This is the Optimem 1000 SCSI Interface Manual, revision F (OPT1.4), dated October, 1985.

While every effort has been made to ensure that the information provided is correct, please notify us in the event of an error or inconsistency. Direct your comments to:

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4.5 Controller Jumpers	Added
5.9 Sector Relocation	Added option
5.10 Medium Track Map	Added
6.4.6.1 Data In Phase	Editorial change
6.4.6.2 Data Out Phase	Editorial change
7.1 Operation Code	Group 6 Relocation Commands added
9.1.4 Request Sense with Relocation	Added 6 bytes to data returned
9.1.5 Read	DRT and EDL bits added
9.1.7 Seek	Changed to an Immediate command
9.1.8 Inquiry	Changed byte 2 in data returned
9.1.9 Mode Select	EBC bit definition rewritten Added to byte 4 ESR bit (Enable Sector Relocation) DSI bit (Disable Seek Immediate)
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1. SCOPE

This document describes the Optimem 1000 SCSI Controller for the Optimem 1000 Optical Disk Drive.

The implementation set forth in this document is intended to specify the current generation of the controller and does not represent an all inclusive implementation of the SCSI Write Once Read Multiple command set. Extensions and enhancements to the present implementation will be forthcoming.

2. RELATED DOCUMENTS

The following documents are related to this document:

- Optimem 1000 Optical Disk Drive OEM Manual
- Small Computer Systems Interface (SCSI), ANSC X3T9.2/REV 16

3. DESCRIPTION

The Optimem 1000 SCSI Controller provides a control interface between the host system(s) and the Optimem 1000 Optical Disk Drive(s) via the SCSI Bus. This controller includes Error Detection And Correction (EDAC) facilities utilizing an interleaved Reed-Solomon code.

The Optimem 1000 SCSI Controller consists of a printed circuit board for the SCSI controller and a printed circuit board for the EDAC functions. The SCSI Controller Board is P/N D01-081404-008 with open collector drivers and receivers. The EDAC Functions Board is P/N D01-081403-001.

An optical drive with a controller will support up to seven additional optical drives without a controller. The additional optical drives are connected to the master drive by the Optimem Disk Interface(ODI).

The Optimem 1000 SCSI Controller supports the following features:

-Single and multiple Initiator systems.

-Single and multiple Target systems.

-Complete SCSI Device ID decoding.

-Accommodation of up to eight optical drives per controller.

-Orientation toward intelligent peripheral devices.

-Data transfers of a maximum of 65536 contiguous logical blocks with a single non-linked command.

-Selectable sector interleave of one or three.

-Sector relocation which handles medium defects on a WRITE and VERIFY operation.

-Performance of self diagnostic routines on the controller and each of the optical drives on power up.

-Performance of host initiated diagnostic routines capable of fault isolation to a functional area.

SCSI terminology:

-Initiator: The host adapter in the computer system.

-ODI: The Optimem Drive Interface is the drive level interface of the Optimem 1000.

-Target: The Optimem 1000 SCSI Controller.

-Peripheral device: The Optimem 1000 Optical Disk Drive. Also referred to in a logical context as a Logical Unit which is identified by Logical Unit Number (LUN). A peripheral device may consist of multiple Logical Units.

-SCSI Bus: A reference to all the signals defined in the SCSI Bus Signals section.

-SCSI Address: The encoded three-bit representation of the unique address (7-0) assigned to an SCSI Device. This address is assigned and set during system installation.

-SCSI Device: A host adapter or a peripheral controller which can be attached to the SCSI Bus. The Initiator and Target are both SCSI Devices. A reference to an SCSI Device would apply to either.

-SCSI ID: The bit significant representation of the SCSI Address referring to one of the signal lines **DB(7-0)**.

4. PHYSICAL INTERFACE

A single-ended driver/receiver interface is used by the controller. This is intended for OEM applications where all interface cabling will occur in properly shielded enclosures for electrical noise control. All SCSI Devices on the SCSI Bus must be of the same driver/receiver type.

4.1. Transmitter Characteristics

All transmitters use open collector or three state drivers. Each signal driven by a SCSI Device has the following output characteristics when measured at the cable connector:

True = Signal Assertion = 0.0 VDC to 0.4 VDC.

Maximum driver output capability = 48 mA sinking at 0.5 VDC.

False = Signal Negation = 2.5 VDC to 5.25 VDC.

4.2. Receiver Characteristics

Each signal received by a SCSI Device has the following output characteristics when measured at the cable connector:

True = Signal Assertion = 0.0 VDC to 0.8 VDC.

Maximum total input load = -0.4 mA at 0.4 VDC.

False = Signal Negation = 2.0 VDC to 5.25 VDC.

Maximum input hysteresis shall be 0.2 VDC.

4.3. Termination

All assigned signal lines are terminated with 220 ohms to +5 VDC (nominal) and 330 ohms to ground at each end of the cable.

Table 4-1: SCSI CABLE PIN ASSIGNMENTS

Single-Ended Driver/Receiver Configuration

SIGNAL	PIN NUMBER	DESCRIPTION
-DB(0)	2	Data Bus Bit 0
-DB(1)	4	Data Bus Bit 1
-DB(2)	6	Data Bus Bit 2
-DB(3)	8	Data Bus Bit 3
-DB(4)	10	Data Bus Bit 4
-DB(5)	12	Data Bus Bit 5
-DB(6)	14	Data Bus Bit 6
-DB(7)	16	Data Bus Bit 7
-DB(P)	18	Data Bus Parity Bit
GROUND	20	Ground
GROUND	22	Ground
GROUND	24	Ground
TERMPWR	26	Terminator Power
GROUND	28	Ground
GROUND	30	Ground
-ATN	32	Attention
-GROUND	34	Ground
-BSY	36	Busy
-ACK	38	Acknowledge
-RST	40	Reset
-MSG	42	Message
-SEL	44	Select
-C/D	46	Control/Data
-REQ	48	Request
-I/O	50	Input/Output

Note: All signals are low true. All odd pins except pin 25 are connected to ground. Pins 25 and 26 are open.

4.4. Connectors

The Optimem 1000 Optical Disk Drive SCSI header connector and ODI header connector are located on the motherboard at the rear of the drive. When viewed from the rear of the drive as depicted below, the ODI connector is on the right and the SCSI connector is in the middle. Pin number one of each connector is on the upper right side of that connector.

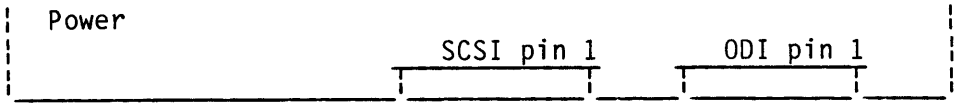


Fig. 4-1: SCSI / ODI CONNECTORS

4.4.1. SCSI Mating Connector

The SCSI mating connector is a 50 conductor socket connector which consists of two rows of 25 male pins on 0.10 inch centers. The 3M Scotchflex #3425-6000 meets this requirement.

The SCSI header connector is a keyed locking type. The mating connector profile should be such that it does not interfere with the locking tabs.

4.4.2. SCSI Cable

A 50 conductor shielded cable is required to meet the FCC regulations for a Class A computer device as stated in Part 15 Subpart J. The 3M Scotchflex cable part number 3517/50 will meet this requirement provided the shield is grounded to the chassis with the cable clamp provided with the drive. The maximum cable length is six meters.

4.5. Controller Jumpers

4.5.1. Interleave Selection

The Controller has a selectable interleave of one (sectors read contiguously), or three (every third sector is read). The interleave is set by jumper 7 at location A6 on the SCSI Controller Board. If the jumper is removed the interleave is one; if the jumper is inserted the interleave is three. Refer to Figure 4-3.

4.5.2. Parity

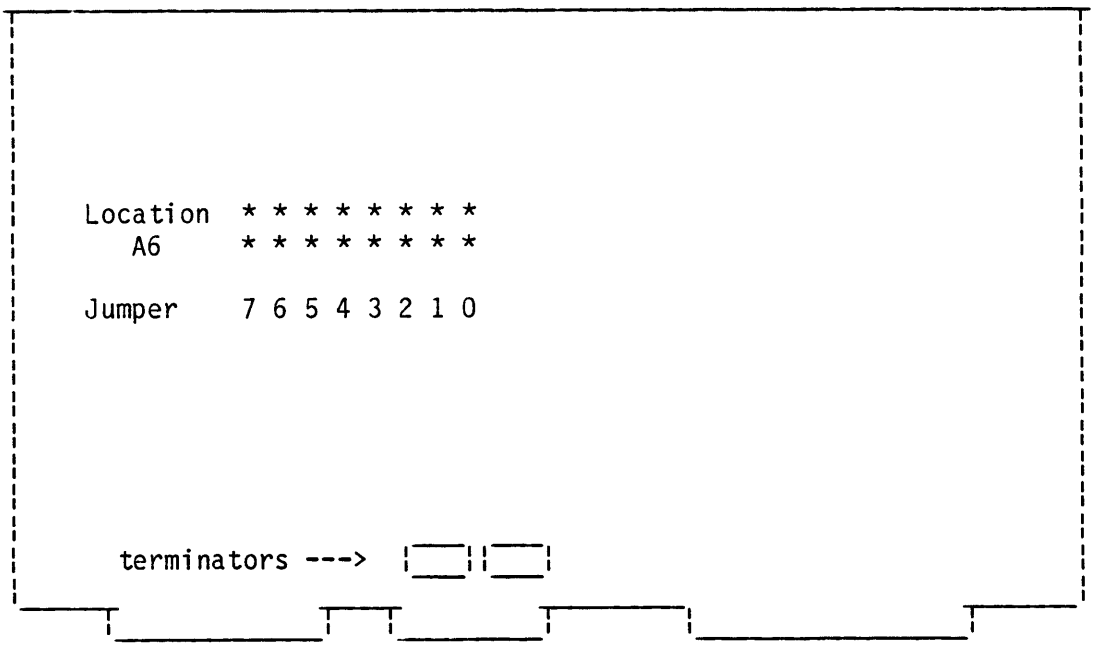
The Controller always generates parity. However, the checking of parity on the SCSI Data Bus on incoming data is optional. Parity can be enabled in hardware by setting jumper 3 on the Controller Board (See Figure 4-2), or in software by setting the Parity Enable Bit (PEB) in the MODE SELECT command. Refer to the sections on MODE SELECT and MODE SENSE.

4.5.3. Relocation

Automatic relocation of defective sectors on WRITE AND VERIFY AND READ operations is available by setting jumper 5 on the Controller Board (See Figure 4-2). Relocation can also be accomplished through software by setting the Enabe Sector Relocation Bit in MODE SELECT. Refer to the section on Sector Relocation.

4.5.4. SCSI ID

The SCSI ID of the Optimem 1000 Controller is assigned by the use of jumpers. Jumpers 0, 1, and 2 are used to set the ID which is presently shipped with an address of zero. See Figure 4-2. below.



Controller Board

Jumper

7	6	5	4	3	2 1 0	
I		R		P	0 0 0	SCSI ID = 7
N		E		A	0 0 1	SCSI ID = 6
T		L		R	0 1 0	SCSI ID = 5
E		0		I	0 1 1	SCSI ID = 4
R		C		T	1 0 0	SCSI ID = 3
L		A		Y	1 0 1	SCSI ID = 2
E		T			1 1 0	SCSI ID = 1
A		I			1 1 1	SCSI ID = 0
V		0				
E		N				

0 means jumper removed
1 means jumper inserted

Fig. 4-2: CONTROLLER JUMPERS

4.6. SCSI ID Selection

An SCSI Device is selected by the assertion of the DATA BUS bit, DB(7) through DB(0), which corresponds to its SCSI ID. The SCSI Device asserts its assigned data bit (SCSI ID) but leaves the other DATA BUS bits in the released state.

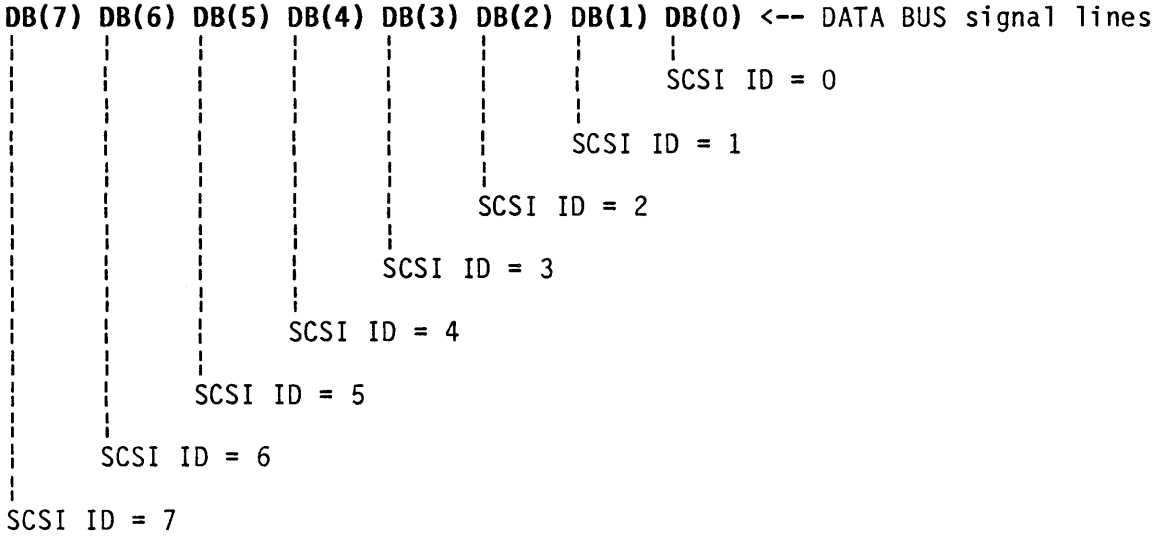


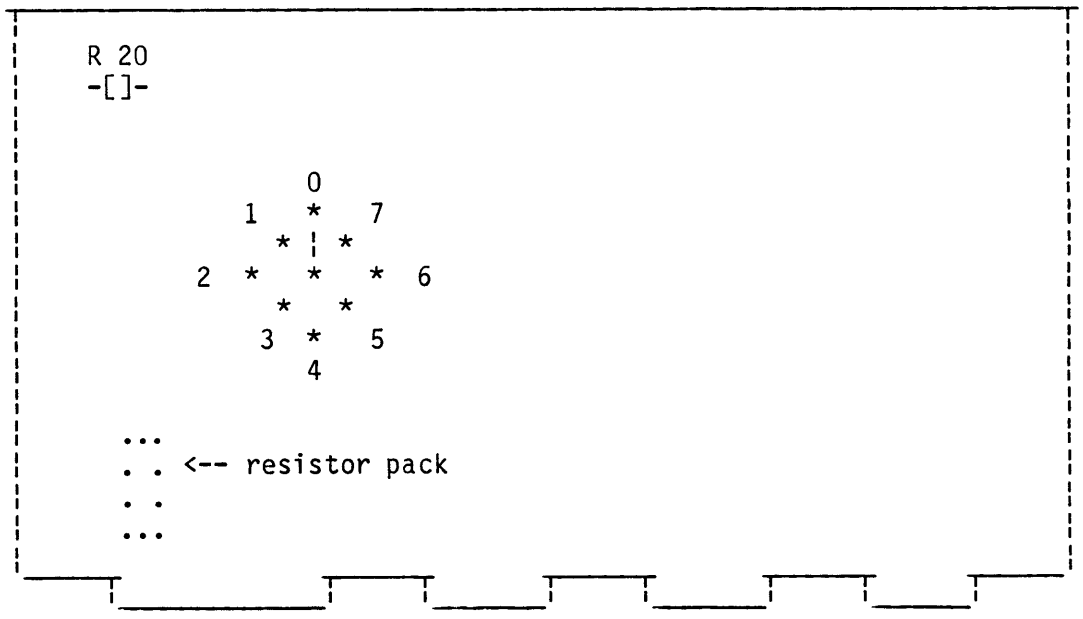
Fig. 4-3: SCSI ID Bit

4.7. SCSI Bus Termination

Termination is required on each end of the SCSI Bus to assure proper signal levels. If multiple SCSI devices are used then termination must be removed from all SCSI devices except those at each end of the SCSI Bus. The terminators on the SCSI Controller Board are located at H2 and J2.

