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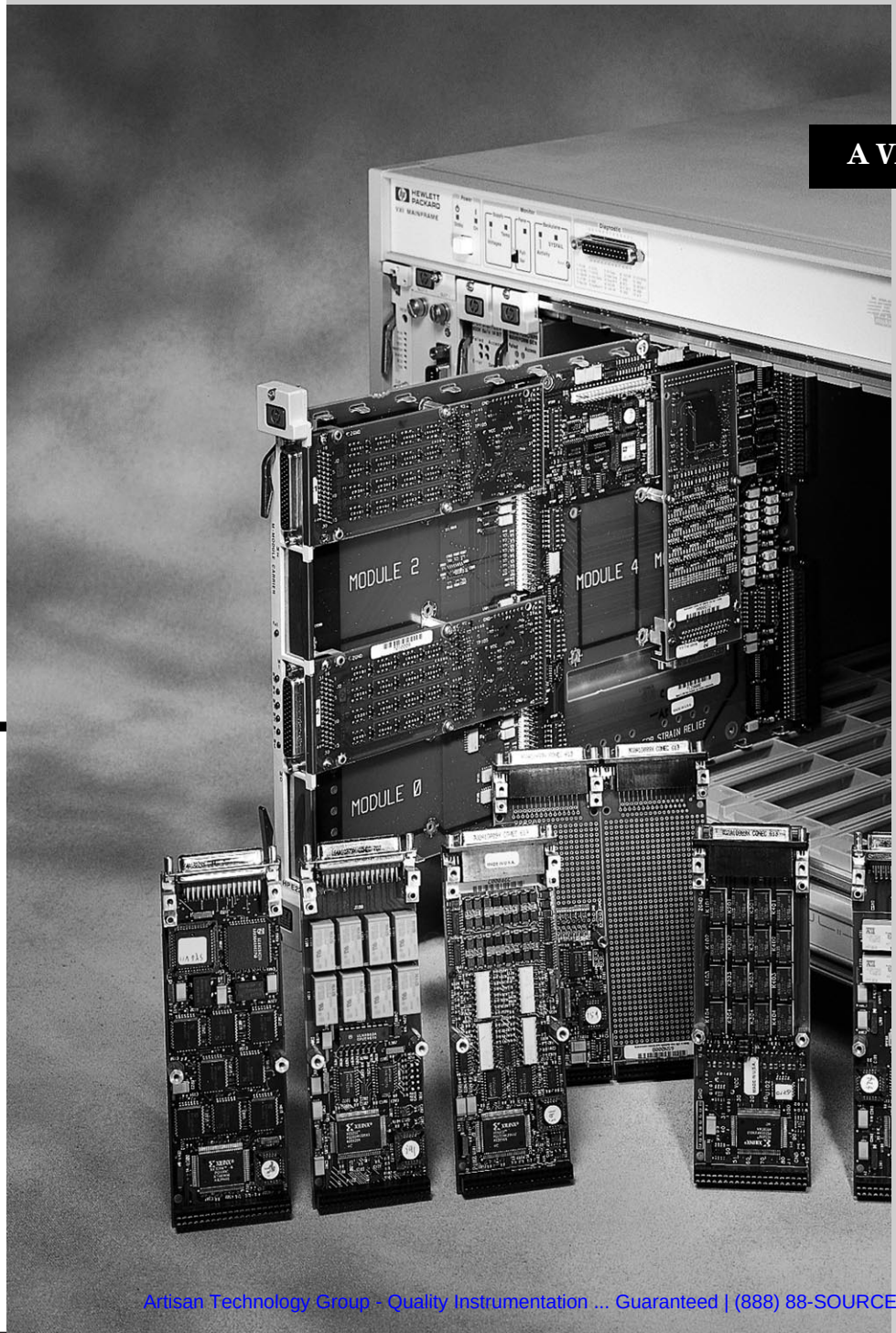
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Using the HP Family of VXI M-Modules



A VXI Product Note

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Introduction

Hewlett-Packard has recently adopted the new M-Module standard for the VXIbus. This standard was originally designed to take advantage of the modularity of a single VME card (A-size), but offer better utilization of space such as double VME cards (B-size).

The inherent advantage of the M-Modules concept is that hardware is not restricted to a particular hardware platform. This results in a very simple hardware interface in which each M-Module is individually addressed and the carrier is not apparent to the instrument bus backplane.

With Hewlett-Packard's new HP E2200 Series of M-Modules and Carrier, you can now plug up to six M-Modules onto one M-Module carrier, each individually addressed and operating independently. This lowers the cost of test by providing multiple, smaller blocks of functionality on one C-size VXI card. The HP E2251A M-Module Carrier and its complementary M-Modules eliminate the need to use multiple cardcage slots when your application requires different types of switching, digital I/O, and RS-232 interface combinations. Custom circuits can also be built with Double-wide Breadboard M-Modules. Additionally, all M-Modules except the breadboard come complete with VXI*plug&play* drivers.

