Contents

HP E2250A M-Module/MA-Module Carrier User's Manual

Edition 1

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HP E2250A M-Module Carrier User's Manual
Edition 1

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 . . . . February 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 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.

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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.

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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.

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WARNINGS (contd.)

In a cleanroom environment, some switch modules (such as the HP E2270A, 2271A, 2273A, etc) are capable of switching voltages that could cause bodily injury or death to an operator. Special precautions must be adhered to (discussed below) when applying voltages in excess of 60Vdc, 30Vac rms, or 42.4 Vac peak for a continuous, complex waveform.

Module connectors and test signal cables connected to them must be made NON-accessible to an operator who has not been told to access them: It is a supervisor's responsibility to advise an operator that dangerous voltages exist when the operator is instructed to access connectors and cables carrying these voltages. Making cables and connectors that carry hazardous voltages inaccessible is a protective measure keeping an operator from inadvertant or unknowing contact with these harmful voltages. Cables and connectors are considered inaccessible if a tool (e.g., screwdriver, wrench, socket, etc.) or a key (equipment in a locked cabinet) is required to gain access to them. Additionally, the operator cannot have access to a conductive surface connected to any cable conductor (High, Low, or Guard).

Assure the equipment under test has adequate insulation between the cable connections and any operator-accessible parts (doors, covers, panels, shields, cases, cabinets, etc.): Verify there are multiple and sufficient protective means (rated for the voltages you are applying) to assure the operator will NOT come into contact with any energized conductor even if one of the protective means fails to work as intended. For example, the inner side of a case, cabinet, door, cover, or panel can be covered with an insulating material as well as routing the test cables to the module's front panel connectors through non-conductive, flexible conduit such as that used in electrical power distribution.

Declaration of Conformity

according to ISO/IEC Guide 22 and EN 45014

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: B-Size VXI M/MA Module Carrier

Model Number: E2250A

Product Options: All

conforms to the following Product Specifications:

Safety:
IEC 1010-1 (1990) + A1(1992) + A2 (1995)/EN61010-1 (1993)
CSA C22.2 #1010.1 (1992)
UL 3111-1 (1994)

IEC 950 (1991) + A1(1992) + A2 (1993) + A3 (1994)
EN 60950 (1992) + A1(1992) + A2 (1993) + A3 (1994)
CSA C22.2 # 950 (1995)
UL 1950 (1995)

IEC 825-1 (1993)/EN 60825-1 (1994)
Class 1 LED Product

EMC:
CISPR 11:1990/EN55011 (1991): Group1 Class A
EN61000-3-2:1995 Class A
EN50082-1:1992
- IEC 801-2:1991: 4kV CD, 8kV AD
- IEC 801-3:1984: 3 V/m
- IEC 801-4:1988: 1kV Power Line, 0.5kV Signal Lines
- ENV50141:1993/prEN50082-1 (1995): 3 Vrms
- ENV50142:1994/prEN50082-1 (1995): 1 kV CM, 0.5 kV DM
- IEC1000-4-8:1993/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 (inclusive 93/68/EEC) and carries the "CE" mark accordingly.

Tested in a typical HP VXI B-Size mainframe.

November 26, 1997:

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: +49-7031-143143)

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HP E2250A M-Module Carrier User's Manual

Edition 1

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• Instructions are easy to understand.	O	O	O	O	O
• The documentation is clearly written.	O	O	O	O	O
• Examples are clear and useful.	O	O	O	O	O
• Illustrations are clear and helpful.	O	O	O	O	O
• The documentation meets my overall expectations.	O	O	O	O	O

Please write any comments or suggestions below–be specific.

Chapter 1
Getting Started

What's in this Manual?

This manual contains a description of the HP E2250A M-Module Carrier[1] and generic M-Module/MA-Module[2] programming information using the Carrier. For module installation instructions and instructions for installing the Carrier in a VXIbus mainframe, refer to the *HP E2250A B-Size M-Module Carrier Installation and Wiring Manual*.

HP E2250A M-Module Carrier Description

The HP E2250A M-Module Carrier allows up to four M-Modules or MA-Modules to be installed in a single B-Size or C-Size VXI mainframe slot, providing each module with its own logical address and A16/A24 memory space. Each module is accessed as though it is a standard VXIbus module occupying its own VXI slot in the cardcage. The Carrier:

- Is a single slot B-size card.
- Supports up to four M-Modules or MA-Modules.
- Can be used in the C-Size VXI mainframe through the HP E1407 B-to-C-Size Adapter.
- Provides a valid VXI logical address for each installed module.
- Provides the four standard VXI registers for each installed module (VXI Module ID, Device Type, Status/Control, and A24 Offset).
- Maps all installed modules I/O space and memory space into A24 space of VXI system.
- Supports Type A/B/C M-Module/MA-Module interrupts and handles them as VXI interrupts. Provides interrupt acknowledge daisy-chain for all four module slots.
- Provides triggering capability for installed MA-Modules.
- Supports both D08(EO), D16, D32 data and A08/A24 addressing.

1. In this manual, Carrier and HP E2250A Carrier all refer to the HP E2250A B-Size M-Module Carrier.
2. M-Module/MA-Modules comply with the American National Standard for the Mezzanine Concept M-Module Specification (ANSI/VITA 12-1996). However, M-Modules have a 2-row, 40-pin connector for communication with the Carrier and MA-Modules have a 3-row, 60-pin connector for communication with the Carrier.

- Supports MA-Module burst access mode and adapts it to VME block transfer mode.
- Is completely transparent in the VXI system.
- Provides +5V and ±12V DC fused power supply for each M/MA-Module slot.

Note If the HP E2250A Carrier is used in an HP E1300/1 VXI mainframe, some features may be limited since the HP E1300/1 mainframe only has the VXI P1 connector.

Note The Carrier supports MA-Modules, but some features of the MA-Modules may have some limitations. See the descriptions later in this manual for specific limitations.

Figure 1-1 shows the HP E2250A Carrier and other accessories provided with the Carrier.

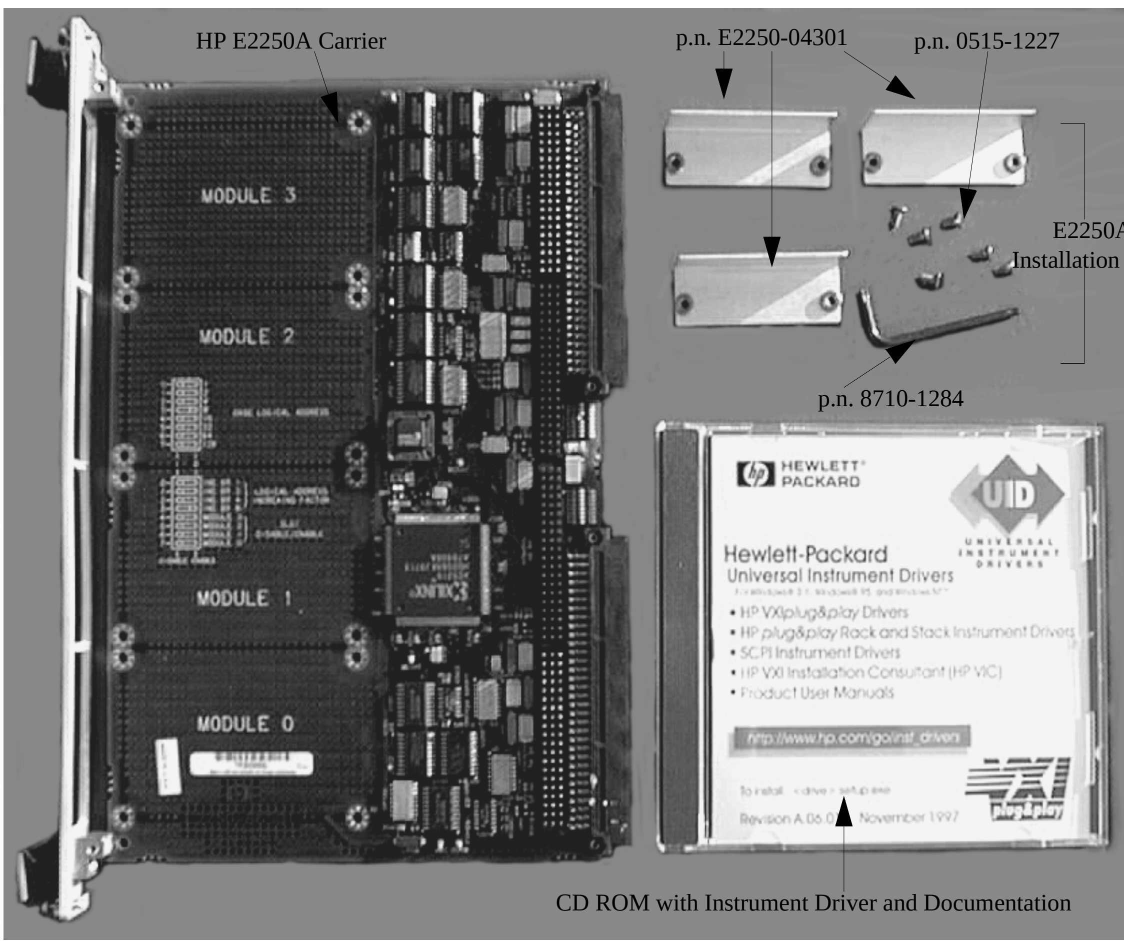

Figure 1-1. HP E2250A M-Module Carrier and Accessories

General Information

M-Modules are defined as modules which comply with the ANSI/VITA Standard for the Mezzanine Concept M-Module Specification and have a 2-row, 40-pin connector for communication with the carrier. MA-Modules also comply with this specification but have extensive functionalities with a 3-row, 60-pin connector for communication with the carrier. Refer to ANSI/VITA 12-1996 documentation for more detailed information.

