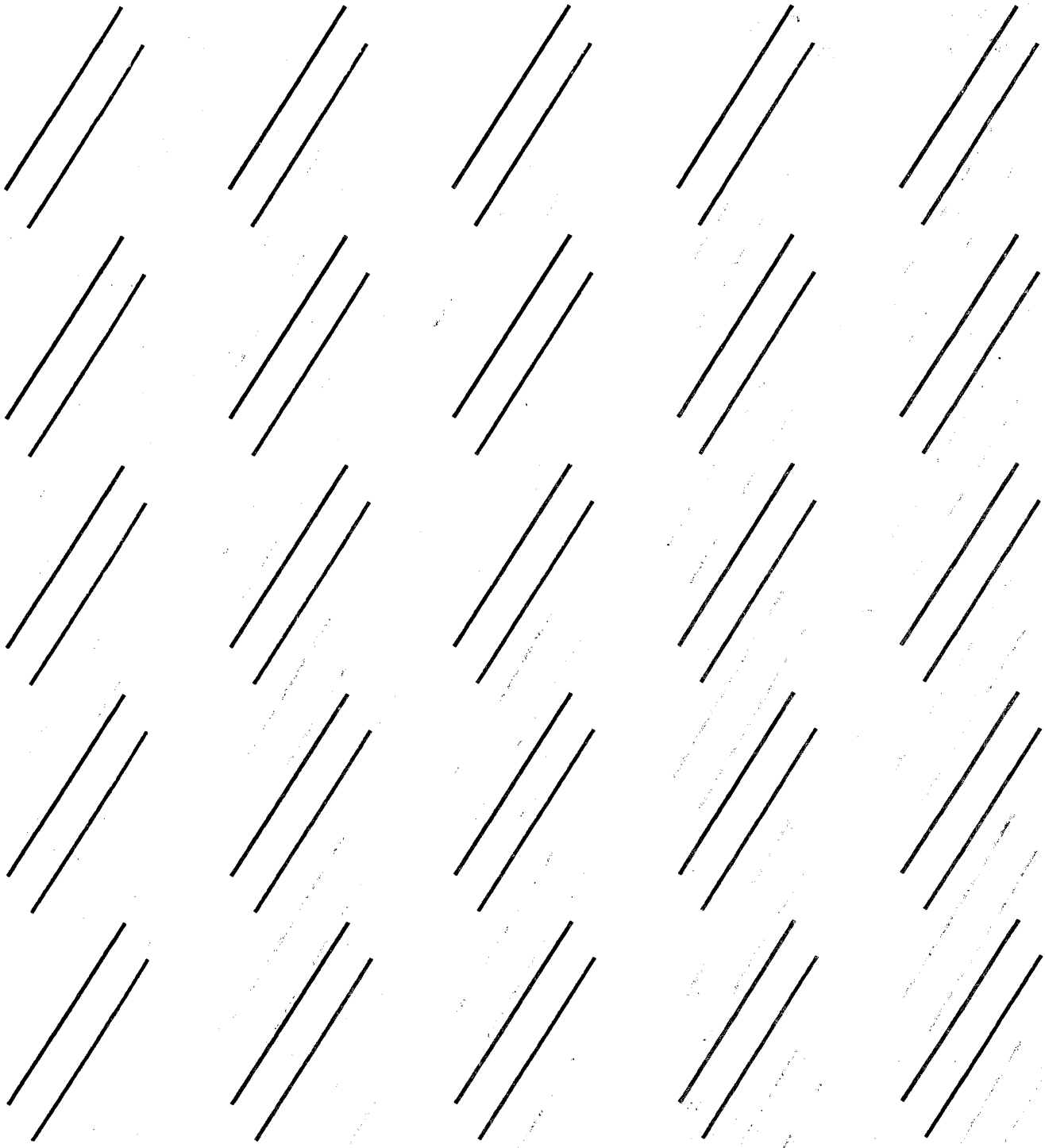
LXT-200

Product Specification and OEM Technical Manual

Revision A/June 1989



Maxtor®

LXT-200

Product Specification
and
OEM Manual

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WARRANTY

Maxtor warrants the LXT-200 Family of disk drives against defects in materials and workmanship for a period of twelve months, for the original purchaser. Direct any questions regarding the warranty to your Maxtor Sales Representative. Maxtor maintains Customer Service Centers for the repair/reconditioning of all Maxtor products. Direct all requests for repair to the Maxtor Service Center in San Jose. This assures you of the fastest possible service.

REGULATORY APPROVALS

UL Recognition obtained:	Application submitted
CSA Certification obtained:	Application submitted
VDE Recognition:	Application submitted

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PREFACE

The purpose of this manual is to provide all of the technical information you need to install and use the Maxtor LXT-200 Family disk drives. It is intended for evaluation and integration engineers who are building or assembling a total computer system. This manual does not include the information needed to repair these disk drives. For this information contact the Maxtor Service Center in San Jose.

Chapter 1 is a complete description of the disk drive, including specifications. Chapter 2 provides the information you need to prepare the disk drive for installation. Chapter 3 covers installation. Chapter 4 provides information on the daily function of the disk drive. Chapter 5 begins the interface discussion by including information on the various possible configurations and on the electrical interface. Chapter 6 continues the discussion on the interface with information on the SCSI phases. Chapter 7 concludes the interface discussion with information on the SCSI commands that the disk drive supports.

Maxtor publishes descriptive brochures and data sheets, this original equipment manufacturer (OEM) manual, and a quick reference guide for each product line. Changes that affect the content of any manual are covered by addenda or revisions to the affected manual.

Maxtor reserves the right to make changes and/or improvements to its products without incurring any obligation to incorporate such changes or improvements in units previously sold or shipped.

1.0 DISK DRIVE DESCRIPTION

The LXT-200™ disk drives are high capacity, high performance, random access storage devices which use nonremovable 3½-inch disks as storage media. Each disk surface employs one moveable head to access the data tracks (see Figure 1•1, LXT-200 Disk Drive). The total formatted capacity of each drive (including spares) is 201 megabytes at 512 bytes per sector. The unformatted capacity is 234 megabytes.

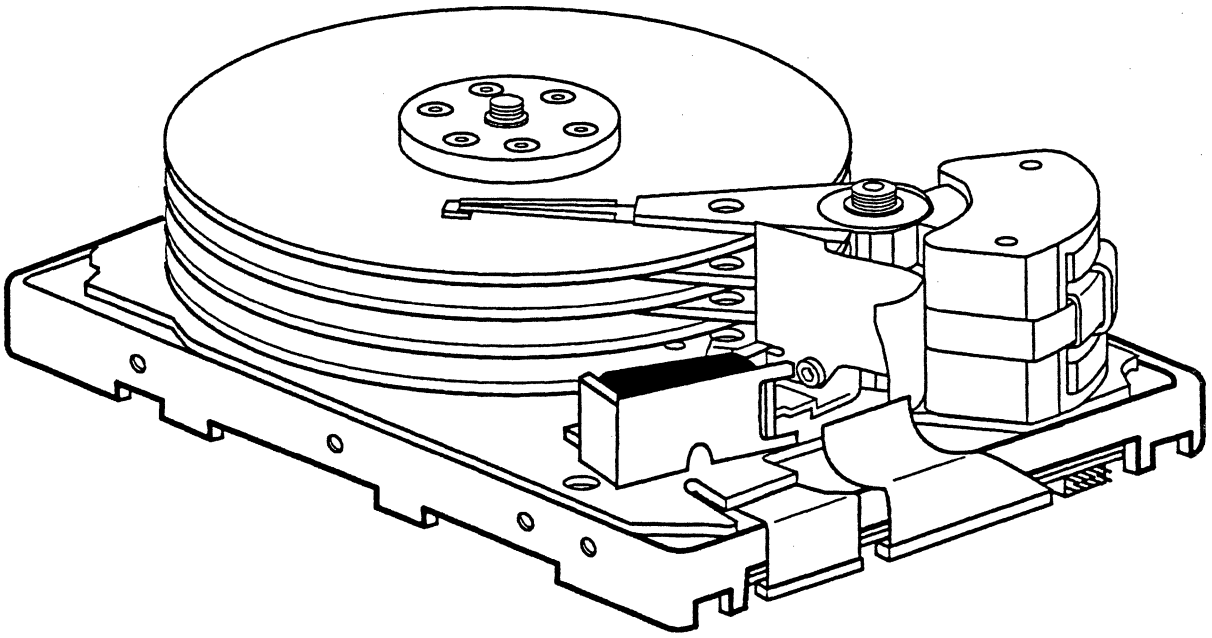


Figure 1•1
LXT-200 Disk Drive

These disk drives include the Small Computer System Interface (SCSI) controller embedded in the drive electronics. An embedded Advanced Technology (AT) controller version, the LXT-200A, will be available in the near future. Some of the resulting benefits of having an integrated controller include the elimination of a separate controller printed circuit board (PCB), reduction in the number of associated cables, and elimination of the controller-specific power supply.

High performance is achieved through the use of a rotary voice coil actuator and a closed loop servo system using a dedicated servo surface. The innovative MAXTORQ™ rotary voice coil actuator provides performance usually achieved only with larger, higher powered linear actuators. The closed loop servo system and dedicated servo surface com-

bine to allow state-of-the-art recording densities (1,591 tracks per inch, 28,910 bits per inch) in a 3 1/2-inch package.

High capacity is achieved by a balanced combination of high areal recording density, run-length limited (RLL) data encoding techniques, and high density packaging techniques. A three-zone implementation of 1,7 code is used. Maxtor's advanced MAXPAK™ electronic packaging techniques use miniature surface-mounted devices to allow all electronic circuitry to fit on one PCB. Advanced flexures and heads allow closer spacing of disks, and therefore allow a higher number of disks in a 3 1/2-inch package. Maxtor's integrated drive motor/spindle design allows a deeper head disk assembly (HDA) casting than conventional designs, thus permitting four disks to be used.

The drive's electrical interface is compatible with the ANSI SCSI standard X3.131-1986, plus the Common Command Set (CCS) requirements. Size and mounting conform to the industry standard 3 1/2-inch form factor for floppy and Winchester disk drives, and uses the same direct current (DC) voltages and connectors.

Some key disk drive features include:

FEATURE	BENEFITS
• Storage capacity of 201 megabytes, formatted at 512 bytes/sector (234 megabytes, unformatted)	Maximum storage in the 3 1/2-inch disk drive market; good upgrade for the 5 1/4-inch disk drives which have less than 200 megabytes of capacity
• Single PCB	High reliability, ease of maintenance
• Rotary voice coil actuator and close loop servo system	Fast, accurate head positioning
• Separate 16-bit microprocessor-controlled servo and spindle motor	Fast access times, precise motor speed control, high reliability, and high density package
• Thin film metallic media	Higher bit density and resolution, plus improved durability
• Brushless DC spindle motor inside hub	Maximum storage capacity
• Industry standard DC power supply requirements	No AC power required, ease of integration

FEATURE	BENEFITS
• Industry standard physical size and mounting	Ease of integration
• No sway space required	Ease of integration of system design
• Available with 5 1/4-inch half-high mounting hardware (optional)	Ease of integration into existing cabinets
• Low 40 decibels audible noise	Ideal for office environments
• Low 10 watts power dissipation	Less current requirements of the power supply; low power use

Some key controller features include:

FEATURE	BENEFITS
• Sophisticated, hardware-based control of SCSI protocol	Minimum time on SCSI bus; maximum bus use
• Up to 3 megabytes per second transfer rate asynchronous, and 5 megabytes per second synchronous.	Maximum SCSI bus use
• High performance buffer manager	Simultaneous data transfers from disk to buffer and buffer to initiator
• In-line sector sparing	Maintains high performance over life of drive, even after numerous reassignments
• Self-test diagnostics	Ensures reliability of the drive
• Microcode down-loadable through SCSI or via serial port	Ease of changing SCSI code
• Microcode up-loadable from the disk drive via the "soft-boot" routine	Flexibility in the offering of firmware implementations
• Very low (600 microseconds) SCSI command overhead	High throughput and performance

FEATURE	BENEFITS
• 32 kilobytes dual ported first-in, first-out buffer (FIFO); two full tracks capacity	Maintains maximum SCSI bus transfer rate
• Dedicated 16-bit microprocessor for SCSI	SCSI bus unaffected by drive interface functions, such as SEEK
• Error map on disk	Automatic defect deallocation during format; no manual entry
• ANSI SCSI standard X3.131-1986 level 2 conformance	Compatibility; ease of integration
• Full implementation of CCS revision 4B	Availability of options and industry compatibility
• Programmable 56 bit error correction code (ECC).	High data integrity
• Programmable automatic retry on SEEK and READ errors	Flexibility and high data integrity
• Interleave of 1:1 supported	Maximum data throughput
• Full disconnect/reconnect capability	Optimum SCSI bus performance
• Sector sizes programmable from 180 to 4,096 bytes	User flexibility; system compatibility
• SCSI implementation is bus compatible with all Maxtor Winchester and optical disk drives at the CCS revision 4B level	Maximum performance and maximum flexibility

The commands supported by the drive are listed and discussed in "7.0 SCSI Command Descriptions" later in this manual. For more information on Group 0 and Group 1 commands for direct-access devices, see the reference documents below:

- ANSI X3.131-1986, SCSI, American National Standards Institute, Inc., June 23, 1986.
- X3T9.2/85-52 Rev 4.B CCS of the SCSI, American National Standards Institute, Inc., June 23, 1986.

1.1 PRODUCT SPECIFICATIONS

"Product Specifications" includes specifications for performance, function, environmental limits, physical dimensions, reliability, error rates, and DC power requirements. At the end of this subchapter is a list of the standards and regulations that apply to this family of disk drives.

1.1.1 Performance Specifications

	LXT-200S
CAPACITY, UNFORMATTED	
PER DRIVE (Mbyte)	234
PER SURFACE (Mbyte)	33.4
CAPACITY, FORMATTED (512 bytes/sector)	
PER DRIVE (Mbyte) *	207
PER SURFACE (Mbyte) *	29.6
SECTOR/TRACK	
INNER BAND	33
MIDDLE BAND	45
OUTER BAND	53
TYPICAL SEEK TIME, msec **	
AVERAGE	15
TRACK-TO-TRACK	3
FULL STROKE	30
MAXIMUM SEEK TIME, msec **	
AVERAGE	16
TRACK-TO-TRACK	3
FULL STROKE	30
SCSI BUS TRANSFER RATE (Mbyte/sec)	
ASYNCHRONOUS	3
SYNCHRONOUS	5 (max)

* Actual capacity available depends on user-defined parameters selected in the format operation. The formatted capacity above was calculated with no spare sectors assigned.

** Includes settling. Maximum times are under the environmental conditions specified. Typical times are at nominal environmental conditions.

Table 1-1
Performance Specifications

	LXT-200S
DISK DATA RATES (Mbit/sec)	
INNER BAND	9.2
MIDDLE BAND	12.6
OUTER BAND	14.8
AVERAGE LATENCY (msec)	8.3
SCSI OVERHEAD	600 µsec
PROGRAMMABLE SECTOR SIZE	(180 byte to full track with 1 byte granularity)
SECTOR SLIPPING	Included
INTERNAL SOFT-BOOT	From Disk
READ LOOK-AHEAD CACHE ALGORITHM	Two-Zoned Read/Write Buffers

Table 1-1 (cont'd)
Performance Specifications

1.1.2 Functional Specifications

	LXT-200S
ROTATIONAL SPEED (rpm)	3,600 ± 0.5%
RECORDING DENSITY (bpi)	
INNER BAND	27,780
MIDDLE BAND	28,910
OUTER BAND	27,370
FLUX DENSITY(fci)	
INNER BAND	20,840
MIDDLE BAND	21,680
OUTER BAND	20,530
RECORDING METHOD	1, 7 RLL
TRACK DENSITY(tpi)	1,591
CYLINDERS *	
PHYSICAL	1,320
LOGICAL	1,314
INNER BAND	440
MIDDLE BAND	440
OUTER BAND	434
TRACKS	9,198
INNER BAND	3,080
MIDDLE BAND	3,080
OUTER BAND	3,038
DATA HEADS	7
SERVO HEADS	1
DISKS	4
ACTUATOR TYPE	Rotary Voice Coil

* Refer To Appendix

Table 1-2
Functional Specifications

1.1.3 Environmental Specifications

	EQUIPMENT OPERATING	EQUIPMENT NONOPERATING
AMBIENT TEMPERATURE	50° to 122° F (5° to 50° C)	-40° to 140° F (40° to 65° C)
MAXIMUM TEMPERATURE GRADIENT	36° F/hr (20° C/hr), Below Condensation	36° F/hr (20° C/hr), Below Condensation
RELATIVE HUMIDITY	5 to 80% Noncondensing with Maximum Gradient of 20°/hr	5 to 80% Noncondensing with Maximum Gradient of 20°/hr
MAXIMUM WET BULB	TBD	TBD
ELEVATION	-1,000 ft to 10,000 ft	-1,000 ft to 40,000 ft
VIBRATION, ALL AXES (inputs to frame of drive)	TBD	TBD
SHOCK, ALL AXES (inputs to frame of drive) (11 msec pulsewidth, half sine wave)	3 G (no errors) and 10 G (recoverable errors)	50 G
AUDIBLE NOISE	40 dB	Not Applicable

Table 1•3
Environmental Limits

1.1.4 Physical Specifications

HEIGHT	= 1.625 in. (41.3 mm)
WIDTH	= 4.000 in. (101.6 mm)
DEPTH	= 5.750 in. (146 mm)
WEIGHT	= 2.2 lb (0.99 kg)
SHIPPING WEIGHT	= TBD

Table 1•4
Physical Dimensions

1.1.5 Reliability Specifications

MTBF	50,000 POH, Typical Usage
PM	Not Required
MTTR	20 Minutes
COMPONENT DESIGN LIFE	5 Years

Table 1-5
Reliability Specifications

1.1.6 Error Rates

RECOVERABLE ERRORS	Less than 10 per 10^{11} Bits Read
UNRECOVERABLE ERRORS	Less than 10 per 10^{15} Bits Read
SEEK ERRORS	Less than 10 per 10^{7} SEEKs
ERROR CORRECTION CAPABILITY (at 512 bytes/sector)	11 Bits
ERROR DETECTION CAPABILITY (at 512 bytes/sector)	32 Bits
PROBABILITY OF MISCORRECTED DATA	Less than 10 per 10^{21} Bits Read
PROBABILITY OF MISDETECTED DATA	Less than 10 per 10^{16} Bits Read

NOTE: On-board diagnostics to provide "self-test capability" are included. These are accessible via the SCSI interface or the serial RS/232 port.

Table 1-6
Error Rates

1.1.7 DC Power Requirements

VOLTAGE (nominal)	+12 V DC	+5 V DC
REGULATION	±5%	±5%
CURRENT (typical)	0.2 A (typical)	0.75 A (typical)
CURRENT (maximum) *	2.0 A (inst.)	TBD
RIPPLE (maximum, P-P)	120 mV	50 mV

* At Spinup Heat Dissipation = 10 W Typical

Table 1-7
DC Power Requirements

1.1.8 Standards and Regulations

The Maxtor LXT-200 disk drives satisfy the following standards and regulations:

UNDERWRITERS LABORATORIES (UL) = United States safety; UL 478, Standard for Safety, Electronic Processing Units and Systems.

CANADIAN STANDARDS ASSOCIATION (CSA) = Canadian safety; CSA C22.2 No. 220, 1986, Information Processing and Business Equipment (Consumer and Commercial Products).

VERBAND DEUTSCHER ELECTROTECHNIKER (VDE) = German safety; VDE 0806/8.81, Safety of Office Appliances and Business Equipment.

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC) = International safety commission; IEC 950 (formerly 380), Safety of Information Technology Equipment.

FEDERAL COMMUNICATIONS COMMISSION (FCC) = United States radiation emissions; Part 15, Subpart J, Class B Consumer Computing Devices.

CAUTION: *This equipment generates and uses radio frequency energy, and may cause interference to radio and television reception if not installed and used in strict accordance with the instructions in this manual.*

The drive has been tested and found to comply with the limits for a Class B computing device, in accordance with the specifications in Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against radio and television reception interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference using one or more of the following measures:

- reorient the receiving antenna
- reorient the computer with respect to the receiver
- move the computer away from the receiver
- plug the computer into a different outlet, so that the computer and receiver are on different branch circuits

If necessary, consult the dealer, or an experience radio/television technician, for additional suggestions. You may find the FCC booklet *How to Identify and Resolve Radio TV Interference Problems* helpful. This booklet is available from the United States Government Printing Office, Washington, D.C., 20402, stock number 004-000-00345-4.

Maxtor is not responsible for any radio or television interference caused by unauthorized modifications to the drive. It is the responsibility of the user to correct such interference.

1.2 MAJOR PARTS

The major elements of the disk drive are the air filter, the head amplifier, the positioning motor, the read/write head assembly, and the spindle motor (see Figure 1•1, LXT-200 Disk Drive). A brief discussion of some of these parts appears below, in alphabetical order.

1.2.1 Air Filtration System

The disks and read/write heads are assembled in a Class 100 environment and then sealed within the HDA. The HDA contains an absolute filter, mounted inside the casting, to provide constant internal air filtration (see Figure 1•2, Air Filtration System).

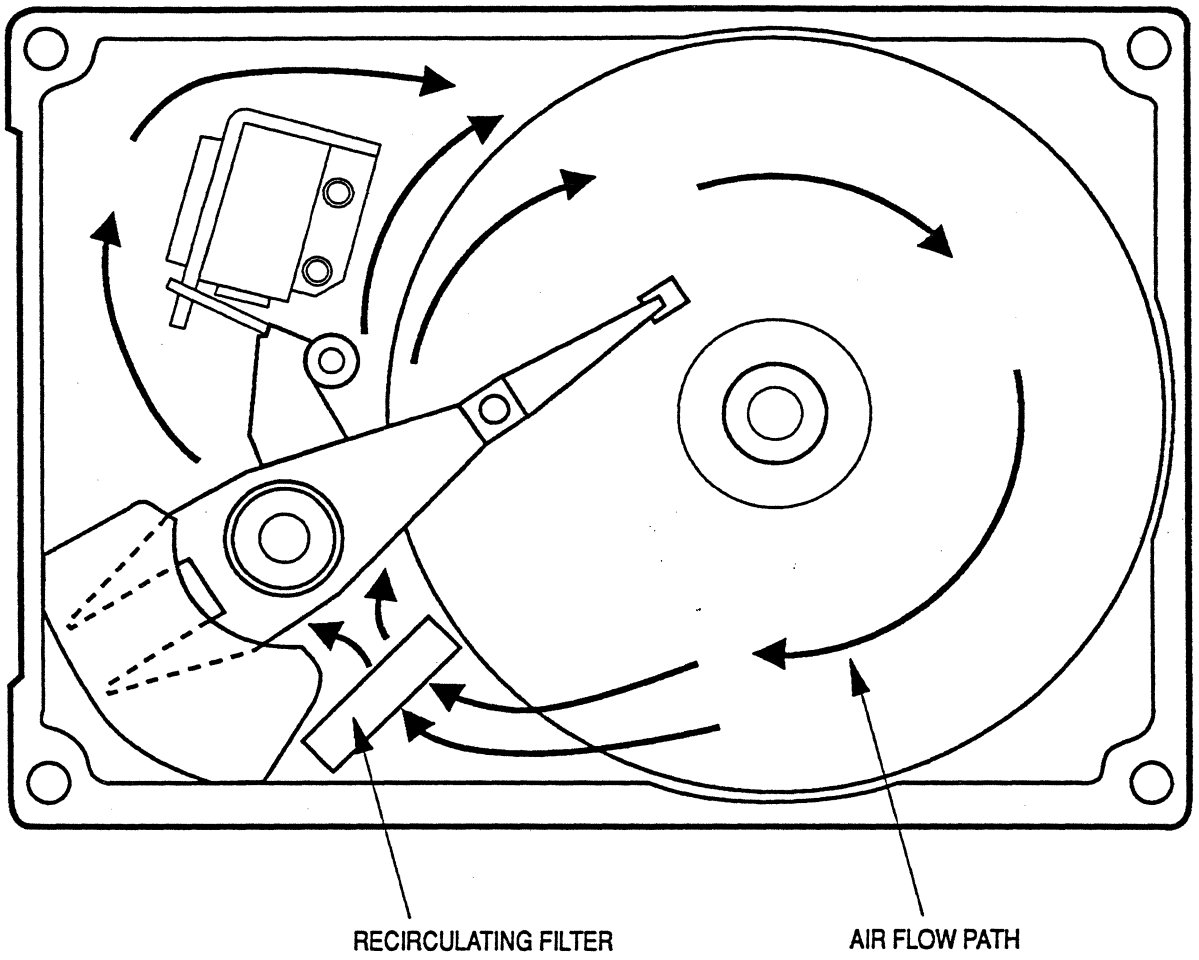


Figure 1-2
Air Filtration System

1.2.2 Drive Mechanism

The HDA is a sealed subassembly containing the mechanical portion of the disk drive. A brushless DC disk drive motor contained within the spindle hub rotates the spindle and is controlled by a dedicated microprocessor. The motor and spindle are dynamically balanced to insure a low vibration level. Shock mounting is provided internally in the HDA to minimize transmission of vibration through the frame. The frame is the mechanical assembly holding the HDA and PCB.

1.2.3 Head Positioning Mechanism

The read/write heads are mounted on a head/arm assembly, which is then mounted on a ball bearing supported shaft (see Figure 1•3, Head Positioning Mechanism). The voice coil, an integral part of the head/arm assembly, lies inside the magnet housing when installed in the disk drive. Current from the power amplifier, controlled by the servo system, induces a magnetic field in the voice coil which either aids or opposes the field around the permanent magnets. This reaction causes the voice coil to move within the magnetic field. Since the head/arm assemblies are connected to the voice coil, the voice coil movement is transferred, through the pivot point, directly to the heads, to position them over the desired cylinder.

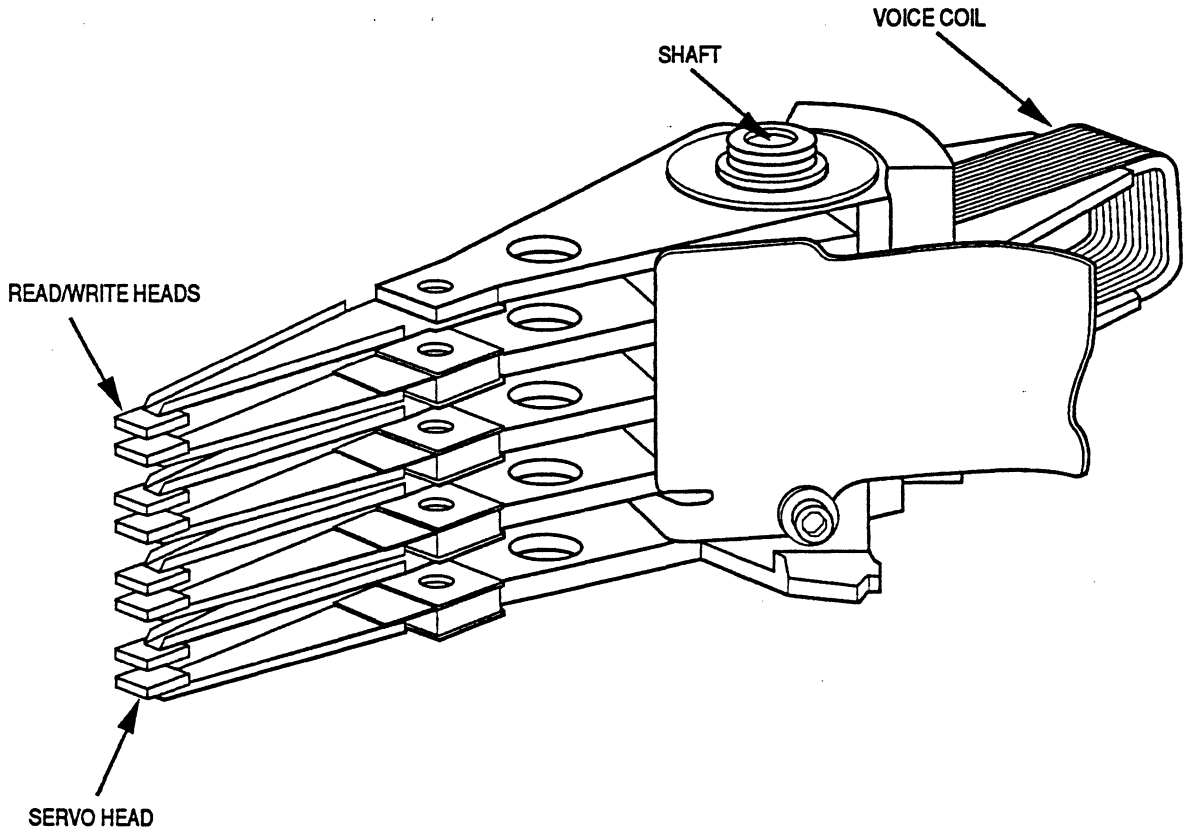


Figure 1•3
Head Positioning Mechanism

Actuator movement is controlled by the servo feedback signal from the servo head. The servo information is prewritten at the factory, and is used as a control signal for the actuator to provide track crossing signals during a seek operation, track following signals during on cylinder operation, and timing information, such as index and servo clock. The servo information also provides the timing to divide a track into sectors used for data storage. The servo control system has a dedicated microprocessor for fast, optimized performance.