4.8. LUN Selection

Slave drives connected through the ODI are selected by Logical Unit Number (LUN). The LUN of each drive is assigned by a jumper on the Drive Control Board as shown below. All drives are assigned a LUN of zero at the factory. If multiple slave drives are used, the LUNs must be changed.



Drive Control Board

termination resistor (R 20) is located at B5
termination resistor pack is located at D7

Fig. 4-4: LUN ASSIGNMENT

4.9. ODI Bus Termination

Termination is required on each end of the ODI Bus to assure proper signal levels. One termination end consists of a resistor pack which resides permanently on the SCSI Controller Board at D1. The other termination which consists of a termination resistor pack and a terminator resistor is located on the Drive Control Board as shown above.

If multiple slave drives are used they should be connected in daisy-chain fashion with a 50 pin cable to each ODI connector. Termination should be removed from all Drive Control boards except for the drive at the end of the bus. This includes both terminator resistor and terminator pack on the Drive Control Board.

5. CONTROLLER SPECIFICATIONS

5.1. Dimensions and Weight

The overall dimensions of the SCSI Controller Board and the EDAC Functions Board are 362 +/- 0.17mm by 151 +/- 0.15 mm by 10mm. The boards are designed to be plugged into two slots in the Optimem 1000 card cage.

The weight of the SCSI Controller Board and the EDAC Functions Board combined does not exceed 1100 grams.

5.2. Power Requirements

The power requirements and connections for the SCSI Controller Board and the EDAC Functions Board are listed below.

Table 5-1: POWER REQUIREMENTS

SCSI Controller Board

Connector P1 pins 1 - 4 \ + 5 VDC @ 3.8 amps (6.0 max)
Connector P2 pins 47-50 /
Connector P1 pins 5 - 8 Ground
Connector P2 pins 43-46 Ground

EDAC Functions Board

Connector P1 pins 1 - 4 + 5 VDC @ 3.00 amps (6.20 max)
Connector P1 pins 5 - 8, pin 10, pin 12 Ground

5.3. Environmental Limits

The environmental limits of the Optimem 1000 SCSI Controller are listed below.

Table 5-2: ENVIRONMENTAL LIMITS

	STORAGE	TRANSIT	NON-OPERATING	OPERATING
Temperature	-40°C to 60°C	-40°C to 60°C	10°C to 46°C	10° to 46°C
Temperature gradient	15°C per hour	15°C per hour	10°C per hour	10°C per hour
Humidity	10-95% RH NonCondensing	10-95% RH NonCondensing	10-80% RH NonCondensing	10-80% RH NonCondensing
Humidity gradient	10% per hour	10% per hour	10% per hour	10% per hour
Altitude	0-12,200 m	0-12,200 m	0-12,200 m	0-3000 m

5.4. Capacity

The controller capacity specifications when the EDAC mode format is used are listed below.

Table 5-3: CAPACITY SPECIFICATION IN EDAC MODE

Block Size(User)	1024 Bytes
Blocks per Track	25
Tracks per surface	40000
Total Capacity	one million 1024 byte blocks one gigabyte
Buffer Size	4096 Bytes
Block Address Range	999,999 blocks (21 bit address) 999,999 blocks (32 bit address)
Transfer Length	256 blocks (Group 0 command) 64K blocks (Group 1 command)

5.5. Data Transfer Rates

The SCSI Bus transfers data asynchronously with single ended drivers and receivers and a cable length of up to 6 meters. The maximum Optimem SCSI data transfer rate is 0.80 Mbytes per second. The sustained average data transfer, limited by the format overhead and error detection and correction, is 0.48 Mbytes per second. The average data transfer rate for an interleave of three

is 0.096 Mbytes per second.

5.6. Medium Defects

A medium defect is a physical characteristic of the medium which results in a repetitive read error. Medium defects are excluded from the error rate calculations. A repetitive read error is defined as a defect which is not corrected by the EDAC on a verification of a write operation without retrying the read.

5.7. Data Error Rates

Specified data error rates are obtained using error detection and correction functions, and retries of the read operation. The data error rates are valid only when the drive and controller are operated within specification. Data error rates due to equipment failures are excluded.

5.7.1. Recoverable Errors

A recoverable read error occurs when data can be read correctly within five retries using the EDAC functions. There will be no more than one recoverable read error in 10^{10} bits of data read. The controller will automatically do five retries if the DRT Bit is zero. See the MODE SELECT command.

5.7.2. Nonrecoverable Errors

A nonrecoverable read error occurs when data cannot be read correctly within five retries using the EDAC functions. There will be no more than one nonrecoverable read error in 10^{12} bits of data read.

5.7.3. Nondetected Errors

A nondetected read error may result from any of the following conditions:

-The EDAC not detecting an error which exists and reporting good data.
-The EDAC not properly correcting data and reporting the data as good.
-The EDAC reporting good data as bad.

There will be no more than one nondetected read error in 10^{16} bits of data read.

5.8. Data Formats

The controller is able to write information to the disk in EDAC mode, non-EDAC mode, and Diagnostic mode. The options are set using the MODE SELECT command.

5.8.1. EDAC Format

The Optimem 1000 SCSI Controller normally operates in the EDAC format. A MODE SELECT command must be sent by the Initiator to change to another format. The EDAC format consists of the following fields:

Reserved	24 bits - 00h
Write Check Field	8 bits - AAh
Address Field	24 bits
User Data Field	8192 bits
CRC1 Field	16 bits
CRC2 Field	16 bits
EDAC Field	640 bits
Gap Field	5 bits

The EDAC format is illustrated in Figure 5-1.

The Reserved Field contains three bytes of zeroes.

The Write Check Field contains one byte of AAh.

The Address Field contains the three bytes of logical block address written with the first byte as the MSB.

The Data Field contains 1024 bytes of user data.

The CRC1 Field contains two bytes of cyclical redundancy code, which is generated using the polynomial $X^{16}+X^{15}+X^{13}+X^{7}+X^{4}+X^{2}+X^{1}+1$ on all the preceding bytes in the sector.

The CRC2 contains two bytes of cyclical redundancy code, which is generated using the polynomial $X^{16}+X^{15}+X^{2}+1$ on the preceding bytes in the sector.

The EDAC Field contains eighty bytes of error detection and correction code, which is generated using the EDAC Functions Board on the preceding bytes in the sector. The EDAC Functions Board has multiple burst correction capability using a Reed-Solomon code in a Galois field of 2^{8} with an interleave of five. Each subcode block can correct up to eight bytes in error. This provides a single burst correction of up to 320 bits, or the ability to correct a combination of shorter bursts.

An EDAC format write transfers 1024 bytes of user data to the User Data Field on the medium. The Write Check Field, the Address Field, the CRC1 Field, the CRC2 Field and EDAC Field are all also written.

An EDAC format read uses the Write Check Field, the Address Field and the

error detection and correction fields to transfer 1024 bytes of corrected user data to the Initiator.

5.8.2. Non-EDAC Format

The non-EDAC format is selected by sending a MODE SELECT command with the DEDAC Bit set to the controller. The non-EDAC format consists of the following fields:

Reserved	24 bits - 00h
Write Check Field	8 bits - 55h
Address Field	24 bits
User Data Field	8192 bits
Zero Field	672 bits
Gap Field	5 bits

The non-EDAC format is illustrated in Figure 5-2.

The Reserved Field contains three bytes of zeroes.

The Write Check Field contains one byte of 55h.

The Address Field contains the three bytes of logical block address written with the first byte as the MSB.

The Data Field contains 1024 bytes of user data.

The Zero Field contains eighty-four bytes of zeroes.

A non-EDAC format write transfers 1024 bytes of user data to the User Data Field on the medium. The Write Check Field and the Address Field are written; the CRC1 Field, CRC2 Field and EDAC Field are not written and are not used.

A non-EDAC format read transfers 1024 bytes of uncorrected user data to the Initiator. The Write Check Field, the Address Field, the CRC1 Field, CRC2 Field, and EDAC Field are not used. Even if the data was written in EDAC format, no error detection or correction or cyclical redundancy checks are performed during a non-EDAC read.

5.8.3. Diagnostic Format

The Diagnostic format is selected by sending a MODE SELECT command with the DIAG Bit set to the controller and using Group 7 DIAGNOSTIC READ and DIAGNOSTIC WRITE commands. The Diagnostic format consists of the following fields:

User Data Field	8920 bits
Gap Field	5 bits

The sector layout is shown in Figure 5-3.

The User Data Field contains 1115 bytes of user data.

A DIAGNOSTIC WRITE command transfers 1115 bytes of user data to the User Data Field on the medium. The Diagnostic format contains no Write Check Field, no Address Field, no CRC1 Field, CRC2 Field, or EDAC Field.

Data read with a DIAGNOSTIC READ command transfers 1115 bytes of user data to the Initiator. Data written in EDAC or non-EDAC format can be read in Diagnostic format, however no address checking, error detection and correction, or blank checking are performed.

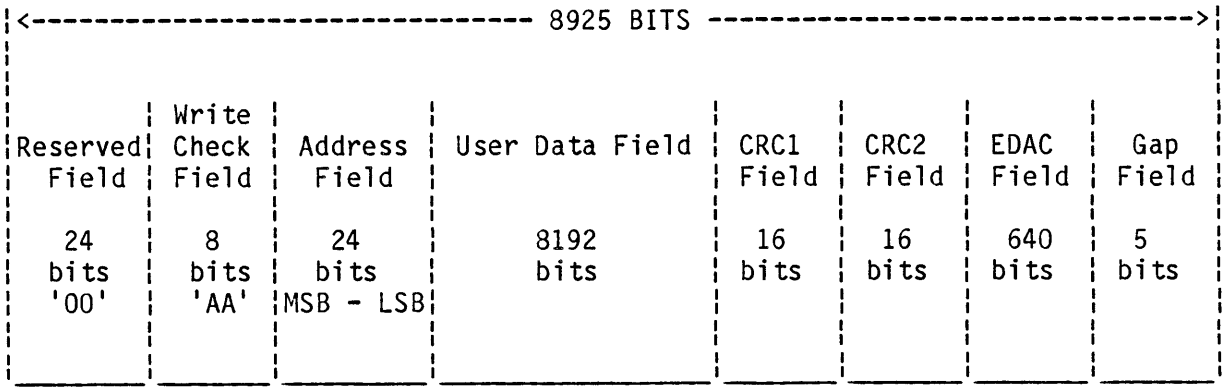


Fig. 5-1: EDAC FORMAT

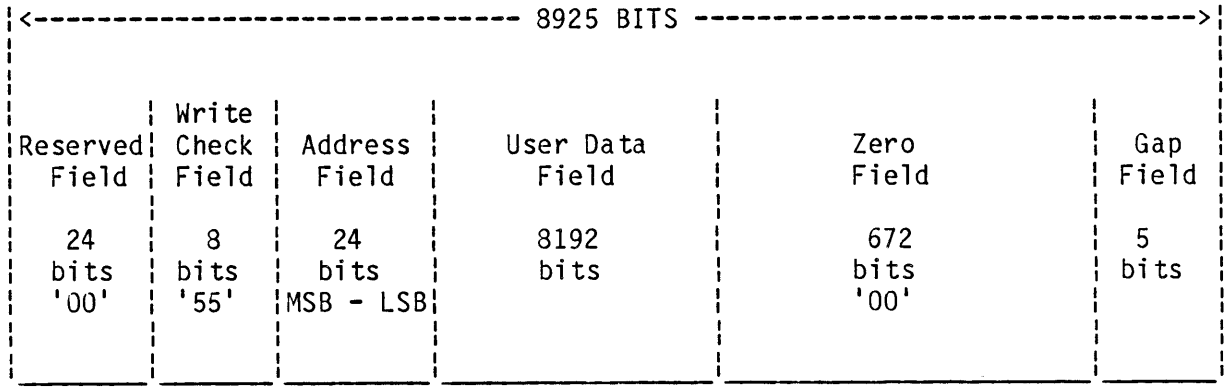


Fig. 5-2: NON-EDAC FORMAT

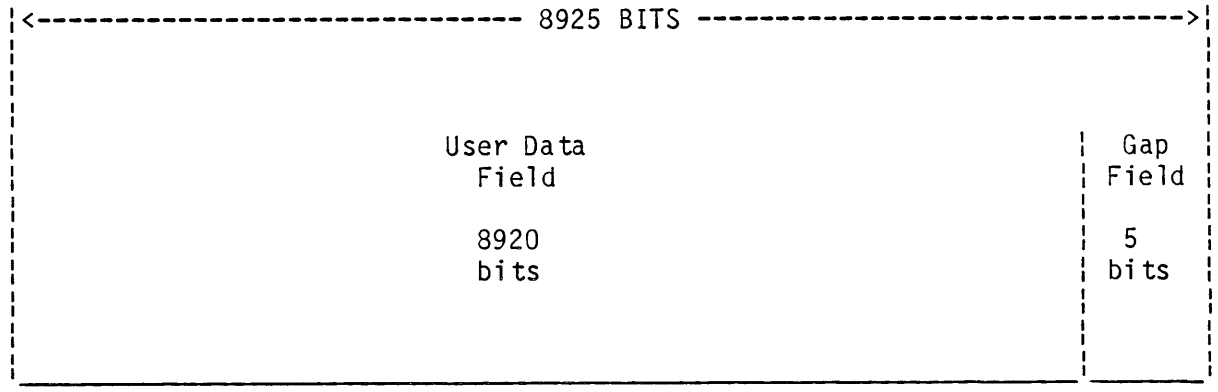


Fig. 5-3: DIAGNOSTIC FORMAT

5.9. Sector Relocation

Sector Relocation is a method for handling defective sectors on the medium. It is optional. A sector is defined by Optimem as defective if it is uncorrectable by the EDAC.

The Relocation option will rewrite a defective sector in an area on the medium set aside for this purpose called the Relocation Area. Refer to the section on the Medium Track Map.