To make M-Module/MA-Modules work as standard VXIbus devices, the HP E2250A Carrier provides a logical address for each module. The Carrier also reads the identification EEPROM from HP M-Modules and copies data into the standard VXI registers (Manufacturer ID and Device Type).

Based on the specification, most M-Module/MA-Modules have an (optional) EEPROM which stores the characteristics of that module. The EEPROM is at least 16 words (32 bytes) deep. However, all HP M-Modules have an EEPROM that is 64 words deep. The EEPROM words are defined in Chapter 3 of this manual (on page 26).

Note If you are using a high level language driver, such as SCPI, you do not need to understand the register mapping of M-Modules. If you need to use register-based programming, refer to Chapter 3 of this manual and individual M-Module user’s manual.

Logical Address

In a VXIbus system, the logical address provides a unique reference for addressing instruments. An M-Module/MA-Module does not have a logical address. To make an M-Module/MA-Module work as a standard VXI instrument, the HP E2250A Carrier provides logical address for each module. It uses two eight-position switch packs to set the logical addresses for the installed modules. Figure 1-2 shows the logical address default settings.

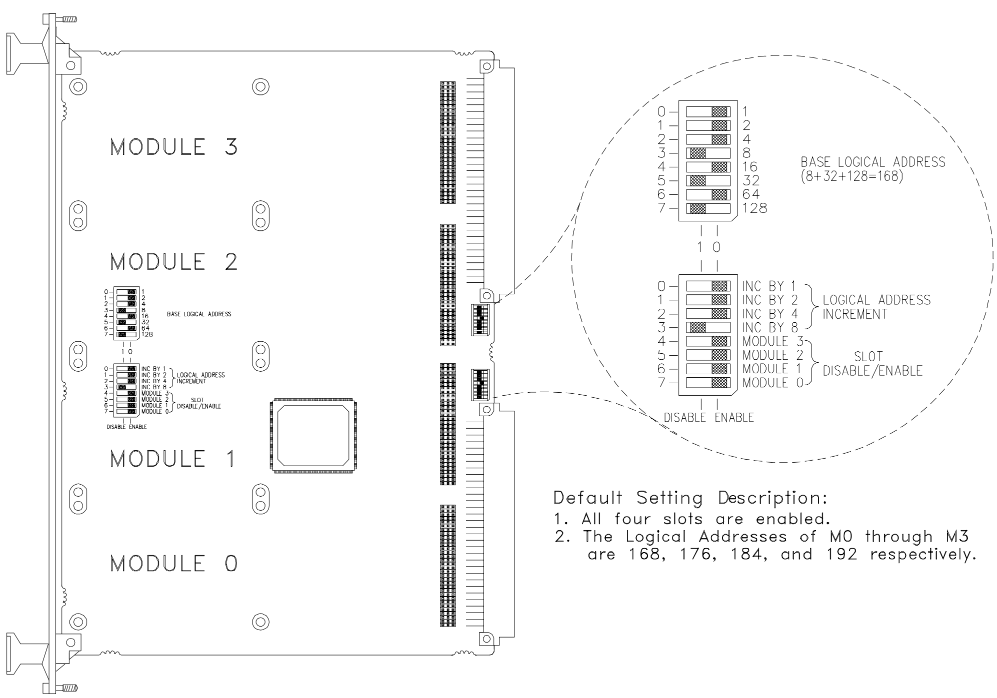

Figure 1-2. Logical Address Switch Packs Layout and Default Settings

The logical address of each module on the carrier is computed by the following formula:

$$\text{Logical Address}_i = \text{Base Logical Address} + (i \times \text{Logical Address Increment})$$

(i = 0, 1, 2, 3; represents slot number)

However, the base logical address could be 1 through 254. The logical address increment could be 1 through 16. If the Logical Address is greater than 256, then the logical address of the module on the carrier should be computed as:

$$\text{Logical Address}_i = \text{Base Logical Address} + (i \times \text{Logical Address Increment}) - 256$$

(i = 0, 1, 2, 3; represents slot number)

Note Logical address zero is reserved for the Command Module. Logical address 255 is for dynamic configuration, but the HP E2250A Carrier does not support dynamic configuration.

Note If all of the logical address increment switches are set to zero, the logical address increment value equals 16.

Note The logical addresses of all M-Module/MA-Modules should be a multiple of eight if the HP E2250A Carrier is used with a Command Module (such as the HP E1300/1, HP E1306 and HP E1406). So the value of the base logical address should be set to a multiple of eight and the logical address increment value should be either 8 (switch 3 is set to 1, switches 0 through 2 are set to 0) or 16 (switches 0 through 3 are all set to 0).

All unused slots should be disabled so that those disabled slots do not claim or use up logical addresses. Refer to the table below for setting. The Slot Disable/Enable setting does not affect the algorithm of logical addresses.

Slot Status	Slot Disable/Enable							
	Switch 7		Switch 6		Switch 5		Switch 4	
	0	1	0	1	0	1	0	1
Enable	M0		M1		M2		M3	
Disable		M0		M1		M2		M3

Refer to the *HP E2250A B-Size M-Module Carrier Installation and Wiring Manual* for more details about how to set the logical addresses for the modules on the Carrier.

Power-on

The HP E2250A Carrier provides seven registers for each slot (refer to Chapter 3, page 34, in this manual for more detailed registers information). When power is applied to the HP E2250A Carrier, the Carrier reads the EEPROM of each installed M-Module/MA-Module and downloads the **VXI Sync code** ($ACBA_h$), **VXI-ID,** and **VXI Device Type** information into its own registers designed for each slot. There are two different cases:

1. If the downloaded VXI sync code from the module is $ACBA_h$ (for HP M-Modules), then the downloaded VXI-ID and VXI-Device Type information will be copied into its own registers. When the logical address of the M-Module provided by the Carrier is valid, the VXI Resource Manager will allocate the proper A16/A24 register space according to the downloaded information.
2. If the VXI Sync code cannot be obtained from the module (either the slot is empty, the M-Module/MA-Module does not have an EEPROM, or the M-Module/MA-Module is a non-HP), the Carrier will set the VXI-ID and VXI-Device Type registers of the module to default values[1]. When the logical address of the module provided by the Carrier is valid, the VXI Resource Manager will use the default information to allocate the proper A16 register space and 256 bytes A24 memory space.

Register Addressing

VXI specifications provide for only 64 bytes of I/O space in A16 memory. However, the M-Module/MA-Module specifications provide for 256-byte multiples of I/O space. To resolve this conflict, the HP E2250A Carrier provides two memory segments for the modules: the first is in standard VXI A16 memory space and provides the four standard VXI registers (Module ID, Device Type, Status/control, etc.) and three additional control registers (for interrupting, triggering and MA-Module A08/A24 selection); the second is in VXI A24 memory space for all of the other M-Module/MA-Module registers.

Note MA-Modules extend the address bus to 24 bits and allow up to 16Mbytes memory to be addressed. However, according to VXI specification, the maximum A24 space that each device could require is 8Mbytes.

Interrupt Handling

The HP E2250A Carrier supports M-Module/MA-Module Type A, B, and C interrupts. Just as in a standard VXI mainframe, the HP E2250A Carrier daisy-chains the IACKIN/IACKOUT lines for the modules. If any slot on the Carrier is empty, the Carrier bypasses that slot automatically for the daisy chain. By default, Type A interrupt is converted to the standard VXI RORA (Release on Register Access) interrupt, Type B and C interrupts are converted to the standard VXI ROAK (Release on Acknowledge) interrupt. Refer to Chapter 3, page 38, in this manual for more details.

Note HP Command Module and HP VXI*plug&play* drivers use VXI ROAK.

1. The default value of VXI-ID is $CFFF_h$, which means a register-based A16/A24 device. The default value of VXI Device Type is $F257_h$, which means an unknown M-Module requiring 256 bytes A24 memory space.

Trigger Handling

Based on M-Module/MA-Module specifications, an MA-Module (with 3-row, 60-pin connector) may have up to two trigger lines, TRIGA and TRIGB. The HP E2250A Carrier provides for adapting these two trigger lines of each MA-Module to any of the eight VXIbus trigger lines. You can control trigger function by writing to the Trigger Selection Register. Refer to Chapter 3, page 40, in this manual for more details.

Burst Access Handling

The HP E2250A converts MA-Module burst access to VME block transfer. However, VME block transfer has more restrictions than MA-Module burst access. As a result, the following limitations will be applied to MA-Module burst access if the HP E2250A Carrier is used.

