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HP 75000 SERIES C

HP E1451/E1452 20MHz Pattern I/O Modules

Hardware Manual

HEWLETT® PACKARD

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According to ISO/IEC Guide 22 and EN 45014

The Hewlett-Packard Company declares that the HP 75000 Model D20 E145xA Series modules and pods conforms to the following Product Specifications.

Safety:	IEC 1010-1 (1990) Incl. Amend 1 (1992)/EN61010 (1993) CSA C22.2 #1010.1 (1992) UL 1244
EMC:	CISPR 11:1990/EN 55011 (1991): Group1 Class A IEC 801-2:1991/EN 50082-1 (1992): 4kVCD, 8kVAD IEC 801-3:1984/EN 50082-1 (1992): 3 V/m IEC 801-4:1988/EN 50082-1 (1992): 1kV Power Line

Supplementary Information: The product herewith complies with the requirements of the low voltage Directive 73/23/EEC and the EMC Directive 89/336/EEX.
Tested in a typical configuration in an HP C-size VXI mainframe.

Jan White

Q.A. Manager
February 1994

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Printing History

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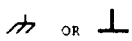
Safety Symbols



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



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



OR

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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Chapter 1
Hardware Descriptions

HP E1451/E1452 Pattern I/O Hardware Description

The HP E1451 Pattern I/O Module and HP E1452 Terminating Pattern I/O Module (Figure 1-1) are single slot, C-size VXIbus register-based modules. They are used to send or receive pattern data to/from the DUT (Device Under Test). Each I/O module contains four identical 8-pin ports (32 I/O pins). Each port can be independently programmed to either output (stimulus), record (response), or real-time compare (response). A module block diagram is shown on the following page.

Each port has a 64k-byte deep sequence memory for holding patterns and control bits. Multiple test sequences may co-reside in this memory. To eliminate skew errors caused by timing variation between ports, each port has its own programmable delay device. This device is programmed based on constants stored in the module's calibration memory.

The HP E1451 and HP E1452 are identical except that the HP E1451 passes along the Local Bus pattern clocks to the next module whereas the HP E1452 terminates the pattern clock lines. The HP E1452 Terminating Pattern I/O Module must be the last module of the Pattern I/O module set so the Local Bus is properly terminated when the HP E1450 Timing Module is used. If external timing is used in lieu of the timing module, then only the HP E1451 Pattern I/O module is required.

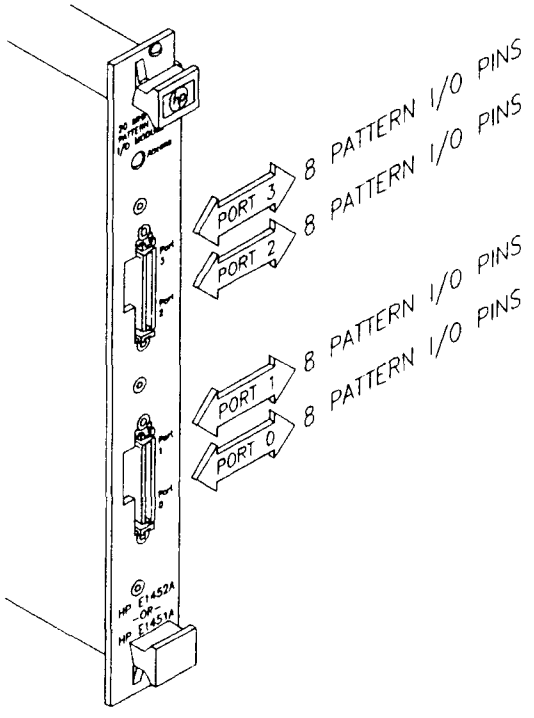


Figure 1-1. HP E1451/E1452 Pattern I/O Module

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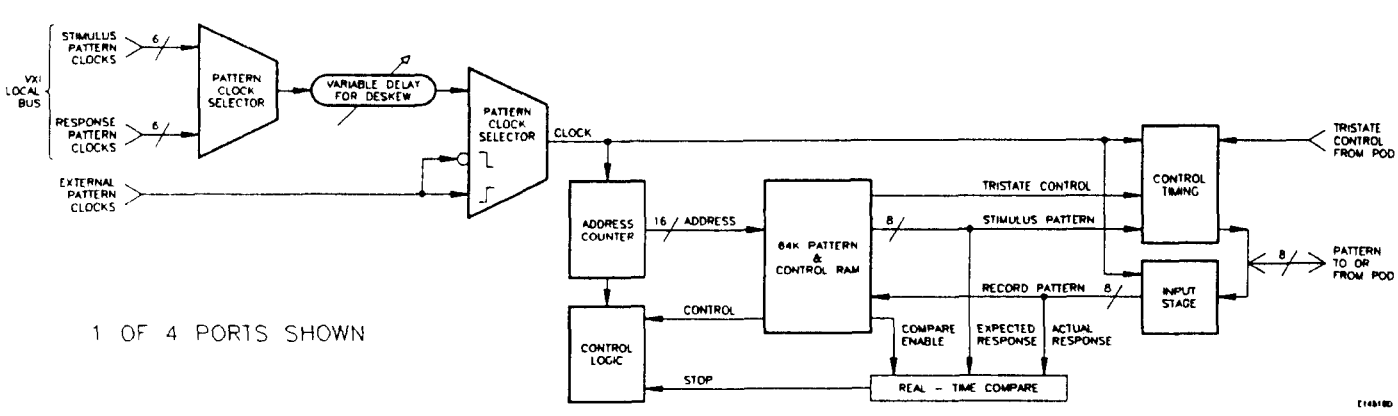


Figure 1-2. Pattern I/O Block Diagram

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HP E1454 Pattern I/O Pod Description

The optional HP E1454 Pattern I/O Pod (Figure 1-3) extends measurement accuracy to a DUT located up to two meters from the front panel of the Model D20. The pods buffer the input and output signals for two of the four HP E1451/E1452 I/O ports. This improves the Model D20's ability to drive DUT inputs and minimizes loading on DUT outputs. Response pattern clocks are delayed relative to the stimulus pattern clocks by the Timing Module so that timing is correct at the DUT. And pin-to-pin skew on the pattern I/O lines is compensated, based on constants stored in the pod's calibration memory. The pattern I/O pods also provide inputs for tri-state control and external clock. The HP E1454 is supplied with a 2.1-meter cable. Two HP E1454 pods are required for each HP E1451/E1452 in the Model D20.