Relocation can be performed only during:

1. a WRITE AND VERIFY command,
2. a READ and Extended Read command and,
3. a RELOCATE BLOCK command.

The Relocation option is handled automtically by the Controller during the WRITE AND VERIFY and READ commands, if a hardware jumper is set on the Controller board (see section on Controller Jumpers), or if the ESR bit (5) of byte (4) in the Mode Select command is set.

Relocation can also be performed at any time by issuing the command, RELOCATE BLOCK.

The following paragraphs give a brief scenario on each of the three commands used with relocation.

WRITE AND VERIFY with relocation (ESR = 1 or hardware jumper set):

1) The first blank sector in the relocation area is found.
2) The total transfer length of sectors to be written on the medium are Blank Checked, ie verified to be unwritten.
3) If a written sector is found, a check condition status is returned with a Blank Check error.
4) The four data buffers are filled with four sectors of data.
5) The four sectors of data are written to the medium.
6) The four sectors are EDAC verified.
7) If the four sectors are verified correct, and there is more data, then the four data buffers are filled and the data is written and verified.
8) If an uncorrectable sector is detected on the verify (the Controller does no automatic retries), a seek to the relocation area is made.
9) The defective sector is written.
10) The relocated sector is verified.
11) If the relocated sector is verified correct, a return is made to the user data area.
12) If the relocated sector is verified as uncorrectable, it is rewritten in the next block. These rewrites are limited to three.
13) Once the relocation area is full, the command is immediately terminated with:
    - a Completion Status of CHECK,
    - the Sense Key set to 0B,
    - the Controller Fault Code set to B2, and
    - the Logical Block Address set to the address of the sector that was attempted to be relocated.

14) If there is more data to be transferred, and the relocation area is not full, then again the four data buffers are filled, the data is written, verified, and relocated if necessary.

READ with relocation (ESR = 1 or hardware jumper set):

1) The sector is read.
2) If an uncorrectable sector is detected, a seek to the relocation area is made to search for a matching address.
3) If the original sector was good, or the relocated good sector is found, the data is transferred.
4) If a matching address in the relocation area is not found, the command is terminated with:
   a Completion Status of CHECK,
   the Sense Key set to 03,
   the Controller Fault Code set to 32, and
   the Logical Block Address set to the defective sector.
5) A return to step 1 is made until the transfer is complete.

RELOCATE BLOCK:

1) A seek to the relocation area is made.
2) A search for a blank sector is performed.
3) If the relocation area is full, the command is immediately terminated with:
   - a Completion Status of CHECK,
   - the Sense Key set to 0B,
   - the Controller Fault Code set to B2, and
   - the Logical Block Address set to the address of the sector not relocated.
4) If a blank sector is found, the data is written.
5) The data is EDAC verified.
6) If the relocated sector is verified correct, the command completed successfully and good status is returned.
7) If the relocated sector is verified as uncorrectable, it is rewritten in the next block. These rewrites are limited to three.
8) If the relocation area is full, the command is immediately terminated with the Check condition status and error information outlinned in Step 3.

5.10. Medium Track Map

The areas of the medium are assigned as follows:

-512	to	-251	Guard Band
-250	to	-150	Medium Qualification Test Tracks
-149	to	-22	Reserved
-21			Medium Qualification Test Track
-20	to	-3	Relocation Area
-2			Pre-recorded Medium Data Track*
-1			Disk Identification Track*
0	to	39999	User Data Area
40000	to	40009	Sector Skipping Area
40010	to	40149	Reserved
40150	to	40250	Medium Qualification Test Tracks
40251	to	40511	Guard Band

* Reserved for future use

6. SCSI Bus

The following sections describe the SCSI Bus signals, the SCSI Bus timings, the SCSI Bus conditions, and the SCSI Bus phases.

The Optimem 1000 SCSI Controller is an SCSI Device, more specifically a Target, by the SCSI terminology. In the general discussions of SCSI that follow, the term Target will be used. The term controller is used when something specific to the Optimem 1000 SCSI Controller is discussed, such as implementation features. The terms are interchangeable for the purposes of this document.

6.1. SCSI Bus Signals

The following signals are used to communicate a desired operation between two SCSI devices, in which one acts as the Initiator and the other acts as the Target.

BSY (BUSY) An "or-tied" signal which indicates that the SCSI Bus is being used.

SEL (SELECT) A signal used by an Initiator to select a Target or by a Target to reselect an Initiator.

C/D (CONTROL/DATA) A signal driven by a Target which indicates whether control or data information is on the DATA BUS. Asserted indicates control.

I/O (INPUT/OUTPUT) A signal driven by a Target which controls the direction of data movement on the DATA BUS with respect to an Initiator. Asserted indicates input to the Initiator.

MSG (MESSAGE) A signal driven by a Target during the MESSAGE phase.

REQ (REQUEST) A signal driven by a Target to indicate a request for a **REQ/ACK** data transfer handshake.

ACK (ACKNOWLEDGE) A signal driven by an Initiator to indicate an acknowledgment for a **REQ/ACK** data transfer handshake.

ATN (ATTENTION) A signal driven by an Initiator to indicate the Attention Condition. This signal is not implemented.

RST (RESET) An "or-tied" signal driven by an Initiator to indicate the Reset Condition.

DB(7-0,P)(DATA BUS) Eight data bit signals, plus a parity bit signal which form the DATA BUS. **DB(7)** is the most significant bit. Data parity is odd. The use of parity is a system option.

The signals **BSY** and **RST** are "or-tied" because they may be simultaneously driven by more than one SCSI Device.

6.2. SCSI Bus Timings

Unless otherwise indicated, the delay time measurements for each SCSI Device shall be calculated from signal conditions existing at that SCSI Device connection to the SCSI Bus. Normally these measurements need not consider delays in the SCSI cable.

Arbitration Delay (2.2 us)
The minimum time an SCSI Device shall wait from asserting **BSY** for arbitration until the DATA BUS can be examined to see if arbitration has been won. There is no maximum time.

Bus Clear Delay (800 ns)
The maximum time for an SCSI Device to stop driving all SCSI Bus signals after:
- the BUS FREE phase is detected (**BSY** and **SEL** both False for a Bus Settle Delay);
- **SEL** is received from another SCSI Device during the Arbitration phase.

Note: The maximum time for an SCSI Device to clear the SCSI Bus after the assertion of **BSY** and **SEL** is 1200 ns. If an SCSI Device requires more than a Bus Settle Delay to detect the BUS FREE phase, it shall clear the SCSI Bus within a Bus Clear Delay minus the excess time required for detection.

Bus Free Delay (800 ns)
The minimum time that an SCSI Device should wait from its detection of the BUS FREE phase (**BSY** and **SEL** both False for a Bus Settle Delay) until its assertion of **BSY** when going to the ARBITRATION phase.

Bus Set Delay (1.8 us)
The maximum time allowed to an SCSI Device from its detection of the BUS FREE phase (**BSY** and **SEL** both False for a Bus Settle Delay) to its assertion of **BSY** and its SCSI ID for the purpose of ARBITRATION.

Bus Settle Delay (400 ns)
The minimum time to wait for the SCSI Bus to settle after changing certain control signals.

Cable Skew (10 ns)
The maximum difference in propagation time allowed between any two SCSI Bus signals when measured between any two SCSI Devices.

Deskew Delay (45 ns)
This time is used to calculate the minimum time required for deskew of certain SCSI Bus signals.

Reset Hold Time (25 us)

The minimum time for which **RST** is asserted. There is no maximum time.

Selection Abort Time (200 us)

The maximum time an SCSI Device shall take from its most recent detection of being selected or reselected until asserting a **BSY** response. This is not the Selection Timeout Period.

Selection Timeout Period (250 ms)

The minimum time that an SCSI Device should wait for a **BSY** response during the SELECTION or RESELECTION phase before starting the timeout procedure.

6.3. SCSI Bus Conditions

The SCSI Bus has two asynchronous conditions:

-Attention Condition
-Reset Condition

These conditions cause certain SCSI Device actions and can alter the SCSI Bus phase sequence.

6.3.1. Attention Condition

The Attention Condition is not implemented in the Optimem 1000 SCSI Controller.

6.3.2. Reset Condition

The Optimem 1000 SCSI Controller implements the hard Reset Condition.

The Reset Condition is used to immediately clear all SCSI Devices from the SCSI Bus. This condition takes precedence over all other phases and conditions.

The Reset Condition is created by the assertion of the **RST** signal for a minimum of a Reset Hold Time. The Reset Condition can occur any time.

The only signal guaranteed to be valid during the Reset Condition, is **RST** .

All SCSI Device operating modes will be set to their default mode.

The Optimem 1000 SCSI Controller will go to the BUS FREE phase by releasing all SCSI Bus signals after detecting a Reset Condition. Any operation suspended by the Reset Condition will be cleared.

If a WRITE command is in progress when a reset is issued, all of the data, up to and including the sector being written, will be completely transferred to the medium.

6.4. SCSI Bus Phases

The SCSI Bus has eight operational phases:

BUS FREE		
ARBITRATION		
SELECTION		
RESELECTION		
COMMAND	\	
DATA	\	These phases are collectively termed the INFORMATION
STATUS	/	TRANSFER phases and are valid only when the REQ
MESSAGE	/	signal is asserted.

The SCSI Bus can never be in more than one phase at any given time.

At the present time the Optimem 1000 SCSI Controller does not implement the ARBITRATION or the RESELECTION phases.

In the following phase descriptions, unless otherwise noted, signals which are not mentioned shall not be asserted.

6.4.1. BUS FREE Phase

The BUS FREE phase is used to indicate that no device is actively using the SCSI Bus and therefore the Bus is available for subsequent users. The BUS FREE phase is detected whenever **SEL** and **BSY** are False for a Bus Settle Delay.

SCSI Devices shall release all SCSI Bus signals within a Bus Clear Delay after **BSY** and **SEL** become continously False for a bus settle delay.

6.4.2. ARBITRATION Phase

The ARBITRATION phase is not implemented in the Optimem 1000 SCSI Controller.

6.4.3. SELECTION Phase

The SELECTION phase allows an Initiator to select a Target for the purpose of initiating some Target function, (e.g. read or write data). During the SELECTION phase **I/O** shall be negated so that this phase can be distinguished from the RESELECTION phase.

In systems where the ARBITRATION phase is not implemented, the Initiator first detects the BUS FREE phase and then waits a minimum of a Bus Clear Delay. The Initiator asserts the DATA BUS with both the desired Target's SCSI ID and its own Initiator SCSI ID. After two Deskew Delays the Initiator asserts **SEL**.

NOTE: The Single Initiator Option is available to Initiators that do not implement the RESELECTION phase and do not operate in the multiple initiator environment. These Initiators are allowed to set only the target's SCSI ID

during the SELECTION phase.

In all systems, the Target determines that it is selected when **SEL** and its own SCSI ID are asserted and **BSY** and **I/O** are negated for at least a bus settle delay.. The selected Target may examine the DATA BUS in order to determine the SCSI ID of the selecting Initiator, unless the Initiator employed the single initiator option (see note above). The selected Target then asserts **BSY** within a Selection Abort Time of its recent detection of being selected; this is required for correct operation of the timeout procedure. In systems with parity implemented, the Target does not respond to a selection if bad parity is detected on the DATA BUS. Also if more than two SCSI IDs' are on the DATA BUS, the Target does not respond to a selection.

At least two Deskew Delays after the Initiator detects **BSY** is True, the Initiator releases **SEL** and may change the DATA BUS.

6.4.3.1. Selection Timeout Procedure

Two optional selection timeout procedures are specified for clearing the SCSI bus if the Initiator waits a minimum of a selection timeout delay and there has been no **BSY** response from the target:

1) the Initiator asserts the **RST** signal,

2) the Initiator continues asserting **SEL** and releases the DATA BUS. If the Initiator has not detected **BSY** to be True after at least a Selection Abort Time plus two Deskew Delays, the Initiator releases **SEL** allowing the SCSI Bus to go to the BUS FREE phase.

SCSI Devices ensure that when responding to selection that the selection was still valid within a Selection Abort Time of their assertion of **BSY.** Failure to comply with this requirement could result in an improper selection (two Targets connected to the same Initiator, wrong Target connected to an Initiator, or a Target not connected to any Initiator.)

6.4.4. RESELECTION Phase

RESELECTION phase is not implemented in the Optimem 1000 SCSI Controller.

6.4.5. COMMAND Phase

The COMMAND phase allows the Target to request command information from the Initiator.

The Target asserts **C/D** and negates **I/O** and **MSG** during the **REQ/ACK** handshake(s) of this phase.

6.4.6. DATA Phase

The DATA phase is a term which encompasses both the DATA IN and the DATA OUT

phase.

6.4.6.1. DATA IN Phase

The DATA IN phase allows the Target to request that data be sent to the Initiator from the Target. The controller asserts **I/O** and **REQ** and negates **C/D** and **MSG** in this phase. The controller first drives DATA(0-7,P) to the desired values, delays at least one Deskew Delay plus a Cable Skew delay, then asserts **REQ**. The Initiator reads DATA(0-7,P) after **REQ** is asserted, and indicates its acceptance of the data by asserting **ACK**. DATA(0-7,P) must remain valid until **ACK** is received at the controller. When **ACK** becomes asserted at the controller, the DATA BUS may change and **REQ** will be negated. After **REQ** is negated, the Initiator then negates **ACK**. After **ACK** is negated, the controller continues the data transfer by driving DATA(0-7,P) and asserting **REQ** as described previously.

6.4.6.2. DATA OUT Phase

The DATA OUT phase allows the Target to request that data be sent from the Initiator to the Target. The controller negates **I/O**, **C/D** and **MSG** and asserts **REQ** in this phase. After receiving a **REQ** the Initiator first drives DATA(0-7,P) to their desired values, waits at least one Deskew Delay plus a Cable Skew delay and asserts **ACK**. The Initiator holds DATA(0-7,P) valid until **REQ** is negated. **REQ** is negated after the controller detects the assertion of **ACK** and reads the value of DATA(0-7,P). When the Initiator detects the negation of **REQ**, it changes or releases DATA(0-7,P) and negates **ACK**.

6.4.7. STATUS Phase

The STATUS phase allows the Target to request that status information be sent from the Target to the Initiator.

The controller asserts **C/D** and **I/O** and negates **MSG** during the **REQ/ACK** handshake of this phase. A Status Byte is then available on the DATA BUS. See Section 8 for further information.

6.4.8. MESSAGE Phase

The MESSAGE phase is a term that references either a MESSAGE IN or a MESSAGE OUT phase. The first byte transferred in either of these phases is either a single byte message or the first byte of a multiple byte message. Multiple byte messages are wholly contained within a single MESSAGE phase.

The message system allows communication between an Initiator and Target for the purpose of physical path management. The Optimem 1000 SCSI Controller implements only the COMMAND COMPLETE message. The controller does not respond to the **ATN** signal.

6.4.8.1. MESSAGE IN Phase

The MESSAGE IN phase allows the Target to request that messages be sent to the Initiator from the Target.

The controller asserts **C/D**, **I/O** and **MSG** during the **REQ/ACK** handshake(s) of this phase.

