MVME360/D2

MVME360
SMD Disk Controller
User's Manual

MOTOROLA INC.

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MVME360

SMD DISK CONTROLLER

USER'S MANUAL

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PREFACE

This manual contains the Interphase Corporation V/SMD 3200 SMD High-performance VMEbus Storage Module Device (SMD) Disk Controller User's Guide, document number UG-0490-000-010.

Note: MVME360 is the Motorola part number for the V/SMD 3200.

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PREFACE

This User's Guide is intended to be a reference document for users who already have a general understanding of the function of disk controllers, a general knowledge of the VERSAmodule European (VME) standard, and a familiarity with disk drives. The following information is provided:

Section 1 - Introduction to the V/SMD 3200

Section 2 - Utilization of VMEbus Facilities

Section 3 - V/SMD 3200 Operation

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SECTION 1

INTRODUCTION TO THE V/SMD 3200

OVERVIEW

The V/SMD 3200 is an extremely fast, intelligent, Storage Module Device (SMD) controller/formatter used to interface VMEbus-based systems to SMD compatible disk drives. The V/SMD 3200 can support any combination of two drives, including dual ported drives. In addition, with an optional cable expander card, a single V/SMD 3200 can control four disk drives. Its intelligence is based on a M68000 16/32 bit microprocessor running with no wait states. The real key to the V/SMD 3200, however, is its multitasking, Virtual Buffer Architecture (SM).

The V/SMD 3200 achieves a throughput far superior to that of any competitive controller by using two bipolar state machines to manage the high-speed data streams. These state machines operate independently, allowing simultaneous data movement between the V/SMD 3200 and the disk drive as well as the VMEbus. One manages data movement between the V/SMD 3200 and the VMEbus. The other manages data movement between the V/SMD 3200 and the disk drive(s).

VIRTUAL BUFFER ARCHITECTURE

The M68000, running under a proprietary multitasking real time firmware operating system, is used to regulate activity on the controller such as sequencing commands and setting up data transfer operations. Its most important function, however, is to manage the pool of virtual buffers. The V/SMD 3200 has 16 Kbytes of RAM of which most is used as a series of sector buffers.

At any given time individual buffers may be allocated to either the disk, the VMEbus, or the cache. The 68000 microprocessor will dynamically allocate and deallocate buffers as they are requested or released by the VMEbus or the disk. During a disk read, for example, the disk read task brings data into a free buffer Simultaneously, as soon as any sector of interest has been captured, the bus write task begins moving data into system memory; thus the sector buffer is freed. If the VMEbus cannot keep up with the drive, the buffers will hold the data until the bus is ready. The buffer thus prevents either overrun or underrun of data. At some point, other tasks such as command processing, caching, housekeeping, and others are running. This environment creates a pool of virtual buffers that is effectively much larger than the physical memory, much the same way that a virtu memory appears to an application program to be unlimited.

The V/SMD 3200 is able to apply certain techniques which can reduce or eliminate disk rotational latencies. These methods include zero latency reads and writes, an caching.

ZERO LATENCY

A traditional controller, upon receiving a multisector request from the operating system, will wait until it encounters the first required sector before beginning to read and transfer the data. Thus, it will incur an average rotational latency equivalent to one half of one track. If the request is for a full track of data, even with a 1:1 interleave factor, the traditional controller will take an average of one and one half revolutions to accomplish the transfer.

In contrast, the V/SMD 3200 begins reading data as soon as the heads land on the track (i.e., zero rotational latency) and begins transferring data as soon as it encounters a sector of interest; it does not wait to rotate around to the beginning o the requested string. In this manner, the V/SMD 3200 will never require more tha a single revolution to transfer an entire track of data.

Zero latency writes are accomplished using the same principle. This technique is most effective for large disk transactions which may access many sectors of data per transaction.

PREFETCH CACHING

To further reduce latency, the V/SMD 3200 also uses an intelligent caching scheme (prefetch caching) to anticipate which data sectors will be requested next. When the V/SMD 3200 has completed a read operation and has transferred the requested data, it will continue to read sectors into the cache until all available buffers have been filled, or until it receives a command from the host requesting a head movement. Thus, if subsequent requests from the operating system are for sectors logically contiguous with the previous sectors, these requests can be satisfied directly from the cache without having to access the disk. In disk intensive applications this can greatly improve overall system throughput.

This form of caching is particularly useful for UNIX™ and UNIX-like operating systems. Tests have shown improvements in disk operation averaging greater than 40 percent over operation with 1:1 interleave only. Caching shows the greatest improvement when disk activity is characterized by a large number of short transactions.

V/SMD 3200 FEATURES AND FUNCTIONS

The V/SMD 3200 provides many options which are either under software control or are mechanically selectable by switch or jumper. For example, sector sizes are programmable varying from 128 bytes to 2048 bytes. The most important features and functions of the V/SMD 3200 are outlined below.

- The V/SMD 3200 is controlled using a simple macro-level software interface.

- The on-board M68000 16/32 bit microprocessor relieves the system CPUs of disk handling tasks.

- The V/SMD 3200 supports 8-, 16-, or 32-bit wide data transfers, and provides 16-, 24-, or 32-bit addressing capability.

- 16 Kbytes of memory is provided; most of which is treated as a pool of virtual buffers.

- The V/SMD 3200 supports disk data rates up to 24 Mb/s with a 1:1 interleave factor.

- Virtual Buffer Architecture reduces or eliminates data transfer delays caused by disk rotational latency and data overrun/underrun.

- A prefetch caching scheme with dynamic buffer allocation and deallocation is provided. Caching algorithms are optimized for UNIX, RMX™/86 and similar operating systems.

- The V/SMD 3200 can control two SMD drives (same or different).

- An optional cable expander card enables a single V/SMD 3200 to control up to four disk drives.

- Automatic error correction is provided using a 32-bit error correction code (ECC).

- Self-diagnostics are performed after each hardware power-up and each software reset.

- Overlapped and implied seeks are supported.

- Seven software programmable interrupt levels are provided.

RMX/86 is a registered trademark of Intel Corporation.

- Bus priority is jumper selectable from zero to three.
- Defective media replacement on a sector or track basis is provided when formatting the disk.
- The disk can be addressed by either physical or logical sectors.
- Zero latency reads and writes insure maximum throughput.
- An interrupt on drive status change is a programmable option for such applications as overlapped seeks.
- Multiple interrupt vectors provide fast interrupt handling.
- Data prefetch during seek time shortens the disk write time.
- Scatter/Gather comands allow the user to place contiguous disk data in noncontiguous areas of system memory or vice versa.

SECTION 2

UTILIZATION OF VMEbus FACILITIES

INTRODUCTION

The evolution of control applications from 8- and 16-bit buses was culminated in the development of the VMEbus. The VMEbus is the first bus structure to support a true 32-bit processor. It is comprised of separate 32-bit data and address lines that not only support 32-bit transactions, but also the traditional 8- and 16-bit transactions as well. This makes the VMEbus particularly appropriate for stand-alone or remote process controller applications. In addition, the VMEbus provides the flexibility for expansion within the microcomputer environment. Given all of these advantages, the V/SMD 3200 is able to exploit the potential of the VMEbus and provide performance necessary in today's systems.

VMEbus STRUCTURE

There are three basic signals which determine the operation of the VMEbus: the Bus Request signal (for getting on the bus), the Bus Grant signal (for allocating the bus for use), and 32 bits of addressing. The addressing is supplemented with six address modifier bits which are used to partition memory spaces. The address modifiers are used to expand memory space by breaking it up into functional blocks.

The VMEbus has seven prioritized interrupts for fully vectored operation. This means that during an interrupt cycle, an interrupt vector provides the CPU with a unique value that describes the interrupt. In nonvectored systems, the CPU must search registers for the cause of the interrupt. The advantage of the vectored interrupt, therefore, is to greatly decrease the amount of time the CPU must spend servicing interrupts.

DATA TRANSFERS

All VMEbus data transfers are performed over the Data Transfer Bus (DTB). The DTB is 32 bits wide and is only used for data transfers. The VMEbus supports data transfers of eight, 16, or 32 bits. All data transfers take place between a bus master and a bus slave. The VMEbus supports multiple bus masters which provides the capability of moving large blocks of data without CPU intervention; thus, the CPU is not tied up for long periods of time during data transfers.

The V/SMD 3200 uses the DTB to transfer commands, status and data between the host system, disk drive, and itself. The V/SMD 3200 supports 8-, 16-, and 32-bit data transfers.

BUS MASTER

A DTB master can be any board that is capable of requesting the VMEbus. The V/SMD 3200 performs all data transfers as a DTB master.

BUS SLAVE

A bus slave is a device that responds to the DTB master during data transfers. When commands are issued to the V/SMD 3200, or status is read from the board, the V/SMD 3200 is acting as a slave device.

DATA TRANSFER OPERATIONS

During a data transfer cycle several things must happen. First, a bus master must request and be granted the bus. The master then puts the address of the slave to which the data will be transferred on the bus, and if it is a write operation, the data is also put on the bus. Since the VMEbus is completely asynchronous, the master must know when the address is valid and if the slave has either received the data or is ready for more data.

Once the address is valid, the master asserts an Address Strobe signal. Then, the master commands the data on the DTB bus with the Data Strobes. That tells the slave that the address is valid and the data is directed at that particular slave. Once the slave has received the data (write operation) or placed the data on the bus (read operation), the slave tells the master that the transfer is complete. To do this, the slave asserts a signal called Data Transfer Acknowledge (DTACK).

There are no restrictions on the VMEbus as to how long data transfers can be. The only real restriction is that address strobe must precede data strobe.

To start a command, a bus master (typically a CPU) will issue commands to the V/SMD 3200 which is acting as a bus slave. After the V/SMD 3200 has received the command and responded to it, it will then request the VMEbus, and when the bus is granted, the V/SMD 3200 will transfer the data as a bus master.

VMEbus ADDRESSING

The memory space accessible to the V/SMD 3200 and the host CPU contains several subdivisions. Each subdivision requires a specific type of addressing. This partitioning of the memory space allows more efficient access and utilization of the memory. The addressing options include:

- Short Addressing (16-bit)
- Standard Addressing (24-bit)
- Extended Addressing (32-bit)

The type of addressing is specified using a six-bit address modifier code that also indicates the nature of the access. For example, address modifiers are commonly used to specify supervisory (restricted) memory access, and user (nonprivileged) memory access. The V/SMD 3200 supports 16-, 24-, and 32-bit addressing as well as all address modifiers (as a bus master).

Short I/O

The V/SMD 3200 requires that all data transfers of control information, command parameters, and status that occur with the host CPU acting as the bus master must be done through the short address space using either address modifiers 29 (user) or 2D (supervisor). This short address space is commonly referred to as short I/O space. (A 512-byte block of this address space resides in the V/SMD 3200 on-board RAM.)

The Short I/O is the window through which the host can send commands and parameters, and can review controller status and error codes. The reason that it is called short I/O space is because anytime a board sees a transaction with an address modifier of 29 or 2D in the address strobe, it only looks at the first (lower) 16 address lines even though the VMEbus supports the full 32 address lines. The upper 16 address lines in short I/O are ignored.

By looking only at the lower 16 address lines, less hardware is needed and less time is spent decoding lines that are not necessary for functions such as reading command registers and status registers. The obvious result is improved performance and reduced cost.

The base address of this block of memory is set by the on-board DIP switches (see section 5).

The V/SMD 3200 provides short I/O space on-board as an added feature for improved performance. The 512 bytes of Short I/O provided, can accomodate several commands at once. This proves advantageous to system performance by eliminating the need to DMA every command across the bus. So not only is system performance improved, but bus bandwidth is also conserved.

NOTE

Short I/O space limitations dictate that all accesses be either eight or 16 bits. Therefore, if the CPU card generates a 32-bit data path and you are using the C programming language, then it is necessary to cast the 32-bit IOPB fields (i.e., buffer address and bytes/sector) as two 16-bit data types (unsigned shorts on MC68020). This is because the VMEbus short I/O space is 16 bits and will not respond properly to high-order data strobes.

ARBITRATION

At some point, either on its own or when it receives a command, every bus master device needs to get on the VMEbus and must request access. This process of requesting and granting the bus is referred to as bus arbitration.

The VMEbus provides four levels of bus request (0-3) to provide prioritized requests. In addition, bus priority is provided by position of the board in the card cage. The closer the board is to slot one (system controller), the higher priority it is given.

The V/SMD 3200 bus request priority is selectable via on-board jumpers. The factory setting is bus priority 3.

This system of prioritizing means that if two devices with the same priority simultaneously request the bus, the one closest to the system controller is granted bus access first. However, before any bus grant can be issued, the bus must first be cleared (i.e., the current bus master must release the Bus Busy signal).

A VMEbus system may utilize one of three different schemes of bus arbitration based on the two methods of prioritizing bus requests. The first method is called single level arbitration. In this scheme, every device on the bus is assigned the same priority level (e.g., level 3), and the bus requests are prioritized by slot only. This scheme is most useful in low-cost systems where the system controller is on the CPU board. In addition, it takes fewer gates to implement and is less expensive than the other two methods of arbitration. However, the remaining two options offer higher performance than single level arbitration.

The second type is called priority arbitration. Priority arbitration utilizes a signal called Bus Clear. When the system controller sees a request from a higher priority than the one already on the bus, the system controller drives the Bus Clear signal which is a recommendation to the bus master to get off of the bus. When the V/SMD 3200 receives a bus clear, it will get off of the bus within two bus cycles. This provides better system performance by allowing the V/SMD 3200 to be run at a low priority level and still not worry about it "hogging" the bus.

Finally, the third type of arbitration is called round robin. With this type, there is no fixed priority based on level (i.e., three is not always the highest priority). Instead, priority is determined in a cyclical fashion. In other words, if a priority three is on the bus, the next bus grant will be given to priority two (even if another priority three is present), the next will be given to a priority one and the next to a zero and then back to three. It is useful in a system that is using many similar devices. For example, if four disk controllers are on the backplane and all need equal access to the bus, the need for "position" priority is eliminated. In this scheme, each board will have equal access regardless of board position.

The V/SMD 3200 supports all three types of arbitration.

PRIORITY INTERRUPTS

Interrupts are a convenient way for a bus master to tell the CPU that it needs to communicate with another device across the bus. The VMEbus supports seven levels of interrupts with seven being the highest and one being the lowest. The interrupt operation is very similar to the bus grant operation, except the signals involved are the interrupt request from the board and the Interrupt Acknowledge (IACK) signal from the system controller. Each V/SMD 3200 command can be programmed with any one of the seven interrupt levels.

As in arbitration, interrupts are also prioritized by slot position. Therefore, if multiple boards request interrupts, the system controller drives the IACK signal and it is passed along serially by each board in the system until the interrupting board reads it.

INTERRUPT OPERATION

After reading a file, a disk controller may want to tell the CPU that it (the CPU) may now use that data. The disk controller gives up the bus and generates the interrupt request on the specified interrupt level. At some point, when the bus is clear, the system controller passes down the IACK signal. When the board that generated the interrupt reads the signal, it responds by issuing an interrupt vector

(if enabled). An interrupt vector describes the interrupt to the system controller. When the interrupt vector is valid on the bus, the CPU is in master mode, and the interrupting device will respond with a data acknowledge signal. This tells the system controller it has the vector for the CPU.

The V/SMD 3200 supports unique error codes and vectors for several different types of operation. In addition, a different vector can be used to indicate normal completion or completion with error. This can significantly reduce system overhead by instanly identifying the status of each command as it is completed.

The V/SMD 3200 has a separate status change interrupt and vector to facilitate interrupt processing during overlapped seek operations. Because a unique vector can be used, the system can immediately identify the source of the interrupt with a minimum of processing.

By using unique vectors, the system driver does not need to access registers to take care of post-interrupt activity. Instead, the vector can tell the host exactly what happened, so the host can proceed without any further delay.

SECTION 3

V/SMD 3200 OPERATION

INTRODUCTION

A typical command might request that the V/SMD 3200 perform a disk function, such as READ or WRITE one or more sectors of data into or out of the disk and host memory. All disk functions have an extended list of parameters that defines the exact function for the V/SMD 3200. This list is called the Input/Output Parameter Block (IOPB).

In addition to the IOPB, the V/SMD 3200 has two 16-bit READ/WRITE registers for communicating commands and statuses between the V/SMD 3200 and the host. The Drive Status register contains 16 bits of data which are used to indicate the status of the two drives. The Command/Status register contains all of the bits used by the host CPU to begin a transaction. It also contains the bits required to indicate the condition of the V/SMD 3200 to the host CPU.

HOW TO ISSUE A COMMAND

To initiate a disk function, the host must first build an IOPB and then write a GO command to the Command/Status register (CSR). A READ MODIFY WRITE operation (without releasing the bus) should be performed when setting the GO bit. This ensures that the status of the other bits in the CSR can be maintained. This bit should not be used as a semaphore between multiple host CPUs even if a READ MODIFY WRITE operation is performed.

The V/SMD 3200 does necessary seeking, handles error corrections, and performs the direct memory access (DMA) required to complete the command. The V/SMD 3200 will then automatically update the IOPB, the CSR, and will freeze the Drive Status register. At this time, the V/SMD 3200 will also issue a system interrupt if enabled to do so.

Interrupts

Interrupts are used to signal the host CPU that the current command has been completed or status has changed (if enabled); therefore, the host does not have to continuously monitor the V/SMD 3200. The interrupt vectors contain numbers previously defined by the host CPU which identify the type of interrupt that has occurred, such as error on last command or command completed normally. The host can then read the updated status and appropriate information in the IOPB. The interrupt signal is taken off the bus when the interrupt acknowledge cycle is performed in accordance with VME specifications.

The OPERATION DONE bit in the Command/Status register must be cleared by the host to let the V/SMD 3200 know that the interrupt has been serviced and that it can begin updating the Drive Status register. Clearing the OPERATION DONE bit should be a READ MODIFY WRITE operation. A sample of this transaction is displayed as a flowchart in Figure 1. The user may wish to review the flowchart briefly at this point, and refer back to it after reading the subsequent sections of the user's guide.

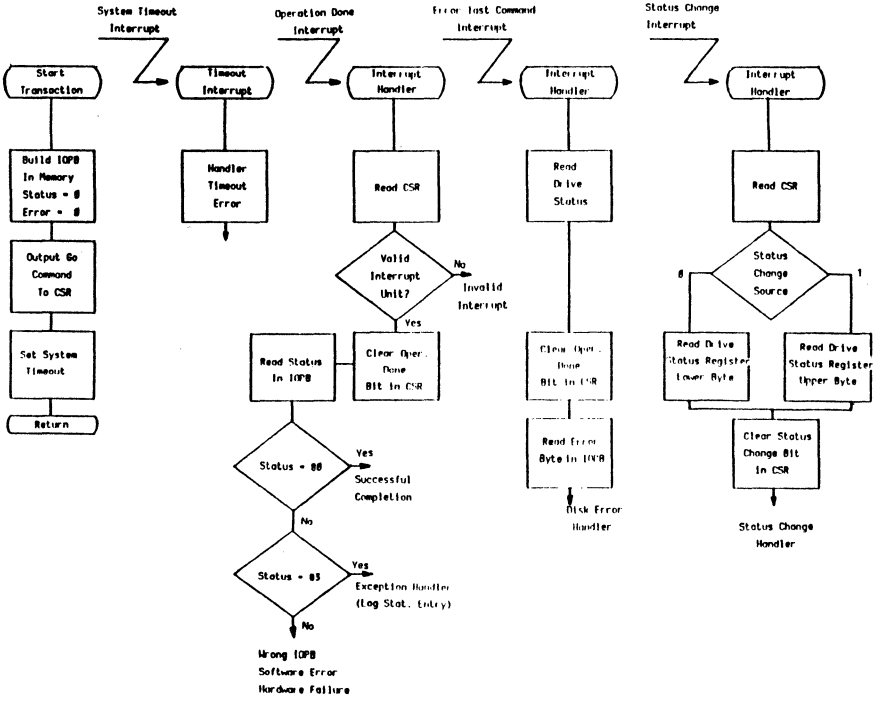


Figure 1. Operation Flowchart

IOPB and I/O Registers

Th host CPU stores the IOPB and the two I/O registers as a 32-byte block of data in the short I/O space. The base address of this block of memory is set by the on-board DIP switches (see section 5). The Drive Status register always resides at the base address. The Command/Status register resides at the base address plus two, and the IOPB resides at the base address plus four. The V/SMD 3200 will only respond to commands when an IOPB exists at this address. Access to these memory locations can be done on either a byte or word basis. Table 1 displays the memory locations of the IOPB and the status registers.

Table 1 - Memory Location of IOPB and I/O Registers

ADDRESS	OFFSET (HEX)		CONTENTS	IOPB WORD (DEC)
BASE ADDRESS	+00	---->	DRIVE STATUS REGISTER	N/A
BASE ADDRESS	+02	---->	COMMAND/STATUS REGISTER	N/A
BASE ADDRESS	+04	---->	COMMAND CODES AND OPTIONS	0
BASE ADDRESS	+06	---->	STATUS & ERROR CODES	1
BASE ADDRESS	+08	---->	CYLINDER ADDRESS	2
BASE ADDRESS	+0A	---->	HEAD & SECTOR NUMBER	3
BASE ADDRESS	+0C	---->	SECTOR COUNT	4
BASE ADDRESS	+0E	---->	BUFFER ADDRESS	5
BASE ADDRESS	+10	---->	BUFFER ADDRESS	6
BASE ADDRESS	+12	---->	MEMORY TYPE/ADDRESS MODIFIER	7
BASE ADDRESS	+14	---->	OPT. DRIVE #/INT. LEVEL & VECTOR	8
BASE ADDRESS	+16	---->	DMA COUNT/ERROR INT. VECTOR	9
BASE ADDRESS	+18	---->	IOPB ADDRESS POINTER	10
BASE ADDRESS	+1A	---->	IOPB ADDRESS POINTER	11
BASE ADDRESS	+1C	---->	IOPB MEMORY TYPE/ADDR. MOD.	12
BASE ADDRESS	+1E	---->	ABSOLUTE SKEW/ENTRY COUNT	13
BASE ADDRESS		---->		
BASE ADDRESS		---->		
BASE ADDRESS		---->		
BASE ADDRESS	+1FA	---->	UNIT 3 & 2 STATUS (4 unit operation only)	
BASE ADDRESS	+1FC	---->	UNIT 1 & 0 STATUS (4 unit operation only)	
BASE ADDRESS	+1FE	---->	OPTIONAL STATUS CHANGE REGISTER	

STATUS REGISTERS

The V/SMD 3200 has two status registers which are used to communicate information from the V/SMD 3200 to the host system. These registers are, the Drive Status register and the Command/Status register. The Drive Status register resides at the base address and the Command/Status register resides at the base address plus two in V/SMD 3200 short I/O memory space.

DRIVE STATUS REGISTER

The Drive Status register contains two identical bytes which represent the status of the drive(s). The status of the drive connected as unit 0 is in the lower byte, while the unit 1 status is displayed in the upper byte.

The format of the Drive Status register as used with two unit operation is displayed below in Figure 2 (see the note below for details of four unit operation). The information residing in the two drive status bytes is tabulated in Table 2 on the following page.

UNIT 1 BIT #								UNIT 0 BIT #							
UPPER BYTE								LOWER BYTE							
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Figure 2. Drive Status Register Format

NOTE

When four unit operation is selected, the format of the Drive Status Register does not change. However, its location in memory and the number of drives reported is affected as follows:

	MSB	LSB
Base Address +506 (1FA hex)	Unit 3 Status	Unit 2 Status
Base Address +508 (1FC hex)	Unit 1 Status	Unit 0 Status

Table 2 - Drive Status Register Bit Descriptions

UNIT 1 Bit #	UNIT 0 Bit #	BIT DESCRIPTION
15	7	UNIT READY
14	6	UNIT PRESENT (selectable)
13	5	SEEK ERROR
12	4	ON CYLINDER
11	3	FAULT
10	2	DRIVE BUSY (Dual ported drives only)
9	1	WRITE PROTECTED
8	0	DRIVE READY

NOTE

These status bits are constantly updated until they are frozen by the occurrence of an interrupting condition. They remain frozen until the interrupting condition is cleared.

