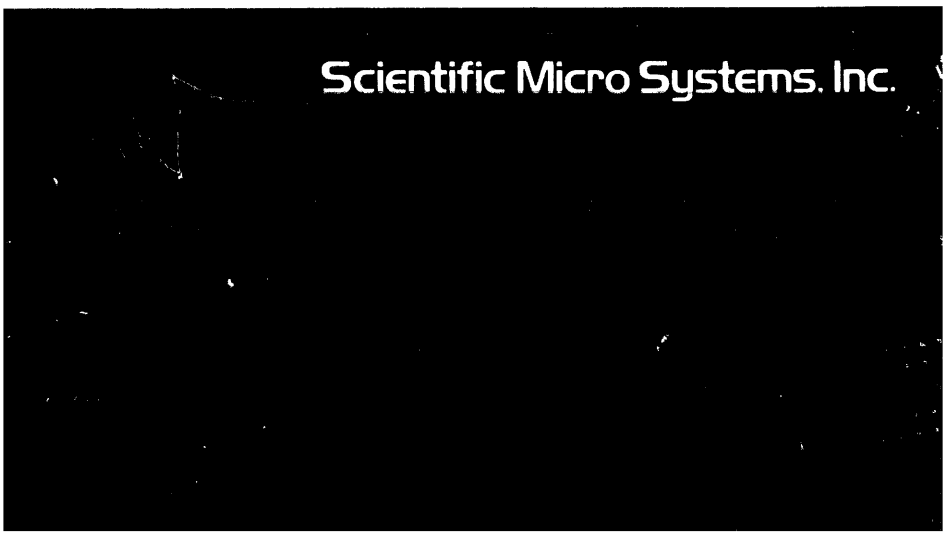
OMTI 7X00 and 3500 SERIES



OMTI 7X00 and 3500 SERIES SCSI INTELLIGENT DATA CONTROLLERS

Programmers Manual
February 3, 1988

OMTI 7X00 and 3500 SERIES

SCSI INTELLIGENT DATA CONTROLLERS

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Scientific Micro Systems
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SCSI

INTELLIGENT DATA CONTROLLER

PROGRAMMERS MANUAL

Models :

5 1/4 inch Form Factor	**OMTI 7000 Flexible disk only** **OMTI 7100 Winchesters** **OMTI 7200 Winchesters and Flexible Disks** **OMTI 7400 Winchesters, Flexible Disks and Tape**
3.5 inch Form Factor	**OMTI 3520 or 3520A (MFM) Winchesters** **OMTI 3527 or 3527A (2,7 RLL) Winchesters**

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FCC APPROVAL

This equipment generates and uses radio frequency energy and, if not installed and used properly, that is, in strict accordance with the manufacturer's instructions, may cause interference to radio and television reception. It has been type tested and found to comply with the limits for a Class B computing device in accordance with the specifications in Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

Re-orient the receiving antenna
Relocate the computer with respect to the receiver
Move the computer away from the receiver
Plug the computer into a different outlet so that computer and receiver are on different branch circuits.

If necessary, the user should consult the dealer or an experienced radio/television technician for additional suggestions. The user may find the following booklet prepared by the Federal Communications Commission helpful:

"How to Identify and Resolve Radio-TV Interference Problems".

This booklet is available from the U.S. Government Printing Office, Washington, DC 20402, Stock No. 004-000-00345-4.

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OMTI 7X00/3500 Programmers Manual	#3001775-0001
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First Edition ..... February 1988

LIST OF EFFECTIVE PAGES

The List of Effective Pages gives the date of the current edition, and lists the dates of all changed pages. Unchanged pages are listed as "ORIGINAL". Within the manual, any page changed since the last edition is indicated by printing the date the changes were made on the bottom of the page. Changes are marked with a vertical bar in the margin.

OMTI 7X00 and 3500 Series
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SECTION 1

INTRODUCTION

1.1 PURPOSE

This manual provides the programmer/system integrator information needed to develop applications, programs and device drives for the OMTI Series of high performance SCSI (Small Computer System Interface) Data Controllers.

1.2 GENERAL

The OMTI SCSI Data Controllers use SMS's advanced VLSI chip set to provide state-of-the-art data management. A single chip data separator circuit ensures data integrity with Winchester disk drives. Error detection/correction on Winchester disk drives is accomplished by the OMTI controller.

The OMTI 7X00/3520/3527 controllers comply with the industry standard 8 bit bi-directional SCSI (Small Computer System Interface) bus.with ANSC X379.2 Common Command Set (CCS).

The OMTI 7X00 Series are intelligent, multi-functional data controllers contained on 5-1/4" PCB's, which mount directly to the disk drive or chassis. The controllers interface with Winchester Disk Drives, Flexible Disk Drives and QIC 02 Tape drives.

The OMTI 3520/3527 data controllers are 3.5" PCB's which can mount to the disk drive or chassis. The controllers support ST506/412 (MFM) and ST412R (RLL) winchester disk interfaces.

3.5 inch Form Factor controllers

OMTI 3520 or 3520A (W). These models support up to two Winchester disk drives. Either drives are ST506/412 interface type drives recording MFM data. Up to two LUNs are supported.

OMTI 3527 or 3527A (W). These models support up to two Winchester disk drives. Either drives are ST412R interface type drives recording 2,7 RLL data. Up to two LUNs are supported.

5 1/4 inch Form Factor controllers

OMTI 7000 (F). This model supports up to four Flexible disk drives. They can be any combination of industry-standard 3-1/2 inch, 5-1/4 or 8 inch Flexible disk drives. The Flexible disk interface can support a data transfer rate of 250 Kbits, 300 Kbits or 500 Kbits/sec, single or double density, and single or double sided drives. The OMTI 7000 supports up to 4 LUNs.

OMTI 7100 (W). This model supports up to two Winchester disk drives. Either drive can be ESDI or ST506/412 interface type drives. The OMTI 7100 supports up to 2 LUNs.

OMTI 7200, (W + F). This model supports up to six drives, of which up to two may be ESDI or ST506/412 Winchester disk drives, and up to four may be any combination of industry-standard 3-1/2 inch, 5-1/4 or 8 inch Flexible disk drives. The Flexible disk interface can support a data transfer rate of 250 Kbits, 300 Kbits or 500 Kbits/sec, single or double density, and single or double sided drives. The OMTI 7200 supports up to 6 LUNs.

OMTI 7400 (W + F + T). This model supports up to seven drives, of which up to two may be ESDI or ST506/412 Winchester disk drives, up to four may be 3.5, 5-1/4 ot 8 inch Flexible disk drives, and one may be a QIC-02 Streaming tape drive. The OMTI 7400 supports up to 7 LUNs.

Note: The 7100, 7200 and 7400 models handle ESDI or ST506/412 Winchester disk drives identically . The 7000, 7200 and 7400 Flexible disk interfaces are identical.

SECTION 2

FUNCTIONAL DESCRIPTION

2.1 GENERAL

The host controller interface is the Small Computer Systems Interface (SCSI) general purpose 8-bit bi-directional bus.

All commands are issued to the controller over the host bus using a predefined protocol. The host always initiates a command sequence by first arbitrating for the bus and selecting the controller. After the controller accepts selection, the controller takes control of the bus and requests the appropriate command bytes from the host.

2.2 BUS TIMINGS

The controller fully complies to the timing requirements as described in the ANSI document (refer to this document for detailed information).

Arbitration Delay	(2.2 microseconds)
Bus Clear Delay	(800 nanoseconds)
Bus Free Delay	(800 nanoseconds)
Bus Set Delay	(1.8 microseconds)
Bus Settle Delay	(400 nanoseconds)
Data Release Delay	(400 nanoseconds)
Reset Hold Delay	(25 microseconds)
Selection Abort Delay	(200 microseconds)
Selection Timeout Delay	(250 milliseconds)

PHASES

The Host interface includes eight distinct operational phases as follows:

1. **BUS FREE** phase (BSY de-asserted)
2. **ARBITRATION** phase (Optional. Used by the host in a Multiple Host configuration or by the controller while reconnecting).
3. **SELECTION** phase
4. **RESELECTION** phase
5. **COMMAND** phase
6. **DATA IN** (Read) or **OUT** (Write) phase
7. **STATUS** phase
8. **MESSAGE IN** (to host) or **OUT** (to the controller) phase

The Host bus can never be in more than one phase at any given time.

The order in which SCSI bus phases are used on the bus follows a prescribed sequence. The Reset condition can interrupt any phase and is always followed by the BUS FREE phase.

2.3 BUS FREE PHASE

The BUS FREE phase is used to indicate that no SCSI device is actively using the SCSI bus and that it is available for subsequent users. The BUS FREE phase is detected after SEL and BSY signals are both false for at least a bus settle delay.

2.4 ARBITRATION PHASE

The ARBITRATION phase allows one SCSI device to gain control of the SCSI bus so that it can assume the role of an initiator or target. The controller analyzes whether or not the host initiator implements the ARBITRATION phase, and memorizes the initiator ID, if so, for further references. If the host supports Disconnect/Reconnect, the controller will generate the ARBITRATION phase prior to entering the RESELECTION phase.

NOTE: Implementation of the ARBITRATION phase is a system option. Systems that do not implement this option can have only one initiator. The ARBITRATION phase is required for systems that use the DISCONNECT/RECONNECT feature.

2.5 SELECTION PHASE

The controller detects selection after the host has won Arbitration (optional), has asserted the SEL signal and both IDs (its ID and the controller ID) on the DATA BUS. The signal I/O is de-asserted by the controller during this phase.

If more than two ID's are asserted on the DATA BUS, or parity is enabled and bad parity is detected, the controller will abort SELECTION by going to BUS FREE phase.

After accepting selection, the controller asserts BUSY. The host must then de-assert SEL and may remove the ID's from the DATA BUS.

NOTE: Upon Power-On reset or bus Reset the controller will execute a comprehensive self-test. During this test the controller will respond to any SELECTION by asserting BUSY.

If, during the SELECTION the host did not assert its ID on the bus, the controller will assume the host cannot support any message other than the COMMAND COMPLETE message and does not support Disconnect/Reconnect. Also, the controller will assume the host ID is zero and will save any status for that host as host zero.

2.6 RESELECTION

After disconnecting to free the bus for other activities, the controller will reconnect when it is ready to transfer data or status across the bus. The controller will arbitrate for the bus and, if it wins the arbitration, will select the host and assert the I/O signal. After reselecting the host, the controller will send an IDENTIFY message to identify the LUN to the host.

If the host does not respond to the reselection within a Selection Timeout Delay (250 milliseconds), the controller will release the bus and then re-arbitrate for the bus and try to reselect the host again. It will do this until the host responds or the controller is reset. The controller will respond to selects from the same or other hosts between reselection retries.

2.7 INFORMATION TRANSFER PHASES

Transfer Phases

Signals MSG	C/D	I/O	Phase Name	Direction Of Transfer	Comment
0	0	0	**DATA OUT**	Initiator to controller	\Data
0	0	1	**DATA IN**	Initiator from controller	/ Phases
0	1	0	**COMMAND**	Initiator to controller	
0	1	1	**STATUS**	Initiator from controller	
1	0	0	*		
1	0	1	*		
1	1	0	**MESSAGE OUT**	Initiator to controller	\Message
1	1	1	**MESSAGE IN**	Initiator from controller	/ Phases

Key: 0 = False or de-asserted 1 = True or asserted * = Reserved

2.8 ATTENTION CONDITION

The ATTENTION condition allows an initiator to inform the controller that the initiator has a message ready. The controller may get this message at its convenience by performing a MESSAGE OUT phase. The initiator creates the ATTENTION condition by asserting ATN at any time except during the ARBITRATION or BUS FREE phases.

The initiator shall keep ATN asserted if more than one byte is to be transferred. The initiator may negate the ATN signal at any time except it shall not negate the ATN signal while the ACK signal is asserted during a MESSAGE OUT phase. Normally, the initiator negates ATN while REQ is true and ACK is false during the last REQ/ACK handshake of the MESSAGE OUT phase.

2.9 SCSI BUS ERROR HANDLING

If the host detects the BUS FREE phase (other than as a result of a RESET condition) without first receiving a DISCONNECT or COMMAND COMPLETE message, the host should consider this a catastrophic error condition. If the controller intentionally creates this condition, then it will clear the current command.

Bus Parity Errors :

Identify Message Parity Error :

If the controller detects a parity error while receiving the IDENTIFY message, it will attempt to receive the IDENTIFY a second time. If the second attempt also fails, the controller will go to BUS FREE Phase.

Message Out Phase Parity Error :

If the controller detects a parity error during the MESSAGE OUT Phase (other than IDENTIFY message), it will attempt to receive the message again. If the second attempt fails, the controller will go to BUS FREE Phase, clear the present command and set the Sense Key/Error Code to ABORTED COMMAND/SCSI Parity Error.

Command Phase or Data Out Phase Parity Error :

If enabled, parity is checked on each command byte (in the COMMAND phase) or after each block or group of blocks is transferred in the DATA OUT phase. If bad, parity is detected and the command is aborted as follows. The controller enters the STATUS phase, creates a CHECK CONDITION status and sets the Sense Key/Error code to "ABORTED COMMAND/SCSI bus Parity Error" for that host. The controller will then enter the MESSAGE IN phase, return a COMMAND COMPLETE message and go to BUS FREE phase.

2.10 INTERNAL DIAGNOSTICS

2.10.1 Self-Test

The controller performs a hard reset after each Power-On or Bus Reset. After power-up, the controller executes the following self-tests :

TEST #	DEVICE TESTED	COMMENTS
	Z8	Includes test of the control functions and registers.
0	Program ROM	Uses the ROM checksum to verify the ROM.
1	Micro RAM	Uses a moving inversion test to test the RAM. Leaves the RAM filled with zeros.
2	Buffer RAM	Determines the size of the buffer RAM then tests it. Leaves the buffer filled with zeros. Uses the path through the Sequencer chip and the DMA channel 3 (or 1 on the products that use the KOMBO chip).
3	SCSI chip	Tests the SCSI chip including the interrupt.
4	DMA	Tests the DMA including the interrupt.
5	Sequencer	Tests the Sequencer chip, including the interrupt.
6	Sequencer State	Tests, then initializes the State controller RAM.
7	Disk Bus	Tests the disk bus control chip (OMTI 5080), only valid with the 7X00 series.
8	NEC 765 chip	Interface tests (only valid with the 7000, 7200 and 7400).
9	Tape Interface tests	Only valid with the 7400

After a Bus Reset the controller executes tests 3 - 9.

2.11 HOST INTERFACE PROTOCOL

The ANSI X3.131-1986 System Computer System Interface (SCSI) specification (approved as a standard since June 23rd, 1986) may be ordered from the :

American National Standard Institute, inc.
1430 Broadway, New York, N.Y. 10018
Tel. (212) 642-4900
Fax (212) 302-1286
Telex 42 42 96 ANSI UI

Global Engineering Documents
2805 McGaw
Irvine, CA 92714
Tel (800) 854-7179
(714) 261-1455

2.12 AUTOMATIC SELF CONFIGURATION (EXCEPT OMTI 7000)

During initialization the 7X00 Series controllers store configuration information on the Winchester disk drives. This allows the controller to self-configure upon each power up to a preset state which was established by the application under Mode Select.

SECTION 3

SCSI COMMANDS SUMMARY

3.1 General

The command definitions provide continuous logical blocks of a fixed data length.

A single command may transfer one or more logical blocks of data. Multiple commands may be linked if they are sent to the same logical unit. The controller may disconnect from the SCSI bus to allow activity by other SCSI devices while a logical unit is being prepared to transfer data.

3.2 COMMAND SET SUMMARY

COMMAND NAME	DRIVE TYPE	OPERATION CODE (HEX)	COMMAND LENGTH	DATA IN* OR OUT
GROUP 0				
FORMAT UNIT	W,F	04	6	0, 4 or Host dependent
INQUIRY	W,F	12	6	up to 36 Bytes
MODE SELECT	W,F	15	6	
MODE SENSE	W,F	1A	6	
READ	W,F	08	6	up to 256 Blocks
REASSIGN BLOCKS	W	07	6	Host dependent
RELEASE UNIT	W,F	17	6	0
REQUEST SENSE	W,F	03	6	up to 16 Bytes
RESERVE UNIT	W,F	16	6	0
REZERO UNIT	W,F	01	6	0
SEEK	W,F	0B	6	0
SEND DIAGNOSTIC	D	1D	6	0
START/STOP UNIT	W,F	1B	6	0
TEST UNIT READY	W,F	00	6	0
WRITE	W,F	0A	6	up to 256 Blocks
GROUP 1				
READ BUFFER	W,F	3C	10	up to Buffer Size
READ CAPACITY	W,F	25	10	8 Bytes
READ DEFECT DATA	W	37	10	Medium dependent
READ EXTENDED	W,F	28	10	up to 64K Blocks
SEEK EXTENDED	W,F	2B	10	0
VERIFY	W	2F	10	0
WRITE BUFFER	W,F	3B	10	up to Buffer Size
WRITE EXTENDED	W,F	2A	10	up to 64K Blocks
WRITE & VERIFY	W	2E	10	up to 64K Blocks

GROUP 7				
DEFECT LIST				
READ LONG	W	E5, E8	10	One Block + 6 Bytes
WRITE LONG	W	E6, EA	10	One Block + 6 Bytes
WRITE PRIMARY	W	FE	10	Medium dependent

W = Winchester (all products)
F = Flexible Disk drive (7000, 7200 and 7400 only)
D = Diagnostic (all products)

3.3 TAPE COMMAND SET SUMMARY (OMTI 7300 and 7400)

COMMAND NAME	DRIVE TYPE	OPERATION CODE (HEX)	COMMAND LENGTH	DATA IN OR OUT
GROUP 0				
COPY	T,W,F	18	6	
ERASE	T	19	6	0
INQUIRY	T, W,F	12	6	up to 36 bytes
LOAD/UNLOAD	T	1B	6	0
MODE SELECT	T,W,F	15	6	
MODE SENSE	T,W,F	1A	6	
READ	T	08	6	up to 16M blocks
READ BLOCK LIMITS	T	05	6	6 bytes
RECOVERED BUFFER DATA	T	14	6	
RELEASE UNIT	T,W,F	17	6	0
REQUEST SENSE	T, W,F	03	6	24 bytes
RESERVE UNIT	T,W,F	16	6	0
REWIND	T	01	6	0
SEND DIAGNOSTIC	D	1D	6	0
SPACE FORWARD	T	11	6	0
TEST UNIT READY	T, W,F	00	6	0
VERIFY	T	13	6	0
WRITE	T	0A	6	up to 16M blocks
WRITE FILE MARK	T	10	6	up to 16M

W = Winchester (all products)
F = Flexible Disk (7000, 7200 and 7400)
T = QIC 02 Tape (7400)
D = Diagnostic (allproducts)

SECTION 4

SCSI COMMANDS

4.1 GENERAL

The command definitions provide continuous logical blocks of a fixed data length.

A single command may transfer one or more logical blocks of data. Multiple commands may be linked if they are sent to the same logical unit. The controller may disconnect from the SCSI bus to allow activity by other SCSI devices while a logical unit is being prepared to transfer data.

Upon command completion (successful or unsuccessful), the controller returns a status byte to the initiator (see 4.1.9).

4.1.1 RESERVED

Reserved bits, fields, bytes, and code values are set aside. A reserved bit, field, or byte shall be set to zero by the initiator. When receiving a reserved bit, field, or byte that is not zero, the controller terminates the command with a CHECK CONDITION status and the sense key is set to ILLEGAL REQUEST.

4.1.2 UNIT ATTENTION CONDITION

A Unit Attention condition for a Logical Unit is created (reported by a Sense Key in the REQUEST SENSE data) and if enabled (depending on the ATTN bit of MODE SELECT command Page 0) for each initiator whenever :

- the removable medium may have been changed.
- once the device becomes ready after a START/STOP UNIT command.
- the controller has been reset (by a BUS DEVICE RESET message or a "hard" RESET condition).
- the MODE SELECT Parameters have been changed from other hosts.

The Unit Attention condition, if enabled, persists for each initiator until that initiator issues a command to the Logical Unit other than REQUEST SENSE or INQUIRY for which the controller returns CHECK CONDITION status. If the next command from that initiator to the Logical Unit (following the CHECK CONDITION status) is REQUEST SENSE, the UNIT ATTENTION sense key is returned. (If any other command is received, the Unit Attention condition is lost).

If an INQUIRY command is received from an initiator with a pending Unit Attention condition (before the controller reports CHECK CONDITION status), the controller performs the INQUIRY command and does not clear the Unit Attention condition.

If a REQUEST SENSE command is received from an initiator with a pending Unit Attention condition (before the controller reports CHECK CONDITION status), then the controller will report any pending sense data and preserve the Unit Attention condition.

If an initiator issues a command other than INQUIRY or REQUEST SENSE while a Unit Attention condition exists for that initiator, the controller does not perform the command and reports CHECK CONDITION status.

4.1.3 COMMAND DESCRIPTOR BLOCK (CDB)

A request from an initiator to a peripheral device is performed by sending a CDB to the controller during the COMMAND phase. For some commands, the request is accompanied by a list of parameters sent during the DATA OUT phase.

4.1.4 OPERATION CODE

The operation code of the CDB has a group code field and a command code field defined in byte 0 of each command.

The group code specifies one of the following groups :

Group 0 - six-byte commands
Group 1 - ten-byte commands
Group 2 - 6 reserved
Group 7 - ten byte commands

Operation Code

Bit / Byte	7	6	5	4	3	2	1	0
0	**Group Code**			**Command Code**				

Typical CDB for Six-byte Commands for Direct Access Devices

Bit / Byte	7	6	5	4	3	2	1	0
0	**Operation Code**							
1	**Logical Unit Number**	**Logical Block Addr. (if required) (MSB)**						
2	**Logical Block Addr. (if required)**							
3	**Logical Block Addr. (if required) (LSB)**							
4	**Transfer Length (if required)**							
5	**Control Byte**							

Typical CDB for Ten-byte Commands for Direct Access Devices

Bit / Byte	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			Reserved				
2	Logical Block Address (if required) (MSB)							
3	Logical Block Address (if required)							
4	Logical Block Address (if required)							
5	Logical Block Address (if required) (LSB)							
6	Reserved							(00h)
7	Transfer Length (if required) (MSB)							
8	Transfer Length (if required) (LSB)							
9	Control Byte							

4.1.5 LOGICAL UNIT NUMBER (LUN)

The logical unit number addresses one of up to seven devices attached to the controller with up to 2 Winchesters 7100, 7200, 7400, up to 4 Flexible disk drives (7000, 7200 and 7400 models) and up to 1 QIC 02 Tape (7400). This method of addressing is provided for systems that do not implement the IDENTIFY message. With systems implementing the IDENTIFY message, the controller ignores the LUN specified within the CDB.

4.1.6 LOGICAL BLOCK ADDRESS (LBA)

Winchesters : The logical block address begins with block zero, head one, cylinder zero and is contiguous up to the last logical block on that logical unit. Track zero on winchesters is de-allocated from the user addressable blocks and reserved for the controller's use. See section 4.

Flexible disks : The logical block address begins with block zero, head zero, cylinder zero and is contiguous up to the last logical block on that logical unit.

Group 0 commands contain 21-bit logical block addresses.
Group 1and 7 commands contain 32-bit logical block addresses.

4.1.7 TRANSFER LENGTH

The Transfer Length specifies the amount of data to be transferred (which is with the number of blocks). Six byte commands that use one byte for Transfer Length allow up to 256 blocks of data to be transferred by one command. A Transfer Length value of 1 to 255 indicates the number of blocks that shall be transferred. A value of zero indicates 256 blocks.

Ten byte commands that use two bytes for Transfer Length allow up to 65,535 blocks of data to be transferred by one command. In this case, a Transfer Length of zero indicates that no data transfer shall take place. A value of 1 to 65,535 indicates the number of blocks that shall be transferred.

A Transfer Length of the commands that are used to send a list of parameters to a controller is called the Parameter List Length. The Parameter List Length specifies the number of bytes sent during the DATA OUT phase.

The Transfer Length of the commands that are used to return sense data (e.g. REQUEST SENSE, INQUIRY, MODE SENSE, etc.) to an initiator is called the Allocation Length. The Allocation Length specifies the number of bytes that the initiator has allocated for returned data. The controller terminates the DATA IN phase when Allocation Length bytes have been transferred or when all Available Sense Data have been transferred to the initiator, whichever is less.

4.1.8 CONTROL BYTE

The Control Byte is the last byte of every CDB.