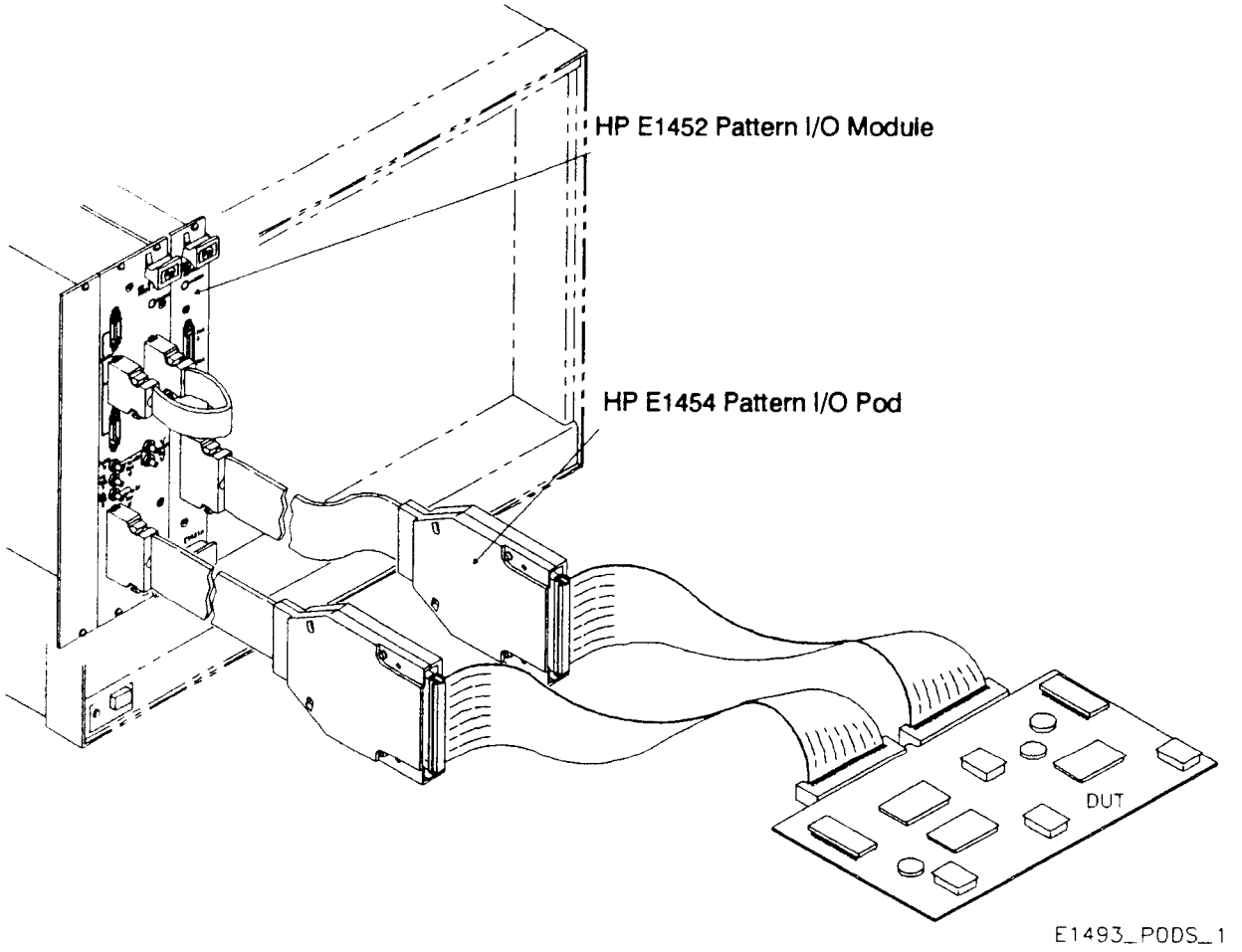


Figure 1-3. Pattern I/O Module/Pod

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Using the HP E1451/E1452 as a Stand-Alone Instrument

You can use the pattern module as a stand-alone digital I/O instrument without the need for an HP E1450 Timing Module. In this configuration, the pattern module must have a logical address that is a direct multiple of 8 (i.e., 8, 16, 24, 32, . . . 240). You must also use an external clock source since the Timing Module is not present (refer to "Using External Clocks" in chapter 3 of the Model D20 Task and Command Reference). When used as a stand-alone instrument, the pattern module is capable of executing only those commands shown in Table 1-1. Refer to the Command Reference, chapter 4 of the Model D20 Task and Command Reference Manual for details about these commands.

PN E1493-90030
includes this manual

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Table 1-1. Stand-Alone Pattern Module Command Set

[DIGital] Subsystem

```
:GROup
    :CATalog?
    :DEFine <name>,<port_list>
    :DEFine? <group_name>
    :DELete:ALL
    :DELete[:NAME] <group_name>
    :MODE RESPonse|STIMulus
    :MODE?
    [:SELect] <group_name>|NONE
    [:SELect]?

:RESPonse
    :COMPare
        :ENABle
          :SEQuence
            [:FULL] <boolean_block>
            [:FULL]?
            :PARTial <start_vector>,1|0|ON|OFF{,1|0|ON|OFF}
            :PARTial? <start_vector>,<count>
            :REPeat <start_vector>,<count>,1|0|ON|OFF
        [:STATe] 1|0|ON|OFF
        [:STATe]?
        :ERRor?
        :MASK[:VALue] <pattern_value>
        :MASK[:VALue]?
    :PATTern
        :SEQuence
            [:FULL] <pattern_block>
            [:FULL]?
            :PARTial <start_vector>,<pattern_value>
                {,<pattern_value>}
            :PARTial? <start_vector>,<count>
            :REPeat <start_vector>,<count>,<pattern_value>
        [:VALue]?
    :CLOCk
        :EXTernal:SLOPe POSitive|NEGative
        :EXTernal:SLOPe?
        :SOURce HOLD|EXTernal
        :SOURce?

:SEQuence
    :CATalog?
    :DEFine <name>,<#_vectors>
    :DEFine? <seq_name>
    :DELete:ALL
    :DELete[:NAME] <seq_name>
    :POSition?
    [:SELect] <seq_name>|NONE
    [:SELect]?
    :WINDow
        :BOUNdary <start_vector>,<stop_vector>
        :BOUNdary?
        [:STATe] 1|0|ON|OFF
        [:STATe]?

:STIMulus
    :ENABle
        :SEQuence
            [:FULL] <boolean_block>
            [:FULL]?
            :PARTial <start_vector>,1|0|ON|OFF{,1|0|ON|OFF}
            :PARTial? <start_vector>,<count>
            :REPeat <start_vector>,<count>,1|0|ON|OFF
        [:VALue] 1|0|ON|OFF
        [:VALue]?
    :PATTern
        :SEQuence
            [:FULL] <pattern_block>
            [:FULL]?
            :PARTial <start_vector>,<pattern_value>
                {,<pattern_value>}
            :PARTial? <start_vector>,<count>
            :REPeat <start_vector>,<count>,<pattern_valu
        [:VALue] <pattern_value>
        [:VALue]?
    :CLOCk
        :EXTernal:SLOPe POSitive|NEGative
        :EXTernal:SLOPe?
        :SOURce HOLD|EXTernal
        :SOURce?
```

System Operation Commands

```
RUN
STOP
```

System Status, Management, and Test Commands

```
STATus
    :OPERation
        [:EVENt]?
        :CONDition?
        :ENABle <pattern_value>
        :ENABle?
        :NTRansition <pattern_value>
        :NTRansition?
        :PTRansition <pattern_value>
        :PTRansition?
    :PRESet
    :QUEStionable
        [:EVENt]?
        :CONDition?
        :ENABle <pattern_value>
        :ENABle?
        :NTRansition <pattern_value>
        :NTRansition?
        :PTRansition <pattern_value>
        :PTRansition?

SYSTem
    :ERRor?
    :PRESet
    :VERSion?

TEST
    [:ALL]?
    :MODule? <module_#>
```

Query Data Format Commands

```
FORMat
    [:DATA] ASCii|HEXadecimal|OCTal|BINary
    [:DATA]?
```


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Chapter 2
Configuration and Wiring

Using this Chapter

This chapter contains configuration and wiring information for the HP E1451/E1452 Pattern I/O Modules, the optional HP E1454 Pattern I/O Pods, and the optional module to DUT interface cables. For complete details on installing this equipment in a C-Size mainframe, refer to the "HP 75000 Model D20 Hardware Installation Guide" and the "C-Size VXIbus Systems Installation and Getting Started Guide".

WARNING

SHOCK HAZARD. Only service-trained personnel who are aware of the hazards involved should install, remove, or configure the system. Before you perform any procedures in this guide, disconnect AC power and field wiring from the mainframe.

Caution

STATIC ELECTRICITY. Static electricity is a major cause of component failure. To prevent damage to the electrical components in the mainframe and plug-in modules, observe anti-static techniques whenever handling a module.

