VM31 VMEBUS HARD DISK CONTROLLER TECHNICAL MANUAL



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TABLE OF CONTENTS

SECTION 1 GE	NERAL	DESCRIPTION
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1.1	INTRODUCTION	1-1
1.2	OVERVIEW	1-1
1.2.1	Part Numbers	1-1
1.3	FEATURES	1-2
1.3.1	Speed	1-3
1.3.2	Flexibility	1-4
1.3.3	Easy Application	1-4
SECTIO	N 2 SPECIFICATIONS	
olc110		
2.1	SPECIFICATIONS	2-1
2.1	DISK DRIVE COMPATIBILITY	2-2
2.2	TYPICAL (MEASURED) THROUGHPUT	2-2
2.3	ERROR DETECTION AND CORRECTION CAPABILITIES	2-3
SECTIO	N 3 INSTALLATION	
2 1	OVERVIEW	3-1
3.1 3.1.1	Maintaining FCC Class A Compliance	3-1
3.2	INSPECTION	3-1
3.3	CONSIDERATIONS FOR USE OF THE VM31 IN VMEBUS SYSTEMS	3-2
	CONFIGURING THE VM31 BOARD	3-2
3.4	VM31 Board Component Locations	3-2
3.4.1	DIR Coult de Tomas	3-4
3.4.2	DIP Switch Types	3-4
3.4.3	SW1 Switch Settings	3 -4
3.4.3.1	Reset - SW1-1	3-5
3.4.3.2	Shared Memory Starting Address (SW1-2 to SW1-4)	3-5 3-5
3.4.4	Jumper Settings on the VM31	3-5 3-5
3.4.4.1	Interrupt Jumpers - J6 and J7	3-3 3-7
3.4.4.2	DMA Priority Jumpers - J8 and J9	3-7 3-8
3.4.4.3	Early Release Jumper - J10	3-8
3.5	INSTALLING THE VM31 IN A BACKPLANE	3-0 3-9
3.6	SETUP OF DISK DRIVES FOR USE WITH THE VM31	
3.6.1	Sector Sizes	3-9 3-9
3.6.2	Hard Sector Format	
3.6.3	Drive Setting for Sector Size	3-10
3.7	CABLING	3-11
3.7.1	Cabling for Same Cabinet Installations	3-13
3.7.1.1	A Cable	3-14
3.7.1.2	B Cable	3-15
3.7.1.3	Grounding	3-16
3 8	POWER-UP AND SYSTEM VERIFICATION	3-16

SECTION 4 PROGRAMMING THE VM31

4.1	OVERVIEW	4-1
4.2	FORMAT CONVENTIONS	4-1
4.3	VM31 COMMAND TABLES	4-2
4.3.1	Standard Command Table Format	4-3
4.3.2	Communicating with the VM31	4-4
4.3.3	Command Table Memory Usage	4-4
4.4	PROGRAMMING GUIDELINES	4-4
4.5	START/DONE CODE AND ERROR STATUS - BA + 0	4-7
4.6		4-9
4.7	VM31 COMMANDS READ AND WRITE TO CONTIGUOUS MEMORY (00H and 04H)	4-10
4.7.1	Command Table Format	4-10
4.7.2	Command Number, Interrupt Mask, and Read Copies - BA+4	4-11
4.7.3	Offset of Next Command Table - BA+84	4-11
4.7.4	Caching and Read-Ahead - BA+C	4-12
4.7.5	Drive Number and Block Address - BA + 14	4-13
4.7.6	Number of Blocks to be Transferred - BA + 18	4-14
4.7.7		4-15
4.7.8	10 11/11 Office to 10/1 10 office 1 and 10 of 10/10/10/10/10/10/10/10/10/10/10/10/10/1	4-15
4.7.9	DIOCKO ICCACI I CACIC DIL I LEO MINIMI I	4- 16
4.7.10		4-16
4.8	TELLED THE TO CONTINUE TO THE TELLED THE TEL	4-18
4.8.1		4-19
4.8.2	Communicativamoet, interrupt many and record depression	4-20
4.8.3		4-20
4.8.4	Caciffic and ficad fatical Dirical	4-20
4.8.5	Scatter Address Mask - BA+10	4-21
4.8.6	Direct and Diock Library	4-21
4.8.7	1 Validation of Diocko to De 11 and tell and 11 1 20 111111111111111111111111111111	4-21
4.8.8	1 Officer to Dediter List in 14 List 211 / 10	4-22
4.8.9	Communa Tubic Example infinition	4-23
4.8.10	Start Seck	4-28
4.9	101111111111111111111111111111111111111	4-28
4.9.1	Communa Table I Office Communication	4-29
4.9.2	Communication and a production of the contraction o	4-30
4.9.3	Communa rable rollination many rate (4-31
4.10	ODI DILITORIA CONTINUE CONTINU	4-32
4.10.1	Communication and a communication of the communicat	4-32
4.10.2	Command Number, Interrupt Mask, and Read Copies - BA+4	4-33
4.10.3	Office of 14cht Communa 14bic 21110 initial	4-34
4.10.4		4-34
4.10.5	Debited 14CW 1 didnieter value 211 20 mm	4-34
4.10.6	Tidia Cott occoming I distribute to the contract of the contract of the contract occording to the contract occurrence	4-36
4.10.7		4-36
4.10.8	7 171110 000 1 100 001 1110 001 1110 11 11 1	4-37
4.10.9	Diagrootic reporting a mountain a continuous and a mountain and a	4-38
4.10.10	VIVIED NO INCOME V OCCUPANTO TO THE STATE OF	4-39
4.10.11	Doura Francisco	4-39
4.10.12	Sectors per Page - Parameter B0	4-40

4.11	REPORT DRIVE AND CONTROLLER PARAMETERS (21H)
4.11.1	Command Table Format
4.11.2	Hard/Soft Sectoring - Parameter 00
4.11.3	Sector Size Code - Parameter 04
4.11.4	Diagnostic Reporting - Parameter 1C
4.11.5	Drive Status - Parameter 70
4.11.6	Board Address - Parameter 90
4.11.7	Sectors per Page - Parameter B0
4.11.8	Board Type and Firmware Revision - Parameter C0
4.11.6	
4.12.1	READ DISK DEFECT LIST (28H)
	Command Table Format
4.12.2	Command Number and Interrupt Mask - BA+4
4.12.3	Offset of Next Command Table - BA+8
4.12.4	Drive Number and Block Address - BA + 14
4.12.5	RAM address for read data - BA+1C
4.12.6	Command Table Example
4.13	TEST DMA TRANSFERS TO EXTERNAL MEMORY (72H)
4.13.1	Command Table Format
4.14	RESET DRIVE (90H)
4.14.1	Command Table Format
4.14.2	Command Number and Interrupt Mask - BA+4
4.14.3	Offset of Next Command Table - BA+8
4.14.4	Drive Number - BA + 14
4.14.5	Command Table Example
4.15	SPECIAL COMMAND - RESET CONTROLLER
4.16	ILLEGAL COMMANDS
4.17	CHAINING OF COMMAND TABLES
SECTIO	ON 5 APPLICATION INFORMATION
	O III BIGILIOI IIII OMMIIIOI
5.1	OVERVIEW
5.2	BAD BLOCK RE-MAPPING
5.2.1	Recommended Two-Level Defect Skipping Scheme
5.3	OPTIMAL CACHE UTILIZATION
5.3.1	Caching of New Read Data
5.3.2	The Cache During Writes
5.4	ERROR DETECTION AND CORRECTION
5.4.1	
	Background
5.4.2	Recommended Implementation
A	CABLE PIN ASSIGNMENTS
4 2	CABILITY MODISTRICTIO

LIST OF FIGURES

Figure	Title	Page
3-1	VM31 Board Component Locations	3-3
3-2	Switch Setting Example	3-4
3-3	Interrupt Jumper Settings - J6 and J7	3-6
3-4	Jumper Settings for DMA Priority	3-7
3- 5	Jumper Settings for Early Release	3-8
3-6	Drive Cabling	3-12
4-1	Standard Command Table Format	4-3
4- 2	Commands in an Interrupt Driven System - Single Command Table	4-6
4-3	Reads and Writes to Contiguous RAM	4-10
4-4	Example, Reads to Two RAM Addresses with Caching	4-17
4- 5	Command Table Format for Transfers To or From Scattered RAM	4-19
4-6	Example of Read to Scattered RAM - Page Size Equal to Disk Block Size	4-24
4-7	Example of Read to Scattered RAM - Page Size is Four Times Block Size	4-27
4-8	Command Table for Disk Formatting	4-30
4-9	Example of Disk Formatting with Interleave 2	4-31
4-10	Formatting for Replacement of Bad Track with Spare Track	4-32
4-11	Command Table for Set Drive and Controller Parameters	4-33
4-12	VM31 Board Serial I/O Port	4-38
4-13	Command Table for Reporting Drive and Controller Parameters	4-40
4-14	General Defect Format Readable by VM31	4-45
4-15	Fujitsu 2333 Media Defect Format	4-45
4-16	Command Table Format for Read Defect	4-46
4-17	Example, Read Fujitsu Defect for Cylinder 5, Head 0	4-49
4-18	Command Table for Test DMA Command	4-50
4-19	Command Table Format for Reset Drive Command	4- 51
4-20	Example, Reset on Unit 2	4- 53
4-21	Ping-Pong Chaining of Two Command Tables	4-56
5-1	Formatting for Spare Location on a Perfect Track	5-3
5-2	Formatting for Skipping of Bad Sector, by Sector Slipping	5-4
5-3	Formatting for Replacement of Bad Track with Spare Track	5-5

LIST OF TABLES

Table	Title	Page
1-1	VM31 Part Numbers	1-2
2-1	VM31 Specifications	2-1
2-2	Throughput Measurements	2-2
2-3	VM31 Record Length Specifications	2 - 3
3-1	Starting Address Switch Settings	3-5
3-2	DMA Priority Jumper Functions	3-7
3-3	Cable Kits (includes an A and B cable)	3-13
3-4	Individual Flat A Ribbon Cables	3-14
3-5	Individual Flat B Ribbon Cables	3-14
4-1	VM31 Error Codes (Bits 0-7)	4-8
4-2	VM31 Commands	4-9
4-3	Drive and Controller Parameters That May Be Set	4-35
4-4	Diagnostic Report Bits	4-39
4-5	Drive and Controller Parameters That May Be Reported	4-41
A-1	Control Cable Pin Assignments	A-1
A-2	Data Cable Pin Assignments	A-2

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BASIC WARRANTY - In the absence of any optional warranty or continuing provisions extended by formal agreement, Emulex warranties its Products in accordance with the schedules listed below.

In all cases where equipment is to be returned to Emulex, a "Return Authorization" must be issued by the "Repair Center," (714) 662-5600.

CONTROLLERS - PERIPHERALS - DATA COMMUNICATION PRODUCTS - Emulex warrants for a period of twelve (12) months from the date of shipment, that each product shall be free of defects in material and workmanship. These products include all Disk and Tape Controllers, Magnetic Disk and Tape Drives, Optical Disk Drives, Communication Multiplexers, and modem products.

During this period, if the customer experiences difficulties with an Emulex product and is unable to resolve the problem via the phone with Emulex Technical Support, a Return Authorization will be issued. Following receipt of a Return Authorization, the customer is responsible for returning the product to Emulex, freight prepaid. Emulex, upon verification of warranty will, at its option, repair or replace the product in question, and return to the customer freight prepaid.

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In the event product(s) returned under the provisions of this Warranty are subsequently determined by Emulex to be functionally operational and in accordance to its published specifications, i.e., "No Defect Found" (NDF), Purchaser will be charged a NDF fee and the product shall be returned to Purchaser freight collect.

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1.1 Introduction

This manual contains information and applications data for the Emulex VM31 VMEbus hard disk controller. It is designed to be used for setup, installation, cabling, and programming of the VM31 controller. Installation of software is described in the *Emulex VMEbus Unix Software Installation and User's Guide, Emulex part number VS9950901-00*.

The contents of the manual are as follows:

Section 1	General Description
Section 2	Specifications
Section 3	Installation
Section 4	Programming the VM31
Section 5	Applications Information

Cable Pin Assignments

1.2 Overview

Appendix A

The VM31 is a high-throughput SMD disk controller for use in VMEbus systems. This controller conforms to the VMEbus Specification, Rev. C (April 1982) and is capable of supporting four industry-standard SMD disk drives.

1.2.1 Part Numbers

Table 1-1 lists the part numbers for the VM31 hard disk controller and accessories.

Table 1-1. VM31 Part Numbers

Model	Part Number	Qty	Description
VM31	VM3110501-00	1	VM31 Controller Board
		-	Cabinet Cabling Kit, see Tables 3-3 to 3-5 for choices
	VS9951801-XX	1	Emulex Diagnostics and Driver; media on 9-track tape (-01)
			Emulex Diagnostics and Driver; media on 5.25-inch floppy disk, 360K bytes (-02)
			Emulex Diagnostics and Driver; media on 5.25-inch floppy disk, 1.2M bytes (-03)
	VM3151001-00	1	VM31 VMEbus Hard Disk Controller Technical Manual
	VS9950901-00	1	Emulex VMEbus UNIX Software Installation and User's Guide (included with Diagnostics and Driver)

1.3 Features

- Controls up to four industry-standard SMD drives with data rate up to 24 megabits per second
- Dual-ported 256K byte cache for read data
- Can read or write all data on a track in only slightly more than the period of one disk rotation. No interleaving is required.
- 32-bit or 16-bit DMA transfers (software selectable)
- 32-, 24-, or 16-bit DMA addressing (software selectable)
- Switch-selectable VMEbus address setting
- Can perform disk reads to multiple addresses with a single command
- Transfers data to contiguous or scattered RAM (software selectable)
- Performs all data transfers in single cycles by DMA, using fast prerequesting of VMEbus, for minimum bus occupancy

- On-board 12.5-MHertz 68000 microprocessor with 512K bytes of RAM (including the 256K byte cache)
- Full 48-bit ECC (Error Checking and Correcting) using a Data Systems Technology computer-generated polynomial
- High-speed state machine with writable control-store
- High-level software interface allows controller to read page tables directly, with any logical block size. This facilitates scatter/gather transfers with minimum system overhead.
- Automatic error detection and retries on error
- Automatic defect skipping and bad-track re-vectoring
- Supports sector sizes of 512, 1024, or 2048 bytes (software selectable)
- Supports overlapped seeks
- Comprehensive self-test of processor, RAM, state machine, and ECC generator on power up. Status indicated by LEDs.
- 19.2K-baud serial output port for diagnostic reporting, as well as for software-selectable dynamic disk transaction reporting

1.3.1 Speed

The VM31 includes many features designed to enhance performance. An MC68000 is used to control seeking and error recovery and to start VMEbus DMA (direct memory access) transfers. A RAM-based state machine, configured in a uniquely efficient architecture, performs read and write timing and data routing.

Proprietary circuitry and a disk-transfer algorithm permit a full track to be transferred in only slightly more time than one revolution of the disk, irrespective of the position of the head above the track when the transfer is started. This allows the highest achievable disk-data throughput efficiency in a single-read-channel disk controller. These out-of-order transfers may be performed with nearly equal speed for both writes and reads. No interleaving is required.

A 256-Kbyte region in the controller's dynamic RAM is used to cache data read from the disk. A look-ahead/look-around caching algorithm greatly reduces the number of seeks required for data retrieval and other data movement operations, such as copying files between two areas on the disk. After a seek operation is started on one drive, the controller is free to perform operations on another drive while the seek is in progress.

The VM31 can perform disk reads to multiple addresses with a single command and at a higher speed than could be achieved by making multiple requests for separate reads with a standard disk controller. This allows fast "pseudo-simultaneous" loading of data or software to several processors/memories in a multiprocessor system.

1.3.2 Flexibility

Data transfers between disks and the VMEbus are performed with either 32-bit or 16-bit words to reduce bus occupancy by the controller. Therefore, memories need to be capable of 16-bit transfers only. If the host VMEbus system is not capable of 32-bit transfers, the VM31 may be commanded to perform only 16-bit transfers, with a slight throughput degradation of 5-30% depending on system and disk characteristics.

All data transfers are performed in single cycles (about 0.6 microseconds) by DMA. While this requires bus arbitration after each cycle, it does not impact system performance severely. The board releases the BBSY signal early in the cycle to allow arbitration to occur during the cycle. Data transfers performed in single cycles guarantee that higher priority DMA devices will have access to the bus after each cycle. No minimum bus access time is required by the VM31.

The VM31 can be connected to most SMD drives that have a data-transfer rate of less than or equal to 24 MHertz (3.0 MB/sec). The four drives that can be connected to the VM31 need not be of the same type. However, they must be sector equivalent (i.e. all hard or all soft sectored with equal sector sizes). The VM31 is designed to be compatible with virtually all disk drives having either standard or extended SMD interfaces.

1.3.3 Easy Application

The VM31 is designed to be easy to use and efficient for time-sharing operating systems. The VM31 occupies an address space of 512 bytes and appears to the rest of the system as a 512-byte memory in the VMEbus short address space with base address set by the SW1 switch on the VM31 board. The SW1 switch selects one of a list of eight possible addresses. The host system passes commands and status to and from the VM31 by writing to and reading from this "shared memory". The VM31 performs the actual *data* transfers using direct memory access (DMA) to any location within the four-gigabyte VMEbus address space.

The VM31's versatile command set supports up to a full disk transfer with a single command, as well as automatic logical-to-physical conversions and movements over head and cylinder boundaries. Reads and Writes may be done to either contiguous or scattered system memory. Bad-block skipping and alternate track re-vectoring are supported.

2.1 **Specifications**

Table 2-1 lists the specifications for the VM31 controller.

Table 2-1. VM31 Specifications

Parameter	Description
VMEbus Compatibility	The VM31 complies with Revision C of the VMEbus Specification.
Master Data Transfer Options	A32 - 31 address lines D32 - 32 data lines
Slave Data Transfer Options	A16 - 15 address lines D16 - 16 data lines
Requester Options	Any one of R(0), R(1), R(2) or R(3) (STAT) RWD Static (STAT) selection of request line Release-When-Done (RWD)
Interrupter Options	Any one of I(1), I(2), I(3), I(4), I(5), I(6) or I(7) (STAT) Static selection of interrupt line Dynamic selection of interrupt vector
Environmental Requirements	Operating Temperature: 0 to 55 degrees C Maximum Operating Humidity: 90 %
Power Requirements	7.5 A max. (5.0 A typ.) at +5 VDC 500 mA max. (300 mA typ.) at -12 VDC
Physical Configuration	Standard double-height Eurocard (160mm x 230mm).

2.2 Disk Drive Compatibility

The VM31 is designed to be compatible with virtually all disk drives having either standard or extended SMD interfaces and having data rates up to 24 megabits-per-second (up to 3.0 megabytes-per-second). The VM31 has been tested and found compatible with the following disk drives:

- CDC 9710-80
- CDC 9715-340, 9715-500
- CDC 9771 XMD I
- CDC 9772 XMD II
- CDC 9773 XMD III
- Fujitsu M2333, 2351A, M2361A

2.3 Typical (Measured) Throughput

Throughput measurements for two Fujitsu disk drives are listed in Table 2-2. The measurements were made when transferring one-megabyte strings of contiguous blocks of data, using 32-bit DMA data transfers aligned to longword boundaries in system memory, one spare sector per track, and using 2M bytes memory boards.

