logical Address

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Setting the Interrupt Priority Line

For most applications the default priority line should not have to be changed. An interrupt is generated after any channel is opened or closed when interrupts are enabled. The interrupt is generated approximately 5 ms after command execution allowing for relay settling time. The interrupt line can be set to any one of the VXI backplane lines 1-7 through writing the bits 10, 9 and 8 of the Status/Control Register. The default value is 1. The interrupt can be disabled at power-up, after a SYSRESET, or after resetting the module via the Control Register.

See the DIAGnostic:INTerrupt[:LINE] command for setting the interrupt priority line using a SCPI command. See *Appendix B, HP E8462A Register-Based Programming*, for more information about setting the interrupt priority line by writing to the Status/Control Register.

Protection Resistors

Figure 1-1 shows the 100Ω protection resistors in series with each bank line. These protection resistors limit the maximum current through the relays. However, in some measurements (such as 2-Wire resistance measurements) you may want to bypass the protection resistors. Each resistor has a jumper (J601 for Bank 0, JP602 for Bank 1, JP 603 for Bank2, . . . JP616 for Bank 15) across it allowing you to short out the resistor if necessary. Refer to Figure 1-3.

Installing Protection Resistor Jumpers

The module is shipped from the factory with a bag of jumpers. You must install these on the E8462A PC board in one of the two settings shown in Figure 1-3. It is recommended you install them in the default position shown in Figure 1-3 if your application requires 100Ω protection resistors. Install them over both jumper pins if you want to bypass the 100Ω protection resistors.

Note

The module is shipped from the factory with a bag of jumpers. You should load these jumpers in the default position as shown in Figure 1-3 if your application requires 100Ω protection resistors. Install the jumpers across both pins if you do not require the 100Ω protection resistors in your application.

JUMPERS ARE SUPPLIED IN A BAG AND MUST BE INSTALLED

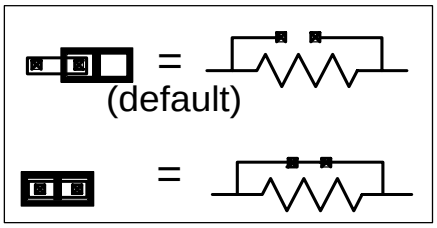


Figure 1-3. Protection Resistors and Jumpers

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Installing the Multiplexer in a Mainframe

The HP E8462A may be installed in any slot (except slot 0) in a C-size VXIbus mainframe. Refer to Figure 1-4 to install the Multiplexer in a mainframe.

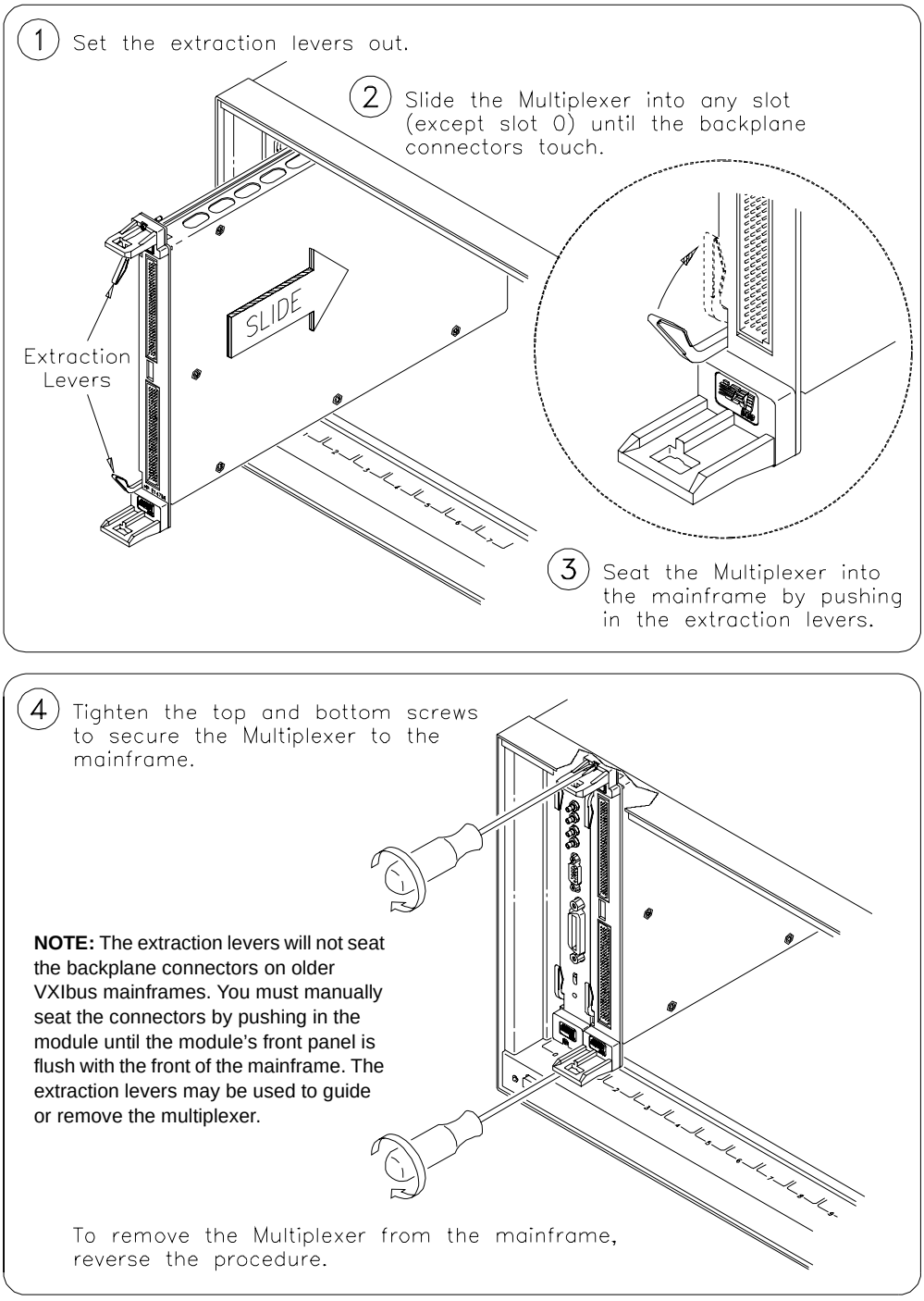


Figure 1-4. Installing the Multiplexer in a VXIbus Mainframe

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Connecting Field Wiring

Field Wiring Not Using Optional Terminal Cards

The E8462A *IS NOT* supplied with a terminal card or connectors. You may purchase 160-pin terminal connectors, necessary crimp-and-insert contacts and the required crimp tool from Hewlett-Packard or directly from the manufacturer, ERNI Components[1] (see Table 1-1 below).

Table 1-1. You Must Purchase Connectors, Contacts and Tools.

Manufacturer	Component	Connector P/N
Hewlett-Packard Co.	160-pin connector	1252-6531
	one (1) crimp-and-insert contact	1252-6533
	one (1) crimp-and-insert contact single conductor assembly	8150-5207 (see Figure 1-5)
	required crimp tool	8710-2306
	disassembly tool (optional)	8710-2307
ERNI Components[1]	160-pin connector	024070
	one (1) crimp-and-insert contact	014728
	required crimp tool	014374
	disassembly tool (optional)	471555

Field Wiring Terminal Connector

Refer to Table 1-1 and Figure 1-5. You can purchase 160-pin field wiring terminal connectors (two are required, order HP P/N 1252-6531 or order direct from the manufacturer, ERNI Components, P/N 024070) and the necessary crimp-and-insert contacts (HP P/N for single contact is 1252-6533, or ERNI P/N 014728). The contacts are gold-plated, accept a wire size of 20 to 26AWG, and carry a maximum current of 2A @70°C. You will also need a crimp tool (HP P/N 8710-2306 or ERNI P/N 014374) and optionally a disassembly tool (HP P/N 8710-2307 or ERNI P/N 471555).

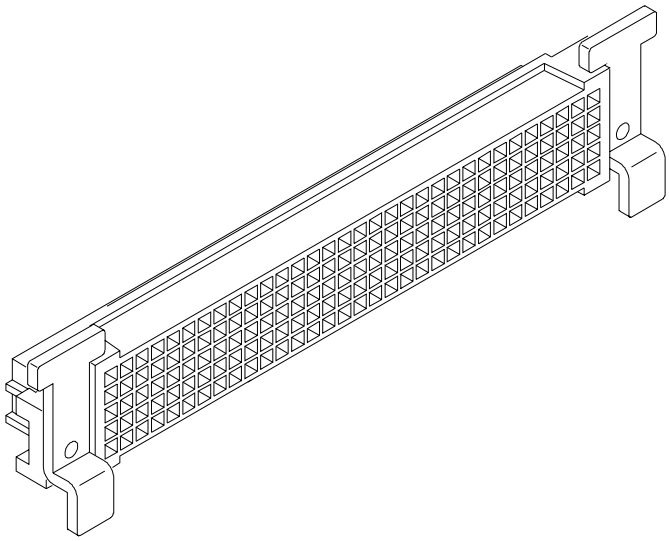
Caution

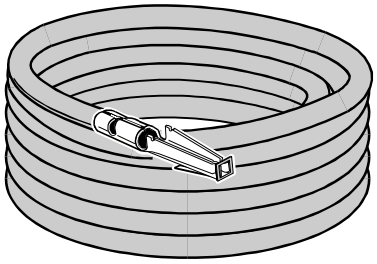
Due to the close terminal spacing and the potential for pin-to-pin leakage, the terminal connector blocks on the Option 012 Crimp-and-Insert Terminal Card must be replaced after 15,000 hours of voltage stress if the module regularly switches voltages greater than 60VDC, 50VACrms, or 70.7 VACpeak.

1. Contact ERNI Components, A Division of ODIN Components, Inc., 520 Southlake Blvd., Richmond, VA 23236, U.S.A. Telephone, (804) 794-6367, FAX (804) 379-2109.

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A single-conductor with contact (a crimp-and-insert contact is crimped onto one end, the other end is not terminated) is available as HP pn 8150-5207.





Length: 2 meters
Wire Gauge: 24 AWG
Insulation Rating: 105 C maximum
Voltage: 250 V maximum

Figure 1-5. Connector Block and Single-Conductor Wire with Contact (not provided).

Front Panel Connector Pin-Out

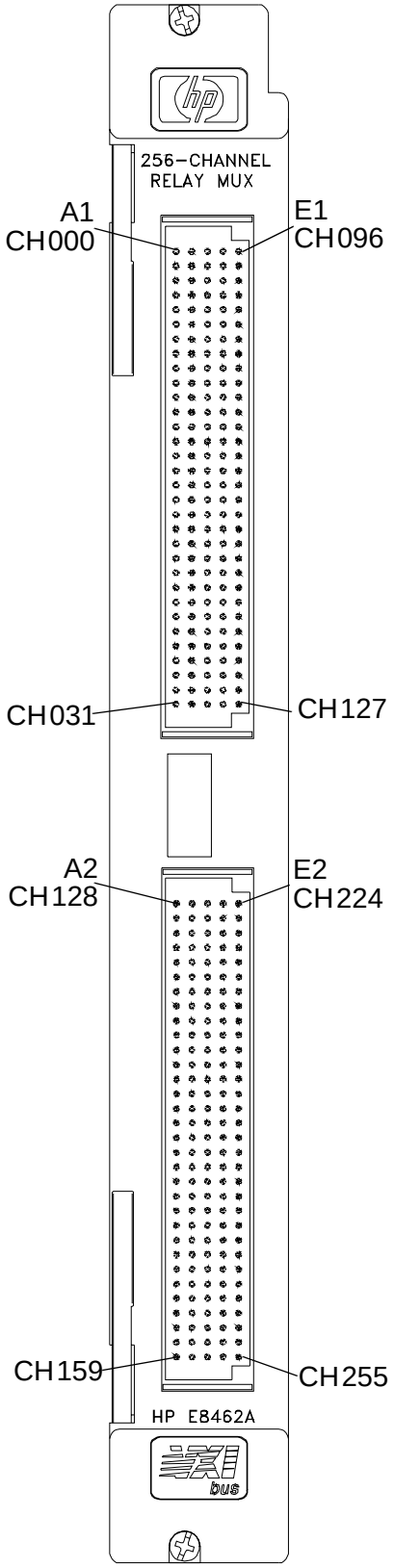
Figure 1-6 shows the Multiplexer's front panel and the connector pin-out.

Note

The HP E8462A is not supplied with terminal connectors, field wiring contacts or terminal cards. However, terminal cards can be ordered as an option.

In Figure 1-6, columns C1 and C2 contain the terminals for the 16-line multiplexer bus (Ter0 to Ter15) as well as terminals for T_ACCESS* and T_ERROR*. Ter0 to Ter15 refer to Terminal 0 through Terminal 15. T_ACCESS* and T_ERROR* are two signals to drive LEDs on the Option 012 Terminal Card. "NC" refers to "Not Connected" and "CGND" refers to "Chassis Ground".

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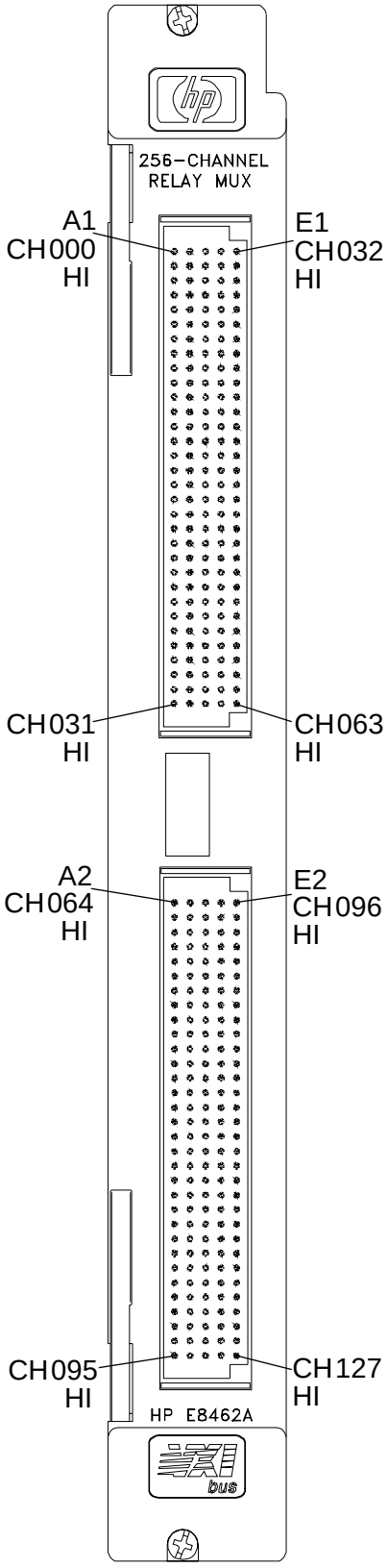


A1	B1	C1	D1	E1
CH 0	CH 32	NC	CH 64	CH 96
CH 1	CH 33	NC	CH 65	CH 97
CH 2	CH 34	NC	CH 66	CH 98
CH 3	CH 35	Terminal 0	CH 67	CH 99
CH 4	CH 36	NC	CH 68	CH 100
CH 5	CH 37	H1	CH 69	CH 101
CH 6	CH 38	NC	CH 70	CH 102
CH 7	CH 39	Terminal 1	CH 71	CH 103
CH 8	CH 40	NC	CH 72	CH 104
CH 9	CH 41	NC	CH 73	CH 105
CH 10	CH 42	NC	CH 74	CH 106
CH 11	CH 43	Terminal 2	CH 75	CH 107
CH 12	CH 44	NC	CH 76	CH 108
CH 13	CH 45	L1	CH 77	CH 109
CH 14	CH 46	NC	CH 78	CH 110
CH 15	CH 47	Terminal 3	CH 79	CH 111
CH 16	CH 48	CGND	CH 80	CH 112
CH 17	CH 49	CGND	CH 81	CH 113
CH 18	CH 50	CGND	CH 82	CH 114
CH 19	CH 51	Terminal 4	CH 83	CH 115
CH 20	CH 52	NC	CH 84	CH 116
CH 21	CH 53	L2	CH 85	CH 117
CH 22	CH 54	NC	CH 86	CH 118
CH 23	CH 55	Terminal 5	CH 87	CH 119
CH 24	CH 56	NC	CH 88	CH 120
CH 25	CH 57	G	CH 89	CH 121
CH 26	CH 58	NC	CH 90	CH 122
CH 27	CH 59	Terminal 6	CH 91	CH 123
CH 28	CH 60	NC	CH 92	CH 124
CH 29	CH 61	H2	CH 93	CH 125
CH 30	CH 62	NC	CH 94	CH 126
CH 31	CH 63	Terminal 7	CH 95	CH 127

A2	B2	C2	D2	E2
CH 128	CH 160	T_ACCESS*	CH 192	CH 224
CH 129	CH 161	T_ERROR*	CH 193	CH 225
CH 130	CH 162	Reserved	CH 194	CH 226
CH 131	CH 163	Terminal 8	CH 195	CH 227
CH 132	CH 164	Reserved	CH 196	CH 228
CH 133	CH 165	XVCC	CH 197	CH 229
CH 134	CH 166	Reserved	CH 198	CH 230
CH 135	CH 167	Terminal 9	CH 199	CH 231
CH 136	CH 168	Reserved	CH 200	CH 232
CH 137	CH 169	Reserved	CH 201	CH 233
CH 138	CH 170	Reserved	CH 202	CH 234
CH 139	CH 171	Terminal 10	CH 203	CH 235
CH 140	CH 172	NC	CH 204	CH 236
CH 141	CH 173	NC	CH 205	CH 237
CH 142	CH 174	Reserved	CH 206	CH 238
CH 143	CH 175	Terminal 11	CH 207	CH 239
CH 144	CH 176	CGND	CH 208	CH 240
CH 145	CH 177	CGND	CH 209	CH 241
CH 146	CH 178	CGND	CH 210	CH 242
CH 147	CH 179	Terminal 12	CH 211	CH 243
CH 148	CH 180	Reserved	CH 212	CH 244
CH 149	CH 181	Reserved	CH 213	CH 245
CH 150	CH 182	Reserved	CH 214	CH 246
CH 151	CH 183	Terminal 13	CH 215	CH 247
CH 152	CH 184	Reserved	CH 216	CH 248
CH 153	CH 185	Reserved	CH 217	CH 249
CH 154	CH 186	Reserved	CH 218	CH 250
CH 155	CH 187	Terminal 14	CH 219	CH 251
CH 156	CH 188	Reserved	CH 220	CH 252
CH 157	CH 189	Reserved	CH 221	CH 253
CH 158	CH 190	Reserved	CH 222	CH 254
CH 159	CH 191	Terminal 15	CH 223	CH 255

Figure 1-6. HP E8462A Multiplexer Front Panel Pin-out
1-Wire Mode

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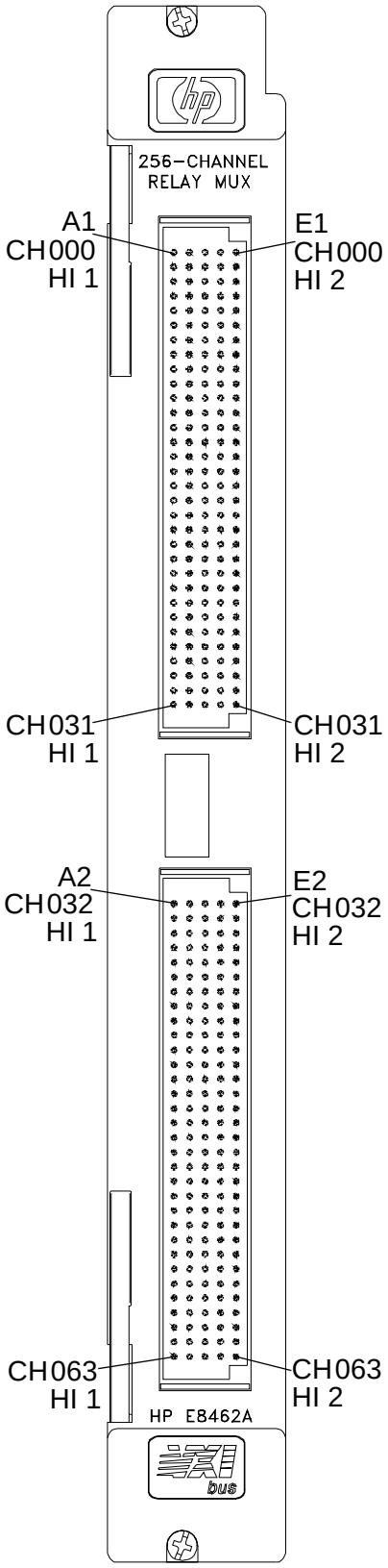


A1	B1	C1	D1	E1
CH 0 HI	CH 0 LO	NC	CH 32 LO	CH 32 HI
CH 1 HI	CH 1 LO	NC	CH 33 LO	CH 33 HI
CH 2 HI	CH 2 LO	NC	CH 34 LO	CH 34 HI
CH 3 HI	CH 3 LO	Terminal 0	CH 35 LO	CH 35 HI
CH 4 HI	CH 4 LO	NC	CH 36 LO	CH 36 HI
CH 5 HI	CH 5 LO	H1	CH 37 LO	CH 37 HI
CH 6 HI	CH 6 LO	NC	CH 38 LO	CH 38 HI
CH 7 HI	CH 7 LO	Terminal 1	CH 39 LO	CH 39 HI
CH 8 HI	CH 8 LO	NC	CH 40 LO	CH 40 HI
CH 9 HI	CH 9 LO	NC	CH 41 LO	CH 41 HI
CH 10 HI	CH 10 LO	NC	CH 42 LO	CH 42 HI
CH 11 HI	CH 11 LO	Terminal 2	CH 43 LO	CH 43 HI
CH 12 HI	CH 12 LO	NC	CH 44 LO	CH 44 HI
CH 13 HI	CH 13 LO	L1	CH 45 LO	CH 45 HI
CH 14 HI	CH 14 LO	NC	CH 46 LO	CH 46 HI
CH 15 HI	CH 15 LO	Terminal 3	CH 47 LO	CH 47 HI
CH 16 HI	CH 16 LO	CGND	CH 48 LO	CH 48 HI
CH 17 HI	CH 17 LO	CGND	CH 49 LO	CH 49 HI
CH 18 HI	CH 18 LO	CGND	CH 50 LO	CH 50 HI
CH 19 HI	CH 19 LO	Terminal 4	CH 51 LO	CH 51 HI
CH 20 HI	CH 20 LO	NC	CH 52 LO	CH 52 HI
CH 21 HI	CH 21 LO	L2	CH 53 LO	CH 53 HI
CH 22 HI	CH 22 LO	NC	CH 54 LO	CH 54 HI
CH 23 HI	CH 23 LO	Terminal 5	CH 55 LO	CH 55 HI
CH 24 HI	CH 24 LO	NC	CH 56 LO	CH 56 HI
CH 25 HI	CH 25 LO	G	CH 57 LO	CH 57 HI
CH 26 HI	CH 26 LO	NC	CH 58 LO	CH 58 HI
CH 27 HI	CH 27 LO	Terminal 6	CH 59 LO	CH 59 HI
CH 28 HI	CH 28 LO	NC	CH 60 LO	CH 60 HI
CH 29 HI	CH 29 LO	H2	CH 61 LO	CH 61 HI
CH 30 HI	CH 30 LO	NC	CH 62 LO	CH 62 HI
CH 31 HI	CH 31 LO	Terminal 7	CH 63 LO	CH 63 HI

A2	B2	C2	D2	E2
CH 64 HI	CH 64 LO	T_ACCESS*	CH 96 LO	CH 96 HI
CH 65 HI	CH 65 LO	T_ERROR*	CH 97 LO	CH 97 HI
CH 66 HI	CH 66 LO	Reserved	CH 98 LO	CH 98 HI
CH 67 HI	CH 67 LO	Terminal 8	CH 99 LO	CH 99 HI
CH 68 HI	CH 68 LO	Reserved	CH 100 LO	CH 100 HI
CH 69 HI	CH 69 LO	XVCC	CH 101 LO	CH 101 HI
CH 70 HI	CH 70 LO	Reserved	CH 102 LO	CH 102 HI
CH 71 HI	CH 71 LO	Terminal 9	CH 103 LO	CH 103 HI
CH 72 HI	CH 72 LO	Reserved	CH 104 LO	CH 104 HI
CH 73 HI	CH 73 LO	Reserved	CH 105 LO	CH 105 HI
CH 74 HI	CH 74 LO	Reserved	CH 106 LO	CH 106 HI
CH 75 HI	CH 75 LO	Terminal 10	CH 107 LO	CH 107 HI
CH 76 HI	CH 76 LO	NC	CH 108 LO	CH 108 HI
CH 77 HI	CH 77 LO	NC	CH 109 LO	CH 109 HI
CH 78 HI	CH 78 LO	Reserved	CH 110 LO	CH 110 HI
CH 79 HI	CH 79 LO	Terminal 11	CH 111 LO	CH 111 HI
CH 80 HI	CH 80 LO	CGND	CH 112 LO	CH 112 HI
CH 81 HI	CH 81 LO	CGND	CH 113 LO	CH 113 HI
CH 82 HI	CH 82 LO	CGND	CH 114 LO	CH 114 HI
CH 83 HI	CH 83 LO	Terminal 12	CH 115 LO	CH 115 HI
CH 84 HI	CH 84 LO	Reserved	CH 116 LO	CH 116 HI
CH 85 HI	CH 85 LO	Reserved	CH 117 LO	CH 117 HI
CH 86 HI	CH 86 LO	Reserved	CH 118 LO	CH 118 HI
CH 87 HI	CH 87 LO	Terminal 13	CH 119 LO	CH 119 HI
CH 88 HI	CH 88 LO	Reserved	CH 120 LO	CH 120 HI
CH 89 HI	CH 89 LO	Reserved	CH 121 LO	CH 121 HI
CH 90 HI	CH 90 LO	Reserved	CH 122 LO	CH 122 HI
CH 91 HI	CH 91 LO	Terminal 14	CH 123 LO	CH 123 HI
CH 92 HI	CH 92 LO	Reserved	CH 124 LO	CH 124 HI
CH 93 HI	CH 93 LO	Reserved	CH 125 LO	CH 125 HI
CH 94 HI	CH 94 LO	Reserved	CH 126 LO	CH 126 HI
CH 95 HI	CH 95 LO	Terminal 15	CH 127 LO	CH 127 HI

Figure 1-7. HP E8462A Multiplexer Front Panel Pin-out 2-Wire Mode

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NOTE: 3-Wire Mode *does not* use the column E connections.

A1	B1	C1	D1	E1
CH 0 HI 1	CH 0 LO 1	NC	CH 0 LO 2	CH 0 HI 2
CH 1 HI 1	CH 1 LO 1	NC	CH 1 LO 2	CH 1 HI 2
CH 2 HI 1	CH 2 LO 1	NC	CH 2 LO 2	CH 2 HI 2
CH 3 HI 1	CH 3 LO 1	Terminal 0	CH 3 LO 2	CH 3 HI 2
CH 4 HI 1	CH 4 LO 1	NC	CH 4 LO 2	CH 4 HI 2
CH 5 HI 1	CH 5 LO 1	H1	CH 5 LO 2	CH 5 HI 2
CH 6 HI 1	CH 6 LO 1	NC	CH 6 LO 2	CH 6 HI 2
CH 7 HI 1	CH 7 LO 1	Terminal 1	CH 7 LO 2	CH 7 HI 2
CH 8 HI 1	CH 8 LO 1	NC	CH 8 LO 2	CH 8 HI 2
CH 9 HI 1	CH 9 LO 1	NC	CH 9 LO 2	CH 9 HI 2
CH 10 HI 1	CH 10 LO 1	NC	CH 10 LO 2	CH 10 HI 2
CH 11 HI 1	CH 11 LO 1	Terminal 2	CH 11 LO 2	CH 11 HI 2
CH 12 HI 1	CH 12 LO 1	NC	CH 12 LO 2	CH 12 HI 2
CH 13 HI 1	CH 13 LO 1	L1	CH 13 LO 2	CH 13 HI 2
CH 14 HI 1	CH 14 LO 1	NC	CH 14 LO 2	CH 14 HI 2
CH 15 HI 1	CH 15 LO 1	Terminal 3	CH 15 LO 2	CH 15 HI 2
CH 16 HI 1	CH 16 LO 1	CGND	CH 16 LO 2	CH 16 HI 2
CH 17 HI 1	CH 17 LO 1	CGND	CH 17 LO 2	CH 17 HI 2
CH 18 HI 1	CH 18 LO 1	CGND	CH 18 LO 2	CH 18 HI 2
CH 19 HI 1	CH 19 LO 1	Terminal 4	CH 19 LO 2	CH 19 HI 2
CH 20 HI 1	CH 20 LO 1	NC	CH 20 LO 2	CH 20 HI 2
CH 21 HI 1	CH 21 LO 1	L2	CH 21 LO 2	CH 21 HI 2
CH 22 HI 1	CH 22 LO 1	NC	CH 22 LO 2	CH 22 HI 2
CH 23 HI 1	CH 23 LO 1	Terminal 5	CH 23 LO 2	CH 23 HI 2
CH 24 HI 1	CH 24 LO 1	NC	CH 24 LO 2	CH 24 HI 2
CH 25 HI 1	CH 25 LO 1	G	CH 25 LO 2	CH 25 HI 2
CH 26 HI 1	CH 26 LO 1	NC	CH 26 LO 2	CH 26 HI 2
CH 27 HI 1	CH 27 LO 1	Terminal 6	CH 27 LO 2	CH 27 HI 2
CH 28 HI 1	CH 28 LO 1	NC	CH 28 LO 2	CH 28 HI 2
CH 29 HI 1	CH 29 LO 1	H2	CH 29 LO 2	CH 29 HI 2
CH 30 HI 1	CH 30 LO 1	NC	CH 30 LO 2	CH 30 HI 2
CH 31 HI 1	CH 31 LO 1	Terminal 7	CH 31 LO 2	CH 31 HI 2

A2	B2	C2	D2	E2
CH 32 HI 1	CH 32 LO 1	T_ACCESS*	CH 32 LO 2	CH 32 HI 2
CH 33 HI 1	CH 33 LO 1	T_ERROR*	CH 33 LO 2	CH 33 HI 2
CH 34 HI 1	CH 34 LO 1	Reserved	CH 34 LO 2	CH 34 HI 2
CH 35 HI 1	CH 35 LO 1	Terminal 8	CH 35 LO 2	CH 35 HI 2
CH 36 HI 1	CH 36 LO 1	Reserved	CH 36 LO 2	CH 36 HI 2
CH 37 HI 1	CH 37 LO 1	XVCC	CH 37 LO 2	CH 37 HI 2
CH 38 HI 1	CH 38 LO 1	Reserved	CH 38 LO 2	CH 38 HI 2
CH 39 HI 1	CH 39 LO 1	Terminal 9	CH 39 LO 2	CH 39 HI 2
CH 40 HI 1	CH 40 LO 1	Reserved	CH 40 LO 2	CH 40 HI 2
CH 41 HI 1	CH 41 LO 1	Reserved	CH 41 LO 2	CH 41 HI 2
CH 42 HI 1	CH 42 LO 1	Reserved	CH 42 LO 2	CH 42 HI 2
CH 43 HI 1	CH 43 LO 1	Terminal 10	CH 43 LO 2	CH 43 HI 2
CH 44 HI 1	CH 44 LO 1	NC	CH 44 LO 2	CH 44 HI 2
CH 45 HI 1	CH 45 LO 1	NC	CH 45 LO 2	CH 45 HI 2
CH 46 HI 1	CH 46 LO 1	Reserved	CH 46 LO 2	CH 46 HI 2
CH 47 HI 1	CH 47 LO 1	Terminal 11	CH 47 LO 2	CH 47 HI 2
CH 48 HI 1	CH 48 LO 1	CGND	CH 48 LO 2	CH 48 HI 2
CH 49 HI 1	CH 49 LO 1	CGND	CH 49 LO 2	CH 49 HI 2
CH 50 HI 1	CH 50 LO 1	CGND	CH 50 LO 2	CH 50 HI 2
CH 51 HI 1	CH 51 LO 1	Terminal 12	CH 51 LO 2	CH 51 HI 2
CH 52 HI 1	CH 52 LO 1	Reserved	CH 52 LO 2	CH 52 HI 2
CH 53 HI 1	CH 53 LO 1	Reserved	CH 53 LO 2	CH 53 HI 2
CH 54 HI 1	CH 54 LO 1	Reserved	CH 54 LO 2	CH 54 HI 2
CH 55 HI 1	CH 55 LO 1	Terminal 13	CH 55 LO 2	CH 55 HI 2
CH 56 HI 1	CH 56 LO 1	Reserved	CH 56 LO 2	CH 56 HI 2
CH 57 HI 1	CH 57 LO 1	Reserved	CH 57 LO 2	CH 57 HI 2
CH 58 HI 1	CH 58 LO 1	Reserved	CH 58 LO 2	CH 58 HI 2
CH 59 HI 1	CH 59 LO 1	Terminal 14	CH 59 LO 2	CH 59 HI 2
CH 60 HI 1	CH 60 LO 1	Reserved	CH 60 LO 2	CH 60 HI 2
CH 61 HI 1	CH 61 LO 1	Reserved	CH 61 LO 2	CH 61 HI 2
CH 62 HI 1	CH 62 LO 1	Reserved	CH 62 LO 2	CH 62 HI 2
CH 63 HI 1	CH 63 LO 1	Terminal 15	CH 63 LO 2	CH 63 HI 2

Figure 1-8. HP E8462A Multiplexer Front Panel Pin-out
3-Wire Mode and 4-Wire Mode

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Connecting the Analog Bus

The analog bus provides a common bus to all switch modules in multiple switch cards. A multimeter or other instrument can be connected to the analog bus. Use flat ribbon analog bus cables between Multiplexers and other HP VXI modules that have an analog bus (both C-size modules or B-size modules in a C-size adapter). HP E1411A/B 5-Digit Multimeter users (and HP E1326 in a C-size adapter) must continue the analog bus connection between Multiplexers and switch modules to the multimeter in order to use the scanning and measurement capability the multimeter has to offer. These cables provide the input to the multimeter from the multiplexer/switch channels and fit under the Multiplexer's optional terminal cards. Refer to Figure 1-9.

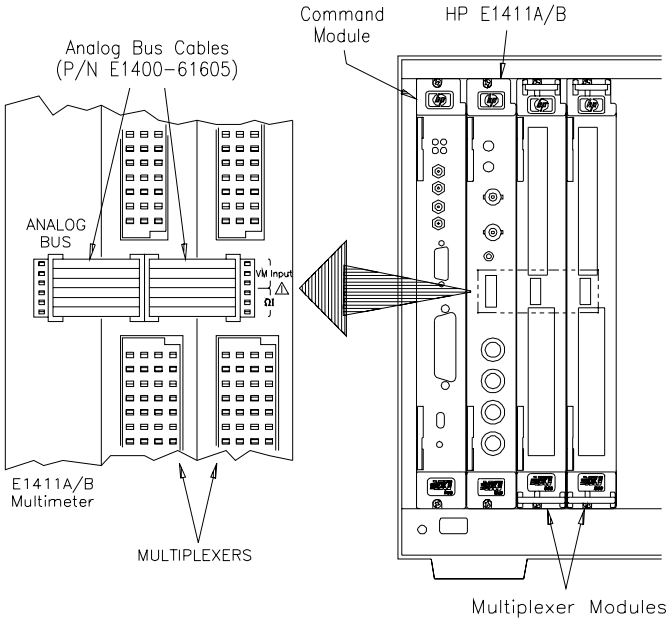


Figure 1-9. HP E1411A/B Connections to the Analog Bus

Note The Option 014 and 015 Terminal Cards distribute the analog bus from P109 in the Terminal Card. An external measuring device can be connected to the analog bus through the terminal card's terminals (pin 5 through pin 16 of connector P109). You can connect this Multiplexer to an HP E1412A Multimeter, or other instruments not having an analog bus connector, via a ribbon cable (not supplied). See Option 014 Fault Tolerant Terminal Block on page 24 (and Option 015 on page 25) for more information.

Note **To use the HP E1326A/B 5½-Digit Multimeter in a C-size adapter:** Use the 19.5 inch analog bus cable part number E1326-61611 for analog bus connection between your HP E1326 and the HP E8462A. The cable described in Figure 1-9 will be too short for connection to the HP E1326.

WARNING **The Multiplexer inputs must be limited to 30VACrms or 60VDC if either end of the analog bus is accessible to users (such as on the front panel of a multimeter).**

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Terminal Cards

Three optional terminal cards are available for the HP E8462A:

- Option 012 Crimp-and-Insert Terminal Card
- Option 014 Fault Tolerant Terminal Card
- Option 015 Ribbon Cable Connector Terminal Card

Option 012 Crimp-and-Insert Terminal Block

The Option 012 Terminal Block provides a terminal card housing and two 160-pin terminal connector blocks (HP P/N 1252-6531).

Note

The contacts for the Option 012 Terminal Block connectors **ARE NOT** provided. This allows you to purchase only the number of contacts you require for your application.

HP P/N 8150-5207 is available for purchase and is a single-conductor with contact (a crimp-and-insert contact is crimped onto one end, the other end is not terminated). Refer to Figure 1-5. "Connector Block and Single-Conductor Wire with Contact (not provided)." on page 19.

The crimp-and-insert contacts you must purchase (HP P/N 1252-6533 for single contact) are gold-plated, accept a wire size of 20 to 26AWG, and carry a maximum current of 2A @70°C. You will also need a crimp tool (HP P/N 8710-2306 or ERNI Components P/N 014374) and optionally a disassembly tool (HP P/N 8710-2307 or ERNI Components P/N 471555).

Caution

The HP E8462A Option 012 Crimp-and-Insert Terminal Block connectors must be replaced after 15,000 hours of use if the module regularly switches voltages >190VDC or >190VACrms due to the close terminal spacing and the potential for pin-to-pin leakage.

Option 014 Fault Tolerant Terminal Block

Option 014 Terminal Block provides nine ribbon-cable header connectors. P101 through P108 provide the channels and terminal bus connection from the front panel connectors (J101 and J102) of the HP E8462A; P109 is a 16-pin connector for the analog bus connection. DS101 and DS102 are LEDs which provide information as follows. The green LED (DS101) will light as the Multiplexer is accessed by the VXI controller. The yellow LED (DS102) monitors the firmware execution, and will light whenever there is error during DIAG:TEST? or *TST? command execution.

Caution

The Option 014 Fault Tolerant Terminal Block is limited to voltages of 60VDC or 50 VACrms or 70.7 VACpeak maximum. Do not exceed these voltages.

Figure 1-10 shows the associated channel numbers. RT100 through RT355 are 256 PTC[1] resistors which behave like a resettable fuse and will increase

1. PTC: Positive Temperature Coefficient.

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impedance when excessive current is flowing in the channel. For example, if the contacts of one relay are welded together because it switches a large voltage, the PTC resistors help protect user circuitry on other channels in the same bank when their relays close.

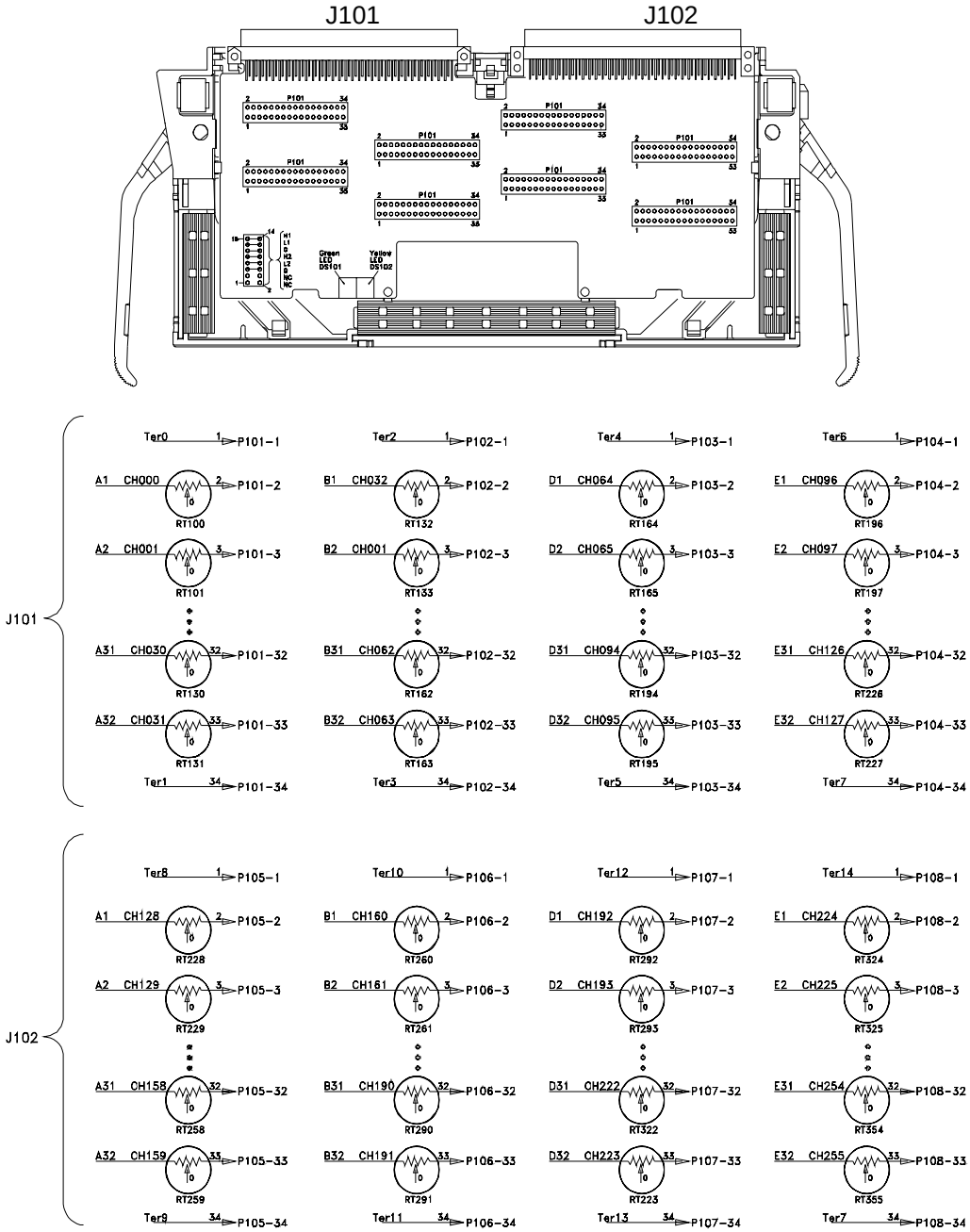


Figure 1-10. HP E8462A Option 014 Fault Tolerant Terminal Card Connector Pin-Out

Option 015 Ribbon Cable Connector Terminal Block

Option 015 Terminal Block provides nine ribbon-cable header connectors. This option is identical to option 014 but does not have fault protection PTC resistors. Zero ohm resistors (short) are loaded in place of the PTC resistors. This option provides the convenience of bringing field wiring to the module by way of flat ribbon cable and terminating on the terminal block at the header connectors.

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Wiring a Terminal Card Figure 1-11 shows how to connect wire to the optional terminal blocks.