1.2.4 Read/Write Heads and Disks

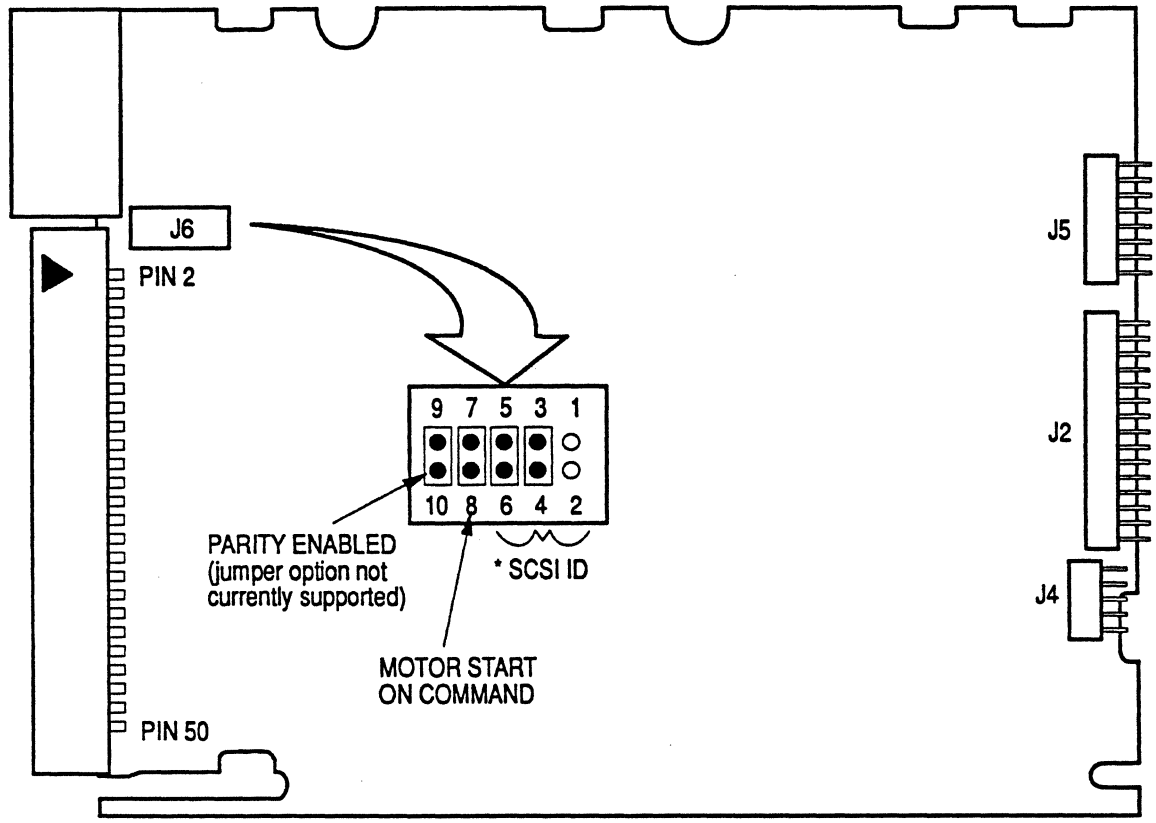
The disk drive employs state of the art sliders and flexures. The configuration of the sliders and flexures provides improved aerodynamic stability, superior head/disk compliance, and a higher signal-to-noise ratio.

The disk media uses a nickel-cobalt metallic film that yields high amplitude signals, and very high resolution performance, compared to conventional oxide coated media. It also provides a highly abrasion and impact resistant surface, decreasing the potential for damage caused by shipping shock and vibration.

Data on each of the data surfaces is read by one read/write head; each head accesses 1,314 user accessible cylinders. There is one surface dedicated to servo information in each disk drive.

2.0 DISK DRIVE SETUP

Jumper locations are identified in Figure 2•1, PCB Layout.



** Disk drive is shipped as SCSI ID 6 as shown in this figure. All solid dots indicate that the drive is shipped with those jumpers installed.*

Figure 2•1
PCB Layout

2.1 SCSI ID SELECTION

SCSI ID jumpers (pins one through six) are provided to configure each disk drive with a SCSI device ID for use in multiple SCSI device configurations.

Table 2•1, SCSI ID Jumpers, is a reference table for the SCSI ID jumper configuration, the ID, and the priority on the SCSI bus. An ID of seven is the highest priority in a multiple device configuration, and is usually used for the initiator.

SCSI ID	PRIORITY	PINS 5 & 6	PINS 3 & 4	PINS 1 & 2
0	Lowest	Out	Out	Out
1		Out	Out	In
2		Out	In	Out
3		Out	In	In
4		In	Out	Out
5		In	Out	In
6		In	In	Out
7	Highest	In	In	In

In = Installed, Shorted
Out = Not Installed, Open

Table 2•1
SCSI ID Jumpers

The disk drive is shipped from the factory with an ID of six. This assures that sufficient jumpers are available for any address except seven, which is usually reserved for the host system.

2.2 DRIVE POWER-UP OPTIONS

SUMMARY	
J6 PINS 7 & 8 (spin with power)	MODE
Out	Wait for START Command
In	Start When Power Applied

Table 2•2
Summary of Power-Up Options

Wait for START Command: With no jumper on pins seven and eight of J6, the disk drive does not spin up until the initiator issues a START/STOP UNIT command with the start bit equal to one. (This option is not implemented).

Start When Power Is Applied: When pins seven and eight of J6 are jumpered, the motor starts as soon as power is applied. The disk drive is shipped in this configuration.

2.3 TERMINATOR POWER SELECTION

Power to the terminators may come internally from the disk drive, or externally from the SCSI bus.

The drive electronics are capable of sensing if the host is providing the power to the terminators. If the host is not providing the power then the disk drive automatically provides the power to the terminators.

2.4 PARITY DISABLE OPTION

The parity disable jumper, pins nine and ten of J6, is currently not supported. When it is it will enable (in) or disable (out) odd parity detection in the disk drive. Currently, odd parity is always generated by the disk drive and provided to the SCSI bus.

The disk drive is shipped with pins nine and ten in, enabling parity detection.

2.5 SECTOR SIZE

The disk drive is shipped from the factory formatted with 512-byte sectors. Configuration parameters are default values in all optional cases. It is recommended that users reformat the disk drive with the user's sector size, using the P list, and the user's configuration parameters.

2.6 INTERFACE TERMINATION

SCSI devices require proper interface termination. The first device and the last device on a SCSI bus daisy chain must be terminated (see Figure 5•1, Typical SCSI Configurations). Remove the terminators from any devices in between. For instance, if a disk drive is in the middle of a SCSI bus daisy chain, remove its terminators. The disk drive terminators are shown in Figure 2•1, PCB Layout.

Terminator pin one is marked with a dot on the terminator as shown in Figure 2•1, PCB Layout. The terminators (U40 through U42) all look like the side view inset in the figure. The orientation of the terminator on the PCB is also shown. Note that the PCB's hole/solder pad for pin one has a square outline, whereas all the other holes/pads have a round outline. Also, note that pin one is always the closest pin to the power connector, J3.

NOTE: *All terminator packs (U40 through U42) must be oriented with the dot towards J3 for the disk drive to work properly.*

As shipped, the interface signal lines are terminated with three removable 220/330 ohm resistor network packs.

The devices driving the disk drive inputs should be open collector devices capable of sinking at least 48 milliamps at a voltage level of less than 0.5 volts DC (7438 or equivalent).

Devices receiving the disk drive outputs should be of SCHMITT trigger type to improve noise immunity (74LS14, 74LS240, or equivalent). The initiator should not load the bus with more than one standard low power Schotky transistor-transistor logic (LSTTL) input load per line, and should terminate all signals with 220/330 ohm terminators.

2.7 SERVICE CONNECTOR

Connector J4 in Figure 2•2, *Connector Locations, Front View of Drive*, is a service connector providing the RS-232, the synchronous spindle, and the ability to carry the LED signal beyond the disk drive. The RS-232 is used to port new firmware updates to the disk. The synchronous spindle option is currently not supported. The service connector is a ten-pin part. The mating connector is a Berg 6976410 part.

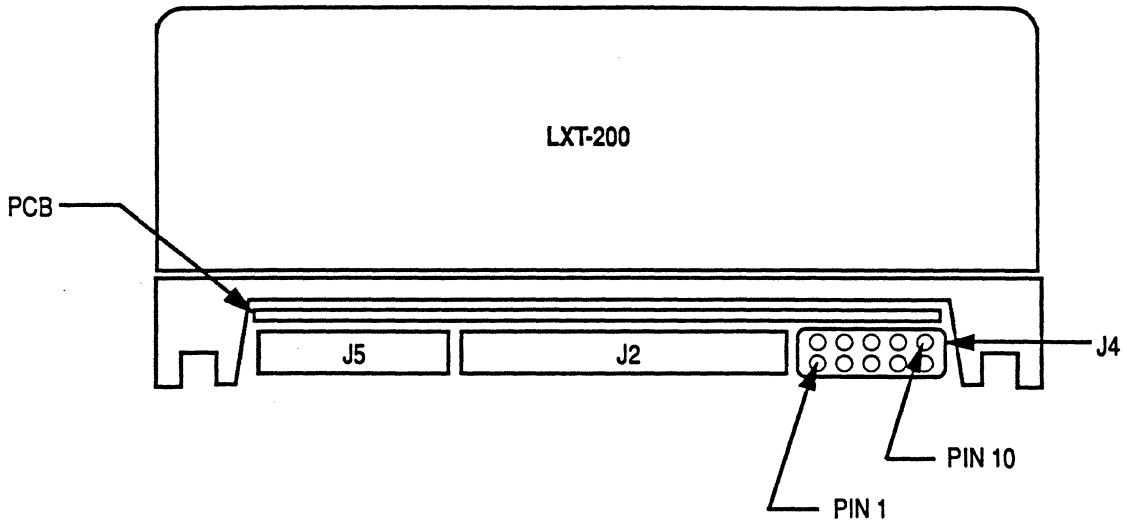


Figure 2•2
Connector Locations, Front View of Drive

Pin assignments are as in Table 2•3, Service Connector Pin Assignments (also see Figure 5•2, Connector Locations, Rear View of Drive).

	PIN 9 +5V	PIN 7 N/C	PIN 5 Gnd	PIN 3 CTDX	PIN 1 Gnd
Active Low	PIN 10 - LED DRV	PIN 8 SPDL Pulse Ref	PIN 6 Gnd	PIN 4 CRDX	PIN 2 CNMI

Table 2•3
Service Connector Pin Assignments

When an LED is connected to pin nine (+) and pin ten (-), that LED functions in the same manner as the LED which is mounted on the disk drive's faceplate. This is typically used in cases where the disk drive is mounted in a position where the disk drive's LED is not visible and the faceplate is removed.

Pins two through four are the RS-232 lines used to down load firmware updates to the microprocessor which are then stored on the disk. Pins three (transmit data) and four (receive data) are the main communication lines. Pin two is used to debug the processor

and for a non-maskable interrupt. Pins five and six are signal ground lines. Pin eight will be used at a later date to implement the synchronous spindles.

2.8 SPINDLE SYNCHRONIZATION CONTROL

Spindle synchronization is not currently available, but this feature, when implemented, will allow a number of Maxator LXT-200 disk drives to synchronize the rotational position of their spindles. The pin assignment for connector J4, which will be used for this feature, is shown in Table 2•3, Service Connector Pin Assignments, Pin 8.

3.0 DISK DRIVE INSTALLATION

"Disk Drive Installation" includes the information you need to install the disk drive, specifically mounting and shipping considerations.

3.1 MOUNTING

The disk drive may be mounted in any orientation. In any final mounting configuration, insure that the operation of the three shock mounts, which isolate the HDA from the frame, are not restricted. Certain switching power supplies may emanate electrical noise, which can degrade the specified read error rate. For best results, orient the disk drive so that the PCB assembly is not adjacent to these noise sources.

Eight mounting holes, four on the bottom and two on each side, are provided for mounting the disk drive into an enclosure. The size and location of these holes, shown in Figure 3•1, Mechanical Outline, Bottom and Side Views, are identical to industry standards. Overall height, width, and depth, along with other key dimensions, are shown in Figure 3•1, and Figure 3•2, Mechanical Outline, Isometric.

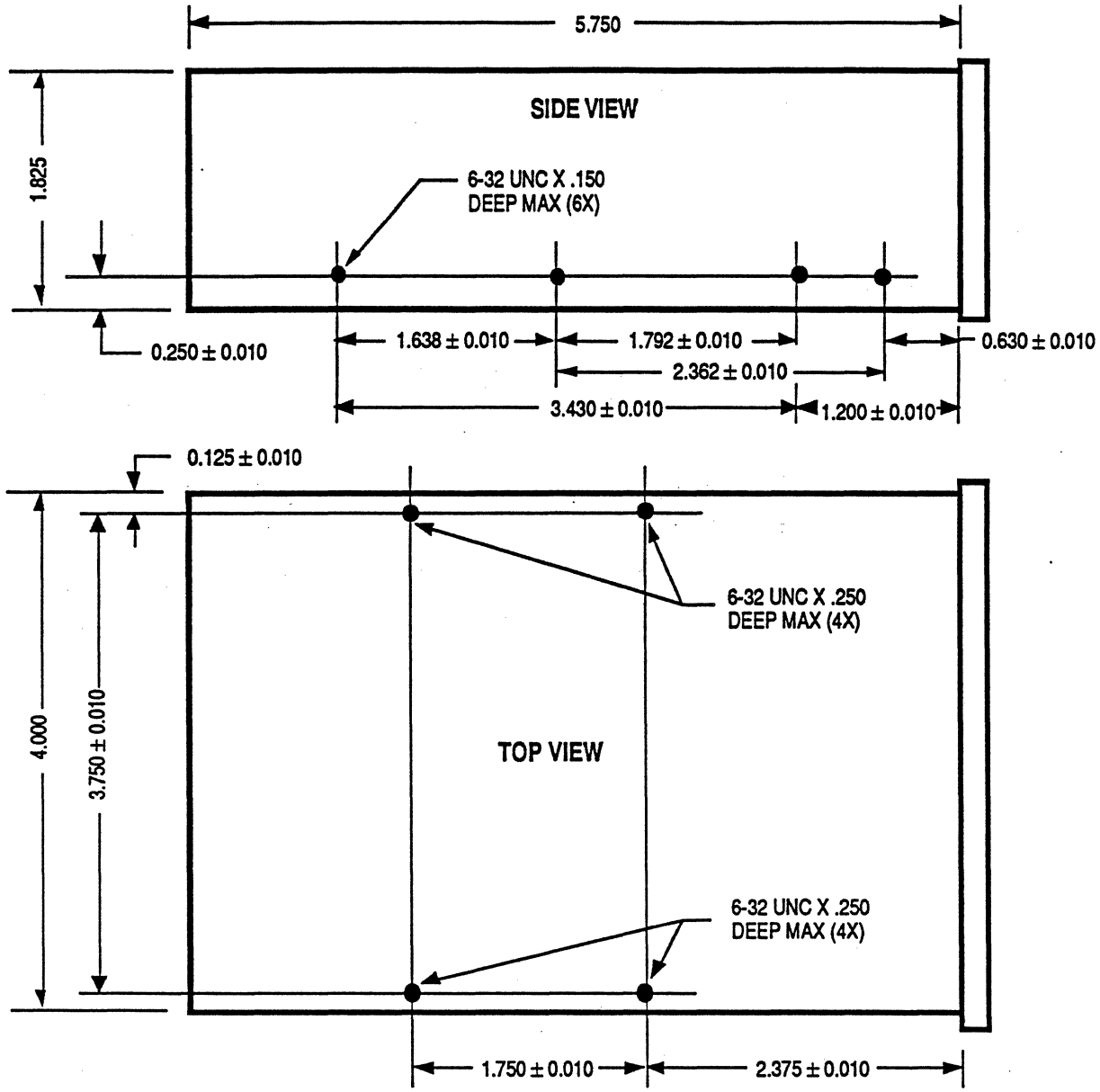
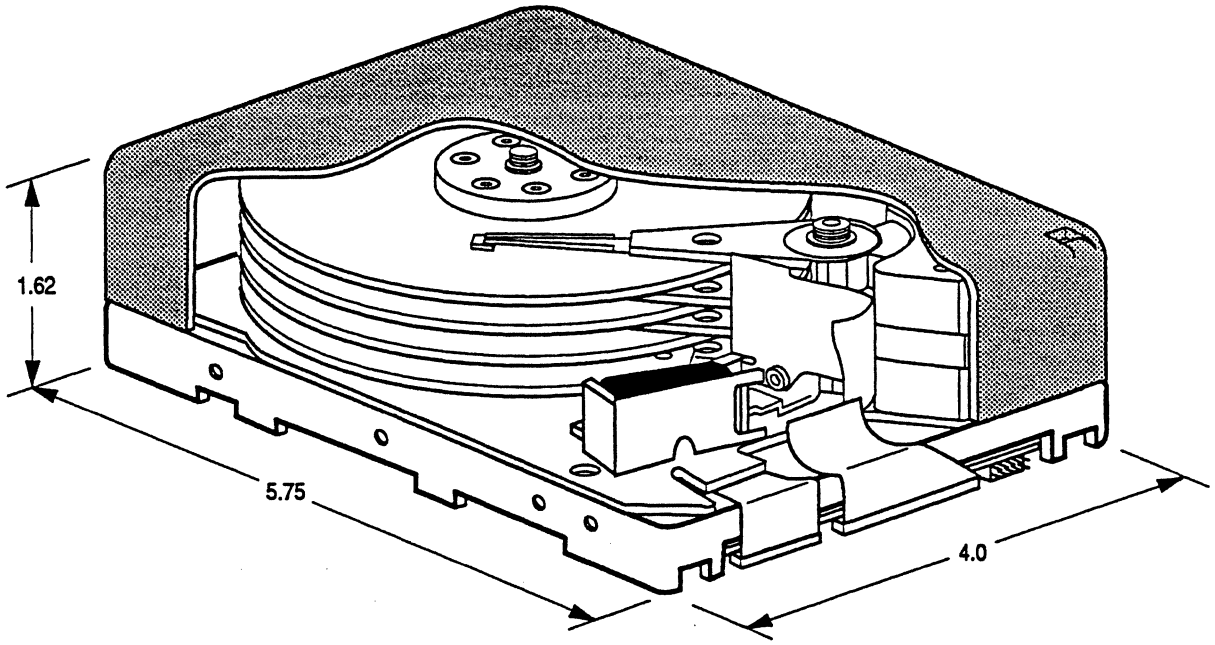


Figure 3-1
Mechanical Outline, Bottom and Side Views



NOTE: Dimensions are provided for reference only. For exact measurements see the figure Mechanical Outline, Bottom and Side Views. Units are in inches.

Figure 3•2
Mechanical Outline, Isometric View

The faceplate is clipped on to the front of the HDA and may be removed in installations that require it. Lift up on the faceplate clips and unplug the light-emitting diode (LED) cable from the PCB, as shown in Figure 3•3, Removable Faceplate.

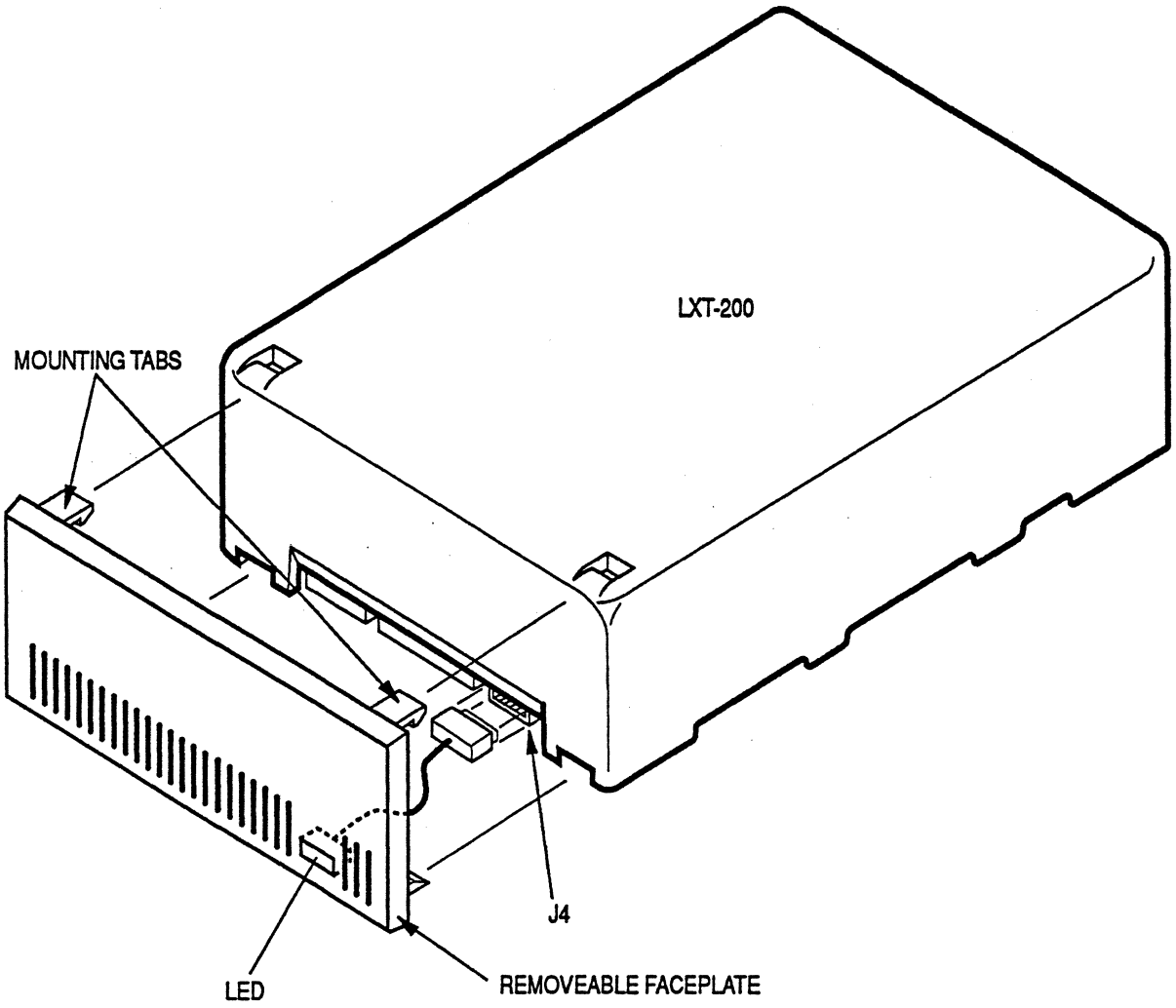


Figure 3-3
Removable Faceplate

3.2 POWER-UP TESTING

The following information is based on the ANSI SCSI standard (X3.131-1986), and the CCS. For more information, refer to these publications.

This section describes the sequence of events during drive self-test and initialization sequences. The self-test sequence is performed upon power up, and is followed by the initialization sequence. When the drive is reset, either by the SCSI bus -RST signal or by the BUS DEVICE RESET message, only the initialization sequence is performed.

NOTE: *The self-test sequence can also be initiated via the SEND DIAGNOSTIC and RECEIVE DIAGNOSTIC RESULTS commands, and these commands include options for more comprehensive diagnostics.*

3.2.1 Self-Test Sequence

The self-test sequence is executed upon disk drive power up. The self-test sequence verifies the integrity of the hardware. This test is not an exhaustive hardware diagnostic, but simply checks the major components for full functionality. The disk drive does not respond to a SELECTION phase on the SCSI bus for about the first 250 milliseconds of the self-test. After 250 milliseconds have passed, the disk drive responds to SELECTION with a BUSY status for 2 to 3 seconds: this time is spent completing the remaining self-test sequences, initializing the SCSI chip, and enabling the SCSI interrupts. After the self-test is complete and the SCSI circuitry is initialized (approximately 3 seconds), the disk drive responds to SELECTION with CHECK CONDITION status and the appropriate sense data (i.e., UNIT ATTENTION, POWER ON/RESET condition).

The self-test sequence consists of the following events:

- Hardware Reset Test - This routine tests the microprocessor, buffer controller, disk formatter, and SCSI reset latch for the proper power up condition. If any of these tests fail, the disk drive can only be reset by a POWER UP condition.

- Microprocessor Test - This routine tests the microprocessor's internal memory, timers, and register bank switching for proper operation.

- Buffer Controller Test - This routine tests the buffer controller for proper operation. All the registers are tested and the chip is engaged to access random-access memory (RAM).

- Disk Formatter Test - This routine tests the disk formatter chip by writing and reading all possible patterns to each of the disk formatter chip registers. After the registers are tested, the interrupts are tested to ensure that the formatter chip generates an interrupt when a command completes.

- SCSI Controller Test - This routine tests the SCSI controller chip by executing the chip diagnostic command. After the diagnostic test completes, the interrupts are tested to ensure that the SCSI chip generates an interrupt when a command completes. Finally, the registers are tested by writing and reading all possible patterns to each of the SCSI controller chip registers.

If any portion of the self-test fails, except the hardware reset test, the disk drive can be reset by a SCSI bus RESET condition or a power up RESET condition. The failure of the hardware reset test is considered a catastrophic failure and the controller can only be reset from such a failure by a power up RESET condition.

3.2.2 Initialization Sequence

The initialization sequence is executed for any one of the following three reasons:

- a POWER UP condition occurs
- the SCSI bus -RST signal is asserted
- a BUS DEVICE RESET message (on the SCSI bus) is received

After a successful initialization, the first command from each initiator is terminated with a CHECK CONDITION and POWER ON/RESET sense code of 29h.

Until the disk drive has been spun up, any command sent by an initiator which requires a ready disk drive for GOOD completion status, is terminated with a CHECK status and DRIVE NOT READY sense key. Commands that may complete with GOOD status prior to the disk drive being ready are REQUEST SENSE, INQUIRY, RESERVE UNIT, RELEASE UNIT, START/STOP UNIT, READ BUFFER, and WRITE BUFFER.

After the disk drive has spun up, the first command sent by the initiator which accesses the media, loads the MODE SENSE parameters. An initiator should not request any MODE SENSE parameters until the disk drive is ready.

3.2.3 Self-Configuration

When the disk drive powers up or is reset, it configures itself from the parameters and information saved on the disk drive from the previous format operation. This includes the disk drive's exact model number returned in the INQUIRY command and the MODE SELECT parameters in the pages of parameters. Refer to "7.4 MODE SELECT," and "7.5 MODE SENSE" later in this manual, which describe the parameters in the pages.

3.2.4 UNIT ATTENTION Condition

A UNIT ATTENTION condition is created for each initiator whenever the disk drive has been reset (by a BUS DEVICE RESET message or a RESET condition), or when the MODE SELECT parameters have been changed by other initiators. The UNIT ATTENTION condition (sense key 06h) is returned in the sense data by the disk drive in re-

sponse to the CHECK CONDITION (02h) status byte. The UNIT ATTENTION condition persists for each initiator until that initiator issues any command other than INQUIRY.

If an INQUIRY command is received from an initiator with a pending UNIT ATTENTION condition (before the disk drive reports CHECK CONDITION status), then the disk drive reports any pending sense data and preserves the UNIT ATTENTION condition.

If a REQUEST SENSE command is received from an initiator with a pending UNIT ATTENTION condition (before the disk drive reports CHECK CONDITION status), then the disk drive reports any pending sense data and preserves the UNIT ATTENTION condition in the sense data. However, the CHECK CONDITION is cleared, and thus GOOD status is returned on a subsequent command, which then clears the UNIT ATTENTION from the sense data.

3.2.5 Buffering Scheme

The disk drive buffer is a 32-kilobyte FIFO buffer. There are 32,767 bytes available for data storage. The buffer controller allows transfer to the disk and from the initiator simultaneously, or from the disk and to the initiator simultaneously.

3.3 SHIPPING

At power down, the heads are automatically positioned over the nondata, dedicated landing zone on each disk surface. The automatic shipping lock solenoid is also engaged at this time. Maxtor ships the disk drive in single- and multipack shipping containers. Users can ship the disk drive installed when the nonoperating shock and vibration limits are not exceeded.

4.0 DISK DRIVE DAILY OPERATION

The disk drive consists of read/write, control, and interface electronics, read/write heads, a servo head, a head positioning actuator, a disk drive motor/spindle, media, and an air filtration system. The components perform the following functions:

- interpret and generate control signals
- position the heads over the desired track
- read and write data
- provide automatic error correction to the data
- provide a contamination-free environment
- provide a controller to interact with the initiator
- maintain precise spindle rotation speed

4.1 READ/WRITE CONTROL AND SCSI CONTROLLER ELECTRONICS

All the disk drive and controller electronics are packaged on a single PCB. This PCB, which includes three microprocessors, performs the following disk drive functions:

- data separation
- reading/writing of data
- index detection
- head positioning
- head selection
- disk drive selection
- fault detection
- track zero detection
- recalibration to track zero on power up
- track position counter
- power and speed control for spindle disk drive motor
- disk drive up-to-speed indication
- reduced write current on the inner tracks
- monitoring for WRITE FAULT conditions
- control of all internal timing
- generation of SEEK COMPLETE signals

The PCB performs the following controller functions:

- error detection and correction

- SCSI bus disconnect/reconnect functions
- SCSI bus arbitration
- defect handling
- data transfer
- automatic retries
- data buffering
- command linking
- sector formatting

4.2 TRACK AND SECTOR FORMAT

The standard track format is organized into numbered data segments, or sectors (see Figure 4•1, Track Format). The sectors are addressed via the logical block address (LBA) in the SCSI commands. The method of encoding is 1,7 code.

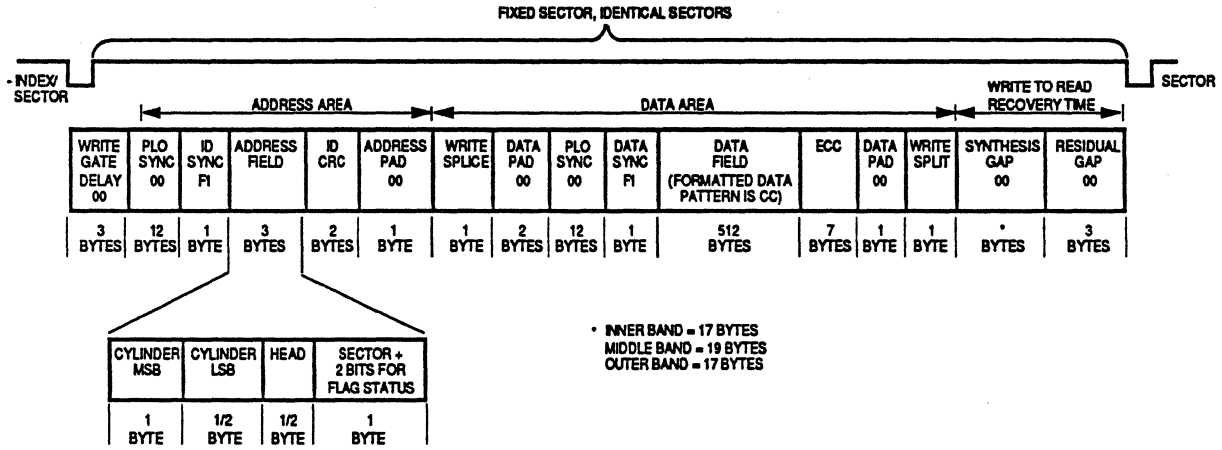


Figure 4•1
Track Format

5.0 INTERFACE

"Interface" is the first of three chapters on the SCSI interface. This chapter includes information on the logical interface and the electrical power interface.