1. Memory locations are in ascending order;
2. Block transfer cycles shall not cross any 256-byte boundary.

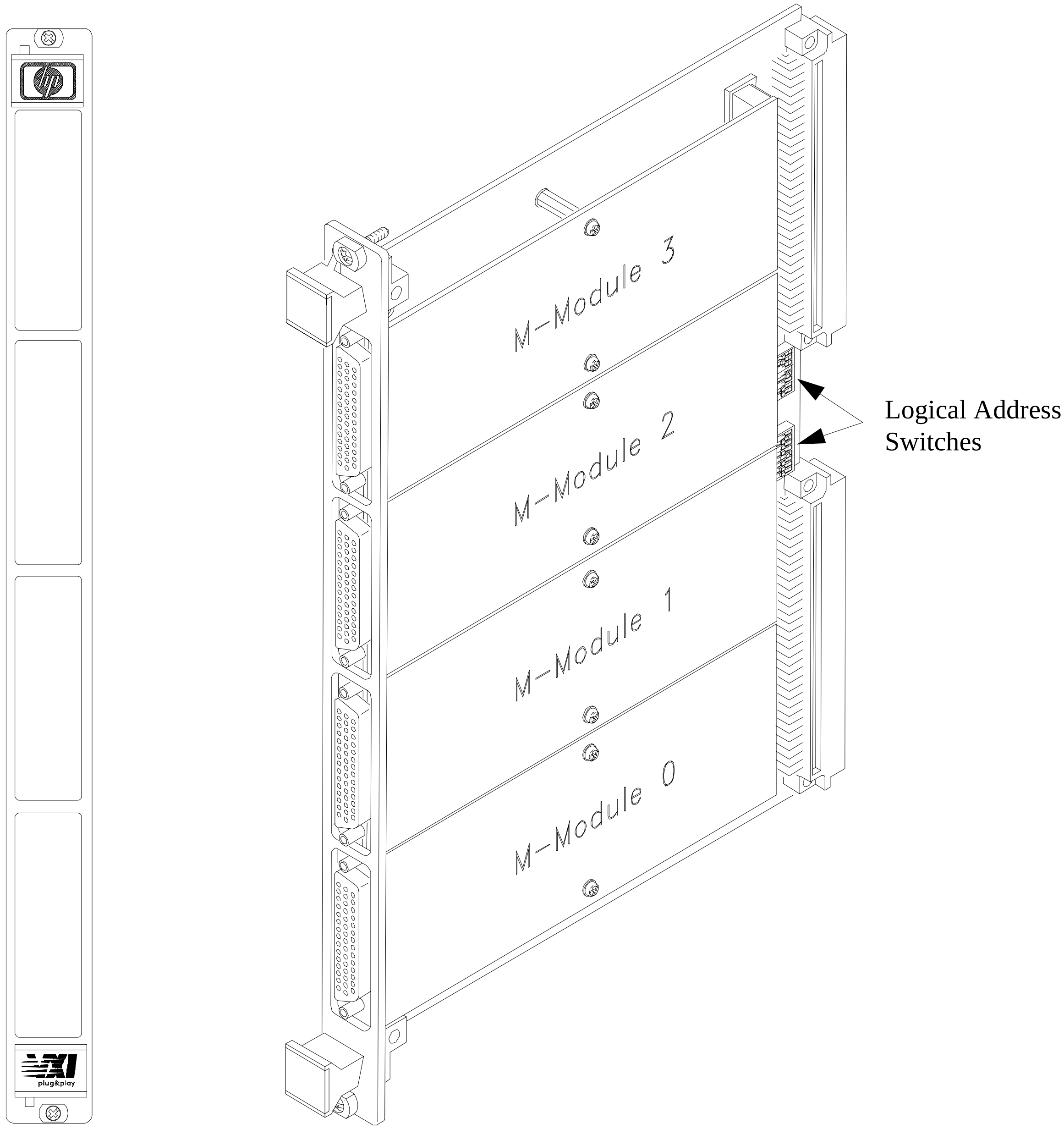

Figure 1-3. HP E2250A Front Panel and Module Layout

Connector Pinout

The control interface between the HP E2250A Carrier and each M-Module/MA-Module is via a 40-pin or 60-pin connector. Figure 1-4 shows the connector from the top-side of the HP E2250A Carrier. Table 1-1 lists the pin definitions.

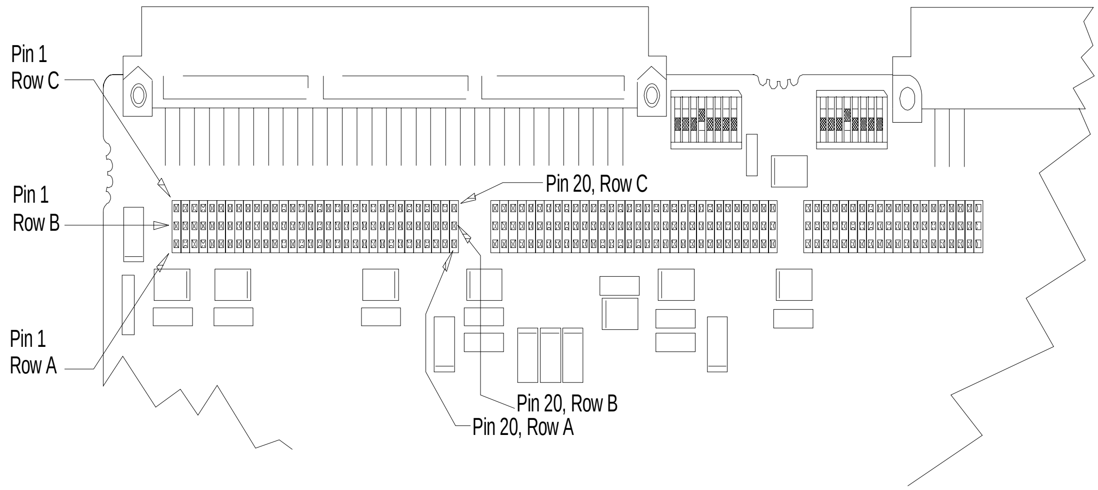

Figure 1-4. Control Interface Connector Pin Numbering

Table 1-1. Control Interface Connector Pin Definitions

Pin	Row A	Row B	Row C
1	CS*	Ground	AS*
2	A01	+5V	D16
3	A02	+12V	D17
4	A03	-12V	D18
5	A04	Ground	D19
6	A05	DREQ*	D20
7	A06	DACK*	D21
8	A07	Ground	D22
9	D08/A16	D00/A08	TRIGA
10	D09/A17	D01/A09	TRIGB
11	D10/A18	D02/A10	D23
12	D11/A19	D03/A11	D24
13	D12/A20	D04/A12	D25
14	D13/A21	D05/A13	D26
15	D14/A22	D06/A14	D27
16	D15/A23	D07/A15	D28
17	DS1*	DS0*	D29
18	DTACK*	WRITE*	D30
19	IACK*	IRQ*	D31
20	RESET*	SYSCLK	DS2*

Chapter 2
SCPI Programming

Most HP M-Modules are provided with a downloadable SCPI driver. This chapter provides a brief overview of the Standard Commands for Programmable Instruments (SCPI) and summarizes IEEE 488.2 Common Commands applicable to the HP M-Modules. This chapter also provides generic programming information for controlling HP M-Modules installed on an HP E2250A Carrier.

Note Do not write to registers if you are controlling the modules by the downloaded SCPI driver. This is because the SCPI driver will not know the instrument state and an interrupt may occur causing the driver and/or command module to fail.

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 such as 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   *ESR?   *STB?

SCPI Command Format

The SCPI commands perform functions like closing switches, making measurements, and 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 commands, and their parameters. The following example shows part of a typical subsystem:

[ROUTe:]
    CLOSe <*channel_list*>
    CLOSe? <*channel_list*>
    OPEN <*channel_list*>
    OPEN? <*channel_list*>

[ROUTe:] is the root command, CLOSe, CLOSE?, OPEN, and OPEN? are second level commands with parameters.

Command Separator

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

STATus:OPERation:CONDition?

Colons separate the root command from the second level command (STATus:OPERation) and the second level from the third level (OPERation:CONDition?).

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, you may send 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 `MEASure`, then `MEAS` and `MEASURE` are both acceptable forms. Other forms of `MEASure`, such as `MEASU` or `MEASUR` will generate an error. You may use upper or lower case letters. Therefore, `MEASURE`, `measure`, and `MeAsUrE` are all acceptable.

Implied Commands

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

[ROUTe:]
  CLOSe <*channel_list*>
  CLOSe? <*channel_list*>
  OPEN <*channel_list*>
  OPEN? <*channel_list*>

Note The brackets are not part of the command and are not sent to the instrument.

The root command [ROUTe:] is an implied command. To close relays in a channel list, you can send either of the following command statements:

ROUT:CLOS (@02:05,07,09:11)
or
CLOS (@02:05,07,09:11)

These commands function the same: closing channels 02 through 05, 07, and 09 through 11.

Note A range of channels (*@nn:nn*) must be specified in ascending order, that is lower channel number on the left, higher channel number on the right.

Command Parameters

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

Parameter Type	Explanations and Examples
Numeric	Accepts all commonly used decimal representations of numbers 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 BUS, EXT, HOLD, or IMM.