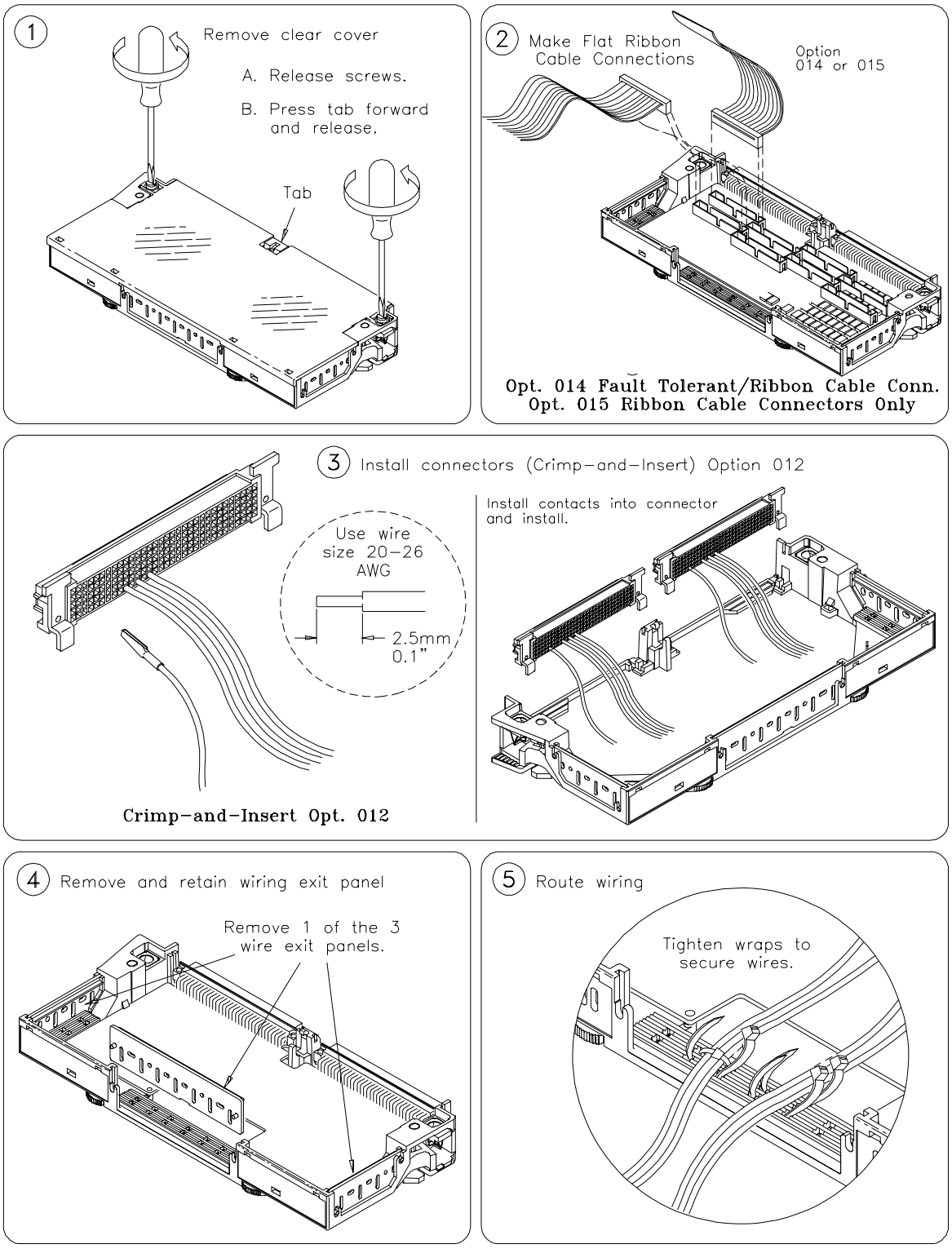


Figure 1-11. Wiring a Terminal Card

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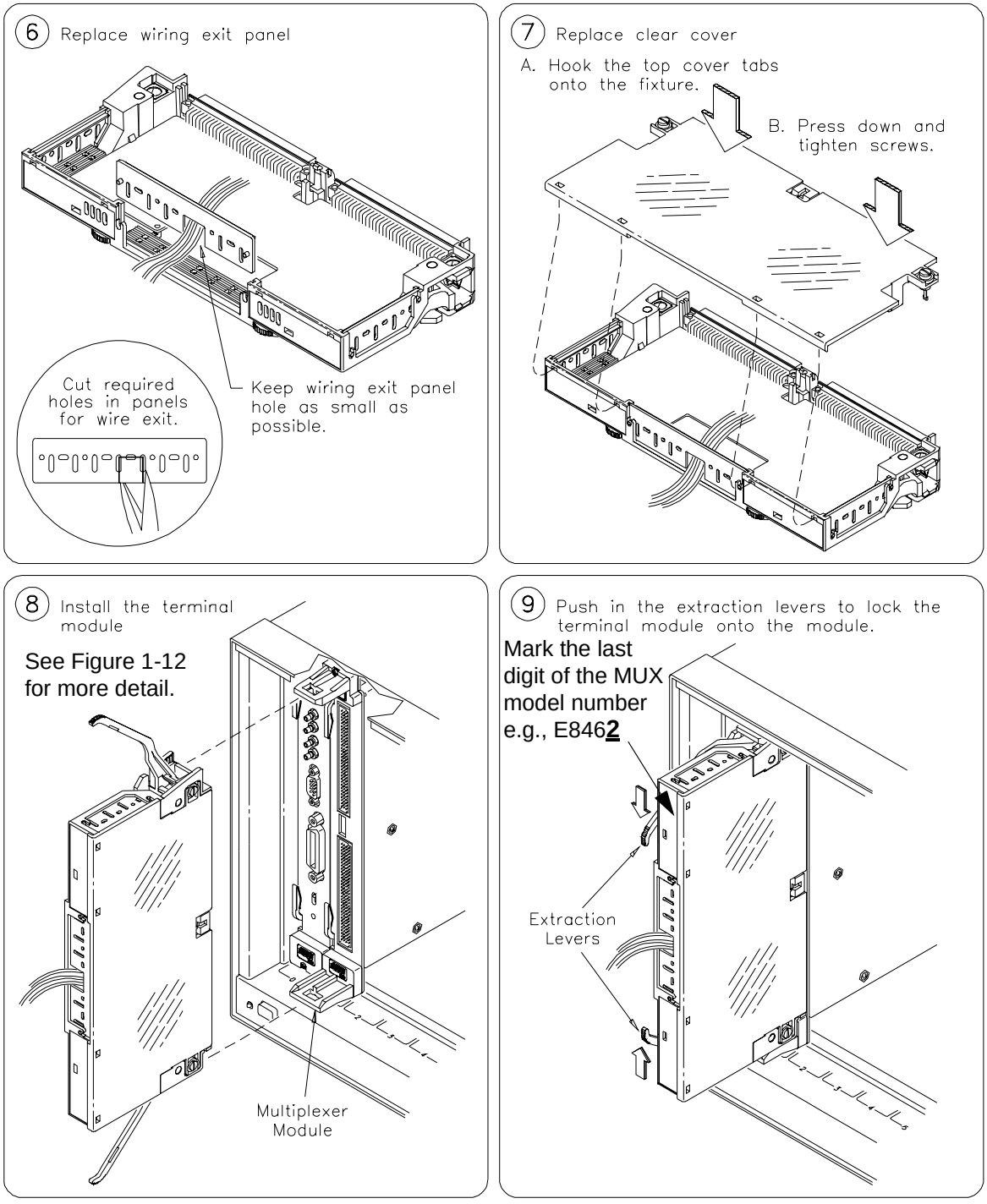


Figure 1-11. Wiring a Terminal Card (continued)

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Attaching a Terminal Block to the Multiplexer

Figure 1-12 shows how to attach an optional terminal block to the HP E8462A Relay Multiplexer module.

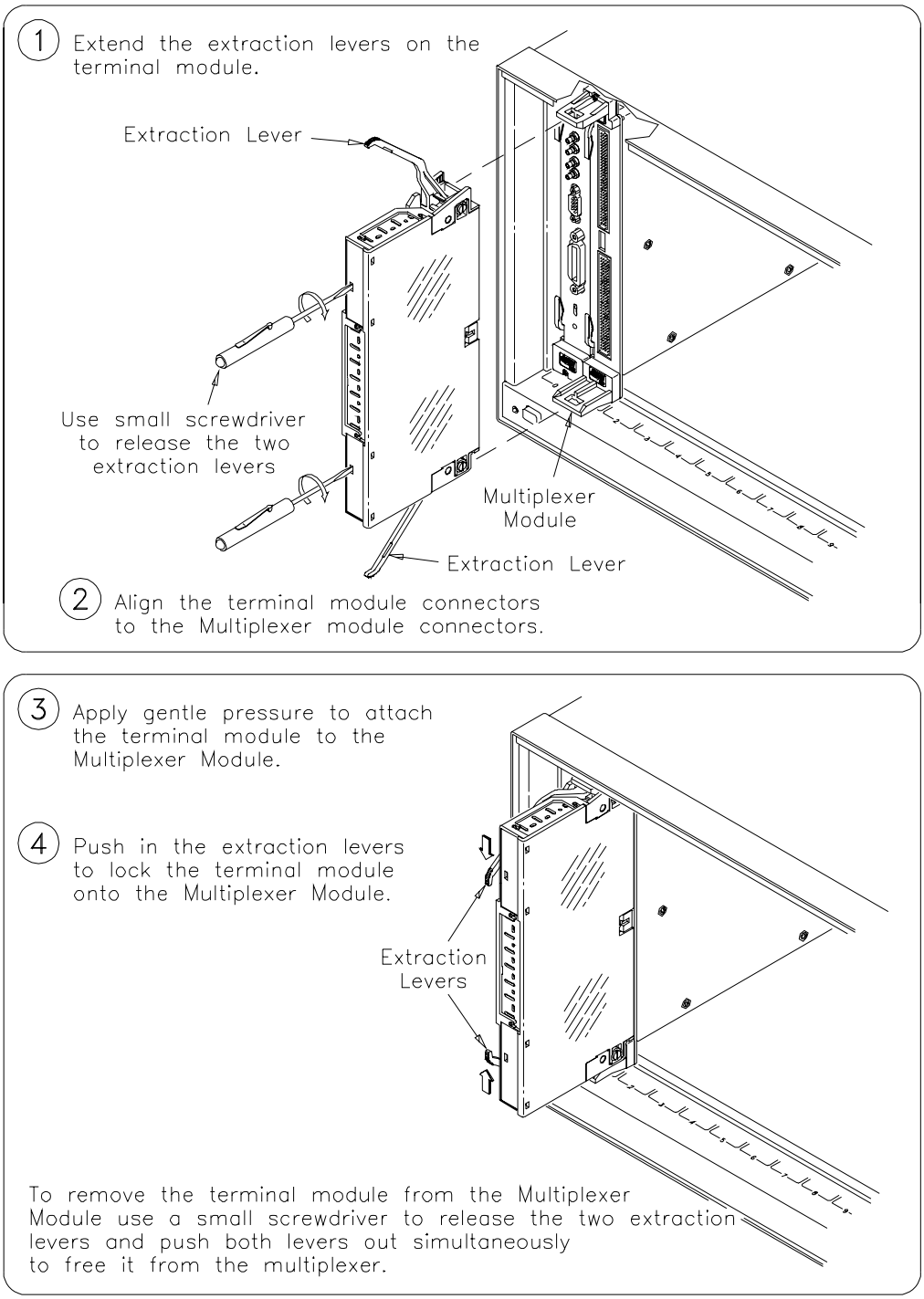


Figure 1-12. Attach a Terminal Block to the Multiplexer

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Programming the Multiplexer

To program the HP E8462A Multiplexer using SCPI, you must know the interface and module address and SCPI commands to be used. Guidelines to select SCPI commands for the Multiplexer follow. See the *HP 75000 Series C Installation and Getting Started Guide* for interface addressing.

Note This discussion applies only to SCPI (Standard Commands for Programmable Instruments) programming. See Appendix B for information on the Multiplexer's registers.

Specifying SCPI Commands

To address specific channels within a Multiplexer, you must specify the SCPI command and channel address. Use CLOSe <*channel_list*> to close the channels specified, OPEN <*channel_list*> to open the channels specified, and SCAN <*channel_list*> to close and open the set of channels specified, one channel at a time.

Channel Address

The Multiplexer's channel address (*channel_list*) has the form (@ccbnnn) where cc = module (card) number (01-99), b = bank or MUX number (0 to one less than banks or muxes) and nnn = channel numbers. The channel number consists of three parts listed in the below table:

Channel List	Card Number (cc)	Bank or Mux (b)	Channel Number (nnn)	Channel Description
ssbccc	01-99	0-7	000-255	256 channel relays
		9	000-021	22 tree relays
		9	100-108	9 Form C tree relays
		9	200-204	5 analog bus relays

The tree relays and analog bus relays have the same channel number no matter what operating mode the Multiplexer is. But the channel relays (CH000-255) may have different channel numbers under different operating mode. See the following table:

Operating Mode	Valid Channel Number	Corresponds to 1-Wire Mode Channel
1-wire	000-255	000-255
2-wire	000-127	000-031, 064-095, 128-159, 192-223 (Channel 000 is paired with channel 032, 001 is paired with 033, etc. Channel 064 is paired with 096, 065 with 097, etc. Channel 128 is paired with 160, channel 129 with 161, etc. Channel 192 is paired with 224, channel 193 with 225, etc.)
3-wire	000-063	000-031, 128-159
4-wire	000-063	000-031, 128-159

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Refer to Chapter 3 of this Manual, the command [ROUTe:]CLOSe for the paired channel information.

You must specify the operating mode BEFORE you execute the commands OPEN, CLOSe, and SCAN. Pay attention to the valid channel numbers when you open, close or scan the specific channel(s) in different operating modes.

The channels can be addressed using channel numbers or channel ranges. You can address the following:

- single channels (@ccbnnn);
- multiple channels (@ccbnnn,ccbnnn,...);
- sequential channels (@ccbnnn:ccbnnn);
- groups of sequential channels (@ccbnnn:ccbnnn,ccbnnn:ccbnnn);
- or any combination of the above.

Card Numbers

The card number (ss of the *channel list*) identifies the module within a multiple switching cards. The card number assigned depends on the switch configuration used. Leading zeroes can be ignored for the module (card) number.

Single-module. In a single Multiplexer module configuration, the card number is always 01 or 1.

Multiple-module. In a multiple-module configuration, modules are set to successive logical addresses. The module with the lowest logical address is always card number 01. The module with the next successive logical address is card number 02, and so on.

Figure 1-13 illustrates the card numbers and logical addresses of a typical multiple-module configuration.

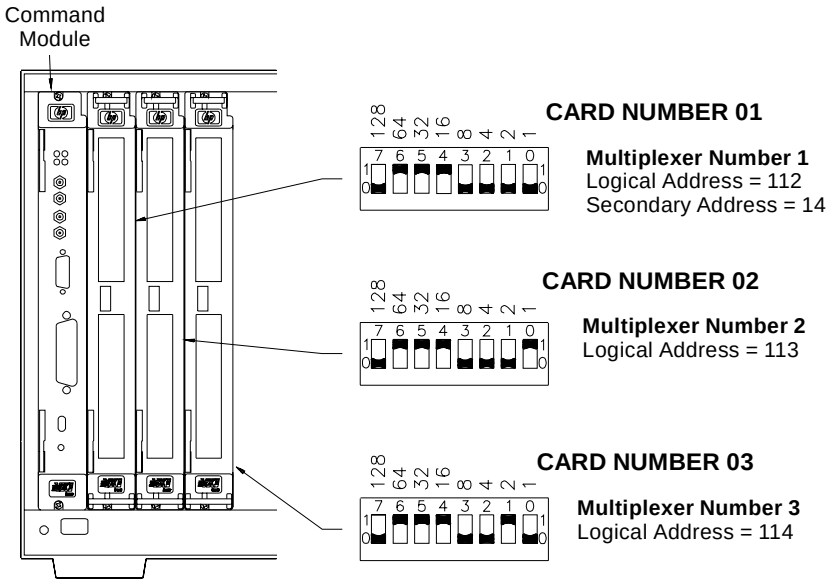


Figure 1-13. Card Numbers in a Multiple-module Configuration

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Channel Numbers, Ranges, and Lists

The HP E8462A Multiplexer channel numbers are 0000 through 0255 under the 1-wire mode. The channels can be addressed using individual channel numbers or channel ranges.

Note

For all other modes, the "channel" is actually used to refer to the paired channel. Under 2-wire mode, there are 128 2-wire paired channels, under 3-wire and 4-wire modes, there are only 64 paired 3-wire or 4-wire channels. See Chapters 2 and 3 for more information of paired channels.

Use commas (,) to form a channel list or use a colon (:) to form a channel range. Only valid channels can be accessed in a channel list or channel range. Also, the channel list or channel range must be from a lower channel number to a higher channel number. For example, CLOS(@1000:1015) is acceptable, but CLOS(@1015:1000) generates an error.

Using the channel range (@cc0000:cc9999) with the SCAN command causes all channels to be scanned except the tree relays (CH9000-9204). Tree relays switch the channels to the appropriate terminal lines and therefore are not included in a scan list.

Below are some SCPI commands and a description of their effect on channel lists and ranges.

Channel Lists:

FUNC 1, WIRE2	*Set the module to 2-wire mode.*
CLOS(@1000,1001)	*Close paired channels 000 and 001 on card #1 (channels 0, 1, 32 & 33 will be closed together).*
OPEN(@1003,1010)	*Open paired channels 03 and 10 on card #1.*

Channel Ranges:

FUNC 1, WIRE1	*Set the module to 1-wire mode.*
OPEN (@1000:1255)	*Open all channels on card #1.*
CLOS (@1000,1127)	*Close channels 000 and 127 on card #1.*
SCAN (@1128:1255)	*Define channels 128-255 to be scanned.*

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Initial Operation

You must download the HP E8462A SCPI driver into the HP E1405/E1406 Command Module to perform the initial operation.

At power-on or following a reset of the module (*RST command), all 256 channels are open. A *RST command invalidates the current scan list (that is, you must specify a new scan list). Command parameters are set to the default conditions as shown below.

Parameter	Default Value	Description
ARM:COUNt	1	Number of scanning cycles is one.
TRIGger:SOURce	IMM	Advances through a scanning list automatically.
INITiate:CONTinuous	OFF	Continuous scanning disabled.
OUTPut[:STATe]	OFF	Trigger output from EXT, TTL, or ECL sources is disabled.
[ROUTe:]FUNC	WIRE2	Operating mode is set to WIRE2 at power-on. This mode is NOT changed by *RST.
[ROUTe:]SCAN:MODE	NONE	Channel list is not set up.
[ROUTe:]SCAN:PORT	NONE	Analog bus connections are disabled from channels.

Execute SCAN:PORT ABUS to enable use of the analog bus for the SCAN command. The SCPI driver will then automatically open and close the five analog bus relays during a scan. A CLOSe command on a channel will also automatically close the appropriate tree relays for the given ROUTe:FUNCtion (see Page 13 "Figure 1-1. HP E8462A Simplified Schematic").

Note Do not execute register writes if you are controlling the module by a high level driver such as SCPI or VXI*plug&play*. Changing values in registers with register writes will confuse the driver because it has a record of the register states after the last command executed by the driver. The driver record of register states is not updated by a register write, only the register value is changed. Therefore, the driver will not know the module state. However, the SCPI driver will re-sync to the hardware if a CLOSe? query is executed.

The following example program was developed with the ANSI C language using the HP VISA extensions. The program was written and tested in Microsoft® Visual C++ but should compile under any standard ANSI C compiler.

To run the program you must have the HP SICL Library, the HP VISA extensions, and an HP 82340 or 82341 HP-IB module installed and properly configured in your PC. An HP E1406 Command Module is required.

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Example: Reset, Self Test, Module ID, and Close Channel

The following example reads the module ID string, performs module self-test, displays the results, closes channel 0002 and queries the channel closure state. The result is returned to the computer and displayed ("1" = channel closed, "0" = channel open).

```
#include <visa.h>
#include <stdio.h>
#include <stdlib.h>

    /* Module Logical address is 112, secondary address is 14*/
#define INSTR_ADDR "GPIB0::9::14::INSTR"

int main()
{
   ViStatus errStatus;                  /*Status from each VISA call*/
   ViSession viRM;                      /*Resource mgr. session */
   ViSession E8462A;                    /* Module session  */
   char id_string[256];                 /*ID string*/
   char selftst_string[256];            /*self-test string*/
   char ch_state;                       /*channel open/close state*/

    /* Open the default resource manager  */
   errStatus = viOpenDefaultRM ( &viRM);
   if(VI_SUCCESS > errStatus){
      printf("ERROR: viOpenDefaultRM() returned 0x%x\n",errStatus);
      return errStatus;}

    /* Open the Module instrument session  */
   errStatus = viOpen(viRM,INSTR_ADDR, VI_NULL,VI_NULL,&E8462A);
   if(VI_SUCCESS > errStatus){
      printf("ERROR: viOpen() returned 0x%x\n",errStatus);
      return errStatus;}

    /* Reset the Module */
   errStatus = viPrintf(E8462A, "*RST;*CLS\n");
   if(VI_SUCCESS > errStatus){
      printf("ERROR: viPrintf() returned 0x%x\n",errStatus);
      return errStatus;}

    /* Query the Module ID string */
   errStatus = viQueryf(E8462A,"*IDN?\n","%t",id_string);
   if (VI_SUCCESS > errStatus) {
      printf("ERROR: viQueryf() returned 0x%x\n",errStatus);
      return errStatus;}
   printf("ID is %s\n",id_string);

    /* Close Channel 002 */
   errStatus = viPrintf(E8462A, "FUNC 1,WIRE1;CLOS (@1002)\n");
   if(VI_SUCCESS > errStatus){
      printf("ERROR: viPrintf() returned 0x%x\n",errStatus);
      return errStatus;}
```


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```
    /* Query State of Channel 002 */
    errStatus=viQueryf(E8462A,"ROUT:CLOS? (@10002)\n","%t",ch_state);
    if (VI_SUCCESS > errStatus) {
        printf("ERROR: viQueryf() returned 0x%x\n",errStatus);
        return errStatus;}
    printf("Channel State is: %s\n",ch_state);

    /* Open Channel 002 */
    errStatus = viPrintf(E8462A, "OPEN (@10002)\n");
    if(VI_SUCCESS > errStatus){
        printf("ERROR: viPrintf() returned 0x%x\n",errStatus);
        return errStatus;}

    /* Close the Module Instrument Session */
    errStatus = viClose (E8462A);
    if (VI_SUCCESS > errStatus) {
        printf("ERROR: viClose() returned 0x%x\n",errStatus);
        return 0;}

    /* Close the Resource Manager Session */
    errStatus = viClose (viRM);
    if (VI_SUCCESS > errStatus) {
        printf("ERROR: viClose() returned 0x%x\n",errStatus);
        return 0;}

    return VI_SUCCESS;
}
```


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Chapter 2
Using the Multiplexer

What's in This Chapter

This chapter contains the following sections:

- Reset Conditions . . . . . Page 35
- Switching or Scanning . . . . . Page 36
- Switching Channels to the Analog Bus. . . . . Page 36
- Recalling and Saving States . . . . . Page 52
- Detecting Error Conditions . . . . . Page 53

Reset Conditions

At power-on or following the reset of the module (*RST command), all 256 channel relays, 21 tree relays, and five analog bus connection relays are open. The nine C relays are in their normally closed position. In addition, after a *RST command, the scan channel list is empty. Table 2-1 lists the parameters and default values for the functions following turn-on or reset.

Table 2-1. HP E8462A Default Conditions for Power-on and Reset

Parameter	Default Value	Description
ARM:COUNt	1	Number of scanning cycles is one.
TRIGger:SOURce	IMM	Advances through a scanning list automatically.
INITiate:CONTinuous	OFF	Continuous scanning disabled.
OUTPut[:STATe]	OFF	Trigger output from EXT, TTL, or ECL sources is disabled.
[ROUTe:]SCAN:MODE	NONE	Channel list is not set up.
[ROUTe:]SCAN:PORT	NONE	Analog bus connections are disabled.
[ROUTe:]FUNCtion	WIRE2	2-wire mode is set at power-on. FUNCtion is not changed by *RST.
DIAGnostic:INTerrupt[:LINE]	1	Interrupt line setting. NOT changed by *RST.
DIAGnostic:INTerrupt:TIME	0.005	Sets interrupt timer value. NOT changed by *RST.
DIAGnostic:SCAN:DELay	0.0	Wait time between opening and closing channels. Reset by *RST.
Channel state	All 256 channels are open (CH000-255 are open).	
Tree relays state	All 22 tree relays are open (CH9000-9021).	
Routing relays state	All routing relays are open and use the normally closed path (CH9100-9108).	
Analog bus connection relay status	5 analog bus relays are open (CH9200-9204).	
Channel list from SCAN command (after *RST)	Channel list is empty following a reset of the module with *RST command.	

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Switching or Scanning

There are two general ways to use the HP E8462A Relay Multiplexer. First, you can use the ROUTe:FUNCTion command subsystem (see Chapter 3) to set up the multiplexer in any of its 12 operating modes: 1-Wire (1-1X256, 2-1X128, 4-1X64, 8-1X32), 2-Wire (1-2X128, 2-2X64, 4-2X32, 8-2X16), 3-Wire (1-3X64), or 4-Wire (1-4X64, 2-4X32, 4-4X16). You can then use the [ROUTe:]CLOSe or [ROUTe:]OPEN commands to control individual channel relays. In the 2-Wire, 3-Wire, and 4-Wire modes, banks of channels are paired together such that when you close one channel the paired relay(s) also close automatically. The ROUTe command subsystem automatically closes the appropriate tree relays depending on the multiplexer mode.

Alternately, you can set the multiplexer mode and scan through a list of channels. Scanning involves sequentially closing/opening channels in a channel list. Use the ROUTe:SCAN command to set the scan mode, use the analog bus, and specify the channel in the channel list.

The channel list used in the ROUTe command subsystem includes the 256 channel relays (CH000-255). Valid channel numbers depend on the specified mode. The 22 tree relays (CH9000-9021), the nine routing relays (CH9100-9108) and five analog bus connection control relays (CH9200-9204) are automatically set depending on the specified mode.

Note You must specify the Multiplexer's operating mode with the [ROUTe:]FUNCtion command before executing the [ROUTe:]CLOSe, OPEN, or SCAN functions. This closes the appropriate tree relays configuring the module for the specified mode. See the ROUTe command in Chapter 3 for more details. Also, Figure 1-6 on page 20, Figure 1-7 on page 21, and Figure 1-8 on page 22 show the valid channel and front panel connections for 1-, 2-, 3- and 4-wire modes.

Note Pay special attention to the valid channel numbers when you execute these SCPI commands. Refer to the comments of the ROUTe subsystem commands in Chapter 3 for more information of the **paired channel** and **valid channel numbers**.

Switching Channels to the Analog Bus

When the multiplexer FUNCtion is set to one of the WIREn modes (any mode but NONE), the appropriate tree relays are automatically closed at the close channel command connecting the channel to the appropriate terminal bus line (Ter0-Ter15). To use the analog bus, however, you must execute the ROUTe:SCAN:PORT command. The analog bus relays will automatically close and open when a scanning operation is executed and the mode is not NONE. Only the tree relays needed for the closed channel are closed. All others are opened. All tree relay and channel realys are opened when power is removed from the module, the module is reset with the *RST command or ROUTe:FUNCtion NONE is executed reconfiguring the module. These actions also open all other relays that are closed. You must manually close the tree relays, routing relays and analog bus relays when you specify the FUNCtion to be NONE.

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Performing Measurements via Analog Bus

To perform measurements via analog bus, you need to either manually close the analog bus connection control relays (CH9200-9204) through command ROUTe:CLOSe or execute the command ROUTe:SCAN:PORT ABUS. 1-wire, 2-wire, 3-wire and 4-wire measurements can be made via analog bus by connecting CH9200-9204.

1-Wire Mode:

All the 256 channel relays are connected to Ter0 and connected to analog bus H1 through closing AB200 (CH9200). Routing relay C108 will be automatically switched between banks as required to route all banks to H1. Valid channel numbers are 000 through 255. Analog Bus L1 will be connected to Analog Bus G and to the user's common ground on Terminal 3.

2-Wire Mode:

The 256 channel relays form 128 2-wire pairs which are connected to Ter0 and Ter1 Terminal buses. Through closing AB200 and AB201 (CH9200-9201), the specific channel pair is connected to analog bus H1 and L1 to perform 2-wire measurements such as voltage and 2-wire resistance measurements. Analog Bus H2 and L2 may also be connected through channels 9203-9204 and tree relays 9109 and 9102 to provide a current source for the resistance measurements. Also, Analog Bus L1 also be connected to G for voltage measurements. Valid channel numbers are 000 through 127. From the perspective of the 1-Wire mode, channel 000 becomes channel 000 HI, channel 032 becomes channel 000 LO, etc. Refer to Figure 1-7 on page 21.

3-Wire Mode:

The 256 channel relays form 64 3-wire pairs which connect to H1, L1 and L2 through closing AB200, AB201, and AB204 (CH9200, 9201 and 9204) respectively. The 64 3-wire pairs are: Banks 0/2, 1/3, 4/6 and 5/7. Valid channel numbers are 000 through 063. From the perspective of the 1-wire mode, channel 000 becomes channel 000 HI, channel 032 becomes channel 000 LO1, and channel 064 becomes channel 000 LO2.

4-Wire Mode:

The 256 channel relays form 64 4-wire pairs which connect to H1, L1, H2, and L2 by closing AB200, AB201, AB203, and AB204 (CH9000, 9201, 9203 and 9204) . In this mode the 4-wire pairs are: Banks 0/2, 1/3, 4/6 and 5/7. Valid channel numbers are 000 through 063. From the perspective of the 1-wire mode, channel 000 becomes channel 000 HI1, channel 032 becomes channel 000 LO1, channel 064 becomes channel 000 LO2, and channel 096 becomes channel 000 HI2.

The analog bus connection control relays are closed to connect specific 4-wire pairs to analog bus H1, L1, H2, and L2. In this mode the 4-wire pairs are: Banks 0/2, 1/3, 4/6 and 5/7. The valid channel numbers that can be closed/opened/scanned are 000 through 63. Refer to Chapter 3, ROUTe command subsystem for more information on valid channel numbers and paired channels under different operating modes.

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Mode: WIRE1

Figure 2-1 shows the 1-Wire mode (configured as a 1 x 256 multiplexer).

Description:
one 1-wire x 256 ch MUX

Front Panel Pin-out:
See Figure 1-6

- Tree Relays: T0 through T7 are closed to connect the specific channels to Terminal Bus Ter0 and Ter1.
- Routing Relays: C100 and C108, toggles between the Ter0 and Ter1 terminal bus line to route all channels to Ter0 (1-wire).
- Valid Channel List: All 256 channels (000-255).
- Analog Bus: All the channels can be also connected to analog bus line H1 by closing AB200 (CH9200) and toggling C108 (CH9108).
- SCPI Example: How to set the mode and close a channel.

FUNC 1, WIRE1	*Specify the 1-Wire mode.*
CLOS (@10005)	*Close channel 5.*

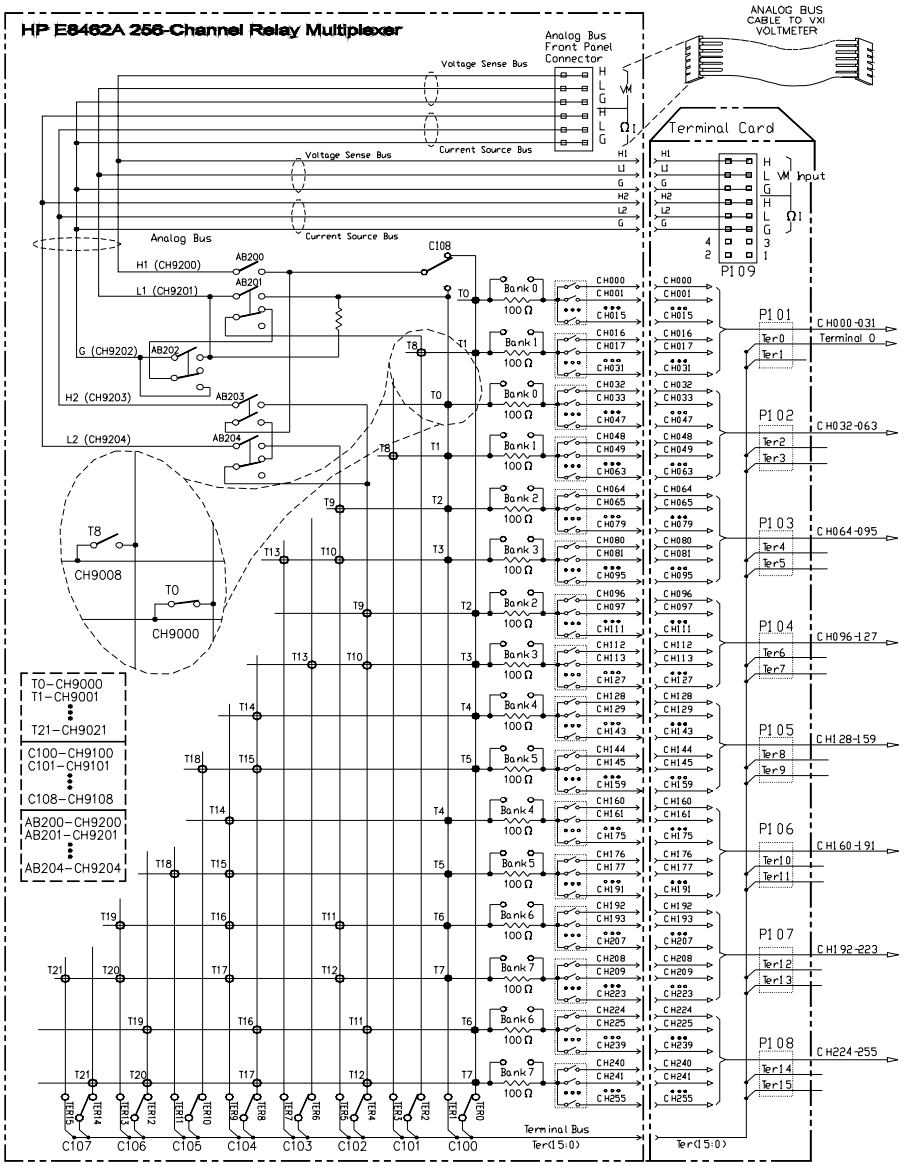


Figure 2-1. 1-Wire (1 x 256 Multiplexer) Operating Mode

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Mode: WIRE2

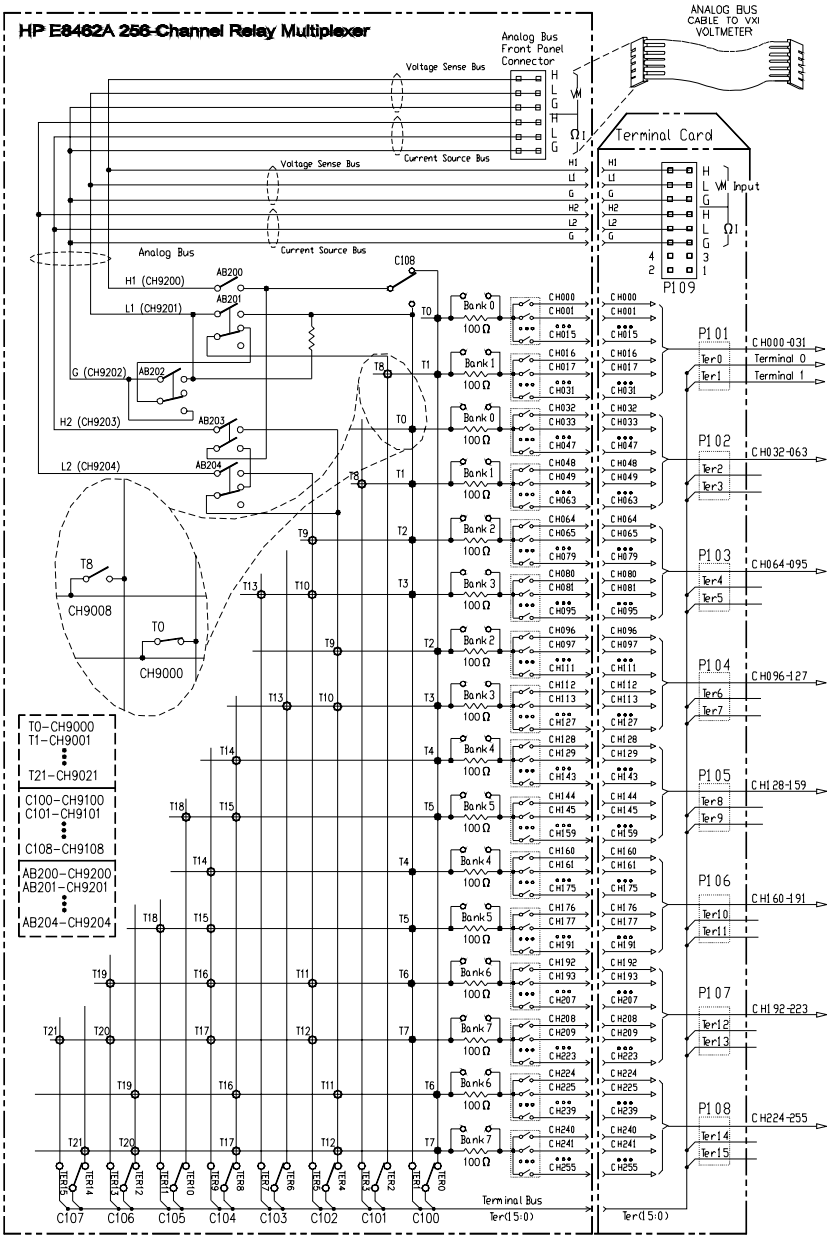
Description:
one 2-wire x 128 ch MUX

Front Panel Pin-out:
See Figure 1-7

Figure 2-2 shows the 2-Wire mode. All 256 channels form 128 2-wire pairs which connect to Terminal Bus Ter0 and Ter1.

- Tree Relays: T0 through T7 are closed to connect the specific channel pairs to Terminal Bus Ter0 and Ter1.
- Routing Relays: C100 and C108 remain connected to Ter0.
- Valid Channel List: 000-127.
- Analog Bus: All the channels can be also connected to analog bus lines H1 and L1 by closing AB200 (CH9200) and AB201 (CH9201).
- SCPI Example: How to make a 2-wire measurement with a paired channel (CH000 and CH032).

FUNC 1, WIRE2 — *Specify 2-wire Mode.*
CLOS (@10000) — *Close paired Ch000 and Ch032*



2-Wire @ Ter0 and Ter1

Figure 2-2. 2-Wire Operating Mode

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Mode: WIRE3 and WIRE4

Description:
one 3-wire x 64 ch MUX
or
one 4-wire x 64 ch MUX

Front Panel Pin-out:
See Figure 1-8

The same basic configuration is used for both the 3-Wire and the 4-Wire modes. Refer to Figure 2-3. In the 3-Wire mode, relays 0-31 and 128-159 switch to terminal bus Ter0, relays 32-63 and 160-191 switch to Ter1, and relays 64-95 and 192-223 switch to Ter5. In the 4-Wire mode, relays 0-31 and 128-159 switch to terminal bus Ter0, relays 32-63 and 160-191 switch to Ter1, relays 64-95 and 192-223 switch to Ter5 and relays 96-127 and 224-255 switch to Ter4.

In either mode the 256 channels will form 64 wire pairs. The valid channel numbers are 0 through 63. Measurements can be done either through the four terminal bus Terminals 0, 1, 5, and 4 or through the analog bus by closing the analog bus relays AB200, AB201, AB203 and AB204 (CH9200, 9201, 9203, 9204).

For 4-Wire measurements, you would typically use a pair of channels from banks 0 and 2 for the voltage sense and another pair of channels from banks 4 and 6 for the current source, these four channels forms one 4-wire pair. Closing any channel in the pair automatically closes the other channel in the pair. The following SCPI example shows how to set the 4-Wire mode and how to close the paired channels.