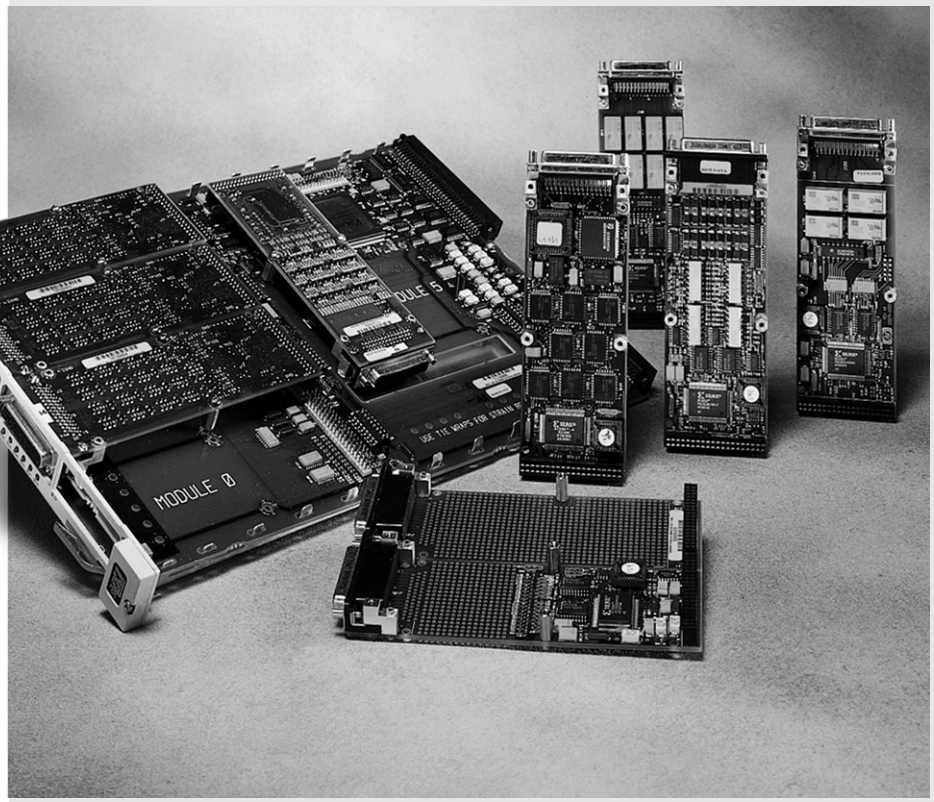


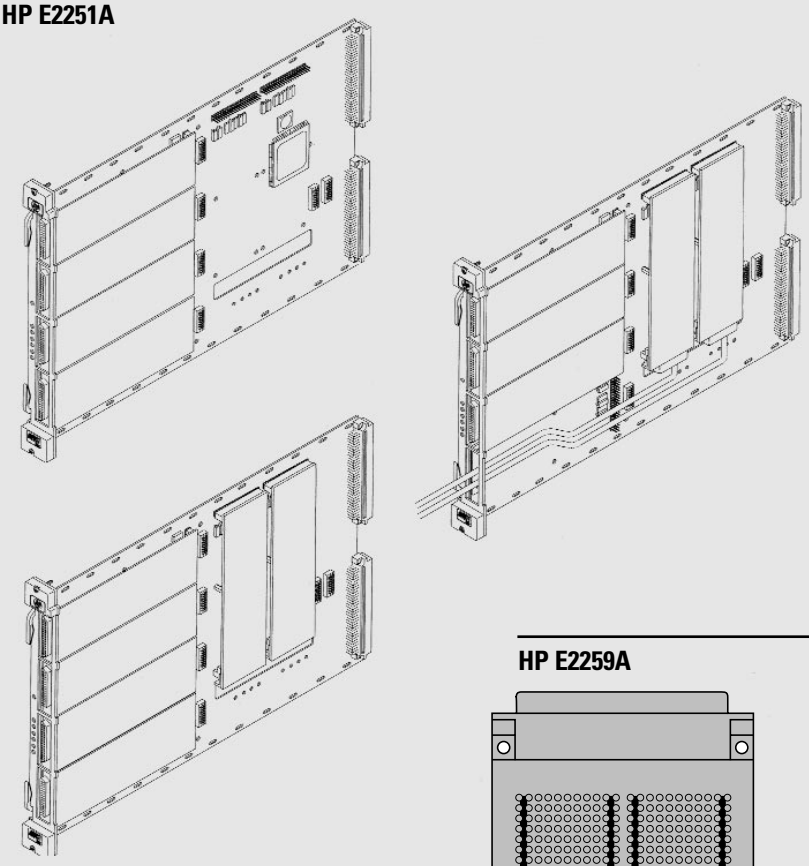
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Connections and Configurations

HP E2251A

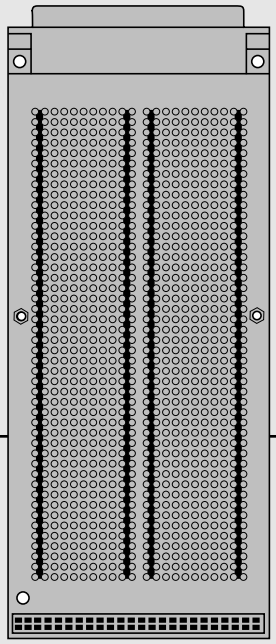


Switch / Control Modules

HP E2251A M-Module Carrier

The HP E2251A M-Module Carrier allows the cost-effective addition of small blocks of functionality to any C-size VXI system. It provides backplane access to as many as 6 different M-Modules, each with an independent address. You can use up to 31 M-Modules with the HP E1406A Command Module, or 255 M-Modules with embedded controllers and VXLink or MXIbus solutions.

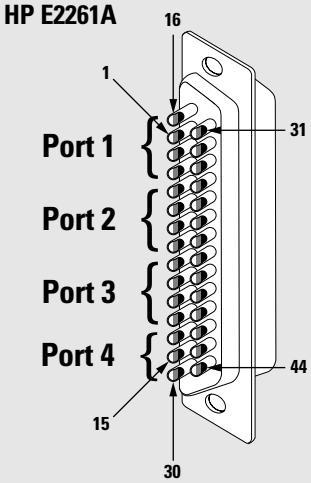
HP E2259A



HP E2259A Double-wide M-Module Breadboard

Use the breadboard for custom circuits and special-purpose functions in your test system. Filters, amplifiers, and other custom circuitry can be implemented on the breadboard's plated holes.

HP E2261A



HP E2261A Quad RS-232 Interface

This module provides 4 independently programmable RS-232 ports. With software limitations, this module can be used as a general purpose RS-232 communications interface for control of other instruments. The built-in data handshaking and internal 2 KB/port data buffers reduce communication overhead.

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HP E2270A 16-Channel Form-A General Purpose Switch

Use this module to switch non-multiplexed signals or to actuate external devices with a contact closure. The 16 one-wire independent SPST relays provide quality connections for low-level signals.

HP E2271A 4X4 Matrix Switch

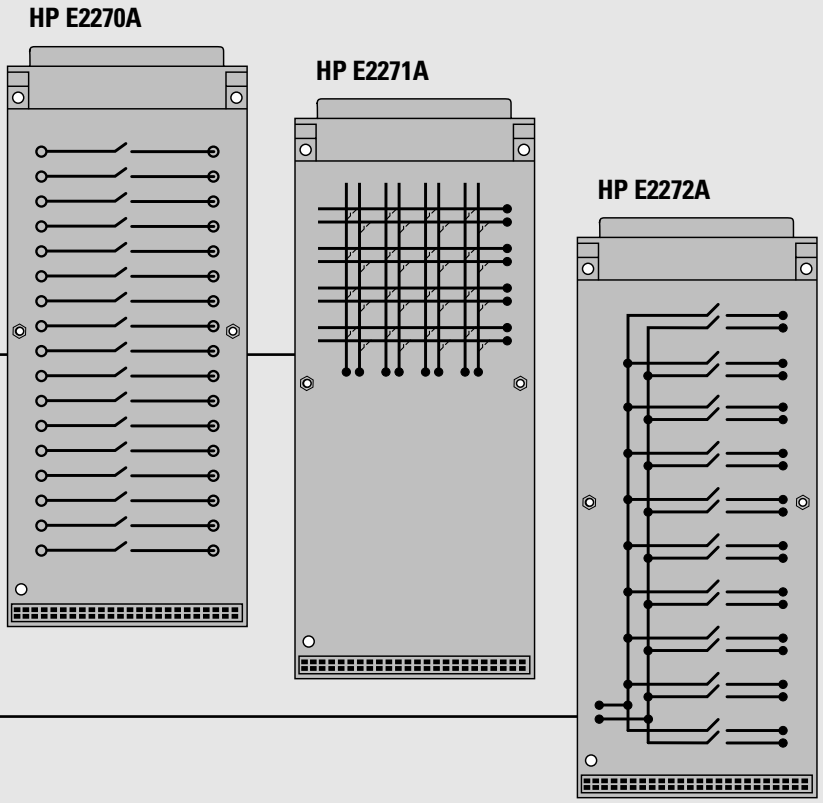
Connect any combination of signal inputs to outputs with highly flexible matrix switching. Combine matrix and multiplexer modules for larger switching configurations. This module consists of 16 relays configured as 4 rows and 4 columns of two-wire switches.