Throughput rate includes all overhead due to inter-sector gaps, headers, head and track switching times, and command decode times. Peak transfer rates are slightly higher than the sustained rates given here.

Table 2-2. Throughput Measurements

Drive Type	Sector Size (bytes)	Number of Sectors per Track	Bytes pe	a Throughput r Second Contiguous Write
Fujitsu 2333	2048	19	1,500,000	1,250,000
	1024	36	1,350,000	1,200,000
Fujitsu 2312	2048	9	950,000	800,000
	1024	18	950,000	800,000

The following is a list of throughput considerations:

- Throughput rates are slower when using 16-bit data transfers or transfers to odd word boundaries.
- Throughput rates may vary depending on system configuration factors such as system memory speed, bus arbitration speed, bus occupancy by other devices, and drive parameters.
- Throughput rates may be up to 30% slower when using a 512-byte block size. For this reason, 1024-byte or 2048-byte block sizes are recommended for best performance.
- Transfers to scattered RAM are slightly slower than contiguous transfers.

2.4 Error Detection and Correction Capabilities

The error detection and correction capabilities of the 48-bit polynomial implemented in the VM31 controller are specified below. Record lengths that vary 10-20% from the specifications below will have the same capabilities.

Table 2-3. VM31 Record Length Specifications

	record length (bytes)		
	512	1024	2048
Single burst correction span:	11	11	11
Single burst detection span:	27	25	25
Double burst detection span:	7	6	4
Miscorrection probability:	14.90 x 10 ⁻⁹	29.80 x 10 ⁻⁹	59.61 x 10 ⁻⁹ 3.550 x 10 ⁻¹⁵
Misdetection probability:	3.550 x 10 ⁻¹⁵	3.550 x 10 ⁻¹⁵	

3.1 Overview

This section describes the procedures for installing and checking the VM31 controller. The subsection titles are listed below to serve as an outline of the procedure.

Subsection	Title
3.1	Overview
3.2	Inspection
3.3	Considerations for Use of the VM31 in VMEbus Systems
3.4	Configuring the VM31 Board
3. 5	Installing the VM31 in a Backplane
3.6	Setup of Disk Drives for Use with the VM31
3.7	Cabling
3.8	Power-Up and System Verification

3.1.1 Maintaining FCC Class A Compliance

Emulex has tested the VM31 controller for FCC compliance. The VM31 complies with FCC Class A limits for radiated and conducted interference.

3.2 Inspection

Emulex products are shipped in special containers designed to provide full protection under normal shipping conditions. Immediately upon receipt, the shipping container should be inspected for evidence of possible damage incurred in transit. Any obvious damage to the container, or indications of actual or probable equipment damage, should be reported to the carrier company in accordance with instructions on the form included in the container.

Unpack the VM31 controller and, using the shipping invoice, verify that all equipment is present. Verify also that model or part number (P/N) designation, revision level, and serial numbers agree with those on shipping invoice. Subsection 1.2 explains model and part numbers. These verifications are important to confirm warranty. If evidence of physical damage or identity mismatch is found, notify an Emulex representative immediately. If the equipment must be returned to Emulex, it should be shipped in the original container.

Visually inspect all components after unpacking. Check for such items as bent or broken connector pins, damaged components or any evidence of physical damage.

Examine all socketed components carefully to ensure they are properly seated.

Considerations for Use of the VM31 in VMEbus Systems 3.3

The VM31 requires good airflow to cool the comparatively large number of parts on it. Forced air cooling is mandatory for the VM31 board.

Since the VM31 performs longword transfers, it requires a backplane with low-impedance grounds to avoid noise problems. If the VMEbus backplane grounds are poor, intermittent errors are likely to occur. A low-noise backplane permits the controller to operate correctly.

The VM31 transfers all data between disk and VMEbus RAM in 16-bit words or 32-bit longwords depending on the setup parameters given to the board. Of course, if the host system's memory boards cannot perform 32-bit wide transfers, the VM31 must be set up for 16-bit transfers only. See "Set Drive and Controller Parameters (20H)" command in Section 4.

Command information written to or from the shared memory (resident on VM31) may be done via 8- or 16-bit transfers, depending on the cycles chosen by the host. This may not be done using longword VMEbus transfers. Longword transfers to shared memory must be deliberately prevented when using a 32-bit microprocessor, such as the Motorola 68020.

The address PAL provides for eight different starting addresses for the shared memory on the VM31 board and identifies the VM31 as the first disk controller in a VMEbus-based computer system. The factory-configured 16-bit (short addressing) shared memory starting address is 0400H (400 hexadecimal). You can select one of the other seven addresses by changing the setting of switch SW1 on the VM31 board, as described in Section 3.4.3.2.

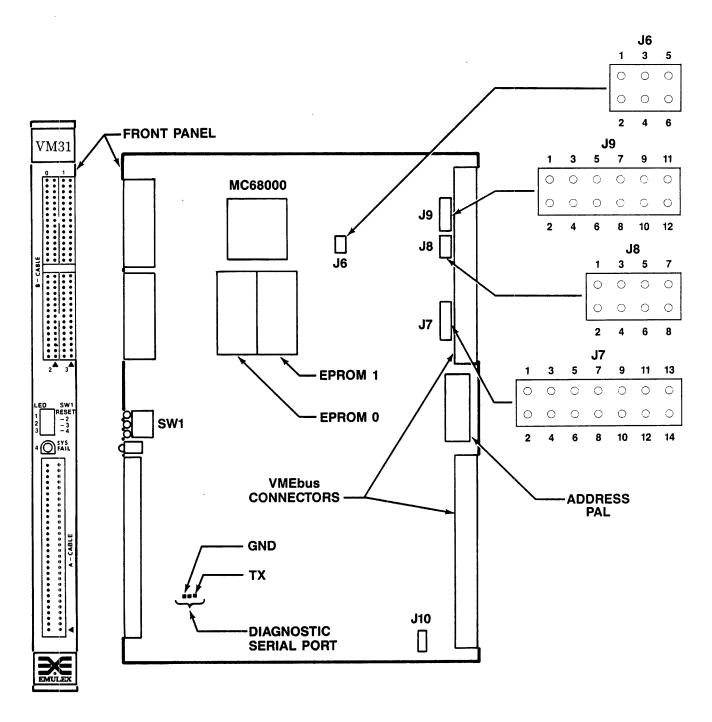
If a board address other than 0400H is used, the VM31 must be informed of the new address via Command 20H, parameter 90H (see Section 4). This parameter change must be made before any other commands are issued to the board.

3.4 Configuring the VM31 Board

The following subsections describe how to set the switches and jumpers on the VM31 board so that they are compatible with your VMEbus system.

3.4.1 VM31 Board Component Locations

Figure 3-1 shows the location on the VM31 board of the SW1 switch block, jumpers J6, J7, J8, J9, J10, and other important components.



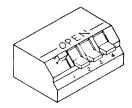
VM3101-1468

Figure 3-1. VM31 Board Component Locations

3.4.2 DIP Switch Types

Switch-setting tables in this manual use the numeral one (1) to indicate the ON (closed) position and the numeral zero (0) to indicate the OFF (open) position.

The DIP switch type used in this product is shown in Figure 3-2. The switch is set to the code shown in the switch setting example.



VM3101-0034

	SW	V1	
1	2	3	4
0	1	1	1

Figure 3-2. Switch Setting Example

3.4.3 SW1 Switch Settings

The VM31 board has one dual-inline package (DIP) switch, labeled SW1 (see Figure 3-1 for location). Switch functions are described in the following subsections.

3.4.3.1 Reset - SW1-1

When placed in the ON (closed) position, switch SW1-1 halts and resets the VM31 microprocessor. Upon placing the switch back in the OFF (open) position, the VM31 controller executes its power-up self diagnostic and initialization routine.

This switch should not be left in the ON position. When this switch is left ON, the board fails, asserting the SYSFAIL signal and locking up the VMEbus system.

NOTE

Toggling the reset switch (SW1-1) should never be done when the operating system is running. On many operating systems, toggling this switch while the operating system is running causes a system crash.

3.4.3.2 Shared Memory Starting Address (SW1-2 through SW1-4)

Switches SW1-2 through SW1-4 set the starting address of the shared memory on the VM31 board. There are eight possible starting addresses. The addresses and the corresponding switch settings are provided in Table 3-1. This table uses the numeral one (1) to indicate the ON (closed) position and the numeral zero (0) to indicate the OFF (open) position.

SW1-4 SW1-3 SW1-2 Starting Address 0 0 0 0400H (default) 1 0 0 0600H 0 0 1 H0080 1 0 1 0A00H 0 1 0 0C00H 1 1 0 0E00H 0 1 1 1000H 1 1200H 1 1

Table 3-1. Starting Address Switch Settings

The default setting for the board is 0400H. If you change the switch settings on the board to select a different starting address, you must initialize the board for this change by issuing a Command 20H, parameter 90H. This parameter change must be made before any other commands are issued to the board.

3.4.4 Jumper Settings on the VM31

There are four sets of jumpers on the VM31 board, J6, J7, J8, J9, and J10. Refer to Figure 3-1 for jumper locations on the VM31 board. The functions of the jumper settings are described in the following subsections.

3.4.4.1 Interrupt Jumpers - J6 and J7

Jumpers J6 and J7, shown in Figure 3-3, set the interrupt-request level. Only one jumper may be installed at location J7, and it selects an interrupt level from 1 to 7. J6 is set to represent the binary code for the interrupt level, with a jumper installed in J6 for a binary 0 and removed for a binary 1. The default jumper setting is for interrupt level 3.

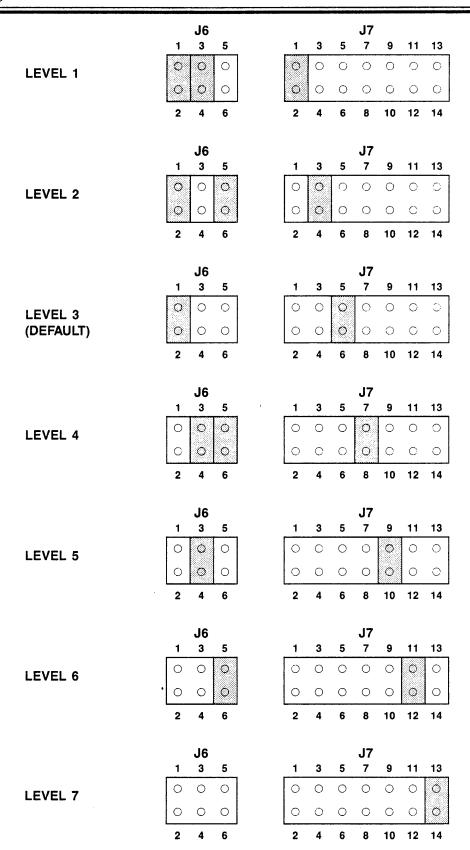


Figure 3-3. Interrupt Jumper Settings - J6 and J7

VM3101-1470

3.4.4.2 DMA-Priority Jumpers - J8 and J9

The jumpers labeled J8 and J9 are used to set the DMA bus-request priority level. Table 3-2 provides a guide for DMA selection. Figure 3-3 depicts the jumper settings for each DMA priority level. Use Figure 3-1 for proper orientation of the board.

Table 3-2. DMA Priority Jumper Functions

Priority>	3	2	1	0
Factory Setting		*		
Standard Setting		*		
Priority Ranking	Highest			Lowest
Systems With No Arbiter	Must use			

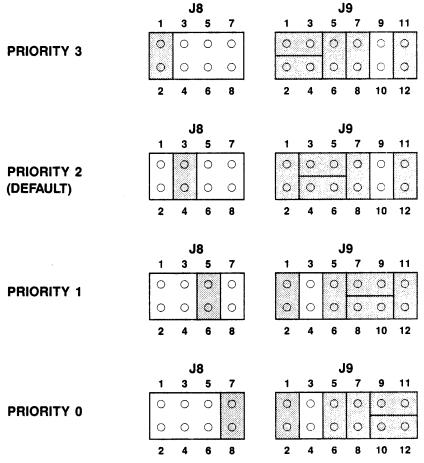
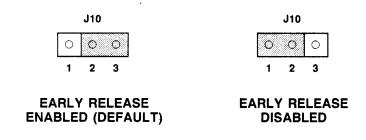


Figure 3-4. Jumper Settings for DMA Priority

VM3101-1469

3.4.4.3 Early Release Jumper - J10

The jumper labeled J10 can enable or disable the VMEbus Early Release feature. The default setting for the jumper block is to enable early release. With early release enabled, the VMEbus Busy signal is released soon after the address strobe for the VM31 is asserted. If Early Release is disabled, then the VMEbus Busy signal is asserted for the entire duration of the address strobe.



VM3101-1799

Figure 3-5. Jumper Settings for Early Release

3.5 Installing the VM31 in a Backplane

Use the following procedure to install the VM31 in a backplane.

- Shut down the operating system and remove the AC power.
- Remove the covers from the CPU cabinet to make the VMEbus backplane accessible.
- 3. Select a card slot for the VM31. Remove any jumpers that are installed for the slot that you have selected (for example, an IRQ jumper).
- 4. Install the VM31 board by firmly plugging it into the backplane. Orient the components on the board in the same direction as the CPU and other modules.
- 5. Connect cables using the information in subsection 3.7.

3.6 Setup of Disk Drives for Use with the VM31

Proper operation of any disk controller depends on correct disk-drive switch and/or jumper settings, correct placement of a terminator network, and proper power distribution and grounding of drives.

The disk drive connected to port 0 on the VM31 board must be set (via switches or jumpers on the drive) to have a logical unit-number of 0. For each drive, the physical port and logical unit-number must match.

3.6.1 Sector Sizes

Sector sizes of 512, 1024, and 2048 bytes are supported. The selection is made by using the Set Drive and Controller Parameters command (20H). On power-up, the board defaults to 1024-byte sectors. All four drives must have the same sector size although they may be different in other respects.

The drive must be set for hard sectoring. Soft sectoring is not supported on the VM31. In some drives, there is a switch or jumper that needs to be set to specify sectoring, hard versus soft. All four drives should be set for hard sectoring.

3.6.2 Hard Sector Format

The VM31 uses a disk format that requires 80 bytes of overhead for each sector. For example, a "1K" byte sector will require 1024 + 80 = 1104 bytes of disk space.

Hard sectoring (sector pulses are required from the disk drive) is required by the VM31. The drive must produce index and sector pulses on the 60-conductor control cable (most SMD drives do this).

The hard sector format is as follows:

Index or Sector>		
HEAD SCATTER (GAP 0)	16	Bytes (0's)
PLO SYNC (GAP 1)		Bytes (0's)
SYNC BYTE	1	Byte (19 hex)
FLAG		Byte
CYLINDER		Bytes
HEAD	1	Byte
SECTOR		Byte
ECC-48	6	Bytes
WRITE SPLICE		Byte (0's)
PLO SYNC (GAP 2)		Bytes (0's)
SYNC BYTE	1	Byte (19 hex)
DATA	512	Bytes
	or 1024	Bytes
	or 2048	Bytes
ECC-48	6	Bytes
END OF RECORD PAD		Bytes (0's)
GAP 3	11	Bytes (0's)

3.6.3 Drive Setting for Sector Size

The drive setting for sector size is crucial when hard sectoring is used. The VM31 requires that each sector pulse be followed by a sector long enough for data and header. Some drives produce additional short sectors after the last complete sector and before the index mark. These "runt" sectors will not allow correct operation of the VM31.

NOTE

Sector size must be set so that all sectors are the same length or so that the last sector, although shorter, is still usable.

The way in which this is done varies from drive to drive, but the following general rules apply:

1. Calculate the minimum sector size required. The VM31 requires 80 bytes of overhead. Therefore, the minimum sector size is the data block size (e.g. 512 or 1024, or 2048) plus 80.

For example, if a 1024-byte block size is chosen, the minimum sector size will be 1024 + 80 = 1104 bytes.

- 2. Look up the total number of bytes per track in the disk drive manual. For example, for a Fujitsu 2312 drive, this number is 20480 bytes.
- 3. Divide the number of bytes per track by the number of disk bytes required per sector; discard the remainder to get the number of sectors which will fit on the track. In this example, the number of sectors per track is 20480/1104 = 18.551, which is truncated to 18 sectors per track.
- 4. The remainder in the example above indicates that there will be an extra sector at the end that will be too short. A remainder is not allowable. To prevent the existence of such a "runt" sector, increase the size of all of the sectors, so that no sector exists that has a byte count less than the minimum disk sector size (1104 in this example). This is done by dividing the number of bytes-per-track by the number of sectors that will fit (18). In this example, 20480/18 = 1137.77. Round this number up to the next integer (1138) and set the switches on the drive for bytes-per-sector to this number.

In this example, each of the first 17 sectors will occupy a disk area of 1138 bytes, while the eighteenth (last) sector will occupy a disk area of 1134 bytes.

The above is only a guideline. In most cases, the drive manual will give more specific instructions for setting the sector size.

The only rule that must hold absolutely is: no disk sector may be shorter than the desired data sector-size plus 80.

3.7 Cabling

The VM31 controller interfaces with each disk drive that it controls via one control cable (A cable) and one data cable (B cable).

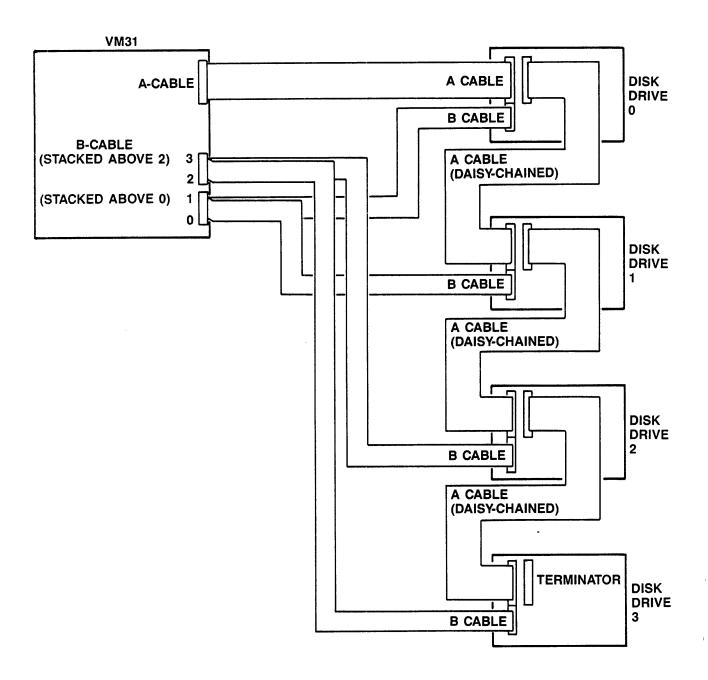
The A cable originates from the connector labeled A-CABLE on the VM31 front panel, and is daisy-chained to all of the supported drives, terminating on the last drive. The maximum cumulative length for the A cable is 50 feet (15 meters).