```
FUNC 1, WIRE4
CLOS (@100)
```

Configure 4-wire mode.
Close channel 00. Channels 32, 64, 96 are 4-wire pair and will close automatically.

Other Modes

The HP E8462A can also be configured as two 128x1, four 64x1, eight 32x1, two 64x2, four 32x2, eight 16x2, two 32x4 or four 16x4 multiplexers. The ROUTe:FUNCtion command can be used to automatically set these modes. You must use mode NONE and manually set all tree and routing relays if you want a mixture of modes (e.g., one 128x1, one 32x2 and one 16x4).

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NOTE: See Figure 1-8 for 3-wire and 4-wire front panel pin-out.

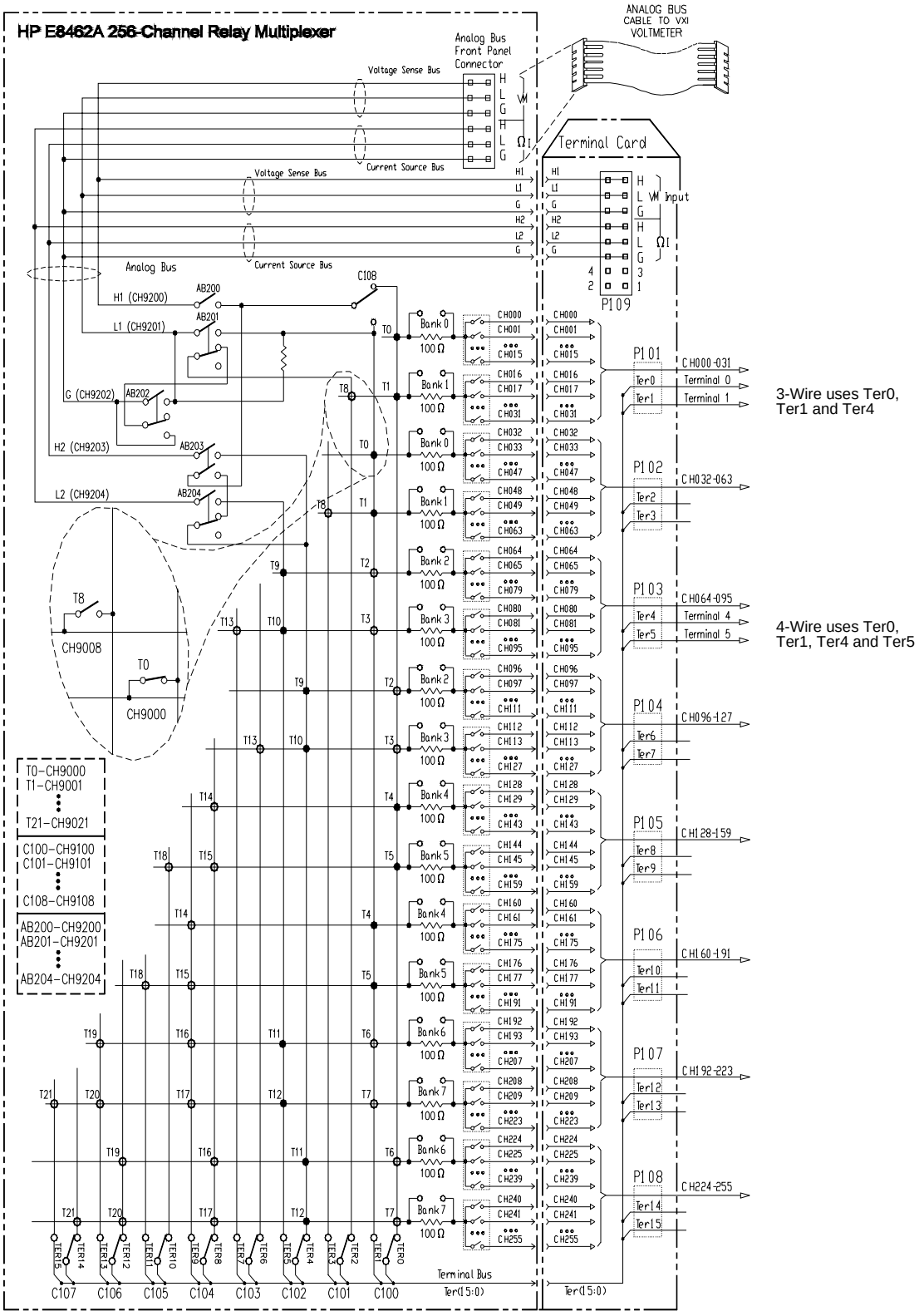


Figure 2-3. 3-Wire and 4-wire Operating Mode

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Mode: WIRE1x2 and WIRE2x2

The HP E8462A can be configured as two 128 x 1 or two 64 x 2 multiplexers. Figure 2-4 illustrates these configurations.

Description:
two 1-wire x 128 ch MUX
or
two 2-wire x 64 ch MUX

Front Panel Pin-out: See Figure 1-6 for 1-wire or Figure 1-7 for 2-wire.

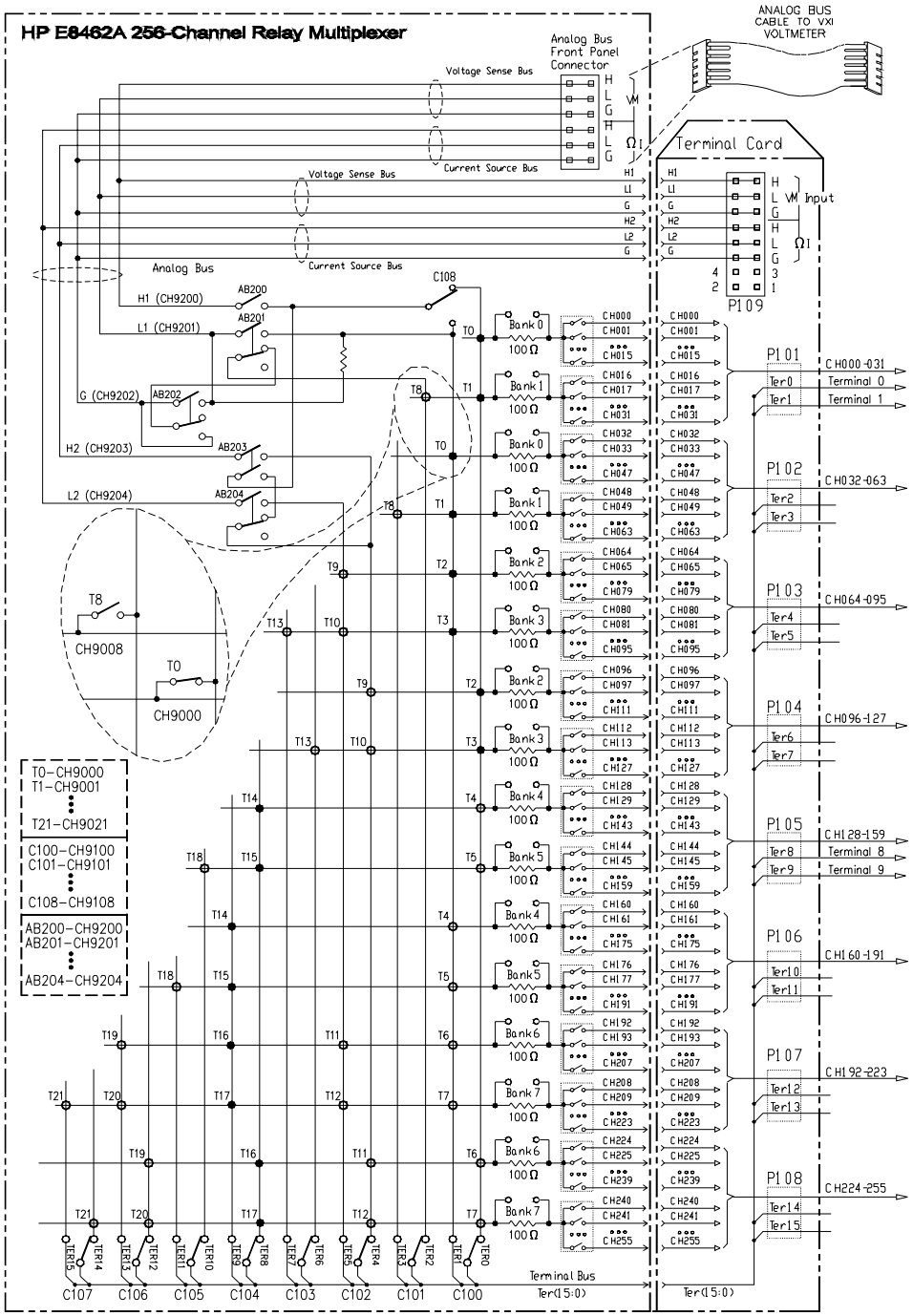


Figure 2-4. Two 1 x 128 or Two 2 x 64 Multiplexer

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Mode: WIRE1x4, WIRE2x4, WIRE4x2

Description:
four 1-wire x 64 ch MUX
or
four 2-wire x 32 ch MUX
or
two 4-wire x 32 ch MUX

The HP E8462A can be configured as four 64 x 1, four 32 x 2 and two 32 x 4 multiplexers. In this configuration, the 256 channels are divided into 8 groups, each one is a 32 x 1 multiplexer. The 8 groups are connected to eight terminal bus (Terminals 0, 2, 4, 6, 8, 10, 12, 14) by closing 16 related tree relays. These modes are automatically set with the ROUTe:FUNC command which automatically sets the appropriate tree relays.

Front Panel Pin-out: See Figure 1-6 for 1-wire or Figure 1-7 for 2-wire or Figure 1-8 for 4-wire.

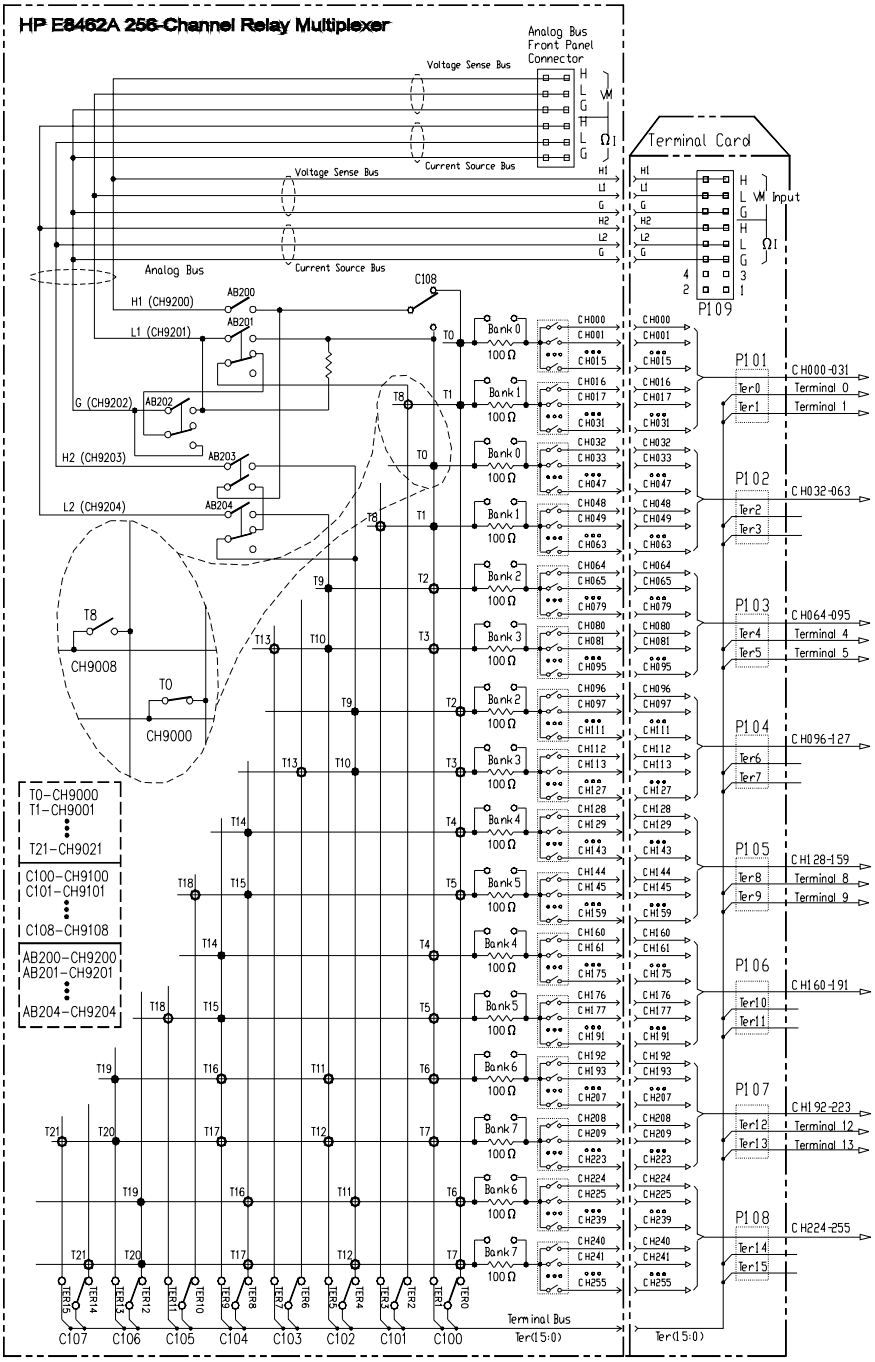


Figure 2-5. Four 1 x 64, Four 2 x 32 or Two 4 x 32 Multiplexer

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Mode: WIRE1x8, WIRE2x8, WIRE4x4

Description:
eight 1-wire x 32 ch MUX
or
eight 2-wire x 16 ch MUX
or
four 4-wire x 16 ch MUX

The HP E8462A can be configured as eight 32 x 1, eight 16 x 2 and four 16 x 4 multiplexers. In this configuration, the 256 channels are divided into 8 groups, each one is a 32 x 1 multiplexer. The 8 groups are connected to eight terminal bus (Terminals 0, 2, 4, 6, 8, 10, 12, 14) by closing 16 related tree relays. These modes are automatically set with the ROUTe:FUNC command which automatically sets the appropriate tree relays.

Front Panel Pin-out: See Figure 1-6 for 1-wire or Figure 1-7 for 2-wire or Figure 1-8 for 4-wire.

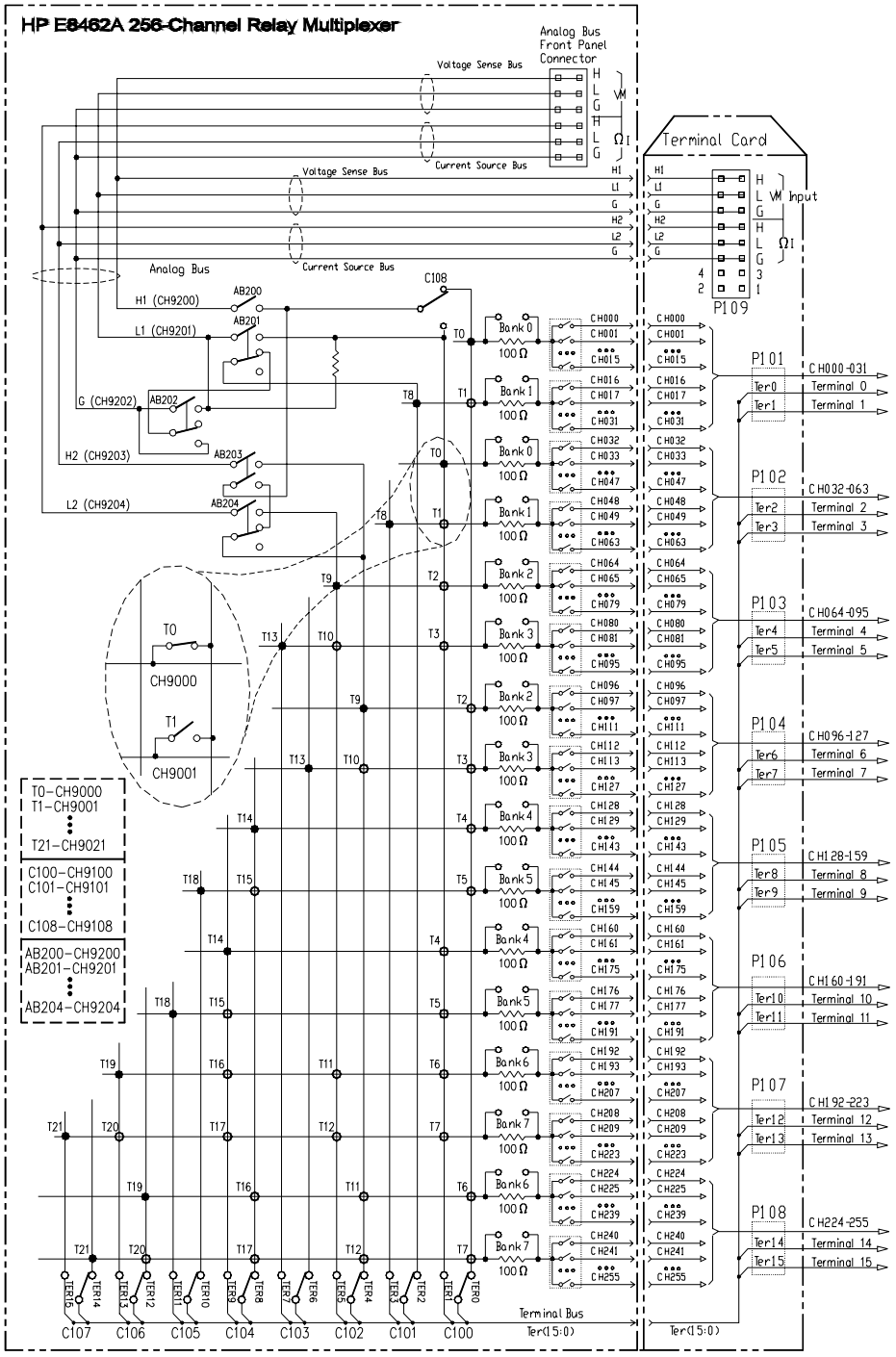


Figure 2-6. Eight 1 x 32, Eight 2 x 16 or Four 4 x 16 Multiplexer

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Scanning Channels

Scanning the Multiplexer channels consists of sequentially closing a channel (and its associated tree relays), making some measurement , opening that channel, and then repeating that process with the next channel in a channel list. You can make a single scan through the channel list or scan a multiple number of times. You can also scan the channel list continuously until the scan is aborted.

The TRIGger:SOURce command specifies the source to advance the scan. The OUTPut command can be used to enable the HP E1406A Command Module's “Trig Out” port, TTL Trigger bus line (0-7) or ECL Trigger bus lines (0-1). Figure 2-7 illustrates the commands in the scanning sequence.

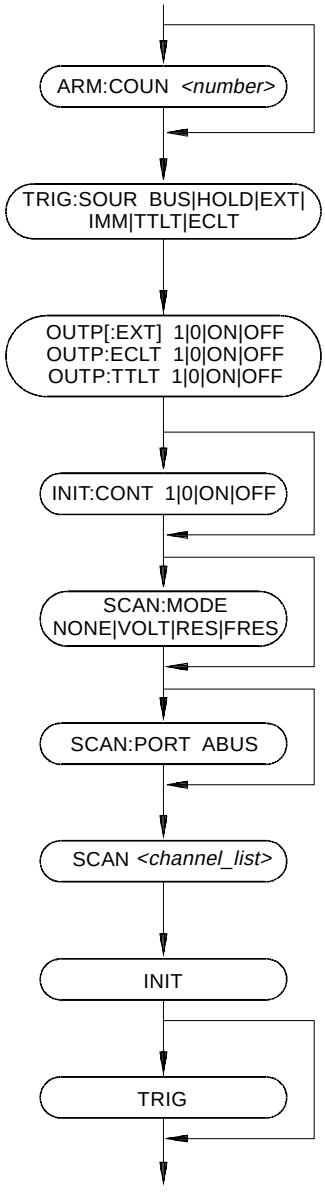


Figure 2-7. Command Sequence for Scanning Channels

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You can scan a channel or a list of channels using the SCAN command. The analog bus connection control relays (CH9200-9204) are automatically closed when you specify the command SCAN:PORT ABUS. This command is required for the analog bus control relays to function during the scan through the channel list. The default value is SCAN:PORT NONE which does not automatically close these relays and connect channels to the analog bus. They may however, still be manually controlled with the OPEN and CLOSe commands.

At power-on or after resetting the module with the *RST command, connection to the analog bus is disabled for scan operations. You must execute the command SCAN:PORT ABUS to enable analog bus connection control relay operation. Access is through the front panel analog bus connector (usually connected to other multiplexers or to the E1411A/B multimeter) or through the terminal module (Opt 014) "VM Input" and "ΩI" terminals on P109 connector (see Figure 1-1 on page 13).

Synchronizing the Multiplexer with a Multimeter

This example uses the TTL VXIbus triggers (TTLT 0-7) to synchronize channel closures with the HP E1412A 6 1/2-Digit Multimeter. DC Voltage measurements are performed. Measurement synchronization is attained by the multimeter sending a voltmeter complete signal on TTL Trigger Line 1 and receiving the channel closed signal on TTL Trigger Line 0. Similarly, the multiplexer module sends its channel closed signal on TTL 0 and receives its channel advance signal on TTL 1. Note; Figure 2-8 shows connections between the HP E1406A Command Module Trigger In and Trigger Out to the HP E1412A Trigger In and Voltmeter Complete. This simply demonstrates an alternate method of synchronizing the measurements.

Measurement Set-Up

- HP E1412A has an HP-IB select code = 7, primary address = 09 and secondary address = 03.
- HP E8462A has an HP-IB select code = 7, primary address = 09 and secondary address = 14.
- Controller is an IBM compatible PC, the programming language is Visual C/C++ with HP VISA extensions.

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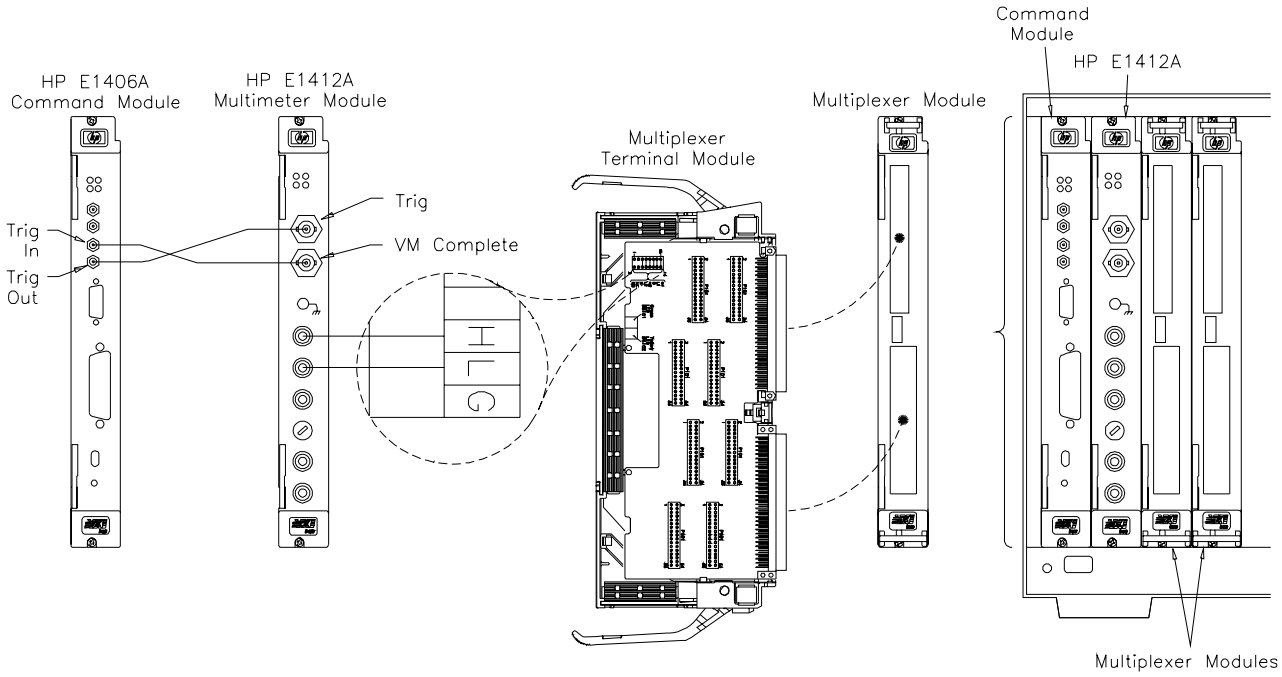


Figure 2-8. Scanning with VXIbus Triggers

The following example program was developed with the ANSI C language using the HP VISA extensions. The program was written and tested in Microsoft® Visual C++ but should compile under any standard ANSI C compiler.

To run the program you must have the HP SICL Library, the HP VISA extensions, and an HP 82340 or 82341 HP-IB module installed and properly configured in your PC. An HP E1406 Command Module is required.

This following example resets and configures the multimeter for DC Voltage measurements, resets and configures the multiplexer for 2-Wire configuration TTL Trigger bus synchronization, use of the analog bus, and scanning channels 00 through 09.

```
#include <visa.h>
#include <stdio.h>
#include <stdlib.h>

    /* Interface address is 112, Module secondary address is 14*/
#define INSTR_ADDR "GPIB0::9::14::INSTR"
    /* interface address for HP E1412 Multimeter */
#define MULTI_ADDR "GPIB0::9::3::INSTR"

int main()
{
```


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```
ViStatus errStatus;                          /*Status from each VISA call*/
ViSession viRM;                              /*Resource mgr. session */
ViSession E8462A;                            /* Module session  */
ViSession E1412A;                            /* Multimeter session */
viSetAttribute (E1412A,VI_ATTR_TMO_VALUE,268435456)
                                             /* multimeter timeout value */

int ii;                                      /* loop counter */
char opc_int[21]                             /* OPC? variable */
double readings [10];                        /* Reading Storage*/

  /* Open the default resource manager  */
errStatus = viOpenDefaultRM ( &viRM);
if(VI_SUCCESS > errStatus)
    printf("ERROR: viOpenDefaultRM() returned 0x%x\n",errStatus);

  /* Open the Module instrument session  */
errStatus = viOpen(viRM,INSTR_ADDR, VI_NULL,VI_NULL,&E8462A);
if(VI_SUCCESS > errStatus)
    printf("ERROR: viOpen() returned 0x%x\n",errStatus);

  /* Open the Multimeter instrument session  */
errStatus = viOpen(viRM,MULTI_ADDR, VI_NULL,VI_NULL,&E1412A);
if(VI_SUCCESS > errStatus)
    printf("ERROR: viOpen() returned 0x%x\n",errStatus);

  /* Reset the Multimeter, clear status system */
errStatus = viPrintf(E1412A, "*RST;*CLS\n");
if(VI_SUCCESS > errStatus)
    printf("ERROR: viPrintf() returned 0x%x\n",errStatus);

  /*Configure Multimeter for DCV measurements, 12 V max, min resolution */
errStatus = viPrintf(E1412A, "CONF:VOLT 12,MIN\n");
if(VI_SUCCESS > errStatus)
    printf("ERROR: viPrintf() returned 0x%x\n",errStatus);

  /* Set multimeter trig input TTLT0 Trigger Line */
errStatus = viPrintf(E1412A, "TRIG:SOUR:TTLT0\n");
if(VI_SUCCESS > errStatus)
    printf("ERROR: viPrintf() returned 0x%x\n",errStatus);

  /* Enable Measurement Complete on TTL2 */
errStatus = viPrintf(E1412A, "OUTP:TTLT1 ON\n");
if(VI_SUCCESS > errStatus)
    printf("ERROR: viPrintf() returned 0x%x\n",errStatus);

  /* Enable Trigger Delay */
errStatus = viPrintf(E1412A, "TRIG:DEL 0.001\n");
if(VI_SUCCESS > errStatus)
    printf("ERROR: viPrintf() returned 0x%x\n",errStatus);
```


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```
 /* Set Multimeter for  10  triggers */
errStatus = viPrintf(E1412A, “TRIG:COUN 10\n”);
if(VI_SUCCESS > errStatus)
   printf(“ERROR: viPrintf() returned 0x%x\n”,errStatus);

 /* Pause until multimeter is ready */
errStatus = viQueryf(E1412A, “*OPC?\n”,”%t”,opc_int);
if(VI_SUCCESS > errStatus)
   printf(“ERROR: viQueryf() returned 0x%x\n”,errStatus);

 /* Initialize Multimeter, wait for trigger */
errStatus = viPrintf(E1412A, “INIT\n”);
if(VI_SUCCESS > errStatus)
   printf(“ERROR: viPrintf() returned 0x%x\n”,errStatus);

 /* Reset E8462A */
errStatus = viPrintf(E8462A,”*RST;*CLS\n”);
if (VI_SUCCESS > errStatus)
   printf(“ERROR: viPrintf() returned 0x%x\n”,errStatus);

 /* Enable Trigger Output on TTL2 */
errStatus = viPrintf(E8462A, “OUTP:TTLT0 ON\n”);
if(VI_SUCCESS > errStatus)
   printf(“ERROR: viPrintf() returned 0x%x\n”,errStatus);

 /* Set Trigger Input On TTL 1 */
errStatus = viPrintf(E8462A, “TRIG:SOUR TTLT1\n”);
if(VI_SUCCESS > errStatus)
   printf(“ERROR: viPrintf() returned 0x%x\n”,errStatus);

 /* Set Multiplexer to 2-Wire mode */
errStatus = viPrintf(E8462A, “ROUT:FUNC ,WIRE2\n”);
if(VI_SUCCESS > errStatus)
   printf(“ERROR: viPrintf() returned 0x%x\n”,errStatus);

 /* Set Multiplexer to Voltage mode */
errStatus = viPrintf(E8462A, “SCAN:MODE VOLT\n”);
if(VI_SUCCESS > errStatus){
   printf(“ERROR: viPrintf() returned 0x%x\n”,errStatus);}

 /* Enable Analog Bus */
errStatus = viPrintf(E8462A, “SCAN:PORT ABUS\n”);
if(VI_SUCCESS > errStatus){
   printf(“ERROR: viPrintf() returned 0x%x\n”,errStatus);}

 /* Set Scan List */
errStatus = viPrintf(E8462A, “SCAN(@100:109)\n”);
if(VI_SUCCESS > errStatus){
   printf(“ERROR: viPrintf() returned 0x%x\n”,errStatus);}
```


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```
    /* Pause until ready */
    errStatus = viQueryf(E8462A, "*OPC?\n","%t",opc_int);
    if(VI_SUCCESS > errStatus){
        printf("ERROR: viQueryf() returned 0x%x\n",errStatus);}

    /* Start Scan */
    errStatus = viPrintf(E8462A, "INIT\n");
    if(VI_SUCCESS > errStatus){
        printf("ERROR: viPrintf() returned 0x%x\n",errStatus);}

    /* Get readings from Multimeter */
    errStatus = viQueryf(E1412A, "FETC?\n","%,10lf",readings);
    if(VI_SUCCESS > errStatus){
        printf("ERROR: viQueryf() returned 0x%x\n",errStatus);}

    for (ii=0;ii<10;ii++) {
        printf (Reading %d is: %lf\n",ii,readings[ii]);  }

    /* Reset E8462A to open all channels*/
    errStatus = viPrintf(E8462A,"*RST\n");
    if (VI_SUCCESS > errStatus) {
        printf("ERROR: viPrintf() returned 0x%x\n",errStatus);}

    /* Close the E8462A Instrument Session */
    errStatus = viClose (E8462A);
    if (VI_SUCCESS > errStatus)
        printf("ERROR: viClose() returned 0x%x\n",errStatus);

    /* Close the Multimeter Instrument Session */
    errStatus = viClose (E1412A);
    if (VI_SUCCESS > errStatus)
        printf("ERROR: viClose() returned 0x%x\n",errStatus);

    /* Close the Resource Manager Session */
    errStatus = viClose (viRM);
    if (VI_SUCCESS > errStatus)
        printf("ERROR: viClose() returned 0x%x\n",errStatus);

    return VI_SUCCESS;
}
```


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Using BUS Triggers with an External Device to Scan Channels

Refer to Figure 2-9. This example uses the BUS trigger (GET or *TRG) to synchronize channel closures with the HP 3457A Multimeter. A DC voltage measurement is performed. Measurement synchronization is attained by:

1. After the multimeter and multiplexer are configured, iniitate the scan on the HP E8462A (INIT command). This closes the first channel.
2. FETCH? the reading from the multimeter.
3. Trigger the multiplexer (*TRG command). This opens the channel and closes the next channel in the list. After the relay settles, the HP E1406A outputs a trigger to trigger the multimeter.
4. Repeat steps 2 and 3 in a loop until all channels in the channel list have been scanned.

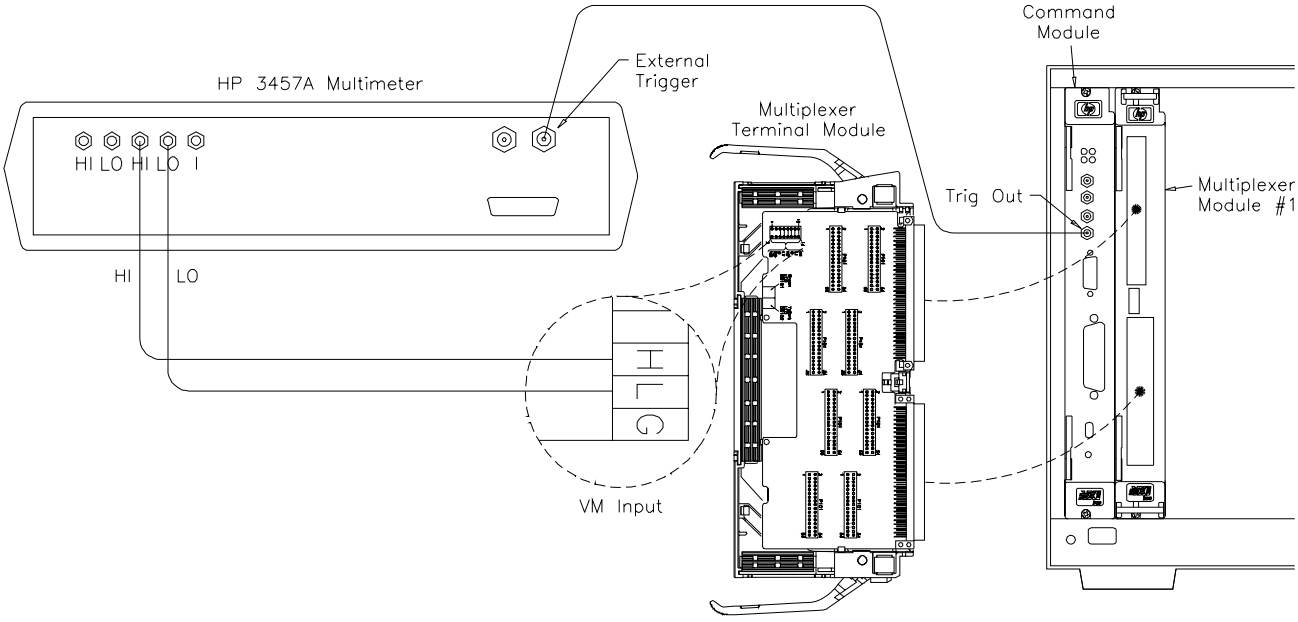


Figure 2-9. Scanning with an External Device

The actual C++ language program is similar to the previous example and will not be presented again.

Hybrid MUX Configuration

The module can be configured into segments of channels that are of different modes using the FUNCtion NONE and manually setting appropriate tree switches. Figures 1-1 and 2-1 through 2-6 show the location of tree relays and will help you determine what relays you should close. An example program on the driver CD (in the examples subdirectory) titled hybrid.c configures part of the module as 1-wire, part as 2-wire and part as 4-wire.

Distribution MUX

You can use the multiplexer to distribute a signal to many different channels as well as multiplexing many channels into one signal line. The example program distrib.c on the drivers CD (in the examples subdirectory) shows how a signal input on terminal line TER0 can be distributed to 128 different channels.

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Recalling and Saving States

This section contains information about saving and recalling a Multiplexer module state.

Saving States

The *SAV <*numeric_state*> command saves the current instrument state. The state number (0-9) is specified in the state parameter. The following settings are saved:

- Channel Relay State (CH000-256 open or closed);
- Tree Relay State (CH9000-9021 open or closed);
- Routing Relay Stare (CH9100-9108 open or closed).
- Analog Bus Connection Control Relay State (CH9200-9204 open or closed)
- ARM:COUNt Value
- TRIGger:SOURce Mode
- OUTPut[:STATe] Configuration
- INITiate:CONTinuous Mode
- [ROUTe:]FUNCtion Mode
- [ROUTe:]SCAN:MODE Mode
- [ROUTe:]SCAN:PORT Mode
- DIAGnostic:SCAN:DELay Time
- DIAGnostic:INTerrupt[:LINE] Setting
- DIAGnostic:INTerrupt:TIME Time

Recalling States

The *RCL <*numeric_state*> command recalls a previously saved state. Enter the number (0-9) in the state parameter of the desired saved state. If *SAV was not previously executed using the selected number, the Multiplexer will be configured to the reset values (see "Table 2-1. HP E8462A Default Conditions for Power-on and Reset" on page 35).

Note Scan lists are not saved when a state is saved. You must re-enter your scan list after recalling a state.

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Detecting Error Conditions

There are two general approaches to error checking. The simplest, but most time consuming, is to ask the instrument whether there are errors at every step of the switching process. This is called “polling” and is illustrated in the two previous program examples.

Using Interrupts With Error Checking

The second approach involves the use of interrupts. In this approach, the program monitors the Multiplexer's Standard Event Status Register for an error condition. If no errors occur, the Multiplexer functions as programmed. If errors do occur, the Multiplexer interrupts the computer, and the error codes and messages are read from the error queue.

Analog Bus 2-Wire Resistance Measurements

[ROUTe:]SCAN:MODE RES sets the scanning mode to 2-wire resistance measurements. The current source from the ohmmeter to the unknown resistance is supplied over analog bus lines H2 and L2. The RES mode closes Tree relays T9 and T2 which connect H2 to H1 and L2 to L1. This configuration allows H2 and L2 to source the current through the unknown resistance and H1 and L1 to sense the voltage and make the resistance measurement. You must make this connection manually if you use the FUNCtion mode NONE or register program the multiplexer and desire 2-wire ohms measurements.

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Routing Relay Operation

The HP E8462A uses eight Form C (C100 - C107) relays to route closed channels to the appropriate terminal line (Ter0 to Ter15) dependent on the FUNCtion mode set. A ninth Form C relay (C108) is used to switch terminal lines to the analog bus. Figure 2-10 shows routing relays C100, C101 and C102. These are three of the nine form C routing relays.

WIRE1 (1-wire) Example

In the 1-wire mode, all channels are routed to terminal line Ter0. Tree relays T0 through T7 are closed to connect channels to either terminal line Ter0 or Ter1. Tree relay T0 connects channels 0 - 15 to Ter0 and channels 32 - 47 to Ter1. Tree relay T1 connects channels 16 - 31 to Ter0 and channels 48 - 63 to Ter1. Tree relays T2 through T7 make similar connections to Ter0 and Ter1. The routing relay C100 toggles between terminal lines Ter0 and Ter1 depending on the channel that is closed to route all channels to Ter0. When you specify [ROUTe:]FUNCtion NONE, you are required to switch the routing relays as required.

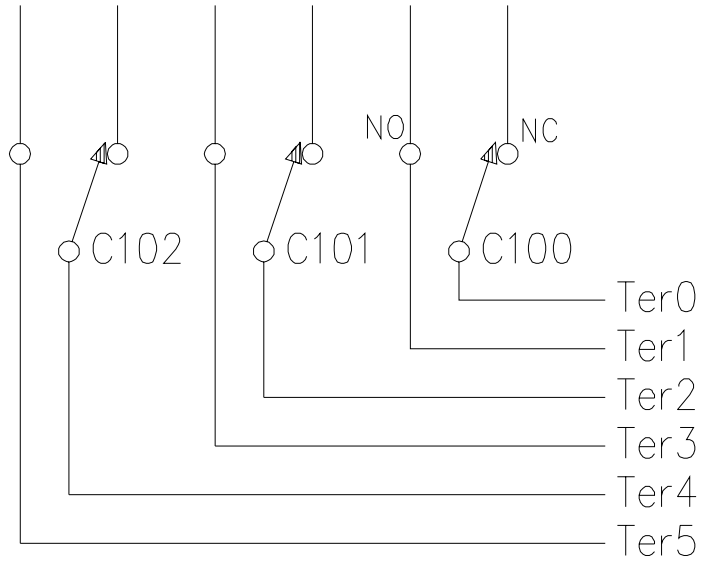


Figure 2-10. Routing Relay Example (3 of 9 Form C Relays).

Function Mode Topologies

The following pages describe the topologies of the 12 modes you set with the [ROUTe:]FUNCtion command. These tables list the bank and relay associated with the channel of each mode. These are helpful when programming the module using [ROUTe:]FUNCtion NONE and custom configuring the 256 channels into a mixture of switching topologies. These are also helpful when register programming the module.

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WIRE1 Mode Topology

Table 2-2. One 1-Wire X 256-Channel Topology Table.

Channel #	Relay Closure	Channel #	Relay Bank-Ch	Channel #	Relay Bank-Ch	Channel #	Relay Bank-Ch
0	bank 0-ch 0	64	bank 2-ch 0	128	bank 4-ch 0	192	bank 6-ch 0
1	bank 0-ch 1	65	bank 2-ch 1	129	bank 4-ch 1	193	bank 6-ch 1
2	bank 0-ch 2	66	bank 2-ch 2	130	bank 4-ch 2	194	bank 6-ch 2
3	bank 0-ch 3	67	bank 2-ch 3	131	bank 4-ch 3	195	bank 6-ch 3
4	bank 0-ch 4	68	bank 2-ch 4	132	bank 4-ch 4	196	bank 6-ch 4
5	bank 0-ch 5	69	bank 2-ch 5	133	bank 4-ch 5	197	bank 6-ch 5
6	bank 0-ch 6	70	bank 2-ch 6	134	bank 4-ch 6	198	bank 6-ch 6
7	bank 0-ch 7	71	bank 2-ch 7	135	bank 4-ch 7	199	bank 6-ch 7
8	bank 0-ch 8	72	bank 2-ch 8	136	bank 4-ch 8	200	bank 6-ch 8
9	bank 0-ch 9	73	bank 2-ch 9	137	bank 4-ch 9	201	bank 6-ch 9
10	bank 0-ch 10	74	bank 2-ch 10	138	bank 4-ch 10	202	bank 6-ch 10
11	bank 0-ch 11	75	bank 2-ch 11	139	bank 4-ch 11	203	bank 6-ch 11
12	bank 0-ch 12	76	bank 2-ch 12	140	bank 4-ch 12	204	bank 6-ch 12
13	bank 0-ch 13	77	bank 2-ch 13	141	bank 4-ch 13	205	bank 6-ch 13
14	bank 0-ch 14	78	bank 2-ch 14	142	bank 4-ch 14	206	bank 6-ch 14
15	bank 0-ch 15	79	bank 2-ch 15	143	bank 4-ch 15	207	bank 6-ch 15
16	bank 1-ch 0	80	bank 3-ch 0	144	bank 5-ch 0	208	bank 7-ch 0
17	bank 1-ch 1	81	bank 3-ch 1	145	bank 5-ch 1	209	bank 7-ch 1
18	bank 1-ch 2	82	bank 3-ch 2	146	bank 5-ch 2	210	bank 7-ch 2
19	bank 1-ch 3	83	bank 3-ch 3	147	bank 5-ch 3	211	bank 7-ch 3
20	bank 1-ch 4	84	bank 3-ch 4	148	bank 5-ch 4	212	bank 7-ch 4
21	bank 1-ch 5	85	bank 3-ch 5	149	bank 5-ch 5	213	bank 7-ch 5
22	bank 1-ch 6	86	bank 3-ch 6	150	bank 5-ch 6	214	bank 7-ch 6
23	bank 1-ch 7	87	bank 3-ch 7	151	bank 5-ch 7	215	bank 7-ch 7
24	bank 1-ch 8	88	bank 3-ch 8	152	bank 5-ch 8	216	bank 7-ch 8
25	bank 1-ch 9	89	bank 3-ch 9	153	bank 5-ch 9	217	bank 7-ch 9
26	bank 1-ch 10	90	bank 3-ch 10	154	bank 5-ch 10	218	bank 7-ch 10
27	bank 1-ch 11	91	bank 3-ch 11	155	bank 5-ch 11	219	bank 7-ch 11
28	bank 1-ch 12	92	bank 3-ch 12	156	bank 5-ch 12	220	bank 7-ch 12
29	bank 1-ch 13	93	bank 3-ch 13	157	bank 5-ch 13	221	bank 7-ch 13
30	bank 1-ch 14	94	bank 3-ch 14	158	bank 5-ch 14	222	bank 7-ch 14
31	bank 1-ch 15	95	bank 3-ch 15	159	bank 5-ch 15	223	bank 7-ch 15
32	bank 0-ch 0	96	bank 2-ch 0	160	bank 4-ch 0	224	bank 6-ch 0
33	bank 0-ch 1	97	bank 2-ch 1	161	bank 4-ch 1	225	bank 6-ch 1
34	bank 0-ch 2	98	bank 2-ch 2	162	bank 4-ch 2	226	bank 6-ch 2
35	bank 0-ch 3	99	bank 2-ch 3	163	bank 4-ch 3	227	bank 6-ch 3
36	bank 0-ch 4	100	bank 2-ch 4	164	bank 4-ch 4	228	bank 6-ch 4
37	bank 0-ch 5	101	bank 2-ch 5	165	bank 4-ch 5	229	bank 6-ch 5
38	bank 0-ch 6	102	bank 2-ch 6	166	bank 4-ch 6	230	bank 6-ch 6
39	bank 0-ch 7	103	bank 2-ch 7	167	bank 4-ch 7	231	bank 6-ch 7
40	bank 0-ch 8	104	bank 2-ch 8	168	bank 4-ch 8	232	bank 6-ch 8
41	bank 0-ch 9	105	bank 2-ch 9	169	bank 4-ch 9	232	bank 6-ch 9
42	bank 0-ch 10	106	bank 2-ch 10	170	bank 4-ch 10	234	bank 6-ch 10
43	bank 0-ch 11	107	bank 2-ch 11	171	bank 4-ch 11	235	bank 6-ch 11
44	bank 0-ch 12	108	bank 2-ch 12	172	bank 4-ch 12	236	bank 6-ch 12
45	bank 0-ch 13	109	bank 2-ch 13	173	bank 4-ch 13	237	bank 6-ch 13
46	bank 0-ch 14	110	bank 2-ch 14	174	bank 4-ch 14	238	bank 6-ch 14
47	bank 0-ch 15	111	bank 2-ch 15	175	bank 4-ch 15	239	bank 6-ch 15
48	bank 1-ch 0	112	bank 3-ch 0	176	bank 5-ch 0	240	bank 7-ch 0
49	bank 1-ch 1	113	bank 3-ch 1	177	bank 5-ch 1	241	bank 7-ch 1
50	bank 1-ch 2	114	bank 3-ch 2	178	bank 5-ch 2	242	bank 7-ch 2
51	bank 1-ch 3	115	bank 3-ch 3	179	bank 5-ch 3	243	bank 7-ch 3
52	bank 1-ch 4	116	bank 3-ch 4	180	bank 5-ch 4	244	bank 7-ch 4
53	bank 1-ch 5	117	bank 3-ch 5	181	bank 5-ch 5	245	bank 7-ch 5
54	bank 1-ch 6	118	bank 3-ch 6	182	bank 5-ch 6	246	bank 7-ch 6
55	bank 1-ch 7	119	bank 3-ch 7	183	bank 5-ch 7	247	bank 7-ch 7
56	bank 1-ch 8	120	bank 3-ch 8	184	bank 5-ch 8	248	bank 7-ch 8
57	bank 1-ch 9	121	bank 3-ch 9	185	bank 5-ch 9	249	bank 7-ch 9
58	bank 1-ch 10	122	bank 3-ch 10	186	bank 5-ch 10	250	bank 7-ch 10
59	bank 1-ch 11	123	bank 3-ch 11	187	bank 5-ch 11	251	bank 7-ch 11
60	bank 1-ch 12	124	bank 3-ch 12	188	bank 5-ch 12	252	bank 7-ch 12
61	bank 1-ch 13	125	bank 3-ch 13	189	bank 5-ch 13	253	bank 7-ch 13
62	bank 1-ch 14	126	bank 3-ch 14	190	bank 5-ch 14	254	bank 7-ch 14
63	bank 1-ch 15	127	bank 3-ch 15	191	bank 5-ch 15	255	bank 7-ch 15

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WIRE2 Mode Topology

Table 2-3. One 2-Wire X 128-Channel Topology Table.