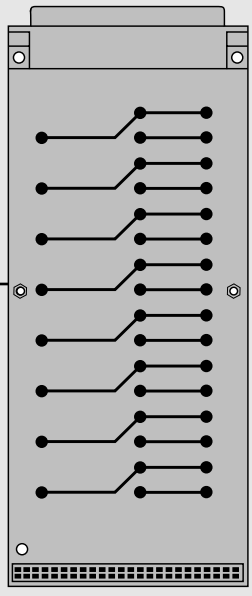
HP E2272A Dual 8-to-1 Relay Multiplexer

Switch multiple signal inputs to instruments and test system points. Modules as input or output multiplexers can be used for scanning or with multiple channel closures. The HP E2272A operates as two separate 8-to-1 two-wire multiplexers; by moving a jumper to connect common channels, it operates as a single 16-to-1 two-wire multiplexer.

HP E2273A 8 Channel Form-C Switch

The Form-C relay module provides eight independent channels for general purpose switching and control of external devices. Using an external power supply, the module can drive programmable attenuators, microwave switches or high power switches.





Operating Characteristics

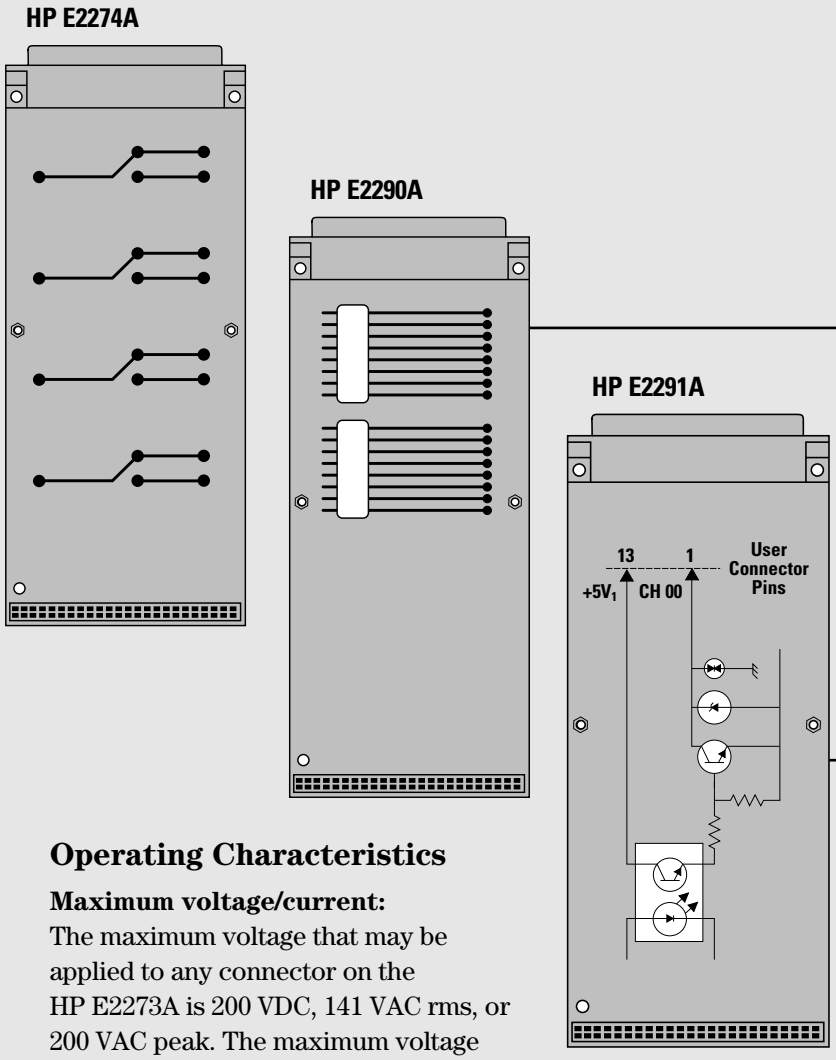
Maximum voltage/current:
The maximum voltage that may be applied to any connector on the E2270A, HP E2271A, or HP E2272A is 200 VDC, 125 VAC rms, or 175 VAC peak. These limits apply only if the product is installed in a humidity-controlled (<60% RH) cleanroom environment where airborne contaminants and no relay connection is made to power mains. If these conditions cannot be maintained, then maximum voltage is 60 VDC, 48 VAC-rms or 68 VAC-peak.

The maximum current (non-inductive) that may be applied to the HP E2270A, E2271A, or E2272A is:

- Per Switch: 2 ADC, 2 AAC peak
- Per Module: 8 ADC, 8 AAC peak

Caution: The switch M-Modules DO NOT have provision for on-board current limiting components. If it is possible that input current could exceed 2 ADC or 2AAC-Peak per channel, you must install external current limiting circuitry.

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HP E2274A 4-Channel Form-C Power Relay

The Form-C relay module provides four independent channels for general purpose power switching. With its heavier 5A current, it can easily switch external power supplies.

HP E2290A 16-bit Digital I/O

This module offers versatile digital control and sensing with 16 bi-directional data / actuator lines. These data lines offer TTL compatible inputs and open-drain outputs up to 30 V. Each I/O line also provides active pull-up and pull-down for actuating external devices.

HP E2291A 16-Channel Isolated Digital Output

This module provides 16 channels of isolated open-collector digital output in four groups of four. You can use channels as digital outputs or as drivers for external relays. All channels have their own ground, isolated from the chassis, and can sink up to 200mA at 36V. Requires external 5V supply.