Control Byte

Bit / Byte	7	6	5	4	3	2	1	0
Last	Reserved						**Flag**	**Link**

7 through 2 Reserved

1 **Flag** bit - If the Link bit is zero, then the Flag bit shall be set to zero. If the Link bit is one, and if the command terminates successfully, the controller will send the LINKED COMMAND COMPLETE message if the Flag bit is zero and will send LINKED COMMAND COMPLETE (WITH FLAG) message if the Flag bit is one.

0 **Link** bit - This bit is set to one to indicate that the host desires an automatic Link to the next command upon successful completion of the current command. If the Link bit is one, the controller will, upon successful termination of the command, return INTERMEDIATE status and then send one of two messages defined by the Flag bit (above). Next, the controller will enter the "COMMAND"phase for the next command from the host link list.

The controller creates the CHECK CONDITION status with ILLEGAL REQUEST Sense Key when FLAG = 1 and LINK = 0.

4.1.9 STATUS BYTE

The controller sends a status byte to the host during the STATUS phase at the termination of each command as specified in the following table unless the command is cleared by an ABORT message, by a BUS DEVICE RESET message, by a "hard" RESET condition, or by a hardware error in the controller.

Status Byte Code. Bit Values

Bits of Status Byte		
7 6 5 4 3 2 1 0		Status(es) Represented
0 0 0 0 0 0 0 0	00h	**GOOD**
0 0 0 0 0 0 1 0	02h	**CHECK CONDITION**
0 0 0 0 1 0 0 0	08h	**BUSY**
0 0 0 1 0 0 0 0	10h	**INTERMEDIATE/GOOD**
0 0 0 1 0 1 0 0	14h	**INTERMEDIATE**
0 0 0 1 1 0 0 0	18h	**RESERVATION CONFLICT**

A description of the status byte codes is given below:

GOOD (00h). This status indicates that the controller has successfully completed the command.

CHECK CONDITION (02h). Any error, exception, or abnormal condition that causes sense data to be set, shall cause a CHECK CONDITION status. The REQUEST SENSE command should be issued following a CHECK CONDITION status, to determine the nature of the condition.

BUSY (08h). The controller is busy. The controller will return this status whenever it is unable to accept a command.

The controller returns this status when it is busy doing its self-tests and self-configuration (reading the device independence parameters on track zero for Winchester devices) at power-up or following a bus reset.

INTERMEDIATE (10h and 14h). This status is to be returned for every command in a series of linked commands (except the last command), unless an error, exception, or abnormal condition causes a CHECK CONDITION status or a RESERVATION CONFLICT status to be set. If this status is not returned, the chain of linked commands is broken; no further commands in the series are executed.

RESERVATION CONFLICT (18h). This status is returned whenever a host attempts to access a logical unit that is reserved by another host.

4.1.10 COMMAND PROCESSING

The following is common to all commands.

After being selected the controller sets C/D, I/O and MSG for the MESSAGE OUT phase and, if the host bus asserted the ATN signal, the controller will issue the REQ signal and get the message from the host. If the message was the IDENTIFY message, the controller switches to the COMMAND phase and transfers the command into the Z8's registers unless the controller is disconnected while executing a command. In this case, the command is not transferred, but the controller responds with busy.

The controller performs the following functions on every command.

- Checks the LUN and associates the LUN with the physical device.

- Checks if a self-test failure exists. If the controller has failed one of it's self-tests and it affects the LUN that is being accessed and the command is not a REQUEST SENSE, INQUIRY or DIAGNOSTIC command, returns CHECK CONDITION status.

- Checks if this is the first command after power-up or reset for this host and LUN. If the Unit Attention condition exists see paragraph 4.1.2.

- Decodes command operation code. If the command is not supported, the CHECK CONDITION status is created with the Sense Key/Error Code to "ILLEGAL REQUEST/Invalid Command Operation Code".

- Checks the reserved bits. If nonzero, the CHECK CONDITION status is created with the Sense Key/error Code "ILLEGAL REQUEST/Illegal Field".

- If the LUN is for a nonexistant device and the command is not REQUEST SENSE, or INQUIRY, the CHECK CONDITION status is created with the Sense Key/Error Code "ILLEGAL REQUEST/Invalid LUN".

4.2 COMMAND SET (Common to All Drives)

Group 0 Commands

Operation Code	Command Name	Drive Type	Section
18h	**COPY**	T	4.2.1
12h	**INQUIRY**	W,F,T	4.2.2
03h	**REQUEST SENSE**	W,F,T	4.2.3
1Dh	**SEND DIAGNOSTIC**	D	4.2.4
00h	**TEST UNIT READY**	W,F,T	4.2.5

W = Winchester disk drives. Valid for all products of the 7X00 and 3500 series.
F = Flexible disk drives. Valid for the 7000, 7200 and 7400 models only.
T = QIC 02 Tape. Valid for the 7400 model only.
D = Diagnostic

See section 4.3 for other Group 0 commands.

4.2.1 COPY Command

Peripheral Device Type: **All**

COPY Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	**18h**							
1	**Logical Unit Number**				Reserved			
2	**Parameter List Length (MSB)**							(00h)
3	**Parameter List Length**							(00h)
4	**Parameter List Length (LSB)**							
5	**Control Byte**							

The COPY command provides a means to copy data from one logical unit to another or to the same logical unit. The logical units shall reside on the same controller. If the host desires exclusive access to the devices involved in the COPY, it must issue the RESERVE UNIT commands to the devices performing the COPY. The PARAMETER LIST LENGTH specifies the length in bytes of the parameters that shall be sent during the DATA OUT phase of the command. A Parameter List Length of zero indicates that no data shall be transferred. This condition is not considered an error.

The COPY Parameter List begins with a four-byte header that contains the COPY function code. Following the header is the Segment Descriptor. The controller accepts only one Segment Descriptor.

COPY Parameter List

Bit / Byte	7	6	5	4	3	2	1	0
0	**COPY Function Code**					Reserved		
1	Reserved							(00h)
2	Reserved							(00h)
3	Reserved							(00h)

COPY Functions

The following lists the COPY functions supported by the controller.

Peripheral Device Type Copy Source in Byte 0	**Function Destination**	**Comment Code**	
00h	01h	**00h**	**Direct Access (Disk) to Sequential Access (Tape)**
01h	00h	**01h**	**Sequential Access (Tape) to Direct Access (Disk)**

COPY Function Code 00h and 01h Disk to Tape and Tape to Disk

The format for the segment descriptor for COPY transfer between Direct-Access and Sequential Access devices is as follows. This format is required for COPY function codes 00h and 01h.

Bit / Byte	7	6	5	4	3	2	1	0
0	**Source Address ID**				Reserved		**Source LUN**	
1	**Destination Address ID**				Reserved		**Destination LUN**	
2	**Tape Block Length (MSB)**							(02h)
3	**Tape Block Length (LSB)**							(00h)
4	**Disk Number of Blocks (MSB)**							(00h)
5	**Disk Number of Blocks**							(00h)
6	**Disk Number of Blocks**							
7	**Disk Number of Blocks (LSB)**							
8	**Disk Logical Block Address (MSB)**							
9	**Disk Logical Block Address**							
10	**Disk Logical Block Address**							
11	**Disk Logical Block Address (LSB)**							

Source and Destination addresses shall be identical and equal to the controller SCSI device ID. If not, the controller creates the CHECK CONDITION status and sets the Sense Key to ILLEGAL REQUEST. Source and Destination LUNs specify the logical units of the controller to use for this segment of the COPY command. If the Source and Destination LUNs are not allocated to Disk or Tape according to the COPY function, the controller creates the CHECK CONDITION status and sets the Sense Key to ILLEGAL REQUEST. The Block Length is only supported by the controller for the QIC 02 Tape as 512 bytes. If bytes 2 and 3 are not equal to (0200h), the controller creates the CHECK CONDITION status and sets the Sense Key to ILLEGAL REQUEST.

The Disk Number of Blocks specifies the number of blocks to transfer in this segment. A value of zero indicates that no blocks shall be transferred. The Disk Logical Block Address specifies the starting logical block address on the disk.

Disk Block Size :
The controller creates the CHECK CONDITION status and sets the Sense Key to ILLEGAL REQUEST with additional sense code 22h of "Illegal function for device type", if the disk block size is not equal to 512 bytes.

4.2.2 INQUIRY Command

Peripheral Device Type: All

INQUIRY Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0				**12h**				
1	**Logical Unit Number**					Reserved		
2				Reserved				(00h)
3				Reserved				(00h)
4				**Allocation Length**				
5				**Control Byte**				

The INQUIRY command requests that information regarding parameters of the controller and its attached peripheral device(s) be sent to the initiator.

The ALLOCATION LENGTH specifies that the number of bytes the initiator has allocated for returned INQUIRY data. An Allocation Length of zero indicates that no INQUIRY data is transferred. This condition will not be considered an error. Any other value indicates the maximum number of bytes that are to be transferred.

The controller will terminate the DATA-IN phase when Allocation Length bytes have been transferred or when all available INQUIRY data have been transferred to the host, whichever is less. The controller will return up to 36 or 54 bytes of INQUIRY data depending on the device type and the revision level of the product.

The INQUIRY command will return a CHECK CONDITION status only when the controller cannot return the requested INQUIRY data. The INQUIRY data is returned even though the peripheral device may not be ready for other commands.

If an INQUIRY command is received from an initiator with a pending unit attention condition (before the controller reports CHECK CONDITION status), the controller will perform the INQUIRY command and will not clear the unit attention condition.

The INQUIRY data contains a 5 byte Header followed with 31 (1Fh) or 49 (31h) bytes of Data Format.

INQUIRY Data

Bit / Byte	7	6	5	4	3	2	1	0
0	**Peripheral Device Type**							
1	**RMB**	Reserved						(80h) or (00h)
2	**ISO Version**	(0)	**ECMA Version** (0)			**ANSI Version** (1)		
3	Reserved			**Response Data Format**				(01h)
4	**Additional Length**							(1Fh or 31h)

Data Format

5-7	Reserved (00h)
8-15	**Vendor Identification "SMS" in ASCII**
16-31	**Product Identification "OMTI 7x00" or "OMTI 352x" in ASCII**
32-35	**Firmware Revision Level "A through Z" in ASCII**

Peripheral Device Type

Code	Description
00h	**Direct-Access device** (Winchester or Flexible Disk)
01h	**Sequential Access device** (QIC 02 Tape)
7Fh	Logical Unit not present

An RMB (removable medium) byte 1, bit 7 byte 1 set to zero indicates that the medium is not fixed (not removable). An RMB bit set to one indicates that the medium is removable.

The VERSION BYTE 2 set to one is the implemented version number of the SCSI standard.

The ADDITIONAL LENGTH specifies the length in bytes of the following parameters. If the Allocation Length of the CDB is too small to transfer all of the parameters, the Additional Length is not adjusted to reflect the truncation.

RESPONSE DATA FORMAT Code 01h indicates compliance to CCS (Common Command Set).

4.2.3 REQUEST SENSE Command

Peripheral Device Type: All

REQUEST SENSE Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0				**03h**				
1	**Logical Unit Number**					Reserved		
2				Reserved				(00h)
3				Reserved				(00h)
4				**Allocation Length**				
5				**Control Byte**				

The REQUEST SENSE command requests that the controller transfer sense data to the host.The sense data is valid for a CHECK CONDITION status returned on the prior command. This sense data is preserved by the controller for the host until retrieved by the REQUEST SENSE command or until the receipt of any other command for the same logical unit from the host that issued the command resulting in the CHECK CONDITION status. Sense data is cleared upon receipt of any subsequent command to the logical unit from the host receiving the CHECK CONDITION status. In the case of the single host option, the controller will assume that the REQUEST SENSE command is from host zero.

The ALLOCATION LENGTH specifies the number of bytes that the host has allocated for returned sense data. An Allocation Length of zero indicates that four bytes of sense data are to be transferred. Any other value indicates the maximum number of bytes that are to be transferred. The controller will terminate the DATA IN phase when the Allocation Length bytes have been transferred or when all available sense data have been transferred to the host, whichever is less. The controller will return up to 16 bytes of sense for Direct Access devices and up to 24 bytes of sense for Sequential Access device (QIC 02).

The Additional Sense code 00h indicates that the controller does not support any Additional Sense Code for the related Sense Key or does not have any appropriate additional sense to return for the CHECK CONDITION status that it created.

Additional Sense Codes

VALUE	DEFINITION
00	**No Additional Sense Information.**
01	**No Index/Sector signal (disks)**
02	**No Seek Complete (disks)**
03	**Write Fault**
04	**Drive Not Ready**

VALUE	DEFINITION
05	**Drive Not Selected**
06	**No Track Zero found (disks)**
07	**Multiple Drives Selected (Check Drive Select signals)**
08h through 0Ch	Reserved
0Dh	**Operation in Progress**
10h	**ID CRC error (Direct Access Devices) or Tape Exception (QIC 02)**
11h	**Unrecovered Read error of data blocks (Uncorrectable)**
12h	**No Address Mark found in ID field (disks)**
13h	**No Address Mark found in Data field (disks)**
14h	**No record found (disks)**
15h	**Seek Positioning error (disks)**
16h	Reserved
17h	**Recovered Read data with controller's Read retries (not with ECC)**
18h	Reserved
19h	**Defect List (P or G lists) read error (Winchester only)**
1Ah	**Parameter Overrun**
1Bh	Reserved
1Ch	**Primary Defect List not found (Winchester only)**
1Dh	Reserved
1Eh	Reserved
1Fh	**Tape handshake failure (Tape only)**
20h	**Invalid Command Operation Code**
21h	**Invalid Logical Block Address. Address greater than the LBA returned by the READ CAPACITY data with PMI bit set in the CDB.**
22h	**Illegal function for device type.**
23h	Reserved
24h	**Illegal field in Command Descriptor Block**
25h	**Invalid LUN**
26h	**Invalid field Parameter List (data out bytes)**
27h	**Write Protected**
28h	**Medium Changed**
29h	**Power On or Reset or Bus Device Reset occurred.**
2Ah	**Mode Select Parameters changed**
2Bh	**FDC 765 error (7000, 7200 or 7400 only)**
2Ch through 2Fh	Reserved
30h	**Incompatible Cartridge**
31h	**Medium Format Corrupted**
32h	**No Defect Spare Location Available (Winchester only)**
33h through 3Fh	Reserved

VALUE	DEFINITION
40h	**RAM Failure**
41h through 42h	Reserved
43h	**Message Reject Error**
44h	**Internal Controller Error**
45h	**Select/Reselect failed**
46h	Reserved
47h	**SCSI Interface Parity Error**
48h	**Initiator Detected Error**
49h	**Inappropriate/Illegal Message**
4Ah through 7Fh	Reserved
80h through 8Bh	**Correctable ECC error, number of bits correctable = x (0 through B)**
8Ch through 8Fh	Reserved
90h	**Configuration Error (See 6.13.3)**
91h through 9Fh	Reserved
A0h through AFh	**SelfTest "Ax" Failed (See 6.13.2)**
B0h through FFh	Reserved

Code 10h, Tape Exception is not necessarily an error. As an example, in the case of a Tape File Mark detected, the Tape Exception condition is created by the Tape drive in order to report the event.

The REQUEST SENSE command will return the CHECK CONDITION status only to report fatal errors for the REQUEST SENSE command. For example:

(1) The controller receives a nonzero reserved bit in the CDB.
(2) An unrecovered parity error occurs on the DATA BUS.
(3) A controller malfunction prevents return of the sense data.

If any non-fatal error occurs during the execution of the REQUEST SENSE command, the controller will return the sense data with GOOD status.

Following a fatal error on a REQUEST SENSE command, sense data may be invalid.

Extended Sense. Error class 7 specifies Extended Sense. Error Code zero specifies the Extended Sense data format.

The Extended Sense Data Format is shown in the following table.

Extended Sense Data Format (for 7400 only)

Bit / Byte	7	6	5	4	3	2	1	0
0	**Valid**	**Class (7)**			**Error Code (0)**			(70h)or (F0h)
1	**COPY Segment Number**							(00h)
2	**FileMark**	**EOM**	0	0	**Sense Key**			
3	**Information Byte (MSB)**							
4	**Information Byte**							
5	**Information Byte**							
6	**Information Byte (LSB)**							
7	**Additional Sense Length**							(08h or 10h)
8	Zero Value							(00h)
9	Zero Value							(00h)
10	Zero Value							(00h)
11	Zero Value							(00h)
12	**Additional Sense Code**							
13	Zero Value							(00h)
14	Zero Value							(00h)
15	Zero Value							(00h)
16	**Tape Sense Byte 0**							
17	**Tape Sense Byte 1**							
18	**Tape Sense Byte 2**							
19	**Tape Sense Byte 3**							
20	**Tape Sense Byte 4**							
21	**Tape Sense Byte 5**							
22	**Tape Sense Byte 6**							
23	**Tape Sense Byte 7**							

The FILEMARK bit indicates that the current Tape command has read a filemark. This bit is only used for Sequential-Access Device (QIC 02 Tape).

The END-OF-MEDIUM (EOM) bit indicates that an end-of-medium (end-of-tape, beginning-of-tape) has occurred on a sequential access device. For sequential-access devices, this bit indicates that the unit is at or past the early-warning end-of-tape if the direction was forward. Direct-access devices will not use this bit; instead, these devices will report attempts to access beyond the end-of-medium as ILLEGAL REQUEST sense key.

The INFORMATION BYTES are not defined if the Valid bit is zero. If the Valid bit is one, the Information Bytes contain the unsigned LBA associated with the Sense Key. These bytes report the number of Tape Blocks accessed. When requesting access to more blocks than recorded, the difference between the Block Count of the command and the Information bytes, computed by the host software, would provide the remaining block count requested.

- SPACE command : These bytes report the number of Tape Blocks spaced with the Block Mode or the number of File Marks spaced with the File Mark Mode.

The ADDITIONAL SENSE LENGTH specifies the number of additional sense bytes to follow, which is 8 for Direct Access devices or 16 (10h) for Tape. If the Allocation Length of the CDB is too small to transfer all of the additional sense bytes, the Additional Sense Length is not adjusted to reflect the truncation.

TAPE SENSE BYTES (valid for the 7400 model only) :
The first six Tape Sense bytes come from the Tape Formatter, as specified in the QIC-02 specification. The last two Tape Sense bytes are generated by the controller. The Exception condition bit 7 of bytes 0,1,6, and 7 is set to one only if this byte contains an error condition or the tape has to report a physical event. More than one byte may have bit 7 set to one.

Note: When Operation in Progress error (0Dh) is returned by a REQUEST SENSE command, only bytes 6 and 7 of the Tape Sense bytes reported are valid, and the other six Tape Sense bytes are meaningless.

TAPE SENSE BYTE 0
- Bit 7 Exception condition (at least one of bits 0-6 is on)
- Bit 6 Cartridge not installed
- Bit 5 Unselected Tape drive
- Bit 4 Write Protected cartridge
- Bit 3 End of medium (EOM)
- Bit 2 Unrecoverable data error
- Bit 1 Bad block not located
- Bit 0 File Mark detected

TAPE SENSE BYTE 1

- Bit 7 Exception condition (at least one of bits 0-6 is on)
- Bit 6 Illegal QIC 02 command
- Bit 5 No data detected
- Bit 4 Reserved
- Bit 3 Beginning of medium (BOM)
- Bit 2 Reserved
- Bit 1 Reserved- Bit 0 Power On, Reset occured

TAPE SENSE BYTE 2 AND 3

- The number of blocks rewritten by the controller recovery procedure, for WRITE and VERIFY commands.
- The number of READ retries exercised by the controller recovery procedure. The most significant byte is 2.

TAPE SENSE BYTES 4 AND 5 (UNDERFLOW COUNTER)

- These bytes indicate the number of times streaming operations were interrupted due to host failure to maintain minimum throughput rate. The most significant byte is byte 4.

The following two bytes are prepared by the controller, not returned by the Tape Formatter.

TAPE SENSE BYTE 6

- Bit 7 Exception Condition (at least one of bits 0-6 is on)
- Bit 6 DMA time-out during handshake on the QIC 02 bus
- Bit 5 Reserved
- Bit 4 Reserved
- Bit 3 Reserved
- Bit 2 Reserved
- Bit 1 Reserved
- Bit 0 Tape Parity error

TAPE SENSE BYTE 7

- Bit 7 Exception Condition (at least one of bits 0-6 is on)
- Bit 6 Reserved
- Bit 5 Reserved
- Bit 4 Rewind in progress
- Bit 3 End of data recorded on the tape (EOD)
- Bit 2 Reserved
- Bit 1 See table below
- Bit 0 See table below

Bits 1	0	Meaning
0	0	Off Line
0	1	On Line (default to Read if Bit 1 =0)
1	0	Illegal
1	1	Write operation in progress

SENSE KEYs Description (Byte 2)

Sense Key	Description
0h	**NO SENSE.** Indicates that there is no specific sense key information to be reported for the designated logical unit. This is the case for a successful command.
1h	**RECOVERED ERROR.** Indicates that the last command was completed successfully with some recovery action performed by the controller. Details may be determined by examining the additional sense bytes and the information bytes.
2h	**NOT READY.** Indicates that the logical unit addressed cannot be accessed. Operator intervention may be required to correct this condition.
3h	**MEDIUM ERROR.** Indicates that the command terminated with a nonrecovered error condition that was probably caused by a flaw in the medium or an error in the recorded data.
4h	**HARDWARE ERROR.** Indicates that the controller detected a nonrecoverable hardware failure (for example, controller failure, device failure, parity error, etc) while performing the command or during a self test.
5h	**ILLEGAL REQUEST.** Indicates that there was an illegal parameter in the CDB or in the additional parameters supplied as data for some commands (FORMAT UNIT, etc). If the controller detects an invalid parameter in the CDB, then it will terminate the command without altering the medium.
6h	**UNIT ATTENTION.** Indicates that the removable medium may have been changed or the controller has been reset or MODE SELECT Parameters have changed. This status is reported to all hosts for all LUN`s as the initial status after the controller is powered-up or reset unless the controller had a self-test failure.
7h	**DATA PROTECT.** Indicates that a command that reads or writes the medium was attempted on a block that is protected from this operation. The read or write operation is not performed.
Ah	**COPY ABORTED.** Indicates a COPY was aborted due to an error condition on the source LUN, the destination LUN or both.
Bh	**ABORTED COMMAND.** Indicates that the controller aborted the command. The host may be able to recover by trying the command again.
Dh	**VOLUME OVERFLOW.** Indicates that the Tape has reached the end of medium (EOM). Valid for the and 7400 models.

4.2.4 SEND DIAGNOSTIC Command

Peripheral Device Type: All

SEND DIAGNOSTIC Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0				**1Dh**				
1	**Logical Unit Number**			Reserved		**SelfTest**	0	0
2				Reserved				(00h)
3				Reserved				(00h)
4				Reserved				(00h)
5				**Control Byte**				

The SEND DIAGNOSTIC command requests the controller to perform its default diagnostic test. The SELFTEST bit is ignored.

The controller executes the following self tests:

TEST #	TEST #
0 = ROM	6 = Sequencer State Control RAM
2 = Buffer RAM	7 = Disk interface chip
5 - Sequencer Chip	

If the self test successfully passes, the command is terminated with a GOOD status; otherwise, the command will be terminated with a CHECK CONDITION status and the sense key is set to HARDWARE ERROR/Additional sense set to the Self Test number (A0 to AF) that failed (See error conditions in section 6).

4.2.5 TEST UNIT READY Command

Type: All

TEST UNIT READY Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0				**00h**				
1	**Logical Unit Number**						Reserved	
2				Reserved				(00h)
3				Reserved				(00h)
4				Reserved				(00h)
5				**Control Byte**				

This command selects the LUN specified; and if the device is ready and not seeking, GOOD STATUS is returned. In the case of a Winchester with a Removable Cartridge, GOOD STATUS indicates that the cartridge is installed. In the case of a Tape drive, GOOD STATUS indicates that the unit is on line and ready.

When issued to the Flexible disk, the motor is turned on and the command waits for Ready. When issued to a Winchester device, this command does not wait for the device to become ready and does not disconnect while executing the command.