Channel #	Relay Closure	Channel #	Relay Bank-Ch	Channel #	Relay Bank-Ch	Channel #	Relay Bank-Ch
0 HI	bank 0-ch 0	0 LO	bank 0-ch 0	64 HI	bank 4-ch 0	64 LO	bank 4-ch 0
1 HI	bank 0-ch 1	1 LO	bank 0-ch 1	65 HI	bank 4-ch 1	65 LO	bank 4-ch 1
2 HI	bank 0-ch 2	2 LO	bank 0-ch 2	66 HI	bank 4-ch 2	66 LO	bank 4-ch 2
3 HI	bank 0-ch 3	3 LO	bank 0-ch 3	67 HI	bank 4-ch 3	67 LO	bank 4-ch 3
4 HI	bank 0-ch 4	4 LO	bank 0-ch 4	68 HI	bank 4-ch 4	68 LO	bank 4-ch 4
5 HI	bank 0-ch 5	5 LO	bank 0-ch 5	69 HI	bank 4-ch 5	69 LO	bank 4-ch 5
6 HI	bank 0-ch 6	6 LO	bank 0-ch 6	70 HI	bank 4-ch 6	70 LO	bank 4-ch 6
7 HI	bank 0-ch 7	7 LO	bank 0-ch 7	71 HI	bank 4-ch 7	71 LO	bank 4-ch 7
8 HI	bank 0-ch 8	8 LO	bank 0-ch 8	72 HI	bank 4-ch 8	72 LO	bank 4-ch 8
9 HI	bank 0-ch 9	9 LO	bank 0-ch 9	73 HI	bank 4-ch 9	73 LO	bank 4-ch 9
10 HI	bank 0-ch 10	10 LO	bank 0-ch 10	74 HI	bank 4-ch 10	74 LO	bank 4-ch 10
11 HI	bank 0-ch 11	11 LO	bank 0-ch 11	75 HI	bank 4-ch 11	75 LO	bank 4-ch 11
12 HI	bank 0-ch 12	12 LO	bank 0-ch 12	76 HI	bank 4-ch 12	76 LO	bank 4-ch 12
13 HI	bank 0-ch 13	13 LO	bank 0-ch 13	77 HI	bank 4-ch 13	77 LO	bank 4-ch 13
14 HI	bank 0-ch 14	14 LO	bank 0-ch 14	78 HI	bank 4-ch 14	78 LO	bank 4-ch 14
15 HI	bank 0-ch 15	15 LO	bank 0-ch 15	79 HI	bank 4-ch 15	79 LO	bank 4-ch 15
16 HI	bank 1-ch 0	16 LO	bank 1-ch 0	80 HI	bank 5-ch 0	80 LO	bank 5-ch 0
17 HI	bank 1-ch 1	17 LO	bank 1-ch 1	81 HI	bank 5-ch 1	81 LO	bank 5-ch 1
18 HI	bank 1-ch 2	18 LO	bank 1-ch 2	82 HI	bank 5-ch 2	82 LO	bank 5-ch 2
19 HI	bank 1-ch 3	19 LO	bank 1-ch 3	83 HI	bank 5-ch 3	83 LO	bank 5-ch 3
20 HI	bank 1-ch 4	20 LO	bank 1-ch 4	84 HI	bank 5-ch 4	84 LO	bank 5-ch 4
21 HI	bank 1-ch 5	21 LO	bank 1-ch 5	85 HI	bank 5-ch 5	85 LO	bank 5-ch 5
22 HI	bank 1-ch 6	22 LO	bank 1-ch 6	86 HI	bank 5-ch 6	86 LO	bank 5-ch 6
23 HI	bank 1-ch 7	23 LO	bank 1-ch 7	87 HI	bank 5-ch 7	87 LO	bank 5-ch 7
24 HI	bank 1-ch 8	24 LO	bank 1-ch 8	88 HI	bank 5-ch 8	88 LO	bank 5-ch 8
25 HI	bank 1-ch 9	25 LO	bank 1-ch 9	89 HI	bank 5-ch 9	89 LO	bank 5-ch 9
26 HI	bank 1-ch 10	26 LO	bank 1-ch 10	90 HI	bank 5-ch 10	90 LO	bank 5-ch 10
27 HI	bank 1-ch 11	27 LO	bank 1-ch 11	91 HI	bank 5-ch 11	91 LO	bank 5-ch 11
28 HI	bank 1-ch 12	28 LO	bank 1-ch 12	92 HI	bank 5-ch 12	92 LO	bank 5-ch 12
29 HI	bank 1-ch 13	29 LO	bank 1-ch 13	93 HI	bank 5-ch 13	93 LO	bank 5-ch 13
30 HI	bank 1-ch 14	30 LO	bank 1-ch 14	94 HI	bank 5-ch 14	94 LO	bank 5-ch 14
31 HI	bank 1-ch 15	31 LO	bank 1-ch 15	95 HI	bank 5-ch 15	95 LO	bank 5-ch 15
32 HI	bank 0-ch 0	32 LO	bank 2-ch 0	96 HI	bank 6-ch 0	96 LO	bank 6-ch 0
33 HI	bank 0-ch 1	33 LO	bank 2-ch 1	97 HI	bank 6-ch 1	97 LO	bank 6-ch 1
34 HI	bank 0-ch 2	34 LO	bank 2-ch 2	98 HI	bank 6-ch 2	98 LO	bank 6-ch 2
35 HI	bank 0-ch 3	35 LO	bank 2-ch 3	99 HI	bank 6-ch 3	99 LO	bank 6-ch 3
36 HI	bank 0-ch 4	36 LO	bank 2-ch 4	100 HI	bank 6-ch 4	100 LO	bank 6-ch 4
37 HI	bank 0-ch 5	37 LO	bank 2-ch 5	101 HI	bank 6-ch 5	101 LO	bank 6-ch 5
38 HI	bank 0-ch 6	38 LO	bank 2-ch 6	102 HI	bank 6-ch 6	102 LO	bank 6-ch 6
39 HI	bank 0-ch 7	39 LO	bank 2-ch 7	103 HI	bank 6-ch 7	103 LO	bank 6-ch 7
40 HI	bank 0-ch 8	40 LO	bank 2-ch 8	104 HI	bank 6-ch 8	104 LO	bank 6-ch 8
41 HI	bank 0-ch 9	41 LO	bank 2-ch 9	105 HI	bank 6-ch 9	105 LO	bank 6-ch 9
42 HI	bank 0-ch 10	42 LO	bank 2-ch 10	106 HI	bank 6-ch 10	106 LO	bank 6-ch 10
43 HI	bank 0-ch 11	43 LO	bank 2-ch 11	107 HI	bank 6-ch 11	107 LO	bank 6-ch 11
44 HI	bank 0-ch 12	44 LO	bank 2-ch 12	108 HI	bank 6-ch 12	108 LO	bank 6-ch 12
45 HI	bank 0-ch 13	45 LO	bank 2-ch 13	109 HI	bank 6-ch 13	109 LO	bank 6-ch 13
46 HI	bank 0-ch 14	46 LO	bank 2-ch 14	110 HI	bank 6-ch 14	110 LO	bank 6-ch 14
47 HI	bank 0-ch 15	47 LO	bank 2-ch 15	111 HI	bank 6-ch 15	111 LO	bank 6-ch 15
48 HI	bank 1-ch 0	48 LO	bank 3-ch 0	112 HI	bank 7-ch 0	112 LO	bank 7-ch 0
49 HI	bank 1-ch 1	49 LO	bank 3-ch 1	113 HI	bank 7-ch 1	113 LO	bank 7-ch 1
50 HI	bank 1-ch 2	50 LO	bank 3-ch 2	114 HI	bank 7-ch 2	114 LO	bank 7-ch 2
51 HI	bank 1-ch 3	51 LO	bank 3-ch 3	115 HI	bank 7-ch 3	115 LO	bank 7-ch 3
52 HI	bank 1-ch 4	52 LO	bank 3-ch 4	116 HI	bank 7-ch 4	116 LO	bank 7-ch 4
53 HI	bank 1-ch 5	53 LO	bank 3-ch 5	117 HI	bank 7-ch 5	117 LO	bank 7-ch 5
54 HI	bank 1-ch 6	54 LO	bank 3-ch 6	118 HI	bank 7-ch 6	118 LO	bank 7-ch 6
55 HI	bank 1-ch 7	55 LO	bank 3-ch 7	119 HI	bank 7-ch 7	119 LO	bank 7-ch 7
56 HI	bank 1-ch 8	56 LO	bank 3-ch 8	120 HI	bank 7-ch 8	120 LO	bank 7-ch 8
57 HI	bank 1-ch 9	57 LO	bank 3-ch 9	121 HI	bank 7-ch 9	121 LO	bank 7-ch 9
58 HI	bank 1-ch 10	58 LO	bank 3-ch 10	122 HI	bank 7-ch 10	122 LO	bank 7-ch 10
59 HI	bank 1-ch 11	59 LO	bank 3-ch 11	123 HI	bank 7-ch 11	123 LO	bank 7-ch 11
60 HI	bank 1-ch 12	60 LO	bank 3-ch 12	124 HI	bank 7-ch 12	124 LO	bank 7-ch 12
61 HI	bank 1-ch 13	61 LO	bank 3-ch 13	125 HI	bank 7-ch 13	125 LO	bank 7-ch 13
62 HI	bank 1-ch 14	62 LO	bank 3-ch 14	126 HI	bank 7-ch 14	126 LO	bank 7-ch 14
63 HI	bank 1-ch 15	63 LO	bank 3-ch 15	127 HI	bank 7-ch 15	127 LO	bank 7-ch 15

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WIRE3 and WIRE4 Mode Topology

Table 2-4. One 3-Wire (or 4-Wire) X 64-Channel Topology Table.

Channel #	Relay Closure	Channel #	Relay Bank-Ch	Channel #	Relay Closure	Channel #	Relay Bank-Ch
0 HI1	bank 0-ch 0	0 LO1	bank 0-ch 0	0 HI2	bank 2-ch 0	0 LO2	bank 2-ch 0
1 HI1	bank 0-ch 1	1 LO1	bank 0-ch 1	1 HI2	bank 2-ch 1	1 LO2	bank 2-ch 1
2 HI1	bank 0-ch 2	2 LO1	bank 0-ch 2	2 HI2	bank 2-ch 2	2 LO2	bank 2-ch 2
3 HI1	bank 0-ch 3	3 LO1	bank 0-ch 3	3 HI2	bank 2-ch 3	3 LO2	bank 2-ch 3
4 HI1	bank 0-ch 4	4 LO1	bank 0-ch 4	4 HI2	bank 2-ch 4	4 LO2	bank 2-ch 4
5 HI1	bank 0-ch 5	5 LO1	bank 0-ch 5	5 HI2	bank 2-ch 5	5 LO2	bank 2-ch 5
6 HI1	bank 0-ch 6	6 LO1	bank 0-ch 6	6 HI2	bank 2-ch 6	6 LO2	bank 2-ch 6
7 HI1	bank 0-ch 7	7 LO1	bank 0-ch 7	7 HI2	bank 2-ch 7	7 LO2	bank 2-ch 7
8 HI1	bank 0-ch 8	8 LO1	bank 0-ch 8	8 HI2	bank 2-ch 8	8 LO2	bank 2-ch 8
9 HI1	bank 0-ch 9	9 LO1	bank 0-ch 9	9 HI2	bank 2-ch 9	9 LO2	bank 2-ch 9
10 HI1	bank 0-ch 10	10 LO1	bank 0-ch 10	10 HI2	bank 2-ch 10	10 LO2	bank 2-ch 10
11 HI1	bank 0-ch 11	11 LO1	bank 0-ch 11	11 HI2	bank 2-ch 11	11 LO2	bank 2-ch 11
12 HI1	bank 0-ch 12	12 LO1	bank 0-ch 12	12 HI2	bank 2-ch 12	12 LO2	bank 2-ch 12
13 HI1	bank 0-ch 13	13 LO1	bank 0-ch 13	13 HI2	bank 2-ch 13	13 LO2	bank 2-ch 13
14 HI1	bank 0-ch 14	14 LO1	bank 0-ch 14	14 HI2	bank 2-ch 14	14 LO2	bank 2-ch 14
15 HI1	bank 0-ch 15	15 LO1	bank 0-ch 15	15 HI2	bank 2-ch 15	15 LO2	bank 2-ch 15
16 HI1	bank 1-ch 0	16 LO1	bank 1-ch 0	16 HI2	bank 3-ch 0	16 LO2	bank 3-ch 0
17 HI1	bank 1-ch 1	17 LO1	bank 1-ch 1	17 HI2	bank 3-ch 1	17 LO2	bank 3-ch 1
18 HI1	bank 1-ch 2	18 LO1	bank 1-ch 2	18 HI2	bank 3-ch 2	18 LO2	bank 3-ch 2
19 HI1	bank 1-ch 3	19 LO1	bank 1-ch 3	19 HI2	bank 3-ch 3	19 LO2	bank 3-ch 3
20 HI1	bank 1-ch 4	20 LO1	bank 1-ch 4	20 HI2	bank 3-ch 4	20 LO2	bank 3-ch 4
21 HI1	bank 1-ch 5	21 LO1	bank 1-ch 5	21 HI2	bank 3-ch 5	21 LO2	bank 3-ch 5
22 HI1	bank 1-ch 6	22 LO1	bank 1-ch 6	22 HI2	bank 3-ch 6	22 LO2	bank 3-ch 6
23 HI1	bank 1-ch 7	23 LO1	bank 1-ch 7	23 HI2	bank 3-ch 7	23 LO2	bank 3-ch 7
24 HI1	bank 1-ch 8	24 LO1	bank 1-ch 8	24 HI2	bank 3-ch 8	24 LO2	bank 3-ch 8
25 HI1	bank 1-ch 9	25 LO1	bank 1-ch 9	25 HI2	bank 3-ch 9	25 LO2	bank 3-ch 9
26 HI1	bank 1-ch 10	26 LO1	bank 1-ch 10	26 HI2	bank 3-ch 10	26 LO2	bank 3-ch 10
27 HI1	bank 1-ch 11	27 LO1	bank 1-ch 11	27 HI2	bank 3-ch 11	27 LO2	bank 3-ch 11
28 HI1	bank 1-ch 12	28 LO1	bank 1-ch 12	28 HI2	bank 3-ch 12	28 LO2	bank 3-ch 12
29 HI1	bank 1-ch 13	29 LO1	bank 1-ch 13	29 HI2	bank 3-ch 13	29 LO2	bank 3-ch 13
30 HI1	bank 1-ch 14	30 LO1	bank 1-ch 14	30 HI2	bank 3-ch 14	30 LO2	bank 3-ch 14
31 HI1	bank 1-ch 15	31 LO1	bank 1-ch 15	31 HI2	bank 3-ch 15	31 LO2	bank 3-ch 15
32 HI1	bank 4-ch 0	32 LO1	bank 4-ch 0	32 HI2	bank 6-ch 0	32 LO2	bank 6-ch 0
33 HI1	bank 4-ch 1	33 LO1	bank 4-ch 1	33 HI2	bank 6-ch 1	33 LO2	bank 6-ch 1
34 HI1	bank 4-ch 2	34 LO1	bank 4-ch 2	34 HI2	bank 6-ch 2	34 LO2	bank 6-ch 2
35 HI1	bank 4-ch 3	35 LO1	bank 4-ch 3	35 HI2	bank 6-ch 3	35 LO2	bank 6-ch 3
36 HI1	bank 4-ch 4	36 LO1	bank 4-ch 4	36 HI2	bank 6-ch 4	36 LO2	bank 6-ch 4
37 HI1	bank 4-ch 5	37 LO1	bank 4-ch 5	37 HI2	bank 6-ch 5	37 LO2	bank 6-ch 5
38 HI1	bank 4-ch 6	38 LO1	bank 4-ch 6	38 HI2	bank 6-ch 6	38 LO2	bank 6-ch 6
39 HI1	bank 4-ch 7	39 LO1	bank 4-ch 7	39 HI2	bank 6-ch 7	39 LO2	bank 6-ch 7
40 HI1	bank 4-ch 8	40 LO1	bank 4-ch 8	40 HI2	bank 6-ch 8	40 LO2	bank 6-ch 8
41 HI1	bank 4-ch 9	41 LO1	bank 4-ch 9	41 HI2	bank 6-ch 9	41 LO2	bank 6-ch 9
42 HI1	bank 4-ch 10	42 LO1	bank 4-ch 10	42 HI2	bank 6-ch 10	42 LO2	bank 6-ch 10
43 HI1	bank 4-ch 11	43 LO1	bank 4-ch 11	43 HI2	bank 6-ch 11	43 LO2	bank 6-ch 11
44 HI1	bank 4-ch 12	44 LO1	bank 4-ch 12	44 HI2	bank 6-ch 12	44 LO2	bank 6-ch 12
45 HI1	bank 4-ch 13	45 LO1	bank 4-ch 13	45 HI2	bank 6-ch 13	45 LO2	bank 6-ch 13
46 HI1	bank 4-ch 14	46 LO1	bank 4-ch 14	46 HI2	bank 6-ch 14	46 LO2	bank 6-ch 14
47 HI1	bank 4-ch 15	47 LO1	bank 4-ch 15	47 HI2	bank 6-ch 15	47 LO2	bank 6-ch 15
48 HI1	bank 5-ch 0	48 LO1	bank 5-ch 0	48 HI2	bank 7-ch 0	48 LO2	bank 7-ch 0
49 HI1	bank 5-ch 1	49 LO1	bank 5-ch 1	49 HI2	bank 7-ch 1	49 LO2	bank 7-ch 1
50 HI1	bank 5-ch 2	50 LO1	bank 5-ch 2	50 HI2	bank 7-ch 2	50 LO2	bank 7-ch 2
51 HI1	bank 5-ch 3	51 LO1	bank 5-ch 3	51 HI2	bank 7-ch 3	51 LO2	bank 7-ch 3
52 HI1	bank 5-ch 4	52 LO1	bank 5-ch 4	52 HI2	bank 7-ch 4	52 LO2	bank 7-ch 4
53 HI1	bank 5-ch 5	53 LO1	bank 5-ch 5	53 HI2	bank 7-ch 5	53 LO2	bank 7-ch 5
54 HI1	bank 5-ch 6	54 LO1	bank 5-ch 6	54 HI2	bank 7-ch 6	54 LO2	bank 7-ch 6
55 HI1	bank 5-ch 7	55 LO1	bank 5-ch 7	55 HI2	bank 7-ch 7	55 LO2	bank 7-ch 7
56 HI1	bank 5-ch 8	56 LO1	bank 5-ch 8	56 HI2	bank 7-ch 8	56 LO2	bank 7-ch 8
57 HI1	bank 5-ch 9	57 LO1	bank 5-ch 9	57 HI2	bank 7-ch 9	57 LO2	bank 7-ch 9
58 HI1	bank 5-ch 10	58 LO1	bank 5-ch 10	58 HI2	bank 7-ch 10	58 LO2	bank 7-ch 10
59 HI1	bank 5-ch 11	59 LO1	bank 5-ch 11	59 HI2	bank 7-ch 11	59 LO2	bank 7-ch 11
60 HI1	bank 5-ch 12	60 LO1	bank 5-ch 12	60 HI2	bank 7-ch 12	60 LO2	bank 7-ch 12
61 HI1	bank 5-ch 13	61 LO1	bank 5-ch 13	61 HI2	bank 7-ch 13	61 LO2	bank 7-ch 13
62 HI1	bank 5-ch 14	62 LO1	bank 5-ch 14	62 HI2	bank 7-ch 14	62 LO2	bank 7-ch 14
63 HI1	bank 5-ch 15	63 LO1	bank 5-ch 15	63 HI2	bank 7-ch 15	63 LO2	bank 7-ch 15

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WIRE1X2 Mode Topology

Table 2-5. Two 1-Wire X 128-Channel Topology Table.

Channel #	Relay Closure	Channel #	Relay Bank-Ch	Channel #	Relay Bank-Ch	Channel #	Relay Bank-Ch
MUX0		MUX0		MUX1		MUX1	
0	bank 0-ch 0	64	bank 2-ch 0	0	bank 4-ch 0	64	bank 6-ch 0
1	bank 0-ch 1	65	bank 2-ch 1	1	bank 4-ch 1	65	bank 6-ch 1
2	bank 0-ch 2	66	bank 2-ch 2	2	bank 4-ch 2	66	bank 6-ch 2
3	bank 0-ch 3	67	bank 2-ch 3	3	bank 4-ch 3	67	bank 6-ch 3
4	bank 0-ch 4	68	bank 2-ch 4	4	bank 4-ch 4	68	bank 6-ch 4
5	bank 0-ch 5	69	bank 2-ch 5	5	bank 4-ch 5	69	bank 6-ch 5
6	bank 0-ch 6	70	bank 2-ch 6	6	bank 4-ch 6	70	bank 6-ch 6
7	bank 0-ch 7	71	bank 2-ch 7	7	bank 4-ch 7	71	bank 6-ch 7
8	bank 0-ch 8	72	bank 2-ch 8	8	bank 4-ch 8	72	bank 6-ch 8
9	bank 0-ch 9	73	bank 2-ch 9	9	bank 4-ch 9	73	bank 6-ch 9
10	bank 0-ch 10	74	bank 2-ch 10	10	bank 4-ch 10	74	bank 6-ch 10
11	bank 0-ch 11	75	bank 2-ch 11	11	bank 4-ch 11	75	bank 6-ch 11
12	bank 0-ch 12	76	bank 2-ch 12	12	bank 4-ch 12	76	bank 6-ch 12
13	bank 0-ch 13	77	bank 2-ch 13	13	bank 4-ch 13	77	bank 6-ch 13
14	bank 0-ch 14	78	bank 2-ch 14	14	bank 4-ch 14	78	bank 6-ch 14
15	bank 0-ch 15	79	bank 2-ch 15	15	bank 4-ch 15	79	bank 6-ch 15
16	bank 1-ch 0	80	bank 3-ch 0	16	bank 5-ch 0	80	bank 7-ch 0
17	bank 1-ch 1	81	bank 3-ch 1	17	bank 5-ch 1	81	bank 7-ch 1
18	bank 1-ch 2	82	bank 3-ch 2	18	bank 5-ch 2	82	bank 7-ch 2
19	bank 1-ch 3	83	bank 3-ch 3	19	bank 5-ch 3	83	bank 7-ch 3
20	bank 1-ch 4	84	bank 3-ch 4	20	bank 5-ch 4	84	bank 7-ch 4
21	bank 1-ch 5	85	bank 3-ch 5	21	bank 5-ch 5	85	bank 7-ch 5
22	bank 1-ch 6	86	bank 3-ch 6	22	bank 5-ch 6	86	bank 7-ch 6
23	bank 1-ch 7	87	bank 3-ch 7	23	bank 5-ch 7	87	bank 7-ch 7
24	bank 1-ch 8	88	bank 3-ch 8	24	bank 5-ch 8	88	bank 7-ch 8
25	bank 1-ch 9	89	bank 3-ch 9	25	bank 5-ch 9	89	bank 7-ch 9
26	bank 1-ch 10	90	bank 3-ch 10	26	bank 5-ch 10	90	bank 7-ch 10
27	bank 1-ch 11	91	bank 3-ch 11	27	bank 5-ch 11	91	bank 7-ch 11
28	bank 1-ch 12	92	bank 3-ch 12	28	bank 5-ch 12	92	bank 7-ch 12
29	bank 1-ch 13	93	bank 3-ch 13	29	bank 5-ch 13	93	bank 7-ch 13
30	bank 1-ch 14	94	bank 3-ch 14	30	bank 5-ch 14	94	bank 7-ch 14
31	bank 1-ch 15	95	bank 3-ch 15	31	bank 5-ch 15	95	bank 7-ch 15
32	bank 0-ch 0	96	bank 2-ch 0	32	bank 4-ch 0	96	bank 6-ch 0
33	bank 0-ch 1	97	bank 2-ch 1	33	bank 4-ch 1	97	bank 6-ch 1
34	bank 0-ch 2	98	bank 2-ch 2	34	bank 4-ch 2	98	bank 6-ch 2
35	bank 0-ch 3	99	bank 2-ch 3	35	bank 4-ch 3	99	bank 6-ch 3
36	bank 0-ch 4	100	bank 2-ch 4	36	bank 4-ch 4	100	bank 6-ch 4
37	bank 0-ch 5	101	bank 2-ch 5	37	bank 4-ch 5	101	bank 6-ch 5
38	bank 0-ch 6	102	bank 2-ch 6	38	bank 4-ch 6	102	bank 6-ch 6
39	bank 0-ch 7	103	bank 2-ch 7	39	bank 4-ch 7	103	bank 6-ch 7
40	bank 0-ch 8	104	bank 2-ch 8	40	bank 4-ch 8	104	bank 6-ch 8
41	bank 0-ch 9	105	bank 2-ch 9	41	bank 4-ch 9	105	bank 6-ch 9
42	bank 0-ch 10	106	bank 2-ch 10	42	bank 4-ch 10	106	bank 6-ch 10
43	bank 0-ch 11	107	bank 2-ch 11	43	bank 4-ch 11	107	bank 6-ch 11
44	bank 0-ch 12	108	bank 2-ch 12	44	bank 4-ch 12	108	bank 6-ch 12
45	bank 0-ch 13	109	bank 2-ch 13	45	bank 4-ch 13	109	bank 6-ch 13
46	bank 0-ch 14	110	bank 2-ch 14	46	bank 4-ch 14	110	bank 6-ch 14
47	bank 0-ch 15	111	bank 2-ch 15	47	bank 4-ch 15	111	bank 6-ch 15
48	bank 1-ch 0	112	bank 3-ch 0	48	bank 5-ch 0	112	bank 7-ch 0
49	bank 1-ch 1	113	bank 3-ch 1	49	bank 5-ch 1	113	bank 7-ch 1
50	bank 1-ch 2	114	bank 3-ch 2	50	bank 5-ch 2	114	bank 7-ch 2
51	bank 1-ch 3	115	bank 3-ch 3	51	bank 5-ch 3	115	bank 7-ch 3
52	bank 1-ch 4	116	bank 3-ch 4	52	bank 5-ch 4	116	bank 7-ch 4
53	bank 1-ch 5	117	bank 3-ch 5	53	bank 5-ch 5	117	bank 7-ch 5
54	bank 1-ch 6	118	bank 3-ch 6	54	bank 5-ch 6	118	bank 7-ch 6
55	bank 1-ch 7	119	bank 3-ch 7	55	bank 5-ch 7	119	bank 7-ch 7
56	bank 1-ch 8	120	bank 3-ch 8	56	bank 5-ch 8	120	bank 7-ch 8
57	bank 1-ch 9	121	bank 3-ch 9	57	bank 5-ch 9	121	bank 7-ch 9
58	bank 1-ch 10	122	bank 3-ch 10	58	bank 5-ch 10	122	bank 7-ch 10
59	bank 1-ch 11	123	bank 3-ch 11	59	bank 5-ch 11	123	bank 7-ch 11
60	bank 1-ch 12	124	bank 3-ch 12	60	bank 5-ch 12	124	bank 7-ch 12
61	bank 1-ch 13	125	bank 3-ch 13	61	bank 5-ch 13	125	bank 7-ch 13
62	bank 1-ch 14	126	bank 3-ch 14	62	bank 5-ch 14	126	bank 7-ch 14
63	bank 1-ch 15	127	bank 3-ch 15	63	bank 5-ch 15	127	bank 7-ch 15

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WIRE1X4 Mode Topology

Table 2-6. Four 1-Wire X 64-Channel Topology Table.

Channel #	Relay Closure	Channel #	Relay Bank-Ch	Channel #	Relay Bank-Ch	Channel #	Relay Bank-Ch
MUX0		MUX1		MUX2		MUX3	
0	bank 0-ch 0	0	bank 2-ch 0	0	bank 4-ch 0	0	bank 6-ch 0
1	bank 0-ch 1	1	bank 2-ch 1	1	bank 4-ch 1	1	bank 6-ch 1
2	bank 0-ch 2	2	bank 2-ch 2	2	bank 4-ch 2	2	bank 6-ch 2
3	bank 0-ch 3	3	bank 2-ch 3	3	bank 4-ch 3	3	bank 6-ch 3
4	bank 0-ch 4	4	bank 2-ch 4	4	bank 4-ch 4	4	bank 6-ch 4
5	bank 0-ch 5	5	bank 2-ch 5	5	bank 4-ch 5	5	bank 6-ch 5
6	bank 0-ch 6	6	bank 2-ch 6	6	bank 4-ch 6	6	bank 6-ch 6
7	bank 0-ch 7	7	bank 2-ch 7	7	bank 4-ch 7	7	bank 6-ch 7
8	bank 0-ch 8	8	bank 2-ch 8	8	bank 4-ch 8	8	bank 6-ch 8
9	bank 0-ch 9	9	bank 2-ch 9	9	bank 4-ch 9	9	bank 6-ch 9
10	bank 0-ch 10	10	bank 2-ch 10	10	bank 4-ch 10	10	bank 6-ch 10
11	bank 0-ch 11	11	bank 2-ch 11	11	bank 4-ch 11	11	bank 6-ch 11
12	bank 0-ch 12	12	bank 2-ch 12	12	bank 4-ch 12	12	bank 6-ch 12
13	bank 0-ch 13	13	bank 2-ch 13	13	bank 4-ch 13	13	bank 6-ch 13
14	bank 0-ch 14	14	bank 2-ch 14	14	bank 4-ch 14	14	bank 6-ch 14
15	bank 0-ch 15	15	bank 2-ch 15	15	bank 4-ch 15	15	bank 6-ch 15
16	bank 1-ch 0	16	bank 3-ch 0	16	bank 5-ch 0	16	bank 7-ch 0
17	bank 1-ch 1	17	bank 3-ch 1	17	bank 5-ch 1	17	bank 7-ch 1
18	bank 1-ch 2	18	bank 3-ch 2	18	bank 5-ch 2	18	bank 7-ch 2
19	bank 1-ch 3	19	bank 3-ch 3	19	bank 5-ch 3	19	bank 7-ch 3
20	bank 1-ch 4	20	bank 3-ch 4	20	bank 5-ch 4	20	bank 7-ch 4
21	bank 1-ch 5	21	bank 3-ch 5	21	bank 5-ch 5	21	bank 7-ch 5
22	bank 1-ch 6	22	bank 3-ch 6	22	bank 5-ch 6	22	bank 7-ch 6
23	bank 1-ch 7	23	bank 3-ch 7	23	bank 5-ch 7	23	bank 7-ch 7
24	bank 1-ch 8	24	bank 3-ch 8	24	bank 5-ch 8	24	bank 7-ch 8
25	bank 1-ch 9	25	bank 3-ch 9	25	bank 5-ch 9	25	bank 7-ch 9
26	bank 1-ch 10	26	bank 3-ch 10	26	bank 5-ch 10	26	bank 7-ch 10
27	bank 1-ch 11	27	bank 3-ch 11	27	bank 5-ch 11	27	bank 7-ch 11
28	bank 1-ch 12	28	bank 3-ch 12	28	bank 5-ch 12	28	bank 7-ch 12
29	bank 1-ch 13	29	bank 3-ch 13	29	bank 5-ch 13	29	bank 7-ch 13
30	bank 1-ch 14	30	bank 3-ch 14	30	bank 5-ch 14	30	bank 7-ch 14
31	bank 1-ch 15	31	bank 3-ch 15	31	bank 5-ch 15	31	bank 7-ch 15
32	bank 0-ch 0	32	bank 2-ch 0	32	bank 4-ch 0	32	bank 6-ch 0
33	bank 0-ch 1	33	bank 2-ch 1	33	bank 4-ch 1	33	bank 6-ch 1
34	bank 0-ch 2	34	bank 2-ch 2	34	bank 4-ch 2	34	bank 6-ch 2
35	bank 0-ch 3	35	bank 2-ch 3	35	bank 4-ch 3	35	bank 6-ch 3
36	bank 0-ch 4	36	bank 2-ch 4	36	bank 4-ch 4	36	bank 6-ch 4
37	bank 0-ch 5	37	bank 2-ch 5	37	bank 4-ch 5	37	bank 6-ch 5
38	bank 0-ch 6	38	bank 2-ch 6	38	bank 4-ch 6	38	bank 6-ch 6
39	bank 0-ch 7	39	bank 2-ch 7	39	bank 4-ch 7	39	bank 6-ch 7
40	bank 0-ch 8	40	bank 2-ch 8	40	bank 4-ch 8	40	bank 6-ch 8
41	bank 0-ch 9	41	bank 2-ch 9	41	bank 4-ch 9	41	bank 6-ch 9
42	bank 0-ch 10	42	bank 2-ch 10	42	bank 4-ch 10	42	bank 6-ch 10
43	bank 0-ch 11	43	bank 2-ch 11	43	bank 4-ch 11	43	bank 6-ch 11
44	bank 0-ch 12	44	bank 2-ch 12	44	bank 4-ch 12	44	bank 6-ch 12
45	bank 0-ch 13	45	bank 2-ch 13	45	bank 4-ch 13	45	bank 6-ch 13
46	bank 0-ch 14	46	bank 2-ch 14	46	bank 4-ch 14	46	bank 6-ch 14
47	bank 0-ch 15	47	bank 2-ch 15	47	bank 4-ch 15	47	bank 6-ch 15
48	bank 1-ch 0	48	bank 3-ch 0	48	bank 5-ch 0	48	bank 7-ch 0
49	bank 1-ch 1	49	bank 3-ch 1	49	bank 5-ch 1	49	bank 7-ch 1
50	bank 1-ch 2	50	bank 3-ch 2	50	bank 5-ch 2	50	bank 7-ch 2
51	bank 1-ch 3	51	bank 3-ch 3	51	bank 5-ch 3	51	bank 7-ch 3
52	bank 1-ch 4	52	bank 3-ch 4	52	bank 5-ch 4	52	bank 7-ch 4
53	bank 1-ch 5	53	bank 3-ch 5	53	bank 5-ch 5	53	bank 7-ch 5
54	bank 1-ch 6	54	bank 3-ch 6	54	bank 5-ch 6	54	bank 7-ch 6
55	bank 1-ch 7	55	bank 3-ch 7	55	bank 5-ch 7	55	bank 7-ch 7
56	bank 1-ch 8	56	bank 3-ch 8	56	bank 5-ch 8	56	bank 7-ch 8
57	bank 1-ch 9	57	bank 3-ch 9	57	bank 5-ch 9	57	bank 7-ch 9
58	bank 1-ch 10	58	bank 3-ch 10	58	bank 5-ch 10	58	bank 7-ch 10
59	bank 1-ch 11	59	bank 3-ch 11	59	bank 5-ch 11	59	bank 7-ch 11
60	bank 1-ch 12	60	bank 3-ch 12	60	bank 5-ch 12	60	bank 7-ch 12
61	bank 1-ch 13	61	bank 3-ch 13	61	bank 5-ch 13	61	bank 7-ch 13
62	bank 1-ch 14	62	bank 3-ch 14	62	bank 5-ch 14	62	bank 7-ch 14
63	bank 1-ch 15	63	bank 3-ch 15	63	bank 5-ch 15	63	bank 7-ch 15

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WIRE1X8 Mode Topology

Table 2-7. Eight 1-Wire X 32-Channel Topology Table.

Channel #	Relay Closure	Channel #	Relay Bank-Ch	Channel #	Relay Bank-Ch	Channel #	Relay Bank-Ch
MUX0		**MUX2**		**MUX4**		**MUX6**	
0	bank 0-ch 0	0	bank 2-ch 0	0	bank 4-ch 0	0	bank 6-ch 0
1	bank 0-ch 1	1	bank 2-ch 1	1	bank 4-ch 1	1	bank 6-ch 1
2	bank 0-ch 2	2	bank 2-ch 2	2	bank 4-ch 2	2	bank 6-ch 2
3	bank 0-ch 3	3	bank 2-ch 3	3	bank 4-ch 3	3	bank 6-ch 3
4	bank 0-ch 4	4	bank 2-ch 4	4	bank 4-ch 4	4	bank 6-ch 4
5	bank 0-ch 5	5	bank 2-ch 5	5	bank 4-ch 5	5	bank 6-ch 5
6	bank 0-ch 6	6	bank 2-ch 6	6	bank 4-ch 6	6	bank 6-ch 6
7	bank 0-ch 7	7	bank 2-ch 7	7	bank 4-ch 7	7	bank 6-ch 7
8	bank 0-ch 8	8	bank 2-ch 8	8	bank 4-ch 8	8	bank 6-ch 8
9	bank 0-ch 9	9	bank 2-ch 9	9	bank 4-ch 9	9	bank 6-ch 9
10	bank 0-ch 10	10	bank 2-ch 10	10	bank 4-ch 10	10	bank 6-ch 10
11	bank 0-ch 11	11	bank 2-ch 11	11	bank 4-ch 11	11	bank 6-ch 11
12	bank 0-ch 12	12	bank 2-ch 12	12	bank 4-ch 12	12	bank 6-ch 12
13	bank 0-ch 13	13	bank 2-ch 13	13	bank 4-ch 13	13	bank 6-ch 13
14	bank 0-ch 14	14	bank 2-ch 14	14	bank 4-ch 14	14	bank 6-ch 14
15	bank 0-ch 15	15	bank 2-ch 15	15	bank 4-ch 15	15	bank 6-ch 15
16	bank 0-ch 0	16	bank 2-ch 0	16	bank 4-ch 0	16	bank 6-ch 0
17	bank 0-ch 1	17	bank 2-ch 1	17	bank 4-ch 1	17	bank 6-ch 1
18	bank 0-ch 2	18	bank 2-ch 2	18	bank 4-ch 2	18	bank 6-ch 2
19	bank 0-ch 3	19	bank 2-ch 3	19	bank 4-ch 3	19	bank 6-ch 3
20	bank 0-ch 4	20	bank 2-ch 4	20	bank 4-ch 4	20	bank 6-ch 4
21	bank 0-ch 5	21	bank 2-ch 5	21	bank 4-ch 5	21	bank 6-ch 5
22	bank 0-ch 6	22	bank 2-ch 6	22	bank 4-ch 6	22	bank 6-ch 6
23	bank 0-ch 7	23	bank 2-ch 7	23	bank 4-ch 7	23	bank 6-ch 7
24	bank 0-ch 8	24	bank 2-ch 8	24	bank 4-ch 8	24	bank 6-ch 8
25	bank 0-ch 9	25	bank 2-ch 9	25	bank 4-ch 9	25	bank 6-ch 9
26	bank 0-ch 10	26	bank 2-ch 10	26	bank 4-ch 10	26	bank 6-ch 10
27	bank 0-ch 11	27	bank 2-ch 11	27	bank 4-ch 11	27	bank 6-ch 11
28	bank 0-ch 12	28	bank 2-ch 12	28	bank 4-ch 12	28	bank 6-ch 12
29	bank 0-ch 13	29	bank 2-ch 13	29	bank 4-ch 13	29	bank 6-ch 13
30	bank 0-ch 14	30	bank 2-ch 14	30	bank 4-ch 14	30	bank 6-ch 14
31	bank 0-ch 15	31	bank 2-ch 15	31	bank 4-ch 15	31	bank 6-ch 15
MUX1		**MUX3**		**MUX5**		**MUX7**	
0	bank 1-ch 0	32	bank 3-ch 0	32	bank 5-ch 0	32	bank 7-ch 0
1	bank 1-ch 1	33	bank 3-ch 1	33	bank 5-ch 1	33	bank 7-ch 1
2	bank 1-ch 2	34	bank 3-ch 2	34	bank 5-ch 2	34	bank 7-ch 2
3	bank 1-ch 3	35	bank 3-ch 3	35	bank 5-ch 3	35	bank 7-ch 3
4	bank 1-ch 4	36	bank 3-ch 4	36	bank 5-ch 4	36	bank 7-ch 4
5	bank 1-ch 5	37	bank 3-ch 5	37	bank 5-ch 5	37	bank 7-ch 5
6	bank 1-ch 6	38	bank 3-ch 6	38	bank 5-ch 6	38	bank 7-ch 6
7	bank 1-ch 7	39	bank 3-ch 7	39	bank 5-ch 7	39	bank 7-ch 7
8	bank 1-ch 8	40	bank 3-ch 8	40	bank 5-ch 8	40	bank 7-ch 8
9	bank 1-ch 9	41	bank 3-ch 9	41	bank 5-ch 9	41	bank 7-ch 9
10	bank 1-ch 10	42	bank 3-ch 10	42	bank 5-ch 10	42	bank 7-ch 10
11	bank 1-ch 11	43	bank 3-ch 11	43	bank 5-ch 11	43	bank 7-ch 11
12	bank 1-ch 12	44	bank 3-ch 12	44	bank 5-ch 12	44	bank 7-ch 12
13	bank 1-ch 13	45	bank 3-ch 13	45	bank 5-ch 13	45	bank 7-ch 13
14	bank 1-ch 14	46	bank 3-ch 14	46	bank 5-ch 14	46	bank 7-ch 14
15	bank 1-ch 15	47	bank 3-ch 15	47	bank 5-ch 15	47	bank 7-ch 15
16	bank 1-ch 0	48	bank 3-ch 0	48	bank 5-ch 0	48	bank 7-ch 0
17	bank 1-ch 1	49	bank 3-ch 1	49	bank 5-ch 1	49	bank 7-ch 1
18	bank 1-ch 2	50	bank 3-ch 2	50	bank 5-ch 2	50	bank 7-ch 2
19	bank 1-ch 3	51	bank 3-ch 3	51	bank 5-ch 3	51	bank 7-ch 3
20	bank 1-ch 4	52	bank 3-ch 4	52	bank 5-ch 4	52	bank 7-ch 4
21	bank 1-ch 5	53	bank 3-ch 5	53	bank 5-ch 5	53	bank 7-ch 5
22	bank 1-ch 6	54	bank 3-ch 6	54	bank 5-ch 6	54	bank 7-ch 6
23	bank 1-ch 7	55	bank 3-ch 7	55	bank 5-ch 7	55	bank 7-ch 7
24	bank 1-ch 8	56	bank 3-ch 8	56	bank 5-ch 8	56	bank 7-ch 8
25	bank 1-ch 9	57	bank 3-ch 9	57	bank 5-ch 9	57	bank 7-ch 9
26	bank 1-ch 10	58	bank 3-ch 10	58	bank 5-ch 10	58	bank 7-ch 10
27	bank 1-ch 11	59	bank 3-ch 11	59	bank 5-ch 11	59	bank 7-ch 11
28	bank 1-ch 12	60	bank 3-ch 12	60	bank 5-ch 12	60	bank 7-ch 12
29	bank 1-ch 13	61	bank 3-ch 13	61	bank 5-ch 13	61	bank 7-ch 13
30	bank 1-ch 14	62	bank 3-ch 14	62	bank 5-ch 14	62	bank 7-ch 14
31	bank 1-ch 15	63	bank 3-ch 15	63	bank 5-ch 15	63	bank 7-ch 15

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WIRE2X2 Mode Topology

Table 2-8. Two 2-Wire X 64-Channel Topology Table.

Channel #	Relay Closure	Channel #	Relay Bank-Ch	Channel #	Relay Bank-Ch	Channel #	Relay Bank-Ch
MUX0				MUX1			
0 HI	bank 0-ch 0	0 LO	bank 0-ch 0	0 HI	bank 4-ch 0	0 LO	bank 4-ch 0
1 HI	bank 0-ch 1	1 LO	bank 0-ch 1	1 HI	bank 4-ch 1	1 LO	bank 4-ch 1
2 HI	bank 0-ch 2	2 LO	bank 0-ch 2	2 HI	bank 4-ch 2	2 LO	bank 4-ch 2
3 HI	bank 0-ch 3	3 LO	bank 0-ch 3	3 HI	bank 4-ch 3	3 LO	bank 4-ch 3
4 HI	bank 0-ch 4	4 LO	bank 0-ch 4	4 HI	bank 4-ch 4	4 LO	bank 4-ch 4
5 HI	bank 0-ch 5	5 LO	bank 0-ch 5	5 HI	bank 4-ch 5	5 LO	bank 4-ch 5
6 HI	bank 0-ch 6	6 LO	bank 0-ch 6	6 HI	bank 4-ch 6	6 LO	bank 4-ch 6
7 HI	bank 0-ch 7	7 LO	bank 0-ch 7	7 HI	bank 4-ch 7	7 LO	bank 4-ch 7
8 HI	bank 0-ch 8	8 LO	bank 0-ch 8	8 HI	bank 4-ch 8	8 LO	bank 4-ch 8
9 HI	bank 0-ch 9	9 LO	bank 0-ch 9	9 HI	bank 4-ch 9	9 LO	bank 4-ch 9
10 HI	bank 0-ch 10	10 LO	bank 0-ch 10	10 HI	bank 4-ch 10	10 LO	bank 4-ch 10
11 HI	bank 0-ch 11	11 LO	bank 0-ch 11	11 HI	bank 4-ch 11	11 LO	bank 4-ch 11
12 HI	bank 0-ch 12	12 LO	bank 0-ch 12	12 HI	bank 4-ch 12	12 LO	bank 4-ch 12
13 HI	bank 0-ch 13	13 LO	bank 0-ch 13	13 HI	bank 4-ch 13	13 LO	bank 4-ch 13
14 HI	bank 0-ch 14	14 LO	bank 0-ch 14	14 HI	bank 4-ch 14	14 LO	bank 4-ch 14
15 HI	bank 0-ch 15	15 LO	bank 0-ch 15	15 HI	bank 4-ch 15	15 LO	bank 4-ch 15
16 HI	bank 1-ch 0	16 LO	bank 1-ch 0	16 HI	bank 5-ch 0	16 LO	bank 5-ch 0
17 HI	bank 1-ch 1	17 LO	bank 1-ch 1	17 HI	bank 5-ch 1	17 LO	bank 5-ch 1
18 HI	bank 1-ch 2	18 LO	bank 1-ch 2	18 HI	bank 5-ch 2	18 LO	bank 5-ch 2
19 HI	bank 1-ch 3	19 LO	bank 1-ch 3	19 HI	bank 5-ch 3	19 LO	bank 5-ch 3
20 HI	bank 1-ch 4	20 LO	bank 1-ch 4	20 HI	bank 5-ch 4	20 LO	bank 5-ch 4
21 HI	bank 1-ch 5	21 LO	bank 1-ch 5	21 HI	bank 5-ch 5	21 LO	bank 5-ch 5
22 HI	bank 1-ch 6	22 LO	bank 1-ch 6	22 HI	bank 5-ch 6	22 LO	bank 5-ch 6
23 HI	bank 1-ch 7	23 LO	bank 1-ch 7	23 HI	bank 5-ch 7	23 LO	bank 5-ch 7
24 HI	bank 1-ch 8	24 LO	bank 1-ch 8	24 HI	bank 5-ch 8	24 LO	bank 5-ch 8
25 HI	bank 1-ch 9	25 LO	bank 1-ch 9	25 HI	bank 5-ch 9	25 LO	bank 5-ch 9
26 HI	bank 1-ch 10	26 LO	bank 1-ch 10	26 HI	bank 5-ch 10	26 LO	bank 5-ch 10
27 HI	bank 1-ch 11	27 LO	bank 1-ch 11	27 HI	bank 5-ch 11	27 LO	bank 5-ch 11
28 HI	bank 1-ch 12	28 LO	bank 1-ch 12	28 HI	bank 5-ch 12	28 LO	bank 5-ch 12
29 HI	bank 1-ch 13	29 LO	bank 1-ch 13	29 HI	bank 5-ch 13	29 LO	bank 5-ch 13
30 HI	bank 1-ch 14	30 LO	bank 1-ch 14	30 HI	bank 5-ch 14	30 LO	bank 5-ch 14
31 HI	bank 1-ch 15	31 LO	bank 1-ch 15	31 HI	bank 5-ch 15	31 LO	bank 5-ch 15
32 HI	bank 0-ch 0	32 LO	bank 2-ch 0	32 HI	bank 6-ch 0	32 LO	bank 6-ch 0
33 HI	bank 0-ch 1	33 LO	bank 2-ch 1	33 HI	bank 6-ch 1	33 LO	bank 6-ch 1
34 HI	bank 0-ch 2	34 LO	bank 2-ch 2	34 HI	bank 6-ch 2	34 LO	bank 6-ch 2
35 HI	bank 0-ch 3	35 LO	bank 2-ch 3	35 HI	bank 6-ch 3	35 LO	bank 6-ch 3
36 HI	bank 0-ch 4	36 LO	bank 2-ch 4	36 HI	bank 6-ch 4	36 LO	bank 6-ch 4
37 HI	bank 0-ch 5	37 LO	bank 2-ch 5	37 HI	bank 6-ch 5	37 LO	bank 6-ch 5
38 HI	bank 0-ch 6	38 LO	bank 2-ch 6	38 HI	bank 6-ch 6	38 LO	bank 6-ch 6
39 HI	bank 0-ch 7	39 LO	bank 2-ch 7	39 HI	bank 6-ch 7	39 LO	bank 6-ch 7
40 HI	bank 0-ch 8	40 LO	bank 2-ch 8	40 HI	bank 6-ch 8	40 LO	bank 6-ch 8
41 HI	bank 0-ch 9	41 LO	bank 2-ch 9	41 HI	bank 6-ch 9	41 LO	bank 6-ch 9
42 HI	bank 0-ch 10	42 LO	bank 2-ch 10	42 HI	bank 6-ch 10	42 LO	bank 6-ch 10
43 HI	bank 0-ch 11	43 LO	bank 2-ch 11	43 HI	bank 6-ch 11	43 LO	bank 6-ch 11
44 HI	bank 0-ch 12	44 LO	bank 2-ch 12	44 HI	bank 6-ch 12	44 LO	bank 6-ch 12
45 HI	bank 0-ch 13	45 LO	bank 2-ch 13	45 HI	bank 6-ch 13	45 LO	bank 6-ch 13
46 HI	bank 0-ch 14	46 LO	bank 2-ch 14	46 HI	bank 6-ch 14	46 LO	bank 6-ch 14
47 HI	bank 0-ch 15	47 LO	bank 2-ch 15	47 HI	bank 6-ch 15	47 LO	bank 6-ch 15
48 HI	bank 1-ch 0	48 LO	bank 3-ch 0	48 HI	bank 7-ch 0	48 LO	bank 7-ch 0
49 HI	bank 1-ch 1	49 LO	bank 3-ch 1	49 HI	bank 7-ch 1	49 LO	bank 7-ch 1
50 HI	bank 1-ch 2	50 LO	bank 3-ch 2	50 HI	bank 7-ch 2	50 LO	bank 7-ch 2
51 HI	bank 1-ch 3	51 LO	bank 3-ch 3	51 HI	bank 7-ch 3	51 LO	bank 7-ch 3
52 HI	bank 1-ch 4	52 LO	bank 3-ch 4	52 HI	bank 7-ch 4	52 LO	bank 7-ch 4
53 HI	bank 1-ch 5	53 LO	bank 3-ch 5	53 HI	bank 7-ch 5	53 LO	bank 7-ch 5
54 HI	bank 1-ch 6	54 LO	bank 3-ch 6	54 HI	bank 7-ch 6	54 LO	bank 7-ch 6
55 HI	bank 1-ch 7	55 LO	bank 3-ch 7	55 HI	bank 7-ch 7	55 LO	bank 7-ch 7
56 HI	bank 1-ch 8	56 LO	bank 3-ch 8	56 HI	bank 7-ch 8	56 LO	bank 7-ch 8
57 HI	bank 1-ch 9	57 LO	bank 3-ch 9	57 HI	bank 7-ch 9	57 LO	bank 7-ch 9
58 HI	bank 1-ch 10	58 LO	bank 3-ch 10	58 HI	bank 7-ch 10	58 LO	bank 7-ch 10
59 HI	bank 1-ch 11	59 LO	bank 3-ch 11	59 HI	bank 7-ch 11	59 LO	bank 7-ch 11
60 HI	bank 1-ch 12	60 LO	bank 3-ch 12	60 HI	bank 7-ch 12	60 LO	bank 7-ch 12
61 HI	bank 1-ch 13	61 LO	bank 3-ch 13	61 HI	bank 7-ch 13	61 LO	bank 7-ch 13
62 HI	bank 1-ch 14	62 LO	bank 3-ch 14	62 HI	bank 7-ch 14	62 LO	bank 7-ch 14
63 HI	bank 1-ch 15	63 LO	bank 3-ch 15	63 HI	bank 7-ch 15	63 LO	bank 7-ch 15

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WIRE2X4 Mode Topology

Table 2-9. Four 2-Wire X 32-Channel Topology Table.