The bits of the Drive Status register are either a direct reflection of the drive status, or they are calculated by the controller based on the drive status indicators. If a '1' is returned, then the status bit is set, if a '0' is returned, then the status bit is not set (for example, if a '0' is returned in the "WRITE PROTECTED" field, then the track is not write protected).

UNIT READY (UR): This bit is calculated by the controller. If '1', the drive is ready, on cylinder, and no fault conditions or seek errors have been detected.

UNIT PRESENT (UP): This bit is asserted by the controller. If '1', the drive unit has responded to a select sequence.

SEEK ERROR (SE): This signal originates at the drive. If '1', an error occurred while moving the heads during a SEEK. The head position is unknown when this occurs. To clear the error, issue a CLEAR DRIVE FAULT command or a RESTORE command.

ON CYLINDER (OC): This signal originates at the drive. If '1', the read/write heads are positioned over a track, and READS or WRITES can proceed.

FAULT (F): This signal originates at the drive. If '1', the drive has experienced something which caused it to go into a fault condition. All reading and writing is disabled until the fault is cleared. To clear the fault, issue a CLEAR DRIVE FAULT command or a RESTORE command

DRIVE BUSY (DB): This signal originates at the drive. If '1', this signal indicates that the drive is busy with another controller. BUSY is used only with dual ported drives.

WRITE PROTECTED (WP): This signal originates at the drive. If '1', the drive is write protected and must be write enabled before formatting or writing data to disk may proceed.

DRIVE READY (DR): This signal is supplied by the drive. If '1', the drive is spun up (up to speed) and is ready to SEEK, READ or WRITE.

COMMAND/STATUS REGISTER

The Command/Status register contains all of the control bits used by the host CPU to initiate commands in the V/SMD 3200. It also contains the bits required to indicate the condition of the V/SMD 3200 to the host CPU. The CSR is located at the base address plus two in the short I/O space of the controller.

The format of the Command/Status register is shown in Figure 3. All bits can physically be both written and read by the host, but some of the bits are logically read only or write only. When bit type operations are being performed, a READ MODIFY WRITE operation should be used.

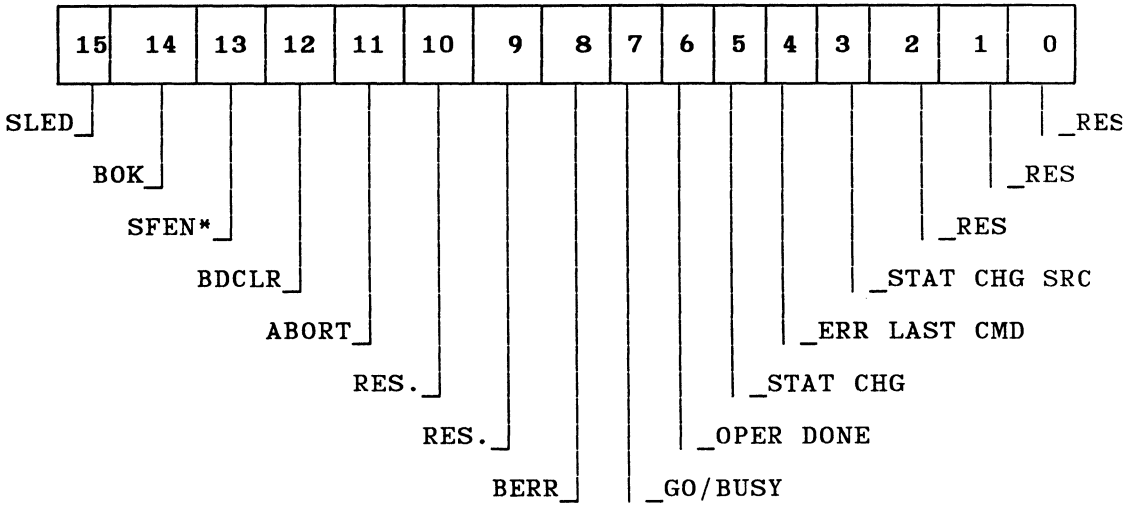


Figure 3. Command/Status Register Format

NOTE

The Command/Status register is accessible by the host through the short I/O address space. Byte (D8) and word (D16) accesses are both supported, but long word (D32) accesses are not supported. The Status Change and Status Change Source bits can optionally be relocated in the Optional Status Change register.

A definition of each Command/Status register bit is provided in the following paragraphs.

BIT 15 - SLED (STATUS LED): If '0', the on-board LED status indicator is red unless the V/SMD 3200 is accessing the disk, in which case it is green. When '1', the LED is always green provided BOARD OK (bit 14) is '1' (the LED may flicker during a disk access). This bit is controlled by the host and is never changed by the V/SMD 3200.

BIT 14 - BOK (BOARD OK): If '1', this bit indicates that power-up diagnostics were completed successfully. If '0', this bit indicates that a board-detected fault occurred during the power-up diagnostics. This bit is valid only when the GO/BUSY bit is '0'. This bit is logically a read only bit and should not be changed by the host.

BIT 13 - SFEN* (SYSFAIL ENABLE): If '0', and BOK is also '0' (inactive), this bit enables BOK to cause SYSFAIL to be asserted on the VMEbus. If '1', this bit causes the SYSFAIL indication to be disabled. The V/SMD 3200 never changes this bit.

BIT 12 - BDCLR (BOARD CLEAR): If the host sets this bit to '1' and holds it at a '1' for at least one microsecond before setting it to a '0', this causes a hardware reset of the controller. After the reset, the controller will execute its power-up diagnostics (BUSY set). When finished (and if the power-up diagnostics are successful), BUSY is reset and BOK is '1'. If they are not successfully completed, BOK and BUSY are both '0'. There is a 100 microsecond delay before the CSR is valid after a BOARD CLEAR has occurred. This bit is never changed by the V/SMD 3200. For some of the faster host CPUs, a few NOPs may be necessary between setting and clearing this bit for the V/SMD 3200 to properly reset.

BIT 11 - ABORT: If the host sets this bit to '1', the V/SMD 3200 will abort any IOPB in progress. This bit is set to '0' by the V/SMD 3200 upon receipt. If an IOPB was in progress, the OPERATION DONE and ERROR LAST commands will be set to '1' once the abort is completed. If the abort signal is detected during a sector write operation, the V/SMD 3200 will finish the operation before aborting.

BIT 10, 9 - RESERVED: Bits must be zero.

BIT 8 - BERR (BUS ERROR): The V/SMD 3200 sets this bit to '1' if a bus error has occurred. This bit is both read and modified by the host. If an error occurs, the host must clear this bit (set it to '0').

BIT 7 - GO/BUSY: The host sets this bit to '1' in order to start the command defined in the resident IOPB. The V/SMD 3200 will execute the command, and on completion will clear the GO/BUSY bit, set the OPERATION DONE bit, update the ERROR LAST COMMAND bit (see bit 4), and interrupt the host if enabled to do so. The host responds by clearing the OPERATION DONE bit.

BIT 6 - OPER DONE (OPERATION DONE INTERRUPT): The V/SMD 3200 sets this bit to '1' upon completion of a command. Then, immediately after setting this bit, the V/SMD 3200 will generate a system interrupt if enabled to do so. However, this bit is set regardless of the interrupt enable status. The host must clear this bit after it has responded to the command completion condition. (See note on following page for more information.)

BIT 5 - STAT CHG (STATUS CHANGE INTERRUPT): The V/SMD 3200 modifies this bit only when the STATUS CHANGE INTERRUPT enable bit (in the UIB) is set. This bit is set to '1', if as a result of a SEEK command, any one of the following drive bits change from an inactive to an active state (see note on following page for more information):

- DRIVE READY
- FAULT
- ON CYLINDER
- SEEK ERROR

This bit is not set and an interrupt is not generated when these lines toggle during a command which has an implied seek. A change in the WRITE PROTECT line does not constitute a status change condition. Immediately after setting this bit, the V/SMD 3200 will generate a system interrupt. The host clears the status change bit to acknowledge that it has responded to the status change condition.

This bit and the STATUS CHANGE SOURCE bit will appear in word 1FE if the Optional Status Change register is selected. In this case, bit 5 and bit 3 of the CSR register will not be used and will remain set to zero.

NOTE

Bits 5 and 6 are interrupt bits in the Command/Status register. They are used to determine the type of interrupt and to acknowledge that the interrupt has been serviced. When either one is set, the drive status (two bytes) and controller status (two bytes) are frozen. The status registers will not change until the interrupt bit is cleared. This is done by resetting the appropriate interrupt bit in the Command/Status register. The controller can stack up to ten interrupts in this manner. These bits are mutually exclusive such that only one interrupt is provided at a time. The above is true even if the Optional Status Change register is used, except the status change interrupt is cleared in the Optional Status Change register instead of the CSR.

BIT 4 - ERR LAST CMD (ERROR LAST COMMAND): The V/SMD 3200 sets this bit to '1' if an error occurred during the last command. It sets this bit to '0' if an error was not detected.

BIT 3 - STAT CHG SRC (STATUS CHANGE SOURCE): This bit indicates which drive (1 or 0) was responsible for generating the status change interrupt. If '0', drive 0 generated the interrupt. If '1', drive 1 generated the interrupt. If the optional status change register is used, this bit will not be used and will remain zero.

BIT 2, 1, 0 - RESERVED BITS: Must be zero.

IOPB FORMAT

The Input/Output Parameter Block (IOPB) allows the host CPU to communicate with the V/SMD 3200 and issue the necessary commands. Although some commands do not need certain parameters, the length of the IOPB is always 14 words. The IOPB starts at the base address plus four in the short I/O space of the controller. The format of the IOPB is shown in Table 3 below.

Table 3 - IOPB Format

WORD (DEC)	HEX BYTE	15 14 13 12 11 10 9 8	7 6 5 4 3 2 1 0
0	0	COMMAND CODES	COMMAND OPTIONS
1	2	STATUS CODE	ERROR CODE
2	4	CYL. HIGH (LOGICAL D24-31)	CYLINDER LOW (LOG. D16-D23)
3	6	HEAD # (LOGICAL D08-D15)	SECTOR # (LOGICAL D00-D07)
4	8	SECTOR COUNT HIGH	SECTOR COUNT LOW
5	A	BUFFER ADDRESS (A24-A31)	BUFFER ADDRESS (A16-A23)
6	C	BUFFER ADDRESS (A08-A15)	BUFFER ADDRESS (A00-A07)
7	E	MEMORY TYPE	ADDRESS MOD. CODE
8	10	OPT. DRIVE #/INT LEVEL (1-7)	NORMAL COMPLETE INT. VECTOR
9	12	DMA TRANSFER COUNT	ERROR INTERRUPT VECTOR
10	14	IOPB POINTER (A24-A31)	IOPB POINTER (A16-A23) A
11	16	IOPB POINTER (A08-A15)	IOPB POINTER (A00-A07)
12	18	IOPB MEMORY TYPE	IOPB ADDRESS MOD. CODE
13	1A	ABSOLUTE SKEW	ENTRY COUNT

The IOPB words are discussed in detail in the following subsection of the user's guide The following words are included:

Command Codes	- Word 0, upper byte
Command Options	- Word 0, lower byte
Status Codes	- Word 1, upper byte
Error Codes for Commands Completed with Exception	- Word 1, lower byte
Error Codes for Commands Completed with Error	- Word 1, lower byte
IOPB Parameters	- Words 2-13

The individual command codes and error codes (for commands completed with error) are discussed in Appendixes B, and D respectively.

WORD 0

The upper byte of word 0 of the IOPB specifies such commands as READ or WRITE data from the disk. The command options are contained in the lower byte of word 0. These options allow the user to specify such parameters as volume and unit number, as well as operating modes such as logical or physical disk addressing modes.

Word 0, Upper Byte - IOPB Command Codes

The upper byte of the first word in the IOPB (word 0) is the command information that must be provided to the V/SMD 3200 by the host. The following table contains all of the available commands in ascending hexadecimal code order. Each command is defined in Appendix B. In addition, Appendix C contains the IOPB format for all of the command codes and the IOPB that results once the command is executed.

Table 4 - IOPB Commands

CODE	COMMAND	CODE	COMMAND
70	DIAGNOSTICS	8B	REFORMAT
71	READ LONG	8C	FORMAT TRACK WITH DATA
72	WRITE LONG	90	MAP SECTOR
74	READ HEADER	91	READ SECTORS SEQUENTIAL
75	READ RAW DATA	92	WRITE SECTORS SEQUENTIAL
76	READ CDC FLAW MAP	93	VERIFY SECTORS SEQUENTIAL
77	REPORT CONFIGURATION	94	READ NONCACHED
78	WRITE SECTOR BUFFER	95	READ SEQ., DISABLE ADDR.
79	READ SECTOR BUFFER	96	WRITE SEQ., DISABLE ADDR.
81	READ SECTOR(S)	97	CLEAR DRIVE FAULT
82	WRITE SECTOR(S)	99	VERIFY TRACK
83	VERIFY SECTOR(S)	9A	TRACK ID
84	FORMAT TRACK	9B	FETCH AND EXECUTE IOPB
85	MAP TRACK	9C	VERIFY TRACK SEQUENTIAL
86	HANDSHAKE	9E	EXTENDED DIAGNOSTICS
87	INITIALIZE	9F	DUAL PORT PRIORITY SELECT
89	RESTORE (RETURN TO 0)	A1	READ AND SCATTER
8A	SEEK	A2	GATHER AND WRITE

Word 0, Lower Byte - IOPB Command Options

The IOPB command options are contained in the lower byte of Word 0 of the IOPB and are used to give the V/SMD 3200 instructions for executing commands. The format of the command option byte is shown in Figure 4 on the following page, and is followed by a short description of each option.

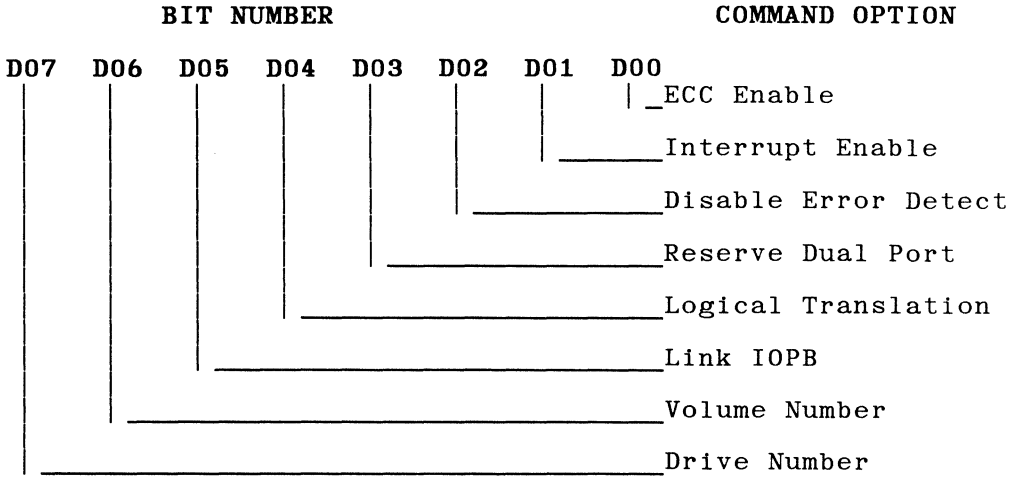


Figure 4. Command Option Byte Format

BIT 7 - DRIVE NUMBER: This bit specifies the drive (0 or 1) on which the command is to be performed. If bit 6 of UIB byte F (see page 46) is set to '1' indicating four unit operation, this bit is no longer used. If that is the case, the unit number is specified in the upper byte of IOPB word 8, bits 12 and 13.

BIT 6 - VOLUME NUMBER: This bit specifies upon which volume (1 or 0) of the specified drive the command is to be performed. This bit is only necessary when in logical translation mode (when bit #4 is '1'). Volume boundaries are defined in the UIB.

BIT 5 - LINK IOPB: If this bit is set at '1', IOPB linking is allowed. The process for linking IOPBs starts by setting this bit in the resident (base) IOPB; in the first IOPB in the case of a FETCH AND EXECUTE IOPB command. The host CPU decides where the linked IOPBs will reside and must provide the address of the next IOPB in the address pointer of the base IOPB (Words 10 and 11). Each linked IOPB in turn has its link bit set, and points to the next IOPB in the series. The status of each linked IOPB is displayed in its status word (Word 1), and the host can track the status of each IOPB individually. Thus, if an error occurs and the link is broken, the host can determine which IOPB was responsible and read its status and error code. The link bit in the final IOPB must be zero. If this bit is set at '0', it indicates that no linking is to be done and the IOPB address pointers are ignored.

Only one interrupt per set of linked IOPBs is generated. This interrupt occurs upon completion of the link, whether the completion is normal, with error, or with exception. The data the V/SMD 3200 needs for an interrupt (interrupt enable bit and interrupt vector) are obtained from the last completed IOPB.

BIT 4 - LOGICAL TRANSLATION: If this bit is set at '1', the logical sector number is first translated to a physical cylinder, head, and sector number before execution. Logical translation can only be used with the following commands: READ SECTOR, WRITE SECTOR, READ LONG, WRITE LONG, READ HEADER, SEEK, READ NON-CACHED, DIAGNOSTIC, and VERIFY SECTOR. During any other command, such as FORMAT or MAP TRACK, this bit is ignored and physical addressing must be used. If this bit is '0', physical addressing must be used for all commands.

BIT 3 - RESERVE DUAL PORT: If this bit is set at '1', it reserves a dual ported drive upon command completion. If '0', the drive is released. The dual port option in the UIB must be set to enable this bit.

BIT 2 - DISABLE ERROR DETECTION: If this bit is set at '1', it disables error detection on the data fields. If '0', the data is checked for errors on every disk read operation.

BIT 1 - INT ENABLE: If this bit is set at '1', it enables the system interrupt to be generated upon command completion. If '0', no interrupt is generated and the host must monitor the OPERATION DONE bit in the CSR to detect completion.

BIT 0 - ECC ENABLE: If this bit is set at '1', the error correction algorithm is applied to erroneous data fields after all retries and/or reseeks have been exhausted. If '0', no error correction is attempted.

WORD 1, UPPER BYTE - IOPB STATUS CODES

Word 1 of the IOPB contains the status and error codes. The status code resides in the upper byte and is used to reflect to the host, the execution status of the current IOPB. The status code also provides the status of individual IOPBs when a series of IOPBs are linked. If only one IOPB is in system memory, the status code will contain the same command completion information as the Command/Status register. The IOPB status codes are updated prior to updating the CSR.

Table 5 - Command Status Codes

CODE (hex)	STATUS
80	Command Completed With No Error
81	Command In Progress
82	Command Completed With Error
83	Command Completed With Exception

80 - COMMAND COMPLETED WITH NO ERROR: This indicates that the command has been completed without any errors or exceptions. The Command/Status register will display OPER DONE as '1', ERROR LAST COMMAND as '0', and BUSY as '0'.

81 - COMMAND IN PROGRESS: This code indicates that the IOPB is currently being executed. This code is displayed after the GO bit is '1' in the Command/Status register.

82 - COMMAND COMPLETED WITH ERROR: In the event of an error, the appropriate code for the error is contained in the lower byte of Word 1. In the Command/Status register OPER DONE and ERROR LAST COMMAND are '1', and BUSY is '0'. Errors do not occur in normal operation, so the user should investigate the error when this code is displayed.

83 - COMMAND COMPLETED WITH EXCEPTION: This code indicates that the command was completed successfully, but that some method of error recovery was required. The appropriate error information will be contained in the lower byte of Word 1. The user may want to log the exception to indicate that system troubleshooting may be required.

WORD 1, LOWER BYTE - IOPB COMMAND ERROR CODES

The error code resides in the lower byte of IOPB Word 1. The error code is used to indicate to the host which error occurred while executing the IOPB.

The IOPB command error codes fall into two categories; codes from commands completed with exception and codes from commands completed with error. Appendix D contains a complete list of error codes for commands completed with error and a brief description of each one.

Error Codes For Commands Completed With Exception

BIT 7: If this bit is set at '1', error correction was applied to the data field. If it is set at '0', data correction was either not required or was disabled.

BIT 6: If this bit is set at '1', it indicates that the data transferred into system memory may be erroneous. This bit is used in conjunction with the MOVE BAD DATA bit in the UIB attribute flags (byte E, bit 1), which allows the transfer of erroneous data into memory, and the command option Disable Error Detection (bit 2 of the command options).

BIT 5: Bit 5 is a reserved bit and must be set at '0'.

BIT 4: If this bit is set at '1', a RESTORE and RESEEK was performed. The ability to perform a RESTORE as part of the error recovery is enabled in the UIB.

BITS 3-0: These bits are used to indicate the number of rotational retries that was attempted. The maximum number that can be displayed is 15. If 15 or more retries were attempted, these bits will all be '1'. The maximum number of rotational retries is specified in the UIB.

IOPB Error Codes For Commands Completed With Error

Errors do not occur during normal operation and the source of the error should be determined by the user. A list of valid error codes is tabulated on the folowing page. Codes that are not used for a specific error have been omitted (i.e., these codes should never be posted). For a complete description of error codes for commands completed with error, refer to Appendix D.

Table 6 - IOPB Error Codes

10 - DISK NOT READY	2C - NO VALID HEADER FOUND
12 - SEEK ERROR	2D - SEEK TIMEOUT ERROR
13 - ECC ERROR-DATA FIELD	2E - BUSY TIMEOUT
14 - INVALID COMMAND CODE	2F - NOT ON CYLINDER
15 - ILLEGAL FETCH AND EXECUTE	30 - RTZ TIMEOUT
16 - INVALID SECTOR IN COMMAND	31 - INVALID SYNC IN HEADER
17 - ILLEGAL MEMORY TYPE	40 - UNIT NOT INITIALIZED
18 - BUS TIMEOUT	41 - NOT USED
19 - HEADER CHECKSUM ERROR	42 - GAP SPECIFICATION ERROR
1A - DISK WRITE PROTECTED	4B - SEEK ERROR
1B - UNIT NOT SELECTED	50 - SECTORS/TRACK ERROR
1C - SEEK ERROR TIMEOUT	51 - BYTES/SECTOR SPEC ERROR
1D - FAULT TIMEOUT	52 - INTERLEAVE SPEC FACTOR
1E - DRIVE FAULTED	53 - INVALID HEAD ADDRESS
1F - READY TIMEOUT	54 - INVALID CYLINDER ADDR
20 - END OF MEDIUM	5D - INVALID DMA XFER COUNT
21 - TRANSLATION FAULT	60 - IOPB FAILED
22 - INVALID HEADER PAD	61 - DMA FAILED
23 - UNCORRECTABLE ERROR	62 - ILLEGAL VME ADDRESS
24 - TRANSLATION ERROR, CYL	6A - UNRECOGNIZED HEADER FIELD
25 - TRANSLATION ERROR, HEAD	6B - MAPPED HEADER ERROR
26 - TRANSLATION ERROR, SECT	6F - NO SPARE SECTOR ENABLED
27 - DATA OVERRUN	77 - COMMAND ABORTED
28 - NO INDEX PULSE ON FORMAT	78 - ACFAIL DETECTED
29 - SECTOR NOT FOUND	F0-FE - IMPROBABLE ERROR
2A - ID FIELD ERROR-WRONG HEAD	FF - COMMAND NOT IMPLEMENTED
2B - INVALID SYNC IN DATA FIELD	

IOPB WORDS 2-13

The first two words of the IOPB (Words 0 and 1) contain the command, status, and error codes as well as the user selectable command options. These words have been discussed in detail in the preceding sections of the user's guide.

The remaining words in the IOPB provide additional information to the V/SMD 3200 to execute the desired command. These words specify parameters such as spiral skew, head and cylinder number, memory type, and buffer address. The head number, cylinder number and sector count words are automatically updated by the V/SMD 3200 upon completion of the command. This feature is most often used as a diagnostic aid in cases of partially successful completion of a transaction.

Table 7 shows the format of the remaining words, and the following pages define the operating parameters specified by those words.