The B cables originate from four connectors. The connectors are labeled by silkscreened numbers on the front panel of the VM31 board, 0, 1, 2, and 3. A radial B cable is connected directly from the VM31 to each supported disk drive. The maximum cable length for a B cable is 50 feet (15 meters).

To prevent excessive RFI, some cabinet manufacturers surround their computers with a grounded metal shield. These shields are built into the computer cabinet.

Cabling has a direct effect on the amount of electromagnetic interference radiated by a computer system. When installing the VM31 and its drives, you must take steps to preserve the integrity of the shield built into FCC-compliant

If both the controller and the peripheral are installed in the same cabinet, then you need only replace the shields that you have removed, to keep the computer compliant with FCC regulations.



VM3101-1481

Figure 3-6. Drive Cabling

3.7.1 Cabling for Same Cabinet Installations

When the VM31 and its drives are installed in the same cabinet, the cabinet itself provides sufficient shielding. In such cases, it is not necessary to shield the A and B cables that connect the subsystem.

NOTE

If the cabinet in which the VM31 and CPU are installed was manufactured before 1 October 1983, it may not provide sufficient shielding or filtering to prevent excessive RFI radiation or conduction. In case of complaint, it is the operator's responsibility to take whatever steps are necessary to correct the interference.

Since the VM31 supports the SMD interface, standard 60-conductor A cables and 26-conductor B cables are required. If more than one drive is connected to the VM31 controller, a second 60-conductor A cable is required for each additional disk drive to serve as the daisy chain cable. The cables listed below are flat ribbon cables and are not FCC compliant. A minimum of at least one A cable and one B cable are required per controller.

Emulex makes unshielded A and B cables in several lengths. Table 3-3 shows the cable kits, which include one A and one B cable only. Tables 3-4 and 3-5 list individual A and B cables of different lengths.

Table 3-3. Cable Kits (includes an A and B cable)

Part Number	Description	Length
SU1112308-00 SU1112315-00 SU1112325-00 SU1112335-00 SU1112350-00	A & B Cable Kit	8 ft 15 ft 25 ft 35 ft 50 ft

Table 3-4. Individual Flat A Ribbon Cables

Part Number	Description	Length
SU1111201-00	60 Cond. A Cable	8 ft
SU1111203-00	60 Cond. A Cable	15 ft
SU1111205-00	60 Cond. A Cable	25 ft
SU1111207-00	60 Cond. A Cable	35 ft
SU1111209-00	60 Cond. A Cable	50 ft

Table 3-5. Individual Flat B Ribbon Cables

Part Number	Description	Length
SU1111202-00	26 Cond. B Cable	8 ft
SU1111204-00	26 Cond. B Cable	15 ft
SU1111206-00	26 Cond. B Cable	25 ft
SU1111208-00	26 Cond. B Cable	35 ft
SU1111210-00	26 Cond. B Cable	50 ft

The items listed in Tables 3-3 to 3-5 can be ordered from your Emulex sales representative or directly from the factory. The factory address is:

Emulex Customer Service 3545 Harbor Boulevard Costa Mesa, CA 92626 (714) 662-5600 TWX 910-595-2521

NOTE

Emulex does not provide cabling for separate cabinet installations.

3.7.1.1 A Cable

To cable the subsystem, see Figure 3-5 and use the following procedures:

1. Look at the header at either end of the A cable. Find the molded-in arrow that identifies pin 1 of the connector.

- 2. The front panel of the VM31 has "A-CABLE" silkscreened directly adjacent to the A-cable connector. Pin 1 for the A-cable connector is indicated by a small triangle silkscreened onto the board. Align the arrow on the cable header with pin 1 of the A-cable connector and press the header into the connector.
- 3. Find the molded-in arrow on the cable header at the other end of the A cable.
- 4. Find the arrow on the disk drive's A cable connector. Most SMD drives have two A cable interfaces to allow daisy-chaining; use the first one. Align the arrow on the cable header with the connector arrow and press the header into the connector. Make sure that the locking tabs on the connector are fully flush with the sides of the cable header.
- 5. Connect the first drive to the second drive supported by the VM31 using another A cable. In a similar manner, run the cable from the second A cable connector on the first drive to the first A cable connector on the second drive.
- 6. After the A cable has been daisy-chained to all the drives, install the A cable terminator (supplied with the drive) on the second A-cable connector of the last drive.

End of Procedure

3.7.1.2 B Cable

- 1. Look at the header at either end of the B cable. Find the molded-in arrow that identifies pin 1 of the connector.
- 2. The front panel of the VM31 has 4 B Cable connectors under the label B-CABLE. They are numbered from 0 through 3. Pin 1 for the connector is at the lower right corner of the connector. Pointers to the pin 1 locations are silkscreened on the VM31 Front Panel for the B-CABLE connectors 2 and 3. Align the arrow on the cable header with pin one for the VM31 connector 0, and press the header into the connector.
- 3. Find the molded-in arrow on the cable header at the other end of the B cable.
- 4. Find the arrow on the first disk drive's B cable connector. If the drive is a dual port model, make sure you connect the B cable to the same port to which you connected the A cable. Align the arrow on the cable header with pin one on the disk drive connector and press the header into the connector. Make sure that the locking tabs on the connector are fully flush with the sides of the cable header.
- 5. Repeat steps 1 through 4 for the remaining drives, using B cable connectors 1, 2, and 3 on the VM31.

End of Procedure

3.7.1.3 Grounding

Proper grounding is extremely important for proper operation of the disk subsystem. There must be a good connection between each drive in the subsystem and the CPU logic ground. The recommended grounding method is to connect each drive to a common point on the CPU chassis using a half-inch or larger braided ground strap, preferably insulated, or an AWG number 10 (or heavier) wire.

Another option, though a less desirable one, is to daisy-chain a ground wire between the drives, then connect it to the CPU.

For most applications, connect the drive chassis and logic grounds (AC and DC grounds). However, in environments with noise problems, it may work better to separate these two grounds. Whatever drive ground method is used, all drives in the subsystem must be configured the same way. Consult the disk drive manual for specific instructions on connecting the chassis and logic grounds.

Because each subsystem is unique, it is impossible to predict which method will work best for each. Be aware that some experimentation may be required.

NOTE

Failure to observe proper signal grounding methods generally results in marginal operation with random error conditions.

3.8 Power-Up and System Verification

There are four LEDs on the VM31 board. Their locations are shown in Figure 3-1. When the system is powered up after the VM31 has been installed, all four LEDs will light if there is an error condition. If no LEDs remain lighted after powerup, then the board is functioning properly.

In order to initialize its DMA circuitry, the VM31 does some DMA transfers to its own shared memory. Therefore, the VM31 must be told what its own shared memory address is. This initializing DMA transfer (to itself) occurs only once after the first Set Drive and Controller Parameters command is issued to the board. Also, you should allow 5-15 seconds for initialization.

4.1 Overview

This section contains the following subsections:

Subsection	Title
4.1	Overview
4.2	Format Conventions
4.3	VM31 Command Tables
4.4	Programming Guidelines
4.5	Start/Done Code and Error Status Block
4.6	VM31 Commands
4.7	Read, Write to Contiguous Memory (00H, 04H)
4.8	Read, Write to Scattered Memory (02H, 06H)
4.9	Format Tracks (10H)
4.10	Set Drive and Controller Parameters (20H)
4.11	Report Drive and Controller Parameters (21H)
4.12	Read Disk Defect List (28H)
4.13	Test DMA Transfers to External Memory (72H)
4.14	Reset Drive (90H)
4.15	Special Reset Controller Command
4.16	Illegal Commands
4.17	Chaining of Command Tables

4.2 **Format Conventions**

Command codes and parameter values in this section are in hexadecimal notation, while bit numbering is decimal. The block diagrams and command tables provided show all parameter field values in hexadecimal and bit numbering from 31 to 0 in decimal.

The term "BA" used throughout this section refers to the value set for the VM31 Base I/O address by means of switch SW1 (the default factory setting is 0400H). BA is usually shown with an offset in bytes (BA+X). The offset is in hexadecimal.

The text paragraphs of this section show all hexadecimal values with a trailing "H".

4.3 VM31 Command Tables

Command tables (sometimes called parameter blocks or I/O parameter blocks) are used to control the operation of the VM31. The host system passes parameters to the VM31 by writing to a command table in the VM31's shared memory. This shared memory appears in the VMEbus address space at a base (starting) address that is selected by the setting of switch SW1 on the VM31. The default setting is 0400H (short addressing mode). The VM31 reads command codes and their associated parameters from the command tables. When a command is completed, the VM31 writes the returned status information into the command tables.

Each command table is shown as a block of contiguous 32-bit longwords starting at the base address BA+0, with offsets of BA+4, BA+8, and so on. The Base Address is selected with switch SW1 and is referred to as BA throughout this section. The size of the command table can vary from eight longwords up to 25 longwords, depending on the specific command. Each longword is subdivided into groups of parameter fields that vary in size from 1 bit to 32 bits.

NOTE

All reads and writes to the command-table area must be done using word or byte transfers, never longword transfers. When using a 16-bit microprocessor, such as the Motorola (R) 68010, this will never be a problem, even if the variables written to the command table are longword variables (the 68010 will write them automatically as two sequential 16-bit transfers).

However, when using a 32-bit microprocessor, such as the Motorola 68020, the variables written to, or read from, the command table must be declared as WORD ("SHORT", using the C language). While the host computer may otherwise use longword variables, they must be converted to two WORD variables immediately before they are written to the command table.

Standard Command Table Format 4.3.1

The standard command table format for the VM31 commands is shown in Figure 4-1.

Address Offse in Bytes (Hex)		Fields 23	16	15	8	7	0
BA+0:	Start/Do	ne Code			Error S	tatus	
BA+4:				IM		C	MD#
BA+8:				Offset Next CD Table			
BA+C:	*****						
BA+10:							
BA+14:	Unit #	Start	ing L	ogica	Block		
BA+18:							

Figure 4-1. Standard Command Table Format

The parameter fields that are shown with dashes (-----) vary for different commands. All the command tables include seven fields in common. The first two 16-bit fields in each command table are the Start/Done Code and Error Status fields, which are described in Section 4.54. Descriptions follow for the remaining five fields.

In the BA+4 longword, bits 0-7 are the command number. Table 4-2 lists the command numbers. Bits 8-14 are ignored. Bit 15 is the interrupt mask. The interrupt-mask bit, when set, allows completion of a command, as indicated by the DONE word, to cause an interrupt. If the interrupt-mask bit is not set, the DONE code will still be set on completion of a command, but no interrupt will be generated. This bit is cleared on power-up.

In the BA+8 longword, bits 15-0 define the offset in bytes (from the Base Address) of the next command table - this number may not be negative, nor greater than 01B0H. Set these bits to zero if chaining is not desired. See also the section "Chaining of Command Tables" at the end of this chapter.

The BA+14 longword indicates the drive number and 24-bit starting block address of disk transfer. The most significant byte of the unit-number/blockaddress field determines the logical unit number. A 00H specifies that operations will be performed on drive zero, a 01H specifies drive one, a 02H specifies drive two, and a 03H specifies drive three. The rest of the byte should be all zeros to maintain compatibility with possible future versions of the VM31.

4.3.2 Communicating with the VM31

The basic procedure for communicating with the VM31 using command tables is as follows:

- 1. When it is done with its previous command and is ready for a new one, the VM31 sets the START/DONE code (the first word in the command table (at BA+0)) to DONE (55AAH). At this point the number of retries and the error code are undefined. After powerup the error code will be set to 20H, indicating that the board was reset.
- 2. The host system then writes the desired command information into the command table and sets both the START/DONE field and error status field to START (0000H) to start the VM31 executing the desired command.
- 3. When the VM31 is finished executing the command, it will write any necessary status information back to the command table and then set the START/DONE code back to DONE (55AAH). The VM31 will also issue an interrupt, if programmed to do so.

4.3.3 Command Table Memory Usage

The VM31 occupies 512 bytes of memory in the VMEbus short address space. Command tables are movable structures within this shared memory. They may be chained and may start on any longword boundary within the address range of 0400H through 05B0H. During normal usage of the VM31, the host system should not write to addresses 05E0-05FFH.

On power-up, the starting location of the first command table is at the base address set by switch SW1, by default 0400H. Unless chaining is desired, only a single command table will be used and it will always start at address 0400H.

4.4 Programming Guidelines

In an interrupt-driven operating system, the normal procedure for starting a disk transfer is described in the steps below. Figure 4-2 illustrates the sequence of events.

1. Check the contents of the Start/Done Code, the first 16-bit field in the command table. The DONE code (55AAH) should appear in bits 16-31 of the block. The Start/Done Code and Error Status fields have the following format:

 31
 24
 23
 16
 15
 8
 7
 0

 Start/Done Code
 # Retries
 Error Code

BA + 0:

(The Start/Done Code field is described in detail in the following subsection.) If the DONE code does not appear, then the VM31 must be performing a previously requested operation or initializing itself. Wait or do something else until this code (55AAH) is read.

- 2. Set up the command table for the transfer to be performed.
- 3. Say "START" by clearing the DONE and error-status codes to 0000H.
- 4. Return to processing another job.

In the interrupt handling routine, a procedure along the following lines is recommended:

- 1. Interrupt is received.
- 2. Read VM31 Start/Done code and Error Status.
- 3. If DONE code and interrupt-mask bit (discussed later) were set, then interrupt is from VM31. If not, then service another interrupt.
- 4. If another disk request is waiting, set up a command table and clear the DONE code, which will start the next command. Do not reset the DONE word unless you have set up another command and want it executed.
- 5. Resume processing the job that had requested the just-completed disk transfer.
- 6. Return from interrupt code.

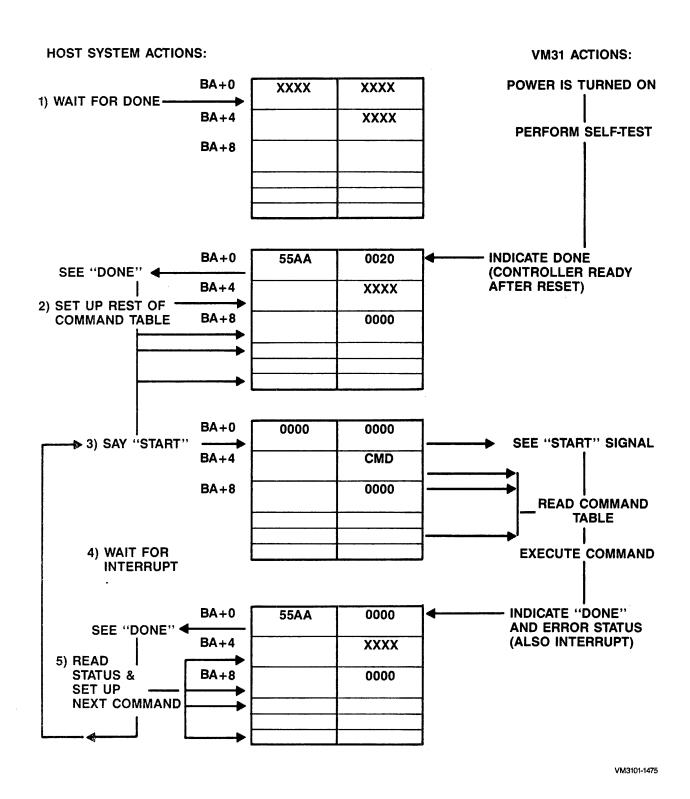


Figure 4-2. Commands in an Interrupt Driven System - Single Command Table

4.5 Start/Done Code and Error Status - BA+0

The first longword in the command table is at the base address plus zero and always has the same format. All the other longwords in the command table vary depending on the command. The format of the first longword follows:

 31
 24
 23
 16
 15
 8
 7
 0

 Start/Done Code
 # Retries
 Error Code

Bits 16-31

BA + 0:

The DONE code (55AAH) in these bits indicates that VM31 has completed its task, and is ready for a new one. If the task has not been completed, the code will read some number other than 55AAH. This code is cleared initially on power-up, but is set to DONE when the VM31 has finished performing initialization and self test.

Bits 0-15

Bits 0 through 15 are used by the VM31 to indicate whether or not any errors were detected and, if so, the nature of the error (Table 4-1). If no error occurred during the previous instruction, these bits will be 0000H. If an error has occurred, an error code and a retry count will be readable in these bits.

The error code (bits 0-7) is provided to allow the operating system to determine quickly whether a transfer has been successful or not. Information about soft (recoverable) errors is also provided for convenient logging by the operating system. Refer to Table 4-1.

An error code with bit 7 = 0 indicates a soft error, which means that an error occurred but the correct data could be recovered. Examples of such errors are seek errors, where the first seek got the wrong track, but a re-zero and repeated seek got the correct track. The total number of retries, up to 27, required to obtain correct data is given in the retry byte (bits 8-15). If both fatal and non-fatal errors are encountered, the fatal error number is given.

Error code 20H indicates that the controller has been reset recently. The controller is reset after it is powered up or after a system reset. Under other circumstances, error code 20H is not likely to occur. However, if the VM31 "crashes", it may attempt to recover by resetting itself. Since an error code of 20H will appear, the host will know that a crash has occurred. In this case, all of its parameters will be set to default values, and the host will have to re-initialize them.

The START code (0000H) written to the Start/Done and Retry/Error status fields causes the VM31 to execute its next command. Writing this zero code clears both the DONE code (55AAH) and the error status bits. The VM31 will not start executing the command until both 16-bit words are set to zero.

All data in the rest of the command table must be set to the required values before the start code is written. After the command has been executed, the VM31 will set the DONE code. Table 4-1 lists the VM31 error codes.

Table 4-1. VM31 Error Codes (Bits 0-7)

Error Code (Hex)	Fatal Errors (Bit 7 = 1):
82H 83H 84H 85H 86H 87H 88H 89H 8AH 8BH 8CH 8DH 8EH 90H 91H	Bad arguments (e.g. incorrect drive #). Drive would not select. Drive not ready. Seek error. Seek timeout. Fault occurred on drive. Attempt to write to protected drive. Bad header on wanted data sector. No or bad data on wanted sector; not corrected by ECC. Header not found on wanted data sector. Timeout on DMA transfer completion. VMEbus bus error during DMA transfer. Timeout on format completion. Parity Error on internal RAM. AC power failure reported on VMEbus. Non-Fatal Errors (Bit 7 = 0):
05H 06H 07H 09H 08H 0BH 10H 18H 20H	Seek error, recovered after retry(s). Seek timeout, recovered after retry(s). Fault occurred, recovered after retry. Bad, but recoverable header on wanted sector. Bad, but recoverable data on wanted sector. Header not found on wanted data sector, was recovered. Parity error on internal RAM in area that could be re-loaded. Bad data on wanted sector but corrected by ECC. Board was just reset. All parameters must now be initialized by the host. While this error is normal on power-up, it indicates a serious problem at any other time.

4.6 VM31 Commands

Table 4-2 lists all the commands that may be issued to the VM31. The command number is placed in the command table in bits 0-7 of the longword at BA+4 (base address of command table plus 4).