Valid responses:

	SENSE KEY	ADDITIONAL CODE
Drive not ready	NOT READY	DRIVE NOT READY
Drive not selected	HARDWARE ERROR	DRIVE NOT SELECTED
Multiple drives selected	HARDWARE ERROR	MULTIPLE DRIVES SELECTED
Cartridge changed	UNIT ATTENTION	CARTRIDGE CHANGED
Seek/Command in Progress	NOT READY	SEEK IN PROGRESS

4.3 GROUP 0 DIRECT ACCESS COMMANDS

Group 0 Commands for Direct-Access Devices

Operation Code	Command Name	Type	Section
04h	**FORMAT UNIT**	W,F	7.3.2
15h	**MODE SELECT**	W,F	7.3.7
1Ah	**MODE SENSE**	W,F	7.3.10
08h	**READ**	W,F	7.3.4
07h	**REASSIGN BLOCKS**	W	7.3.3
17h	**RELEASE**	W,F	7.3.9
16h	**RESERVE**	W,F	7.3.8
01h	**REZERO UNIT**	W,F	7.3.1
0Bh	**SEEK**	W,F	7.3.6
1Bh	**START/STOP UNIT**	W	7.3.11
0Ah	**WRITE**	W,F	7.3.5

See section 4.2 for other Group 0 commands.

4.3.1 FORMAT UNIT

Peripheral Device Type: Direct Access

FORMAT UNIT Command Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	**04h**							
1	**Logical Unit Number**			**FmtDta**	**CmpLst**	**Defect List Format**		
2	Reserved							(00h)
3	**Interleave Factor (MSB)**							(00h)
4	**Interleave Factor (LSB)**							
5	**Control Byte**							

The FORMAT UNIT command formats the medium on the logical unit.

A FMTDATA (Format Data) bit set to one indicates that a DATA OUT Phase takes place during the command execution. The defect list header can be used to specify that the P list be used (DPRY), that the controller check the media for defects (DCRT), whether the controller should stop if it is unable to read the defect lists (STPF), whether a special certification pattern should be used (CP)

and if a defect list is included and how long it is (List Length). The defect list which may be included (if Defect List Length is different than zero) with this data specifies the defect list that shall be entered into the defect map. The flaw areas of this map will be removed by the controller from the host addressable blocks. The format of the defect list is determined by the Defect List Format defined by bits 0 through 2. The controller accepts Bytes from Index and Physical Sector defect list format.

A FMTDATA bit set to zero indicates that the DATA OUT phase shall not occur (no defect list header and no defect data are supplied by the host). This shall always be the case for Flexible Disk drives. For ST506 type winchester drives the controller will format without using a P list, without certification,will format the G list tracks and initialize with zero defects, and will stop if it is unable to read or write the G list tracks. For ESDI type winchester drives the controller will format using the OMTI P list if available or by reading the Manufactures defect list and creating the OMTI P list, without certification, will format the G list tracks and initialize with zero defects, and will stop if it is unable to read or write the G or P list tracks.

A FMTDATA bit set to one indicates that the DATAOUT phase shall occur. The Defect List header defines this Format Option.

A CMPLST (Complete List) bit set to one indicates the data supplied by the host during the DATA OUT phase of the command execution is the complete list of known defects. Any previous host-specified defect map or defect data will be erased by the controller. The result is to format the tracks containing the G List and initialize with zero defects.

A CMPLST bit set to zero indicates that the data supplied by the host during the DATA OUT phase will be added to the current G list. NOTE: If the current G list is unreadable this option will cause an error.

INTERLEAVE

The Interleave field (byte 3 and 4) requests that the logical blocks be related in a specific fashion to the physical blocks to facilitate speed matching. An interleave value of zero requests that the controller use its default interleave which is one to one. An interleave value of one requests that consecutive logical blocks be placed in consecutive physical order. The controller will not accept a value different than zero or one. An interleave value greater than one is not needed because of the large buffer provided and because the controller Ring buffer scheme implemented in the OMTI chip set allow simultaneous access to the RAM from the drive and from the SCSI bus.

The order in which logical blocks are placed on the each track of the disk drive depends on the defect sparing scheme chosen, none, zone = track or zone = cylinder and the skewing factor that is chosen.

The controller disconnects after the command phase to release the bus for hosts that support disconnect/reconnect.

The defect list shown in the following Table contains a four-byte Header followed by one or more Defect Descriptors. The Defect List Length is equal to eight times the number of Defect Descriptors.

Defect List Header

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved							(00h)
1	**FOV**	**DPRY**	**DCRT**	**STPF**		**CP**	Reserved	
2	**Defect List Length (MSB)**							
3	**Defect List Lenght (LSB)**							

Certification Pattern Field (if CP = 1 above)

0	**Certification Pattern Length**							(02h)
1	**Pattern (MSB)**							
2	**Pattern (LSB)**							

Byte 1 of the Defect List Header defines how the host may optionally control the Primary defect list flaw management scheme during the FORMAT UNIT command.

- Bits 0 through 3 are reserved.

FOV (Format Options Valid) Bit 7 set to zero indicates that the initiator requests the controller's default values to be set for the functions defined by bits 4 through 6. If bit 7 is set to zero, the initiator shall set bits 4 through 6 to zero, otherwise the controller creates the CHECK CONDITION status with ILLEGAL REQUEST Sense Key.

- DPRY (Disable Primary) bit set to zero and FOV set to one indicates that the controller shall manage the Primary list of defects while formatting. - DPRY bit set to one and FOV set to one indicates that the controller shall exclude the Primary list from the list of flaws to manage while formatting.

- DCRT (Disable Certification) bit set to zero and FOV set to one indicates that the controller shall execute the target certification routine. Enabling certification makes the time of execution of the FORMAT UNIT command much longer, as described in the following. After the disk is formatted, the selected certification pattern is written to the buffer then to each valid sector on a track. Then each track is verified. If any defects are found during the verify process, the number of Bytes from Index is calculated and the defect is added to the G list. After all tracks are checked and if at least one defect is found, the disk is re-formatted using the current G and, if enabled, P lists. The disk is then re-certified to ensure that no new defects were introduced after the re-format. The format/write/verify procedure ends when no new defect is found after the verify process. The time of execution of a high capacity disk drive may then be very long. The default certification pattern is 4E65h. However, the pattern may be selectable by the initiator, see the definition of the CP bit. DCRT bit set to one and FOV set to one indicates that the target shall disable the target certification routine while formatting.

- STPF (Stop Format) bit set to zero indicates that the controller shall continue the format process, even if either of the lists of defects P or G are not successfully accessed in whole or in part. The controller will create the CHECK CONDITION status after completion of the format process with RECOVERED ERROR Sense key, if no other error occurred than successful access the P or G lists. STPF bit set to one indicates that the controller shall stop the format process upon failing to successfully access, in whole or in part, any of the lists of defects P or G. The controller creates the CHECK CONDITION status with MEDIUM ERROR Sense key.

- CP (Certification Pattern) bit set to one indicates that the initiator is passing a 2 byte pattern in the three bytes following the defect list header and before any defect descriptors (if any). The defect list length shall not include the three bytes used for the certification pattern. Among these three bytes, the first byte shall be set to two, defining the length in bytes of the pattern, the last two bytes shall be set to the choosen 16 bit pattern. This does not change the default of 4E65h, so if another FORMAT UNIT command is issued, the desired pattern must be passed again by the initiator. CP bit set to zero indicates that the initiator is not passing a 2 byte pattern and that the default pattern of 4E65h shall be used by the controller.

If the Fmtdata bit is set to zero by the initiator, the default format parameters set by the controller are:

DPRY=0 for ESDI drives = 1 for ST drives, DCRT = 1, STPF=1 and CP = 0 standing for handling of the P list with ESDI drives (not with ST drives) but no certification performed.

Defect Descriptor(s)

PHYSICAL SECTOR FORMAT

Bit / Byte	7	6	5	4	3	2	1	0
0	**Cylinder Number of Defect (MSB)**							(00h)
1	**Cylinder Number of Defect**							
2	**Cylinder Number of Defect (LSB)**							
3	**Head Number of Defect**							
4	**Defect Sector Number (MSB)**							(00h)
5	**Defect Sector Number**							(00h)
6	**Defect Sector Number**							(00h)
7	**Defect Sector Number (LSB)**							

Each defect descriptor for the physical sector format specifies a sector size defect location comprized of the cylinder number of the defect, the head and the defect sector number. The defect descriptors shall be in ascending order. For determining ascending order, the cylinder number of the defect is considered the most significant part of the address and the defect sector number is considered the least significant part. A defect sector number of FFFFFFFFh indicates that the entire track shall be reassigned.

The controller stores these defects in the G list in the Bytes From Index format. The defect is assumed to be 80h bytes from the beginning of the specified sector.

BYTES FROM INDEX FORMAT

Bit / Byte	7	6	5	4	3	2	1	0
0	**Cylinder Number of Defect (MSB)**							(00h)
1	**Cylinder Number of Defect**							
2	**Cylinder Number of Defect (LSB)**							
3	**Head Number of Defect**							
4	**Defect Bytes from Index (MSB)**							
5	**Defect Bytes from Index**							
6	**Defect Bytes from Index**							
7	**Defect Bytes from Index (LSB)**							

Each Defect Descriptor for the Bytes From Index format specifies the starting byte address of the defect on the medium. The Defect Descriptor is defined as an eight-byte field in the Data Out phase. Each Defect Descriptor is comprised of the cylinder number of the defect, the head number of the defect, and the defect bytes from index. The Defect Descriptors shall be sent in ascending order by the host. To determine ascending order, the cylinder number of the defect is considered the most significant part of the address and the defect Bytes From Index is considered the least significant part of the address. If the defect length is over 11 bits, it is recommended that the host specifies multiple defect descriptors.

A defect Bytes From Index of FFFFFFFFh indicates that the entire track is to be reassigned.

FORMAT UNIT Command Variations :
Cases with no Defect Descriptors sent from the host in the data out phase (No D list)

CDB's Bit Reference 4 3 2 1 0 FmtData | CmpLst | | Defect List | | | Format	F O V	D P O	D C T	Defect List Length	List(s) used	Comments
0 0 0 0 0 (00h)	x	x	x	N/A		This variation is to be used to format previously unformatted drives . The controller executes the format with no defect data sent from the initiator to the controller (no Data Out phase, no defect list header, no defect descriptors). The two tracks that contain the G list are formatted and initialized to no defects.
					P, G	If the drive is an ESDI type, the controller will attempt to read the P list and will map out any defects contained in the P list. If the controller is not able to read the ESDI P list, the controller creates the CHECK CONDITION status with MEDIUM ERROR sense key (03h) and additional sense code of 19h.
					G	If the drive is an ST type, no defects will be mapped out. This variation is the only valid selection for LUNs allocated to FLEXIBLE DISK drives. Note : There is no mapping of defects and no P nor G lists for Flexible disks.
1 0 0 0 0 (10h)	0	0	0 (00h)	zero	**G**	Reformats using the G list recorded on the disk (if any). The Defect List Length shall be set to zero by the initiator (No D list).Format with no P List or Certification.
1 0 0 0 0 (10h)	1	1	1 (E0h)	zero	**G**	Same as above. Format with no P list nor certification (FOV = 1 with DPRY and DCRT = 1).
1 0 0 0 0 (10h)	1	0	1 (A0h)	zero	**G,P**	Same as above with P list.
1 0 0 0 0 (10h)	1	0	0 (80h)	zero	**G,P**	Same as above with P list and certification.

1 1 0 0 0 (18h)	0 0 0 (00h)	zero	None	Reformats without using the current G list recorded on the disk (CmpLst bit set to one). The controller formats the G list tracks and initializes the number of defects to zero.The Defect List Length shall be set to zero by the initiator.
1 1 0 0 0 (18h)	1 1 1 (E0h)	zero	None	Same as above. Format with no P list nor certification (FOV = 1 with DPRY and DCRT = 1).
1 1 0 0 0 (18h)	1 0 1 (A0h)	zero	**P**	Same as above with P list. NOTE: Does not wipe out the "P" list.
1 1 0 0 0 (18h)	1 0 0 (80h)	zero	**P**	Same as above with P list and certification.

FORMAT UNIT Command Variations : Cases with Defect Descriptors sent from the host in the data out phase (with D list)

CDB's Bit Reference 4 3 2 1 0 FmtData | CmpLst | | Defect List | | | Format	F O V / D P R Y / D C R T	Defect List Length	List(s) used	Comments
1 0 1 0 0 (14h)	0 0 0 (00h)	non-zero	**D,G**	New Format adding defects. The controller executes the format adding the defects provided in the Data Out phase to the defects in the current G list (if any). Format with no P list nor certification (FOV =0). The D list format is Bytes From Index.
1 0 1 0 0 (14h)	1 1 1 (E0h)	non-zero	**D,G**	Same as above. Format with no P list nor certification (FOV =1 with DPRY and DCRT = 1).
1 0 1 0 0 (14h)	1 0 1 (A0h)	non-zero	**D,G,P**	Same as above with P list.
1 0 1 0 0 (14h)	1 0 0 (80h)	non-zero	**D,G,P**	Same as above with P list and certification.
1 0 1 0 1 (15h)	0 0 0 (00h)	non-zero	**D,G**	The controller executes the format adding the defects provided in the Data Out phase to the defects in the current G list (if any). Format with no P list nor certification (FOV =0). The D list format is in Physical Sector Format.
1 0 1 0 1 (15h)	1 1 1 (E0h)	non-zero	**D,G**	Same as above. Format with no P list nor certification (FOV =1 with DPRY and DCRT = 1).
1 0 1 0 1 (15h)	1 0 1 (A0h)	non-zero	**D,G,P**	Same as above with P list.
1 0 1 0 1 (15h)	1 0 0 (80h)	non-zero	**D,G,P**	Same as above with P list and certification.

1	1	1	0	0	(1Ch)	0	0	0	(00h)	non-zero	**D**	The controller executes the format using the defects provided in the Data Out phase as the full set of known defects (CmpLst = 1). The controller formats the G list tracks and creates a new list with these new set of defects provided in the Data Out phase. The D list format is in Bytes From Index Format. Format with no P list nor certification (FOV = 0). Same result would be achieved with FOV, DPRY and DCRT =1).
1	1	1	0	0	(1Ch)	1	1	1	(E0h)	non-zero	**D**	Same as above. Format with no P list nor certification (FOV =1 with DPRY and DCRT = 1).
1	1	1	0	0	(1Ch)	1	0	1	(A0h)	non-zero	**D,P**	Same as above with P list, DPRY = 0.
1	1	1	0	0	(1Ch)	1	0	0	(80h)	non-zero	**D,P**	Same as above with P list and certification.
1	1	1	0	1	(1Dh)	0	0	0	(00h)	non-zero	**D**	The controller executes the format using the defects provided in the Data Out phase as the full set of known defects (CmpLst = 1). The controller formats the G list tracks and creates a new list with these new set of defects provided in the Data Out phase. The D list format is in Physical Sector Format. Format with no P list nor certification (FOV = 0). Same result would be achieved with FOV,DPRY and DCRT =1).
1	1	1	0	1	(1Dh)	1	1	1	(E0h)	non-zero	**D**	Same as above. Format with no P list nor certification (FOV =1 with DPRY and DCRT = 1).
1	1	1	0	1	(1Dh)	1	0	1	(A0h)	non-zero	**D,P**	Same as above with P list, DPRY = 0.
1	1	1	0	1	(1Dh)	1	0	0	(80h)	non-zero	**D,P**	Same as above with P list and certification.

Specifics for Winchester Disk drives :
The FORMAT UNIT command also creates control structures for the management of defects (if requested by the host) and, after all tracks are formatted, saves the self configuration parameters on track 0. The MODE SELECT Page 3 defines the parameters to be set by the host for defect management.

It is important to get the correct system information on track 0 of both winchester disks so the system will self configure after power up and Bus Reset. To do this the system should be configured as it will be used. All devices that will be connected to the controller should be connected and powered up. If winchester device select 1 is an ESDI drive, the jumper W6 should be installed and if winchester device select 2 is an ESDI drive, the jumper W7 should be installed.

The following sequence should be followed:

This sequence assumes none of the Winchesters have been formatted. If they have, it may be necessary to reformat track 0 by starting a format on each drive then doing a Bus Reset or power down after several seconds. Track 0 is written after the format is complete so this will leave track 0 formatted but uninitialized.

- Reserve all connected units
- Mode Select of Page 22 with the desired LUN association
- Mode Sense for the first winchester
- Mode Select with the SP (Save Pages) bit = 0.
- Mode Sense and Mode Select for each device connected to the controller.(With the SP bit = 0)
- Format Unit for the first winchester
- Format Unit for the second winchester
- Release all units.

Formatting starts from track zero included of cylinder zero and proceeds until all user tracks are formatted. The tracks are written starting with the index. If no certification is required during the format process, all sector data fields are filled with 6Ch or E5h pattern.

SKEWING

Track and Cylinder skew factors in the Mode Select command Page 3, are the parameters which also control the relation between physical and logical blocks on the disk drive (see Mode Sense for default values). These parameters should be set depend on the specific disk drive characteristics to allow enough time for head and cylinder switching.

The following table represent the advantage of using sector skewing to improve controller throughput. All figures are relative and aproximate. Data transfer rate for Zone = Cyl and #Spares = 1 is 100%.

Other parameters are: Interleave = 1
Track skew factor = 1
Cylinder skew factor = 4

ZONE SIZE / # OF SPARES	NO SPARES		ZONE = CYL		ZONE = TRACK	
	NO SKEW	SKEW	NO SKEW	SKEW	NO SKEW	SKEW
0	102	115	----	----	----	----
1	----	----	100	108	96	103
2	----	----	----	----	91	99
4	----	----	118	103	97	85
8	----	----	112	86	----	----
16	----	----	97	78	----	----

Note: In some instances the throughput is better without sector skewing.

BAD SECTOR HANDLING

The controller has the capability of mapping out bad sectors on Winchester Disks so the medium appears error free to the host.

In the MODE SELECT command Page 3, the number of sectors (or blocks) per zone to be de-allocated is programmable. The zone size can be programmed to be either :

- one track
- or one cylinder

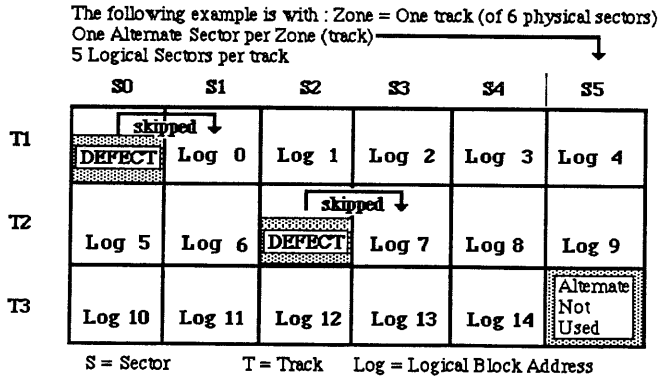
The controller de-allocates spare sectors at the end of the zone (See MODE SENSE default values).

If the host does not de-allocate any spare sectors in the MODE SELECT Page 3 (if issued), then the controller will not map out any flaws, and will let the host operating system handle defects.

DEFECTIVE SECTOR SCHEME

The scheme that OMTI chose to implement avoids any impact on performance when a single or multi-block data transfer does not include handling a defective block among the blocks to access. Impact on command time of execution will only occur when accessing an alternate location (or spare). The OMTI controller does not read a lookup table to count the previous defect addresses prior to converting the Logical Block address of the CDB to physical address. Other schemes implementing a lookup table would have to access this table for each access, whether the blocks to transfer include a defective sector or not. Accessing the table is time consuming, and is added to the overhead. The result of OMTI's scheme is lower overhead and a faster time of execution in Command phase and/or Data phase.

Also during FORMAT or REASSIGN BLOCKS command, the controller skips known defects. This scheme is also described as "in line sparing" and is designed to minimize the number of revolutions necessary to read consecutive tracks. In the following example, the 3 tracks will be read in 3 disk revolutions (even with 2 defects included). Only if two sectors are defective in one track (with one spare available per track) will the controller read in 4 revolutions. The extra revolution would be for accessing the next spare available on the next track (s).



DEFECT LISTS

P = PRIMARY DEFECT LIST: This list refers to the list of defects recorded on the medium (if any) by the manufacturer (of ESDI drives) or by the WRITE PRIMARY DEFECT LIST command.

During the FORMAT UNIT command, if FMTDATA (see CDB) is set to zero and the drive type is ESDI , or if FMTDATA is set to one and DRPY (see header of Data Out phase) is not set to one, the controller attempts to read the P list in order to remove the P list flaws from the host addressable data blocks.

There are actually two primary lists maintained on the disk on ESDI drives: The Manufacturer's list, which was written by the manufacturer of the drive, and an OMTI P list. The Manufacturer's list is only read one time and the defects are written to the OMTI P list. The OMTI P list is then used during all subsequent FORMAT or REASSIGN BLOCK commands unless it becomes unreadable, in which case, the Manufacturer's List is again used to create the OMTI P list. The OMTI P list is contained on two tracks for redundancy. These tracks are formatted during the initial format of the drive or by issuing the WRITE PRIMARY DEFECT LIST command. Once this list is created by the controller, it is not written to during subsequent FORMAT or REASSIGN BLOCK commands to assure its integrity.

A copy of the P list is created at the same time as the OMTI P list. The list is updated during a format with the cylinder, head and sector address of where each defect is mapped to.

Assuming that the list of defects had grown during the lifetime of the medium, the host can select the controller to use only the P List flaws, to return to the "as shipped" condition from the manufacturer.

G = GROWN DEFECT LIST: This list is maintained by the controller on the disk. This list includes defects identified to or by the controller. This list does not include the Primary list of defects (P list).

Entries to this Grown Defect List include:

- Defects provided to the controller in Data Defect lists during previous and current FORMAT UNIT commands.
- Defects found during the certification process of the FORMAT UNIT command.
- Defects appended by the REASSIGN BLOCKS commands.
- Defects added to the G list if the original defects are within 32 bytes of the end or the start of a sector.

D = DATA DEFECT LIST : This list is supplied to the controller by the host in the DATA OUT phase. The Defect List Length (Byte 2 and 3) of the Defect List Header may be null. The D defects identified by the host are mapped out and added to the Grown list (G List).

NUMBER OF DEFECTS THE CONTROLLER CAN HANDLE

During the process of finding alternates for the defects, the controller uses a table to hold the defect addresses that are being remapped. The maximum size of this table is 128 addresses. As an example, one sector per track is deallocated. The combined P ang G lists (if both requested) have two sectors to be reassigned in the first track and 3 in the following track. The first sector of the first track to be reassigned will use the alternate sector of the first track. The second sector of the first track to be reassigned will use the alternate sector of the second track. Prior to formatting the second track, the address of this second sector is stored in the table limited to 128 addresses. Prior to formatting the third track, the address of the 3 sectors of the second track are stored in the table limited to 128 addresses.

As another example, with 32 sectors per track, no more than 4 tracks (or 4 times 32 sectors) in a row can be specified as Defect Descriptor with a value of FFFFFFFFh.

P & G LIST SIZES

The maximum number of defects that the controller may authorize per P or G lists depend on the RAM BUFFER size and the block size. The reason is the G and P lists are kept in the RAM BUFFER during the FORMAT UNIT and REASSIGN BLOCKS commands. With an 8K RAM BUFFER, the maximum number of defects is 390 per list for a total of 780 defects or 390 total if there is no P list recorded or found. With some block sizes the number is less. The maximum number of defects with an 8K RAM BUFFER and 820h block size is 223 defects per list. If too many defects are being added to the "G" list during the WRITE PRIMARY DEFECT LIST, FORMAT UNIT and REASSIGN BLOCKS commands the controller reports an ILLEGAL REQUEST Sense Key with No Spare Location Available additional sense code.

4.3.2 MODE SELECT Command

Peripheral Device Type: **Direct Access (W+F)**

MODE SELECT Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0				**15h**				
1	**Logical Unit Number**			**PF**		Reserved		**SP**
2				Reserved				(00h)
3				Reserved				(00h)
4				**Parameter List Length**				
5				**Control Byte**				

The MODE SELECT command provides a means for the initiator to specify or change medium, logical unit, or peripheral device parameters in the controller and by using the Save Pages (SP) bit to save these parameters on the winchester disks.

The PARAMETER LIST LENGTH specifies the length in bytes of the MODE SELECT parameter list that is transferred during the DATA OUT phase. A Parameter List Length of zero indicates that no data is transferred. This condition will not be considered an error.

PF (PAGE FORMAT) byte 1 bit 4 set to one, indicates that the data sent by the initiator complies with the Page Format definition. PF (PAGE FORMAT) byte 1 bit 4 set to zero, indicates that the data sent by the initiator is limited by the Parameter List length to the Mode Select header and the Block Descriptor (if any).

