Maxtor®

Maxtor D740X-6L 20.0/40.0/60.0/80.0GB AT
Product Manual

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UL/CSA/VDE/TUV

UL standard 1954 recognition granted under File No. E78016

CSA standard C22.2-950 certification granted under File No. LR49896

TUV Rheinland EN 60 950

Tested to FCC Rules for Radiated and Conducted Emissions, Part 15, Sub Part J, for Class-B Equipment.

PATENTS

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4,419,701; 4, 538,193 4,625,109; 4,639,798; 4,647,769; 4,647,997; 4,661,696; 4,669,004; 4,675,652; 4,703,176; 4,730,321; 4,772,974; 4,783,705; 4,819,153; 4,882,671; 4,920,442; 4,920,434; 4,982,296; 5,005,089; 5,027,241; 5,031,061; 5,084,791; 5,119,254; 5,160,865; 5,170,229; 5,177,771; Other U.S. and Foreign Patents Pending.

Before You Begin

Thank you for your interest in Maxtor hard disk drives. This manual provides technical information for OEM engineers and systems integrators regarding the installation and use of Maxtor hard drives. Drive repair should be performed only at an authorized repair center. For repair information, contact the Maxtor Customer Service Center at 800-2MAXTOR or 408-922-2085.

CAUTION: Maxtor hard drives are precision products. Failure to follow these precautions and guidelines outlined here may lead to product failure, damage and invalidation of all warranties.

1 **BEFORE** unpacking or handling a drive, take all proper electro-static discharge (ESD) precautions, including personnel and equipment grounding. Stand-alone drives are sensitive to ESD damage.

2 *BEFORE* removing drives from their packing material, allow them to reach room temperature.

3 During handling, *NEVER* drop, jar, or bump a drive.

4 Once a drive is removed from the Maxtor shipping container, *IMMEDIATELY* secure the drive through its mounting holes within a chassis. Otherwise, store the drive on a padded, grounded, antistatic surface.

5 *NEVER* switch DC power onto the drive by plugging an electrically live DC source cable into the drive's connector. *NEVER* connect a live bus to the drive's interface connector.

6 *ELECTRICAL GROUNDING* - For proper operation, the drive must be securely fastened to a device bay that provides a suitable electrical ground to the drive baseplate.

Please do not remove or cover up Maxtor factory-installed drive labels. They contain information required should the drive ever need repair.

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Chapter 1
ABOUT THIS MANUAL

This chapter gives an overview of the contents of this manual, including the intended audience, how the manual is organized, terminology and conventions, and references.

1.1   AUDIENCE

The Maxtor D740X-6L 20.0/40.0/60.0/80.0GB AT Product Manual is intended for several audiences. These audiences include: the end user, installer, developer, consumer electronics and personal computer original equipment manufacturer (CE/PC OEM), and distributor. The manual provides information about installation, principles of operation, interface command implementation, and maintenance.

The Maxtor D740X-6L 20.0/40.0/60.0/80.0GB AT family of drives provide a high-quality, low-cost, market leading 40 GB per disk products to serve the consumer and mainstream commercial markets, as well as the consumer electronics market.

1.2   MANUAL ORGANIZATION

This manual is organized into the following chapters:

- Chapter 1 – *About This Manual*

- Chapter 2 – *General Description*

- Chapter 3 – *Installation*

- Chapter 4 – *Specifications*

- Chapter 5 – *Basic Principles of Operation*

- Chapter 6 – *ATA Bus Interface and ATA Commands*

1.3   TERMINOLOGY AND CONVENTIONS

In the Glossary at the back of this manual, you can find definitions for many of the terms used in this manual. In addition, the following abbreviations are used in this manual:

- ASIC   application-specific integrated circuit
- ATA   advanced technology attachment

- bpi   bits per inch
- dB   decibels
- dBA   decibels, A weighted
- DPS   Data Protection System
- SPS   Shock Protection System
- ECC   error correcting code
- Kfci   thousands of flux changes per inch
- Hz   hertz
- KB   kilobytes
- LSB   least significant bit
- mA   milliamperes
- MB   megabytes (1 MB = 1,000,000 bytes when referring to disk transfer rates or storage capacities and 1,048,576 bytes in all other cases)
- Mb/s   megabits per second
- MB/s   megabytes per second
- MHz   megahertz
- ms   milliseconds
- MSB   most significant bit
- mV   millivolts
- ns   nanoseconds
- tpi   tracks per inch
- µs   microseconds
- V   volts

The typographical and naming conventions used in this manual are listed below. Conventions that are unique to a specific table appear in the notes that follow that table.

Typographical Conventions:

- **Names of Bits:** Bit names are presented in initial capitals. An example is the Host Software Reset bit.

- **Commands:** Interface commands are listed in all capitals. An example is WRITE LONG.

- **Register Names:** Registers are given in this manual with initial capitals. An example is the Alternate Status Register.

- **Parameters:** Parameters are given as initial capitals when spelled out, and are given as all capitals when abbreviated. Examples are Prefetch Enable (PE), and Cache Enable (CE).

- **Hexadecimal Notation:** The hexadecimal notation is given in 9-point subscript form. An example is 30_H.

- **Signal Negation:** A signal name that is defined as active low is listed with a minus sign following the signal. An example is RD–.

- **Messages:** A message that is sent from the drive to the host is listed in all capitals. An example is ILLEGAL COMMAND.

Naming Conventions:

- **Host:** In general, the system in which the drive resides is referred to as the host.

- **Computer Voice:** This refers to items you type at the computer keyboard. These items are listed in 10-point, all capitals, Courier font. An example is FORMAT C:/S.

1.4   REFERENCES

For additional information about the ATA interface, refer to the latest revision of the draft standard on the internet at http://www.t13.org/ using the link under "1410D AT Attachment - 6 with Packet Interface (ATA/ATAPI - 6)."

This chapter summarizes the general functions and key features of the Maxtor D740X-6L 20.0/40.0/60.0/80.0GB AT hard disk drives, as well as the applicable standards and regulations.

2.1   PRODUCT OVERVIEW

Maxtor's D740X-6L hard disk drives are part of a family of high performance, 1-inch-high hard disk drives manufactured to meet the highest product quality standards.

These hard disk drives use nonremovable, 3 1/2-inch hard disks and are available with the ATA interface.

The Maxtor D740X-6L 20.0/40.0/60.0/80.0GB AT hard disk drives feature an embedded hard disk drive controller, and use ATA commands to optimize system performance. Because the drive manages media defects and error recovery internally, these operations are fully transparent to the user.

The innovative design of the Maxtor D740X-6L hard disk drives incorporate leading edge technologies such as Ultra ATA/133, Advanced Cache Management, Shock Protection System™ (SPS), Data Protection System (DPS) and Quiet Drive Technology (QDT). These enhanced technologies enable Maxtor to produce a family of high-performance, high-reliability drives.

2.2   KEY FEATURES

The Maxtor D740X-6L 20.0/40.0/60.0/80.0GB AT hard disk drives include the following key features:

General

- Formatted storage capacity of 20.0GB (1 disk, 1 head), 40.0GB (1 disk, 2 heads), 60.0GB (2 disks, 3 heads), and 80.0GB (2 disks, 4 heads)
- Low profile, 1-inch height
- Industry standard 3 1/2-inch form factor
- Emulation of IBM® PC AT® task file register, and all AT fixed disk commands
- Windows NT and 9X Certification

Performance

- Average seek time of 8.5ms
- Average rotational latency of 4.17ms
- New Ultra ATA interface with Maxtor-patented Ultra ATA/133 protocol supporting burst data transfer rates of 133MB/s.
- 2 MB buffer with 1.9MB (approximate) Advance Cache Management (ACM).
- Look-ahead DisCache feature with continuous prefetch and WriteCache write-buffering capabilities
- AutoTask Register update, Multi-block AutoRead, and Multi-block AutoWrite features in a custom ASIC
- Read-on-arrival firmware
- Quadruple-burst ECC, and double burst ECC on-the-fly
- 1:1 interleave on read/write operations
- Support of all standard ATA data transfer modes with PIO mode 4 and multiword DMA mode 2, and Ultra DMA modes 0, 1, 2, 3, 4 and 5
- Adaptive cache segmentation

Reliability

- 800,000 hours mean time between failure (MTBF) in the field
- Automatic retry on read errors
- 320-bit, non-interleaved Reed-Solomon Error Correcting Code (ECC), with cross checking correction up to fifteen separate bursts of 10 bits each totalling up to 150 bits in length
- S.M.A.R.T. 4 (Self-Monitoring, Analysis and Reporting Technology)
- Patented Airlock® automatic shipping lock, magnetic actuator retract, and dedicated landing zone
- Transparent media defect mapping
- High performance, in-line defective sector skipping
- Reassignment of defective sectors discovered in the field, without reformatting
- Shock Protection System to reduce handling induced failures
- Data Protection System to verify drive integrity
- Quiet Drive Technology (QDT)
- 800,000 MTBF

Versatility

- Power saving modes
- Downloadable firmware
- Cable select feature
- Ability to daisy-chain two drives on the interface

2.3   REGULATORY COMPLIANCE STANDARDS

Maxtor Corporation's disk drive products meet all domestic and international product safety regulatory compliance requirements. Maxtor's disk drive products conform to the following specifically marked Product Safety Standards:

- Underwriters Laboratories (UL) Standard 1950. This certificate is a category certification pertaining to all 3.5-inch series drives models.
- Canadian Standards Association (CSA) Standard C.22.2 No. 1950. This certificate is a category certification pertaining to all 3.5-inch series drives models.
- TUV Rheinland Standard EN60 950. This certificate is a category certification pertaining to all 3.5-inch series drives models.

Product EMI/EMS Qualifications:

- CE Mark authorization is granted by TUV Rheinland in compliance with our qualifying under EN 55022:1994 and EN 50082-1:1997.
- C-Tick Mark is an Australian authorization marked noted on Maxtor's disk drive products. The mark proves conformity to the regulatory compliance document AS/NZS 3548: 1995 and BS EN 55022: 1995.
- Maxtor's disk drives are designed as a separate subassembly that conforms to the FCC Rules for Radiated and Conducted emissions, Part 15 Subpart J; Class B when installed in a given computer system.
- Approval from Taiwan BSMI. Number: 3892A638

2.4   HARDWARE REQUIREMENTS

The Maxtor D740X-6L hard disk drives are compatible with the IBM PC AT, and other computers that are compatible with the IBM PC AT. It connects to the PC either by means of a third-party IDE-compatible adapter board, or by plugging a cable from the drive directly into a PC motherboard that supplies an ATA interface.

Chapter 3
INSTALLATION

This chapter explains how to unpack, configure, mount, and connect the Maxtor D740X-6L 20.0/40.0/60.0/80.0GB AT hard disk drive prior to operation. It also explains how to start up and operate the drive.

3.1   SPACE REQUIREMENTS

The Maxtor D740X-6L hard disk drives are shipped without a faceplate. Figure 3-1 shows the external dimensions of the Maxtor D740X-6L 20.0/40.0/60.0/80.0GB AT drives.

26.1 mm (max)
(1.00 inches)

147 mm (max)
(5.75 inches)

101.6 ± 0.25 mm
(4.00 inches)
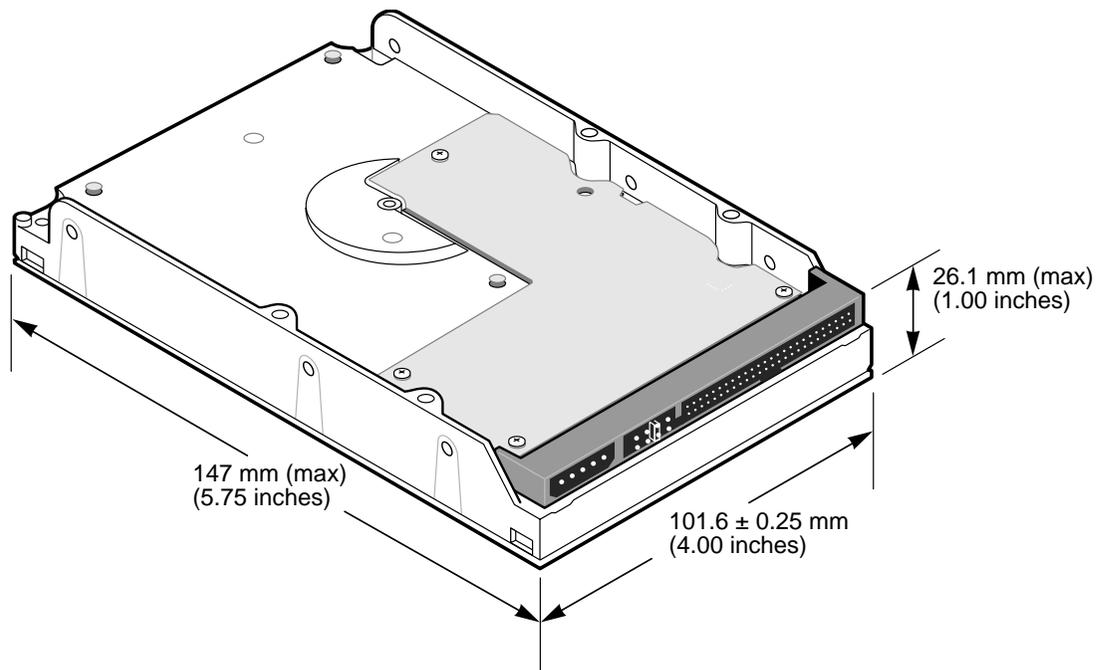
Figure 3-1 *Mechanical Dimensions of Maxtor D740X-6L Hard Disk Drive*

3.2　UNPACKING INSTRUCTIONS

> **CAUTION:**　The maximum limits for physical shock can be exceeded if the drive is not handled properly. Special care should be taken not to bump or drop the drive. It is highly recommended that Maxtor D740X-6L drives are not stacked or placed on any hard surface after they are unpacked. Such handling could cause media damage.

1. Open the shipping container and remove the packing assembly that contains the drive.

2. Remove the drive from the packing assembly.

> **CAUTION:**　During shipment and handling, the antistatic electrostatic discharge (ESD) bag prevents electronic component damage due to electrostatic discharge. To avoid accidental damage to the drive, do not use a sharp instrument to open the ESD bag and do not touch PCB components. Save the packing materials for possible future use.

3. When you are ready to install the drive, remove it from the ESD bag.

Figure 3-2 shows the packing assembly for a single Maxtor D740X-6L hard disk drive. A 20-pack shipping container is available for multiple drive shipments.
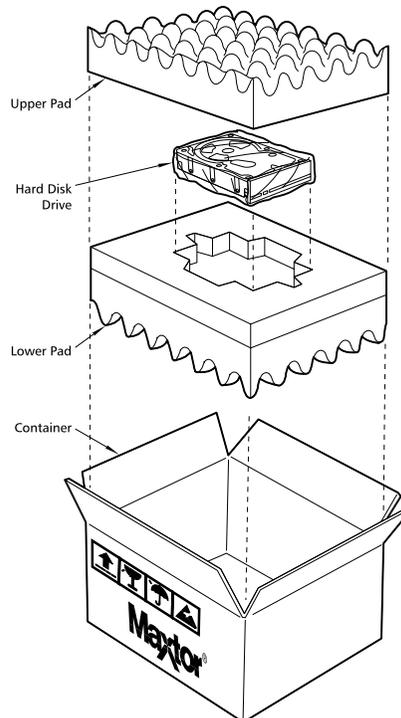
Figure 3-2　*Drive Packing Assembly*
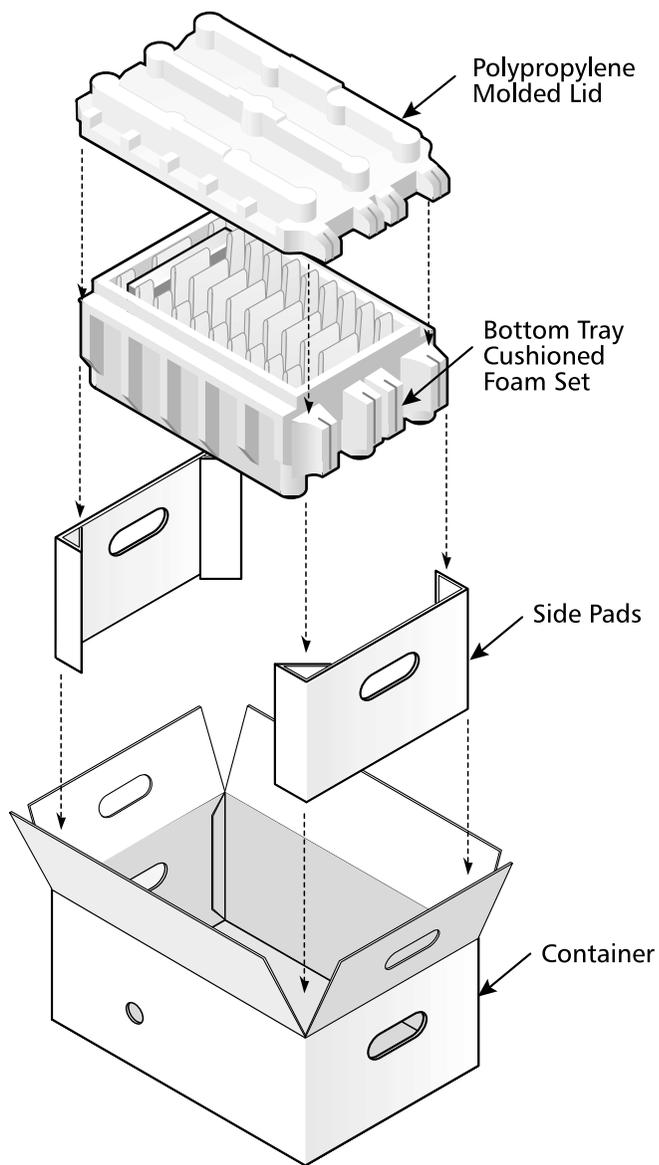
Figure 3-3 *Drive Packing Assembly of a Polypropylene 20-Pack Container*

Note: The 20-pack container should be shipped in the same way it was received from Maxtor. When individual drives are shipped from the 20-pack container then it should be appropriately packaged (not supplied with the 20-pack) to prevent damage.

3.3 HARDWARE OPTIONS

The configuration of a Maxtor D740X-6L 20.0/40.0/60.0/80.0GB AT hard disk drive depends on the host system in which it is to be installed. This section describes the hardware options that you must take into account prior to installation. Figure 3-4 shows the printed circuit board (PCB) assembly, indicating the jumpers that control some of these options.