Optional Parameters. Parameters shown within square brackets ([]) are optional parameters. (Note that 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` setting 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;OUTP ON
```

or

```
TRIG:SOUR HOLD;*TRG
```

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

```
ARM:COUN 1;:TRIG:SOUR EXT
```

Example Programs

This section provides examples demonstrating programming M-Modules installed on the Carrier.

Note Do not write registers if you are controlling the modules by a high level language such as SCPI. This is because the high level language driver will not know the instrument state and an interrupt may occur, causing the driver and/or command module to fail.

The following two program examples are developed with the ANSI C language using the HP VISA extensions. The program was written and tested in Microsoft Visual C++ but can be compiled 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 E1306 or HP E1406 Command Module is also required.

Example 1: Initial Operation

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

```
#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: viPrintf() 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: viQueryf() 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: viQueryf() 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;
}
```

Example 2: Closing Multiple Channels

This example closes channels 01 and 10 through 13 on any one of the HP E2270A, E2271A, E2272A Switch M-Modules. The program then opens channels 01 and 11. The program assumes an M-Module secondary address of 3 and an interface address of 9.

```
#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 */

    /* 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: viPrintf() returned 0x%x\n", errStatus);
      return errStatus;}

    /* 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;}

    /* 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;}
```

```
    /* 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;
}
```

IEEE 488.2 Common Command Reference

The following table lists the IEEE 488.2 Common Commands accepted by the HP M-Modules. For more information on Common Commands, refer to an HP Serie-1987.

Command	Command Description
*CLS	Clear all status registers and clears the error queue.
*ESE *<register value>*	Enable Standard Event.
*ESE?	Enable Standard Event Query.
*ESR?	Standard Event Register Query.
*IDN?	Instrument ID Query; returns identification string of the module.
*OPC	Operation Complete.
*OPC?	Operation Complete Query.
*RCL *<numeric state>*	Recall the instrument state saved by *SAV.
*RST	Reset the module to its power-on/reset state.
*SAV *<numeric state>*	Store the instrument state.
*SRE *<register value>*	Service request enable, enables status register bits.
*SRE?	Service request enable query.
*STB?	Read status byte query.
*TRG	Trigger the module (if module is equipped for triggers).
*TST?	Self-test. Executes an internal self-test and returns only the first error encountered. Does not return multiple errors.
*WAI	Wait to Complete.

Note These commands apply to VXI instruments as well as M-Modules. Refer to an HP Series C Mainframe User's Manual or the ANSI/IEEE Standard 488.2 for more information about these commands. Refer to the individual M-Module or VXI instrument user's manual for details on IEEE 488.2 Common Command actions and results.

Chapter 3
M-Module Register-Based Programming

To fully understand the operation of M-Modules installed on the HP E2250A M-Module Carrier, you need to know how the Carrier operates and how M-Module Registers are mapped onto the Carrier. This chapter presents a basic tutorial for M-Module register-based programming.

Note If you are using a high-level driver, such as SCPI, you do not need to know the register-based information contained in this chapter. Do not write to registers if you are also controlling the modules by the SCPI drivers. This is because the high level driver will not know the instrument state and an interrupt may occur, causing the driver and/or command module to fail.

HP E2250A Block Diagram

Figure 3-1 shows the overall block diagram of the HP E2250A M-Module Carrier. Refer to the following discussion to understand Carrier operation.

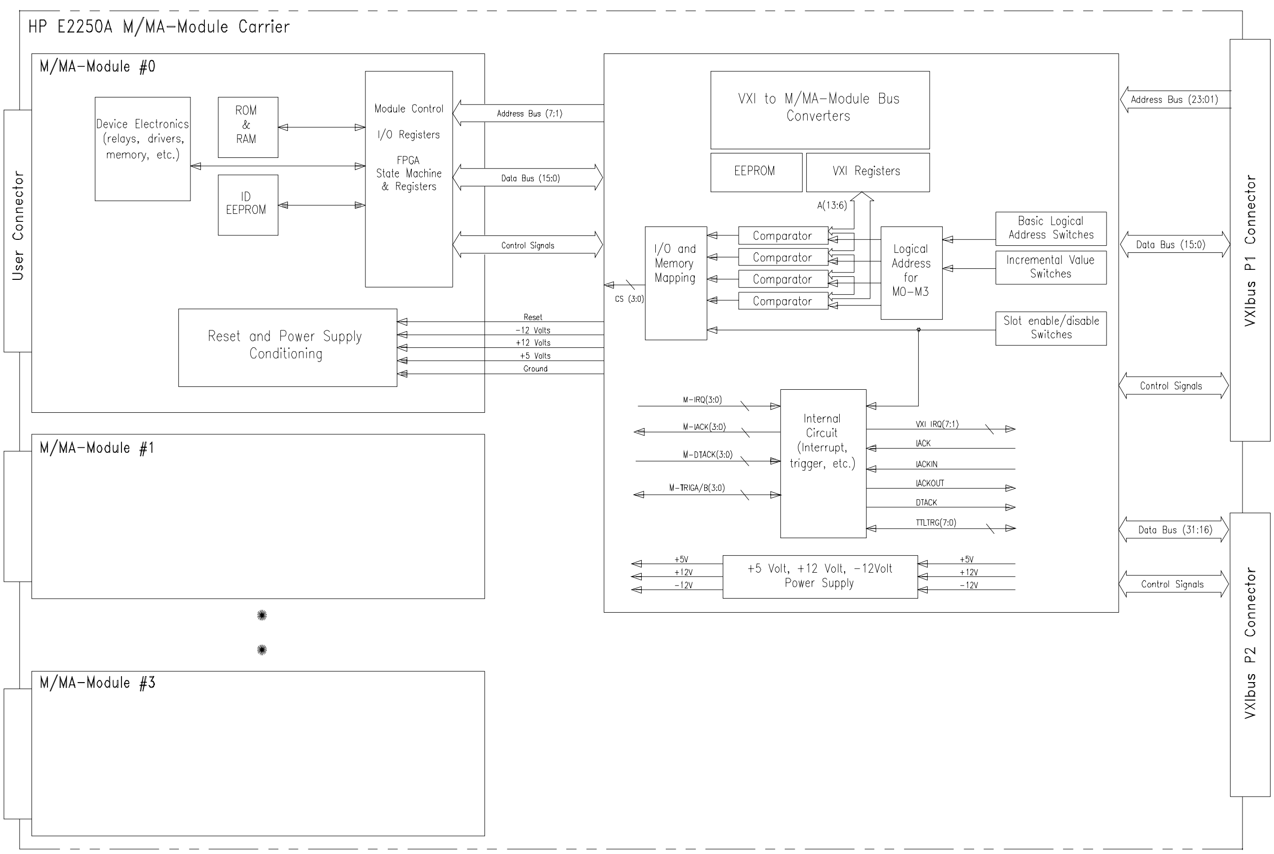

Figure 3-1. HP E2250A Simplified Block Diagram

Logical Address

The ANSI/VITA Mezzanine Concept M-Module Specification does not define logical addresses for M-Modules. To make M-Modules work as standard VXIbus devices, the HP E2250A Carrier provides a logical address for each M-Module and also provides standard VXIbus registers (Manufacturer ID, Device Type, Status/Control, etc.) for each M-Module. These standard registers are located in the lowest 64-byte space for register-based VXIbus instruments.

Note Logical Addresses set on the HP E2250A Carrier can not be used anywhere else in the VXI system. Unused slots in the Carrier should be disabled by setting corresponding Slot Disable/Enable Switches to 1. Refer to the *HP E2250A B-Size M-Module Carrier Installation and Wiring Manual* for more information.

M-Module Register Mapping

Based on the M-Module specifications, each M-Module has an optional 16 word deep (32 bytes) Identification EEPROM which stores the characteristics of that module. Note: EEPROMs on all HP M-Modules are (at least) 64 words deep. Table 3-1 lists the words of the HP M-Modules. The HP E2250A Carrier copies some of these words into its own registers and then the VXI System Resource Manager maps them into A16 and A24 VXI memory registers.[1]

Table 3-1. M-Module EEPROM Words

	Word #	Description	Default Value
Standard M-Module Words	0	Sync Code	5346_h
	1	Module Number (see Table 3-2)	(M-Module Dependent)
	2	Revision Number	(M-Module Dependent)
	3	Module Characteristics (refer to M-Module specifications for bit definitions)	(M-Module Dependent)
	4 - 7	Reserved	
	8-15	M-Modules Specific	(Module Dependent)
Words used on HP M-Modules for VXI use	16	VXI Sync Code	$ACBA_h$ (2's complement of 5346_h)
	17	VXI ID	(M-Module Dependent)
	18	Model Code (see Table 3-1)	(M-Module Dependent)
	19-31	Reserved	
	32-63	M-Modules Specific	(M-Module Dependent)

1 Numbers with a subscript h, such as $1F0000_h$, are shown in hexadecimal format. Numbers without the subscript h are in decimal format.

VXI specifications provide for only 64 bytes of I/O space in A16 memory. However, the M-Module specifications provide for 256-byte multiples of I/O space. To resolve this conflict, the HP E2250A Carrier provides two memory segments for each of the installed M-Modules: the first segment is in VXI A16 memory space and provides standard VXI registers (The M-module's VXI ID word is mapped into the VXI A16 memory as the VXI ID Register at address 00_h and the M-Module's VXI Device Type word is mapped into the VXI Device Type Register at 02_h, the VXI Status/Control Register at 04_h, the VXI Offset Register at 06_h), and optionally other module-specific registers (Interrupt Selection Register at 20_h, Trigger Selection Register at 22_h, and MA-Module A08/A24 Selection Register at 24_h). The second memory segment is in VXI A24 memory space for all of the M-Module registers.

These registers may have different bit descriptions than standard VXI registers. Refer to the register descriptions later in this chapter and in the individual M-Module user's manual for detailed register information.

Table 3-2. HP M-Module Model Codes

HP M-Module Model Number	M-Module Number (M-Module Specification)	M-Module Model Code (VXI Specification)
HP E2250A Empty Slot (but with Logical Address switches set to be effective)	1651	257_h
HP E2259A Double-Wide Breadboard M-Module	1659	258_h
HP E2261A Quad RS-232 Interface M-Module	1661	$25A_h$
HP E2270A 16-Channel Form A Switch M-Module	1670	$25B_h$
HP E2271A 4x4 Matrix Switch M-Module	1671	$25C_h$