Table 7 - IOPB Words 2-13

WORD# (DEC)	UPPER BYTE 15 14 13 12 11 10 9 8	LOWER BYTE 7 6 4 3 2 1 0
2	CYLINDER HIGH (LOG. D24-D31)	CYLINDER LOW (LOG. D16-D23)
3	HEAD # (LOGICAL D08-D15)	SECTOR # (D00-D07
4	SECTOR COUNT HIGH	SECTOR COUNT LOW
5	BUFFER ADDRESS (A24-A31)	BUFFER ADDRESS (A16-A23)
6	BUFFER ADDRESS (A08-A15)	BUFFER ADDRESS (A00-A07)
7	MEMORY TYPE	ADDRESS MODIFIER CODE
8	OPT. DRIVE #/INT. LEVEL (1-7)	NORMAL COMPLETE INT. VECTOR
9	DMA TRANSFER COUNT	ERROR INTERRUPT VECTOR
10	IOPB POINTER (A24-A31)	IOPB POINTER (A16-A23)
11	IOPB POINTER (A08-A15)	IOPB POINTER (A00-A07)
12	IOPB MEMORY TYPE	IOPB ADDRESS MODIFIER CODE
13	ABSOLUTE SKEW	ENTRY COUNT

CYLINDER ADDRESS (Word 2): This word contains the cylinder address. When the V/SMD 3200 is operating in physical mode, Word 2 is the actual cylinder address where the read/write heads are to be moved. In logical translation mode, Word 2 specifies the upper word of the two-word logical address. If an error occurs during a READ or WRITE, the cylinder address will point either to the physical or logical error location.

HEAD AND SECTOR NUMBERS (Word 3): The head and sector numbers are specified by Word 3. In physical mode, the head number is in the upper byte of the Word, and the sector number is in the lower byte. In logical translation mode, Word 3 is the lower word of the address. If an error occurs, Word 3 will point either to the physical head and sector or to the logical sector where the error occurred.

SECTOR COUNT (Word 4): The sector count, or number of sectors to be transferred, is specified in Word 4.

BUFFER ADDRESS (Words 5 and 6): These words contain the buffer address, or memory address where the data is to be transferred to or from. If an error occurs, the buffer address will point to the start of the sector buffer in system memory where the bus transfer was when the error occurred.

MEMORY TYPE/ADDRESS MODIFIER CODES (Word 7): This word contains the memory type and address modifier codes. The upper byte contains the memory type code as detailed below in Table 8.

Table 8 - IOPB (Word 7) Memory Type Codes

CODE	MEMORY TYPE
00	8-bit (Byte-Wide) Data Transfers
01	16-bit Internal Memory (not valid for disk data transfers)
02	16-bit (Word-Wide) Data Transfers
03	32-bit (Long Word) Data Transfers

When using memory type 03 (long word), if the buffer address is not aligned on a VMEbus-specified long word boundary, the V/SMD 3200 will transfer that block of data using 16-bit transfers. If this happens, the V/SMD 3200 will change the memory type to an 02 before indicating command complete.

If bit 2 of the memory type is set to '1' (codes 4-7), this disables the incrementing of the VME address counters during data transfers. This is useful when transferring data to a slave device whose data buffer is a single address. This bit is only interrogated when reading/writing data sequentially (command codes 91, 92, and 9A). All three memory types (D8, D16, and D32) are supported.

The lower byte contains the address modifier codes. When the V/SMD 3200 is transferring data to or from system memory, 6-bit address modifiers are used to indicate the type of memory access to be made for a particular address. These modifiers range from 0 to 3F.

OPTIONAL DRIVE #/INTERRUPT LEVEL AND VECTOR (Word 8): The V/SMD 3200 has seven levels of interrupts which are software programmable on a per command basis. Each IOPB must specify an interrupt level, and can contain two interrupt vectors, one for normal command completion and one for abnormal command completion (see Word 9, lower byte). This word contains the interrupt level in the upper byte (bits 8-11) and the interrupt vector for normal command completion and command completed with exception in the lower byte. The interrupts can be stacked up to ten at a time. If two interrupts occur at the same time, status is presented for one and the interrupt is generated. Then, after the first interrupt is serviced and cleared, the second interrupt is generated.

If bit 6 of UIB byte F is set to '1', indicating four unit operation, then bits 12 and 13 of the upper byte of word 8 are used to specify the drive number. For two unit operation (bit 6 of UIB byte F is '0'), bits 12 and 13 are reserved and must be set to '0'. Bits 11, 14 and 15 of the upper byte of word 8 are reserved and must be set to '0' at all times.

DMA TRANSFER COUNT/ERROR INTERRUPT VECTOR (Word 9): The DMA transfer count is contained in the upper byte of Word 9. The transfer count is used to specify how many transfers of data the V/SMD 3200 is to perform before releasing the VMEbus and re-requesting it. After the VMEbus is released, it will be re-requested within 300 nanoseconds.

The DMA transfer count allows higher priority devices to request and be granted control of the bus. In systems not using the priority arbitration option, if the transfer count is '0', the bus is released only after the entire sector of data is transferred. It should be set to '0' in systems using priority arbitration, since the arbitrator will assert Bus Clear when a higher priority device requests the bus. In this event, the V/SMD 3200 will release the bus within two transfers of the assertion of the Bus Clear signal.

Changes in the transfer count between transactions should be minimized because they require firmware overhead to recalculate where the transfers will occur. The minimum transfer count is two (2).

The lower byte of Word 9 contains the error interrupt vector for abnormal command completion.

ADDRESS POINTERS (Words 10 and 11): These two words contain the address pointer to the linked IOPB when running in linked mode. The upper and lower byte of Word 10 contain pointer addresses A24-A31 and A16-A23, respectively. The upper and lower byte of Word 11 contain pointer addresses A08-A15 and A00-A07, respectively.

MEMORY TYPE/ADDRESS MODIFIER CODES (Word 12): The linked IOPB memory type codes and address modifier codes are contained in the upper and lower byte of Word 12, respectively. The memory type codes are listed below in Table 9.

Table 9 - Linked IOPB (Word 12) Memory Type Codes

CODE	MEMORY TYPE
00	8-Bit (Byte-Wide) Memory
01	16-Bit Internal Memory
02	16-Bit (Word-Wide) Memory
03	32-Bit (Long Word) Memory

The 16-bit internal memory is the V/SMD 3200 short I/O space. Memory type 01 indicates that the next linked IOPB already resides in the controller's short I/O space and not in external system memory. When external IOPBs are fetched (memory type 00, 02, or 03), they are not moved to the controller's short I/O space which is reserved for the resident IOPB.

When using memory type 01 (internal short I/O space), the IOPB pointer points to the first word of the IOPB. For example, if the short I/O space is set at address 8600 (see Section 5) and the IOPB is loaded 30 bytes from the start of the short I/O, the IOPB pointer for memory type 01 is 8630. The purpose of using memory type 01 is to increase speed by reducing the number of bus accesses needed. When this type of memory is specified, external IOPBs do not have to be fetched before they can be executed; thus, the time required for two bus accesses and for transferring the IOPB data is saved.

When using memory type 03, if the linked IOPB address is not aligned on a VMEbus-specified long word boundary, the V/SMD 3200 will transfer that block of data using two 16-bit transfers. Note that after completion, the IOPB memory type will be changed to an 02.

The linked IOPB address modifier code is in the lower byte of Word 12. The address modifier codes are defined by the VMEbus specification. This byte is a "DON'T CARE" if the memory type is set to 01.

ABSOLUTE SKEW/ENTRY COUNT (Word 13): The upper byte of this word is used when a skew factor is required other than the skew value specified in the UIB. The upper byte of Word 13 specifies this skew factor. If this byte is nonzero during a FORMAT, the value of this byte is used as the skew factor for each track. If this byte is zero, the skew factor specified in the UIB for this drive unit will be used.

There is an important difference between the skew value in the UIB and the absolute skew specified here in the IOPB. The skew in the UIB is used with the cylinder number and the head number to calculate the number of sectors between the index pulse and the first logical sector (sector 0) on the track. The skew value here in the IOPB (if nonzero) is taken as an absolute value and fixes the first logical sector regardless of the location of the track on the drive.

The lower byte of Word 13 is used with the Scatter/Gather commands to specify the number of entries in the Scatter/Gather list (see page 42).

LINKED IOPBs

Linking IOPBs increases performance when noncontiguous blocks of data must be transferred to/from system memory. The higher level of performance is achieved by reducing driver overheads and by eliminating the need for the host CPU to service multiple interrupts. In addition, even greater performance is achieved if the linked IOPBs are stored in the V/SMD 3200 short I/O space; then, multiple bus requests are eliminated as well.

Linked IOPBs are enabled by setting bit 5 of the IOPB command options byte (word 0, lower byte). Only one interrupt (if enabled) is generated at the completion of the link. Note that interrupts and vectors may be enabled in all of the IOPBs in the link if it is so desired. If the link is terminated due to an error, the current IOPB (the one being processed) is used to generate the interrupt information. Subsequent IOPBs will not be processed once the link is broken.

Instead of using linked IOPBs to transfer noncontiguous blocks of data to/from system memory to contiguous blocks on the disk, the scatter/gather command can be used much more efficiently.

OVERLAPPED SEEKS

The V/SMD 3200 supports overlapped seeks in addition to the implied seeks embedded in many of the commands. Overlapped seeks are used to minimize seek latency when the V/SMD 3200 is operating two drives. The overlapped seeks allow the host to start a seek on one drive and then transfer data on another drive while the first drive is still seeking.

For example, if the host has a transaction to conduct with the first drive that requires a seek of three cylinders and a transaction with the second drive that requires a seek of twenty cylinders, it can issue a SEEK command to the second drive and a READ or WRITE command with an implied seek to the first drive and a SEEK command to the second drive. After the transaction with the first drive has been completed, the host can either wait for a status change interrupt from the second drive or immediately issue a READ or WRITE command and ignore the status change interrupt (status change interrupts can also be disabled).

In some systems, the host can issue explicit seeks on both drives and then service whichever drive returns the first status change interrupt. This method frees the host from the sometimes complicated calculations involved in deciding which drive will be able to respond first.

STATUS CHANGE INTERRUPTS

In multiple drive systems, the Status Change Interrupts are used with overlapped seek operations to improve system performance. The Status Change Interrupt requires the following sequence of events:

A SEEK command is issued.

An OPERATION DONE interrupt is posted and acknowledged. The host is now free to issue another command.

The drive completes the SEEK and sets its "ON CYLINDER" bit active.

The V/SMD 3200 sets the status change bit in the CSR (or Optional Status Change register) and posts an interrupt.

The host performs an interrupt acknowledge cycle which clears the hardware interrupt and fetches a vector to the host's status change interrupt routine.

The host clears the status change bit.

Internally, the V/SMD 3200 can have more than one interrupt ready to post at the same time. The rules are as follows:

First, interrupts are internally queued. The V/SMD 3200 will never post both an OPERATION DONE and a STATUS CHANGE condition at the same time. The next pending interrupt is posted only after the present interrupt has been responded to by clearing either the OPERATION DONE or STATUS CHANGE bit in the CSR or optional status change register.

And second, a status change condition can be posted even if a command is in progress. Therefore, it is possible for the GO/BUSY and the STATUS CHANGE bits to be active at the same time.

Due to the asynchronous nature of the status change interrupt, its use with some operating systems can prove to be somewhat arduous.

INTERPHASE recommends using the Optional Status Change Register. This is selected by setting bit 7 in the Status Change Interrupt Level (byte 10 HEX) of the UIB (see next section for details).

The use of this option separates the Status Change Bits (bits 3 and 5 in the CSR) from the Operation Done and GO/BUSY bits. It is important to note that bits 3 and 5 will not be updated in the CSR when this option is used. They are updated in the Optional Status Change Register instead and the bit positions (3 and 5) remain the same. Other than a different address for the Status Change Register, the details of the status change mechanism remain the same.

If for some reason the above technique is not acceptable, there are other methods for handling status change interrupts. One way to prevent too many interrupts is to disable the interrupt that is normally generated by the SEEK command and let the status change interrupt be the one that wakes up a sleeping seek process. However, unless another command can be given while the seek process is asleep, the status change mechanism is no more efficient than the normal implied seek commands.

When status change interrupts are used and the status change bits remain in the CSR, it is possible for the V/SMD 3200 to be updating the CSR at the same time the host is issuing a "GO" to the CSR. There is a small possibility that the GO will be overwritten by the V/SMD 3200 and be lost.

One possible method for avoiding this situation is to set a timer when a command is issued and then retry the command if a timeout occurs. This is acceptable because a command timeout is good design practice and the probability of the conflict is small.

A second way of handling the conflict is to issue the command and then read the CSR to make sure the GO/BUSY bit remained set. If it did not, then the host simply issues another "GO."

DUAL PORT OPERATION

When using a common database, the user may wish to utilize two controllers to share access of a dual ported drive. The V/SMD 3200 has a dual port bit which can be set to allow this activity (bit 3 of the UIB attribute flag byte). In addition, a command option bit is provided to reserve the drive in the IOPB (bit 3 of the lower byte of IOPB Word 0). Setting the dual port bit insures that the V/SMD 3200 will honor the drive's BUSY signal. If the bit is not set, the V/SMD 3200 will ignore the BUSY signal. During dual port operation, the V/SMD 3200 will select a drive and will check to see if the drive's BUSY signal is set. An active BUSY signal from a drive tells the V/SMD 3200 that the other controller is using the drive, and the V/SMD 3200 is not free to take control of the drive. All seeks and data transactions will be conducted as soon as the BUSY signal is no longer active.

Once the V/SMD 3200 takes control of the drive, the other controller's BUSY signal becomes active. The V/SMD 3200 gives up control of the drive whenever it de-selects the drive unless the RESERVE bit was set, in which case it retains control of the drive. The RESERVE feature is useful when READ-MODIFY-WRITE operations are required in shared data areas.

SCATTER GATHER OPERATION

The scatter command (A1) and gather command (A2) allow the user to place contiguous disk data in noncontiguous areas of system memory (scatter operation) or to place noncontiguous areas of system memory in contiguous areas of the disk (gather operation).

The purpose of the Scatter/Gather commands is to unburden the host of having to process several transactions when noncontiguous blocks of data are being transferred. The commands allow multiple blocks of data to be transferred using only one command, rather than one command per block. So, whenever the Scatter/Gather commands are used, system performance is improved because both the number of VMEbus interrupts and the number of bus transactions associated with common disk activity are minimized.

The disk control aspects of the Scatter command are identical to the Read Sector(s) command (81). Similarly, the disk control aspects of the Gather command are identical to the Write Sector(s) command (82). Zero latency and virtual buffering are operational on scatter/gather commands.

Scatter/Gather Lists

When data is stored on a disk, it is generally written to noncontiguous blocks specified by the host Memory Management Unit. Scatter/Gather uses the information in the MMU to "map" the location of one or more of the blocks. The Scatter/Gather "map" is actually a list of elements. Each element in the list is used to specify the byte count, address, memory type, and address modifier of a block of data stored in system memory. The host uses the elements to build a list that specifies a number of noncontiguous blocks, and the V/SMD 3200 then uses this list to scatter or gather the data.

The beginning of the list is pointed to by bytes 0A-0F in the IOPB (words 5-7). The total number of elements in the list is specified by byte 1B (word 13 LSB). The remaining IOPB parameters are the same as the corresponding parameters in the Read and Write commands. The lists can reside anywhere in system memory, but for optimum performance, it should be stored in V/SMD 3200 short I/O space.

Each element in a list is an eight-byte entry with the following format:

UPPER BYTE	WORD	LOWER BYTE
Byte Count (High)	0	Byte Count (Low)
Address (A31-A24)	1	Address (A23-A16)
Address (A15-A08)	2	Address (A07-A00)
Memory Type	3	Address Modifier Code

Word 0 must contain the number of bytes in the data memory block. This parameter must be an even multiple of the sector size. Words 1 and 2 contain the starting address of the VMEbus data memory block. The address modifier is designated in bits 0-5 of Word 3, and the memory type is defined in bits 8-9. All other bits in Word 3 are reserved and should be set to '0'.

Scatter/Gather Guidelines

The following guidelines must be observed when using the scatter or gather command.

1. The list size must be less than or equal to the number of bytes per sector.
2. All elements within a list must contain the same VMEbus memory type and address modifier code.
3. The byte count must be a multiple of the bytes/sector parameter.

Scatter/Gather Completion

After a Scatter/Gather command has been completed, the V/SMD 3200 sets IOPB bytes 0A-0F back to the beginning of the list. Then, IOPB bytes 8 and 9 are updated to include the number of sectors that have not yet been processed. This number will be zero for an error-free transaction. In the event of an error, it is recommended that the entire list be retried since it is sometimes difficult to ascertain exactly which entries have not been transferred.

HOW TO INITIALIZE THE V/SMD 3200

The V/SMD 3200 can control a wide variety of disk drives with differing formats, sizes and speeds. To accommodate this versatility, the controller must be told which drive is attached to each of the ports, and which options are to be selected before using the drives. To do this, an INITIALIZE command must be issued for each port upon power-up and again after every reset.

For the INITIALIZE command, the buffer address in the IOPB points to a list of initialization parameters called a Unit Initialization Block (UIB). The UIB contains 18 bytes of information.

Upon power-up, the V/SMD 3200 installs default UIB parameters for each port. The default UIB contains the minimum information necessary to read data from a typical SMD-type drive. This feature allows boot programs to be drive-independent.

The UIB information for a specific drive can be stored in the first sector of data in that drive. The default UIB allows the host to read this information from the drive and to configure the V/SMD 3200 to conform to the required drive specifications. A list of suggested drive-specific UIB parameters for various drive configurations is included in Appendix A of this user's guide.

The V/SMD 3200 will not allow any type of WRITE or FORMAT commands to be executed before an INITIALIZE command has been issued and executed. Note that failure to initialize a drive before a WRITE or FORMAT operation is attempted will result in an error code of 40 (HEX), unit not initialized.

Since the end of the UIB does not fall on a long word boundary, the V/SMD 3200 will access the UIB in word mode if the "memory type" IOPB parameter is set to 03 (long word). The memory type will be changed to 02 by the V/SMD 3200 if this occurs.

UIB

The format of the UIB is shown below in Table 10. Each byte is defined individually following the table.

Table 10 - Format of UIB

BYTE #	DESCRIPTION
0	V0SH - VOLUME 0 STARTING HEAD #
1	V0SH - VOLUME 0 NUMBER OF HEADS (2 drives only)
2	V1SH - VOLUME 1 STARTING HEAD # (2 drives only)
3	V1SH - VOLUME 1 NUMBER OF HEADS
4	SCT/TRK - SECTORS PER TRACK
5	SKEW - SPIRAL SKEWING FACTOR
6	BYTES/SCT (MSB) - BYTES PER SECTOR (UPPER BYTE)
7	BYTES/SCT (LSB) - BYTES PER SECTOR (LOWER BYTE)
8	GAP 1 - NUMBER OF WORDS IN GAP 1
9	GAP 2 - NUMBER OF WORDS IN GAP 2
A	SCT INT - SECTOR INTERLEAVE FACTOR
B	RETRY - NUMBER OF RETRIES ON DATA ERROR
C	CYL (MSB) - NUMBER OF CYLINDERS (UPPER BYTE)
D	CYL (LSB) - NUMBER OF CYLINDERS (LOWER BYTE)
E	ATTRIB - ATTRIBUTES
F	4 UNIT SELECT/SMD EXTENDED ADDRESSING
10	STATUS CHANGE INTERRUPT LEVEL
11	STATUS CHANGE INTERRUPT VECTOR

BYTES 11 and 10 - STATUS CHANGE INTERRUPT LEVEL, REGISTER, VECTOR: Bytes 10 and 11 are the level and vector for the Status Change Interrupt for this drive. The level can be set to any number from one (1) to seven (7). The vector is the data returned during the VME interrupt acknowledge cycle. Any value is acceptable. If bit 7 of byte 10 is '1', the optional status change register at 1FE is used instead of using the bits of the Command/Status register. This bit is ignored if bit 4 in the attributes byte is 0.

BYTE F - 4 UNIT SELECT/SMD EXTENDED ADDRESSING: This byte serves two purposes: first, it enables the SMD extended addressing function on the SMD interface, and second, it determines whether the V/SMD 3200 will control two or four units.

BIT 7 - (SMD-E EXTENDED ADDRESSING ENABLE): When this bit is set to '1', SMD extended addressing capabilities are enabled. When this bit is set, it selects bits 2^{10} and 2^{11} on the SMD interface via Tag 2 (see Section 6 for the SMD Tag bus decode specifications). The extended addressing feature is used by some drives to extend their addressing capabilities beyond 1024 cylinders. When this bit is reset, SMD bit 2^{10} (not 2^{11}) will be selected via Tag 1.

BIT 6 - (4 UNIT SELECT): This bit must be set to '1', if four unit operation is desired. When this bit is set, the drive number must be selected by setting bits 12 and 13 of the upper byte of IOPB word 8. (If this bit is set, the normal drive number specification bit is no longer used.)

There are some important guidelines to follow if four drives are to be used. The Drive Status registers reside at the base address plus 1FA (hex) and the base address plus 1FC (hex). The Drive Status register at base address 1FA (hex) supports both unit 3 (in the MSB) and unit 2 (in the LSB), and the Drive Status register at base address +1FC (hex) supports both unit 1 (in the MSB) and unit 0 (in the LSB). Also, if this bit is set, then bit 7 of byte 10 (Optional Status Change Register) must also be set. The Optional Status Change register resides at base address plus 1FE (hex).

BYTE E - ATTRIBUTES: Attributes such as reseek, move bad data, increment by head, etc. are defined by this byte. The individual bits in the attributes byte are listed in the following figure which is proceeded by definitions of each bit.

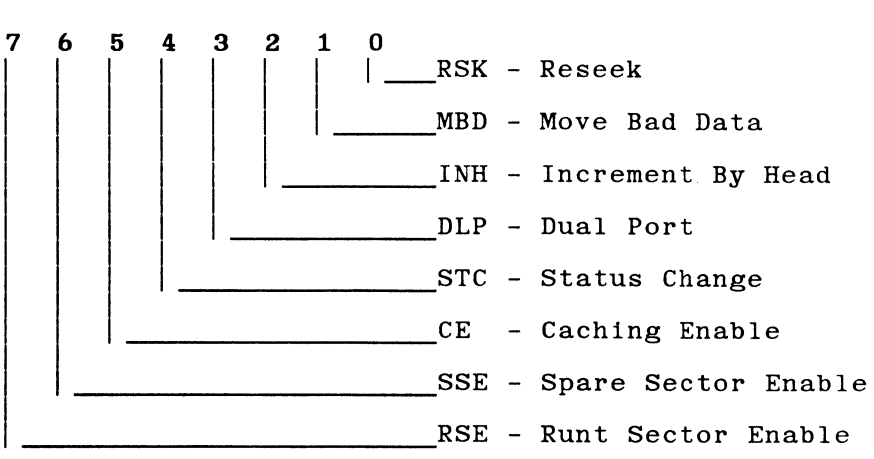


Figure 5. UIB Attribute Bits

BYTE E (cont.)

BIT 7 (RSE - RUNT [Short] SECTOR ENABLE): This allows the V/SMD 3200 to run with a small last sector on a track. This sector cannot be smaller than 120 microseconds. For example, on a drive with a 20 Mbit/sec. data rate, 120 microseconds would be equal to 120 divided by (8/20), which equals 300 bytes.

BIT 6 (SSE - SPARE SECTOR ENABLE): If this bit is set at '1', it allows the use of a spare sector on each track. The sector is allocated when the track is formatted. Refer to the MAP SECTOR command for a discussion of slip sector mapping methods.

BIT 5 (CE - CACHING ENABLE): If '1', this bit enables sector caching. If '0', data is always transferred from the disk, and no extra data is moved into the on-board buffers. Zero latency operation is not affected.

BIT 4 (STC - STATUS CHANGE): If '1', this bit enables an interrupt and updating of the STATUS CHANGE bit in the CSR (or optional status change register) when any unit's status changes (e.g., ready or not ready, explicit seek complete, etc.). Note that busy is ignored on single port drives (when bit 3 is 0).

BIT 3 (DLP - DUAL PORT): If this bit is set at '1', dual porting protocol is observed, and the drive's BUSY signal is honored. If '0', the drive's BUSY signal is ignored.

BIT 2 (INH - INCREMENT BY HEAD): If '1', this bit specifies increment by head, then cylinder when a track boundary is crossed. If '0', increments are done by cylinder, then head at track boundaries. An increment by head scheme is usually preferred since head switch time is much less than cylinder-to-cylinder seek time.