DC Power
Connector

Jumpers

ATA-Bus
Interface
Header

Back of
Drive

Front of
Drive
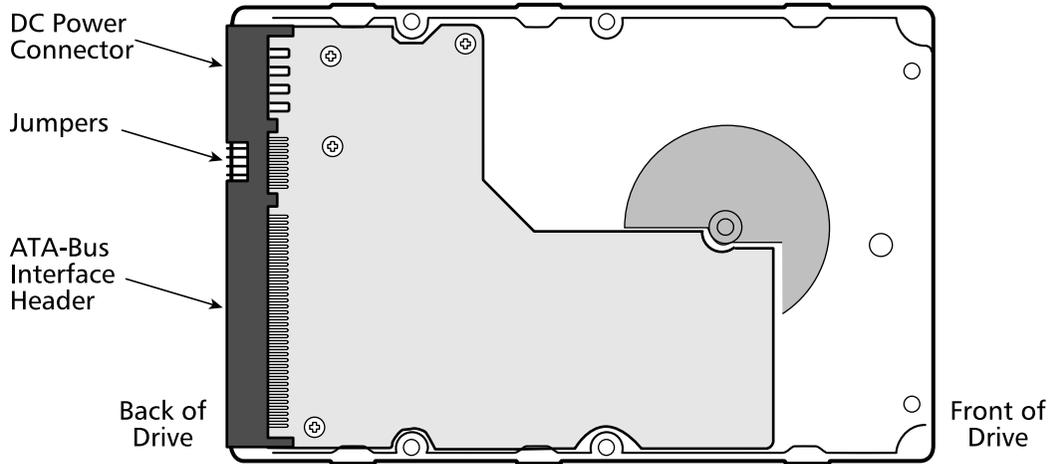
Figure 3-4 *Jumper Locations for the Hard Disk Drive*
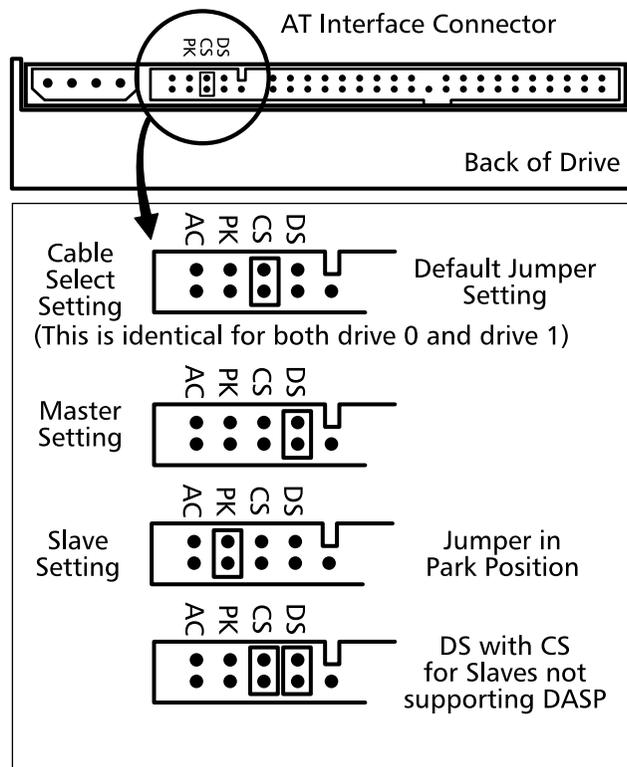
Figure 3-5 *Jumper Locations on the Interface Connector*

The configuration of the following Three jumpers controls the drive's five modes of operation:

- CS – Cable Select
- DS – Drive Select
- PK– Jumper Parking Position (Slave mode)
- AC– Alternate Capacity

The AT PCB has two jumper locations provided to configure the drive in a system. The default configuration for the drive as shipped from the factory is with a jumper across the DS location, and open positions in the CS, PK and AC positions.

Table 3-1 defines the operation of the master/slave jumpers and their function relative to pin 28 on the interface. *1* indicates that the specified jumper is installed; *0* indicates that the jumper is not installed.

Table 3-1 *AT Jumper Options*

CS	DS	PK	PIN 28	DESCRIPTION
0	0	X	X	Drive is configured as a slave
1	0	X	Gnd	Drive is configured as Master (Device 0) when attached to the end of a 80 conductor Ultra ATA cable
0	1	X	X	Drive is configured as a Master
1	0	X	Open	Drive is configured as a Slave (Device 1) when attached to the middle of a 80 conductor Ultra ATA cable
1	1	X	X	Drive is configured as a Master with an attached slave that does not support DASP

Note: In Table 3-1, a *0* indicates that the jumper is removed, a *1* indicates that the jumper is installed, and an X indicates that the jumper setting does not matter.

3.3.1   Cable Select (CS) Jumper

When a Maxtor D740X-6L 20.0/40.0/60.0/80.0GB AT hard disk drive and another ATA hard disk drive are daisy-chained together, they can be configured as Master or Slave either by the CS or DS jumpers. To configure the drive as a Master or Slave with the CS feature, the CS jumper is installed (1). The drive's position on the 80 conductor Ultra ATA data cable then determines whether the drive is a Master (Device 0) or a Slave (Device 1). If the drive is connected to the end of the Ultra (cable Select) data cable the drive is a Master. If the drive is connected to the middle connection it is set as a Slave.

Once you install the CS jumper, the drive is configured as a Master or Slave by the state of the Cable Select signal: pin 28 of the ATA bus connector. Please note that pin 28 is a vendor-specific pin that Maxtor is using for a specific purpose. More than one function is allocated to CS, according to the ATA CAM specification (see reference to this specification in Chapter 1). If pin 28 is a *0* (grounded), the drive is configured as a Master. If it is a *1* (high), the drive is configured as a Slave. In order to configure two drives in a Master/Slave relationship using the CS jumper, you need to use a cable that provides the proper signal level at pin 28 of the ATA bus connector. This allows two drives to operate in a Master/Slave relationship according to the drive cable placement.

The Maxtor D740X-6L 20.0/40.0/60.0/80.0GB AT hard disk drives are shipped from the factory as a Master (Device 0 - CS jumper installed). To configure a drive as a Slave (Device 1- DS scheme), the CS jumper must be removed. In this configuration, the spare jumper removed from the CS position may be stored on the PK jumper pins.

3.3.2   Drive Select (DS) Jumper

You can also daisy-chain two drives on the ATA bus interface by using their Drive Select (DS) jumpers. To use the DS feature, the CS jumper must not be installed.

To configure a drive as the Master (Device 0), a jumper must be installed on the DS pins.

Note: The order in which drives are connected in a daisy chain has no significance.

3.3.3   Master Jumper configuration

In combination with the current DS or CS jumper settings, the Slave Present (SP) jumper can be implemented if necessary as follows:

Note: The CS position doubles as the Slave present on this drive.

- When the drive is configured as a Master (DS jumper installed **or** CS jumper installed, and the Cable Select signal is set to (*0*), adding an additional jumper (both jumpers DS and CS now installed) will indicate to the drive that a Slave drive is present. This Master with Slave Present jumper configuration should be installed on the Master drive only if the Slave drive does *not* use the Drive Active/Slave Present (DASP–) signal to indicate its presence.

3.3.4   Jumper Parking (PK) Position

The PK position is used as a holding place for the jumper for a slave drive in systems that do not support Cable Select. The pins used for the parking position are vendor unique.

3.3.5   Alternate Capacity (AC)

For user capacities below 66,055,248 sectors (32GB), inserting the AC jumper limits the Number of Cylinders field 1 to a value of 16,383, as reported in IDENTIFY DEVICE data word. This allows software drivers to determine that the actual capacity is larger than indicated by the maximum CHS, requiring LBA addressing to use the full capacity.

A summary of these effects for the Maxtor D740X-6L drives is shown in the following table:

	AC JUMPER OUT	AC JUMPER IN
20GB	C=16,383 H=16 S=63 LBA=40,132,503	C=4,092 H=16 S=63 LBA=39,876,479
40GB	C=16,383 H=16 S=63 LBA=78,177,792	C=16,383 H=16 S=63 LBA=66,055,247
60GB	C=16,383 H=16 S=63 LBA=117,266,688	C=16,383 H=16 S=63 LBA=66,055,247
80GB	C=16,383 H=16 S=63 LBA=156,355,584	C=16,383 H=16 S=63 LBA= 66,055,247
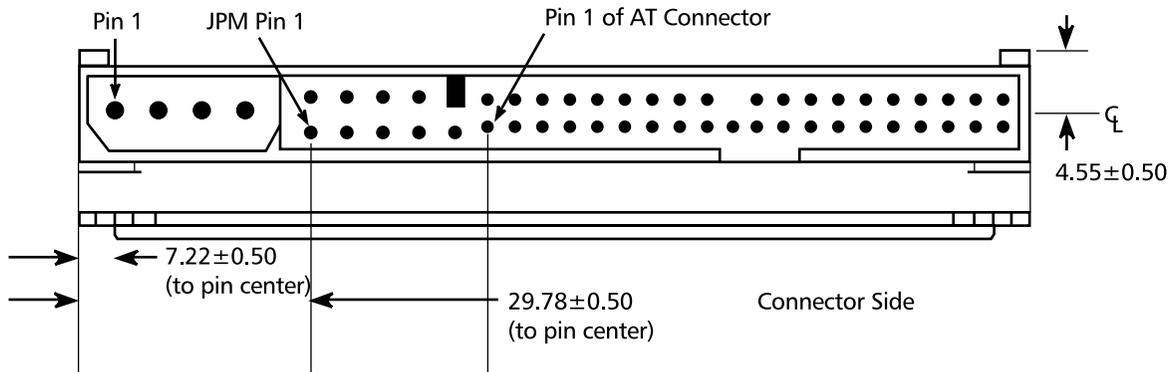
Figure 3-6 *AT Connector and Jumper Location*

3.4 ATA BUS ADAPTER

There are two ways you can configure a system to allow the Maxtor D740X-6L hard disk drives to communicate over the ATA bus of an IBM or IBM-compatible PC:

1. Connect the drive to a 40-pin ATA bus connector (if available) on the motherboard of the PC.

2. Install an IDE-compatible adapter board in the PC, and connect the drive to the adapter board.

3.4.1 40-Pin ATA Bus Connector

Most PC motherboards have a built-in 40-pin ATA bus connector that is compatible with the 40-pin ATA interface of the Maxtor D740X-6L 20.0/40.0/60.0/80.0GB AT hard disk drives. If the motherboard has an ATA connector, simply connect a 40-pin ribbon cable between the drive and the motherboard.

You should also refer to the motherboard instruction manual, and refer to Chapter 6 of this manual to ensure signal compatibility.

3.4.2 Adapter Board

If your PC motherboard does not contain a built-in 40-pin ATA bus interface connector, you must install an ATA bus adapter board and connecting cable to allow the drive to interface with the motherboard. Maxtor does not supply such an adapter board, but they are available from several third-party vendors.

Please carefully read the instruction manual that comes with your adapter board, as well as Chapter 6 of this manual to ensure signal compatibility between the adapter board and the drive. Also, make sure that the adapter board jumper settings are appropriate.

3.5   MOUNTING

Drive mounting orientation, clearance, and ventilation requirements are described in the following subsections.

3.5.1   Orientation

The mounting holes on the Maxtor D740X-6L 20.0/40.0/60.0/80.0GB AT hard disk drives allow the drive to be mounted in any orientation. Figure 3-6 and Figure 3-7 show the location of the three mounting holes on each side of the drive. The drive can also be mounted using the four mounting hole locations on the PCB side of the drive.

Note: It is highly recommended that the drive is hard mounted on to the chassis of the system being used for general operation, as well as for test purposes. Failure to hard mount the drive can result in erroneous errors during testing.

Drives can be mounted in any orientation. Normal position is with the PCB facing down.

All dimensions are in millimeters. For mounting, #6-32 UNC screws are recommended.
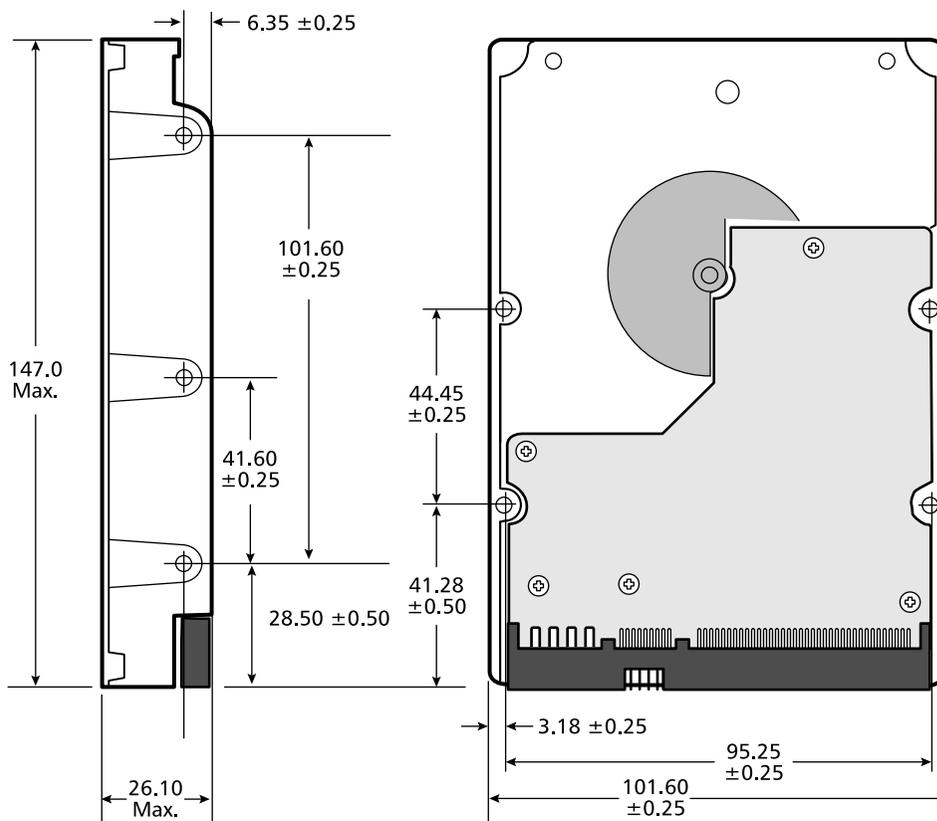
Figure 3-7 *Mounting Dimensions for the Maxtor D740X-6L Hard Disk Drives*
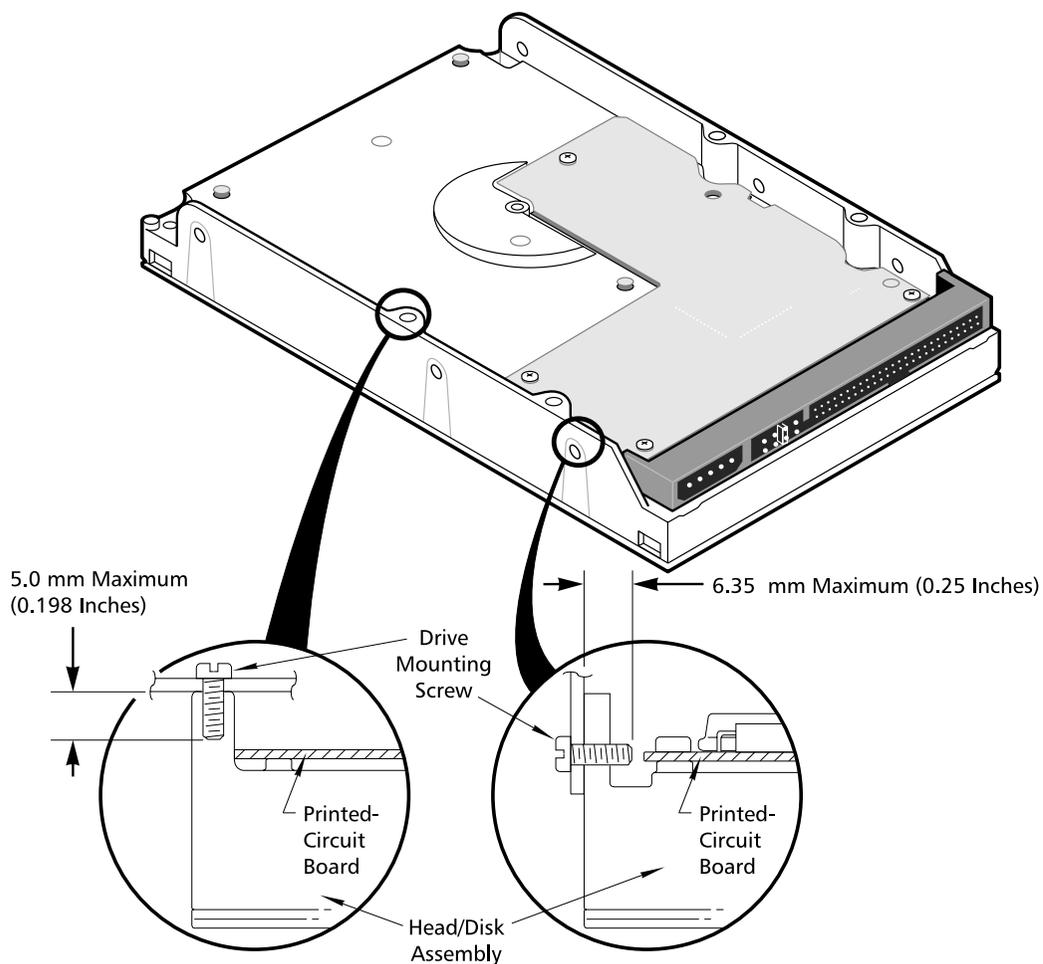
Figure 3-8 *Mounting Screw Clearance for the Maxtor Hard Disk Drives*

CAUTION: The PCB is very close to the mounting holes. Do not exceed the specified length for the mounting screws. The specified screw length allows full use of the mounting hole threads, while avoiding damaging or placing unwanted stress on the PCB. Figure 3-8 specifies the minimum clearance between the PCB and the screws in the mounting holes. To avoid stripping the mounting hole threads, the maximum torque applied to the screws must not exceed 8 inch-pounds. A maximum screw length of 0.25 inches may be used.

3.5.2   Clearance

Clearance from the drive to any other surface (except mounting surfaces) must be a minimum of 1.25 mm (0.05 inches).

3.5.3   Ventilation

The Maxtor D740X-6L 20.0/40.0/60.0/80.0GB AT hard disk drives operate without a cooling fan, provided the ambient air temperature does not exceed 131°F (55°C) at any point along the drive form factor envelope.