HP E2272A Dual 8-to-1 Relay Multiplexer M-Module	1672	$25D_h$
HP E2273A 8-Channel Form C Switch M-Module	1673	$25E_h$
HP E2274A 4-Channel Form C Power Relay M-Module	1674	$25F_h$
HP E2290A 16-Bit Digital I/O M-Module	1690	260_h
HP E2291A 16-Channel Isolated Digital Output M-Module	1691	261_h

Note HP E2261A is not compatible with HP E2250A M-Module Carrier, since some components on the HP E2261A are beyond the height limitation of the M-Module specification.

At Power-on

When power is applied to the VXI mainframe (and hence to the Carrier and M-Module/MA-Modules), the HP E2250A Carrier reads the EEPROM of each installed M-Module/MA-Module and downloads the **VXI Sync code** ($ACBA_h$), **VXI-ID,** and **VXI Device Type** information into its own registers (Carrier provides seven registers for each slot). There are two different cases:

1. If the downloaded VXI sync code from the module is $ACBA_h$ (for HP M-Module), then the downloaded VXI-ID and VXI-Device Type information will be copied into its own registers on the carrier. When the logical address of the M-Module provided by the Carrier is valid,

the VXI Resource Manager will allocate the proper A16/A24 register space according to the downloaded information.

2. If the VXI Sync code cannot be obtained from the module (either the slot is empty, the M-Module/MA-Module does not have an EEPROM, or the M-Module/MA-Module is a non-HP), the Carrier will set the VXI-ID and VXI-Device Type registers of the module to default values[1]. When the logical address of the module provided by the Carrier is valid, the VXI Resource Manager will use the default information to allocate the proper A16 register space and 256 bytes A24 memory space.

Addressing the Registers

Register addresses for the M-Modules (and VXI modules) are found in the address space known as A16 and A24. The exact location of the A16 address space within a VXIbus master's memory map depends on the design of the VXIbus master you are using. For example, in the HP E1306 Command Module, the A16 memory space starts at address $1F0000_h$.

The A16 space is further divided so that the modules are addressed only at locations above $1FC000_h$ within A16. Further, every module is allocated 64 register addresses (40_h). The address of a module is determined by its logical address (set by two eight-position switch packs on the Carrier) times 64 (40_h). For example, if an M-Module's logical address is 120 (78_h), the register addresses for that module in VXI A16 space start at $1FDE00_h$:

$$1FC000_h + (78_h*40_h) = 1FDE00_h$$

A16 Register Space

The base address used in register-based programming depends on whether the A16 address space is inside or outside the HP E1306 Command Module.

A16 Address Space Inside an HP Command Module

When the A16 address space is inside a Command Module (see Figure 3-2), the module's base address is computed as:

$$1FC000_h + (LADDR * 40_h)$$

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 module's logical address, and 64 is the number of address bytes per register-based device. Again, this example uses an M-Module's logical address of 120 (78_h). If this address is not changed, the module will have a base address of:

$$1FC000_h + (78_h * 40_h) = 1FC000_h + 1E00_h = 1FDE00_h$$

or (decimal)

$$2,080,768 + (120*64) = 2,080,768 + 7680 = 2,088,448$$

1 The default value of VXI-ID is $CFFF_h$, which means a register-based A16/A24 device. The default value of VXI Device Type is $F257_h$, which means an unknown M-Module requiring 256 bytes A24 memory space.

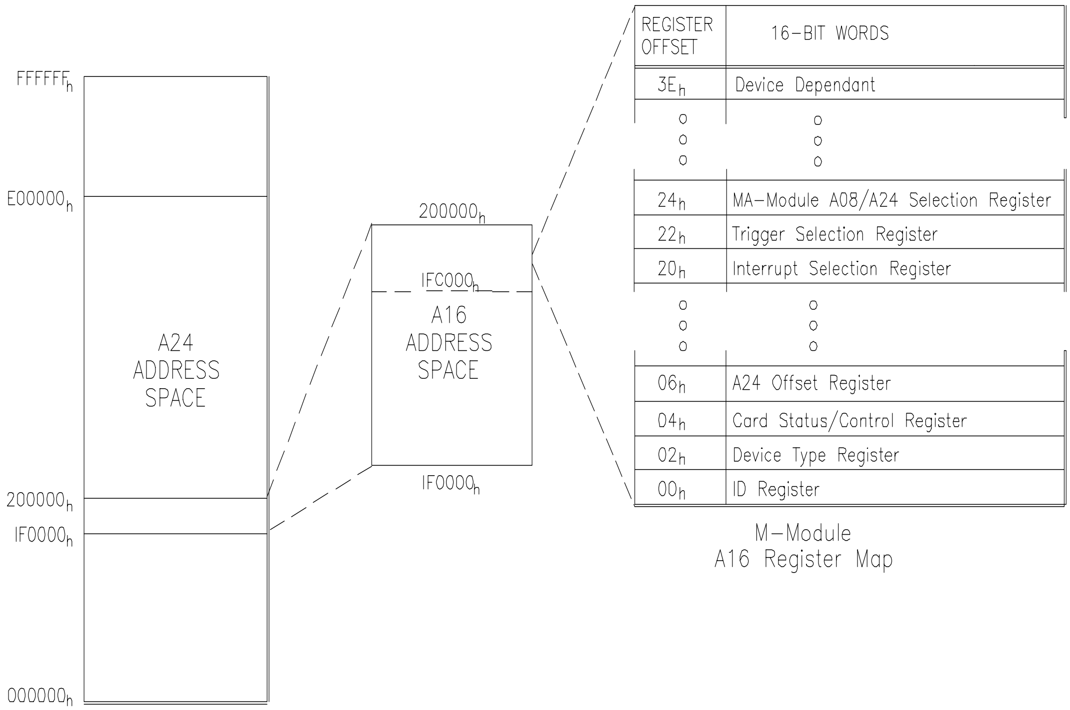

Figure 3-2. Register Address Space in an HP Command Module (such as HP E1306)

A16 Address Space Outside a Command Module

When an HP Command Module is not a part of your VXIbus system (see Figure 3-3), an M-Module's base address is computed as:

$A16_{base} + C000_h + (LADDR * 40_h)$

or (decimal)

$A16_{base} + 49{,}152 + (LADDR * 64)$

where $C000_h$ (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 VXI device. For example, if an M-Module's logical address (LADDR) is 120 (78_h), it will have a base address of:

$A16_{base} + C000_h + (78_h * 40_h) = C000_h + 1E00_h = DE00_h$

or (decimal)

$A16_{base} + 49{,}152 + (120 * 64) = 49{,}152 + 7{,}680 = 56832$

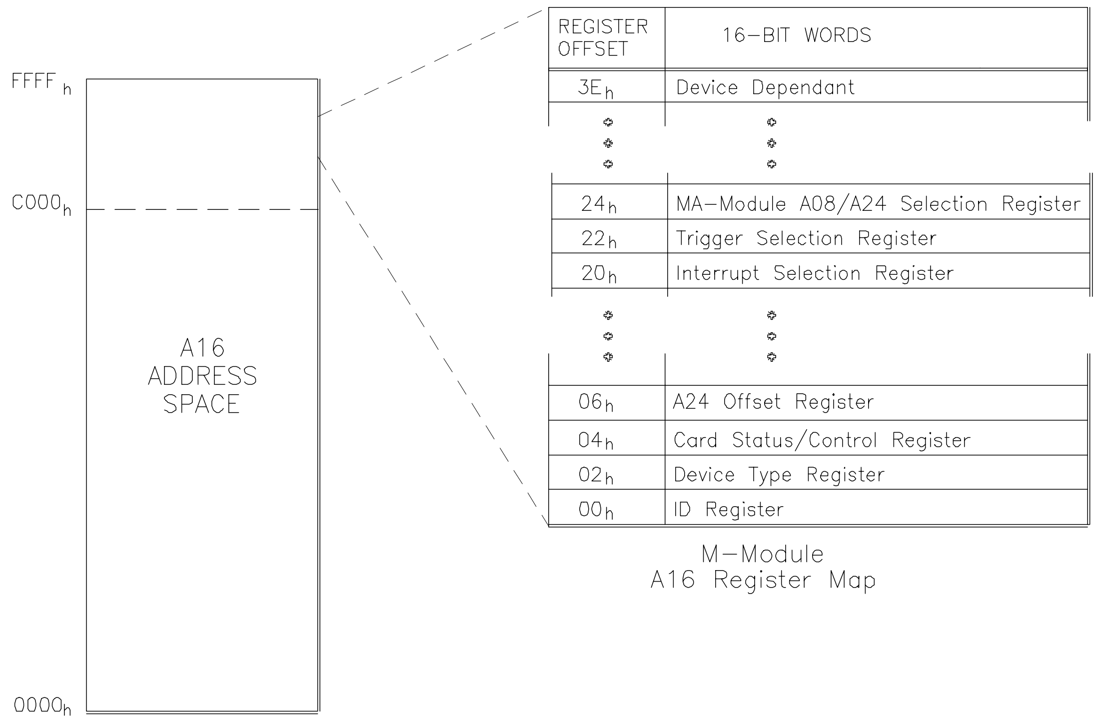

Figure 3-3. Register Address Location in A16 Memory Space

A24 Register Space

Most M-Modules use A24 memory for specific, unique purposes. If an M-Module uses A24 memory space, the VXI Resource manager performs the following steps:

1. Read the M-Module's ID Register Address Space field (bits 12 and 13) to determine if the module uses A24.

2. Read the M-Module's Device Type Register Required Memory field (bits 12 - 15) to determine the size of the A24 memory space needed by the M-Module.

3. Assign the A24 offset for the M-Module and ensure no overlap.

4. Assign the A24 base address and write it to the Offset Register (06_h in A16 memory space).

5. Enable the M-Module's A24 registers by writing a '1' to the A24 Enable bit (bit 15) of the Status/Control Register.

To access the registers in A24 memory space you must:

1. Verify that the registers have been enabled by reading the A24 Enable bit (bit 15) of the VXI Status/Control Register and verifying that it is a ‘1’.

2. Obtain the A24 Base Address by reading the VXI Offset Register (06_h) in the A16 memory space.

3. Use this A24 Base Address plus the specific register offset specified for the M-Module. Refer to the individual M-Module User’s Manual for detailed register descriptions.

Figure 3-4 shows a typical M-Module register mapping in A24 Address Space.

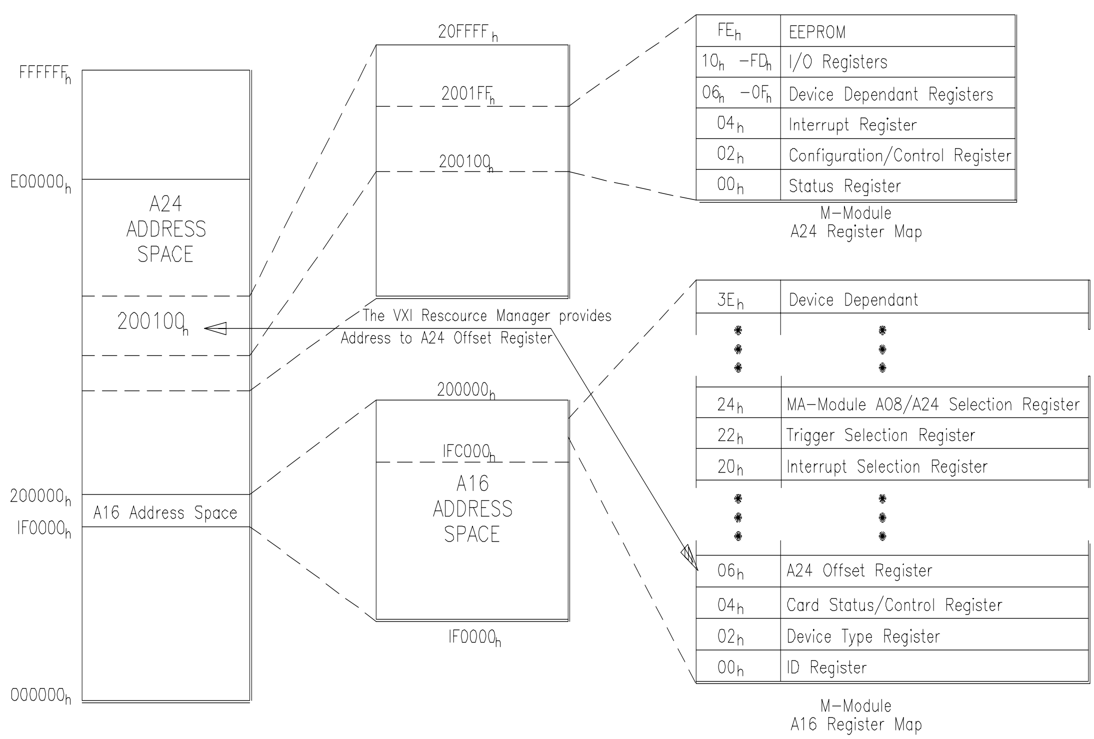

Figure 3-4. Register Mapping in A16 and A24 Address Space

Accessing the Registers

An M-Module’s VXI register address consists of a base address (either A16 or A24) and an offset. For example, an M-Module's Status/Control Register has an offset of 04_h and is in A16 address space. When you write to or read from this register, the offset is added to the base address to form the register address. Similarly, to access a register in A24 memory, you may need to read the A24 Offset Register (06_h in A16 memory) to obtain the A24 Base Address.

Example

Figure 3-5 shows an example register map for four M-Modules installed on the Carrier. The VXI Resource Manager (in this example, an HP E1306 Command Module) allocates both A16 and A24 memory space for each M-Module. An HP E2273A is installed on the Carrier and has its logical address switches set to 24 (or 18_h). The base address for this module is:

$$1FC000_h + (18_h * 40_h) = 1FC600_h$$

The Device Type register for this module has an offset of 02_h. Therefore, to read this register, use the address 1FC602:

$$1FC600_h + 02_h = 1FC602_h$$

Reading this register returns the value $F25E_h$, identifying it as an HP E2273A.

Similarly, use the address $1FC606_h$ to read the A24 Offset register:

$$1FC600_h + 06_h = 1FC606_h$$

Reading this register returns the value 2600_h, which is the most significant 16 bits of the A24 address; the remaining eight bits are always 00_h. Therefore, to access any of the registers in A24 memory, use the sum of the base address 260000_h and the register offset as the address.

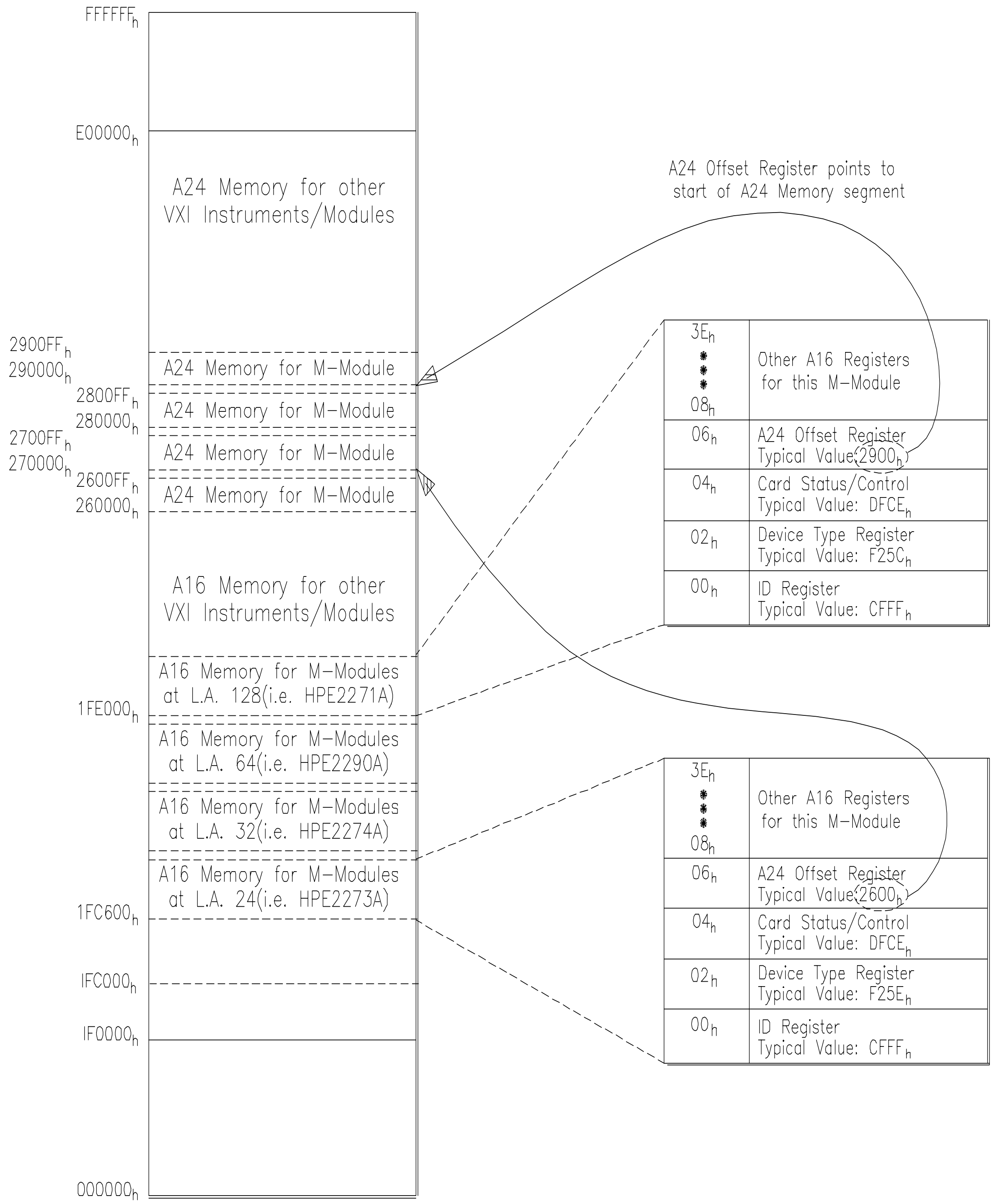

Figure 3-5. Example Register Addressing for M-Modules on the HP E2250A Carrier

VXI A16 Register Descriptions

All HP M-Modules installed on the HP E2250A Carrier have the following A16 registers. The register bit definitions may be different than standard VXI bit definitions.

Note M-Modules may use A16 space registers in addition to the ones described here. They may also have memory space mapped into A24 Memory Space. Refer to the individual M-Module user's manual for details on specific registers, their addressing and use.

VXI ID Register

The ID Register is a read-only register (at address 00_h and 01_h).