5.1 SCSI INTERFACE

This section includes information on initiator-target configurations, signal definitions, pin assignments, and the connector.

5.1.1 Initiator-Target Configurations

The SCSI initiator interface offers a number of unique advantages which facilitate the interconnection of the disk drive with one (or more) computer systems. Unlike traditional microcomputer disk interfaces, such as ST506, SCSI supports multiple peripherals and different peripheral types, all operating on the same bus structure. Figure 5•1, Typical SCSI Configurations, shows examples of typical configurations.

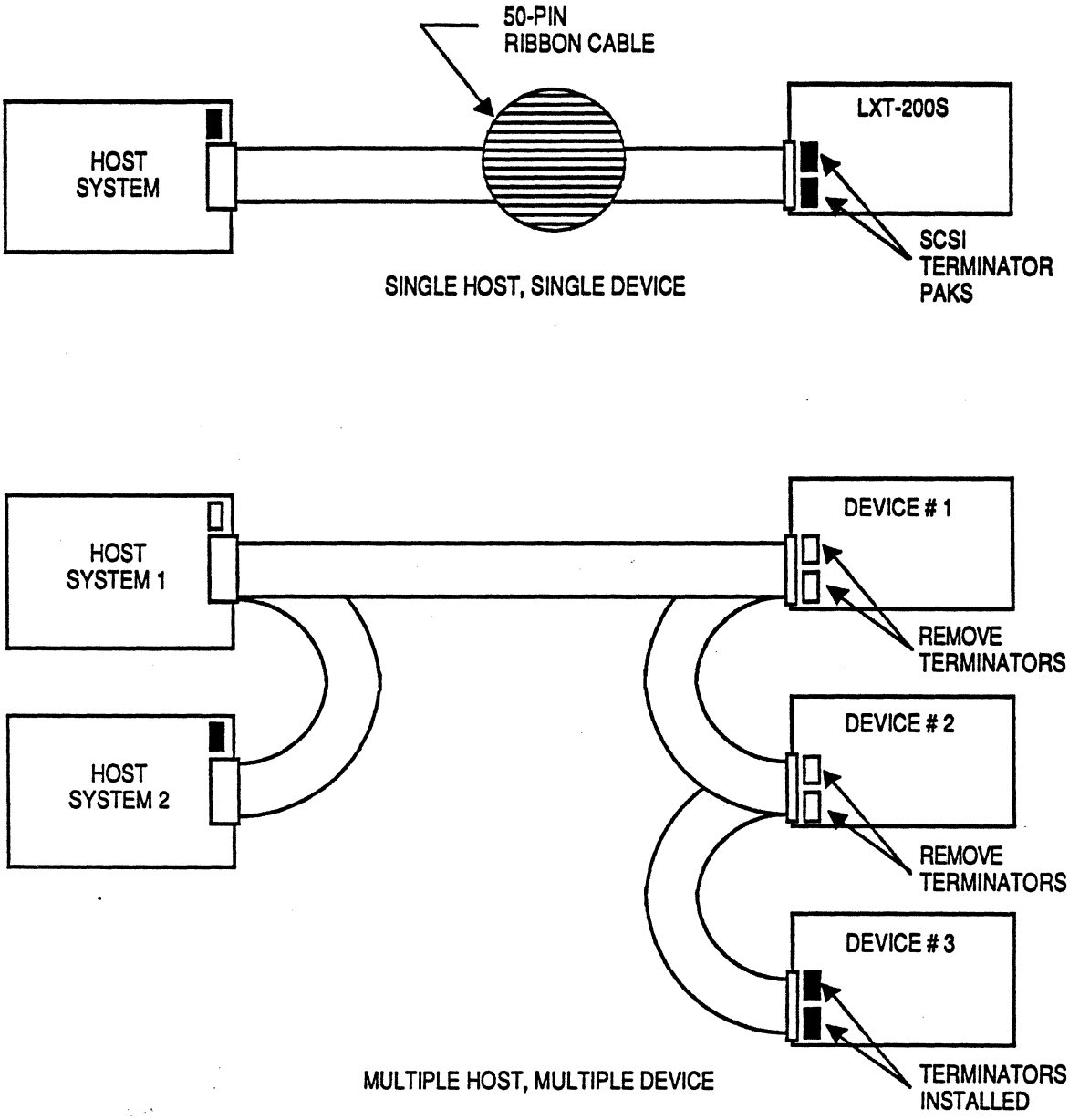


Figure 5-1
Typical SCSI Configurations

The disk drive also supports multiple initiator configurations consistent with the established arbitration cycle outlined in the SCSI standards. Configuration changes are made by SCSI address jumpers, which are set when the disk drive is installed in the system (jumper settings are discussed in "2.0 Disk Drive Setup" earlier in this manual).

The SCSI implementation used in the disk drive is intended to facilitate high-speed data transfer between the initiator and the disk drive. Interconnection between the initiator system(s) and the disk drive is via a fifty-pin ribbon cable, and uses the single-ended alternative, which allows up to 6 meters of cable length.

5.1.2 Logical/Electrical Signal Definitions

The SCSI bus uses eighteen signals. Nine signals are for the 8-bit data bus, with one data parity bit; the other nine signals are the SCSI control lines, which coordinate bus accesses for transfers of commands, data, status, and messages. The interface signals are listed below; refer to the SCSI standard for further details. Pin assignments of the connector are provided in "5.1.3 Pin Assignments and Connector" later in this chapter.

Across the SCSI bus all initiator signals are low-true. The signals are asserted, or active, at 0 to 0.4 volts DC, and negated, or inactive, at 2.5 to 5.25 volts DC. This low-true logic is indicated by the negative sign which precedes the signal name.

-RST
The -RST (reset) signal is an or-tied signal asserted by the initiator, causing the disk drive to do a "hard" RESET, self configure and return to the IDLE condition. This signal is normally used during a power-up sequence. The -RST pulse should be at least 25 microseconds wide.

-SEL
The -SEL (select) signal is asserted by the initiator, along with the disk drive's SCSI ID bit (zero through seven), causing the disk drive to be selected. The -SEL line must be negated by the initiator after the disk drive asserts the -BSY line in response to a proper selection. The signal can be asserted by the arbiter (initiator or disk drive) in the ARBITRATION phase. The signal is also asserted by the disk drive during the RESELECTION phase.

-BSY
The -BSY (busy) signal is an or-tied signal asserted by the disk drive, indicating that the bus is being used. It is also asserted by the arbiter during the ARBITRATION phase and by the initiator and the disk drive during the RESELECTION phase.

-C/D
Assertion of the -C/D (control/data) signal by the disk drive indicates that command, status, or message information is to be transferred on the data bus. Negation of this line indicates that data is to be transferred on the data bus.

-I/O
When the -I/O (input/output) signal is asserted by the disk drive it indicates that information is transferred to the initiator from the disk drive. Negation of the signal indicates that information is transferred to the disk drive from the initiator. Note that IN means toward the initiator.

-REQ
When asserted by the disk drive, the -REQ (request) signal indicates that a byte is to be transferred on the data bus. -REQ is negated following assertion of the -ACK line by the initiator.

-ACK
The -ACK (acknowledge) signal is asserted by the initiator, following assertion of the -REQ line, to indicate data has been accepted by the initiator, or that data is ready to be transferred from the initiator to the disk drive. -ACK is negated following negation of the -REQ line.

-ATN
The -ATN (attention) signal is asserted by the initiator to indicate the ATTENTION condition, which is a request by the initiator for the disk drive to enter the MESSAGE OUT phase.

-MSG
The -MSG (message) signal is asserted by the disk drive during one of the message phases. Messages may be either IN or OUT, depending on the state of the -I/O signal.

-DB (7-0, P)
The eight bidirectional data bus lines (DB 7-0) and parity line (DBP) are used to transfer 8 bit parallel data to/from the initiator. Bit seven is the most significant bit. Bits zero through seven are also used as SCSI ID bits during the ARBITRATION, SELECTION and RESELECTION phases. Data bus parity (DBP) is odd.

5.1.3 Pin Assignments and Connector

The disk drive communicates with an initiator system via a fifty-pin connector, J1. The logical/electrical configuration of the SCSI connector is given in Table 5•1, Connector Pin Assignments. Note that the minus sign (-) indicates low-true logic, and that all odd-numbered pins are return (ground) pins for the associated even-numbered pins, except for pin twenty-five, which is not connected. Pin one is located on the end of J1 closest to the DC power connector, J3. (See Figure 5•2, Connector Locations, Rear View of Drive.)

PIN NUMBER	SIGNAL NAME	DESCRIPTION	DRIVEN BY
2	- DB0	Data Bit 0	Host or Drive
4	- DB1	Data Bit 1	Host or Drive
6	- DB2	Data Bit 2	Host or Drive
8	- DB3	Data Bit 3	Host or Drive
10	- DB4	Data Bit 4	Host or Drive
12	- DB5	Data Bit 5	Host or Drive
14	- DB6	Data Bit 6	Host or Drive
16	- DB7	Data Bit 7	Host or Drive
18	- DBP	Data Parity (odd)	Host or Drive
20	Gnd	Reserved	
22	Gnd	Reserved	
24	Gnd	Reserved	
26	- TERMPWR	Termination Power (+5 V DC)	Host or Drive
28	Gnd	Reserved	
30	Gnd	Reserved	
32	- ATN	Attention	Host
34	Gnd	Reserved	
36	- BSY	Busy	Host or Drive
38	- ACK	Acknowledge	Host
40	- RST	Reset	Host
42	- MSG	Message	Drive
44	- SEL	Select	Host or Drive
46	- C/D	Control/Data	Drive
48	- REQ	Request	Drive
50	- I/O	Input/Output	Drive
ALL ODD PINS (except pin 25)	Gnd	Ground	
PIN 25		Open (no connection)	

Table 5-1
Connector Pin Assignments

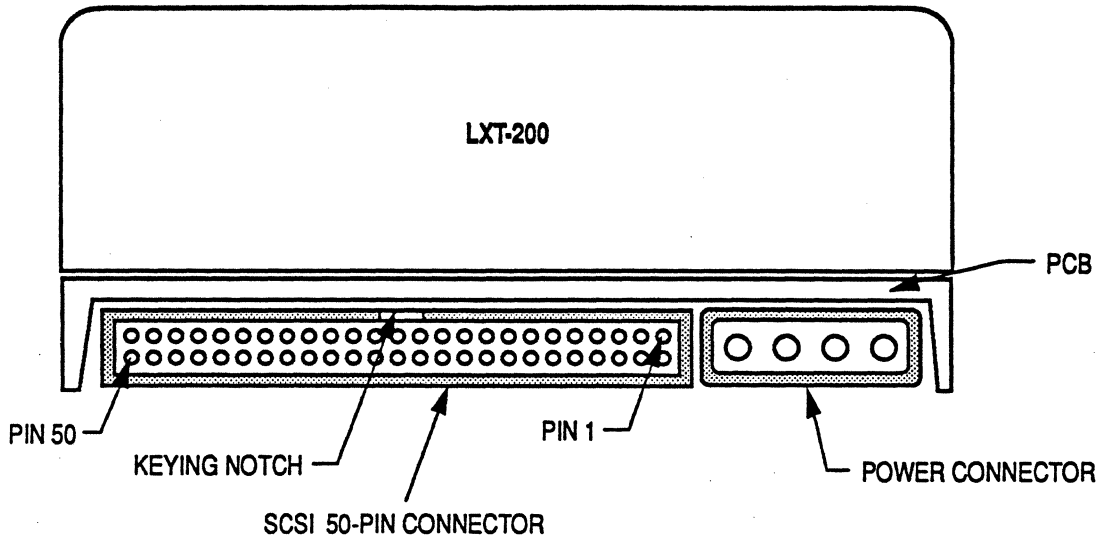


Figure 5•2
Connector Locations, Rear View of Drive

Connection to J1 is via a nonshielded fifty-conductor connector, consisting of two rows of twenty-five female contacts on 0.1 inch centers. Figure 5•3, SCSI Cable Connector, shows the configuration and dimensions of a suitable mating connector. Recommended strain-relief connectors are AMP part number 1-499506-2, or Dupont part number 669002 (66900-250). Use of a keyed connector is strongly recommended.

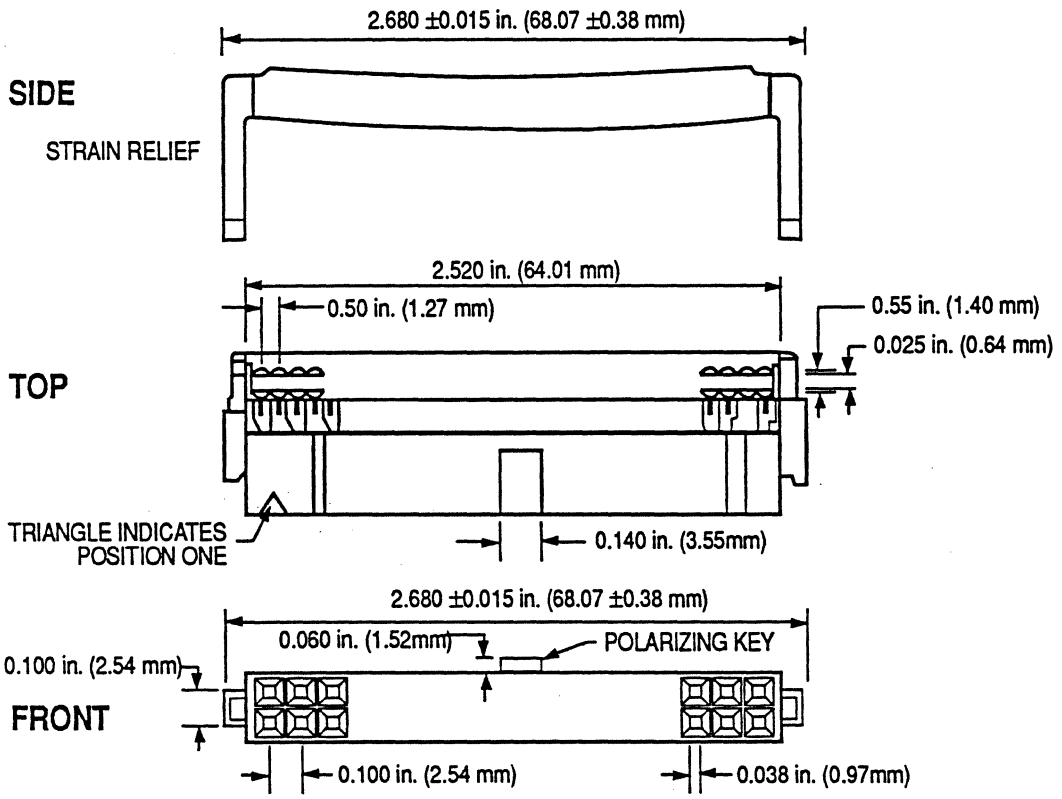


Figure 5-3
SCSI Cable Connector

5.2 ELECTRICAL POWER INTERFACE

This subsection describes the power-up sequence for the disk drive, and the two connectors associated with the electrical power interface. These connectors are the power connector, J3, and the frame ground connector, J4.

5.2.1 Power-Up Sequence

DC power (+5 volts and +12 volts) may be supplied in any order. Both power supplies must be present, and within the tolerances of the power sensing circuit, before the motor will spin up. The typical current draw upon power up has not been determined for the release of this manual. However, this information will be available in the near future. When the spindle reaches full speed, the actuator lock automatically disengages. The disk drive performs automatic SEEK calibration during start up for optimum SEEK performance. The disk drive spins up and becomes ready in 15 seconds. The disk drive

executes its recalibration sequence whenever power is applied or the SCSI START/STOP command is invoked via the SCSI bus.

5.2.2 Power Connector

The DC power connector, J3 (shown in Figure 5•4, J3 Connector) is a four-pin AMP MATE-N-LOCK connector, part number 3505430-1. The recommended mating connector is AMP part number 1-480424-0, using AMP pins part number 350078-4 (strip) or part number 61173-4 (loose piece). J3 pins are numbered and assigned as shown in Figure 5•4. Figure 5•2, Connector Locations, Rear View of Drive, shows the location of J3 on the disk drive.

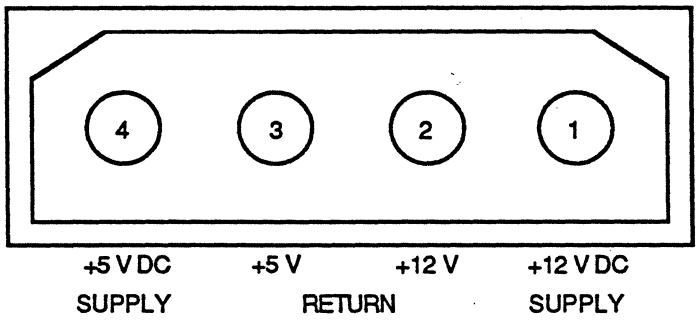


Figure 5•4
J3 Connector

6.0 SCSI PHASES

The condition on the SCSI bus can be divided into eight distinct phases:

BUS FREE phase
ARBITRATION phase
SELECTION phase
RESELECTION phase
COMMAND phase \
DATA phase \ These phases are collectively termed the
STATUS phase / Information Transfer phases.
MESSAGE phase /

The various phases are defined by the state of the SCSI bus signals -SEL, -BSY, -MSG, -C/D, -I/O, -REQ, and -ACK. The SCSI bus can never be in more than one phase at a time. Figure 6•1, Signal Sequence Chart for SCSI Phases, shows the signal sequence of the eight phases. The figure has been provided for your reference while reading the following sections.

NOTE: *A new phase does not begin until the REQ signal is asserted for the first byte of the new phase.*

-SEL	-BSY	-MSG	-C/D	-I/O	BUS	PHASE
HI	HI	X	X	X	X	BUS FREE
HI	LO	X	X	X	ID	ARBITRATION
I	I&T	X	X	X	IDs	SELECTION
T	I&T	X	X	X	ID	RESELECTION
HI	LO	HI	HI	HI	Bytes	DATA OUT
HI	LO	HI	HI	LO	Bytes	DATA IN
HI	LO	HI	LO	HI	Bytes	COMMAND
HI	LO	HI	LO	LO	Byte	STATUS
HI	LO	LO	LO	HI	Byte	MESSAGE OUT
HI	LO	LO	LO	LO	Byte	MESSAGE IN

I = Initiator Asserts
T = Target Asserts

HI = False/negated
LO = True/asserted
X = HI or LO

Table 6•1
Signal States and Bus Phases

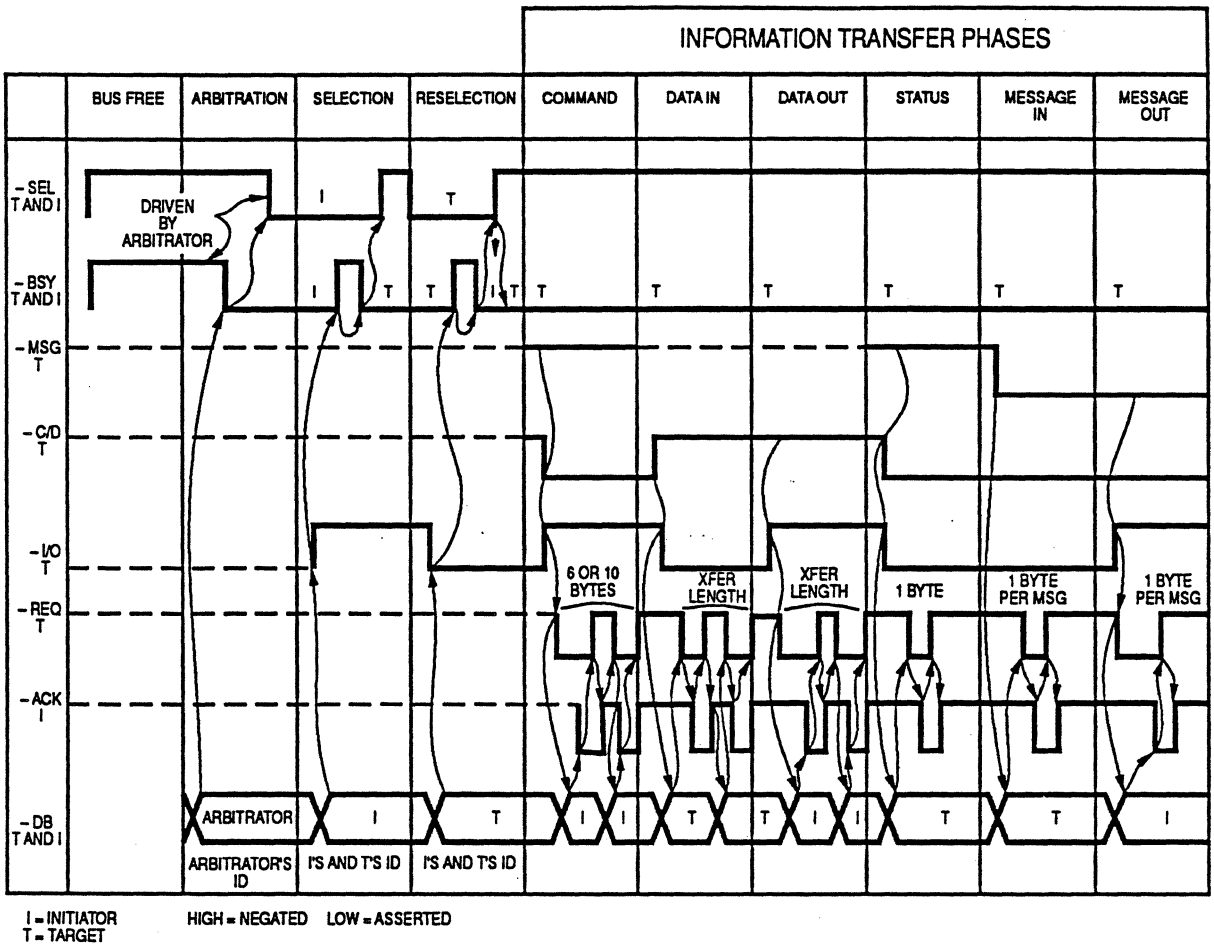


Figure 6-1
Signal Sequence Chart for SCSI Phases

6.1 BUS FREE PHASE

The BUS FREE phase is used to indicate that no SCSI device is actively using the SCSI bus, and that it is available for subsequent users. BUS FREE occurs when the drive releases -BSY following a RESET condition, or certain message phases (that is, COMMAND COMPLETE and DISCONNECT).

6.2 ARBITRATION PHASE

The ARBITRATION phase allows one SCSI device to gain control of the SCSI bus so that it can assume the role of an initiator or target (drive). The arbitrating device waits for the BUS FREE phase to occur. It then asserts its own SCSI ID bit and -BSY. The arbitrating

device then examines the data bus. If a higher priority SCSI ID bit exists on the data bus, the arbitrating device loses arbitration and releases -BSY and the data bus. Otherwise, the arbitrating device wins arbitration and asserts -SEL.

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

6.3 SELECTION PHASE

If the initiator wins arbitration, it enters the SELECTION phase by continuing to assert its own initiator SCSI ID bit and asserting the drive's SCSI ID bit. The initiator then negates -BSY (-SEL remains asserted by the initiator). If the initiator expects the drive to disconnect/reconnect, the initiator must assert the -ATN line prior to the negation of -BSY.

If the initiator does not support arbitration, then the SELECTION phase is entered from the BUS FREE phase. The initiator asserts only the drive's SCSI ID bit and asserts -SEL.

During the SELECTION phase, the drive maintains a negated -I/O line so that the SELECTION phase may be distinguished from the RESELECTION phase.

The drive determines that it has been selected by detecting its SCSI ID bit asserted on the bus (as determined by the ID jumpers—see "2.1 SCSI ID Selection" earlier in this manual).

If more than two IDs are asserted on the data bus, or parity is enabled and bad parity is detected, the drive does not respond to SELECTION.

The drive asserts -BSY after detecting it has been selected. At this point, the initiator must negate -SEL and may remove the IDs from the data bus.

6.4 RESELECTION PHASE

After disconnecting to free the bus for other activity, the drive reconnects when it is ready to transfer data or status across the bus. The drive arbitrates for the bus and, if it wins, reselects the initiator. RESELECTION is very similar to SELECTION, except that the -I/O signal line is asserted. The drive asserts its own SCSI ID bit and the SCSI ID bit of the initiator which is being reselected. The drive releases -BSY (-BSY was already asserted during arbitration) and continues to assert -SEL. The initiator detects that it has been selected and responds by asserting -BSY. The drive detects that the -BSY signal is now true and responds by also asserting -BSY (at this point, both the initiator and the drive are holding the -BSY signal low). The drive then releases -SEL and the initiator responds by

releasing -BSY (-BSY is still being asserted by the drive. See Figure 6•1, Signal Sequence Chart for SCSI Phases.)

After reselecting the initiator, the drive sends an IDENTIFY message to identify itself to the initiator.

If the initiator does not respond to the reselection within a selection time-out delay (see Table 6•2, SCSI Bus Timing), the drive releases the bus and then rearbitrates for the bus, trying to reselect the initiator. It does this up to 255 times, or until the initiator responds or the drive is reset.

NOTE: *The drive does not disconnect if, during the SELECTION phase, the initiator does not set its initiator SCSI device ID on the bus and if the initiator does not send an IDENTIFY message out (with bit six asserted) to the drive.*

6.5 INFORMATION TRANSFER PHASES

The -C/D, -I/O, and -MSG signals are used to distinguish between the different information transfer phases (COMMAND, DATA, STATUS, and MESSAGE). The drive controls these three signals, and, therefore, controls all changes from one phase to another. The initiator can request a MESSAGE OUT phase by asserting -ATN, and the drive can cause a BUS FREE phase by deasserting -SEL and -BSY (and all other SCSI bus signals).

The information transfer phases use one or more -REQ/-ACK handshakes to control the information transfer. Each -REQ/-ACK handshake allows the transfer of 1 byte of information. During the information transfer phases, -BSY remains true and -SEL remains false. Additionally, during the information transfer phases, the drive continuously envelopes the -REQ/-ACK handshake(s) with -C/D, -I/O), and -MSG in such a manner that these control signals are valid for a bus settle delay (see Table 6•2, SCSI Bus Timing) before the assertion of -REQ of the first handshake, and remain valid until the negation of -ACK at the end of the last handshake.

NAME	DELAY TIME
ARBITRATION DELAY	2.2 µsec
ASSERTION PERIOD	90 nsec
BUS CLEAR DELAY	800 nsec
BUS FREE DELAY	800 nsec
BUS SET DELAY	1.8 µsec
BUS SETTLE DELAY	400 nsec
CABLE SKEW DELAY	10 nsec
DATA RELEASE DELAY	400 nsec
DESKEW DELAY	45 nsec
HOLD TIME	45 nsec
NEGATION PERIOD	90 nsec
RESET HOLD TIME	25 µsec
SELECTION ABORT TIME	200 µsec
SELECTION TIMEOUT DELAY	250 msec (recommended)
TRANSFER PERIOD	(set during MESSAGE phase)

Table 6•2
SCSI Bus Timing

6.5.1 Asynchronous Information Transfer

The drive controls the direction of information transfer by means of a -I/O signal. When -I/O is true, information is transferred from the drive to the initiator. When -I/O is false, information is transferred from the initiator to the drive.

If -I/O is true (transfer to the initiator), the drive first drives -DB (7-0, P) to their desired values, delays at least one deskew delay, plus a cable skew delay (see Table 6•2, SCSI Bus Timing), and then asserts -REQ. -DB (7–0, P) remains valid until -ACK is true at the drive. The initiator reads -DB (7-0, P) after -REQ is true, then signals its acceptance of the data by asserting -ACK. When -ACK becomes true at the drive, the drive may change or release -DB (7-0, P) and negates -REQ. After -REQ is false, the initiator then negates -ACK. After -ACK is false, the drive may continue the transfer by continuing to drive -DB (7-0, P) and asserting -REQ as described above.

If -I/O is false (transfer to the drive), the drive requests information by asserting -REQ. The initiator drives -DB (7-0, P) to their desired values, delays at least one deskew delay, plus a cable skew delay (see Table 6•2, SCSI Bus Timing), and asserts -ACK. The initiator continues to drive -DB (7-0, P) until -REQ is false. When -ACK becomes true at the drive, the drive reads -DB (7-0, P) and then negates -REQ. When -REQ becomes false at the initiator, the initiator may change or release -DB (7-0, P), and negates -ACK. The drive may continue the transfer by asserting -REQ as described above.

6.5.2 Synchronous Data Transfer

Synchronous data transfer is not yet supported. When it is supported, synchronous data transfer will be optional, and may be used only if previously agreed to by the initiator and drive through the message system (see "6.6 SYNCHRONOUS DATA TRANSFER REQUEST Message" later in this chapter). The messages determine the use of synchronous mode by the initiator and the drive, and establish a -REQ/-ACK offset and a transfer period. The synchronous mode, once established, remains in effect for all DATA phases until a RESET condition or power cycle occurs.

The -REQ/-ACK offset specifies the maximum number of -REQ pulses that can be sent by the target in advance of the number of -ACK pulses received from the initiator, thereby establishing a pacing mechanism. If the number of -REQ pulses exceeds the number of -ACK pulses by the -REQ/-ACK offset, the drive does not assert -REQ until the next -ACK pulse is received. A requirement for successful completion of the DATA phase is that the number of -ACK and -REQ pulses be equal.

The drive asserts the -REQ signal for a minimum of one assertion period. The drive waits at least the greater of a transfer period from the last transition of -REQ to true, or the minimum of a negation period from the last transition of -REQ to false before the drive asserts the -REQ signal.

The initiator sends one pulse of the -ACK signal for each -REQ pulse received. The initiator asserts the -ACK signal for a minimum of one assertion period. The initiator waits at least the greater of a transfer period from the last transition of -ACK to true, or for a minimum of a negation period from the last transition of -ACK to false, before the initiator asserts the -ACK signal.

If -I/O is true (transfer to the initiator), the drive first drives -DB (7-0, P) to their desired values, waits at least one deskew delay, plus one cable skew delay (see Table 6•2, SCSI Bus Timing), and then asserts -REQ. -DB (7–0, P) are held valid for a minimum of one deskew delay, plus one cable skew delay, plus one hold time (see Table 6•2) after the assertion of -REQ. The drive asserts -REQ for a minimum of one assertion period. The drive may then negate -REQ and change or release -DB (7-0, P). The initiator reads the value on -DB (7-0, P) within one hold time of the transition of -REQ to true. The initiator then responds with an -ACK pulse.