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Configuration Information

This section shows you how to set the module's logical address switch.

Logical Address Guidelines

- The HP E1450 Timing Module must have a Logical Address that is an Instrument Identifier. An Instrument Identifier is a Logical Address that is an exact multiple of 8 (i.e., 8, 16, 24, 32, . . . 240).
- HP E1451 Pattern I/O and E1452 Terminating I/O modules must have successive Logical Addresses beginning with the address of the Instrument Identifier. The HP E1452 Terminating I/O Module must have the highest Logical Address (last in the list).

NOTE

When using an HP E1451 or E1452 as a stand-alone instrument (no other modules involved), it must have a Logical Address that is an Instrument Identifier (an exact multiple of 8).

Logical Address Switch

Figure 2-1 shows a Logical Address Switch. Notice that the switch is made up of 8 switches each having a decimal value. To determine the Logical Address, add the decimal values of all set switches. For example, if you set switches 7 and 3 to "1" (see Figure 2-1), the logical address is 128 + 8 = 136. The HP-IB Secondary Address is determined by dividing the Instrument Identifier by 8. For example, if the Instrument Identifer logical address is 136, the Secondary Address is 136 / 8 = 17. Figure 2-2 shows how to set the Logical Address switch.

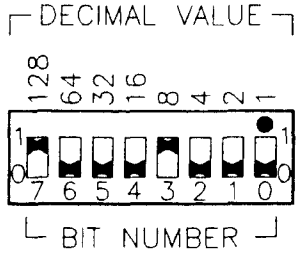


Figure 2-1. Logical Address Switch

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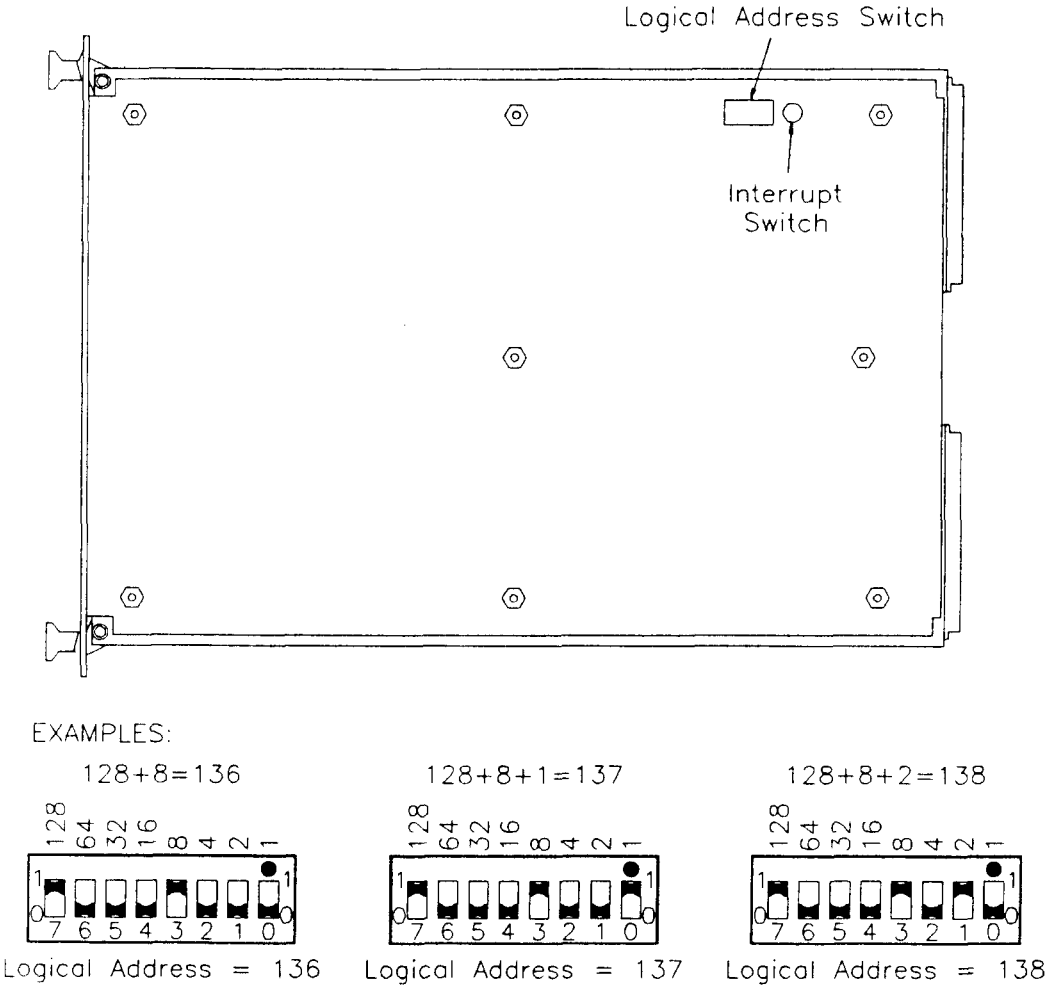


Figure 2-2. Setting a Logical Address Switch

NOTE

Plug-in modules also contain Interrupt Switches. We recommend that you leave these switches set to 1 (factory setting). This causes the modules to use interrupt line 1 which is the default line for most interrupt handlers (command module, embedded controller, etc.). Refer to the "C-Size VXIbus Systems Installation and Getting Started Guide" if you need more information on Interrupt Switches.

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Wiring Information

This section shows the module's front panel connector pin-out, the optional HP E1454 Pattern I/O Pod connector pin-out (DUT side), and the optional DUT interface cable wiring.