3.6   COMBINATION CONNECTOR (J1)

J1 is a three-in-one combination connector. The drive's DC power can be applied to section A. The ATA bus interface (40-pin) uses section C. The connector is mounted on the back edge of the printed-circuit board (PCB), as shown in Figure 3-9.
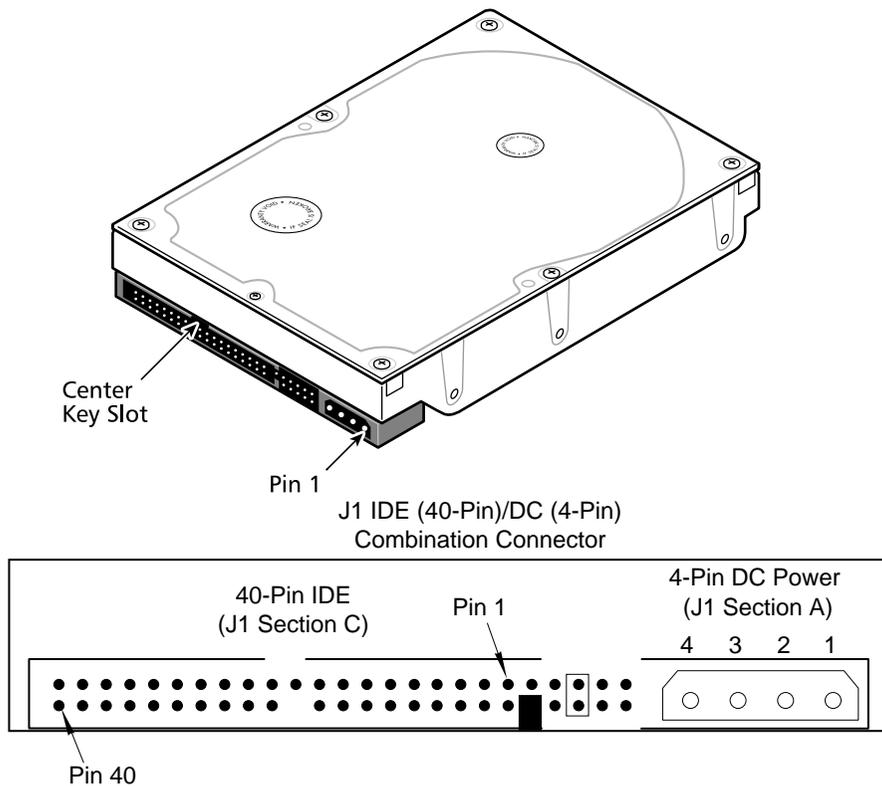
Figure 3-9 *J1 DC Power and ATA Bus Combination Connector*

3.6.1   DC Power (J1, Section A)

The recommended mating connectors for the +5 VDC and +12 VDC input power are listed in Table 3-2.

Table 3-2   *J1 Power Connector, Section A*

PIN NUMBER	VOLTAGE LEVEL	MATING CONNECTOR TYPE AND PART NUMBER (OR EQUIVALENT)
J1 Section A (4-Pin):		
1	+12 VDC	4-Pin Connector: AMP P/N 1-480424-0 Loose piece contacts: AMP P/N VS 60619-4 Strip contacts: AMP P/N VS 61117-4
2	Ground Return for +12 VDC	
3	Ground Return for +5 VDC	
4	+5 VDC	

Note: Labels indicate the pin numbers on the connector. Pins 2 and 3 of section A are the +5 and +12 volt returns and are connected together on the drive.

3.6.2   External Drive Activity LED

An external drive activity LED may be connected to the DASP-I/O pin 39 on J1. For more details, see the pin description in Table 6-1.

3.6.3   ATA Bus Interface Connector (J1, Section C)

On the Maxtor D740X-6L 20.0/40.0/60.0/80.0GB AT hard disk drives, the ATA bus interface cable connector (J1, section C) is a 40-pin Universal Header, as shown in Figure 3-9.

To prevent the possibility of incorrect installation, the connector has been keyed by removing Pin 20. This ensures that a connector cannot be installed upside down.

See Chapter 6, "ATA Bus Interface and ATA Commands," for more detailed information about the required signals. Refer to Table 6-1 for the pin assignments of the ATA bus connector (J1, section C).

3.7   FOR SYSTEMS WITH A MOTHERBOARD ATA ADAPTER

You can install the Maxtor D740X-6L 20.0/40.0/60.0/80.0GB AT hard disk drives in an AT-compatible system that contains a 40-pin ATA bus connector on the motherboard.

To connect the drive to the motherboard, use a 40 conductor ribbon cable (80 conductor ribbon cable if using Ultra ATA/133 drive) 18 inches in length or shorter. Ensure that pin 1 of the drive is connected to pin 1 of the motherboard connector.

3.8   FOR SYSTEMS WITH AN ATA ADAPTER BOARD

To install the Maxtor D740X-6L 20.0/40.0/60.0/80.0GB AT hard disk drive in an AT-compatible system without a 40-pin ATA bus connector on its motherboard, you need a third-party IDE-compatible adapter board.

3.8.1   Adapter Board Installation

Carefully read the manual that accompanies your adapter board before installing it. Make sure that all the jumpers are set properly and that there are no address or signal conflicts. You must also investigate to see if your AT-compatible system contains a combination floppy and hard disk controller board. If it does, you must disable the hard disk drive controller functions on that controller board before proceeding.

Once you have disabled the hard disk drive controller functions on the floppy/hard drive controller, install the adapter board. Again, make sure that you have set all jumper straps on the adapter board to avoid addressing and signal conflicts.

Note: For Sections 3.7 and 3.8, power should be turned off on the computer before installing the drive.

3.8.1.1   Connecting the Adapter Board and the Drive

Use a 40-pin ribbon cable to connect the drive to the board. See Figure 3-10. To connect the drive to the board:

1. Insert the 40-pin cable connector into the mating connector of the adapter board. Make sure that pin 1 of the connector matches with pin 1 on the cable.

2. Insert the other end of the cable into the header on the drive. When inserting this end of the cable, make sure that pin 1 of the cable connects to pin 1 of the drive connector.

3. Secure the drive to the system chassis by using the mounting screws, as shown in Figure 3-11.
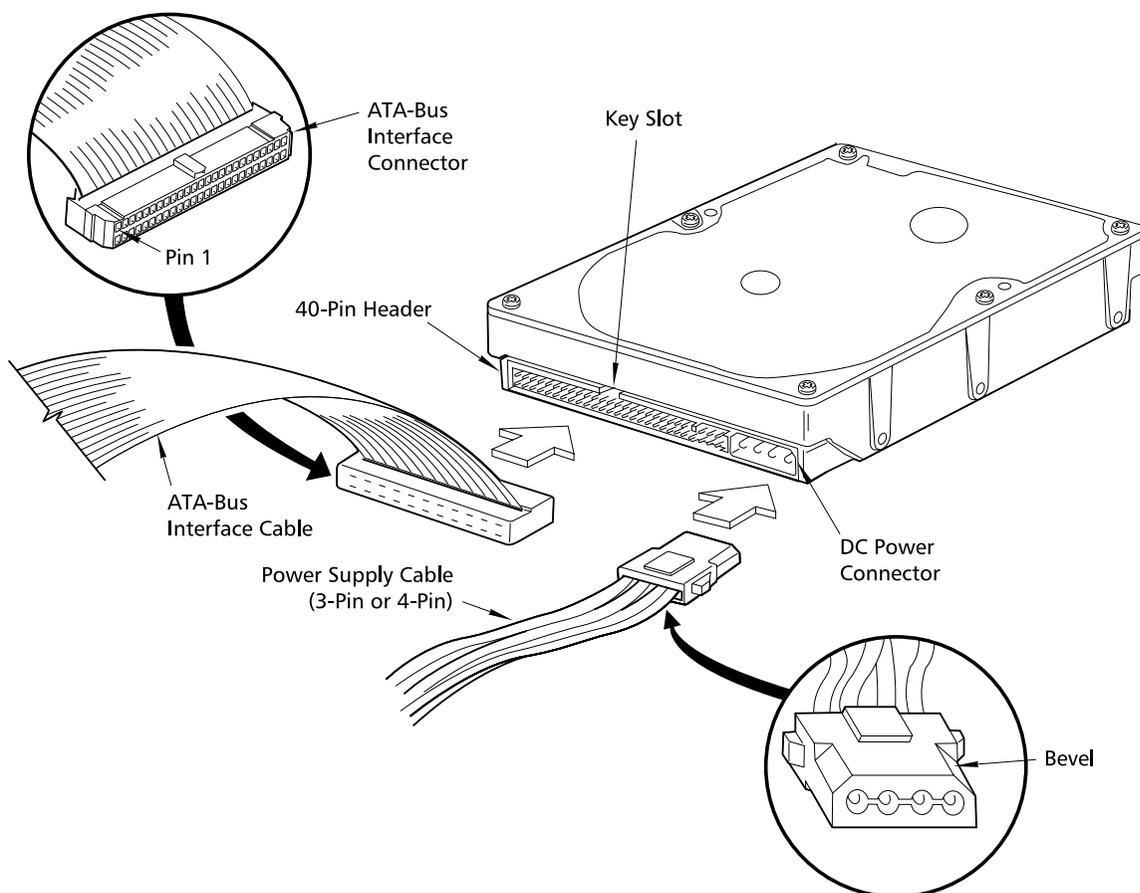
Figure 3-10 *Drive Power Supply and ATA Bus Interface Cables*

Mounting Screws

ATA-Bus Interface Cable

Mounting Bracket
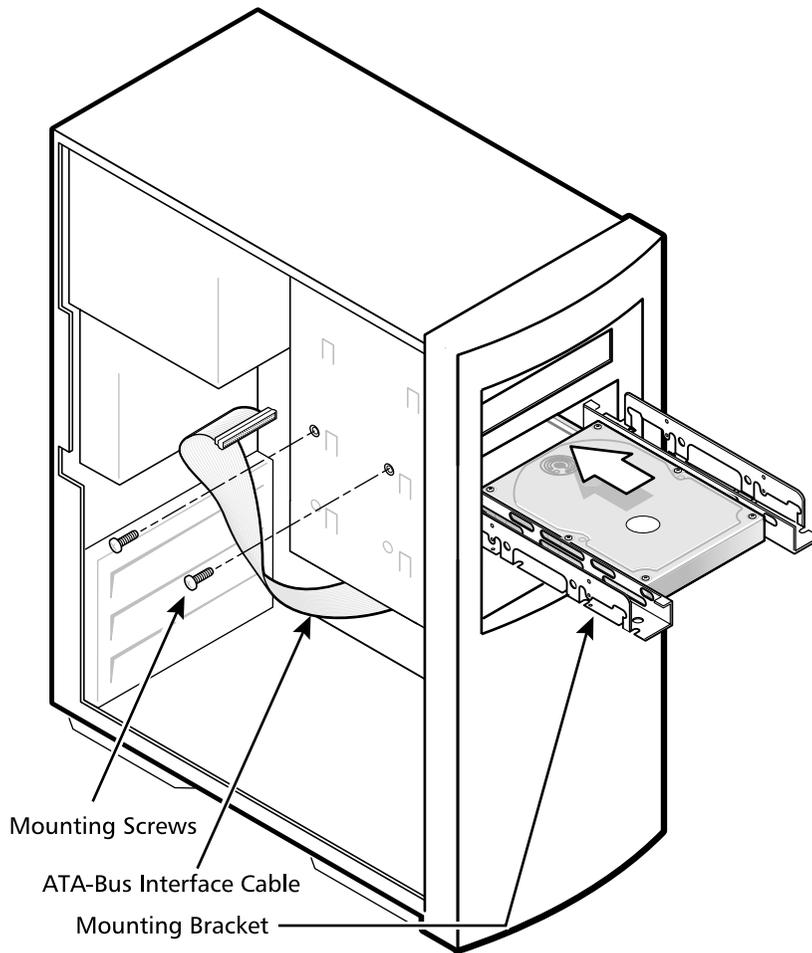
Figure 3-11 *Completing the Drive Installation*

3.9 TECHNIQUES IN DRIVE CONFIGURATION

3.9.1 The 528-Megabytes Barrier

Older BIOS that only support Int 13 commands for accessing ATA drives through DOS based operating systems will be limited to use only 1024 cylinders. This will reduce the effective capacity of the drive to 528Mbytes.

Whenever possible the Maxtor D740X-6L 20.0/40.0/60.0/80.0GB AT drive should be used on systems that support LBA translation to ensure the use of the entire capacity of the disk drive. If that is not possible the following are some techniques that can be used to overcome this barrier.

- Use a third party software program that translates the hard drive parameters to an acceptable configuration for MS-DOS.

- Use a hard disk controller that translates the hard drive parameters to an appropriate setup for both MS-DOS and the computer system's ROM-BIOS.

- Insert the Alternate Capacity (AC) jumper on the drive (see Section 3.3.5).

3.9.2   The 8.4-Gigabytes Barrier

Newer BIOS's allow users to configure disk drives to go beyond the 528MB barrier by using several BIOS translation schemes. However, while using these translations the BIOS using Int 13 functions are limited to 24 bits of addressing which results in another barrier at the 8.4GB capacity.

To overcome this barrier a new set of Int 13 extensions are being implemented by most BIOS manufacturers. The new Int 13 extension allows for four words of addressing space (64 bits) resulting in 9.4 Terrabytes of accessible space.

Whenever possible the Maxtor D740X-6L 20.0/40.0/60.0/80.0GB AT drive should be used on systems with BIOS that support Int 13 extensions. If that is not possible the following are some techniques that can be used to overcome this barrier:

- Use a third party software that supplements the BIOS and adds Int 13 extension support.

- Obtain a BIOS upgrade from the system board manufacturer. Many system board manufacturers allow their BIOS to be upgraded in the field using special download utilities. Information on BIOS upgrades can be obtained on the System Board Customer Service respective web sites on the Internet.

- Insert the Alternate Capacity (AC) jumper on the drive (see Section 3.3.5).

3.9.3   Operating system limitations

Most popular operating systems available today have additional limitations which affect the use of large capacity drives. However, these limitations can not be corrected on the BIOS and it is up to the operating system manufacturers to release improved versions to address these problems.

The most popular operating systems available today, DOS and Win 95, use a File Allocation Table (FAT) size of 16 bits which will only support partitions up to 2.1GB. A newer release of Win 95 called OSR2 with a 32 bit FAT has been released to system manufacturers only. This new FAT size table will support partitions of up to 2.2 Terrabytes.

3.10   SYSTEM STARTUP AND OPERATION

Once you have installed the Maxtor D740X-6L 20.0/40.0/60.0/80.0GB AT hard disk drive, and adapter board (if required) in the host system, you are ready to partition and format the drive for operation. To set up the drive correctly, follow these steps:

1. Power on the system.

2. Run the SETUP program. This is generally on a Diagnostics or Utilities disk, or within the system's BIOS. Some system BIOS have an auto-detecting feature making SETUP unnecessary.

3. Enter the appropriate parameters.

The SETUP program allows you to enter the types of optional hardware installed—such as the hard disk drive type, the floppy disk drive capacity, and the display adapter type. The system's BIOS uses this information to initialize the system when the power is switched on. For instructions on how to use the SETUP program, refer to the system manual for your PC.

During the AT system CMOS setup, you must enter the drive type for the Maxtor D740X-6L hard disk drives. The drive supports the translation of its physical drive geometry parameters such as cylinders, heads, and sectors per track to a logical addressing mode. The drive can work with different BIOS drive-type tables of the various host systems.

You can choose any drive type that does not exceed the capacity of the drive. Table 3-3 gives the logical parameters that provide the maximum capacity on the Maxtor D740X-6L family of hard disk drives.

Table 3-3   *Logical Addressing Format*

	MAXTOR D740X-6L			
	20.0GB	**40.0GB**	**60.0GB**	**80.0GB**
LBA Capacity	20.0GB	40.0GB	60.0GB	80.0GB
CHS Capacity	8,455MB	8,455MB	8,455MB	8,455MB
Logical Cylinders	16,383* (39,813)	16,383* (58,168)	16,383* (77,557)	16,383* (116,336)
Logical Heads	16	16	16	16
Logical Sectors/ Track	63	63	63	63
Total Number Logical Sectors	40,132,503	78,177,792	117,266,688	156,355,584

Note: *Capacity may be restricted to 8.4GB (or less) due to system BIOS limitations. Check with your system manufacturer to determine if your BIOS supports LBA Mode for hard drives greater than 8.4GB. Default logical cylinders is limited to 16,383 as per the ATA-4 specifications.

To match the logical specifications of the drive to the drive type of a particular BIOS, consult the system's drive-type table. This table specifies the number of cylinders, heads, and sectors for a particular drive type.

You must choose a drive type that meets the following requirements:

For the 10.2GB, 20.0GB, 30.0GB, 40.0GB, 60.0GB:

Logical Cylinders x Logical Heads x Logical Sectors/Track x 512 = 8,455,200,768

4.   Boot the system using the operating system installation disk—for example, MS-DOS—then follow the installation instructions in the operating system manual.

Chapter 4
SPECIFICATIONS

This chapter gives a detailed description of the physical, electrical, and environmental characteristics of the Maxtor D740X-6L hard disk drives.

4.1   SPECIFICATION SUMMARY

Table 4-1 gives a summary of the Maxtor D740X-6L hard disk drives.

Table 4-1   *Specifications*

DESCRIPTION	MAXTOR D740X-6L			
	20.0GB	**40.0GB**	**60.0GB**	**80.0GB**
Formatted Capacity	20,547MB	40,027MB	60,040MB	80,054MB
Nominal rotational speed (rpm)	7,200	7,200	7,200	7,200
Number of Disks	1	1	2	2
Number of R/W heads	1	2	3	4
Data Organization:				
Zones per surface	15	15	15	15
Tracks per surface	58,970	58,970	58,970	58,970
Total tracks	58,970	117,940	176,910	235,880
Sectors per track:				
Inside zone	481	481	481	481
Outside zone	882	882	882	882
Total User Sectors	40,132,503	78,177,792	117,266,688	156,355,584
Bytes per sector	512	512	512	512
Number of tracks per cylinder	1	2	3	4
Recording:				
Recording technology	Multiple Zone	Multiple Zone	Multiple Zone	Multiple Zone
Maximum linear density	568,451 fci	568,451 fci	568,451 fci	568,451 fci
Encoding method	50/52 NPR	50/52 NPR	50/52 NPR	50/52 NPR
Interleave	1:1	1:1	1:1	1:1
Track density	60,000 tpi	60,000 tpi	60,000 tpi	60,000 tpi

DESCRIPTION	MAXTOR D740X-6L			
	20.0GB	**40.0GB**	**60.0GB**	**80.0GB**
Maximum effective areal density (Gb/in^2)	Max. 34.1 Min. 22.6	Max. 34.1 Min. 22.6	Max. 34.1 Min. 22.6	Max. 34.1 Min. 22.6
Performance: Seek times:				
Read-on-arrival	8.5 ms typ.	8.5 ms typ.	8.5 ms typ.	8.5 ms typ.
Track-to-track	0.8 ms typ.	0.8 ms typ.	0.8 ms typ.	0.8 ms typ.
Average write	10.5 ms typ.	10.5 ms typ.	10.5 ms typ.	10.5 ms typ.
Full stroke	17.8 ms typ.	17.8 ms typ.	17.8 ms typ.	17.8 ms typ.
Data transfer Rates:				
Disk to Read Once a Revolution[1,2]	236Mb/sec min. 433Mb/sec maximum	236Mb/sec min. 433Mb/sec maximum	236Mb/sec min. 433Mb/sec maximum	236Mb/sec min. 433Mb/sec maximum
Disk to Read Instantaneously[1]	257Mb/sec minimum 472Mb/sec maximum	257Mb/sec minimum 472Mb/sec maximum	257Mb/sec minimum 472Mb/sec maximum	257Mb/sec minimum 472Mb/sec maximum
Read Buffer to ATA Bus (PIO Mode with IORDY)	16.7MB/sec. maximum	16.7MB/sec. maximum	16.7MB/sec. maximum	16.7MB/sec. maximum
Read Buffer to ATA Bus (Ultra ATA Mode)	133MB/sec. maximum	133MB/sec. maximum	133MB/sec. maximum	133MB/sec. maximum
Buffer Size	2MB	2MB	2MB	2MB
Reliability:				
Seek error rate[2]	1 in 10^6	1 in 10^6	1 in 10^6	1 in 10^6
Unrecoverable error rate[2]	1 in 10^{14}	1 in 10^{14}	1 in 10^{14}	1 in 10^{14}
Error correction method (with cross check)	36 Bytes Reed Solomon	36 Bytes Reed Solomon	36 Bytes Reed Solomon	36 Bytes Reed Solomon
Projected MTBF[3]	800,000 hrs	800,000 hrs	800,000 hrs	800,000 hrs
Contact Start/Stop Cycles[3] (Ambient temperature)	50,000 min.	50,000 min.	50,000 min.	50,000 min.
Auto head-park method				

1. Disk to read buffer transfer rate is zone-dependent, instantaneous

2. Refer to Section 4.1, "DISK ERRORS" for details on error rate definitions.

3. CSS specifications assumes a duty cycle of one power off operation for every one idle spin down.

4.2   FORMATTED CAPACITY

At the factory, the Maxtor D740X-6L 20.0/40.0/60.0/80.0GB AT hard disk drives receive a low-level format that creates the actual tracks and sectors on the drive. Table 4-2 shows the capacity resulting from this process. Formatting done at the user level, for operation with DOS, UNIX, or other operating systems, may result in less capacity than the physical capacity shown in Table 4-2.