If -I/O is false (transfer to the drive), the initiator transfers 1 byte for each -REQ pulse received. After receiving a -REQ pulse, the initiator first drives -DB (7-0, P) to the desired values, delays at least one deskew delay, plus one cable skew delay (see Table 6•2, SCSI Bus Timing) and then asserts -ACK. The initiator holds -DB (7-0, P) valid for at least one deskew delay, plus one cable skew delay, plus one hold time (see Table 6•2) after the assertion of -ACK. The initiator asserts -ACK for a minimum of one assertion period.

The initiator may then negate -ACK and may change or release -DB (7-0, P). The drive reads the value of -DB (7-0, P) within one hold time of the transition of -ACK to true.

6.5.3 COMMAND Phase

After being selected and processing the IDENTIFY message, if any, the drive normally switches to the COMMAND phase. The 6 or 10 bytes of command information (command descriptor block, or CDB) are transferred from the initiator to the drive.

If enabled, parity is checked on each command byte. If bad parity is detected, the command is aborted. The drive switches to the STATUS phase, returns a CHECK CONDITION status, and sets the sense key/error code to ABORTED COMMAND/Parity Error for that initiator. The drive then switches to the MESSAGE phase, returns a COMMAND COMPLETE message, and goes to the BUS FREE phase.

After each command byte transfer, the -ATN bit is checked; if set, the drive switches to the MESSAGE OUT phase, and receives and then acts on the message.

6.5.4 DATA IN and DATA OUT Phases

In commands that require a DATA phase (READ, WRITE, MODE SELECT), the drive enters a DATA phase. During the DATA IN phase, data is transferred from the drive to the initiator. During the DATA OUT phase, data is transferred from the initiator to the drive.

If bus parity is enabled and bad parity is detected, the command is aborted. The controller switches to the STATUS phase, returns a CHECK CONDITION status, and sets the sense key/error code to ABORTED COMMAND/Parity Error for that initiator. The drive then switches to the MESSAGE phase, returns a COMMAND COMPLETE message, and goes to the BUS FREE phase.

After each block, or group of blocks, is transferred, the -ATN bit is checked; if set, the drive switches to the MESSAGE phase to receive, and then act on, the message.

6.5.5 STATUS Phase

After completing any command (successfully or unsuccessfully, as indicated by the status byte), the drive switches to the STATUS phase and returns the status byte to the initiator (as specified in Table 6•3, Status Byte). The drive also switches to the STATUS phase for reporting a BUSY, INTERMEDIATE/GOOD, or RESERVATION CONFLICT status. The drive does not go to the STATUS phase if it is cleared by a BUS DEVICE

RESET or ABORT message, or by a "hard" RESET condition. Following the STATUS phase, the drive enters the MESSAGE phase.

The format of the status byte containing the command completion information is defined in Table 6•3, Status Byte.

BIT	7	6	5	4	3	2	1	0
	Reserved		Status Code					Reserved

Table 6•3
Status Byte

The reserved field, bit seven, is set aside for future standardization and is always set to zero.

The vendor unique fields, bits five, six, and zero, are reserved and are always set to zero.

The status code field, bits one through four, is used to specify the status of the completed command. Table 6•4, Status Codes, gives the bit values for the status codes returned by the drive.

STATUS CODE BYTE						HEX VALUE	STATUS
5	4	3	2	1	0		
0	0	0	0	0	0	00	GOOD
0	0	0	0	1	0	02	CHECK CONDITION
0	0	1	0	0	0	08	BUSY
0	1	0	0	0	0	10	INTERMEDIATE/GOOD
0	1	1	0	0	0	18	RESERVATION CONFLICT

Table 6•4
Status Codes

Descriptions of the status codes are given below:

GOOD - This status byte indicates that the operation completed as expected.

CHECK CONDITION - Any error, exception, or abnormal condition, that causes sense data to be set causes a CHECK CONDITION status. The REQUEST SENSE command should be issued following a CHECK CONDITION status, to determine the condition.

NOTE: *If any command other than REQUEST SENSE or INQUIRY is issued following a CHECK CONDITION, the sense data is lost.*

BUSY - The drive returns this status whenever it is unable to accept a command. The drive returns this status when it is busy doing self-tests and self configuration after being powered up or reset, or if it is busy executing a previously received command.

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

RESERVATION CONFLICT - This status is returned whenever an initiator attempts to access a drive that is reserved by another initiator.

6.5.6 MESSAGE Phase

The MESSAGE phase is used to transfer information about exception conditions between the initiator and the drive. The MESSAGE IN and MESSAGE OUT phases are discussed below, followed by descriptions of the SCSI messages. Message codes supported by the drive are shown in Table 6•5, Message Codes.

CODE	DESCRIPTION	DIRECTION
00h	COMMAND COMPLETE	Drive to Initiator
01h	EXTENDED MESSAGE (synchronous data transfer request)	Both Ways
02h	SAVE DATA POINTERS	Drive to Initiator
03h	RESTORE POINTERS	Drive to Initiator
04h	DISCONNECT	Drive to Initiator
05h	INITIATOR DETECTED ERROR	Initiator to Drive
06h	ABORT	Initiator to Drive
07h	MESSAGE REJECT	Both ways
08h	NO OPERATION	Initiator to Drive
09h	MESSAGE PARITY ERROR	Initiator to Drive
0Ah	LINKED COMMAND COMPLETE	Drive to Initiator
0Bh	LINKED COMMAND COMPLETE WITH FLAG	Drive to Initiator
0Ch	BUS DEVICE RESET	Initiator to Drive
8Xh	IDENTIFY	Both ways

Table 6•5
Message Codes

A MESSAGE IN PHASE

During the MESSAGE IN phase, a message is transferred from the drive to the initiator. The drive may enter this phase at any time.

B MESSAGE OUT PHASE

During the MESSAGE OUT phase, a message is transferred from the initiator to the drive. The initiator requests the drive to enter the MESSAGE OUT phase by asserting the -ATN line. The drive frequently monitors the -ATN line and enters the MESSAGE OUT phase at its earliest convenience in response to the initiator's assertion of -ATN.

After being selected, the drive checks if -ATN was inserted with the selection. If the initiator has -ATN asserted, the drive requests a message from the initiator by asserting -REQ. The first message is expected to be an IDENTIFY message. If any other message is received, the drive goes to the BUS FREE phase with a CHECK CONDITION status and the sense key/error code set to ABORTED COMMAND/Inappropriate/Illegal Message (0Bh/49h). ("2.6 SYNCHRONOUS DATA TRANSFER REQUEST Message," provides additional information.)

If, during the selection, the initiator does not assert its ID on the bus, or -ATN is not asserted, the drive assumes the initiator cannot support DISCONNECT/RECONNECT.

NOTE: *If the initiator expects the drive to disconnect/reconnect, then a MESSAGE OUT phase (IDENTIFY with bit six true) must occur immediately following a SELECTION phase which had both the initiator's, and the drive's, SCSI device ID asserted on the bus.*

C COMMAND COMPLETE (00h)

This message is sent from the drive to the initiator to indicate that the execution of a command (or a series of linked commands) has terminated, and that valid status has been sent to the initiator. After sending this message successfully, the drive goes to the BUS FREE phase by releasing -BSY unless the initiator sets the -ATN line.

NOTE: *The command may or may not have been executed successfully, as indicated in the status.*

If the initiator rejects this message with a MESSAGE REJECT, the drive goes to the BUS FREE phase and does not consider this an error.

D SAVE DATA POINTER (02h)

When doing disconnects, this message is sent before every DISCONNECT message. If the initiator rejects this message with a MESSAGE REJECT, the drive does not disconnect.

E RESTORE POINTERS (03h)

This message is sent from the drive to the initiator. The message acts to restore to the active state the most recently saved pointers for the currently attached logical unit. Pointers to the command, data, and status locations for the logical unit are restored to the active pointers. Command and status pointers are restored to the beginning of the present command and status areas. The data pointer is restored to the value at the beginning of the data area, or to the value at the point at which the last SAVE DATA POINTERS message occurred for that logical unit.

If the initiator rejects this message with a MESSAGE REJECT, the drive immediately terminates the present command with a CHECK CONDITION status and sets the sense key/error code to ABORTED COMMAND/Message Reject Error (0Bh, 43h) for that initiator.

When the drive reselects the initiator, the IDENTIFY message implies that the initiator should restore its pointers. Therefore, this message is not normally used in reselection.

F DISCONNECT (04h)

This message is sent from the drive to inform the initiator that the present physical path is about to be broken (the drive plans to disconnect by releasing -BSY), but that a later reconnect is required in order to complete the current operation. This message does not cause the initiator to save the data pointer. If the initiator rejects this message with a MESSAGE REJECT, the drive does not disconnect.

G INITIATOR DETECTED ERROR (05h)

This message is issued by an initiator to inform the drive that an error has occurred during an operation. This message should be sent by the initiator when a parity error is detected. The disk drive aborts the current command with a CHECK CONDITION status and a sense key/error code of ABORTED COMMAND/Initiator Detect Error (0Bh/48h).

H ABORT (06h)

This message is sent from the initiator to the drive to clear the present operation. All pending data and status for the issuing initiator is cleared from the drive, and the drive goes to the BUS FREE phase. Pending data and status for other initiators is not cleared. No status or ending message is sent for the operation. It is not an error to issue this message to a logical unit that is not currently performing an operation for the initiator.

I MESSAGE REJECT (07h)

This message is sent from either the initiator or the drive to indicate that the last message received was inappropriate or has not been implemented.

In order to indicate its intentions in sending this message, the initiator asserts -ATN prior to its release of -ACK for the handshake of the message to be rejected. When the drive sends this message, it changes to MESSAGE IN phase and sends this message prior to requesting additional message bytes from the initiator. This provides an interlock so that the initiator can determine which message is rejected.

If the initiator responds to this message with a MESSAGE REJECT message, the drive immediately terminates the present command with a CHECK CONDITION status and sets

the sense key/error code to ABORTED COMMAND/Message Reject Error (0Bh, 43h) for that initiator.

J NO OPERATION (08h)

The initiator sends this message when it has no valid message for the drive request. The drive receives and ignores this message.

K MESSAGE PARITY ERROR (09h)

The initiator sends this message to indicate a parity error on one or more bytes of the last message sent from the drive. The initiator asserts -ATN prior to releasing -ACK for the last byte of the message in error, so that the drive knows which message is in error. The drive goes to the BUS FREE phase and aborts the current command for that initiator. No further reconnection is attempted, and neither STATUS nor COMMAND COMPLETE messages are returned for the command. The sense key/error code is set to ABORTED COMMAND/Parity Error (0Bh, 47h) for that initiator.

L LINKED COMMAND COMPLETE (0Ah)

This message is sent to the initiator to indicate that the execution of a linked command has completed and the status has been sent.

If the initiator responds with a MESSAGE REJECT message, the drive goes to the BUS FREE phase and does not execute the next command in the chain. The sense key/error code is set to ABORTED COMMAND/Message Reject Error (0Bh, 43h) for that initiator.

M LINKED COMMAND COMPLETE (WITH FLAG) (0Bh)

This message is sent to the initiator to indicate that the execution of a linked command (with the flag bit set to one) has completed and that the status has been sent.

If the initiator responds with a MESSAGE REJECT message, the drive goes to the BUS FREE phase and does not execute the next command in the chain. The sense key/error code is set to ABORTED COMMAND/Message Reject Error (0Bh, 43h).

N BUS DEVICE RESET (0Ch)

An initiator may send this message to the drive to clear all current commands on that SCSI device. The drive clears all commands, goes through its initial power up checks, its self configuration, and goes to the BUS FREE state ("hard" RESET).

O IDENTIFY (C0h/80h)

This message is sent by an initiator after it selects a drive. It is sent by the drive as the first message after a reconnect. In addition, this message specifies that the sender supports some or all of the optional messages. The bits in Table 6•6, IDENTIFY Message Codes, show that the only truly changeable bit is bit six; therefore, the command can have only two values: C0h if disconnect/reconnect is supported, 80h if disconnect/reconnect is not supported.

BITS	IDENTIFY MESSAGE FUNCTION
7	Always Set
6	Set Indicates Ability to Disconnect and Reconnect
3 - 5	Reserved
2 - 0	Specify Logical Unit Number (always zero value)

Table 6•6
IDENTIFY Message Codes

If the initiator responds to this message with a MESSAGE REJECT, the drive goes to the BUS FREE phase and sets the sense key/error code to ABORTED COMMAND/Message Reject Error (0Bh, 43h) for that initiator.

NOTE: *The drive does not disconnect if, during the SELECTION phase, the initiator does not set its initiator SCSI device ID on the bus, and if the initiator does not send an IDENTIFY message out (with bit six set) to the drive.*

6.6 SYNCHRONOUS DATA TRANSFER REQUEST MESSAGE (01h)

Presently the Synchronous Data Transfer option is not yet supported and will be determined at a later date.

The drive can, optionally, perform synchronous data transfers, as discussed in "6.5.2 Synchronous Data Transfer." A pair of SYNCHRONOUS DATA TRANSFER REQUEST messages (see Table 6•7, SYNCHRONOUS DATA TRANSFER REQUEST Byte Values) are exchanged between an initiator and the drive under the following conditions:

- A SCSI device that supports synchronous data transfer recognizes it has not communicated with the other SCSI device since receiving the last "hard" RESET.
- A SCSI device that supports synchronous data transfer recognizes it has not communicated with the other SCSI device since receiving a BUS DEVICE RESET message.

SCSI devices may also exchange messages to establish synchronous data transfer when requested to do so. The messages exchanged establish the transfer period and the -REQ/-ACK offset.

BYTE	VALUE	DESCRIPTION
0	01h	Extended Message
1	03h	Extended Message Length
2	01h	SYNCHRONOUS DATA TRANSFER REQUEST Code
3	m	Transfer Period (m times 4 nanoseconds)
4	00–0Fh	REQ/ACK offset

Table 6•7
SYNCHRONOUS DATA TRANSFER REQUEST Byte Values

The transfer period is defined as the minimum time between the leading edge of a -REQ pulse and of its corresponding -ACK pulse. The -REQ/-ACK offset is defined as the maximum number of -REQ pulses that may be outstanding before the corresponding -ACK pulse is received at the drive. A -REQ/-ACK offset value of zero indicates asynchronous mode; a value of 0Fh yields the maximum number of outstanding -REQ pulses supported (15).

If the initiator recognizes that negotiation is required, it asserts -ATN and, if the drive implements message transfers, sends a SYNCHRONOUS DATA TRANSFER REQUEST message, specifying the -REQ/-ACK offset and minimum transfer period. The -REQ/-ACK offset is chosen to meet the data handling requirements of the target, while the minimum transfer period is chosen to meet the data handling requirements of the initiator. The drive responds in any of the following ways:

Drive Response	Implied Agreement
-REQ/-ACK offset less than or equal to the requested value.	-REQ/-ACK offset equal to drive value.
Minimum transfer period equal to or greater than requested period.	Minimum transfer period equal to the drive value.
-REQ/-ACK offset equal to zero.	Asynchronous transfer.
MESSAGE REJECT.	Asynchronous transfer.

The implied agreement remains in effect until a BUS DEVICE RESET message is received, a "hard" RESET condition occurs, or until one of the two SCSI devices elects to modify the agreement. Renegotiation at every selection is not recommended since a significant performance impact is likely. The default mode of data transfer is asynchronous. The default mode is entered at power on, after a BUS DEVICE RESET message, or after a "hard" RESET condition. The SYNCHRONOUS DATA TRANSFER REQUEST message exchange can only take place following a SELECTION phase that includes the SCSI IDs for both the initiator and the target. Violation of this rule may make data transfer impossible owing to disagreements among SCSI devices about the data transfer mode.

6.7 ERROR CONDITIONS

Under several error conditions, the drive changes the phase to BUS FREE without correctly terminating the command (that is, no DISCONNECT or COMMAND COMPLETE message is sent). The drive clears all information regarding the command, except sense data (if any), and does not attempt to reconnect, or in any other way terminate, the command. The initiator must assume this is a catastrophic failure and return the error to the system software.

Sense data may or may not be valid when this condition occurs. If the initiator issues a REQUEST SENSE command and the returned sense key/error code is anything other than 00h/00h, the sense data is valid.

6.7.1 MESSAGE OUT Phase Parity Error

If the drive detects a parity error during the MESSAGE OUT phase, the drive processes the error using the following sequence:

- The drive terminates the present command with a CHECK CONDITION status and sets the sense key/error code to ABORTED COMMAND/Parity Error (0Bh/47h). This error does not prevent the initiator from trying the command again.

6.7.2 COMMAND Phase Parity Error

When the drive detects a parity error during the COMMAND phase, the drive aborts the command using the following sequence:

- The disk drive terminates the command with a CHECK CONDITION status and sets the sense key/error code to ABORTED COMMAND/Parity Error (0Bh/47h). This error does not prevent the initiator form trying the command again.

6.7.3 DATA OUT Phase Parity Error

If the drive detects a parity error during the DATA OUT phase, it terminates the command with a CHECK CONDITION status, and sets the sense key/error code to ABORTED COMMAND/Parity Error (0Bh/47h). This error does not prevent the initiator from trying the command again.

6.7.4 Initiator Detected Error

If the drive receives an initiator detected error message at any time during the command, except during the STATUS phase or COMMAND COMPLETE message, it terminates the current command with a CHECK CONDITION status and sets the sense key/error code to ABORTED COMMAND/Initiator Detected Error (0Bh/48h). This error does not prevent the initiator from trying the command again.

If the initiator sends an initiator detected error message immediately after the STATUS phase, the drive immediately goes to the BUS FREE phase. The sense key/error code is set to ABORTED COMMAND/Initiator Detected Error (0Bh/48h). This error does not prevent the initiator from trying the command again.

If the initiator sends an initiator detected error message immediately after the COMMAND COMPLETE message is sent, the drive immediately goes to the BUS FREE phase. The sense key/error code is set to ABORTED COMMAND/Initiator Detected Error (0Bh/48h). This error does not prevent the initiator from trying the command again.

6.7.5 REJECTED Message

When the drive receives a MESSAGE REJECT message from the initiator, the drive takes one of the following actions, based on which message was rejected:

- COMMAND COMPLETE - The drive goes to the BUS FREE phase and does not consider this an error.

- DISCONNECT - The drive does not disconnect from the initiator and continues the current command. This condition does not preclude the drive from attempting to disconnect at a later time.

  NOTE: *The drive does not send a DISCONNECT message to an initiator which does not support the disconnect/reconnect option.*

- IDENTIFY (Reconnect) - The drive immediately goes to the BUS FREE phase and aborts the current SCSI command. No further reconnection is attempted, and no STATUS or COMMAND COMPLETE message is sent for the command. The sense key/error code is set to ABORTED COMMAND/Message Reject Error (0Bh, 43h).

- LINKED COMMAND COMPLETE - The drive immediately goes to the BUS FREE phase and does not read the next command in the linked list. The sense key/error code is set to ABORTED COMMAND/Message Reject Error (0Bh, 43h).

- MESSAGE REJECT - The drive immediately terminates the present command with a CHECK CONDITION status and sets the sense key/error code to ABORTED COMMAND/Message Reject Error (0Bh, 43h).

- RESTORE POINTERS - Since the RESTORE POINTERS message is only used in an error recovery or retry situation, the drive aborts the recovery or retry attempt, assumes the error is unrecoverable, and completes the command according to the error condition.

- SAVE DATA POINTER - The drive assumes the initiator does not support this message and does not attempt to disconnect from the bus during this command.

6.7.6 Initiator MESSAGE PARITY ERROR

When the drive receives a MESSAGE PARITY ERROR message from the initiator, the drive immediately goes to the BUS FREE phase, and aborts the current SCSI command. No further reconnection is attempted, and no STATUS or COMMAND COMPLETE message is returned for the command. The sense key/error code is set to ABORTED COMMAND/Parity Error (0Bh/47h).

6.7.7 RESELECTION Time-Out

When the drive attempts to reselect the initiator and the initiator does not respond within a selection time-out delay (as defined in the SCSI standard), the reselection is aborted. No further reconnection is attempted, and no STATUS or COMMAND COMPLETE message is returned for the command. The sense key/error code is set to ABORTED COMMAND/Select-Reselect Time-Out (0Bh/45h).

NOTE: *The initiator must have an overall command time-out delay to detect this error.*

6.7.8 Internal Controller Errors

If an error occurs within the embedded controller that is related to the SCSI hardware or firmware, the drive terminates the present command with a CHECK CONDITION status and sets the sense key/error code to HARDWARE ERROR/SCSI Hardware Error (04h/44h). This error does not prevent the initiator from trying the command again.

7.0 SCSI COMMAND DESCRIPTIONS

This section describes the SCSI commands implemented by the Maxtor LXT-200 disk drives. The command descriptions are listed alphabetically as a reference aid. The SCSI Command Overview explains the fields in the command descriptor block (CDB) that are common to all commands. Each individual command description explains the command function, the CDB, and any data returned.

7.1 SCSI COMMAND OVERVIEW

This subsection describes the fields in the CDB common to every command. Each SCSI command is described in a separate subsection, including CDB formats, hexadecimal operation code, byte and bit functions, and any necessary effects produced by the commands.

A request from the initiator is performed by sending a CDB to the drive. For some commands, the request is accompanied by a list of parameters, or other information sent during the DATA OUT phase, or a list may be returned to the initiator from the drive during the DATA IN phase. Table 7•1, Typical CDB for 6-Byte Commands, and Table 7•2, Typical CDB for 10-Byte Commands, show the basic organization of CDBs. Explanations of those fields which are common among all commands follow.

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

Table 7•1
Typical CDB for 6-Byte Commands

BYTE \ BIT	7	6	5	4	3	2	1	0
0	Operation Code							
1	LUN			Reserved (zeros)				
2	Logical Block Address (MSB) (if required)							
3	Logical Block Address (if required)							
4	Logical Block Address (if required)							
5	Logical Block Address (LSB) (if required)							
6	Reserved (zeros)							
7	Transfer Length (MSB) (if required)							
8	Transfer Length (LSB) (if required)							
9	Control Byte							

Table 7•2
Typical CDB for 10-Byte Commands

The reserved bits, bytes, fields, and code values are set aside for future standardization. All reserved bits, bytes, or fields are checked by the drive and must be set to zero. If a reserved field is not set to zero, the drive may terminate the command with a CHECK CONDITION status and an ILLEGAL REQUEST/Illegal Field in CDB (05h/24h), or ILLEGAL REQUEST/Illegal Field in Parameter List (05h/26h) sense key/error code.

The operation code is the first byte, byte zero, of a CDB (see Table 7•3, CDB Operation Code Format). The operation code contains two fields: the group code in the high-order three bits, bits five through seven, and the command code in the low-order five bits, bits zero through four. The group code specifies the length of the CDB and, together with the command code, determines the operation to be performed. If the specified operation code is invalid or not implemented, the drive returns a CHECK CONDITION status with an ILLEGAL REQUEST/Invalid Command (05h/20h) sense key/error code.

BYTE \ BIT	7	6	5	4	3	2	1	0
0	Group Code			Command Code				

Table 7•3
CDB Operation Code Format

The group code specifies one of the following groups:

Group 0 - 6-byte commands (see Table 7•1).
Group 1 & 7 - 10-byte commands (see Table 7•2).

The command code specifies one of the commands in Table 7•4, CDB Operation Codes.

OPERATION CODE	COMMAND NAME	OPERATION CODE	COMMAND NAME
00h	TEST UNIT READY	1Ch	RECEIVE DIAGNOSTIC RESULTS
01h	REZERO UNIT	1Dh	SEND DIAGNOSTIC
03h	REQUEST SENSE	25h	READ CAPACITY
04h	FORMAT UNIT	28h	READ (EXTENDED)
07h	REASSIGN BLOCK	2Ah	WRITE (EXTENDED)
08h	READ	2Bh	SEEK (EXTENDED)
0Ah	WRITE	2Eh	WRITE AND VERIFY
0Bh	SEEK	2Fh	VERIFY
12h	INQUIRY	37h	READ DEFECT LIST
15h	MODE SELECT	3Bh	WRITE BUFFER
16h	RESERVE UNIT	3Ch	READ BUFFER
17h	RELEASE UNIT	E8h or 3Eh	READ LONG
1Ah	MODE SENSE	EAh or 3Fh	WRITE LONG
1Bh	START/STOP UNIT		

Table 7•4
CDB Operation Codes

The logical unit number (LUN) field, byte one, bits five through seven, contains the number of the device being addressed. The drive, acting as a SCSI bus target, supports only a LUN field value of zero. Therefore, the value for the LUN field (in byte one of the CDB) is limited to 000 (binary). If an invalid LUN field value is specified, the drive returns a CHECK CONDITION status, with an ILLEGAL REQUEST/Invalid LUN (05h/25h) sense key/error code. The drive provides this method of addressing the device for initiators that do not implement the IDENTIFY message. An LUN specified in the IDENTIFY message overrides any LUN specified in the CDB.

The relative address (RelAdr) bit is not currently supported. When it is implemented it will be set to one to indicate that the LBA portion of the CDB is a twos complement displacement. This negative or positive displacement is added to the LBA last accessed on the logical unit, to form the LBA for this command. This feature will only be available when linking commands, and it requires that a previous command in the linked group have accessed a block of data on the logical unit.

The LBA field begins with block zero and is contiguous up to the last logical block. The maximum LBA is variable, depending on the parameters selected for the number of bytes per sector and number of alternate sectors.

NOTE: *The maximum LBA allowable is returned to a READ CAPACITY command with a partial media indicator (PMI) bit equal to zero.*

Group 0 commands contain 21-bit LBAs.

Group 1 and 7 commands contain 32-bit LBAs.

The control byte is the last byte in every CDB. The control byte is separated into three fields, as shown in Table 7•5, Control Byte.

BIT / BYTE	7	6	5	4	3	2	1	0
Last	Reserved (zeros)						Flag	Link

Table 7•5
Control Byte

Bits seven through two are reserved.

Bit one is defined as the flag bit, and is only checked when the link bit is set to one. When the flag bit is zero, the drive sends a LINKED COMMAND COMPLETE message when the command completes successfully. If the flag bit is set to one, the drive sends a LINKED COMMAND COMPLETE (WITH FLAG) message when the command completes successfully.

Bit zero is defined as the link bit. When the current command completes successfully and the link bit is set to one, the drive returns an INTERMEDIATE status, followed by one of the two messages defined by the flag bit above. The drive then automatically links to the next command. If a linked command is not completed successfully, the drive returns a CHECK CONDITION status, and does not link to the next command.

The remaining bytes in the CDB are primarily command dependent, and are described in the following individual command sections.

7.2 FORMAT UNIT - 04h

The FORMAT UNIT command ensures that the media is formatted so that all data blocks can be accessed. The drive maintains a defective sector and track file on the disk on a cylinder that is inaccessible to the initiator. During the formatting process, the initiator may specify a set of defective blocks or tracks to be reassigned using spare blocks or alternate tracks, as appropriate.

The FORMAT UNIT command requires two disk revolutions to format each track and uses three different sets of defect information:

- Primary, or Manufacturer's, Defect List (P list) - The primary defect list is supplied by the manufacturer, and is resident on the disk drive.

- Initiator Defect List (D list) - This list is the defect descriptor(s) supplied to the drive by the initiator in the DATA OUT phase. The list is supplied by the initiator when bits four and two of byte one of the CDB are set to one, and bytes two and/or three of the defect list header are not zero. If the defect list length (bytes two and three) of the defect list header is null, no defect descriptor(s) (D list) is transferred. The defects identified by the initiator in the D list are mapped out and added to the grown list (G list).

- Grown Defect List (G list) - This list includes defects identified to, or by, the drive (the D and G lists). It does not include the P list. These defects are classified as flaws appearing after the medium has been formatted. The initiator may request that the current G list be used during formatting (CDB bit CmpLst–complete list) set to zero, and FmtData set to one), or that the current G list be erased and a new one begun (CDB bit CmpLst set to one, and FmtData set to one). Entries to this G list include defects provided to the drive in D lists during previous FORMAT UNIT commands, the drive C list defects detected during the previous FORMAT UNIT command, and defects appended by successful completion of the REASSIGN BLOCKS command.

7.2.1 Defect List Management

The FORMAT UNIT command uses the drive geometry, and format information read from a reserved area on the disk during power up, to format the disk drive. These parameters may be changed by using the MODE SELECT command just prior to issuing the FORMAT UNIT command. If the information contained in the reserved area is invalid, or cannot be read, the FORMAT UNIT command uses the default parameters, as returned by a MODE SENSE command. See "7.5 MODE SENSE" later in this chapter.

In order for any list of defects to be relocated, the drive's current values for the alternates per zone field in MODE SELECT, Page Code 3, or MODE SENSE, Page Code 3, must be greater than zero.

The initiator may select how the drive handles the list by using of the bits in the CDB and the defect list header (see Table 7-6, FORMAT UNIT CDB).

The drive has the capability of mapping out bad sectors so that the drive medium appears error free to the initiator. In the D list header, during the DATA OUT phase of a FORMAT UNIT command, the initiator may use the disable primary (DPRY), and format options valid (FOV), bits to request whether or not the drive relocates the P list recorded by Maxtor prior to shipment. Also, the drive maintains, and maps out, an additional list of flaws (G list) on the disk if requested by the initiator in the FORMAT UNIT CDB, by using the complete list (CmpLst) bit. The G list, if it exists and is readable, may include any errors identified by the initiator in the D list supplied in the defect descriptors during the DATA OUT phase of the FORMAT UNIT command. The G list also includes errors previously identified by all REASSIGN BLOCK commands that have been issued since the last completion of a FORMAT UNIT command with the complete list (CmpLst) bit set to one.

With the MODE SELECT command, the initiator specifies how many sectors are deallocated, either per track or per cylinder, to handle bad sectors. See the zone definition in "7.4.6 Direct-Access Device Format Parameters Page" later in this chapter. If the initiator deallocates no spare sectors with the MODE SELECT command (zero alternates per zone), then the drive does not map out any flaws or create any spare sectors (the initiator operating system must handle the defects). If the initiator attempts either a REASSIGN BLOCK , or FORMAT UNIT, command which involves block reassignment, without first deallocating spare sectors, the drive returns an error condition.