BIT 1 (MBD - MOVE BAD DATA): If '1', this bit enables the transfer of possibly bad data into system memory. If the data is still in error after all retries and error correction attempts, and reseeks that are specified have been performed, the V/SMD 3200 will normally post an error without transferring any data to system memory. If the MOVE BAD DATA bit is set, the V/SMD 3200 will move the bad data to system memory (set bit 6 of the error code byte in the IOPB) and return a Command Completed with Exception status in the IOPB.

BIT 0 (RSK - RESEEK): If '1', this bit enables a restore and reseek after the retry count has been exhausted on an erroneous data field. The restore and reseek operation is performed after the retry count has been exhausted and prior to applying ECC (if enabled).

BYTES D and C - NUMBER OF CYLINDERS: Bytes C and D represent the number of cylinders that the V/SMD 3200 knows are on the drive. This number is used to determine if a SEEK request is valid. Any SEEK or implied SEEK request for cylinders greater than the known number will result in an error.

BYTE B - RETRY COUNT: Byte B is the maximum number of retries attempted when an error occurs in the data field.

BYTE A - SECTOR INTERLEAVE: The sector interleave determines how the physical sectors are formatted on disk. With byte A set to '1', the sectors are formatted with 1:1 interleave. With byte A set to '2', the sectors are formatted with 2:1 interleaving. Other interleave factors are defined by setting this byte to the desired number (i.e., '3' = 3:1, '4' = 4:1, etc.). INTERPHASE suggests that this byte be set to '1' for maximum performance.

BYTE 9 - GAP 2 WORDS: GAP 2 is the all zeros gap between the header and the data field on each sector. Byte 9 represents the number of words of zeros that is written in GAP 2 during a FORMAT or WRITE operation.

BYTE 8 - GAP 1 WORDS: GAP 1 is the all zeros gap before the header information on each sector. Byte 8 represents the number of words of zeros that are written in GAP 1 during a format only.

BYTES 7 and 6 - BYTES PER SECTOR: These two bytes are the number of data bytes per sector, but do not include overhead bytes such as gaps. This number must be even (no half words). The minimum sector size is 256 bytes, and the maximum is 2048 bytes.

BYTE 5 - SPIRAL SKEW: The spiral skew is used by the V/SMD 3200 to determine the number of sectors that sector 0 is offset from the index pulse. Setting the spiral skew factor allows head increments on each track without losing a revolution. This byte is used only during formatting and only when the spiral skew in the IOPB is set to zero. For a more detailed explanation of the use of spiral skew with the V/SMD 3200, please refer to page 55.

BYTE 4 - SECTORS/TRACK: Byte 4 is the number of sectors per track for the drive. The maximum allowable number of sectors is 160. This number indicates the usable sectors per track, and should not contain the spare or runt sector, if either exists.

BYTES 3, 2, 1, 0, - VOLUME SPECIFICATION: Each drive can be separated into two volumes, and each volume can then be treated as an individual drive. This option is particularly useful when dealing with mixed media such as fixed and removable drives. By specifying where the removable and fixed media starts, each medium can be treated as a separate drive. This prevents head increments from crossing medium boundaries. Bytes 0 and 1 specify the starting head and the number of heads for volume 0. Bytes 2 and 3 specify the starting head and the number of heads for volume 1.

If volume 1 does not exist, bytes 2 and 3 must be zero (0). It should be noted, however, that a drive need not have mixed media to use the volume selections. All fixed or removable drives can also be set up as if they contained two volumes.

DEFAULT UIB

Upon power-up or reset, the V/SMD 3200 automatically initializes itself to a set of default conditions chosen for the typical SMD drive. Using the default UIB, the user can read the desired UIB in from the drive to replace the default UIB without requiring an INITIALIZE command. If a write- or format-type command is to be performed as the first operation, the user must issue the INITIALIZE command to the drives even if the default conditions are sufficient for the user's needs.

Table 11 - Default UIB

BYTE#	CONTENTS (hex)	DESCRIPTION	DEFAULT SETTING
0	0	VOLUME 0 STARTING HEAD #	0
1	A	VOLUME 0 NUMBER OF HEADS	10
2	0	VOLUME 1 STARTING HEAD #	0
3	0	VOLUME 1 NUMBER OF HEADS	0
4	40	SECTORS PER TRACK	64
5	0	SKEW	0
6	2	BYTES PER SECTOR (MSB)	512
7	0	BYTES PER SECTOR (LSB)	
8	10	NUMBER OF WORDS IN GAP 1	16
9	20	NUMBER OF WORDS IN GAP 2	32
A	1	INTERLEAVE FACTOR	1
B	3	NUMBER OF RETRIES ON DATA ERROR	3
C	2	NUMBER OF CYLINDERS (MSB)	644
D	84	NUMBER OF CYLINDERS (LSB)	
E	5	ATTRIBUTES SET	5
F	0	4 UNIT SELECT/SMD EXTENDED ADDR.	0
10	1	STATUS CHANGE INTERRUPT LEVEL	1
11	FF	STATUS CHANGE INTERRUPT VECTOR	255

ATTRIBUTES ENABLED: No Cache, Increment by head, and Reseek

NOTE

Appendix A contains suggested UIB parameters for most SMD drives.

SECTION 4

INITIALIZATION OF DISK MEDIA

INTRODUCTION

Before any disk can be put into service, that disk must first be formatted. That means that all header information for each sector on a track is recorded along with a dummy data field that can later be overwritten. The header information tells the V/SMD 3200 where the READ/WRITE head is located so that proper position can be ascertained before data transfers are attempted.

GENERAL INFORMATION

A hard disk drive unit is typically made up of a number of disk platters with two sides (surfaces) each. Each surface contains a number of concentric tracks which are further divided into sectors. The term cylinder refers to the three-dimensional cross section of a given track (radially coincident) on a stack of platters. The term is sometimes used interchangeably with the term track. However, a track is really specified by a combination of a cylinder number and head number.

The V/SMD 3200 automatically formats one track of a disk when it receives a FORMAT command. To format an entire unit, the user must write an iterative program loop with each iteration specifying a different cylinder/head (in the IOPB) until all tracks have been formatted. If the default UIB is used, then the initialization process must precede the format operation since some formatting parameters are defined by the UIB.

In addition, the optimum number of sectors per track should be set before the disk drive is formatted. This parameter is usually specified on SMD devices by setting switches on the drive (refer to the drive manual for specific details). The number of sectors per track determines the number of bytes in each sector. This is

important because in addition to the data field, each sector must be large enough to to accommodate any overhead required by the disk drive and the controller to operate properly. (Drive overhead includes the PLO synchronization time and the length of the write splice. Controller overhead includes the header field, the ECC field, and the space between the sector pulse, header field and data field.) Interphase has compiled a list of the proper parameters required by many popular disk drives. Refer to Appendix A for a current list (as of this printing) of parameters. If the drive that you intend to use is not listed, please call the Interphase Applications Engineering Department for assistance.

The data field can vary from 128 to 2048 bytes but must be an even number. The data placed in the data field during a format command can be either a constant value (specified by byte 15 of the IOPB) or a data field pointed to by the buffer address bytes (IOPB bytes 13, 14, 15). This variable data field is used when the "Format with Sector Data" command is specified instead of the "Format" command.

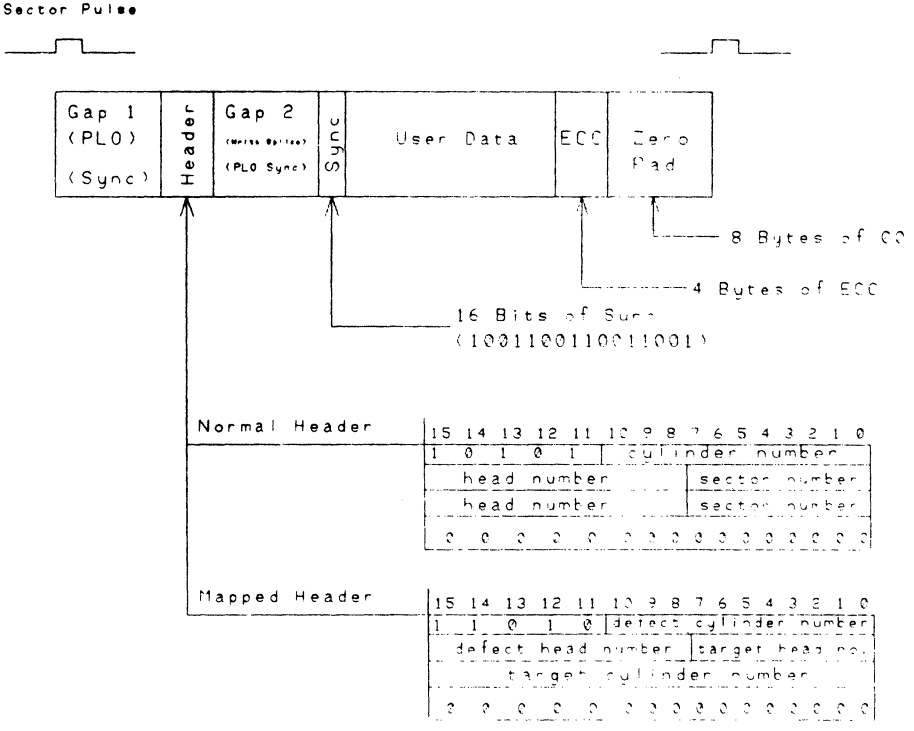


Figure 6. Sample Formatted Sector

FORMATTING CONSIDERATIONS

The format procedure, although simple to implement, must allow for such variables as system and disk latencies, bottlenecks, faulty media, reformatting faulty media, and media verification.

SPIRAL SKEW

The spiral skew controls the number of sectors that sector 0 is offset from the index pulse. This factor is used to reduce latencies during disk transactions. The skew factor can be set in two locations (IOPB Word 13 and UIB Word 5).

If Word 13 in the IOPB is zero, then the data in UIB Word 5 is used to calculate the skew. In some systems the normal spiral skew algorithm is not effective because the data is placed on the drive in an unusual way. In this case, the user can specify the skew on a track-for-track basis by setting the skew in Word 13 of the IOPB.

A nonzero value in Word 13 encountered during a FORMAT TRACK operation causes the skew in the UIB to be ignored and the data in Word 13 to be interpreted as the number of sectors that sector 0 is to be skewed from the index pulse.

How To Determine Skew

If the UIB data is used, the V/SMD 3200 uses the following algorithm to determine the skew on a track. The first sector on the track is placed N sectors from the index pulse. N is determined by multiplying the skew factor by either the cylinder number (for increment by cylinder schemes) or by the head number (for increment by head schemes). If the number that results from that operation is larger than the number of sectors per track, then the it must be divided by the number of sectors per track. The remainder represents the distance (in sectors) between the first sector on the track and the index pulse.

Example: Skew = 5 Head = 9 Sectors/Track = 16

1. 5 * 9 = 45
2. 45/16 = 2, remainder 13
3. N = 13

INTERLEAVE

All of the sectors on a track of data are numbered sequentially from 0 to N minus 1, but are not necessarily physically contiguous (N = the number of sectors each track contains). The interleave factor controls the physical separation of these logically sequential sectors. For example, on a disk with an interleave factor of 2:1, logical sectors 1 and 2 are actually one physical sector apart. Interleave factors other than 1:1 are only used when the V/SMD 3200 is operating without caching. In most cases, caching and zero latency reads/writes provide better system performance than interleaving. If you wish to use interleave factors other than 1:1, please call the Interphase Applications Engineerig Department so that we can help you optimize your system.

SHORT SECTORS

When the total number of bytes per sector is not evenly divisible by the number of sectors per track, there will be bytes left over on the track. Some drives put the excess bytes in the last sector, while other drives create a "runt" or short sector. The V/SMD 3200 supports the use of short sectors with the stipulation that the short sector's sector pulse must occur at least 120 microseconds before the index pulse. This is so that the controller can write and recognize a header field that identifies the short sector. The short sector option is enabled by setting bit 7 of the UIB attributes byte (Byte E) to '1'. If a short sector is enabled, it should not be counted when setting the UIB sectors per track byte.

PHYSICAL AND LOGICAL TRANSLATION

Most operating systems store data in logical addresses, and in order to access or move the data, the host CPU must translate the logical addresses to physical addresses. The V/SMD 3200 offers a logical translation option which relieves the host of this activity. In many cases, allowing the V/SMD 3200 to perform the logical-to-physical translation results in improved overall system performance. This command option is selected with bit 4 of the lower byte of IOPB Word 0.

DISK SURFACE ANALYSIS

Many disk manufacturers will send a media flaw map with the drive. However, there will usually be a difference between the manufacturer's media flaw map and the results of the disk user's surface analysis. This is because some disk manufacturers conduct their testing under environmental extremes and measure

internal analog signals to detect bad media. Therefore, some users with very controlled disk environments may choose to ignore the manufacturer's flaw map and only map (or deallocate) areas that his/her surface analysis detects. **Interphase** recommends recording all of the manufacturer's flaws in addition to any other flaws that may be indicated by the surface analysis. This is because a flaw not indicated by the initial surface analysis may show up after a period of time. The V/SMD 3200 has some useful features that facilitate surface analysis. For example, the "Format Track With Data" command allows worst case data patterns to be placed while formatting, and the "Verify Track" command provides a quick way to check data integrity.

In order to detect media flaws that occur over a period of time, some users keep disk statistics. This activity is simplified by the ability of the V/SMD 3200 to report a command completed with exception status (code 83). If this status is returned in the IOPB, the host can examine the error byte to determine what type of error recovery was required to obtain good data. The host can then log the error condition and the disk location, thus maintaining accurate statistics on the disk.

FAULTY MEDIA MAPPING

It is not uncommon for a hard disk drive to have imperfect media on the disk surface. It is assumed by the manufacturer that these bad areas will be "mapped out." Even if perfect media is shipped, bad areas may develop over time.

Bad Track Mapping

Most operating systems allow for this condition through some sort of deallocation scheme. These schemes usually deallocate large blocks of disk space. This method, however, proves to be wasteful. A more efficient method of dealing with this problem is through "bad track mapping." When a bad area is detected, the track on which it occurs can be "mapped" to an alternate track on the disk.

When the mapped bad track is encountered during a READ or WRITE operation, the V/SMD 3200 automatically seeks to the alternate track. This scheme is efficient in terms of disk space, but a slight speed penalty is incurred due to the extra seek that is required.

Bad Sector Mapping

When speed is more important than disk space, or if a very high number of disk flaws is anticipated, it may make more sense to use "bad sector mapping." This method of bad area mapping requires that room for a spare sector be left on each track when the disk is originally formatted.

When a bad sector is mapped, the track is reformatted such that the bad sector is moved to the next consecutive sector, which is in turn moved to the next consecutive sector, and so on until the last sector is moved into the spare sector space. This is called "sector slipping."

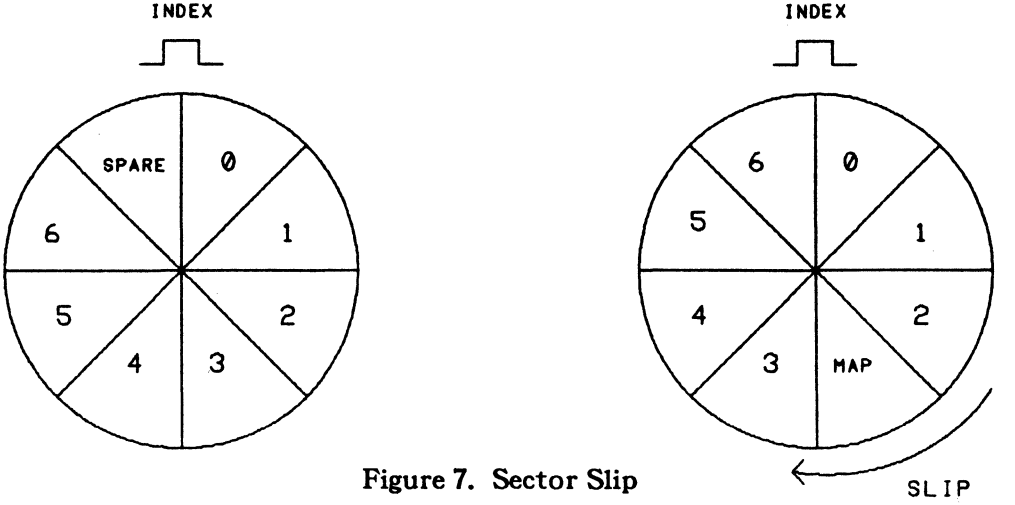


Figure 7. Sector Slip

The V/SMD 3200 marks the sector containing the bad area as unusable. When the marked sector is encountered during normal READS and WRITES, the V/SMD 3200 knows to go on to the next sector instead. The V/SMD 3200 supports both bad track mapping and bad sector mapping.

NOTE

An error will result if bad sector mapping is attempted on a track that has already been mapped bad.

SECTION 5

V/SMD 3200 INSTALLATION

CABLING OPTIONS

The SMD drive cables connect to the V/SMD 3200 through vertically mounted headers (J1-J3) on the V/SMD 3200 card. J2 is the header for drive 0 and J3 is the header for drive 1. This connection scheme was chosen to provide flexibility to the user. Cables can be routed through the front, back, or side of a card cage.

If the cables are routed through the back of the card cage, the V/SMD 3200 card will probably have to be installed into the card cage last so that there is room to route the cables around connector P2. Also, if the cables are routed through the back or side of the card cage, there must be enough slack in the cables to allow the card to be removed while the cables are attached. If the cables are routed through the front of the card cage, they can exit through the notch provided in the front panel.

Figure 8 on the following page shows the position of the cable connections, the jumpers, and the location of the option switches on the V/SMD 3200 printed circuit card. Please refer to the diagram for information as indicated in the remainder of this section of the user's guide.

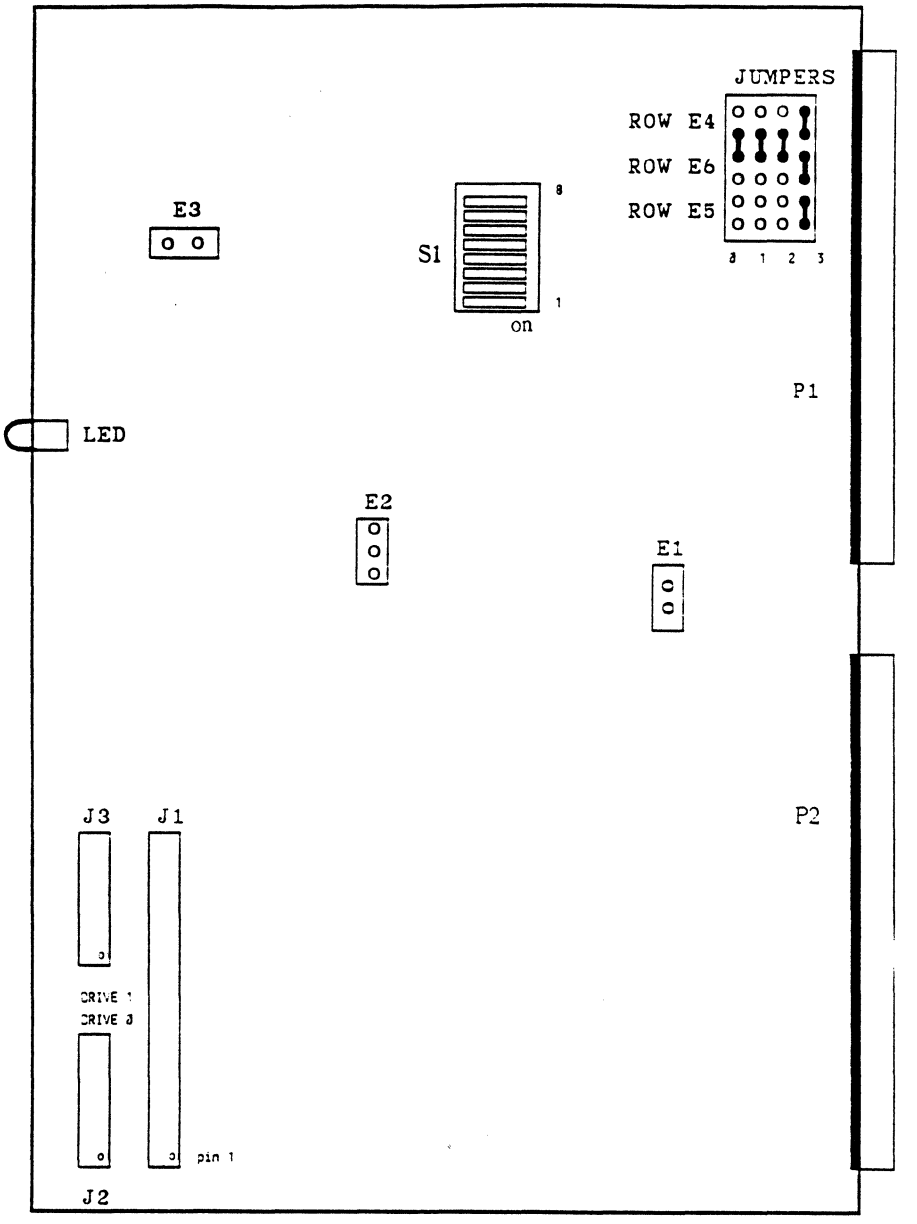


Figure 8. Board Layout

OPTION SWITCH SETTINGS

The V/SMD 3200 has a switch block (S1) that contains eight switches (numbered 1-8). (See Figure 8 on the preceding page.) These switches are used to select the base address of the controller.

Switches one through seven correspond to the address lines A9-A15 respectively. An OFF switch has a value of '1' and an ON switch has a value of '0.'

Switch eight is used to select the address modifiers for the V/SMD 3200 short I/O space. If switch eight is on, only supervisor accesses are permitted (address modifier 2D only). If switch eight is off, then both 2D and 29 address modifiers are selected.

The following is a sample switch setting for a starting base address of 8600, supervisor only accesses.

ADDRESS BIT		A15	A14	A13	A12	A11	A10	A9
SWITCH #	8	7	6	5	4	3	2	1
VALUE	ON	OFF	ON	ON	ON	ON	OFF	OFF
SUPERVISOR ONLY		8 UPPER NIBBLE, LOWER WORD				6 LOWER NIBBLE, LOWER WORD		

Figure 9. Sample Switch Block Setting

The following figure contains a blank switch block so that the user can maintain a record of the desired switch settings for his/her application.

ADDRESS BIT		A15	A14	A13	A12	A11	A10	A9
SWITCH #	8	7	6	5	4	3	2	1
VALUE	___	___	___	___	___	___	___	___

Figure 10. Switch Block Notes

JUMPER SETTINGS

The user can select bus request priority from 0 (lowest) to 3 (highest) using the on-board jumpers. For the physical location of the jumpers for this option, refer back to Figure 8. All of the possible jumper configurations for bus request priorities (0 to 3) are illustrated below.

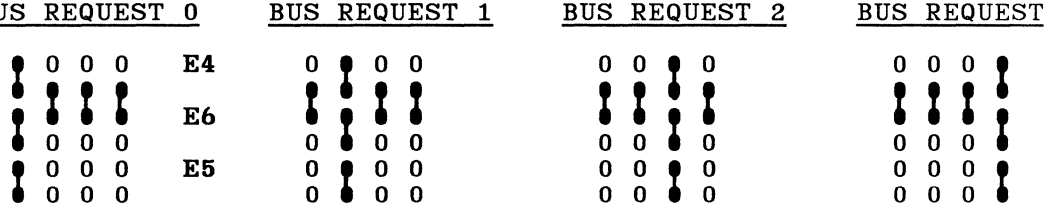


Figure 11. Jumper Configurations

The unmarked jumpers are for factory use only and should not be changed by the user. The board is shipped with the jumpers in the positions shown in Figure 8, Board Layout.

INSTALLATION

The V/SMD 3200 is designed to ensure easy installation into the VME system.

Upon receipt of the board, check to make sure that no damage has occurred during shipping. Usually, a thorough visual inspection is sufficient since each board is thoroughly checked at Interphase just prior to shipment.

WARNING

Do NOT install or apply power to a damaged board. Failure to observe this warning could result in extensive damage to the board and/or system.

If the board is undamaged and all parts are accounted for, proceed with the installation.

1. The first step is to set all on-board jumpers so that the V/SMD 3200 is properly configured for operation within your system. Those options are discussed at the beginning of this section, and should be reviewed before continuing.