Table 4-2   *Formatted Capacity*

	20.0GB	40.0GB	60.0GB	80.0GB
Formatted Capacity	20,547MB	40,027MB	60,040MB	80,054MB
Number of 512-byte sectors available	40,132,503	78,177,792	117,266,688	156,355,582

Note: The AT capacity is artificially limited to a 2.1GB partition boundary.

4.3   DATA TRANSFER RATES

Data is transferred from the disk to the read buffer at a rate of up to 750Mb/s in bursts. Data is transferred from the read buffer to the ATA bus at a rate of up to 16.7MB/s using programmed I/O with IORDY, or at a rate of up to 133MB/s using Ultra ATA/133. For more detailed information on interface timing, refer to Chapter 6.

4.4   TIMING SPECIFICATIONS

Table 4-3 illustrates the timing specifications of the Maxtor D740X-6L hard disk drives.

Table 4-**3**   *Timing Specifications*

PARAMETER	TYPICAL NOMINAL[1]	WORST CASE[2]
Sequential Cylinder Switch Time[3]	0.8ms	1.2ms
Sequential Head Switch Time[4]	1ms	1.75ms
Random Average (Read or Seek)[9]	8.5ms	12ms
Random Average (Write)[9]	10.5ms	13ms
Full-Stroke Seek	17.8ms	24ms
Average Rotational Latency	4.163ms	—
Power On[5] to Drive Ready[6]	12.5 seconds	30.0 seconds[6]
Standby[7] to Interface Ready	10.0 seconds	—
Spindown Time, Standby Command	19.0 seconds	25.0 seconds[8]
Spindown Time, Power loss	20.0 seconds	30.0 seconds[8]

1. Nominal conditions are as follows:

   • Nominal temperature 77°F (25°C)

   • Nominal supply voltages (12.0V, 5.0V)

   • No applied shock or vibration

2. Worst case conditions are as follows:

   • Worst case temperature extremes 41 to 131°F (5°C to 55°C)

   • Worst case supply voltages (12.0V ±10%, 5.0V ±5%)

3. Sequential Cylinder Switch Time is the time from the conclusion of the last sector of a cylinder to the first logical sector on the next cylinder (no more than 6% of cylinder switches exceed this time).

4. Sequential Head Switch Time is the time from the last sector of a track to the beginning of the first logical sector of the next track of the same cylinder (no more than 6% of head switches exceed this time).

5. Power On is the time from when the supply voltages reach operating range to when the drive is ready to accept any command.

6. Drive Ready is the condition in which the disks are rotating at the rated speed, and the drive is able to accept and execute commands requiring disk access without further delay at power or start up. Error recovery routines may extend the time to as long as 45 seconds for drive ready.

7. Standby is the condition at which the microprocessor is powered, but not the HDA. When the host sends the drive a shutdown command, the drive parks the heads away from the data zone, and spins down to a complete stop.

8. After this time it is safe to move the disk drive

9. Average random seek is defined as the average seek time between random logical block addresses (LBAs).

4.5   POWER

The Maxtor D740X-6L 20.0/40.0/60.0/80.0GB AT hard disk drives operate from two supply voltages:

- +12V ±10%

- +5V ±5%

The allowable ripple and noise is 250 mV peak-to-peak for the +12 Volt supply and 150 mV peak-to-peak for the +5Volt supply.

4.5.1   Power Sequencing

You may apply the power in any order, or open either the power or power return line with no loss of data or damage to the disk drive. However, data may be lost in the sector being written at the time of power loss. The drive can withstand transient voltages of +10% to −100% from nominal while powering up or down.

4.5.2   Power Reset Limits

When powering up, the drive remains reset (inactive) until both rising voltage thresholds reset limits are exceeded for ≥30 ms. When powering down, the drive becomes reset when either supply voltage drops below the falling voltage threshold for ≥ μ1 ms.

Table 4-4   *Power Reset Limits*

DC VOLTAGE	THRESHOLD	HYSTERESIS
+5 V	$V_{Threshold}$ = 4.3V minimum 4.6V maximum	60 mV (typical)
+12 V	$V_{Threshold}$ = 8.7V minimum 9.7V maximum	180 mV (typical)

4.5.3 Power Requirements

Table 4-5 lists the voltages and typical average corresponding currents for the various modes of operation of the Maxtor D740X-6L hard disk drives.

Table 4-5 *Typical Power and Current Consumption*

MODE OF OPERATION	TYPICAL AVERAGE CURRENT[2] (mAmps RMS unless otherwise noted)			
	+12V		+5V	
MODEL NUMBER	20/40GB (1-Disk)	60/80GB (2-Disks)	20/40GB (1-Disk)	60/80GB (2-Disks)
Startup[1] (peak)	1800	1800	450	450
Idle[3]	350	425	375	375
Maximum Seeking[4]	780	850	450	450
Standby[5]	25	25	100	100
Read/Write On Track[6]	375	450	475	475

MODE OF OPERATION	TYPICAL AVERAGE POWER[2] (WATTS)	
MODEL NUMBER	20/40GB (1-Disk)	60/80GB (2-Disks)
Startup[1] (peak)	23.9	24.0
Idle[3]	6.5	7.4
Maximum Seeking[4]	11.6	12.5
Standby[4]	0.8	0.8
Read/Write On Track[6] (peak)	7.1	8.0

1. Current is rms except for startup. Startup current is the typical peak current of the peaks greater than 10 ms in duration. This power is required for less than 6 seconds.

2. Power requirements reflect nominal for +12V and +5V power.

3. Idle mode is in effect when the drive is not reading, writing, seeking, or executing any commands. A portion of the R/W circuitry is powered down, the motor is up to speed and the Drive Ready condition exists.

4. Maximum seeking is defined as continuous random seek operations with minimum controller delay.

5. Standby mode is defined as when the motor is stopped, the actuator is parked, and all electronics except the interface control are in low power state. Standby occurs after a programmable time-out after the last host access. Drive ready and seek complete status exist. The drive leaves standby upon receipt of a command that requires disk access or upon receiving a spinup command.

6. Read/Write On Track is defined as 50% read operations and 50% write operations on a single physical track.

4.6   ACOUSTICS

Table 4-6 specifies the acoustical characteristics of the Maxtor D740X-6L 20.0/40.0/ 60.0/80.0GB AT hard disk drive. The acoustics are measured in an anechoic chamber with background noise at least <10dBA less than the expected sound pressure Lp(A). To distinguish between sound power and sound pressure standards, sound power Lw(A) is specified in Bels. The relationship between bels and dBA for sound power is 1 bel = 10dBA.

Table 4-6   *Acoustical Characteristics—Sound Power*

OPERATING MODE	1-DISK	2-DISK
Ball Bearing Spindle Idle Seek	3.0/3.3 Bels 3.5/3.8 Bels	3.2/3.5 Bels 3.5/3.8 Bels
Fluid Bearing Spindle Idle Seek	2.7/2.9 Bels 3.2/3.4 Bels	2.8/3.0 Bels 3.3/3.6 Bels

4.7   MECHANICAL

Maxtor D740X-6L hard disk drives are designed to meet the form factor dimensions of the SFF committee specification SFF8300.

Height: 25.4 mm maximum

Width: 101.6 ± 0.25mm

Depth: 147.0 mm maximum

Weight: 1.3 lb

4.8   ENVIRONMENTAL CONDITIONS

Table 4-7 summarizes the environmental specifications of the Maxtor D740X-6L hard disk drives.

Table 4-7 *Environmental Specifications*

PARAMETER	OPERATING	NON-OPERATING
Temperature[1] (Non-condensing)	5° to 55°C (41° to 131°F)	-40° to 65°C (-40° to 149°F)
Temperature Gradient (Non-condensing)	20°C/hr maximum (68°F/hr)	30°C/hr maximum (86°F/hr)
Humidity[2](Non-condensing) Maximum Wet Bulb Temperature	10% to 85% RH 30°C (86°F)	5% to 95% RH 40°C (104°F)
Humidity Gradient	10% / hour	10% / hour
Altitude[3, 4]	–200m to 3,000m (–650 to 10,000ft.)	–200m to 12,000m (–650 to 40,000ft.)
Altitude Gradient	1.5 kPa/min	8 kPa/min

1. Maximum operating temperature must not exceed the drive at any point along the drive form factor envelope. Airflow or other means must be used as needed to meet this requirement.

2. The humidity range shown is applicable for temperatures whose combination does not result in condensation in violation of the wet bulb specifications.

3. Altitude is relative to sea level.

4. The specified drive uncorrectable error rate will not be exceeded over these conditions.

4.9 SHOCK AND VIBRATION

The Maxtor D740X-6L 20.0/40.0/60.0/80.0GB AT hard disk drives can withstand levels of shock and vibration applied to any of its three mutually perpendicular axes, or principal base axis, as specified in Table 4-8. A functioning drive can be subjected to specified operating levels of shock and vibration. When a drive has been subjected to specified nonoperating levels of shock and vibration, with power to the drive off, there will be no loss of user data at power on.

When packed in its 1-pack shipping container, the Maxtor D740X-6L drives can withstand a drop from 30 inches onto a concrete surface on any of its surfaces, six edges, or three corners. The 20-pack shipping container can withstand a drop from 30 inches onto a concrete surface on any of its surfaces, six edges, or three corners.

Table 4-8   Shock and Vibration Specifications

SHOCK[1]	OPERATING	NONOPERATING
Translational 1/2 sine wave	30.0Gs, 2ms (write) 63.0Gs, 2ms (read)	300Gs, 2ms 150Gs, 1ms
Rotational 2 ms applied at geometry center of the drive	2,000 rad/sec^2	20,000 rad/sec^2
Vibration[1] Translational Random Vibration (G^2/Hz)	0.004 (10 – 500Hz)	0.05 (10 – 500Hz)
Sine wave (peak to peak)	.5G P-P 5-500Hz 1/2 octave per minute sweep	2G P-P 5–500Hz 1 octave per minute sweep
Rotational	12.5 rad/sec^2 (10 – 300Hz)	

1. The specified drive unrecovered error rate will not be exceeded over these conditions.

4.10 HANDLING THE DRIVE

Before handling the Maxtor hard disk drive some precautions must to be taken to ensure that the drive is not damaged. Use both hands while handling the drive and hold the drive by its edges. Maxtor drives are designed to withstand normal handling, however, hard drives can be damaged by electrostatic discharge (ESD), dropping the drive, rough handling, and mishandling. Use of a properly grounded wrist strap to the earth is strongly recommended. Always keep the drive inside its special antistatic bag until ready to install.

Note: To avoid causing any damage to the drive do not touch the Printed Circuit Board (PCB) or any of its components when handling the drive.

4.11   RELIABILITY

Mean Time Between Failures (MTBF):	The projected field MTBF is 800,000 hours. The Maxtor MTBF numbers represent Bell-Core TR-332 Issue #6, December 1997 MTBF predictions and represent the minimum MTBF that Maxtor or a customer would expect from the drive.
Component Life:	5 years
Preventive Maintenance (PM):	Not required
Start/Stop:	50,000 cycles at ambient temperature (minimum)

Note: CSS specification assumes a duty cycle of one power off operation for every one idle mode spin downs.

4.12   ELECTROMAGNETIC SUSCEPTIBILITY

E Field: (3Volts/meter at 27-1000 MHz)[10]. [10] Standard as per 61000-4-3 is 3Volts/meter.

B Field: As per standard EN61004-8

4.13   SPINDLE IMBALANCE

0.5 g-mm maximum

(This is approximately equivalent to 0.04 G emitted vibrations)

4.14   DISK ERRORS

Table 4-9 provides the error rates for the Maxtor D740X-6L hard disk drives.

Table 4-9   *Error Rates*

ERROR TYPE	MAXIMUM NUMBER OF ERRORS
Retry recovered read errors[1]	1 event per 10^9 bits read
Unrecovered read errors[2]	1 event per 10^{14} bits read
Seek errors[3]	1 error per 10^6 seeks

1. Retry recovered read errors are errors which require retries for data correction. Errors corrected by ECC on-the-fly are not considered recovered read errors. Read on arrival is disabled to meet this specification. Errors corrected by the thermal asperity correction are not considered recovered read errors.

2. Unrecovered read errors are errors that are not correctable using ECC or retries. The drive terminates retry reads either when a repeating error pattern occurs, or after the programmed limit for unsuccessful retries and the application of quadruple-burst error correction.

3. Seek errors occur when the actuator fails to reach (or remain) over the requested cylinder and the drive requires the execution of a full recalibration routine to locate the requested cylinder.

Note: Error rates are for worst case temperature and voltage.

Chapter 5
BASIC PRINCIPLES OF OPERATION

This chapter describes the operation of Maxtor D740X-6L hard disk drives' functional subsystems. It is intended as a guide to the operation of the drive, rather than a detailed theory of operation.

5.1   MAXTOR D740X-6L DRIVE MECHANISM

This section describes the drive mechanism. Section 5.2 describes the drive electronics. The Maxtor D740X-6L hard disk drives consist of a mechanical assembly and a PCB as shown in Figure 5-1.

The head/disk assembly (HDA) contains the mechanical subassemblies of the drive, which are sealed under a metal cover. The HDA consists of the following components:

- Base casting
- DC motor assembly
- Disk stack assembly
- Headstack assembly
- Rotary positioner assembly
- Automatic actuator lock
- Air filter

The drive is assembled in a Class-100 clean room.

CAUTION: To ensure that the air in the HDA remains free of contamination, never remove or adjust its cover and seals. Tampering with the HDA will void your warranty.
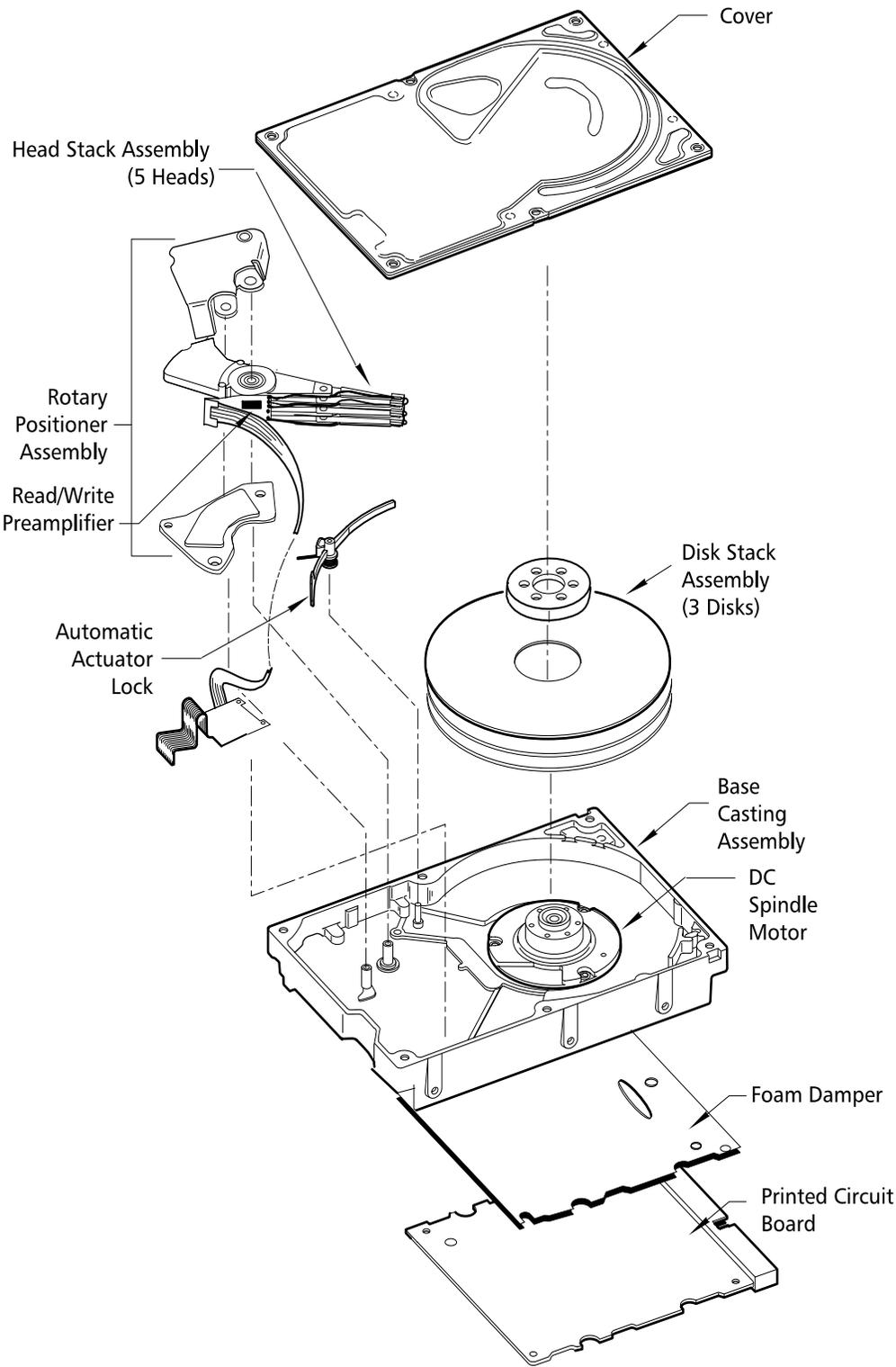
Figure 5-1 *A Generic Hard Disk Drive Exploded View*

5.1.1 Base Casting Assembly

A single-piece, e-coated, aluminum-alloy base casting provides a mounting surface for the drive mechanism and PCB. The base casting also acts as the flange for the DC motor assembly. To provide a contamination-free environment for the HDA, a gasket provides a seal between the base casting, and the metal cover that encloses the drive mechanism.