Operating Characteristics

Maximum voltage/current:
The maximum voltage that may be applied to any connector on the HP E2273A is 200 VDC, 141 VAC rms, or 200 VAC peak. The maximum voltage that may be applied to any connector on the HP E2274A is 125 VDC, 141 VAC rms, or 200 VAC peak. These limits apply only if the product is installed in a humidity-controlled (<60% RH) cleanroom environment where airborne contaminants and transients are controlled, and there is NOT a relay connection made to power mains. If these conditions CANNOT be maintained, then the maximum voltage for either M-Module is 60 VDC, 48 VAC-rms or 68 VAC-peak.

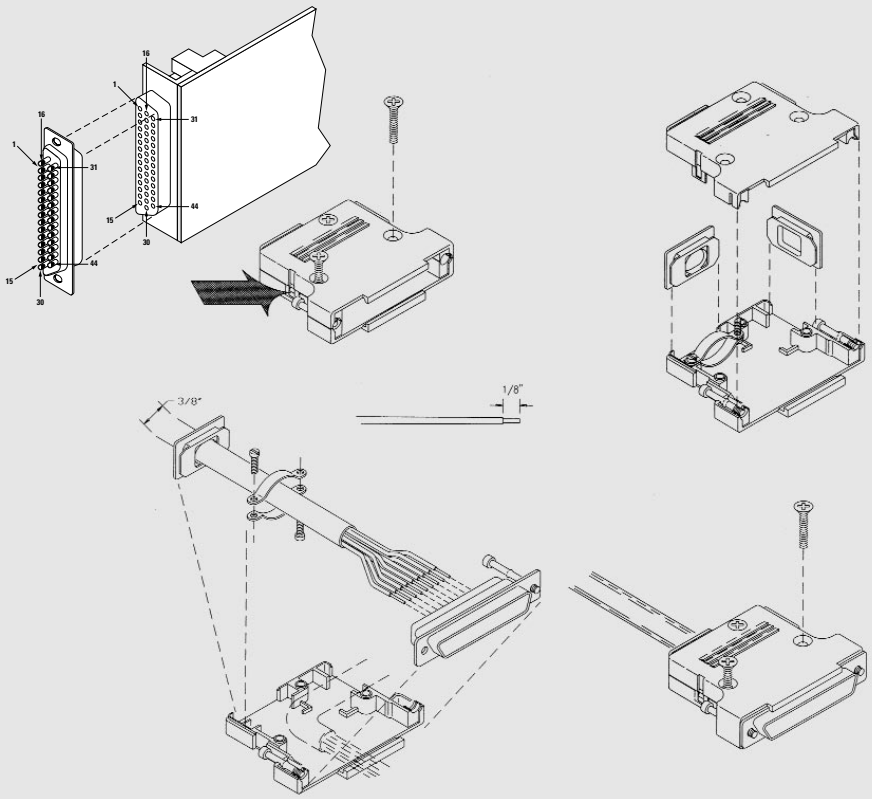
The maximum current (non-inductive) that may be applied to the HP E2273A is 1 ADC, 1 AAC peak per switch. Maximum power is 40W DC, 40VA AC per switch; 100W DC, 100VA AC per M-Module.

The maximum current (non-inductive) that may be applied to the HP E2274A is 5 ADC, 5 AAC peak per switch. Maximum power is 100W DC, 110VA AC per switch; 300W DC, 300VA AC per M-Module.

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Connections and Configurations

All HP M-Modules come supplied with a 44-pin connector and matching hood with strain relief. For the two internally mounted M-Modules, the connectors hood should not be used; strain relief is provided by wire ties inserted through holes in the carrier and cable clamps.



Switch / Control Module Configuration

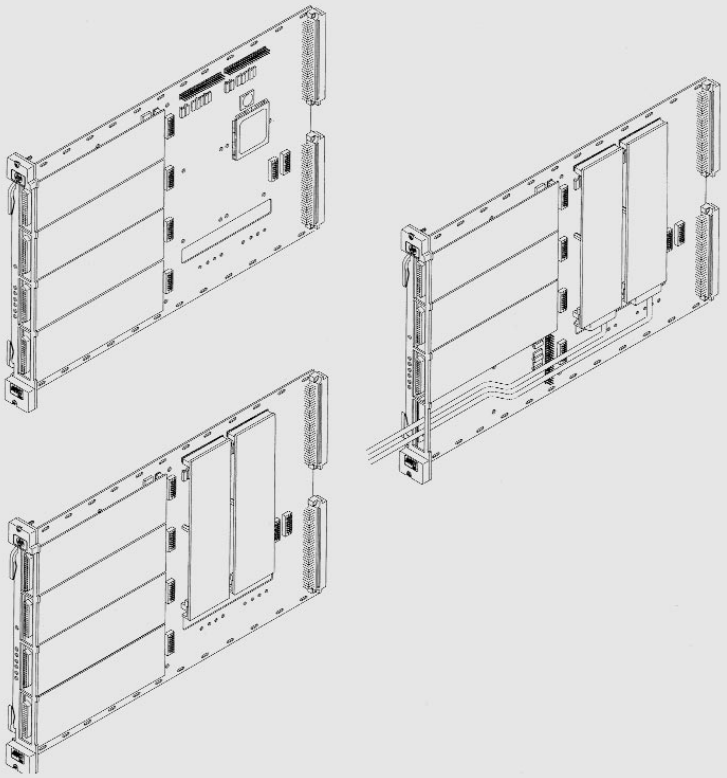
HP E2251A

HP E2251A M-Module Carrier

The HP E2251A M-Module Carrier can hold up to six M-Modules only if neither of the modules in the two interior slots (4 & 5) require external cabling. If one or both interior modules require external cabling, the bottom-front slot must be left open to accommodate the wiring and strain relief.

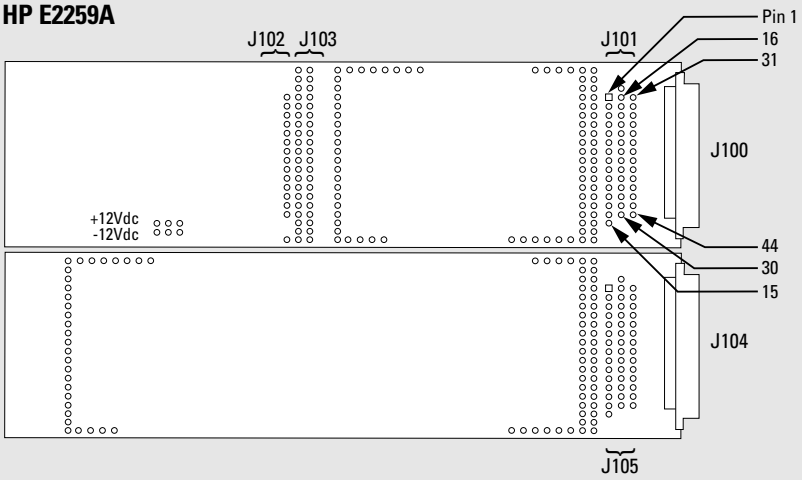
General Features:

- Supports up to 6 independent M-Modules simultaneously.
- Separate logical address for each M-Module slot.
- Fully programmable interrupts for each M-Module slot.
- VXI*plug&play* Win95/NT frameworks supported.