SP (SAVE PARAMETERS) byte 1 bit 0 set to one (winchester only) and PF bit 4 set to one indicates that the controller shall :

- update the Current Page values with the values defined in the Pages, if issued;
- save all of the parameters for all LUN's on track 0 of the selected winchester device.
- then report command complete with no CHECK CONDITION status when successfully completing the above.

The SP bit shall not be set to 1 when doing Mode Selects to non-winchester devices, otherwise the controller will create the CHECK CONDITION status. If the drive has not yet been formatted, the SP bit shall not be set to one, otherwise the controller will create the CHECK CONDITION status.

SP byte 1 bit 0 set to zero indicates that the controller shall :

- update the Current Page values with the values defined in the Pages, if issued;
- not save any Pages ;
- not modify any saved Pages.
- then report command complete with no CHECK CONDITION status when succesfully completing the above.

Examples of MODE SELECT commands:

CDB	BUFFER	
15 50 00 00 04 00	00 1A 00 00	Change floppy type to 1A
15 10 00 00 14 00	00 00 00 08	Page 1
	00 00 00 00 00 00 02 00	Sector size = 512 bytes
	01 06 26 08 00 00 00 00	TB=PER=DTE=1 RTY=8
15 10 00 00 2C 00	00 00 00 08	Page 1 & 3
	00 00 00 00 00 00 02 00	
	01 06 20 08 00 00 00 00	Page 1
	03 16 00 01 00 01 00 00	Page 3,Zone=Track,1 spare/trk
	00 00 00 23 02 00 00 01	23h sectors/trk
	00 01 00 03 80 00 00 00	trk skew=1, cyl skew=3,soft sec
15 11 00 00 18 00	00 00 00 08	Page 20 (Serial Number), Saved to disk
	00 00 00 00 00 00 02 00	
	20 0A 11 22 33 44 55 66	
	77 88 00 00	
15 50 00 00 2C 00	00 1A 00 08	Page 5, Flexible disk
	00 00 00 00 00 00 02 00	
	05 1E 00 FA 02 08 02 00	
	00 50 00 50 00 50 00 3C	
	00 01 18 04 46 E0 01 00	
	00 00 10 00 00 00 00 00	

Note : All pages are reported saveable in MODE SENSE commands with the PS bit (bit 7 byte 0) of the Page Header set to one.

The MODE SELECT parameter list contains a four-byte Header, followed by one or no Block Descriptor, followed by zero or more Pages of parameters, if any.

MODE SELECT Parameter List
MODE SELECT Header

Bit / Byte	7	6	5	4	3	2	1	0	
0	Reserved								(00h)
1	**Medium Type**								
2	Reserved								(00h)
3	**Block Descriptor Length**								(00h or 08h)

Block Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	**Reserved**							(00h)
1	**Number of Blocks (MSB)**							
2	**Number of Blocks**							
3	**Number of Blocks (LSB)**							
4	Reserved							(00h)
5	**Block Length (MSB)**							(00h)
6	**Block Length**							
7	**Block Length (LSB)**							

Page Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	R	R	**Page Code**					
1	**Page Length**							
2-n	Refer to Page Definition							

MODE SELECT HEADER

MEDIUM TYPE :

Winchester Disk drives :

The Code value for the MEDIUM TYPE field is 00h, set as Default value (currently mounted medium type)

FLEXIBLE DISK PARAMETERS

LUNs 2, 4, 5 and 6 have default values for various types of 3.5, 5 1/4 and 8 inch Flexible Disk drives. The MODE SELECT command may not need to be issued if these default values match the desired host values. If the default values are not satisfactory then there are numerous Medium Type codes that can be used to select appropriate parameters. If no Medium Type code is satisfactory then Page 5 must be issued.See the MODE SENSE command Page 5 default values and Page 22 for Drive Select assignment per LUN.

Flexible Disk Medium Type Codes

NOTE: Medium Type 0 should be used if a Mode Select is being issued to a Flexible Disk without Page 5 and the current parameters are correct. Medium Type 0 will not change the Flexible Disk parameters.

	MEDIUM TYPE						
	05h	**06h**	**0Ah***	**0Dh***	**12h***	**16h**	**1Ah**
Transfer Rate	500K	500K	500K	500K	250K	250K	250K
Sector Size	128	128	512	256	256	256	512
Density	FM	FM	FM/MFM	FM/MFM	FM/MFM	MFM	MFM
# Heads	1	2	2	1	2	2	2
Sectors/Track	26(1Ah)	26(1Ah)	15(0Fh)	9	9	8	8
# Cylinders	77	77	77	40	40	80	80
Write Precomp	no	no	no	no	no	no	no
Reduced Current	no	no	no	no	no	no	no
Step Rate	3ms(1Eh)	3ms	3ms	3ms	4ms	4ms	4ms
Head Settle Dly	28ms(118h)	28ms	28ms	22ms(DCh)	28ms	28ms	28ms
Motor On Dly	.4sec	.4sec	.4sec	.5sec	.5sec	.4sec	.4sec
Motor Off Dly	7sec	7sec	7sec	7sec	7sec	7sec	7sec
True Ready	yes	yes	yes	no	no	yes	yes
Starting Sector #	1	1	1	1	1	1	1
MO	1	1	1	1	1	1	1
Steps/Cyl	1	1	1	1	1	1	1
Precomp Level	2	2(125ns)	2	2	2	0	0
Pin 34	1(RDY)	1	1	0	0	1	1
Pin 2	0	0	0	0	0	0	0
Pin 4	0	0	0	0	0	0	0
Pin 1	0	0	0	0	0	0	0

MEDIUM TYPE

	1Bh	1Eh	20h	21h*	22h*	23h
Transfer Rate	500K	500K	500K	500K	250K	250K
Sector Size	512	512	512	256	256	512
Density	MFM	MFM	MFM	FM/MFM	FM/MFM	MFM
# Heads	2	2	2	1	2	2
Sectors/Track	15(0Fh)	9	15(0Fh)	9	9	9
# Cylinders	80	80	80	40	40	80
Write Precomp	yes	no	yes	no	no	no
Reduced Current	no	no	no	no	no	no
Step Rate	3ms	3ms	3ms	3ms	4ms	4ms
Head Settle Dly	22ms	22ms	22ms	28ms	28ms	28ms
Motor On Dly	.5sec	.4sec	.4sec	.4sec	.4sec	.4sec
Motor Off Dly	7sec	7sec	7sec	7sec	7sec	7sec
True Ready	no	yes	yes	yes	yes	yes
Starting Sector #	1	1	1	1	1	1
MO	1	1	1	1	1	1
Steps/Cyl	1	1	1	2	2	1
Precomp Level	2(125ns)	0	2	0	0	0
Pin 34	2(Dsk Chng)	1(RDY)	1	1	1	1
Pin 2	D(Hi Den)	0	0	0	0	0
Pin 4	0	0	0	0	0	0
Pin 1	0	0	0	0	0	0

MEDIUM TYPE

	24h	25h	26h	27h	28h	29h
Transfer Rate	500K	300K	250K	250K	500K	250K
Sector Size	512	512	512	512	512	512
Density	MFM	MFM	MFM	MFM	MFM	MFM
# Heads	2	2	2	2	2	2
Sectors/Track	18	9	10	9	18	10
# Cylinders	80	40	80	40	80	80
Write Precomp	no	yes	no	no	no	no
Reduced Current	no	no	no	no	no	no
Step Rate	3ms	3.4ms	4ms	4ms	3ms	4ms
Head Settle Dly	22ms	23ms	28ms	28ms	22ms	28ms
Motor On Dly	.4sec	.5sec	.4sec	.4sec	.5sec	.5sec
Motor Off Dly	7sec	7sec	7sec	7sec	7sec	7sec
True Ready	yes	no	yes	yes	no	no
Starting Sector #	1	1	1	1	1	1
MO	1	1	1	1	1	1
Steps/Cyl	1	2	1	2	1	1
Precomp Level	0	2(125nsec)	0	0	0	0
Pin 34	1(RDY)	2(DskChng)	1	1	2(DskChng)	2
Pin 2	2(DskChng)	5(Lo Den)	2	0	D	5
Pin 4	1 (in use)	0	1	0	0	0
Pin 1	1	0	1	0	0	0

The controller creates the CHECK CONDITION status with ILLEGAL REQUEST Sense Key for codes other than those listed in the table above.

* Codes 0Ah , 0Dh, 12h, 21h & 22h:
- Track zero, side zero has 128 byte sectors(FM recording). The number of sectors is the same as for all other tracks.

The BLOCK DESCRIPTOR LENGTH (byte 3 of the header) specifies the length in bytes of the Block Descriptor. A Block Descriptor Length of zero indicates that no block descriptor is included in the parameter list. This condition is not considered an error.

BLOCK DESCRIPTOR

The block descriptor specifies the medium characteristics for each logical unit. It contains the Number of Blocks and a Block Length as follows :

The NUMBER OF BLOCKS field (bytes 1 through 3) specifies the number of logical blocks on the medium that meet the density code and block length in the block descriptor.

The BLOCK LENGTH (bytes 5 through 7) specifies the length in bytes of each logical block described by the block descriptor. On Winchesters, the controller accepts increments of 1 to 4 bytes from 128 to 4096 bytes per block. The data fields in each sector on the disk are the same size as the block size.

For ESDI Hard sector drives, if 4096 bytes per sector is selected, the sector size jumper in the ESDI drive itself has to be inserted (if provided in the drive).

For Flexible Disk drives, the controller accepts 128, 256, 512,1024, 2048 or 4096 bytes per sector.

For Tape drive, the controller only accepts 512 bytes.

PAGES

Additional blocks of parameters called PAGES may be sent to the controller, following the MODE SELECT header, if the Block Descriptor length is set to zero, or following the Block Descriptor. The Block Descriptor Length does not include the length of the Pages.

The Pages are separated into sub-blocks containing a list of related flags and/or values. Each page is preceded by a Page code and the length of the page. The length byte value shall not include itself. The Page code identifies the meaning of the following bytes within the page length. Those pages in which the host requests parameters to be changed shall be sent to the controller. All pages may be sent by the host, but Page 22 shall be sent alone. The pages do not have to be sent in ascending order.

It is recommended that the host issue a MODE SENSE command requesting Changeable values in byte 2 of the CDB prior to issuing a MODE SELECT command, in order to find out which pages are implemented by the controller, the length of each Page and which parameters may be changed.

Hosts may issue a MODE SELECT command at any time.

Page Codes

Page code	Meaning
0h	**Unit Attention parameters**
1h	**Error Recovery parameters**
3h	**Direct Access Device Format parameters**
4h	**Rigid Disk Drive Geometry parameters** (valid to be sent for ST506/412 Winchesters only, but not for ESDI drives)
5h	**Flexible Disk Drive Geometry parameters**
20h	**Serial Number**
22h	**Controller Parameters** This page should be sent alone.

The controller will return a CHECK CONDITION status and set the Sense Key to ILLEGAL REQUEST when receiving a Page Code different than those listed above.

Note related to MODE SELECT SELF CONFIGURATION (Not applicable to OMTI 7000 Controllers).

The Mode Select parameters for each device on the system are kept on track zero of each winchester drive once the drive has been formatted. Whenever the controller is reset or powered-up, these parameters are read by the controller and used to auto-configure the controller. This is called Device Independence or Auto Configuration. Therefore, it is only necessary for the host to set up the Mode Select parameters for each device before formatting the winchesters. If the controller is not connected to a winchester or if the controller is unable to read the system parameters, it creates the CHECK CONDITION status on the first command received to indicate the Unit Attention condition (Sense Key =O6h/Additional Sense Key =90h). In this case, the host should issue a MODE SELECT command after every Reset or Power-up unless the default parameters returned by the MODE SENSE command are acceptable.

UNIT ATTENTION PARAMETERS Page code 0

Bit / Byte	7	6	5	4	3	2	1	0
0	R	R	**Page Code = 0h**					(00h)
1	**Page Length** (in bytes)							(02h)
2	0	0	0	**Unit Attn**	0	0	0	0
3	Reserved							(00h)

When bit four (4) of byte two (2) is set, then Unit Attention is logged in sense only, the CHECK CONDITION status is never created. When this bit is reset (0) the Unit Attention condition is generated following a reset or power-up or when the Mode Select parameters are changed by another initiator. The default state of UnitAttn is reset.

ERROR RECOVERY PARAMETERS Page code 1

Bit / Byte	7	6	5	4	3	2	1	0
0	R	R	**Page Code = 1h**					(01h)
1	**Page Length** (in bytes)							(06h)
2	0	0	**TB**	**RC**	**EEC**	**PER**	**DTE**	**DCR**
3	**Retry Count**							(06)
4-7	**Reserved**							(00h)

A DCR (Disable Correction), (Winchester only), bit 0, set to one indicates that the data is to be transferred without applying correction, whether or not it is actually possible to correct the data. A DCR bit set to zero indicates that the data is to be corrected if possible.

A DTE (Disable Transfer on Error), (Winchester & Flexible), bit 1, set to one and if the PER bit is set to one, indicates that the controller creates the CHECK CONDITION status and will terminate the data transfer to the host immediately upon detection of an error. In this case, the Transfer Length is not exhausted. The block in error, which is the first erring block encountered, may or may not be transferred to the host depending upon the setting of the TB bit. The DTE bit can only be set to one by the host if the PER bit is also set to one. The controller creates the Check Condition status with Illegal Request Sense Key if it receives PER bit of zero and DTE bit set to one. A DTE bit set to zero enables data transfer for any data which can be recovered within the limits of the Error Recovery Flags. Any erroring block that would be posted, which is the last recovered block encountered, is not posted until the Transfer Length is exhausted.

A PER (Post Error), (Winchester & Flexible), bit 2, set to one indicates that the controller enables the reporting of the CHECK CONDITION status for recovered errors with the appropriate Sense Key. The CHECK CONDITION happens during the data transfer, depending either on the DTE bit value, or if an unrecoverable error occurred. If multiple errors occur, the Sense data shall report the block address of either the unrecoverable error, or if no unrecoverable error occurred, the last block with recovered error. A PER bit set to zero indicates that the controller will not create the CHECK CONDITION status for errors recovered within the limits established by the other Error Recovery Flags. Recovery procedures exceeding the limits established by the other Error Recovery Flags are posted accordingly. The transfer of data may terminate prior to exhausting the Transfer Length depending on the error and the state of the other Error Recovery Flags.

An EEC (Enable Early Correction), (Winchester only), bit 3, set to one indicates that the controller enables the use of the error correction, before applying retries. Seek of positioning retries and the recovery procedure retries of the message system are not affected by the value of this bit. EEC and DCR both of one is an invalid request for which the controller will create the CHECK CONDITION with Illegal Request Sense Key. An EEC bit set to zero, indicates that the controller exhausts the defined retry limit prior to enabling error correction.

An RC (Read Continuous), (Winchester only), bit 4, set to one requests the controller to transfer the Transfer Length without adding delays which would increase or ensure data integrity (ie. Delays caused by the controller's Error recovery schemes). This implies that the controller may send data which may be erroneous or fabricated in order to maintain a continuous flow of data and avoid delays. The controller assigns priority to this bit over conflicting error control bits within this byte. The CHECK CONDITION status is never created during reading and writing when RC is set to one.An RC bit set to zero, indicates that error recovery operations which cause reasonable delays are acceptable during the data transfer. Data is not fabricated.

Implementors note: Fabricated data may be data already in the buffer or any other controller scheme.

A TB (Transfer Block), (Winchester only), bit 5, set to one, indicates that the failing block data is to be transferred to the host. A TB bit set to zero indicates that the failing block data is not to be transferred to the host.

Bit 6 and 7 are Reserved.

The following table summarizes all valid modes of operation.

ERROR RECOVERY FLAGS

EEC	PER	DTE	DCR	Description
0	0	0	0	Retries then Correction are attempted. Recovered and/or corrected data (if any) is transferred corrected (EEC and DCR off) with no CHECK CONDITION Status (PER off) at the end of the transfer. - Transfer Length is exhausted. Data transfer stops only if an unrecoverable error is encountered. The controller creates CHECK CONDITION status with the appropriate Sense Key. - The data of the unrecoverable Block (if any) may or may not be transferred to the initiator depending on the setting of the TB bit.
0	0	0	1	Same as (0 0 0 0) but No Correction Applied (EEC off, DCR on).
0	0	1	0	Invalid Request (DTE on, PER off)
0	0	1	1	Invalid Request (DTE on, PER off)
0	1	0	0	Report Last Data Block in error at the end of transfer. Retries then Correction (EEC off, DCR off) are attempted and recovered data (if any) is transferred corrected. -The Transfer Length is exhausted if no unrecoverable error occurred (DTE off). - The controller creates CHECK CONDITION status with RECOVERED ERROR Sense Key and reports, in the Information bytes field of the Extended Sense data, the last block for which recovered error occurred, if any (PER on). - The data of the unrecoverable Block (if any) may or may not be transferred to the initiator depending on the setting of the TB bit.
0	1	0	1	Same as 0 1 0 0) above but No Correction Applied (EEC off, DCR on).
0	1	1	0	Stop Transfer on First Recovered Error Encountered. Retries then Correction (EEC off, DCR off) are attempted and recovered data (if any) is transferred corrected, but transfer stop (DTE on) after the first recovered (or not) or unrecoverable error is detected. - The controller creates CHECK CONDITION status (PER on) with RECOVERED ERROR Sense Key on the first block for which a recovered error occurred, if any. - This combination is only valid if the corrected data is transferred, therefore TB bit shall be set to one. TB bit not set to one is an invalid request.
0	1	1	1	Same as (0 1 1 0) above but No Correction Applied (EEC off, DCR on). - The data of the erring Block (if any) may or may not be transferred to the initiator depending on the setting of the TB bit.

ERROR RECOVERY FLAGS (continued)

EEC	PER	DTE	DCR	Description
1	0	0	0	**Correction then Retries** (DCR off, EEC on). Same as (0 0 0 0) except apply ECC Correction first.
1	0	0	1	Invalid Request (EEC on, DCR on).
1	0	1	0	Invalid Request (DTE on, PER off).
1	0	1	1	Invalid Request (DTE on, PER off)(EEC on, DCR on).
1	1	0	0	Report Last Data Block in error at the end of transfer. Same as (0 1 0 0) except apply ECC Correction first.
1	1	0	1	Invalid Request (EEC on, DCR on).
1	1	1	0	Stop transfer on First Recovered Error Encountered. Same as (0 1 0 0) except Correction then Retries are attempted.
1	1	1	1	Invalid Request (EEC on, DCR on).

The controller creates the CHECK CONDITION status and sets the Sense Key/Error code to "ILLEGAL REQUEST/ Illegal Function for Device Type" for an invalid combination of the above bits.

Retry Count is the number of times the controller shall attempt its recovery algorithm. The retry count is used for seek errors and read and write data errors. The maximum allowed is 7Fh or 127 retries. The default as set in the MODE SENSE is 8 retries. For some seek errors, at half the count of retries, a recalibrate is performed.

DIRECT ACCESS DEVICE
WINCHESTER Devices ONLY (not for Flexible Disk drives)
FORMAT PARAMETERS Page code 3

Bit / Byte	7	6	5	4	3	2	1	0	
0	R	R		**Page Code = 3h**					(03h)
1	**Page Length** (in bytes)								(16h)
	HANDLING OF DEFECTS FIELDS								
2	**Tracks per Zone (MSB)**								(00h)
3	**Tracks per Zone (LSB)**								
4	**Alternate Sectors per Zone (MSB)**								(00h)
5	**Alternate Sectors per Zone (LSB)**								
6 through 7	Zero Value								(00h)
8	**Alternate Tracks per Volume (MSB)**								(00h)
9	**Alternate Tracks per Volume (LSB)**								(00h)
	TRACK and SECTOR FORMAT FIELDs								
10	**Sectors per Track (MSB)**								(00h)
11	**Sectors per Track (LSB)**								
12	**Data Bytes per Physical Sector (MSB)**								
13	**Data Bytes per Physical Sector (LSB)**								
14	**Interleave (MSB)**								(00h)
15	**Interleave (LSB)**								(01h)
16	**Track Skew Factor (MSB)**								(00h)
17	**Track Skew Factor (LSB)**								
18	**Cylinder Skew Factor (MSB)**								(00h)
19	**Cylinder Skew Factor (LSB)**								

DRIVE TYPE FIELD

20	**SSEC**	**HSEC**	**RMB**	Reserved	(00h)
21 through 23			Reserved		(00h)

The information of this Page is only valid when sent to the controller prior to the execution of the FORMAT UNIT command.

HANDLING OF DEFECT FIELDS (WINCHESTER DISKS ONLY):

The defective sector mapping scheme supported by the controller allows the host to de-allocate a programmable number of spare sectors per zone. A zone can be :

- one track
- one cylinder

The spare sectors are physically located at the end of the zones. De-allocating one sector per track with 512 bytes per sector, which is probably the most used sector size, results in reducing the drive capacity of an ST506/412 MFM drive by 1/17th.
During the FORMAT UNIT command, prior to formatting, the controller stores the P and G lists (if requested to be handled by the host) in its buffer RAM.

With the zone equal to one track, when a listed sector address is to be mapped out, the next physical valid sector is used as the logical block and all subsequent sectors are shifted until the end of the track. This is done to minimize the performance degradation due to defective sectors. This scheme allows the controller to still read a track including defective sector in one revolution.

If more sectors than the number of alternates are to be reassigned in one zone, the next unused alternate sectors in the following zones will become the alternate sectors.

DESCRIPTION OF THE FIELDS

TRACKS PER ZONE :

Specifies the zone size. It indicates that the controller shall divide the capacity of the device, prior to formatting, in equal number of tracks for the purpose of allocating with the next four bytes, a programmable number of sectors per zone for defect handling. A value of zero will create the CHECK CONDITION status with ILLEGAL REQUEST Sense Key, if the number of Alternate Sectors per Zone is different than zero. The capacity of the logical unit to be divided in zones is represented by the number of cylinders and number of heads sent by the host in the MODE SELECT Page 4 or of the MODE SENSE current values or of the default values. The zone size can be one track or one cylinder.If the host specifies a value for the "Tracks Per Zone" that is not supported by the controller the controller will round the value up or down to a supported zone size and create the CHECK CONDITION status at completion of the MODE SELECT command. The Sense Key/Error Code will be set to "ILLEGAL REQUEST/Illegal Block Descriptor". The host may then issue a MODE SENSE command requesting the Current values to be returned in order to be informed about which value has been set by the controller in response to the initially requested value of the MODE SELECT command. The round up or down value is only available with the current values, and will be available as saved values after successful completion of the next FORMAT UNIT command.

ALTERNATE SECTORS PER ZONE:

Indicates the number of sectors that the controller shall de-allocate from the host addressable blocks during the next FORMAT UNIT command. These sectors will be available to the controller as replaceable sectors for the automatic defective sector handling. These alternates will be located at the end of each zone.

The Alternate Sectors per Zone must be less than the number of Sectors per Track when the Zone size is equal to one track. The Alternate Sectors per Zone must be less than or equal to the number of Sectors per Track when the Zone size is equal to one cylinder. If greater, the CHECK CONDITION status is created with ILLEGAL REQUEST Sense Key.

ALTERNATE TRACKS PER VOLUME indicates the number of tracks that the controller de-allocates from the initiator addressable blocks during the next FORMAT UNIT command. These tracks will be available to the controller as replaceable sectors for defect handling. This field cannot be changed by the initiator.

Note : Reduced available storage capacity and impact on access time should be considered when setting the zone size and the number of alternates per zone.

NO DEFECT HANDLING:

The controlller defect handling may be disabled by setting the field Alternate Sectors per Zone to zero in this MODE SELECT Page 3. In this case, the controller will not map out any bad sectors. The Tracks per zone field shall also be set to zero.

TRACK FORMAT FIELD:

Sectors per Track :
Indicates the number of physical sectors that the controller shall format per disk track. The controller will format as many sectors as it can. Up to FFh sectors per track are allowed. This field is not changeable for ESDI drives, therefore it should be set to zero for this type of drive.

SECTOR FORMAT FIELD:

Data Bytes per Physical Sector :
Indicates the number of data bytes that the controller shall allocate per physical sector. If both the Block Descriptor and the Page 3 are sent, and both specify a different block size, the controller will use the value of this field instead of the Block Length value specified in the Block Descriptor. This field is returned by the MODE SENSE command, if requested, and matches the Logical Block Length value indicated in the READ CAPACITY data.

Interleave is the same parameter value of the CDB of the last successfully completed FORMAT UNIT command, and is only returned by the MODE SENSE command. The controller reports this field as non-changeable in the corresponding MODE SENSE commands. The controller ignores this field in MODE SELECT commands.