6.4.8.2. MESSAGE OUT Phase

The MESSAGE OUT phase is not implemented in the Optimem 1000 SCSI controller.

The controller does not respond to the Attention Condition.

6.4.9. Signal Restrictions Between Phases

When the SCSI BUS is between two information transfer phases (COMMAND, DATA, STATUS and MESSAGE), the following restrictions apply to the SCSI Bus signals:

- **BSY**, **SEL**, **REQ** and **ACK** do not change.
- **C/D**, **I/O**, **MSG** and **DB(7-0,P)** may change.
- **ATN** and **RST** may change as defined under the descriptions for the Attention Condition or the Reset Condition.

6.4.10. Phase Sequencing

The order in which phases are used follows a prescribed sequence. In all systems, the Reset Condition can abort any phase and is always followed by a BUS FREE phase. Also, any other phase can be followed by the BUS FREE phase.

In systems where the ARBITRATION phase is not implemented, the allowable sequencing is as shown below.

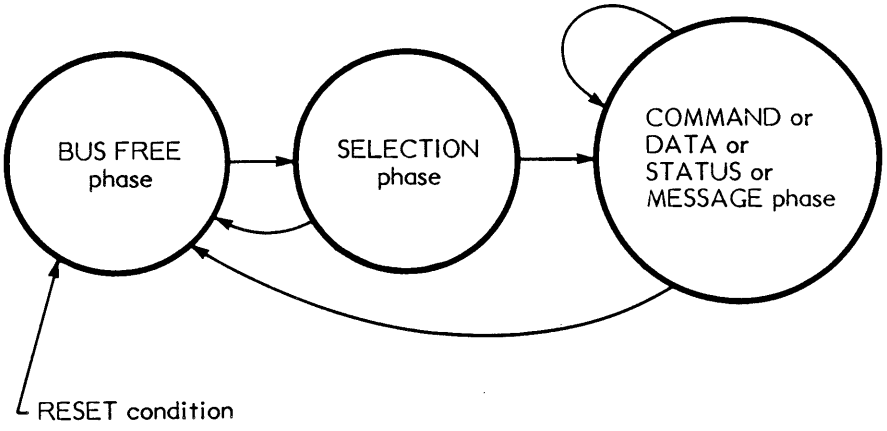


Fig. 6-1: PHASE SEQUENCING WITHOUT ARBITRATION

SIGNAL MSG	C/D	I/O	PHASE NAME	DIRECTION OF TRANSFER
0	0	0	DATA OUT	INITIATOR TO TARGET
0	0	1	DATA IN	INITIATOR FROM TARGET
0	1	0	COMMAND	INITIATOR TO TARGET
0	1	1	STATUS	INITIATOR FROM TARGET
1	0	0	*	
1	0	1	*	
1	1	0	MESSAGE OUT	INITIATOR TO TARGET
1	1	1	MESSAGE IN	INITIATOR FROM TARGET

1 = asserted

Table 6-1: INFORMATION TRANSFER PHASES

7. Command Descriptor Block

Requests to peripheral devices are performed by sending commands to the controller in the form of Command Descriptor Blocks (CDB).

A Command Descriptor Block contains an Operation Code which is the first byte of the command, followed by a Logical Unit Number, a Logical Block Address, a Transfer Length and a Control Byte. There are two types of Command Descriptor Blocks, six byte and ten byte. The following figures illustrate typical six byte and ten byte Command Descriptor Blocks. An explanation of each byte within the CDB follows.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			Logical Block Address bits if required (MSB)				
2	Logical Block Address if required							
3	Logical Block Address if required (LSB)							
4	Transfer/Allocation/Parameter Length if required							
5	Control Byte							

Fig. 7-1: TYPICAL COMMAND DESCRIPTOR BLOCK FOR SIX BYTE COMMANDS

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							
7	Transfer/Allocation/Parameter Length if required (MSB)							
8	Transfer/Allocation/Parameter Length if required (LSB)							
9	Control Byte							

Fig. 7-2: TYPICAL COMMAND DESCRIPTOR BLOCK FOR TEN BYTE COMMANDS

7.1. Operation Code

The Operation Code of the Command Descriptor Block has a Group Code Field and a Command Code Field. The three bit Group Code Field provides for eight groups of command codes. The five bit Command Code Field provides for thirty-two command codes. Thus a total of 256 possible Operation Codes exist.

Four Group Codes are implemented in the Optimem 1000 SCSI Controller:

Group 0 6 Byte Commands
Group 1 10 Byte Commands
Group 6 10 Byte Relocation Commands
Group 7 10 Byte Diagnostic Commands

The Operation Codes implemented in the Optimem 1000 SCSI Controller are summarized in Table 7.1.

Table 7-1: SUMMARY OF GROUP 0 AND 1 COMMANDS IMPLEMENTED

Group 0		Group 1	
Code	Description	Code	Description
00h	TEST UNIT READY	20h	
01h	REZERO UNIT	21h	
02h		22h	
03h	REQUEST SENSE	23h	
04h		24h	
05h		25h	READ CAPACITY
06h		26h	
07h		27h	
08h	READ	28h	READ
09h		29h	
0Ah	WRITE	2Ah	WRITE
0Bh	SEEK	2Bh	SEEK
0Ch		2Ch	
0Dh		2Dh	
0Eh		2Eh	WRITE AND VERIFY
0Fh		2Fh	VERIFY
10h		30h	
11h		31h	
12h	INQUIRY	32h	
13h		33h	
14h		34h	
15h	MODE SELECT	35h	
16h		36h	
17h		37h	
18h		38h	
19h		39h	
1Ah	MODE SENSE	3Ah	
1Bh	START/STOP UNIT	3Bh	
1Ch	RECEIVE DIAGNOSTIC	3Ch	
1Dh	SEND DIAGNOSTIC	3Dh	
1Eh	PREVENT/ALLOW REMOVAL	3Eh	
1Fh		3Fh	

Table 7-2: SUMMARY OF GROUP 6 AND 7 COMMANDS IMPLEMENTED

Group 6		Group 7	
Code	Description	Code	Description
C0h		E0h	
C1h		E1h	
C2h		E2h	
C3h		E3h	
C4h		E4h	
C5h		E5h	
C6h		E6h	READ DRIVE STATUS
C7h		E7h	
C8h	READ RELOCATED BLOCK	E8h	DIAGNOSTIC READ
C9h		E9h	
CAh	RELOCATE BLOCK	EAh	DIAGNOSTIC WRITE
CBh		EBh	
CCh		ECh	
CDh		EDh	
CEh		EEh	READ RELOCATION AREA
CFh		EFh	
D0h		F0h	
D1h		F1h	
D2h		F2h	
D3h		F3h	
D4h		F4h	
D5h		F5h	
D6h		F6h	
D7h		F7h	
D8h		F8h	
D9h		F9h	
DAh		FAh	
DBh		FBh	
DCh		FCh	
DDh		FDh	
DEh		FEh	
DFh		FFh	

7.2. Logical Unit Number

A controller communicates with a specific drive by using the designated Logical Unit Number (LUN) of that drive. Each controller can attach up to eight drives, and therefore eight possible Logical Unit Numbers exist per controller. The Optimem 1000 Optical Disk Drive is assigned the Logical Unit Number zero as shipped from the factory. This number is set by a jumper on the Drive Control Board. Refer to the section on LUN Selection.

7.3. Logical Block Address

Data is transferred across the SCSI Bus with a fixed block structure and a logical address scheme. The Logical Block Address begins with block zero and runs contiguously until the last accessable block on the medium.

Group 0 commands contain twenty-one bit starting block addresses, for an addressing range up to two million blocks. Group 1 commands contain thirty-two bit starting block addresses for an extended addressing range up to four billion blocks.

The logical block size used by the Optimem 1000 SCSI Controller is 1024 bytes, and the maximum Logical Block Address in decimal is 999,999.

7.4. Transfer Length, Allocation Length, Parameter List Length

This byte in the Command Descriptor Block is referred to as:

- -Transfer Length when it specifies the number of blocks of data to be transferred.
- -Allocation Length when it indicates the maximum number of bytes that the initiator has allocated for returned sense data.
- -Parameter List Length, when it indicates the number of bytes of parameters which are sent by the Initiator with that particular command.

NOTE: The Group 0 commands use one byte to specify the Transfer Length. This allows up to 256 blocks of data to be transferred by one command. A byte value of 1 to 255 indicates that number of blocks will be transferred. A byte value of zero indicates 256 blocks will be transferred. The block size in the Optimem 1000 SCSI Controller is 1024 bytes, a quarter megabyte of user data can be transferred with one Group 0 command.

The Group 1 commands can use two bytes to specify the Transfer Length, allowing up to 65,535 blocks or 64 megabytes of data, to be transferred by one command. Unlike the Group 0 commands, a value of zero indicates there is no data transfer.

Note to the Systems Integrator: The Allocation Length can be set to the maximum amount of host memory allocated for sense data. At least 32 bytes but preferably 64, should be allocated for returned sense data.

7.5. Control Byte

The Control Byte is the last byte in all command descriptor blocks. The Control Byte is not implemented in the Optimem 1000 SCSI Controller and is set to zero by the Initiator for all commands.

7.6. Reserved Bits and Bytes

All bits and bytes designated RESERVED are set to zero by the Initiator.

8. STATUS

The Optimem 1000 SCSI Controller sends to the Initiator a completion status for every command executed. Good status, a byte of '00' is returned in the Status Phase if the command completed successfully. A Check Condition, a byte of '02', is returned if any error, exception or abnormal condition is encountered during execution of the command. Busy status, a byte of '08,' is returned if the Controller is busy and unable to accept a command. Refer to the table below.

The STATUS phase is followed by a final MESSAGE phase. This consists of the COMMAND COMPLETE message, a byte of '00' sent to the Initiator.

A Check Condition status indicates an error, exception or abnormal condition occurred during execution of the command. Further information regarding this condition is returned to the initiator with a REQUEST SENSE command. In order to obtain valid error information, a REQUEST SENSE command must be issued immediately after a command is returned with a Check Condition status.

Several commands have specific fault conditions associated with them. See the detailed command descriptions for further information.

Table 8-1: COMPLETION STATUS BYTE ENCODING

Completion Status Byte DB(7-0)								Status Description
7	6	5	4	3	2	1	0	
0	0	0	0	0	0	0	0	GOOD
0	0	0	0	0	0	1	0	CHECK CONDITION
0	0	0	0	1	0	0	0	BUSY

GOOD: This status indicates that the controller successfully completed the command.

CHECK CONDITION: This status indicates any error, exception or abnormal condition.

BUSY: This status indicates that the controller is busy and is therefore unable to accept a command from an Initiator.

9. COMMAND DESCRIPTIONS

This portion of the manual describes each Optimem 1000 SCSI command and its command descriptor block.

9.1. Group 0 Commands

The Optimem 1000 Group 0 Commands are listed in the table below.

Table 9-1: GROUP 0 COMMANDS

Operation Code	Description	Section
00h	TEST UNIT READY	9.1.1
01h	REZERO UNIT	9.1.2
02h		
03h	REQUEST SENSE	9.1.3
04h		
05h		
06h		
07h		
08h	READ	9.1.5
09h		
0Ah	WRITE	9.1.6
0Bh	SEEK	9.1.7
0Ch		
0Dh		
0Eh		
0Fh		
10h		
11h		
12h	INQUIRY	9.1.8
13h		
14h		
15h	MODE SELECT	9.1.9
16h		
17h		
18h		
19h		
1Ah	MODE SENSE	9.1.10
1Bh	START/STOP UNIT	9.1.11
1Ch	RECEIVE DIAGNOSTIC	9.1.12
1Dh	SEND DIAGNOSTIC	9.1.13
1Eh	PREVENT/ALLOW REMOVAL	9.1.14
1Fh		

9.1.1. TEST UNIT READY

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			RESERVED				
2	RESERVED							
3	RESERVED							
4	RESERVED							
5	Control Byte							

The TEST UNIT READY command checks with the controller on the unit's ready status. This is not a request for a self test. A CHECK CONDITION status with the Sense Key set to NOT READY will be returned if the following conditions are not met:

- The drive selected must be connected to the controller.
- The drive selected must be powered up.
- No fault conditions are detected by the drive diagnostics.
- The cartridge must be loaded and spun up on the drive selected.

The Operation Code for this command is 00h.

The Control Byte is not implemented in the Optimem 1000 SCSI Controller.

9.1.2. REZERO UNIT

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			RESERVED				
2	RESERVED							
3	RESERVED							
4	RESERVED							
5	Control Byte							

The REZERO UNIT command requests the controller set the specified Logical Unit to its initial state, clearing fault conditions and positioning the Rotary Actuator at detent zero. All drive parameters are returned to their default conditions including all MODE SELECT and PREVENT/ALLOW options.

The Operation Code for this command is 01h.

The Control Byte is not implemented in the Optimem 1000 SCSI Controller.

9.1.3. REQUEST SENSE

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			RESERVED				
2	RESERVED							
3	RESERVED							
4	Allocation Length							
5	Control Byte							

The REQUEST SENSE command transfers fault sense data to the Initiator.

This request by the Initiator should be made immediately after receipt of a check condition status because sense data may no longer be valid after receipt of the next command.

The Operation Code for this command is 03h.

The Allocation Length specifies the number of bytes that the Initiator has allocated for returned sense data. An Allocation Length of zero indicates the transfer of four bytes of sense data. Any other value indicates the transfer of that number of bytes. The controller will terminate the DATA IN phase when Allocation Length bytes have been transferred or when all available sense data has been transferred to the Initiator, whichever is less. The Optimem 1000 SCSI Controller returns up to ten bytes of normal Request Sense data. With the relocation option implemented, the Controller returns up to sixteen bytes of Request Sense data.

The CHECK CONDITION status is only returned if a RESERVED bit is not set to zero or if a malfunction prevents return of valid sense data.

The Control Byte is not implemented in the Optimem 1000 SCSI Controller.

Table 9-2: FORMAT OF DATA RETURNED BY REQUEST SENSE

BIT / BYTE	7	6	5	4	3	2	1	0
0	Valid	Sense Class			Sense Code			
1	Segment Number							
2	0	0	ILI	RESERVED	Sense Key			
3	Information Byte (MSB)							
4	Information Byte							
5	Information Byte							
6	Information Byte (LSB)							
7	Additional Sense Length							
8	Additional Sense Byte 1							
9	Additional Sense Byte 2							

The Valid bit set to one indicates that the Information Bytes contain a valid Logical Block Address related to the error which has occurred.

The Sense Class Field is set to a value of seven.

The Sense Code Field is set to a value of zero. This designates that Extended Sense data is being returned.

The Segment Number contains the number of the current segment descriptor, when the Extended Sense is in response to a Copy command. This byte is set to zero by the Optimem 1000 SCSI Controller.

The Incorrect Length Indicator (ILI) bit set to one indicates that the requested block size did not match the block size of data on the medium. This bit is set to zero by the Optimem 1000 SCSI Controller.

The Sense Key Field contains an encoded value which represents the type of Fault Code reported. There are sixteen types of Fault Codes, beginning with Miscellaneous Faults 00h. Refer to the Sense Key Descriptions in the Appendix.