Table 4-2. VM31 Commands

Command # (Hexadecimal)	Command Name and Function
00H	Read from disk to contiguous RAM.
02H	Read from disk to scattered RAM.
04H	Write to disk from contiguous RAM.
06H	Write to disk from scattered RAM.
10H	Format tracks on the disk.
20H	Set controller and drive parameters from system.
21H	Report controller and drive parameters to system.
28H	Read media defects from Fujitsu 2333 disk drives.
72H	Test DMA circuitry by doing transfers to external memory.
90H	Reset drive recalibrating unit and clearing all fault conditions.

4.7 Read and Write to Contiguous Memory (00H and 04H)

The area of RAM that holds the command table has the format shown in Figure 4-3 for disk reads (00H) and writes (04H) to contiguous memory. Other commands use the fields somewhat differently, and are covered later. The command table must be aligned to a longword boundary (A0H and A1H are zero).

When execution is required, a further memory write to set the start code at the beginning of the command table will start the VM31 processing the information in the command table.

4.7.1 Command Table Format

Figure 4-3 shows the parameter fields in the command table for the commands to Read and Write to contiguous memory.

Address Offse Byte (Hex)		0.4	20	Fie		0	-	•		
	31	24	23	· 16	15	8	7	0		
BA+0:	Sta	rt/Don	e Code	,	Error Status					
BA+4:	#Re	ead Co	pies		IM			CMD#		
BA+8:		Reser	ved		0	ffset Ne	xt C	D Table		
BA+C:	(Caching Mode				# Blocks Read-Ahead				
BA + 10:		N	lust be	set to	00000	0000				
BA+14:	Ur	nit#	Star	ting L	ogical	Block				
BA+18:		Nu	mber o	f Bloc	ks to	be Trans	ferr	ed		
BA+1C:		1st	Startin	g RAN	/I Add	lress for	Tra	nsfer		
BA + 20:		2nd Starting RAM Address for Transfer						ansfer		
				etc.	•					

Figure 4-3. Reads and Writes to Contiguous RAM

Bit descriptions follow for the individual longwords in the command table. The BA+0 longword is fully described in Section 4.5.

4.7.2 Command Number, Interrupt Mask, and Read Copies - BA+4

BA+4: #Read Copies IM ----- CMD #

Bits 0-7 are the command number. The command number 00 is entered for reads, and 04 is entered for writes.

Bits 8-14 are ignored.

Bit 15 is the interrupt mask. The interrupt-mask bit, when set, allows completion of a command, as indicated by the DONE word, to cause an interrupt. If the interrupt-mask bit is not set, the DONE code will still be set on completion of a command, but no interrupt will be caused. This bit is cleared on power-up.

Bits 16-31 are used only for read commands, and specify the number of memory regions to which data will be sent if the number is greater than 1. See also "RAM Pointers for Additional Address Spaces - BA + 20 and UP" in this section.

4.7.3 Offset of Next Command Table - BA+8

31 24 23 16 15 8 7 0

BA+8: Reserved Offset Next CD Table

This block provides the ability to chain commands. Bits 15-0 define the offset in bytes (from the Base Address) of the next command table - this number may not be negative, nor greater than 01B0H. Set these bits to zero if chaining is not desired.

Note that this parameter does not have to be re-written before each command, as the VM31 does not alter this location. See also the section "Chaining of Command Tables" at the end of this chapter.

4.7.4 Caching and Read-Ahead - BA+C

31 24 23 16 15 8 7 0

BA+C: Caching Mode # Blks Read-Ahead

Data in this longword is used only during read commands and is ignored during writes.

Bits 16-31 specify caching mode. The VM31 allows the user to specify, on an advisory basis, the amount of data to be cached during each read command. Bits 16-31 may be 0, 1, or 2: Where 0 specifies no caching, 1 specifies caching only on the last track of a transfer, and 2 specifies caching on all tracks of a transfer.

Bits 0-15 specify number of blocks to read ahead and cache on the last track of a transfer. Caching and read-ahead can occur only during read commands; during writes, the VM31 ignores all data in BA+C. For convenience, data in BA+C may be left at any value during write commands. See also "Optimal Cache Utilization" in Section 5.

NOTE

If the most significant word (bits 16-31) is 0, the least significant word (bits 0-15) must be 0.

Example 1 (below): No caching and no read-ahead. This mode is recommended only for transfers of 100 blocks or more.

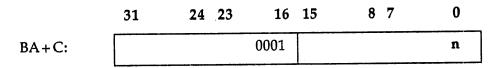
BA+C: 0000 0000

Example 2 (below): Read from cache, if any of desired data is in cache. Cache blocks on last track of transfer only. No read-ahead caching.

BA+C: 0001 0000

Example 3 (below): Cache blocks on last track of transfer only. Read ahead, if possible, up to n blocks after the highest wanted block on the last track. Such data is read only into VM31's cache; not into the host system RAM.

Read-ahead caching will stop early if the end of the track is reached, or if another command is issued while read-ahead caching is still in progress. Note that the VM31 will issue a DONE (and an interrupt, if requested) as soon as the wanted sectors are read. In other words, the DONE is not delayed until lookahead caching is finished. This use of the caching facility is recommended as a default and for all transfers of less than 100 blocks. A good set of caching parameters to specify for most uses is 0001 0030 (hex). See Section 5 for more detailed information on efficient caching.



Example 4 (below): Cache blocks on all tracks of transfer. Read ahead, as above, up to $\bf n$ blocks.

	31	24	23	16	15	8	7	0
BA+C:				0002				n

CAUTION

Use the above command (example 4) sparingly. As the whole cache is only 256K Bytes, it is desirable to limit the number of blocks cached to just a few at a time. The cache required for large multi-track transfers will necessitate the VM31 removing more previously-cached blocks.

4.7.5 Drive Number and Block Address - BA+14

	31	24	23	16	15	8	7	0
BA+14:	Unit	#		St	arting	Logica	Bloc	ck

This block indicates the drive number and 24-bit starting block address of disk transfer.

The most significant byte of the drive-number/block-address field determines the drive number. A 00H specifies that operations will be performed on drive zero, a 01H specifies drive one, a 02H specifies drive two, and a 03H specifies drive three. The rest of the byte should be all zeros to maintain compatibility with possible future versions of the VM31.

The three least significant bytes define the block number of the first disk block to be transferred. Hence, a starting block number of 38740H on unit 2 would be indicated as 02038740H at address BA+14, as follows:

BA+14: 02 03 87 40

4.7.6 Number of Blocks to be Transferred - BA+18

31 24 23 16 15 8 7 0

BA+18: Number of Blocks to be Transferred

This longword specifies the number of blocks to be transferred with a disk or RAM transfer.

BA+18 also doubles as a status location. On completion of an operation, the number of blocks actually transferred is placed in this location by the VM31. Hence, in the case of an ECC error in a multiple-block transfer, the number of contiguous good blocks transferred after the starting block is put in this longword by the controller. This status location is not valid when fatal seek errors, headernot-found errors, drive fault errors, or parity errors occur. This status is only valid on fatal data or header ECC errors.

If an error occurs during a multiple-block read, some of the disk blocks requested after the block containing the error may have transferred to RAM. This should not cause any difficulty.

If an error occurs during a multiple-block write, some of the disk blocks requested after the block containing the error may have been written to. If this is likely to cause difficulty, then the write command should be split up into smaller block requests. Of course, splitting the command will result in a significant loss of speed.

4.7.7 RAM Pointer - BA+1C

31 24 23 16 15 8 7 0

BA+1C: 1st Starting RAM Addr for Transfer

This 32-bit location in the command table contains the starting address of the area of RAM to which transfers will be made. The upper 8 bits of this location are not used for systems which permit only 24 address bits. All data transfers are done by DMA, a 16- or 32-bit word at a time. The least significant bit of this pointer must be zero, since all data transfers must start on word boundaries.

Note that you can request longword transfers at starting addresses that do not align with a longword boundary. For example, if the board has been initialized at boot time (using command 20H) to do longword DMA transfers, and later a transfer is requested to VMEbus address 800002 (which is not on a longword boundary), the board will switch automatically to 16-bit DMA transfers for this one transfer, and then will revert back to 32-bit transfers automatically. In other words, the board adapts to misaligned longword transfers by doing word (16-bit) transfers as necessary. However, there is speed degradation in this case (typically 5-20% lower disk throughput and twice as much bus utilization), and therefore it is recommended that such misaligned transfers be minimized. Of course, at no time may any transfers be requested which begin on odd byte boundaries.

4.7.8 RAM Pointers for Additional Address Spaces - BA+20 and Up

BA+20: 24 23 16 15 8 7 0

2nd Starting RAM Address for Transfer (Optional & Only for Reads)

Start Address of RAM to be transferred (2nd address space, if any)

0

Start Address of RAM to be transferred (last address space, if any).

The VM31 is capable of providing up to 32 copies to the host's memory of data read from the disk. The starting address of the second region in system RAM is stored in block BA+20. The starting addresses of additional RAM locations (up to a total of 32) can be specified in following blocks of the command table.

4.7.9 Blocks Read From Cache - BA+1E8

The VM31 is capable of reporting the number of cache hits during a read command. Address 05E8H (BA+1E8) contains a running total of the number of blocks read from cache. The user may want to know the number of blocks read from cache for a particular read, since that number is a good indication of efficiency in disk transfers. If this is the case, zeros should be written to the 16-bit word at BA + 1E8 before the read command is given. After the read is done, the 16-bit word at BA+1E8 will contain the number of blocks read from the cache during the read command. To obtain the total number cache hits for several reads, zero the word at BA+1E8 before the first read and then look at the contents of the 16-bit word at BA + 1E8 after the last read.

For example, if a command was given to read 40 blocks of data and the controller found 12 of the wanted blocks in the cache, then the number 12 would be found in BA + 1E8.

This feature is particularly useful when fine-tuning the algorithm in the driver program that tells the VM31 what to cache and what not to cache.

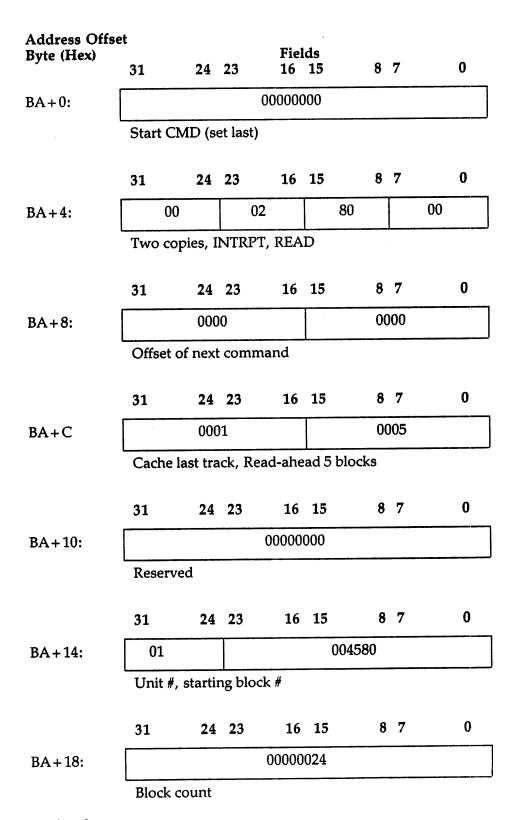
CAUTION

Never allow a command table to extend into addresses 05E0-05FFH (BA+1E0 to BA+1EF). If caching is enabled, BA + 1E8 will be soon rewritten with a number representing the quantity of blocks read from cache.

Since clearing and reading BA + 1E8 takes time, it should be done only temporarily, for the purpose of studying the cache hit rate.

4.7.10 **Command Table Example**

Figure 4-4 shows the content of the command table for transferring data from 24H blocks on unit 1 starting at block 4580H to two regions in system RAM; the first region having a starting address of 00450000H and the second region having a starting address of 00980000H. This example also specifies caching all blocks read on the last track of the transfer and, if possible, read-ahead caching five blocks.



continued on next page

Figure 4-4. Example, Reads to Two RAM Addresses with Caching of Last Track of Transfer, and Read-Ahead of 5 Blocks (page 1 of 2)

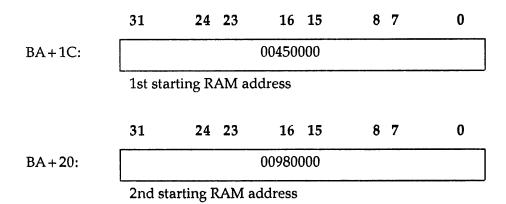


Figure 4-4. Example, Reads to Two RAM Addresses with Caching of Last Track of Transfer, and Read-Ahead of 5 Blocks (page 2 of 2)

4.8 Read and Write to Scattered Memory (02H and 06H)

The area of RAM that holds the command table has the format shown in Figure 4-5 for disk reads (02H), and writes (06H) to scattered memory. As opposed to the reads and writes to contiguous memory (discussed in the previous section), scattered RAM transfers do not transfer sequential disk blocks to sequential portions of system RAM. Instead, the host system sets up a list, in system RAM, of starting DMA addresses for the desired disk blocks. Then, as part of the command table, the host gives the VM31 the starting DMA address for the list. When the VM31 is actually transferring the data, it will transfer the first block(s) of disk data to (or from) the first address on the list. The second block(s) of data will be transferred to the second address on the list, and so forth.

Because a logical block (page) from the host's point-of-view is set at 1, 2, 4, or 8 kilobytes, the VM31 must be informed of the system page size at boot-up time via the Report Drive and Controller Parameters Command (21H), parameter B0H listed in Table 4-5. Then the number of disk blocks required for a page (1, 2, 4, or 8) are transferred to (or from) each address in the scatter list. There are as many entries in the scatter list as there are pages and partial pages to be transferred.

Scattered transfers are generally used in systems using paged memory-management hardware. The VM31 is highly suited for use in such systems, as it is capable of using (reading) a portion of the existing system page table as this scatter list. In systems with appropriately configured page tables, the VM31 must merely be told the following:

- 1. The starting physical block, the number of physical disk blocks to transfer, and whether to read or write.
- 2. The address of the starting entry in the page table which specifies which physical memory addresses to transfer to.
- 3. A mask, so that the controller ignores any unused bits in the page table.

4.8.1 **Command Table Format**

Figure 4-5 shows the parameter fields in the command table for the commands to Read and Write to scattered memory.

Address Offse Byte (Hex)	et			Fie	lds					
2900 (2201)	31	24	23	16	15	8	7	0		
BA+0:	Start/Done Code				Error Status					
BA+4:	Must be set to 0				IM			CMD #		
BA+8:		Rese	rved		Offset Next CD Table					
BA+C:	C	Cachin	g Mode		# Blocks Read-Ahead					
BA+10:		Со	mpleme	nt of	Scatt	er Addr	ess N	1ask		
BA+14:	Un	it#	St	arting	Logi	cal Bloc	k			
BA+18:	Number of Blocks to be Transferred "N"					ed "N"				
BA+1C:	RAM	I Addı	ess "SL	A" of	Scat	ter Addr	ess I	List		

Scatter Address List (Located in system RAM, at address "SLA" specified in Command Table Location BA+1C):

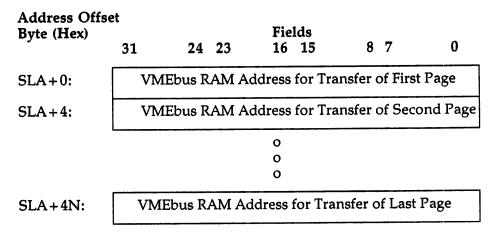


Figure 4-5. Command Table Format for Transfers To or From Scattered RAM

4.8.2 Command Number, Interrupt Mask, and Read Copies - BA+4

BA+4: Must be set to 0 IM ----- CMD #

Bits 0-7 are the command number. The command number 02H is entered for reads to scattered RAM, and 06H is entered for writes.

Bits 8-14 are ignored.

Bit 15 is the interrupt mask. As with transfers to contiguous RAM (described earlier), when the interrupt-mask bit is set, the completion of a command, as indicated by the DONE word, will cause an interrupt. If the interrupt-mask bit is not set, the DONE code will still be set on completion of a command, but no interrupt will be caused. This bit is cleared on power-up.

Bits 16-31 are not used for scattered transfers and must be set to zero.

4.8.3 Offset of Next Command Table - BA+8

31 24 23 16 15 8 7 0

BA+8: Reserved Offset Next CD Table

This longword allows for chaining of commands. The function of this command table location is exactly the same as for transfers to contiguous RAM, described earlier. Bits 15-0 contain the offset in bytes from the Base Address of next command table. This offset may not be negative, nor greater than 01B0H. It should be set to zero if chaining is not desired.

4.8.4 Caching and Read-Ahead - BA+C

31 24 23 16 15 8 7 0

BA+C: Caching Mode # Blks Read-Ahead

Data in this longword is used only during read commands and is ignored during writes. Bits 16-31 specify a caching mode. Bits 0-15 specify the number of blocks of read-ahead.

The function of this command table location is exactly the same as for transfers to contiguous RAM. A more detailed description and examples are provided in Section 4.7.4.

4.8.5 Scatter Address Mask - BA+10

31 24 23 16 15 8 7 0

BA+10: Complement of Scatter Address Mask

Each of the DMA addresses in the scatter list may be masked by (ANDed with) the complement of the number in BA+10. If no masking is desired, BA+10 should be set to zero.

For example, if the logical system page size is 4 KB, then the least significant twelve bits could be masked off, so that even if they were used for other purposes in the system page table entries, the controller would not interpret them as address bits.

4.8.6 Drive Number and Block Address - BA+14

31 24 23 16 15 8 7 0

BA+14: Unit # Starting Logical Block

Bits 31-24 contain the drive unit #. Bits 23-0 contain the 24-bit starting block address of the disk transfer.

The function of this command table location is exactly the same as for transfers to contiguous RAM, described in Section 4.7.5.

4.8.7 Number of Blocks to be Transferred - BA+18

31 24 23 16 15 8 7 0

BA+18: Number of Blocks to be Transferred

Bits 31-0 specify the number of blocks to be transferred with a disk or RAM transfer. The number of entries in the scatter list multiplied by the number of disk-blocks-per-page must be greater than or equal to the number of blocks to be transferred.

BA+18 also doubles as a status location. On completion of an operation, the number of blocks actually transferred is placed in this location by the VM31. Hence, in the case of an ECC error in a multiple block transfer, the number of contiguous good blocks transferred after the starting block is put in this longword by the controller. This status location is not valid when fatal seek errors, headernot-found errors, drive fault errors, or parity errors occur. This status is only valid on fatal data or header ECC errors.

If an error occurs during a multiple-block read, some of the disk blocks requested after the block containing the error may have transferred to RAM. This should not normally cause any difficulty.

If an error occurs during a multiple-block write, some of the disk blocks requested after the block containing the error may have been written to. If this is likely to cause difficulty, then the write command should be split up into smaller block-requests. Of course, splitting the command will result in a loss of speed.