Channel #	Relay Closure	Channel #	Relay Bank-Ch	Channel #	Relay Bank-Ch	Channel #	Relay Bank-Ch
MUX0				**MUX2**			
0 HI	bank 0-ch 0	0 LO	bank 0-ch 0	0 HI	bank 4-ch 0	0 LO	bank 4-ch 0
1 HI	bank 0-ch 1	1 LO	bank 0-ch 1	1 HI	bank 4-ch 1	1 LO	bank 4-ch 1
2 HI	bank 0-ch 2	2 LO	bank 0-ch 2	2 HI	bank 4-ch 2	2 LO	bank 4-ch 2
3 HI	bank 0-ch 3	3 LO	bank 0-ch 3	3 HI	bank 4-ch 3	3 LO	bank 4-ch 3
4 HI	bank 0-ch 4	4 LO	bank 0-ch 4	4 HI	bank 4-ch 4	4 LO	bank 4-ch 4
5 HI	bank 0-ch 5	5 LO	bank 0-ch 5	5 HI	bank 4-ch 5	5 LO	bank 4-ch 5
6 HI	bank 0-ch 6	6 LO	bank 0-ch 6	6 HI	bank 4-ch 6	6 LO	bank 4-ch 6
7 HI	bank 0-ch 7	7 LO	bank 0-ch 7	7 HI	bank 4-ch 7	7 LO	bank 4-ch 7
8 HI	bank 0-ch 8	8 LO	bank 0-ch 8	8 HI	bank 4-ch 8	8 LO	bank 4-ch 8
9 HI	bank 0-ch 9	9 LO	bank 0-ch 9	9 HI	bank 4-ch 9	9 LO	bank 4-ch 9
10 HI	bank 0-ch 10	10 LO	bank 0-ch 10	10 HI	bank 4-ch 10	10 LO	bank 4-ch 10
11 HI	bank 0-ch 11	11 LO	bank 0-ch 11	11 HI	bank 4-ch 11	11 LO	bank 4-ch 11
12 HI	bank 0-ch 12	12 LO	bank 0-ch 12	12 HI	bank 4-ch 12	12 LO	bank 4-ch 12
13 HI	bank 0-ch 13	13 LO	bank 0-ch 13	13 HI	bank 4-ch 13	13 LO	bank 4-ch 13
14 HI	bank 0-ch 14	14 LO	bank 0-ch 14	14 HI	bank 4-ch 14	14 LO	bank 4-ch 14
15 HI	bank 0-ch 15	15 LO	bank 0-ch 15	15 HI	bank 4-ch 15	15 LO	bank 4-ch 15
16 HI	bank 1-ch 0	16 LO	bank 1-ch 0	16 HI	bank 5-ch 0	16 LO	bank 5-ch 0
17 HI	bank 1-ch 1	17 LO	bank 1-ch 1	17 HI	bank 5-ch 1	17 LO	bank 5-ch 1
18 HI	bank 1-ch 2	18 LO	bank 1-ch 2	18 HI	bank 5-ch 2	18 LO	bank 5-ch 2
19 HI	bank 1-ch 3	19 LO	bank 1-ch 3	19 HI	bank 5-ch 3	19 LO	bank 5-ch 3
20 HI	bank 1-ch 4	20 LO	bank 1-ch 4	20 HI	bank 5-ch 4	20 LO	bank 5-ch 4
21 HI	bank 1-ch 5	21 LO	bank 1-ch 5	21 HI	bank 5-ch 5	21 LO	bank 5-ch 5
22 HI	bank 1-ch 6	22 LO	bank 1-ch 6	22 HI	bank 5-ch 6	22 LO	bank 5-ch 6
23 HI	bank 1-ch 7	23 LO	bank 1-ch 7	23 HI	bank 5-ch 7	23 LO	bank 5-ch 7
24 HI	bank 1-ch 8	24 LO	bank 1-ch 8	24 HI	bank 5-ch 8	24 LO	bank 5-ch 8
25 HI	bank 1-ch 9	25 LO	bank 1-ch 9	25 HI	bank 5-ch 9	25 LO	bank 5-ch 9
26 HI	bank 1-ch 10	26 LO	bank 1-ch 10	26 HI	bank 5-ch 10	26 LO	bank 5-ch 10
27 HI	bank 1-ch 11	27 LO	bank 1-ch 11	27 HI	bank 5-ch 11	27 LO	bank 5-ch 11
28 HI	bank 1-ch 12	28 LO	bank 1-ch 12	28 HI	bank 5-ch 12	28 LO	bank 5-ch 12
29 HI	bank 1-ch 13	29 LO	bank 1-ch 13	29 HI	bank 5-ch 13	29 LO	bank 5-ch 13
30 HI	bank 1-ch 14	30 LO	bank 1-ch 14	30 HI	bank 5-ch 14	30 LO	bank 5-ch 14
31 HI	bank 1-ch 15	31 LO	bank 1-ch 15	31 HI	bank 5-ch 15	31 LO	bank 5-ch 15
MUX1				**MUX3**			
0 HI	bank 0-ch 0	0 LO	bank 2-ch 0	0 HI	bank 6-ch 0	0 LO	bank 6-ch 0
1 HI	bank 0-ch 1	1 LO	bank 2-ch 1	1 HI	bank 6-ch 1	1 LO	bank 6-ch 1
2 HI	bank 0-ch 2	2 LO	bank 2-ch 2	2 HI	bank 6-ch 2	2 LO	bank 6-ch 2
3 HI	bank 0-ch 3	3 LO	bank 2-ch 3	3 HI	bank 6-ch 3	3 LO	bank 6-ch 3
4 HI	bank 0-ch 4	4 LO	bank 2-ch 4	4 HI	bank 6-ch 4	4 LO	bank 6-ch 4
5 HI	bank 0-ch 5	5 LO	bank 2-ch 5	5 HI	bank 6-ch 5	5 LO	bank 6-ch 5
6 HI	bank 0-ch 6	6 LO	bank 2-ch 6	6 HI	bank 6-ch 6	6 LO	bank 6-ch 6
7 HI	bank 0-ch 7	7 LO	bank 2-ch 7	7 HI	bank 6-ch 7	7 LO	bank 6-ch 7
8 HI	bank 0-ch 8	8 LO	bank 2-ch 8	8 HI	bank 6-ch 8	8 LO	bank 6-ch 8
9 HI	bank 0-ch 9	9 LO	bank 2-ch 9	9 HI	bank 6-ch 9	9 LO	bank 6-ch 9
10 HI	bank 0-ch 10	10 LO	bank 2-ch 10	10 HI	bank 6-ch 10	10 LO	bank 6-ch 10
11 HI	bank 0-ch 11	11 LO	bank 2-ch 11	11 HI	bank 6-ch 11	11 LO	bank 6-ch 11
12 HI	bank 0-ch 12	12 LO	bank 2-ch 12	12 HI	bank 6-ch 12	12 LO	bank 6-ch 12
13 HI	bank 0-ch 13	13 LO	bank 2-ch 13	13 HI	bank 6-ch 13	13 LO	bank 6-ch 13
14 HI	bank 0-ch 14	14 LO	bank 2-ch 14	14 HI	bank 6-ch 14	14 LO	bank 6-ch 14
15 HI	bank 0-ch 15	15 LO	bank 2-ch 15	15 HI	bank 6-ch 15	15 LO	bank 6-ch 15
16 HI	bank 1-ch 0	16 LO	bank 3-ch 0	16 HI	bank 7-ch 0	16 LO	bank 7-ch 0
17 HI	bank 1-ch 1	17 LO	bank 3-ch 1	17 HI	bank 7-ch 1	17 LO	bank 7-ch 1
18 HI	bank 1-ch 2	18 LO	bank 3-ch 2	18 HI	bank 7-ch 2	18 LO	bank 7-ch 2
19 HI	bank 1-ch 3	19 LO	bank 3-ch 3	19 HI	bank 7-ch 3	19 LO	bank 7-ch 3
20 HI	bank 1-ch 4	20 LO	bank 3-ch 4	20 HI	bank 7-ch 4	20 LO	bank 7-ch 4
21 HI	bank 1-ch 5	21 LO	bank 3-ch 5	21 HI	bank 7-ch 5	21 LO	bank 7-ch 5
22 HI	bank 1-ch 6	22 LO	bank 3-ch 6	22 HI	bank 7-ch 6	22 LO	bank 7-ch 6
23 HI	bank 1-ch 7	23 LO	bank 3-ch 7	23 HI	bank 7-ch 7	23 LO	bank 7-ch 7
24 HI	bank 1-ch 8	24 LO	bank 3-ch 8	24 HI	bank 7-ch 8	24 LO	bank 7-ch 8
25 HI	bank 1-ch 9	25 LO	bank 3-ch 9	25 HI	bank 7-ch 9	25 LO	bank 7-ch 9
26 HI	bank 1-ch 10	26 LO	bank 3-ch 10	26 HI	bank 7-ch 10	26 LO	bank 7-ch 10
27 HI	bank 1-ch 11	27 LO	bank 3-ch 11	27 HI	bank 7-ch 11	27 LO	bank 7-ch 11
28 HI	bank 1-ch 12	28 LO	bank 3-ch 12	28 HI	bank 7-ch 12	28 LO	bank 7-ch 12
29 HI	bank 1-ch 13	29 LO	bank 3-ch 13	29 HI	bank 7-ch 13	29 LO	bank 7-ch 13
30 HI	bank 1-ch 14	30 LO	bank 3-ch 14	30 HI	bank 7-ch 14	30 LO	bank 7-ch 14
31 HI	bank 1-ch 15	31 LO	bank 3-ch 15	31 HI	bank 7-ch 15	31 LO	bank 7-ch 15

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WIRE2X8 Mode Topology

Table 2-10. Eight 2-Wire X 16-Channel Topology Table.

Channel #	Relay Closure	Channel #	Relay Bank-Ch	Channel #	Relay Bank-Ch	Channel #	Relay Bank-Ch
MUX0				**MUX4**			
0 HI	bank 0-ch 0	0 LO	bank 0-ch 0	0 HI	bank 4-ch 0	0 LO	bank 4-ch 0
1 HI	bank 0-ch 1	1 LO	bank 0-ch 1	1 HI	bank 4-ch 1	1 LO	bank 4-ch 1
2 HI	bank 0-ch 2	2 LO	bank 0-ch 2	2 HI	bank 4-ch 2	2 LO	bank 4-ch 2
3 HI	bank 0-ch 3	3 LO	bank 0-ch 3	3 HI	bank 4-ch 3	3 LO	bank 4-ch 3
4 HI	bank 0-ch 4	4 LO	bank 0-ch 4	4 HI	bank 4-ch 4	4 LO	bank 4-ch 4
5 HI	bank 0-ch 5	5 LO	bank 0-ch 5	5 HI	bank 4-ch 5	5 LO	bank 4-ch 5
6 HI	bank 0-ch 6	6 LO	bank 0-ch 6	6 HI	bank 4-ch 6	6 LO	bank 4-ch 6
7 HI	bank 0-ch 7	7 LO	bank 0-ch 7	7 HI	bank 4-ch 7	7 LO	bank 4-ch 7
8 HI	bank 0-ch 8	8 LO	bank 0-ch 8	8 HI	bank 4-ch 8	8 LO	bank 4-ch 8
9 HI	bank 0-ch 9	9 LO	bank 0-ch 9	9 HI	bank 4-ch 9	9 LO	bank 4-ch 9
10 HI	bank 0-ch 10	10 LO	bank 0-ch 10	10 HI	bank 4-ch 10	10 LO	bank 4-ch 10
11 HI	bank 0-ch 11	11 LO	bank 0-ch 11	11 HI	bank 4-ch 11	11 LO	bank 4-ch 11
12 HI	bank 0-ch 12	12 LO	bank 0-ch 12	12 HI	bank 4-ch 12	12 LO	bank 4-ch 12
13 HI	bank 0-ch 13	13 LO	bank 0-ch 13	13 HI	bank 4-ch 13	13 LO	bank 4-ch 13
14 HI	bank 0-ch 14	14 LO	bank 0-ch 14	14 HI	bank 4-ch 14	14 LO	bank 4-ch 14
15 HI	bank 0-ch 15	15 LO	bank 0-ch 15	15 HI	bank 4-ch 15	15 LO	bank 4-ch 15
MUX1				**MUX5**			
0 HI	bank 1-ch 0	0 LO	bank 1-ch 0	0 HI	bank 5-ch 0	0 LO	bank 5-ch 0
1 HI	bank 1-ch 1	1 LO	bank 1-ch 1	1 HI	bank 5-ch 1	1 LO	bank 5-ch 1
2 HI	bank 1-ch 2	2 LO	bank 1-ch 2	2 HI	bank 5-ch 2	2 LO	bank 5-ch 2
3 HI	bank 1-ch 3	3 LO	bank 1-ch 3	3 HI	bank 5-ch 3	3 LO	bank 5-ch 3
4 HI	bank 1-ch 4	4 LO	bank 1-ch 4	4 HI	bank 5-ch 4	4 LO	bank 5-ch 4
5 HI	bank 1-ch 5	5 LO	bank 1-ch 5	5 HI	bank 5-ch 5	5 LO	bank 5-ch 5
6 HI	bank 1-ch 6	6 LO	bank 1-ch 6	6 HI	bank 5-ch 6	6 LO	bank 5-ch 6
7 HI	bank 1-ch 7	7 LO	bank 1-ch 7	7 HI	bank 5-ch 7	7 LO	bank 5-ch 7
8 HI	bank 1-ch 8	8 LO	bank 1-ch 8	8 HI	bank 5-ch 8	8 LO	bank 5-ch 8
9 HI	bank 1-ch 9	9 LO	bank 1-ch 9	9 HI	bank 5-ch 9	9 LO	bank 5-ch 9
10 HI	bank 1-ch 10	10 LO	bank 1-ch 10	10 HI	bank 5-ch 10	10 LO	bank 5-ch 10
11 HI	bank 1-ch 11	11 LO	bank 1-ch 11	11 HI	bank 5-ch 11	11 LO	bank 5-ch 11
12 HI	bank 1-ch 12	12 LO	bank 1-ch 12	12 HI	bank 5-ch 12	12 LO	bank 5-ch 12
13 HI	bank 1-ch 13	13 LO	bank 1-ch 13	13 HI	bank 5-ch 13	13 LO	bank 5-ch 13
14 HI	bank 1-ch 14	14 LO	bank 1-ch 14	14 HI	bank 5-ch 14	14 LO	bank 5-ch 14
15 HI	bank 1-ch 15	15 LO	bank 1-ch 15	15 HI	bank 5-ch 15	15 LO	bank 5-ch 15
MUX2				**MUX6**			
0 HI	bank 2-ch 0	0 LO	bank 2-ch 0	0 HI	bank 6-ch 0	0 LO	bank 6-ch 0
1 HI	bank 2-ch 1	1 LO	bank 2-ch 1	1 HI	bank 6-ch 1	1 LO	bank 6-ch 1
2 HI	bank 2-ch 2	2 LO	bank 2-ch 2	2 HI	bank 6-ch 2	2 LO	bank 6-ch 2
3 HI	bank 2-ch 3	3 LO	bank 2-ch 3	3 HI	bank 6-ch 3	3 LO	bank 6-ch 3
4 HI	bank 2-ch 4	4 LO	bank 2-ch 4	4 HI	bank 6-ch 4	4 LO	bank 6-ch 4
5 HI	bank 2-ch 5	5 LO	bank 2-ch 5	5 HI	bank 6-ch 5	5 LO	bank 6-ch 5
6 HI	bank 2-ch 6	6 LO	bank 2-ch 6	6 HI	bank 6-ch 6	6 LO	bank 6-ch 6
7 HI	bank 2-ch 7	7 LO	bank 2-ch 7	7 HI	bank 6-ch 7	7 LO	bank 6-ch 7
8 HI	bank 2-ch 8	8 LO	bank 2-ch 8	8 HI	bank 6-ch 8	8 LO	bank 6-ch 8
9 HI	bank 2-ch 9	9 LO	bank 2-ch 9	9 HI	bank 6-ch 9	9 LO	bank 6-ch 9
10 HI	bank 2-ch 10	10 LO	bank 2-ch 10	10 HI	bank 6-ch 10	10 LO	bank 6-ch 10
11 HI	bank 2-ch 11	11 LO	bank 2-ch 11	11 HI	bank 6-ch 11	11 LO	bank 6-ch 11
12 HI	bank 2-ch 12	12 LO	bank 2-ch 12	12 HI	bank 6-ch 12	12 LO	bank 6-ch 12
13 HI	bank 2-ch 13	13 LO	bank 2-ch 13	13 HI	bank 6-ch 13	13 LO	bank 6-ch 13
14 HI	bank 2-ch 14	14 LO	bank 2-ch 14	14 HI	bank 6-ch 14	14 LO	bank 6-ch 14
15 HI	bank 2-ch 15	15 LO	bank 2-ch 15	15 HI	bank 6-ch 15	15 LO	bank 6-ch 15
MUX3				**MUX7**			
0 HI	bank 3-ch 0	0 LO	bank 3-ch 0	0 HI	bank 7-ch 0	0 LO	bank 7-ch 0
1 HI	bank 3-ch 1	1 LO	bank 3-ch 1	1 HI	bank 7-ch 1	1 LO	bank 7-ch 1
2 HI	bank 3-ch 2	2 LO	bank 3-ch 2	2 HI	bank 7-ch 2	2 LO	bank 7-ch 2
3 HI	bank 3-ch 3	3 LO	bank 3-ch 3	3 HI	bank 7-ch 3	3 LO	bank 7-ch 3
4 HI	bank 3-ch 4	4 LO	bank 3-ch 4	4 HI	bank 7-ch 4	4 LO	bank 7-ch 4
5 HI	bank 3-ch 5	5 LO	bank 3-ch 5	5 HI	bank 7-ch 5	5 LO	bank 7-ch 5
6 HI	bank 3-ch 6	6 LO	bank 3-ch 6	6 HI	bank 7-ch 6	6 LO	bank 7-ch 6
7 HI	bank 3-ch 7	7 LO	bank 3-ch 7	7 HI	bank 7-ch 7	7 LO	bank 7-ch 7
8 HI	bank 3-ch 8	8 LO	bank 3-ch 8	8 HI	bank 7-ch 8	8 LO	bank 7-ch 8
9 HI	bank 3-ch 9	9 LO	bank 3-ch 9	9 HI	bank 7-ch 9	9 LO	bank 7-ch 9
10 HI	bank 3-ch 10	10 LO	bank 3-ch 10	10 HI	bank 7-ch 10	10 LO	bank 7-ch 10
11 HI	bank 3-ch 11	11 LO	bank 3-ch 11	11 HI	bank 7-ch 11	11 LO	bank 7-ch 11
12 HI	bank 3-ch 12	12 LO	bank 3-ch 12	12 HI	bank 7-ch 12	12 LO	bank 7-ch 12
13 HI	bank 3-ch 13	13 LO	bank 3-ch 13	13 HI	bank 7-ch 13	13 LO	bank 7-ch 13
14 HI	bank 3-ch 14	14 LO	bank 3-ch 14	14 HI	bank 7-ch 14	14 LO	bank 7-ch 14
15 HI	bank 3-ch 15	15 LO	bank 3-ch 15	15 HI	bank 7-ch 15	15 LO	bank 7-ch 15

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WIRE4X2 Mode Topology

Table 2-11. Two 4-Wire X 32-Channel Topology Table.

Channel #	Relay Closure	Channel #	Relay Bank-Ch	Channel #	Relay Closure	Channel #	Relay Bank-Ch
MUX0							
0 HI1	bank 0-ch 0	0 LO1	bank 0-ch 0	0 HI2	bank 2-ch 0	0 LO2	bank 2-ch 0
1 HI1	bank 0-ch 1	1 LO1	bank 0-ch 1	1 HI2	bank 2-ch 1	1 LO2	bank 2-ch 1
2 HI1	bank 0-ch 2	2 LO1	bank 0-ch 2	2 HI2	bank 2-ch 2	2 LO2	bank 2-ch 2
3 HI1	bank 0-ch 3	3 LO1	bank 0-ch 3	3 HI2	bank 2-ch 3	3 LO2	bank 2-ch 3
4 HI1	bank 0-ch 4	4 LO1	bank 0-ch 4	4 HI2	bank 2-ch 4	4 LO2	bank 2-ch 4
5 HI1	bank 0-ch 5	5 LO1	bank 0-ch 5	5 HI2	bank 2-ch 5	5 LO2	bank 2-ch 5
6 HI1	bank 0-ch 6	6 LO1	bank 0-ch 6	6 HI2	bank 2-ch 6	6 LO2	bank 2-ch 6
7 HI1	bank 0-ch 7	7 LO1	bank 0-ch 7	7 HI2	bank 2-ch 7	7 LO2	bank 2-ch 7
8 HI1	bank 0-ch 8	8 LO1	bank 0-ch 8	8 HI2	bank 2-ch 8	8 LO2	bank 2-ch 8
9 HI1	bank 0-ch 9	9 LO1	bank 0-ch 9	9 HI2	bank 2-ch 9	9 LO2	bank 2-ch 9
10 HI1	bank 0-ch 10	10 LO1	bank 0-ch 10	10 HI2	bank 2-ch 10	10 LO2	bank 2-ch 10
11 HI1	bank 0-ch 11	11 LO1	bank 0-ch 11	11 HI2	bank 2-ch 11	11 LO2	bank 2-ch 11
12 HI1	bank 0-ch 12	12 LO1	bank 0-ch 12	12 HI2	bank 2-ch 12	12 LO2	bank 2-ch 12
13 HI1	bank 0-ch 13	13 LO1	bank 0-ch 13	13 HI2	bank 2-ch 13	13 LO2	bank 2-ch 13
14 HI1	bank 0-ch 14	14 LO1	bank 0-ch 14	14 HI2	bank 2-ch 14	14 LO2	bank 2-ch 14
15 HI1	bank 0-ch 15	15 LO1	bank 0-ch 15	15 HI2	bank 2-ch 15	15 LO2	bank 2-ch 15
16 HI1	bank 1-ch 0	16 LO1	bank 1-ch 0	16 HI2	bank 3-ch 0	16 LO2	bank 3-ch 0
17 HI1	bank 1-ch 1	17 LO1	bank 1-ch 1	17 HI2	bank 3-ch 1	17 LO2	bank 3-ch 1
18 HI1	bank 1-ch 2	18 LO1	bank 1-ch 2	18 HI2	bank 3-ch 2	18 LO2	bank 3-ch 2
19 HI1	bank 1-ch 3	19 LO1	bank 1-ch 3	19 HI2	bank 3-ch 3	19 LO2	bank 3-ch 3
20 HI1	bank 1-ch 4	20 LO1	bank 1-ch 4	20 HI2	bank 3-ch 4	20 LO2	bank 3-ch 4
21 HI1	bank 1-ch 5	21 LO1	bank 1-ch 5	21 HI2	bank 3-ch 5	21 LO2	bank 3-ch 5
22 HI1	bank 1-ch 6	22 LO1	bank 1-ch 6	22 HI2	bank 3-ch 6	22 LO2	bank 3-ch 6
23 HI1	bank 1-ch 7	23 LO1	bank 1-ch 7	23 HI2	bank 3-ch 7	23 LO2	bank 3-ch 7
24 HI1	bank 1-ch 8	24 LO1	bank 1-ch 8	24 HI2	bank 3-ch 8	24 LO2	bank 3-ch 8
25 HI1	bank 1-ch 9	25 LO1	bank 1-ch 9	25 HI2	bank 3-ch 9	25 LO2	bank 3-ch 9
26 HI1	bank 1-ch 10	26 LO1	bank 1-ch 10	26 HI2	bank 3-ch 10	26 LO2	bank 3-ch 10
27 HI1	bank 1-ch 11	27 LO1	bank 1-ch 11	27 HI2	bank 3-ch 11	27 LO2	bank 3-ch 11
28 HI1	bank 1-ch 12	28 LO1	bank 1-ch 12	28 HI2	bank 3-ch 12	28 LO2	bank 3-ch 12
29 HI1	bank 1-ch 13	29 LO1	bank 1-ch 13	29 HI2	bank 3-ch 13	29 LO2	bank 3-ch 13
30 HI1	bank 1-ch 14	30 LO1	bank 1-ch 14	30 HI2	bank 3-ch 14	30 LO2	bank 3-ch 14
31 HI1	bank 1-ch 15	31 LO1	bank 1-ch 15	31 HI2	bank 3-ch 15	31 LO2	bank 3-ch 15
MUX1							
0 HI1	bank 4-ch 0	0 LO1	bank 4-ch 0	0 HI2	bank 6-ch 0	0 LO2	bank 6-ch 0
1 HI1	bank 4-ch 1	1 LO1	bank 4-ch 1	1 HI2	bank 6-ch 1	1 LO2	bank 6-ch 1
2 HI1	bank 4-ch 2	2 LO1	bank 4-ch 2	2 HI2	bank 6-ch 2	2 LO2	bank 6-ch 2
3 HI1	bank 4-ch 3	3 LO1	bank 4-ch 3	3 HI2	bank 6-ch 3	3 LO2	bank 6-ch 3
4 HI1	bank 4-ch 4	4 LO1	bank 4-ch 4	4 HI2	bank 6-ch 4	4 LO2	bank 6-ch 4
5 HI1	bank 4-ch 5	5 LO1	bank 4-ch 5	5 HI2	bank 6-ch 5	5 LO2	bank 6-ch 5
6 HI1	bank 4-ch 6	6 LO1	bank 4-ch 6	6 HI2	bank 6-ch 6	6 LO2	bank 6-ch 6
7 HI1	bank 4-ch 7	7 LO1	bank 4-ch 7	7 HI2	bank 6-ch 7	7 LO2	bank 6-ch 7
8 HI1	bank 4-ch 8	8 LO1	bank 4-ch 8	8 HI2	bank 6-ch 8	8 LO2	bank 6-ch 8
9 HI1	bank 4-ch 9	9 LO1	bank 4-ch 9	9 HI2	bank 6-ch 9	9 LO2	bank 6-ch 9
10 HI1	bank 4-ch 10	10 LO1	bank 4-ch 10	10 HI2	bank 6-ch 10	10 LO2	bank 6-ch 10
11 HI1	bank 4-ch 11	11 LO1	bank 4-ch 11	11 HI2	bank 6-ch 11	11 LO2	bank 6-ch 11
12 HI1	bank 4-ch 12	12 LO1	bank 4-ch 12	12 HI2	bank 6-ch 12	12 LO2	bank 6-ch 12
13 HI1	bank 4-ch 13	13 LO1	bank 4-ch 13	13 HI2	bank 6-ch 13	13 LO2	bank 6-ch 13
14 HI1	bank 4-ch 14	14 LO1	bank 4-ch 14	14 HI2	bank 6-ch 14	14 LO2	bank 6-ch 14
15 HI1	bank 4-ch 15	15 LO1	bank 4-ch 15	15 HI2	bank 6-ch 15	15 LO2	bank 6-ch 15
16 HI1	bank 5-ch 0	16 LO1	bank 5-ch 0	16 HI2	bank 7-ch 0	16 LO2	bank 7-ch 0
17 HI1	bank 5-ch 1	17 LO1	bank 5-ch 1	17 HI2	bank 7-ch 1	17 LO2	bank 7-ch 1
18 HI1	bank 5-ch 2	18 LO1	bank 5-ch 2	18 HI2	bank 7-ch 2	18 LO2	bank 7-ch 2
19 HI1	bank 5-ch 3	19 LO1	bank 5-ch 3	19 HI2	bank 7-ch 3	19 LO2	bank 7-ch 3
20 HI1	bank 5-ch 4	20 LO1	bank 5-ch 4	20 HI2	bank 7-ch 4	20 LO2	bank 7-ch 4
21 HI1	bank 5-ch 5	21 LO1	bank 5-ch 5	21 HI2	bank 7-ch 5	21 LO2	bank 7-ch 5
22 HI1	bank 5-ch 6	22 LO1	bank 5-ch 6	22 HI2	bank 7-ch 6	22 LO2	bank 7-ch 6
23 HI1	bank 5-ch 7	23 LO1	bank 5-ch 7	23 HI2	bank 7-ch 7	23 LO2	bank 7-ch 7
24 HI1	bank 5-ch 8	24 LO1	bank 5-ch 8	24 HI2	bank 7-ch 8	24 LO2	bank 7-ch 8
25 HI1	bank 5-ch 9	25 LO1	bank 5-ch 9	25 HI2	bank 7-ch 9	25 LO2	bank 7-ch 9
26 HI1	bank 5-ch 10	26 LO1	bank 5-ch 10	26 HI2	bank 7-ch 10	26 LO2	bank 7-ch 10
27 HI1	bank 5-ch 11	27 LO1	bank 5-ch 11	27 HI2	bank 7-ch 11	27 LO2	bank 7-ch 11
28 HI1	bank 5-ch 12	28 LO1	bank 5-ch 12	28 HI2	bank 7-ch 12	28 LO2	bank 7-ch 12
29 HI1	bank 5-ch 13	29 LO1	bank 5-ch 13	29 HI2	bank 7-ch 13	29 LO2	bank 7-ch 13
30 HI1	bank 5-ch 14	30 LO1	bank 5-ch 14	30 HI2	bank 7-ch 14	30 LO2	bank 7-ch 14
31 HI1	bank 5-ch 15	31 LO1	bank 5-ch 15	31 HI2	bank 7-ch 15	31 LO2	bank 7-ch 15

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WIRE4X4 Mode Topology

Table 2-12. Four 4-Wire X 16-Channel Topology Table.

Channel #	Relay Closure	Channel #	Relay Closure	Channel #	Relay Closure	Channel #	Relay Closure
MUX0							
0 HI1	bank 0-ch 0	0 LO1	bank 0-ch 0	0 HI2	bank 2-ch 0	0 LO2	bank 2-ch 0
1 HI1	bank 0-ch 1	1 LO1	bank 0-ch 1	1 HI2	bank 2-ch 1	1 LO2	bank 2-ch 1
2 HI1	bank 0-ch 2	2 LO1	bank 0-ch 2	2 HI2	bank 2-ch 2	2 LO2	bank 2-ch 2
3 HI1	bank 0-ch 3	3 LO1	bank 0-ch 3	3 HI2	bank 2-ch 3	3 LO2	bank 2-ch 3
4 HI1	bank 0-ch 4	4 LO1	bank 0-ch 4	4 HI2	bank 2-ch 4	4 LO2	bank 2-ch 4
5 HI1	bank 0-ch 5	5 LO1	bank 0-ch 5	5 HI2	bank 2-ch 5	5 LO2	bank 2-ch 5
6 HI1	bank 0-ch 6	6 LO1	bank 0-ch 6	6 HI2	bank 2-ch 6	6 LO2	bank 2-ch 6
7 HI1	bank 0-ch 7	7 LO1	bank 0-ch 7	7 HI2	bank 2-ch 7	7 LO2	bank 2-ch 7
8 HI1	bank 0-ch 8	8 LO1	bank 0-ch 8	8 HI2	bank 2-ch 8	8 LO2	bank 2-ch 8
9 HI1	bank 0-ch 9	9 LO1	bank 0-ch 9	9 HI2	bank 2-ch 9	9 LO2	bank 2-ch 9
10 HI1	bank 0-ch 10	10 LO1	bank 0-ch 10	10 HI2	bank 2-ch 10	10 LO2	bank 2-ch 10
11 HI1	bank 0-ch 11	11 LO1	bank 0-ch 11	11 HI2	bank 2-ch 11	11 LO2	bank 2-ch 11
12 HI1	bank 0-ch 12	12 LO1	bank 0-ch 12	12 HI2	bank 2-ch 12	12 LO2	bank 2-ch 12
13 HI1	bank 0-ch 13	13 LO1	bank 0-ch 13	13 HI2	bank 2-ch 13	13 LO2	bank 2-ch 13
14 HI1	bank 0-ch 14	14 LO1	bank 0-ch 14	14 HI2	bank 2-ch 14	14 LO2	bank 2-ch 14
15 HI1	bank 0-ch 15	15 LO1	bank 0-ch 15	15 HI2	bank 2-ch 15	15 LO2	bank 2-ch 15
MUX1							
0 HI1	bank 1-ch 0	0 LO1	bank 1-ch 0	0 HI2	bank 3-ch 0	0 LO2	bank 3-ch 0
2 HI1	bank 1-ch 1	1 LO1	bank 1-ch 1	1 HI2	bank 3-ch 1	1 LO2	bank 3-ch 1
3 HI1	bank 1-ch 2	2 LO1	bank 1-ch 2	2 HI2	bank 3-ch 2	2 LO2	bank 3-ch 2
19 HI1	bank 1-ch 3	3 LO1	bank 1-ch 3	3 HI2	bank 3-ch 3	3 LO2	bank 3-ch 3
4 HI1	bank 1-ch 4	4 LO1	bank 1-ch 4	4 HI2	bank 3-ch 4	4 LO2	bank 3-ch 4
5 HI1	bank 1-ch 5	5 LO1	bank 1-ch 5	5 HI2	bank 3-ch 5	5 LO2	bank 3-ch 5
6 HI1	bank 1-ch 6	6 LO1	bank 1-ch 6	6 HI2	bank 3-ch 6	6 LO2	bank 3-ch 6
7 HI1	bank 1-ch 7	7 LO1	bank 1-ch 7	7 HI2	bank 3-ch 7	7 LO2	bank 3-ch 7
8 HI1	bank 1-ch 8	8 LO1	bank 1-ch 8	8 HI2	bank 3-ch 8	8 LO2	bank 3-ch 8
9 HI1	bank 1-ch 9	9 LO1	bank 1-ch 9	9 HI2	bank 3-ch 9	9 LO2	bank 3-ch 9
10 HI1	bank 1-ch 10	10 LO1	bank 1-ch 10	10 HI2	bank 3-ch 10	10 LO2	bank 3-ch 10
11 HI1	bank 1-ch 11	11 LO1	bank 1-ch 11	11 HI2	bank 3-ch 11	11 LO2	bank 3-ch 11
12 HI1	bank 1-ch 12	12 LO1	bank 1-ch 12	12 HI2	bank 3-ch 12	12 LO2	bank 3-ch 12
13 HI1	bank 1-ch 13	13 LO1	bank 1-ch 13	13 HI2	bank 3-ch 13	13 LO2	bank 3-ch 13
14 HI1	bank 1-ch 14	14 LO1	bank 1-ch 14	14 HI2	bank 3-ch 14	14 LO2	bank 3-ch 14
15 HI1	bank 1-ch 15	15 LO1	bank 1-ch 15	15 HI2	bank 3-ch 15	15 LO2	bank 3-ch 15
MUX2							
0 HI1	bank 4-ch 0	0 LO1	bank 4-ch 0	0 HI2	bank 6-ch 0	0 LO2	bank 6-ch 0
1 HI1	bank 4-ch 1	1 LO1	bank 4-ch 1	1 HI2	bank 6-ch 1	1 LO2	bank 6-ch 1
2 HI1	bank 4-ch 2	2 LO1	bank 4-ch 2	2 HI2	bank 6-ch 2	2 LO2	bank 6-ch 2
3 HI1	bank 4-ch 3	3 LO1	bank 4-ch 3	3 HI2	bank 6-ch 3	3 LO2	bank 6-ch 3
4 HI1	bank 4-ch 4	4 LO1	bank 4-ch 4	4 HI2	bank 6-ch 4	4 LO2	bank 6-ch 4
5 HI1	bank 4-ch 5	5 LO1	bank 4-ch 5	5 HI2	bank 6-ch 5	5 LO2	bank 6-ch 5
6 HI1	bank 4-ch 6	6 LO1	bank 4-ch 6	6 HI2	bank 6-ch 6	6 LO2	bank 6-ch 6
7 HI1	bank 4-ch 7	7 LO1	bank 4-ch 7	7 HI2	bank 6-ch 7	7 LO2	bank 6-ch 7
8 HI1	bank 4-ch 8	8 LO1	bank 4-ch 8	8 HI2	bank 6-ch 8	8 LO2	bank 6-ch 8
9 HI1	bank 4-ch 9	9 LO1	bank 4-ch 9	9 HI2	bank 6-ch 9	9 LO2	bank 6-ch 9
10 HI1	bank 4-ch 10	10 LO1	bank 4-ch 10	10 HI2	bank 6-ch 10	10 LO2	bank 6-ch 10
11 HI1	bank 4-ch 11	11 LO1	bank 4-ch 11	11 HI2	bank 6-ch 11	11 LO2	bank 6-ch 11
12 HI1	bank 4-ch 12	12 LO1	bank 4-ch 12	12 HI2	bank 6-ch 12	12 LO2	bank 6-ch 12
13 HI1	bank 4-ch 13	13 LO1	bank 4-ch 13	13 HI2	bank 6-ch 13	13 LO2	bank 6-ch 13
14 HI1	bank 4-ch 14	14 LO1	bank 4-ch 14	14 HI2	bank 6-ch 14	14 LO2	bank 6-ch 14
15 HI1	bank 4-ch 15	15 LO1	bank 4-ch 15	15 HI2	bank 6-ch 15	15 LO2	bank 6-ch 15
MUX3							
0 HI1	bank 5-ch 0	0 LO1	bank 5-ch 0	0 HI2	bank 7-ch 0	0 LO2	bank 7-ch 0
1 HI1	bank 5-ch 1	1 LO1	bank 5-ch 1	1 HI2	bank 7-ch 1	1 LO2	bank 7-ch 1
2 HI1	bank 5-ch 2	2 LO1	bank 5-ch 2	2 HI2	bank 7-ch 2	2 LO2	bank 7-ch 2
3 HI1	bank 5-ch 3	3 LO1	bank 5-ch 3	3 HI2	bank 7-ch 3	3 LO2	bank 7-ch 3
4 HI1	bank 5-ch 4	4 LO1	bank 5-ch 4	4 HI2	bank 7-ch 4	4 LO2	bank 7-ch 4
5 HI1	bank 5-ch 5	5 LO1	bank 5-ch 5	5 HI2	bank 7-ch 5	5 LO2	bank 7-ch 5
6 HI1	bank 5-ch 6	6 LO1	bank 5-ch 6	6 HI2	bank 7-ch 6	6 LO2	bank 7-ch 6
7 HI1	bank 5-ch 7	7 LO1	bank 5-ch 7	7 HI2	bank 7-ch 7	7 LO2	bank 7-ch 7
8 HI1	bank 5-ch 8	8 LO1	bank 5-ch 8	8 HI2	bank 7-ch 8	8 LO2	bank 7-ch 8
9 HI1	bank 5-ch 9	9 LO1	bank 5-ch 9	9 HI2	bank 7-ch 9	9 LO2	bank 7-ch 9
10 HI1	bank 5-ch 10	10 LO1	bank 5-ch 10	10 HI2	bank 7-ch 10	10 LO2	bank 7-ch 10
11 HI1	bank 5-ch 11	11 LO1	bank 5-ch 11	11 HI2	bank 7-ch 11	11 LO2	bank 7-ch 11
12 HI1	bank 5-ch 12	12 LO1	bank 5-ch 12	12 HI2	bank 7-ch 12	12 LO2	bank 7-ch 12
13 HI1	bank 5-ch 13	13 LO1	bank 5-ch 13	13 HI2	bank 7-ch 13	13 LO2	bank 7-ch 13
14 HI1	bank 5-ch 14	14 LO1	bank 5-ch 14	14 HI2	bank 7-ch 14	14 LO2	bank 7-ch 14
15 HI1	bank 5-ch 15	15 LO1	bank 5-ch 15	15 HI2	bank 7-ch 15	15 LO2	bank 7-ch 15

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Chapter 3
HP E8462A Relay Multiplexer Command Reference

Using This Chapter

This chapter describes the Standard Commands for Programmable Instruments (SCPI) and IEEE 488.2 Common (*) commands applicable to the HP E8462A 256-Channel Relay Multiplexer. See the *HP E1406A Command Module User's Manual* for additional information on SCPI and common commands. This chapter contains the following sections:

- Command Types. . . . . page 67
- SCPI Command Reference . . . . . page 70
- SCPI Command Quick Reference . . . . . page 115
- IEEE 488.2 Common Command Reference . . . . . page 114

Command Types

Commands are separated into two types: IEEE 488.2 Common Commands and SCPI Commands.

Common Command Format

The IEEE 488.2 standard defines the common commands that perform functions like reset, self-test, status byte query, and so on. Common commands are four or five characters in length, always begin with the asterisk character (*), and may include one or more parameters. The command keyword is separated from the first parameter by a space character. Some examples of common commands are shown below:

```
*RST        *ESE <mask>   *STB?
```

SCPI Command Format

The SCPI commands perform functions like closing switches, opening switches, scanning channels, querying instrument states, or retrieving data. A subsystem command structure is a hierarchical structure that usually consists of a top level (or root) command, one or more lower level sub commands, and their parameters. The following example shows part of a typical subsystem:

```
[ROUTe:]
    CLOSe <channel_list>
    SCAN <channel_list>
        :MODE?
```

[ROUTe:] is the root command, CLOSe and SCAN are the second level sub commands with <*channel_list*> as a parameter, and :MODE? is a third level command. [ROUTe:] is also an implied command and is, therefore, optional.

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Note There is a space between the second level command (for example, CLOSe) and the <*channel_list*>.

Command Separator

A colon (**:**) always separates one command from the next lower level command as shown below:

```
ROUTe:SCAN:MODE?
```

Colons separate the root command from the second level command ([ROUTe:]SCAN), and the second level from the third level (SCAN:MODE?).

Abbreviated Commands

The command syntax shows most commands as a mixture of upper and lower case letters. The upper case letters indicate the abbreviated spelling for the command. For shorter program lines, send only the abbreviated form. For better program readability, you may send the entire command. The instrument will accept either the abbreviated form or the entire command.

For example, if the command syntax shows DIAGnostic, then DIAG and DIAGNOSTIC are both acceptable forms. Other forms of DIAGnostic, such as DIAGN or DIAGNOS will generate an error. You may use upper or lower case letters. Therefore, DIAGNOSTIC, diagnostic, and DiAgNoStIc are all acceptable.

Implied Commands

Implied commands are those which appear in square brackets ([ ]) in the command syntax. (Note that the brackets are not part of the command and are not sent to the instrument.) Suppose you send a second level command but do not send the preceding implied command. In this case, the instrument assumes you intend to use the implied command and it responds as if you had sent it. Examine the portion of the [ROUTe:] subsystem shown below:

```
[ROUTe:]
    CLOSe? <channel_list>
```

The root command [ROUTe:] is an implied command. To make a query about a channel's present status, you can send either of the following command statements:

```
ROUT:CLOSe? <channel_list>  or   CLOSe? <channel_list>
```

Common Command Format

The IEEE 488.2 standard defines the Common commands that perform functions like reset, self-test, status byte query, etc. Common commands are four or five characters in length, always begin with the asterisk character (*), and may include one or more parameters. The command keyword is separated from the first parameter by a space character. Some examples of common commands are shown below:

```
*RST    *ESR 32    *STB?
```

Linking Commands

Linking IEEE 488.2 Common Commands with SCPI Commands. Use only a semicolon between the commands. For example:

```
*RST;OUTP:TTLT4  ON      or      ARM:COUNt  25;*WAI
```


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Linking Multiple SCPI Commands From the Same Subsystem. Use only a semicolon between commands within the same subsystem. For example, to set the trigger slope and the trigger source which are both set using the TRIGger subsystem, send the following SCPI string:

```
TRIG:SLOPe NEG;SOURce EXT
```

Linking Multiple SCPI Commands of Different Subsystems. Use both a semicolon and a colon between commands of different subsystems. For example, a ARM and OUTPut command can be sent in the same SCPI string linked with a semicolon and colon (;:) as follows:

```
ARM:COUNt 10;:OUTP:TTLT4 ON
```

Variable Command Syntax

Some commands have what appears to be a variable syntax. For example:

OUTPut:ECLTrg*n* and OUTPut:TTLTrg*n*

In these commands, the "*n*" is replaced by a number. No space is left between the command and the number because the number is not a parameter. The number is part of the command syntax. In the case of OUTPut:ECLTrg*n*, "*n*" can range from 0 to 1. In OUTPut:TTLTrg*n*, "*n*" can range from 0 through 7.