The Information Bytes are valid only when the Valid bit is set. They specify a Logical Block Address associated with the error that has occurred.

The Additional Sense Length specifies the number of Additional Sense Bytes returned. The value of this byte is two for the Optimem 1000 SCSI Controller.

The Additional Sense Byte 1 contains error information relating to the Drive in a Ready Code and an ODI Fault Code. Refer to the Ready and ODI Fault Code Tables in the Appendix.

The Additional Sense Byte 2 contains error information relating to the Controller in a Controller Fault Code which correlates to the Sense Key in byte 2. e.g.

Sense Key		Controller Fault Code
09	represents	Miscellaneous Faults
02	represents	Not Ready Faults
03	represents	Medium Faults
etc		etc

Refer to the Controller Fault Code tables in the Appendix.

Table 9-3: DATA RETURNED BY REQUEST SENSE COMMAND

BIT / BYTE	7	6	5	4	3	2	1	0
0	Valid	1	1	1	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	Sense Key			
3	Logical Block Address (MSB)							
4	Logical Block Address							
5	Logical Block Address							
6	Logical Block Address (LSB)							
7	0	0	0	0	0	0	1	0
8	Ready Code		ODI Fault Code					
9	Controller Fault Code							

9.1.4. REQUEST SENSE WITH RELOCATION

The following REQUEST SENSE format is used to obtain error information with Relocation during a WRITE AND VERIFY command only. Other Relocation error reporting is processed with the normal ten byte REQUEST SENSE response.

Table 9-4: FORMAT OF DATA RETURNED BY REQUEST SENSE WITH RELOCATION AND W & V

BIT / BYTE	7	6	5	4	3	2	1	0
0	Valid	Sense Class				Sense Code		
1	Segment Number							
2	0	0	ILI	RESERVED		Sense Key		
3	Information Byte (MSB)							
4	Information Byte							
5	Information Byte							
6	Information Byte (LSB)							
7	Additional Sense Length							
8	Additional Sense Byte 1							
9	Additional Sense Byte 2							
10	Additional Sense Byte 3							
11	Additional Sense Byte 4							
12	Additional Sense Byte 5							
13	Additional Sense Byte 6							
14	Additional Sense Byte 7							
15	Additional Sense Byte 8							

The difference between the normal REQUEST SENSE and the REQUEST SENSE WITH RELOCATION formats is an additional six bytes labeled Additional Sense Byte 3 through 8.

The Additional Sense Length specifies the number of Additional Sense Bytes returned, and therefore must be set to a value of eight. An explanation follows.

Table 9-5: DATA RETURNED BY REQUEST SENSE COMMAND WITH RELOCATION AND W & V

BIT / BYTE	7	6	5	4	3	2	1	0
0	Valid	1	1	1	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	Sense Key			
3	Last Logical Block Address Written Correctly + 1 (MSB)							
4	Last Logical Block Address Written Correctly + 1							
5	Last Logical Block Address Written Correctly + 1							
6	Last Logical Block Address Written Correctly + 1 (LSB)							
7	0	0	0	0	0	1	1	1
8	Ready Code			ODI Fault Code				
9	Controller Fault Code							
10	Last Logical Block Address Verified Correctly + 1 (MSB)							
11	Last Logical Block Address Verified Correctly + 1							
12	Last Logical Block Address Verified Correctly + 1							
13	Last Logical Block Address Verified Correctly + 1 (LSB)							
14	0	0	0	0	0	0	0	0
15	Controller Fault Code							

The WRITE AND VERIFY command is performed in two sequences. The writing of four sectors occurs first and the verification of those sectors follows. If an error occurs and the Valid bit is set, then bytes 3 through 6 contain the address of the last correctly written block + 1. Bytes 10 through 13 contain the address of the last correctly verified block + 1.

The Controller Fault Code in byte 9 is associated with the Logical Block Address Written. The Controller Fault Code in byte 15 is associated with the Logical Block Address Verified.

The Sense Key corresponds to the Controller Fault Code reported.

9.1.5. READ

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			Logical Block Address (MSB)				
2	Logical Block Address							
3	Logical Block Address (LSB)							
4	Transfer Length							
5	DRT	EDL		Control Byte				

The READ command requests that the controller transfer written data on the medium to the Initiator.

The Operation Code for this command is 08h.

The Logical Block Address specifies the location of the first block to be read.

The Transfer Length is the number of contiguous logical blocks of data to be transferred. A Transfer Length of zero indicates 256 logical blocks are to be transferred. Any other value indicates that number of logical blocks are to be transferred.

The Disable Retry Times (DRT) bit is ignored by the Controller unless set to one. If set to one, it causes the retry of read and seek operations to be disabled.

The Error Detection Level (EDL) bit is ignored by the Controller unless set to one. If set to one, it causes the Controller to report a check condition status with a Sense Key of Medium Error whenever the error cannot be corrected by the front end processor of the EDAC.

When a Read command has completed, the position of the optical head is not on the last track read. This is due to the spiral track format of the medium.

9.1.6. WRITE

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code							
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 data transferred by the Initiator to the medium.

The Operation Code for this command is 0Ah.

The Logical Block Address specifies the location of the first block to be written.

The Transfer Length is the number of contiguous logical blocks of data to be transferred. A Transfer Length of zero indicates 256 logical blocks are to be transferred. Any other value indicates that number of logical blocks are to be transferred.

The Control Byte is not implemented in the Optimem 1000 SCSI Controller.

When a Write command has completed, the position of the optical head is not on the last track written. This is due to the spiral track format of the medium.

9.1.7. SEEK

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			Logical Block Address (MSB)				
2	Logical Block Address							
3	Logical Block Address (LSB)							
4	RESERVED							
5	Control Byte							

The SEEK command requests that the Logical Unit Number seek to the track that contains the specified Logical Block Address. The SEEK command is an immediate command, that is, the Controller returns an immediate GOOD status to the Initiator as soon as the SEEK command is received. After the status is returned, the SEEK is processed. If an error condition is encountered during execution of the SEEK, then a CHECK CONDITION is returned on the next command.

A non-immediate SEEK can also be issued by first setting the Disable Seek Immediate (DSI) bit in MODE SELECT. Refer to the section on MODE SELECT.

The Operation Code for this command is OBh.

The Control Byte is not implemented in the Optimem 1000 SCSI Controller.

9.1.8. INQUIRY

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			RESERVED				
2	RESERVED							
3	RESERVED							
4	Allocation Length							
5	Control Byte							

The INQUIRY command requests that information regarding parameters of the controller and its attached drives be sent to the Initiator.

The Operation Code for this command is 12h.

The Allocation Length specifies the number of bytes that the Initiator has allocated for returned sense data. An Allocation Length of zero indicates no sense data is requested. Any other value indicates the maximum number of bytes to be transferred. The controller terminates the DATA IN phase when Allocation Length bytes have been transferred or when all available sense data has been transferred to the Initiator, whichever is less. The Optimem 1000 SCSI Controller returns up to eight bytes of sense data.

The Control Byte is not implemented in the Optimem 1000 SCSI Controller.

Table 9-6: FORMAT OF DATA RETURNED BY INQUIRY

BIT / BYTE	7	6	5	4	3	2	1	0
0	Device Type Code							
1	RMB	Device Type Qualifier						
2	Reserved			ECMA Version			ANSI Version	
3	RESERVED							
4	Additional Length							
5	Manufacturer Identification							
6	Firmware Version (MSB)							
7	Firmware Version (LSB)							

The Device Type Code returned by the Optimem 1000 SCSI Controller is 04h for a Write Once Read Multiple Device. If the specified LUN is not accessible, the Code 7Fh is returned by the Controller.

The Removable Medium (RMB) bit is set to one to indicate that the medium is removable in the Optimem 1000 drive.

The Device Type Qualifier is not implemented in the Optimem 1000 SCSI Controller.

The ECMA and ANSI versions are set to zero because the SCSI standard is not yet officially approved.

The Additional Length is set to three by the controller.

The Manufacturer Identification is as follows:
- 01h to 0Fh Optimem SCSI Controller.
- 10h to F0h Alcatel-Thomson Gigadisc SCSI Controller.

The Firmware Version bytes define the installed level of code in the SCSI Controller.

Table 9-7: DATA RETURNED BY INQUIRY COMMAND

BIT / BYTE	7	6	5	4	3	2	1	0
0	0	0	0	0	0	1	0	0
1	1	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	1	1
5	0	0	0	0	0	0	0	1
6	0	0	0	0	0	0	0	1
7	0	0	0	0	0	1	0	0

9.1.9. MODE SELECT

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			RESERVED				
2	RESERVED							
3	RESERVED							
4	Parameter List Length							
5	Control Byte							

The MODE SELECT Command provides the means for an Initiator to specify medium, Logical Unit, or peripheral device parameters to the controller.

The Operation Code for this command is 15h.

The Parameter List Length specifies the length in bytes of the Mode Select parameter list which is transferred during the DATA OUT phase. The Parameter List Length, if zero, indicates no data will be transferred. The Parameter List Length for the Optimem 1000 SCSI Controller is six bytes.

The Control Byte is not implemented in the Optimem 1000 SCSI Controller.

Table 9-8: MODE SELECT PARAMETER LIST

BIT / BYTE	7	6	5	4	3	2	1	0
0	RESERVED							
1	RESERVED							
2	RESERVED							EBC
3	Block Descriptor Length							
4	EPR	DER	ESR	DSI	0	0	0	0
5	DRT	EDL	0	DEDAC	PEB	DIAG	0	0

The Enable Blank Check (EBC) bit set to one, verifies during a write operation, that the blocks are unwritten. This is performed by first checking for a UCB error. If there is a UCB, then the block is considered non-blank. If there is no UCB, then the Write Check Field of the data format is read. If the Write Check Field contains any value other than zero, the block will be considered non-blank. Any non-blank block found during the write operation will cause the command to terminate with a CHECK CONDITION status and the Sense Key set to BLANK CHECK. Enabling blank checking results in two revolutions per sector written, because the sector must be read before it is written. The EBC bit set to zero, disables blank checking. Blank checking is valid only in EDAC mode.

The Block Descriptor is not used, therefore the Block Descriptor Length is set to zero.

The Enable Physical Read (EPR) bit set to one, allows the Optimem 1000 SCSI Controller to read disks whose Address Fields have been written in the physical format. The EPR bit set to zero, reads disks written with the logical address format.

The Delay Error Reporting (DER) bit set to one, inhibits the drive from stopping on UCB errors during normal Read Operations. The controller waits after detecting a UCB error or errors, until the Read operation has completed before returning a CHECK Completion Status. A Request Sense issued for this check condition reports the sense data of the first UCB encountered only. The DER bit set to zero, returns the drive to normal error stopping.

The Enable Sector Relocation (ESR) bit set to one, causes the Controller to relocate defective sectors when using the WRITE AND VERIFY command. The six and ten byte WRITE commands and the VERIFY command are not affected by the setting of the ESR bit. If an uncorrectable sector is detected during a read operation, a search is made for it in the sector relocation area of the

medium. This option can also be set in hardware with a jumper on the Controller Board. Refer to section on Controller Jumpers. The ESR bit in MODE SELECT takes precedence over the jumper.

The Enable Sector Relocation (ESR) bit set to zero, causes the Controller to perform the WRITE AND VERIFY command without relocating defective sectors. The detection of an uncorrectable block during a read operation, terminates the data transfer with a completion status of CHECK.

The Disable Seek Immediate (DSI) bit set to one, causes SEEK commands to be of the non-immediate type. The DSI bit set to zero, restores operation to the immediate SEEK.

The Disable Retry Times (DRT) bit set to one, causes controller retry operations to be disabled. The DRT bit set to zero, causes the controller to automatically retry operations up to five times before reporting a fault condition.

The Error Detection Level (EDL) bit set to one, causes the controller to report a CHECK CONDITION status with a Sense Key of MEDIUM ERROR whenever the error cannot be corrected by the front end processor of the EDAC. The EDL bit set to zero, restores error reporting to the full power of the EDAC.

The Disable Error Detection and Correction (DEDAC) bit set to one, causes the controller to perform a read or write operation without error correction(EDAC). The DEDAC bit set to zero, causes the use of EDAC to resume. The DEDAC bit also affects the format of the information written to the medium. If EDAC is not used during a write operation only the Write Check Field, Address Field and the User Data Field have valid data written in them. The other fields have zeroes written in them.

The Parity Enable (PEB) bit set to one, causes the controller to enable parity checking of the DATA BUS on incoming data. The PEB bit set to zero, disables the checking of parity and therefore no parity errors are reported. However, parity is always generated by the controller. This option can also be set in hardware with a jumper on the Controller Board. Refer to section on Controller Jumpers. The PEB bit in MODE SELECT takes precedence over the jumper.

The Diagnostic (DIAG) bit set to one, enables the read and write operations of the Group 7 Commands. The DIAG bit set to zero, inhibits the read and write operations of the Group 7 Commands. A CHECK CONDITION status, with the Sense Key set to ILLEGAL REQUEST is returned if a Group 7 read or write command is attempted without first issuing a MODE SELECT command to enable their use.

The default condition for all bits in MODE SELECT is zero. However, default conditions for the two MODE SELECT options, PEB and ESR, can be changed by setting jumpers on the Controller Board.

Table 9-9: DATA SENT BY MODE SELECT COMMAND

BIT / BYTE	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	EBC
3	0	0	0	0	0	0	0	0
4	EPR	DER	ESR	DSI	0	0	0	0
5	DRT	EDL	0	DEDAC	PEB	DIAG	0	0

9.1.10. MODE SENSE

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			RESERVED				
2	RESERVED							
3	RESERVED							
4	Allocation Length							
5	Control Byte							

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

The Operation Code for this command is 1Ah.

The Allocation Length specifies the number of bytes that the Initiator has allocated for returned sense data. No sense data is transferred with an Allocation Length of zero. Any other value indicates the transfer of that number of bytes. The controller terminates the DATA IN phase when Allocation Length bytes have been transferred or when all available sense data has been transferred to the Initiator, whichever is less. The Optimem 1000 SCSI Controller returns fourteen bytes of sense data.

The Control Byte is not implemented in the Optimem 1000 SCSI Controller.

Table 9-10: FORMAT OF DATA RETURNED BY MODE SENSE

BIT / BYTE	7	6	5	4	3	2	1	0
0	Sense Data Length							
1	Medium Type							
2	WP	RESERVED						EBC
3	Block Descriptor Length							
4	Density Code							
5	Number of Blocks (MSB)							
6	Number of Blocks							
7	Number of Blocks (LSB)							
8	Reserved							
9	Block Length (MSB)							
10	Block Length							
11	Block Length (LSB)							
12	EPR	DER	ESR	DSI	0	0	0	0
13	DRT	EDL	ITF	DEDAC	PEB	DIAG	0	MSS

The Sense Data Length specifies the number of bytes of Mode Sense data that follows. The Sense Data Length is thirteen for the Optimem 1000 SCSI Controller.

The Medium Type is defined as zero which is the default for the currently mounted medium type.

The Write Protected (WP) bit set to one, indicates that the currently accessable medium surface is write protected. The WP bit set to zero, indicates the currently accessable medium surface is write enabled.