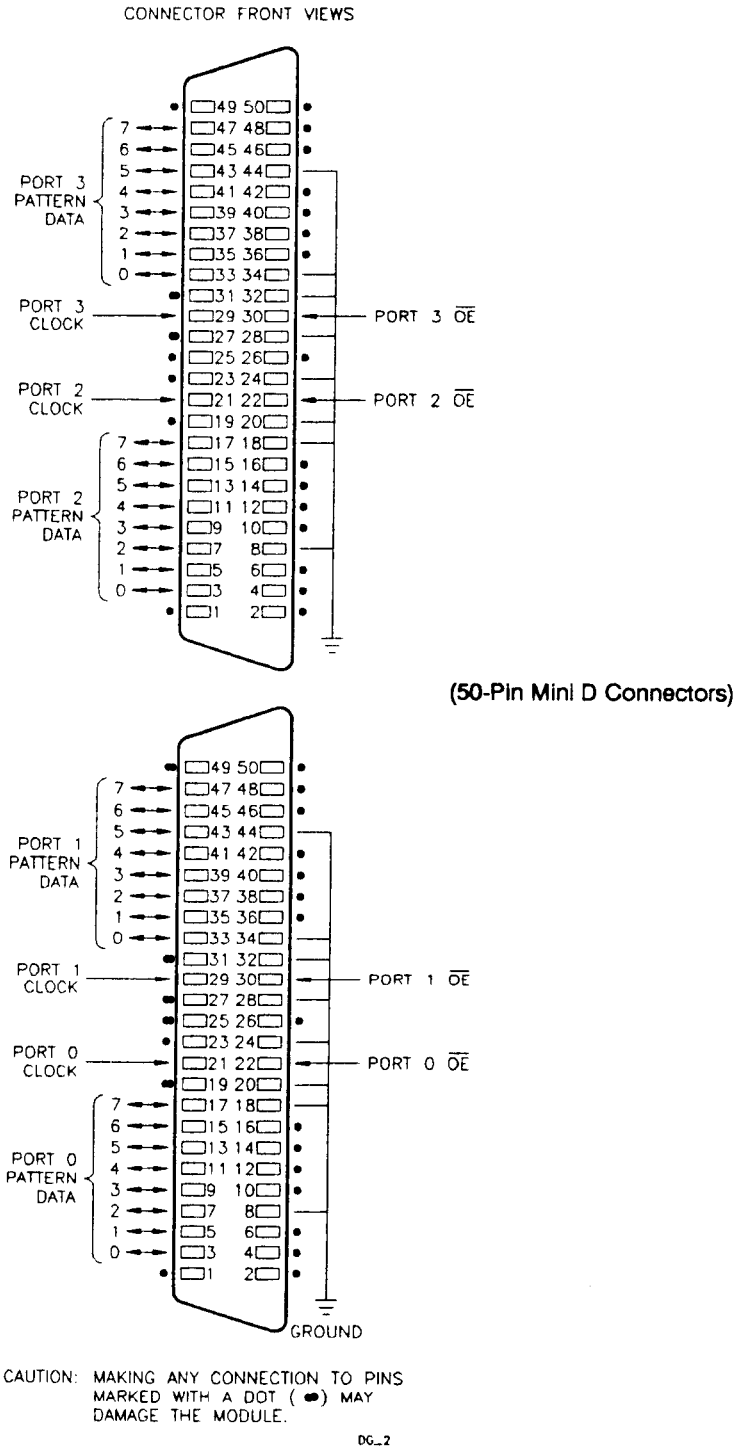


Figure 2-3. Pattern I/O Front Panel Connectors

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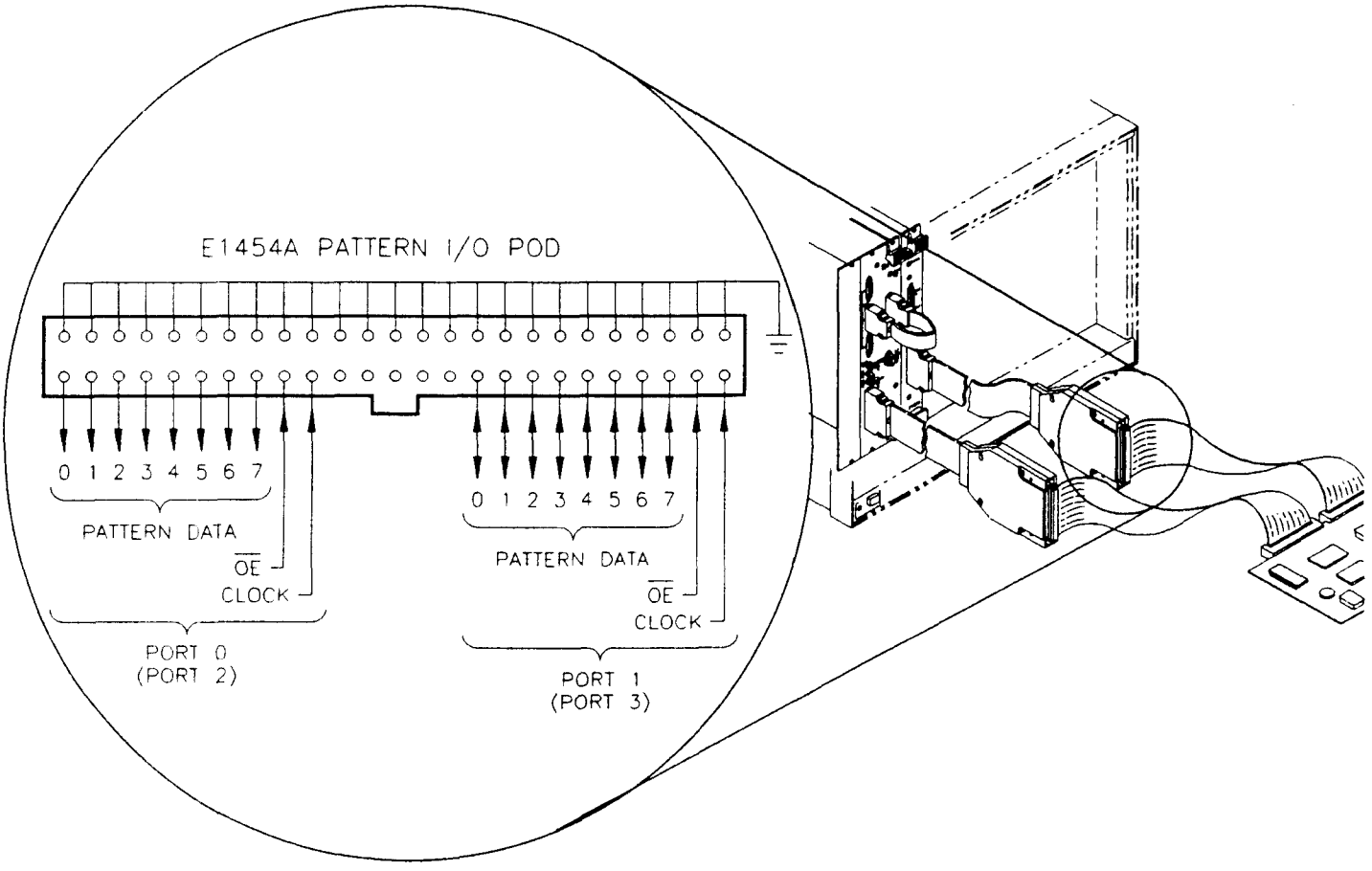
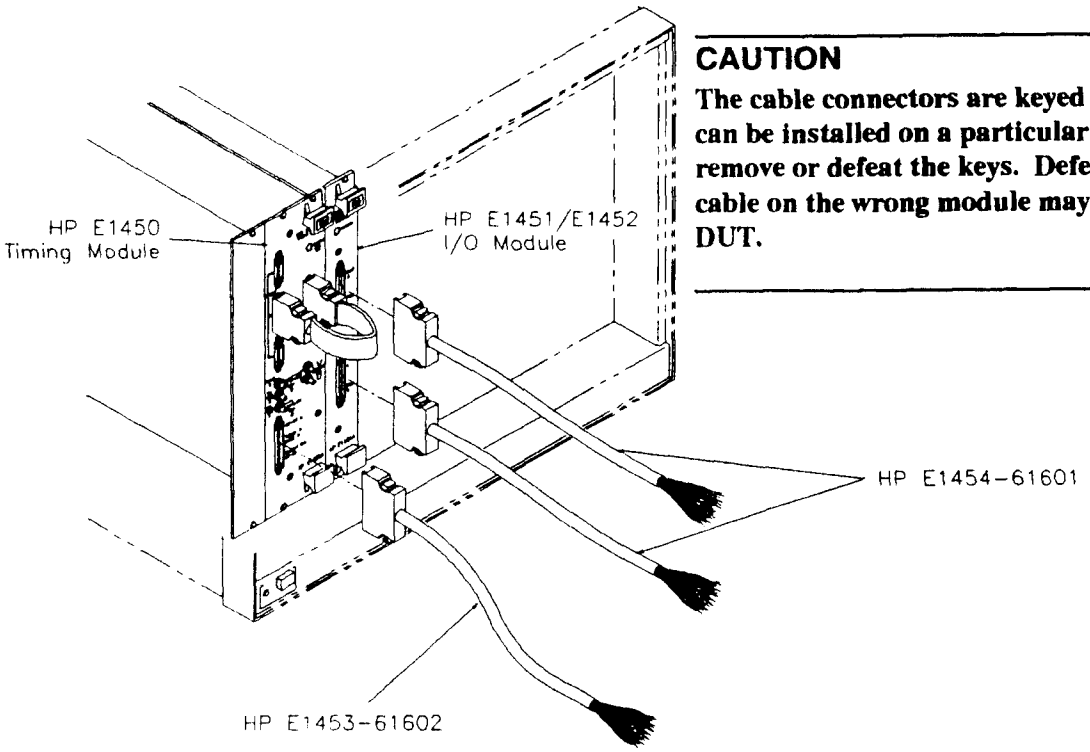


Figure 2-4. Pattern I/O Pod Connector

CAUTION

The pod connectors are keyed so that only the correct pod can be installed on a particular plug-in module. Do not remove or defeat the keys. Defeating a key and installing a pod on the wrong module will damage the module and the pod.