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HP E2259A



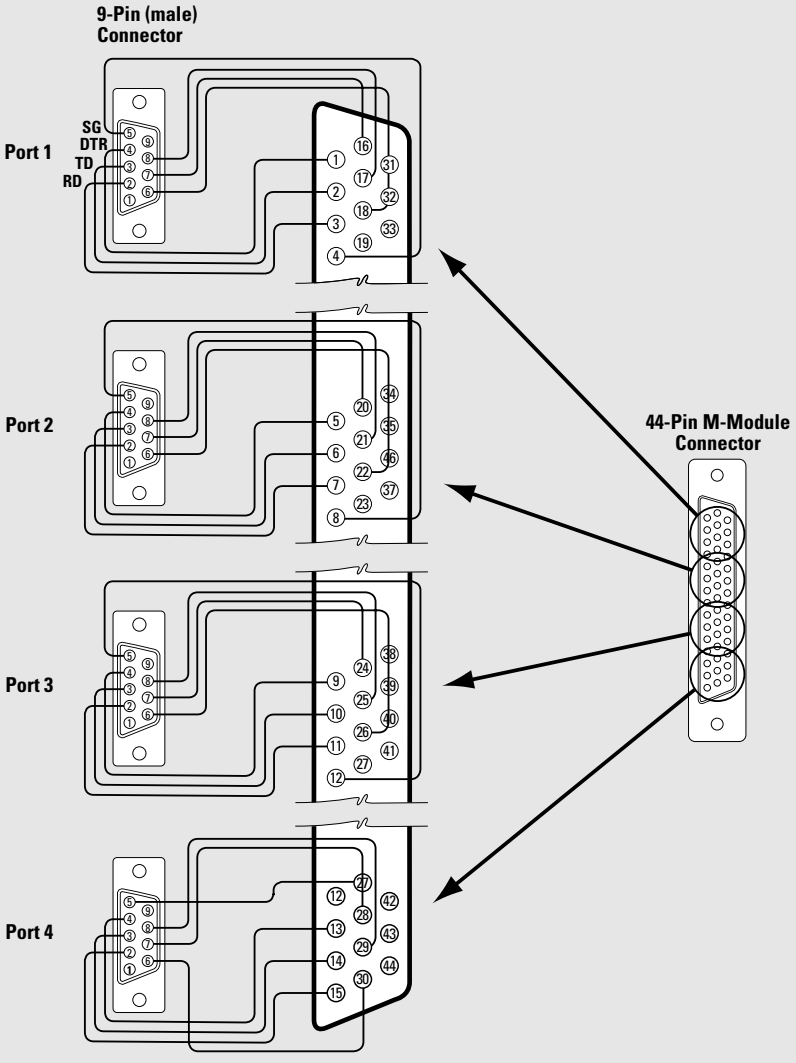
HP E2259A Double-wide M-Module Breadboard

The HP E2259A plugs onto an M-Module carrier and works as a standard VXI device.

General Features

- A8/D16 Register-based M-Module circuitry.
- Programmable BUSY Timer Register and a 16-bit input/output register.
- Decoder lines and support for internal and external interrupts.
- Double-wide but can easily be snapped in half.

HP E2261A



HP E2261A Quad RS-232 Interface

General Features

- 4 independently programmable RS-232 ports.
- 75 to 33.4K baud rate.
- 2 KB/port input and output buffering.
- Breakout cable to four D-sub connectors (male) available.

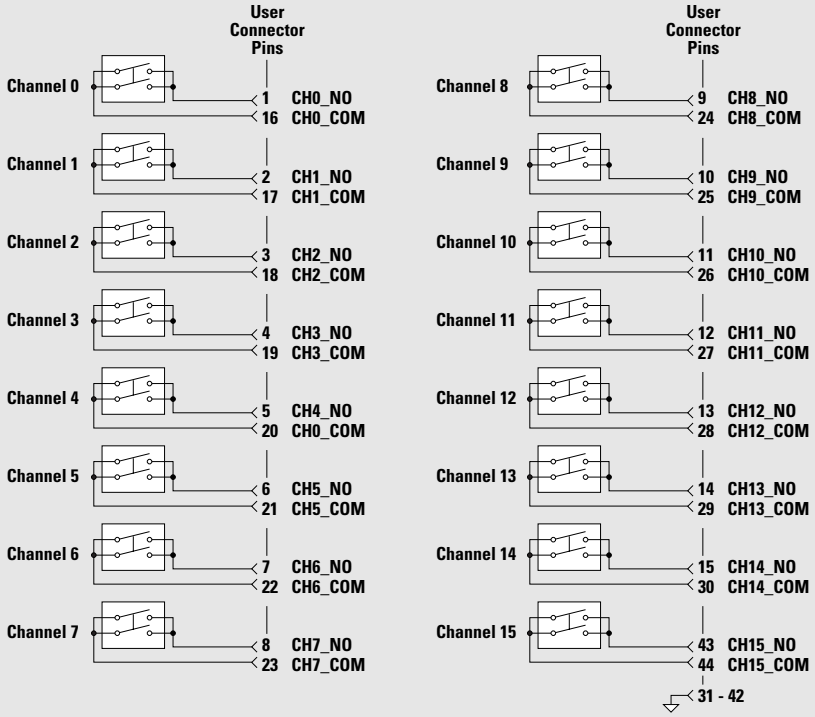
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HP E2270A 16-Channel Form-A General Purpose Switch

General Features

- 16 independent SPST latching relays.
- FIFO for storing up to 8 relay operations.