2. Once the board is configured, ensure that both the system power and the disk drive power are OFF.

WARNING

System power and disk drive power must be OFF before the V/SMD 3200 can be installed. Failure to do so may result in severe damage to the board and/or system.

3. When the power is off, connect the "A" cable (see Section 6 for details) to the disk drive, making sure that the pins are properly oriented. If only one disk drive is used, it must be connected to the last connector on the cable.

   Then, install terminators on the last drive on the cable. (If only one drive is connected, the terminators must be connected to that drive.)

4. After routing the "A" cable through the VME system to the proper card slot, connect a "B" cable (see Section 6 for details) to the disk drive. If a more than one drive is used, connect a "B" cable to each one, ensuring that the pins are properly oriented.

5. Route the "B" cable to the proper VME card slot, and insert the V/SMD 3200 about one-third of the way into the slot. Carefully connect the cables as follows:

   "A" Cable - J1
   "B" Cable - J2 (Drive 0)
   "B" Cable - J3 (Drive 1)

NOTE

See the Applications Note for installation and cabling information if the optional small expander board is used for four unit operation.

6. Carefully slide the board the rest of the way into the slot. It should slide all the way in without any difficulty. If it doesn't pull it out and check to make sure that the cables are not in the way.

   If there is not enough clearance for the board, the cable strain relief may need to be removed.

7. Once the board is properly installed in the slot, tighten the captive mounting screws on each end of the board.

When the board is installed, run a complete test on the system to ensure system integrity.

SECTION 6

SPECIFICATIONS

VMEbus SPECIFICATIONS:

DTB Master	:	A32, D8, D16, D32 DMA transfers
DTB Slave	:	A16, D8, D16 (Commands & Status)
Requester	:	Any of R(0-3) (static)
Interrupter	:	Any of I(1,7) (Dynamic)
Data Rate	:	Up to 24 Megabits per second

ENVIRONMENTAL SPECIFICATIONS:

Operating Temperature	:	32-131 deg. F. (0-55 deg. C)
Maximum Relative Humidity	:	10-90% noncondensing

ELECTRICAL SPECIFICATIONS:

Power:	4.5 A max @ +5V DC (± 5%) 0.5 A max @ -12V DC (± 5%)

PHYSICAL SPECIFICATIONS:

Length	:	9.20" (233 mm)
Width	:	6.30" (160 mm)
Thickness	:	0.77" (19.6 mm)
Weight	:	1.01 lb. (0.45 kg)

The V/SMD 3200 uses industry standard "A" cable (daisy chain), and "B" cable (radial) to interface with the drives. The "B" cables may be up to 50 feet long, and the "A" cable may be up to 100 feet long. The V/SMD 3200 is compatible with all known SMD drives, some of which are listed below.

ALPHA DATA	FUJITSU	MEMOREX	STC
AMCODYNE	HITACHI	NEC	TECSTOR
AMPEX	IMI	NORTHERN TELECOM	TOSHIBA
CENTURY DATA	KENNEDY	PERTEC	
CONTROL DATA	MEGAVAULT (SLI)	PRIAM	...and all other SMD drives

"A" CABLE

DESCRIPTION	3M PN	BRAND REX
Connector (60 pos.)	3334-6660	
Connector pull tab	3490-6	
Shielded cable, 30 pair, AWG		T-7978-30PR-286A

CONTROLLER		Lo, Hi	DRIVE
Init Select Tag		22, 52	
		23, 53	
Unit Select 2		24, 54	
Unit Select 2		26, 56	
Unit Select 2 /Tag 5	T5	27, 57	
Tag 1	T2	1, 31	
Tag 2	T2	2, 32	
Tag 3	T2	3, 33	
Bit 0 Bus Out	T2 T3	4, 34	
Bit 1 Bus Out	T2 T3	5, 35	
Bit 2 Bus Out	T2 T3	6, 36	
Bit 3 Bus Out	T2 T3	7, 37	
Bit 4 Bus Out	T2 T3	8, 38	
Bit 5 Bus Out	T2 T3	9, 39	
Bit 6 Bus Out	T2 T3	10, 40	
Bit 7 Bus Out	T2 T3	11, 41	
Bit 8 Bus Out	T2 T3	12, 42	
Bit 9 Bus Out	T2 T3	13, 43	
Open Cable Detect		14, 44	
Bit 0 Bus In	T2 T4	19, 49	
Bit 1 Bus In	T2 T4	17, 47	
Bit 2 Bus In	T2 T4	16, 46	
Bit 3 Bus In	T2 T4	15, 45	
Bit 4 Bus In	T2 T4	28, 58	
Bit 5 Bus In	T2 T4	20, 50	
Bit 6 Bus In	T2 T4	18, 48	
Bit 7 Bus In	T2 T4	25, 55	
Power Seq. Pick (Power On)		29	
Power Seq. Hold (Power On)		59	
Busy	T2	21, 51	
Tag 4		30, 60	

60-Position, 28 AWG, Sheielded Cable
Maximum Length: 100 Feet

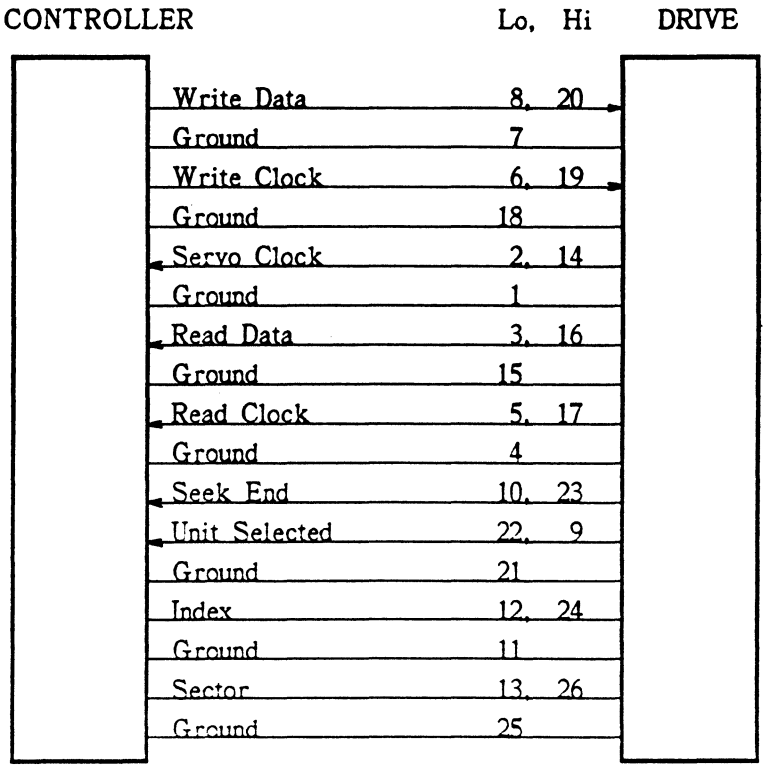
T1 - Dual Channel Units Only
T2 - Gated By Unit Selected
T3 - Bus Out Information
T4 - Bus In Information
T5 - Gated By Unit Selected
T6 - Logical "AND" of T4 & T5

Figure 12. "A" Cable Interface

"B" CABLE

DESCRIPTION	3M PN	BRAND REX
Connector (26 pos.)	3399-6626	
Connector pull tab	3490-3	
Shielded Cable, 13 pair, 28 AWG		T-7978-13PR-286A

"B" CABLE



26-Conductor, Shielded Cable
Maximum Length: 50 feet

No Signals Gated by Unit Selected

Figure 13. "B" Cable Interface

SMD INTERFACE *

BUS OUT BIT	UNIT SELECT TAG	TAG 1 CYLINDER SELECT	TAG 2 HEAD AND HIGH ORDER CYLINDER SEL.	TAG 3 CONTROL SELECT
0		2^0	2^0	WRITE GATE
1		2^1	2^1	READ GATE
2		2^2	2^2	SERVO OFFSET PLUS
3		2^3	2^3	SERVO OFFSET MINUS
4		2^4	2^4	FAULT CLEAR
5		2^5		ADDR. MARK ENABLE
6		2^6		RETURN TO ZERO
7		2^7	2^{10}	DATA STROBE EARLY
8		2^8	2^{11}	DATA STROBE LATE
9	PRIORITY SELECT	2^9		CHANNEL RELEASE

BUS IN BIT	DRIVE STATUS
0	UNIT READY
1	ON CYLINDER
2	SEEK ERROR
3	FAULT
4	WRITE PROTECT
5	ADDRESS MARK
6	INDEX MARK
7	SECTOR MARK

Figure 14. Tag Bus Decode

The SMD interface is a multiplexed Tag Bus interface. Commands are sent to the drive via ten bus-out bits. The meaning of the bits is determined by one of three tags. Tag 1 is the cylinder tag, Tag 2 is the head tag, and Tag 3 is the control tag. Status is returned on the eight bus-in bits.

APPENDIX A

UIB PARAMETER TABLE

DRIVE TYPE AND MODEL	SECTORS/TRACK (DEC) 256	512	1024	2048	GAP SIZE (DEC) 256/512/1024 G1	G2	DRIVE NOTES
AMCODYNE							
7110	64	32	XX		16	16	1,3
AMPEX							
DM940,DM980	64	32	16		16	16	1
9160,9300	64	32	16		16	16	1
DFR SERIES	64	32	16		16	16	1
9100,9200	44	22	12		16	16	1
CAPRICORN	64	32	16		16	16	1
CDC							
9400,9700	64	32	16		16	16	1,2
LARK 9455	64	32	XX		16	16	1,3
LARK 9457	XX	32	XX		16	16	1,3
9772XMD	XX	80	45		16	16	
9720EMD	XX	48	27		16	16	
CDC FSD 340	64	32	16		16	16	1
CDC FSD 515	90	48	24		16	16	
CDC9771XMD	160	80	40		16	16	
CENTURY DATA							
T80,T3000	64	32	16		16	16	1,2
T20,T25,T50	44	22	12		16	16	1
M20,M40,M80	64	32	16		16	16	1
AMS190	75	40	20		16	16	1
M160,AMS380	80	50	25		16	16	1
C2075,C8048	64	32	XX		16	16	1
DISK TEK ONE							
ALL MODELS	64	32	16		16	16	1
FUJITSU							
2311,2312	64	32	16		16	16	1,5
M2284	64	32	16		16	16	1
M2351/EAGLE	80	44	24		16	16	4
M2361	128	64	32		12	12	1,6
2333	128	64	32		12	12	1,6
HITACHI							
DK815-5	XX	48	XX		12	12	
DK5125-17	XX	34	XX		10	10	

UIB PARAMETER TABLE (cont.)

DRIVE TYPE AND MODEL	SECTORS/TRACK (DEC) 256	512	1024	2048	GAP SIZE (DEC) 256/512/1024 G1	G2	DRIVE NOTES
KENNEDY/BASF							
6170	32	22	11		16	16	1
MICROPOLIS							
1400 SERIES	64	32	16		16	16	1
NEC CORP							
D2200 SERIES	64	32	16		16	16	1
NORTHERN TELECOM							
8200	XX	33			8	8	1
8300	XX	33			8	8	1
PERTEC							
DX180	XX	32	18	9	12	12	
DX240	XX	32	18	9	12	12	
DX300	XX	32	18	9	12	12	
PRIAM							
806	XX	32	18	9	16	16	
807	XX	32	18	9	16	16	
808	XX	32	18	9	16	16	
3350,6650	64	32	16		16	16	1
3450,7050	32	21	16		16	16	1
15450,803	64	22	16		16	16	1
SLI							
CHEYENNE	32	22	11		16	16	1
TECSTOR							
	64	32	16	10	16	16	1

DISK DRIVE INTERFACING NOTES

NOTE 1: For information on 2048 byte sectors and larger, please contact INTERPHASE CORPORATION.

NOTE 2: Certain CDC 9400 series and equivalent drives have unique characteristics that require special attention when run with 1024 byte sectors. Please contact the INTERPHASE Application Engineering department for assistance in using 1024 sector sizes for these drives.

NOTE 3: This drive has an embedded servo and has only two fixed sector size options, 32 or 64 sectors per track.

NOTE 4: Early manuals on the EAGLE drives have errors in the tables that show the switch settings vs. sectors per track. The switch settings should be verified using the formula given in the disk drive manual.

NOTE 5: Drive switch settings for the Fujitsu 2312 and 2311 for 2048 sector sizes are as follows:

S2						
1	2	3	4	5	6	7
C	C	O	C	O	C	C

S3						
1	2	3	4	5	6	7
O	O	O	O	C	O	O

Figure 15. Fujitsu Drive Switch Settings

NOTE 6: If this drive is set up for 128 sectors/track, The V/SMD 3200 must operate in sequential mode. If zero latency reads and writes, and caching is needed, the drive must be set up for 115 sectors/track.

APPENDIX B

IOPB COMMAND CODES

CODE	COMMAND	CODE	COMMAND
70	DIAGNOSTICS	8B	REFORMAT
71	READ LONG	8C	FORMAT TRACK WITH DATA
72	WRITE LONG	90	MAP SECTOR
74	READ HEADER	91	READ SECTORS SEQUENTIAL
75	READ RAW DATA	92	WRITE SECTORS SEQUENTIAL
76	READ CDC FLAW MAP	93	VERIFY SECTORS SEQUENTIAL
77	REPORT CONFIGURATION	94	READ NONCACHED
78	WRITE SECTOR BUFFER	95	READ SEQ., DISABLE ADDR.
79	READ SECTOR BUFFER	96	WRITE SEQ., DISABLE ADDR.
81	READ SECTOR(S)	97	CLEAR DRIVE FAULT
82	WRITE SECTOR(S)	99	VERIFY TRACK
83	VERIFY SECTOR(S)	9A	TRACK ID
84	FORMAT TRACK	9B	FETCH AND EXECUTE IOPB
85	MAP TRACK	9C	VERIFY TRACK SEQUENTIAL
86	HANDSHAKE	9E	EXTENDED DIAGNOSTICS
87	INITIALIZE	9F	DUAL PORT PRIORITY SELECT
89	RESTORE	A1	READ AND SCATTER
8A	SEEK	A2	GATHER AND WRITE

70 - DIAGNOSTICS: This command causes the power-up diagnostics to be executed within the V/SMD 3200. Diagnostic tests include checksum on the EPROMS, memory test on the RAM buffer, handshaking with the disk interface hardware, and operation of the buffer control hardware. Any errors will be reported as command completed with error (command status code 82). For a complete list of the error codes, refer to pages Appendix D of this User's Guide.

71 - READ LONG: This is a diagnostic tool used to read and transfer the data field and the four ECC bytes of a disk sector. Error detection is disabled during a READ LONG command.

72 - WRITE LONG: The WRITE LONG command is the reverse of the READ LONG command. This is a diagnostic tool used to write the data field and the four bytes of the ECC to the appropriate sector on the disk. Error detection is disabled during a WRITE LONG command.

74 - READ HEADER: This command causes the drive to read the first header field that it encounters. If logical translation is not enabled, the cylinder number is returned in Word 2, the head number is returned in the upper byte of Word 3, and the sector that was encountered is returned in the lower byte of Word 3. Since the command only reads the first header field that it encounters, the sector number will vary from command to command on the same track. If logical translation is enabled, the logical value of the first sector encountered is placed in Words 2 and 3 with Word 2 as the most significant word.

75 - READ RAW DATA: This command causes the drive to read data from the specified disk starting at the index pulse. The command is initiated as soon as the drive reads the sync pulse. The data that is specified in the UIB bytes/sector field is then read and the data is transferred as specified by the IOPB.

76 - READ CDC FLAW MAP: This command is similar to the READ RAW DATA command, except it compensates for the unique structure of the Control Data Corporation flaw map sync byte. If the normal READ RAW DATA command were used on a CDC flaw map, the data would be returned "bit-shifted" by three bits. This command causes the V/SMD 3200 to accommodate this shift and make the appropriate adjustments for reading the data.

77 - REPORT CONFIGURATION: This command causes the operating parameters (UIB) of the specified unit to be returned. The data is written to memory and pointed to by the buffer address pointer (Words 5 and 6), the memory type, and the address modifier (Word 7) in the IOPB. The UIB is returned in the exact format in which it was written.

78 - WRITE SECTOR BUFFER: This diagnostic command transfers one sector of data from system memory to the on-board memory of the V/SMD 3200. It does not transfer the data to the disk. The purpose of this command is to check the handshaking over the VMEbus. It is used in conjunction with the READ SECTOR BUFFER command.

79 - READ SECTOR BUFFER: This is a diagnostic command that transfers one sector's worth of data from an on-board buffer to system memory. The purpose of this command is to allow a VMEbus transfer check. It is used in conjunction with the WRITE SECTOR BUFFER command. The buffer that is loaded with the WRITE SECTOR BUFFER command is transferred to system memory, and no data is read from the disk. If the READ SECTOR BUFFER command is not preceded by a WRITE SECTOR BUFFER command, any arbitrary sector buffer can be transferred and a command completed with exception will result.

81 - READ SECTOR(S): This command reads one or more sectors of data from the specified disk (or from cache memory if the data has been cached) and transfers the data to system memory. The starting sector is specified in Words 2 and 3 of the IOPB. If the logical translation mode option was specified in the lower byte of the command word, a logical-to-physical translation is done on the specified disk address. The number of sectors transferred is determined by the sector count in Word 5 of the IOPB. The data is transferred to system memory starting at the address given in the buffer address words of the IOPB (Words 5 and 6). The transfer is done with the V/SMD 3200 as Bus Master, thus relieving the host CPU of the burden of performing the transfers.

82 - WRITE SECTOR(S): This command is the reverse of READ SECTOR(S). Data is not cached on write operations.

83 - VERIFY SECTOR(S): This command is used to verify that one or more logically sequential sectors of previously written data contains no ECC errors. No data is transferred to the VMEbus during this command. Data is always read from the disk during this command, and the cache is not used. This command does not check the spare sector (if one exists) unless it has already been mapped. The sector or sectors of data to be verified are specified exactly like the READ SECTORS command.

84 - FORMAT TRACK: This command is used to format a given track with the proper header information. Formatting records header information for each sector on the track to allow the V/SMD 3200 to verify head position prior to a read or write. All disk surfaces must be formatted before they can be read from or written to. The first two words in the data field of each sector will contain the cylinder number (in the first word), the head number (in the MSB of the second word), and the sector number (in the LSB of the second word). The rest of the sector is filled with the data supplied in Word 6 of the IOPB. The track to be formatted is specified in Words 2 and 3 of the IOPB.

85 - MAP TRACK: This command is used to map a bad track on any disk surface to any available spare track on the disk surface. The bad track and the spare track are identified in the IOPB. The track to be mapped is identified in Word 2 and the upper byte of Word 3 of the IOPB (cylinder address and head address in physical mode). The alternate (spare) track is specified in Words 4 and 5 with word 4 as the alternate (spare) cylinder address, and the upper byte of Word 5 as the alternate (spare) head address. The bad track is formatted with a special header field that allows the V/SMD 3200 to recognize it as a bad track. This field also tells the V/SMD 3200 where the spare track is located. When the bad track is encountered during a normal operation, the V/SMD 3200 recognizes the special format and automatically seeks the specified spare track. This operation is transparent to the user, except for the extra seek time required to get to the alternate (spare) track.

86 - HANDSHAKE: This command is a diagnostic tool used to verify controller operation. When executed, this command returns product identification information in Words 2-7 of the IOPB. Word 2 contains the product code in the upper byte and the reference designation in the lower byte. Word 3 contains the PROM ID and revision level, Word 4 is reserved and must be all zeros, Word 5 contains the release month and date, and Word 6 contains the release year. Word 7 is reserved and must be all zeros.

87 - INITIALIZE: This command is used to initialize the V/SMD 3200 with parameters that identify the type of disk drive(s) being used. One INITIALIZE command is needed for each drive. The INITIALIZE command tells the V/SMD 3200 all of the information necessary to run the drive, including the drive-dependent options as specified in the Unit Initialization Block (UIB). This command can be issued at any time to change the operating characteristics of a drive. The initialization procedure and the UIB are detailed later in this section.

89 - RESTORE: This command causes the specified drive to be recalibrated and any faults to be reset. The RESTORE command seeks the drive to cylinder 0 by issuing either a recalibrate or seek home command to the drive. It then restores any fault conditions by issuing a CLEAR FAULT to the drive. RESTORE waits for recalibrate to finish and the fault to be cleared before the completion interrupt is generated. If the recalibrate fails, a command complete with error condition will result after a timeout. The error code will be 1C, 1D, 1F or 30.

8A - SEEK: The SEEK command causes the specified drive to move its read/write heads to the specified cylinder and then select the specified head. This command is primarily used for overlapped seeks, since commands such as READ SECTOR or WRITE SECTOR have implied seeks. The seek command generates a command complete interrupt as soon as it is done (i.e., as soon as the seek has started). Thus, the V/SMD 3200 does not wait for the seek to complete before allowing execution of the next command. The V/SMD 3200 can be programmed, via the UIB, to generate a disk status change interrupt when a drive completes a seek.

8B - REFORMAT: This command formats a track exactly like the FORMAT command does, unless the specified track was previously mapped as bad, or if bad sector mapping has been performed on the track. If the specified track is mapped bad, then the alternate (spare) track is formatted for the bad track, and the bad track is left unchanged. If bad sector mapping was performed, the track will be reformatted with the same sector mapped as bad. This command is used to format without having to worry about remapping tracks that were previously mapped bad. Skew and interleave are calculated as with the normal format.

8C - FORMAT TRACK WITH DATA: This command is similar to the FORMAT TRACK command except that the user can specify a block of data to be written to each sector on the track. Each sector of data that is to be written is pointed to by the buffer address pointer (Words 5 and 6), the memory type, and the address modifier (Word 7). The same data is written to each sector, so the sector count in the IOPB is not required when using this command. The number of sectors is specified by the SECTORS PER TRACK byte in the UIB. This command is used for surface analysis of the disk. Skew and interleave are calculated as with the normal format.

90 - MAP SECTOR: The MAP SECTOR command identifies and maps a sector on a given track that is bad. This command causes the track to be reformatted, and the bad sector to be formatted with a special header field. All sectors proceeding the bad sector are "slipped" out one-by-one towards the end of the track. This allows the spare sector to be used during a READ or WRITE without requiring extra latency. Skew and interleave are calculated as with normal formatting. To use this command, the "spare sector enable" bit must be set in the UIB. It should also be noted that only one sector per track can be mapped using this command. If a larger area must be mapped, the MAP TRACK command must be used.

91 - READ SECTOR(S) SEQUENTIAL: This command is similar to the normal read command except the zero latency feature is turned off. This forces the drive to begin reading data at the beginning of the sector specified by the IOPB. This command is usually used in situations that require data to be read in a specific order.

92 - WRITE SECTOR(S) SEQUENTIAL:
This is the reverse of READ SECTOR(S) SEQUENTIAL. Data is not cached on write operations.

93 - VERIFY SECTOR(S) SEQUENTIAL: This command is similar to the normal VERIFY SECTOR(S) command except the zero latency feature is turned off. This forces the drive to begin verification starting at the beginning of the sector specified in the IOPB. No data is transferred to the VMEbus during this command.

94 - READ NONCACHED: This command executes in the same manner as the READ SECTOR(S) command, except that the cache buffer is ignored. The data will be read from the disk drive regardless of whether or not it is already contained in the cache. This command is useful for verifying that the data has been correctly written to the disk.

95 - READ SEQUENTIAL, DISABLE ADDRESS: This command is the same as the READ SEQUENTIAL command except an address disabling feature has also been added. When this command is used, the bus address is not incremented on the VMEbus; therefore, data is transferred to a single address instead of a block of memory.

96 - WRITE SEQUENTIAL, DISABLE ADDRESS: This command is the reverse of the READ SEQUENTIAL, DISABLE ADDRESS command.

97 - CLEAR DRIVE FAULT: This command issues a CLEAR FAULT to the specified drive. No head movements are initiated. CLEAR DRIVE FAULT waits for any fault conditions to be cleared before the completion interrupt is generated. If the fault condition fails to clear, the interrupt is generated after a timeout. If this happens, the Error Code byte and Drive Status byte indicate the remaining fault conditions.