Track skew factor indicates the number of physical sectors between the last logical block of one track and the first logical block on the next sequential track of the same cylinder.

Cylinder skew factor indicates the number of physical sectors between the last logical block of one cylinder and the first logical block on the next sequential cylinder.

DRIVE TYPE FIELD :

For ESDI drives, this field is reported not changeable in MODE SENSE commands, therefore,it should be set to zero in MODE SELECT commands. Check MODE SENSE default values for ESDI drives to get the values of the following bits.

A SSEC bit of one indicates that the controller shall use soft sector formatting.

A HSEC bit of one indicates that the controller shall use hard sector formatting. The HSEC bit and the SSEC bit are mutually exclusive.

The RMB bit of one indicates that the logical unit is removeable. The RMB bit of zero indicates that the logical unit is not removeable.
When the removable bit is set the controller handles the seek and recalibrate differently than it does for non-removable drives. For ESDI drives the controller checks to be sure the cartridge is in place. For ST type drives the controller waits for up to 200 microseconds after issuing the step pulses before checking for seek complete. Also for ST type drives the controller does a buffered recalibrate instead of a non-buffered (single step) recalibrate.

RIGID DISK DRIVE GEOMETRY PARAMETERS.
(WINCHESTER Devices ONLY)
Page code 4

Bit / Byte	7	6	5	4	3	2	1	0	
0	R	R	**Page Code = 4h**						(04h)
1	**Page Length** (in bytes)								(12h)
2	**Number of Cylinders (MSB)**								(00h)
3	**Number of Cylinders**								
4	**Number of Cylinders (LSB)**								
5	**Number of Heads**								
6	**Starting Cylinder- Write Precompensation (MSB)**								(00h)
7	**Starting Cylinder- Write Precompensation**								
8	**Starting Cylinder- Write Precompensation (LSB)**								
9	**Starting Cylinder- Reduced Write Current (MSB)**								(00h)
10	**Starting Cylinder- Reduced Write Current**								
11	**Starting Cylinder- Reduced Write Current (LSB)**								
12	**Drive Step Rate (MSB)**								
13	**Drive Step Rate (LSB)**								
14	**Landing Zone Cylinder (MSB)**								
15	**Landing Zone Cylinder**								
16	**Landing Zone Cylinder (LSB)**								
17	Reserved								(00h)
18	Reserved								(00h)
19	Reserved								(00h)

Note : It is recommended that the host not issue Page 4 for ESDI drives.

NUMBER OF CYLINDERS AND NUMBER OF HEADS:

The controller creates a CHECK CONDITION status with ILLEGAL REQUEST Sense Key if any of these two fields are set to zero. Up to 64K cylinders and up to 16 heads for ST drives and 32 heads for ESDI drives may be selected. Bytes 6 through 19 shall be set to zero for ESDI drives.

Drive Step Rate is expressed in units of 100 nanoseconds. The controller uses the lowest step rate, greater than or equal to the step rate required, that it is capable of implementing. The default and minimum value is 7.7 microseconds.

Value	Pulse Width in usec	Period in usec
0000h to 004Dh	2.0	7.7
004Eh to 006Bh	3.6	10.7
006Ch to 007Fh	5.7	12.7
.....	.....	.....
00F8h to 010Bh	19.6	26.7
.....	.....	.....
01D4h to 01E7h	40.2	48.7

Landing Zone Cylinder field indicates two's complement location where the controller will position the disk heads prior to stopping the spindle with the START/STOP command. This only applies to ST type devices. A negative value steps the device outside the recorded cylinders. A value greater than the number of cylinders steps the device beyond the recorded cylinders toward the spindle.

The NUMBER OF CYLINDERS is not changeable for an ESDI type drive but is changeable for an ST506/412 type drive. A value greater than the real capacity of a ST506/412 drive will result in an error in subsequent commands. Defining a number of cylinders less than the real capacity of the drive is allowed. From this value, the controller de-allocates 4 tracks from the user area if no handling of defect is requested or 12 tracks or more if defect handling is requested. The controller always de-allocates the track zero from the user addressable blocks, where the LUN device independence information will be stored. See READ CAPACITY data for more information.
The number of heads is not changeable for ESDI drives.

FLEXIBLE DISK DRIVE GEOMETRY PARAMETERS.
Page code 5

Bit / Byte	7	6	5	4	3	2	1	0	
0	R	R	Page Code = 5h						(05h)
1	Page Length (in bytes)								(1Eh)
2	Transfer Rate (MSB)								
3	Transfer Rate (LSB)								
	TRACK FORMAT FIELD								
4	Number of Heads								
5	Sectors per Track								
	SECTOR FORMAT FIELDS								
6	Data Bytes per Physical Sector (MSB)								
7	Data Bytes per Physical Sector (LSB)								
8	Number of Cylinders (MSB)								
9	Number of Cylinders (LSB)								
10	Starting Cylinder- Write Precompensation (MSB)								
11	Starting Cylinder- Write Precompensation (LSB)								
12	Starting Cylinder- Reduced Write Current (MSB)								
13	Starting Cylinder- Reduced Write Current (LSB)								
14	Drive Step Rate (MSB)								
15	Drive Step Rate (LSB)								
16	Drive Step Pulse Width								(00h)
17	Head Settle Delay (MSB)								
18	Head Settle Delay (LSB)								

Bit / Byte	7	6	5	4	3	2	1	0
19	Motor On Delay							
20	Motor Off Delay							
21	TRDY	SSN	MO	Reserved				
22	Reserved			Step Pulses per Cylinder				
23	Write Precompensation Level							
24	Head Load Delay							(00h)
25	Head Unload Delay							(00h)
26	PIN 34 Definition			PIN 2 Definition				
27	PIN 4 Definition			PIN 1 Definition				
28 through 31	Reserved							(00h)

SERIAL DATA TRANSFER RATE (byte 2 and 3) is expressed in kilobits per second. The value in byte 2 and 3 shall be one of the three following values. The controller creates the CHECK CONDITION status with ILLEGAL REQUEST Sense Key for a different value :

- 00FAh to select 250 kbit/second data transfer rate.
- 012Ch to select 300 kbit/second data transfer rate.
- 01F4h to select 500 kbit/second data transfer rate.

NUMBER OF HEADS (byte 4) or number of sides. The controller creates the CHECK CONDITION status with ILLEGAL REQUEST Sense Key for a value over 2. Heads used for servo information (if any) are excluded.

NUMBER OF SECTORS PER TRACK (byte 5) shall be set in hex values and according to the parameter "Data Bytes per Physical Sector". It defines the number of physical sectors per surface (or per head) recorded in one revolution of the medium.

DATA BYTES PER PHYSICAL SECTOR (bytes 6 and 7) or Sector size or user accessible data Bytes per Sector shall be set in hex values.

NUMBER OF CYLINDERS (bytes 8 and 9) : The maximum number of user accessible cylinders shall be set in hex values.

STARTING WRITE PRECOMPENSATION CYLINDER (bytes 10 and 11): Write precompensation is applied from the specified cylinder to all cylinders greater than the cylinder value specified. If no Write Precompensation is required, this field shall be set to the same value as the "Number of Cylinders" field.

REDUCE WRITE CURRENT CYLINDER (bytes 12 and 13) : Defines from which cylinder number the Reduce Write Current shall be applied. The value is only valid if PIN 2 (REDUCE WRITE CURRENT) on the interface is asserted.

If this field is equal to zero 0000h, Reduce Write Current is applied to all cylinders.

If this field is set to one 0001h, Reduce Write Current is not applied on cylinder zero, but is applied from cylinder one to the last cylinder (as defined by bytes 8 and 9).

If this field is set to 000Ah, Reduce Write Current is not applied on cylinder zero through 9, but is applied from cylinder 10 to the last cylinder (as defined by bytes 8 and 9).

If no Reduce Write Current is required, this field shall be set to the same value as the "Number of Cylinders" field.

DRIVE STEP RATE OR STEP PERIOD (bytes 14 and 15) : The time between two step pulses is expressed in units of 100 microseconds (tenth of milliseconds). The controller will round up to its nearest capable value. A value of zero requests the controller to set its default value. Since the FDC 765 controls these step pulses, the period changes depending on the drive data rate as follows :

500 Kbit	300 Kbit	250 Kbit
0000h = Default values	0000h = Default values	0000h = Default values
000Ah or 10 = 1 ms	0011h or 17 = 1.7 ms	0014h or 20 = 2 ms
0014h or 20 = 2 ms	0022h or 34 = 3.4 ms	0028h or 40 = 4 ms
001Eh or 30 = 3 ms	0033h or 51 = 5.1 ms	003Ch or 60 = 6 ms
0028h or 40 = 4 ms	0044h or 68 = 6.8 ms	005Ch or 80 = 8 ms
0028h or 40 = 4 ms	0044h or 68 = 6.8 ms	005Ch or 80 = 8 ms
0096h or 150 = 15 ms	00FFh or 255 = 25.5 ms	012Ch or 300 = 30 ms
00A0h or 160 = 16 ms	0110h or 272 = 27.2 ms	0140h or 320 = 32 ms

DRIVE STEP PULSE WIDTH (00h) (byte 16) expressed in one microsecond increments is not analyzed, and shall be set to zero. The FDC 765 controls the step pulses. Typical values are 5 microseconds when using a 500 KBit transfer rate, and 10 microseconds when using a 250 KBit transfer rate.

HEAD SETTLE DELAY (bytes 17 and 18) : The delay required from the last step pulse to a valid read or write is expressed in 100 microsecond increments. The controller will round up to its nearest capable value. A value of zero requests the controller to set its default value.

500 Kbit	300 Kbit	250 Kbit
0000h = Default values	0000h = Default values	0000h = Default values
0014h or 20 = 2 ms	0022h or 34 = 3.4 ms	0028h or 40 = 4 ms
0028h or 40 = 4 ms	0044h or 68 = 6.8 ms	0050h or 80 = 8 ms
003Ch or 60 = 6 ms	0066h or 102 = 10.2 ms	0078h or 120 = 12 ms
003Ch or 60 = 6 ms	0066h or 102 = 10.2 ms	0078h or 120 = 12 ms
00DCh or 220 = 22 ms	00EEh or 238 = 23.8 ms	0118h or 280 = 28 ms
00DCh or 220 = 22 ms	00EEh or 238 = 23.8 ms	0118h or 280 = 28 ms
09ECh or 2540 = 254 ms	10DEh or 4318 = 431.8 ms	13D8h or 5080 = 508 ms
0A00h or 2560 = 256 ms	1100h or 4352 = 435.2 ms	1400h or 5120 = 512 ms

MOTOR ON DELAY (byte 19) : This function depends on the state of the TRDY bit. If TRDY is not set, the motor on Delay indicates the amount of time in 1/10th second or 100 milliseconds which the controller will delay before trying to access data after asserting the MOTOR ON signal to the drive. If TRDY is set, the Motor On Delay indicates the amount of time the controller will delay for drive ready status before aborting a disk access.

MOTOR OFF DELAY (byte 20) : indicates the amount of time in 1/10th second or in 100 milliseconds which the controller will delay before deasserting the MOTOR ON signal to the drive after the controller has become idle. A value of FFh indicates that the motors are to be left on. In this case, the motor may still be controlled by the START/STOP UNIT command.

A TRDY (TRUE READY) (byte 21) bit of one indicates that the drive provides a ready signal which indicates that the spindle motor is up to speed and the drive and medium are ready to transmit and receive data. In this case, the controller may attempt to access the disk immediately upon sensing drive ready.

SSN (byte 21) bit of one indicates that the starting sector number is one (IBM standard). SSN bit of zero indicates that the starting sector number is zero (non-standard).

MO (byte 21) bit of zero means that Pin 16 (motor on) will be asserted. MO bit of one means that Pin 16 (motor on) shall remain de-asserted.

STEPS PER CYLINDER field (byte 22) is used to specify the number of step pulses required per cylinder. Non-zero values allow a drive to read a diskette formatted on a drive with lower TPI (tracks per inch). For example a value of Bit 3,2 and 0 = 0, and a Bit 1 = 1 will allow a 96 TPI drive to access tracks on a diskette from a 48 TPI drive.

Bit 3	Bit 2	Bit 1	Bit 0	Steps/Cylinder
0	0	0	0	Default
0	0	0	1	1 (Normal Usage)
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4

WP field (byte 23), **Write Precompensation Level** is defined as follows :

500 KBits/second	300 KBits/second	250 KBits/second
0 = 0.0 NSEC	0 = 0.0 NSEC	0 = 0.0 NSEC
1 = 62.5 NSEC	1 = 104.2 NSEC	1 = 125.0 NSEC
2 = 125 NSEC	2 = 208.3 NSEC	2 = 250.0 NSEC
3 = 187.5 NSEC	3 = 312.5 NSEC	3 = 375.0 NSEC
4 = 250.0 NSEC	4 = 416.7 NSEC	4 = 500.0 NSEC
5 = 250.0 NSEC	5 = 416.7 NSEC	5 = 500.0 NSEC
6 = 312.5 NSEC	6 = 520.8 NSEC	6 = 625.0 NSEC
7 = 312.5 NSEC	7 = 520.8 NSEC	7 = 625.0 NSEC

HEAD LOAD DELAY (byte 24) is not analyzed and shall be set to zero (00h). The controller assumes the head is loaded when the motor is turned on and does not do an additional Head Load delay . If the drive supports the Head Load function it should be jumpered to load when the motor is turned on or when Pin 4 is asserted. The controller asserts Pin 4 when the motor is turned on if the Pin 4 definition is set for Head Load.
HEAD UNLOAD DELAY (byte 25) is not analyzed and shall be set to zero (00h).

PIN 34 DEFINITION (byte 26) bits 6,5 and 4 define Pin 34 of the Flexible disk drive interface which is used differently by drive vendors and drive models. Pin 34 may be defined as Drive Ready or Disk Changed. The following setting allows the user to select how Pin 34 shall be interpreted by the controller.

Bit 7	6	5	4	
P	0	0	0	OPEN. The controller does not use Pin 34.
0	0	0	1	DRIVE READY
0	0	1	0	DISK CHANGED. The controller performs Select /Deselect to check the drive status.
P	1	0/1	0/1	Reserved.

P Bit 7 is the polarity of the pin. 0 means low true or active low.1 means high true or active high.

PIN 2 DEFINITION (byte 26) bits 2, 1 and 0 define Pin 2 of the Flexible disk drive interface, which is used differently by drive vendors and drive models. The following setting allows the user to select how Pin 2 shall be interpreted by the controller.

Bit 3	2	1	0	
P	0	0	0	OPEN. The controller does not use Pin 2.
0	0	0	1	READY
0	0	1	0	DISK CHANGED
P	0	1	1	HIGH SPEED
P	1	0	0	HIGH TRANSFER RATE
P	1	0	1	HIGH DENSITY
P	1	1	0	REDUCE WRITE CURRENT
P	1	1	1	Reserved.

P Bit 3 is the polarity of the pin. 0 means low true or active low. 1 means high true or active high.

PIN 4 DEFINITION (byte 27) bits 6, 5 and 4 define Pin 4 of the Flexible disk drive interface which is used differently by drive vendors and drive models. Pin 4 may be defined as In Use or Eject or Head Load. The following setting allows the user to select how Pin 4 shall be interpreted by the controller.

Bit 7	6	5	4	
P	0	0	0	OPEN. The controller does not use Pin 4.
P	0	0	1	IN USE
P	0	1	0	EJECT
P	0	1	1	HEAD LOAD
P	1	0/1	0/1	Reserved.

P Bit 7 is the polarity of the pin. 0 means low true or active low. 1 means high true or active high.

PIN 1 DEFINITION (byte 27) bits 2, 1 and 0 define Pin 1 of the Flexible disk drive interface which is used differently by drive vendors and drive models. The following setting allows the user to select how Pin 1 shall be interpreted by the controller.

Bit 3	2	1	0	
P	0	0	0	OPEN. The controller does not use Pin 1.
P	0	0	1	DISK CHANGE RESET
P	0	1	X	reserved
P	1	X	X	reserved

P Bit 3 is the polarity of the pin. 0 means low true or active low. 1 means high true or active high.

SERIAL NUMBER. Page code 20

Bit / Byte	7	6	5	4	3	2	1	0
0	R	R	**Page Code = 20h**					(20h)
1	**Page Length** (in bytes)							(0Ah)
2	**Drive Serial Number (MSB)**							
3	**Drive Serial Number**							
4	**Drive Serial Number**							
5	**Drive Serial Number**							
6	**Drive Serial Number**							
7	**Drive Serial Number**							
8	**Drive Serial Number**							
9	**Drive Serial Number (LSB)**							
10	Reserved							(00h)
11	Reserved							(00h)

This page is intended to be used in the MODE SELECT command by the drive vendor to record on disk the drive serial number. It is recommended that the initiator not attempt to modify this page.

CONTROLLER PARAMETERS Page code 22h

This page shall be sent alone, with no other pages.

Bit / Byte	7	6	5	4	3	2	1	0
0	R	R	**Page Code = 22h**					
1	**Page Length** (in bytes)							(0Eh)
2	**LUN**				**LUN**			
3	**LUN**				**LUN**			
4	**LUN**				**LUN**			
5	**LUN**				**LUN**			
6 through 15	Reserved							(00h)

The LUNs are used to change the association between a Logical Unit Number and a physical device (up to seven in total). The LUN may be from 0 to 7. Each nibble shall be loaded with a different LUN. The controller does not check if a LUN is used more than twice. The last nibble specified will be held. Unused LUN's should be set to 0Fh.

Each nibble is allocated to a particular physical device and its Drive Select line as defined in the drive hardware. The following table shows which drive type and drive select owns which nibble :

2	**Winchester Drive Select 1**	**Winchester Drive Select 2**
3	**Flexible Disk Select 1**	**QIC 02 Tape**
4	**Flexible Disk Select 2**	**Flexible Disk Select 3**
5	**Flexible Disk Select 4**	Null

Null is non-associated device.

The default values for the 7400 are :
Byte 2 = 01h
Byte 3 = 23h
Byte 4 = 45h
Byte 5 = 6Fh

Example:
To change the LUN on the Winchester with Drive Select 2 from 1 to 2, allocating LUN 1 to the tape device, the Flexible disk with Drive Select 1 becoming LUN 3, the setting shall be :

Byte 2	02h
Byte 3	31h
Byte 4	45h
Byte 5	6Fh

All other devices keep their default values.

Example:

Byte 2	02h	Winchester Drive Select 1 is LUN 0 - Winchester Drive Select 2 is LUN 2
Byte 3	65h	Flexible Drive Select 1 is LUN 6 - Tape is LUN 5
Byte 4	13h	Flexible Drive Select 2 is LUN 1 - Flexible Drive Select 3 is LUN 3
Byte 5	4Fh	Flexible Drive Select 4 is LUN 4 - LUN 7 is a null device

NOTE: It is recommended that the host issue an INQUIRY command after a MODE SELECT command which changes the contents of this Page.

NOTE: If the LUN association is changed by issuing Page 22 or by removing Jumper W5 the Mode Sense Default values will no longer reflect the initial Default values.

4.3.3 MODE SENSE Command

Peripheral Device Type: All

MODE SENSE Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	1Ah							
1	Logical Unit Number			Reserved				
2	Page Control Field			Page Code				
3	Reserved							(00h)
4	Allocation Length							
5	Control Byte							

The MODE SENSE command provides a means for a controller to report its medium, logical unit, or peripheral device parameters to the initiator.

The PCF (Page Control Field) bits 7 and 6 of byte define the type of Page Parameter values to be returned. The values may be either :

- **Current**
- **Changeable**
- **Default**
- or **Saved**

	PCF (bits 7 & 6) =	Byte 2 for all pages =
Current	**00**	**3Fh**
Changeable	**01**	**7Fh**
Default	**10**	**BFh**
Saved	**11**	**FFh**

The PAGE CODE (bits 5 through 0 of byte 2) indicates which page(s) shall be returned in the Data In phase of the command execution. An initiator may request a single page or all Pages (with code 3Fh) to be returned by the controller. When code 3Fh is selected, the controller returns only the pages related to the device type, which are different from Winchester, Flexible disk and Tape.

The ALLOCATION LENGTH specifies the number of bytes that the initiator has allocated for returned MODE SENSE data. An Allocation Length of zero indicates that no MODE SENSE data is to be transferred. This condition will not be considered an error. Any other value indicates the maximum number of bytes that are to be transferred. The controller will terminate the DATA IN phase when Allocation Length bytes have been transferred or when all available MODE SENSE data have been transferred to the initiator, whichever is less.

The MODE SENSE data contains a four-byte Header, followed by one eight-byte Block Descriptor, followed by zero or more Pages.

Pages returned (with code 3Fh) by LUNs allocated to the drive types listed below:

Winchester disks :	Flexible Disks :	Tape drive :	
0h	**0h**	**0h**	Unit Attention
1h	**1h**	**1h**	Error Recovery
3h	not returned	not returned	Format
4h	not returned	not returned	Disk drive Geometry
	5h		Flexible disk
20h	**20h**	**20h**	Serial Number
22h	**22h**	**22h**	Controller

Page Code	Page Length	Total # bytes in Page (+ 2 bytes from Page Length)
0	2	4
1	6	8
3	22	24
4	18	20
5	22	24
20	10	12
22	14	16

Example of a Mode Sense DCB to request current values:

1Ah 00* 3Fh 00 FFh** 00

* LUN specified in Identify Message.

** Less then FFh bytes can be specified if the host buffer size is limited.

- If the Page Code is equal to 3Fh, all Pages are returned to the initiator.
- If the Page Code is different than 3Fh, the Page defined by the Page Code is returned to the initiator.

Page Code Field bits 7 and 6 byte 2 of the CDB.

7	6	Bits
0	0	**Report Current Values.** Pages are returned to the initiator with fields and bits set to Current values. The Current values are the values currently in the micro processor RAM and in the Z8 registers for the selected LUN. These values are either: - the same as the saved values if the last Self Configuration was successfull and a Mode Select has not been issued since the Self Configuration. - the default parameters if no Self Configuration was done or it was not successfull and no Mode Selects have been executed since the last power up or bus reset - the latest successfull Mode Select Fields and bits not supported by the controller are set to zero.
0	1	**Report Changeable Values.** Fields and bits that are allowed to be changed in MODE SELECT commands are set to one. The entire field is set to one even if part of the field may only be changed. Fields and bits not allowed to be changed are set to zero. Subsequent MODE SELECT commands shall issue those fields and bits set to zero.
1	0	**Report Default Values.** Fields and bits are set to the controller default values. All of these values are stored in the controller ROM, and not read from the system disk. MODE SENSE commands requesting default values may be issued to any LUN, even if the drives are not connected. Fields and bits not supported by the controller are set to zero. The value of the fields returned with this code is intended to avoid confusion over whether the value of zero is the default or the non-supported value.
1	1	**Report Saved Values.** Fields and bits are set to the saved values. The Saved values are either : - the values saved during the last successfully completed FORMAT UNIT or during the last successfully MODE SELECT commands with SP and PF = 1. - or identical to the Default values if saving was not requested or if access to the saved values is unsuccessful. The saved values are recorded on disk on track zero (not accessible to the user). Fields and bits not supported by the controller in the Pages are set to zero.

Page Code
Page Codes (bits 0 through 5 of byte 0 in the Page Header)
Page Codes (bits 0 through 5 of byte 2 of the CDB)

Page code	Meaning
0h	**Unit Attention parameters** (be advised that this page may not yet be supported. At the time of the printing of this document, the firmware has been released without this page being implemented. The MODE SENSE with PCF = 3Fh will inform you).
1h	**Error Recovery parameters**
3h	**Direct Access Device Format parameters**
4h	**Disk Drive Geometry parameters**
5h	**Flexible Disk Drive Geometry**
20h	**Serial Number**
22h	**Controller Parameters (LUN association)**
3Fh	**Return all Pages** for the LUN involved to the initiator. See PCF bit configuration. Page Code valid for MODE SENSE commands only.

The controller returns the same Page Length value in each Page that it supports with the 3Fh Page Code whatever the value of each bit of the PCF field is.

MODE SENSE Data

Bit / Byte	7	6	5	4	3	2	1	0
0	**Sense Data Length**							
1	**Medium Type**							
2	**WP**			Reserved				(80h) or (00h)
3	**Block Descriptor Length**							(08h)

Block Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	**Density Code**							(00h)
1	**Number of Blocks (MSB)**							
2	**Number of Blocks**							
3	**Number of Blocks (LSB)**							
4	Reserved							(00h)
5	**Block Length (MSB)**							(00h)
6	**Block Length**							
7	**Block Length (LSB)**							

The SENSE DATA LENGTH (Byte 0 of the Header) specifies the length in bytes of the following MODE SENSE data that is available for transfer during the DATA IN phase. The Sense Data Length does not include the byte 0.