HP E2270A

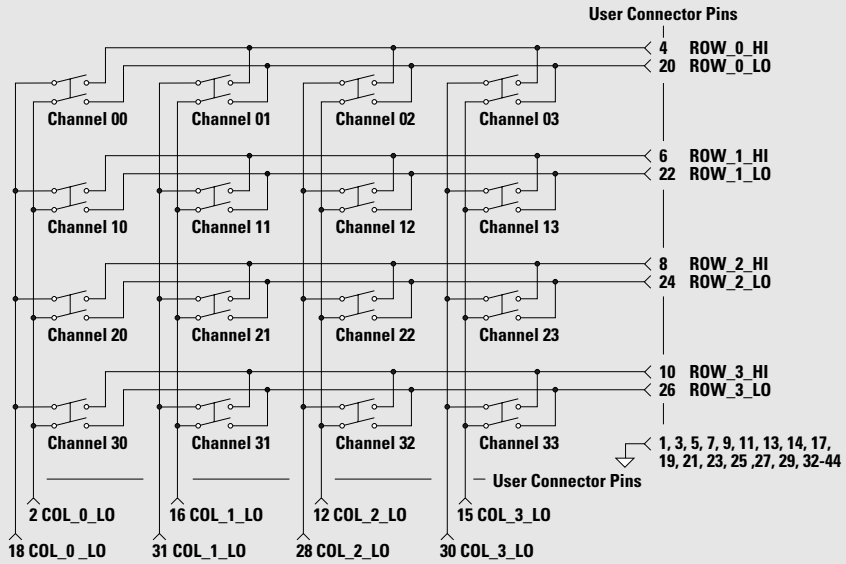


HP E2271A 4x4 Matrix Switch

General Features

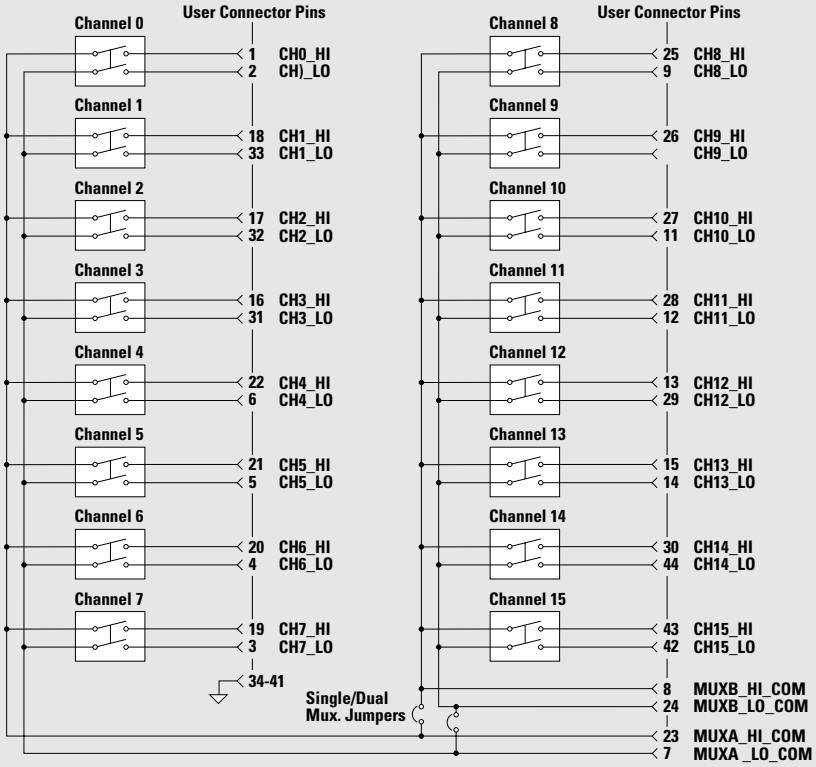
- 16 DPST latching relays (2-wire).
- FIFO for storing up to 8 relay operations.

HP E2271A



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HP E2272A

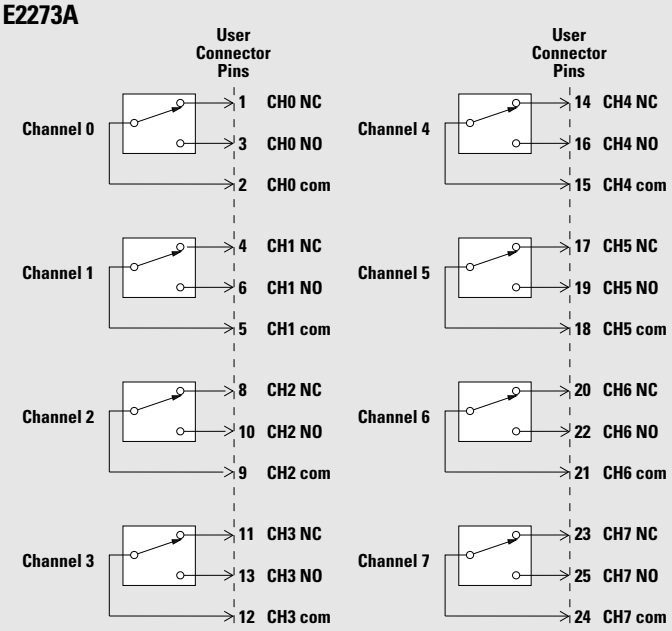


HP E2272A Dual 8-to-1 Relay Multiplexer

General Features

- Configure as two 8-to-1 multiplexers or one 16-to-1 multiplexer.
- 16 DPST latching relays.
- FIFO for storing up to 8 relay operations.

HP E2273A



HP E2273A 8-Channel Form-C Switch

General Features

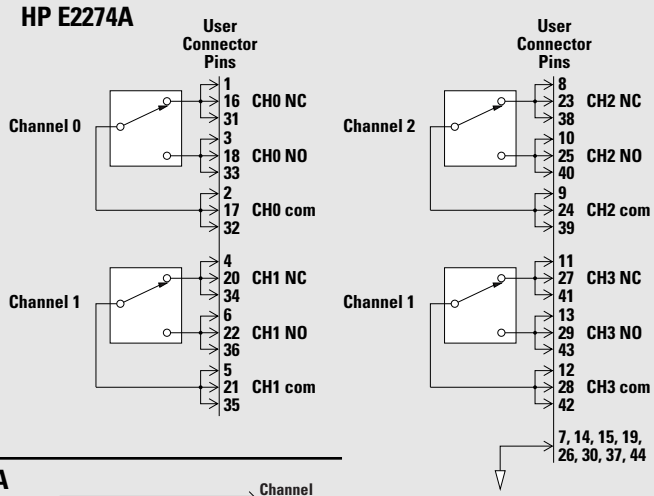
- 8 SPST armature relays.
- Can be used to drive microwave switches.
- FIFO for storing up to 8 relay operations.