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CAUTION

The cable connectors are keyed so that only the correct cable can be installed on a particular plug-in module. Do not remove or defeat the keys. Defeating a key and installing a cable on the wrong module may damage the module and the DUT.

Figure 2-5. Module to DUT Interface Cables

Table 2-1. Pattern I/O (HP E1454-61601) Wiring

Pin	Color	Signal	Pin	Color	Signal
1	NC		2	NC	
3	RED/BLUE	D0 (Port 0 or 2)	4	NC	
5	WHITE/BROWN	D1 (Port 0 or 2)	6	NC	
7	RED/ORANGE	D2 (Port 0 or 2)	8	VIOLET/BLUE	GROUND
9	WHITE/ORANGE	D3 (Port 0 or 2)	10	NC	
11	RED/GREEN	D4 (Port 0 or 2)	12	NC	
13	WHITE/GREEN	D5 (Port 0 or 2)	14	NC	
15	WHITE/BLUE	D6 (Port 0 or 2)	16	NC	
17	RED/BROWN	D7 (Port 0 or 2)	18	BLUE/VIOLET	GROUND
19	NC		20	VIOLET/ORANGE	GROUND
21	WHITE/GRAY	EXT CLK2 (Port 0 or	22	YELLOW/BROWN	$\overline{OE}$ (Port 0 or 2)
23	NC		24	ORANGE/VIOLET	GROUND
25	NC		26	NC	
27	NC		28	VIOLET/GREEN	GROUND
29	RED/GRAY	EXT CLK3 (Port 1 or	30	YELLOW/GRAY	$\overline{OE}$ (Port 1 or 3)
31	NC		32	GREEN/VIOLET	GROUND
33	BLACK/ORANGE	D0 (Port 1 or 3)	34	VIOLET/BROWN	GROUND
35	BLACK/BROWN	D1 (Port 1 or 3)	36	NC	
37	YELLOW/BLUE	D2 (Port 1 or 3)	38	NC	
39	BLACK/GREEN	D3 (Port 1 or 3)	40	NC	
41	BLACK/BLUE	D4 (Port 1 or 3)	42	NC	
43	YELLOW/ORANGE	D5 (Port 1 or 3)	44	BROWN/VIOLET	GROUND
45	BLACK/GRAY	D6 (Port 1 or 3)	46	NC	
47	YELLOW/GREEN	D7 (Port 1 or 3)	48	NC	
49	NC		50	NC	

Notes: NC = No Connection. Colors listed as main body color/stripe color. For example, WHITE/BROWN is a white wire with a brown stripe.

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Recommended Fixturing Techniques

- The pod mating connector (Dut side) is a 50-pin (2 x 25) male dual in-line connector with 0.025-inch (0.64mm) round or square pins on 0.100-inch (2.54mm) centers. This connector is not supplied with the product and is available from electronic supply houses.

- Do not connect the device under test (DUT) directly to the pod connector. Whenever possible, use intermediate wiring between the pod mating connector and the test fixture connector (such as the PC Board Edge Connector shown below). This minimizes the number of insertions/removals made to the pod connector which extends its lifetime.

- Keep all wiring to the DUT as short as possible.

CAUTION

Clearly label the wiring and connectors to identify timing connections and I/O connections. Equipment or DUT damage can occur if these connections are accidentally reversed.

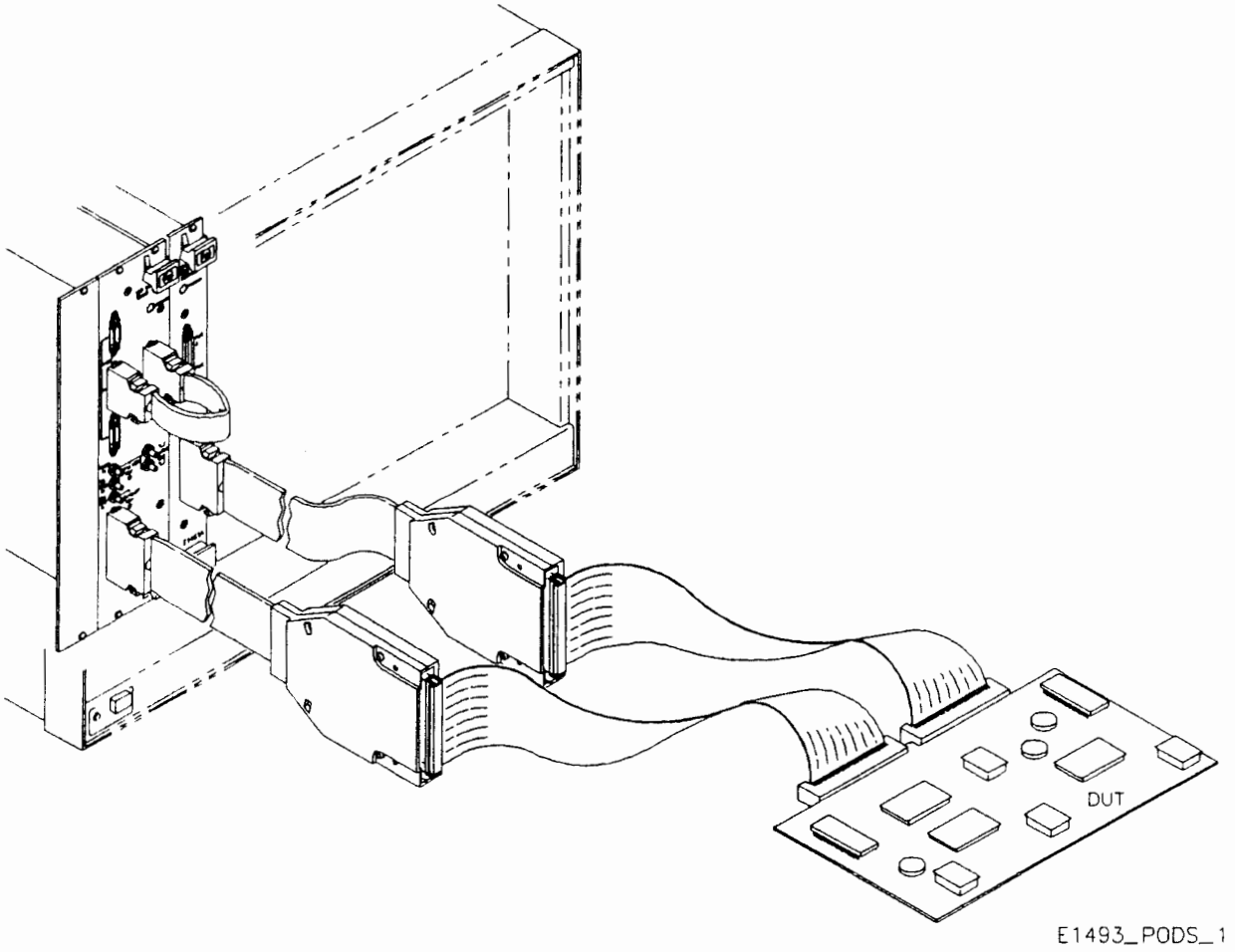


Figure 2-6. Recommended Fixturing Techniques

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Chapter 3
Register Maps

Using This Chapter

The HP E1451/E1452 modules are a register-based devices. This chapter contains the register information for these modules.