5.1.2 DC Motor Assembly

Integral with the base casting, the DC motor assembly is a fixed-shaft, brushless DC spindle motor that drives the counter-clockwise rotation of the disks.

5.1.3 Disk Stack Assemblies

The disk stack assembly in the Maxtor D740X-6L hard disk drives consist of disks secured by a disk clamp. The aluminum-alloy disks have a sputtered thin-film magnetic coating.

A carbon overcoat lubricates the disk surface. This prevents head and media wear due to head contact with the disk surface during head takeoff and landing. Head contact with the disk surface occurs only in the landing zone outside of the data area, when the disk is not rotating at full speed. The landing zone is located at the inner diameter of the disk, beyond the last cylinder of the data area.

Table 5-1 *Cylinder Contents*

CYLINDER CONTENTS	ZONE[1]	NUMBER OF TRACKS	SECTORS PER TRACK	DATA RATE
System Data	0	68	299	469.23
	1	2582	837	551.28
	2	4412	826	543.59
	3	4123	814	536.20
	4	3539	805	530.22
	5	4068	789	520.51
	6	4380	784	509.62
	7	4388	744	489.88
	8	5022	700	461.54
	9	5190	658	434.62
	10	4406	616	407.05
	11	3332	588	387.96
	12	3985	548	360.95
	13	2933	522	344.62
	14	2914	490	323.53
	15	3696	457	304.20

1.   For user data, zone 15 is the innermost zone and zone 1 is the outermost zone.

5.1.4   Headstack Assembly

The headstack assembly consists of read/write heads, head arms, and a coil joined together by insertion molding to form a rotor subassembly, bearings, and a flex circuit. Read/write heads mounted to spring-steel flexures are swage mounted onto the rotary positioner assembly arms.

The flex circuit exits the HDA through the base casting. A cover gasket seals the gap. The flex circuit connects the headstack assembly to the PCB. The flex circuit contains a read preamplifier/write driver IC.

5.1.5   Rotary Positioner Assembly

The rotary positioner, or rotary voice-coil actuator, is a Maxtor-proprietary design that consists of upper and lower permanent magnet plates, a rotary single-phase coil molded around the headstack mounting hub, and a bearing shaft. The single bi-polar magnet consists of two alternating poles and is bonded to the magnet plate. A resilient crash stop prevents the heads from being driven into the spindle or off the disk surface.

Current from the power amplifier induces a magnetic field in the voice coil. Fluctuations in the field around the permanent magnet cause the voice coil to move. The movement of the voice coil positions the heads over the requested cylinder.

5.1.6   Automatic Actuator Lock

To ensure data integrity and prevent damage during shipment, the drive uses a dedicated landing zone, an actuator magnetic retract, and Maxtor's patented Airlock®. The Airlock holds the headstack in the landing zone whenever the disks are not rotating. It consists of an air vane mounted near the perimeter of the disk stack, and a locking arm that restrains the actuator arm assembly.

When DC power is applied to the motor and the disk stack rotates, the rotation generates an airflow on the surface of the disk. As the flow of air across the air vane increases with disk rotation, the locking arm pivots away from the actuator arm, enabling the headstack to move out of the landing zone. When DC power is removed from the motor, an electronic return mechanism automatically pulls the actuator into the landing zone, where the magnetic actuator retract force holds it until the Airlock closes and latches it in place.

5.1.7   Air Filtration

The Maxtor D740X-6L hard disk drives are Winchester-type drives. The heads fly very close to the media surface. Therefore, it is essential that the air circulating within the drive be kept free of particles. Maxtor assembles the drive in a Class-100 purified air environment, then seals the drive with a metal cover. When the drive is in use, the rotation of the disks forces the air inside of the drive through an internal 0.3 micron filter. The internal HDA cavity pressure equalizes to the external pressure change by passing air through a 0.3 micron, carbon impregnated breather filter.

5.2   DRIVE ELECTRONICS

Advanced circuit (Very Large Scale Integration) design and the use of miniature surface-mounted devices and proprietary VLSI components enable the drive electronics, including the ATA bus interface, to reside on a single printed circuit board assembly (PCBA).

Figure 5-2 contains a simplified block diagram of the Maxtor D740X-6L hard disk drive electronics.

The only electrical component not on the PCBA is the PreAmplifier and Write Driver IC. It is on the flex circuit (inside of the sealed HDA). Mounting the preamplifier as close as possible to the read/write heads improves the signal-to-noise ratio. The flex circuit (including the PreAmplifier and Write Driver IC) provides the electrical connection between the PCB, the rotary positioner assembly, and read/write heads.
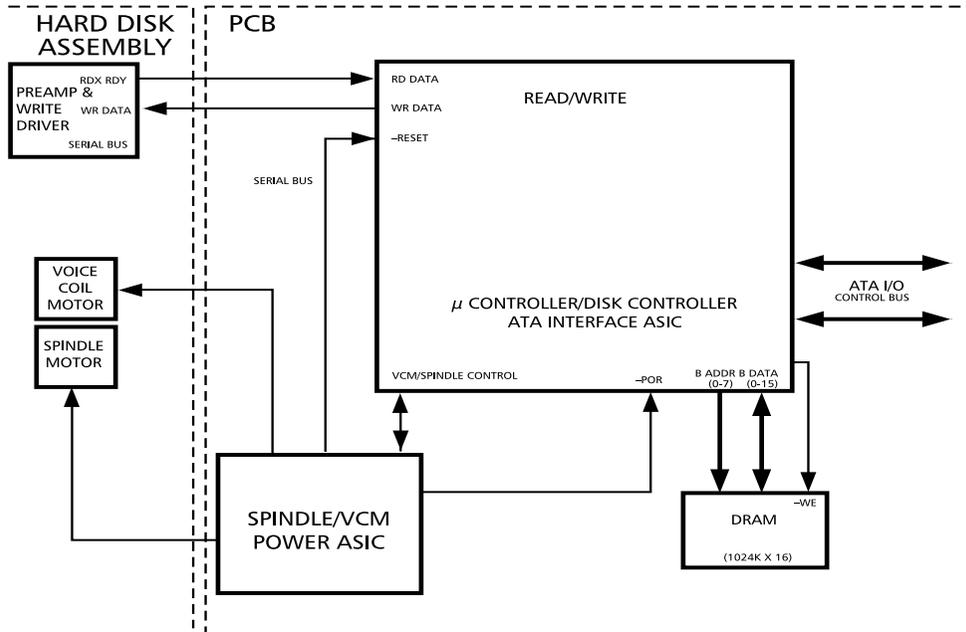
Figure 5-2   *Maxtor D740X-6L Hard Disk Drive Block Diagram*

5.2.1 Integrated *μ*Processor, Disk Controller and ATA Interface Electronics

The μProcessor, Disk Controller, and ATA Interface electronics are contained in a proprietary ASIC developed by Maxtor, as shown below in Figure 5-3.
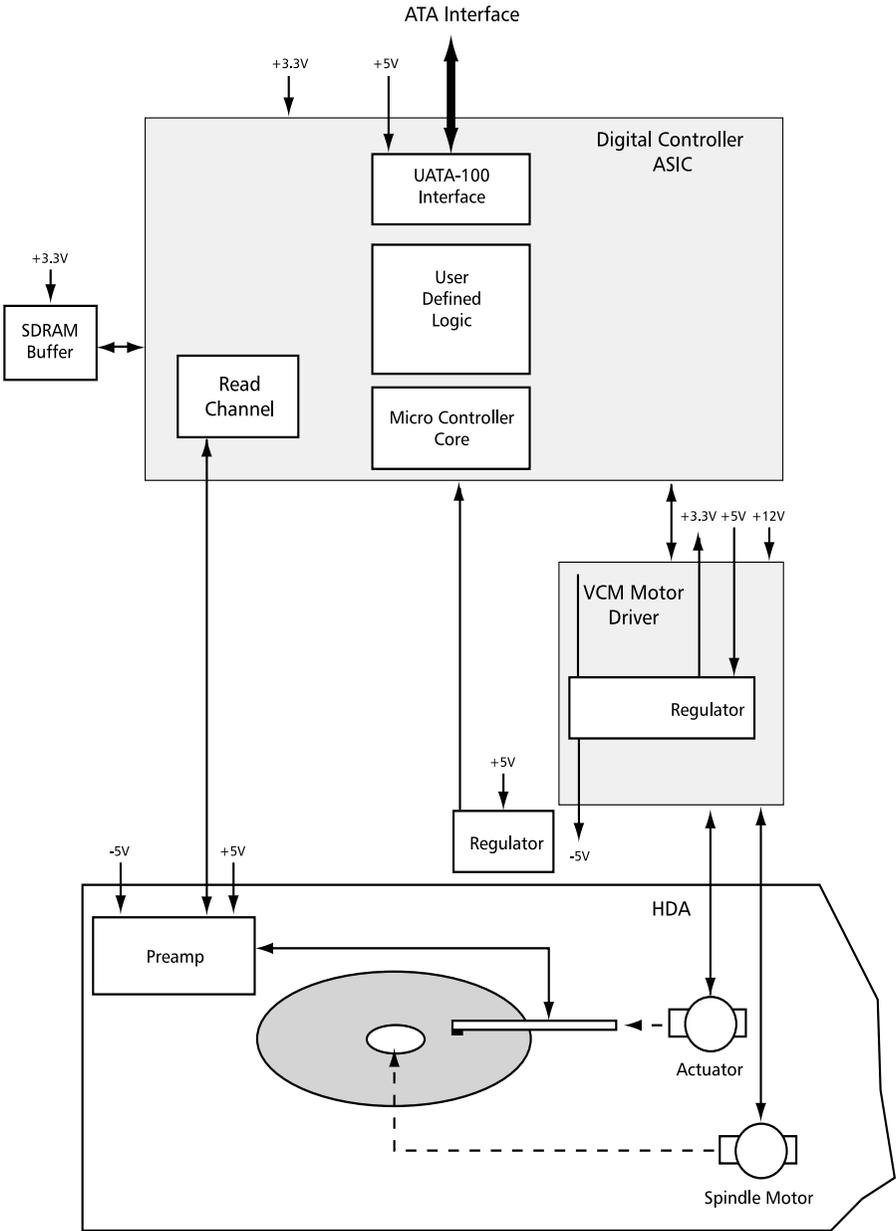
Figure 5-3 *Block Diagram*

The integrated µProcessor, Disk Controller, and ATA Interface Electronics have nine functional modules (described below):

- µProcessor
- Digital Synchronous Spoke (DSS)
- Error Correction Code (ECC) Control
- Formatter
- Buffer Controller
- Servo Controller, including PWM
- Serial Interface
- ATA Interface Controller
- Motor Controller

5.2.1.1 *µ*Processor

The µProcessor core provides local processor services to the drive electronics under program control. The µProcessor manages the resources of the Disk Controller, and ATA Interface internally. It also manages the Read/Write ASIC (Application Specific Integrated Circuit), and the Spindle/VCM driver externally.

5.2.1.2 Digital Synchronous Spoke

The DSS decodes servo information written on the drive at the factory to determine the position of the read/write head. It interfaces with the read/write channel, process timing and position information, and stores it in registers that are read by the servo firmware.

5.2.1.3 Error Correction Code (ECC) Control

The Error Correction Code (ECC) Control block utilizes a Reed-Solomon encoder/decoder circuit that is used for disk read/write operations. It uses a total of 44 redundancy bytes organized as 40 ECC (Error Correction Code) bytes with one interleave, and four cross-check bytes. The ECC uses ten bits per symbol and one interleave. This is guaranteed to correct 150 bits and as many as 160 bits in error.

5.2.1.4 Formatter

The Formatter controls the operation of the read and write channel portions of the ASIC. To initiate a disk operation, the µProcessor loads a set of commands into the WCS (writable control store) register. Loading and manipulating the WCS is done through the µProcessor Interface registers.

The Formatter also directly drives the read and write gates (RG, WG) and Command Mode Interface of the Read/Write ASIC and the R/W Preamplifier, as well as passing write data to the Precompensator circuit in the Read/Write ASIC.

5.2.1.5 Buffer Controller

The Buffer Controller supports a 2MB buffer, which is organized as 1M x 16 bits. The 16-bit width implementation provides a 233MB/s maximum buffer bandwidth. This increased bandwidth allows the µProcessor to have direct access to the buffer, eliminating the need for a separate µProcessor RAM IC.

The Buffer Controller supports both drive and host address rollover and reloading, to allow for buffer segmentation. Drive and host addresses may be separately loaded for automated read/write functions.

The Buffer Controller operates under the direction of the μProcessor.

5.2.1.6   Servo Processor

The Servo Processor in the Read Write Channel ASIC provides servo data recovery and burst demodulation to extract the actuator position information. This information is processed in the controller ASIC/microprocessor, and a control signal is output to the VCM in the Power ASIC. This controls the current in the actuator coil which controls the position of the actuator.

5.2.1.7   Read/Write Interface

The Read/Write interface allows the integrated μprocessor, disk controller to communicate with the Read/Write chip.

5.2.1.8   ATA Interface Controller

The ATA Interface Controller portion of the ASIC provides data handling, bus control, and transfer management services for the ATA interface. Configuration and control of the interface is accomplished by the μController across the MAD bus. Data transfer operations are controlled by the Buffer Controller module.

5.2.1.9   Motor Controller

The Motor Controller controls the spindle and voice coil motor (VCM) mechanism on the drive.

5.2.2   Read/Write Block

The Read/Write ASIC integrates an Advanced Partial Response Maximum Likelihood (PRML) processor, a selectable code rate Encoder-Decoder (ENDEC), and a Servo Processor with data rates up to 750MHz. Programming is done through a fast 40 MHz serial interface. The controller and data interface through an 8-bit wide data interface. The Read/Write ASIC is a low power 3.3Volts, dual-supply, with selective power down capabilities.

The Read/Write ASIC comprises 12 main functional modules (described below):

- Pre-Compensator
- Variable Gain Amplifier (VGA)
- Butterworth Filter
- FIR Filter
- Flash A/D Converter
- Viterbi Detector
- ENDEC
- Servo Processor
- Clock Synthesizer

- PLL

- Serial Interface

- TA Detection and Correction

5.2.2.1 Pre-Compensator

The pre-compensator introduces pre-compensation to the write data received from the sequencer module in the DCIIA. The pre-compensated data is then passed to the R/W Pre-Amplifier and written to the disk. Pre-compensation reduces the write interference from adjacent write bit.

5.2.2.2 Variable Gain Amplifier (VGA)

Digital and analog controlled AGC function with input attenuator for extended range.

5.2.2.3 Butterworth Filter

Continuous time data filter which can be programmed for each zone rate.

5.2.2.4 FIR (Finite Impulse Response) Filter

Digitally controlled and programmable filter for partial response signal conditioning.

5.2.2.5 Flash A/D Converter

Provides very high speed digitization of the processed read signal.

5.2.2.6 Viterbi Detector

Decodes ADC result into binary bit stream.

5.2.2.7 ENDEC

Provides 50/52 code conversion to NRZ. Includes preamble and sync mark generation and detection.

5.2.2.8 Servo Processor

Servo processor with servo data recovery and burst demodulation.

5.2.2.9 Clock Synthesizer

Provides programmable frequencies for each zone data rate.

5.2.2.10 PLL

Provides digital read clock recovery.

5.2.2.11 Serial Interface

High speed interface for digital control of all internal blocks.

5.2.2.12 TA Detection and Correction

Detects thermal asperities' defective sectors and enables thermal asperity recoveries.

5.2.3   PreAmplifier and Write Driver

The PreAmplifier and Write Driver provides write driver and read pre-amplifier functions, and R/W head selection. The write driver receives precompensated write data from the PreCompensator module in the Read/Write ASIC. The write driver then sends this data to the heads in the form of a corresponding alternating current. The read pre-amplifier amplifies the low-amplitude voltages generated by the R/W heads, and transmits them to the VGA module in the Read/Write ASIC. Head select is determined by the controller.

5.3   FIRMWARE FEATURES

This section describes the following firmware features:

- Disk caching

- Head and cylinder skewing

- Error detection and correction

- Defect management

5.3.1   Disk Caching

The Maxtor D740X-6L hard disk drives incorporate DisCache, a 1.9MB disk cache, to enhance drive performance. This integrated feature is user-programmable and can significantly improve system throughput. Read and write caching can be enabled or disabled by using the Set Configuration command.

5.3.1.1   Adaptive Caching

The cache buffer for the Maxtor D740X-6L drives features adaptive segmentation for more efficient use of the buffer's RAM. With this feature, the buffer space used for read and write operations is dynamically allocated. The cache can be flexibly divided into several segments under program control. Each segment contains one cache entry.

A cache entry consists of the requested read data plus its corresponding prefetch data. Adaptive segmentation allows the drive to make optimum use of the buffer. The amount of stored data can be increased.

5.3.1.2   Read Cache

DisCache anticipates host-system requests for data and stores that data for faster access. When the host requests a particular segment of data, the caching feature uses a prefetch strategy to "look ahead", and automatically store the subsequent data from the disk into high-speed RAM. If the host requests this subsequent data, the RAM is accessed rather than the disk.

Since typically 50 percent or more of all disk requests are sequential, there is a high probability that subsequent data requested will be in the cache. This cached data can be retrieved in microseconds rather than milliseconds. As a result, DisCache can provide substantial time savings during at least half of all disk requests. In these instances, DisCache could save most of the disk transaction time by eliminating the seek and rotational latency delays that dominate the typical disk transaction. For example, in a 1K data transfer, these delays make up to 90 percent of the elapsed time.

DisCache works by continuing to fill its cache memory with adjacent data after

transferring data requested by the host. Unlike a noncaching controller, Maxtor's disk controller continues a read operation after the requested data has been transferred to the host system. This read operation terminates after a programmed amount of subsequent data has been read into the cache segment.

The cache memory consists of a 1.9MB DRAM buffer allocated to hold the data, which can be directly accessed by the host by means of the READ and WRITE commands. The memory functions as a group of segments with rollover points at the end of cache memory. The unit of data stored is the logical block (that is, a multiple of the 512 byte sector). Therefore, all accesses to the cache memory must be in multiples of the sector size. Almost all non-read/write commands force emptying of the cache:

5.3.1.3 Write Cache

When a write command is executed with write caching enabled, the drive stores the data to be written in a DRAM cache buffer, and immediately sends a GOOD STATUS message to the host before the data is actually written to the disk. The host is then free to move on to other tasks, such as preparing data for the next data transfer, without having to wait for the drive to seek to the appropriate track, or rotate to the specified sector.

While the host is preparing data for the next transfer, the drive immediately writes the cached data to the disk.

WriteCache allows data to be transferred in a continuous flow to the drive, rather than as individual blocks of data separated by disk access delays. This is achieved by taking advantage of the ability to write blocks of data sequentially on a disk that is formatted with a 1:1 interleave. This means that as the last byte of data is transferred out of the write cache and the head passes over the next sector of the disk, the first byte of the of the next block of data is ready to be transferred, thus there is no interruption or delay in the data transfer process.

The WriteCache algorithm fills the cache buffer with new data from the host while simultaneously transferring data to the disk that the host previously stored in the cache.