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HP E2274A 4-Channel Form-C Power Relay

General Features

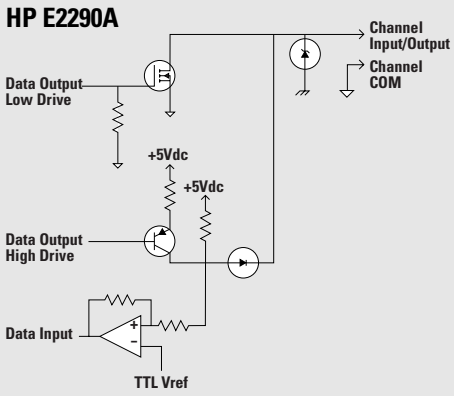
- 4 armature relays.
- Use to switch power supplies.
- FIFO for storing up to 8 relay operations.



HP E2290A 16-bit Digital I/O

General Features

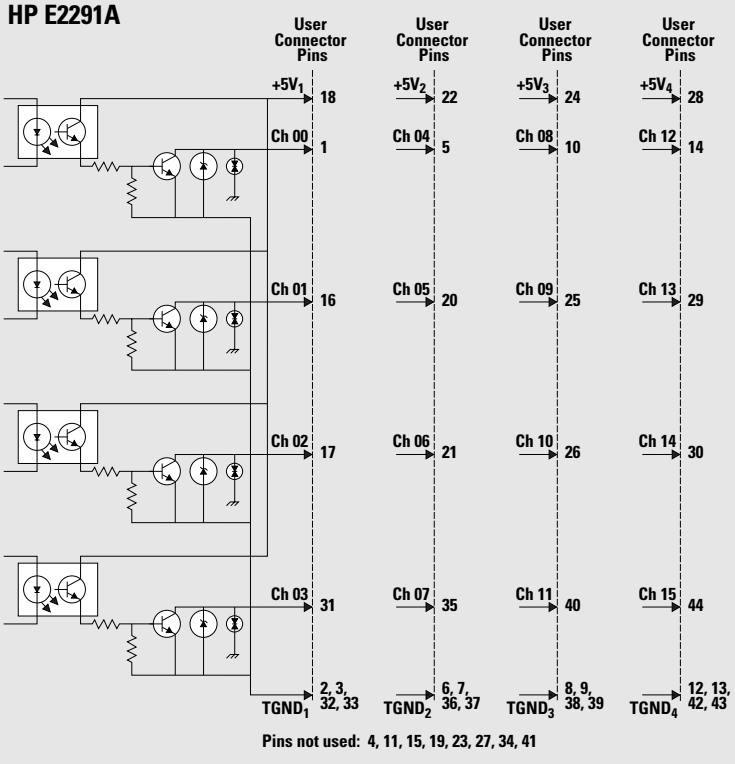
- Can interrupt on pattern matching.
- TTL compatible I/O.
- Selectable debounce on inputs (3 msec. default)



HP E2291A 16-Channel Isolated Digital Output

General Features

- Isolated digital output or external relay driver grouped in 4 groups of four.
- Requires up to four power supplies.
- Outputs isolated from chassis.
- Programmable Delay Interrup Timer (0.031 - 2089 msec.).



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IEEE 488 Common Commands

*CLS	Clears all status registers and clears the error queue
*ESE <register value>	Enables Standard Event
*ESE?	Enables Standard Event Query
*ESR?	Standard Event Register Query

*IDN?	Instrument ID Query; returns identification string of the module
	
	/* Query the M-Module ID string */
	errStatus = viQueryf(m_mod,"*IDN?\n","%t",id_string);
	if (VI_SUCCESS > errStatus) {
	printf("ERROR: viPrintf() returned 0x%x\n",errStatus);
	return errStatus;}
	printf("ID is %s\n",id_string);

*OPC	Operation Complete
*OPC?	Operation Complete Query
*RCL <numeric value>	Recalls the instrument state saved by *SAV

*RST	Resets the module to its power-on/reset state
	
	/* Reset the M-Module */
	errStatus = viPrintf(m_mod, "*RST\n");
	if(VI_SUCCESS > errStatus){
	printf("ERROR: viPrintf() returned 0x%x\n",errStatus);
	return errStatus;}

*SAV <numeric state>	Stores the instrument state
*SRE <register value>	Service request enable, enables status register bits
*SRE?	Service request enable query
*STB	Read status byte query

*TST?
error
	Self-test; executes an internal self-test and returns only the first
	
	encountered; does not return multiple errors
	
	/* Perform M-Module Self-Test */
	errStatus = viQueryf(m_mod,"*TST?\n","%t",selftst_string);
	if (VI_SUCCESS > errStatus) {
	printf("ERROR: viPrintf() returned 0x%x\n",errStatus);
	return errStatus;}
	printf("Self Test Result is %s\n",selftst_string);

*WAI	Wait to Complete

The HP E2251A M-Module Carrier allows up to six M-Modules to be installed in a single C-Size VXI Mainframe slot providing each M-Module with its own logical address and A16/A24 memory space. Each M-Module is accessed as though it is a standard VXIbus module occupying its own VXI slot in the cardcage.

To make M-Modules work as standard VXIbus devices, the HP E2251A Carrier provides a logical address scheme for each M-Module. The Carrier itself does not have a logical address and is transparent to the VXIbus. A set of logical address switches are located on the Carrier for each M-Module and provides a unique reference for addressing specific M-Modules. Slots not used on the Carrier should have their logical address switches set to 0 (zero). The Carrier also reads the identification EEPROM from HP M-Modules and copies data into the standard VXI registers.

Most HP M-Modules are provided with a downloadable SCPI driver. While using such a high level language driver, you do not need to understand the register mapping of M-Modules. If, however, you need to use register-based programming, do not mix register writes with SCPI commands.

To execute any of the following examples you must have the HP SICL or HP VISA library, an HP-IB (IEEE 488) interface installed in an external PC with an HP E1406 Command Module, or an embedded PC controller such as the HP E6232A or E6233A.

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Initial Operation

The following example reads the module ID string, performs module self-test, and displays the results. This program can be used on any of the M-Modules except the breadboard.