Parameters

Parameter Types. The following table contains explanations and examples of parameter types you might see later in this chapter.

Table 3-1.

Parameter Type	Explanations and Examples
Numeric	Accepts all commonly used decimal representations of number including optional signs, decimal points, and scientific notation. 123, 123E2, -123, -1.23E2, .123, 1.23E-2, 1.23000E-01. Special cases include MINimum, MAXimum, and DEFault.
Boolean	Represents a single binary condition that is either true or false. ON, OFF, 1, 0
Discrete	Selects from a finite number of values. These parameters use mnemonics to represent each valid setting. An example is the TRIGger:SOURce <*source*> command where source can be OFF, BUS, EXT1-2, HOLD, IMM, INT1-4 or TTLT0-7.

Parameter Types

The following list contains explanations and examples of parameter types you will see later in this chapter.

Boolean Parameters represent a single binary condition that is either true or false (for example, ON, OFF, 1, 0). Any non-zero value is considered true.

Discrete Parameters selects from a finite number of values. These parameters use mnemonics to represent each valid setting.

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An example is the TRIGger:SOURce <*source*> command where *source* can be BUS, EXTernal, HOLD, IMMediate, ECLTrg*n*, or TTLTrg*n*.

Numeric Parameters are commonly used decimal representations of numbers including optional signs, decimal points, and scientific notation (for example, 123, 123E2, -123, -1.23E2, .123, 1.23E-2, 1.23000E- 01). Special cases include MINimum, MAXimum and DEFault.

Optional Parameters are shown within square brackets (**[ ]**). The brackets are not part of the command, and are not sent to the instrument. If you do not specify a value for an optional parameter, the instrument chooses a default value. For example, consider the ARM:COUNt? [<MIN|MAX>] command. If you send the command without specifying a parameter, the present ARM:COUNt value is returned. If you send the MIN parameter, the command returns the minimum count available. If you send the MAX parameter, the command returns the maximum count available. Be sure to place a space between the command and the parameter.

Linking Commands

Linking IEEE 488.2 Common Commands with SCPI Commands. Use a semicolon between the commands. For example:

```
*RST;*RCL 1      or      CLOS (@101);*SAV 1
```

Linking Multiple SCPI Commands. Use both a semicolon and a colon between the commands. For example:

```
CLOS (@101);:CLOS? (@101)
```

SCPI also allows several commands within the same subsystem to be linked with a semicolon. For example:

```
ROUT:CLOS (@101);:ROUT:CLOS? (@101)
```

or

```
ROUT:CLOS (@101);CLOS? (@101)
```

SCPI Command Reference

This section describes the Standard Commands for Programmable Instruments (SCPI) reference commands for the multiplexer. Commands on the following pages are listed alphabetically by subsystem and also within each subsystem.

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The ABORt command stops a scan in progress when the scan is enabled via the interface and the trigger source is TRIGger:SOURce BUS or TRIGger:SOURce HOLD.

Subsystem Syntax

```
ABORt
```

Comments

ABORt Actions: The ABORt command terminates a scan in progress by causing the switchbox to no longer wait for a trigger. When the ABORt command is executed, the last channel switched during the scan remains in the position.

Stopping Scan Enabled Via Interface: When a scan is enabled via an interface, an interface clear command (CLEAR 7) can be used to stop the scan. When the scan is enabled via the interface and TRIG:SOUR BUS or HOLD is set, you can use ABORt to stop the scan.

Restarting a Scan: Use the INITiate command to restart the scan.

Related Commands: ARM, INITiate:CONTinuous, [ROUTe:]SCAN, TRIGger

Example

Stopping a Scan with ABORt

This example stops a (continuous) two-wire scan in progress in a single-module switchbox.

```
TRIG:SOUR BUS                 Trigger command will be via backplane
                              (bus) interface (*TRG command
                              generates trigger).
INIT:CONT ON                  Set continuous scanning.
SCAN (@10000:10007)           Scan channels 0 to 7.
INIT                          Starts scan, closes channel 0.
  .
  .
  .
ABOR                          Abort scan in progress.
```


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The ARM subsystem selects the number of scanning cycles (1 to 32767) for each INITiate command.

Subsystem Syntax

```
ARM
    :COUNt <number> MIN|MAX
    :COUNt? [MIN|MAX]
```

ARM:COUNT

ARM:COUNt <*number*> MIN|MAX Allows scanning cycles to occur a multiple of times (1 to 32,767) with one INITiate command when INITiate:CONTinuous OFF|0 is set. MIN sets 1 cycle and MAX sets 32,767 cycles.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Value
number	numeric	1 thru 32,767|MIN|MAX	1

Comments

Number of Scans: Use only numeric values between 1 and 32767, MIN, or MAX for the number of scanning cycles.

Related Commands: ABORt, INITiate:IMMediate

***RST Condition:** ARM:COUNt 1

Example

Setting Ten Scanning Cycles

This example sets a multiplexer module for 10 scans of channels 10 through 17 in a single-module switchbox.

```
ARM:COUN  10          10 scans per INIT command.
SCAN  (@10010:10017)  Scan channels 10 to 17.
INIT                  Start scan, close channel 10.
```

ARM:COUNt?

ARM:COUNt? [MIN|MAX] Returns the current number of scanning cycles set by ARM:COUNt. The current number of scan cycles is returned when MIN or MAX is not specified. With MIN or MAX as a parameter, MIN returns 1 and MAX returns 32,767.

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Parameters

Parameter Name	Parameter Type	Range of Values	Default Value
MIN|MAX	numeric	MIN=1, MAX=32,767	current cycles

Comments

Related Commands: INITiate[:IMMediate]

Example

Query Number of Scans

This example sets a multiplexer module for 10 scanning cycles and queries the number of scan cycles set. The ARM:COUN? command returns 10.

```
ARM:COUN  10          Set 10 scans per INIT command.
ARM:COUN?             Query number of scans.
```


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The **DIAGnostic** subsystem controls setting and querying the Multiplexer's interrupt line, interrupt timer and checks the state of the bank fuses.

Subsystem Syntax

```
DIAGnostic
    :FUSE? <card_number>
    :INTerrupt[:LINE] <card_number>, <line_number>
    :INTerrupt[:LINE]? <card_number>
    :INTerrupt:TIMer <card_number>, <time>
    :INTerrupt:TIMer? <card_number>
    :SCAN:DELay <card_number>, delay_time
    :SCAN:DELay? <card_number>
```

DIAGnostic:FUSE?

DIAGnostic:FUSE? <*card_number*> queries the HP E8462A module's fuse register (0x38) and returns a value from 0 through 15 to indicate the state of each of four bank fuses.

Parameters

Name	Type	Range of Values	Default value
<*card_number*>	numeric	1 - 99	1

Comments

- The module's fuse register identifies good fuses on bits 0, 1, 2 and 3 as noted in the following table.

Fuse Register Bit	Fuse
0	Banks 0-2 fuse
1	Banks 3-5 fuse
2	Banks 6-8 fuse
3	Banks 9-11 fuse

- A good fuse is idicated by the bit being "1". A "0" bit indicates the associated banks are not receiving power. Check the fuse and replace if necessary. Check hardware associated with the no-power banks for shorts.

- The *TST? command will return <*card_number*>*100 + 14 for any HP E8462A module that has a bank not receiving power. The DIAG:FUSE? command can then be used to find out which fuse on the module has the problem.

Example

```
DIAG:FUSE? 1
```

Query the number 1 module's fuses. If 15 is returned, all fuses are good. If 10 is returned, the fuses to banks 0-2 and banks 6-8 are open.

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DIAGnostic:INTerrupt[:LINE]

DIAGnostic:INTerrupt[:LINE] <*card_number*>, <*line_number*> sets Multiplexer interrupt line. The *card_number* specifies which HP E8462A in a multiple-module switchbox, is being referred to. The *line_number* can be 1 through 7 corresponding to VXI backplane interrupt line 1-7.

Parameter

Name	Type	Range of Values	Default Value
<card_number>	numeric	1 - 99	1
<line_number>	numeric	0 - 7	1

Comments

- Setting <*line_number*> = 0 will disable the Multiplexer's interrupt.
- Only one value (1 through 7) can be set at one time.
- The default value of <*line_number*> is 1 (lowest interrupt line).

Example

Setting the Multiplexer's interrupt line equal to interrupt line 6.

```
DIAG:INT:LINE 1, 6          Set the interrupt line equal to line 6.
```

DIAGnostic:INTerrupt[:LINE]?

DIAGnostic:INTerrupt[:LINE]? <*card_number*> queries the module's VXI backplane interrupt line and the return value is one of 1, 2, 3, 4, 5, 6, 7 which corresponding to the module's interrupt line 1-7. The return value being 0 indicates that the Multiplexer is interrupt disabled. The *card_number* specifies which HP E8462A in a multiple-module switchbox, is being referred to.

Parameter

Name	Type	Range of Values	Default Value
<card_number>	numeric	1 - 99	1

Comments

- Return value of "0" indicates that the Multiplexer's interrupt is disabled. Return values of 1-7 correspond to VXI backplane interrupt lines 1 through 7.
- When power-on or reset the module, the default interrupt line is 1.

Example

Query the Multiplexer's interrupt line.

```
DIAG:INT:LINE  1, 6         Set the interrupt line equal to 6.
DIAG:INT:LINE?              Query the Multiplexer's interrupt line.
```


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DIAGnostic:INTerrupt:TIMer

DIAGnostic:INTerrupt:TIMer <*card_number*>, <*time*> sets the multiplexer interrupt timer. The <*card_number*> parameter specifies which module to set.

Parameters

Name	Type	Range of Values	Default
<*card_number*>	numeric	1-99	1
<*time*>	numeric	0.002 - 0.064 (0.002, 0.005, 0.008 or 0.064)	0.005 seconds

Comments

- The time specified in the command will be rounded to 0.002, 0.005, 0.008 or 0.064 seconds.

Note Setting the interrupt time too small can cause system problems.

- The module's interrupt timer will be set to the specified value. This is the amount of time the module will wait after a relay close or open command is given before sending an interrupt and clearing the "busy" bit.
- *RST does not change the selected time.

Example

Delay the interrupt signal 8 mS after a relay is opened or closed.

```
DIAG:INT:TIM  2,0.008
```

Interrupt timer on card number 2 is set for 8 mS . Interrupt signal is delayed 8 mS after an open or close to allow for settling of relay contacts.

DIAGnostic:INTerrupt:TIMer?

DIAGnostic:INTerrupt:TIMer? <*card_number*> queries the specified multiplexer module and returns the interrupt delay time.

Example

Query the interrupt timer setting.

```
DIAG:INT:TIM?  2
```

Query the interrupt timer setting on card number 2.

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DIAGnostic:SCAN:DELay

DIAGnostic:SCAN:DELay <*card_number*>, *delay_time* sets the amount of extra time the module will wait between opening one channel and closing the next in a scan operation.specified multiplexer module and returns the interrupt delay time.

Parameters

Name	Type	Range of Values	Default
<*card_number*>	numeric	1-99	1
<delay_*time*>	numeric		0 seconds

Comments

-

Example

Set the scan delay time for scanning operations.

```
DIAG:SCAN:DEL  2,.005
```

5 mS scan delay setting on card number 2.

DIAGnostic:SCAN:DELay?

DIAGnostic:SCAN:DELay? <*card_number*> queries the specified multiplexer module and returns the delay time set between opening and closing during a scan.

Example

Query the scan delay time setting.

```
DIAG:SCAN:DELay?  2
```

Query the scan delay time setting on card number 2.

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The **DISPlay** subsystem monitors the channel state of a selected module (or card) in a switchbox. The DISPlay command subsystem only operates with a RS-232 terminal connected to the HP E1405/1406 command module's RS-232 port. These commands control the display on the terminal, and would in most cases be typed directly from the terminal keyboard. It is possible however, to send these commands over the HP-IB interface, and control the terminal's display. In this case, care must be taken that the instrument receiving the DISPlay command is the same one that is currently selected on the terminal; otherwise, the HP-IB command will have no visible affect.

Subsystem Syntax

```
DISPlay
    :MONitor
        :CARD <card_number> | AUTO
        :CARD?
        :STATe <mode>
        :STATe?
```

DISPlay:MONitor:CARD

DISPlay:MONitor:CARD <*card_number*> | AUTO selects the module in a switchbox to be monitored. NOTE: You must use DISP:MON:STAT ON to actually display the monitored module state to the RS-232 terminal.

Parameters

Name	Type	Range of Values	Default value
<*card_number*>	numeric	1 - 99	AUTO

Comments

- **Selecting a Specific Module to be Monitored:** Send the card number in a switchbox with the DISPlay:MONitor:CARD command.
- **Selecting the Present Module to be Monitored:** Use the DISPlay:MONitor:CARD AUTO command to select the last module addressed by a switching command ([ROUTe:]CLOSe, for example).
- ***RST Conditions:** DISPlay:MONitor:CARD AUTO

Example

Select Module #2 in a Switchbox for Monitoring

```
DISP:MON:CARD 2          Select module #2 in a switchbox
```

DISPlay:MONitor:CARD?

DISPlay:MONitor:CARD? queries the setting of the DISPlay:MONitor:CARD command and returns the module in a switchbox to be monitored.

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DISPlay:MONitor[:STATe]

DISPlay:MONitor[:STATe] <*mode*> turns the monitor mode ON or OFF. When monitor mode is on, the RS-232 terminal display presents an array of values indicating the open/close state of every switch on the module. This display is dynamically updated each time a switch is opened or closed.

Parameters

Name	Type	Range of Values	Default value
<*mode*>	boolean	ON | OFF | 1 | 0	OFF | 0

Comments

- Monitoring Switchbox Channels: DISPlay:MONitor:STATe ON or DISPlay:MONitor:STATe 1 turns the monitor mode ON to show the channel state of the selected module.

  DISPlay:MONitor:STATe OFF or DISPlay:MONitor:STATe 0 turns the channel monitor OFF.

- Typing in another command on the terminal will cause the DISPlay:MONitor[:STATe] to automatically be set to OFF (0). NOTE: Use of the OFF parameter is useful only if the command is issued across the HP-IB interface.

- Selecting the Module to be Monitored: Use the DISPlay:MONitor:CARD command to select the module.

- Monitor Mode on an HP E1405/E1406 Command Module Display: The display format for the HP E8462A 256-Channel Multiplexer is as follows:

WIRE1, WIRE1x2, WIRE1x4 and WIRE1x8 Displays

Closed channels are identified in each mux. A closed relay on each mux will be displayed for all 1-wire modes (WIRE1, WIRE1x2, WIRE1x4 and WIRE1x8). The indicator "---" will appear for a mux in which all relays are open. The mux display values are followed by three hexidecimal displays which show the values of the two Tree registers and the Analog Bus register. For example, assume FUNCtion is set to WIRE1x2, all channels of MUX 0 are open and channel 5 of MUX 1 is closed (this also closes tree relay T14 connecting channel 5 of MUX 1 to Terminal 8). The display would be:

"Mux 0: --- Mux 1: 005 T0: #H4000 T1: #H0000 An: #H0000"

where the hexidecimal value 4000 in the Tree bank 0 register indicates the T14 tree register is closed.

Modes other than WIRE1, WIRE1x2, WIRE1x4 and WIRE1x8

Closed channels are identified by displaying the Bank register values in hexidecimal format with one value for each bank. The WIRE3, WIRE4, WIRE4x2 and WIRE4x4 modes will show only banks 0, 1, 4 and 5 because the other banks are paired with these banks to configure 3- or 4-wire channels. The bank values are followed by

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three hexidecimal displays which show the values of the two Tree registers and the Analog Bus register. For example, assume FUNCtion is set to WIRE4 and channel 35 is closed (this also closes tree relays T4 and T11 connecting the 4-wire channel 35 to Terminals 0, 1, 4 and 5). The display would be:

"B0: #H0000 B1: #H0000 B4: #H0008 B5: #H0000 T0: #H0810 T1: #H0000 An: #H0000"

where the hexidecimal value 0008 for B4 indicates channel 3 in bank 4 is closed (channel 3 in bank 6 is paired with this channel and is also closed). The hexidecimal value 0810 for T0 (the Tree bank 0 register) indicates the T4 and T11 tree relays are closed connecting channel 3 of bank 4 to Terminal lines 0 and 1 and channel 3 of bank 6 to Terminal lines 4 and 5.

Example Enabling the Monitor Mode

```
DISP:MON:CARD  2          Select module #2 in a switchbox
DISP:MON  1               Turn the monitor mode on
```

DISPlay:MONitor[:STATe]?

DISPlay:MONitor[:STATe]? queries the monitor mode state to determine if it is set to ON or OFF.

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The INITiate command subsystem selects continuous scanning cycles and starts the scanning cycle.

Subsystem Syntax

```
INITiate
    :CONTinuous <mode>
    :CONTinuous?
    [:IMMediate]
```

INITiate:CONTinuous

INITiate:CONTinuous <*mode*> Enables or disables continuous scanning cycles.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Value
mode	boolean	0|1|OFF|ON	OFF|0

Comments

Continuous Scanning Operation: Continuous scanning is enabled with the INITiate:CONTinuous ON or INITiate:CONTinuous 1 command. Sending the INITiate:IMMediate command closes the first channel in the channel list. Each trigger from the source specified by the TRIGger:SOURce command advances the scan through the channel list. A trigger at the end of the channel list closes the first channel in the channel list and the scan cycle repeats.

Non-Continuous Scanning Operation: Non-continuous scanning is enabled with the INITiate:CONTinuous OFF or INITiate:CONTinuous 0 command. Sending the INITiate:IMMediate command closes the first channel in the channel list. Each trigger from the source specified by the TRIGger:SOURce command advances the scan through the channel list. At the end of the scanning cycle, the last channel in the channel list is closed and the scanning cycle stops.

Stopping Continuous Scan: See the ABORt command on page page 71.

Related Commands: ABORt, ARM:COUNt, TRIGger

***RST Condition:** INITiate:CONTinuous OFF | 0

Example

Enabling Continuous Scanning

This example enables continuous scanning of channels 30 through 37 of a switchbox. Since TRIGger:SOURce IMMediate (default) is set, the example uses an interface clear command (CLEAR 7) to stop the scan.

```
INIT:CONT ON                    Enable continuous scanning.
SCAN (@10030:10037)             Scan channels 30 to 37.
INIT                            Start scan, close channel 30.
  .
CLEAR 7                         Stop scan cycle.
```


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INITiate:CONTinuous?

INITiate:CONTinuous? Queries the scanning state. With continuous scanning enabled, the command returns "1" (ON). With continuous scanning disabled, the command returns "0" (OFF).

Example Query Continuous Scanning State

This example enables continuous scanning of a switchbox and queries the state. Since continuous scanning is enabled, INIT:CONT? returns "1".

```
INIT:CONT  ON          Enable continuous scanning.
INIT:CONT?             Query continuous scanning state.
```

INITiate[:IMMediate]

INITiate[:IMMediate] Starts the scanning process and closes the first channel in the channel list. Successive triggers from the source specified by the TRIGger:SOURce command advance the scan through the channel list.

Comments

Starting the Scanning Cycle: The INITiate:IMMediate command starts scanning by closing the first channel in the channel list. Each trigger received advances the scan to the next channel in the channel list. An invalid channel list definition causes an error (see [ROUTe:]SCAN on page 96).

Stopping Scanning Cycles: See the ABORt command on page page 71.

Example Enabling a Single Scan

This example enables a single scan of channels 50 through 57 of a single-module switchbox. The trigger source to advance the scan is immediate (internal) triggering set with TRIGger:SOURce IMMediate (default).

```
SCAN  (@150:157)       Scan channels 50 to 57.
INIT                   Begin scan, close channel 50 (use
                       immediate triggering).
```


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The OUTPut command subsystem selects the source of the output trigger generated when a channel is closed during a scan. The selected output can be enabled, disabled, and queried. The three available outputs are the ECLTrg, TTLTrg trigger buses as well as the command module's (HP E1406A) front panel "Trig Out" port.

Subsystem Syntax

```
OUTPut
    :ECLTrgn (:ECLTrg0 or :ECLTrg1)
        [:STATe] <mode>
        [:STATe]?
    [:EXTernal]
        [:STATe] <mode>
        [:STATe]?
    :TTLTrgn (:TTLTrg0 through :TTLTrg7)
        [:STATe] <mode>
        [:STATe]?
```

OUTPut:ECLTrg*n*[:STATe]

OUTPut:ECLTrg*n*[:STATe] *<mode>* Selects and enables which ECL Trigger bus line (0 or 1) will output a trigger when a channel is closed during a scan. This is also used to disable a selected ECL Trigger bus line. "*n*" specifies the ECL Trigger bus line (0 or 1) and "*mode*" enables (ON or 1) or disables (OFF or 0) the specified ECLTrg bus line.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Value
n	numeric	0 or 1	N/A
mode	boolean	0|1|OFF|ON	OFF|0

Comments

Enabling ECL Trigger Bus: When enabled, a pulse is output from the selected ECL Trigger bus line (0 or 1) after each channel is closed during a scan. If disabled, a pulse is not output. The output is a negative-going pulse.

ECL Trigger Bus Line Shared by Switchboxes: Only one switchbox configuration can use the selected trigger at a time. When enabled, the selected ECL Trigger bus line (0 or 1) is pulsed by the switchbox each time a scanned channel is closed. To disable the output for a specific switchbox, send the OUTPut:ECLTrg*n* *OFF or 0* command for that switchbox.

One Output Selected at a Time: Only one output (ECLTrg0 or 1; TTLTrg0, 1, 2, 3, 4, 5, 6, or 7; or EXTernal) can be enabled at one time. Enabling a different output source will automatically disable the active output. For example, if TTLTrg1 is the active output, and TTLTrg4 is enabled, TTLTrg1 will become disabled and TTLTrg4 will become the active output.

Related Commands: [ROUTe:]SCAN, TRIGger:SOURce, OUTPut:ECLTrg*n*[:STATe]*?*

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***RST Condition:** OUTPut:ECLTrg*n*[:STATe] *OFF* (disabled)

Example Enabling ECL Trigger Bus Line 0

```
OUTP:ECLT0:STAT 1          Enable ECL Trigger bus line 0 to output
                           pulse after each scanned channel is
                           closed.
```

OUTPut:ECLTrg*n*[:STATe]?

OUTPut:ECLTrg*n*[:STATe]*?* Queries the present state of the specified ECL Trigger bus line. The command returns "1" if the specified bus line is enabled or "0" if the specified bus line is disabled.

Example Query ECL Trigger Bus Enable State

This example enables ECL Trigger bus line 0 and queries the enable state. The OUTPut:ECLTrg*n?* command returns "1" since the port is enabled.

```
OUTP:ECLT0:STAT 1          Enable ECL Trigger bus line 0.
OUTP:ECLT0?                Query bus enable state.
```

OUTPut[:EXTernal][:STATe]

OUTPut[:EXTernal][:STATe] <*mode*> Enables or disables the "Trig Out" port on the HP E1406A Command Module to output a trigger when a channel is closed during a scan. ON|1 enables the port and OFF|0 disables the port.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Value
mode	boolean	0|1|OFF|ON	OFF|0

Comments

Enabling "Trig Out" Port: When enabled, a pulse is output from the "Trig Out" port after each scanned switchbox channel is closed. If disabled, a pulse is not output from the port after channel closures. The output is a negative-going pulse.

"Trig Out" Port Shared by Switchboxes: Only one switchbox configuration can use the selected trigger at a time. When enabled, the "Trig Out" port is pulsed by the switchbox each time a scanned channel is closed. To disable the output for a specific switchbox, send the OUTP OFF or 0 command for that switchbox.

One Output Selected at a Time: Only one output (ECLTrg0 or 1; TTLTrg0, 1, 2, 3, 4, 5, 6, or 7; or EXTernal) can be enabled at one time. Enabling a different output source will automatically disable the active output. For example, if TTLTrg1 is the active output and TTLTrg4 is enabled, TTLTrg1 will become disabled and TTLTrg4 will become the active output.

Related Commands: [ROUTe:]SCAN, TRIGger:SOURce, OUTPut[:EXTernal][:STATe]?

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***RST Condition:** OUTPut[:EXTernal][:STATe] OFF (disabled)

Example **Enabling "Trig Out" Port**

```
OUTP:EXT 1                    Enable "Trig Out" port to output pulse
                              after each scanned channel is closed.
```

OUTPut[:EXTernal][:STATe]?

OUTPut[:EXTernal][:STATe]? Queries the present state of the "Trig Out" port. The command returns "1" if the port is enabled or "0" if disabled.

Example **Query "Trig Out" Port Enable State**

This example enables the "Trig Out" port and queries the enable state. The OUTPut? command returns "1" since the port is enabled.

```
OUTP:EXT ON                   Enable "Trig Out" port.
OUTP:EXT?                     Query port enable state.
```

OUTPut:TTLTrg*n*[:STATe]

OUTPut:TTLTrg*n*[:STATe] <*mode*> Selects and enables which TTL Trigger bus line (0 to 7) will output a trigger when a channel is closed during a scan. This is also used to disable a selected TTL Trigger bus line. "*n*" specifies the TTL Trigger bus line (0 to 7) and "*mode*" enables (ON or 1) or disables (OFF or 0) the specified TTL Trigger bus line.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Value
n	numeric	0 to 7	N/A
mode	boolean	0 | 1 | OFF | ON	OFF|0

Comments

Enabling TTL Trigger Bus: When enabled, a pulse is output from the selected TTL Trigger bus line (0 to 7) after each channel in the switchbox is closed during a scan. If disabled, a pulse is not output. The output is a negative-going pulse.

TTL Trigger Bus Line Shared by Switchboxes: Only one switchbox configuration can use the selected TTL Trigger at a time. When enabled, the selected TTL Trigger bus line (0 to 7) is pulsed by the switchbox each time a scanned channel is closed. To disable the output for a specific switchbox, send the OUTPut:TTLTrgn OFF or 0 command for that switchbox.

One Output Selected at a Time: Only one output (ECLTrg0 or 1; TTLTrg0, 1, 2, 3, 4, 5, 6, or 7; or EXTernal) can be enabled at one time. Enabling a different output source will automatically disable the active output. For example, if TTLTrg1 is the active output and TTLTrg4 is enabled, TTLTrg1 will become disabled and TTLTrg4 will become the active output.

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Related Commands: [ROUTe:]SCAN, TRIGger:SOURce, OUTPut:TTLTrg*n*[:STATe]?

***RST Condition:** OUTPut:TTLTrg*n*[:STATe] OFF (disabled)

Example Enabling TTL Trigger Bus Line 7

```
OUTP:TTLT7:STAT 1
```

Enable TTL Trigger bus line 7 to output pulse after each scanned channel is closed.

OUTPut:TTLTrg*n*[:STATe]?

OUTPut:TTLTrg*n*[:STATe]*?* Queries the present state of the specified TTL Trigger bus line. The command returns "1" if the specified TTLTrg bus line is enabled or "0" if disabled.

Example Query TTL Trigger Bus Enable State

This example enables TTL Trigger bus line 7 and queries the enable state. The OUTPut:TTLTrg*n?* command returns "1" since the port is enabled.

```
OUTP:TTLT7:STAT 1
OUTP:TTLT7?
```

Enable TTL Trigger bus line 7.
Query bus enable state.

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The [ROUTe:] command subsystem controls switching and scanning operations for multiplexer modules in a switchbox.

Note This command opens all previously closed relays, therefore, it should be the first relay configuration command.

Subsystem Syntax

```
[ROUTe:]
    CLOSe <channel_list>
    CLOSe? <channel_list>
    FUNCtion <card_number>, <function>
    FUNCtion? <card_number>
    OPEN <channel_list>
    OPEN? <channel_list>
    SCAN <channel_list>
        :MODE <mode>
        :MODE?
        :PORT <port>
        :PORT?
```

[ROUTe:]CLOSe

[ROUTe:]CLOSe <*channel_list*> Closes the multiplexer channels specified by *channel_list*. *Channel_list* has the form (@ccbnnn) where cc = card number (01-99), b = bank or MUX number (0 - one less than number of muxes), and nnn = channel number (0 - one less than number of switches per MUX).

Parameters

Parameter Name	Parameter Type	Mode	Range of Values
channel_list	numeric	WIRE1 WIRE2 WIRE3 WIRE4	cc0000 to cc0255 cc0000 to cc0127 cc0000 to cc0063 cc0000 to cc0063
		WIRE1X2	cc0000 to cc0127 cc1000 to cc1127
		WIRE2X2	cc0000 to cc0063 cc1000 to cc1063
		WIRE4X2	cc0000 to cc0031 cc1000 to cc1031
		WIRE1X4	cc0000 to cc0063 cc1000 to cc1063 cc2000 to cc2063 cc3000 to cc3063

table is continued on next page

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Parameter Name	Parameter Type	Mode	Range of Values
channel_list	numeric	WIRE2X4	cc0000 to cc0031 cc1000 to cc1031 cc2000 to cc2031 cc3000 to cc3031
		WIRE4X4	cc0000 to cc0015 cc1000 to cc1015 cc2000 to cc2015 cc3000 to cc3015
		WIRE1X8	cc0000 to cc0031 cc1000 to cc1031 cc2000 to cc2031 cc3000 to cc3031 cc4000 to cc4031 cc5000 to cc5031 cc6000 to cc6031 cc7000 to cc7031
		WIRE2X8	cc0000 to cc0015 cc1000 to cc1015 cc2000 to cc2015 cc3000 to cc3015 cc4000 to cc4015 cc5000 to cc5015 cc6000 to cc6015 cc7000 to cc7015
		NONE	cc0000 to cc0015 cc1000 to cc1015 cc2000 to cc2015 cc3000 to cc3015 cc4000 to cc4015 cc5000 to cc5015 cc6000 to cc6015 cc7000 to cc7015

Comments

The [ROUTe:]FUNCtion command is used to selct the mode for the HP E8462A module. The interpretation of the *channel_list* as to which relays will open or close depends upon the selected mode.

One-wire modes (WIRE1, WIRE1X2, WIRE1X4 and WIRE1X8):
The HP E8462A consists of double pole relays. To obtain 1-wire capability, a control relay is used to switch the connection from one set of common poles to the other. If you change the position of the control relay, a different channel from what you originally closed will be closed. Only one channel per MUX may be closed at any time in the 1-wire modes due to the need of the control relay to choose the appropriate “side” to connect to the common terminal.

Closing Channels:

To Close:	Use this command:
a single channel	ROUT:CLOS (@ccbnnn)
multiple channels	ROUT:CLOS (@ccbnnn,ccbnnn,...)
sequential channels	ROUT:CLOS (@ccbnnn:ccbnnn)
groups of sequential channels	ROUT:CLOS (@ccbnnn:ccbnnn, ccbnnn:ccbnnn)

- Any combination of the above channel lists is valid in one command.

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- Closure order for multiple channels with a single command is not guaranteed.

Note Channel numbers can be in the *channel_list* in any random order but when the sequential channel list is used (ccbnnn:ccbnnn), the second channel identifier must be greater than the first.

Closing the Control Relays: The control relays (9000 to 9021, 9100 to 9108) can be closed to perform special functions (for example, connecting channels to the analog bus). However, if the multiplexer has not been configured to the NONE mode with [ROUTe:]FUNCtion command, then doing a CLOSe or SCAN of any bank switch channel will automatically close the associated control relays. Closing other control relays may cause undesired results. Close:

9000 to 9021 to connect the associated bank of relays to the common terminals (Ter0 - Ter15). These are the T0 to T21 switches of Figure 1-1.

9100 to 9107 to connect the low side of the banks to the high terminal. These are the C100 to C107 form-C switches of Figure 1-1. These switches are used for making one-wire connections.

9108 to connect the low side of the banks to the high terminal when making one-wire measurements and the scan port is set to the analog bus. This switch is switch C108 in Figure 1-1.

9200 to 9204 to connect the banks to the analog bus. These switches are labeled AB200 - AB204 in Figure 1-1.
- **9200** connects analog H1 to switch C108 (9108).
- **9201** connects analog L1 to the low side of the channel connection.
- **9202** connects analog G to analog L1. This is needed to connect the Guard of an HP E1411 to the Low connection.
- **9203** connects analog H2 to the high side of the second pair of a four-wire connection or connects H2 to the high side of a two-wire conection through 9109 and 9102 for resistance measurements with meters that have a separate current source such as the HP E1411A.
- **9204** connects analog L1 to the low side of the second pair of a four-wire connection or connects L2 to the low side of a two-wire conection through 9109 and 9102 for resistance measurements with meters that have a separate current source such as the HP E1411A..

***OPC? Command:** Using the *OPC? command after the CLOSe command in your programs will ensure that the channel CLOSe command has executed prior to performing the next function (measure, read, and so on). This programming practice is highly recommended.

Related Commands: [ROUTe:]OPEN, CLOSe?, SCAN

***RST Condition:** All multiplexer channels are open.

Example Closing Multiplexer Channels

This example closes channel 0 in card 01, and channel 67 in card 02 of a two-module switchbox. Both modules are in two-wire mode.

```
CLOS (@1000,20067)          10000 closes channel 0 of card #1, and
```


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20067 closes channel 67 of card #2.

[ROUTe:]CLOSe?

[ROUTe:]CLOSe? <*channel_list*> Returns the current state of the channel(s) queried. *Channel_list* has the form (@ccbnnn) (see [ROUTe:]CLOSe for definition). The command returns "1" if channel(s) are closed or returns "0" if channel(s) are open.

Comments

Query is Firmware Readback: The ROUTe:CLOSe? command returns the current firmware state of the channel(s) specified. It does not account for relay hardware failures. A maximum of 128 channels at a time can be queried for any switchbox. To query all the channels in the WIRE1 mode requires at least two queries (e.g., 10000:10127 and 10128:10255).

Example

Query Channel Closure

This example closes channel 0 in card 01, and channel 67 in card 02 of a two-module switchbox and queries channel closure. Since the channels are programmed to be closed "1,1" is returned.

```
CLOS (@10000,20067)
```
10000 closes channel 0, card #1, and 20067 closes channel 67, card #2.

```
CLOS? (@10000,20067)
```
Query state of channel 0, card #1; and channel 67, card #2.

[ROUTe:]FUNCtion

[ROUTe:]FUNCtion <*card_number*>, <*function*> Selects the operating mode of the multiplexer channels. All channels on the card specified by *card_number* operate in the specified mode. **ROUTe: is NOT optional when ROUT:FUNC is used with a scanning multimeter configuration.**

Parameters

Parameter Name	Parameter Type	Range of Values	Default Value
card_number	numeric	01 to 99	N/A
function	discrete	WIRE1|WIRE2|WIRE3|WIRE4| WIRE1X2|WIRE2X2|WIRE4X2| WIRE1X4|WIRE2X4|WIRE4X4 WIRE1X8|WIRE2X8|NONE	WIRE2

Comments

Defaults to WIRE2 mode: This command is required if you want to set a configuration other than 2-wire.

ROUTe: is Not Always Optional: If used with a scanning multimeter configuration, ROUTe:FUNCtion must be used.

Using the FUNCtion Command: Using the FUNCtion command to reconfigure the multiplexer, the command must be sent **EACH TIME** the card is powered up.

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[ROUTe:]FUNC opens relays: Sending the ROUT:FUNC command will automatically open all relays on the card.

[ROUTe:]FUNC automatically closes tree relays: Sending the ROUT:FUNC command will cause all appropriate control relays to be automatically closed or opened during subsequent CLOSe, OPEN or SCAN operations. The user does not have to manually set the control relays.

[ROUTe:]FUNC command required before CLOSe or OPEN: The ROUT:FUNC command is required before the CLOSe or OPEN commands because the FUNCtion command defines which tree relays are required for a channel closure or opening.

One-Wire Modes (WIRE1, WIRE1X2, WIRE1X4 and WIRE1X8):
One-wire by 1 MUX, 2 MUXs, 4 MUXs or 8 MUXs. The HP E8462A uses double-pole relays and a control relay is used to obtain one-wire capability. A different channel will appear if you change the position of the control relay. Only one channel per MUX can be closed at any time in the WIRE1 modes due to the need of the control relay to choose the "side" for connection to the common terminal. For example, in the WIRE1 mode (one 1X256), the control relay chooses either Ter0 or Ter1 for connection to the one-wire common terminal (Ter0). Do not make any field connection to the odd numbered common terminals (e.g., Ter1, 3, 5, 7, 9, 11, 13 or 15) because these connectors do get routed to the channels by the control relay.

Two-Wire Modes (WIRE2, WIRE2X2, WIRE2X4 and WIRE2X8):
Two-wire by 1 MUX, 2 MUXs, 4 MUXs or 8 MUXs. A pair of wires is connected to the common terminal pair by closing a double-pole relay. A single channel closure will connect both wires.

Three-Wire Modes (WIRE3):
The three-wire mode is identical to WIRE4, except that SCAN:MODE FRES is not available and Analog H2 is not connected during SCAN operations.

Four-Wire Modes (WIRE4, WIRE4X2, WIRE4X4):
Four-wire by 1 MUX, 2 MUXs, or 4 MUXs. This mode pairs relay banks to provide four wires at the common terminals. You only need to list a single channel number in OPEN, CLOSE or SCAN channel lists to affect all four wires.

User-Defined Mode (NONE):
The user has complete control of all channels AND tree and control relays in this mode. The user is responsible for closing the appropriate tree relays and control relays to make connections to the common terminals (Ter0 - Ter15). This mode allows the user to configure the module with a mixture of 1-wire, 2-wire and 4-wire MUXs. The channel list is of the form ccb0cc, where cc is the card number (1-99), b is the bank number (0-7) and cc is the relay number within the bank (0-15). You must close both relays if you are trying to create 4-wire configurations in this mode. You must also send commands to control the control relays C100 - C107 if you are trying to create 1-wire configurations. SCAN operations with anything but a 2-wire configuration are not possible in this mode because the HP E8462A would not know which relays to pair or which Cx control relay to close for a user-defined 4-wire or 1-wire configuration.

Related Commands: [ROUTe:]OPEN, [ROUTe:]CLOSe, [ROUTe:]SCAN

***RST:** *RST does not change the selected mode.

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Example Configuring Multiplexer Mode

This example configures card 01 of a single-module switchbox to four-wire mode.

```
FUNC 1,WIRE4          Configures card #1 to four-wire mode.
```

[ROUTe:]FUNCtion?

[ROUTe:]FUNCtion? <*card_number*> Returns the current operating mode of the card(s) queried. See the [ROUTe:]FUNCtion command for *card_number* definition. The command returns the "Mode" which defines the MUXs as shown below:

Function Mode	MUX(s)
WIRE1	one 256 X 1-wire MUX
WIRE2	one 128 X 2-wire MUX
WIRE3	one 64 X 3-wire MUX
WIRE4	one 64 X 4-wire MUX
WIRE1X2	two 128 X 1-wire MUXs
WIRE2X2	two 64 X 2-wire MUXs
WIRE4X2	two 32 X 4-wire MUXs
WIRE1X4	four 64 X 1-wire MUXs
WIRE2X4	four 32 X 2-wire MUXs
WIRE4X4	four 16 X 4-wire MUXs
WIRE1X8	eight 32 X 1-wire MUXs
WIRE2X8	eight 16 X 2-wire MUXs
NONE	user configured

Example **Query Operating Mode**

This example sets card #1 in a single-module switchbox to one-wire mode and queries the operating state. Since the one-wire mode is selected, "WIRE1" is returned.

```
FUNC  1,WIRE1         Configures card #1 to one-wire mode.
FUNC?  1              Query mode of card #1.
```

[ROUTe:]OPEN

[ROUTe:]OPEN <*channel_list*> Opens the multiplexer channels specified by *channel_list*. *Channel_list* has the form (@ccbnnn) where cc = card number (01 - 99), b = bank or MUX number (0 to one less than number of MUXs), and nnn = channel number (0 to one less than the number of switches per MUX).

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Parameters

Parameter Name	Parameter Type	Mode	Range of Values
channel_list	numeric	WIRE1 WIRE2 WIRE3 WIRE4	cc0000 to cc0255 cc0000 to cc0127 cc0000 to cc0063 cc0000 to cc0063
		WIRE1X2	cc0000 to cc0127 cc1000 to cc1127
		WIRE2X2	cc0000 to cc0063 cc1000 to cc1063
		WIRE4X2	cc0000 to cc0031 cc1000 to cc1031
		WIRE1X4	cc0000 to cc0063 cc1000 to cc1063 cc2000 to cc2063 cc3000 to cc3063
channel_list	numeric	WIRE2X4	cc0000 to cc0031 cc1000 to cc1031 cc2000 to cc2031 cc3000 to cc3031
		WIRE4X4	cc0000 to cc0015 cc1000 to cc1015 cc2000 to cc2015 cc3000 to cc3015
		WIRE1X8	cc0000 to cc0031 cc1000 to cc1031 cc2000 to cc2031 cc3000 to cc3031 cc4000 to cc4031 cc5000 to cc5031 cc6000 to cc6031 cc7000 to cc7031
		WIRE2X8	cc0000 to cc0015 cc1000 to cc1015 cc2000 to cc2015 cc3000 to cc3015 cc4000 to cc4015 cc5000 to cc5015 cc6000 to cc6015 cc7000 to cc7015
		NONE	cc0000 to cc0015 cc1000 to cc1015 cc2000 to cc2015 cc3000 to cc3015 cc4000 to cc4015 cc5000 to cc5015 cc6000 to cc6015 cc7000 to cc7015

Comments

Select MODE with [ROUTe:]FUNCtion command. The ROUT:FUNC command is used to select the mode for the HP E8462A module. The interpretation of the channel_list as to which relays will open or close depends upon the selected mode.

One-Wire Modes (WIRE1, WIRE1X2, WIRE1X4 and WIRE1X8): One-wire by 1 MUX, 2 MUXs, 4 MUXs or 8 MUXs. The HP E8462A uses double-pole relays and a control relay is used to obtain one-wire capability. A different channel will appear if you change the position of the control relay. Only

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one channel per MUX can be closed at any time in the WIRE1 modes due to the need of the control relay to choose the "side" for connection to the common terminal. For example, in the WIRE1 mode (one 1X256), the control relay chooses either Ter0 or Ter1 for connection to the one-wire common terminal (Ter0). You should not make any field connection to the odd numbered common terminals (e.g., Ter1, 3, 5, 7, 9, 11, 13 or 15) because these connectors do get routed to the channels by the control relay.

Channel numbers 0 to 99 in MUX 0: Channel numbers from 0 to 99 in MUX 0 can be referred to by ccnn. The long-hand version would be ccbnnn. For MUX 0, b = 0 and the first n = 0 for channels 0 to 99. The leading zeros in the bnnn specification can be deleted in pairs to shorten the channel specification.

Opening Channels:

To Open:	Use this command:
a single channel	[ROUT:]OPEN (@ccbnnn)
multiple channels	[ROUT:]OPEN (@ccbnnn,ccbnnn,...)
sequential channels	[ROUT:]OPEN (@ccbnnn:ccbnnn)
groups of sequential channels	[ROUT:]OPEN (@ccbnnn:ccbnnn, ccbnnn:ccbnnn)

- Any combination of the above channel lists is valid in one command.
- Opening order for multiple channels with a single command is not guaranteed.

Note Channel numbers can be in the *channel_list* in any random order but if the sequential channel list is used (ccbnnn:ccbnnn), the second channel listed must be greater than the first channel specified.

Opening the Control Relays: The control relays (9000 to 9021, 9100 to 9108, 9200 to 9204) can be opened to perform special functions (for example, isolating channels from the analog bus). However, if the multiplexer has not been configured to the NONE mode with [ROUTe:]FUNCtion command, then doing a CLOSe or SCAN of any bank switch channel will automatically close the associated control relays. Open:

9000 to 9021 to disconnect the associated bank of relays from the common terminals (Ter0 - Ter15). These are the T0 to T21 switches of Figure 1-1.

9100 to 9107 to disconnect the low side of the banks from the high terminal. These are the C100 to C107 form-C switches of Figure 1-1. These switches are used for making one-wire connections.

9108 to disconnect the low side of the banks from the high terminal when making one-wire measurements and the scan port is set to the analog bus. This switch is switch C108 in Figure 1-1.

9200 to 9204 to disconnect the banks from the analog bus. These switches are labeled AB200 - AB204 in Figure 1-1.

- **9200** disconnects analog H1 from switch C108 (9108).

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- **9201** disconnects analog L1 from the low side of the channel connection.
- **9202** disconnects analog G from analog L1. This is needed to disconnect the Guard of an HP E1411 from the Low connection.
- **9203** disconnects analog H2 from the high side of the second pair of a four-wire connection.
- **9204** disconnects analog L1 from the low side of the second pair of a four-wire connection.

***OPC? Command:** Using the *OPC? command after the OPEN command in your programs will ensure that the channel OPEN command has executed prior to performing the next function (measure, read, and so on). This programming practice is highly recommended.