A WP (Write Protected) bit set to zero indicates that the logical unit is write enabled. A WP set to one indicates that the logical unit is write protected.

The BLOCK DESCRIPTOR LENGTH (Byte 3) specifies the length in bytes of the Block Descriptor. The controller only accepts one or zero Block Descriptor. A Block Descriptor Length of zero indicates that no Block Descriptor is included in the parameter list. This condition will not be considered an error.

The Block Descriptor specifies the medium characteristics for all the logical unit numbers. The Block Descriptor contains a Density Code, a Number of Blocks, and a Block Length. Only the Block Length can be changed.

The NUMBER OF BLOCKS field specifies the number of logical blocks on the medium that meet the density code and block length in the Block Descriptor.

The BLOCK LENGTH specifies the length in bytes of each logical block (see MODE SELECT command similar paragraph). The data fields in each sector on the disk are the same size as the block size.

Code values for the MEDIUM TYPE field and the DENSITY CODE field are set to 00h as default value for Winchester disk drives. See MODE SELECT for other device types.

Page Descriptor

Bit / Byte	7	6	5	4	3	2	1	0
0	**PS**	R		**Page Code**				
1	**Page Length**							
2-n	Refer to Page Definitions							

Additional blocks of parameters called Pages may be sent to the controller in the DATA OUT phase of the MODE SELECT command, following either :
- the MODE SELECT Header, if the Block Descriptor length is set to zero.
- or the Block Descriptor.

The Block Descriptor Length does not include the length of the Pages. Each Page is preceded by a Header of two bytes defining the Page Code and the length of the Page. Following the Header, the Pages are separated into sub-blocks containing a list of related flags and/or values.

PAGE DESCRIPTION:
PS (Parameters Saveable) bit 7 byte 0 of each Page Header is always set to one by the controller indicating that parameters of all Pages can be saved by the controller. When successfully completing MODE SELECT commands issued with the SP bit set in the CDB, the controller will save the parameters of the defined Page (if not already saved as for Pages 3 and 4). See MODE SELECT command definition.

Bit 6 of byte 0 is reserved.
The PAGE CODE identifies the meaning of the following bytes in the Page.

The PAGE LENGTH indicates the number of bytes that the controller supports in each Page. The Page Length value of each page does not include the Page Length byte. The controller returns in the Pages of the MODE SENSE commands as many consecutive bytes that it supports for each Page that it supports. The Page Length shall be set in the pages of the MODE SELECT commands to the exact same value returned by the controller in the MODE SENSE Page Length bytes. Otherwise, the controller shall create CHECK CONDITION status with the Sense Key of ILLEGAL REQUEST.

The initiator shall issue a MODE SENSE command requesting the controller to return all Changeable values (CDB's byte 2 = 7Fh with PCF field configuration 0 1 and Page Code 3Fh) prior to issuing any MODE SELECT commands, in order to find out which Pages are implemented by the controller and the length of each Pages.

UNIT ATTENTION PARAMETERS Page code 0

At the time of the printing of this document, this page was not yet implemented.

Bit / Byte	7	6	5	4	3	2	1	0	
0	1	0	**Page Code = 0h**						(80h)
1	**Page Length** (in bytes)								(02h)
2	0	0	0	**Unit Attn**	0	0	0	0	
3	Reserved								(00h)

MODE SENSE Page 0 returned values

	Current	Changeable	7x00 Default	352xA Default	Saved
Byte 0	80h	80h	80h	80h	80h
Byte 1	02h	02h	02h	02h	02h
Byte 2	Host dependent	10h	00h	10h	Host dependent
Byte 3	00h	00h	00h	00h	00h

ERROR RECOVERY PARAMETERS Page code 1
Current, Changeable, Default and Saved values.

Bit / Byte	7	6	5	4	3	2	1	0
0	**1**	0	**Page Code = 1h**					(81h)
1	**Page Length** (in bytes)							(02h)
2	0	0	**TB**	**RC**	**EEC**	**PER**	**DTE**	**DCR**
3	**Retry Count**							
4	**00h**							
5	**00h**							
6	**00h**							
7	**00h**							

MODE SENSE Page 1 returned values for both LUNs
for both ST506/412 or ESDI type of drives

	Current	**Changeable**	**Default**	**Saved**
Byte 0	81h	81h	81h	81h
Byte 1	02h	02h	02h	02h
Byte 2	Host dependent	3Fh	20h (TB set)	Host dependent
Byte 3	Host dependent	FFh (yes)	08h	Host dependent

DIRECT ACCESS DEVICE
FORMAT PARAMETERS Page code 3
Current, Changeable, Default and Saved values.

Bit / Byte	7	6	5	4	3	2	1	0	
0	**1**	0		**Page Code = 3h**					(83h)
1				**Page Length** (in bytes)					(16h)
2				**Tracks per Zone (MSB)**					(00h)
3				**Tracks per Zone (LSB)**					
4				**Alternate Sectors per Zone (MSB)**					
5				**Alternate Sectors per Zone (LSB)**					
6 through 7				Zero Value					(00h)
8				**Alternate Tracks per Volume (MSB)**					(00h)
9				**Alternate Tracks per Volume (LSB)**					(00h or 02h)

TRACK and SECTOR FORMAT FIELDs

Bit	7	6	5	4	3	2	1	0
10				**Sectors per Track (MSB)**				(00h)
11				**Sectors per Track (LSB)**				
12				**Data Bytes per Physical Sector (MSB)**				
13				**Data Bytes per Physical Sector (LSB)**				
14				**Interleave (MSB)**				(00h)
15				**Interleave (LSB)**				(01h)
16				**Track Skew Factor (MSB)**				(00h)
17				**Track Skew Factor (LSB)**				
18				**Cylinder Skew Factor (MSB)**				(00h)
19				**Cylinder Skew Factor (LSB)**				
20	**SSEC**	**HSEC**	**RMB**	Reserved				
21	through 23			Zero value				(00h)

MODE SENSE Page 3 returned values for LUN 0 (ST506/412 drives)

	Current	Changeable	Default	Saved
Byte 0	83h	83h	83h	83h
Byte 1	16h	16h	16h	16h
Byte 2 and 3	Host dependent	FFFFh (Yes)	0001h (one track)	Host dependent
Byte 4 and 5	Host dependent	FFFFh (Yes)	0001h (one sector)	Host dependent
Byte 6 and 7	zero	zero (no)	zero	zero
Byte 8 and 9	0002h	0000h (no)	0002h	0002h
Byte 10 and 11	Host dependent	FFFFh (Yes)	0011h (17 sectors)	Host dependent
Byte 12 and 13	Host dependent	FFFFh (Yes)	0200h (512 bytes)	Host dependent
Byte 14 and 15	0001h	0000h (no)	0001h	0001h
Byte 16 to 19	Host dependent	FFFFh	zero	Host dependent
Byte 20	Host dependent	E0h	80h	Host dependent
Byte 21 to 23	zero	zero (no)	zero	zero

MODE SENSE Page 3 returned values for ESDI drives (LUN 0 or LUN 1)

	Current	Changeable	Default	Saved
Byte 10 and 11	Drive dependent	0000h (no)	0011h	Host dependent
Byte 20	Drive dependent	00h (no)	80h	Host dependent

Refer to the ST506/412 table above for other fields and bytes .
The controller reads the ESDI configuration during the MODE SENSE command to configure these bytes.

MODE SENSE Page 3 returned values for LUN 1 (ST506/412 drives)

	Current	Changeable	Default	Saved
Byte 0	83h	83h	83h	83h
Byte 1	16h	16h	16h	16h
Byte 2 and 3	Host dependent	FFFFh (yes)	0000h	Host dependent
Byte 4 and 5	Host dependent	FFFFh (yes)	0000h (no mapping)	Host dependent
Byte 6 and 7	zero	zero (no)	zero	zero
Byte 8 and 9	0000h	0000h (no)	0000h	0000h
Byte 10 and 11	Host dependent	FFFFh (yes)	0004h (4 sectors)	Host dependent
Byte 12 and 13	Host dependent	FFFFh (yes)	0820h (2080 bytes)	Host dependent
Byte 14 and 15	0001h	0000h (no)	0001h	0001h
Byte 16 to 19	Host dependent	FFFFh	zero	Host dependent
Byte 20	Host dependent	E0h	80h	Host dependent
Byte 21 to 23	zero	zero (no)	zero	zero

DISK DRIVE GEOMETRY PARAMETERS. Page code 4
Current, Changeable, Default and Saved values.

Bit / Byte	7	6	5	4	3	2	1	0
0	**1**	0	**Page Code = 4h**					(84h)
1	**Page Length** (in bytes)							(12h)
2	**Number of Cylinders (MSB)**							(00h)
3	**Number of Cylinders**							
4	**Number of Cylinders (LSB)**							
5	**Number of Heads**							
6	**Starting Cylinder- Write Precompensation (MSB)**							(00h)
7	**Starting Cylinder- Write Precompensation**							
8	**Starting Cylinder- Write Precompensation (LSB)**							
9	**Starting Cylinder- Reduced Write Current (MSB)**							(00h)
10	**Starting Cylinder- Reduced Write Current**							
11	**Starting Cylinder- Reduced Write Current (LSB)**							
12	**Drive Step Rate (MSB)**							
13	**Drive Step Rate (LSB)**							
14	**Landing Zone Cylinder (MSB)**							
15	**Landing Zone Cylinder**							
16	**Landing Zone Cylinder (LSB)**							
17 thru 19	Reserved						(00)	

MODE SENSE Page 4 returned values for ST506/412 drive Type (LUN 0)

	Current	Changeable	Default	Saved
Byte 0	84h	84h	84h	84h
Byte 1	12h	12h	12h	12h
Byte 2 to 4	Host dependent	FFFFFFh (yes)	000132h (306 cyl.)	Host dependent
Byte 5	Host dependent	FFh (yes)	04h (4 heads)	Drive dependent
Byte 6 to 8	Host dependent	FFFFFFh (yes)	000080h (128 cyl.)	Drive dependent
Byte 9 to 11	Host dependent	FFFFFFh (yes)	000000h	Drive dependent
Byte 12 and 13	Host dependent	FFFFh (yes)	006Bh (10.7 us)	Drive dependent
Byte 14 to 16	Host dependent	FFFFFFh (yes)	000000h	Drive dependent
Byte 17 to 19	zero	zero (no)	zero	zero

The default Logical Block Address returned by the READ CAPACITY data is 4BBFh.

MODE SENSE Page 4 returned values for ST506/412 drive type (LUN 1)

	Current	Changeable	7400/352xA Default	7400 Default	Saved
Byte 0	84h	84h	84h	84h	84h
Byte 1	12h	12h	12h	12h	12h
Byte 2 to 4	Host dependent	FFFFFFh	000132h (306 cyl.)	00003FF	Host dpnt
Byte 5	Host dependent	FFh	04h (4 heads)	08h (8 heads)	Drive dpnt
Byte 6 to 8	Host dependent	FFFFFFh	000080h (128 cyl.)	000000h	Drive dpnt
Byte 9 to 11	Host dependent	FFFFFFh	000000h	000000h	Drive dpnt
Byte 12 and 13	Host dependent	FFFFh	006Bh (10.7 us)	004Dh (7.7 us)	Drive dpnt
Byte 14 to 16	Host dependent	FFFFFFh	00000Uh	000000h	Drive dpnt
Byte 17 to 19	zero	zero	zero	zero	zero

The default Logical Block Address returned by the READ CAPACITY data is 1317h.

MODE SENSE Page 4 returned values for ESDI drive Type

	Current	Changeable	Default	Saved
Byte 0	84h	84h	84h	84h
Byte 1	12h	12h	12h	12h
Byte 2 to 4	Drive Dependent	000000h	000132h	Drive Dependent
Byte 5	Drive Dependent	00h	04h	Drive dependent
Byte 6 to 8	Drive Dependent	000000h	000000h	Drive dependent
Byte 9 to 11	Drive Dependent	000000h	000000h	Drive dependent
Byte 12 and 13	Drive Dependent	0000h	0000h	Drive dependent
Byte 14 to 16	Drive Dependent	000000h	000000h	Drive dependent
Byte 17 to 19	zero	zero	zero	zero

The controller gets the ESDI configuration from the drive to configure the Current values in the above table. Notice that no parameters are changeable; therefore, a MODE SELECT may not issue this page.

FLEXIBLE DISK DRIVE GEOMETRY PARAMETERS. Page code 5
Current, Changeable, Default and Saved values.

Bit / Byte	7	6	5	4	3	2	1	0
0	**1**	0	**Page Code = 5h**					(85h)
1	**Page Length (in bytes)**							(1Eh)
2	**Transfer Rate (MSB)**							
3	**Transfer Rate (LSB)**							
	TRACK FORMAT FIELD							
4	**Number of Heads**							(01h or 02h)
5	**Sectors per Track**							
	SECTOR FORMAT FIELDS							
6	**Data Bytes per Physical Sector (MSB)**							
7	**Data Bytes per Physical Sector (LSB)**							
8	**Number of Cylinders (MSB)**							
9	**Number of Cylinders (LSB)**							
10	**Starting Cylinder- Write Precompensation (MSB)**							
11	**Starting Cylinder- Write Precompensation (LSB)**							
12	**Starting Cylinder- Reduced Write Current (MSB)**							
13	**Starting Cylinder- Reduced Write Current (LSB)**							
14	**Drive Step Rate (MSB)**							
15	**Drive Step Rate (LSB)**							
16	**Drive Step Pulse Width**							(00h)
17	**Head Settle Delay (MSB)**							

Bit / Byte	7	6	5	4	3	2	1	0
18	**Head Settle Delay (LSB)**							
19	**Motor On Delay**							
20	**Motor Off Delay**							
21	**TRDY**	**SSN**	**MO**	Reserved				
22	Reserved		**Step Pulses per Cylinder**					
23	**Write Precompensation Level**							
24	**Head Load Delay**							(00h)
25	**Head Unload Delay**							(00h)
26	**PIN 34 Definition**				**PIN 2 Definition**			
27	**PIN 4 Definition**				**PIN 1 Definition**			
28 through 31	Reserved							(00h)

Data Bytes per Physical Sector may be 128 (FM only), 256, 512, 1024, 2048 or 4096

Returned values for Flexible Disk drives

	LUN 2	LUN 4	LUN 5	LUN 6	
Header					
Byte 0	xxh	xxh	xxh	xxh	
Byte 1	1Ah	1Ah	1Ah	0Ah	Medium Type
Byte 2	00h	00h	00h	00h	
Byte 3	08h	08h	08h	08h	Block Descriptor Length
Block Descriptor					
Byte 0	00h	00h	00h	00h	
Byte 1	00h	00h	00h	00h	
Byte 2	00h	00h	00h	00h	
Byte 3	00h	00h	00h	00h	
Byte 4	00h	00h	00h	00h	Reserved
Byte 5	00h	00h	00h	00h	
Byte 6	02h (512)	02h (512)	02h (512)	02h (512)	Bytes/Sector
Byte 7	00h	00h	00h	00h	
corresponds to :	5 /14 inch 250Kbit	5 1/4 inch 300Kbit	5 1/4 inch 500Kbit	8 inch 500Kbit	

MODE SENSE Page 5 (LUN 2)

	Current	Changeable	Default	Saved
			250 Kbit, 5 1/4 inch drive.	
Byte 0	85h	85h	85h	85h
Byte 1	1Eh	1Eh	1Eh	1Eh
Bytes 2 and 3	Host dependent	FFFFh	00FAh (250Kbit)	Host dependent
Byte 4	Host dependent	FFh	02h (2 heads)	Host dependent
Byte 5	Host dependent	FFh	08h (8 sect/track)	Host dependent
Bytes 6 and 7	Host dependent	FFFFh	0200h (512 bytes)	Host dependent
Bytes 8 and 9	Host dependent	FFFFh	0050h (80 Cyl.)	Host dependent
Bytes 10 and 11	Host dependent	FFFFh	0050h (80 Cyl.)	Host dependent
Bytes 12 and 13	Host dependent	FFFFh	0050h (80 Cyl.)	Host dependent
Bytes 14 and 15	Host dependent	FFFFh	003Ch (6 ms)	Host dependent
Byte 16	00h	00h	00h	00h
Bytes 17 and 18	Host dependent	FFFFh	0118h (28 ms)	Host dependent
Byte 19	Host dependent	FFh	04h (0.4 sec)	Host dependent
Byte 20	Host dependent	FFh	46h (7 seconds)	Host dependent
Byte 21	Host dependent	E0h	E0h (TRDY, SSN, MO)	Host dependent
Byte 22	Host dependent	0Fh	01h (Step Pulses)	Host dependent
Byte 23	Host dependent	FFh	00h	Host dependent
Bytes 24 and 25	0000h	0000h	0000h	0000h
Byte 26	Host dependent	FFh	10h (Pin 34=READY)	Host dependent
Byte 27	Host dependent	FFh	00h	Host
dependentBytes 28 thru 31		zero	zero	zero zero

MODE SENSE Page 5 (LUN 4)

	Current	Changeable	Default	Saved
			300 Kbit, 5 1/4 inch drive	
Byte 0	85h	85h	85h	85h
Byte 1	1Eh	1Eh	1Eh	1Eh
Bytes 2 and 3	Host dependent	FFFFh	012Ch (300Kbit)	Host dependent
Byte 4	Host dependent	FFh	02h (2 heads)	Host dependent
Byte 5	Host dependent	FFh	08h (8 sect/track)	Host dependent
Bytes 6 and 7	Host dependent	FFFFh	0200h (512 bytes)	Host dependent
Bytes 8 and 9	Host dependent	FFFFh	0050h (80 Cyl.)	Host dependent
Bytes 10 and 11	Host dependent	FFFFh	0000h	Host dependent
Bytes 12 and 13	Host dependent	FFFFh	0050h (80 Cyl.)	Host dependent
Bytes 14 and 15	Host dependent	FFFFh	0044h (6.8 ms)	Host dependent
Byte 16	00h	00h	00h	00h
Bytes 17 and 18	Host dependent	FFFFh	00EEh (23.8 ms)	Host dependent
Byte 19	Host dependent	FFh	05h (0.5 sec)	Host dependent
Byte 20	Host dependent	FFh	46h (7 seconds)	Host dependent
Byte 21	Host dependent	E0h	60h (SSN, MO)	Host dependent
Byte 22	Host dependent	0Fh	01h (Step Pulses)	Host dependent
Byte 23	Host dependent	FFh	01h (WRT PRE=104n)	Host dependent
Bytes 24 and 25	0000h	0000h	0000h	0000h
Byte 26	Host dependent	FFh	00h	Host dependent
Byte 27	Host dependent	FFh	00h	Host dependent
Bytes 28 thru 31	zero	zero	zero	zero

MODE SENSE Page 5 (LUN 5)

	Current	Changeable	Default	Saved
			500 Kbit, 5 1/4 inch drive	
Byte 0	85h	85h	85h	85h
Byte 1	1Eh	1Eh	1Eh	1Eh
Bytes 2 and 3	Host dependent	FFFFh	01F4h (500Kbit)	Host dependent
Byte 4	Host dependent	FFh	02h (2 heads)	Host dependent
Byte 5	Host dependent	FFh	0Fh (15 sect/track)	Host dependent
Bytes 6 and 7	Host dependent	FFFFh	0200h (512 bytes)	Host dependent
Bytes 8 and 9	Host dependent	FFFFh	0050h (80 Cyl.)	Host dependent
Bytes 10 and 11	Host dependent	FFFFh	0000h	Host dependent
Bytes 12 and 13	Host dependent	FFFFh	0050h (80 Cyl.)	Host dependent
Bytes 14 and 15	Host dependent	FFFFh	0028h (4 ms)	Host dependent
Byte 16	00h	00h	00h	00h
Bytes 17 and 18	Host dependent	FFFFh	00DCh (22 ms)	Host dependent
Byte 19	Host dependent	FFh	05h (.5 sec)	Host dependent
Byte 20	Host dependent	FFh	46h (7 seconds)	Host dependent
Byte 21	Host dependent	E0h	60h (SSN, MO)	Host dependent
Byte 22	Host dependent	0Fh	01h (Step Pulses)	Host dependent
Byte 23	Host dependent	FFh	02h (WRT PRE=125n)	Host dependent
Bytes 24 and 25	0000h	0000h	0000h	0000h
Byte 26	Host dependent	FFh	05h (Pin 2 = HI DEN)	Host dependent
Byte 27	Host dependent	FFh	00h	Host dependent
Bytes 28 thru 31	zero	zero	zero	zero

MODE SENSE Page 5 (LUN 6)

	Current	Changeable	Default	Saved
			500 Kbit, 8 inch drive	
Byte 0	85h	85h	85h	85h
Byte 1	1Eh	1Eh	1Eh	1Eh
Byte 2 and 3	Host dependent	FFFFh	01F4h (500Kbit)	Host dependent
Byte 4	Host dependent	FFh	02h (2 heads)	Host dependent
Byte 5	Host dependent	FFh	0Fh (15 sect/track)	Host dependent
Byte 6 and 7	Host dependent	FFFFh	0200h (512 bytes)	Host dependent
Byte 8 and 9	Host dependent	FFFFh	004Dh (77 Cyl.)	Host dependent
Byte 10 and 11	Host dependent	FFFFh	0000h	Host dependent
Byte 12 and 13	Host dependent	FFFFh	004Dh (77 Cyl.)	Host dependent
Bytes 14 and 15	Host dependent	FFFFh	0028h (4ms)	Host dependent
Byte 16	00h	00h	00h	00h
Bytes 17 and 18	Host dependent	FFFFh	00DCh (22 ms)	Host dependent
Byte 19	Host dependent	FFh	05h (.5 sec)	Host dependent
Byte 20	Host dependent	FFh	46h (7 seconds)	Host dependent
Byte 21	Host dependent	E0h	60h (SSN, MO)	Host dependent
Byte 22	Host dependent	0Fh	01h (Step Pulses)	Host dependent
Byte 23	Host dependent	FFh	02h (WRT PRE=125n)	Host dependent
Bytes 24 and 25	0000h	0000h	0000h	0000h
Byte 26	Host dependent	FFh	00h	Host dependent
Byte 27	Host dependent	FFh	00h	Host dependent
Bytes 28 thru 31	zero	zero	zero	zero

SERIAL NUMBER. Page code 20
Current, Changeable, Default and Saved values.

Bit / Byte	7	6	5	4	3	2	1	0
0	1	0	**Page Code = 20h**					(A0h)
1			**Page Length** (in bytes)					(0Ah)
2			**Drive Serial Number (MSB)**					
3			**Drive Serial Number**					
4			**Drive Serial Number**					
5			**Drive Serial Number**					
6			**Drive Serial Number**					
7			**Drive Serial Number**					
8			**Drive Serial Number**					
9			**Drive Serial Number (LSB)**					
10			Reserved					(00h)
11			Reserved					(00h)

MODE SENSE Page 20 returned values

	Current	Changeable	Default	Saved
Byte 0	A0h	A0h	A0h	A0h
Byte 1	0Ah	0Ah	0Ah	0Ah
Bytes 2 through 9	Drive dependent	8 x FFh	zero	Drive dependent
Bytes 10 through 11	zero	zero	zero	zero

CONTROLLER PARAMETERS Page code 22
Current, Changeable, Default and Saved values.

Bit / Byte	7	6	5	4	3	2	1	0
0	**1**	0		**Page Code = 22h**				(A2h)
1				**Page Length** (in bytes)				(0Eh)
2		**LUN**				**LUN**		
3		**LUN**				**LUN**		
4		**LUN**				**LUN**		
5		**LUN**				Null		
6 through 15				Reserved				(00h)

Each nibble is allocated to a particular physical device and its Drive Select line as defined in the drive hardware. The following table shows which drive type and Drive Select owns which nibble :

2	**Winchester Drive Select 1**	**Winchester Drive Select 2**
3	**Flexible Disk Select 1**	**QIC 02**
4	**Flexible Disk Select 2**	**Flexible Disk Select 3**
5	**Flexible Disk Select 4**	Null

Null is a non-associated device.