The Enable Blank Check (EBC) bit set to one, indicates that blank checking is being performed on write operations. The EBC bit, if zero, indicates that blank checking is inhibited.

The Block Descriptor Length specifies the length in bytes of the block descriptor which follows. The Block Descriptor Length for the Optimem 1000 SCSI Controller is eight. A block descriptor length of zero indicates that no

block descriptors are included. This condition is not considered an error.

The block descriptor specifies the medium characteristics for all or part of a logical unit. The block descriptor contains a Density Code, a Number of Blocks, and a Block Length.

The Density Code is assigned a value of zero, meaning that only one medium density type is supported by the Optimem 1000 SCSI Controller.

The Number of Blocks field specifies the number of logical blocks of the medium that meets the density code and block length in the block descriptor. A number of blocks of zero indicates that all of the remaining logical blocks of the logical unit have the medium characteristics specified by the block descriptor.

The Block Length specifies the length in bytes of each logical block.

The Enable Physical Read (EPR) bit set to one, indicates that read operations are based on using the physical address format in the Address Field. The EPR bit set to zero, indicates the logical address format is used for read operations. This provides compatibility with the data format used prior to firmware release OPT1.3

The Delay Error Reporting (DER) bit set to one, indicates that the drive has been inhibited from stopping on UCB errors during Read Operations. The DER bit set to zero, indicates that the drive is stopping on normal Read errors.

The Disable Retry Times (DRT) bit set to one, indicates the retry of operations is disabled. The DRT bit set to zero, indicates the controller will automatically retry operations up to five times.

The Enable Sector Relocation (ESR) bit set to one, indicates the automatic relocation of defective sectors for the WRITE AND VERIFY and READ commands. The ESR bit set to zero, indicates the Controller will perform the WRITE AND VERIFY without relocating defective sectors and READ commands will not check the relocation area for uncorrectable blocks.

The Disable Seek Immediate (DSI) bit set to one, indicates that seek operations will be non-immediate. The DSI bit set to zero, indicates all seek operations will be immediate.

The Error Detection Level (EDL) bit set to one, indicates the controller will report a CHECK CONDITION status with a Sense Key of MEDIUM ERROR whenever the error cannot be corrected by the front end processor of the EDAC. The EDL bit set to zero, indicates error reporting has been restored to the full power of the EDAC. The EDL bit effects read operations only.

The Interleave Factor (ITF) bit set to one, indicates that the interleave is three, that is, that jumper 7 on the SCSI Controller Board is inserted. Refer to section on Interleave Selection. The ITF bit set to zero,indicates that the Controller interleave is one.

The Disable Error Detection and Correction (DEDAC) bit set to one, indicates the controller is not using error detection and corrections (EDAC) during a

read or write operation. The DEDAC bit set to zero, indicates that EDAC is in use. Refer to section on Data Formats.

The Parity Enable (PEB) bit set to one, indicates parity checking of the DATA BUS on incoming data is enabled. The PEB bit set to zero, indicates no checking of parity on the DATA BUS, therefore DB(P) is ignored and no parity errors are reported.

The Diagnostic (DIAG) bit set to one, enables the Group 7 read and write commands. The DIAG bit set to zero, indicates that all Group 7 read and write commands are inhibited with the exception of the READ DRIVE STATUS command.

The Medium Side Selected (MSS) bit set to one, indicates that side two of the medium is the currently accessable surface. The MSS bit set to zero, indicates side one is the currently accessable surface.

Table 9-11: DATA RETURNED BY MODE SENSE COMMAND

BIT / BYTE	7	6	5	4	3	2	1	0
0	0	0	0	0	1	1	0	1
1	0	0	0	0	0	0	0	0
2	WP	0	0	0	0	0	0	EBC
3	0	0	0	0	1	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	1	1	1	1
6	0	1	0	0	0	0	1	0
7	0	0	1	1	1	1	1	1
8	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0
10	0	0	0	0	0	1	0	0
11	0	0	0	0	0	0	0	0
12	EPR	DER	ESR	DSI	0	0	0	0
13	DRT	EDL	ITF	DEDAC	PEB	DIAG	0	MSS

9.1.11. START/STOP UNIT

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			RESERVED				Immed
2	RESERVED							
3	RESERVED							
4	RESERVED							Start
5	Control Byte							

The START/STOP UNIT command requests that the controller enable or disable a Logical Unit for further operations.

The Operation Code for this command is 1Bh.

The Immediate (Immed) bit set to one, causes the command to terminate with GOOD status as soon as the Spin Up/Spin Down sequence is initiated. If an error condition is encountered during the Spin Up/Spin Down process, then a CHECK CONDITION is returned on the next command. The (Immed) bit set to zero, causes the command to terminate when the medium has completed the Spin Up/Spin Down sequence.

The Start (Start) bit set to zero, causes the controller to remove the Logical Unit from further use and issue a Spin Down command to the drive. The Start bit set to one, causes the controller to prepare the Logical Unit addressed for use and issue a Spin Up command to the drive.

The Control Byte is not implemented in the Optimem 1000 SCSI Controller.

Note: Performing a sequence of Start/Stop Unit commands can damage the spindle motor unless a 15 second delay is inserted after each spin down.

9.1.12. RECEIVE DIAGNOSTIC

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			RESERVED				
2	RESERVED							
3	RESERVED							
4	Allocation Length							
5	Control Byte							

The RECEIVE DIAGNOSTIC command requests diagnostic data be sent to the Initiator after completion of a SEND DIAGNOSTIC command.

This command allows the operating system to be independent of VENDOR UNIQUE diagnostic commands. The diagnostic software also becomes more portable to various operating systems.

The Operation Code for this command is 1Ch.

The Allocation Length specifies the number of bytes that the Initiator has allocated for returned diagnostic data. An Allocation Length of zero indicates no diagnostic data is requested. Any other value indicates the maximum number of bytes to be transferred. The controller will terminate the DATA IN phase when Allocation Length bytes have been transferred or when all available diagnostic data has been transferred to the Initiator, whichever is less. The Optimem 1000 SCSI Controller returns two bytes of diagnostic data.

The Control Byte is not implemented in the Optimem 1000 SCSI Controller.

Table 9-12: DATA RETURNED BY RECEIVE DIAGNOSTIC COMMAND

BIT / BYTE	7	6	5	4	3	2	1	0
0	Controller and EDAC Diagnostic Status							
1	Drive Diagnostic Status							

The Controller and EDAC Diagnostic Status Byte reports the fault detected in the controller diagnostic routine requested.

The Drive Diagnostic Status Byte reports the fault detected in the drive diagnostic routine requested.

Refer to the Diagnostic Status in the Appendix for descriptions of each.

9.1.13. SEND DIAGNOSTIC

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			RESERVED		SelfTest	DevOfl	UnitOfl
2	RESERVED							
3	RESERVED							
4	Parameter List Length							
5	Control Byte							

The SEND DIAGNOSTIC command transfers data to the Target which specifies diagnostic routines for the Target and peripheral devices. Diagnostics should be issued with the drive spun down. A SEND DIAGNOSTIC command will also reset all Mode Select options to their default state.

The Operation Code for this command is 1Dh.

The Self Test (SelfTest) bit causes the controller to complete its default self test which includes the Diagnostic Overall Drive Test. A Completion Status of GOOD returned by the Controller, indicates the test passed. The RECEIVE DIAGNOSTIC command is not used with Self Test.

The Device Off Line (DevOfl) bit is not implemented in the Optimem 1000 SCSI Controller.

The Unit Off Line (UnitOfl) bit is not implemented in the Optimem 1000 SCSI Controller.

The Parameter List Length should equal zero when the Self Test bit is set, and equal to two when the Self Test bit is not set.

The Control Byte is not implemented in the Optimem 1000 SCSI Controller.

Table 9-13: FORMAT OF SEND DIAGNOSTIC PARAMETERS

BIT / BYTE	7	6	5	4	3	2	1	0
0	0	0	0	0	0	DIAG-2	DIAG-1	DIAG-0
1	Diagnostic Test							

The DIAG-0 bit set to one, indicates the Diagnostic Test is performed on the SCSI Controller Board.

The DIAG-1 bit set to one, indicates the Diagnostic Test is performed on the EDAC Functions Board.

The DIAG-2 bit set to one, indicates the Diagnostic Test is performed on the Drive.

If more than one bit is set, a CHECK CONDITION status is returned, with the Sense Key set to ILLEGAL REQUEST.

Refer to the Appendix for specific Controller, EDAC and Drive Diagnostic Tests.

9.1.14. PREVENT/ALLOW MEDIUM REMOVAL

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			RESERVED				
2	RESERVED							
3	RESERVED							
4	RESERVED							Prevent
5	Control Byte							

The PREVENT/ALLOW MEDIUM command requests that the Target enable or disable the removal of the medium in the specified Logical Unit.

The Operation Code for this command is 1Eh.

The Prevent bit set to one, inhibits removal of the cartridge from the drive and disables the effect of the front panel switches. A START/STOP UNIT command is allowed but removal of the cartridge is not allowed even with the drive spun down until the effect of the Prevent bit being set is terminated.

The Prevent bit set to zero, allows the removal of the cartridge. Receipt of a Bus Device Reset message or a hard Reset Condition from any Initiator will teminate the Prevention of medium removal.

Issuing this command without a cartridge in place does not result in an error condition. A cartridge may be loaded and spun up after the Prevent bit has been set to one, however it then cannot be removed until the prevention has been terminated.

The Control Byte is not implemented in the Optimem 1000 SCSI Controller.

9.2. Group 1 Commands

The Optimem 1000 Group 1 Commands are listed in the table below.

Table 9-14: GROUP 1 COMMANDS

Operation Code	Description	Section
20h		
21h		
22h		
23h		
24h		
25h	READ CAPACITY	9.2.1
26h		
27h		
28h	READ	9.2.2
29h		
2Ah	WRITE	9.2.3
2Bh	SEEK	9.2.4
2Ch		
2Dh		
2Eh	WRITE AND VERIFY	9.2.5
2Fh	VERIFY	9.2.6
30h		
31h		
32h		
33h		
34h		
35h		
36h		
37h		
38h		
39h		
3Ah		
3Bh		
3Ch		
3Dh		
3Eh		
3Fh		

9.2.1. READ CAPACITY

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			RESERVED				RelAdr
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	RESERVED							
7	RESERVED							
8	0	0	RESERVED					PMI
9	Control Byte							

The READ CAPACITY command requests information regarding the capacity of the Logical Unit. The controller returns the Logical Block Address and Logical Block size of the last block on the medium of the Logical Unit.

The Operation Code for this command is 25h.

The Logical Block Address is set to zero, because only the total capacity in blocks is returned by the Optimem 1000 SCSI Controller.

The Relative Address (RelAdr) bit is not implemented in the Optimem 1000 SCSI Controller.

The Partial Medium Indicator (PMI) bit is not implemented in the Optimem 1000 SCSI Controller.

The Control Byte is not implemented in the Optimem 1000 SCSI Controller.

The following eight bytes of READ CAPACITY data are sent during the DATA IN phase.

Table 9-15: FORMAT OF DATA RETURNED BY READ CAPACITY

BIT / BYTE	7	6	5	4	3	2	1	0
0	Logical Block Address (MSB)							
1	Logical Block Address							
2	Logical Block Address							
3	Logical Block Address (LSB)							
4	Logical Block Size (MSB)							
5	Logical Block Size							
6	Logical Block Size							
7	Logical Block Size (LSB)							

The Logical Block Address returned will be 999,999 decimal and the Logical Block Size will be 1024 bytes.

Table 9-16: DATA RETURNED BY READ CAPACITY COMMAND

BIT / BYTE	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0
1	0	0	0	0	1	1	1	1
2	0	1	0	0	0	0	1	0
3	0	0	1	1	1	1	1	1
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	1	0	0
7	0	0	0	0	0	0	0	0

9.2.2. READ

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			RESERVED				RelAdr
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	RESERVED							
7	Transfer Length (MSB)							
8	Transfer Length (LSB)							
9	DRT	EDL	Control Byte					

The READ command requests that the controller transfer the previously written data on the medium to the Initiator.

The Operation Code for this command is 28h.

The Relative Address (RelAdr) bit is not implemented in the Optimem 1000 SCSI Controller and is set to zero by the Initiator.

The Logical Block Address specifies the location of the first block to be read.

The Transfer Length specifies the number of contiguous logical blocks of data to be transferred. A Transfer Length of zero indicates no data is transferred but the addressed drive will perform a seek to the specified track. A Transfer Length from 1 to 65,535 indicates the transfer of that number of blocks.

The Disable Retry Times (DRT) bit is ignored by the Controller unless set to one. If set to one, it causes the retry of read and seek operations to be disabled.

The Error Detection Level (EDL) bit is ignored by the Controller unless set to one. If set to one, it causes the Controller to report a check condition status with a Sense Key of Medium Error whenever the error cannot be corrected by the front end processor of the EDAC.

When a Read command has completed, the position of the optical head is not on the last track read. This is due to the spiral track format of the medium.

9.2.3. WRITE

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			RESERVED				RelAdr
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	RESERVED							
7	Transfer Length (MSB)							
8	Transfer Length (LSB)							
9	Control Byte							

The WRITE command requests that the controller write the data sent by the Initiator on the medium.

The Operation Code for this command is 2Ah.

The Relative Address (RelAdr) bit is not implemented in the Optimem 1000 SCSI Controller and is set to zero by the Initiator.

The Logical Block Address specifies the location of the first block to be written.

The Transfer Length specifies the number of contiguous logical blocks of data to be transferred. A Transfer Length of zero indicates no data is to be transferred but the addressed drive will seek to the specified track. Any other value from 1 to 65,535 indicates the transfer of that number of blocks.

The Control Byte is not implemented in the Optimem 1000 SCSI Controller.

When a Write command has completed, the position of the optical head is not on the last track written. This is due to the spiral track format of the medium.

9.2.4. SEEK

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			RESERVED				RelAdr
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 SEEK command requests that the Logical Unit Number seek to the track that contains the specified Logical Block Address. The SEEK command is an immediate command, that is, the Controller returns an immediate GOOD status to the Initiator as soon as the SEEK command is received. After the status is returned, the SEEK is processed. If an error condition is encountered during execution of the SEEK, then a CHECK CONDITION is returned on the next command.

A non-immediate SEEK can also be issued by first setting the Disable Seek Immediate (DSI) bit in MODE SELECT. Refer to the section on MODE SELECT.

The Operation Code for this command is 2Bh.

The Control Byte is not implemented in the Optimem 1000 SCSI Controller.

9.2.5. WRITE AND VERIFY

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			RESERVED			BytChk	RelAdr
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	RESERVED							
7	Transfer Length (MSB)							
8	Transfer Length (LSB)							
9	Control Byte							

The WRITE AND VERIFY command requests that the controller write all of the blocks of data sent by the Initiator and then verify the data written.

NOTE: With the Relocation option enabled, only four sectors are written per revolution. The verification is performed on the next revolution. Refer to the section on Sector Relocation.

The Operation Code for this command is 2Eh.