Related Commands: [ROUTe:]CLOSe, [ROUTe:]OPEN?, [ROUTe:]SCAN

***RST Condition:** All multiplexer channels are open.

Example — Opening Multiplexer Channels

This example opens channel 0 in card #1; and channel 67 in card #2 of a two-module switchbox. Both modules are in two-wire mode.

```
OPEN (@100,267)
```

100 opens channel 0 of card #1, and 267 opens channel 67 of card #2.

[ROUTe:]OPEN?

[ROUTe:]OPEN? <*channel_list*> Returns the current state of the channel(s) queried. *Channel_list* has the form (@ccbnnn) (see [ROUTe:]OPEN for definition). The command returns "1" if channel(s) are open or returns "0" if channel(s) are closed.

Comments

Query is Firmware Readback: The ROUTe:OPEN? command returns the current firmware state of the channel(s) specified. It does not account for relay hardware failures. A maximum of 128 channels at a time can be queried for any switchbox.

Three/Four-Wire Modes (WIRE3/WIRE4): When configured for three- or four-wire modes, the upper bank pair (4-7) channels cannot be queried. If an attempt is made to query the upper bank pair (4-7) channels, an error will be generated.

Example — Query Channel Open State

This example opens channel 0 in card #1; and channel 67 in card #2 of a two-module switchbox and queries the channels open state. Since the channels are programmed to be opened "1,1" is returned.

```
OPEN (@100,267)
```

100 opens channel 0 on card #1, and 267 opens channel 67 on card #2.

```
OPEN? (@100,267)
```

Query state of channel 0, card #1; and channel 67, card #2.

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[ROUTe:]SCAN <*channel_list*> Defines the channels to be scanned. *Channel_list* has the form (@ccbnnn) where cc = card number (01-99), b = bank number (0-7), and nnn = channel number (000-255).

Parameters

Parameter Name	Parameter Type	Mode	Range of Values
channel_list	numeric	WIRE1 WIRE2 WIRE3 WIRE4	cc0000 to cc0255 cc0000 to cc0127 cc0000 to cc0063 cc0000 to cc0063
		WIRE1X2	cc0000 to cc0127 cc1000 to cc1127
		WIRE2X2	cc0000 to cc0063 cc1000 to cc1063
		WIRE4X2	cc0000 to cc0031 cc1000 to cc1031
		WIRE1X4	cc0000 to cc0063 cc1000 to cc1063 cc2000 to cc2063 cc3000 to cc3063
channel_list	numeric	WIRE2X4	cc0000 to cc0031 cc1000 to cc1031 cc2000 to cc2031 cc3000 to cc3031
		WIRE4X4	cc0000 to cc0015 cc1000 to cc1015 cc2000 to cc2015 cc3000 to cc3015
		WIRE1X8	cc0000 to cc0031 cc1000 to cc1031 cc2000 to cc2031 cc3000 to cc3031 cc4000 to cc4031 cc5000 to cc5031 cc6000 to cc6031 cc7000 to cc7031
		WIRE2X8	cc0000 to cc0015 cc1000 to cc1015 cc2000 to cc2015 cc3000 to cc3015 cc4000 to cc4015 cc5000 to cc5015 cc6000 to cc6015 cc7000 to cc7015
		NONE	cc0000 to cc0015 cc1000 to cc1015 cc2000 to cc2015 cc3000 to cc3015 cc4000 to cc4015 cc5000 to cc5015 cc6000 to cc6015 cc7000 to cc7015

Comments

Defining Scan List: When ROUTe:SCAN is executed, the channel list is checked

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for valid card, and channel numbers. An error is generated for an invalid channel list.

64 Channel Limit: Individual channel numbers are limited to 64 due to the maximum length of command in the current driver.

Select MODE with [ROUTe:]FUNCtion command. The ROUT:FUNC command is used to select the mode for the HP E8462A module. The interpretation of the channel_list as to which relays will open or close depends upon the selected mode.

Control Relays: The SCAN command will automatically close and open the appropriate control relays to connect the desired channels to the common terminals.

Scanning Channels:

To Scan:	Use this command:
a single channel	SCAN (@ccbnnn)
multiple channels	[ROUT:]SCAN (@ccbnnn,ccbnnn,...)
sequential channels	[ROUT:]SCAN (@ccbnnn:ccbnnn)
groups of sequential channels	[ROUT:]SCAN (@ccbnnn:ccbnnn, ccbnnn:ccbnnn)

- Any combination of the above channel lists is valid in one command.

Note Channel numbers can be in the *channel_list* in any random order but if the sequential channel list is used (ccbnnn:ccbnnn), the second channel listed must be greater than the first channel specified.

Multiple Scanning Operations NOT Allowed: The SCAN command does not allow multiple scanning operations even when the module is configured to one of the multiple MUX modes (e.g., WIRE1X2, WIRE2X2, WIRE4X2, WIRE1X4, etc.). When the switchbox scans to the next channel, the previous channel will open regardless of which MUX it is in. However, you can close channels in one MUX and they will remain closed while you are scanning in another MUX.

Scanning Operation: INITiate[:IMMediate] begins the scan of a valid channel list and closes the first channel in the *channel_list*. Successive triggers from the source, specified by TRIGger:SOURce, advance the scan through *channel_list*.

Stopping Scan: See the ABORt command.

Related Commands: OUTPut, TRIGger

***RST Condition:** All channels open.

Example

Scanning Using External Device

See “Scanning Channels” in Chapter 2 for examples of scanning programs using external instruments.

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[ROUTe:]SCAN:MODE

[ROUTe:]SCAN:MODE <*mode*> Sets the multiplexer channels defined by the [ROUTe:]SCAN <*channel_list*> command for none, volts, two-wire ohms, or four-wire ohms measurements.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Value
mode	discrete	NONE|VOLT|RES|FRES	NONE

Comments

Order of Command Execution: The [ROUTe:]SCAN:MODE and [ROUTe:]FUNCtion commands must be executed before the [ROUTe:]SCAN <*channel_list*> command.

RES Mode versus 4-wire: When [ROUTe:]FUNC is WIRE4, WIRE4X2 OR WIRE4X4, RES Mode will operate the same as FRES.

NONE and VOLT Mode: When selected, *channel_list* is setup for volts measurements. VOLT mode is also used when making two-wire ohms measurements using two-wire multimeters.

RES Mode in WIRE2: When selected, *channel_list* is setup for two-wire ohms measurements. Control relays 9002 and 9009 are closed to connect Terminal 4 (Ter4) to Terminal 0 (Ter0) and Terminal 5 (Ter5) to Terminal 1 (Ter1). Ter4 and Ter5 could be used to connect to the Ohmmeter's current source. When SCAN:PORT ABUS is selected, control relays 9203 and 9204 are also closed to connect Analog H2 and Analog L2 which are the Analog Bus connections to the Ohmmeter's current source. When selected, the multimeter SENSE/SOURCE leads are used to make the measurement. When using the HI/LO leads on a multimeter to make the measurement, use the VOLT mode.

FRES Mode: When selected, *channel_list* is setup for four-wire ohms measurements. This mode is supported by the WIRE4, WIRE4X2 and WIRE4X4 FUNCtions. All channels of WIRE4 may be routed to the Analog Bus, but only the lowest bank of WIRE4X2 and WIRE4X4 may be routed to the Analog Bus.

***RST Condition:** [ROUTe:]SCAN:MODE NONE

Example

Selecting the Four-Wire Ohms Measurement

This example selects the four-wire ohms measurement mode (FRES) on card #1 of a single-module switchbox.

```
FUNC 1,WIRE4          Set mode to four-wire.
TRIG:SOUR EXT         Selects external trigger source.
SCAN:MODE FRES        Selects four-wire Ω scan mode.
SCAN (@130:137)       Scan channels 30 to 37.
INIT                  Starts scanning cycle.
```


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[ROUTe:]SCAN:MODE?

[ROUTe:]SCAN:MODE? Returns the current state of the scan mode. The command returns NONE, VOLT, RES, or FRES if the scan mode is in the none, volts, two-wire ohms, or four-wire ohms measurement mode, respectively.

Example

Query the Scanning Mode

This example selects the four-wire ohms measurement mode (FRES) on card #1 of a single-module switchbox, then queries the measurement state. Because four-wire ohms mode is selected, the query command returns "FRES".

```
SCAN:MODE  FRES          Selects the four-wire ohms scanning mode.
SCAN:MODE?               Query the scanning mode.
```

[ROUTe:]SCAN:PORT

[ROUTe:]SCAN:PORT *<port>* Enables or disables the closing of the analog bus connection control relays 9200 through 9204 during scanning. SCAN:PORT ABUS closes the appropriate control relay for analog bus connections. The ROUTe:SCAN:PORT NONE command prevents closing the control relays.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Value
port	discrete	ABUS|NONE	NONE

Comments

Order of Command Execution: Measurement modes are selected by the [ROUTe:]FUNCtion and [ROUTe:]SCAN:MODE commands. Then followed by the [ROUTe:]SCAN:PORT and [ROUTe:]SCAN <*channel_list*> commands.

Analog Bus Connection: The SCAN:PORT ABUS command only connects/disconnects the analog bus during scans. To connect/ disconnect the analog bus when not scanning channels, it is necessary to switch the appropriate control relays (9200 through 9204). Refer to [ROUTe:]CLOSe or [ROUTe:]OPEN for more information.

[ROUTe:]SCAN:PORT versus [ROUTe:]FUNCtion: With FUNC set to WIRE1X2, WIRE1X4, WIRE1X8, WIRE2X2, WIRE2X4, WIRE2X8, WIRE4X2 or WIRE4X4, only the lowest MUX can be connected to the Analog Bus. FUNC NONE will not connect to the Analog Bus.

[ROUTe:]SCAN:PORT ABUS with 1-Wire Functions: With FUNC set to WIRE1, WIRE1X2, WIRE1X4 or WIRE1X8 and SCAN:PORT set to ABUS, analog bus relays 9200 and 9202 will close and control relays 9201, 9203 and 9204 will open. This connects Analog Low of the Multimeter to Analog Guard (Common) of the Multimeter and Analog Hi of Multimeter to the MUX switches. It also connects Analog Low of the mulitmeter to Ter2 to provide a connection to the user common ground.

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[ROUTe:]SCAN:PORT ABUS with 2-Wire Functions: With FUNC set to WIRE2, WIRE2X2, WIRE2X4 or WIRE2X8 and SCAN:PORT set to ABUS, control relays 9200 and 9201 are closed. In addition, if the SCAN:MODE is not RES, then control relays 9203 and 9204 are closed. If SCAN:MODE is not RES, then Analog Control Relay 9202 is closed. Analog Control Relays that are not listed as being closed will be opened.

[ROUTe:]SCAN:PORT ABUS with 3-Wire Functions: With FUNC set to WIRE3 and SCAN:PORT set to ABUS, control relays 9200, 9201 and 9204 are closed. Control relays 9202 and 9203 are opened.

[ROUTe:]SCAN:PORT ABUS with 4-Wire Functions: With FUNC set to WIRE4, WIRE4X2, or WIRE4X8 and SCAN:PORT set to ABUS, control relays 9200, 9201, and 9204 are closed. Control relay 9202 is opened. If SCAN:MODE is VOLT, then Analog Control Relay 9203 is opened; if the mode is not VOLT, 9203 is closed.

***RST Condition:** [ROUTe:]SCAN:PORT NONE

Example Selecting the Analog Bus Port

This example selects the four-wire ohms measurement mode (FRES) on card #1 of a single-module switchbox, then enables the analog bus connection. Control relays 9200, 9201, 9203 and 9204 will close, and 9202 will open.

```
FUNC 1,WIRE4              Set mode to four-wire.
TRIG:SOUR EXT             Selects external trigger source.
SCAN:MODE FRES            Selects the four-wire ohms mode.
SCAN:PORT ABUS            Selects the analog bus port.
SCAN (@130:137)           Scan channels 30-37.
INIT                      Start scanning cycle.
```

[ROUTe:]SCAN:PORT?

[ROUTe:]SCAN:PORT? Returns the current state of the analog bus port. The command returns NONE if the analog bus connection control relays are disabled or ABUS if the control relays are enabled.

Example Query the Scan Port

This example selects the analog bus port, then queries the state. Because the analog bus port is selected, the query command returns "ABUS".

```
SCAN:PORT ABUS            Selects the analog bus port.
SCAN:PORT?                Query the port selection.
```


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The STATus subsystem reports the bit values of the Operation Status Register. It also allows you to unmask the bits you want reported from the Standard Event Register and to read the summary bits from the Status Byte Register.

Subsystem Syntax

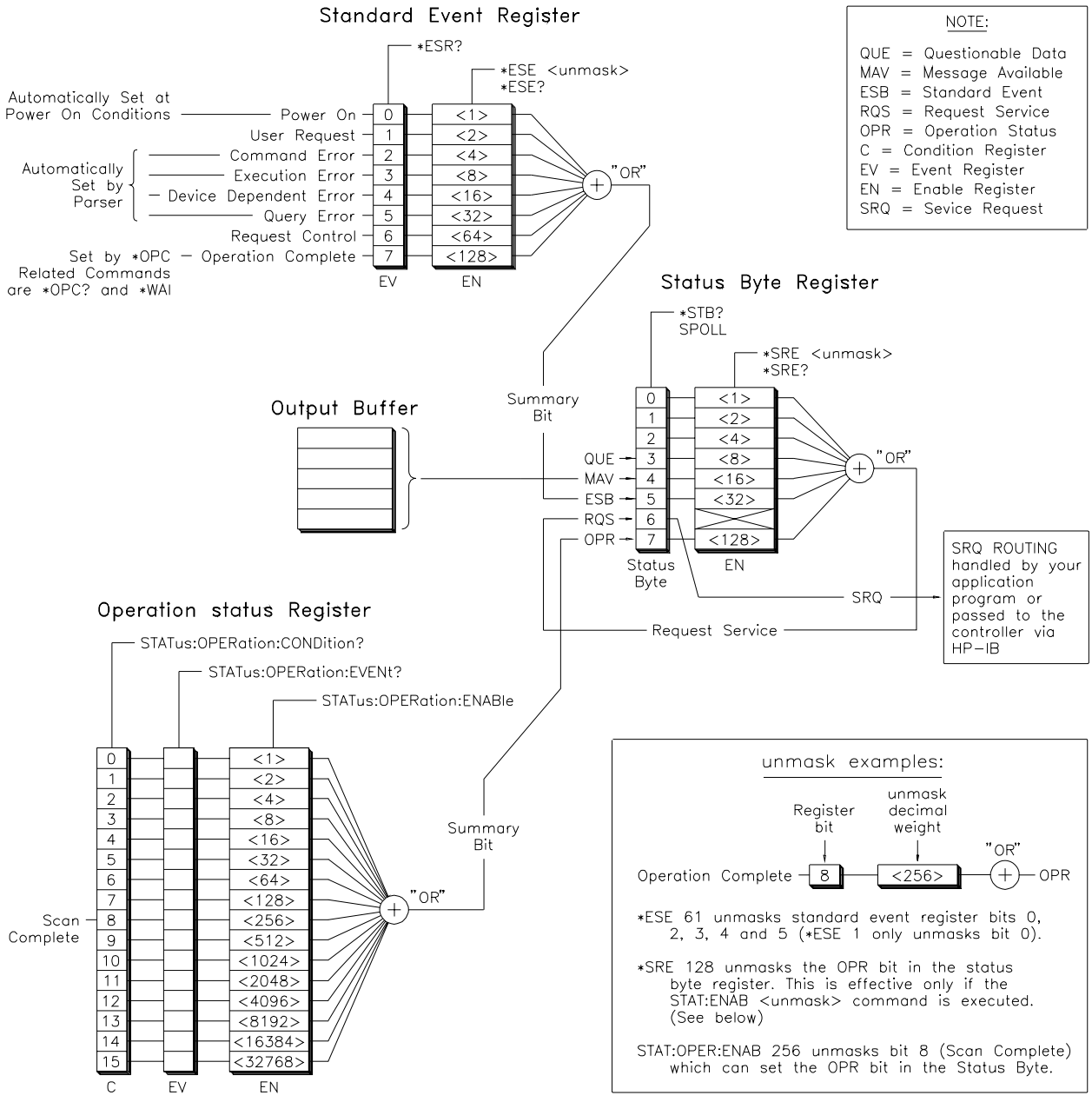
```
STATus
    :OPERation
        :CONDition?
        :ENABle <number>
        :ENABle?
        [:EVENt?]
    :PRESet
```

The STATus system contains four registers, two of which are under IEEE 488.2 control; the Standard Event Status Register (*ESE?) and the Status Byte Register (*STB?). The operational status bit (OPR), service request bit (RQS), standard event summary bit (ESB), message available bit (MAV) and questionable data bit (QUE) in the Status Byte Register (bits 7, 6, 5, 4 and 3 respectively) can be queried with the *STB? command. Use the *ESE? command to query the "*unmask*" value for the Standard Event Status Register (the bits you want logically OR'd into the summary bit). The registers are queried using decimal weighted bit values. The decimal equivalents for bits 0 through 15 are included in figure 3-1.

A numeric value of 256 executed in a STAT:OPER:ENABle <*number*> command allows only bit 8 to generate a summary bit. The decimal value for bit 8 is 256.

The decimal values are also used in the inverse manner to determine which bits are set from the total value returned by an EVENt or CONDition query. The "SWITCH" driver exploits only bit 8 of Operation Status Register. This bit is called the scan complete bit which is set whenever a scan operation completes. Since completion of a scan operation is an event in time, you will find that bit 8 will never appear set when STAT:OPER:COND? is queried. However, you can find bit 8 set with the STAT:OPER:EVEN? query command.

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STATus:OPERation:CONDition?

STATus:OPERation:CONDition? Returns the state of the Condition Register in the Operation Status Group. The state represents conditions which are part of the instrument's operation. The "SWITCH" driver does not set bit 8 in this register (see STATus:OPERation[:EVENt]? on page 103).

STATus:OPERation:ENABle

STATus:OPERation:ENABle *<number>* Sets an enable mask to allow events recorded in the Event Register to send a summary bit to the Status Byte Register (bit 7). For multiplexer modules, when bit 8 in the Operation Status Register is set to 1 and that bit is enabled by the STATus:OPERation:ENABle command, bit 7 in the Status Register is set to 1.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Value
number	numeric	1 through 65,535	N/A

Comments

Setting Bit 7 of the Status Register: STATus:OPERation:ENABle 256 sets bit 7 of the Status Register to 1 after bit 8 of the Operation Status Register is set to 1.

Related Commands: [ROUTe:]SCAN

Example

Enabling the Status Register

```
STAT:OPER:ENAB 256
```

Enables bit 8 of the Operation Status Register to be reported to bit 7 (OPR) in the Status Register.

STATus:OPERation:ENABle?

STATus:OPERation:ENABle? Returns which bits in the Event Register (Operation Status Group) are unmasked.

STATus:OPERation[:EVENt]?

STATus:OPERation[:EVENt]? Returns which bits in the Event Register (Operation Status Group) are set. The Event Register indicates when there has been a time-related instrument event.

Comments

Setting Bit 8 of the Operation Status Register: Bit 8 (scan complete) is set to 1 after a scanning cycle completes. Bit 8 returns to 0 (zero) after sending the STATus:OPERation[:EVENt]? command.

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Returned Data after sending the STATus:OPERation[:EVENt]? Command: The command returns "+256" if bit 8 of the Operation Status Register is set to 1. The command returns "+0" if bit 8 of the Operation Status Register is set to 0.

Event Register Cleared: Reading the Event Register with the STATus:OPERation:EVENt? command clears it.

Aborting a scan: Aborting a scan will leave bit 8 set to 0.

Related Commands: [ROUTe:]SCAN

Example

Reading the Operation Status Register After a Scanning Cycle

```
STAT:OPER                    Returns the bit values of the Standard
                             Operation Status Register.
read the register value      +256 shows bit 8 is set to 1;
                             +0 shows bit 8 is set to 0.
```

STATus:PRESet

STATus:PRESet Affects only the Enable Register by setting all Enable Register bits to 0. It does not affect either the "status byte" or the "standard event status". PRESet does not clear any of the Event Registers.

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The SYSTem subsystem returns the numbers and messages in the error queue of a switchbox, and returns the switchbox module descriptions.

Subsystem Syntax

```
SYSTem
    :CDEScription? <number>
    :CPON <number> | ALL
    :CTYPe? <number>
    :ERRor?
```

SYSTem:CDEScription?

SYSTem:CDEScription? *<number>* Returns the module description.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Value
number	numeric	1 through 99	N/A

Comments

Multiplexer Module Description: The SYSTem:CDEScription? command returns, depending on mode currently configured, the following HP E8462A descriptions:

FUNCtion	Mode	Description
NONE	User defined mode	“8 x 16 Channel GP Relay Mux”
WIRE1	One-wire mode	“256 Channel 1-Wire Relay Mux”
WIRE2	Two-wire mode	“128 Channel 2-Wire Relay Mux”
WIRE3	Three-wire mode	“64 Channel 3-Wire Relay Mux”
WIRE4	Four-wire mode	“64 Channel 4-Wire Relay Mux”
WIRE1X2	2 One-wire mode	“2 x 128 Channel 1-Wire Relay Mux”
WIRE2X2	2 Two-wire mode	“2 x 64 Channel 2-Wire Relay Mux”
WIRE4X2	2 Four-wire mode	“2 x 32 Channel 4-Wire Relay Mux”
WIRE1X4	4 One-wire mode	“4 x 64 Channel 1-Wire Relay Mux”
WIRE2X4	4 Two-wire mode	“4 x 32 Channel 2-Wire Relay Mux”
WIRE4X4	4 Four-wire mode	“4 x 16 Channel 4-Wire Relay Mux”
WIRE1X8	8 One-wire mode	“8 x 32 Channel 1-Wire Relay Mux”
WIRE2X8	8 Two-wire mode	“8 x 16 Channel 2-Wire Relay Mux”

Example

Reading the Description of a Card #1 Module

This example selects the one-wire mode, then queries the description.

```
FUNC 1,WIRE1                    Sets mode to one-wire.
```


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```
SYST:CDES?                          Return the description.
```

SYSTem:CPON

SYSTem:CPON <*number*> | ALL Sets the selected module (card) in a switchbox to its power-on state, with the exception of the mode, interrupt line and interrupt timer selected.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Value
number	numeric	1 through 99	N/A

Comments

Multiplexer Module Power-on State: The power-on state is all channels (relays) open. Note that SYSTem:CPON ALL and *RST opens all channels of all modules in a switchbox, while SYSTem:CPON <*number*> opens the channels in only the module (card) specified in the command. Current operating mode (as set by FUNCtion command) will not be affected by execution of the SYSTem:CPON <*number*> or *RST commands. In addition, these commands do not affect the DIAGnostic:INTerrupt or DIAGnostic:INTerrupt:TIMer commands.

Example

Setting Card #1 Module to its Power-on State

```
SYST:CPON 1                         Sets card #1 to power-on state.
```

SYSTem:CTYPe?

SYSTem:CTYPe? <*number*> Returns the module (card) type of a selected module in a switchbox.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Value
number	numeric	1 through 99	N/A

Comments

256-Channel Multiplexer Module Model Number: The SYSTem:CTYPe? <*number*> command returns:

HEWLETT-PACKARD,E8462A,0,A.09.00

where the 0 after E8462A is the module serial number (always 0) and A.09.00 is an example of the module revision code number.

Example

Reading the Model Number of a Card #1 Module

```
SYST:CTYP? 1                        Returns the model number.
```


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SYSTem:ERRor?

SYSTem:ERRor? Returns the error numbers and corresponding error messages in the error queue of a switchbox. See Appendix C for a listing of switchbox error numbers and messages.

Comments

Error Numbers/Messages in the Error Queue: Each error generated by a switchbox stores an error number and corresponding error message in the error queue. The error message can be up to 255 characters long.

Clearing the Error Queue: An error number/message is removed from the queue each time the SYSTem:ERRor? command is sent. The errors are cleared first-in, first-out. When the queue is empty, each following SYSTem:ERRor? command returns +0, "No error". To clear all error numbers/messages in the queue, execute the *CLS command.

Maximum Error Numbers/Messages in the Error Queue: The queue holds a maximum of 30 error numbers/messages for each switchbox. If the queue overflows, the last error number/message in the queue is replaced by -350, "Too many errors". The least recent error numbers/messages remain in the queue and the most recent are discarded.

***RST Condition:** *RST does not clear the error queue.

Example

Reading the Error Queue

```
SYST:ERR?
```

Query the error queue, read and print the numbers/message.

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The TEST command subsystem allows you to cycle through a particular self-test a specified number of times instead of running the entire suite of self-tests as is performed with the *TST? command.

Subsystem Syntax

```
TEST
    :NUMBer? <test_number>,<cycles>
```

TEST:NUMBer?

TEST:NUMBer? *<**test_number**>,<**cycles**>* is a query and returns the number of times the specified test failed out of the specified number of times the test was cycled. For example, send the command TEST:NUMB? 110,5 to cycle through test number "10" on card 1 ("110") five times. A "5" is returned if all five test cycles fail.

Parameters

Parameter Name	Parameter Type	Range of Values	Default Value
test_number	numeric	cc + 1 through 99	N/A
cycle	numeric	1 through 32767	N/A

Comments

- *test_number* values are of the form ccnn, where cc is the card number (1-99) and nn is the 2-digit test number. The values for nn are the same as the error codes given by the *TST? query and are summarized in the following table.

test_number	Description
cc03	This test reads the manufacturer code (0xFFFF) from the ID register and device type (0x026B) from the device type register.
cc10	This test writes a value to the bank 0 register and checks if an interrupt is generated within the expected time
cc11	This test writes a value to the bank 0 register and checks if the card's status register indicates "not busy" after the expected time.
cc14	This test reads the fuse register to check for open fuses. Use the DIAGnostic:FUSE? <card> query to determine which fuse is open.
cc15	This test reads the status/configuration register and other registers, writes to and reads from unused portions of the Analog Switch Register and checks if the register data are as expected.

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test_number	Description
cc99	This is a special test that scans through all relays. **DO NOT USE this test when the card has terminal block connections.** **NOTE:** The Multiplexer function must be set to the eight 1-wire MUX mode ([ROUTe:]FUNC cc,WIRE1X8 where cc is the card number) to test relays C100 through C108. Otherwise, these relays are not tested. This is a precaution taken that prevents shorting of field wiring if terminal block connections are inadvertently left connected. This test first opens all the relays, then closes one relay at a time. Register read-back is used to determine if all bits of all relay registers are independent. Then it restores the original relay pattern. This test is not performed during a *TST? self-test since the test disturbs the switch connections.

Example

Cycle through a self-test and return the number of times it failed.

```
TEST:NUMB? 110,5
```

Cycle through self-test 10 five times on card number 1 (test_number parameter is 110) and return the number of times the self-test fails.

Test all relays on the module.

```
SCAN:PORT ABUS
```

Set the module port to analog bus.

```
FUNC 2,WIRE1X8
```

Set module number 2 to the 1-wire by 8 MUX mode.

```
TEST:NUMB? 299,4
```

Cycle through self-test 99 four times on card number 2 (test_number parameter is 299) and return the number of times the self-test fails. This test operates all relays on the card.

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The TRIGger command subsystem controls the triggering operation of multiplexer modules in a switchbox.

Subsystem Syntax

```
TRIGger
    [:IMMediate]
    :SLOPe <slope>
    :SLOPe?
    :SOURce <source>
    :SOURce?
```

TRIGger[:IMMediate]

TRIGger[:IMMediate] Causes a trigger event to occur when the defined trigger source is TRIGger:SOURce BUS or TRIGger:SOURce HOLD.

Comments

Executing the TRIGger[:IMMediate] Command: First, the measurement modes must be selected using the [ROUTe:]FUNCtion and [ROUTe:]SCAN:MODE commands. Then [ROUTe:]SCAN:PORT is selected, followed by the [ROUTe:]SCAN <*channel_list*> command and an INITiate[:IMMediate] command. All must be executed (unless defaults are used) before TRIGger[:IMMediate] will execute.

BUS or HOLD Source: If selected, the TRIGger:SOURce BUS or TRIGger:SOURce HOLD commands remain in effect after triggering a switchbox with the TRIGger[:IMMediate] command.

Related Commands: INITiate, [ROUTe:]SCAN

Example

Advancing Scan Using TRIGger Command

This example uses the TRIGger command to advance the scan of a single-module switchbox from bank 0, channels 0 through 7. Since TRIGger:SOURce HOLD is set, the scan is advanced one channel each time TRIGger is executed. For the example, ROUTe:SCAN:MODE and ROUTe:SCAN:PORT default values of NONE are used.

```
TRIG:SOUR  HOLD          Sets trigger source to HOLD.
SCAN  (@100:107)         Scan channels 0 to 7
INIT                     Begin scan, close channel 00.
loop statement           Start count loop.
TRIG                     Advance scan to next channel.
increment loop           Increment loop count.
```

TRIGger:SLOPe

TRIGger:SLOPe <*slope*> Is used to select the polarity of the output trigger. For the HP E8462A, this command is not used.

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Parameters

Parameter Name	Parameter Type	Range of Values	Default Value
slope	discrete	NEG	NEG

Comments **Command Not Supported.** Attempting to change the TRIGger:SLOPe to anything other than NEG will generate an error.

TRIGger:SLOPe?

TRIGger:SLOPe? Is used to query the polarity of the output trigger. For the HP E8462A, this query always returns NEG.

Example **Query Trigger Slope**

TRIG:SLOP? *Always returns NEG.*

TRIGger:SOURce

TRIGger:SOURce <*source*> Specifies the trigger *source* to advance the channel list during scanning.

Parameters

Parameter Name	Parameter Type	Parameter Description	Default Value
BUS	discrete	*TRG or GET command	IMM
ECLTrg*n*	numeric	ECL Trigger bus line 0 or 1	IMM
EXTernal	discrete	"Trig In" port	IMM
HOLD	discrete	Hold Triggering	IMM
IMMediate	discrete	Immediate Triggering	IMM
TTLTrg*n*	numeric	TTL Trigger bus line 0 - 7	IMM

Comments **Enabling the Trigger Source:** The TRIGger:SOURce command only selects the trigger *source*. The INITiate[:IMMediate] command enables the trigger source.

Using the TRIGger Command: You can use TRIGger[:IMMediate] to advance the scan when TRIGger:SOURce BUS or TRIGger:SOURce HOLD is selected.

One Trigger Input Selected at a Time: Only one input (ECLTrg0 or 1; TTLTrg0, 1, 2, 3, 4, 5, 6, or 7; or EXTernal) can be selected at one time. Enabling a different trigger source will automatically disable the active input. For example, if TTLTrg1 is the active input, and TTLTrg4 is enabled, TTLTrg1 will become disabled and TTLTrg4 will become the active input.

Using External Trigger Inputs: With TRIGger:SOURce EXTernal selected, only one switchbox at a time can use the external trigger input at the HP E1406A "Trig In" port. The trigger input is assigned to the first switchbox that requested the

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external trigger source (with an TRIGger:SOURce EXTernal command).

Using TTL or ECL Trigger Bus Inputs:

With TRIGger:SOURce TTLTrg*n* or ECLTrg*n* selected, only one switchbox at a time can use the trigger bus selected on the HP E1406A Command Module bus. The trigger input is assigned to the first switchbox that requested the trigger source (with a TRIGger:SOURce TTLTrg*n* or ECLTrg*n* command). Only one of the ten available trigger bus lines (ECL0 to 1 or TTL0 to 7) can be specified at one time.

Assigning EXTernal|TTLTrg|ECLTrg Trigger Source: A switchbox assigned with TRIGger:SOURce EXT|TTLT|ECLT remains assigned to that source until the switchbox trigger source is changed to BUS, HOLD, or IMMediate. When the source is changed, the trigger source is available to the next switchbox that requests it (with a TRIGger:SOURce ECLT*n* command). If a switchbox requests a trigger already assigned to another switchbox, an error is generated.

Using Bus Triggers: To trigger the switchbox with TRIGger:SOURce BUS selected, use the IEEE 488.2 common command *TRG or the HP-IB Group Execute Trigger (GET) command.

"Trig Out" Port Shared by Switchboxes: See the OUTPut command on page 83.

Related Commands: ABORt, [ROUTe:]SCAN, OUTPut

***RST Condition:** TRIGger:SOURce IMMediate

Example Scanning Using External Triggers

This example uses external triggering (TRIG:SOUR EXT) to scan bank 0, channels 0 through 7 of a single-module switchbox. The trigger source to advance the scan is the input to the "Trig In" on an HP E1406A Command Module. When INIT is executed, the scan is started and bank 0, channel 0 is closed. Then each trigger received at the "Trig In" port advances the scan to the next channel. For the example, ROUTe:SCAN:MODE and ROUTe:SCAN:PORT default values of NONE are used.

```
TRIG:SOUR EXT          Select external triggering.
SCAN (@100:107)        Scan channels 0 to 7.
INIT                   Begin scan, close channel 0.
trigger externally     Advance scan to next channel.
```

Example Scanning Using Bus Triggers

This example uses bus triggering (TRIG:SOUR BUS) to scan bank 0, channels 0 through 7 of a single-module switchbox. The trigger source to advance the scan is the *TRG command (as set with TRIGger:SOURce BUS). When INIT is executed, the scan is started and channel 0 is closed. Then, each *TRG command advances the scan to the next channel. For the example, ROUTe:SCAN:MODE and ROUTe:SCAN:PORT default values of NONE are used.

```
TRIG:SOUR BUS          Trigger command will be via backplane
                       (bus) interface (*TRG command
                       generates trigger).
SCAN (@100:107)        Scan channels 0 to 7 in bank 0.
INIT                   Begin scan, close channel 0.
loop statement         Loop to scan all channels.
*TRG                   Advance scan using bus triggering.
```


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Increment loop — *Increment loop count.*

TRIGger:SOURce?

TRIGger:SOURce? Returns the current trigger source for the switchbox. Command returns BUS, ECLT, EXT, HOLD, IMM, or TTLT for sources BUS, ECLTrg*n*, EXTernal, HOLD, IMMediate, or TTLTrg*n*, respectively.

Example — Querying the Trigger Source

This example sets external triggering and queries the trigger source. Since external triggering is set, TRIG:SOUR? returns "EXT".

```
TRIG:SOUR  EXT        Set external trigger source.
TRIG:SOUR?            Query trigger source.
```


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The following table lists the IEEE 488.2 Common (*) Commands that apply to the HP E8462A module. The operation of some of these commands is described earlier in this manual. For more information on Common Commands, refer to the *HP E1406A Command Module User's Manual* or the ANSI/IEEE Standard 488.2-1987.

Table 3-2.

Command	Command Description
*CLS	Clears all status registers (see STATus:OPERation[:EVENt]?) and clears the error queue.
*ESE *<register value>*	Enable Standard Event.
*ESE?	Enable Standard Event Query.
*IDN?	Instrument ID Query; returns identification string of the module.
*OPC	Operation Complete.
*OPC?	Operation Complete Query.
*RCL *<numeric state>*	Recalls the instrument state saved by *SAV. You must reconfigure the scan list.
*RST	Resets the module. Opens all channels and invalidates current channel list for scanning. Sets ARM:COUN 1, TRIG:SOUR IMM, and INIT:CONT OFF, DIAG:SCAN:DEL 0.0.
*SAV *<numeric state>*	Stores the instrument state but does not save the scan list.
*SRE *<register value>*	Service request enable, enables status register bits.
*SRE?	Service request enable query.
*STB?	Read status byte query.
*TRG	Triggers the module to advance the scan when scan is enabled and trigger source is TRIGger:SOURce BUS.
*TST?	Self-test. Executes an internal self-test and returns only the first error encountered. Does not return multiple errors. The following is a list of responses you can obtain where "cc" is the card number with the leading zero deleted. +0 if self test passes. +cc01 for firmware error. +cc02 for bus error (problem communicating with the module). +cc03 for incorrect ID information read back from the module's ID register. +cc10 if an interrupt was expected but not received. +cc11 if the busy bit was not held for a sufficient amount of time. +cc14 if one of the four bank fuses is open. +cc15 if the data read from a register is different from the register's setting.
*WAI	Wait to Complete.

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Table 3-3. HP E8462A SCPI Command Quick Reference.

Command		Description
ABORt		Abort a scan in progress.
ARM	:COUNt <*number*> MIN|MAX :COUNT? [MIN|MAX]	Multiple scans per INIT command. Query number of scans.
DIAGnostic	:FUSE? <*card_number*> :INTerrpt[:LINE] <*card_number*>,<*line_number*> :INTerrpt[:LINE]? <*card_number*> :INTerrpt:TIMer <*card_number*>,<*time*> :INTerrupt:TIMer? <*card_number*> :SCAN:DELay <*card_number*>,<*time*> :SCAN:DELay? <*card_number*>	Query fuse continutity. Set interrupt line of multiplexer. Query interrupt line. Set wait time after an open or close before interrupt. Query interrupt time. Set additional scan delay time. Query scan delay time.
DISPlay	:MONitor:CARD <*card_number*> | AUTO :MONitor:CARD? :MONitor[:STATe] <*mode*> :MONitor[:STATe]?	Selects a switchbox module to be monitored. Queries the card monitor setting. Sets the monitor state. Quries the monitor state setting.
INITiate	:CONTinuous ON|OFF|1|0 :CONTinuous? [:IMMediate]	Enables/Disables continuous scanning. Query continuous scan state. Starts a scanning cycle.
OUTPut	:ECLTrg*n*[:STATe] ON|OFF|1|0 :ECLTrg*n*[:STATe]? [:EXTernal][:STATe] ON|OFF|1|0 [:EXTernal][:STATe]? :TTLTrg*n*[:STATe] ON|OFF|1|0 :TTLTrg*n*[:STATe]?	Enables/Disables ECL Trigger bus line pulse. Query ECL Trigger bus line state. Enables/Disables "Trig Out" pulse. Query port enable state. Enables/Disables TTL Trigger bus line pulse. Query TTL Trigger bus line state.
[ROUTe:]	CLOSe <*channel_list*> CLOSe? <*channel_list*> FUNCtion <*card_number*>,<*function*> FUNCtion? <*card_number*> OPEN <*channel_list*> OPEN? <*channel_list*> SCAN <*channel_list*> SCAN:MODE <*mode*> SCAN:MODE? SCAN:PORT <*port*> SCAN:PORT?	Close channel(s). Query channel(s) closed. Set operating mode. Query operating mode. Open channel(s). Query channel(s) opened. Define channels for scanning. Set scan mode. Query scan mode. Select Analog Bus. Query Analog Bus state.
STATus	:OPERation:CONDition? :OPERation:ENABle <*number*> :OPERation:ENABle? :OPERation[:EVENt]? :PRESet	Returns status of Condition register. Enables events in the Event register to be reported. Returns which bits in the Event register are unmasked. Returns which bits in the Event register are set. Sets Enable register bits to 0.
SYSTem	:CDEScription? <*number*> :CPON <*number*>|ALL :CTYPe? <*number*> :ERRor?	Returns description of module in switchbox. Sets specified module in a switchbox to power-on state. Returns the module type. Returns error number/message to error queue.
TRIGger	[:IMMediate] :SLOPe <*slope*> :SLOPe? :SOURce BUS :SOURce ECLTrgn :SOURce EXTernal :SOURce HOLD :SOURce IMMediate :SOURce TTLTrgn :SOURce?	Causes a trigger to occur. Select negative polarity of the output trigger. Query polarity of the output trigger. Trigger source is *TRG. Trigger source is ECL Trigger bus line 0 or 1. Trigger source is "Trig In" port. Hold off triggering. Continuous (internal) triggering. Trigger source is TTL Trigger bus line (0-7). Query current trigger source.

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Chapter 4
HP E8462A Scanning Voltmeter Application Examples

Using This Chapter

This chapter gives application information and examples for using the HP E8462A 256-Channel Relay Multiplexer to make measurements with the HP E1411 (or HP E1326 used with a C-size adapter installed in the C-size mainframe) 5½-Digit Multimeter in the scanning voltmeter configuration.

This chapter contains the following sections:

- Reset Conditions . . . . . Page 118
- The Scanning Voltmeter . . . . . Page 119
- Making Measurements . . . . . Page 120
- Scanning Voltmeter Command Quick Reference . . . . . Page 122

Note The multimeter must be the HP E1411 (or the E1326 used with a C-size adapter installed in the C-size mainframe). The device driver for these two multimeters controls HP switches in the scan mode. The scanning voltmeter configuration does not use the "SWITCH" switchbox device driver and therefore, you do not use the switchbox command reference in Chapter 3. Instead you use the "VOLTMTR" device driver and the HP E1411B multimeter command reference. The "VOLTMTR" device driver was provided with the E8462A multiplexer. See "Initial Operation" on page 33 for more information on the "SWITCH" and "VOLTMTR" drivers. The multimeter's command quick reference from the *HP E1326/E1411 5½-Digit Multimeter User's Manual* is provided at the end of this chapter for your convenience. Refer to your multimeter manual for detailed descriptions of the commands.

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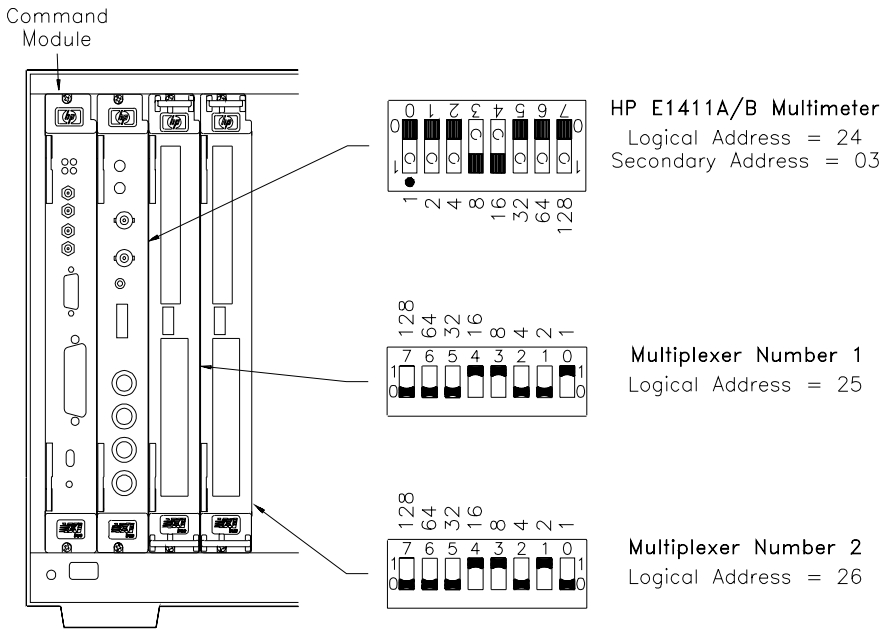


Figure 4-1. "Scanning Voltmeter" Configuration

Reset Conditions

This section describes the power-on and reset condition the E8462A switch module is in when a “scanning voltmeter” reset occurs. The “VOLTMTR” device driver controls both the voltmeter and any switch module configured with it in a scanning voltmeter configuration. At power-on or following the reset of a scanning voltmeter (*RST command sent to the voltmeter address), all 256 channels and the tree relays are open. All E8462A routing relay common terminals are set to the normally closed contact. In addition, after a *RST command, the current scan channel list is invalidated. See the *HP E1326/E1411B 5½-Digit Multimeter User's Manual* for the reset conditions of the multimeter.

Table 4-1 lists the parameters and default values for the switch module functions following power-on or reset. These are not accessible to you via the “VOLTMTR” driver but are provided so you know the switch module condition after power-on or following a reset

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Table 4-1. HP E8462A Default Conditions for Power-on and Reset

Parameter	Default Value	Description
ARM:COUNt	1	Number of scanning cycles is one.
TRIGger:SOURce	IMM	Advances through a scanning list automatically.
INITiate:CONTinuous	OFF	Number of scanning cycles is set by ARM:COUNt.
OUTPut[:STATe]	OFF	Trigger output from EXT, TTL, or ECL sources is disabled.
[ROUTe:]SCAN:MODE	NONE	Channel list is set up for volts measurement (the default mode).
[ROUTe:]SCAN:PORT	NONE	Analog bus connections are disabled.
Channel state	All 256 channels are open (channels 00 - 255)	
Tree relay state	All tree relays are open (channels 9000 - 9108)	
Analog Bus relay state	All analog bus relays are open (channels 9200 - 9204)	
Channel list from SCAN command (after *RST)	Current channel list is invalidated following a reset of the module with *RST command.	

The Scanning Voltmeter

The switchbox device driver discussed in Chapter 2 DOES NOT apply to the E8462A multiplexer when part of a scanning voltmeter. The note on Page 117 prescribes the use of the HP E1326/E1411 5½-Digit Multimeter device driver and command reference. The multimeter's Command Quick Reference is provided at the end of this chapter for your scanning voltmeter application reference. Use your HP E1326/E1411 5½-Digit Multimeter User's Manual for detailed information about multimeter commands used with the scanning voltmeter. The scanning voltmeter is easily configured to perform voltage, 2-wire ohms, 4-wire ohms or a combination of 1-, 2-, 3- or 4-wire measurements over the module's internal analog bus. The E1326/E1411 multimeter automatically controls the channels and tree relays when you use the MEASure or CONFigure commands. Tree relays are described in Table 4-2.

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Table 4-2. Tree Relay Descriptions (controlled automatically by the "VOLTMTR" Scanning Voltmeter Driver)

Relay Function	Tree Relay Channel	Designation	Funfional Description
Analog Bus Relays	9200	AB200	Connects the Voltage Sense H1 terminal of the Analog Bus to the Terminal Bus, line Ter0.
	9201	AB201	Connects the Voltage Sense L1 terminal of the Analog Bus to the Terminal Bus, line Ter1.
	9202	AB202	Connects the G terminal of the Analog Bus to the Terminal Bus, line Ter1 or Ter2.
	9203	AB203	Connects the H2 terminal of the Analog Bus to the Terminal Bus, line Ter4.
	9204	AB204	Connects the L2 terminal of the Analog Bus to the Terminal Bus, line Ter5.

The analog bus provides access to all wires of the channel regardless of being configured as a 1-, 2-, 3- or 4-wire channel. Access is through the front panel analog bus connector which is used to connect to other multiplexers and to the E1411 (or E1326) multimeter. Figure 4-1 is a schematic representation of the scanning voltmeter using the E1411B multimeter with an E8462A multiplexer. The analog bus is connected from multiplexer to multiplexer in multiple switch module scanning voltmeter instruments to provide a continuous bus for the instrument.

Making Measurements

The following sections provide examples for making voltage, 2-wire ohms and 4-wire ohms with the scanning voltmeter. The multimeter (E1326/ E1411) MEASure command is used to both specify the channel list to scan and to make measurements.

Scanning Voltmeter Measurement Program

This example scans a list of multiplexer channels and makes a measurement on each channel (this example scans 32 channels of the multiplexer). The measured readings are entered into the computer and displayed after the scan.

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```
10   !Dimension a computer array to store readings.
20   DIM Rdgs(1:32)

30   !Clear and reset the scanning voltmeter (voltmeter & multiplexer).
40   !See Figure 4-1 for module addresses.
50   CLEAR 70903
60   OUTPUT 70903;"*RST"

70   !Configure the multimeter for DCV measurements and
80   !specify the channel list to scan (channels 00 through 31).
90   OUTPUT 70903;"MEAS:VOLT:DC?  (@100:131)"

100  !Enter and display measured readings. Note: The number of
110  !channels in the scan list must equal the number of elements in
120  !the array Rdgs to use Rdgs(*).
130  ENTER 70903;Rdgs(*)
140  PRINT Rdgs(*)
150  END
```

Note: When the multimeter buffer fills, measurements are suspended until readings are read from the buffer (by the computer) to make space available.