The initiator may disable the relocation of all defect lists (including default format) while enabling the deallocation of spare sectors (assuming the current value of alternates per zone is greater than zero), by performing a FORMAT UNIT command 04, 18, 00, 00, 00, 00, with a header DATA OUT phase of 00, E0 (or F0), 00, 00.

The initiator may disable deallocation of spare sectors, and relocation of all defect lists, by performing a MODE SELECT command, which sets alternates per zone, and alternates per volume, to zero, followed by a FORMAT UNIT command 04, 00, 00, 00, 00, 00.

7.2.2 SCSI Deviations

There are no deviations.

7.2.3 Command Parameters

The CDB for the FORMAT UNIT command is formatted as shown in Table 7-6, FORMAT UNIT CDB.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Command Code (04h)							
1	LUN (zeros)			FmtData	CmpLst	Defect List Format		
2	Reserved (zeros)							
3	Interleave Factor (MSB)							
4	Interleave Factor (LSB)							
5	Control Byte							

Table 7-6
FORMAT UNIT CDB

A format data (FmtData) bit of one indicates that a DATA OUT phase takes place during command execution. The DATA OUT phase consists of the 4-byte defect list header and, if there is a nonzero defect list length, a D list. The header specifies if the drive formats using the P list, if the drive stops on an error during format, and the length of the D list, if any. The optional D list follows the header during the DATA OUT phase. The D list consists of one or more defect descriptors.

The format of the D list is determined by the defect list format defined by bits zero through two of the CDB. If bit two of byte one of the CDB equals zero, only the 4-byte defect list header is transferred from the initiator during the DATA OUT phase. In this case, the defect list length of the header (bytes two and three) must equal zero. If bit two of byte one of the CDB equals one, then one or more defect descriptors is transferred in the bytes from index format.

A format data (FmtData) bit of zero indicates that the DATA OUT phase does not occur (no defect list header and no defect descriptors are supplied by the initiator). If MODE SELECT Page Code 3 (alternates per zone) does not equal zero, then the P list is mapped out. If alternates per zone equals zero, then no defects are mapped out and the drive is not requested to handle defects at all. No spare locations are deallocated by the drive. Further REASSIGN BLOCK commands are rejected with a CHECK CONDITION status and ILLEGAL REQUEST sense key.

A complete list (CmpLst) bit of one indicates the D list defined by the initiator during the DATA OUT phase of the command execution is the complete list of known defects. The result is to erase the current G list and build a new G list.

NOTE: *The format data (FmtData) bit must equal one if the complete list (CmpLst) bit equals one.*

A complete list (CmpLst) bit of zero indicates that the data supplied by the initiator during the DATA OUT phase (header only, or header and descriptors) is an addition to existing defect data already removed from the initiator-addressable blocks. The result is that the existing G list (if one exists) is used. At the initiator request, the P and/or D lists are also used.

The defect list format (bits zero through two) is used to specify the format of the defect descriptors used for a D list. See "7.2.5 Initiator Defect List" later in this chapter.

The interleave factor field, bytes three and four, only supports an interleave factor of one (1:1 ratio) for best drive performance.

NOTE: *An interleave factor of zero or one requests that the target use its default interleave (1:1 sequential).*

7.2.4 Format Modes

The format mode is selected by a combination of the FORMAT UNIT CDB, and the defect list header. Through control of the appropriate fields, the initiator determines whether the drive's internal defect lists are used, the initiator is to supply the defect list, or both. The D list is discussed in detail in "7.2.5 Initiator Defect List."

If the format data (FmtData) bit is set to one, the drive transfers the defect list header from the initiator to the drive during the DATA OUT phase of the FORMAT UNIT command. The defect list header is 4 bytes long, followed by zero or more defect descriptors. The header specifies the total number of bytes in the defect list and several parameters for the format mode (see Table 7•7, FORMAT UNIT Defect List Header).

BYTE \ BIT	7	6	5	4	3	2	1	0
0	Reserved (zeros)							
1	FOV	DPRY	DCRT	STPF	Reserved (zeros)			
2	Defect List Length (MSB)							
3	Defect List Length (LSB)							

Table 7-7
FORMAT UNIT Defect List Header

The format options valid (FOV) bit, byte one, bit seven, when set to one, indicates the other fields in this byte are valid and may be set to one also. If this bit is set to zero, bits one through six must also be set to zero, and the drive formats the drive using the P list.

The disable primary (DPRY) bit, byte one, bit six, when set to one, specifies the drive is to format the disk without using the P list. If this bit is zero, the drive uses the P list. This bit is only valid if the format options valid (FOV) bit is set to one.

The disable certification (DCRT) bit, byte one, bit five, must be set to one for disabling all of the certification options. The drive does not support certification.

The stop format (STPF) bit, byte one, bit four, when set to one, specifies that the drive terminates the command when it encounters an unrecoverable error while accessing any of the defect lists. When this bit is zero, the drive continues the format operation if any of the above errors occur. This bit is only valid if the format options valid (FOV) bit is set to one.

The vendor unique (VU) bit, byte one, bit zero, is not supported by the drive and must be set to zero.

The defect list length field, bytes two and three, specifies the total number of bytes (not the total number of defect descriptors) in the D list (provided by the initiator). This length does not include the 4 bytes in the header. A defect list length of zero indicates that no D list is provided by the initiator, and is not considered an error by the drive.

The format mode for the drive is specified with the following bits: format data (FmtData), complete list (CmpLst), and disable primary (DPRY). If the format options valid (FOV) bit in the defect list header is zero, or if the format data (FmtData) bit is zero, the drive treats the disable primary (DPRY) and disable certification (DCRT) bits as if they were set to zero and one, respectively. Table 7•8, FORMAT UNIT Drive Format Modes, lists the format modes supported by the drive, and their corresponding states for the 4 bits.

FMT DAT	CMP LST	DPRY	DCRT	FORMAT MODE
0	X	X	X	The disk drive formats the media using the P list. The previous G list is purged. There is no DATA phase for this format mode.
1	0	0	1	The disk drive formats the media using the P list and the current G list to produce the full set of known defects.
1	1	0	1	The disk drive formats the media using the P list to produce the full set of known defects. The previous G list is purged.
1	0	1	1	The disk drive formats the media using the current G list to produce the full set of known defects.
1	1	1	1	The disk drive formats the media using the D list (if any). The previous G list is purged.

X = Either 0 or 1

Table 7•8
FORMAT UNIT Drive Format Modes

7.2.5 Initiator Defect List

In order for the initiator to provide a D list, the format data (FmtData) bit must be set to one in the CDB, and bits zero through two of byte one in the CDB must be set to one of the three valid options shown in Table 7•9, FORMAT UNIT D List Formats. Also, the defect list length, bytes two and three of the defect list header, must be set to the appropriate nonzero value. The two valid D list options, bytes from index and physical, are detailed as in Table 7•9.

NOTE: *The initiator should use the drive's internal defect maps, rather than sending a D list to the drive. Maxtor performs extensive testing of all drives, and adds all areas of defective or marginal performance to the defect lists. If the initiator disables the internal lists using the disable primary (DPRY) bit, marginal sectors might cause future loss of data.*

Also, the drive uses sophisticated algorithms to determine when to deallocate multiple sectors for a single defect. The limitations of the bytes from index format of the READ DEFECT LIST and FORMAT UNIT commands do not allow for reporting the length of a defect, even though this information is stored in the P list. Therefore, the drive is better able to judge when a defect will cross sector boundaries than is the initiator.

DEFECT LIST FORMAT BITS			DESCRIPTION
2	1	0	
1	0	0	Format with bytes from index format. The D list, if any, is in bytes from index format.
1	0	1	Format with physical sector format. The D list, if any, is in physical sector format.
1	1	0	Vendor unique (reserved).
1	1	1	Reserved.

Table 7-9
FORMAT UNIT D List Formats

A **D LIST BYTES FROM INDEX FORMAT**

The D list is transferred from the initiator to the drive during the DATA OUT phase of the FORMAT UNIT command. The D list begins with a 4-byte header, followed by zero or more 8-byte defect descriptors. When the D list is specified using the number of bytes from index, the drive uses the format described in Table 7-10, FORMAT UNIT Defect Descriptor(s), Bytes from Index Format.

BYTE \ BIT	7	6	5	4	3	2	1	0
0	Cylinder Number of Defect (MSB)							
1	Cylinder Number of Defect							
2	Cylinder Number of Defect (LSB)							
3	Head Number of Defect							
4	Defect Bytes from Index (MSB)							
5	Defect Bytes from Index							
6	Defect Bytes from Index							
7	Defect Bytes from Index (LSB)							

Table 7•10
FORMAT UNIT Defect Descriptor(s), Bytes from Index Format

The cylinder number of defect field, bytes zero through two, specifies the physical cylinder number which contains the defect.

The head number of defect field, byte three, specifies the head number which contains the defect.

The defect bytes from index field, bytes four through seven, specifies the number of bytes between the index and the defect on the specified track.

The defect descriptors must be in ascending order. For determining ascending order, the cylinder number of defect is considered the most significant part of the address, and the defect bytes from index is considered the least significant part of the address.

B D LIST PHYSICAL SECTOR FORMAT

The defect list is transferred from the initiator to the drive during the DATA OUT phase of the FORMAT UNIT command. The defect list begins with a 4-byte header, followed by zero or more 8-byte defect descriptors. When the defect list is specified using physical sector addresses, the drive uses the format in Table 7•11, FORMAT UNIT Defect Descriptor(s), Physical Sector Format.

BYTE \ BIT	7	6	5	4	3	2	1	0
0	Cylinder Number of Defect (MSB)							
1	Cylinder Number of Defect							
2	Cylinder Number of Defect (LSB)							
3	Head Number of Defect							
4	Defect Sector Number (MSB)							
5	Defect Sector Number							
6	Defect Sector Number							
7	Defect Sector Number (LSB)							

Table 7-11
FORMAT UNIT Defect Descriptor(s), Physical Sector Format

The cylinder number of defect field, bytes zero through two, specifies the physical cylinder number which contains the defect.

The head number of defect field, byte three, specifies the head number which contains the defect.

The defect sector number field, bytes four through seven, specifies the sector number which contains the defect.

The defect descriptors must be in ascending order. For determining ascending order, the cylinder number of defect is considered the most significant part of the address, and the defect sector number is considered the least significant part of the address.

7.2.6 Error Conditions

If the format mode is invalid, the drive terminates the command with a CHECK CONDITION status and an ILLEGAL REQUEST/Invalid Field in CDB (05h/24h), or ILLEGAL REQUEST/Invalid Field in Parameter List (05h/26h) sense key/error code, whichever is applicable.

If the stop format (STPF) bit is one, and the drive encounters an unrecoverable error reading or accessing a defect list, the drive terminates the command with a CHECK CONDITION status and a MEDIUM ERROR/Defect List Error (03h/19h) sense key/error code.

If the drive has insufficient capacity to reassign all the defective blocks, it terminates the command with a CHECK CONDITION status and a MEDIUM ERROR/No Defect Spare Location Available (03h/32h) sense key/error code.

If the stop format (STPF) bit is zero, and the drive encounters an error while accessing a defect list, it continues the FORMAT UNIT command. When the command is completed, and no other errors occur, it terminates with a CHECK CONDITION status and a RECOVERED ERROR/Defect List Error (01h/19h) sense key/error code.

If the format options valid (FOV) bit in the defect list header is zero, and the disable primary (DPRY), disable certification (DCRT), and stop format (STPF), bits are not zero, the drive terminates the command with a CHECK CONDITION status and an ILLEGAL REQUEST/Invalid Field in Parameter List (05h/26h) sense key/error code.

If the stop format (STPF) bit is one, the disable primary (DPRY) bit is zero, and the drive cannot locate the P list, the drive terminates the command with a CHECK CONDITION status and an ILLEGAL REQUEST/Primary Defect List Not Found (05h/1Ch) sense key/error code.

If the stop format (STPF) bit is zero, the disable primary (DPRY) bit is zero, and the drive cannot locate the P list, it continues the FORMAT UNIT command. When the command is completed, and no other errors occur, the drive terminates with a CHECK CONDITION status and a RECOVERABLE ERROR/Primary Defect List Not Found (01h/1Ch) sense key/error code.

7.3 INQUIRY - 12h

The INQUIRY command provides a means by which the initiator may request information regarding the drive.

If an INQUIRY command is received from an initiator with a pending UNIT ATTENTION condition, the drive executes the INQUIRY command, returns a GOOD status, and does not clear the UNIT ATTENTION condition.

When the INQUIRY command is sent to a nonexistent LUN (that is, any LUN other than zero), the drive transfers the INQUIRY response data back to the initiator and terminates the command with GOOD status. The initiator must examine the peripheral device type field to determine if it is a valid LUN.

7.3.1 SCSI Deviations

There are no deviations.

7.3.2 Command Parameters

The INQUIRY CDB is formatted as shown in Table 7•12, INQUIRY CDB.

BYTE \ BIT	7	6	5	4	3	2	1	0
0	Operation Code (12h)							
1	LUN (zeros)			Reserved (zeros)				
2	Reserved (zeros)							
3	Reserved (zeros)							
4	Allocation Length							
5	Control Byte							

Table 7•12
INQUIRY CDB

The allocation length field, byte four, specifies the number of bytes the initiator has allocated for the returned INQUIRY data. An allocation length of zero indicates that no data is transferred to the initiator, and this is not considered an error. Any other value indicates the maximum number of bytes that are transferred. The drive terminates the data transfer when the number of bytes specified in the allocation length field is transferred, or when all available INQUIRY data is transferred, whichever is less.

7.3.3 Data Format

The INQUIRY command returns 36 bytes of data to the initiator. This data is formatted as in Table 7•13, INQUIRY Response Data.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Peripheral Device Type (00h)							
1	RMB	Device Type Qualifier						
2	ANSI Version (01h)							
3	Reserved (zeros)				Response Data Format (1h)			
4	Additional Length (1Fh)							
5	Request Sense Length							
6-7	Reserved (zeros)							
8-15	Vendor Identification- "MAXTOR" (in ASCII)							
16-31	Product Identification (in ASCII)							
32-35	Firmware Revision Level (in ASCII)							

Table 7•13
INQUIRY Response Data

If the LUN field in the CDB is zero, the peripheral device type field, byte zero, is zero to indicate that this is a direct-access device (disk drive). If the specified LUN is nonexistent (that is, any LUN other than zero), this field is set to 07Fh. A nonexistent LUN is a LUN not supported by the drive. The drive supports a LUN equal to zero only.

INQUIRY - 12h

The removable media (RMB) bit, byte one, bit seven, is always set to zero because the drive does not support removable media.

The device type qualifier field, byte one, bits six through zero, is always zero because the drive supports a direct-access device.

The ANSI version field, byte two, is always 01h to indicate the drive complies with the ANSI SCSI standard X3.131-1986.

The response data format field, byte three, bits zero through three, is always set to one, indicating that the drive conforms to the SCSI CCS for direct-access devices.

The additional length field, byte four, defines the number of parameter bytes which follow. The field is always set to 31 (1Fh).

The vendor identification field, bytes eight through fifteen, is always set to the ASCII string "MAXTOR." The string is left justified and followed by two ASCII spaces (20h), for a total of eight characters.

The product identification field, bytes sixteen through thirty one, contains the Maxtor product identifier in ASCII, followed by the product name, left justified and filled with ASCII spaces (20h). There are 16 characters in the string; the LXT-200 disk drives have the ASCII string "LXT-200S" in this field.

The revision level field, bytes thirty two through thirty five, contains the Maxtor firmware revision level in ASCII. There are four characters in the string.

7.4 MODE SELECT - 15h

The MODE SELECT command provides a means by which the initiator may specify various parameters to the drive. Any changes in the MODE SELECT parameters take effect immediately after the MODE SELECT command has terminated. The MODE SELECT command is complementary to the MODE SENSE command, which allows the initiator to request that the drive send values for the parameters to the initiator.

The initiator can send the drive optional blocks of parameters that are separated into categories, or pages. The individual pages specify various options and features which the initiator may change.

Pages 1, 3, and 4 of the MODE SELECT data are written to the disk when the FORMAT UNIT command is executed. Subsequent drive power up or reset conditions cause the drive to read this information from the drive.

The initiator sends those pages to the drive for which it requests parameters to be changed. The initiator may send pages individually, or all pages at one time, and the pages do not need to be sent in any particular order.

It is recommended that, prior to issuing a MODE SELECT command, the initiator first issue a MODE SENSE command, with the page code set for all pages, and the page control field set for current values, to determine which pages are implemented, the page lengths, and current values. This should be followed by another MODE SENSE command, with the page control field set to changeable values, to determine which values may be altered. The initiator should analyze this information, and should not issue a MODE SELECT command which attempts to change values in fields which are not implemented or not changeable.

When a MODE SELECT command is issued that changes any parameters in pages 3 or 4, the drive issues a CHECK CONDITION status with a sense key/error code of UNIT ATTENTION/MODE SELECT Changed Condition (06h/2Ah) to the first command received from all initiators, except the one that issued the MODE SELECT command. When a MODE SELECT command is issued that changes any parameters in page 3 or 4, a FORMAT UNIT command must be issued prior to the next media access command.

The MODE SELECT command can affect the following types of drive parameters:

- Saved Values: The saved values are all the changeable MODE SELECT parameters saved by the drive on the medium when it performs a FORMAT UNIT command. The initiator may change the saved values of pages 1 and/or 2 by issuing a MODE SE-

LECT command with the save parameters (SP) bit in the CDB set to one. This action does not change the saved values of pages 3 and 4.

- Current Values: The current values are the MODE SELECT parameters used by the drive during normal drive operation. Any MODE SELECT command issued to the drive changes the current values.

7.4.1 SCSI Deviations

Only a single block descriptor may be sent to the drive.

The drive ignores the number of blocks field in the block descriptor.

7.4.2 Command Parameters

The MODE SELECT CDB is formatted as shown in Table 7•14, MODE SELECT CDB.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code (15h)							
1	LUN (zeros)			PF	Reserved (zeros)			SP
2	Reserved (zeros)							
3	Reserved (zeros)							
4	Parameter List Length							
5	Control Byte							

Table 7•14
MODE SELECT CDB

The page format (PF) bit, byte one, bit four, is set to one to indicate that the format of the data sent by the initiator, after the MODE SELECT header and the block descriptors (if any), complies with the page format as defined in the CCS.

The save parameters (SP) bit, byte one, bit zero, when set to one, specifies that the drive should take the current values for pages 1 and/or 2, and write them to the disk as the

saved values. Before the drive saves the parameters, it makes any changes to these pages as specified in the current MODE SELECT command. If the drive encounters an error during the MODE SELECT command, it terminates the command without writing the parameters to the disk as the saved values. If the save parameters (SP) bit is zero, the drive updates the current values and does not modify the saved values.

The parameter list length field, byte four, specifies the length, in bytes, of the parameters that are sent from the initiator to the drive during the DATA OUT phase of the MODE SELECT command. A parameter list length of zero indicates that no data is transferred and is not considered an error by the drive.

7.4.3 Parameter List Format

The MODE SELECT parameter list is sent by the initiator to the drive during the DATA OUT phase. This list consists of a parameter list header, zero or one block descriptors, and zero or more page descriptors. The entire length of the parameter list is specified in the MODE SELECT CDB.

The parameter list header is 4 bytes, and specifies the medium type and the length of the block descriptor.

The block descriptor consists of 8 bytes, and specifies the medium density, the number of blocks, and the logical block length.

The page descriptors contain various parameters, separated into pages. These parameters specify various options and features which the initiator may change. One or more pages may be sent during the MODE SELECT command.

A PARAMETER LIST HEADER FORMAT

The MODE SELECT parameter list header is the first part of the parameter list. The header is formatted as shown in Table 7•15, MODE SELECT Parameter List Header.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Reserved (zeros)							
1	Medium Type (zeros)							
2	Reserved (zeros)							
3	Block Descriptor Length (00h or 08h)							

Table 7•15
MODE SELECT Parameter List Header

The medium type field, byte one, must be set to zero.

The block descriptor length field, byte three, specifies the length of the block descriptor, in bytes, starting at byte four of the parameter list. The drive supports zero or one block descriptors per MODE SELECT command, so the only valid block descriptor lengths are 0 and 8 bytes.

B PARAMETER LIST BLOCK DESCRIPTOR FORMAT

The MODE SELECT block descriptor immediately follows the parameter list header. The drive does not report an error if the block descriptor is not in the parameter list (block descriptor length equals zero). The block descriptor is formatted as shown in Table 7•16, MODE SELECT Parameter List Block Descriptor Format.

BYTE \ BIT	7	6	5	4	3	2	1	0
0	Density Code (00h)							
1	Number of Blocks (MSB) (00h)							
2	Number of Blocks (00h)							
3	Number of Blocks (LSB) (00h)							
4	Reserved (zeros)							
5	Block Length (MSB)							
6	Block Length							
7	Block Length (LSB)							

Table 7•16
MODE SELECT Parameter List Block Descriptor Format

The density code field, byte zero, must be set to zero.

The number of logical blocks field, bytes one through three, is ignored by the drive.

The logical block length field, bytes five through seven, specifies the length of the logical block, in bytes. The block length must be equal to the physical sector size. The drive supports logical block sizes of 180 to 4,096 bytes.

C PAGE HEADER FORMAT

Each of the optional page descriptors is preceded by a page header. The page header is 2 bytes long and identifies the page type length. Each page header is immediately followed by its corresponding page parameters.

The page code field, byte zero, bits zero through five, identifies the page type. Table 7•17, MODE SELECT Page Codes, lists the page codes and their corresponding page descriptions.

PAGE CODE	PAGE DESCRIPTION
00h	Vendor Unique (not used by the drive)
01h	Error Recovery Parameters
02h	Disconnect/Reconnect Control Parameters
03h	Direct Access Device Format Parameters
04h	Rigid Disk Drive Geometry Parameters
3Fh	Reserved for use in MODE SENSE Command

Table 7•17
MODE SELECT Page Codes

NOTE: *The disconnect/reconnect control parameters are not currently supported by the disk drive.*

The page length field, byte one, specifies the number of bytes in the page, not including the page length byte. The initiator must send the entire page to the drive.

7.4.4 Error Recovery Parameters Page

This section specifies the MODE SELECT error recovery options supported by the drive. The format for the error recovery parameters page (page code 1) is shown in Table 7•18, MODE SELECT Error Recovery Parameters (Page Code 1). The drive saves a single copy of these parameters to be used by the initiators.

BYTE \ BIT	7	6	5	4	3	2	1	0
0	Reserved (zeros)		Page Code (01h)					
1	Page Length (in bytes) (06h)							
2	AWRE	ARRE	TB	RC	EEC	PER	DTE	DCR
3	Retry Count							
4	Correction Span							
5	Head Offset Count							
6	Data Strobe Offset Count							
7	Recovery Time Limit							

Table 7•18
MODE SELECT Error Recovery Parameters (Page Code 1)

NOTE: *The drive saves this page whenever the initiator issues a FORMAT UNIT, or MODE SELECT, command with the save parameters (SP) bit set to one.*

The automatic write reallocation enabled (AWRE) bit, byte two, bit seven, option is not currently supported by the drive and must be set to zero.

The automatic read reallocation enabled (ARRE) bit, byte two, bit six, option is not currently supported by the drive and must be set to zero.

The transfer block (TB) bit, byte two, bit five, when set to one, specifies that the drive transfers the block with the data error before terminating the command. This bit is only applicable when a hard error is encountered, or when the disable transfer on error (DTE) bit is set to one and a recoverable error is encountered. If this bit is zero, the drive does not transfer the block with the data error. In both cases, the drive reports the block address of the block with the error, rather than that of the preceding block, in the sense data. If the transfer terminates with other than a data error (that is, data not found), the drive does not transfer the block.

The read continuous (RC) bit, byte two, bit four, when set to one, overrides the enable early correction (EEC), disable transfer on error (DTE), post error (PER), and disable correction (DCR) bits, and disables all retries and data correction. The transfer block (TB) bit is not applicable. When the read continuous (RC) bit is set to one, the drive transfers the

entire requested length of data without adding delays that are caused by its error recovery schemes. The drive sends data which may be erroneous, or fabricated, to maintain a continuous flow of data and avoid delays.

The enable early correction (EEC) bit, byte two, bit three, when set to one, specifies that the drive does not exhaust the retry count before attempting any ECC correction. When this bit is zero, the drive exhausts the retry count (as specified in byte three) before it attempts any ECC correction. Also, the drive attempts to recover the data, using head offset and data strobe offset, before attempting ECC correction.

NOTE: *This field does not disable retries during seek operations. For any seek or positioning error, the drive performs a recalibrate operation, then retries the seek operation. If the second attempt also fails, the drive terminates the command.*

The post error (PER) bit, byte two, bit two, when set to one, instructs the drive to report any recoverable errors to the initiator. This error is either reported immediately, or at the normal completion of the command, depending on the state of the disable transfer on error (DTE) bit. The drive may terminate the data transfer before all data has been transferred, depending on the error encountered and the states of the other error recovery bits in byte two. When set to zero, this bit suppresses the reporting of recovered errors. Unrecovered errors are always reported.

The disable transfer on error (DTE) bit, byte two, bit one, when set to one, and when the post error (PER) bit is set to one, instructs the drive to terminate the command immediately when a recoverable error is encountered, and create the CHECK CONDITION status. The drive may or may not transfer the data contained in the block in error, depending on the setting of the transfer block (TB) bit. The initiator can only set the disable transfer on error (DTE) bit to one if it has set the post error (PER) bit to one. If the disable transfer on error (DTE) bit is zero, the drive continues the data transfer when a recoverable error is encountered. When disable transfer on error (DTE) equals zero, and post error (PER) equals one, the sense data reports the last recoverable error that occurred within a transfer.

The disable correction (DCR) bit, byte two, bit zero, when set to one, disables ECC correction when reading a sector from the disk drive. No correction is attempted, and if a correctable ECC error occurs it is treated as an unrecoverable error.

The retry count field, byte three, specifies the maximum number of retries to attempt when an error is encountered. The drive supports retry counts from 0 to 255.

The correction span field, byte four, specifies the largest read data error, in bits, on which correction may be attempted. The drive supports a correction span of 0 to 17 bits.

The head offset count field, byte five, is not supported by the drive and must be set to zero.

The data strobe offset count field, byte six, is not supported by the drive and must be set to zero.

The recovery time limit field, byte seven, is not supported by the drive and must be set to 00h.

Table 7•19, MODE SELECT Error Recovery Modes, lists the possible error recovery modes which may occur using the above parameters. Those combinations which do not provide any useful function, that is, terminate on errors but do not report them, are marked as invalid mode and should not be selected by the initiator. Data transfers terminate immediately for any unrecoverable error.

EEC	PER	DTE	DCR	DESCRIPTION
0	0	0	0	Retries Then Correction. Retries are exhausted, ECC correction is attempted, and recovered errors are not reported.
0	0	0	1	No Correction. Retries are exhausted, no ECC correction is attempted and recovered errors are not reported.
0	0	1	0	Invalid Mode. The initiator should not use this mode.
0	0	1	1	Invalid Mode. The initiator should not use this mode.
0	1	0	0	Report Recovered Errors. Retries are exhausted, ECC is attempted, and recovered errors are reported.
0	1	0	1	Report Errors, No Correction. Retries are exhausted, no ECC correction is attempted, and recovered errors are reported.
0	1	1	0	Report Errors and Stop. Retries are exhausted, ECC correction is attempted, and recovered errors are reported. The transfer terminates prematurely if any error occurs.
0	1	1	1	Report Errors, No Correction, Stop. Retries are exhausted, no ECC correction is attempted, and recovered errors are reported. The transfer terminates prematurely if any error occurs.
1	0	0	0	Early Correction. ECC correction is attempted before the disk drive attempts to recover data with retries. Any recovered errors are not reported.
1	0	0	1	Invalid Mode. The initiator should not use this mode.
1	0	1	0	Invalid Mode. The initiator should not use this mode.
1	0	1	1	Invalid Mode. The initiator should not use this mode.
1	1	0	0	Report Recovered Errors with ECC First. ECC correction is attempted before the disk drive attempts to recover data with retries. Any recovered errors are reported.
1	1	0	1	Invalid Mode. The initiator should not use this mode.
1	1	1	0	Report Errors and Stop with ECC First. ECC correction is attempted before the disk drive attempts to recover data with retries. Any recovered errors are reported. The transfer terminates prematurely if any error occurs.
1	1	1	1	Invalid Mode. The initiator should not use this mode.

Table 7-19
MODE SELECT Error Recovery Modes

7.4.5 Disconnect/Reconnect Parameters Page

This section specifies the MODE SELECT disconnect/reconnect parameter options. These options are not currently supported by the disk drive.

BYTE \ BIT	7	6	5	4	3	2	1	0
0	Reserved		Page Code (02h)					
1	Page Length (in bytes) (0Ah)							
2	Buffer Full Ratio							
3	Buffer Empty Ratio							
4	Bus Inactivity Limit (MSB)							
5	Bus Inactivity Limit (LSB)							
6	Disconnect Time Limit (MSB)							
7	Disconnect Time Limit (LSB)							
8	Connect Time Limit (MSB)							
9	Connect Time Limit (LSB)							
10	Reserved							
11	Reserved							

Table 7•20
MODE SELECT Disconnect/Reconnect Control Parameters (Page Code 2)

NOTE: *Page code 2 options are not currently supported by the disk drive.*

The buffer full ratio field, byte one, specifies how full the internal buffer should be before the drive reconnects to transfer the data to the initiator. This option is not currently supported by the drive and must be set to zero. Future versions of the drive will support this option.

The buffer empty ratio field, bytes two and three, specifies how empty the internal buffer should be before the drive reconnects to transfer more data from the initiator. This option is not currently supported by the drive and must be set to zero. Future versions of the drive will support this option.

The bus inactivity limit field, bytes four and five, specifies the length of time, in 100 microsecond increments, that the drive is allowed to stay connected to the SCSI bus without any bus activity. The drive supports a range of 1 (100 microseconds) to 650 (65,000 microseconds). A value of zero in this field means the drive can stay connected to the bus indefinitely.

The disconnect time limit field, bytes six and seven, is not supported by the drive and must be set to zero.

The connect time limit field, bytes eight and nine, is not supported by the drive and must be set to zero.

7.4.6 Direct-Access Device Format Parameters Page

This section specifies the MODE SELECT direct-access device format parameters (page code 3) supported by the drive. The format for the disk format parameter page is shown in Table 7•21, MODE SELECT Direct-Access Device Format Parameters (Page Code 3).