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

/* Interface address is 9, M-Module secondary address is 3*/
#define INSTR_ADDR "GPIB0::9::3::INSTR"
int main()
{
        ViStatus errStatus;         /*Status from each VISA call*/
        ViSession viRM;             /*Resource mgr. session */
        ViSession m_mod;            /* M-module session  */
        char id_string[256];        /*ID string*/
        char selftst_string[256];   /*self-test string*/

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

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

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

/* Perform M-Module Self-Test */
        errStatus = viQueryf(m_mod,"*TST?\n","%t",selftst_string);
        if (VI_SUCCESS > errStatus) {
                printf("ERROR: viPrintf() returned 0x%x\n",errStatus);
                return errStatus;}
        printf("Self Test Result is %s\n",selftst_string);

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

/* Close the M_Module Instrument Session */
        errStatus = viClose (m_mod);
        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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Closing and Opening Channels

[ROUTe]:CLOSe <channel_list>	Closes one or more channels on a switch M-Module

```
/* Close channels 1 and 10 through 13 on the M-Module */
    errStatus = viPrintf(m_mod,"ROUT:CLOS (@01,10:13)\n");
    if (VI_SUCCESS > errStatus) {
        printf("ERROR: viPrintf() returned 0x%x\n",errStatus);
        return errStatus;}
```

[ROUTe]:OPEN <channel_list>	Opens one or more channels on a switch M-Module

```
/* Open channels 1 and 11 on the M-Module */
    errStatus = viPrintf(m_mod,"ROUT:OPEN (@01,11)\n");
    if (VI_SUCCESS > errStatus) {
        printf("ERROR: viPrintf() returned
    0x%x\n",errStatus);
        return errStatus;}
```

HP E2272A Relay Multiplexer Note:

In the dual 8-to-1 mode, ROUTe:CLOSe ensures that only one relay is closed at a time in each multiplexer. In the single 16-to-1 mode, ROUTe:CLOSe ensures that only one relay is closed at a time on the entire module.

Note: The [ROUTe]: portion of the command is optional syntax and can be omitted. For example, the command [ROUTe]:CLOSe <channel_list> can be shortened to CLOSe <channel_list>.

Channel Lists

The <channel_list> parameter in the CLOSe or OPEN command has the form (@ccnn), where cc is the card number and nn is the channel number.

You can specify a single channel (@nn), use commas to specify multiple channels (@nn,nn,..), or use a colon to specify a range of channels (@nn:nn). You can also specify any combination of single channels, multiple channels, and channel ranges. In the above examples, cc is always 1 as the SCPI driver only supports a single module. To simplify programming, the card number (cc) can be eliminated.

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Digital I/O Module Commands

DISPlay:MONitor[:STATe] 0 | 1 | ON | OFF	This subsystem turns on the Digital I/O modules monitor mode. Parameters related to the state of the data are shown on an external monitor. The display monitor is an RS-232 terminal attached to an HP E1405B, E1406A/B, or E1306 Command Module. This provides an interactive user interface to the HP E2290A.
DISPlay:MONitor[:STATe]?	Returns the value of the Display Monitor State as either 0 (for OFF) or 1 (for ON).
INPut:DEBounce[:STATe] 0 | 1 | ON | OFF	This subsystem configures the input debounce circuitry. The debounce circuitry allows the incoming data to be debounced for approximately 3 msec before being latched into the Input Register. Debounce for the Input Register can be enabled or disabled but is always active for the pattern match interrupt.
INPut:DEBounce[:STATe]?	Returns the value of the Input Register Debounce circuitry as either 1 (enabled / ON) or 0 (disabled / OFF).
MEASure Subsystem	The MEASure commands return data corresponding to the current value of the input signals

:DIGital:DATAn[:BYTE]:BITm?
:DIGital:DATAn[:BYTE][:VALue]?
:DIGital:DATAn:WORD:BITm?
:DIGital:DATAn:WORD[:VALue]?
	/* Read the value from Port 1 */
	errStatus = viQueryf(E2290,"MEAS:DIG:DATA1?\n","%t",value);
	if VI_SUCCESS > errStatus) {
	printf("ERROR: viPrintf() returned 0x%x\n",errStatus);
	return errStatus;}
	printf("Value read from Port 1 is: %i\n",value);

SENSe Subsystem	The SENSe commands allow matching of digital input patterns; an interrupt is generated when a pattern match occurs

[:EVENt][:PATTern]<pattern>
[:EVENt][:PATTern]?
[:EVENt][:PATTern]:ENABle<mask>
	/* Define Pattern for Matching */
	errStatus = viPrintf (E2290, "SENS:EVEN:PATT %d\n",0xAAAA);
	if (VI_SUCCESS > errStatus){
	printf("ERROR: viPrintf() returned 0x%x\n",errStatus);
	return errStatus;}
	/* Set Pattern Mask */
	errStatus = viPrintf (E2290, "SENS:EVEN:ENAB %d\n",0xFFFF);
	if (VI_SUCCESS > errStatus){
	printf("ERROR: viPrintf() returned 0x%x\n",errStatus);
	return errStatus;}

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SOURce Subsystem	The SOURce commands are used to output (source) digital data from the HP E2290A to external instrumentation or device-under-test

:DIGital:DATAn[:BYTe]:BITm 0 | 1
:DIGital:DATAn[:BYTe]:BITm?
:DIGital:DATAn[:BYTe][:VALue]<data>
:DIGital:DATAn[:BYTe][:VALue]?
:DIGital:DATAn:WORD:BITm 0 | 1
:DIGital:DATAn:WORD:BITm?
:DIGital:DATAn:WORD[:VALue]<data>
:DIGital:DATAn:WORD[:VALue]?
:CONTrol[:ENABle]?
	/* Write a value to Port 0 */
	errStatus = viPrintf(E2290,"SOUR:DIG:DATA0 0xAA\n");
	if(VI_SUCCESS > errStatus) {
	printf("ERROR: viPrintf() returned 0x%x\n",errStatus);
	return errStatus;}

STATus Subsystem	The STATus subsystem controls the SCPI-defined Operation and Questionable Status registers, Standard Event register, and the Status Byte register. Each is comprised of a condition register, an event register, an enable mask, and transition filters.

:OPERation
:CONDition?
:ENABle<mask>
:ENABle?
:[:EVENt]?
:PRESet
:QUEStionable
:CONDition?
:ENABle<mask>
:ENABle?
:[:EVENt]?
:CONDition?
:ENABle<mask>
:ENABle?
:[:EVENt]?
	/* Enable SRQ Event */
	errStatus = viEnableEvent(E2290,VI_EVENT_SERVICE_REQ,VI_QUEUE,VI_NULL);
	if (VI_SUCCESS > errStatus){
	printf("ERROR: viEnableEvent() returned 0x%x\n",errStatus);
	return errStatus;}
	errStatus = viPrintf (E2290, "STAT:OPER:ENAB 256\n");
	if (VI_SUCCESS > errStatus){
	printf("ERROR: viPrintf() returned 0x%x\n",errStatus);
	return errStatus;}
	errStatus = viPrintf (E2290, "*SRE 128\n");
	if (VI_SUCCESS > errStatus){
	printf("ERROR: viPrintf() returned 0x%x\n",errStatus);
	return errStatus;}

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