4.8.8 Pointer to Scatter List in RAM - BA+1C

31 24 23 16 15 8 7 0

BA+1C: Starting RAM Address for Scatter List

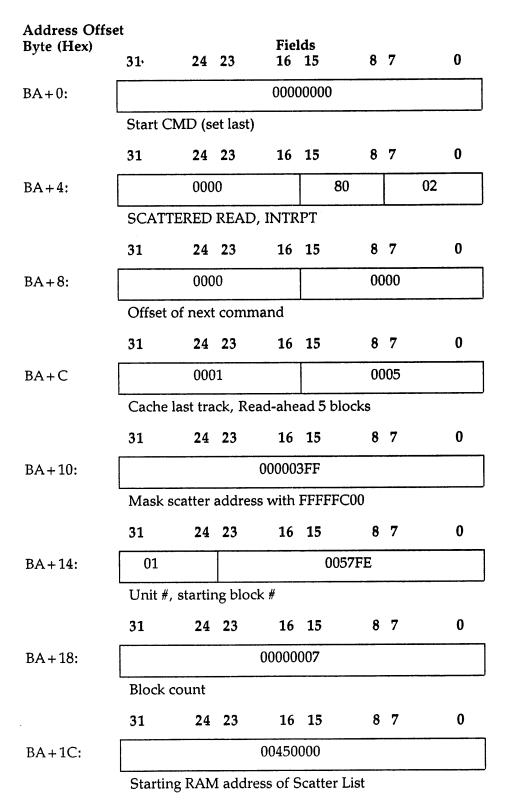
This 32-bit quantity in the command table contains the address of the scatter list. The upper 8 bits of this quantity are not used for systems which permit only 24 address bits. All data transfers are done by DMA, a 16- or 32-bit word at a time. The least significant bit of this pointer must be zero, since all data transfers must start on word boundaries.

It is not necessary for the scatter list to start on a longword boundary, even if the board has been initialized for longword transfers (32 bit). If the scatter list begins at an odd word, the board will switch temporarily to 16-bit transfers, do the transfer, and then automatically switch back to 32-bit mode. Likewise, it is permissible for any addresses in the scatter list to begin on word or longword boundaries. Longword boundaries are preferred for maximum speed. As mentioned above, in many systems, this pointer could merely point to the portion in the system page table which is to be interpreted as the scatter list.

4.8.9 **Command Table Example**

Figure 4-6 shows the contents of the command table for transferring data from 7 blocks on unit 0, starting at block 57FEH, to system RAM, to the listed VMEbus addresses. In this example, both a page and a sector are 1K byte. This example specifies caching all blocks read on the last track of the transfer and, if possible, read-ahead caching five blocks. The scatter address list begins at address 450000H. Each scatter address is ANDed with the number FFFFFC00H which requires that 000003FFH be written at BA + 10.

Disk Block # (Hex)	VMEbus Address for Transfer (Hex)
57FE	00809E00
57FF	007F3800
5800	007F2600
5801	00927E00
5802	00928000
5803	007F1000
5804	00639A00



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Figure 4-6. Example of Read to Scattered RAM - Page Size Equal to Disk Block Size (page 1 of 2)

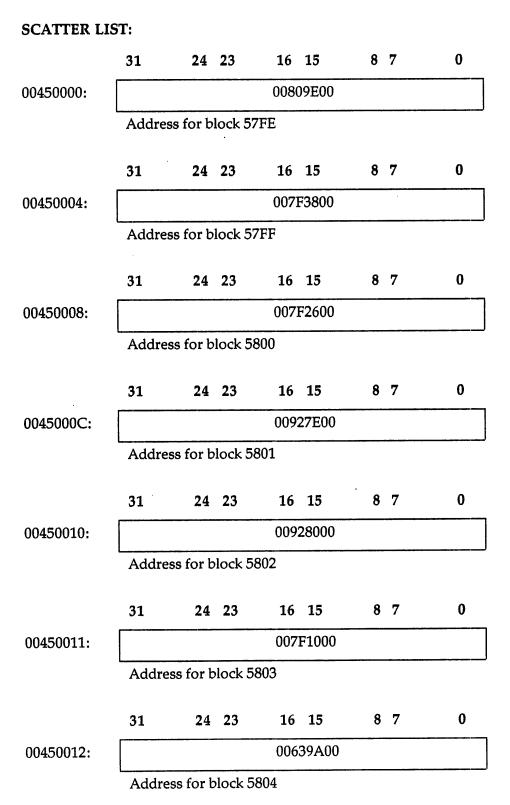
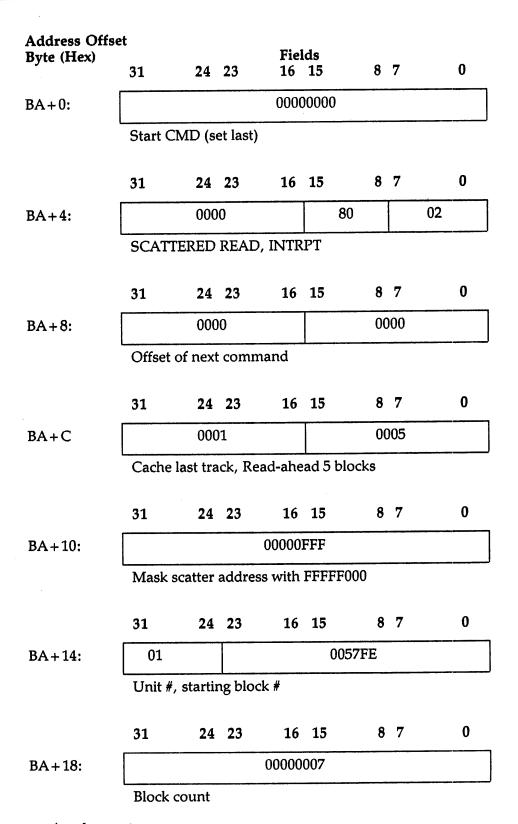


Figure 4-6. Example of Read to Scattered RAM - Page Size Equal to Disk Block Size (page 2 of 2)

Figure 4-7 shows a transfer to scattered RAM of the same disk blocks as shown in Figure 4-6. In Figure 4-7, however, system page size is 4K bytes while the disk block size is 1K byte. Also, each scatter address is ANDed with the number FFFFF000H, which requires that 00000FFFH be written at BA+10. In order for this command to function, the VM31 must have been informed at boot-up time of the system page size.

Disk Block # (Hex)	VMEbus Address for Transfer (Hex)
57FE	00809000
57FF	00809400
5800	00809800
5801	00809C00
5802	007F3000
5803	007F3400
5804	007F3800



continued on next page

Figure 4-7. Example of Read to Scattered RAM - Page Size Set to Four Times the Disk Block Size (page 1 of 2)

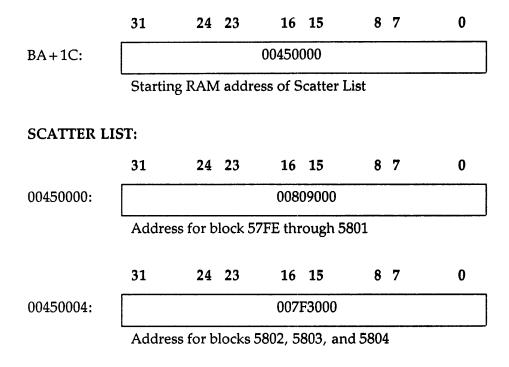


Figure 4-7. Example of Read to Scattered RAM - Page Size Set to Four Times the Disk Block Size (page 2 of 2)

4.8.10 Start Seek

Overlapped seeks may be implemented merely by doing a zero-byte read from the desired location on the drive. This will start a seek to the track containing the specified block. To minimize waiting time for the host system's processor, this command is indicated as done shortly after it has been received by the VM31. If an error is found, such as a too large block-number, it is not reported by the execution of this command. It will, however, be reported later when one of the data transfer commands is used to read or write the desired section of the disk.

4.9 Format Tracks (10H)

Each block of data on the disk is preceded by a header which contains the following information:

cylinder number head number sector number six bytes of ECC

The controller uses the cylinder and head numbers to ensure that the heads are positioned on a correct track. The sector number is used directly by the controller to determine sectors to be transferred. The controller will consider the first sector in a track to have a sector number of zero and subsequent sectors will have sector numbers of one, two, three, and so on.

In most cases, sectors will be numbered in ascending order. Sector one will follow sector zero and so on, but the design of the controller does not require this. Normal data-write operations only affect the data areas on the disk. The headers remain untouched by such operations.

Before a disk is used for the first time, headers must be written onto the disk. This operation is known as formatting. The controller writes data with a valid ECC to the data areas at the same time.

The format command always formats one or more tracks on the disk. It is not possible to format partial tracks. To format the entire disk, it is necessary to format every track on the disk. At format time, bad blocks may be marked for automatic re-mapping. The chapter on bad-block remapping discusses this in detail.

4.9.1 Command Table Format

Address BA+4 of the command table (Figure 4-8) contains the command for formatting, Command 10H. Bit 16 in this word contains a flag (IL) which determines the way in which the VM31 will interleave the sectors on the track. If bit 16 is zero, an interleave factor of one is assumed and the controller ignores the later information which would otherwise start at byte 1CH of the command table. If bit 16 is one, the sectors are ordered as specified by bytes 1CH and on in the command table. The sector immediately following the index pulse is given the sector number which was specified at location 1CH of the command table. The next sector's number is specified at location 1DH, the next at 1EH, and so on. The ability to choose any desired sector ordering allows flexibility in choosing interleave, track-to-track skewing, and so on.

Address BA+14 must contain the drive number and block address of the first sector in the track. Block addresses other than the first sector will cause the VM31 to abort the command and give an error message of "illegal arguments".

Address BA+18 contains the number of blocks to be formatted after the starting block. This number must be the number of blocks which would occur in an integer number of disk tracks. If there are 34 (decimal) sectors on a track, the longword at address BA+18 must contain a number which is a multiple of 34, for example, 102. Otherwise, the VM31 will abort the command and give an error message of "illegal arguments".

Address Offse Byte (Hex)	31	24	23	Fiel 16	lds 15	8	7	0	
BA+0:	Star	t/Don	e Code			Error S	tatus		
BA+4:					IM		10		
BA+8:		000	0		Offset Next CD Table				
BA+C:			Must b	e set t	to 000	000000			
BA+10:			Must b	e set	to 000	000000			
BA+14:	Uni	t #		Sta	Starting Logical Block				
BA+18:		Nu	mber of	Block	ks to l	be Form	atted		
BA+1C:	0 TH		1 ST	1	2	ND	3 I	RD	
BA+20:	4 TH	I etc (if IL = 1)							

Figure 4-8. Command Table for Disk Formatting

4.9.2 **Command Table Example**

To format the tracks containing blocks 0 through 23FFFFH on unit 2, with an interleave factor of two, the command table shown in Figure 4-9 would be used. Note that before executing this or any command, the drive and controller parameters must have been previously entered using command 20H (Set Drive and Controller Parameters). In this example, we will assume that the number of sectors per track had been set to 34 (22H) with command 20H.

Address Offse Byte (Hex)	et		Fie	lds			
byte (Hex)	31	24 23			8	7	0
BA+0:			000	000000	-		
BA+4:		0001		80		10	
BA+8:		0000			00	00	
BA+C:			000	000000			
BA+10:			000	00000			
BA+14:	02			000000			
BA+18:			002	240000			
BA+1C:	00		11	01		12	
BA+20:	02		13	03		14	
BA+24:	04		15	05		16	
BA+28:	06		17	07		18	
BA+2C:	08		19	09		1A	
BA+30:	0A		1B	0B		1C	
BA+34:	0C		1D	0D		1E	
BA+38:	0E		1F	0F		20	
BA+3C:	10		21	NOT	U	SED	

Figure 4-9. Example of Disk Formatting with Interleave 2

Command Table Format for Mark Track Bad (MKBD) Operation 4.9.3

The format command has a mode whereby an entire track may be marked as "defective", and where the controller will later (during read or write commands) skip such a track automatically and re-seek to an alternate track. This is useful for mapping out bad tracks at format time for the purpose of later having the drive look like a perfect disk to the operating system.

In this case, address BA+4 of the command table (Figure 4-10) contains the command for formatting, Command 10. However, bit 17 in this word contains a flag, which, if set to 1, commands the VM31 to do a MKBD operation instead of a normal format operation. The complete strategy for mapping out bad tracks is discussed in more detail in the section titled "Bad Block Re-Mapping", in Section 5.

Address Offse Byte (Hex)	et			Fie	lds				
2900 (2200)	31	24	23		15	8	7	0	
BA+0:	Start	:/Done	Code		E	rror Sta	tus		
BA+4:	0002				IM		10		
BA+8:		00	00		Offset Next CD Table				
BA+C:			Must	be set	to 00000000				
BA+10:			Must	be set	to 000	000000			
BA + 14:	Unit #	ŧ	Sta	arting l	Block	of Bad	Γrack		
BA+18:		S	ize of E	ad Tra	rack, in Blocks				
BA+1C:	Cyl #	of Rep	l Track	ς	He	ad # of	Repl 7	Гrack	

Figure 4-10. Formatting for Replacement of Bad Track with Spare Track

Set Drive and Controller Parameters (20H) 4.10

As the name indicates, the Set Drive and Controller Parameters command sets drive parameters in the controller. This function permits the number of heads, number of cylinders, and number of sectors per track to be changed to suit different drives. Also, DMA width, sector size, interrupt vector number, and other parameters are set using this command.

4.10.1 Command Table Format

Figure 4-11 shows the command table format for the Set Drive and Controller Parameters command.

Address Offse Byte (Hex)	et	Fields								
- J 10 (,	31	24	23		15	8	7	0		
BA+0:	Start	/Done	Code			Er	ror Sta	tus		
BA+4:	-	00	000		IM		20			
BA+8:	Res	erved			Offset Next CD Table					
BA+C:			Must	be set	to 000	000000				
BA+10:										
BA+14:		000	00		00)	Para	Param. #1		
BA+18:		De	sired n	ew Par	rameter Value ²					

¹Parameter to be set.

Figure 4-11. Command Table for Set Drive and Controller Parameters

4.10.2 Command Number, Interrupt Mask, and Read Copies - BA+4

8 7 0 31 24 23 16 15 CMD# Must be set to 0 IM BA+4:

> Bits 0-7 are the command number. The command number 20H is entered to set drive and controller parameters.

Bits 8-14 are ignored.

Bit 15 is the interrupt mask. As with transfers to contiguous RAM (described earlier), when the interrupt-mask bit is set, the completion of a command, as indicated by the DONE word, will cause an interrupt. If the interrupt-mask bit is not set, the DONE code will still be set on completion of a command, but no interrupt will be caused. This bit is cleared on power-up.

Bits 16-31 are not used for this command and must be set to zero.

²Parameter value.

4.10.3 Offset of Next Command Table - BA+8

31 24 23 16 15 8 7 0

BA+8: Reserved Offset Next CD Table

This longword allows for chaining of commands. The function of this command table location is exactly the same as for transfers to contiguous RAM, described earlier. Bits 15-0 contain the offset in bytes from the Base Address of next command table. This offset may not be negative, nor greater than 01B0H. It should be set to zero if chaining is not desired.

4.10.4 Parameter to be Set - BA+14

BA+14: 0000 16 15 8 7 0 Param.

Bits 31-8 all contain zeros. Bits 7-0 contain the number that identifies the parameter that needs to be set. A list of the parameters is provided in Table 4-3, in Section 4.10.5.

4.10.5 Desired New Parameter Value - BA+18

BA + 18: Desired new Parameter Value

Bits 23-0 contain the desired new parameter value for the Set Drive and Controller Parameters command. The default parameter values and descriptions of the parameter values are provided in Table 4-3.

Table 4-3. Drive and Controller Parameters That May Be Set

Parameter # (Hex)	Name	Default (Hex)	Description of Parameter							
00	hd soft	0	0 if hard sectoring desired (default) 1 if soft sectoring desired (not recommended by Emulex)							
04	secsiz	400	0200H if 512 byte sectors desired 0400H if 1024 byte sectors desired (default) 0800H if 2048 byte sectors desired NOTE: Not possible to have mixed sizes of sectors on the different drives.							
0C	funcod	3D00	Desired address modifiers and LWORD value to be sent to the VMEbus during DMA							
10	nrdrtry	8	Max. No. of retries for read errors (1H to 1FH)							
14	nwrrtry	3	Max. No. of retries for header errors during write operations (1-3)							
18	18 eccdis		ECC error retry disable. If nonzero, ECC errors on data will be ignored. Normally, this should not be used.							
1C	diagnos	0	Diagnostic reporting desired. See section below.							
20	intvect	FF2F	VMEbus interrupt-vector number (0H to FFH)							
28 2C	headersync datasync	F0 F0	Header sync byte (1H to FFH). Default is 19H. Data sync byte (1H to FFH). Default is 19H. Normally, there is no need to set these parameters.							
40 41 42 43	ncyl(0) ncyl(1) ncyl(2) ncyl(3)	337 337 337 337	Number of cylinders on drive 0 (2047 max) Number of cylinders on drive 1 (2047 max) Number of cylinders on drive 2 (2047 max) Number of cylinders on drive 3 (2047 max)							
50 51 52 53	nhd(0) nhd(1) nhd(2) nhd(3)	7 7 7 7	Number of heads on drive 0 (255 max) Number of heads on drive 1 (255 max) Number of heads on drive 2 (255 max) Number of heads on drive 3 (255 max)							
60 61 62 63	nspt(0) nspt(1) nspt(2) nspt(3)	22 22 22 22 22	Number of sectors per track on drive 0 (126 max). Number of sectors per track on drive 1 (126 max) Number of sectors per track on drive 2 (126 max) Number of sectors per track on drive 3 (126 max)							

continued on next page

Parameter # (Hex)	Name	Defaults (Hex)	Description of Parameter
80-84	(spare)	0	Null command; inserted for compatibility with Emulex VM21 controller.
90	boardadr	400	VMEbus base address of board in short space. If address not 0400H, this parameter must be set before issuing any other command.
В0	phytolog	1	For scattered transfers, the size (1, 2, 4, or 8) in physical disk blocks, of each page.
E0-EF	(spare)	0	Null command; inserted for compatibility with Emulex VM21 controller.

Remember, a drive having seven heads has them numbered 0-6, and the number of heads specified to the VM31 is seven. Any specified values that are larger than the recommended values will cause a "bad arguments" error, 82H. No attempts should be made to use the drive after a fatal error has been returned by this command, as some parameters may have been changed and others may still have their original values. A new command 20H should be given, with correct values.

4.10.6 Hard/Soft Sectoring - Parameter 00

Hard sectoring is the default type of sectoring used by the VM31 and is normally recommended for use with this controller. If, however, soft sectoring is desired, the value of 01H should be written, using command 20H.

4.10.7 Sector Size Code - Parameter 04

The sector size code indicates the size of the data field used for each data sector. When the controller is first turned on, sector size is set to 1024 bytes by the firmware in the VM31. This size can be changed subsequently by the use of Command 20H. All four drives must have the same sector size. The values which may be written are as follows:

200H = 512 byte sectors

400H = 1024 byte sectors (Default Value)

800H = 2048 byte sectors

Note that the minimum size of an actual sector on the disk is 80 bytes plus the data. For example, to use a 512-byte data sector, the switches on the disk drive need to be set so that the smallest sector on the track would be at least 512+80 = 592 bytes. For best data throughput, larger sector sizes should be used (2K or 1K).