b+00_h	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Write	Undefined															
Read	Device Class		Address Space		Manufacturer ID											

- **Device Class** indicates the classification of the VXI bus device. 00 is for memory, 01 is extended memory, 10 is for message-based devices, and 11 is for a register-based module. The HP E2250A Carrier supports only register-based M-Modules and this field should always be 11.
- **Address Space** indicates the addressing modes of the module's operational registers according to the following table.

Bit Pattern	Addressing Mode
00	A16/A24 (Since all HP M-Modules are A16/A24, this field should always be 00)
01	A16/A32
10	reserved
11	A16 devices only

- **Manufacturer ID** = 4095 (decimal) for Hewlett-Packard M-Modules.

VXI Device Type Register

The Device Type Register is a read-only register (at address 02_h and 03_h). Reading this register returns a unique identifier for each M-Module. Refer to the individual M-Module User's Manual for Device Type Register details.

$b+02_h$	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Write	Undefined															
Read	Required Memory				M-Module Model Code											

- **Required Memory** specifies the memory required by the M-Module. The default value of this field is 15, which means the default memory space is 256 bytes.

Bits 15 - 12	Memory Required		Bits 15 - 12	Memory Required
1111	256 Bytes		0111	64 kBytes
1110	512 Bytes		0110	128 kBytes
1101	1 kBytes		0101	256 kBytes
1100	2 kBytes		0100	512 kBytes
1011	4 kBytes		0011	1 MBytes
1010	8 kBytes		0010	2 MBytes
1001	16 kBytes		0001	4 MBytes
1000	32 kBytes		0000	8 MBytes

- **M-Module Model Code** is a unique identifier for that M-Module. For example, $25E_h$ for HP E2273A 8-Channel Form C Switch M-Module or $25F_h$ for HP E2274A 4-Channel Form C Power Relay M-Module. If an installed M-Module does not have an EEPROM, the default M-Module Model Code is 257_h. The following table lists the valid Model Codes for the current HP M-Modules.

HP M-Module Model Number	M-Module Model Code
HP E2250A Empty Slot (but with Logical Address switches set to other than 0)	257_h
HP E2259A Double-Wide Breadboard M-Module	258_h
HP E2261A Quad RS-232 Interface M-Module	$25A_h$
HP E2270A 16-Channel Form A Switch M-Module	$25B_h$
HP E2271A 4x4 Matrix Switch M-Module	$25C_h$
HP E2272A Dual 8-to-1 Relay Multiplexer M-Module	$25D_h$
HP E2273A 8-Channel Form C Switch M-Module	$25E_h$
HP E2274A 4-Channel Form C Power Relay M-Module	$25F_h$
HP E2290A 16-Bit Digital I/O M-Module	260_h
HP E2291A 16-Channel Isolated Digital Output M-Module	261_h

VXI Status/Control Register

The Status/Control Register is a read/write register (at address 04_h and 05_h) that controls the module and indicates its status.

$b+04_h$	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Write (Control)	A24 Enable	Reserved													Sysfail Inhibit	Reset
Read (Status)	A24 Active	MODID*	Reserved										Ready	Passed	Reserved	

- **A24 Enable.** Writing a ‘1’ to this field enables access to the device A24 registers.
- **Sysfail Inhibit.** Writing a ‘1’ to this field disables the M-Module from driving **SYSFAIL*** line.
- **Reset.** Writing a ‘1’ to this field forces the M-Module to reset.
- **A24 Active.** A ‘1’ in this field indicates the M-Module’s registers in A24 memory space can be accessed.
- **MODID*.** A ‘1’ in this field indicates that the M-Module is not selected via the P2 MODID line. A zero indicates the M-Module is selected by a high state on the P2 MODID line.
- **Ready.** A ‘1’ in this field indicates that the M-Module is ready to accept commands. A zero indicates the M-Module is busy and not ready to accept commands.
- **Passed.** A ‘1’ in this field indicates the M-Module passed its self test successfully. A zero indicates the M-Module is either executing or has failed its self test.

Note All the reserved fields are reserved by the Carrier and cannot be used by users. A read/write to these bits may get unstable results.

Note As the I/O and memory space for all M-Modules are always mapped into A24 space, the Carrier will always enable A24 access, which means the A24 enable bit is always set to ‘1’.

Note Since the M-Module cannot provide the information about its self-test results through the interface to the Carrier, the Ready and Passed fields will always be set to ‘1’ by the Carrier after the Carrier’s initialization.

VXI Offset Register

The Offset Register (at address 06_h and 07_h) is a read/write register that contains the highest 16 bits of the starting address for accessing registers in the A24 address space. So the M-Module/MA-Module's register addresses in A24 address space are determined by combining the value of the Offset Register (as the highest 16 bits) and the register offset (as the lowest 8 bits) of this M-Module/MA-Module (refer to the specific M-Module/MA-Module User's Manual).

b+06h	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Write	A24 Space Base address for those M-Modules needing A24 memory															
Read	A24 Space Base address for those M-Modules needing A24 memory															

Interrupt Selection Register

The Interrupt Selection Register (at address 20_h and 21_h) specifies which VXI interrupt line the M-Module will use. M-Modules may generate interrupts to indicate that a SCPI command has been completed. These interrupts are sent to and acknowledged by the HP Command Module or other system controllers via one of seven VXI backplane interrupt lines. Different controllers treat the interrupt lines differently, and you should refer to your controller's documentation to determine how to set the interrupt level. HP Command Modules configured as VXI Resource Managers treat all interrupt lines as having equal priority. If interrupters are using the same line, priority is determined by which slot they are installed in; lower-numbered slots have higher priority than higher-numbered slots. HP Command Modules service line 1 by default, so it is normally correct to leave the interrupt level set to the factory default of IRQ1.

$b+20_h$	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Write	Reserved												INT	VXI Interrupt Line		
Read (default value)	Reserved												INT 1	VXI Interrupt Line 0	0	1

If your controller's documentation instructs you to change the interrupt level, you need to specify the level in the VXI Interrupt Selection Register. To cause the M-Module to interrupt through one of the VXI interrupt lines, write to the appropriate bits (refer to the table below). To disable the module's interrupt, set the bits to 000. Reading the default value of this register returns the value $XXX9_h$. However, selecting other than the default interrupt line 1 is not recommended.

Bits 2 - 0	Selected Interrupt Line
000	NONE (Interrupt Disabled)
001	IRQ1 (default)
010	IRQ2
011	IRQ3
100	IRQ4
101	IRQ5
110	IRQ6
111	IRQ7

M-Module specifications define three types of interrupts. The INT bit (bit 3) determines which M-Module interrupt type is supported. If INT bit is set to a '0', the M-Module supports interrupt types A and B. If INT bit is set to a '1', the M-Module supports interrupt type C (this is the default).

Type A Interrupts The interrupting M-Module removes the interrupt request upon a register access to the interrupting M-Module (such as reading a Status Register), M-DTACK* is not asserted during interrupt acknowledge cycle.

Type B Interrupts The interrupting M-Module removes the interrupt request via a hardware method (on M-IACK* going low), but provides no vector information for the interrupt (since it probably has only one reason to interrupt). This is the same as Type C interrupts except that no vector is supplied and M-DTACK* is not asserted.