5.3.1.4 Performance Benefits

In a drive without DisCache, there is a delay during sequential reads because of the rotational latency, even if the disk actuator already is positioned at the desired cylinder. DisCache eliminates this rotational latency time (4.17 ms on average) when requested data resides in the cache.

Moreover, the disk must often service requests from multiple processes in a multitasking or multiuser environment. In these instances, while each process might request data sequentially, the disk drive must share time among all these processes. In most disk drives, the heads must move from one location to another. With DisCache, even if another process interrupts, the drive continues to access the data sequentially from its high-speed memory. In handling multiple processes, DisCache achieves its most impressive performance gains, saving both seek and latency time when desired data resides in the cache.

The cache can be flexibly divided into several segments under program control. Each segment contains one cache entry. A cache entry consists of the requested read data plus its corresponding prefetch data.

The requested read data takes up a certain amount of space in the cache segment. Hence, the corresponding prefetch data can essentially occupy the rest of the space within the segment. The other factors determining prefetch size are the maximum and minimum prefetch. The drive's prefetch algorithm dynamically controls the actual prefetch value based on the current demand, with the consideration of overhead to subsequent commands.

5.3.2 Head and Cylinder Skewing

Head and cylinder skewing in the Maxtor D740X-6L hard disk drives minimize latency time and thus increases data throughput.

5.3.2.1 Head Skewing

Head skewing reduces the latency time that results when the drive must switch read/write heads to access sequential data. A head skew is employed such that the next logical sector of data to be accessed will be under the read/write head once the head switch is made, and the data is ready to be accessed. Thus, when sequential data is on the same cylinder but on a different disk surface, a head switch is needed but not a seek. Since the sequential head-switch time is well defined on the Maxtor D740X-6L drives, the sector addresses can be optimally positioned across track boundaries to minimize the latency time during a head switch. See Table 5-2.

5.3.2.2 Cylinder Skewing

Cylinder skewing is also used to minimize the latency time associated with a single-cylinder seek. The next logical sector of data that crosses a cylinder boundary is positioned on the drive such that after a single-cylinder seek is performed, and when the drive is ready to continue accessing data, the sector to be accessed is positioned directly under the read/write head. Therefore, the cylinder skew takes place between the last sector of data on the last head of a cylinder, and the first sector of data on the first head of the next cylinder. Since single-cylinder seeks are well defined on the Maxtor D740X-6L drives, the sector addresses can be optimally positioned across cylinder boundaries to minimize the latency time associated with a single-cylinder seek. See Table 5-2.

5.3.2.3 Skewing with ID-less

In the ID-less environment, the drive's track and cylinder skewing will be based in unit of wedges instead of the traditional sectors. The integrated µprocessor, disk controller and ATA interface contains a "Wedge Skew Register" to assist in the task of skewing, where the skew offset must now be calculated with every read/write operation. The firmware will program the skew offset into this register every time the drive goes to a new track. The integrated µprocessor, disk controller and ATA interface will then add this value to the wedge number in the ID calculator, effectively relocating the "first" sector of the track away from the index. For example, if without skew, sector 0 is to be found following wedge 0, then if the skew register is set to 10, sector 0 will be found following wedge 10.

Since the wedge-to-wedge time is constant over the entire disk, a single set of head and cylinder skew off-sets will fulfill the requirement for all recording zones.

5.3.2.4   Skew Offsets

Table 5-2   *Skew Offsets*

	SWITCH TIME	WEDGE OFFSET
Head Skew	1.83ms	43
Cylinder Skew	TBDms	43

> **Note:** Nominal wedge-to-wedge time of 42.5μs is used. Worst case instantaneous spindle variation (±0.12%) is used while calculating to provide a safety margin.
>
> Wedge offsets are rounded to the closest whole number.

5.3.2.5   Runtime Calculation

Since the wedge-to-wedge time is constant over the entire disk, a single set of head and cylinder skew offsets will fulfill the requirement for all recording zones. The formula used to compute the wedge skew for a given cylinder and head is:

Wedge skew=[C* ((# of heads – 1) * TS + CS) + H * TS] MOD 196

Where:C=Cylinder number

H=Head number

TS=Head Skew Offset

CS Cylinder Skew Offset

(wedges/track=196)

5.3.3   Error Detection and Correction

As disk drive areal densities increase, obtaining extremely low error rates requires a new generation of sophisticated error correction codes. Maxtor D740X-6L hard disk drive series implement 320-bit Reed-Solomon error correction techniques to reduce the uncorrectable read block error rate to less than one bit in 1×10^{14} bits read.

When errors occur, an automatic retry of 15 10-bit symbols and a more rigorous 16 10-bit symbols correction algorithm enable the correction of any sector with single bursts, or up to sixteen multiple random one 10-bit symbol burst. In addition to these advanced error correction capabilities, the drive uses an additional cross-checking code and algorithm to double check the main ECC correction. This greatly reduces the probability of a miscorrection.

5.3.3.1   Background Information on Error Correction Code and ECC On-the-Fly

A sector on the Maxtor D740X-6L drive is comprised of 512 bytes of user data, followed by four cross-checking (XC) bytes (32 bits), followed by 40 ECC check bytes (320 bits) or 32 10-bit symbols. The four cross-checking bytes are used to double check the main ECC correction and reduce the probability of miscorrection. Errors

of up to 150 bits within one sector can be corrected "on-the-fly," in real time as they occur, allowing a high degree of data integrity with no impact on the drive's performance.

The drive does not need to re-read a sector on the next disk revolution or apply ECC for those errors that are corrected on-the-fly. Errors corrected in this manner are invisible to the host system.

When errors cannot be corrected on-the-fly, an automatic retry, and a more rigorous 16 10-bit symbols error correction algorithm enables the correction of any sector with single bursts (up to 16 contiguous 10-bit symbols), or up to 16 multiple random one 10-bit symbol burst errors. In addition to this error correction capability, the drive's implementation of an additional cross-checking code and algorithm double checks the main ECC correction, and greatly decreases the likelihood of miscorrection.

The 32 ECC check symbols shown in Figure 5-4 are used to detect and correct errors. The cross-checking and ECC data is computed and appended to the user data when the sector is first written.

1	2	3	4	5		512	513	516	517	518		556
d 1	d 2	d 3	d 4	d 5	●●●●●●	d 512	xc 1	xc 2	ecc 1	ecc 2	●●●●	ecc 40

512 data bytes	4 cross-check bytes	40 bytes or 32 ECC 10-bit symbols
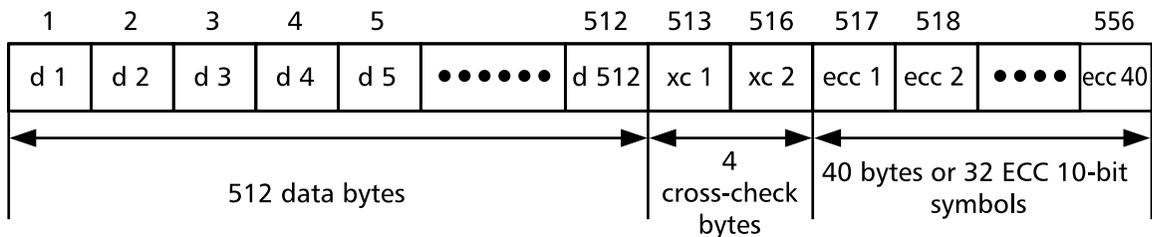
Figure 5-4 *Sector Data Field with ECC Check Bytes*

Because the ECC check symbols follow the cross checking bytes, errors found within the cross-checking bytes can be corrected. Due to the power and sophistication of the code, errors found within the ECC check bytes can also be corrected.

Each time a sector of data is read, the Maxtor D740X-6L drives will generate a new set of ECC check symbols and cross-checking bytes from the user data. These new check symbols are compared to the ones originally written to the disk. The difference between the newly computed and original check symbols is reflected in a set of 32 *syndromes* and three cross checking syndromes, which correspond to the number of check symbols. If all the ECC syndrome values equal zero, and cx syndrome value equals zero or 0FF, the data was read with no errors, and the sector is transferred to the host system. If any of the syndromes do not equal zero or OFF, an error has occurred. The type of correction the drive applies depends on the nature and the extent of the error.

High speed on-the-fly error correction saves several milliseconds because there is no need to wait for a disk revolution to bring the sector under the head for re-reading.

5.3.3.2 ECC Error Handling

When a data error occurs, the Maxtor D740X-6L hard disk drives check to see if the error is correctable on-the-fly. This process takes about 160μs. If the error is correctable on-the-fly, the error is corrected and the data is transferred to the host system.

If the data is not correctable on-the-fly, the sector is re-read in an attempt to read the data correctly without applying firmware ECC correction. Before invoking the complex firmware ECC algorithm, the drive will always try to recover from an error by attempting to re-read the data correctly. This strategy prevents invoking correction on non-repeatable errors. Each time a sector in error is re-read a set of ECC syndromes is computed. If all of the ECC syndrome values equal zero, and xc syndrome value equals to 0 or 0FF, the data was read with no errors, and the sector is transferred to the host system. If any of the syndrome values do not equal zero, an error has occurred, the syndrome values are retained, and another re-read is invoked.

Note: Non-repeatable errors are usually related to the signal to noise ratio of the system. They are not due to media defects.

This event may be significant depending on whether the automatic read reallocation or early correction features have been enabled. If the early correction feature has been enabled and a stable syndrome has been achieved, firmware ECC correction is applied, and the appropriate message is transferred to the host system (e.g., corrected data, etc.).

Note: These features can be enabled or disabled through the ATA Set Configuration command. The EEC bit enables early firmware ECC correction before all of the re-reads have been exhausted. The ARR bit enables the automatic reallocation of defective sectors.

The Maxtor D740X-6L drives are shipped from the factory with the automatic read reallocation feature enabled so that any new defective sectors can be easily and automatically reallocated for the average AT end user.

5.3.4 Defect Management

In the factory, the media is scanned for defects. If a sector on a cylinder is found to be defective, the address of the sector is added to the drive's defect list. Sectors located physically subsequent to the defective sector are assigned logical block addresses such that a sequential ordering of logical blocks is maintained. This inline sparing technique is employed in an attempt to eliminate slow data transfer that would result from a single defective sector on a cylinder.

If more than 32 sectors are found defective, the above off-line sparing technique is applied to the 32 sectors only. The remaining defective sectors are replaced with the nearest available pool of spares.

Defects that occur in the field are known as *grown* defects. If such a defective sector is found in the field, the sector is reallocated according to the same algorithm used at the factory for those sectors that are found defective *after* the first 32 spares per pool of spares; that is, inline sparing is not performed on these grown defects. Instead, the sector is reallocated to an available spare sector on a nearby available pool of spares.

Sectors are considered to contain grown defects if the 14/15/16 10-bit symbols ECC algorithm must be applied to recover the data. If this algorithm is successful, the corrected data is stored in the newly allocated sector. If the algorithm is not successful, a pending defect will be added to the defect list. Any subsequent read to the original logical block will return an error if the read is not successful. A host command to over-write the location will result in 4 write/read/verifies of the suspect location. If any of the 4 write/read/verifies fail, the new data will be written to a spare sector, and the original location will be added to the permanent defect list. If all 4 write/read/verifies pass, data will be written to the location, and the pending defect will be removed from the list.

Chapter 6
ATA BUS INTERFACE AND ATA COMMANDS

This chapter describes the interface between Maxtor D740X-6L 20.0/40.0/60.0/ 80.0GB AT hard disk drives and the ATA bus. The commands that are issued from the host to control the drive are listed, as well as the electrical and mechanical characteristics of the interface.

6.1   INTRODUCTION

Maxtor D740X-6L 20.0/40.0/60.0/80.0GB AT hard disk drives use the standard ATA/ATAPI-6 interface. Support of various options in the standard are explained in the following sections.

6.2   MECHANICAL INTERFACE

6.2.1   Signal Cable and Connector

The Maxtor D740X-6L hard disk drive contains a 50-pin unitized connector for both signal and power connections as well as configuration jumpers. The dimensions of the unitized connector comply with figure A.12 and table A.15 of the ATA/ATAPI-6 standard.

6.3   ELECTRICAL INTERFACE

6.3.1   ATA Bus Interface

6.3.1.1   Electrical Characteristics

Signals on the ATA interface are assigned to connector pins according to Table A.1 and A.8 of the ATA/ATAPI-6 standard. The signaling protocol complies with section 9 and signal timing complies with section 10 of the standard.

The Maxtor D740X-6L hard disk drives support all Ultra DMA Data Transfer modes of ATA/ATAPI-6. In Mode 6, it can send and receive data at the full 133MB/s transfer rate. IN addition, the drive supports Ultra DMA Mode 6.

Hosts may assert the RESET- signal for longer than the minimum. When power is applied with RESET- asserted, the Maxtor D740X-6L disk media will not begin to spin up until RESET- is negated. This may reduce maximum current consumption for the overall system.

6.4   REGISTER ADDRESS DECODING

The Maxtor D740X-6L hard disk drives allow their host systems to address the full set of command and control registers as specified in ATA/ATAPI-6 section 7.

6.5   COMMAND INTERFACE

6.5.1   General Feature Set

The µProcessor, Disk Controller, and ATA Interface electronics are contained in a proprietary ASIC developed by Maxtor as shown in Figure 5-3.

The Maxtor D740X-6L hard disk drives support all the mandatory commands from the general feature set for non-packet devices. They are:

- EXECUTE DEVICE DIAGNOSTIC
- FLUSH CACHE
- IDENTIFY DEVICE
- INITIALIZE DEVICE PARAMETERS
- READ DMA
- READ MULTIPLE
- READ SECTOR(S)
- READ VERIFY SECTOR(S)
- SEEK
- SET FEATURES
- SET MULTIPLE MODE
- WRITE DMA
- WRITE MULTIPLE
- WRITE SECTOR(S)

The drives support the following optional commands from the general feature set for non-packet devices:

- DOWNLOAD MICROCODE
- NOP
- READ BUFFER
- WRITE BUFFER

6.5.2   Multiword DMA

The drives support the Multiword DMA protocol.

6.5.3   Ultra DMA Feature Set

The drives support the Ultra DMA feature set for the following commands:

- READ DMA
- WRITE DMA

6.5.4   Power Management Feature Set

The drives support the following commands from the optional Power Management feature set:

- CHECK POWER MODE
- IDLE
- IDLE IMMEDIATE
- SLEEP
- STANDBY
- STANDBY IMMEDIATE

6.5.5   Security Mode Feature Set

The drives support the following commands from the optional Security Mode feature set:

- SECURITY SET PASSWORD
- SECURITY UNLOCK
- SECURITY ERASE PREPARE
- SECURITY ERASE UNIT
- SECURITY FREEZE LOCK
- SECURITY DISABLE PASSWORD

6.5.6   Self-monitoring, Analysis, and Reporting (SMART) Feature Set

The drives support the following commands from the optional SMART feature set:

- SMART DISABLE OPERATIONS
- SMART ENABLE/DISABLE AUTOSAVE
- SMART ENABLE OPERATIONS
- SMART RETURN STATUS
- SMART EXECUTE OFF-LINE IMMEDIATE
- SMART READ DATA
- SMART READ LOG SECTOR
- SMART WRITE LOG SECTOR

6.5.7   Host Protected Area Feature Set

The drives support the following commands from the optional Host Protected Area feature set including security extensions:

- READ NATIVE MAX ADDRESS
- SET MAX ADDRESS
- SET MAX SET PASSWORD
- SET MAX LOCK
- SET MAX FREEZE LOCK
- SET MAX UNLOCK

6.5.8   Automatic Acoustic Management Feature Set

The drives support the optional Automatic Acoustic Management feature set which uses subcommands of the SET FEATURES command.

6.5.9   IDENTIFY DEVICE Information

Table 6-1 *Identify Device Parameters*

Word	Bits	Description	Value
0	15 14-8 7 6 5-3 2 1 0	General configuration bit-significant information: 0 = ATA device Retired removable media device not removable controller and/or device Retired Response incomplete Retired Reserved	045Ah
1		Obsolete	3FFFh
2		Specific configuration	0000h
3		Obsolete	0010h
4-5		Retired	7E00h-5332h
6		Obsolete	003Fh
7-8		Reserved for the CompactFlash™ Association	0000h-0000h
9		Retired	5154h
10-19		Serial number (20 ASCII characters)	Variable
20-21		Retired	0003h-0E39h
22		Obsolete	0004h
23-26		Firmware revision (8 ASCII characters)	Variable
27-46		Model number (40 ASCII characters)	6L020J1 6L040J2 6L060J3 6L080J4 6L020L1 6L040L2 6L060L3 6L080L4
47	15-8 7-0	80h Maximum sectors per interrupt on MULTIPLE commands	8010h
48		Reserved	Reserved

49	15- 14 13 12 11 10 9 8 7-0	Capabilities Reserved for the IDENTIFY PACKET DEVICE command. Standby timer values are supported Reserved for the IDENTIFY PACKET DEVICE command. IORDY supported IORDY may be disabled LBA supported DMA supported. Retired	0F00h
50	15 14 13-2 1 0	Capabilities Shall be cleared to zero. Shall be set to one. Reserved. Obsolete Shall be set to one to indicate a device specific Standby timer value minimum.	0 1 000h 0 0
51-52		Obsolete	0200h-0200h
53	15-3 2 1 0	Reserved the fields reported in word 88 are valid the fields reported in words 64-70 are valid the fields reported in words 54-58 are valid	0 1 1 1
54		Obsolete	3FFFh
55		Obsolete	0010h
56		Obsolete	003Fh
57-58		Current capacity in Sectors	Variable
59		Multiple sector setting	0100h
60-61		Total number of user addressable sectors	Variable
62		Obsolete	0000h
63		Multiword DMA mode	0407h
64		Advanced PIO modes	0003h
65		Minimum Multiword DMA transfer cycle time	0078h
66		recommended Multiword DMA transfer cycle time	0078h
67		Minimum cycle time without flow control	0078h
68		Minimum cycle time with IORDY flow control	0078h
69-70		Reserved	Reserved

71-74		Reserved	Reserved
75		Maximum queue depth – 1	0000h
76-79		Reserved	Reserved
80		Major version number	003Eh
81		Minor version number	0015h
82		Command set supported	346Bh
83		Command set supported	5B01h
84		Command set/feature supported extension	4003h
85		Command set/feature enabled	3469h
86		Command set/feature enabled	1A01h
87		Command set/feature default	4003h
88		Ultra DMA mode	007Fh
89		Time required for security erase unit completion	0005h-1head 000Ah-2head 000Fh-3head 0014h-4head
90		Time required for Enhanced security erase completion	0000h
91		Current advanced power management value	0000h
92		Master Password Revision Code	80FEh
93		Hardware reset result	Variable
94		acoustic management value	80h
95-99		Reserved	Reserved
100-103		Maximum user LBA address for 48-bit Address feature set	777Fh, 0260h, 0000h, 0000h
104-126		Reserved	Reserved
127		Removable Media Status Notification feature set support	0000h
128		Security status	0001h
129-159		Vendor specific	Reserved

160		CFA power mode 1	0000h
161-175		Reserved for assignment by the CompactFlash™ Association	Reserved
176-254		Reserved	Reserved
255	15-8 7-0	Integrity word checksum Integrity word signature	Variable 68A5h

6.5.10   SET FEATURES Supported Commands

Table 6-2 shows the suported subcommands of SET FEATURES organized by feature name. The ID Word column shows if the current default setting can be determined from the information returned from the IDENTIFY DEVICE command. Where the entry is none, the default setting must be determined by other analytical means or by asking a trusted human source. The last column shows the default setting (enabled or disabled) for each supported feature.