99 - VERIFY TRACK: This command is used to verify that all of the sectors on a track, except the spare sector (unless already mapped), are readable and contain no ECC errors. No data is transferred to the VMEbus during execution of this command. If this track has been mapped bad, the alternate (spare) track is verified. Data is always read from the disk during execution of this command, and the cache is not used. The track to be verified is specified in Words 2 and 3 of the IOPB.

9A - TRACK ID: This command causes the head to read all of the header fields on a given track and return them in the order in which they were encountered starting from the index pulse. This command is useful in determining the format of a particular track (interleave and skew). The track number is specified in Word 2 of the IOPB, in physical mode only. The headers will be transferred to system memory starting at the buffer address specified in Words 5 and 6 of the IOPB. Four (4) words are transferred for each header that is found. The first word contains the sync field and the cylinder number, and the second word contains the head and sector number (upper and lower byte, respectively). The third word contains duplicate head and sector information for error detection, and the fourth word contains all zeros. The total number of words transferred is equal to four times the number of sectors per track specified in the UIB. All headers returned are physical addresses.

9B - FETCH AND EXECUTE IOPB: This command is used to allow external IOPBs to direct the activities of the V/SMD 3200. This command code must be written to the resident internal IOPB (Word 0 - upper byte), and the location of the external IOPB must be pointed to by the IOPB pointer (Words 10 and 11), the IOPB memory type, and the address modifier code (Word 12). When the GO bit is set, all information in the resident IOPB is ignored except for the IOPB pointer address. The V/SMD 3200 will next go to the address in the IOPB pointer and read in the external IOPB, and then the commands from this IOPB are executed.

The FETCH AND EXECUTE command code can only be used in the resident IOPB. If a FETCH AND EXECUTE command code is found in an external IOPB (i.e., not in short I/O space), an error (code 15) will result. If the external IOPB is not fetched successfully during a FETCH AND EXECUTE command, a BUSY ERROR will result. The only action taken by the V/SMD 3200 under these circumstances will be to set the OPERATION DONE bit and the error bit in the Command/Status Register and to wait for the host to respond. No interrupts will be generated because it is not possible for the V/SMD 3200 to know which interrupt vector to use, or which command options are in effect when an external IOPB is read incorrectly. This action will be the same in the case of linked external IOPBs. FETCH AND EXECUTE commands cannot be nested (i.e., the resident IOPB cannot point to another FETCH AND EXECUTE).

9C - VERIFY TRACK SEQUENTIAL: This command is the same as the VERIFY TRACK command, except the zero latency feature is turned off and the data is always read starting at sector 0.

9E - EXTENDED DIAGNOSTICS: This command causes diagnostic tests not included in the normal diagnostic command (command code 70) to be performed during system power-up. If the IOPB buffer address is nonzero, the VME buffer read and write functions are tested. If the IOPB cylinder, head and sector numbers are all nonzero, then the following tests are performed: select drive and check for unit ready, issue seek to the drive, wait for "on cylinder" and check write protect, format track, and verify track. Any errors will be reported as commands completed with error (command status code 82). Once the command has completed, the results of the tests will reside in the reserve byte of the IOPB.

9F - DUAL PORT PRIORITY SELECT: When operating dual-ported drives, this command should be used to cause the drive to immediately release (within 600 nanoseconds) the controller from either port and respond to the requesting controller. This command should only be used when it is determined that a controller has crashed or become inoperative but still has the drive selected or reserved.

A1 - READ AND SCATTER: The scatter command allows the user to place contiguous disk data in noncontiguous system memory. The disk control aspects of the scatter command are identical to those of the read sectors command (81). For more information on scatter, see Section 3.

A2 - GATHER AND WRITE: The gather command allows the user to place noncontiguous areas of system memory in contiguous disk areas. The disk control aspects of the gather command are identical to those of the write sectors command (82). For more information on gather, see Section 3.

APPENDIX C

The figures in this appendix give detailed information about each of the V/SMD 3200 commands. Each figure provides the following:

COMMAND CODE: The hex value of the command code is shown here. The pages are presented in ascending command code order.

COMMAND NAME: The name of the command is given here.

IOPB FORMAT: The data requirements for the IOPB are given here. The position of the parameters is consistent for all commands. Some commands do not require all of the parameters and others (such as FORMAT TRACK) require some unique parameters. The codes used in this section are defined directly below the IOPB FORMAT area. INTERPHASE recommends setting the "DON'T CARE" parameters to zero. This will insure that future enhancement of some of the commands will have no effect on existing drivers.

DATA TRANSFERS: The direction and type of any data transfers that result from the execution of the command are given here.

BLOCK SIZE: If data transfers are performed, the size of one block of data is given here. Each transfer will be either the size specified here or smaller depending on the DMA TRANSFER COUNT parameter. The total amount of data transferred will always be greater than or equal to the value given here times the value in the block count.

BLOCK COUNT: Either the number of blocks that will be transferred or the parameter that specifies the number of blocks to be transferred is given here.

RESULTANT IOPB FORMAT: The state of the IOPB after the command has been executed is shown here. An 'X' means that the parameter is returned unchanged.

UIB PARAMETERS: All applicable UIB parameters are listed here. All other UIB parameters are "DON'T CARE."

UIB ATTRIBUTES: The attributes listed under this heading must be set in the UIB attributes flag in order to use the command.

COMMAND CODE: 70
COMMAND NAME: DIAGNOSTICS

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	0	1	1	1	0	0	0	0	UN	VO	LK	XL	RV	DE	IE	EC
2	set to '0'										set to '0'					
4	cylinder number (logical addr 31-16)															
6	head number (logical 15-8)								sector number (logical 7-0)							
8	sector count															
A	VME buffer address (bits 31-16)															
C	VME buffer address (bits 15-0)															
E	VME memory type								VME address modifier							
10	IOPB interrupt level								normal complete vector							
12	DMA transfer count								error complete vector							
14	linked IOPB address (bits 31-16)															
16	linked IOPB address (bits 15-0)															
18	linked IOPB memory type								linked IOPB address modifier							
1A	X											set to '0'				

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Don't Care (not used)
RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

Data Transfers: None
Block Size: 0
Block Count: 0

Resultant IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X												X			
2	status code											error code				
4	last cylinder number (logical addr 31-16)															
6	last head number (logical 15-8)								last sector number (logical 7-0)							
8	last VME sector buffer starting address (bits 31-16)															
A	last VME sector buffer starting address (bits 15-0)															
C	X												X			
E	X												X			
10	X												X			
12	X												X			
14	X												X			
16	X												X			
18	X												X			
1A	X												UNDEFINED			

X - RETURNED UNCHANGED

UIB PARAMETERS

UIB ATTRIBUTES

COMMAND CODE: 71
COMMAND NAME: READ LONG SECTOR

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	0	1	1	1	0	0	0	1	UN	VO	LK	XL	RV	X	IE	X
2	set to '0'										set to '0'					
4	cylinder number (logical addr 31-16)															
6	head number (logical 15-8)								sector number (logical 7-0)							
8	X															
A	VME buffer address (bits 31-16)															
C	VME buffer address (bits 15-0)															
E	VME memory type										VME address modifier					
10	IOPB interrupt level										normal complete vector					
12	DMA transfer count										error complete vector					
14	linked IOPB address (bits 31-16)															
16	linked IOPB address (bits 15-0)															
18	linked IOPB memory type										linked IOPB address modifier					
1A	X										set to '0'					

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Don't Care (not used)

RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

Data Transfers: Write to VME system memory **Block Count:** 1
Block Size: (UIB bytes/sector) + 4 ECC bytes

Resultant IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X												X			
2	status code											error code				
4	X												X			
6	X												X			
8	remaining sector count															
A	X												X			
C	X												X			
E	X												X			
10	X												X			
12	X												X			
14	X												X			
16	X												X			
18	X												X			
1A	X												UNDEFINED			

X - RETURNED UNCHANGED

UIB PARAMETERS

Volume boundaries Max cylinder number
Sectors/track
Bytes/sector

UIB ATTRIBUTES

Dual port enable

COMMAND CODE: 72
COMMAND NAME: WRITE LONG SECTOR

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	0	1	1	1	0	0	1	0	UN	VO	LK	XL	RV	X	IE	X
2	set to '0'										set to '0'					
4	cylinder number (logical addr 31-16)															
6	head number (logical 15-8)								sector number (logical 7-0)							
8	X															
A	VME buffer address (bits 31-16)															
C	VME buffer address (bits 15-0)															
E	VME memory type								VME address modifier							
10	IOPB interrupt level								normal complete vector							
12	DMA transfer count								error complete vector							
14	linked IOPB address (bits 31-16)															
16	linked IOPB address (bits 15-0)															
18	linked IOPB memory type								linked IOPB address modifier							
1A	X								set to '0'							

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Don't Care (not used)

RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

Data Transfers: Read from VME system memory **Block Count:** 1
Block Size: (UIB bytes/sector) + 4 ECC bytes

Resultant IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X												X			
2	status code											error code				
4	X												X			
6	X												X			
8	remaining sector count															
A	X												X			
C	X												X			
E	X												X			
10	X												X			
12	X												X			
14	X												X			
16	X												X			
18	X												X			
1A	X												UNDEFINED			

X - RETURNED UNCHANGED

UIB PARAMETERS

Volume boundaries
Sectors/track
Bytes/track
Max cylinder number

UIB ATTRIBUTES

Dual port enable

COMMAND CODE: 74
COMMAND NAME: READ HEADER

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	0	1	1	1	0	1	0	0	UN	VO	LK	XL	RV	X	IE	X
2	set to '0'										set to '0'					
4	X										X					
6	X										X					
8	X										X					
A	X										X					
C	X										X					
E	X										X					
10	IOPB interrupt level										normal complete vector					
12	X										error complete vector					
14	linked IOPB address (bits 31-16)															
16	linked IOPB address (bits 15-0)															
18	linked IOPB memory type										linked IOPB address modifier					
1A	X										set to '0'					

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Don't Care (not used)

RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

Data Transfers: NONE
Block Size: 0

Block Count: 0

Resultant IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X											X				
2	status code											error code				
4	cylinder number (logical addr 31-16)															
6	head number (logical 15-8)								sector number (logical 7-0)							
8	target cylinder number															
A	target head number								target sector number							
C	X											X				
E	X											X				
10	X											X				
12	X											X				
14	X											X				
16	X											X				
18	X											X				
1A	X											UNDEFINED				

X - RETURNED UNCHANGED

UIB PARAMETERS
Volume boundaries
Max number of cylinders

UIB ATTRIBUTES
Dual port enable

COMMAND CODE: 75
COMMAND NAME: READ RAW DATA

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	0	1	1	1	0	1	0	1	UN	X	LK	X	RV	X	IE	X
2	set to '0'											set to '0'				
4	Cylinder number															
6	Head Number												X			
8	X												X			
A	VME Buffer address (bits 31-16)															
C	VME Buffer address (bits 15-0)															
E	VME Memory Type											VME Memory Modifier				
10	IOPB interrupt level											normal complete vector				
12	DMA Burst Count											error complete vector				
14	linked IOPB address (bits 31-16)															
16	linked IOPB address (bits 15-0)															
18	linked IOPB memory type											linked IOPB address modifier				
1A	X											Reserved				

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Don't Care (not used)

RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

Data Transfers: Write to VME system memory **Block Count:** 1
Block Size: UIB bytes/sector

Resultant IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X											X				
2	status code											error code				
4	X											X				
6	X											X				
8	X											X				
A	X											X				
C	X											X				
E	X											X				
10	X											X				
12	X											X				
14	X											X				
16	X											X				
18	X											X				
1A	X											UNDEFINED				

X - RETURNED UNCHANGED

UIB PARAMETERS
Bytes/sector
Max number of cylinders
Volume boundaries

UIB ATTRIBUTES
Dual port enable

COMMAND CODE: 76
COMMAND NAME: READ CDC FLAW MAP

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	0	1	1	1	0	1	1	0	UN	X	LK	X	RV	X	IE	X
2	set to '0'											set to '0'				
4	Cylinder number															
6	Head Number												X			
8	X												X			
A	VME Buffer address (bits 31-16)															
C	VME Buffer address (bits 15-0)															
E	VME Memory Type											VME Memory Modifier				
10	IOPB interrupt level											normal complete vector				
12	DMA Burst Count											error complete vector				
14	linked IOPB address (bits 31-16)															
16	linked IOPB address (bits 15-0)															
18	linked IOPB memory type											linked IOPB address modifier				
1A	X											Reserved				

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Don't Care (not used)

RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

Data Transfers: Write to VME system memory **Block Count:** 1
Block Size: UIB bytes/sector

Resultant IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X												X			
2	status code											error code				
4	X												X			
6	X												X			
8	X												X			
A	X												X			
C	X												X			
E	X												X			
10	X												X			
12	X												X			
14	X												X			
16	X												X			
18	X												X			
1A	X											UNDEFINED				

X - RETURNED UNCHANGED

UIB PARAMETERS
Bytes/sector
Max number of cylinders
Volume boundaries

UIB ATTRIBUTES
Dual port enable

COMMAND CODE: 77
COMMAND NAME: REPORT CONFIGURATION

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	0	1	1	1	0	1	1	1	UN	X	LK	X	X	X	IE	X
2	set to '0'				X							set to '0'				
4	X												X			
6	X												X			
8	X												X			
A	VME buffer address (bits 31-16)															
C	VME buffer address (bits 15-0)															
E	VME memory type								VME address modifier							
10	IOPB interrupt level								normal complete vector							
12	X								error complete vector							
14	linked IOPB address (bits 31-16)															
16	linked IOPB address (bits 15-0)															
18	linked IOPB memory type								linked IOPB address modifier							
1A	X								set to '0'							

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Don't Care (not used)

RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

Data transfers: Write to VME system memory **Block Count:** 1
Block Size: UIB length (9 Words)

Resultant IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X											X				
2	status code											error code				
4	X											X				
6	X											X				
8	X											X				
A	X											X				
C	X											X				
E	X											X				
10	X											X				
12	X											X				
14	X											X				
16	X											X				
18	X											X				
1A	X											UNDEFINED				

X - RETURNED UNCHANGED

UIB PARAMETERS **UIB ATTRIBUTES**

COMMAND CODE: 78
COMMAND NAME: WRITE SECTOR BUFFER

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	0	1	1	1	1	0	0	0	UN	X	LK	X	X	X	IE	X
2	set to '0'											set to '0'				
4	X												X			
6	X												X			
8	X												X			
A	VME buffer address (bits 31-16)															
C	VME buffer address (bits 15-0)															
E	VME memory type										VME address modifier					
10	IOPB interrupt level										normal complete vector					
12	DMA transfer count										error complete vector					
14	linked IOPB address (bits 31-16)															
16	linked IOPB address (bits 15-0)															
18	linked IOPB memory type										linked IOPB address modifier					
1A	X										set to '0'					

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Don't Care (not used)

RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

Data transfers: Read from VME system memory **Block Count:** 1
Block Size: UIB bytes/sector

Resultant IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X											X				
2	status code											error code				
4	X											X				
6	X											X				
8	X											X				
A	X											X				
C	X											X				
E	X											X				
10	X											X				
12	X											X				
14	X											X				
16	X											X				
18	X											X				
1A	X											UNDEFINED				

X - RETURNED UNCHANGED

UIB PARAMETERS
Bytes/sector

UIB ATTRIBUTES

COMMAND CODE: 79
COMMAND NAME: READ SECTOR BUFFER

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	0	1	1	1	1	0	0	1	UN	X	LK	X	X	X	IE	X
2	set to '0'											set to '0'				
4	X												X			
6	X												X			
8	X												X			
A	VME buffer address (bits 31-16)															
C	VME buffer address (bits 15-0)															
E	VME memory type								VME address modifier							
10	IOPB interrupt level								normal complete vector							
12	DMA transfer count								error complete vector							
14	linked IOPB address (bits 31-16)															
16	linked IOPB address (bits 15-0)															
18	linked IOPB memory type								linked IOPB address modifier							
1A	X								set to '0'							

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Don't Care (not used)

RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

Data Transfers: Write to VME system memory **Block Count:** 1
Block Size: UIB bytes/sector

Resultant IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X											X				
2	status code											error code				
4	X											X				
6	X											X				
8	X											X				
A	X											X				
C	X											X				
E	X											X				
10	X											X				
12	X											X				
14	X											X				
16	X											X				
18	X											X				
1A	X											UNDEFINED				

X - RETURNED UNCHANGED

UIB PARAMETERS
Bytes/sector

UIB ATTRIBUTES

COMMAND CODE: 81
COMMAND NAME: READ SECTOR(S)

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	1	0	0	0	0	0	0	1	UN	VO	LK	XL	RV	DE	IE	EC
2	set to '0'								set to '0'							
4	cylinder number (logical addr 31-16)															
6	head number (logical 15-8)								sector number (logical 7-0)							
8	sector count															
A	VME buffer address (bits 31-16)															
C	VME buffer address (bits 15-0)															
E	VME memory type								VME address modifier							
10	IOPB interrupt level								normal complete vector							
12	DMA transfer count								error complete vector							
14	linked IOPB address (bits 31-16)															
16	linked IOPB address (bits 15-0)															
18	linked IOPB memory type								linked IOPB address modifier							
1A	X								set to '0'							

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Don't Care (not used)
RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

Data Transfers: Write to VME system memory **Block count:** IOPB Sector Count
Block Size: UIB bytes/sector

Resultant IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X											X				
2	status code											error code				
4	last cylinder number (logical addr 31-16)															
6	last head number (logical 15-8)								last sector number (logical 7-0)							
8	remaining sector count															
A	last VME sector buffer starting address (bits 31-16)															
C	last VME sector buffer starting address (bits 15-0)															
E	X											X				
10	X											X				
12	X											X				
14	X											X				
16	X											X				
18	X											X				
1A	X											UNDEFINED				

X - RETURNED UNCHANGED

UIB PARAMETERS

Volume boundaries
Retries
Sectors/track
Max Cylinders
Bytes/sector

UIB ATTRIBUTES

Cache Enable
Move Bad Data
Dual port enable
Reseek Enable
Increment by head

COMMAND CODE: 82
COMMAND NAME: WRITE SECTOR(S)

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	1	0	0	0	0	0	1	0	UN	VO	LK	XL	RV	X	IE	X
2	set to '0'								set to '0'							
4	cylinder number (logical addr 31-16)															
6	head number (logical 15-8)								sector number (logical 7-0)							
8	sector count															
A	VME buffer address (bits 31-16)															
C	VME buffer address (bits 15-0)															
E	VME memory type								VME address modifier							
10	IOPB interrupt level								normal complete vector							
12	DMA transfer count								error complete vector							
14	linked IOPB address (bits 31-16)															
16	linked IOPB address (bits 15-0)															
18	linked IOPB memory type								linked IOPB address modifier							
1A	X								set to '0'							

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Don't Care (not used)

RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

Data Transfers: Read from VME system memory **Block Count:** IOPB Sector Count
Block Size: UIB Bytes/sector

Resultant IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X												X			
2	status code											error code				
4	last cylinder number (logical addr 31-16)															
6	last head number (logical 15-8)								last sector number (logical 7-0)							
8	remaining sector count															
A	last VME sector buffer starting address (bits 31-16)															
C	last VME sector buffer starting address (bits 15-0)															
E	X												X			
10	X												X			
12	X												X			
14	X												X			
16	X												X			
18	X												X			
1A	X												UNDEFINED			

X - RETURNED UNCHANGED

UIB PARAMETERS		UIB ATTRIBUTES
Volume boundaries	Gap 2	Increment by head
Sectors/track	Max Cylinders	Dual port enabale
Bytes/sector		

COMMAND CODE: 83
COMMAND NAME: VERIFY SECTOR(S)

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	1	0	0	0	0	0	1	1	UN	VO	LK	XL	RV	DE	IE	EC
2	set to '0'										set to '0'					
4	cylinder number (logical addr 31-16)															
6	head number (logical 15-8)								sector number (logical 7-0)							
8	sector count															
A	X												X			
C	X												X			
E	X												X			
10	IOPB interrupt level								normal complete vector							
12	X								error complete vector							
14	linked IOPB address (bits 31-16)															
16	linked IOPB address (bits 15-0)															
18	linked IOPB memory type								linked IOPB address modifier							
1A	X								set to '0'							

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Don't Care (not used)

RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

Data Transfers: None
Block Size: 0

Block Count: 0

Resultant IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X												X			
2	status code											error code				
4	last cylinder number (logical addr 31-16)															
6	last head number (logical 15-8)								last sector number (logical 7-0)							
8	remaining sector count															
A	X												X			
C	X												X			
E	X												X			
10	X												X			
12	X												X			
14	X												X			
16	X												X			
18	X												X			
1A	X												UNDEFINED			

X - RETURNED UNCHANGED

UIB PARAMETERS

Volume boundaries
Sectors/track
Bytes/sector
Retries
Max Cylinders

UIB ATTRIBUTES

Increment by head
Dual port enable
Reseek enable

COMMAND CODE: 84
COMMAND NAME: FORMAT TRACK

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	1	0	0	0	0	1	0	0	UN	X	LK	X	RV	X	IE	X
2	set to '0'											set to '0'				
4	cylinder number															
6	head number												X			
8	X												X			
A	X												X			
C	data field fill word															
E	X												X			
10	IOPB interrupt level									normal complete vector						
12	X									error complete vector						
14	linked IOPB address (bits 31-16)															
16	linked IOPB address (bits 15-0)															
18	linked IOPB memory type								linked IOPB address modifier							
1A	X											set to '0'				

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Don't Care (not used)

RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

Data Transfers: None
Block Size: 0

Block Count: 0

Resultant IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X												X			
2	status code											error code				
4	cylinder number															
6	head number										last sector formatted					
8	number of sectors formatted															
A	X												X			
C	X												X			
E	X												X			
10	X												X			
12	X												X			
14	X												X			
16	X												X			
18	X												X			
1A	X											UNDEFINED				

X - RETURNED UNCHANGED

UIB PARAMETERS

Volume boundaries
Max number of cylinders
Skew & Gap 1 & 2
Sectors/track
Bytes/sector
Interleave

UIB ATTRIBUTES

Dual port enable
Spare sector enable
Runt sector enable

COMMAND CODE: 85
COMMAND NAME: MAP TRACK

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	1	0	0	0	0	1	0	1	UN	X	LK	X	RV	X	IE	X
2	set to '0'											set to '0'				
4	defective cylinder number															
6	defective head number												X			
8	target cylinder number															
A	target head number												X			
C	data field fill word															
E	X												X			
10	IOPB interrupt level								normal complete vector							
12	X								error complete vector							
14	linked IOPB address (bits 31-16)															
16	linked IOPB address (bits 15-0)															
18	linked IOPB memory type								linked IOPB address modifier							
1A	X								set to '0'							

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Don't Care (not used)

RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

Data Transfers: None
Block Size: 0

Block Count: 0

Resultant IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X											X				
2	status code											error code				
4	cylinder number															
6	defective head number								last sector formatted							
8	number of sectors formatted															
A	X											X				
C	X											X				
E	X											X				
10	X											X				
12	X											X				
14	X											X				
16	X											X				
18	X											X				
1A	X											UNDEFINED				

X - RETURNED UNCHANGED

UIB PARAMETERS		UIB ATTRIBUTES
Volume boundaries	Sectors/track	Dual port enable
Max number of cylinder	Interleave	Spare sector enable
Skew and Gap 1 & 2	Bytes/sector	Runt sector enable

COMMAND CODE: 86
COMMAND NAME: HANDSHAKE

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	1	0	0	0	0	1	1	0	X	X	LK	X	X	X	IE	X
2	set to '0'											set to '0'				
4	X											X				
6	X											X				
8	X											X				
A	X											X				
C	X											X				
E	X											X				
10	IOPB interrupt level										normal complete vector					
12	X										error complete vector					
14	linked IOPB address (bits 31-16)															
16	linked IOPB address (bits 15-0)															
18	linked IOPB memory type										linked IOPB address modifier					
1A	X										set to '0'					

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Don't Care (not used)

RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

Data Transfers: None
Block Size: 0

Block Count: 0

Resultant IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X											X				
2	status code											error code				
4	firmware PROM ID number (bits 31-16)															
6	firmware PROM ID number (bits 15-0)															
8	undefined															
A	firmware release date (mm/dd)															
C	firmware release date (yy)															
E	undefined															
10	X												X			
12	X												X			
14	X												X			
16	X												X			
18	X												X			
1A	X											UNDEFINED				

X - RETURNED UNCHANGED

UIB PARAMETERS

UIB ATTRIBUTES

COMMAND CODE: 87
COMMAND NAME: INITIALIZE

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	1	0	0	0	0	1	1	1	X	X	LK	X	X	X	IE	X
2	set to '0'											set to '0'				
4	X												X			
6	X												X			
8	X												X			
A	VME memory address for UIB (bits 31-16)															
C	VME memory address for UIB (bits 15-0)															
E	VME memory type											VME address modifier				
10	IOPB interrupt level											normal complete vector				
12	X											error complete vector				
14	linked IOPB address (bits 31-16)															
16	linked IOPB address (bits 15-0)															
18	linked IOPB memory type											linked IOPB address modifier				
1A	X											set to '0'				

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Don't Care (not used)

RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

Data Transfers: Read from VME system memory **Block Count:** 1
Block Size: UIB length (9 Words)

Resultant IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X											X				
2	status code											error code				
4	X											X				
6	X											X				
8	X											X				
A	X											X				
C	X											X				
E	X											X				
10	X											X				
12	X											X				
14	X											X				
16	X											X				
18	X											X				
1A	X											UNDEFINED				

X - RETURNED UNCHANGE

UIB PARAMETERS

Status interrupt level
Sectors/track
Bytes/sector
Interleave
Gaps 1 & 2
Max Cylinders

UIB ATTRIBUTES

Status interrupt enable

COMMAND CODE: 89
COMMAND NAME: RESTORE

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	1	0	0	0	1	0	0	1	UN	X	LK	X	RV	X	IE	X
2	set to '0'										set to '0'					
4	X												X			
6	X												X			
8	X												X			
A	X												X			
C	X												X			
E	X												X			
10	IOPB interrupt level										normal complete vector					
12	X										error complete vector					
14	linked IOPB address (bits 31-16)															
16	linked IOPB address (bits 15-0)															
18	linked IOPB memory type										linked IOPB address modifier					
1A	X										set to '0'					

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Don't Care (not used)

RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

Data Transfers: None
Block Size: 0

Block Count: 0

Resultant IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X											X				
2	status code											error code				
4	X											X				
6	X											X				
8	X											X				
A	X											X				
C	X											X				
E	X											X				
10	X											X				
12	X											X				
14	X											X				
16	X											X				
18	X											X				
1A	X											UNDEFINED				

X - RETURNED UNCHANGED

UIB PARAMETERS

UIB ATTRIBUTES

COMMAND CODE: 8A
COMMAND NAME: SEEK

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	1	0	0	0	1	0	1	0	UN	VO	LK	XL	RV	X	IE	X
2	set to '0'								set to '0'							
4	cylinder number (logical addr 31-16)															
6	head number (logical 15-8)								sector number (logical 7-0)							
8	X								X							
A	X								X							
C	X								X							
E	X								X							
10	IOPB interrupt level								normal complete vector							
12	X								error complete vector							
14	linked IOPB address (bits 31-16)															
16	linked IOPB address (bits 15-0)															
18	linked IOPB memory type								linked IOPB address modifier							
1A	X								set to '0'							

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Don't Care (not used)

RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

DATA Tatasfers: None
Block count: 0

Block Count: 0

Resultant IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X											X				
2	status code											error code				
4	X											X				
6	X											X				
8	X											X				
A	X											X				
C	X											X				
E	X											X				
10	X											X				
12	X											X				
14	X											X				
16	X											X				
18	X											X				
1A	X											UNDEFINED				

X - RETURNED UNCHANGED

UIB PARAMETERS

Volume boundaries
Sectors/track
Max Cylinders
Status Change Int. Level
Status Change Int. Vect.