NOTE: *The drive saves this page whenever the initiator issues a FORMAT UNIT command.*

BYTE \ BIT	7	6	5	4	3	2	1	0
0	Reserved (zeros)		Page Code (03h)					
1	Page Length (in bytes) (16h)							
2	Tracks Per Zone (MSB)							
3	Tracks Per Zone (LSB)							
4	Alternate Sectors Per Zone (MSB)							
5	Alternate Sectors Per Zone (LSB)							
6	Alternate Tracks Per Zone (MSB)							
7	Alternate Tracks Per Zone (LSB)							
8	Alternate Tracks Per Volume (MSB)							
9	Alternate Tracks Per Volume (LSB)							
10	Sectors Per Track (MSB)							
11	Sectors Per Track (LSB)							
12	Data Bytes per Physical Sector (MSB)							
13	Data Bytes per Physical Sector (LSB)							
14	Interleave (MSB)							
15	Interleave (LSB)							
16	Track Skew (MSB)							
17	Track Skew (LSB)							
18	Cylinder Skew (MSB)							
19	Cylinder Skew (LSB)							
20	SSEC	HSEC	RMB	SURF	Reserved (zeros)			
21	Reserved (zeros)							
22	Reserved (zeros)							
23	Reserved (zeros)							

Table 7•21
MODE SELECT Direct-Access Device Format Parameters (Page Code 3)

The tracks per zone field, bytes two and three, supports one track per zone. This field is set to one .

The alternate sectors per zone field, bytes four and five, specifies the number of alternate sectors per zone to allocate during formatting.

The alternate tracks per zone field, bytes six and seven, is not used by the drive and must be set to zero.

The alternate tracks per volume field, bytes eight and nine, specifies the number of alternate tracks to deallocate for bad sectors. A sector is mapped onto the alternate tracks by the FORMAT UNIT or REASSIGN BLOCK commands when relocation occurs in a zone whose alternate sectors have been exhausted. This field is not changeable.

The sectors per track field, bytes ten and eleven, specifies the number of physical sectors per track. This field is not changeable.

The data bytes per physical sector field, bytes twelve and thirteen, specifies the number of bytes per physical sector. The drive supports sector sizes from 180 to 4,096 bytes per sector.

The interleave field, bytes fourteen and fifteen, is ignored by the drive and is always set to one (1:1 ratio) for best drive performance. The interleave value is set in the CDB of the FORMAT UNIT command.

The track skew field, bytes sixteen and seventeen, specifies the number of physical sectors between the last logical block of one track and the first logical block on the next sequential track of the same cylinder. This field's default value is set to one for best drive performance.

The cylinder skew field, bytes eighteen and nineteen, is not supported by the drive and must always be set to zero.

The soft sector format (SSEC) bit, byte twenty, bit seven, cannot be set by the MODE SELECT command and the drive ignores this field (see "7.5 MODE SENSE").

The hard sector format (HSEC) bit, byte twenty, bit six, cannot be set by the MODE SELECT command and the drive ignores this field (see "7.5 MODE SENSE").

The removable media (RMB) bit, byte twenty, bit five, is not used by the drive and must be set to zero.

The surface (SURF) bit, byte twenty, bit four, is not supported by the drive and must be set to zero.

7.4.7 Rigid Disk Drive Geometry Parameters Page

This subsection specifies the MODE SELECT rigid disk drive geometry options (page code 4) supported by the drive. The format for the rigid disk drive geometry page is shown in Table 7-22, MODE SELECT Rigid Disk Drive Geometry Parameters (Page Code 4).

NOTE: *The drive saves this page whenever the initiator issues a FORMAT UNIT command.*

BYTE \ BIT	7	6	5	4	3	2	1	0
0	Reserved (zeros)		Page Code (04h)					
1	Page Length (in bytes) (12h)							
2	Maximum Number of Cylinders (MSB)							
3	Maximum Number of Cylinders							
4	Maximum Number of Cylinders (LSB)							
5	Maximum Number of Heads							
6	Starting Cylinder- Write Precompensation (MSB)							
7	Starting Cylinder- Write Precompensation							
8	Starting Cylinder- Write Precompensation (LSB)							
9	Starting Cylinder- Reduced Write Current (MSB)							
10	Starting Cylinder- Reduced Write Current							
11	Starting Cylinder- Reduced Write Current (LSB)							
12	Drive Step Rate (MSB)							
13	Drive Step Rate (LSB)							
14	Landing Zone Cylinder (MSB)							
15	Landing Zone Cylinder							
16	Landing Zone Cylinder (LSB)							
17	Reserved (zeros)							
18	Reserved (zeros)							
19	Reserved (zeros)							
20-23	RPO (to be added)							

Table 7•22
MODE SELECT Rigid Disk Drive Geometry Parameters (Page Code 4)

The maximum number of cylinders field, bytes two through four, specifies the maximum logical number of cylinders that are accessible by the user. This value already takes into account the reserved cylinders for the alternate tracks per volume, defect management, and any other reserved tracks that the drive may be using. The most significant bytes (MSB), bytes two and three, must be set to zero. This field is not changeable by the user.

The maximum number of heads field, byte five, is not changeable and must be set to seven for the maximum number of data heads.

The starting cylinder - write precompensation field, bytes six through eight, is not supported by the drive and must be set to zero.

The starting cylinder - reduced write current field, bytes nine through eleven, is not supported by the drive and must be set to zero.

The drive step rate field, byte twelve and thirteen, is not supported by the drive and must be set to zero.

The landing zone cylinder field, bytes fourteen through sixteen, is not supported by the drive and must be set to zero.

7.4.8 Error Conditions

If any field not used or supported by the drive is not set to zero, the drive terminates the MODE SELECT command with a CHECK CONDITION status and an ILLEGAL REQUEST/Invalid Field in Parameter List (05h/26h) sense key/error code.

If the medium type is not set to zero, the drive terminates the MODE SELECT command with a CHECK CONDITION status and an ILLEGAL REQUEST/Invalid Field in Parameter List (05h/26h) sense key/error code.

If a block descriptor length of other than zero or eight is specified, the drive terminates the MODE SELECT command with a CHECK CONDITION status and an ILLEGAL REQUEST/Invalid Field in Parameter List (05h/26h) sense key/error code.

If the density code is not set to zero, the drive terminates the MODE SELECT command with a CHECK CONDITION status and an ILLEGAL REQUEST/Invalid Field in Parameter List (05h/26h) sense key/error code.

If the bytes per physical sector is less than 180, or greater than 4,096, the drive terminates the MODE SELECT command with a CHECK CONDITION status and an ILLEGAL REQUEST/Invalid Field in Parameter List (05h/26h) sense key/error code.

If the track skew parameter exceeds 33 sectors per track (the inner-most zone sector size), the drive terminates the MODE SELECT command with a CHECK CONDITION status and an ILLEGAL REQUEST/Invalid Field in Parameter List (05h/26h) sense key/error code.

If the tracks per zone field is not set to one the drive terminates the MODE SELECT command with a CHECK CONDITION status and an ILLEGAL REQUEST/Invalid Field in Parameter List (05h/26h) sense key/error code.

If the alternate sectors per zone field value is not within the supported range, the drive terminates the MODE SELECT command with a CHECK CONDITION status and an ILLEGAL REQUEST/Invalid Field in Parameter List (05h/26h) sense key/error code.

If the initiator specifies an invalid mode in the error recovery bits, the drive terminates the MODE SELECT command with a CHECK CONDITION status and an ILLEGAL REQUEST/Invalid Field in Parameter List (05h/26h) sense key/error code.

If, in the rigid disk drive geometry parameters page, the drive receives a value in the maximum number of heads field that is greater than the actual maximum number of heads, the drive terminates the MODE SELECT command with a CHECK CONDITION status and an ILLEGAL REQUEST/Invalid Field in Parameter List (05h/26h) sense key/error code.

If the page length byte in each page header does not match the page length, as specified in this document and returned by the MODE SENSE command, the drive terminates the MODE SELECT command with a CHECK CONDITION status and an ILLEGAL REQUEST/Invalid Field in Parameter List (05h/26h) sense key/error code.

7.5 MODE SENSE - 1Ah

The MODE SENSE command provides a means by which the initiator may receive various parameters from the drive. MODE SENSE is a complementary command to the MODE SELECT command.

The drive sends blocks of parameters that are separated into categories, called pages. These pages specify various options and features which the initiator may change. Each page is preceded by a page code and the length of the page. The page length value does not include bytes zero or one of the page.

The drive maintains the following four different sets of MODE SENSE data:

- Default Values: The default values are stored in the drive programmable read only memory (PROM), the disk drive, and the drive jumpers.

- Saved Values: The saved values are the MODE SELECT parameters saved by the drive on the medium when the drive performs a FORMAT UNIT or MODE SELECT command, with the save parameters (SP) bit (in the CDB) set to one.

- Current Values: The current values are the MODE SELECT parameters used by the drive during normal drive operation. Any MODE SELECT command issued to the drive changes the current values.

- Changeable Values: The changeable values are those parameters supported by the drive that can be changed by the MODE SELECT command.

At initialization time (a POWER ON or RESET condition has occurred, see "2.0 Disk Drive Setup"), the drive copies the default values into the current values. After the drive spins up, it reads the saved values from the drive and copies them into the current values.

When the drive completes a FORMAT UNIT command, it writes all supported pages to the medium. (On an unformatted drive, the current parameters are the same as the default parameters.) The initiator may then change the current parameters using a MODE SELECT command prior to formatting the disk drive. When the FORMAT UNIT command completes, the drive writes the current values (which may have been changed by a MODE SELECT command) to the medium as the saved values.

7.5.1 SCSI Deviations

There are no deviations.

7.5.2 Command Parameters

The MODE SENSE CDB is formatted as shown in Table 7•23, MODE SENSE CDB.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code (1Ah)							
1	LUN			Reserved (zeros)				
2	Page Control Field		Page Code					
3	Reserved (zeros)							
4	Allocation Length							
5	Control Byte							

Table 7•23
MODE SENSE CDB

The page control field (PCF), byte two, bits six and seven, specifies the type of page values the drive returns: current, changeable, default, or saved. Table 7•24, MODE SENSE Page Control Fields, lists and describes the page control fields.

BIT 7	BIT 6	PAGE CONTROL FIELD
0	0	Report Current Values. If the page code is 3Fh, the drive returns all the pages it implements, with the fields and bits set to their current values. If the page code is not 3Fh and the drive implements the page specified (only pages 1 through 4), the drive returns the page with the fields and bits set to their current values. The drive returns the length specified in the Page Length field for each page.
0	1	Report Changeable Values. If the page code is 3Fh, the drive returns all the pages it implements, with the fields and bits that can be changed set to one. Fields and bits that are not changeable are set to zero. If the page code is not 3Fh and the drive implements the page specified (only pages 1 through 4), the drive returns the page with the fields and bits that can be changed set to one. Fields and bits that are not changeable are set to zero. The drive returns the length specified in the page length field for each page.
1	0	Report Default Values. If the page code is 3Fh, the drive returns all the pages it implements with the fields and bits set to the drive's default values. If the page code is not 3Fh and the drive implements the page specified (only pages 1 through 4), the drive returns the page with the fields and bits set to the drive's default values. Any fields or bits not supported by the drive are set to zero. The drive returns the length specified in the page length field for each page.
1	1	Report Saved Values. If the page code is 3Fh, the drive returns all the pages it implements with the fields and bits set to their saved values. If the page code is not 3Fh and the drive implements the page specified (only pages 1 through 4), it returns the page with the fields and bits set to their saved values. Any fields or bits not supported by the drive are set to zero. The drive returns the length specified in the page length field for each page.

Table 7•24
MODE SENSE Page Control Fields

The page code field, byte two, bits zero through five, specifies the page(s) to be returned in the MODE SENSE data. Table 7•25, MODE SENSE Page Codes, lists and describes the page codes. If a single page is requested (that is, the page code is set to one, two, three, or four), the drive only returns the requested page. The block descriptor information is always sent with MODE SENSE data.

PAGE CODE	PAGE DESCRIPTION
01h	Error Recovery Parameters. This page code causes the MODE SENSE command to return a single page which contains the error recovery parameters.
02h	Disconnect/Reconnect Control Parameters. This page code causes the MODE SENSE command to return a single page which contains the disconnect/reconnect control parameters.
03h	Direct-Access Device Format Parameters. This page code causes the MODE SENSE command to return a single page which contains the direct-access device format parameters.
04h	Rigid Disk Drive Geometry Parameters. This page code causes the MODE SENSE command to return a single page which contains the rigid disk drive geometry parameters.
3Fh	Report All Pages. This page code causes the MODE SENSE command to return pages 1 through 4. The value of each field is set to the values specified by the page control field (PCF) bits. The drive returns all of the fields and bits for each of the pages.

Table 7-25
MODE SENSE Page Codes

NOTE: *Page code 2 is currently not supported by the disk drive.*

The allocation length field, byte four, specifies the number of bytes the initiator has allocated for returned MODE SENSE data. If the drive receives a zero value in byte four, it does not transfer any data and does not treat this condition as an error. A nonzero allocation length value indicates the maximum number of bytes to be transferred. The drive terminates the DATA IN phase when the number of bytes which have been transferred reaches the value of the allocation length field, or when all available MODE SENSE data has been transferred to the initiator, whichever is less.

7.5.3 Parameter List Format

The MODE SENSE parameter list is sent by the drive to the initiator during the DATA IN phase. This list consists of a parameter list header, one block descriptor, and one to four page descriptors.

The parameter list header is 4 bytes long, and specifies the medium type and the length of the block descriptor.

The block descriptor is 8 bytes long, and specifies the medium density, the number of blocks, and the block length.

The page descriptors contain various parameters separated into pages. These parameters specify various options and features which the initiator may change with the MODE

SELECT command. The type of page data returned is specified with the page code and page control field (PCF) in the CDB.

Each defined page is preceded by a header of 2 bytes that specifies the page code and the page length. The page code identifies the meaning of the bytes which follow it. The page length field indicates the number of bytes supported by the drive for that page. The page length value does not include the page code on page length bytes. After the header, the pages are separated into sub-blocks that contain a list of related flags and/or values.

A PARAMETER LIST HEADER FORMAT

The MODE SENSE parameter list header is the first part of the parameter list. The header is formatted as shown in Table 7•26, MODE SENSE Parameter List Header.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Sense Data Length							
1	Medium Type							
2	WP	Reserved (zeros)						
3	Block Descriptor Length							

Table 7•26
MODE SENSE Parameter List Header

The sense data length field, byte zero, specifies the length of the data that is sense, returned when a MODE SENSE command is issued. This length does not include the data length field itself. The sense data length varies depending on which page(s) are requested.

The medium type field, byte one, indicates the medium type on the drive. The drive always returns a medium type of zero.

The write protect (WP) bit, byte two, bit seven, is not supported by the drive and must be set to zero.

The block descriptor length field, byte three, specifies the length of the block descriptor and is set to eight.

B PARAMETER LIST BLOCK DESCRIPTOR FORMAT

The MODE SENSE parameter list block descriptor immediately follows the parameter list header. The block descriptor is formatted as shown in Table 7•27, MODE SENSE Parameter List Block Descriptor Format.

BYTE \ BIT	7	6	5	4	3	2	1	0
0	Density Code (00h)							
1	Number of Blocks (MSB) (00h)							
2	Number of Blocks (00h)							
3	Number of Blocks (LSB) (00h)							
4	Reserved (zeros)							
5	Block Length (MSB)							
6	Block Length							
7	Block Length (LSB)							

Table 7•27
MODE SENSE Parameter List Block Descriptor Format

The density code field, byte zero, defines the density of the medium on the addressed drive. The density code has a value of zero, to indicate only the default density of the hard disk drive is supported.

The number of blocks field, bytes one through three, specifies the total number of logical blocks which use media of the density code defined in byte zero. The number of blocks field always returns zeros to indicate that all blocks have the same medium type.

The logical block length field, bytes five through seven, specifies the length of the logical block, in bytes.

C PAGE HEADER FORMAT

Each of the optional page descriptors is preceded by a page header. The page header is 2 bytes long and identifies the page type length. Each page header is immediately followed by its corresponding page parameters.

The page code field, byte zero, bits zero through five, identifies the page type. Table 7•28, MODE SENSE Page Codes, lists the page codes and their corresponding page descriptions.

PAGE CODE	PAGE DESCRIPTION
00h	Vendor Unique (not used by the drive)
01h	Error Recovery Parameters
02h	Disconnect/Reconnect Control Parameters
03h	Direct-Access Device Format Parameters
04h	Rigid Disk Drive Geometry Parameters
3Fh	Reserved for use in MODE SENSE Command

Table 7•28
MODE SENSE Page Codes

NOTE: *Page code 2 is currently not supported by the disk drive.*

The page length field, byte one, specifies the number of bytes in the page, not including the page length byte. The initiator must send the entire page to the drive.

7.5.4 Error Recovery Parameters Page

This subsection specifies the format of the error recovery parameter page (page code 1), as returned by the MODE SENSE command (see Table 7•29, MODE SENSE Error Recovery Parameters (Page Code 1)). A copy of each of these parameters is saved for each initiator. The values returned are for the initiator which sent the MODE SENSE command.

BIT / BYTE	7	6	5	4	3	2	1	0
0	PS	Rsrv	Page Code (01h)					
1	Page Length (in bytes) (06h)							
2	AWRE	ARRE	TB	RC	EEC	PER	DTE	DCR
3	Retry Count							
4	Correction Span							
5	Head Offset Count							
6	Data Strobe Offset Count							
7	Recovery Time Limit							

Table 7•29
MODE SENSE Error Recovery Parameters (Page Code 1)

The parameter savable (PS) bit, byte zero, bit seven, when set to one, indicates the that drive saves the parameters supported in this page. When the parameter savable (PS) bit is zero, the drive does not save the page parameters. The drive always returns a one in this field.

The automatic write reallocation enabled (AWRE) bit, byte two, bit seven, is not supported and the drive always returns a zero in this field.

The automatic read reallocation enabled (ARRE) bit, byte two, bit six, is not supported and the drive always returns a zero in this field.

The transfer block (TB) bit, byte two, bit five, when set to one, specifies that the drive should transfer the block with the data error before terminating the command. This bit is only applicable when a hard error is encountered, or when the disable transfer on error (DTE) bit is set to one, and a recoverable error is encountered. If the transfer block (TB) bit is zero, the drive does not transfer the block with the data error. In both cases, the drive reports the block address of the block with the error, rather than that of the preceding block, in the sense data. If the transfer terminates with other than a data error (that is, data not found), the block is not transferred. If the initiator requested the changeable values, the transfer block (TB) bit is set to one.

The read continuous (RC) bit, byte two, bit four, when set to one, overrides the enable early correction (EEC), disable transfer on error (DTE), post error (PER), and disable correction (DCR) bits, and disables all retries and data correction. The transfer block (TB) bit is not applicable. When the read continuous (RC) bit is set to one, the drive transfers the entire requested length of data without adding delays that are caused by its error recovery schemes. The drive sends data which may be erroneous, or fabricated, to maintain a continuous flow of data and avoid delays. If the initiator requested the changeable values, this bit is set to one.

The enable early correction (EEC) bit, byte two, bit three, specifies that the drive should perform a minimum number of retries before applying any correction algorithm. When this bit is set to one, the drive does not exhaust the retry count before attempting any ECC correction. When this bit is set to zero, the drive exhausts the retry count, as specified in byte three, before it attempts any ECC correction. If the initiator requested the changeable values, this bit is set to one.

NOTE: *The enable early correction (EEC) bit does not disable retries during seek operations. For any seek or positioning error, the drive issues a RECALIBRATE command to the drive, then retries the seek operation. If the second attempt also fails, the drive terminates the command.*

The post error (PER) bit, byte two, bit two, when set to one, instructs the drive to report any recoverable errors to the initiator. This error is either reported immediately, or at the normal completion of the command, depending on the state of the disable transfer on error (DTE) bit. The error reported to the initiator is the last error encountered during the data transfer. If multiple errors occur, the drive reports (in the sense information) the block address of either 1) the last block where the recovered error occurred; or 2) the block with the first unrecoverable error. If the initiator requested the changeable values, the post error (PER) bit is set to one.

The disable transfer on error (DTE) bit, byte two, bit one, when set to one, and when the post error (PER) bit is also set to one, instructs the drive to terminate the command immediately when a recoverable error is encountered, and create the CHECK CONDITION status. The drive may or may not transfer the data contained in the block in error, depending on the setting of the transfer block (TB) bit. The initiator can only set the disable transfer on error (DTE) bit to one if it has set the post error (PER) bit to one. If the disable transfer on error (DTE) bit is set to zero, the drive continues the data transfer when a recoverable error is encountered. If the initiator requested the changeable values, the disable transfer on error (DTE) bit is set to one.

The disable correction (DCR) bit, byte two, bit zero, when set to one, disables ECC correction when reading a sector from the drive. No correction is attempted, and if a correctable ECC error occurs, it is treated as a recoverable error. If the initiator requested the changeable values, this bit is set to one.

The retry count field, byte three, specifies the maximum number of retries to attempt when an error is encountered. The drive supports retry counts from 0 to 255 (decimal). If the initiator requested the changeable values, this field is set to FFh.

The correction span field, byte four, specifies the largest read data error, in bits, on which correction may be attempted. The drive supports a correction span of 0 to 17 (decimal). If the initiator requested the changeable values, this field is set to FFh.

The head offset count field, byte five, is not supported and the drive always returns a zero in this field.

The data strobe offset count field, byte six, is not supported by the drive and must be set to zero.

The recovery time limit field, byte seven, is not supported and the drive always returns 00h in this field.

7.5.5 Disconnect/Reconnect Parameters Page

This section specifies the format of the disconnect/reconnect parameter page (page code 2), as returned by the MODE SENSE command (see Table 7•30, MODE SENSE Disconnect/Reconnect Control Parameters (Page Code 2)). The drive saves a copy of each of these parameters for each initiator. This allows any one initiator to examine its own parameters without affecting the parameters of any other initiator.

NOTE: *Page code 2 is currently not supported by the disk drive.*

BYTE \ BIT	7	6	5	4	3	2	1	0
0	PS	Rsrv	Page Code (02h)					
1	Page Length (in bytes) (0Ah)							
2	Buffer Full Ratio							
3	Buffer Empty Ratio							
4	Bus Inactivity Limit (MSB)							
5	Bus Inactivity Limit (LSB)							
6	Disconnect Time Limit (MSB)							
7	Disconnect Time Limit (LSB)							
8	Connect Time Limit (MSB)							
9	Connect Time Limit (LSB)							
10	Reserved							
11	Reserved							

Table 7-30
MODE SENSE Disconnect/Reconnect Control Parameters (Page Code 2)

The parameter savable (PS) bit, byte zero, bit seven, when set to one, indicates the that drive saves the parameters supported in this page. When the parameter savable (PS) bit is zero, the drive does not save the page parameters. The drive always returns a one in this bit.

The buffer full ratio field, byte one, specifies how full the internal buffer should be before the drive reconnects to transfer the data to the initiator. The drive does not currently support this option and always returns a zero in this field. This option will be supported in future releases.

The buffer empty ratio field, byte two, specifies how empty the internal buffer should be before the drive reconnects to transfer more data from the initiator. The drive does not currently support this option and always returns a zero in this field. This option will be supported in future releases.

The bus inactivity limit field, bytes four and five, specifies the length of time, in 100 microsecond increments, that the drive is allowed to stay connected to the SCSI bus without any bus activity. The drive supports a range of 1 to 650 (100 to 65,000 microseconds). If the initiator requested the changeable values, this field is set to FFFFh.

The disconnect time limit field, bytes six and seven, is not supported and the drive always returns a zero in this field.

The connect time limit field, bytes eight and nine, is not supported and the drive always returns a zero in this field.

7.5.6 Direct-Access Device Format Parameters Page

This section specifies the format of the direct-access device format parameters page (page code 3), as returned by the MODE SENSE command (see Table 7•31, MODE SENSE Direct-Access Device Format Parameters (Page Code 3)).

BYTE \ BIT	7	6	5	4	3	2	1	0
0	PS	Rsrv	Page Code (03h)					
1	Page Length (in bytes) (16h)							
2	Tracks Per Zone (MSB)							
3	Tracks Per Zone (LSB)							
4	Alternate Sectors Per Zone (MSB)							
5	Alternate Sectors Per Zone (LSB)							
6	Alternate Tracks Per Zone (MSB)							
7	Alternate Tracks Per Zone (LSB)							
8	Alternate Tracks Per Volume (MSB)							
9	Alternate Tracks Per Volume (LSB)							
10	Sectors Per Track (MSB)							
11	Sectors Per Track (LSB)							
12	Data Bytes per Physical Sector (MSB)							
13	Data Bytes per Physical Sector (LSB)							
14	Interleave (MSB)							
15	Interleave (LSB)							
16	Track Skew (MSB)							
17	Track Skew (LSB)							
18	Cylinder Skew (MSB)							
19	Cylinder Skew (LSB)							
20	SSEC	HSEC	RMB	SURF	Reserved (zeros)			
21	Reserved (zeros)							
22	Reserved (zeros)							
23	Reserved (zeros)							

Table 7-31
MODE SENSE Direct-Access Device Format Parameters (Page Code 3)

The parameter savable (PS) bit, byte zero, bit seven, is always one, to indicate that the drive saves the parameters supported in this page.

The tracks per zone field, bytes two and three, specifies the number of tracks per zone. The drive supports one track per zone. If the initiator requests the changeable values, this field is set to 0000h, to indicate that the field is not changeable.

The alternate sectors per zone field, bytes four and five, specifies the number of alternate sectors per zone to allocate during formatting. The drive supports from zero to three alternate sectors per track, or one to n sectors per cylinder, where n is the number of sectors per track, minus one. If the initiator requests the changeable values, this field is set to FFFFh.

The alternate tracks per zone field, bytes six and seven, is not supported, and the drive always returns a zero in this field.

The alternate tracks per volume field, bytes eight and nine, specifies the number of alternate tracks to allocate for bad sectors. Bad sectors are mapped onto the alternate tracks by the FORMAT UNIT or REASSIGN BLOCK commands. If the initiator requests the changeable values, this field is set to 0000h, to indicate that the field is not changeable.

The sectors per track field, bytes ten and eleven, specifies the number of physical sectors per track. If the initiator requests the changeable values, this field is set to 0000h, to indicate that the field is not changeable.

The bytes per physical sector field, bytes twelve and thirteen, specifies the number of bytes per physical sector. The drive supports sectors sizes of 180 to 4,096 bytes. If the initiator requests the changeable values, this field is set to FFFFh.

The interleave value field, bytes fourteen and fifteen, returns the interleave value specified in the FORMAT UNIT command when the drive was formatted. If the initiator requests the changeable values, this field is set to 0000h, to indicate that it is an unchangeable field.

The track skew field, bytes sixteen and seventeen, specifies the number of physical sectors between the last logical block of one track and the first logical block of the next sequential track of the same cylinder. If the initiator requests the changeable values, this field is set to FFFFh.

The cylinder skew field, bytes eighteen and nineteen, is not supported by the drive. If the initiator requests the changeable values, this field is set to 0000h to indicate that the field is not changeable.

The soft sector format (SSEC) bit, byte twenty, bit seven, is not supported, and is always set to zero.

The hard sector format (HSEC) bit, byte twenty, bit six, is set to one to indicate that the drive uses hard sector formatting. If the initiator requested the changeable values, this bit is set to zero.

The removable media (RMB) bit, byte twenty, bit five, is not supported by the drive and is always set to zero.

The surface (SURF) bit, byte twenty, bit four, is not supported, and the drive always returns a zero in this bit.

7.5.7 Rigid Disk Drive Geometry Parameters Page

This section specifies the format of the rigid disk drive geometry, page code 4, as returned by the MODE SENSE command (see Table 7-32, MODE SENSE Rigid Disk Drive Geometry Parameters (Page Code 4)).

BYTE \ BIT	7	6	5	4	3	2	1	0
0	PS	Rsrv	Page Code (04h)					
1	Page Length (in bytes) (12h)							
2	Maximum Number of Cylinders (MSB)							
3	Maximum Number of Cylinders							
4	Maximum Number of Cylinders (LSB)							
5	Maximum Number of Heads							
6	Starting Cylinder- Write Precompensation (MSB)							
7	Starting Cylinder- Write Precompensation							
8	Starting Cylinder- Write Precompensation (LSB)							
9	Starting Cylinder- Reduced Write Current (MSB)							
10	Starting Cylinder- Reduced Write Current							
11	Starting Cylinder- Reduced Write Current (LSB)							
12	Drive Step Rate (MSB)							
13	Drive Step Rate (LSB)							
14	Landing Zone Cylinder (MSB)							
15	Landing Zone Cylinder							
16	Landing Zone Cylinder (LSB)							
17	Reserved (zeros)							
18	Reserved (zeros)							
19	Reserved (zeros)							

Table 7-32
MODE SENSE Rigid Disk Drive Geometry Parameters (Page Code 4)

The parameter savable (PS) bit, byte zero, bit seven, when set to one, indicates that the drive saves the parameters supported in this page. When the parameter savable (PS) bit is zero, the drive does not save the page parameters. The drive always returns a one in this bit.

The maximum number of cylinders field, bytes two through four, specifies the maximum logical number of cylinders that are accessible by the user. This value already takes into account the reserved cylinders for the alternate tracks per volume, defect management, and any other reserved tracks that the drive may be using. The most significant bytes (MSB), bytes two and three, must be set to zero. If the initiator requests the changeable values, this field is set to 0000h, to indicate that the field is not changeable.

The maximum number of heads field, byte five, is not changeable and must be set to seven for the maximum number of data heads. If the initiator requests the changeable values, this field is set to 00h, to indicate that the field is not changeable.

The starting cylinder - write precompensation field, bytes six through eight, is not supported, and the drive always returns a zero in this field.

The starting cylinder - reduced write current field, bytes nine through eleven, is not supported, and the drive always returns a zero in this field.

The drive step rate field, bytes twelve and thirteen, is not supported, and the drive always returns a zero in this field.

The landing zone cylinder field, bytes fourteen through sixteen, is not supported, and the drive always returns a zero in this field.

7.5.8 Error Conditions

If the page code is not valid, the drive terminates the MODE SENSE command with a CHECK CONDITION status and an ILLEGAL REQUEST/Invalid Field in CDB (05h/24h) sense key/error code.