Table 6-2 *Supported Features*

Enable	Disable	Feature name	ID Word	Default
02h	82h	Write cache	88 bit 5	02h
03h	na	Set transfer mode	63, 88	03h
42h	C2h	Automatic Acoustic Management feature set	86 bit 9, 94	42h
55h	AAh	Read look-ahead feature	85 bit 6	55h
CCh	66h	Reverting to power-on defaults	None	CCh

6.5.11   Maxtor Specific Commands

The drives support the following Maxtor specific commands:

- READ DEFECT LIST
- READ CONFIGURATION
- SET CONFIGURATION

6.5.11.1 READ DEFECT LIST

The READ DEFECT LIST command enables the host to retrieve the drive's defect list. Prior to issuing this command the host should issue the READ DEFECT LIST LENGTH command. This command will not transfer any data. It instead, stores the

length in sectors of the defect list in the Sector Count register (1F2), and the Sector Number register (1F3), with the Sector Count register containing the LSB of the 2-byte value (see Table 6-3). The defect list length is a fixed value for each Maxtor product and can be calculated as follows:

length in sectors = (((maximum number of defects) * 8 + 4) + 511)/512

At the completion of the command, the task file registers 1F2 – 1F6 will contain bytes necessary to execute the READ DEFECT LIST command, and the host will only need to write the extended command code (F0h) to the Command register (1F7) to proceed with the READ DEFECT LIST command execution.

Table 6-3 *READ DEFECT LIST LENGTH Command Bytes*

REGISTER	VALUE (Before)	DEFINITION	VALUE (After)
Sector Count	0	Defect List Subcode	Length in Sectors (LSB)
Sector Number	FFh	Password	Length in Sectors (MSB)
Cylinder Low	FFh	Password	FFh
Cylinder High	3Fh	Password	3Fh
Device/ Head	AXh (Drive 0)	Drive Select	AXh = Drive 0
	BXh (Drive 1)	—	BXh = Drive 1
Command	F0h	Extended Command Code	Status Register

Note: Registers 1F2h through 1F5h must contain the exact values shown. These values function as a key. The drive issues the message ILLEGAL COMMAND if the bytes are not entered correctly.

The READ DEFECT LIST command is an extended AT command that enables the host to retrieve the drive's defect list. The host begins by writing to address 1F6h to select the drive. Then the host writes to addresses 1F2h – 1F5h using values indicated in Table 6-4. When the host subsequently writes the extended command code F0h to address 1F7h, the drive sets BSY, retrieves the defect list, sets DRQ, and resets BSY. The host can now read the requested number of sectors (512 bytes) of data. An INTRQ precedes each sector. Bytes 1F2h and 1F3h contain the 2-byte number of sectors that the host expects to read, with address 1F2h containing the LSB (see Table 6-4). The sector count (1F2h – 1F3h) may vary from product to product and if the wrong value is supplied for a specific product, the drive responds by setting the ABRT bit in the Error register. If the host does not know the appropriate sector count for a specific product, it can issue the Read Defect List Length command, described in the previous section to set up the task file for the Read Defect List command.

Table 6-4 *READ DEFECT LIST Command Bytes*

REGISTER	VALUE	DEFINITION
Sector Count	Variable	Length in Sectors (LSB)
Sector Number	Variable	Length in Sectors (MSB)
Cylinder Low	FFh	Password
Cylinder High	3Fh	Password
Device/ Head	AXh = Drive 0	Drive Select
	BXh = Drive 1	—
Command	F0h	Extended Command Code

Note: Registers 1F2h and 1F3h must contain the transfer length that is appropriate for the specific product, and 1F4h and 1F5h must contain the exact values shown. These values function as a key. The drive responds by setting the ABRT bit in the Error register if the bytes are not entered correctly.

Pending defects will be excluded from the list, since no alternate sector is being used as their replacement, and since they may be removed from the drive's internal pending list at a later time. Table 6-5 shows the overall format of the defect list, and Table 6-6 shows the format of the individual defect entries.

Table 6-5 *DEFECT LIST DATA FORMAT*

BYTE	DESCRIPTION
0	0
1	1Dh
2	8* (Number of Defects) (MSB)
3	8* (Number of Defects) (LSB)
4–11	Defect Entry #1
12–19	Defect Entry #2
	•
	•

Table 6-6 *DEFECT ENTRY DATA FORMAT*

BYTE	DESCRIPTION
0	Defect cylinder (MSB)
1	Defect cylinder
2	Defect cylinder (LSB)
3	Defect head
4	Defect sector (MSB)
5	Defect sector
6	Defect sector
7	Defect sector (LSB)

Note: Bytes 4 – 7 will be set to FFh for bad track entries.

Configuration

In addition to the SET FEATURES command, the Maxtor D740X-6L 20.0/40.0/ 60.0/80.0GB AT hard disk drives provide two configuration commands:

- The SET CONFIGURATION command, which enables the host to change DisCache and Error Recovery parameters
- The READ CONFIGURATION command, which enables the host to read the current configuration status of the drive

See Chapter 5 for more details about DisCache and setting cache parameters. See Chapter 5 also for more information about error detection and defect management.

6.5.11.2 READ CONFIGURATION

The READ CONFIGURATION command displays the configuration of the drive. Like the SET CONFIGURATION command, this command is secured to prevent accidentally accessing it. To access the READ CONFIGURATION command, you must write the pattern shown in Table 6-7 to the Command Block Registers. The first byte, 01h, is a subcode to the extended command code, F0h.

Table 6-7 *Accessing the READ CONFIGURATION Command*

ADDRESS	VALUE	DEFINITION
Sector Count	01h	Read Configuration Subcode
Sector Number	FFh	Password
Cylinder Low	FFh	Password
Cylinder High	3Fh	Password
Device/Head	AXh (Drive 0)	Drive Select
	BXh (Drive 1)	Drive Select
Command	F0h	Extended Command Code

Note: In Table 6-7:

Only the value in address 1F2h of the Command Block Registers is different from the SET CONFIGURATION command.

Registers 1F2h through 1F5h must contain the exact values shown in Table 6-7. These values function as a key. The drive responds by setting the ABRT bit in the Error register if the key is not entered correctly.

To select the drive for which the configuration is to be read, set register 1F6h. For execution of the command to begin, load register 1F7h with F0h.

A 512-byte data field is associated with the READ CONFIGURATION command. A 512-byte read sequence sends this data from the drive to the host. The information in this data field represents the current settings of the configuration parameters. The format of the READ CONFIGURATION command data field is similar to that for the data field of the SET CONFIGURATION command, shown in Table 6-8. However, in the READ CONFIGURATION command, bytes 0 through 31 of the data field are *not* KEY information, as they are in the SET CONFIGURATION command. The drive reads these bytes as *Maxtor CONFIGURATION*, followed by eleven spaces. Users can read the configuration into a buffer, then alter the configuration parameter settings.

6.5.11.3 SET CONFIGURATION

The SET CONFIGURATION command is secured to prevent accessing it accidentally. To access the SET CONFIGURATION command, you must write the pattern shown in Table 6-8 to the Command Block Registers. The first byte, FFh, is a subcode to the extended command code F0h.

Table 6-8 *Accessing the SET CONFIGURATION Command*

ADDRESS	VALUE	DEFINITION
1F2h	FFh	Set Configuration Subcode
1F3h	FFh	Password
1F4h	FFh	Password
1F5h	3Fh	Password
1F6h	AXh (Drive 0)	Drive Select
	BXh (Drive 1)	Drive Select
1F7h	F0h	Extended Command Code

Note: Registers 1F2h through 1F5h must contain the exact values shown above. These values function as a key. The drive responds by setting the ABRT bit in the Error register if the key is not entered correctly.
To select the drive being reconfigured, register 1F6h should be set. For execution of the command to begin, load register 1F7h with F0h.

6.5.11.4 SET CONFIGURATION WITHOUT SAVING TO DISK

The SET CONFIGURATION WITHOUT SAVING TO DISK command is secured to prevent accidentally accessing it. To access this command, you must write the pattern shown in Table 6-9 to the Command Block Registers. The first byte, FEh, is a subcode to the extended command code F0h.

Table 6-9 *Accessing the SET CONFIGURATION WITHOUT SAVING TO DISK Command*

ADDRESS	VALUE	DEFINITION
1F2h	FEh	Set Configuration Subcode
1F3h	FFh	Password
1F4h	FFh	Password
1F5h	3Fh	Password
1F6h	AXh (Drive 0)	Drive Select
	BXh Drive 1)	Drive Select
1F7h	F0h	Extended Command Code

Note: In Table 6-9:
Registers 1F2h through 1F5h must contain the exact values
shown above. These values function as a key. The drive responds
by setting the ABRT bit in the Error register if the key is not
entered correctly.
To select the drive being reconfigured, set register 1F6h. For
execution of the command to begin, load register 1F7h with F0h.

Configuration Command Data Field

A 512-byte data field is associated with this command. This data field is sent to the
drive through a normal 512-byte write handshake. Table 6-10 shows the format of the
data field. Bytes 0 through 31 of the data field contain additional KEY information.
The drive responds by setting the ABRT bit in the Error register if this information is
not entered correctly. Bytes 32 through 35 control the operation of DisCache. Bytes
36 through 38 control operation of the error recovery procedure. The drive does not
use bytes 40 through 511, which should be set to 0.

Table 6-10 *Configuration Command Format*

BYTE	BIT							
	7	6	5	4	3	2	1	0
0–31	MAXTOR CONFIGURATION KEY							
32	RESERVED = 0						PE	CE
33	RESERVED							
34	RESERVED = 0							
35	RESERVED = 0							
36	AWRE	ARR	N/A	RC	EEC	N/A	N/A	DCR
37	NUMBER OF RETRIES							
38	ECC CORRECTION SPAN							
39	RESERVED = 0					WCE	RUEE	0
40–511	RESERVED = 0							

Note: All fields marked RESERVED or N/A should be set to zero.

Maxtor Configuration Key (Bytes 0-31)

Bytes 0–6 must contain the ASCII characters *Q, U, A, N, T, U,* and *M*; byte 7, the
ASCII character *space*; and bytes 8–20 must contain the ASCII characters *C, O, N, F,
I, G, U, R, A, T, I, O,* and *N*. Bytes 21–31 must contain an ASCII *space*. If this
information is not entered correctly, the drive responds by setting the ABRT bit in
the Error register.

DisCache Parameters

PE – Prefetch Enable (Byte 32, Bit 1): When set to 1, this bit indicates that the
drive will perform prefetching. A PE bit set to 0 indicates that no prefetching will
occur. The CE bit (bit 0) must be set to 1 to enable use of the PE bit. The default
value is 1.

CE – Cache Enable (Byte 32, Bit 0): When set to 1, this bit indicates that the drive will activate caching on all READ commands. With the CE bit set to 0, the drive will disable caching and use the RAM only as a transfer buffer. The default setting is 1.

Error Recovery Parameters

AWRE – Automatic Write Reallocation Enabled (Byte 36, Bit 7): When set to 1, indicates that the drive will enable automatic reallocation of bad blocks. Automatic Write Reallocation is similar to the function of Automatic Read Reallocation, but is initiated by the drive when a defective block has become inaccessible for writing. An AWRE bit set to 0 indicates that the Maxtor D740X-6L 20.0/40.0/60.0/80.0GB AT drives will not automatically reallocate bad blocks. The default setting is 1.

ARR – Automatic Read Reallocation (Byte 36, Bit 6): When set to 1, this bit indicates that the drive will enable automatic reallocation of bad sectors. The drive initiates reallocation when the ARR bit is set to 1 and the drive encounters a hard error—that is, if the triple-burst ECC algorithm is invoked. The default setting is 1. When the ARR bit is set to 0, the drive will not perform automatic reallocation of bad sectors. If RC (byte 36, bit 4) is 1, the drive ignores this bit. The default value is 1.

RC – Read Continuous (Byte 36, Bit 4): When set to 1, this bit instructs the drive to transfer data of the requested length without adding delays to increase data integrity—that is, delays caused by the drive's error-recovery procedures. With RC set to 1 to maintain a continuous flow of data and avoid delays, the drive may send data that is erroneous. When the drive ignores an error, it does *not* post the error. The RC bit set to 0 indicates that potentially time-consuming operations for error recovery are acceptable during data transfer. The default setting is 0.

EEC – Enable Early Correction (Byte 36, Bit 3): When set to 1, this bit indicates that the drive will use its ECC algorithm if it detects two consecutive equal, nonzero error syndromes. The drive will not perform rereads before applying correction, unless it determines that the error is uncorrectable. An EEC bit set to 0 indicates that the drive will use its normal recovery procedure when an error occurs: rereads, followed by error correction. If the RC bit (byte 36, bit 4) is set to 1, the drive ignores the EEC bit. The default setting is 0.

SilentMode (Byte 36, Bit 2): When set to 1, this bit indicates that the drive's acoustic emanations will be reduced.

DCR – Disable Correction (Byte 36, Bit 0): When set to 1, this bit indicates that all data will be transferred without correction, even if it would be possible to correct the data. A DCR bit set to 0 indicates that the data will be corrected if possible. If the data is uncorrectable, it will be transferred without correction, though the drive will attempt rereads. If RC (byte 36, bit 4) is set to 1, the drive ignores this bit. The default setting is 0. The drive will post all errors, whether DCR is set to 0 or 1.

NUMBER OF RETRIES (Byte 37): This byte specifies the number of times that the drive will attempt to recover from data errors by rereading the data, before it will apply correction. The drive performs rereads before ECC correction—unless EEC (byte 36, bit 3) is set to 1, enabling early correction. The default is eight.

ECC CORRECTION SPAN (Byte 38): This byte specifies the maximum number of 10-bit symbols that can be corrected using ECC. The default value for this byte is 20h or 32 decimal.

Drive Parameters

WCE – Write Cache Enable (Byte 39, Bit 2): When this bit is set to 1, the Maxtor D740X-6L 20.0/40.0/60.0/80.0GB AT hard disk drives enable the Write Cache. This indicates that the drive returns GOOD status for a write command after successfully receiving the data, but before writing it to the disk. A value of zero indicates that the drive returns GOOD status for a write command after successfully receiving the data and writing it to the disk.

If the next command is another WRITE command, cached data continues to be written to the disk while new data is added to the buffer. The default setting is 1.

RUEE – Reallocate Uncorrectable Error Enables (Byte 39, Bit 1): When set to 1, this bit indicates that the Maxtor D740X-6L 20.0/40.0/60.0/80.0GB AT hard disk drives will automatically reallocate uncorrectable hard errors, if the ARR bit (byte 36, bit 6) is set to 1. The default setting is 1.

6.5.12 SMART READ ATTRIBUTE THRESHOLDS

COMMAND CODE - B0h

TYPE - Optional - SMART Feature set. If the SMART feature set is implemented, this command is optional and not recommended.

PROTOCOL - PIO data in

INPUTS - The Features register shall be set to D1h. The Cylinder Low register shall be set to 4Fh. The Cylinder High register shall be set to C2h.

Register	7	6	5	4	3	2	1	0
Features	D1h							
Sector Count								
Sector Number								
Cylinder Low	4Fh							
Cylinder High	C2h							
Device/Head	1		1	D				
Command	B0h							

NORMAL OUTPUTS - None

ERROR OUTPUTS - If the device does not support this command, if SMART disabled or if the values in the Features, Cylinder Low or Cylinder High registers are invalid, an Aborted command error is posted.

Register	7	6	5	4	3	2	1	0
Error	na	UNC	na	IDNF	na	ABRT	na	na
Sector Count	na							
Sector Number	na							
Cylinder Low	na							

Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

PREREQUISITES - DRDY set equal to one. SMART enabled.

DESCRIPTION - This command returns the device's attribute thresholds to the host. Upon receipt of this command from the host, the device sets BSY, reads the attribute thresholds from non-volatile memory, sets DRQ, clears BSY, asserts INTRQ, and then waits for the host to transfer the 512 bytes of attribute threshold information from the device via the Data register.

The following defines the 512 bytes that make up the attribute threshold information.

The sequence of active attribute thresholds must appear in the same order as their corresponding attribute values (see Section 6.5.12.2).

The data structure revision number shall be the same value used in the device attribute values data structure.

Table 6-11 defines the twelve bytes that make up the information for each threshold entry in the device attribute thresholds data structure. Attribute entries in the individual threshold data structure must be in the same order and correspond to the entries in the individual attribute data structure.

The attribute ID numbers are vendor specific. Any non-zero value in the attribute ID number indicates an active attribute.

Attribute threshold values are to be set at the factory and are not changeable in the field.

The data structure checksum is the two's compliment of the result of a simple eight-bit addition of the first 511 bytes in the data structure.

Table 6-11 *Device Attribute Thresholds Data Structure*

Description	Bytes	Format	Type
Data structure revision number = 0x0004h for this revision	2	binary	Rd only
1st attribute threshold	12		Rd only
.....			
.....			
.....			
30th attribute threshold	12		Rd only
reserved (0x00)	18		Rd only
Vendor specific	131		Rd only
Data structure checksum	1		Rd only
Total bytes	512		

Table 6-12 *Individual Threshold Data Structure*

Description	Bytes	Format	Type
Attribute ID number	1	binary	Rd only
Attribute threshold (for comparison with attribute values from 0x00 to 0xFFh)	1	binary	Rd only
0x00 "always passing" threshold value to be used for code test purposes			
0x01 minimum value for normal operation			
0xFD maximum value for normal operation			
0xFE invalid for threshold value - not to be used			
0xFF "always failing" threshold value to be used for code test purposes			
Reserved	10		Rd only
Total bytes	12		

Table 6-13 *Device SMART Data Structure*

Byte	Description
0-361	Vendor Specific
362	Off-line data collection Status
363	Vendor specific
364-365	Total time in seconds to complete off-line data collection
366	Vendor Specific
367	Off-line data collection capability
368-369	SMART capability
370-385	Reserved
386-510	Vendor Specific
511	Data Structure check sum

The attribute ID numbers and their definitions are vendor specific. Any non-zero value in the attribute ID number indicates an active attribute. Valid values for this byte are from 0x01 through 0xFFh.

Status flag

- Bit 0 -Pre-failure/advisory - If the value of this bit equals zero, an attribute value less than or equal to its corresponding attribute threshold indicates an advisory condition where the usage or age of the device has exceeded its intended design life period. If the value of this bit equals one, an attribute value less than or equal to its corresponding attribute threshold indicates a pre-failure condition where imminent loss of data is being predicted.

- Bit 1 Reserved for future use.

- Bits 3 - 6 - Vendor specific.

- Bits 7 - 15 - Reserved for future use.

The range and meaning of the attribute values is described in Table 6-13. Prior to the monitoring and saving of attribute values, all values are set to 0x64h. The attribute values of 0x00h and 0xFFh are reserved and should not be used by the device.