The Byte Check (BytChk) bit set to zero, causes the verification to be done using the EDAC and CRC bytes. This option is therefore implemented only in EDAC mode. All of the blocks specified in a multiple block write are written and then verified. If an error is detected during verification, the command is immediately terminated with a CHECK CONDITION status and the Sense Key set to MEDIUM ERROR. The Logical Block Address at which the error is detected is returned in the Extended Sense. Additional verification commands must be issued to verify the remainder of the data. This option is implemented in the EDAC mode.

The BytChk bit set to one option is not implemented in the Optimem 1000.

The Relative Address (RelAdr) bit is not implemented in the Optimem 1000 SCSI Controller and is set to zero by the Initiator.

The Logical Block Address specifies the location of the first block to be

written.

The Transfer Length specifies the number of contiguous logical blocks of data to be transferred. A Transfer Length of zero indicates no data is to be transferred but the addressed drive will seek to the specified track. Any other value from 1 to 65,535 indicates the transfer of that number of blocks.

The Control Byte is not implemented in the Optimem 1000 SCSI Controller.

9.2.6. VERIFY

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			RESERVED			BlkVfy	BytChk	RelAdr
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	RESERVED							
7	Transfer Length (MSB)							
8	Transfer Length (LSB)							
9	Control Byte							

The VERIFY command requests that the controller verify the data written on the medium.

The Operation Code for this command is 2Fh.

The Blank Verify (BlkVfy) bit set to one, causes the controller to verify that the blocks are unwritten. This is performed by first checking for a UCB error. If there is a UCB, then the block is considered non-blank. If there is no UCB, then the Write Check Field of the data format is read. If the Write Check Field contains any value other than zero, the block will be considered non-blank. The first occurrence of a non-blank block causes the command to terminate with a CHECK CONDITION status and the Sense Key set to BLANK CHECK. This option is implemented in the EDAC mode.

The Byte Check (BytChk) bit set to one, causes the controller and the Initiator to perform a byte by byte compare of data transferred from the Host against data previously written to the medium. If the compare is unsuccessful the command is immediately terminated with a CHECK CONDITION status and the Sense Key set to MISCOMPARE. The Logical Block Address, at which the miscompare is detected, is returned in the Extended Sense. Additional Verify commands may have to be issued to recover the remainder of errors.

The BytChk bit set to zero, causes a verification using the EDAC and CRC bytes only. In this case, no data is transferred from the Initiator and therefore the Transfer Length specifies the number of blocks to be verified. If an error is detected during verification, the command is immediately terminated

with a CHECK CONDITION status and the Sense Key set to MEDIUM ERROR. The Logical Block Address, at which the error is detected, is returned in the Extended Sense. This option is implemented in the EDAC mode.

The Relative Address (RelAdr) bit is not implemented in the Optimem 1000 SCSI Controller and is set to zero by the Initiator.

The Logical Block Address specifies the location of the first block to be verified.

The Transfer Length specifies the number of contiguous logical blocks of data to be verified. A Transfer Length of zero indicates no data is verified. Any other value from 1 to 65,535 indicates the verification of that number of blocks.

The Control Byte is not implemented in the Optimem 1000 SCSI Controller.

9.3. Group 6 Commands

The Optimem 1000 Group 6 Commands are listed in the table below.

Table 9-17: GROUP 6 COMMANDS

Operation Code	Description	Section
C0h		
C1h		
C2h		
C3h		
C4h		
C5h		
C6h		
C7h		
C8h	READ RELOCATED BLOCK	9.3.1
C9h		
CAh	RELOCATE BLOCK	9.3.2
CBh		
CCh		
CDh		
CEh		
CFh		
D0h		
D1h		
D2h		
D3h		
D4h		
D5h		
D6h		
D7h		
D8h		
D9h		
DAh		
DBh		
DCh		
DDh		
DEh		
DFh		

9.3.1. READ RELOCATED BLOCK

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code							
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	Transfer Length							
9	Control Byte							

The READ RELOCATED command returns 1024 bytes of user data for the requested Logical Block Address from the relocation area of the medium.

The Operation Code for this command is C8h.

The Logical Block Address specifies the block that is to be read.

The Transfer Length specifies the number of blocks to be transferred. The number of blocks returned is one, therefore the length should be set to one.

If the requested Logical Block Address is not found in the relocation area, the command is terminated with a Completion Status of CHECK, and the Sense Key set to Medium Fault.

The Control Byte is not implemented in the Optimem 1000 SCSI Controller.

9.3.2. RELOCATE BLOCK

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code							
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	Transfer Length							
9	Control Byte							

The RELOCATE BLOCK command allows the Initiator to relocate a defective sector. The Initiator sends 1024 bytes of data which are written in the first available sector of the relocation area of the medium. Refer to the section on Sector Relocation.

The Operation Code for this command is CAh.

The Logical Block Address specifies the block that is to be relocated.

The Transfer Length specifies the number of blocks to be transferred. The length should be set to one.

The Control Byte is not implemented in the Optimem 1000 SCSI Controller.

9.4. Group 7 Commands

The Optimem 1000 Group 7 Commands are listed in the table below.

Table 9-18: GROUP 7 COMMANDS

Operation Code	Description	Section
E0h		
E1h		
E2h		
E3h		
E4h		
E5h		
E6h	READ DRIVE STATUS	9.5.1
E7h		
E8h	DIAGNOSTIC READ	9.5.2
E9h		
EAh	DIAGNOSTIC WRITE	9.5.3
EBh		
ECh		
EDh		
EEh	READ RELOCATION AREA	9.5.4
EFh		
F0h		
F1h		
F2h		
F3h		
F4h		
F5h		
F6h		
F7h		
F8h		
F9h		
FAh		
FBh		
FCh		
FDh		
FEh		
FFh		

The Group 7 Commands are drive dependent and therefore are to be used for diagnostic purposes only, and should not be used in production applications software.

With the exception of the READ DRIVE STATUS command, the DIAG bit must be set with a MODE SELECT command prior to executing the Group 7 commands.

9.4.1. READ DRIVE STATUS

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code							
1	Logical Unit Number			RESERVED				Prev
2	RESERVED							
3	RESERVED							
4	RESERVED							
5	RESERVED							
6	RESERVED							
7	RESERVED							
8	Allocation Length							
9	Control Byte							

The READ DRIVE STATUS command transfers the status information available on the ODI Bus to the Initiator.

A Read Drive Status is the only Group 7 Command which can be executed without first setting the Mode Select Diag bit.

The Operation Code for this command is E6h.

The Previous (Prev) bit set to one, causes the controller to send back ODI status for the previously encountered error condition. The Prev bit set to zero causes the controller to return the status byte for the instant immediately prior to responding to this command.

The Allocation Length should be set to ten, reflecting the ten bytes of data returned during the DATA IN phase of the command.

The Control Byte is not implemented in the Optimem 1000 SCSI Controller.

Table 9-19: FORMAT OF DATA RETURNED BY READ DRIVE STATUS

BIT / BYTE	7	6	5	4	3	2	1	0
0	Unit Selected							
1	RESERVED							
2	Address (MSB)							
3	Address							
4	Address (LSB)							
5	ODI Status One							
6	ODI Status Two							
7	ODI Status Three							
8	ODI Status Four							
9	RESERVED							

The data returned by READ DRIVE STATUS is shown in the following table.

Table 9-20: DATA RETURNED BY READ DRIVE STATUS

BIT / BYTE	7	6	5	4	3	2	1	0
0	Unit Selected							
1	RESERVED							
2	Track Address (MSB)							
3	Track Address (LSB)							
4	Sector Address							
5	Unit Status							
6	Unit Sense Key							
7	RESERVED							
8	RESERVED							
9	RESERVED							

The Unit Status and the Unit Sense Key information are found in the following tables.

The Track and Sector Address returned are the track and sector currently under the optical head when the Read Drive Status command was processed. If the PREV bit is set, the Track and Sector Address returned are the track and sector under the optical head when the last error occurred.

Table 9-21: UNIT STATUS

BIT	Description
0	Side Selected: This status reports the side of the disk currently in use. A logic 0 indicates side one or no disk inserted, a logic 1 indicates side two.
1	Write Protected: This status reports the position of the cartridge write protect tab. A logic 1 indicates that the inserted disk is write protected. A logic 0 indicates the disk is write enabled.
2	On Track: In the Spiral Off mode this status reports the beam is on the last track to which a seek was performed. In the Spiral On mode the status reports the beam is locked on any track.
3	Drive Ready: This status reports the disk is at the proper rotational speed, no fault conditions exist within the drive, and no internal function is being performed.
4	Drive Busy: This status reports the drive may not be available to accept a command or report a status.
5	Message: This status reports that the Unit Sense, Bit(5-0), contains a message code. Refer to Unit Sense for Messages Table below.
6	RESERVED
7	Fault: This status reports that the Unit Sense, Bit(5-0), contains a Fault Sense code. Refer to ODI Fault Codes below. Write operations to the drive are inhibited; you must clear the fault with a Fault Clear Control Select command or a Rezero Control Select command.

Table 9-22: UNIT SENSE

The returned sense byte labeled UNIT SENSE KEY always contains an indication of the unit's Ready status in Bits(7-6). The returned sense byte may also contain in Bits(5-0) the following Messages if Bit(5) of the Unit Status is set, or the following ODI Fault Codes if Bit(7) of the Unit Status is set.

UNIT SENSE KEY

BIT / BYTE	7	6	5	4	3	2	1	0
6	Ready Code		Message or Fault Code					

READY CODES

BITS 7 6	DESCRIPTION
0 0	Cartridge inserted and rotational speed within tolerance.
0 1	Cartridge not inserted in drive.
1 0	Cartridge inserted, but spin up or spin down is in progress.
1 1	Drive spun down.

MESSAGE CODES

BITS (5-0)	DESCRIPTION
01h	A spin up or spin down occurred since the last drive access.
02h	Automatic focus offset calibration in progress.

FAULT CODES (00 - 0F)

BITS (5-0)	DESCRIPTION
00h	No fault condition exists. Fault has been reset.
01h	Invalid mode of operation was selected.
02h	Attempt to write on a write protected medium.
03h	Attempt to write when "on-track" was reset.
04h	Attempt was made to seek, or write when "drive ready" was reset or fault was set.
05h	Attempt to spin up without a cartridge inserted.
06h	Rotational speed was not achieved during allotted time, or rotational speed exceeded allowable tolerance.
07h	Drive went out of synchronization while locked on track.
08h	No sector mark was detected.
09h	The beam is not on the expected track.
0Ah	The address requested was invalid.
0Bh	Attempt to write to sector 22, 23 or 24 with spiral off.
0Ch	The LSB of Track Select was sent without an accompanying MSB.
0Dh	Attempt to write when drive is unable to read a valid address.
0Eh	Write On command was sent too late.
0Fh	Invalid medium inserted.

FAULT CODES (10 - 3F)

BITS (5-0)	DESCRIPTION
11h	The track addressed was not found during the allotted time.
12h	Time out due to invalid addresses.
13h	ISBSD time out. Synchronization not achieved in the allotted time following a seek.
21h	Rotary Actuator current exceeded its allowed tolerance or Actuator was reset while enabled.
22h	No scale marks detected by the Rotary Actuator.
23h	Coarse positioner over speed.
24h	A direction fault has occurred in the Rotary Actuator.
31h	The laser current is out of tolerance.
32h	The dc supply voltage exceeded tolerance.
33h	Drive has exceeded allowed temperature.
34h	Power up diagnostics have failed.

9.4.2. DIAGNOSTIC READ

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code							
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	Transfer Length (MSB)							
8	Transfer Length (LSB)							
9	Control Byte							

The DIAGNOSTIC READ command requests that the controller transfer 1115 byte logical blocks of data to the the Initiator during the DATA IN phase.

The Operation Code for this command is E8h.

The Logical Block Address specifies the logical block at which the read operation begins.

The Transfer Length specifies the number of contiguous logical blocks of data to be transferred. A Transfer Length of zero indicates no data is to be transferred. Any other value from 1 to 65,535 indicates the transfer of that number of bytes.

The Control Byte is not implemented in the Optimem 1000 SCSI Controller.

EDAC functions and blank checking are not performed during this command.

9.4.3. DIAGNOSTIC WRITE

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code							
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	Transfer Length (MSB)							
8	Transfer Length (LSB)							
9	Control Byte							

The DIAGNOSTIC WRITE command requests that the controller write 1115 byte logical blocks of data sent by the Initiator during the DATA OUT phase.

The Operation Code for this command is EAh.

The Logical Block Address specifies the logical block at which the write operation begins.

The Transfer Length specifies the number of contiguous logical blocks of data to be transferred. A Transfer Length of zero indicates no data will be transferred. Any other value from 1 to 65,535 indicates that number of blocks are to be transferred.

The Control Byte is not implemented in the Optimem 1000 SCSI Controller.

EDAC functions and blank checking are not performed during this command.

9.4.4. READ RELOCATION AREA

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code							
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	Transfer Length (MSB)							
8	Transfer Length (LSB)							
9	Control Byte							

The READ RELOCATION AREA command returns from 1 to 450 blocks of relocated data, residing in the relocation area of the disk. The data is returned in the Diagnostic Format, 1115 bytes. Refer to the section on Sector Relocation. This command allows the Initiator to read the relocated Logical Block Addresses contained in bytes five, six and seven.

The Operation Code for this command is EEh.

The Block Address specifies the physical location of the block in the relocation area, at which the read operation begins. The Block Address range is from 0 to 449.

The Transfer Length specifies the number of blocks to be transferred. The length is set from 1 to 450, any other value causes the command to be rejected.

The Control Byte is not implemented in the Optimem 1000 SCSI Controller.

APPENDIX

A. REQUEST SENSE FAULT CODES

DATA RETURNED BY REQUEST SENSE COMMAND

BIT / BYTE	7	6	5	4	3	2	1	0
0	Valid	1	1	1	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	Sense Key			
3	Logical Block Address (MSB)							
4	Logical Block Address							
5	Logical Block Address							
6	Logical Block Address (LSB)							
7	0	0	0	0	0	0	1	0
8	Ready Code		ODI Fault Code					
9	Controller Fault Code							

Refer to the following tables for descriptions of the:

Sense Key,
Ready Code,
ODI Fault Code and
Controller Fault Code.

Table A-1: SENSE KEY DESCRIPTIONS (00 - 07)

Key	DESCRIPTION
0h	NO SENSE - This Sense Key indicates that there is no specific sense key information to be reported for the designated unit.
1h	NOT USED
2h	NOT READY - This Sense Key indicates that the addressed Logical Unit cannot be accessed. Operator intervention may be required to correct this condition.
3h	MEDIUM ERROR - This Sense Key indicates that the operation completed with a non-recoverable error condition which was probably caused by a flaw on the medium or an error in the recorded data.
4h	HARDWARE ERROR - This Sense Key indicates that the Target detected a non-recoverable hardware error failure (for example: a controller failure, a device failure or a Bus parity error) while performing the command or during a self test.
5h	ILLEGAL REQUEST - This Sense Key indicates that there was an illegal parameter in the Command Descriptor Block or in the additional parameters supplied as data for some commands.
6h	UNIT ATTENTION - This Sense Key indicates that the removable medium may have been changed or the unit has been reset since the last command was issued to the addressed unit. This Sense Key will be reported the first time that any command is issued after the condition is detected and the requested command will not be performed. This Sense Key is cleared for the next command from the same host. The UNIT ATTENTION Sense Key shall be reported to all SCSI Devices which subsequently request an operation of the Logical Unit.
7h	DATA PROTECT - This Sense Key indicates that a command which reads or writes the medium was attempted on a block that was protected from this operation. The read or write was not performed.