MODE SENSE Page 22 returned values

	Current	Changeable	Default	Saved
Byte 0	A2h	A2h	A2h	A2h
Byte 1	0Eh	0Eh	0Eh	0Eh
Byte 2	Host dependent	0Fh	01h	Host dependent
Byte 3	Host dependent	FFh	23h	Host dependent
Byte 4	Host dependent	FFh	45h	Host dependent
Byte 5	Host dependent	FFh	67h	Host dependent
Byte 6 through 15	zero	zero	zero	zero

4.3.4 READ Command

Peripheral Device Type: **Direct Access (W+F)**

READ Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0				**08h**				
1	**Logical Unit Number**			**Logical Block Address (MSB)**				
2				**Logical Block Address**				
3				**Logical Block Address (LSB)**				
4				**Transfer Length**				
5				**Control Byte**				

The READ command requests that the controller transfer data to the host.
The logical block address specifies the logical block at which the read operation will begin.

The Transfer Length specifies the number of contiguous logical blocks of data to transfer. A Transfer Length of zero indicates that 256 logical blocks are transferred. Any other value indicates the number of logical blocks that are transferred. The most recent data value written in the addressed logical block will be returned.

The progress of the command is influenced by the options set by the MODE SELECT command Page 1 parameters such as the number of retries. Refer to the MODE SENSE and MODE SELECT commands for more information. The controller disconnects after the command phase to release the bus while seeking for hosts that support disconnect/reconnect.

4.3.5 REASSIGN BLOCKS Command

Peripheral Device Type: **Direct Access (Winchester Disks only, not Flexible Disks)**

REASSIGN BLOCKS Command Descriptor Block (07h)

Bit / Byte	7	6	5	4	3	2	1	0
0				**07h**				
1	**Logical Unit Number**			Reserved				
2				Reserved				(00h)
3				Reserved				(00h)
4				Reserved				(00h)
5				**Control Byte**				

The REASSIGN BLOCKS command requests the controller to reassign the defective logical blocks to an area on the logical unit reserved for this purpose.

If the MODE SELECT command in Page 3 was set with no alternate sectors to de-allocate, the drive was not requested to reserve blocks for the defect management. In this case, the drive will reject the REASSIGN BLOCKS command with the CHECK CONDITION status and Sense Key/Error Code set to ILLEGAL REQUEST/No Defect Spare Location Available.

The host transfers a defect list that contains the logical block addresses to be reassigned. The controller will reassign the physical medium used for each logical block address in the list. The data contained in the logical blocks specified in the defect list may be altered, but the data in all other logical blocks on the medium is preserved.

Note: The data contained in the logical block reassigned will not be corrected.

The REASSIGN BLOCKS defect list contains a four-byte Header followed by one or more Defect Descriptors. The length of each Defect Descriptor is four bytes.

REASSIGN BLOCKS Defect List

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved							(00h)
1	Reserved							(00h)
2	**Defect List Length (MSB)**							
3	**Defect List Lenght (LSB)**							

Defect Descriptor(s)

Bit / Byte	7	6	5	4	3	2	1	0
0	**Defect Logical Block Address (MSB)**							
1	**Defect Logical Block Address**							
2	**Defect Logical Block Address**							
3	**Defect Logical Block Address (LSB)**							

The DEFECT LIST LENGTH specifies the total length in bytes of the Defect Descriptors that follow. The Defect List Length is equal to four times the number of Defect Descriptors. All defects specified by the REASSIGN BLOCKS command will be recorded in the G list which is limited to approximately 390 defects.

The Defect Descriptor specifies a four-byte DEFECT LOGICAL BLOCK ADDRESS that contains the defect. The Defect Descriptors shall be sent by the host in descending order.

If the logical unit has insufficient capacity to reassign all of the defective logical blocks, the command terminates with a CHECK CONDITION status and the Sense Key/Error Code is set to "MEDIUM ERROR/No Defect Locations Available" Additional Sense Code.

4.3.6 RELEASE Command

Peripheral Device Type: All

RELEASE Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	**17h**							
1	**Logical Unit Number**			**3rdPty**	**Third Party Device ID**			0
2	Reserved							(00h)
3	Reserved							(00h)
4	Reserved							(00h)
5	**Control Byte**							

The RELEASE command is used to release the previously reserved logical units. It is not an error for an initiator to attempt to release a reservation that is not currently active.

LOGICAL UNIT RELEASE. The initiator requests the controller to terminate all logical unit reservations from the initiator.

THIRD PARTY RELEASE. The controller supports the third party release option.

The third party release option for the RELEASE command allows an initiator to release a logical unit that was previously reserved using the third-party reservation option.

If the third party (3rdPty) bit is zero, then the third-party release option is not requested. If the 3rdPty bit is one then the controller will release the specified logical unit, but only if the reservation was made using the third-party reservation option by the same initiator for the same SCSI device as specified in the third-party device ID field.

4.3.7 RESERVE Command

Peripheral Device Type: All

RESERVE Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0				**16h**				
1	**Logical Unit Number**			**3rdPty**	**Third Party Device ID**			
2				Reserved				(00h)
3				Reserved				(00h)
4				Reserved				(00h)
5				**Control Byte**				

The RESERVE command is used to reserve logical units. The RESERVE and RELEASE commands provide the basic mechanism for contention resolution in multiple-initiator systems.

LOGICAL UNIT RESERVATION. The initiator requests that the entire logical unit be reserved for the exclusive use of the initiator until the reservation is released by a RELEASE command from the same initiator, by a BUS DEVICE RESET message from any initiator, or by a "hard" RESET condition. A logical unit reservation will not be granted if the logical unit is reserved by another initiator. It is permissible for an initiator to reserve a logical unit that is currently reserved by that initiator.

If, after honoring the reservation, any other initiator subsequently attempts to perform any command on the reserved logical unit then the command is rejected with RESERVATION CONFLICT status.

THIRD PARTY RESERVATION. The controller supports the third party reservation option.

The third party reservation option for the RESERVE command allows an initiator to reserve a logical unit for another SCSI device.

If the third-party (3rdPty) bit is zero, then the third-party reservation option is not requested.
If the 3rdPty bit is one, the RESERVE command will reserve the specified logical unit for the SCSI device specified in the third-party device ID field. The controller will preserve the reservation until it is released by the same initiator (or by a BUS DEVICE RESET message from any initiator or a "hard" RESET condition). The controller will ignore any attempt to release the reservation made by any other initiator.

4.3.8 REZERO UNIT Command

Peripheral Device Type: Direct Access

REZERO UNIT Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0				**01h**				
1	**Logical Unit Number**				Reserved			
2				Reserved				(00h)
3				Reserved				(00h)
4				Reserved				(00h)
5				**Control Byte**				

The Head carriage on the drive specified by the LUN is positioned at track zero. The controller will disconnect from the host while this command is in progress, if the host indicated that it supports disconnect in the IDENTIFY message. A non-buffered recalibrate is executed on non-removable disk drives. The recalibrate on removable drives is buffered.

4.3.9 SEEK Command

Peripheral Device Type: **Direct Access (W+F)**

SEEK Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0				**0Bh**				
1	**Logical Unit Number**			**Logical Block Address (MSB)**				
2				**Logical Block Address**				
3				**Logical Block Address (LSB)**				
4				Reserved				(00h)
5				**Control Byte**				

The SEEK command causes the device addressed by the LUN to be physically positioned to the cylinder as defined in bytes one to three. No attempt to verify the seek position is made until a READ or WRITE command is issued.

NOTE : The controller returns completion status while the seek is in progress on Winchester logical units that support buffered step pulses or on ESDI disks. This is so that hosts which do not support disconnect/reconnect can overlap seeks with commands to other devices.

4.3.10 START/STOP UNIT Command

Peripheral Device Type: Direct Access

START/STOP UNIT Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	**1Bh**							
1	**Logical Unit Number**			Reserved				**Immed**
2	Reserved							(00h)
3	Reserved							(00h)
4	Reserved						LoEj	**Start**
5	**Control Byte**							

The START/STOP UNIT command requests that the controller enable or disable the logical unit for further operations.

An IMMED (immediate) bit of one indicates that status will be returned as soon as the operation is initiated. An IMMED bit of zero indicates that status will be returned after the operation is completed. If the Immediate bit is not set and the host supports disconnect/reconnect, the command will disconnect while performing the command.

The Stop command, when issued to a ST type Winchester drive, will cause the heads to be positioned over the Landing Zone Cylinder.

FLEXIBLE DISKS ONLY:

A load/eject (LoEj) bit of zero indicates that no action is to be taken regarding loading or ejecting the medium. A LoEj bit oe one indicates that the medium is to be unloaded.

A START bit of one requests the logical unit be made ready for use. A START bit of zero requests that the logical unit be stopped.

The command following the START/STOP UNIT command issued to start the spindle will be rejected with a CHECK CONDITION status for a UNIT ATTENTION Sense Key.

4.3.11 WRITE Command

Peripheral Device Type: **Direct Access (W+F)**

WRITE Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0				**0Ah**				
1	**Logical Unit Number**			**Logical Block Address (MSB**				
2				**Logical Block Address**				
3				**Logical Block Address (LSB)**				
4				**Transfer Length**				
5				**Control Byte**				

The WRITE command requests that the controller write the data transferred by the host to the medium. The LBA specifies the logical block at which the write operation will begin. The Transfer Length specifies the number of contiguous logical blocks of data to be transferred. A Transfer Length of zero indicates that 256 logical blocks are to be transferred. Any other value indicates the number of logical blocks that are to be transferred.

The progress of the command is influenced by the options set up by the MODE SELECT command Page 1 parameters, such as the number of retries. Refer to the MODE SENSE and MODE SELECT commands for more information. The controller disconnects after the command phase to release the bus while seeking for hosts that support disconnect/reconnect.

SECTION 5

5.1 GROUP 1 COMMANDS FOR DIRECT ACCESS DEVICES

The Group 1 commands that the controller supports for direct-access devices (Winchesters and Flexible disks) are as shown in the following Table:

Group 1 Commands for Direct-Access Devices

Operation Code	Command Name	Device Type	Section
3Ch	**READ BUFFER**	W+F	5.1.1
25h	**READ CAPACITY**	W+F	5.1.2
37h	**READ DEFECT DATA**	W	5.1.3
28h	**READ EXTENDED**	W+F	5.1.4
2Bh	**SEEK EXTENDED**	W+F	5.1.5
2Fh	**VERIFY**	W	5.1.6
2Eh	**WRITE AND VERIFY**	W	5.1.7
3Bh	**WRITE BUFFER**	W+F	5.1.8
2Ah	**WRITE EXTENDED**	W+F	5.1.9

5.1.1 READ BUFFER Command

Peripheral Device Type: **All**

READ BUFFER Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0				**3Ch**				
1	**Logical Unit Number**			Reserved				
2				Reserved				(00h)
3				Reserved				(00h)
4				Reserved				(00h)
5				Reserved				(00h)
6				Reserved				(00h)
7				**Allocation Length (MSB)**				
8				**Allocation Length (LSB)**				
9				**Control Byte**				

The READ BUFFER Command may be used in conjunction with the WRITE BUFFER command as a diagnostic function for testing the controller's buffer memory and the SCSI bus integrity. There is no access to the medium during the execution of this command.

The ALLOCATION LENGTH specifies the maximum number of bytes that the initiator has allocated for returned READ BUFFER data. The Allocation Length contains a four byte header, followed by the READ BUFFER data. An Allocation Length of zero indicates that no Read Buffer Header and no READ BUFFER data shall be transferred. This condition does not create the CHECK CONDITION status. This data is to be used by the initiator for comparison with the data pattern sent during the WRITE BUFFER command. Up to the entire controller buffer size may be requested for transfer including four bytes of header and up to the buffer size minus 4 bytes of READ BUFFER data.

If the Allocation Length is greater than the Available Length added to the four bytes of Read Buffer Header, the Read Buffer Header and the Available Length shall be transferred to the initiator.
It is not an error to request an Allocation Length less than the Available Length.
The controller terminates the DATA IN phase when the Allocation Length bytes have been transferred or when the Read Buffer Header and the Available Length has been transferred to the initiator, whichever is less.

READ BUFFER Header

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved							(00h)
1	Reserved							(00h)
2	**Available Length (MSB)**							
3	**Available Length (LSB)**							

It is recommended that the initiator issue the RESERVE UNIT command to all Logical Units prior to the WRITE BUFFER command, and issue the RELEASE UNIT command after the READ BUFFER command is completed, in order to avoid corruption of the controller's data buffer by another initiator.

5.1.2 READ CAPACITY Command

Peripheral Device Type: **Direct Access (Winchester and Flexible disks)**

READ CAPACITY Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0				**25h**				
1	**Logical Unit Number**			Reserved				
2				**Logical Block Address (MSB)**				
3				**Logical Block Address**				
4				**Logical Block Address**				
5				**Logical Block Address (LSB)**				
6				Reserved				(00h)
7				Reserved				(00h)
8				Reserved				**PMI**
9				**Control Byte**				

The READ CAPACITY command provides a means for the initiator to request information regarding the capacity of the logical unit.

A PARTIAL MEDIUM INDICATOR (PMI) bit set to zero indicates that the information returned in the READ CAPACITY Data is the logical block address of the last logical block of the logical unit and the block length (in bytes) of all blocks in the unit. The LBA in the CDB shall be set to zero.

If defect handling was requested by the host, only user addressable blocks are counted in the calculation of the last logical block address, alternate and alternated blocks are not counted.

A PMI bit set to one indicates that the information returned is the logical block address and block length (in bytes) of the last logical block after the logical block address specified in the CDB before a substantial delay in data transfer will be encountered (e.g., a cylinder boundary). This function is intended to assist storage management software in determining whether there is sufficient space on the current cylinder to contain a frequently accessed data structure such as a file directory or file index.

The eight bytes of READ CAPACITY Data shown in the following table are sent during the DATA IN phase of the command.

READ CAPACITY Data

0	**Logical Block Address (MSB)**	
1	**Logical Block Address**	
2	**Logical Block Address**	
3	**Logical Block Address (LSB)**	
4	**Block Length (MSB)**	(00h)
5	**Block Length**	(00h)
6	**Block Length**	
7	**Block Length (LSB)**	

Winchester Disk drives :

The last LBA of the READ CAPACITY data is calculated with the number of cylinders, number of heads, number of sectors per track, and the number of sectors de-allocated per zone for defect handling (if any) as follows :

- If a MODE SELECT command with Pages 3 and 4 was previously successfully completed and,
  - if a FORMAT UNIT command was successfully completed after this MODE SELECT command, the number of cylinders and heads used are those saved during the FORMAT UNIT command.
  - if a FORMAT UNIT command was not yet issued, the controller returns a CHECK CONDITION status.
- If a MODE SELECT command with Pages 3 and 4 was not previously issued,
  - and if the drive is an ESDI drive, the calculation is performed with the ESDI drive configuration values returned by the drive.
  - and if the drive is not an ESDI drive, the calculation is performed either with :
    - the saved values stored during the previous FORMAT UNIT command.
    - or with the controller default values according to the logical unit number.

Deallocated tracks from the READ CAPACITY data (also See section 5 for more details)
- Without defect handling, 4 tracks are de-allocated in the calculation as follows:
- track zero equivalent to cylinder zero, head zero is used by the controller to provide complete software device independence by storing controller and drive parameters.
- the last 3 tracks of the capacity starting from the maximum cylinder and maximum head and switching backwards to the lower head then when reaching head 0 of the current cylinder, switching to the next upper head of the minus one cylinder number .
- With defect handling, 12 tracks are de-allocated in the calculation added to the number of alternate sectors requested by the host.
- track zero, same as above.
- the last 11 tracks of the capacity located starting from the maximum cylinder and switching to the next upper head of the minus one cylinder number when reaching head 0.

FLEXIBLE DISK DRIVES (VALID FOR THE 7000, 7200 AND 7400 MODELS):

The last LBA of the READ CAPACITY data is calculated with the number of cylinders, heads, and sectors per track as reported by the Current values of the MODE SENSE command.

5.1.3 READ DEFECT DATA Command

Peripheral Device Type: **Direct Access (Winchester Drives only)**

READ DEFECT DATA Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0				**37h**				
1	**Logical Unit Number**				Reserved			
2		Reserved		**P**	**G**	**Defect List Format**		
3				Reserved				(00h)
4				Reserved				(00h)
5				Reserved				(00h)
6				Reserved				(00h)
7				**Allocation Length (MSB)**				
8				**Allocation Length (LSB)**				
9				**Control Byte**				

The READ DEFECT DATA command requests that the controller transfer the medium defect data to the initiator.

The meaning of bits 0 through 2 of byte 2 is similar to the bit definition of the bits 0 through 2 of the byte 1 of the FORMAT UNIT command. The host indicates with this field a preferred format for the defect list to be returned by the controller.

The Defect List format the controller supports is :

LIST BIT	2	1	0	FORMAT
P & G Lists	1	0	0	Bytes From Index
P & G Lists	1	0	1	Physical Sector Format

If the host requests another format than "Bytes from Index" or "Physical Sector" the controller will return the list requested in the "Bytes from Index" format and create the CHECK CONDITION status with the Sense Key/Error Code set to "RECOVERED ERROR" at the end of the Read Defect Data data transfer.

- The P bit set to one indicates that the initiator requests that the Primary list of defects be returned. The P bit set to zero indicates that the controller shall not return the Primary list of defects.
(NOTE: This command reads the OMTI P list tracks, not the Copy of the P list or Manufactures Defect List .)

- The G bit set to one indicates that the initiator requests that the Grown list of defects be returned. The G bit set to zero indicates that the controller shall not return the Grown list of defects.

- With bits P and G both set to one, the controller shall return the Primary and the Grown list of defects. The controller returns the G list first, followed by the P list. If the host sent a value of FFFFFFFFh as "Bytes From Index" or "Physical Sector" value in the D list sent during the Data Out phase of the FORMAT UNIT command, the controller will return in the READ DEFECT DATA data all the sector addresses of the track(s) involved.
- With bits P and G both set to zero, the Defect List Header only is returned.

If the controller is unable to read the defect list from the disk, it will create the CHECK CONDITION status and set the Sense Key/Error Code to "MEDIUM ERROR/No Record Found".

The ALLOCATION LENGTH specifies the number of bytes that the initiator has allocated for returned READ DEFECT DATA. An Allocation Length of zero indicates that no READ DEFECT DATA is to be transferred. Any other value indicates the maximum number of bytes that is requested to be transferred.

The controller terminates the DATA IN phase when the Allocation Length bytes have been transferred or when all available READ DEFECT DATA data have been transferred to the initiator, whichever is less. The READ DEFECT DATA contains a four byte header, followed by zero or more Defect Descriptors.

Defect List Header

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved							(00h)
1	Reserved			**P**	**G**	**1**	**0**	**0**
2	**Defect List Length (MSB)**							
3	**Defect List Length (LSB)**							

The meanings of bits 0 through 2 of byte 1 are similar to the Defect List Format of the FORMAT UNIT command. The bits P,G and the Defect List Format indicate which defect list is actually returned by the controller. The format of the defect descriptors, if the Defect List Length is different than zero, are shown in the FORMAT UNIT command. The length of each defect descriptor is eight bytes. The Defect List Length specifies the total length in bytes of the defect descriptors that follow. The Defect List Length is equal to eight times the number of defect descriptors. If the Allocation Length of the CDB is too small to transfer all of the defect descriptors, the Defect List Length is not adjusted by the controller to reflect the truncation. The Defect Descriptors are in ascending order within each list returned. The initiator may be informed about the exact number of defects by dividing the Defect List Length by 8 (the Defect Descriptor Length).

5.1.4 READ EXTENDED Command

Peripheral Device Type: **Direct Access (Winchester and Flexible disks)**

READ EXTENDED Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	**28h**							
1	**Logical Unit Number**			Reserved				
2	**Logical Block Address (MSB)**							
3	**Logical Block Address**							
4	**Logical Block Address**							
5	**Logical Block Address (LSB)**							
6	Reserved							(00h)
7	**Transfer Length (MSB)**							
8	**Transfer Length (LSB)**							
9	**Control Byte**							

The READ EXTENDED command operates the same as the READ command except that the Transfer Length occupies two bytes and the starting Logical Block Address occupies four bytes. The TRANSFER LENGTH can be from 0000 to 65K-1 blocks.

The maximum LBA allowed is the LBA value returned in the READ CAPACITY Data with PMI bit set to zero.

Refer to the READ command Group 0 for more information.

5.1.5 SEEK EXTENDED Command

Peripheral Device Type: **Direct Access (Winchester and Flexible disks)**

SEEK EXTENDED Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	**2Bh**							
1	**Logical Unit Number**			Reserved				
2	**Logical Block Address (MSB)**							
3	**Logical Block Address**							
4	**Logical Block Address**							
5	**Logical Block Address (LSB)**							
6	Reserved							(00h)
7	Reserved							(00h)
8	Reserved							(00h)
9	**Control Byte**							

The SEEK EXTENDED is similar to the SEEK command.

The maximum LBA allowed is the LBA value returned in the READ CAPACITY Data with PMI bit set to zero.

5.1.6 VERIFY Command

Peripheral Device Type: **Direct Access (Winchester Disk drives only)**

VERIFY Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0				**2Fh**				
1	**Logical Unit Number**			Reserved				
2				**Logical Block Address (MSB)**				
3				**Logical Block Address**				
4				**Logical Block Address**				
5				**Logical Block Address (LSB)**				
6				Reserved				(00h)
7				**Verification Length (MSB)**				
8				**Verification Length (LSB)**				
9				**Control Byte**				

The VERIFY command requests that the controller verify the data written on the medium. The purpose of this command is to perform medium verification against ECC recorded. However, the command will be executed according to the setting of the Error Recovery parameters set in Page 1 of the MODE SELECT command. The CHECK CONDITION status will be created upon encountering uncorrectable errors or any error if the DTE bit is set. Correctable ECC errors will not be reported unless the PER bit is set. On correctable ECC errors, if PER bit is set, the number of bits in error will be reported.

The LOGICAL BLOCK ADDRESS specifies the logical block at which the verify operation will begin. The maximum LBA allowed is the LBA value returned in the READ CAPACITY Data with PMI bit set to zero.

The VERIFICATION LENGTH specifies the number of contiguous logical blocks of data that is to be verified. A Transfer Length of zero indicates that no logical blocks are to be verified. This condition will not be considered as an error. Any other value indicates the number of logical blocks that will be verified.

5.1.7 WRITE AND VERIFY Command

Peripheral Device Type: **Direct Access (Winchester Disk drives only)**

WRITE AND VERIFY Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	**2Eh**							
1	**Logical Unit Number**			Reserved				
2	**Logical Block Address (MSB)**							
3	**Logical Block Address**							
4	**Logical Block Address**							
5	**Logical Block Address (LSB)**							
6	Reserved							(00h)
7	**Transfer Length (MSB)**							
8	**Transfer Length (LSB)**							
9	**Control Byte**							

The WRITE AND VERIFY command requests that the controller write the data transferred from the initiator to the medium and then verify that the data is correctly written. The purpose of this command is to perform medium verification against ECC recorded immediately after the write operation occurred. However, the command will be executed according to the setting of the Error Recovery parameters set in Page 1 of the MODE SELECT command. The CHECK CONDITION status will be created upon encountering uncorrectable errors or any error if the DTE bit is set. Correctable ECC errors will not be reported unless the PER bit is set. On correctable ECC errors, if PER bit is set, the number of bits in error will be reported.

The LOGICAL BLOCK ADDRESS specifies the logical block at which the write and verify operation will begin. The maximum LBA allowed is the LBA value returned in the READ CAPACITY Data with PMI bit set to zero.

The TRANSFER LENGTH specifies the number of contiguous logical blocks of data that shall be transferred from the host and verified in the data buffer of the controller. A Transfer Length of zero indicates that no logical blocks are transferred. This condition will not be considered an error and no data is written. Any other value indicates the number of logical blocks that shall be transferred and verified.

5.1.8 WRITE BUFFER Command

Peripheral Device Type: **All**

WRITE BUFFER command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0				**3Bh**				
1	**Logical Unit Number**				Reserved			
2				Reserved				(00h)
3				Reserved				(00h)
4				Reserved				(00h)
5				Reserved				(00h)
6				Reserved				(00h)
7				**Byte Transfer Length (MSB)**				
8				**Byte Transfer Length (LSB)**				
9				**Control Byte**				

The WRITE BUFFER Command is used in conjunction with the READ BUFFER command as a diagnostic function for testing the controller's buffer memory and the SCSI bus integrity. There is no access to the medium during the execution of this command.