CAUTION

The register maps in this chapter are included for reference information only. WE DO NOT RECOMMEND THAT YOU ATTEMPT TO PROGRAM THE MODEL D20 AT THE REGISTER LEVEL. Register-based programming of this product is difficult; requires in-depth knowledge of the internal workings of the product; can result in the erasure of calibration constants requiring the product to be serviced at an HP Service Center. REPAIRS MADE TO THE PRODUCT TO REPLACE CALIBRATION CONSTANTS ERASED BY REGISTER-BASED PROGRAMMING ARE NOT COVERED BY THE PRODUCT WARRANTY.

Register Addresses

The following table shows the HP E1451/E1452 register offset values within the A16 address space (note that a base address must be added to the register offset value to produce the register address).

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Table 2-1. HP E1451/E1452 Registers within A16 Address Space.

Address (Hex)	Register Description
3E	Port 3 Mask/Calibration Value
3C	Port 3 Status/Clock Source
3A	Port 3 I/O Control
38	Port 3 Configuration
36	Port 3 Data Bus
34	Port 3 Branch Destination
32	Port 3 Sequence Memory Address
30	Port 2 Mask/Calibration Value
2E	Port 2 Status/Clock Source
2C	Port 2 I/O Control
2A	Port 2 Configuration
28	Port 2 Data Bus
26	Port 2 Branch Destination
24	Port 2 Sequence Memory Address
22	Port 1 Mask/Calibration Value
20	Port 1 Status/Clock Source
1E	Port 1 I/O Control
1C	Port 1 Configuration
1A	Port 1 Data Bus
18	Port 1 Branch Destination
16	Port 1 Sequence Memory Address
14	Port 0 Mask/Calibration Value
12	Port 0 Status/Clock Source
10	Port 0 I/O Control
0E	Port 0 Configuration
0C	Port 0 Data Bus
0A	Port 0 Branch Destination
08	Port 0 Sequence Memory Address
06	Calibration ROMs
04	Status/Control
02	Device Type
00	ID

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The Base Address

To access a register, you must specify the register address in either hexadecimal or decimal. The register address consists of a base address plus a register offset. The base address depends on whether the A16 address space is accessed via the Series C HP E1405 Command Module or via some other controller.

A16 Address Space when not using the HP E1405 Command Module

When the Command Module or Mainframe is not part of your VXIbus system, the module's base address is computed by taking the controller specific offset and adding the following:

hexadecimal	decimal
C000h + (LADDR * 64)h	49,152 + (LADDR * 64)

where C000h (49,152) is the starting location of the register addresses, LADDR is the module's logical address, and 64 is the number of address bytes per register-based module. For example, the module's factory set logical address is 136. If this address is not changed, the module will have a base address consisting of the controller specific offset with the following added to it:

hexadecimal	decimal
C000h + (136 * 64)h C000h + 2200 = E200h	49,152 + (136 * 64) 49,152 + 8704 = 57,856

A16 Address Space Using the Command Module

When the A16 address space is accessed via the Command Module, the module's base address is computed as:

hexadecimal	decimal
1FC000h + (LADDR * 64)h	2,080,768 + (LADDR * 64)

where 1FC000h (2,080,768) is the starting location of the register addresses, LADDR is the module's logical address, and 64 is the number of address bytes per register-based module. For example, the module's factory set logical address is 136. If this address is not changed, the module will have a base address of:

hexadecimal	decimal
1FC000h + (136 * 64)h 1FC000h + 2200h = 1FE200h	2,080,768 + (136 * 64) 2,080,768 + 8704 = 2,089,472

Register Offset

The register offset is the register's location in the block of 64 address bytes (see Table 2-1). For example, the module's Port 1 Mask/Calibration register has an offset of 22h. When writing a value to this register, this offset is added to the base address to form the register address:

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Address Space	Hexadecimal Register Address	Decimal Register Address
Outside the command module	OFFSET + E200h + 22h = OFFSET + E222h	OFFSET + 57,856 + 34 = OFFSET + 57,890 + 34 = 52,258
Inside the command module	1FE200h + 22h = 1FE222h	2,089,472 + 34 = 2,089,506

Important

These modules are D16-only devices. That is, they may only be accessed via 16-bit words on even addresses. Attempts to access these modules via 8-bit bytes (D8) or 32-bit words (D32) will result in a bus error.

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Register Definitions

All addresses are given in hexadecimal. Unless otherwise noted, register contents are unaffected by hard or soft resets. "X" or "x" denote bits which are "don't-care". All registers reside at even addresses and are WORD wide.

ID Register (Read)

Address = Base + 00_H. This address returns the Hewlett-Packard VXI manufacturer ID of FFFFH

Device Type (Read)

Address = Base + 02_H. This register defines the module's device class, addressing mode and manufacturer's ID according to the VXIbus speicification. A read of this address returns 0151_H (337_{10}) for an HP E1451 or a 0153_H (339_{10}) for an HP E1452 (corresponding to a register-based device using the A16 address space only and manufactured by Hewlett-Packard)..

Status/Control Register (Read)

This register returns the I/O Module Status.

Address: B + 04_H							
Bit #	15	14	13-9	8	7	6-4	3-0
Value	A24	MODID*	1	TERM	INTEN*	ILS2-0	1

Bit Definitions

- A24: Informs VXI controllers that the I/O module is not A24/A32 compatible. This bit is always clear.
- MODID*: A 1 in this field indicates the device is not selected via the P2 MODID line. A 0 indicates that the device is selected by a high state on the P2 MODID line. Reset value is 1.
- INTEN*: Interrupt Enabled. This field indicates the I/O Module may interrupt on the VXI backplane. Reset value is 0 (disabled), value of 1 enables.
- ILS2-0: The octal value read from this field indicates the interrupt level currently selected by the interrupt switch.
- TERM: Terminated. If this field is clear, the I/O module is an E1451 Unterminated Module. If set, the I/O module is an E1452 terminated module (50 ohm terminations on the local bus).

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Status/Control Register (Write)

This register sets Control Bits.

Address: B + 04_H					
Bit #	15-8	7	6-4	3-1	0
Value	X	INTEN*	ILS2-0	X	SRESET

Bit Definitions

- INTEN*: Interrupt Enabled. A write to this field enables the I/O Module to interrupt on the VXI backplane. Reset value is 1 (disabled), value of 0 enables.
- ILS2-0: The octal value written to this field sets the interrupt level which will be set when the I/O Module Interrupts the VXI backplane. Reset value is 0 (interrupts not enabled).
- SRESET: A write of 1 in this field Soft Resets the I/O Module. Bit 7 is set to 1 by Hard Reset (SYSRESET*) but not by SRESET.

Calibration ROM Register (Read/Write)

This address accesses the Calibration ROMs of the I/O Module.

CAUTION

DO NOT WRITE TO THIS REGISTER. DOING SO MAY ALTER THE CALIBRATION ROM'S CONTENTS, CAUSING THE MODULE TO FAIL AND REQUIRE FACTORY REPAIR.

Address: B + 06_H									
Bit #	15-8	7	6	5	4	3	2	1	0
Value	X	POD_1_OUT	POD_0_OUT	ROM_DATA_OUT	POD1_SEL	POD0_SEL	ROM_SEL	DATA_IN	CAL_ROM_CLK

I/O Port Registers

The following registers are common for each of the four I/O ports of the I/O Module (Port 0 through Port 3).