Table A-2: SENSE KEY DESCRIPTIONS (08 - 0F)

Key	DESCRIPTION
8h	BLANK CHECK - This Sense Key indicates that a write encountered a non blank block.
9h	MISCELLANEOUS - This Sense Key indicates miscellaneous type errors.
Ah	NOT USED
Bh	ABORTED COMMAND - This Sense Key indicates that the Target aborted the command. The Initiator may be able to recover by trying the command again.
Ch	NOT USED
Dh	NOT USED
Eh	MISCOMPARE - This Sense Key indicates that the source data did not match the data read from the medium.
Fh	NOT USED

READY AND ODI FAULT CODE DESCRIPTIONS

BIT	7	6	5	4	3	2	1	0
	Ready Code		ODI Fault Code					

Table A-3: READY CODE

BITS 7 6	DESCRIPTION
0 0	Cartridge inserted and rotational speed within tolerance.
0 1	Cartridge not inserted in drive.
1 0	Cartridge inserted, but spin up or spin down is in progress.
1 1	Drive spun down.

Table A-4: ODI FAULT CODES (00 - 09)

BITS (5-0)	DESCRIPTION
00h	No fault condition exists. Fault has been reset.
01h	Invalid mode of operation was selected.
02h	Attempt to write on a write protected medium.
03h	Attempt to write when "on-track" was reset.
04h	Attempt was made to seek, or write when "drive ready" was reset or fault was set.
05h	Attempt to spin up without a cartridge inserted.
06h	Rotational speed was not achieved during allotted time, or rotational speed exceeded allowable tolerance.
07h	Drive went out of synchronization while locked on track.
08h	No sector mark was detected.
09h	The beam is not on the expected track.

Table A-5: FAULT CODES (OA - 3F)

BITS (5-0)	DESCRIPTION
OAh	The address requested was invalid.
OBh	Attempt to write to sector 22, 23 or 24 with spiral off.
OCh	The LSB of Track Select was sent without an accompanying MSB.
ODh	Attempt to write when drive is unable to read a valid address.
OEh	Write On command was sent too late.
OFh	Invalid medium inserted.
11h	The track addressed was not found during the allotted time.
12h	Time out due to invalid addresses.
13h	ISBSD time out. Synchronization not achieved in the allotted time following a seek.
21h	Rotary Actuator current exceeded its allowed tolerance or Actuator was reset while enabled.
22h	No scale marks detected by the Rotary Actuator.
23h	Coarse positioner over speed.
24h	A direction fault has occurred in the Rotary Actuator.
31h	The laser current is out of tolerance.
32h	The dc supply voltage exceeded tolerance.
33h	Drive has exceeded allowed temperature.
34h	Power up diagnostics have failed.

Table A-6: CONTROLLER FAULT CODES - MISCELLANEOUS FAULTS (00 - 0F)

FAULT CODE	DESCRIPTION
00h	SECTOR NOT FOUND
01h	NOT BUSY TIMEOUT
02h	NOT ON TRACK TIMEOUT
03h	SPIN DOWN TIMEOUT
04h	ODI DRIVER ERROR
05h	INTERLEAVE MISMATCH
06h	ID READ ERROR
07h	SEEK TIMEOUT
08h	SEEK VERIFICATION MISCOMPARE
09h	N/A
0Ah	DATA TRANSFER TIMEOUT
0Bh	ERROR WHILE CHECKING SECTOR DURING DATA TRANSFER
0Ch	ERROR WHILE CHECKING TRACK DURING DATA TRANSFER
0Dh	N/A
0Eh	N/A
0Fh	N/A

These Controller Fault Codes are returned for Sense Key 09h.

Table A-7: CONTROLLER FAULT CODES - NOT READY FAULTS (20 - 2F)

FAULT CODE	DESCRIPTION
20h	N/A
21h	DRIVE NOT READY TO PROCESS A MEDIUM ACCESS OPERATION
22h	CONTROLLER NOT ABLE TO SELECT SPECIFIED DRIVE
23h	N/A
24h	DRIVE NOT ON TRACK
25h	N/A
26h	N/A
27h	N/A
28h	N/A
29h	N/A
2Ah	DRIVE NOT READY JUST AFTER READ OR WRITE
2Bh	DRIVE NOT READY JUST BEFORE READ OR WRITE
2Ch	N/A
2Dh	THE DRIVE READY STATUS HAS CHANGED DURING A R/W OPERATION
2Eh	N/A
2Fh	N/A

These Controller Fault Codes are returned for Sense Key 02h.

Table A-8: CONTROLLER FAULT CODES - MEDIUM FAULTS (30 - 3F)

FAULT CODE	DESCRIPTION
30h	LONG PAUSE DURING READ
31h	CRC ERROR
32h	UNCORRECTABLE DATA BLOCK ENCOUNTERED DURING A READ COMMAND
33h	N/A
34h	MISCOMPARE ON WRITE CHECK FIELD IN EDAC MODE
35h	INVALID ADDRESS FIELD
36h	N/A
37h	N/A
38h	UNCORRECTABLE DATA BLOCK ENCOUNTERED DURING A VERIFY COMMAND
39h	A PAUSE DETECTED IN EDAC FUNCTIONS BOARD (REFER TO EDL BIT)
3Ah	N/A
3Bh	N/A
3Ch	N/A
3Dh	N/A
3Eh	N/A
3Fh	N/A

These Controller Fault Codes are returned for Sense Key 03h.

Table A-9: CONTROLLER FAULT CODES - HARDWARE FAULTS (40 - 4F)

FAULT CODE	DESCRIPTION
40h	SELF TEST DIAGNOSTIC FAILED
41h	ALU FAILURE IN SCSI CONTROLLER
42h	RAM FAILURE IN SCSI CONTROLLER
43h	SCSI OR ODI BUS FAILURE
44h	TIMER FAILURE IN SCSI CONTROLLER
45h	FIFO FAILURE IN SCSI CONTROLLER
46h	FAILURE IN EDAC BOARD
47h	ODI REGISTER FAILURE
48h	NO DRIVE SELECTED ON POWER UP
49h	DRIVE IN FAULT AT END OF DIAGNOSTIC
4Ah	N/A
4Bh	N/A
4Ch	N/A
4Dh	N/A
4Eh	N/A
4Fh	SCSI BUS PARITY ERROR

These Controller Fault Codes are returned for Sense Key 04h.

Table A-10: CONTROLLER FAULT CODES - ILLEGAL REQUEST FAULTS (50 - 5F)

FAULT CODE	DESCRIPTION
50h	INVALID COMMAND DESCRIPTOR BLOCK
51h	LOGICAL BLOCK ADDRESS REQUESTED EXCEEDS END OF MEDIUM
52h	DIAG BIT NOT SET
53h	ILLEGAL DIAGNOSTIC TEST
54h	N/A
55h	N/A
56h	N/A
57h	EDAC OPERATION ATTEMPTED WITH DEDAC BIT SET
58h	N/A
59h	COMMAND NOT IMPLEMENTED
5Ah	N/A
5Bh	N/A
5Ch	N/A
5Dh	N/A
5Eh	N/A
5Fh	N/A

These Controller Fault Codes are returned for Sense Key 05h.

Table A-11: CONTROLLER FAULT CODES - UNIT ATTENTION FAULTS (60 - 6F)

FAULT CODE	DESCRIPTION
60h	MEDIUM CHANGED
61h	N/A
62h	N/A
63h	N/A
64h	N/A
65h	N/A
66h	N/A
67h	N/A
68h	N/A
69h	N/A
6Ah	N/A
6Bh	N/A
6Ch	N/A
6Dh	N/A
6Eh	N/A
6Fh	N/A

These Controller Fault Codes are returned for Sense Key 06h.

Table A-12: CONTROLLER FAULT CODES - DATA PROTECT FAULTS (70 - 7F)

FAULT CODE	DESCRIPTION
70h	WRITE PROTECTED
71h	N/A
72h	N/A
73h	N/A
74h	N/A
75h	N/A
76h	N/A
77h	N/A
78h	N/A
79h	N/A
7Ah	N/A
7Bh	N/A
7Ch	N/A
7Dh	N/A
7Eh	N/A
7Fh	N/A

These Controller Fault Codes are returned for Sense Key 07h.

Table A-13: CONTROLLER FAULT CODES - BLANK CHECK FAULTS (80 - 8F)

FAULT CODE	DESCRIPTION
80h	BLANK CHECK ERROR
81h	N/A
82h	N/A
83h	N/A
84h	N/A
85h	N/A
86h	N/A
87h	N/A
88h	N/A
89h	N/A
8Ah	N/A
8Bh	N/A
8Ch	N/A
8Dh	N/A
8Eh	N/A
8Fh	N/A

These Controller Fault Codes are returned for Sense Key 08h.

Table A-14: CONTROLLER FAULT CODES - ABORTED COMMANDS (B0 - BF)

FAULT CODE	DESCRIPTION
B0h	N/A
B1h	N/A
B2h	RELOCATION AREA IS FULL
B3h	N/A
B4h	N/A
B5h	N/A
B6h	N/A
B7h	N/A
B8h	N/A
B9h	N/A
BAh	N/A
BBh	N/A
BCh	N/A
BDh	N/A
BEh	N/A
BFh	N/A

These Controller Fault Codes are returned for Sense Key 08h.

Table A-15: CONTROLLER FAULT CODES - MISCOMPARE FAULTS (E0 - EF)

FAULT CODE	DESCRIPTION
E0h	N/A
E1h	BYTE BY BYTE VERIFY ERROR
E2h	N/A
E3h	N/A
E4h	N/A
E5h	N/A
E6h	N/A
E7h	N/A
E8h	N/A
E9h	N/A
EAh	N/A
EBh	N/A
ECh	N/A
EDh	N/A
EEh	N/A
EFh	N/A

These Controller Fault Codes are returned for Sense Key 0Eh.

B. SEND DIAGNOSTIC TESTS

Table B-1: CONTROLLER DIAGNOSTIC TESTS

CODE	DESCRIPTION
00h	TEST ALU IN SCSI CONTROLLER
01h	TEST TIMERS IN SCSI CONTROLLER
02h	TEST FIFO READ OPERATIONS
03h	TEST FIFO WRITE OPERATIONS

Table B-2: EDAC DIAGNOSTIC TESTS

CODE	DESCRIPTION
00h	TEST EDAC READ OPERATIONS
01h	TEST EDAC WRITE OPERATIONS

Table B-3: CONTROLLER and EDAC DIAGNOSTIC STATUS

CODE	DESCRIPTION
00h	CONTROLLER DIAGNOSTIC PASSED
41h	ALU FAILURE IN SCSI CONTROLLER
42h	RAM FAILURE IN SCSI CONTROLLER
43h	SCSI OR ODI BUS FAILURE
44h	TIMER FAILURE IN SCSI CONTROLLER
45h	FIFO FAILURE IN SCSI CONTROLLER
46h	FAILURE IN EDAC BOARD
47h	ODI MODE REGISTER COMMUNICATION FAILURE
48h	NO DRIVE SELECTED ON POWER UP
49h	DRIVE IN FAULT AT END OF DIAGNOSTIC
4Ah	SELF TEST FAILED

Table B-4: DRIVE DIAGNOSTIC TESTS (10 - 7F)

NOTE: These diagnostics should be executed with the drive spun down.

CODE	DESCRIPTION
10h	ODI TEST. Communication across the ODI is verified by the controller. Data sent by the controller is echoed by the drive in all modes except mode 0.
20h	OVERALL DRIVE TEST. Tests are run on the following modules: drive control, spindle control, coarse positioner, laser control, read channel, focus and tracking.
30h	DRIVE CONTROL TEST. The drive control tests its internal operation. The components tested are RAM, ROM, output ports, and input ports.
40h	PACKAGE TEST. This test verifies that the front panel LEDs, the Start/Stop switch, the cartridge-in sensor 1, the cartridge- in sensor 2, and the solenoid-in sensor are functioning. All front panel LEDs flash for operator verification. The operator must perform the following actions within a 60-second period, or diagnostic errors will occur. - toggle the Start/Stop switch - load side one of a cartridge with write protect enabled - unload the cartridge - load side two of a double-sided cartridge with write protect disabled
50h	SPINDLE TEST. The spindle motor is spun up to speed and speed is verified. A cartridge must be inserted for this test.
60h	ROTARY ACTUATOR TEST. This test requires manual intervention and should be performed by an authorized service person only. The sensors, Rotary Actuator, direction, and velocity are tested.
70h	LASER CONTROL TEST. All of the laser status lines are checked with the disk spinning and the laser enabled outside of the user data area. Drive Sync Board is analyzed to determine system performance.

Table B-5: DRIVE DIAGNOSTIC TESTS (80 - FF)

CODE	DESCRIPTION
80h	READ AMPLIFIER TEST. The AGCLV line and the FOCT line are examined for a failure in the read channel or the focus channel with the disk spinning, the laser on, and focus enabled.
90h	FOCUS AND TRACKING TEST. The INFOC and ONTRACK lines are examined for a failure in focus or tracking with the disk spinning, the laser on, the focus enabled, and the tracking enabled.
AOh	DRIVE SYSTEM TEST. The data out of the phase prom from the Drive Sync Board is analyzed to determine system performance.

Table B-6: DRIVE DIAGNOSTIC STATUS

Code	Description
20h	All tests passed
23h	Drive control test failed
25h	Spindle control test failed
26h	Coarse positioner test failed
27h	Laser control test failed
28h	Read amplifier test failed
29h	Focus and tracking test failed
2Ah	System test failed
30h	Drive control test passed
31h	ROM test failed
32h	RAM test failed
33h	I/O test failed
40h	Package test passed
41h	Start/Stop switch failed
42h	Cartridge-in 1 sensor failed
43h	Cartridge-in 2 sensor failed
44h	Write-protect sensor failed
45h	Solenoid-in sensor failed
50h	Spindle control test passed
51h	Spindle sensor system failed
52h	Spindle motor system failed
53h	Spin-up time exceeded
60h	Coarse positioner test passed
61h	Coarse positioner sensor system failed
62h	Coarse positioner actuator system failed
63h	Coarse positioner direction failed
64h	Coarse positioner velocity failed
70h	Laser control test passed
71h	15-volt power failed
72h	12-volt power failed
73h	Laser current below minimum allowable
74h	Laser current above maximum for reading
75h	Laser current above maximum for writing
80h	Read amplifier test passed
81h	Read channel failed
82h	Focus channel failed
90h	Focus and tracking test passed
91h	Focus loop failed
92h	Tracking loop failed
93h	Insync failed
A0h	Drive system data within allowed tolerance
A1h	Drive system data out of allowed tolerance