4.10.8 VMEbus Address Modifiers during DMA - Parameter 0C

This parameter specifies the address modifiers that the VM31 sends to the VMEbus during DMA cycles. AM5 through AM0 specify the address modifier to be used by the controller board when placing an address onto the VMEbus. The SHT bit instructs the controller to do 16-bit data transfers. If 0 the board will do 32-bit data transfers. Note that on systems that cannot perform 32-bit data transfers (MC68000), this value MUST be set to 1 before transferring any data onto the VMEbus. The function of the bits in this parameter are as follows:

BA + 18

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	SHT	AM5	AM4	АМ3	AM2	AM1	AM0	0	0	0	0	0	0	0	0

The default parameters for the VM31 specify longword transfers, standard (24-bit) addressing, and supervisory accesses. The corresponding value for this parameter is as follows:

BA + 18

															0
0	0	1	1	1	1	0	1	0	0	0	0	0	0	0	0

If 16-bit data transfers are desired instead, the value of the parameter would be changed simply to:

BA + 18

	14														
0	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0

If extended (32-bit) addressing is desired instead of the default 24-bit addressing, the parameter would be:

BA + 18

															0
0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0

4.10.9 Diagnostic Reporting - Parameter 1C

The VM31 Controller Board contains a very simple asynchronous serial I/O port, which is shown in Figure 4-12. This port can be configured to issue diagnostic reports on the internal activities of the board. To use the port, the "serial data out" line should be wired to to pin 3 of the RS-232-C data input of a standard computer terminal having a baud rate of 19200. The "ground" line should be connected to pin 7, signal ground, of the terminal. While the VM31 output is not RS-232-C compatible (TTL levels are used instead), the serial port will work, nevertheless, with most terminals.

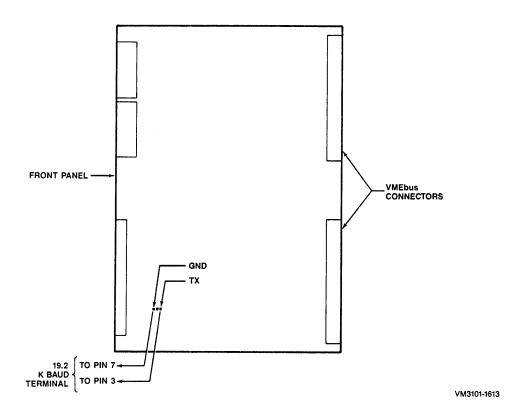


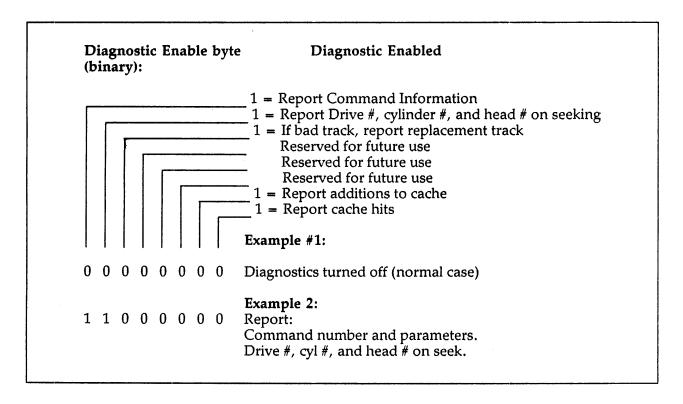
Figure 4-12. VM31 Board Serial I/O Port

The port is always active during the board's power-on diagnostic self-test. In addition, this port can be used to give a real-time description of what the board is engaged in at any moment. For example, one bit can be set so that the VM31 reports the occurrence of every seek (Table 4-4). Another bit can be set for a report of the start of each command. This information is useful for troubleshooting as well as for studying the sequence of disk transfers to determine the type and order of transfers that the system is requesting. As shown below, the bits in address BA + 18 specify the information to be reported through the serial port.

WARNING

Enabling any of the diagnostics will substantially degrade performance of the VM31. Therefore, reporting should be done on a temporary basis only.

Table 4-4. Diagnostic Report Bits



4.10.10 VMEbus Interrupt Vector - Parameter 20

If interrupts are used, the VM31 will supply the VMEbus interrupt vector, which can be from 0H to FFH. The default interrupt vector is 2FH.

4.10.11 Board Address - Parameter 90

The default factory starting address of the shared memory on the board is 0400H in short address space. If the default setting is used, this parameter (90) does not have to be set. However, if switch SW1 is set so that a different starting address is used, the board must be told of this new address each time the board is powered up, and before any other commands are issued. This is done by using Command 20, parameter 90, and inserting the desired base address as the parameter value.

4.10.12 Sectors per Page - Parameter B0

Parameter B0H allows you to inform the VM31 of the size of logical blocks (pages) in terms of disk blocks. For example, if the host regards a page as 4K bytes and the VM31 is set for 1024 bytes-per-sector, then this parameter should be set to 4. In all cases, this parameter should be set to the integer value of the size of a logical block divided by the size of a physical disk block. This parameter is relevant only when scattered reads or writes are used. The default value of this parameter is 1.

Report Drive and Controller Parameters (21H) 4.11

The Report Drive and Controller Parameters command reads various drive and controller parameters from the VM31 and reports them in the command-table area. This command can be used to determine whether a drive can be selected.

Command Table Format 4.11.1

Figure 4-13 shows the command table format for the Report Drive and Controller Parameters command.

Address Offse Byte (Hex)	et			Fiel	ds			
Dyte (11ex)	31	24 2	23	16		8	7	0
BA+0:	Start/Done Code					Error S	tatus	
BA+4:	0000			IM		1		
BA+8:		0000			Offset Next CD Table			
BA+C:	Must be set to 00000000							
BA + 10:]	Must be	set	to 00	000000		
BA+14:		0000			00)	Param. #	
BA+18:		Para	meter V	alue	(Rep	o't by co	ntrolle	r)
BA+1C:	2nd Parameter Value (param 70 only)							
BA + 20:	3rd Parameter Value (param 70 only)							
BA+24:		4th F	aramet	er V	alue	(param ?	70 only)

Figure 4-13. Command Table for Reporting Drive and Controller Parameters

Table 4-5. Drive and Controller Parameters That May Be Reported

Parameter # (Hex)	Name	Description of Parameter
00	hdsoft	0 if hard sectoring invoked 1 if soft sectoring invoked
04	secsiz	0200H if 512 byte sectors invoked 0400H if 1024 byte sectors 0800H if 2048 byte sectors
0C	funcod	Current address modifiers and LWORD value sent to the VMEbus bus during DMA
10	nrdrtry	Max. number of retries for read errors
14	nwrrtry	Max. number of retries for header errors during write operations
18	crcdis	ECC error retry disable. If nonzero, ECC errors on data are being ignored.
1C	diagnos	Diagnostic reporting desired. See section below.
20	intvect	VMEbus interrupt-vector number.
28 2C	headersync datasync	Header sync byte. Data sync byte.
40 41 42 43	ncyl(0) ncyl(1) ncyl(2) ncyl(3)	Number of cylinders on drive 0 Number of cylinders on drive 1 Number of cylinders on drive 2 Number of cylinders on drive 3
50 51 52 53	nhd(0) nhd(1) nhd(2) nhd(3)	Number of heads on drive 0 Number of heads on drive 1 Number of heads on drive 2 Number of heads on drive 2
60 61 62 63	nspt(0) nspt(1) nspt(2) nspt(3)	Number of sectors per track on drive 0 Number of sectors per track on drive 1 Number of sectors per track on drive 2 Number of sectors per track on drive 3
70	drvstat	Drive status bits (see below)
80-84	(spare)	Null command; inserted for compatibility with Emulex VM21 controller

continued on next page

Table 4-5. Drive and Controller Parameters That May Be Reported (Continued)

Parameter # (Hex)	Name	Description of Parameter
90	boardadr	Board VMEbus base address (see below)
В0	phytolog	For scattered transfers, the size (1, 2, 4, or 8), in physical blocks, or each page (default is 1).
C0	firmrev	Type of controller (VM31 or VM21) and date of firmware revision.
E0-EF	(spare)	Null command; inserted for compatibility with Emulex VM21 controller

4.11.2 Hard/Soft Sectoring - Parameter 00

Hard sectoring is the default type of sectoring used by the VM31 and is normally recommended for use with this controller. If, however, soft sectoring has been set with command 20H (Set Drive and Controller Parameters), the value "0001" will appear at BA+18.

4.11.3 Sector Size Code - Parameter 04

The sector-size code returned indicates the current data-field size of each sector. When the controller is first turned on, sector size is initialized to 1024-byte sectors by the firmware in the VM31. This can be changed, subsequently, by the use of command 20H. The values returned are as follows:

200H = 512 byte sectors 400H = 1024 byte sectors 800H = 2048 byte sectors

4.11.4 Diagnostic Reporting - Parameter 1C

The number returned for this parameter value is the level of diagnostic reporting which was specified previously. The functions of the bits in the parameter value were discussed earlier in the section on command 20H (Set Drive and Controller Parameters).

4.11.5 Drive Status - Parameter 70

Since the VM31 automatically handles all drive operations, this parameter should not be used, except for diagnostic purposes. This is a value read internally by the VM31. The value for drive 0 appears at BA+18. The values for drives 1, 2, and 3 appear at BA+1C, BA+20, and BA+24, respectively. The function and arrangement of each bit are as follows:

7	6	5	4	3	2	1	0
Unit	Not	D	Write	Fault	Seek	On	Unit
Sel'd	Used	Busy	Prot'd	raun	Error	Cyl	Ready

- Bit 7 When set, this bit indicates that the unit is able to be selected. If not set, the unit is either not connected, or would not select.
- Bit 5 When set, this bit indicates the drive is busy, usually due to an access on its other port (if dual ported).
- Bit 4 When set, this bit indicates a write-protected drive. Write-protect is set by a switch on the drive. Dual-ported drives are not supported presently.
- Bit 3 The Fault bit indicates that a fault condition has occurred within the drive that makes read and write operations unreliable. The fault condition disables the read and write circuitry and causes the Unit-Ready signal to go low. Typical errors which cause faults are: writing to a write-protected drive, or read and write control-signals asserted at the same time. The VM31 attempts to reset all faults.
- Bit 2 The Seek-Error bit indicates that a seek command did not complete satisfactorily. Probable causes are: cylinder address was too large, rezero or seek operation took too long, or guard bands were detected during the seek operation. Seek errors are reset automatically by the VM31.
- Bit 1 This is the On-Cylinder bit. Bit 1 is set when a seek has been successfully completed.
- **Bit 0** The Unit-Ready bit indicates that the disk is up to speed, the heads are positioned over a data track, and a no-fault condition exists in the drive.

4.11.6 Board Address - Parameter 90

The number returned is the starting address of the on-board shared memory, which is normally 0400H (in the VMEbus short address space).

4.11.7 Sectors per Page - Parameter B0

The number returned is the number of sectors per logical block.

4.11.8 Board Type and Firmware Revision - Parameter C0

The value returned for parameter C0 has the following format:

Address Offse Byte (Hex)	et 31	24	23	Fields 16 15	8	7	0
BA + 18:	Brd T	ype		Revision D	ate		

BOARD TYPE is 1 for a VM31 disk controller and 0 for a VM21 controller.

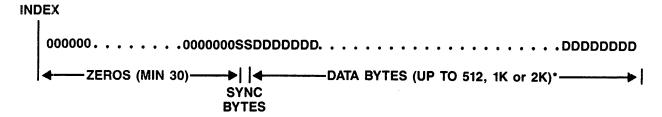
REVISION DATE is a hexadecimal representation of month/day/year. For example, if the firmware revision date was February 18, 1986 (02/18/86), the board would return the following value:

Address Offse Byte (Hex)	et 31	24	23	Fields 16 15	8	7	0
BA + 18:	01			00557E			

The hexadecimal number 00557E is 021886 decimal.

4.12 Read Disk Defect List (28H)

On virtually all disk drives there are media defects, which are small flawed regions on the media, in which data cannot be stored reliably. On most drives, a printed list of flaws is packed with the unit. Additionally, on some disk drives, the manufacturer supplies this information in machine-readable form on the disk itself. The VM31 is capable of reading this defect information from the Fujitsu 2333 drive, and certain other drives which have similar formats. Figure 4-14 shows the general format that the VM31 is capable of reading. Figure 4-15 shows the media defect format for a Fujitsu 2333 disk drive.



*THE NUMBER OF DATA BYTES CAN BE UP TO THE DATA SECTOR SIZE SET FOR THE VM31.

VM3101-1477

Figure 4-14. General Defect Format Readable by VM31

The Fujitsu 2333 stores this information in the format shown in Figure 4-15.

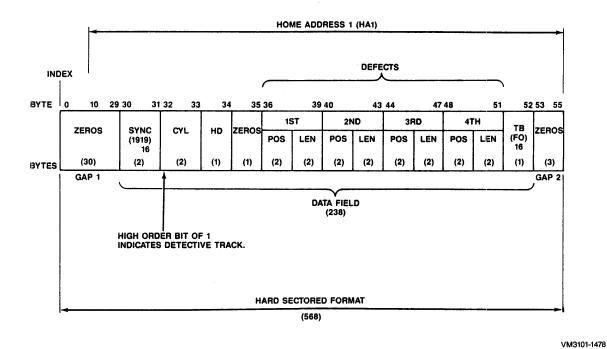


Figure 4-15. Fujitsu 2333 Media Defect Format

Prior to reading the defect information, the header and data sync bytes must be set, at least temporarily, to the values specified by the drive manufacturer. This can be done using parameters 28 (headersync) and 2C (datasync) of command 20H (Set Drive and Controller Parameters). For Fujitsu 2333 drives, both sync bytes must be set to 19 (hex) before command 28 is used to read the defect information.

Also, as there is no error checking for this command (the drive manufacturer does not provide the appropriate error check bits), the data should be read twice and compared for equality. Furthermore, to guard against the possibility of a "framing error" (the controller synchronizing on some data which was erroneously written onto the track), the cylinder and head read from the track should be compared to the cylinder and head number expected for the track.

The above measures are ESSENTIAL, since there is the possibility that the disk was written to erroneously after shipment from the manufacturer - thereby deleting the defect information and replacing it with garbage. Since the VM31 only searches for the sync pattern 19, it is very likely that such a pattern would be found somewhere in the data, and falsely synchronized to. Without error checking to detect this sort of framing error, the VM31 will appear to have read data successfully, when in fact the data is completely wrong.

4.12.1 Command Table Format

The command table format for the Read Defect command is shown in Figure 4-16.

Address Offse Byte (Hex)	et			Fie	lde				
byte (Hex)	31	24	23		15	8	7	0	
BA + 0:	Sta	rt/Dor	ne Code		# Re	tries	Error	Code	
BA+4:	M	lust be	set to 0		IM		28		
BA+8:	Reserved					Offset Next CD Table			
BA+C:			Mu	st be	set to	0 .			
BA+10:		***	Mu	st be	set to	0			
BA+14:	Uni	it #	Logi	cal St	arting	Block c	f Strt T	rk	
BA+18:	Ignored								
BA+1C:		Sta	rting RA	AM A	ddr fo	or Read	Data		

Figure 4-16. Command Table Format for Read Defect

Command Number and Interrupt Mask - BA+4 4.12.2

8 7 0 16 15 31 24 23 28 IM Must be set to 0 BA+4:

Bits 0-7 are the command number.

Bits 8-14 are ignored.

Bit 15 is the interrupt mask. As with other commands described earlier, the interrupt-mask bit, when set, allows completion of a command, as indicated by the DONE word, to cause an interrupt. If the interrupt-mask bit is not set, the DONE code will still be set on completion of a command, but will not cause an interrupt. This bit is cleared on power-up.

Bits 16-31 are not used and must be set to zero.

Offset of Next Command Table - BA+8 4.12.3

8 7 0 16 15 24 23 31 Offset Next CD Table Reserved BA + 8:

> This block specifies the offset of the next command table, and allows for chaining of commands. Bits 15-0 define the offset in bytes (from the Base Address) of the next command table - this number may not be negative, nor greater than 01B0H. Set these bits to zero if chaining is not desired.

> Note that this parameter does not have to be re-written before each command, as the VM31 does not alter this location. For further information, see the section "Chaining of Command Tables" at the end of this chapter.

4.12.4 Drive Number and Block Address - BA+14

31 24 23 16 15 8 7 0

BA+14: Unit # Logical Starting Block of Strt Trk

The most significant byte of the drive-number/block-address field determines the drive number. A 00H specifies that operations will be performed on drive zero, a 01H specifies drive one, a 02H specifies drive two, and a 03H specifies drive three. The rest of the byte should be all zeros to maintain compatbility with possible future versions.

The three least significant bytes define the block number of the first disk block to be transferred. In this case however, the block address must be for the first block on a track. Otherwise, a bad arguments error (82H) will result.

4.12.5 RAM address for read data - BA+1C

31 24 23 16 15 8 7 0

BA+1C: Starting RAM Addr for Read Data

This 32-bit quantity in the command table contains the starting address of the area of RAM to which the transfer will be made. The upper 8 bits of this quantity are not used for systems which permit only 24 address bits. The length of the transfer will be the same as the blocksize set earlier (512, 1024 or 2048 bytes), although generally only the first 30 or 40 bytes contain useful information. Free memory space must be reserved, however, for a full block transfer. The data transfer is done by DMA, a 16- or 32-bit word at a time. The least significant bit of this RAM address must be zero, since all data transfers must start on word boundaries.

4.12.6 Command Table Example

Figure 4-17 shows what would be written into the command table if defect data from cylinder 5, head 0 on unit 1 is desired. Note that the starting block is 0708H (1800 decimal, which is track 5 x 36 blocks-per-track x 10 heads). The address to which the data is to be read is 450000 hex.

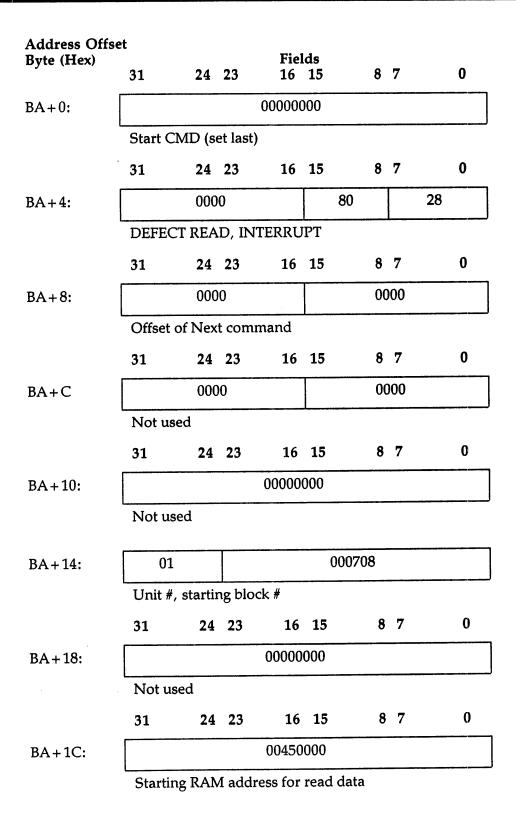


Figure 4-17. Example, Read Fujitsu Defect for Cylinder 5, Head 0

4.13 Test DMA Transfers to External Memory (72H)

This command tests whether the board's DMA circuitry performs transfers to and from external memory on the VMEbus. It is designed to be used in conjunction with the board's 19.2K-baud diagnostic port. This command may be used only in systems with memory having full 32-bit data paths. The command performs a series of DMA transfers of lengths from 2 to 300 words, incrementing each transfer by 18 words. This sequence is repeated for the range of DMA starting addresses that are specified in the command table.