If the drive cannot read the default information from the drive, it terminates the command with a CHECK CONDITION status and a NOT READY/Illegal Function for Device Type (02h/22h) sense key/error code.

7.6 READ - 08h

The READ command requests that the drive transfer data from the logical unit to the initiator. It causes the drive to perform an implied SEEK to the cylinder, head, and sector, which corresponds to the specified LBA.

7.6.1 SCSI Deviations

There are no deviations.

7.6.2 Command Parameters

The READ CDB is formatted as shown in Table 7•33, READ CDB.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operations Code (08h)							
1	LUN			Logical Block Address (MSB)				
2	Logical Block Address							
3	Logical Block Address (LSB)							
4	Transfer Length							
5	Control Byte							

Table 7•33
READ CDB

The LBA field, bytes one through three, specifies the logical block at which the read operation begins.

The transfer length field, byte four, specifies the number of contiguous logical blocks of data to be transferred. A transfer length of zero indicates that 256 logical blocks are transferred.

7.6.3 Error Conditions

If the LBA is invalid, and/or if the LBA plus the transfer length results in an invalid block address, the drive terminates the READ command with a CHECK CONDITION status and an ILLEGAL REQUEST/Illegal Block Address (05h/21h) sense key/error code. No data is transferred if this condition occurs.

7.7 READ (EXTENDED) - 28h

The READ (EXTENDED) command requests that the drive transfer data from the logical unit to the initiator. It causes the drive to perform an implied SEEK to the cylinder, head, and sector, which corresponds to the specified LBA.

7.7.1 SCSI Deviations

There are no deviations.

7.7.2 Command Parameters

The READ (EXTENDED) CDB is formatted as shown in Table 7•34, READ (EXTENDED) CDB.

BYTE \ BIT	7	6	5	4	3	2	1	0
0	Operation Code (28h)							
1	LUN			Reserved (zeros)				
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	Reserved (zeros)							
7	Transfer Length (MSB)							
8	Transfer Length (LSB)							
9	Control Byte							

Table 7•34
READ (EXTENDED) CDB

The LBA, bytes two through five, specifies the logical block at which the read operation begins.

The transfer length field, bytes seven and eight, specifies the number of contiguous logical blocks of data to be transferred. A transfer length of zero indicates that no data is transferred, and is not considered an error by the drive.

7.7.3 Error Conditions

If the LBA is invalid, and/or if the LBA plus the transfer length results in an invalid block address, the drive terminates the READ (EXTENDED) command with a CHECK CONDITION status and an ILLEGAL REQUEST/Illegal Block Address (05h/21h) sense key/error code. No data is transferred if this condition occurs.

7.8 READ BUFFER - 3Ch

The READ BUFFER command is used in conjunction with the WRITE BUFFER command as a diagnostic function for testing the drive's data buffer memory and the SCSI bus integrity. There is no medium access with this command.

7.8.1 SCSI Deviations

There are no deviations.

7.8.2 Command Parameters

The READ BUFFER CDB is formatted as shown in Table 7•35, READ BUFFER CDB.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code (3Ch)							
1	LUN (zero)			Reserved (zeros)				
2	Reserved (zeros)							
3	Reserved (zeros)							
4	Reserved (zeros)							
5	Reserved (zeros)							
6	Reserved (zeros)							
7	Allocation Length (MSB)							
8	Allocation Length (LSB)							
9	Control Byte							

Table 7•35
READ BUFFER CDB

The allocation length field, bytes seven and eight, specifies the number of bytes the initiator has allocated for the returned buffer data. An allocation length of zero is not considered an error by the drive, and no data is sent to the initiator. The initiator may request up to 65,535 bytes to be transferred, including the 4-byte header. If the number of bytes requested exceeds the drive buffer size, the drive transfers the entire buffer and terminates the command without an error. Under this condition, the initiator must check the value in the available length field in the READ BUFFER header (see Table 7•36, READ BUFFER Header) to determine the number of bytes returned.

7.8.3 Command Usage

It is recommended that the initiator issue the RESERVE UNIT command before it issues the READ BUFFER command, to ensure that no other initiator sends data to the drive's data buffer. After the drive has completed the READ BUFFER command, the initiator issues a RELEASE UNIT command to release the drive.

To determine the maximum amount of data that can be transferred with the READ BUFFER and WRITE BUFFER commands, the initiator can issue a READ BUFFER command with the allocation length set to four. This causes the drive to return only the READ BUFFER header. Bytes one through three of the header contain the maximum buffer size.

7.8.4 Data Format

The data returned from the READ BUFFER command during the DATA IN phase consists of a 4-byte header, immediately followed by the data bytes from the drive data buffer. This header is formatted as shown in Table 7•36, READ BUFFER Header.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Reserved (zeros)							
1	Reserved (zeros)							
2	Available Length (MSB)							
3	Available Length (LSB)							

Table 7•36
READ BUFFER Header

The available length field, bytes one through three, specifies the maximum amount of memory that the drive has available in its data buffer. This may or may not be the number of bytes actually transferred, depending on the allocation length specified in the CDB.

7.8.5 Error Conditions

If the data in the buffer has been modified since the last WRITE BUFFER command was issued, or if no WRITE BUFFER command has been issued since the last RESET condition, the READ BUFFER command is terminated with a CHECK CONDITION status and a MISCOMPARE/Compare Error (0Eh/1Dh) sense key/error code. If the allocation length is set to four or less, the drive does not return this error.

7.9 READ CAPACITY - 25h

The READ CAPACITY command is used to determine the maximum logical block number which can be accessed by the initiator. This command also returns the size of the logical block. The information is returned to the initiator during the DATA IN phase.

In addition, the command is used to determine whether a file of a given size will fit within a physically contiguous space, by requesting the number of blocks past a specified block before a substantial delay is encountered (that is, a cylinder boundary).

7.9.1 SCSI Deviations

There are no deviations.

7.9.2 Command Parameters

The READ CAPACITY CDB is formatted as shown in Table 7•37, READ CAPACITY CDB.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code (25h)							
1	LUN				Reserved (zeros)			
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	Reserved (zeros)							
7	Reserved (zeros)							
8	Reserved (zeros)							PMI
9	Control byte							

Table 7•37
READ CAPACITY CDB

The LBA field, bytes two through five, is only used when the partial medium indicator (PMI) bit is set to one. This field specifies the block address to use when computing the last block before a substantial delay is encountered.

A partial medium indicator (PMI) bit, byte eight, bit zero, of one indicates that the information returned is for the last full logical block (from the block specified in the LBA field) which can be transferred before a substantial delay is encountered (that is, a cylinder boundary). A partial medium indicator (PMI) bit of zero indicates that the information returned is for the last logical block of the drive.

7.9.3 Data Format

The 8 bytes of READ CAPACITY data is sent to the initiator during the DATA IN phase and is formatted as shown in Table 7•38, READ CAPACITY Data Format.

BYTE \ BIT	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	Block Length (MSB)							
5	Block Length							
6	Block Length							
7	Block Length (LSB)							

Table 7-38
READ CAPACITY Data Format

The LBA field, bytes zero through three, specifies the last logical block on the unit (if the partial medium indicator (PMI) bit is zero), or the last full logical block before a substantial delay is encountered (if the partial medium indicator (PMI) bit is one).

The block length field, bytes four through seven, specifies the size of the logical block, in bytes.

7.9.4 Error Conditions

If the partial medium indicator (PMI) bit is one, and the LBA is invalid, the drive terminates the READ CAPACITY command with a CHECK CONDITION status and an ILLEGAL REQUEST/Illegal Block Address (05h/21h) sense key/error code.

If the partial medium indicator (PMI) bit is zero and the LBA is not zero, the drive terminates the READ CAPACITY command with a CHECK CONDITION status and an ILLEGAL REQUEST/Invalid Field in CDB (05h/24h) sense key/error code.

7.10 READ DEFECT LIST - 37h

The READ DEFECT LIST command requests that the drive transfer one or more of the defect lists maintained by the drive to the initiator. The initiator may request the original P list, the G list, or both.

7.10.1 SCSI Deviations

There are no deviations.

7.10.2 Command Parameters

The READ DEFECT LIST CDB is formatted as shown in Table 7•39, READ DEFECT LIST CDB.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code (37h)							
1	LUN			Reserved (zeros)				
2	Reserved (zeros)			P	G	Defect List Format		
3	Reserved (zeros)							
4	Reserved (zeros)							
5	Reserved (zeros)							
6	Reserved (zeros)							
7	Alocation Length (MSB)							
8	Allocation Length (LSB)							
9	Control Byte							

Table 7•39
READ DEFECT LIST CDB

The P list bit, byte two, bit four, when set to one, specifies that the P list should be returned by the drive during the DATA IN phase. To request both lists, this bit may be set in combination with the G list bit.

The G list bit, byte two, bit three, when set to one, specifies that the G list should be returned by the drive during the DATA IN phase. To request both lists, this bit may be set in combination with the P list bit. A request by the initiator for a G list to a drive that has no entries in the G list is not considered an error; instead the drive returns only the P list, if also requested, or if only the G list is requested, the 4-byte header, with the defect list length field set to zero.

When both the P and G list bits are set to one, the drive returns both lists. The drive sends the list in ascending order, and merges the lists. When both the P and G list bits are set to zero, the drive returns only the defect list header.

The defect list format field, byte one, bits zero through two, specifies the format of the returned defect list. Table 7•40, READ DEFECT LIST Defect List Formats, lists the types of formats supported by the drive.

NOTE: *The initiator should use the drive's internal defect maps, rather than sending a D list to the drive. Maxtor performs extensive testing of all drives, and adds all areas of defective or marginal performance to the defect lists. If the initiator disables the internal lists using the disable primary (DPRY) bit, marginal sectors might cause future loss of data. Also, the drive uses sophisticated algorithms to determine when to deallocate multiple sectors for a single defect. The limitations of the bytes from index format of the READ DEFECT LIST and FORMAT UNIT commands do not allow for reporting the length of a defect, even though this information is stored in the P list. Therefore, the drive is better able to judge when a defect will cross sector boundaries than is the initiator.*

DEFECT LIST FORMAT BITS			DESCRIPTION
2	1	0	
1	0	0	Bytes from Index Format. The initiator requests that the defect list be returned in bytes from index format.
1	0	1	Physical Sector Format. The initiator requests that the defect list be returned in physical sector format.
1	1	0	Vendor Unique (reserved).
1	1	1	Reserved

Table 7•40
READ DEFECT LIST Defect List Formats

NOTE: *The block format is not supported by the disk drive.*

The allocation length field, bytes seven and eight, specifies the number of bytes the initiator has allocated for the returned defect list. The drive terminates the DATA IN phase when the number of bytes transferred reaches the allocation length field value, or when the entire list has been transferred, whichever is less.

7.10.3 Header

The defect list header (see Table 7•41, READ DEFECT LIST Header) is transferred from the drive to the initiator during the DATA IN phase of the READ DEFECT LIST command. The defect list header is 4 bytes long, followed by zero or more defect descriptors. The header specifies the format and the total number of bytes in the returned defect list.

BYTE \ BIT	9	6	5	4	3	2	1	0
0	Reserved (zeros)							
1	Reserved (zeros)			P	G	Defect List Format		
2	Defect List Length (MSB)							
3	Defect List Length (LSB)							

Table 7•41
READ DEFECT LIST Header

The P list bit, byte two, bit five, when set to one, indicates that the drive returns the P list during the DATA IN phase. This bit may be set in combination with the G list bit.

The G list bit, byte two, bit four, when set to one, indicates that the drive returns the G list during the DATA IN phase. This bit may be set in combination with the P list bit.

The defect list format field, byte one, bits zero through two, specifies the format of the returned defect list. The drive only supports the BYTE from INDEX and physical sector formats.

The defect list length field, bytes two and three, specifies the total number of bytes (not the total number of defect descriptors) in the defect list. This length does not include the 4 bytes in the header.

The defect descriptors are in ascending order. For determining ascending order, the cylinder number of defect is considered the most significant part of the address, and the defect bytes from index/physical sector is considered the least significant part of the address.

7.10.4 Bytes from Index Format

When the bytes from index format is specified, the defect list, transferred to the initiator from the drive during the DATA IN phase, is formatted as shown in Table 7•42, READ DEFECT LIST Defect Descriptor(s), Bytes from Index Format.

BYTE \ BIT	7	6	5	4	3	2	1	0
0	Cylinder Number of Defect (MSB)							
1	Cylinder Number of Defect							
2	Cylinder Number of Defect (LSB)							
3	Head Number of Defect							
4	Defect Bytes from Index (MSB)							
5	Defect Bytes from Index							
6	Defect Bytes from Index							
7	Defect Bytes from Index (LSB)							

Table 7•42
READ DEFECT LIST Defect Descriptor(s), Bytes from Index Format

The defect list format, byte one, bits zero through two of the READ DEFECT LIST header, is set to 04h to indicate that the list is in bytes from index format.

The cylinder number of defect field, bytes zero through two of the defect descriptor, specifies the physical cylinder number which contains the defect.

The head number of defect field, byte three of the defect descriptor, specifies the head number which contains the defect.

The defect bytes from index field, bytes four through seven of the defect descriptor, specifies the number of bytes between the index and the defect on the specified track.

7.10.5 Physical Sector Format

When the physical sector format is specified, the defect list, transferred to the initiator from the drive during the DATA IN phase, is formatted as shown in Table 7-43, READ DEFECT LIST Defect Descriptor(s), Physical Sector Format.

BYTE \ BIT	7	6	5	4	3	2	1	0
0	Cylinder Number of Defect (MSB)							
1	Cylinder Number of Defect							
2	Cylinder Number of Defect (LSB)							
3	Head Number of Defect							
4	Defect Sector Number (MSB)							
5	Defect Sector Number							
6	Defect Sector Number							
7	Defect Sector Number (LSB)							

Table 7-43
READ DEFECT LIST Defect Descriptor(s), Physical Sector Format

The defect list format field, byte one, bits zero through two of the READ DEFECT LIST header, is set to 05h to indicate the list is in physical sector format.

The cylinder number of defect field, bytes zero through two of the defect descriptor, specifies the cylinder number which contains the defect.

The head number of defect field, byte three of the defect descriptor, specifies the head number which contains the defect.

The defect sector number field, bytes four through seven of the defect descriptor, specifies the sector number which contains the defect.

7.10.6 Error Conditions

If the preferred defect list format does not specify bytes from index, or physical format, the drive terminates the READ DEFECT LIST command with a CHECK CONDITION status and an ILLEGAL REQUEST/Invalid Field in CDB (05h/24h) sense key/error code.

7.11 READ LONG - E8h/3Eh

The READ LONG command requests the drive to perform a read operation of one data block and the 6 ECC bytes associated with that block. The data from the block and the ECC bytes are transferred to the initiator during the DATA IN phase.

NOTE: *The READ LONG command does not perform any ECC correction when reading the disk.*

7.11.1 SCSI Deviations

The drive recognizes either E8h or 3Eh as being the READ LONG command. Maxtor implemented this command concept before the SCSI-2 definition of 3Eh. The E8h form is a vendor unique command, and thus is outside of the SCSI standard. The 3Eh form of the command is the recently defined SCSI-2 version of the READ LONG command; however, at this time, the result of either command follows the Maxtor definition. The Maxtor definition differs from the SCSI-2 definition in the following ways:

• SCSI-2 (3Eh) defines bytes 7 and 8 of the CDB as "Byte Transfer Length," and states that, if the data in this field is equal to zero, no data is transferred.	Maxtor (E8h) defines bytes 7 and 8 of the CDB as *always* equal to zero, and the transfer length is always one sector (plus the ECC bytes).
• SCSI-2 defines a CORRCT bit in byte 1.	Maxtor does not currently support the CORRCT bit in byte 1.

7.11.2 Command Parameters

The READ LONG CDB is formatted as shown in Table 7•44, READ LONG CDB.

BYTE \ BIT	7	6	5	4	3	2	1	0
0	Operation Code (E8h/3Eh)							
1	LUN			Reserved (zeros)				
2	Block Address (MSB)							
3	Block Address							
4	Block Address							
5	Block Address (LSB)							
6	Reserved (zeros)							
7	Reserved (zeros)							
8	Reserved (zeros)							
9	Control Byte							

Table 7•44
READ LONG CDB

The block address field, bytes two through five, specifies the block at which the read long operation begins.

CAUTION: *The physical location of the READ LONG and WRITE LONG block address is always computed using the physical sector size instead of the logical block size.*

7.11.3 Error Conditions

If the block address is invalid, the drive terminates the READ LONG command with a CHECK CONDITION status and an ILLEGAL REQUEST/Illegal Block Address (05h/21h) sense key/error code.

7.12 REASSIGN BLOCK - 07h

The REASSIGN BLOCK command requests that the drive relocate a logical block(s) from a defective physical sector(s) to a physical sector(s) without defect.

During the DATA OUT phase, the initiator transfers a defect list that contains the logical block(s) to be reassigned. The drive reassigns the physical medium used for each logical block specified by the initiator. The data contained in those blocks specified by the initiator may be altered, but the data in all other blocks is preserved.

Successful completion of a REASSIGN BLOCK command results in one or more new entries in the G list.

7.12.1 SCSI Deviations

There are no deviations.

7.12.2 Command Parameters

The REASSIGN BLOCK CDB is formatted as shown in Table 7-45, REASSIGN BLOCK CDB.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code (07h)							
1	LUN			Reserved (zeros)				
2	Reserved (zeros)							
3	Reserved (zeros)							
4	Reserved (zeros)							
5	Control Byte							

Table 7-45
REASSIGN BLOCK CDB

7.12.3 Defect List Format

The REASSIGN BLOCK parameter list consists of a 4-byte header (Table 7•46, REASSIGN BLOCK Defect List Header), which contains the defect list length, followed by zero or more defect descriptors. The length of each descriptor is 4 bytes. This information is transferred from the initiator to the drive during the DATA OUT phase of the REASSIGN BLOCK command.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Reserved (zeros)							
1	Reserved (zeros)							
2	Defect List Length (MSB)							
3	Defect List Length (LSB)							

Table 7•46
REASSIGN BLOCK Defect List Header

The defect list length field, bytes two and three, specifies the total length, in bytes, of the defect descriptors that follow. The length is equal to four times the number of defect descriptors. A defect list length of zero is not considered an error by the drive.

The defect descriptor contains the 4-byte defect LBA (see Table 7•47, REASSIGN BLOCK Defect Descriptor(s)) that specifies the location of the defect. The defect descriptors must be in ascending order.

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

Table 7-47
REASSIGN BLOCK Defect Descriptor(s)

7.12.4 Error Conditions

If the drive has insufficient capacity to reassign all the defective blocks, the drive terminates the REASSIGN BLOCK command with a CHECK CONDITION status and a MEDIUM ERROR/No Defect Spare Location Available (03h/32h) sense key/error code.

If the defect LBA is invalid, the drive terminates the REASSIGN BLOCK command with a CHECK CONDITION status and an ILLEGAL REQUEST/Illegal Block Address (05h/21h) sense key/error code.

7.13 RECEIVE DIAGNOSTIC RESULTS - 1Ch

The RECEIVE DIAGNOSTIC RESULTS command is not currently supported. When it is, the command will request analysis data be sent to the initiator after completion of a SEND DIAGNOSTIC command.

7.13.1 SCSI Deviations

There are no deviations.

7.13.2 Command Parameters

The RECEIVE DIAGNOSTIC RESULTS CDB is formatted as shown in Table 7•48, RECEIVE DIAGNOSTIC RESULTS CDB.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code (1Ch)							
1	LUN			Reserved				
2	Reserved							
3	Allocation Length (MSB)							
4	Allocation Length (LSB)							
5	Control Byte							

Table 7•48
RECEIVE DIAGNOSTIC RESULTS CDB

The allocation length field, bytes three and four, specifies the number of bytes that the initiator has allocated for the returned diagnostic data. An allocation length of zero indicates that no diagnostic data is returned. Any other value indicates the maximum number of bytes the drive transfers. The data transfer terminates when the number of bytes in

the allocation length has been transferred, or when all the available diagnostic data has been transferred, whichever is less.

See "7.20 SEND DIAGNOSTIC" later in this chapter, for a description of data sent to the initiator from the drive during the DATA IN phase of a RECEIVE DIAGNOSTIC RESULTS command.

7.13.3 Data Format

See "7.20 SEND DIAGNOSTIC."

7.13.4 Error Conditions

If the RECEIVE DIAGNOSTIC RESULTS command is not preceded by a SEND DIAGNOSTIC command, the drive terminates the RECEIVE DIAGNOSTICS RESULTS command with a CHECK CONDITION status and an ILLEGAL REQUEST/Invalid Command (05h/20h) sense key/error code.

7.14 RELEASE UNIT - 17h

The RELEASE UNIT command causes the drive (previously reserved by the RESERVE UNIT command) to be released. Once the RELEASE UNIT command is issued, other initiators can access the drive.

It is not an error to release a drive which is not currently reserved.

An initiator that holds a current reservation may modify that reservation by issuing another RELEASE UNIT command. The superseding RELEASE UNIT command releases the previous reservation when the new reservation is granted. The previous reservation is not modified if the new reservation cannot be granted, and the drive returns a RESERVATION CONFLICT status.

7.14.1 SCSI Deviations

The drive does not support the extent release option.

7.14.2 Command Parameters

The RELEASE UNIT CDB is formatted as shown in Table 7•49, RELEASE UNIT CDB.

BYTE \ BIT	7	6	5	4	3	2	1	0
0	Operation Code (17h)							
1	LUN			3rd Party	Third Party Device ID			0
2	Reserved (zeros)							
3	Reserved (zeros)							
4	Reserved (zeros)							
5	Control Byte							

Table 7•49
RELEASE UNIT CDB

If the third party reservation (3rdPty) bit, byte one, bit four, is set to one, the drive is released, provided the following conditions are true:

- The unit was originally reserved using the third party option in the RESERVE UNIT command.
- The same initiator that issued the RESERVE UNIT command is requesting the release of the drive.
- The initiator specifies the same SCSI bus device ID in the third party ID field as was specified in that field by the initiator in the RESERVE UNIT command.

The third party device ID field, byte one, bits one through three, specifies the SCSI bus device ID for which the drive was reserved.

7.14.3 Error Conditions

If the extent reservation option is specified, the drive terminates the command with a CHECK CONDITION status and an ILLEGAL REQUEST/Invalid Field in CDB (05h/24h) sense key/error code.

If the third party release option is specified, and the unit was not originally reserved with the third party option, the drive terminates the command with a CHECK CONDITION status and an ILLEGAL REQUEST/Invalid Field in CDB (05h/24h) sense key/error code.

If the third party release option is specified, and the third party device ID is not the same as the one specified in the original RESERVE UNIT command, the drive terminates the command with a CHECK CONDITION status and an ILLEGAL REQUEST/Invalid Field in CDB (05h/24h) sense key/error code.

If the third party release option is specified, and the initiator SCSI ID is not the same as that of the initiator which originally reserved the unit, the drive terminates the command with a RESERVATION CONFLICT status.

7.15 REQUEST SENSE - 03h

The REQUEST SENSE command provides a means for the initiator to obtain more detailed information after execution of a command. Typically, a REQUEST SENSE command is issued if the previous command has completed with a CHECK CONDITION status returned to the initiator.

An initiator should issue a REQUEST SENSE command as soon as it receives a CHECK CONDITION status to obtain the sense data saved by the drive. The sense block is cleared after the REQUEST SENSE command has completed.

The disk drive does not support the nonextended sense format: only the extended format should be used.

7.15.1 SCSI Deviations

There are no deviations.

7.15.2 Command Parameters

The REQUEST SENSE CDB is formatted as shown in Table 7•50, REQUEST SENSE CDB.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code (03h)							
1	LUN			Reserved (zeros)				
2	Reserved (zeros)							
3	Reserved (zeros)							
4	Allocation Length							
5	Control Byte							

Table 7•50
REQUEST SENSE CDB

The allocation length field, byte five, specifies the number of bytes of data the initiator has allocated for the sense information. The drive transfers sense data until the allocation length is exhausted, or until all of the sense data has been transferred, whichever is less. The count supplied determines the format of the returned sense data, as explained in the following section.

7.15.3 Data Format

The format of the returned sense data depends on the number of bytes specified in the allocation length field of the CDB. Two sense data formats are supported:

- An allocation length of zero results in a transfer of 4 bytes in the nonextended sense data format.
- An allocation length greater than zero results in a transfer of up to the requested number of sense bytes, or until all the sense data has been transferred, in the extended sense data format.

A EXTENDED SENSE DATA FORMAT

The extended sense data format is available for all commands, and is returned by the drive when the allocation length specified in the REQUEST SENSE command is greater than 0 bytes (see Table 7•51, REQUEST SENSE Extended Sense Data Format).

BYTE \ BIT	7	6	5	4	3	2	1	0
0	Valid	1	1	1	0	0	0	0
1	Segment Number							
2	0	0	0	0	Sense Key			
3	Information Byte (MSB)							
4	Information Byte							
5	Information Byte							
6	Information Byte (LSB)							
7	Additional Sense Length (0Ah)							
8	Reserved for Copy/Compare Command (zeros)							
9	Reserved for Copy/Compare Command (zeros)							
10	Reserved (zeros)							
11	Reserved (zeros)							
12	Additional Sense Code							
13	Reserved (zeros)							
14	Field Replaceable Unit							
15	FPV	C/D	Reserved (zeros)		BPV	Bit Pointer		
16	Field Pointer							
17	Field Pointer							

Table 7-51
REQUEST SENSE Sense Codes

The valid bit, byte zero, bit seven, when set, indicates that the information byte field contains valid information related to the error condition.

The incorrect length indicator (ILI) bit, byte two, bit five, when set to one, indicates the data available in the drive is larger than the requested transfer size during a READ DATA BUFFER command. This bit is not used by any other command and is always set to zero, except under the condition noted above.

REQUEST SENSE - 03h

The sense key field, byte two, bits zero through three, indicates status information about any errors detected during the operation. The errors are listed and defined in Table 7•52, REQUEST SENSE Sense Key Codes.

CODE	SENSE KEYS
00	No Sense. There is no sense key information to be reported. This code occurs for a successfully completed command.
01	Recovered Error. The last command was completed successfully, but with some recovery action performed by the disk drive.
02	Not Ready. The disk drive cannot be accessed. Operator intervention may be required.
03	Medium Error. The command terminated with a nonrecoverable error condition which was probably caused by a flaw in the media or by an error in the recorded data.
04	Hardware Error. A nonrecoverable hardware error (e.g., disk drive failure, parity error, etc.) was detected while the disk drive was performing the command, or while the disk drive was performing a self-test operation.
05	Illegal Request. There was an illegal parameter in the command or in the additional required parameters supplied as data for some related commands. If the error is detected in the CDB, the disk drive does not alter the media.
06	Unit Attention. The disk drive has been reset. This error is reported the first time any command is issued after the condition is detected and the requested command is not performed. This condition is cleared when the next command that is not an INQUIRY command is issued by the same initiator. UNIT ATTENTION is reported to all SCSI devices that subsequently issue a command to the disk drive.
07	Data Protect. A write operation was attempted on a write protected device.
08	Reserved. This key is reserved.
09	Vendor Unique. A vendor unique error condition occurred. This code is currently not returned by the disk drive.
0A	Copy/Compare Aborted. A COPY or COMPARE command was aborted because an error condition was detected on the source and/or destination device. This code is not returned by the disk drive.
0B	Aborted Command. The disk drive aborted the command. The initiator may recover by trying to execute the command again.
0C	Reserved. This key is reserved.
0D	Reserved. This key is reserved.
0E	Miscompare. Used by the VERIFY and READ DATA BUFFER commands to indicate that the source data did not match the data read from the disk.
0F	Reserved. This key is reserved.

Table 7-52

REQUEST SENSE Sense Key Codes

The information byte field, bytes three through six, are command specific, and are only valid when the valid field bit is set to one. Refer to the individual command for the information returned in this field.

The additional sense length field, byte seven, specifies the number of bytes of additional sense data that follows. If the allocation length specified in the CDB is too small to transfer the additional sense data, the additional sense length field is not adjusted to reflect the truncation. The additional sense data contains information that further defines the nature of the CHECK CONDITION status code. The additional sense length byte is set to ten for all commands.

Bytes eight through eleven are reserved, and are always set to zero.

The additional sense code field, byte twelve, contains additional information about the event that occurred. Refer to Table 7•53, REQUEST SENSE Sense Codes, for a complete listing of these sense codes. When this field is set to zero, the drive does not have any additional sense information.

The field replaceable unit (FRU) field, byte fourteen, is not supported and is always set to zero.

The field pointer valid (FPV) bit, byte fifteen, bit seven, when set to one, indicates the information in the command/data (C/D) and bit pointer valid (BPV) bits, plus the field pointer field (bytes sixteen and seventeen) is valid. Normally the field pointer is only valid when an ILLEGAL REQUEST sense key is returned. In this situation, the field pointer field points to the byte which caused the error. When this field is set to zero, the drive does not have any information on an exact CDB or location in error.

The command/data (C/D) bit, byte fifteen, bit six, when set to one, indicates the field pointer field is pointing to a byte in the CDB. When this bit is zero, it indicates the field pointer field is pointing to a byte in the command parameters which were passed to the drive during the DATA OUT phase. This bit is only valid if the field pointer valid (FPV) bit is set to one.

The bit pointer valid (BPV) bit, byte fifteen, bit three, when set to one, indicates the information in the bit pointer field is valid. This bit is only valid if the field pointer valid (FPV) bit is set to one.

The bit pointer field, byte fifteen, bits zero through two, specifies the bit position within the field indicated by the field pointer field, which was incorrect when an ILLEGAL REQUEST sense key was returned. This field is only valid when the bit pointer valid (BPV) bit is set to one.

The field pointer field, bytes sixteen and seventeen, specifies the byte position that is incorrect when an ILLEGAL REQUEST sense key is returned. This field is only valid when the field pointer valid (FPV) bit is set to one. This pointer points to either the CDB, or the command parameters passed during the DATA OUT phase, depending on the value in the control/data (C/D) bit.

B SENSE CODES

Table 7-53, REQUEST SENSE Sense Codes, lists and describes the sense codes supported by the drive.