Voltage Measurements

Line 90 initiates a DC voltage measurement.

2-Wire Ohms Measurements

To make 2-wire measurements, change line 90 in the voltage measurement example to read:

```
90 OUTPUT 70903;"MEAS:RES?  (@100:131)"
```

4-Wire Ohms Measurements

To make 4-wire measurements, change line 90 in the voltage measurement example to read:

```
90 OUTPUT 70903;"MEAS:FRES?  (@100:131)"
```

(NOTE: 4-wire channels are made by pairing banks 0 and 2, banks 1 and 3, banks 4 and 6 and banks 5 and 7. Two lines from each bank will automatically be paired to form the 4-wire channel)

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Scanning Voltmeter Command Quick Reference

The following tables summarize SCPI commands for the HP E1326 and HP E1411 5½-Digit Multimeters.

Command		Description
ABORt		Place multimeter in idle state.
CALibration	:LFRequency 50 | 60 | MIN | MAX :LFRequency? [MIN | MAX] :ZERO:AUTO OFF | 0 | ON | 1 :ZERO:AUTO?	Change line reference frequency. Query line reference frequency. Enable/disable autozero mode. Query autozero mode.
CONFigure	:FRESistance [<*range*>[,<*resolution*>]] [,<*channel_list*>] :RESistance [<*range*>[,<*resolution*>]] , <*channel_list*> :TEMPerature <*transducer*>,<*type*>,<*channel_list*> :VOLTage:AC [<*range*> [,<*resolution*>]] [,<*channel_list*>] :VOLTage[:DC] [<*range*> [,<*resolution*>]] [,<*channel_list*>]	Configure multimeter for 4-wire ohms. Configure multimeter for 2-wire ohms. Configure multimeter for temperature. Configure multimeter for AC voltage. Configure multimeter for DC voltage.
CONFigure?		Query multimeter configuration.
DIAGnostic	:FETS <*mode*> :FETS?	Selects control of FET multiplexers. Query mode of operation.
DISPlay	:MONitor:CHANnel <*channel*> | AUTO :MONitor:CHANnel? :MONitor[:STATe] OFF | 0 | ON | 1 :MONitor[:STATe]?	Monitor multiplexer channel. Query monitor channel. Enable/disable monitor mode. Query monitor mode.
FETCh?		Place stored readings in output buffer.
FORMat	[:DATA] <*type*>[,<*length*>]	Select output data format and length.
FORMat?		Query format.
INITiate	[:IMMediate]	Place multimeter in wait-for trigger state.
MEASure	:FRESistance? [<*range*>[,<*resolution*>]] [,<*channel_list*>] :RESistance? [<*range*>[,<*resolution*>]], <*channel_list*> :TEMPerature? <*transducer*>,<*type*> [,<*channel_list*>] :VOLTage:AC? [<*range*> [,<*resolution*>]] [,<*channel_list*>] :VOLTage[:DC]? [<*range*> [,<*resolution*>]] [,<*channel_list*>]	Make 4-wire ohms measurements. Make 2-wire ohms measurements. Make temperature measurements. Make AC voltage measurements. Make DC voltage measurements.
MEMory	:VME:ADDRess <*address*> :VME:ADDRess? [MIN | MAX] :VME:SIZE <*bytes*> :VME:SIZE? [MIN | MAX] :VME:STATe <*mode*> :VME:STATe?	Set address of memory on VME card. Query VME memory location (address). Amount of memory used on VME card. Query amount of VME memory used. Direct readings to VME memory card. Query VME memory mode.
OUTPut	:TTLTrg0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 [:STATe] OFF | 0 | ON | 1 :TTLTrg0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 [:STATe]?	Send voltmeter complete to VXIbus trigger lines. Query voltmeter complete destination.
READ?		Place multimeter in wait-for trigger state; place readings in output buffer.
SAMPle	:COUNt 1-16777215 | MIN | MAX :COUNt? [MIN | MAX] :SOURce IMM | TIM :SOURce? :TIMer 76 ms-65.534 ms | MIN | MAX :TIMer? [MIN | MAX]	Set number of readings per trigger. Query number of readings per trigger. Set pacing source. Query pacing source. Define period between readings. Query period between readings.

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Command		Description
[SENSe:]	FUNCtion[:<*function*>] FUNCtion? RESistance:APERture <*time*> | MIN | MAX RESistance:APERture? [MIN | MAX] RESistance:NPLC <*number*> | MIN | MAX RESistance:NPLC? [MIN | MAX] RESistance:OCOMpensated OFF | 0 | ON | 1 RESistance:OCOMpensated? RESistance:RANGe <*range*> | MIN | MAX RESistance:RANGe? [MIN | MAX] RESistance:RANGe:AUTO OFF | 0 | ON | 1 RESistance:RANGe:AUTO? RESistance:RESolution <*resolution*> | MIN | MAX RESistance:RESolution? [MIN | MAX] VOLTage:AC:RANGe <range> | MIN | MAX VOLTage:AC:RANGe? [MIN | MAX] VOLTage:APERture <*time*> | MIN | MAX VOLTage:APERture? [MIN | MAX] VOLTage[:DC]:RANGe <*range*> | MIN | MAX VOLTage[:DC]:RANGe? [MIN | MAX] VOLTage:NPLC <*number*> | MIN | MAX VOLTage:NPLC? [MIN | MAX] VOLTage:RANGe:AUTO OFF | 0 | ON | 1 VOLTage:RANGe:AUTO? VOLTage:RESolution <*resolution*> VOLTage:RESolution? [MIN | MAX]	Select measurement function. Query measurement function. Set aperture (integration) time in seconds. Query aperture (integration) time. Set integration time in PLCs. Query integration time. Enable/disable offset compensation. Query offset compensation mode. Select range. Query range. Enable/disable autorange function. Query autorange mode. Specify resolution. Query resolution. Select measurement range. Query range. Set aperture (integration) time in seconds. Query aperture (integration) time. Select range. Query range. Set integration time in PLCs. Query integration time. Enable/disable autoranging. Query autorange mode. Specify resolution. Query resolution.
SYSTem	:CDEScription? <*card_number*> :CTYPe? <*card_number*> :ERRor?	Return description of multiplexer in scanning multimeter. Return card type of multiplexer in scanning multimeter. Return error number/message from error queue.
TRIGger	:COUNt 1-16777215 | MIN | MAX :COUNt? [MIN | MAX] :DELay 0-16.777215 | MIN | MAX :DELay? [MIN | MAX] :DELay:AUTO OFF | 0 | ON | 1 :DELay:AUTO? [:IMMediate] :SOURce BUS | EXT | HOLD | IMM | TTLTrg0-TTLTrg7 :SOURce?	Set number of triggers or scans. Query trigger count. Set delay between trigger and start of measurement. Query trigger delay. Enable/disable automatic trigger delay. Query automatic trigger delay mode. Trigger immediately. Specify trigger source. Query trigger source.

Command	Title	Description
*RST	Reset	Sets the multimeter and associated multiplexers. Sets FUNC:VOLT:DC, VOLT:RANG 8V, RES:RANG 16384Ω, RANGE:AUTO ON, VOLT:RES 7.629mV, RES:RES 15.6mΩ, APER 16.7ms|20ms, NPLC 1, RES:COMP OFF, CAL:ZERO:AUTO ON, TRIG:COUN 1, TRIG:DELAY:AUTO ON, TRIG:SOUR IMM, SAMP:COUN 1, SAMP:SOURIMM, SAMP:TIM 200µs
*TRG	Bus Trigger	When the multimeter is in the wait-for-trigger state and the trigger source is TRIGger:SOURce BUS, use the *TRG command to trigger the multimeter.
*TST	Self-Test	Should return 0. If code 1, 2, 3, or 4 occurs, return the multimeter to Hewlett-Packard for repair.

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Notes:

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Appendix A
HP E8462A Specifications

General Characteristics

Module Size/Device Type C-Size VXIbus, Register based, A16/D16

Interrupt Level 1-7, selectable

Cooling/Slot

Watts/slot:	30W max, 10W typical
ΔP mm H_2O:	0.1
Air Flow (liters/sec):	3.0

Operating Temperature 0 - 55°C

Operating Humidity 65% RH, 0 - 40°C

Operating Location Intended for indoor use only. Operating location should be a sheltered location where air temperature and humidity are controlled within this product's specifications and the product is protected against direct exposure to climatic conditions such as direct sunlight, wind, rain, snow, sleet and icing, water spray or splash, hoarfrost (frost) or dew.

Pollution Environment Pollution environment for which this product may be operated is IEC 664 Pollution Degree 2 (typically, indoor). Pollution degree 2 means only non-conductive pollution occurs. However, occasionally a temporary concuctivity caused by condensation must be expected.

Power Requirements

Voltage	I_{pm} (A)	I_{dm} (A)
+5V	1.0[1]	0.50
+12V	0.0	0.0
-12V	0.0	0.0

Relay Life (typical)

Condition	Number of Operations
1.0 V & 10 mA	10×10^5
Rated Full Resistive Load (60VA)	10×10^4

NOTE: Relays are subject to normal wear out based on the number of operations.

1. Specified in the worst case typical mux configuration (eight 32 x 1). Add 30 mA per additional relay.

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Input Characteristics

These limits apply only if there are no connections made to power mains.

Maximum Input

	With Option 012 Crimp & Insert Terminal Card	With Opt. 014 Fault Tolerant Terminal Card	With Opt. 015 Ribbon Cable Conn. Terminal Card	Analog Bus
Maximum DC Voltage	250 V (see notes a and b)	60 V	60 V	60 V
Max. ACrms Voltage	250 V (see notes a and b)	50 V (see note c)	50 V (see note c	30 V
Max. ACpeak Voltage	353V (see note a)	70.7 V (see note c)	70.7 V (see note c)	42 V
Transient Voltage	1500 V	-	-	-
Maximum Current per Channel: Switching: Carry:	 2A @ 30V 2A	 100 mA 100 mA	 100 mA 100 mA	 N/A N/A

NOTES:

a. Limited to 15,000 hours of voltage stress above 180V ACrms/DC (254Vpeak).
b. Replace the Crimp and Insert connector after 15,000 hours of operation of switching over 180V ACrms or 180Vdc. Refer to Chapter 1 of this manual.
c. Rating reduced to 30V ACrms, 42V ACpeak for exposed conductors.

Caution **When using the Option 012 Terminal Block:**
The *front panel connectors on the HP E8462A module* must be replaced after 15,000 hours of >180Vrms voltage stress due to the close terminal spacing and the potential for pin-to-pin leakage if the module regularly switches voltages greater than 180VDC, 180VACrms or 254VACpeak/transient.

Caution **When using the Option 014 or Option 015 Terminal Block:**
The ribbon cable header connectors on the HP E8462A Option 014 or Option 015 Terminal Card must be replaced after 15,000 hours of >50Vrms voltage stress due to the close terminal spacing and the potential for pin-to-pin leakage if the module regularly switches voltages greater than 60VDC, 50VACrms, or 70.7 VACpeak.

DC Performance (Typical)

Thermal offset per Channel: 1-wire = ±3µV
2-wire = ±1.5µV

Closed Channel Resistance, 1-wire: <0.9Ω with output protection resistor shorted; protection resistor adds 100Ω.

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AC Performance (Typical)

Bandwidth, 50Ω Source/Load:

Configuration	100Ω Protection Resistor Shorted
256:1 (1-wire)	6.0 MHz
128:1 (2-wire)	12.0 MHz
32:1 (2-wire)	30.0 MHz

Closed Channel Capacitance:

Configuration	to Chassis	To open Channel
256:1	620 pF	410 pF
128:1	340 pF	220 pF
32:1	160 pF	100 pF

Open channel Capacitance (to either open channel or to Chassis): 70 pF

Hi-to-Lo Capacitance (2-Wire Mode):

Configuration	Capacitance
128:1	410 pF
64:1	230 pF
16:1	100 pF

Crosstalk:

Configuration	10kHz	100kHz	1MHz	10MHz
256:1 (1-wire)	70 dB	53 dB	33 dB	15 dB
128:1 (2-wire)	85 dB	65 dB	45 dB	30 dB
16:1 (2-wire)	85 dB	65 dB	45 dB	30 dB

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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 (for example, turning on a lamp or starting a motor) reduces relay life. Exceeding specified maximum inputs can cause catastrophic failure.

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

End-of-Life Detection

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

Contact Resistance. As the relay begins to wear out, its contact resistance increases. When the resistance exceeds a predetermined value, the relay should be replaced.

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. 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. Typical relay life is 10×10^5 relay closures with no load or 10×10^4 relay closures switching full load.

Replacement Strategy

The replacement strategy depends on the application. If some relays are used more often, or at a higher load, than the others, the relays can be individually replaced as needed. If all relays see similar loads and switching frequencies, the entire circuit board can be replaced when the end of relay 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.

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Appendix B
Register-Based Programming

About This Appendix

The HP E8462A 256-Channel Relay Multiplexer is a register-based module which does not support the VXIbus word serial protocol. When a SCPI command is sent to the multiplexer, the instrument driver parses the command and programs the multiplexer at the register level.

Register-based programming is a series of reads and writes directly to the multiplexer registers. This increases throughput speed since it eliminates command parsing and allows the use of an embedded controller. Also, register programming provides an avenue for users to control a VXI module with an alternate VXI controller device and eliminates the need for using an HP E1405/E1406 Command Module.

This appendix contains the information you need for register-based programming. The contents include:

- Register Addressing . . . . . Page 129
- Register Descriptions . . . . . Page 133
- Program Timing and Execution . . . . . Page 139
- Programming Examples . . . . . Page 141

Register Addressing

Register addresses for register-based devices are located in the upper 25% of VXI A16 address space. Every VXI device (up to 256 devices) is allocated a 32 word (64 byte) block of addresses. Figure B-1 shows the register address location within A16 as it might be mapped by an embedded controller. Figure B-2 shows the location of A16 address space in the HP E1405A/B and E1406A Command modules.

The Base Address

When you are reading from, or writing to, a multiplexer register, a hexadecimal or decimal register address is specified. This address consists of a base address plus a register offset.

The base address used in register-based programming depends on whether the A16 address space is outside or inside the HP E1406A Command Module.

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A16 Address Space Outside the Command Module

When the HP E1406A Command Module is not part of your VXIbus system (Figure B-1), the multiplexer's base address is computed as:[1]

$C000_h + (LADDR * 64)_h$

***or** (decimal)*

$49{,}152 + (LADDR * 64)$

where $C000_h$ (49,152) is the starting location of the register addresses, LADDR is the multiplexer's logical address, and 64_{10} is the number of address bytes per VXI device. For example, the multiplexer's factory set logical address is 112 (70_h). If this address is not changed, the multiplexer will have a base address of:

$C000_h + (112 * 64)_h = C000_h + 1C00_h = DC00_h$

***or** (decimal)*

$49{,}152 + (112 * 64) = 49{,}152 + 7168 = 56{,}320$

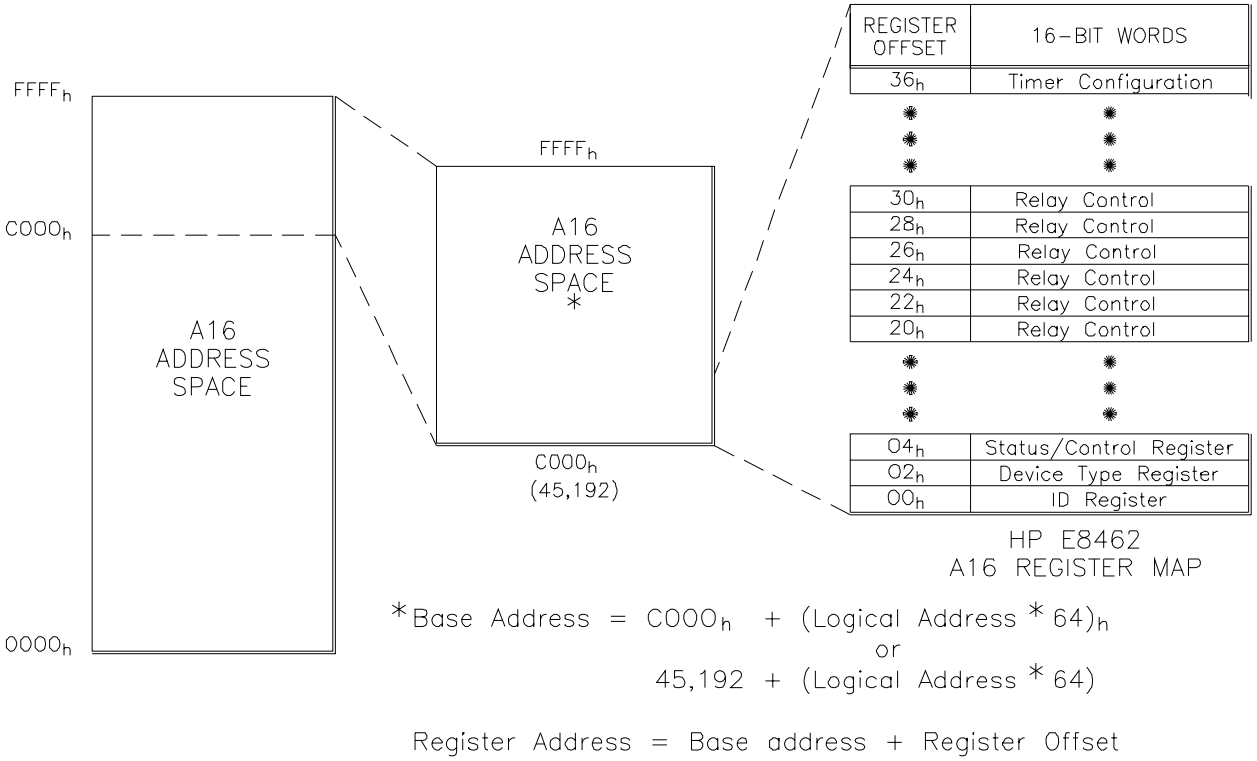


Figure B-1. Registers within A16 Address Space

1. The subscript "h" at the end of the address indicates a hexadecimal number.

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A16 Address Space Inside the Command Module or Mainframe

When the A16 address space is inside the HP E1406A Command module (Figure B-2), the multiplexer's base address is computed as:

$$1FC000_h + (LADDR * 64)_h$$

***or** (decimal)*

$$2{,}080{,}768 + (LADDR * 64)$$

where $1FC000_h$ (2,080,768) is the starting location of the VXI A16 addresses, LADDR is the multiplexer's logical address, and 64 is the number of address bytes per register-based device. Again, the multiplexer's factory set logical address is 112. If this address is not changed, the multiplexer will have a base address of:

$$1FC000_h + (112 * 64)_h = 1FC000_h + 1C00_h = 1FDC00_h$$

***or** (decimal)*

$$2{,}080{,}768 + (112 * 64) = 2{,}080{,}768 + 1536 = 2{,}087{,}936$$

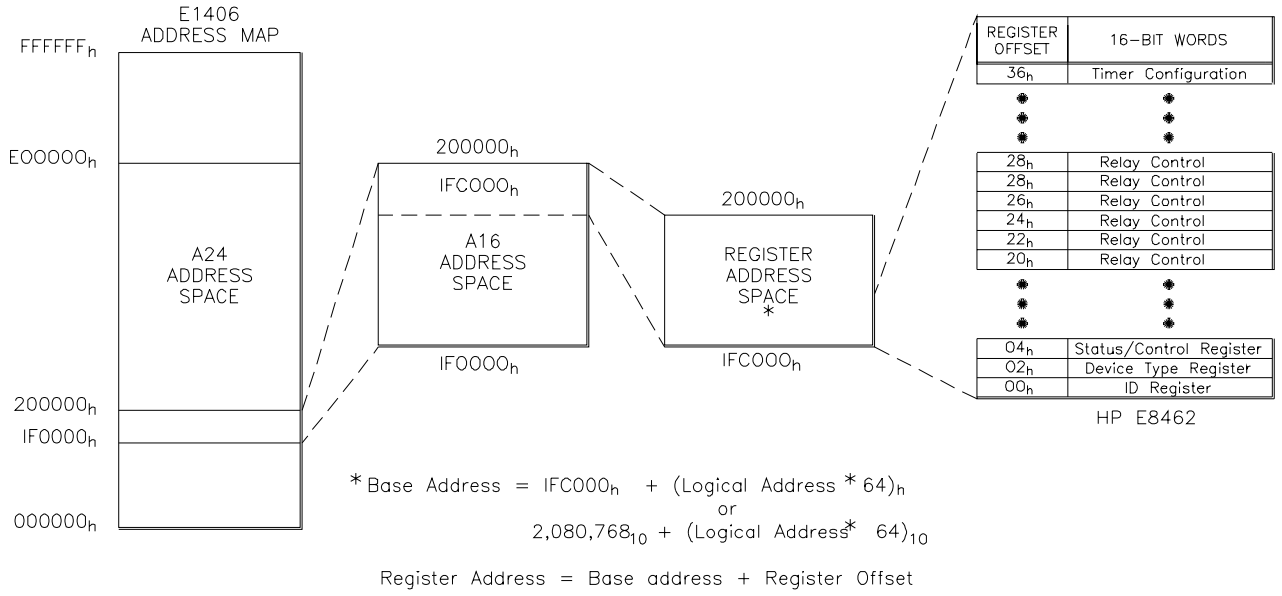


Figure B-2. Registers within Command Module's A16 Address Space

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Register Offset

The register offset is the register's location in the block of 64 address bytes. For example, the multiplexer's Status/Control Register has an offset of 04_h. When you write a command to this register, the offset is added to the base address to form the register address:

$DC00_h + 04_h = DC04_h$

$1FDC00_h + 04_h = 1FDC04_h$

or *(decimal)*

56,320 + 4 = 56,324

2,087,936 + 4 = 2,087,940

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Register Descriptions

The Multiplexer has 25 registers (refer to Table B-1). This section contains a description of each register. Undefined register bits appear as "1" when the register is read, and have no effect when written to.

Table B-1. HP E8462A 256-Channel Multiplexer Registers

Register	Addr. Offset	R/W	Register Description (Register Address)
ID Register	00_h	R	MFG ID Register (Base + 00_h)
Device Type Register	02_h	R	Device Type Register (Base + 02_h)
Status/Control Register	04_h	R/W	Status/Control Register (Base + 04_h)
Relay Control Register 0	20_h	R/W	Bank 0 Channels (CH 000 - 015, 032 - 047) (Base + 20_h)
Relay Control Register 1	22_h	R/W	Bank 1 Channels (CH 016 - 031, 048 - 063) (Base + 22_h)
Relay Control Register 2	24_h	R/W	Bank 2 Channels (CH 064 - 079, 096 - 111) (Base + 24_h)
Relay Control Register 3	26_h	R/W	Bank 3 Channels (CH 080 - 095, 112 - 127) (Base + 26_h)
Relay Control Register 4	28_h	R/W	Bank 4 Channels (CH 128 - 143, 160 - 175) (Base + 28_h)
Relay Control Register 5	$2A_h$	R/W	Bank 5 Channels (CH 144 - 159, 176 - 191) (Base + $2A_h$)
Relay Control Register 6	$2C_h$	R/W	Bank 6 Channels (CH 192 - 207, 224 - 239) (Base + $2C_h$)
Relay Control Register 7	$2E_h$	R/W	Bank 7 Channels (CH 208 - 223, 240 - 255) (Base + $2E_h$)
Tree Relay Control Register 0	30_h	R/W	Tree Relays T1-T15 (CH 9000 - 9015) (Base + 30_h)
Tree Relay Control Register 1	32_h	R/W	Tree Relays T16-T21, C Relays C100-C108 (CH 9016 - 9021, 9100 - 9108) (Base + 32_h)
Analog Bus Relay Control Register	34_h	R/W	Analog Bus Relays AB200-AB204 (CH 9200 - 9204) (Base + 34_h)
Timer Configuration Register	36_h	R/W	Relay Settling Time (Base + 36_h)

You can write to the writable (W) registers and read from the readable (R) registers which are listed in Table B-1.

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There are eight relay registers driving the 256 channels of the Multiplexer and two tree relay registers controlling the 21 tree relays. The second tree relay control register also controls nine C relays used for signal routing. The analog bus register controls five analog bus connection relays. All these relay control registers are readable/writable (R/W) registers. Writing a “1” to one bit will close the respective relay and writing a “0” will open the relay.

When power-on or reset the Multiplexer, all the control relays are open and when you read from these registers, all the bits are zero.

ID Register

Reading the ID register returns $FFFF_h$ indicating the manufacturer is Hewlett-Packard and the module is an A16 register-based device.

base + 00_h	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Write	Undefined								Logical Address							
Read	Manufacturer ID - returns $FFFF_h$ in Hewlett-Packard A16 only register-based card															

The “Programming Example” on page 141 shows how to read the ID Register.

Device Type Register

Reading the Device Type Register returns $026B_h$ (decimal = 619) which identifies the device as the HP E8462A 256-Channel Relay Multiplexer.

base + 02_h	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Write	Undefined															
Read	$026B_h$, 619_{10}															

The “Programming Example” on page 141 shows how to read the Device Type Register.

Status/Control Register

Writing to the Status/Control Register (base + 04_h) enables you to disable/enable the interrupt generated when channels are closed or opened.

base + 04_h	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Write	undefined					Set Interrupt Level				D	undefined				SYS-FAIL	R
Read	0	M	undefined			Interrupt Level			B	D	undefined		1	1	SYS-FAIL	R

The “Programming Example” on page 141 shows how to read the Status Register.

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Status/Control Register Bits Defined:

*WRITE BITS (Control Register)		
bit 0	R	Writing a “1” to bit 0 resets the module to the power-on state (all channels open). Allow a 5 mS delay, then you must set bit 0 back to “0” before the multiplexer will resume normal open/close operations.
bit 1	SYSFAIL	Writing a “1” to bit 1 inhibits the front panel SYSFAIL error LED.
bit 6	D	Writing a “0” to this bit enables the interrupts. Writing a “1” to this bit disables the interrupts.
bits 10, 9, 8	Interrupt level	Write to bits 8, 7, and 6 to set the module’s interrupt level. You can write the bits with 001, 010, 011, 100, 101, 110, 111 to set the interrupt level equal to 1, 2, 3,..., 7. Level 1 is the default value.

**READ BITS (Status Register)		
bit 0	R	“1” = a soft reset initiated; module switching disabled. “0” = module operation enabled.
bit 1	SYSFAIL	“1” = front panel SYSFAIL LED is inhibited. “0” = SYSFAIL LED enabled.
bit 7	B	Busy Status: “0” = busy (relay is opening/closing); “1” = not busy (relay is open/closed).
bit 6	D	“1” = interrupt disabled; “0” = interrupt enabled
bits 10, 9, 8	Interrupt level	The returned value indicates the current interrupt level of the multiplexer (1 - 7).
bit14	M	MODID bit; value “0” indicates that this module has been selected.

Resetting the Module

Follow this procedure to reset the module.

- Set the SYSFAIL bit to “1”.
- Set the R (reset) bit to “1”.
- Wait 10 nanoSeconds.
- Set both bit 0 and bit 1 to “0”

Disable/Enable Interrupts

To disable the interrupt generated when channels are opened or closed, write a “1” to bit 6 of the Status/Control Register (base + 04_h). Refer to your command module's operating manual before disabling the interrupt. Interrupts must be enabled in order to use the module’s driver.

Reading the Status/Control Register Module Status

Each relay requires about 5 ms execution time. During this period, the relay is “busy”. Bit 7 of this register informs the system of a busy condition. The interrupt generated after a channel has been closed can be disabled. Bit 6 of this register is used to inform the user of the interrupt status.

As an example, if the Status Register (base + 04_h) returns “$3EEE_h$ (0011111011101110)” the multiplexer module is not busy (bit 7 set), the module interrupts are disabled (bit 6 set), and interrupt level is set to 1 (bits 10, 9, 8 = 001).

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Relay Control Registers

Writing to the Relay Control Registers (base + 20_h to base + 34_h) allows you to open or close any one of the 256 channel relays or the 21 tree relays, nine routing relays or five analog bus relays. Any number of relays per bank can be closed at a time.

For example, to connect both Bank 0 and Bank 2 to the analog bus, you need to write a "1" to bits 0 and 2 of the Tree Bank 0 Register (base + 30_h) to close Tree Relays T0 and T2, meanwhile, you need also write a "1" to bit 0 of the Analog Bus Control Register (base + 34_h) to close the analog bus control relay AB200. Routing relay C108 is in the normally closed position by setting bit 15 to "1" in Tree Bank 1 Register (base + 32_h). All other bits are set to "0".

The Relay Control Registers bit definitions are listed as below:

Bank 0 Channels 000 - 015 Relay Control Register 0 (base + 20_h)

base + 20_h	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Write	ch015	ch014	ch013	ch012	ch011	ch010	ch009	ch008	ch007	ch006	ch005	ch004	ch003	ch002	ch001	ch000
Read																

Bank 1 Channels 000 - 015 Relay Control Register 1 (base + 22_h)

base + 22_h	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Write	ch015	ch014	ch013	ch012	ch011	ch010	ch009	ch008	ch007	ch006	ch005	ch004	ch003	ch002	ch001	ch000
Read																

Bank 2 Channels 000 - 015 Relay Control Register 2 (base + 24_h)

base + 24_h	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Write	ch015	ch014	ch013	ch012	ch011	ch010	ch009	ch008	ch007	ch006	ch005	ch004	ch003	ch002	ch001	ch000
Read																

Bank 3 Channels 000 - 015 Relay Control Register 3 (base + 26_h)

base + 26_h	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Write	ch015	ch014	ch013	ch012	ch011	ch010	ch009	ch008	ch007	ch006	ch005	ch004	ch003	ch002	ch001	ch000
Read																

Bank 4 Channel 000 - 015 Relay Control Register 4 (Base + 28_h)

base + 28_h	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Write	ch015	ch014	ch013	ch012	ch011	ch010	ch009	ch008	ch007	ch006	ch005	ch004	ch003	ch002	ch001	ch000
Read																

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Bank 5 Channel 000 - 015 Relay Control Register 5 (Base + $2A_h$)

base + $2A_h$	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Write	ch015	ch014	ch013	ch012	ch011	ch010	ch009	ch008	ch007	ch006	ch005	ch004	ch003	ch002	ch001	ch000
Read																

Bank 6 Channel 000 - 015 Relay Control Register 6 (Base + $2C_h$)

base + $2C_h$	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Write	ch015	ch014	ch013	ch012	ch011	ch010	ch009	ch008	ch007	ch006	ch005	ch004	ch003	ch002	ch001	ch000
Read																

Bank 7 Channel 000 - 015 Relay Control Register 7 (Base + $2E_h$)

base + $2E_h$	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Write	ch015	ch014	ch013	ch012	ch011	ch010	ch009	ch008	ch007	ch006	ch005	ch004	ch003	ch002	ch001	ch000
Read																

Tree Bank 0 Channel 9000 - 9015 Tree Relay Control Register 0 (Base + 30_h)

base + 30_h	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Write	T015	T014	T013	T012	T011	T010	T009	T008	T007	T006	T005	T004	T003	T002	T001	T000
Read																

Tree Bank 1 Relays 9016 - 9021 and 9100 - 9108 Tree Relay Control Register 1 (Base + 32_h)

base + 32_h	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Write	C108	C107	C106	C105	C104	C103	C102	C101	C100	unde-fined	T021	T020	T019	T018	T017	T016
Read																

Relays 9200 - 9204 Analog Bus Control Register (Base + 34_h)

base + 34_h	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Write	undefined											AB204	AB203	AB202	AB201	AB200
Read																

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Timer Control Register

This register provides a programmable timer for relay settling time. Programmable times are 2 mS, 5 mS, 8 mS and 64 mS. The primary purpose of the 64 mS time period is testing. Settling times for the relays on this multiplexer can be accomodated by 8 mS or less.

Timer Control Register (Base + 36_h)

base + 36_h	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Write	Undefined													Set Time		unde-fined
Read														Read Time		

*WRITE BITS (Control Register)		
bits 2, 1	Time	Write to bits 2 and 1 to set the module's settling time. Four times can be set as follows: "00" = 5 mS "01" = 2 mS "10" = 8 mS "11" = 64 mS

**READ BITS (Status Register)		
bits 2, 1	Time	The returned value indicates the timer setting: "00" = 5 mS, "01" = 2 mS, "10" = 8 mS, and "11"= 64 mS.

Resetting the Multiplexer

There are two ways to reset the Multiplexer:

You can either simply write a "0" to all bits in the Relay Control Registers or write "1" to bit 0 in the Status/Control Register to reset the Multiplexer.

Reading the Relay Control Registers

Reading the Relay Control Registers returns a hexadecimal number. A bit that is "1" represents a channel or a tree relay or one analog bus relay is closed. A bit that is "0" indicates the channel or the tree relay is open.

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Program Timing and Execution

This section contains flowcharts and comments for using register programming to close/open channels and synchronize the multiplexer with a multimeter. The flowcharts identify the registers used and the status bits monitored to ensure execution of the program.

Closing Channels

The following flowchart shows how to close (or open) a multiplexer channel and determine when it has finished closing (or opening).

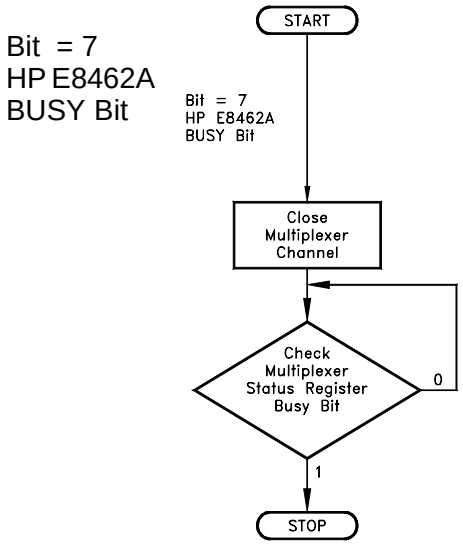


Figure B-3. Closing/Opening a Multiplexer channel

Comments

- The address of the multiplexer Status Register is base + 04_h. The address of the channel register is the base address plus the channel register offset.
- Multiplexer Status Register bit 7 (the BUSY bit) is monitored to determine when a channel has finished closing (or opening).

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Using a Multimeter with the Multiplexer

This flowchart shows the timing sequence between closing an HP E8462A Multiplexer channel and triggering an HP E1326/E1411 multimeter.

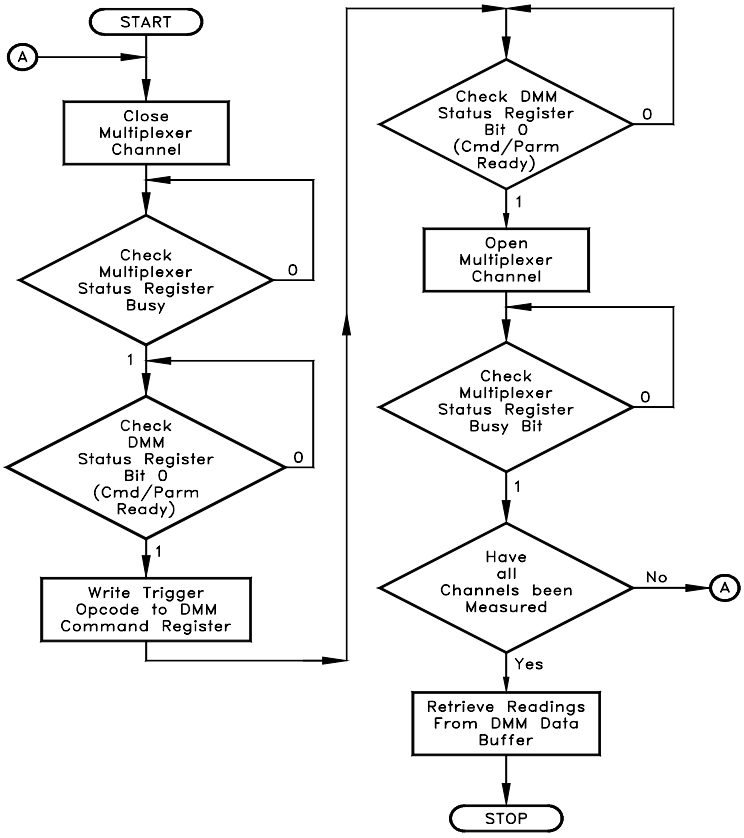


Figure B-4. Program Timing Between Multiplexer and Multimeter

Comments

- Multiplexer Status Register bit 7 (BUSY bit) is monitored to determine when a channel can be closed (or opened), and when a channel has finished closing (or opening).
- Multimeter status bit 0 (ready for command) is monitored to determine when a trigger opcode can be written to the Command Register (flowchart assumes the multimeter is already configured).

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- Multimeter status bit 5 (multimeter complete) is monitored to determine when the analog-to-digital (A/D) conversion is in progress, and thus, when to advance the channel. This enables each channel to be measured before the readings are read from the buffer.The channel can also be advanced by monitoring bit 4 (Data Ready). However, before measuring the next channel, readings from the previous channel must be read from the buffer in order to clear the bit.
- Multimeter Autozero is often turned on in order to detect when bit 5 is active.

Programming Example

The example in this section demonstrate how to program the multiplexer in register format. This example includes:

- Reading the ID, Device Type, and Status Registers
- Closing/Opening a channel, Stand-Alone Multiplexer Measurements
- Scanning through channels

System Configuration

The following programs were developed on an embedded controller using Visual C/C++ programming language and using the SICL interface library. You can also use an external PC connected via HP-IB to an HP E1406A Command Module. The command module simply provides direct access to the VXI backplane.

Example Program

The following example program contains segments that:

- Read the ID and Device Type Registers.
- Read the Status Register.
- Close a group of channels and the associated tree relay.
- Resets the module to open all channels.
- Scans through all the channels on the module.

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Beginning of Program

```
/* This program reads the ID Register, reads the Device Type Register, */
/* reads the Status Register, reads the modules bank 0 Register, */
/* and closes channels 000 and 001. */
/* (Visual C/C++ program using HP VISA I/O calls.) */
#include <visa.h>
#include <stdio.h>
#include <stdlib.h>

/* Function prototype */
void err_handler();
```

Program Main

```
void main(void)
{  viSession defaultRM,mux;
   unsigned short id_reg, dt_reg; /* ID and Device Type Registers */
   unsigned short stat_reg, bank0_ch; /* status reg and bank 0 reg */

   /* create and open a device session */
   ViStatus err;
   ViOpenDefaultRM(&defaultRM);
   /*** HP-IB card address 9, MUX logical address 112 ***/
   viOpen(defaultRM,"GPIB0::9::14::INSTR",VI_NULL,VI_NULL,&mux);
```

Read ID and Device Type Registers

```
/********* read the multiplexer's ID and Device Type registers *********/
   err=viIn16(mux,VI_A16_SPACE, 0x00,&id_reg);
    if(err<VI_SUCCESS) err_handler(mux,err);
   printf("ID Register=0x%4X\n",id_reg);
   err=viIn16(mux,VI_A16_SPACE, 0x02,&id_reg);
    if(err<VI_SUCCESS) err_handler(mux,err);
   printf("Device Type Register=0x%4X\n",dt_reg);
```

Read Status Register

```
/**************** read the multiplexer's status register *************/
   err=viIn16(mux,VI_A16_SPACE, 0x04,&stat_reg);
    if(err<VI_SUCCESS) err_handler(mux,err);
   printf("Status Register=0x%4X\n",stat_reg);
```

Read Bank 0 Control Register

```
/******************** read bank 0 ch 000-015 register ******************/
   err=viIn16(mux,VI_A16_SPACE, 0x20,&bank0_ch);
    if(err<VI_SUCCESS) err_handler(mux,err);
   printf("Bank 0 ch 000-015 Register value =0x%4X\n",bank0_ch);
```

Scan channels

```
/********************** clos channels 000 & 001 *********************/
   err=viIn16(mux,VI_A16_SPACE, 0x20,&bank0_ch);
    if(err<VI_SUCCESS) err_handler(mux,err);
```


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```
   err=viIn16(mux,VI_A16_SPACE, 0x20,&bank0_ch);
    if(err<VI_SUCCESS) err_handler(mux,err);
   printf("Bank 0 ch 000-015 registe value =0x%4X\n",bank0_ch);

   /* close HP VISA session */
   viClose(mux);
   viClose(defaultRM);
 } /* end of main */
```

Error Handling Function

```
/*********************************************************/
void err_handler()
 {
   ViStatus err;
   char err_msg[1024]={0};

   viStatusDesc(mux,err,err_msg);
   printf("ERROR = %s\n",err_msg);
   return;
 }    /* end of error handler routine */
```

Program Output

Printout from example program:

```
ID register = 0xFFFF
Device Type register = 0x 26B
Status register = 0x79BE
Bank 0 ch 000-015 register value = 0x    0
Bank 0 ch 000-015 register value = 0x    3
```


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Appendix C
Error Messages

Error Types

Table C-2 lists the error messages generated by the HP E8462A Relay Multiplexer module firmware when programmed by SCPI. Errors with negative values are governed by the SCPI standard and are categorized in Table C-1. Error numbers with positive values are not governed by the SCPI standard.

Table C-1. Error Types Described

Number Range	Error Types Description
-199 to -100	Command Errors (syntax and parameter errors). See the *HP E1405/E1406 Command Module User's Manual* for a description of these errors.
-299 to -200	Execution Errors (instrument driver detected errors). See the *HP E1405/E1406 Command Module User's Manual* for further details.
-399 to -300	Device Specific Errors (instrument driver errors that are not command nor execution errors). See the *HP E1405/E1406 Command Module User's Manual* for further details.
-499 to -400	Query Errors (problem in querying an instrument). See the *HP E1405/E1406 Command Module User's Manual* for description of these errors.

"Table C-2. Multiplexer Error Messages" appears in its entirety on the following page.

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Table C-2. Multiplexer Error Messages

Code	Error Message	Potential Cause(s)
-211	Trigger ignored	Trigger received when scan not enabled. Trigger received after scan complete. Trigger too fast.
-213	Init Ignored	Attempting to execute an INIT command when a scan is already in progress.
-222	Data out of range	Parameter value is outside valid range.
-224	Illegal parameter value	Attempting to execute a command with a parameter not applicable to the command.
-240	Hardware error	Command failed due to a hardware problem.
-310	System error	Internal driver error. This error can result if an excessively long parameter list is entered.
1500	External trigger source already allocated	Assigning an external trigger source to a switchbox when the trigger source has already been assigned to another switchbox.
1510	Trigger source non-existent	Selected trigger source is not available on this platform (e.g. some triggers are not available on the E1300/E1301 VXI B-size mainframes).
2000	Invalid card number	Addressing a module (card) in a switchbox that is not part of the switchbox.
2001	Invalid channel number	Attempting to address a channel of a module in a switchbox that is not supported by the module (e.g., channel 99 of a multiplexer module).
2006	Command not supported on this card	Sending a command to a module (card) in a switchbox that is unsupported by the module.
2008	Scan list not initialized	Executing a scan without the INIT command.
2009	Too many channels in channel list	Attempting to address more channels than available in the switchbox.
2010	Scan mode not allowed on this card	The selected scanning mode is not allowed with this module or you have misspelled the mode parameter (see SCAN:MODE command).
2011	Empty channel list	No valid channels are specified in the channel_list.
2012	Invalid Channel Range	Invalid channel(s) specified in SCAN <*channel_list*> command. Attempting to begin scanning when no valid channel list is defined.
2600	Function not supported on this card	Sending a command to a module (card) in a switchbox that is not supported by the module or switchbox.
2601	Channel list required	Sending a command requiring a *channel_list* without the *channel_list*.

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