4.13.1 Command Table Format

_ ..

The starting DMA address, the maximum DMA address for start of burst, and the address increment between each successive test, must be set to the required values in the command table (Figure 4-18). All output from this command is channeled through the diagnostic serial port. No status, other than the DONE status is returned via the command table.

Address Offse Byte (Hex)	et 31	24 23		lds 15	8	7	0
BA + 0:	Sta	art/Done Cod	le		Error S	Status	
BA+4:	0000			IM	***	72	
BA+8:	0000			Offset Next CD Table			
BA+C:		00000000					
BA+10:		Must b	e set to	0000	0000		
BA+14:	DMA Starting Address						
BA+18:	Max DMA Address for Start of Burst						
BA+1C:		Addre	ss Incr	Betw	een Burs	sts	

Figure 4-18. Command Table for Test DMA Command

4.14 Reset Drive (90H)

In some instances, it may be necessary to clear error conditions that exist in a disk drive. The two error conditions that may need clearing are seek error and drive fault error conditions. During the course of a read, write, or format command, if the VM31 finds such error conditions in the drive, it will automatically reset the drive. However, to reset the drive outside of one of the commands mentioned, the Reset Drive command (90H) may be used.

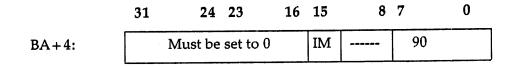
4.14.1 Command Table Format

The command table format for the command is shown in Figure 4-19.

t			Fiel	lds			
31	24	23			8	7	0
Start/Done Code				# Retries Error C			Code
Must be set to 0			IM		90		
Reserved				Offset Next CD Table			
		M	lust be	set to	0		
Must be set to 0							
Unit # 000000							
	Sta	Start/Doi Must be	Start/Done Coo Must be set to Reserved M	Start/Done Code Must be set to 0 Reserved Must be set to 0 Must be set to 0	31 24 23 Fields 15 Start/Done Code # Re Must be set to 0 IM Reserved Off Must be set to Must be set to	Fields 31 24 23 16 15 8 Start/Done Code # Retries Must be set to 0 Reserved Offset Nex Must be set to 0 Must be set to 0	Fields 31 24 23 16 15 8 7 Start/Done Code # Retries Error Must be set to 0 Reserved Offset Next CD Tall Must be set to 0 Must be set to 0

Figure 4-19. Command Table Format for Reset Drive Command

4.14.2 Command Number and Interrupt Mask - BA+4



Bits 0-7 are the command number. The command number 90 is entered for resetting the drive.

Bits 8-14 are ignored.

Bit 15 is the interrupt mask. As with commands described earlier, the interrupt-mask bit, when set, allows completion of a command, as indicated by the DONE word, to cause an interrupt. If the interrupt-mask bit is not set, the DONE code will still be set on completion of a command, but will not cause an interrupt. This bit is cleared on power-up.

Bits 16-31 are not used and must be set to zero.

4.14.3 Offset of Next Command Table - BA+8

31 24 23 16 15 8 7 0

BA+8: Reserved Offset Next CD Table

Bits 15-0 specify the offset from the Base Address of the next command table - the number may not be negative. Set to zero if chaining of commands is not desired.

4.14.4 Drive Number - BA+14

BA+14: Unit # 000000

Bits 31-24 specify the drive number of the drive to be reset.

The function of this command table location is similar to its use in other commands, except that only the drive number is required. The three least significant bytes are not used, and should be set to zero.

4.14.5 Command Table Example

Figure 4-20 is an example of a command table which will result in unit 2 being reset.

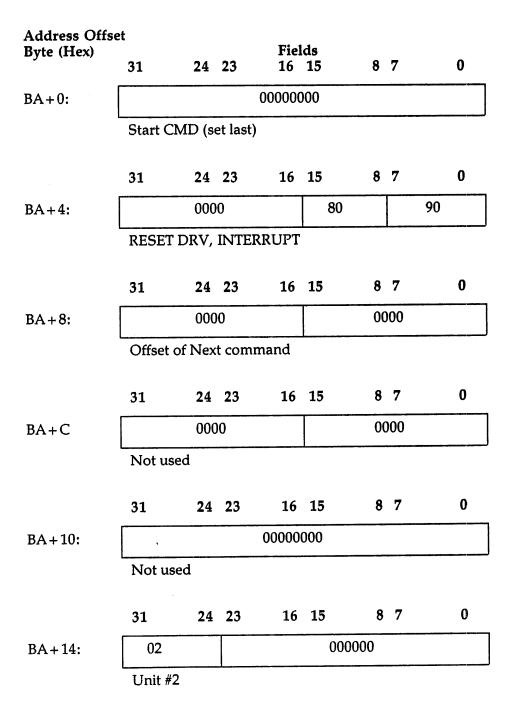


Figure 4-20. Example, Reset (Recalibrate and Clear Fault Conditions) on Unit 2

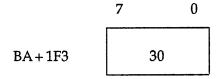
4.15 Special Command - Reset Controller

In some instances, it may be necessary to completely reset the VM31 disk controller. While this should not be necessary in a properly configured system, there are some circumstances during system software development, in which it may be desirable to reset the disk controller under software control, (without having to reset the entire computer system via its front panel reset switch), and start over as if the controller was just reset. The reset command will cause the controller to go through its power-up routines, including its self-test.

The Reset Controller command should be used with extreme care, as ALL setup commands entered earlier will be destroyed, and must be completely reinitialized, just as is required during the normal power-up sequence. In most applications reset will not be necessary.

If the on-board 68000 processor has crashed, the reset command will still be usable. However, if the processor crashes at a time when its local interrupts are disabled, it will be necessary to reset the entire system using the system's RESET switch.

This command is not implemented using the command table, as other commands are. Instead, the reset can be effected by simply writing the single byte 30H at address 5F3 (BA+1F3) as shown below.



The command works as follows: Normally, the byte at location BA+1F3 contains the local interrupt vector number 40 for the on-board processor's memory refresh interrupt (which occurs approximately every 900 us). When the host writes the number 30 to this location, the board jumps automatically to a reset routine upon receipt of its next refresh interrupt. Please allow at least five seconds for execution of the reset command.

4.16 Illegal Commands

The previous sections covered all commands executed by the VM31. Any other commands will return the 82H "bad arguments" error.

Chaining of Command Tables 4.17

While a single command table is adequate for most driver interfaces, in some applications, chaining two or more command tables may be desirable to allow greater throughput. Chaining allows the operating system to set up a command table for a second command while the controller is busy executing the first command. Command tables are chained simply by supplying an offset, other than zero, in the third longword of the command table. Figure 4-21 illustrates the use of chaining.

Note that command tables must be longword aligned.

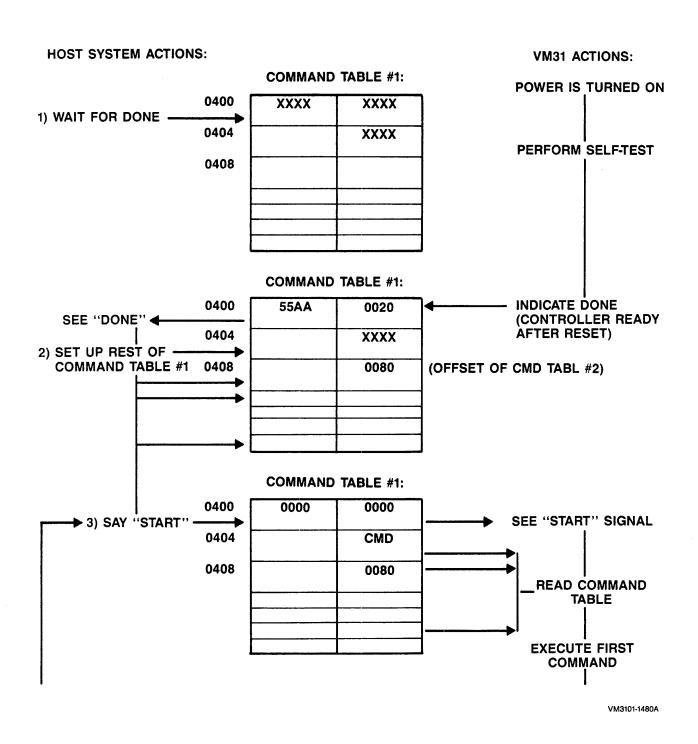
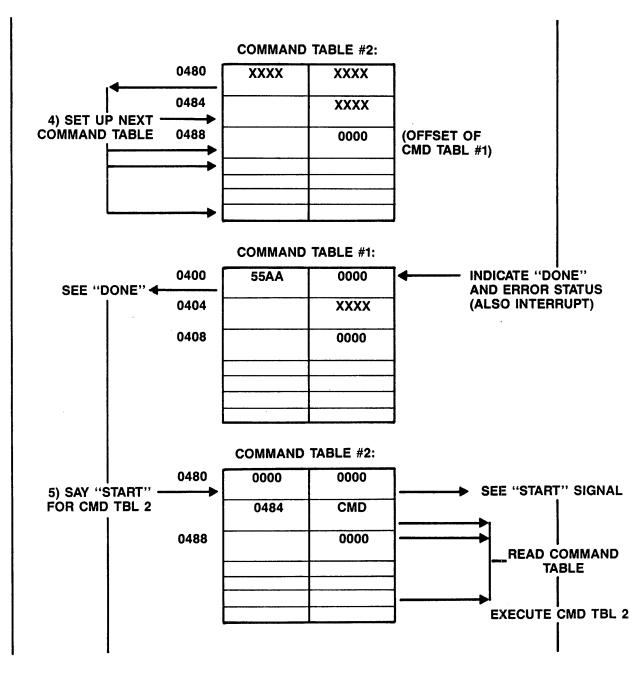
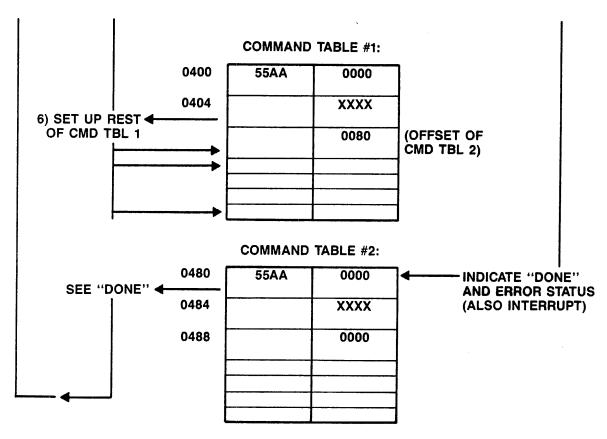


Figure 4-21. Ping-Pong Chaining of Two Command Tables (page 1 of 3)



VM3101-1480B

Figure 4-21. Ping-Pong Chaining of Two Command Tables (page 2 of 3)



VM3101-1480C

Figure 4-21. Ping-Pong Chaining of Two Command Tables (page 3 of 3)

5.1 Overview

This section contains the following subsections.

Subsection	Title
5.1 5.2 5.3 5.4	Overview Bad Block Re-Mapping Optimal Cache Utilization Error Detection and Correction

5.2 Bad Block Re-Mapping

The VM31 is capable of automatic re-mapping of bad blocks on the disk without any attention from the operating system. Re-mapping information is recorded on the disk at format time only. In order to give the user flexibility, the standard formatting commands may be used to implement bad-block re-vectoring.

5.2.1 Recommended Two-Level Defect Skipping Scheme

The following two-level defect skipping scheme is recommended for automatic bad-block substitution. This scheme combines sector slipping (1) and bad-track re-vectoring (2).

1. One unused sector on every track is reserved as a spare replacement sector for a bad block that might be present on that track. All but the last sector on a perfect track is formatted with the desired sector numbers. The last (spare) sector is formatted with a sector ID number of "7F", and the controller will always ignore it.

If however, a bad block is present on a track, the sector ID number in the header of the **bad** sector is formatted as "7F" and the remainder of the sectors are "slipped" one space ahead. The spare sector will thereby be used for the last sector. In any case, the controller will ignore the sector marked 7F, and see only the good sectors.

2. If any track contains more than one bad sector (a relatively rare occurrence), the entire track is marked bad at format time, using the MKBD (MarK BaD) format option. The MKBD option places a sector ID number of "7E" in all sectors of the bad track.

It also stores, in multiple places on the bad track, the replacement cylinder and head number of a complete replacement track (usually located near the end of the disk). Since this re-vectoring information is stored in every sector on the bad track, it is very unlikely that the revectoring information will be unreadable. It is advisable to reserve about 30 tracks (typically, 3 or 4 cylinders) at the end of the disk to be used as replacement tracks.

It is strongly recommended that a combined scheme be implemented. To implement the first part of the scheme, (bad sector slipping) on a given track, the track is formatted using the standard format command (Command 10) with bit 16 of command-table address BA + 4 set to a 1. The sectors are listed just as they are desired to be ordered on the track.

The example in Figure 5-1 below shows the command table which would be used to format the track containing blocks 0H through 21H (0 through 33 decimal) on unit 2, with an interleave factor of one. Note that before executing this or any command, the drive and controller parameters must have been previously entered using command 20H (Set Drive and Controller Parameters). In this example, we will assume that the number of sectors per track had been set to 34, using command 20H. Only 33 (not 34) sectors per track will be used for reading and writing data.

Therefore, after formatting all tracks, and before reading and writing data, the Set Drive and Controller Parameters command must be used again to set the number of sectors per track to 33.

Address Offs Byte (Hex)	et 31	24	23	Fields 16 15	8	7	0	
BA+0:		00000000						
BA+4:		000	01	80		10		
BA+8:		000	00		00	000		
BA+C:				00000000				
BA + 10:			- 172-	00000000				
BA+14:	02			0000	00			
BA+18:				00000022				
BA+1C:	00		01	02		03		
BA+20:	04		05	06		07		
BA+24:	08		09	0A		ОВ		
BA+28:	0C	•	0D	0E		0F		
BA+2C:	10		11	12		13		
BA+30:	14		15	16		17		
BA+34:	18		19	1A		1B		
BA+38:	1C		1D	1E		1F		
BA+3C:	20 7F NOT USED							
	<u> </u>		†					
			SPA	RE				

Figure 5-1. Formatting for Spare Location on a Perfect Track

If there is a bad sector, the bad sector is given a sector number of 7F and all successive sectors are "slipped" ahead by one location. Hence the last sector now appears in the spare sector location (Figure 5-2).

Address Offse Byte (Hex)	t	F	elds				
Byte (IIex)	31 24			7 0			
BA+0:		00	000000				
BA+4:	00	001	80	10			
BA+8:	00	000	0	000			
BA+C:		00	0000000				
BA+10:		00	0000000				
BA+14:	02		000000				
BA+18:	00000022						
BA+1C:	00	01	02	03			
BA+20:	04	05	06	07			
BA+24:	08	09	0A	0B			
BA+28:	0C	0D	0E	0F			
BA+2C:	10	11	12	7F ¹			
BA+30:	13	14	15	16			
BA+34:	17	18	19	1A			
BA+38:	1B	1C	1D	1E			
BA+3C:	1F	20	NOT U	JSED			
•							

SPARE Becomes Filled with Last Sector

Figure 5-2. Formatting for Skipping of Bad Sector, by Sector Slipping

¹ Bad Sector Location

The second part of the re-mapping scheme is used to mark tracks completely bad when more than one block on the track is bad. In this case, Command 10 is used to mark the entire track bad and supply a replacement cylinder and head. Whenever the controller encounters such a track during read and write transfers, it will automatically seek to the replacement track and perform the transfer on it. Figure 5-3 shows how track 3 on unit 2 (blocks 66H through 87H) may be marked bad, with a replacement cylinder of 815 (32FH), head 3 (on the same drive).

Address Offse Byte (Hex)		24 23	Fie 16		8	7	0
BA+0:	Start/Do	one Code		Error Status			
BA+4:	0002		IM	***	10 ¹		
BA+8:	0000		Offset NXT CD TBL			,	
BA+C:	Must be set to 00000000						
BA+10:	Must be set to 00000000						
BA+14:	2			00	0066 ²	-	
BA+18:	00000022 ³						
BA+1C:	032F	4		0003 5			

¹ MKBD Command

Figure 5-3. Formatting for Replacement of Bad Track with Spare Track

² Unit, Strt Blk of Bad Track

³ Size of Bad Track

⁴ Replacement Cylinder

⁵ Replacement Head

5.3 Optimal Cache Utilization

5.3.1 Caching of New Read Data

Rather than using a fixed cache-updating algorithm, the VM31 allows the host operating system to specify, on a command-by-command basis, the amount of data to be cached during a given read command. As discussed earlier, the operating system may specify no caching at all, caching of the entire read transfer or caching of only the last track of a read transfer. Furthermore, the VM31 may be instructed to cache ahead several blocks on the last track of a read transfer. In the read-ahead mode, the extra blocks are not actually transferred into the host system's memory. They are merely stored in the VM31's cache. Then, if a later read command calls for any of these blocks, they will be available in cache, and a time-consuming disk transfer is not needed.

While the flexibility of the caching scheme allows more efficient use of the cache, this same flexibility could, if misused, result in very poor cache usage. As with many caching schemes, the entering of new data into the cache will cause the cache to fill. Once the cache is full, any caching of new data will require the VM31 to remove the oldest (least recently added) blocks in the cache. Obviously, the larger the transfer to the cache, the more old data will be removed. While the removal algorithm is not under the user's control, the number of blocks actually added to the cache is.

These general rules should be followed:

- 1. It is not necessary to change caching parameters for each transfer. Instead, parameters yielding good overall performance, such as those shown below, may be set as a fixed value.
- Do not specify caching for data which is not likely to be required again within the next few disk transfers (generally within the next few seconds).
- 3. Refrain, when possible, from caching large multi-track transfers. The amount of cache space used may displace a large number of smaller cache entries which, collectively, could be more valuable. Remember, the cache is only 256 Kbytes of RAM.

Do not specify read-ahead caching unless subsequent blocks will be needed soon. Read-ahead is usually useful when reading a few blocks of a file in the UNIX file system. In this case, it is likely that subsequent blocks will soon be needed.

Remember, equally important to knowing what to cache, is knowing what not to cache.

5.3.2 The Cache During Writes

Data being written to the disk is not entered into the cache, but is written directly to the disk. Of course, any cache elements corrupted by a write are removed automatically from the cache. Any caching parameters that might be left in command table location BA+1C would be ignored during a write. For this reason, the user may find it convenient to leave the caching parameters unchanged following a read, so that if the same parameters are desired for the next read, they need not be re-entered into the command table.