Sequence Memory (Read/Write)

This register contains the current address into sequence memory. It is used when reading or writing to that memory and it should be set to the first location of a sequence prior to starting that sequence. If bit 6 of the Configuration Register is set, the sequence memory address will increment by 1 whenever the Port Data Bus Register is accessed. Address: Port 0 = Base + 08_H, Port 1 = Base + 16_H, Port 2 = Base + 24_H, Port 3 = Base + 32_H

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Bit #	15-0
Value	AC15-AC0

Branch Destination (Read/Write)

Address: Port 0 = Base + $0A_H$, Port 1 = Base + 18_H, Port 2 = Base + 26_H, Port 3 = Base + 34_H

This register supplies the sequence memory address to which a jump is made when the sequencer encounters a set branch bit. All 16 bits are significant, and reading this location gives the last value written.

Bit #	15-0
Value	BA15-BA0

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Port Data Bus (Read/Write)

Address: Port 0 = Base + $0C_H$, Port 1 = Base + $1A_H$, Port 2 = Base + 28_H, Port 3 = Base + 36_H

This register allows access to the internal pattern and control buses of the port.

Bit #	15-14	13	12	11	10	9-8	7-0
Value	X	COMP	TRIS	BRA	EOS	X	PD7-0

Bit Definitions

- Control Bus:
  COMP: Enables (1) or disables (0) the compare test.
  TRIS: Drives (0) or tri-states (1) the stimulus stage.
  BRA: Branch. If set, causes jump to branch destination.
  EOS: End of Sequence. If set, causes sequencer to stop.

- Pattern Bus PD7-0: Pattern Data.

Configuration Register (Read/Write)

Address: Port 0 = Base + $0E_H$, Port 1 = Base + $1C_H$, Port 2 = Base + $2A_H$, Port 3 = Base + 38_H

This register controls what happens on the port's internal control and pattern buses. It also control the operation of the sequence memory. It can be read at any time and can be written when the port is stopped or paused (not receiving clocks).

Bit #	15-8	7	6	5	4-2	1-0
Value	X	COMEN	ENISC	ENIIOC*	PBRAM2-0	CBRAM1-0

Bit Definitions

- COMEN Compare Enable. When set (1), Compare is Enabled. When clear (0), compare function is disabled and any compare errors generated are cleared (see Status/Clock Source Register). Be sure that errors have been serviced before disabling compare mode.
- ENISC: Enable Injected Sequencer Clock. When set, the Address Counter will be incremented after each read or write to the Port Data Bus Register. This feature is used to load or dump sequence memory. Advancing the sequencer address in this way ignores the stop and branch bits.
- ENIIOC*: Enable Injected I/O Clock. When set (0, notice inverse logic sense), enables an I/O clock to be generated as part of a Read or Write to the Port Data Bus Register. This feature is used to directly control the input or output stages. The I/O clock will clock the input register, output register, tristate register (a group of tristate control flip flops), expected response register, compare flip flop, stop flip flop, and branch flip flop. If compare is enabled, an injected I/O clock operation could cause a compare error. If the branch or stop bits are true, an injected I/O operation could cause a stop or branch.
- PBRAM2-0: Pattern Bus/RAM. These bits control action on the pattern bus and operation of the pattern sequence memory.

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Note

In end of record mode, the ram continues to write the contents of the input register into the last ram location even after the port has stopped. It is important to take the port out of record mode before the contents of the input register or the data on the port data bus is allowed to change.

PBRAM2-0	Function
000	Read (RAM drives bus)
001	Record Mode (see note above)
010	Safe (pattern bus tri-stated
011	Access Input Stage
100	unused
101	Load RAM from VXI
110	Safe (pattern bus tri-stated
111	Access Output Stage

Bit Definitions (continued)

- CBRAM2-0: Control Bus/RAM.

CBRAM1-0	Function
00	Safe (Bus tri-stated
01	Read (RAM drives bus)
10	Load RAM from VXI
11	Access controll flip-flops

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I/O Control (Read/Write)

Address: Port 0 = Base + 10_H, Port 1 = Base + $1E_H$, Port 2 = Base + $2C_H$, Port 3 = Base + $3A_H$

This register controls the external, i.e., the user accessible, buses of the port. A hard or soft reset will set bits 0 - 7 to 0. The port should be stopped or paused (not receiving clocks) before writing to the output control register.

Bit #	15-8	7	6-4	3-2	1-0
Value	X	LIVE_I/O	unused	PDBUS1-0	CSTBUS1-0

Bit Definitions

- LIVE_I/O: When set, live I/O flip-flop will reflect live access.
- PDBUS1-0: Pod Bus Control. The Pod Bus connects the Module to the Pod. When the pod is not being used, this is the bus connected to the device under test. Reset causes the pod bus to go to the safe mode.

PDBUS1-0	Function
00	Safe (Pod Bus is Tristate)
01	Pod Input Buffer is Driver (used for all input modes)
10	Module Output Register can operate (used for output modes with pod absent)
11	Module Output Register Always Drives (used for output modes with pod present)

The following table shows the effects on the outputs by switching from one mode to another. This table is complete and does not assume that power is cycled between cases of pod being present and cases of pod being absent.

FROM	TO	OUTPUTS
reset, input, drive, operate, safe	safe	tristate
safe, drive, operate, input	input	tristate
safe, input, operate, drive	drive	drive
safe, input	operate	tristate
drive	operate	drive
operate	operate	unchanged

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Bit Definitions

- CSTBUS1-0: User Bus Control. The user bus is what the user sees at the end of the pod. Reset causes the user bus to go to the input mode.

CSTBUS1-0	Function
00	User drives the Bus (used for all Pod input modes)
01	Pod Output Register can operate (used for Pod output modes using external clock)
10	Pod Output Buffer drives the Bus (not normally used but could be used for Live Output if you want to ignore the tristate control bit)
11	Pod Output Buffer can operate (used for Pod Output modes using internal clocks)

The following table shows the effects on the outputs by switching from one mode to another.

FROM	TO	OUTPUTS
reset, input, drive, register, buffer	input	tristate
input, drive, register, buffer	register	tristate
input, drive, register, buffer	drive	drive
input, register	buffer	tristate
drive	buffer	drive
buffer	buffer	unchanged

The drive mode may never be used. The following table assumes this case. It further ignores the input case.

FROM	TO	OUTPUTS
input, register, buffer	register	tristate
input, register	buffer	tristate
buffer	buffer	unchanged

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Status/Clock Source Register (Write)

Address: Port 0 = Base + 12_H, Port 1 = Base + 20_H, Port 2 = Base + $2E_H$, Port 3 = Base + $3C_H$

This register performs two different control tasks. Bits 0-6 select the clock source for the sequencer. Bits 15, 14, and 9 control the starting and stopping of the sequencer. This is the Status/Clock Source Register for each I/O Port.If changing the internal clock source, the port should be stopped, not just paused. For other fields in the status/clock register, the port can be either stopped or paused (not receiving clocks) before writing.

Bit #	15	14	13-10	9	8	7	6-5	4	3-0
Value	RUN	CLSE*	X	STOP*	Unused	X	EXTCS1-0	PODECP	INTCS3-0

Bit Definitions

- Bits 15, 14, and 9: These three bits are ephemeral. Their states are not latched. It is the action of writing the specified value into them that produces their effect.