Type C Interrupts The interrupting M-Module removes the interrupt request via a hardware method and provides an interrupt vector on the data bus and M-DTACK* is asserted during the interrupt acknowledge cycle. The M-Module removes the interrupt request by M-IACK* going low.

Note All of the signals leading with "M-" are used for the M-Module-to-Carrier interface.

In VXI specifications, however, only two types of interrupts are defined: RORA (Release on Register Access) and ROAK (Release on Acknowledge). The HP E2250A Carrier converts M-Module Type A interrupts to RORA, Types B and C interrupts to ROAK (default).

RORA Interrupts The interrupting device provides its logical address on the data bus (D0 - D7) during the interrupt acknowledge cycle that was initiated in response to its interrupt request. It does not remove the interrupt request until its Status/Control register is accessed.

ROAK Interrupts The interrupting device removes the interrupt request upon the presence of a properly addressed interrupt acknowledge cycle and provides its logical address on the data bus (D0 - D7). If the M-Module responds as INTC, the vector from M-Module is swapped to D8-D15 of the data bus by the Carrier.

Trigger Selection Register (MA-Module only)

The Trigger Selection Register (at address 22_h and 23_h) specifies the direction of trigger signal and which VXI trigger line the MA-Module will use. The carrier provides the ability to connect each of the MA-Module trigger lines to any one of the eight trigger lines on the VXI backplane with either direction. The bit definitions of the Trigger Selection Register are shown as below:

b+22_h	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Write	BEN	BDIR	-	-	-	Trig B TTL Sel			AEN	ADIR	-	-	-	Trig A TTL Sel		
Read (default value)	BEN 0	BDIR 0	-	-	-	Trig B TTL Sel 0	0	0	AEN 0	ADIR 0	-	-	-	Trig A TTL Sel 0	0	0

- **AEN.** Trigger enable for TRIGA. (enable=1, disable=0, default=0)
- **ADIR.** Trigger direction for TRIGA. (output=1, input=0, default=0)
- **Trig A TTL Sel.** TRIGA link to VXI TTL Trigger line 0-7.(default=0)
- **BEN.** Trigger enable for TRIGB. (enable=1, disable=0, default = 0)
- **BDIR.** Trigger direction for TRIGB. (output=1, input=0, default=0)
- **Trig B TTL Sel.** TRIGB link to VXI TTL Trigger line 0-7.(default=0)

The TTL Sel. is defined as the following table.

Bits 10 - 8 or bits 2 - 0	Selected VXI Trigger Line
000	TTLTRG0
001	TTLTRG1
010	TTLTRG2
011	TTLTRG3
100	TTLTRG4
101	TTLTRG5
110	TTLTRG6
111	TTLTRG7

MA-Module A08/A24 Selection Register

MA-Modules may have physically separate A08 and A24 address space. The MA-Module A08/A24 Selection Register (at address 24_h and 25_h) specifies which address space is going to be accessed..

$b+24_h$	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Write	Reserved															A08/A24
Read (default value)	Reserved															A08/A24 0

- **A08/A24.** A ‘1’ in this field indicates that the A24 address space of MA-Module is being accessed. A ‘0’indicates that the A08 address space of MA-Module is being accessed. Default=0.

Note

The A24 address space of MA-Module is different from the VXI A24 address space. They are the same term but having different meaning.

Other Registers

All M-Module registers are mapped into A24 Memory Space. Refer to the individual M-Module User’s Manual for details on register addressing and use.

Register-Based Programming Examples

This section provides several examples demonstrating how to program M-Modules installed on the Carrier.

Note Do not write registers if you are also controlling the modules by a high level language such as SCPI. This is because the high level language driver will not know the instrument state and an interrupt may occur causing the driver and/or command module to fail.

Example 1: Reading the M-Module ID Registers

The following example reads and prints the four VXI registers (ID, Device Type, Status, A24 Offset) of an M-Module. The program was developed with the ANSI C language using the HP VISA extensions. The program was written and tested in Microsoft Visual C++ but can be compiled by any standard ANSI C compiler.

To run the program you must have the HP I/O Library, and an HP 82340 or 82341 HP-IB module installed and properly configured in your PC. An HP E1306 Command Module provides direct access to the VXI backplane.

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

#define INSTR_ADDR "GPIB-VXI0::24::INSTR"

void main()
{
   ViStatus errStatus;                    /*Status from each VISA call*/
   ViSession viRM;                        /*Resource mgr. session */
   ViSession m_mod;                       /* M-module session  */

   unsigned short id_reg;                 /*ID Register*/
   unsigned short dt_reg;                 /* Device Type Registers*/
   unsigned short stat_reg;               /*Status Register*/
   unsigned short a24_offset;             /* A24 Offset Register*/

   /* 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;}

   /* read  and print the module's ID Register */
   errStatus = viIn16(m_mod,VI_A16_SPACE,0x00,&id_reg);
   if(VI_SUCCESS > errStatus){
      printf("ERROR: viIn16() returned 0x%x\n",errStatus);
```

```
    return errStatus;}
  printf("ID register = 0x%hx\n", id_reg);

  /* read  and print the module's Device Type Register */
errStatus = viIn16(m_mod,VI_A16_SPACE,0x02,&dt_reg);
  if(VI_SUCCESS > errStatus){
    printf("ERROR: viIn16() returned 0x%x\n",errStatus);
    return errStatus;}
  printf("Device Type register = 0x%hx\n", dt_reg);

  /* read and print the module's Status Register */
errStatus = viIn16(m_mod,VI_A16_SPACE,0x04,&stat_reg);
  if(VI_SUCCESS > errStatus){
    printf("ERROR: viIn16() returned 0x%x\n",errStatus);
    return errStatus;}
  printf("Status register = 0x%hx\n", stat_reg);

  /* read and print the module's A24 Offset Register */
errStatus = viIn16(m_mod,VI_A16_SPACE,0x06,&a24_offset);
  if(VI_SUCCESS > errStatus){
    printf("ERROR: viOpen() returned 0x%x\n",errStatus);
    return errStatus;}
  printf("A24 Offset register value = 0x%hx\n", a24_offset);

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

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

Example 2: Closing a Channel Relay

The following example closes channels 1 and 3 and then opens (resets) the channels on an HP E2272A Dual 8-to-1 Relay Multiplexer M-Module. The program was developed with the ANSI C language using the HP VISA extensions. The program was written and tested in Microsoft Visual C++ but can be compiled by any standard ANSI C compiler.

To run the program you must have the HP I/O Library, and an HP 82340 or 82341 HP-IB module installed and properly configured in your PC. An HP E1306 Command Module provides direct access to the VXI backplane.

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

#define INSTR_ADDR "GPIB-VXI0::24::INSTR"
```

```
void main()
{
   ViStatus errStatus;                        /*Status from each VISA call*/
   ViSession viRM;                            /*Resource mgr. session */
   ViSession m_mod;                           /* M-module session */

   /* 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;}

   /* set the Driver Power Enable Bit (bit 3) in the Card Control Register */
   errStatus = viOut16 (m_mod,VI_A24_SPACE,0x02,0x08);
   if(VI_SUCCESS > errStatus){
      printf("ERROR: viOut16() returned 0x%x\n",errStatus);
      return errStatus;}

   /* Close Channels 0 and 2 (bit values 1 and 4 respectively) */
   errStatus = viOut16 (m_mod,VI_A24_SPACE,0x10,0x05);
   if(VI_SUCCESS > errStatus){
      printf("ERROR: viOut16() returned 0x%x\n",errStatus);
      return errStatus;}

   /* Open (Reset) channels in Row 0) */
   errStatus = viOut16 (m_mod,VI_A24_SPACE,0x12,0x00);
   if(VI_SUCCESS > errStatus){
      printf("ERROR: viOut16() returned 0x%x\n",errStatus);
      return errStatus;}

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

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

   return VI_SUCCESS;
   }
```