UIB ATTRIBUTES

Dual port enable
Status change interrupt enable

COMMAND CODE: 8B
COMMAND NAME: REFORMAT

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	1	0	0	0	1	0	1	1	UN	X	LK	X	RV	X	IE	X
2	set to '0'											set to '0'				
4	cylinder number															
6	head number												X			
8	X												X			
A	X												X			
C	Data field fill word															
E	X												X			
10	IOPB interrupt level								normal complete vector							
12	X								error complete vector							
14	linked IOPB address (bits 31-16)															
16	linked IOPB address (bits 15-0)															
18	linked IOPB memory type								linked IOPB address modifier							
1A	Skew factor								set to '0'							

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Don't Care (not used)

RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

Data Transfers: None
Block Size: 0

Block Count: 0

Resultant IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X												X			
2	status code											error code				
4	cylinder number															
6	head number								last sector formatted							
8	number of sectors formatted															
A	X												X			
C	X												X			
E	X												X			
10	X												X			
12	X												X			
14	X												X			
16	X												X			
18	X												X			
1A	X											UNDEFINED				

X - RETURNED UNCHANGED

UIB PARAMETERS		UIB ATTRIBUTES
Volume boundaries	Sectors/track	Dual port enable
Max number of cylinders	Bytes/sector	Spare sector enable
Skew and Gap 1 & 2	Interleave	Runt sector enable

COMMAND CODE: 8C
COMMAND NAME: FORMAT WITH DATA

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	1	0	0	0	1	1	0	0	UN	X	LK	X	RV	X	IE	X
2	set to '0'										set to '0'					
4	cylinder number															
6	head number												X			
8	X												X			
A	VME buffer address (bits 31-16)															
C	VME buffer address (bits 15-0)															
E	VME memory type										VME address modifier					
10	IOPB interrupt level										normal complete vector					
12	X										error complete vector					
14	linked IOPB address (bits 31-16)															
16	linked IOPB address (bits 15-0)															
18	linked IOPB memory type										linked IOPB address modifier					
1A	Skew factor										set to '0'					

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Don't Care (not used)

RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

Data Transfers: Read from VME system memory **Block Count:** 1
Block Size: UIB bytes/sector

Resultant IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X												X			
2	status code											error code				
4	cylinder number															
6	head number										last sector formatted					
8	number of sectors formatted															
A	X												X			
C	X												X			
E	X												X			
10	X												X			
12	X												X			
14	X												X			
16	X												X			
18	X												X			
1A	X											UNDEFINED				

X - RETURNED UNCHANGED

UIB PARAMETERS		UIB ATTRIBUTES
Volume boundaries	Sectors/track	Dual port enable
Number of cylinders	Bytes/sector	Spare sector enable
Skew and Gap 1 & 2	Interleave	Runt sector enable

COMMAND CODE: 90
COMMAND NAME: MAP SECTOR

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	1	0	0	1	0	0	0	0	UN	VO	LK	X	RV	X	IE	X
2	set to '0'										set to '0'					
4	cylinder number															
6	head number										sector number					
8	X										X					
A	X										X					
C	Data field fill word															
E	X										X					
10	IOPB interrupt level										normal complete vector					
12	X										error complete vector					
14	linked IOPB address (bits 31-16)															
16	linked IOPB address (bits 15-0)															
18	linked IOPB memory type										linked IOPB address modifier					
1A	Skew factor										set to '0'					

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Don't Care (not used)

RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

Data Transfers: None
Block Size: 0

Block Count: 0

Result IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X												X			
2	status code												error code			
4	cylinder number															
6	head number										last sector formatted					
8	number of sectors formatted															
A	X												X			
C	X												X			
E	X												X			
10	X												X			
12	X												X			
14	X												X			
16	X												X			
18	X												X			
1A	X												UNDEFINED			

X - RETURNED UNCHANGED

UIB PARAMETERS		UIB ATTRIBUTES
Volume boundaries	Sectors/track	Spare sector enable
Max number of cylinders	Bytes/sector	Dual port enable
Skew and Gap 1 & 2	Interleave	Runt sector enable

COMMAND CODE: 91
COMMAND NAME: READ SECTORS SEQ

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	1	0	0	1	0	0	0	1	UN	VO	LK	XL	RV	DE	IE	EC
2	set to '0'												set to '0'			
4	Cylinder number (logical addr 31-16)															
6	Head Number (logical 15-8)								Sector number (Logical 7-0)							
8	Sector Count															
A	VME Buffer address (bits 31-16)															
C	VME Buffer address (bits 15-0)															
E	VME Memory Type								VME Memory Modifier							
10	IOPB interrupt level								normal complete vector							
12	DMA Burst Count								error complete vector							
14	linked IOPB address (bits 31-16)															
16	linked IOPB address (bits 15-0)															
18	linked IOPB memory type								linked IOPB address modifier							
1A	X								Reserved							

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Don't Care (not used)

RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

Data Transfers: Write to VME system memory
Block Size: UIB bytes/sector
Block Count: IOPB sector count

Resultant IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X												X			
2	status code												error code			
4	Last cylinder number (logical address 31-16)															
6	Last head (logical 15-8)								Last sector (logical 7-0)							
8	Remaining Sector Count															
A	Last VME sector buffer address (bits 31-16)															
C	Last VME sector buffer address (bits 15-0)															
E	X												X			
10	X												X			
12	X												X			
14	X												X			
16	X												X			
18	X												X			
1A	X												UNDEFINED			

X - RETURNED UNCHANGED

UIB PARAMETERS

Bytes/sector
Sectors/Track
Max Cylinders
Retries
Volume boundaries

UIB ATTRIBUTES

Dual port enable
Cache enable
Increment by head

COMMAND CODE: 92
COMMAND NAME: WRITE SECTORS SEQ

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	1	0	0	1	0	0	1	0	UN	VO	LK	XL	RV	X	IE	X
2	set to '0'										set to '0'					
4	Cylinder number (logical addr 31-16)															
6	Head Number (logical 15-8)								Sector number (Logical 7-0)							
8	Sector Count															
A	VME Buffer address (bits 31-16)															
C	VME Buffer address (bits 15-0)															
E	VME Memory Type								VME Memory Modifier							
10	IOPB interrupt level								normal complete vector							
12	DMA Burst Count								error complete vector							
14	linked IOPB address (bits 31-16)															
16	linked IOPB address (bits 15-0)															
18	linked IOPB memory type								linked IOPB address modifier							
1A	X								Reserved							

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Don't Care (not used)

RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

Data Transfers: Read from VME system memory **Block Count:** IOPB sector count
Block Size: UIB bytes/sector

Resultant IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X											X				
2	status code											error code				
4	Last cylinder number (logical address 31-16)															
6	Last head (logical 15-8)								Last sector (logical 7-0)							
8	Remaining Sector Count															
A	Last VME sector buffer address (bits 31-16)															
C	Last VME sector buffer address (bits 15-0)															
E	X												X			
10	X												X			
12	X												X			
14	X												X			
16	X												X			
18	X												X			
1A	X												UNDEFINED			

X - RETURNED UNCHANGED

UIB PARAMETERS

Bytes/sector
Sectors/Track
Max Cylinders
Gap 2
Volume boundaries

UIB ATTRIBUTES

Dual port enable

COMMAND CODE: 93
COMMAND NAME: VERIFY SECTORS SEQ

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	1	0	0	1	0	0	1	1	UN	VO	LK	XL	RV	DE	IE	EC
2	set to '0'								set to '0'							
4	Cylinder number (logical addr 31-16)															
6	Head Number (logical 15-8)								Sector number (Logical 7-0)							
8	Sector Count															
A	X								X							
C	X								X							
E	X								X							
10	IOPB interrupt level								normal complete vector							
12	X								error complete vector							
14	linked IOPB address (bits 31-16)															
16	linked IOPB address (bits 15-0)															
18	linked IOPB memory type								linked IOPB address modifier							
1A	X								Reserved							

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Dón't Care (not used)

RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

Data Transfers: None
Block Size: 0

Block Count: 0

Resultant IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X											X				
2	status code											error code				
4	Last cylinder number (logical address 31-16)															
6	Last head (logical 15-8)								Last sector (logical 7-0)							
8	Remaining Sector Count															
A	X											X				
C	X											X				
E	X											X				
10	X											X				
12	X											X				
14	X											X				
16	X											X				
18	X											X				
1A	X											UNDEFINED				

X - RETURNED UNCHANGED

UIB PARAMETERS

Bytes/sector
Sectors/Track
Max Cylinders
Retries
Volume boundaries

UIB ATTRIBUTES

Dual port enable
Reseek enable
Increment by head

COMMAND CODE: 94
COMMAND NAME: READ SECTOR(S)
NONCACHED

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	1	0	0	1	0	1	0	0	UN	VO	LK	XL	RV	DE	IE	EC
2	set to '0'								set to '0'							
4	cylinder number (logical addr 31-16)															
6	head number (logical 15-8)								sector number (logical 7-0)							
8	sector count															
A	VME buffer address (bits 31-16)															
C	VME buffer address (bits 15-0)															
E	VME memory type								VME address modifier							
10	IOPB interrupt level								normal complete vector							
12	DMA transfer count								error complete vector							
14	linked IOPB address (bits 31-16)															
16	linked IOPB address (bits 15-0)															
18	linked IOPB memory type								linked IOPB address modifier							
1A	X								set to '0'							

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Don't Care (not used)
RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

Data Transfers: Write to VME system memory **Block Count:** IOPB Sector Count
Block Size: UIB bytes/sector

Resultant IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X											X				
2	status code											error code				
4	last cylinder number (logical addr 31-16)															
6	last head number (logical 15-8)								last sector number (logical 7-0)							
8	last VME sector buffer starting address (bits 31-16)															
A	last VME sector buffer starting address (bits 15-0)															
C	X											X				
E	X											X				
10	X											X				
12	X											X				
14	X											X				
16	X											X				
18	X											X				
1A	X											UNDEFINED				

X - RETURNED UNCHANGED

UIB PARAMETERS

Volume boundaries
Sectors/track
Bytes/sector
Retries
Max Cylinders

UIB ATTRIBUTES

Dual port enable
Increment by head
Move bad data
Reseek Enable

COMMAND CODE: 95
COMMAND NAME: READ SECTORS SEQ
DISABLE ADDR BUMP

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	1	0	0	1	0	1	0	1	UN	VO	LK	XL	RV	DE	IE	EC
2	set to '0'								set to '0'							
4	Cylinder number (logical addr 31-16)															
6	Head Number (logical 15-8)								Sector number (Logical 7-0)							
8	Sector Count															
A	VME buffer address (bits 31-16)															
C	VME buffer address (bits 15-0)															
E	VME memory type								VME address modifier							
10	IOPB interrupt level								normal complete vector							
12	DMA burst count								error complete vector							
14	linked IOPB address (bits 31-16)															
16	linked IOPB address (bits 15-0)															
18	linked IOPB memory type								linked IOPB address modifier							
1A	X								Reserved							

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Don't Care (not used)
RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

Data Transfers: Write to VME system memory **Block Count:** IOPB sector count
Block Size: UIB bytes/sector

Resultant IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X											X				
2	status code											error code				
4	Last cylinder number (logical address 31-16)															
6	Last head (logical 15-8)								Last sector (logical 7-0)							
8	Remaining Sector Count															
A	X											X				
C	X											X				
E	X											X				
10	X											X				
12	X											X				
14	X											X				
16	X											X				
18	X											X				
1A	X											UNDEFINED				

X - RETURNED UNCHANGED

UIB PARAMETERS

Bytes/sector Sectors/Track
Max Cylinders Retries
Volume boundaries

UIB ATTRIBUTES

Dual port enable Cache Enable
Reseek enable Move Bad Data
Increment by head

COMMAND CODE: 96
COMMAND NAME: WRITE SECTORS SEQ
DISABLE ADDR BUMP

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	1	0	0	1	0	1	1	0	UN	VO	LK	XL	RV	DE	IE	X
2	set to '0'								set to '0'							
4	Cylinder number (logical addr 31-16)															
6	Head Number (logical 15-8)								Sector number (Logical 7-0)							
8	Sector Count															
A	VME buffer address (bits 31-16)															
C	VME buffer address (bits 15-0)															
E	VME memory type								VME address modifier							
10	IOPB interrupt level								normal complete vector							
12	DMA burst count								error complete vector							
14	linked IOPB address (bits 31-16)															
16	linked IOPB address (bits 15-0)															
18	linked IOPB memory type								linked IOPB address modifier							
1A	X								Reserved							

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Don't Care (not used)

RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

Data Transfers: Read from VME system memory **Block Count:** IOPB sector count
Block Size: UIB bytes/sector

Resultant IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X												X			
2	status code												error code			
4	Last cylinder number (logical address 31-16)															
6	Last head (logical 15-8)								Last sector (logical 7-0)							
8	Remaining Sector Count															
A	X												X			
C	X												X			
E	X												X			
10	X												X			
12	X												X			
14	X												X			
16	X												X			
18	X												X			
1A	X												UNDEFINED			

X - RETURNED UNCHANGED

UIB PARAMETERS

Bytes/sector
Sectors/Track
Max Cylinders
Retries
Volume boundaries

UIB ATTRIBUTES

Dual port enable

COMMAND CODE: 97
COMMAND NAME: CLEAR FAULT

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	1	0	0	1	0	1	1	1	UN	X	LK	X	RV	X	IE	X
2	set to '0'										set to '0'					
4	cylinder number (logical addr 31-16)															
6	X												X			
8	X												X			
A	X												X			
C	X												X			
E	X												X			
10	IOPB interrupt level										normal complete vector					
12	X										error complete vector					
14	linked IOPB address (bits 31-16)															
16	linked IOPB address (bits 15-0)															
18	linked IOPB memory type								linked IOPB address modifier							
1A	X								set to '0'							

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Don't Care (not used)

RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

Data Transfers: None
Block Size: 0

Block Count: 0

Resultant IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X												X			
2	status code											error code				
4	X												X			
6	X												X			
8	X												X			
A	X												X			
C	X												X			
E	X												X			
10	X												X			
12	X												X			
14	X												X			
16	X												X			
18	X												X			
1A	X												UNDEFINED			

X - RETURNED UNCHANGED

UIB PARAMETERS

UIB ATTRIBUTES
Dual port enable

COMMAND CODE: 99
COMMAND NAME: VERIFY TRACK

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	1	0	0	1	1	0	0	1	UN	X	LK	X	RV	DE	IE	EC
2	set to '0'										set to '0'					
4	cylinder number															
6	head number										sector number					
8	X										X					
A	X										X					
C	X										X					
E	X										X					
10	IOPB interrupt level										normal complete vector					
12	X										error complete vector					
14	linked IOPB address (bits 31-16)															
16	linked IOPB address (bits 15-0)															
18	linked IOPB memory type										linked IOPB address modifier					
1A	X										set to '0'					

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Don't Care (not used)

RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

Data Transfers: None
Block Size: 0

Block Count: 0

Resultant IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X												X			
2	status code												error code			
4	X												X			
6	head number												last sector verified			
8	X												X			
A	X												X			
C	X												X			
E	X												X			
10	X												X			
12	X												X			
14	X												X			
16	X												X			
18	X												X			
1A	X												UNDEFINED			

X - RETURNED UNCHANGED

UIB PARAMETERS

Volume boundaries
Sectors/track
Bytes/sector
Retries
Max Cylinders

UIB ATTRIBUTES

Dual port enable
Increment by head
Reseek enable

COMMAND CODE: 9A
COMMAND NAME: TRACK ID

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	1	0	0	1	1	0	1	0	UN	X	LK	X	RV	X	IE	X
2	set to '0'											set to '0'				
4	cylinder number															
6	head number											set to '0'				
8	X											X				
A	VME buffer address (bits 31-16)															
C	VME buffer address (bits 15-0)															
E	VME memory type											VME address modifier				
10	IOPB interrupt level											normal complete vector				
12	DMA transfer count											error complete vector				
14	linked IOPB address (bits 31-16)															
16	linked IOPB address (bits 15-0)															
18	linked IOPB memory type											linked IOPB address modifier				
1A	X											set to '0'				

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Don't Care (not used)

RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

Data Transfers: Write to VME system memory **Block Count:** 1
Block Size: [(UIBsectors/track) + spare sector] * 8

Resultant IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X											X				
2	status code											error code				
4	X											X				
6	X											X				
8	Number of table retries															
A	X											X				
C	X											X				
E	X											X				
10	X											X				
12	X											X				
14	X											X				
16	X											X				
18	X											X				
1A	X											UNDEFINED				

X - RETURNED UNCHANGED

UIB PARAMETERS	UIB ATTRIBUTES
Volume boundaries	Dual port enable
Sectors/track	Spare sector enable
Number of cylinders	Runt sector enable

COMMAND CODE: 9B
COMMAND NAME: FETCH AND EXECUTE

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	1	0	0	1	1	0	1	1	X	X	X	X	X	X	X	X
2	set to '0'											set to '0'				
4	X											X				
6	X											X				
8	X											X				
A	X											X				
C	X											X				
E	X											X				
10	X											X				
12	X											X				
14	linked IOPB address (bits 31-16)															
16	linked IOPB address (bits 15-0)															
18	linked IOPB memory type								linked IOPB address modifier							
1A	X								set to '0'							

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Don't Care (not used)

RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

Data Transfers: Read/Write IOPB if external memory type
Block Size: IOPB length (14 Words) **Block Count:** 1 Read/1 Write/1 Wr

Resultant IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X											X				
2	status code											error code				
4	X											X				
6	X											X				
8	X											X				
A	X											X				
C	X											X				
E	X											X				
10	X											X				
12	X											X				
14	X											X				
16	X											X				
18	X											X				
1A	X											UNDEFINED				

X - RETURNED UNCHANGED

UIB PARAMETERS
Volume boundaries
Number of cylinders
Sectors/track

UIB ATTRIBUTES
Dual port enable
Spare sector enable

COMMAND CODE: 9C
COMMAND NAME: VERIFY TRACK SEQ

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	1	0	0	1	1	1	0	0	UN	X	LK	X	RV	DE	IE	X
2	set to '0'											set to '0'				
4	Cylinder number															
6	Head Number												X			
8	X												X			
A	X												X			
C	X												X			
E	X												X			
10	IOPB interrupt level											normal complete vector				
12	X											error complete vector				
14	linked IOPB address (bits 31-16)															
16	linked IOPB address (bits 15-0)															
18	linked IOPB memory type									linked IOPB address modifier						
1A	X									Reserved						

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Don't Care (not used)

RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

Data Transfers: None
Block Size: 0

Block Count: 0

Resultant IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X												X			
2	status code											error code				
4	X												X			
6	X												X			
8	Number of Sectors in error															
A	X												X			
C	X												X			
E	X												X			
10	X												X			
12	X												X			
14	X												X			
16	X												X			
18	X												X			
1A	X												UNDEFINED			

X - RETURNED UNCHANGED

UIB PARAMETERS

Bytes/sector
Retries
Max number of cylinders
Volume boundaries
Sectors/track

UIB ATTRIBUTES

Dual port enable
Reseek enable
Increment by head

COMMAND CODE: 9E
COMMAND NAME: EXTENDED DIAGNOSTICS

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	1	0	0	1	1	1	1	0	UN	X	LK	X	RV	DE	IE	X
2	set to '0'											set to '0'				
4	Cylinder number															
6	Head number											X				
8	X											X				
A	VME buffer address (bits 31-16)															
C	VME buffer address (bits 15-0)															
E	VME memory type												VME address modifier			
10	IOPB interrupt level											normal complete vector				
12	DMA burst count											error complete vector				
14	linked IOPB address (bits 31-16)															
16	linked IOPB address (bits 15-0)															
18	linked IOPB memory type											linked IOPB address modifier				
1A	X											Reserved				

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Don't Care (not used)

RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

Data Transfers: Write-to-read from VME system memory **Block Size:** UIB bytes/sector
Block Count: IOPB sector count

Resultant IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X											X				
2	status code											error code				
4	X											X				
6	X											X				
8	Remaining Sector Count															
A	X											X				
C	X											X				
E	X											X				
10	X											X				
12	X											X				
14	X											X				
16	X											X				
18	X											X				
1A	X											Last test performed				

X - RETURNED UNCHANGED

UIB PARAMETERS

Bytes/sector
Max Cylinders
Volume boundaries
Sectors/track
Retries
Gap1/Gap2/Skew

UIB ATTRIBUTES

Dual port enable
Reseek enable
Spare sector enable
Runt sector enable

COMMAND CODE: 9F
COMMAND NAME: DUAL PORT PRIORITY SELECT

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	1	0	0	1	1	1	1	1	UN	VO	LK	XL	RV	DE	IE	X
2	set to '0'											set to '0'				
4	X											X				
6	X											X				
8	X											X				
A	X											X				
C	X											X				
E	X											X				
10	IOPB interrupt level											normal complete vector				
12	X											error complete vector				
14	linked IOPB address (bits 31-16)															
16	linked IOPB address (bits 15-0)															
18	linked IOPB memory type											linked IOPB address modifier				
1A	X											Reserved				

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Don't Care (not used)

RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

Data Transfers: None
Block Size: 0

Block Count: 0

Resultant IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X											X				
2	status code											error code				
4	X											X				
6	X											Last Sector				
8	X											X				
A	X											X				
C	X											X				
E	X											X				
10	X											X				
12	X											X				
14	X											X				
16	X											X				
18	X											X				
1A	X											UNDEFINED				

X - RETURNED UNCHANGED

UIB PARAMETERS

UIB ATTRIBUTES
Dual port enable

COMMAND CODE: A1
COMMAND NAME: READ AND SCATTER

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	1	0	1	0	0	0	0	1	UN	VO	LK	XL	RV	DE	IE	EC
2	set to '0'										set to '0'					
4	cylinder number (logical addr. 31-16)															
6	head number (logical 15-8)								sector number (logical 7-0)							
8	sector count															
A	list buffer address															
C	list buffer address															
E	list memory type								list address modifier							
10	IOPB interrupt level								normal complete vector							
12	DMA Burst Count								error complete vector							
14	IOPB Pointer															
16	IOPB Pointer															
18	IOPB memory type								IOPB address modifier							
1A	X								List Element Count							

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Don't Care (not used)

RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

Data Transfers: None
Block Size: 0

Block Count: 0

Resultant IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X												X			
2	status code											error code				
4	X												X			
6	remaining sector count															
8	X												X			
A	X												X			
C	X												X			
E	X												X			
10	X												X			
12	X												X			
14	X												X			
16	X												X			
18	X												X			
1A	X												X			

X - RETURNED UNCHANGED

UIB PARAMETERS

Volume boundaries
Sectors/track
Bytes/sector
Retry Count
Max. cylinders

UIB ATTRIBUTES

Dual port enable
Move bad data
Increment by head
Reseek

COMMAND CODE: A2
COMMAND NAME: GATHER AND WRITE

IOPB FORMAT

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	1	0	1	0	0	0	1	1	UN	VO	LK	XL	RV	X	IE	X
2	set to '0'										set to '0'					
4	cylinder number (logical addr. 31-16)															
6	head number (logical 15-8)								sector number (logical 7-0)							
8	sector count															
A	list buffer address															
C	list buffer address															
E	list memory type								list address modifier							
10	IOPB interrupt level								normal complete vector							
12	DMA Burst Count								error complete vector							
14	IOPB Pointer															
16	IOPB Pointer															
18	IOPB memory type								IOPB address modifier							
1A	X								List Element Count							

UN - Unit number
VO - Unit volume number
LK - Enable IOPB link
XL - Enable logical translation
X - Don't Care (not used)

RV - Reserve Dual port drive
DE - Disable read data errors
IE - Enable IOPB complete interrupt
EC - Enable data error correction

Data Transfers: None
Block Size: 0

Block Count: 0

Resultant IOPB Format

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	X												X			
2	status code												error code			
4	X												X			
6	remaining sector count															
8	X												X			
A	X												X			
C	X												X			
E	X												X			
10	X												X			
12	X												X			
14	X												X			
16	X												X			
18	X												X			
1A	X												X			

X - RETURNED UNCHANGED

UIB PARAMETERS

Volume boundaries Max. cylinders
Sectors/track
Bytes/sector

UIB ATTRIBUTES

Dual port enable
Increment by head

APPENDIX D

ERROR CODES

All error codes are in hexadecimal format.