  RUN: Setting this bit (1) causes the sequencer, if currently stopped, to enter its running state. If the sequencer is already running, setting this bit has no effect. Writing "0" into this bit has no effect.
  CLSE*: Clear Stop Event. Setting this bit to "0" clears the event caused by a sequencer "RUN" to "STOP" transition. Setting this bit to "1" has no effect. The stop events of all four ports are OR'ed together to produce an interrupt request event for the module.
  STOP*: If clear, stop. No action if set. Sending a stop command (write 0 to stop bit) to a running port will stop the port and cause a stop event interrupt. Sending a stop command to a stopped port does not cause a stop event interrupt. Sending a stop command to a port that is receiving clocks will cause it to stop. However, it may stop in an uncoordinated fashion. That is, the contents of the address counter may not match the behavior of the I/O stage. This warning should apply only to external clocks, since it is assumed that clocks from the Timing Module would be turned off before a stop command would be sent to a port.
- PODECP: Pod external Clock Polarity. If set, the pod's external clock is inverted (high-to-low edge clocks). If clear, the pod's external clock has normal polarity, i.e., the low-to-high clocks. This bit is used only if a pod is present. Toggling the pod external clock polarity bit will inject an external clock. This can be used to prime the pipe stage (pod output register) in the pod in the case of output - pod present - external clock. It can also be used to single step the port. In both of these cases, the external clock must be static.
- EXTCS1-0: External Clock Select. If external clock is selected, the internal clock select should be off. Inverted external clock select is normally used only when the pod is absent. If the pod is absent, the polarity of the external clock can be toggled to inject an external clock for the purposes of single step. The external clock must be static high or low in this instance.

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EXTCS1-0	Function
00	External Clock Off
01	Non-inverted External Clock (used if Pod is present or not, internal clock select should be OFF)
10	Select Inverted External Clock (used if Pod is not present, internal clock select should be OFF)
11	unused

- INTCS3-0: Internal Clock Select. When using internal clocks, the external clock select is set OFF. Changing the clock source on a port that is running or PAUSED (not receiving clocks) may cause spurious clocks and uncoordinated operation. The port should be stopped before changing the clock source. Changing the internal clock source will require that a new calibration value be loaded into the mask/cal register.

INTCS3-0	Function
0000	Stimulus CLK 0
0001	Stimulus CLK 1
0010	Stimulus CLK 2
0011	Stimulus CLK 3
0100	Stimulus CLK 4
0101	Stimulus CLK 5
0110	OFF
0111	OFF
1000	Response CLK 0
1001	Response CLK 1
1010	Response CLK 2
1011	Response CLK 3
1100	Response CLK 4
1101	Response CLK 5
1110	OFF
1111	OFF

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Status/Clock Source Register (Read)

Address: Port 0 = Base + 12_H, Port 1 = Base + 20_H, Port 2 = Base + $2E_H$, Port 3 = Base + $3C_H$

Bit #	15	14	13	12	11	10	9	8	7	6-5	4	3-0
Value	RUN	STOPEV	CMPSEI	DA_ STATUS	X	CARD_OE*	QPIPE_OE*	QOBUF_OE*	X	EXTCS1-0	PODECP	INTCS3-0

Bit Definitions

- RUN: Run. If set, Port is presently Running, if clear the Port is presently stopped.
- STOPEV: Stop Event Interrupt. If set, the port had a RUN to STOP transition
- CMPSEI: Compare Error Interrupt. If set, a compare error occurred.
- DA_STATUS: Can be used to indicate whether the current output is due to direct access or due to sequencer.
- CARD_OE*: Card Output Enable. If set,
- QPIPE_OE*: Pipe Register Output Enable. If set.
- QOBUF_OE*: Output Register Output Enable. If set.
- PODECP: Pod external Clock Polarity. Readable status of this field.
- EXTCS1-0: External Clock Select. Readable status of this field.
- INTCS1-0: Internal Clock Select. Readable status of this field.

Mask/Calibration Value Register (Read/Write)

Address: Port 0 = Base + 14_H, Port 1 = Base + 22_H, Port 2 = Base + 30_H, Port 3 = Base + $3E_H$

This is the Status/Clock Source Register for each I/O Port

Bit #	15-8	7-0
Value	CMPMK15-8	CALVAL 7-0

Bit Definitions

- CMPMK15-8: Compare Mask field. If a bit is set in this field, compare in this bit position, otherwise ignore.
- CALVAL7-0: Calibration Value field. Resolution is 100ps. There are minimum and maximum legal values.

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Appendix A
Specifications

Sequencer Specifications

Memory Depth: 65,536 (64k) vectors. Multiple test sequences may co-reside in memory.

Memory Functions: Stimulus Pattern or Response Pattern (expected or recorded) as well as control of Tri-state, Compare, and End-of-Sequence functions.

Specifications For Ports Configured As Outputs

Clock Source : External Clock, HP E1450 Timing Module (one of six Stimulus Pattern Clocks)

Output Levels:

HP E1451/E1452 Module Outputs
- Maximum Continuous Output Current: ± 24mA per line
- High, Open-Circuit: 4.4V, min.
- Low, Open-Circuit: 0.1V, max.
- Output Impedance: 50Ω, typical
- Capacitance (outputs disabled): 30pf, max.
- Leakage Current (outputs disabled): 120μA, max.

HP E1454 Pod Outputs
- Maximum Continuous Output Current: ± 24mA per line
- High, Open-Circuit: 4.3V, min.
- High, Sourcing 24mA: 3.7V, min.
- Low, Open-Circuit: 0.1V, max.
- Low, Sinking 24mA: 0.44V, max
- Capacitance (outputs disabled): 30pf, max.
- Leakage Current (outputs disabled): 120μA, max.

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Tri-state:
Outputs can be disabled on a cycle-by-cycle basis by a control bit in the Sequencer memory, or by driving the Output Enable high. All eight pins of the port are controlled simultaneously.

Tri-State Control Input Levels and Loading (for HP E1451/E1452 and HP E1454):
High:>2.0V at <150μA
Low: <0.8V (internal pull-down)
Tri-state Control Input Delay:
HP E1451/E1452 without pod: 9ns typical, 14ns max
HP E1454 with pod: 8ns typical, 11ns max

Timing:
Pattern Rate: 0 to 20MHz
Skew:
Between output pins in the same port: 3ns, typical
Risetime: 6.5ns typical
Falltime: 7.0ns typical
Data Delay From External Clock:
HP E1451/E1452 without pod: 20ns typical, 27ns max
HP E1454 with pod: 14ns typical, 20ns max

Specifications For Ports Configured As Inputs

Clock Source: External Clock, HP E1450 Timing Module (1 of 6 Response Pattern Clocks)

Input Levels And Loading (for HP E1451/E1452 and HP E1454):
Low: <0.8V at <150μA
High:>2.0V (internal pull-up)
Capacitance: 30pf max.

Real-time Compare:
A programmable static mask can identify any pin of the port to be 'don't-care' for the duration of the test sequence. For those pins which are not masked, a Sequencer Control bit can enable the comparison of input patterns with expected response data on a cycle-by-cycle basis.

Input Timing:
Setup Time to External Clock
HP E1451/E1452 without Pod: -1.6ns
HP E1454 with Pod: 5ns
Hold Time from External Clock
HP E1451/E1452 without Pod: 11.5ns
HP E1454 with Pod: 14ns

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External Clock Input Specifications (for HP E1451/E1452 And HP E1454):

Minimum Period: 50ns
Minimum Pulse Width: 6ns
Polarity: Selectable
Input Levels (for HP E1451/E1452 or HP E1454):
    Low: <0.8V at <150μA
    High:>2.0V (internal pull-up)
Capacitance: 30pf max.

Miscellaneous Specifications

Power Requirements:
    +5.0V (excluding load currents): 1.5A peak, 40ma dynamic
    -5.2V: 2.2A peak, 200mA dynamic
    -2.0V: 0.6A peak, 80mA dynamic
    +12.0V: 0.1A peak, 10mA dynamic

Cooling Requirements:
    Average Power/slot: 22w
    Ambient Temperature:
        Operating: 0 to 55°C
        Storage: -40 to 75°C
    Humidity: 65 % relative from 0 to 40°C
    Operating temp: 0 to 55°C
    Storage temp: -40 to 75°C
    Airflow Requirements (for 10°C rise): 2.0 liter/sec at 1.2 mm water

Weight: 1.1kg

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