Appendix A

HP E2250A M-Module Carrier Specifications

M/MA-Module Standard Compliance

A08/ A24, D08 (EO), D16, D32, INTA, INTB, INTC, TRIGA, TRIGB, Burst Access Mode

Allows standard M/MA-Modules to operate in a VXI system as Register-based devices.

Note MA-Modules extend address bus to 24 bits and allow up to 16Mbytes memory to be addressed. But according to VXI specification, the maximum A24 space that each device could require is 8Mbytes.

Note Limited by the M-Module specification, the D32 capability is only quad-byte (byte 0-3) transferring and is no longer a D32 slave in VME terms (refer to VME specification).

Note MA-Module Burst Access mode will have two limitations according to VME Block Transfer mode: 1). Memory locations are in ascending order. 2). Block transfer cycles shall not cross any 256-byte boundary.

General Capabilities

Size:

- VXI B-Size

Slots required in VXI Mainframe:

- one

VXI Connectors:

- P1, P2

Number of M-Module/MA-Modules:

- Up to four

Watts/Slot:

- 25W maximum.

Caution **When calculating total power for the Carrier (for cooling), you must consider the power dissipated from each M/MA-Module. For example, the relay contacts on the HP E2274A 4-Channel Power Relay M-Module are rated for a maximum of 5.0 Amps DC. With an assumed contact resistance of 0.25Ω, each relay can dissipate a maximum of 6.25 Watts ($I^2R = 6.25$), or a total of 25 Watts per module. The HP E2250A can accommodate a maximum of 25 Watts, so only one HP E2274A Module can be used under those conditions. More modules can be installed if fewer relays are closed at one time, less current is switched, etc. Do not exceed the maximum cooling capacity of the HP E2250A.**

Cooling:

- 0.2 ΔP mm H_2O

Air Flow:

- 4.0 Liter/Sec

Power requirements of the Carrier. Add DC Current and Dynamic Current of all installed M-Module/MA-Modules together to determine total power requirements.

DC Volts	DC Current	Dynamic Current
+5 V	0.25 A	0.01 A
+12 V	0 A	0 A
- 12 V	0 A	0 A

Note Carrier does not use either +12V or -12V power voltage which is only used by M-Module/MA-Modules.

Symbols

A

B

C

D

E

F

G

H

T

V

W