10 - DISK NOT READY: The disk ready signal output is tested at the beginning of any command requiring disk data movement. Error 10 is posted if the disk is not ready. This code is typically posted when an attempt is made to access a disk before it is ready (i.e., the V/SMD 3200 has not received the READY signal for the drive).

11 - NOT USED.

12 - SEEK ERROR: If the V/SMD 3200 cannot find the required sector of data within two revolutions, it will try to verify that the head is on the right track by reading several sectors. If the cylinder number in the header is incorrect, then error 12 is issued (See related errors 29 and 2A).

13 - ECC ERROR-DATA FIELD: This error is issued if the computed ECC on the data did not agree with the ECC appended to the data on the disk, and if no error correction was attempted (see related error 23).

14 - INVALID COMMAND CODE: The command code in the IOPB (byte 0) was not valid.

15 - ILLEGAL FETCH AND EXECUTE COMMAND: This error indicates that a FETCH AND EXECUTE command was encountered in external memory. A FETCH AND EXECUTE command is only valid when it occurs in the on-board short I/O space.

16 - INVALID SECTOR IN COMMAND: The target sector in the IOPB (byte 7) was greater than the capacity of the drive as specified for that drive in byte 4 of the UIB. This check is performed before the command is executed.

17 - ILLEGAL MEMORY TYPE: Either the memory type specified for the buffer address is not 0, 2, or 3, or the IOPB address is not a 0, 1, 2 or 3 as required.

18 - BUS TIMEOUT: This error indicates that bus acquisition was not completed within 100 milliseconds of a request. This error is typically caused by a nonexistent address or address modifier in the data transfer IOPB.

19 - HEADER CHECKSUM ERROR: This error indicates that there was an error in the header field.

1A - DISK WRITE PROTECTED: This error is issued when attempts are made to write to a disk that is write protected.

1B - UNIT NOT SELECTED: This error is issued when a unit select was made and the unit failed to respond with UNIT SELECTED. This occurs when either the drive unit number is incorrectly selected, the drive is not powered up, or the cable is not properly connected.

1C - SEEK ERROR TIMEOUT: This error occurs when a CLEAR FAULT or RESTORE failed to correct a seek error from the drive within three seconds. If this error is issued, check to make sure the "B" cable is not on backwards.

1D - FAULT TIMEOUT: This error is issued when a CLEAR FAULT or RESTORE failed to correct a fault condition from the drive within three seconds. If this error is issued, check to make sure the "B" cable is not on backwards.

1E - DRIVE FAULTED: This indicates that a fault condition exists in a selected unit. The FAULT should be cleared by a RESTORE command. This error is issued when the drive tries to access a nonexistent head or cylinder. Check the drive manual to ensure that the UIB contains the proper settings.

1F - READY TIMEOUT: This error is issued when a CLEAR FAULT or RESTORE failed to bring the drive ready within three seconds.

20 - END OF MEDIUM: This error indicates that a multisector transfer exceeded the end of the medium.

21 - TRANSLATION FAULT: This fault indicates that the volume which was specified in the IOPB contains zero heads in the UIB. This error is usually caused by an error in the UIB.

22 - INVALID HEADER PAD: This error indicates that an improper post-header pad byte was encountered.

23 - UNCORRECTABLE ERROR: When this error is posted, error correction was attempted on the data field and the error was found to be uncorrectable.

24 - TRANSLATION ERROR, CYLINDER: This indicates that the translation of a logical sector resulted in a bad cylinder number. If the drive's UIB is correct, then the logical sector is invalid.

25 - TRANSLATION ERROR, HEAD: This error occurs when the translation of a logical sector resulted in a bad head number. If the drive's UIB is correct, then the logical sector is invalid.

26 - TRANSLATION ERROR, SECTOR: When posted, this error indicates that the translation of a logical sector resulted in a bad physical sector number. If the drive's UIB is correct, then the logical sector is invalid.

27 - DATA OVERRUN: This indicates a data timeout error. It is generally caused by a missing TX (transmit) or RX (receive) clock from the drive. If this error is issued, check to ensure that the "B" cable is on correctly. This error may also be caused if the UIB sectors/track is set to '0'.

28 - NO INDEX PULSE ON FORMAT: During a FORMAT operation, the V/SMD 3200 looks for the index pulse from the disk drive. If not found within 65 milliseconds, this error is posted.

29 - SECTOR NOT FOUND: If the target sector cannot be found during a READ or WRITE, this error is issued (see related errors 12 and 2A). This error is issued if a bad sector on the disk is encountered, or if a track is impoperly formatted.

2A - ID FIELD ERROR-WRONG HEAD: This error is issued if the head number read from the disk in the header field was wrong (see related errors 12 and 29).

2B - INVALID SYNC IN DATA FIELD: This indicates that the first word read from the data field was not a valid sync character.

2C - NO VALID HEADER FOUND. This indicates that during the "read header" command, no valid header was found. After checking every sector (specified by the UIB) including the runt sector and short sector, every header was invalid. This means that the sync character, checksum, and/or post-header pad were invalid. This error is usually posted when attempting to read a disk that has not been formatted for use with the V/SMD 3200.

2D - SEEK TIMEOUT ERROR: If issued, this error indicates that a seek was made and a normal complete response did not occur within 500 milliseconds.

2E - BUSY TIMEOUT: This error is set on a dual ported drive if BUSY has been active for more than 500 milliseconds. This error indicates that one of the controllers has held the drive for too long.

2F - NOT ON CYLINDER: The drive must be on cylinder within three seconds after being selected, or this error will result.

30 - RTZ TIMEOUT: This error is issued when a RESTORE command was executed but a normal complete did not occur within three seconds.

31 - INVALID SYNC IN HEADER: An invalid sync character in the header field will cause this error code to occur.

32-3F - NOT USED.

40 - UNIT NOT INITIALIZED: This error indicates that a WRITE or FORMAT command was attempted on a unit that has not been initialized.

41 - NOT USED.

42 - GAP SPECIFICATION ERROR: This error occurs when the value for either Gap 1 or Gap 2 in the UIB is less than five.

43-4A - NOT USED.

4B - SEEK ERROR: This indicates that a seek error was reported by the disk drive.

4C-4F - NOT USED.

50 - SECTORS PER TRACK ERROR: This indicates that the number of sectors/track set in the UIB is zero or greater than 160.

51 - BYTES PER SECTOR SPECIFICATION ERROR: The bytes per sector are specified in bytes 2 and 3 in the UIB. When the number is less than 256 or greater than 2048, this error is issued.

52 - INTERLEAVE SPECIFICATION FACTOR: If this error occurs, the interleave factor set in byte 6 of the UIB is either zero or greater than the number of sectors per track. If this error is issued, check to make sure that the UIB pointer in the initialize command is pointing to the correct place in memory. If it is not, a UIB of random data is read during initialization.

53 - INVALID HEAD ADDRESS: The capacity of the drive is specified in bytes 0 through 3 of the UIB. This error indicates that the target head address in byte 6 of the IOPB exceeded the capacity of the drive.

54 - INVALID CYLINDER ADDRESS: The capacity of the drive is specified in bytes 12 and 13 of the UIB. This error indicates that the target cylinder in Word 2 of the IOPB exceeded the capacity of the drive.

55-5C - NOT USED.

5D - INVALID DMA TRANSFER COUNT: This error indicates that the specified transfer count causes the V/SMD 3200 to attempt to transfer an odd number of bytes.

5E-5F - NOT USED.

60 - IOPB FAILED: When this error is posted, a bus error occurred during the transfer of an external IOPB. The IOPB pointer (Words 10 and 11), shows the starting address of the IOPB on which the bus error occurred. (See error code 61 for details of bus errors during DMA transfers.)

61 - DMA FAILED: This error indicates that a bus error occurred during the DMA transfer of data to or from the buffer or the bus. Words 5 and 6 of the IOPB (the buffer address) point to the start of the sector block in system memory where the error occurred. Words 2 and 3 of the IOPB (the disk address) point to the disk location where the disk transfers were when the error occurred. If the disk was addressed in physical mode, the disk error location will be a physical location. If logical address mode was used, the disk error location will be a logical location.

62 - ILLEGAL VME ADDRESS: For 8- or 16-bit transfers, the starting address of the VME buffer must fall on a word boundary (even address, multiple of 2). For 32-bit transfers, the starting address of the VME buffer must fall on a long word boundary (even address, multiple of 4).

63-69 - NOT USED.

6A - UNRECOGNIZED HEADER FIELD: During a requested read/verify command, one or more of the requested headers were not found. This error differs from error 29 (SECTOR NOT FOUND) in that one or more headers were ignored because of invalid sync, checksum, or post-header pad fields. Possible causes could include unformatted sectors (UIB sectors/track less than disk sectors/track), UIB Gap 1 too small, or 'short sector' pulse from drive.

6B - MAPPED HEADER ERROR: This indicates that the sync field of a header appeared to be a valid mapped field, but the remainder of the header was unrecognizable. See error code 6A for probable causes.

6C-6E - NOT USED.

6F - NO SPARE SECTOR ENABLED: A MAP SECTOR command was issued and the UIB did not specify spare sector mapping.

70-76 NOT USED.

77 - COMMAND ABORTED: This indicates the V/SMD 3200 observed and serviced the ABORT bit in the CSR.

78 - ACFAIL DETECTED: This indicates the V/SMD 3200 received the VME ACFAIL control signal. This error requires a RESET and ACFAIL release before normal operation can continue.

79-EF - NOT USED.

F0-FE: An improbable situation has resulted in an unforeseen error.

FF - COMMAND NOT IMPLEMENTED: The command issued will be supported in a later release.

APPLICATION NOTES

INTRODUCTION

Several options and parameters are provided by the V/SMD 3200 in the IOPB and UIB, all of which have been discussed in the operations section of this manual. However, some of the concepts require further discussion to clarify their usage. The application notes presented in this section should provide further aid in using those parameters correctly.

FOUR UNIT OPERATION

The V/SMD 3200 can control four drives when the optional cable expander card is added. The following diagram illustrates how the expander board is implemented in the system. A brief outline of four unit operation follows on the next page.

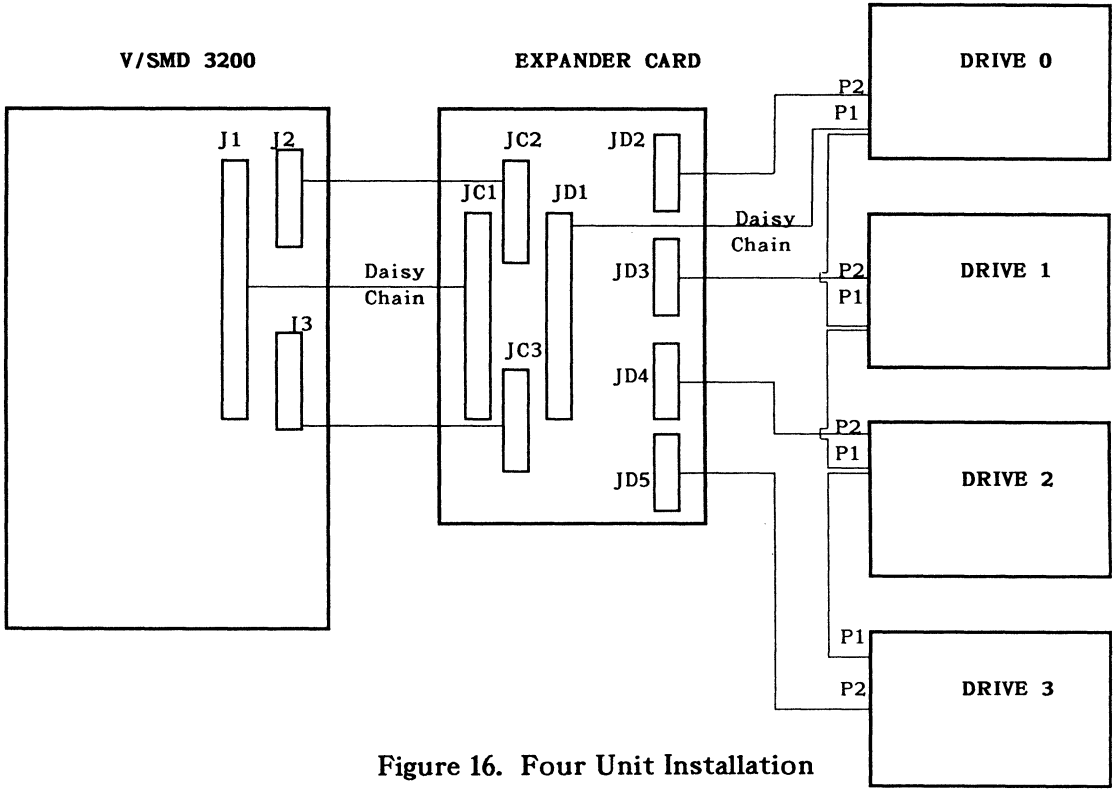


Figure 16. Four Unit Installation

1. Set bit 6 of UIB byte F to '1'.

2. Set bit 7 of UIB byte 10 to '1'.

3. When these two bits are set, the Drive Status register and Optional Status Change register have the following format:

	MSB	LSB
Base Address +1FA	Unit 3 Status	Unit 2 Status
Base Address +1FC	Unit 1 Status	Unit 0 Status
Base Address +1FE	Optional Status Change Register	

4. Cable up the V/SMD 3200 and the Four Unit Expander card as illustrated in the preceding diagram.

5. Indicate the drive number in the upper byte of IOPB word 8 (bits 12 and 13).

6. Set up a separate UIB for each of the four drives. (The format of the UIB does not change for four unit operation.)

ABORT SEQUENCE

Any disk-oriented command which reads or writes data to the drive may be aborted by setting bit eleven (11) in the command/status register (CSR). Data transfers to/from the drive will not be terminated immediately. Instead, to prevent the loss of data, they will be terminated at the end of the current sector being processed. Then, the IOPB will return a command complete with error (status 82) and an error code of 77 (hex). The rest of the IOPB will indicate at what point the operation was terminated.

ACFAIL

ACFAIL is a VMEbus open-collector signal that indicates that the AC input to the power supply is no longer present or that it is not at the proper voltage level. The ACFAIL signal orders the V/SMD 3200 to end operation because a power failure has been detected. To prevent the drive(s) from "scribbling" on the disk, an orderly clean up is executed before operation is halted.

GLOSSARY OF TERMS

ADDRESS

A number which identifies a specific location in memory.

ADDRESS MODIFIER

A VMEbus-specific 6-bit code used to modify the way a VMEbus address is interpreted. The V/SMD 3200 uses address modifiers 29 and 2D to specify short I/O access.

BAD TRACK MAPPING

The process by which the V/SMD 3200 identifies a track as unusable and makes the proper adjustments.

BUS CLEAR

A signal driven by the system controller to recommend that a bus master relinquish contol of the bus.

BUS GRANT

The process by which the system controller lets a bus master have control of the bus.

BUS REQUEST

The process by which a potential bus master indicates to the system controller that bus control is needed.

CACHING

Caching is an intelligent algorithm used to predict which data will be required next by the system after a read request has been received. The desired sectors of data are read from the disk, and stored in the buffer.

CYLINDER

The three-dimensional cross section of a given track on a stack of platters.

DATA STROBE

A signal from a bus master to a bus slave that indicates that a data transfer is about to occur.

DATA TRANSFER ACKNOWLEDGE (DTACK)

An affirmative acknowledgement sent across the bus to a master to indicate that either a block of data has been received or that the slave is ready to receive the data.

DMA (Direct Memory Access)

Direct memory access is an activity that transfers data directly from a peripheral into system memory without requiring the system CPU.

DTB (Data Transfer Bus)

Data transfer bus as used in the VME standard.

DUAL PORTED

A disk drive capable of interfacing to two independent SMD controllers is said to be dual ported.

ECC (Error Correction Code)

The V/SMD 3200 uses written data to calculate a four-byte error code which it appends to the data field during WRITE operations. During data READS, the V/SMD 3200 uses these four bytes to detect and correct (if necessary and possible) data errors. Any number of data bit errors can be detected, but to be correctable, data errors cannot span more than eleven consecutive bits.

EXP (Expanded Double Bus)

Expanded double bus VME board as used in the VME standard.

EXPLICIT SEEK

A seek that is specifically requested by the host, i.e., one not inherent in another command, is said to be explicit.

FIRMWARE

A computer program written onto a storage device such that it cannot be accidentally erased, (i.e., it is stored in Read Only Memory (ROM)).

HEAD

A device which reads, records, or erases information on the magnetic medium.

HOST

Refers to the primary or controlling processor in a system.

IMPLIED SEEK

Seeks that are imbedded within certain commands and are necessary for the command to be completed, are said to be implied.

INTERLEAVE

The sectors on a track are numbered logically from 0 to N, but do not necessarily have to be placed in a physically sequential order. The interleave of a track defines the ordering of the sectors. An interleave of 1 (or 1:1) means that the logically consecutive sectors are also physically consecutive. on a disk with an interleave of 2 (2:1), logically consecutive sectors are physically separated by one sector. For an interleave of 3 (3:1), logically consecutive sectors are physically separated by two sectors, and so on. The idea is for the disk head be approaching the data of interest when the data is requested. Due to zero latency and caching features of the V/SMD 3200, an interleave of 1 is usually optimum.

INTERRUPT

The interrupt capability of the VMEbus provides a means by which devices can interrupt normal bus activity. These interrupts are prioritized (priority interrupts) into seven levels. Priority interrupts utilize signals IACK, IACKIN, and IACKOUT to acknowledge that the interrupt has been generated.

IOPB

The I/O Parameter Block is a 14-word list of parameters necessary to define a command.

LATENCY

Latency refers to time delay in data transfer to/from a disk. It is a combination of seek time, rotational latency, and controller delays.

LINKED IOPBS

Linking IOPBs is a method of processing a series of IOPB commands; thereby reducing driver overhead and host CPU intervention.

LOGICAL ADDRESSING

Most operating systems store data in logical addresses, and in order to access or move the data, the host CPU must translate the logical addresses into physical addresses.

MEDIA FLAW MAP

The media flaw map is provided by the manufacturer of most disk drives to illustrate the integrity of the media.

MEMORY TYPE

The memory type specifies 8-, 16-, or 32-bit addressing and/or data transfers.

MULTITASKING

Refers to the ability of a device to perform two or more tasks concurrently.

PHYSICAL MODE

When Physical Mode is used, the cylinder address is the actual physical address on the disk. That is a cylinder address of 0 would specify the first cylinder on the disk in Physical Mode.

ROTATIONAL LATENCY

After the disk head settles on a track, the rotational latency is the time that elapses before the first sector of interest comes under the head.

SECTOR

A sector is the smallest unit of memory on a disk that can be accessed separately.

SECTOR MAPPING

Sector mapping is a method of bad area mapping that requires a spare sector to be included on each track to accomodate defective media.

SECTOR SLIP

Sector slip refers to the process of moving a bad sector during formatting. When a bad sector is mapped, the track is reformatted such that the bad sector is moved to the next consecutive sector, which is in turn moved to the next consecutive sector, and so on until the last sector is moved into the spare sector space.

SEEK

This command causes the read/write head to move to the requested location on the disk.

SEEK TIME

The time that is required for the head to move from its previous position on the drive to the requested cylinder.

SHORT I/O

Short I/O is a VMEbus-specified block of memory to facilitate processing of certain information. On the V/SMD 3200, short I/O is a 512-byte block of memory set aside for handling command parameters, control information, and statuses that occur when the host CPU is acting as the bus master. It is called short I/O space because the upper 16 VMEbus address lines are ignored, and only the lower 16 are used for transactions that take place in short I/O.

SKEW

The skew defines the number of sectors that sector 0 is offset from the last sector of the previous track.

SMD (STORAGE MODULE DEVICE)

SMD (STORAGE MODULE DEVICE) is a generic term which refers to a class of high-speed interfaces which conform to SMD specifications.

STATE MACHINE

A state machine is a digital device that is capable of generating an output signal based on its current "state" and the input signal.

TRACK

The track is a path along which the head travels as it reads, records, or erases information on a magnetic medium.

UIB (UNIT INITIALIZATION BLOCK)

The (UIB) Unit Initialization Block is used in conjunction with the INITIALIZE command to set the operating parameters for the drive(s) being used. One UIB is required for each drive.

VIRTUAL BUFFER

Virtual buffering is a scheme where buffers (blocks of RAM) are allocated and deallocated as they are requested or released by the VMEbus or disk. At any given time, individual buffers may be allocated to the disk, the VMEbus, or the cache. This environment creates what is effectively a buffer much larger than the physical memory.

VMEbus

VME (VERSAmodule European) bus is an industry standard high-performance 32-bit bus designed with an open bus architecture.

WAIT STATE

The period of dormancy between memory operations.

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