CODE	SENSE CODE DESCRIPTION
00	NO ADDITIONAL SENSE INFORMATION. The disk drive has no additional sense available for the previous command.
01	RESERVED. This code is reserved.
02	NO SEEK COMPLETE. The disk drive could not complete a SEEK operation.
03	PERIPHERAL DEVICE WRITE FAULT. The disk drive determined that a fault occured during a WRITE operation.
04	LOGICAL UNIT NOT READY. The disk drive is not ready.
05	LOGICAL UNIT DOES NOT RESPOND TO SELECTION.
06	NO REFERENCE POSITION FOUND. The disk drive could not rezero the positioner.
07-0F	RESERVED. These codes are reserved.
10	ID CRC OR ECC ERROR. The sector ID field could not be read without a CRC error.
11	UNRECOVERED READ ERROR. A block could not be read after the number of retry attempts specified in the MODE SELECT command.
12	ADDRESS MARK NOT FOUND FOR ID FIELD. The disk drive could not locate the address mark for a sector header.
13	ADDRESS MARK NOT FOUND FOR DATA FIELD. The disk drive could not locate the address mark for the sector data area.
14	RECORDED ENTITY NOT FOUND. The block sequence is improper, a block is missing, or the block cannot be read.
15	RANDOM POSITIONING ERROR. A miscompare occurred between the cylinder address of the data header and the address specified in the CDB of the command.
16	RESERVED. This code is reserved.
17	RECOVERED DATA WITH NO ERROR CORRECTION APPLIED. The disk drive encountered an error which was recovered using retries, not including ECC, while reading the media.
18	RECOVERED DATA WITH ERROR CORRECTION APPLIED. The disk drive encountered an error which was recovered using ECC correction while reading the media.
19	DEFECT LIST ERROR. The disk drive encountered an error while accessing one of the defect lists.
1A	PARAMETER LIST LENGTH ERROR. The parameter list length specified in the CDB by the initiator is too large for the disk drive.
1B	SYNCHRONOUS DATA TRANSFER ERROR.

Table 7-53
REQUEST SENSE Sense Codes

CODE	SENSE CODE DESCRIPTION
1C	DEFECT LIST NOT FOUND. The disk drive could not locate the primary defect list (P list).
1D	MISCOMPARE DURING VERIFY OPERATION. One or more bytes did not compare when the VERIFY or the WRITE AND VERIFY command was issued.
1E-1F	RESERVED. These codes are reserved.
20	INVALID COMMAND OPERATION CODE. The initiator issued a command that cannot be executed or is not applicable.
21	LOGICAL BLOCK ADDRESS OUT OF RANGE. The addressed block is not valid.
22	ILLEGAL FUNCTION FOR DEVICE TYPE. The disk drive is unable to perform the requested function.
23	RESERVED. This code is reserved.
24	INVALID FIELD IN CDB. A field in the CDB is reserved and contains a value other than zero, or the value in the field is incorrect.
25	LOGICAL UNIT NOT SUPPORTED. The LUN specified in the CDB or the SCSI IDENTIFY message is not zero.
26	INVALID FIELD IN PARAMETER LIST. A field in the parameter list is reserved and contains a value other than zero, or the value in the field is incorrect.
27	WRITE PROTECTED. The disk is write protected. The outstanding WRITE command is aborted.
28	NOT READY TO READY TRANSITION. The disk drive has detected a NOT READY condition followed by a READY condition.
29	POWER ON, RESET, OR BUS DEVICE RESET OCCURRED. The disk drive has been reset by a SCSI BUS RESET, BUS DEVICE RESET message, or POWER ON/RESET condition.
2A	PARAMETERS CHANGED. The MODE SELECT parameters for this device have been changed by another initiator and may affect current operations.
2B-30	RESERVED. These codes are reserved.
31	MEDIUM FORMAT CORRUPTED. The FORMAT UNIT command failed to complete.
32	NO DEFECT SPARE LOCATION AVAILABLE . There are no remaining alternate tracks on the addressed disk drive. This error condition may occur during the processing of a FORMAT UNIT or REASSIGN BLOCK command.
33-3F	RESERVED. These codes are reserved.
40	DIAGNOSTIC FAILURE ON COMPONENT. The disk drive detected a RAM error during a SEND DIAGNOSTIC test operation.

Table 7-53 (cont'd)
REQUEST SENSE Sense Codes

CODE	SENSE CODE DESCRIPTION
41-42	RESERVED. These codes are reserved.
43	MESSAGE ERROR. The initiator responded with a MESSAGE REJECT message to a message sent by the disk drive.
44	INTERNAL TARGET FAILURE. The SCSI firmware detected an internal firmware or hardware error and was unable to complete the current command.
45	SELECT/RESELECT FAILURE. The SCSI firmware detected a time-out error while attempting a reselection.
46	RESERVED. This code is reserved.
47	SCSI PARITY ERROR. A parity error occurred on the SCSI bus and the disk drive was unable to recover the data.
48	INITIATOR DETECTED ERROR MESSAGE RECEIVED. The initiator sent an INITIATOR DETECTED ERROR message and the disk drive was unable to recover from the error.
49	INVALID MESSAGE ERROR. The initiator sent an inappropriate or illegal SCSI message to the disk drive.
4A-4F	RESERVED. These codes are reserved.
50-5F	RESERVED. These codes are reserved.
60-6F	RESERVED. These codes are reserved.
70-7F	RESERVED. These codes are reserved.
80-8F	RESERVED. These codes are reserved.

Table 7-53 (cont'd)
REQUEST SENSE Sense Codes

7.15.4 Error Conditions

If a CHECK CONDITION status is received on a REQUEST SENSE command, any sense data returned by the target is invalid.

7.16 RESERVE UNIT - 16h

The RESERVE UNIT command is used to reserve the specified drive for exclusive use by the initiator or a designated third party. This reservation remains in effect until one of the following conditions releases the reservation:

- a RELEASE UNIT command from the same initiator is received by the drive.
- a BUS DEVICE RESET message is received by the drive from any initiator.
- a SCSI BUS RESET occurs.

If a RESERVE UNIT command, or any other command, is received for a drive which is reserved by another initiator, the drive returns a RESERVATION CONFLICT status.

An initiator that holds a current reservation may modify that reservation by issuing another RESERVE UNIT command. The superseding RESERVE UNIT command releases the previous reservation when the new reservation is granted. The previous reservation is not modified if the new reservation cannot be granted, and the drive returns a RESERVATION CONFLICT status.

7.16.1 SCSI Deviations

The drive does not support the extent reservation option.

The drive does not support reservation queuing. If a RESERVE UNIT command is received for a logical unit which is already reserved for a different initiator, the drive returns a RESERVATION CONFLICT status.

7.16.2 Command Parameters

The RESERVE UNIT CDB is formatted as shown in Table 7•54, RESERVE UNIT CDB.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code (16h)							
1	LUN			3rd Party	Third Party Device ID			Extent
2	Reservation Identification							
3	Extent List Length (MSB)							
4	Extent List Length (LSB)							
5	Control Byte							

Table 7-54
RESERVE UNIT CDB

The third party reservation (3rdPty) bit, byte one, bit four, allows an initiator to reserve a drive for another device on the SCSI bus. If the third party reservation (3rdPty) bit is set to one, an initiator is allowed to reserve the specified drive for the SCSI bus device specified in the third party device ID field, byte one, bits one through three. This option is intended for use in multiple-initiator systems. Any device that uses the third party reservation option to reserve must also use the third party reservation option to release (see "7.14 RELEASE UNIT" earlier in this chapter) before any other commands can be sent.

The third party device ID field, byte one, bits one through three, specifies the SCSI bus device ID of the device being reserved. The ID is valid only when the third party reservation bit is set to one.

The extent bit, byte one, bit zero, is not supported and must be set to zero.

The reservation identification field, byte two, is not supported and must be set to zero.

The extent list length field, bytes three and four, is not supported and must be set to zero.

7.16.3 Error Conditions

If the extent, reservation identification, or extent list length fields are not zero, the drive terminates the command with a CHECK CONDITION status and an ILLEGAL REQUEST/Invalid Field in CDB (05h/24h) sense key/error code.

7.17 REZERO UNIT - 01h

The REZERO UNIT command requests that the drive set the logical unit to cylinder zero.

7.17.1 SCSI Deviations

There are no SCSI deviations.

7.17.2 Command Parameters

The REZERO UNIT CDB is formatted as shown in Table 7•55, REZERO UNIT CDB.

BYTE \ BIT	7	6	5	4	3	2	1	0
0	Operation Code (01h)							
1	LUN			Reserved (zeros)				
2	Reserved (zeros)							
3	Reserved (zeros)							
4	Reserved (zeros)							
5	Control Byte							

Table 7•55
REZERO UNIT CDB

7.18 SEEK - 0Bh

The SEEK command causes the drive to SEEK to the cylinder of the specified logical block location. If the logical block number specifies a block on a defective track, the SEEK to the alternate track is not performed until the drive receives and processes a command which accesses the medium.

7.18.1 SCSI Deviations

There are no deviations.

7.18.2 Command Parameters

The SEEK CDB is formatted as shown in Table 7•56, SEEK CDB.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code (0Bh)							
1	LUN			Logical Block Address (MSB)				
2	Logical Block Address							
3	Logical Block Address (LSB)							
4	Reserved (zeros)							
5	Control Byte							

Table 7•56
SEEK CDB

The LBA field, bytes one through three, specifies the LBA to seek to. When the SEEK command completes without any errors, the read/write heads are positioned at the cylinder of the specified block address.

7.18.3 Error Conditions

If the LBA is invalid, the drive terminates the SEEK command with a CHECK CONDITION status and an ILLEGAL REQUEST/Illegal Block Address (05h/21h) sense key/error code.

7.19 SEEK (EXTENDED) - 2Bh

The SEEK (EXTENDED) command causes the drive to SEEK to the cylinder of the specified logical block location. If the logical block number specifies a block on a defective track, the SEEK to the alternate track is not performed until the drive receives and processes a command which accesses the medium.

7.19.1 SCSI Deviations

There are no deviations.

7.19.2 Command Parameters

The SEEK (EXTENDED) CDB is formatted as shown in Table 7•57, SEEK (EXTENDED) CDB.

BYTE \ BIT	7	6	5	4	3	2	1	0
0	Operation Code (2Bh)							
1	LUN			Reserved (zeros)				
2	Logical Block Address MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	Reserved (zeros)							
7	Reserved (zeros)							
8	Reserved (zeros)							
9	Control Byte							

Table 7-57
SEEK (EXTENDED) CDB

The LBA field, bytes two through five, specifies the block address to seek to. When the SEEK command completes without any errors the drive is positioned at the specified block address.

7.19.3 Error Conditions

If the LBA is invalid, the drive terminates the SEEK command with a CHECK CONDITION status and an ILLEGAL REQUEST/Illegal Block Address (05h/21h) sense key/error code.

7.20 SEND DIAGNOSTIC - 1Dh

The SEND DIAGNOSTIC command requests the drive to perform diagnostic tests on it-self.

7.20.1 SCSI Deviations

Only the self-test option is currently supported.

7.20.2 Command Parameters

The SEND DIAGNOSTICS CDB is formatted as shown in Table 7-58, SEND DIAGNOSTIC CDB.

BYTE \ BIT	7	6	5	4	3	2	1	0
0	Operation Code (1Dh)							
1	LUN			Reserved (zeros)		SlfTst	DevOfl	UntOfl
2	Reserved (zeros)							
3	Parameter List Length (MSB)							
4	Parameter List Length (LSB)							
5	Control Byte							

Table 7-58
SEND DIAGNOSTIC CDB

The self-test (SlfTst) bit, byte one, bit two, directs the drive to perform the self-test. No device access occurs during this test.

The device off-line (DevOfl) bit, byte one, bit one, is not supported by the drive and must be set to zero.

The unit off-line (UntOfl) bit, byte one, bit zero, is not supported by the drive and must be set to zero.

The device diagnostics perform write and verify operations on each surface of the diagnostic cylinder of the specified drive. The disk drive performs a limited power up self-test on the disk drive without disturbing the data. The disk drive performs tests on the SCSI chip, buffer controller chip, disk formatter chip, and the RAM.

If any sectors on the diagnostic cylinder cannot be written or verified by using two different bit patterns, the drive terminates the command with a CHECK CONDITION status and sets the sense key/error code to MEDIA ERROR/Uncorrectable Data Error (03h/11h). The sense information bytes contain the number of bad sectors found on this cylinder.

The parameter list length field must be set to zero.

7.20.3 Error Conditions

If the device off-line (DevOfl) bit is not zero, the drive terminates the command with a CHECK CONDITION status and an ILLEGAL REQUEST/Invalid Field in CDB (05h/24h) sense key/error code.

If the self-test (SlfTst) bit is zero and the unit off-line (UntOfl) bit is not zero, the drive terminates the command with a CHECK CONDITION status and an ILLEGAL REQUEST/Invalid Field in CDB (05h/24h) sense key/error code.

If the self-test (SlfTst) bit is set to one and the parameter list length field is not zero, the drive terminates the command with a CHECK CONDITION status and an ILLEGAL REQUEST/Invalid Field in CDB (05h/24h) sense key/error code.

If the diagnostic subcommand specified in the parameter list is not legal, the drive terminates the command with a CHECK CONDITION status and an ILLEGAL REQUEST/Invalid Field in Parameter List (05h/26h) sense key/error code.

7.21 START/STOP UNIT - 1Bh

The START/STOP UNIT command requests that the drive spin up or spin down.

7.21.1 SCSI Deviations

There are no deviations.

7.21.2 Command Parameters

The CDB for the START/STOP UNIT command is formatted as shown in Table 7•59, START/STOP UNIT CDB..

BYTE \ BIT	7	6	5	4	3	2	1	0
0	Operation Code (1Bh)							
1	LUN			Reserved (zeros)				Immed
2	Reserved (zeros)							
3	Reserved (zeros)							
4	Reserved (zeros)							Start
5	Control Byte							

Table 7•59
START/STOP UNIT CDB

The immediate (Immed) bit, byte zero, bit zero, when set to one, indicates that status is to be returned as soon as the operation is initiated. If the immediate bit is zero, the drive returns the status when the operation is completed.

The start bit, byte five, bit zero, when set to one, requests the drive be made ready for use. A start bit of zero requests that the drive be spun down.

7.21.3 Error Conditions

If a command which accesses the medium is sent to the drive after a STOP UNIT command (START/STOP UNIT command with start bit equal to zero), the drive terminates the command with a CHECK CONDITION status and sets the sense key/error code to NOT READY/Drive Not Ready (02h/04h).

7.22 TEST UNIT READY - 00h

The TEST UNIT READY command provides a means for the initiator to check whether the drive is ready.

7.22.1 SCSI Deviations

There are no deviations.

7.22.2 Command Parameters

The CDB for the TEST UNIT READY command is formatted as shown in Table 7•60, TEST UNIT READY CDB.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation (00h)							
1	LUN			Reserved (zeros)				
2	Reserved (zeros)							
3	Reserved (zeros)							
4	Reserved (zeros)							
5	Control Byte							

Table 7•60
TEST UNIT READY CDB

7.22.3 Error Conditions

If the logical unit is not ready, the drive returns a CHECK CONDITION or BUSY status in response to this command. A REQUEST SENSE command can be issued to obtain detailed information about the reason the drive is not ready (unavailable).

7.23 VERIFY - 2Fh

The VERIFY command requests that the drive verify the data written on the drive. Verification may be performed either as a byte-by-byte comparison, or by confirming that the data and ECCs correspond to each other.

7.23.1 SCSI Deviations

There are no deviations.

7.23.2 Command Parameters

The VERIFY CDB is formatted as shown in Table 7•61, VERIFY CDB.

BYTE \ BIT	7	6	5	4	3	2	1	0
0	Operation Code (2Fh)							
1	LUN			Reserved (zeros)				
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	Reserved (zeros)							
7	Verification Length (MSB)							
8	Verification Length (LSB)							
9	Control Byte							

Table 7•61
VERIFY CDB

The byte check (BytChk) bit, byte one, bit one, is not supported by the drive and must be set to zero.

The LBA field, bytes two through five, specifies the logical block at which the verify operation begins.

The verification length field, bytes seven and eight, specifies the number of contiguous logical blocks of data to be verified. A verification length of zero indicates that no data is verified and is not considered an error by the drive.

7.23.3 Error Conditions

If the LBA is invalid, the drive terminates the VERIFY command with a CHECK CONDITION status and an ILLEGAL REQUEST/Illegal Block Address (05h/21h) sense key/error code.

If the LBA, plus the verification length, results in an invalid block address, the drive terminates the VERIFY command with a CHECK CONDITION status and an ILLEGAL REQUEST/Illegal Block Address (05h/21h) sense key/error code.

7.24 WRITE - 0Ah

The WRITE command requests that the drive write the data transferred by the initiator to the medium. It also causes the drive to perform an implied SEEK to the cylinder, head, and sector which corresponds to the specified LBA.

7.24.1 SCSI Deviations

There are no deviations.

7.24.2 Command Parameters

The CDB for the WRITE command is formatted as shown in Table 7•62, WRITE CDB.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code (0Ah)							
1	LUN			Logical Block Address (MSB)				
2	Logical Block Address							
3	Logical Block Address							
4	Transfer Length							
5	Control Byte							

Table 7•62
WRITE CDB

The LBA field, byte one, bits four through zero, and bytes two and three, specifies the logical block at which the write operation begins.

The transfer length field, byte four, specifies the number of contiguous logical blocks of data to be transferred. A transfer length of zero indicates that 256 logical blocks are transferred.

7.24.3 Error Conditions

If the LBA is invalid, and/or if the LBA, plus the transfer length, results in an invalid block address, the drive terminates the WRITE command with a CHECK CONDITION status and an ILLEGAL REQUEST/Illegal Block Address (05h/21h) sense key/error code. No data is transferred if this condition occurs.

7.25 WRITE (EXTENDED) - 2Ah

The WRITE (EXTENDED) command requests that the drive write the data transferred by the initiator to the medium. It also causes the drive to perform an implied SEEK to the cylinder, head, and sector which corresponds to the specified LBA.

7.25.1 SCSI Deviations

There are no deviations.

7.25.2 Command Parameters

The CDB for the WRITE (EXTENDED) command is formatted as shown in Table 7-63, WRITE (EXTENDED) CDB.

BIT / BYTE	7	6	5	4	3	2	1	0
0	Operation Code (2Ah)							
1	LUN			Reserved (zeros)				
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Addresss							
5	Logical Block Address (LSB)							
6	Reserved (zeros)							
7	Transfer Length (MSB)							
8	Transfer Length (LSB)							
9	Control Length							

Table 7-63
WRITE (EXTENDED) CDB

The LBA field, bytes two through five, specifies the logical block at which the write operation begins.

The transfer length field, bytes seven and eight, specifies the number of contiguous logical blocks of data to be transferred. A transfer length of zero indicates that no data is transferred, and is not considered an error by the drive.

7.25.3 Error Conditions

If the LBA field is invalid, and/or if the LBA plus the transfer length results in an invalid block address, the drive terminates the WRITE (EXTENDED) command with a CHECK CONDITION status and an ILLEGAL REQUEST/Illegal Block Address (05h/21h) sense key/error code. No data is transferred if this condition occurs.

7.26 WRITE AND VERIFY - 2Eh

The WRITE AND VERIFY command requests that the drive write the data transferred from the initiator to the drive and then verify that the data is correctly written. The drive supports both the medium verification against ECC, and byte-by-byte comparison options.

7.26.1 SCSI Deviations

There are no deviations.

7.26.2 Command Parameters

The WRITE AND VERIFY CDB is formatted as in Table 7•64, WRITE AND VERIFY CDB.

BYTE \ BIT	7	6	5	4	3	2	1	0
0	Operation Code (2Eh)							
1	LUN			Reserved (zeros)				
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	Reserved (zeros)							
7	Transfer Length (MSB)							
8	Transfer Length (LSB)							
9	Control Byte							

Table 7•64
WRITE AND VERIFY CDB

WRITE & VERIFY - 2Eh

The byte check (BytChk) bit, byte one, bit one, is not supported by the drive and must be set to zero.

The LBA field, bytes two through five, specifies the logical block at which the write operation begins.

The transfer length field, bytes seven and eight, specifies the number of contiguous logical blocks of data are transferred. A transfer length of zero indicates that no logical blocks are transferred. This condition is not considered an error and no data is written. Any other value indicates the number of logical blocks that are transferred.

7.27 WRITE BUFFER - 3Bh

The WRITE BUFFER command is used in conjunction with the READ BUFFER command, as a diagnostic function for testing the drive's data buffer memory and the SCSI bus integrity. There is no medium access with this command.

To determine the maximum amount of data that can be transferred with the READ BUFFER and WRITE BUFFER commands, the initiator can issue a READ BUFFER command with the allocation length field set to four. Bytes two and three returned by the drive contain the maximum buffer size for the specified drive.

7.27.1 SCSI Deviations

There are no deviations.

7.27.2 Command Parameters

The WRITE BUFFER CDB is formatted as shown in Table 7•65, WRITE BUFFER CDB.

BYTE \ BIT	7	6	5	4	3	2	1	0
0	Operation Code (3Bh)							
1	LUN			Reserved (zeros)				
2	Reserved (zeros)							
3	Reserved (zeros)							
4	Reserved (zeros)							
5	Reserved (zeros)							
6	Reserved (zeros)							
7	Byte Transfer Length (MSB)							
8	Byte Transfer Length (LSB)							
9	Control Byte							

Table 7•65
WRITE BUFFER CDB

The byte transfer length field, bytes seven and eight, specifies the number of bytes the drive transfers during the DATA OUT phase, to its internal buffer. The transfer length includes the 4 bytes of header information sent before the actual data. A transfer length of zero is not considered an error by the drive, and no data is expected or read from the initiator.

7.27.3 Data Format

The data sent by the initiator during the DATA OUT phase consists of a 4-byte header, immediately followed by the data bytes to be written to the drive data buffer. This data is formatted as shown Table 7•66, WRITE BUFFER Data Format.

BYTE \ BIT	7	6	5	4	3	2	1	0
0	Reserved (zeros)							
1	Reserved (zeros)							
2	Reserved (zeros)							
3	Reserved (zeros)							
4	Data Byte 0							
5	Data Byte 1							
	• •							
	• •							
	• •							
n+4	Data Byte n							

Table 7-66
WRITE BUFFER Data Format

The data byte field, bytes 4 through n+4, contains the data to be written to the drive data buffer.

7.27.4 Error Conditions

If the byte transfer length exceeds the size of the drive's buffers, the WRITE BUFFER command terminates with a CHECK CONDITION status and a ILLEGAL REQUEST/Illegal Field in CDB (05h/24h) sense key/error code.

7.28 WRITE LONG - EAh/3Fh

The WRITE LONG command requests the drive to perform a write operation of one data block and the 6 bytes of ECC information. The data and the 6 ECC bytes for the specified logical block are supplied by the initiator during the DATA OUT phase.

7.28.1 SCSI Deviations

The drive recognizes either EAh or 3Fh as being the WRITE LONG command. Maxtor implemented this command concept before the SCSI-2 definition of 3Fh. The EAh form is a vendor unique command, and thus is outside of the SCSI standard. The 3Fh form of the command is the recently defined SCSI-2 version of the WRITE LONG command; however, at this time, the result of either command follows the Maxtor definition. The Maxtor definition differs from the SCSI-2 definition in the following ways:

- SCSI-2 (3Fh) defines bytes 7 and 8 of the CDB as "Byte Transfer Length," and states that, if the data in this field is equal to zero, no data is transferred. Maxtor (EAh) defines bytes 7 and 8 of the CDB as *always* equal to zero, and the transfer length is always one sector (plus the ECC bytes).

7.28.2 Command Parameters

The CDB for the WRITE LONG command is formatted as shown in Table 7•67, WRITE LONG CDB.

BYTE \ BIT	7	6	5	4	3	2	1	0
0	Operation Code (EAh/3Fh)							
1	LUN			Reserved (zeros)				
2	Block Address (MSB)							
3	Block Address							
4	Block Address							
5	Block Address (LSB)							
6	Reserved (zeros)							
7	Reserved (zeros)							
8	Reserved (zeros)							
9	Control Byte							

Table 7•67
WRITE LONG CDB

The block address field, bytes two through five, specifies the block at which the write long operation begins.

CAUTION: *The physical location of the READ LONG and WRITE LONG block address is computed using the physical sector size instead of the logical block size.*

7.28.3 Error Conditions

If the LBA is invalid, the drive terminates the WRITE LONG command with a CHECK CONDITION status and an ILLEGAL REQUEST/Illegal Block Address (05h/21h) sense key/error code.

APPENDIX A: CDB BIT DEFINITIONS

Abbreviation	Meaning
ARRE	automatic read reallocation enabled bit
AWRE	automatic write reallocation enabled bit
BytChk	byte check bit
DCR	disable correction bit
DCRT	disable certification bit
DevOfl	device off-line bit
DPRY	disable primary bit
DT	defective track bit
DTE	disable transfer on error bit
EEC	enable early correction bit
FmtData	format data bit
FOV	format options valid bit
HSEC	hard sector format bit
ILI	incorrect length indicator bit
Immed	immediate bit
INS	inhibit save bit
PCF	page control field bit
PER	post error bit
PF	page format bit
PMI	partial medium indicator bit
PS	parameters saveable bit
RC	read continuous bit
RelAdr	relative address bit
RMB	removable media bit
SlfTst	self-test bit
SP	save parameters bit
SS	spare sector bit
SSEC	soft sector format bit
STPF	stop format bit
SURF	surface bit
TB	transfer block bit
3rdPty	third party reservation bit
UntOfl	unit off-line bit
VU	vendor unique bit
WP	write protect bit

APPENDIX B: UNITS OF MEASURE

Abbreviation	Meaning
A/m	amps per meter
AWG	American wire gauge
bpi	bits per inch
dBa	decibel, A-weighted
fci	flux changes per inch
g	gram
Gbyte	gigabyte
Hz	hertz
mA	milliamp
µA	microamp
Mbit	megabit
Mbyte	megabyte
µm	micrometer
msec	millisecond
µsec	microsecond
nsec	nanosecond
Oe	oersted
RH	relative humidity
rpm	revolutions per minute
tpi	tracks per inch
xxb	binary values
xxh	hexadecimal values

LIST OF ABBREVIATIONS

ACK. Acknowledge

ADR. Address

ANSC. American National Standards Committee

ANSI. American National Standards Institute

async. Asynchronous

BCV. Buffer control valid

C/C. Continuous/composite (format)

CCS. Common Command Set

C/D. CONTROL/DATA signal

CDB. Command descriptor block, the structure used to communicate requests from an initiator to a drive.

cmd. Command

CRC. Cyclic redundancy check

CSA. Canadian Standards Association

DB (7-0, P). Eight data-bit signals, plus a parity-bit signal, that form a DATA BUS.

DC. Direct current

DCR. Disable error correction

DMA. Direct memory access

EBP. Erase bypass

ECC. Error correction code

ECL. Emitter-coupled logic

EDAC. Error detection and correction

EIA. Electrical Industry Association

ENDEC. Encoder/decoder

EPROM. Erasable programmable read only memory

ERA. Erase all

FCC. Federal Communications Commission

FW. Firmware

G. Constant of gravitation

gnd. Ground

HDA. Head/disk assembly

hex. Hexadecimal

HW. Hardware

I/O. Input and/or output

ISG. Intersector gap

ISO. International Standardization Organization

LBA. Logical block address

LED. Light-emitting diode

LSB. Least significant bit

LSI. Large-scale integration

LSTTL. Low power Schotky transistor-transistor logic

LUN. Logical unit number, an encoded 3-bit identifier for the logical unit.

µC. Microcomputer

µcomputer. Microcomputer

MFM. Modified frequency modulation (encoding)

MO. Magneto optics

µP. Microprocessor

MSB. Most significant bit

MSG. Message

MTBF. Mean time between failures

MTTR. Mean time to repair

N.C. No connection

nom. Nominal

OEM. Original equipment manufacturer

PC. Polycarbonate

PCB. Printed circuit board

PLL. Phase-locked loop

PLO. Phase-locked oscillator

PM. Preventive maintenance

P/N. Part number

POH. Power On hours

P-P. Peak to peak

PROM. Programmable read only memory

ptrn. Pattern

RAM. Random-access memory

REQ. Request

RLL. Run-length limited

ROM. Read-only memory

rsrv. Reserved

R/W. Read and/or write

SCSI. Small Computer Systems Interface

std. Standard

SW. Software

sync. Synchronization, synchronous

tbd. To be determined.

TLA. Top level assembly

TTL. Transistor-transistor logic

typ. Typical

UL. Underwriter's Laboratories, Inc.

UNC. Unified National Coarse

UNF. Unified National Fine

VCO. Voltage-controlled oscillator

VDE. Verband Deutscher Electrotechniker

WORM. Write once read multiple

XFER. Transfer

GLOSSARY

This glossary includes definitions of words used in the text, figures, and tables of this manual. It also includes some definitions of industry-specific terms. Glossary entries in all lower case are entries with no case-specific meaning. For example, "assert" has the same meaning no matter what the capitalization. Glossary entries with some kind of capitalization are entries that are incorrect if any other capitalization is used. "CDB" is an example of a glossary entry with case-specific meaning.

arbitration winner. The arbitrating SCSI device which has the highest SCSI address.

assert. A signal driven to the true state.

bit. Binary digit

byte. Eight consecutive binary digits

connect. The function that occurs when an initiator selects a target to start an operation.

disconnect. The function that occurs when a target releases control of the SCSI bus allowing it to go to the BUS FREE phase.

false. A signal value of zero

firmware. Computer programs encoded permanently into a ROM

hard error. An error which is not recoverable by read retries, excluding ECC correction.

initiator. A SCSI device, usually a host system, that requests that an operation be performed by another SCSI device.

INTERMEDIATE status. A status code sent from a target to an initiator upon completion of each command in a set of linked commands, except for the last command in the set.

logical thread. The logical path which exists between an initiator's memory and a bus device LUN, even though the physical path may be disconnected.

logical unit. A physical or virtual device addressable through a target.

negate. A signal driven to the false state

one. True signal value

parity. A method of ensuring the accuracy of byte values

reconnect. The function that occurs when a target selects an initiator to continue an operation after having been disconnected.

reserved. Bits, bytes, fields and code values that are set aside for future standardization.

SCSI address. The representation of the unique address (0 - 7) assigned to a SCSI device.

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

status. One byte of information sent from a target to an initiator upon completion of each command.

target. A SCSI device that performs an operation requested by an initiator, in this manual, usually a disk drive.

tbd. To be determined. Values which are not defined as of the date the manual is published.

true. A signal value of one

vendor unique. The bits, fields, or code values that are vendor specific.

zero. False signal value