5.4 **Error Detection and Correction**

5.4.1 Background

The use of ECC (Error Control Codes) with disk drive subsystems is one technique that greatly increases the probability that partially corrupted data blocks can be completely recovered. By appending check bits to each data block written to the disk, the most common data errors can be detected and a large percentage of these can be corrected. In order to provide sufficient detection and correction capabilities, the VM31 controller employs a 48-bit polynomial.

In order to decrease the probability of miscorrection (the probability that the error exceeds the capabilities of the code), the corrupted block read from the disk should be reread in order to exclude the possibility of a soft error. Often, the data can be read successfully after a few retries so that correction is not required.

5.4.2 Recommended Implementation

The ECC capabilities of the VM31 controller are automatic and require no input from the host. The detection of errors is done in real time so there is no throughput degradation when ECC checking is enabled. If an error is detected, the controller automatically rereads the corrupted block until the data is read successfully or the maximum number of retries is reached. The number of retries before correction is attempted may be set by the user at boot time; the default is 8. If the rereads are unsuccessful, the controller attempts to correct the data using ECC. If the correction is successful, only a "soft" error is reported (error code 18H), otherwise an unsuccessful error code of 8AH is returned.

ECC should not be invoked to read data from a defective block on a regular basis - the data block should be remapped to some defect free portion of the disk at the earliest convenient time. Failure to do so will compromise the data accuracy and throughput capabilities of the disk drive subsystem.

Table A-1. Control Cable Pin Assignments

Signal Name	Signal Pin	Ground Pin
Tag 1 (Cyl)	1	31
Tag 2 (Hd sel)	2	32
Tag 3 (Control)	3	33
Bus bit 0	4	34
Bus bit 1	5	35
Bus bit 2	6	36
Bus bit 3	7	37
Bus bit 4	8	38
Bus bit 5	9	39
Bus bit 6	10	40
Bus bit 7	11	41
Bus bit 8	12	42
Bus bit 9	13	43
Open cable Det	14	44
Fault	15	45
Seek Error	16	46
On Cylinder	17	47
Index	18	48
Unit ready	19	49
Addr mark found	20	50
Busy (dual port)	21	51
Unit select tag	22	52
Unit select 0	23	53
Unit select 1	24	54
Sector	25	55
Unit select 2	26	56
Unit select 3	27	57
Write protected	28	58
Power pick	29	*
Power hold	59	*
Bus bit 10	30	60

Table A-2. Data Cable Pin Assignments

Signal Name	Signal Pin	Ground Pin
Servo clock	2	14
Read data	3	16
Read clock	5	17
Write clock	6	19
Write data	8	20
Seek end	10	23
Unit selected	22	9

The remaining pins are grounded at the controller.

COMMAND TABLE FORMAT FOR RESET DRIVE (90H)

Address Offset	31	Fiel 31 24 23 16				87 0	
BA+0:		Start/Done Code		# Retries		Error Code	
BA+4:		0000		IM		90	
BA+8:		0000			Offset Next CMD		
BA+C:		Mus	be set	to 00	000000		
BA+10:		Must be set to 00000000					
BA+14:		Unit #			000000		

COMMAND TABLE FORMAT FOR SET/REPORT DRIVE AND CONTROLLER PARAMETERS (20H/21H)

Address Offset	•	elds 6 15		87 0		
BA+0:	Start/Done Code		Error S	Status		
BA+4:	0000	IM	_	20/21		
BA+8:	0000	0000 Offset N				
BA+C:	Must be se	Must be set to 00000000				
BA+10:	Must be se	Must be set to 00000000				
BA+14:	0000		00	Param. #		
BA+18:	Parameter V	alue (re	eport/set)		
BA+1C:	2nd Param. Valu	2nd Param. Value (report only, #70)				
BA+20:	3rd Param. Value (report only, #70)					
BA+24	4th Param. Valu	e (repo	ort only,	#70)		

PARAMETERS FOR SET/REPORT DRIVE AND CONTROLLER COMMANDS

Param.	Name	Description
00H	hdsoft	OH for hard sectoring (default). 1H for soft sectoring.
04H	secsiz	0200H for 512-byte sectors. 0400H for 1024-byte sectors (default). 0800H for 2048-byte sectors.
0CH	funcod	address modifiers and LWORD value sent to the VMEbus during DMA (3D00H default).
10H	nrdrtry	maximum number of retries for read errors (08H default).
14H	nwrrtry	maximum number of retries for header errors during write operations (03H default).
18H	eccdis	ECC error retry disable. If nonzero, ECC errors on data are being ignored (default 00H).
1CH	diagnos	Diagnostic reporting desired (default 00H).
20H	intvect	VMEbus interrupt vector number (default EF2FH).
28H	headersync	Header sync byte (default F0H).
2CH	datasync	Data sync byte (default F0H).
40-43H	ncyl(0-3)	No. of cylinders on drive 0-3 (default 337H).
50-53H	nhd(0-3)	No. of heads on drive 0-3 (default 07H).
60-63H	nspt(0-3)	No. of sectors per track on drive 0-3 (default 22H).
70H	drvstat	Drive status bits (see manual).
80-84H	(spare)	Null command: for compatibility with VM21 controller (default 00H).
90H	boardadr	Board VMEbus base address (default 400H).
В0	Phytolog	Size in blocks of each page (default 01H).
C0	firmrev	Type of controller.
E0-EF	(spare)	Null command for compatibility with VM21.

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STANDARD COMMAND TABLE FORMAT

Address Offset	31			Fields 24 23 16 15				87	0
BA+0:	St	Start/Done Code			Error S	Status			
BA+4:		_		М	_	CMD#			
BA+8:		_		Offset Next CMD					
BA+C:		_			_	•			
BA+10:			-	_					
BA+14:	U	Unit # Sta		arting	Logical	Block			
BA+18:				_					

VM31 COMMAND DESCRIPTIONS

Command Number	Name and Function
00Н	Read from disk to contiguous RAM.
02H	Read from disk to scattered RAM.
04H	Write to disk from contiguous RAM.
06H	Write to disk from scattered RAM.
10H	Format tracks on the disk.
20H	Set controller and drive parameters from system.
21H	Report controller and drive parameters to system.
28H	Read media defects from Fujitsu 2333 drives.
72H	Test DMA circuitry by doing transfers to external memory (see manual).
90H	Reset drive recalibrating unit and clear all fault conditions.

VM3101-1804

COMMAND TABLE FORMAT FOR READ/WRITE TO CONTIGUOUS MEMORY (00H, 04H)

Address Offset	31 24 23		lds 15		87	0
BA+0:	Start/Done C	ode		Error S	Status	
BA+4:	# Read Cop	oies	IM		CMD #	
BA+8:	Reserved	I	C	Offset Next CMD		
BA+C:	Caching Mo	ode	#	# Blks Read-Ahead		
BA+10:	Mus	t be set	to 00	000000		
BA+14:	Unit #	Sta	arting	Logical	Block	
BA+18:	Number	of Blocks	to b	e Transfe	erred	
BA+1C:	1st Star	1st Starting Address for Transfer				
BA+20:	2nd Sta	2nd Starting Address for Transfer				
		el	tc.			

COMMAND TABLE FORMAT FOR READ/WRITE TO SCATTERED MEMORY (02H, 06H)

Address Offset	31	24 23		lds 15	;	87	0
BA+0:		Start/Done C	ode		Error S	Status	İ
BA+4:	Must be set to 0			IM		CMD #	
BA+8:		Reserved			Offset Next CMD		
BA+C:		Caching Mode			# Blks Read-Ahead		
BA+10:		Compleme	nt of Sc	atter .	Address	Mask	
BA+14:		Unit # Starting Logical Block				Block	
BA+18:		Number of Blocks to be Transferred "N"					
BA+1C:		RAM Addr	ess of S	catte	Addres	s List	

COMMAND TABLE FORMAT FOR FORMAT TRACKS (command 10H)

Address Offset	31 24	23	Fie 16	lds 15	;	87	0
BA+0:	Start/Dor	ne Code	Э		Error S	Status	
BA+4:			IL	IM	_	10	
BA+8:	000	00		Offset Next CMD			
BA+C:		Must be set to 00000000					
BA+10:		Must be	e set	to 00	000000		
BA+14:	Unit #		Sta	arting Logical Block			
BA+18:	Numi	ber of E	Block	s to b	e Forma	tted	
BA+1C:	отн	18	Т	2	ND	3RD	
BA+20	4TH	4TH 5TI			Hetc. (if IL=1)		

COMMAND TABLE FORMAT FOR REPLACING A BAD TRACK (command 10H)

Address Offset	31 24 23	lds 15		87	0	
BA+0:	Start/Done (Code		Error Status		
BA+4:	0002		ІМ	_	10	
BA+8:	0000		C	Offset Next CMD		
BA+C:	Must be set to 00000000					
BA+10:	Must be set to 00000000					
BA+14:	Unit #	Unit # Starting Block of Bad Track				
BA+18:	Size of Bad Track, in Blocks					
BA+1C:	Cyl # of Repl	l. Trk.	He	ad # of I	Repl. Trk.	

COMMAND TABLE FORMAT FOR READ DEFECT (28H)

Address Offset	31	Fields 31 24 23 16 15 87					
Offiset	31	24 23	10	10		87	0
BA+0:		Start/Done C	ode	# F	Retries	Error Co	de
BA+4:		Must be set	to 0	IM	_	28	
BA+8:		Reserved	1	Offset Next CMD			
BA+C:		Mus	t be set	to 00	000000		
BA+10:		Mus	t be set	to 00	000000		
BA+14:		Unit #	Unit # First Block of Start Trk			art Trk	
BA+18:		Ignored					
BA+1C:		Starting	RAM Ad	dr fo	Read D	ata	

ERROR STATUS CODES RETURNED (BA+0, Bits 7-0)

Code	Fatal Errors (Bit 7=1)
82H	Bad arguments (incorrect drive #).
83H	Drive would not select.
84H	Drive not ready.
85H	Seek error.
86H	Seek timeout.
87H	Fault occurred on drive.
88H	Attempt to write on protected drive.
89H	Bad header on wanted data sector.
8AH	No or bad data on wanted sector; not fixed by ECC.
8BH	Header not found on wanted data sector.
8CH	Timeout on DMA transfer completion.
8DH	VMEbus error during DMA transfer.
8EH	Timeout on format completion.
90H	Parity Error on internal RAM.
91H	AC power failure reported on VMEbus.

Code	Non-Fatal Errors (Bit 7=0)
05H	Seek error, recovered after retry(s).
06H	Seek timeout, recovered after retry(s).
07H	Fault occurred, recovered after retry.
09H	Bad, but recoverable header on wanted sector.
0AH	Bad, but recoverable data on wanted sector.
0BH	Header not found on wanted data sector, recovered.
10H	Parity error in internal RAM, can be re-loaded.
18H	Bad data on wanted sector but corrected by ECC.
20H	Board was just reset. All parameters must now be initialized by the host. Normal on power-up, but indicates a serious problem at any other time.

COMMAND TABLE FORMAT FOR RESET DRIVE (90H)

Address Offset	31	24 23		lds 15		87 0		
BA+0:		Start/Done Code		Start/Done Code		# Retries		Error Code
BA+4:		0000		IM	_	90		
BA+8:		0000 Offset Next (ext CMD			
BA+C:		Must	be set	to 00	000000			
BA+10:		Must be set to 00000000						
BA+14:		Unit #			000000			

COMMAND TABLE FORMAT FOR SET/REPORT DRIVE AND CONTROLLER PARAMETERS (20H/21H)

Address Offset	31	24 23	Fie 16	lds 15		87	0	
BA+0:	SI	Start/Done Code			Error S	Status		
BA+4:		0000			_	20/21		
BA+8:		0000		Offset Next CMD				
BA+C:		Must be set to 00000000						
BA+10:		Must be set to 00000000						
BA+14:		0000		00		Param. #	,	
BA+18:		Paramet	er Val	ue (re	eport/set))		
BA+1C:		2nd Param.	Value	(repo	ort only,	#70)		
BA+20:		3rd Param.	Value	(repo	ort only, a	#70)		
BA+24		4th Param.	Value	(repo	rt only, #	¥70)		

PARAMETERS FOR SET/REPORT DRIVE AND CONTROLLER COMMANDS

Param.	Name	Description
00H	hdsoft	OH for hard sectoring (default). 1H for soft sectoring.
04H	secsiz	0200H for 512-byte sectors. 0400H for 1024-byte sectors (default). 0800H for 2048-byte sectors.
0CH	funcod	address modifiers and LWORD value sent to the VMEbus during DMA (3D00H default).
10H	nrdrtry	maximum number of retries for read errors (08H default).
14H	nwrrtry	maximum number of retries for header errors during write opera- tions (03H default).
18H	eccdis	ECC error retry disable. If nonzero, ECC errors on data are being ignored (default 00H).
1CH	diagnos	Diagnostic reporting desired (default 00H).
20H	intvect	VMEbus interrupt vector number (default EF2FH).
28H	headersync	Header sync byte (default F0H).
2CH	datasync	Data sync byte (default F0H).
40-43H	ncyl(0-3)	No. of cylinders on drive 0-3 (default 337H).
50-53H	nhd(0-3)	No. of heads on drive 0-3 (default 07H).
60-63H	nspt(0-3)	No. of sectors per track on drive 0-3 (default 22H).
70H	drvstat	Drive status bits (see manual).
80-84H	(spare)	Null command: for compatibility with VM21 controller (default 00H).
90H	boardadr	Board VMEbus base address (default 400H).
B0	Phytolog	Size in blocks of each page (default 01H).
C0	firmrev	Type of controller.
E0-EF	(spare)	Null command for compatibility with VM21.

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STANDARD COMMAND TABLE FORMAT

Address Offset	31 24 23	Field 16 1			87	0
BA+0:	Start/Done (Code		Error S	status	
BA+4:			IM	-	CMD#	
BA+8:	_		Offset Next CMD			
BA+C:	_					
BA+10:		_				
BA+14:	Unit #	Star	ting	Logical	Block	
BA+18:		_			-	

VM31 COMMAND DESCRIPTIONS

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Command Number	Name and Function
00Н	Read from disk to contiguous RAM.
02H	Read from disk to scattered RAM.
04H	Write to disk from contiguous RAM.
06H	Write to disk from scattered RAM.
10H	Format tracks on the disk.
20H	Set controller and drive parameters from system.
21H	Report controller and drive parameters to system.
28H	Read media defects from Fujitsu 2333 drives.
72H	Test DMA circuitry by doing transfers to external memory (see manual).
90H	Reset drive recalibrating unit and clear all fault conditions.

VM3101-1804

COMMAND TABLE FORMAT FOR READ/WRITE TO CONTIGUOUS MEMORY (00H, 04H)

Address Offset	31	24 23		lds 15	i	87	0
BA+0:	s	tart/Done C	ode		Error S	Status	
BA+4:	#	# Read Cop	ies	IM	_	CMD #	
BA+8:		Reserved		C	Offset Ne	xt CMD	
BA+C:		Caching Mo	de	#	# Blks Read-Ahead		
BA+10:		Mus	t be set	to 00	000000		
BA+14:		Unit #	St	arting	Logical	Block	
BA+18:		Number o	f Blocks	to b	e Transfe	erred	
BA+1C:		1st Star	ting Add	ress	for Trans	fer	
BA+20:		2nd Star	ting Add	dress	for Trans	sfer	
			е	tc.			

COMMAND TABLE FORMAT FOR READ/WRITE TO SCATTERED MEMORY (02H, 06H)

Address Offset	31	24 23	• •	elds 15		87	0
BA+0:		Start/Done C	ode		Error S	Status	
BA+4:		Must be set to 0			_	CMD #	
BA+8:		Reserved			Offset Next CMD		
BA+C:	Caching Mode			#	Biks Rea	ad-Ahead	
BA+10:		Compleme	nt of So	atter.	Address	Mask	
BA+14:		Unit #	s	tarting	Logical	Block	
BA+18:		Number of I	Blocks t	o be 1	Fransferre	ed "N"	
BA+1C:		RAM Addr	ess of S	Scatte	r Addres	s List	

COMMAND TABLE FORMAT FOR FORMAT TRACKS (command 10H)

Address Offset	31	24	23	Fie 16	lds 15	i	87	0
BA+0:		Start/Done Code				Error S	status	
BA+4:		_		IL	IM	_	10	
BA+8:		0000			C	Offset Next CMD		
BA+C:		1	Must b	e set	to 00	000000		
BA+10:		1	Must b	e set	to 00	000000		
BA+14:		Unit #		Sta	arting	Logical	Block	
BA+18:		Numi	ber of I	Block	s to b	e Forma	tted	
BA+1C:		отн	18	Т	2	2ND	3RD	
BA+20		4TH	5TH etc. (if IL=1)					
	L							_

COMMAND TABLE FORMAT FOR REPLACING A BAD TRACK (command 10H)

Address Offset	31	31 24 23		lds 15	87		0
BA+0:		Start/Done Code			Error Status		
BA+4:		0002		М	1	10	
BA+8:		0000			Offset Next CMD		
BA+C:		Mus	t be set	to 00	000000		
BA+10:		Mus	t be set	to 00	000000		
BA+14:		Unit #	Starti	ng Bl	ock of B	ad Track	
BA+18:		Size o	of Bad Tr	ack,	in Blocks	3	
BA+1C:		Cyl # of Repl	. Trk.	He	ad # of	Repl. Trk.	

COMMAND TABLE FORMAT FOR READ DEFECT (28H)

Address		Fields						
Offset	31	24 23	16	15		87	0	
BA+0:		Start/Done Cod	е	# F	Retries	Error C	ode	
BA+4:		Must be set to	0	IM	_	28		
BA+8:		Reserved			Offset Next CMD			
BA+C:		Must be set to 00000000						
BA+10:		Must be set to 00000000						
BA+14:		Unit # First Block of Start Trk						
BA+18:		Ignored						
BA+1C:		Starting RAM Addr for Read Data						

ERROR STATUS CODES RETURNED (BA+0, Bits 7-0)

Code	Fatal Errors (Bit 7=1)
82H	Bad arguments (incorrect drive #).
83H	Drive would not select.
84H	Drive not ready.
85H	Seek error.
86H	Seek timeout.
87H	Fault occurred on drive.
88H	Attempt to write on protected drive.
89H	Bad header on wanted data sector.
8AH	No or bad data on wanted sector; not fixed by ECC.
8BH	Header not found on wanted data sector.
8CH	Timeout on DMA transfer completion.
8DH	VMEbus error during DMA transfer.
8EH	Timeout on format completion.
90H	Parity Error on internal RAM.
91H	AC power failure reported on VMEbus.

Code	Non-Fatal Errors (Bit 7=0)
05H	Seek error, recovered after retry(s).
06H	Seek timeout, recovered after retry(s).
07H	Fault occurred, recovered after retry.
09H	Bad, but recoverable header on wanted sector.
0AH	Bad, but recoverable data on wanted sector.
0BH	Header not found on wanted data sector, recovered.
10H	Parity error in internal RAM, can be re-loaded.
18H	Bad data on wanted sector but corrected by ECC.
20H	Board was just reset. All parameters must now be initialized by the host. Normal on power-up, but indicates a serious problem at any other time.



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