The BYTE TRANSFER LENGTH specifies the maximum number of bytes to be transferred to and retained in the controller buffer. The Byte Transfer Length contains a four byte header, followed by the WRITE BUFFER data. A Byte Transfer Length of zero indicates that no Write Buffer Header and no WRITE BUFFER data shall be transferred. This condition does not create the CHECK CONDITION status. Up to the controller buffer size may be transferred added to the four bytes of header. If the controller buffer size is 64K bytes, 65,531 bytes of WRITE BUFFER data is transferred. If the Byte Transfer Length is greater than the maximum size of the controller data buffer (Available length of the READ BUFFER command data) plus four, the controller creates the CHECK CONDITION status with the Sense Key of ILLEGAL REQUEST. In this case no data is transferred from the initiator. It is not an error to request a Byte Transfer Length less than the Available Length.

WRITE BUFFER Header

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved							(00h)
1	Reserved							(00h)
2	Reserved							(00h)
3	Reserved							(00h)

It is recommended that the initiator link the WRITE BUFFER and READ BUFFER commands and that disconnection not be allowed during the process to guarantee that the data buffer not be corrupted by uncompleted commands issued from the same or other initiators to other LUNs.

5.1.9 WRITE EXTENDED Command

Peripheral Device Type: **Direct Access (Winchester and Flexible disks)**

WRITE EXTENDED Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0				**2Ah**				
1	**Logical Unit Number**			Reserved				
2				**Logical Block Address (MSB)**				
3				**Logical Block Address**				
4				**Logical Block Address**				
5				**Logical Block Address (LSB)**				
6				Reserved				(00h)
7				**Transfer Length (MSB)**				
8				**Transfer Length (LSB)**				
9				**Control Byte**				

The WRITE EXTENDED command operates the same as the WRITE command except the Transfer Length occupies two bytes and the starting Logical Block Address occupies four bytes. The TRANSFER LENGTH can be from 0000 to 65K-1 blocks.

The maximum LBA allowed is the LBA value returned in the READ CAPACITY Data with PMI bit set to zero.

Refer to the WRITE command Group 0 for more information.

5.2 GROUP 7 COMMANDS for DIRECT ACCESS DEVICES

These commands are only valid for Winchester disk drives, but not for Flexible disk drives.

Group 7 Commands

Operation Code	Command Name	Section
E8h	**READ LONG**	5.2.1
EAh	**WRITE LONG**	5.2.2
FEh	**WRITE PRIMARY DEFECT LIST**	5.2.3 for ST506/412 drives only

5.2.1 READ LONG Command

Peripheral Device Type: **Winchesters only**

READ LONG Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	**E8h**							
1	**Logical Unit Number**			Reserved				
2	**Logical Block Address (MSB)**							
3	**Logical Block Address**							
4	**Logical Block Address**							
5	**Logical Block Address (LSB)**							
6	Reserved							
7	Reserved							
8	Reserved							
9	**Control Byte**							

The READ LONG command is used to read the block addressed by the LBA and the 6 byte Error Correction Code that was written by the controller for that block.

NOTE: The number of bytes transferred by this command is the block size + 6 bytes.

5.2.2 WRITE LONG Command

Peripheral Device Type: **Winchester only**

WRITE LONG Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	**EAh**							
1	**Logical Unit Number**			Reserved				
2	**Logical Block Address (MSB)**							
3	**Logical Block Address**							
4	**Logical Block Address**							
5	**Logical Block Address (LSB)**							
6	Reserved							
7	Reserved							
8	Reserved							
9	**Control Byte**							

The WRITE LONG command is used to write the block addressed by the LBA plus the 6 byte Error Correction Code.

NOTE: The number of bytes transferred by this command is the block size + 6 bytes.

5.2.3 WRITE PRIMARY DEFECT LIST Command

Peripheral Type : **ST506/412 drives only**

WRITE PRIMARY DEFECT LIST Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	**FEh**							
1	**Logical Unit Number**			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	**Parameter List Length**							
9	**Control Byte**							

The WRITE PRIMARY DEFECT LIST command is used to record on the innermost cylinder of the drive the Primary Defect list (or P list). The cylinder number on which the drive records this information is either the Cylinder Default value as specified in the MODE SENSE Default values or with the cylinder number specified by the MODE SELECT if changed from the default value. The defects entered in this P list will be mapped during the next FORMAT UNIT command with DPRY set to zero.

The Parameter List Length is expressed in number of blocks (not of bytes) and sent by the host during the Data Out phase of the command execution. It shall be computed according to the number of defect descriptors specified.

- The first 64 bytes of the first block of data of this parameter list shall be sent by the host as specified in the following table. The controller checks if these 64 bytes are sent correctly.
- After these 64 bytes, each Defect Descriptor occupies 9 bytes. The last 9 bytes shall be set to FFh to indicate the end of the list.

Parameter List length shall be = [64 + (9 * Number of Defect Descriptors) + 9] divided by the Block Size

- The maximum number of Defect Descriptors that the host is allowed to send is 390. Therefore the maximum number of bytes to send is 3583 = (391 * 9 + 64). This value, divided by the block size, determines the Parameter list Length.

As an example with a block size of 512 bytes,
for one to 49 defects, the Parameter List Length shall be set to 01h.
for 390 defects the Parameter List Length shall be 07h.

PARAMETER LIST

HEADER (64 bytes in length or 40h)

Bit / Byte	7	6	5	4	3	2	1	0
0	**Block Length** (MSB) example (02h) for 512 bytes/sector							
1	**Block Length** (LSB) example (00h) for 512 bytes/sector							
2	**Number of Sectors per Track** (not counting spare sectors, if any) example is for 512 bytes/sector 17 sectors/track and one spare/track							(10h)
3	**P** in ASCII							(50h)
4	Blank							(20h)
5	**L** in ASCII							(4Ch)
6	**I** in ASCII							(49h)
7	**S** in ASCII							(53h)
8	**T** in ASCII							(54h)
9 through 31	Blank							(20h)

VENDOR IDENTIFICATION

32	**S** in ASCII							(53h)
33	**M** in ASCII							(4Dh)
34	**S** in ASCII							(53h)
35 through 39	Blank							(20h)

40	**O** in ASCII	(4Fh)
41	**M** in ASCII	(4Dh)
42	**T** in ASCII	(54h)
43	**I** in ASCII	(49h)
44	**7** in ASCII	(37h)
45	**?** in ASCII	(3?h)
46	**0** in ASCII	(30h)
47	**0** in ASCII	(30h)
48 through 55	Blank (in ASCII)	(20h)

FIRMWARE REVISION LEVEL

56	**FIRMWARE REVISION** (MSB)	
57	**FIRMWARE REVISION**	
58	**FIRMWARE REVISION**	
59	**FIRMWARE REVISION** (LSB)	
60 through 63	Reserved	(00h)

These above fields (VENDOR IDENTIFICATION and FIRMWARE REVISION LEVEL) shall be the exact same fields as returned by the INQUIRY Data in the INQUIRY command.

PRIMARY DEFECT LIST DEFECT DESCRIPTOR (9 bytes per defect)

Bit / Byte	7	6	5	4	3	2	1	0
0	**CYLINDER NUMBER** (MSB)							
1	**CYLINDER NUMBER** (LSB)							
2	**HEAD NUMBER**							
3	**BYTES FROM INDEX** (MSB)							
4	**BYTES FROM INDEX** (LSB)							
5	Reserved							(00h)
6	Reserved							(00h)
7	Reserved							(00h)
8	Reserved							(00h)

Each Defect Descriptor specifies the starting Byte address of the defect on the medium. The Defect Descriptor is defined as an nine-byte field in the Data Out phase. Each Defect Descriptor is comprised of the cylinder number of defect, the head number of defect, and the defect bytes from index. The Defect Descriptors shall be sent in ascending order by the host. For determining ascending order, the cylinder number of defect is considered the most significant part of the address and the defect Bytes From Index is considered the least significant part of the address.

FORMAT OF THE LAST 9 BYTES

These 9 bytes are to be sent after the last Defect Descriptor specified to indicate to the drive that this is the end of the list.

Bit / Byte	7	6	5	4	3	2	1	0
0 through 8	(FFh)							

SECTION 6

TAPE COMMANDS

6.1 GENERAL

The OMTI 7400 controller supports a QIC-02 Cartridge Tape drive interface, which is an intelligent device level interface to a Streaming Tape Drive.

6.1.1 Drive Type

A streaming drive is a tape drive that is designed to maintain continuous tape motion without the requirement to start and stop within an inter-record gap. If the tape motion is interrupted for any reason, the drive re-positions the tape by moving far enough in the reverse direction to allow the tape to be brought up to speed in the forward direction before it reaches the point at which the preceding operation was terminated.

6.1.2 Data Bus

Data and commands are transferred to and from the QIC-02 device on an eight-bit bi-directional data bus with an asynchronous handshake to eliminate rigorous timing constraints. The controller includes an internal 16K or 32K buffer to optimize streaming operations during COPY commands between disk and tape. The recording of information on the tape is performed in the Sequential mode.

6.1.3 Data Integrity

The ability to enable or disable the tape drive bus parity is jumper selectable.

6.1.4 Host/Controller/Drive Communication

The tape drive can be commanded by the host, through a set of commands, to either rewind the cartridge to the BOM (beginning of medium), erase the cartridge, write data and file marks onto the tape, read data and/or file marks from the tape, verify the tape, backup data from a disk, or restore data onto the disk connected to the same controller. The host may request sense information from the controller/tape drive to obtain status.

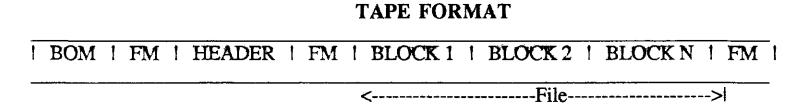
6.1.5 Media

The tape medium is an industry-standard, one quarter inch (1/4") cartridge, recorded bi-directionally on serpentine tracks.

6.1.6 Tape Format of Fixed Length Block

The minimum length of data accessible by the controller is a block. Blocks have a fixed length of 512 bytes. A group of blocks constitute a file. Each READ or WRITE command specifies the number of blocks to access. Files are separated by file marks.

TAPE FORMAT



FM = File Mark

BLOCK FORMAT (QIC 24)

6.1.7 Operational Warnings

- **Exception:** Condition with File Mark encountered unexpectedly with the READ and COPY commands : Because the Tape Formatter may read more blocks from the Tape drive than the READ or COPY commands ask for, an Exception condition may be created by the Tape Drive for a File Mark detected by the Tape Formatter within the block count limit requested. This situation is more likely to occur with tape formatters containing a large buffer. This should not be considered an error condition.

- When an End of Medium Exception Condition is encountered while writing, one File Mark followed by one Tape Block and another File Mark are allowed to be written after EOM.

6.2 TAPE COMMANDS

6.2.1 Command Phase

The command process for the Tape drive is identical to the command process for the Direct Access devices.

6.2.2 LUN 3

The Default Logical Unit Number (LUN) specified for all exclusively Tape related commands is three (3). COPY command implies the use of LUN 3 except if a MODE SELECT command issued with Page 20 allocates the Tape to another LUN.

Typical CDB for Six-byte TAPE Commands

Bit / Byte	7	6	5	4	3	2	1	0
0	**Operation Code**							
1	**Logical Unit Number**			Reserved				**Fixed**
2	**Transfer Length (MSB)**							(00h)
3	**Transfer Length**							(00h)
4	**Transfer Length (LSB)**							(00h)
5	**Control Byte**							

The above commands may transfer up to 16 MegaBlocks per Command.

6.3 TAPE COMMAND SET SUMMARY

Group 0 Commands for Sequential Access Device

Operation Code	Command Name	Type	Section
19h	**ERASE**	T	6.3.1
1Bh	**LOAD/UNLOAD**	T	6.3.2
08h	**READ**	T	6.3.3
05h	**READ BLOCK LIMITS**	T	6.3.4
14h	**RECOVER BUFFERED DATA**	T	6.3.5
01h	**REWIND**	T	6.3.6
11h	**SPACE FORWARD**	T	6.3.7
13h	**VERIFY**	T	6.3.8
0Ah	**WRITE**	T	6.3.9
10h	**WRITE FILE MARK**	T	6.3.10

6.3.1 ERASE Command

Peripheral Device Type : **Sequential Access Device**

ERASE Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0				**(19h)**				
1	**Logical Unit Number**				Reserved			**0**
2				Reserved				(00h)
3				Reserved				(00h)
4				Reserved				(00h)
5				**Control Byte**				

The ERASE command causes all of the medium to be erased from the beginning of medium (BOM) to the end of medium (EOM). The medium is then rewound. The controller disconnects while executing the command if requested by the host in the IDENTIFY message.

6.3.2 LOAD/UNLOAD Command

Peripheral Device Type : **Sequential Access Device**

LOAD/UNLOAD Command Descriptor Block (1Bh)

Bit / Byte	7	6	5	4	3	2	1	0
0	**Operation Code**							
1	**Logical Unit Number**			Reserved				**Immed**
2	Reserved							(00h)
3	Reserved							(00h)
4	Reserved						**Re-Ten**	**Load**
5	**Control Byte**							

The LOAD/UNLOAD command requests that the controller enable or disable the logical unit for further operations. This command may also be used to request the re-tension function on peripheral devices that support this function.

A LOAD bit of one indicates that the medium on the logical unit shall be positioned to the beginning-of-medium (BOM) or load-point as determined by the peripheral device. A Load bit of zero indicates that the medium on the logical unit shall be positioned for removal from the peripheral device.

Status shall be returned after the medium is positioned unless the IMMEDIATE (Immed) bit is one. If the Immed bit is one, status may be returned as soon as the command has been accepted.

A RE-TENTION (Re-Ten) bit of one indicates that the medium on the addressed logical unit shall be correctly tensioned before the LOAD/UNLOAD command is completed. This is an optional function intended for use by those peripheral devices that support the re-tension function.

6.3.3 READ Command

Peripheral Device Type : **Sequential Access Device**

READ Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	**(08h)**							
1	**Logical Unit Number**			Reserved				**Fixed**
2	**Transfer Length (MSB)**							
3	**Transfer Length**							
4	**Transfer Length (LSB)**							
5	**Control Byte**							

The READ command transfers the specified Transfer Length (or number of blocks) to the host, beginning with the next block of the logical unit. Blocks are transferred until either the Block count is exhausted, or a File Mark is encountered, or the End of Medium (EOM) is encountered. The last two conditions create an Exception condition, and the Block Count read is available in the Sense Bytes. Up to 16 Megablocks can be transferred by a single command.

The FIXED bit shall always be set to one, which specifies that the Transfer Length is in number of blocks and not in number of bytes, and that the data transferred is with Fixed Length blocks and not with Variable Length blocks.

Upon termination of the command, the medium is positioned after the last block transferred.

When the Transfer Length is zero, no data is transferred and the current position on the logical unit is not changed. This condition does not create an error.

FILEMARK CONDITION :
If the logical unit reads a Filemark during the READ command, the CHECK CONDITION status is created and the FileMark bit is set in the Sense Bytes. Upon termination, the medium is positioned after the FileMark. The Valid bit is set to one in the Sense bytes, and the Information bytes are set to the actual number of blocks sent to the host (not including the FileMark).

EOM CONDITION :
If the logical unit encounters the physical End of Medium (EOM) during the READ command, the CHECK CONDITION status is created and the EOM bit is set in the Sense Bytes. The Sense Key is set to MEDIUM ERROR. The Valid bit is set to one in the Sense bytes, and the Information bytes are set to the actual number of blocks sent to the host. The medium position following this condition is not defined.

6.3.4 READ BLOCK LIMITS Command

Peripheral Device Type : **Sequential Access Device**

READ BLOCK LIMITS Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0				**(05h)**				
1	**Logical Unit Number**				Reserved			
2				Reserved				(00h)
3				Reserved				(00h)
4				Reserved				(00h)
5				**Control Byte**				

The READ BLOCK LIMITS command requests that the controller's capability for block length limits be returned for the logical unit. The following 6 bytes of READ BLOCK LIMITS data are sent during the DATA IN phase of the command execution.

READ BLOCK LIMITS Data

0	Reserved	(00h)
1	**Maximum Block Length (MSB)**	(00h)
2	**Maximum Block Length**	(02h)
3	**Maximum Block Length (LSB)**	(00h)
4	**Minimum Block Length (MSB)**	(02h)
5	**Minimum Block Length (MSB)**	(00h)

The Maximum Block Length is equal to the Minimum Block Length specifying Fixed Length Block mode.

6.3.5 RECOVER BUFFERED DATA Command

Peripheral Device Type : **Sequential Access Device**

RECOVER BUFFERED DATA Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0				**(14h)**				
1	**Logical Unit Number**				Reserved			**Fixed**
2				**Transfer Length (MSB)**				
3				**Transfer Length**				
4				**Transfer Length (LSB)**				
5				**Control Byte**				

The RECOVER BUFFERED DATA command is used to read data that has been transferred to the controller buffer. The data may or may not have been written on the medium. This command is normally used only to recover from error or exception conditions that make it impossible to write the buffered data on the medium. This command should immediately follow the WRITE command, which should be preceeded by the RESERVE UNIT command.

This command functions similarly to the READ command except that the data is transferred from the controller buffer instead of the medium. The order in which block(s) are transferred is the same as if they would have been transferred to the medium.

The Fixed bit shall be set to one, otherwise the target creates the CHECK CONDITION status with the sense key of ILLEGAL REQUEST.

If an attempt is made to recover more logical blocks of data than are contained in the controller buffer, the command is terminated with the CHECK CONDITION status. The Valid bit is set to one and the Information Bytes are set to the number of blocks requested in the Transfer Length if less than the buffer size or set to the maximum number of blocks available in the buffer (buffer size).

The Transfer Length specifies the number of contiguous logical blocks of data to be transferred. A Transfer Length of zero indicates that no data shall be transferred. This condition is not considered an error.

6.3.6 REWIND Command

Peripheral Device Type : **Sequential Access Device**

REWIND Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0				**(01h)**				
1	**Logical Unit Number**			Reserved				**Immed**
2				Reserved				(00h)
3				Reserved				(00h)
4				Reserved				(00h)
5				**Control Byte**				

The REWIND command requests that the controller rewind the logical unit to the beginning of medium or load point (BOM).

An IMMED (Immediate) bit of one indicates that Status shall be returned as soon as the operation is initiated. An IMMED (Immediate) bit of zero indicates that Status shall be returned after the operation is completed.

If a REWIND command is issued after a WRITE command and a File Mark has not been written, the controller will automatically write a File Mark before initiating the rewind. After the tape drive re-wind to the BOM, the tape drive LED will turn off.

6.3.7 SPACE Command

Peripheral Device Type : **Sequential Access Device**

SPACE Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	**(11h)**							
1	**Logical Unit Number**			Reserved				**Code**
2	**Count (MSB)**							
3	**Count**							
4	**Count (LSB)**							
5	**Control Byte**							

The SPACE command provides a variety of positioning functions that are determined by the code and the count. It moves the tape forward :

- over the subsequent data Block(s), (Block Mode)
- over the subsequent File Mark(s), (File Mark Mode),
- to the physical end of the data, (Physical End of Data Mode).

Byte 1 Code	Bits 1	0	Meaning
	0	**0**	**Block Mode**
	0	**1**	**File Mark Mode**
	1	**1**	**Physical End of Data Mode (EOD)**

When spacing over Blocks or File Marks, the count field specifies the number of Blocks or FileMarks to be spaced over. A zero value in the Count field causes no medium movement.
NOTE: The controller disconnects while executing the spacing.

FILEMARK ENCOUNTERED :
If a FileMark is encountered while spacing over blocks, medium movement is stopped. The medium will then be positioned on the end-of-medium side of the FileMark. The controller creates the CHECK CONDITION status. The FileMark and the Valid bits are set in the Extended Sense. The Information bytes are set to the difference (residue) between the requested Count of the CDB and the actual number of blocks spaced over (not including the FileMark).

EOM ENCOUNTERED:
If the physical end-of-medium is encountered while spacing over blocks or FileMarks, the controller creates the CHECK CONDITION status. The EOM and the Valid bits are set in the Extended Sense. The Sense key is set to MEDIUM ERROR. The Information bytes are set to the difference (residue) between the requested Count of the CDB and the actual number of blocks or FileMarks spaced over.

When spacing over sequential FileMarks, the Count field is interpreted as follows :
- A positive value N causes forward medium movement to the first occurrance of N or more consecutive Filemarks stopping after the Nth FileMark.
- A zero value causes no medium movement.
- A negative value -N (2's complement notation) causes a CHECK CONDITION status with ILLEGAL Sense Key.

When spacing to physical end-of-data, the Count field is ignored. Forward medium movement occurs until the logical unit encounters physical end-of-data. Subsequent WRITE commands may then be issued.
A SPACE command with Physical End of Data Mode shall be issued prior to executing a COPY command from Disk to Tape if the data is to be appended to the existing recorded medium. Otherwise, a REWIND command is only necessary if the data is intended to be recorded from BOM.

6.3.8 VERIFY Command

Peripheral Device Type : **Sequential Access Device**

VERIFY Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	(13h)							
1	Logical Unit Number			Reserved			0	Fixed
2	Verification Length (MSB)							
3	Verification Length							
4	Verification Length (LSB)							
5	Control Byte							

The VERIFY command performs a rewind (if not at BOM), then verifies the entire medium from the BOM to EOM. The pattern (E5h) is written on the medium. The Tape Formatter performs a CRC check on every block. When reaching the EOM, the medium is rewound. Then the medium is erased from BOM to EOM. Finally the medium is rewound. The controller disconnects while executing the command if requested by the host in the IDENTIFY message.

A REQUEST SENSE command may then be issued to obtain the number of blocks (available in the Tape Sense bytes 2 and 3) rewritten during the Verify process.The FIXED bit shall be set to one indicating the Fixed block length. If the Fixed bit is set to zero, the controller creates the CHECK CONDITION with ILLEGAL REQUEST Sense Key.

If the read after write drive function detects a bad block, rewrite will occur. If the Tape Formatter exhausts its rewrite count, and the procedure is still unsuccessful, the process stops, and the CHECK CONDITION status is created with Exception condition.
A REQUEST SENSE command may be issued to obtain the total number of blocks (information bytes) been verified during the verify process.

6.3.9 WRITE Command

Peripheral Device Type : **Sequential Access Device**

WRITE Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	**(0Ah)**							
1	**Logical Unit Number**			Reserved				**Fixed**
2	**Transfer Length (MSB)**							
3	**Transfer Length**							
4	**Transfer Length (LSB)**							
5	**Control Byte**							

The WRITE command transfers the specified number of blocks from the host, starting at the current position, that is, the next block of the unit. The operation terminates when the number of blocks to be transferred is exhausted, or when the Tape Formatter recovery procedure of unsuccessful retries of rewrite has been exhausted, or when the End of Medium (EOM) is encountered. The last two conditions create an Exception condition, and the Transfer Length or Block Count written will be available in the Sense Bytes.

The FIXED bit shall always be set to one, which specifies that the Transfer Length is in number of blocks and not in number of bytes, and that the data transferred is with Fixed Length blocks and not with Variable Length blocks.

When the Transfer Length is zero, no data is transferred and the current position on the logical unit is not changed. This condition does not create an error.

EOM CONDITION :
If the logical unit encounters the early warning End of Medium (EOM) while writing, the controller will attempt to finish writing some buffered blocks, then the CHECK CONDITION status is created and the EOM bit is set in the Sense Bytes. If any data remains in the controller's buffer, the Sense Key is set to VOLUME OVERFLOW. The Valid bit is set to one in the Sense bytes, and the Information bytes are set to the total number of blocks written. The medium position following this condition is not defined.

6.3.10 WRITE FILEMARK Command

Peripheral Device Type : **Sequential Access Device**

WRITE FILEMARK Command Descriptor Block

Bit / Byte	7	6	5	4	3	2	1	0
0	**(10h)**							
1	**Logical Unit Number**			Reserved				
2	**Number of Filemarks (MSB)**							
3	**Number of Filemarks**							
4	**Number of Filemarks (LSB)**							
5	**Control Byte**							

The WRITE FILEMARK command causes the specified number of FileMarks to be written beginning at the current medium position on the logical unit. A zero value in bytes 2 through 4 indicates that no FileMark is to be written. FileMarks can be searched by SPACE FORWARD commands.

EOM CONDITION :
If the logical unit encounters the early warning End of Medium (EOM) while writing, the controller will attempt to finish writing some buffered blocks, then the CHECK CONDITION status is created and the EOM bit is set in the Sense Bytes. If any FileMarks remain to be written, the Sense Key is set to VOLUME OVERFLOW. The Valid bit is set to one in the Sense bytes, and the Information bytes are set to the total number of written FileMarks. The medium position following this condition is not defined.

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