SMART capability

- Bit 0 - Pre-power mode attribute saving capability - If the value of this bit equals one, the device will save its attribute values prior to going into a power saving mode (Idle, Standby or Sleep modes).

- Bit 1 - Attribute autosave after event capability - If the value of this bit is equal to one, the device supports the SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE command.

- Bits 2-15 - Reserved for future use.

The data structure checksum is the two's compliment of the result of a simple eight-bit addition of the first 511 bytes in the data structure.

6.5.12.1 SMART RETURN STATUS

COMMAND CODE - B0h

TYPE - Optional - SMART Feature set. If the SMART feature set is implemented, this command shall be implemented.

PROTOCOL - Non-data command.

INPUTS - The Features register shall be set to DAh. The Cylinder Low register shall be set to 4Fh. The Cylinder High register shall be set to C2h.

Register	7	6	5	4	3	2	1	0
Features	DAh							
Sector Count								
Sector Number								
Cylinder Low	4Fh							

Register	7	6	5	4	3	2	1	0
Cylinder High				C2h				
Device/Head	1		1	D				
Command				B0h				

NORMAL OUTPUTS - If the device has not detected a threshold exceeded condition, the device sets the Cylinder Low register to 4Fh and the Cylinder High register to C2h. If the device has detected a threshold exceeded condition, the device sets the Cylinder Low register to F4h and the Cylinder High register to 2Ch.

ERROR OUTPUTS - If the device does not support this command, if SMART is disabled or if the values in the Features, Cylinder Low or Cylinder High registers are invalid, an Aborted command error is posted.

Register	7	6	5	4	3	2	1	0
Error	na	UNC	na	IDNF	na	ABRT	na	na
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

PREREQUISITES - **DRDY set equal to one. SMART enabled.**

DESCRIPTION - **This co**mmand is used to communicate the reliability status of the device to the host at the host's request. Upon receipt of this command the device sets BSY, saves any updated attribute values to non-volatile memory and compares the updated attribute values to the attribute thresholds.

6.5.12.2 SMART SAVE ATTRIBUTE VALUES

COMMAND CODE - B0h

TYPE - Optional - SMART Feature set. If the SMART feature set is implemented, this command is optional and not recommended.

PROTOCOL - Non-data command

INPUTS - The Features register shall be set to D3h. The Cylinder Low register shall be set to 4Fh. The Cylinder High register shall be set to C2h.

Register	7	6	5	4	3	2	1	0
Features	D3h							
Sector Count								
Sector Number								
Cylinder Low	4Fh							
Cylinder High	C2h							
Device/Head	1		1	D				
Command	B0h							

NORMAL OUTPUTS - None

ERROR OUTPUTS - If the device does not support this command, if SMART is disabled or if the values in the Features, Cylinder Low or Cylinder High registers are invalid, an Aborted command error is posted.

Register	7	6	5	4	3	2	1	0
Error	na	UNC	na	IDNF	na	ABRT	na	na
Sector Count	na							
Sector Number	na							
Cylinder Low	na							
Cylinder High	na							
Device/Head	obs	na	obs	DEV	na			
Status	BSY	DRDY	DF	na	DRQ	na	na	ERR

PREREQUISITES - DRDY set equal to one. SMART enabled.

DESCRIPTION - This command causes the device to immediately save any updated attribute values to the device's non-volatile memory regardless of the state of the attribute autosave timer. Upon receipt of this command from the host, the device sets BSY, writes any updated attribute values to non-volatile memory, clears BSY and asserts INTRQ.

GLOSSARY

A

ACCESS – (v) Read, write, or update information on some storage medium, such as a disk. (n) One of these operations.

ACCESS TIME – The interval between the time a request for data is made by the system and the time the data is available from the drive. Access time includes the actual seek time, rotational latency, and command processing overhead time. See also seek, rotational latency, and overhead.

ACTUATOR – Also known as the *positioner*. The internal mechanism that moves the read/write head to the proper track. The Maxtor actuator consists of a rotary voice coil and the head mounting arms. One end of each head mounting arm attaches to the rotor with the read/write heads attached at the opposite end of each arm. As current is applied to the rotor, it rotates, positioning the heads over the desired cylinder on the media.

AIRLOCK – A patented Maxtor feature that ensures durable and reliable data storage. Upon removal of power from the drive for any reason, the read/write heads automatically park and lock in a non data area called the landing zone. AIRLOCK allows the drive to withstand high levels of non-operating shock. When power is applied to the drive, airflow created from the spinning disks causes the AIRLOCK arm to swing back and unlock the actuator, allowing the heads to move from the landing zone. Upon power down, the AIRLOCK swings back to the locked position, locking the heads in the landing zone. A park utility is not required to park the heads on drives equipped with AIRLOCK (all Maxtor drives).

ALLOCATION – The process of assigning particular areas of the disk to particular files. See also allocation unit.

ALLOCATION UNIT – An allocation unit, also known as a *cluster*, is a group of sectors on the disk that can be reserved for the use of a particular file.

AVERAGE SEEK TIME – The average time it takes for the read/write head to move to a specific location. To compute the average seek time, you divide the time it takes to complete a large number of random seeks all over the disk by the number of seeks performed.

B

BACKUP – A copy of a file, directory, or volume on a separate storage device from the original, for the purpose of retrieval in case the original is accidentally erased, damaged, or destroyed.

BAD BLOCK – A block (usually the size of a sector) that cannot reliably hold data because of a media flaw or damaged format markings.

BAD TRACK TABLE – A label affixed to the casing of a hard disk drive that tells which tracks are flawed and cannot hold data. The listing is typed into the low-level formatting program when the drive is being installed. Because Maxtor disk drive's defect-management scheme handles all such flaws automatically, there is no need to concern yourself with bad track tables.

BIT – Abbreviation for binary digit. A binary digit may have one of two values—1 or 0. This contrasts with a decimal digit, which may have a value from 0 to 9. A bit is one of the logic 1or logic 0 binary settings that make up a byte of data. See also byte.

BLOCK – A sector or group of sectors. By default, a block of data consists of 512 bytes.

BPI – Abbreviation for *bits per inch.* A measure of how densely information is packed on a storage medium. Flux changes per inch is also a term commonly used in describing storage density on a magnetic surface.

BUFFER – An area of RAM reserved for temporary storage of data that is waiting to be sent to a device that is not yet ready to receive it. The data is usually on its way to or from the disk drive or some other peripheral device.

BUS – The part of a chip, circuit board, or interface designed to send and receive data.

BYTE – The basic unit of computer memory, large enough to hold one character of alphanumeric data. Comprised of eight bits. See also bit.

C

CACHE – Random-access memory used as a buffer between the CPU and a hard disk. Information more likely to be read or changed is placed in the cache, where it can be accessed more quickly to speed up general data flow.

CAPACITY – The amount of information that can be stored on a disk drive. The data is stored in bytes, and capacity is usually expressed in megabytes.

CDB – Command Descriptor Block. The SCSI structure used to communicate requests from an initiator (system) to a target (drive).

CLEAN ROOM – An environmentally controlled dust-free assembly or repair facility in which hard disk drives are assembled or can be opened for internal servicing.

CLUSTER – A group of sectors on a disk drive that is addressed as one logical unit by the operating system.

CONTROLLER – Short form of *disk controller.* The chip or complete circuit that translates computer data and commands into a form suitable for use by the disk drive.

CONTROLLER CARD – An adapter holding the control electronics for one or more hard disks, usually installed in a slot in the computer.

CPU – Acronym for *Central Processing Unit.* The microprocessor chip that performs the bulk of data processing in a computer.

CRC – Acronym for *Cyclic Redundancy Check.* An error detection code that is recorded within each sector and is used to see whether parts of a string of data are missing or erroneous.

CYLINDER – On a disk drive that has more than one recording surface and heads that move to various tracks, the group of all tracks located at a given head position. The number of cylinders times the number of heads equals the number of tracks per drive.

D

DATA SEPARATOR – On a disk drive that stores data and timing information in an encoded form, the circuit that extracts the data from the combined data and clock signal.

DEDICATED SERVO – A surface separate from the surface used for data that contains only disk timing and positioning information and contains no data.

DEFECT MANAGEMENT – A method that is implemented to ensure long term data integrity. Defect management eliminates the need for user defect maps. This is accomplished by scanning the disk drives at the factory for defective sectors. Defective sectors are deallocated prior to shipment. In addition, during regular use, the drive continues to scan and compensate for any new defective sectors on the disk.

DISK – In general, any circular-shaped data-storage medium that stores data on the flat surface of the platter. The most common type of disk is the magnetic disk, which stores data as magnetic patterns in a metal or metal-oxide coating. Magnetic disks come in two forms: floppy and hard. Optical recording is a newer disk technology that gives higher capacity storage but at slower access times.

DISK CONTROLLER – A plug-in board, or embedded circuitry on the drive, that passes information to and from the disk. The Maxtor disk drives all have controllers embedded on the drive printed-circuit board.

DISKWARE – The program instructions and data stored on the disk for use by a processor.

DMA – Acronym for *direct memory access.* A process by which data moves directly between a disk drive (or other device) and system memory without passing through the CPU, thus allowing the system to continue processing other tasks while the new data is being retrieved.

DRIVE – Short form of *disk drive.*

DRIVE GEOMETRY – The functional dimensions of a drive in terms of the number of heads, cylinders, and sectors per track. See also logical format.

E

ECC – Acronym for *error correction code.* The recording of extra verifying information encoded along with the disk data. The controller uses the extra information to check for data errors, and corrects the errors when possible.

EMBEDDED SERVO – A timing or location signal placed on the disk's surface on the tracks that also store data. These signals allow the actuator to fine-tune the position of the read/write heads.

ENCODING – The protocol by which particular data patterns are changed prior to being written on the disk surface as a pattern of On and Off or 1 and 0 signals.

EXTERNAL DRIVE – A drive mounted in an enclosure separate from the PC or computer system enclosure, with its own power supply and fan, and connected to the system by a cable.

F

FAT – Acronym for *file allocation table.* A data table stored on the outer edge of a disk that tells the operating system which sectors are allocated to each file and in what order.

FCI – Acronym for *flux changes per inch.* See also BPI.

FILE SERVER – A computer that provides network stations with controlled access to shareable resources. The network operating system is loaded on the file server, and most shareable devices (disk subsystems, printers) are attached to it. The file server controls system security and monitors station-to-station communications. A dedicated file server can be used only as a file server while it is on the network. A non dedicated file server can be used simultaneously as a file server and a workstation.

FLUX DENSITY – The number of magnetic field patterns that can be stored in a given length of disk surface. The number is usually stated as flux changes per inch (FCI), with typical values in the thousands.

FLYING HEIGHT – The distance between the read/write head and the disk surface caused by a cushion of air that keeps the head from contacting the media. Smaller flying heights permit more dense storage of data, but require more precise mechanical designs.

FORMAT – To write onto the disk surface a magnetic track pattern that specifies the locations of the tracks and sectors. This information must exist on a disk before it can store any user data. Formatting erases any previously stored data.

FORMATTED CAPACITY – The amount of room left to store data on the disk after the required space has been used to write sector headers, boundary definitions, and timing information generated by a format operation. All Maxtor drive capacities are expressed in formatted capacity.

FORM FACTOR – The physical outer dimensions of a device as defined by industry standard. For example, most Maxtor disk drives use a 3 1/2-inch form factor.

G

GIGABYTE (GB) – One billion bytes (one thousand megabytes).

GUIDE RAILS – Plastic strips attached to the sides of a disk drive mounted in an IBM AT and compatible computers so that the drive easily slides into place.

H

HALF HEIGHT – Term used to describe a drive that occupies half the vertical space of the original full size 5 1/4-inch drive. 1.625 inches high.

HARD DISK – A type of storage medium that retains data as magnetic patterns on a rigid disk, usually made of an iron oxide or alloy over a magnesium or aluminum platter. Because hard disks spin more rapidly than floppy disks, and the head flies closer to the disk, hard disks can transfer data faster and store more in the same volume.

HARD ERROR – A repeatable error in disk data that persists when the disk is reread, usually caused by defects in the media surface.

HEAD – The tiny electromagnetic coil and metal pole piece used to create and read back the magnetic patterns (write and read information) on the media.

HIGH-CAPACITY DRIVE – By industry conventions typically a drive of 1 gigabytes or more.

HIGH-LEVEL FORMATTING – Formatting performed by the operating system's format program. Among other things, the formatting program creates the root directory and file allocation tables. See also low-level formatting.

HOME – Reference position track for recalibration of the actuator, usually the outer track (track 0).

HOST ADAPTER – A plug-in board that forms the interface between a particular type of computer system bus and the disk drive.

I

INITIALIZE – See low level formatting.

INITIATOR – A SCSI device that requests another SCSI device to perform an operation. A common example of this is a system requesting data from a drive. The system is the initiator and the drive is the target.

INTERFACE – A hardware or software protocol, contained in the electronics of the disk controller and disk drive, that manages the exchange of data between the drive and computer.

INTERLEAVE – The arrangement of sectors on a track. A 1:1 interleave arranges the sectors so that the next sector arrives at the read/write heads just as the computer is ready to access it. See also interleave factor.

INTERLEAVE FACTOR – The number of sectors that pass beneath the read/write heads before the next numbered sector arrives. When the interleave factor is 3:1, a sector is read, two pass by, and then the next is read. It would take three revolutions of the disk to access a full track of data. Maxtor drives have an interleave of 1:1, so a full track of data can be accessed within one revolution of the disk, thus offering the highest data throughput possible.

INTERNAL DRIVE – A drive mounted inside one of a computer's drive bays (or a hard disk on a card, which is installed in one of the computer's slots).

J

JUMPER – A tiny box that slips over two pins that protrude from a circuit board. When in place, the jumper connects the pins electrically. Some board manufacturers use Dual In-Line Package (DIP) switches instead of jumpers.

K

KILOBYTE (K) – A unit of measure consisting of 1,024 (2^{10}) bytes.

L

LANDING ZONE – A position inside the disk's inner cylinder in a non data area reserved as a place to rest the heads during the time that power is off. Using this area prevents the heads from touching the surface in data areas upon power down, adding to the data integrity and reliability of the disk drive.

LATENCY – The period of time during which the read/write heads are waiting for the data to rotate into position so that it can be accessed. Based on a disk rotation speed of 3,662 rpm, the maximum latency time is 16.4 milliseconds, and the average latency time is 8.2 milliseconds.

LOGICAL FORMAT – The logical drive geometry that appears to an AT system BIOS as defined by the drive tables and stored in CMOS. With an installation program like Disk Manager, the drive can be redefined to any logical parameters necessary to adapt to the system drive tables.

LOOK AHEAD – The technique of buffering data into cache RAM by reading subsequent blocks in advance to anticipate the next request for data. The look ahead technique speeds up disk access of sequential blocks of data.

LOW-LEVEL FORMATTING – Formatting that creates the sectors on the platter surfaces so the operating system can access the required areas for generating the file structure. Maxtor drives are shipped with the low-level formatting already done.

LOW PROFILE – Describes drives built to the 3 1/2-inch form factor, which are only 1 inch high.

M

MB – See megabyte.

MEDIA – The magnetic film that is deposited or coated on an aluminum substrate which is very flat and in the shape of a disk. The media is overcoated with a lubricant to prevent damage to the heads or media during head take off and landing. The media is where the data is stored inside the disk in the form of magnetic flux or polarity changes.

MEGABYTE (MB) – A unit of measurement equal to 1,024 kilobytes, or 1,048,576 bytes except when referring to disk storage capacity.

1 MB = 1,000,000 bytes when referring to disk storage capacity.

See also kilobyte.

MEGAHERTZ – A measurement of frequency in millions of cycles per second.

MHz – See megahertz.

MICROPROCESSOR – The integrated circuit chip that performs the bulk of data processing and controls the operation of all of the parts of the system. A disk drive also contains a microprocessor to handle all of the internal functions of the drive and to support the embedded controller.

MICROSECOND (µs) – One millionth of a second (.000001 sec.).

MILLISECOND (ms) – One thousandth of a second (.001 sec.).

MTBF – Mean Time Between Failure. Used as a reliability rating to determine the expected life of the product expressed in power on hours (POH). There are several accepted methods for calculating this value that produce very different results and generate much confusion in the industry. When comparing numbers you should first verify which method was used to calculate the values.

MTTR – Mean Time To Repair. The average time it takes to repair a drive that has failed for some reason. This only takes into consideration the changing of the major sub-assemblies such as circuit board or sealed housing. Component level repair is not included in this number as this type of repair is not performed in the field.

O

OVERHEAD – The processing time of a command by the controller, host adapter or drive prior to any actual disk accesses taking place.

OVERWRITE – To write data on top of existing data, erasing it.

OXIDE – A metal-oxygen compound. Most magnetic coatings are combinations of iron or other metal oxides, and the term has become a general one for the magnetic coating on tape or disk.

P

PARTITION – A portion of a hard disk devoted to a particular operating system and accessed as one logical volume by the system.

PERFORMANCE – A measure of the speed of the drive during normal operation. Factors affecting performance are seek times, transfer rate and command overhead.

PERIPHERAL – A device added to a system as an enhancement to the basic CPU, such as a disk drive, tape drive or printer.

PHYSICAL FORMAT – The actual physical layout of cylinders, tracks, and sectors on a disk drive.

PLATED MEDIA – Disks that are covered with a hard metal alloy instead of an iron-oxide compound. Plated disks can store greater amounts of data in the same area as a coated disk.

PLATTER – An disk made of metal (or other rigid material) that is mounted inside a fixed disk drive. Most drives use more than one platter mounted on a single spindle (shaft) to provide more data storage surfaces in a small package. The platter is coated with a magnetic material that is used to store data as transitions of magnetic polarity.

POH – Acronym for *power on hours.* The unit of measurement for Mean Time Between Failure as expressed in the number of hours that power is applied to the device regardless of the amount of actual data transfer usage. See MTBF.

POSITIONER – See actuator.

R

RAM – Acronym for *random access memory.* An integrated circuit memory chip which allows information to be stored and retrieved by a microprocessor or controller. The information may be stored and retrieved in any order desired, and the address of one storage location is as readily accessible as any other.

RAM DISK – A "phantom disk drive" for which a section of system memory (RAM) is set aside to hold data, just as if it were a number of disk sectors. The access to this data is extremely fast but is lost when the system is reset or turned off.

READ AFTER WRITE – A mode of operation that has the computer read back each sector on the disk, checking that the data read back is the same as recorded. This slows disk operations, but raises reliability.

READ VERIFY – A disk mode where the disk reads in data to the controller, but the controller only checks for errors and does not pass the data on to the system.

READ/WRITE HEAD – The tiny electromagnetic coil and metal pole piece used to create and read back the magnetic patterns (write or read information) on the disk. Each side of each platter has its own read/write head.

REMOVABLE DISK – Generally said of disk drives where the disk itself is meant to be removed, and in particular of hard disks using disks mounted in cartridges. Their advantage is that multiple disks can be used to increase the amount of stored material, and that once removed, the disk can be stored away to prevent unauthorized use.

RLL – Run Length Limited. A method used on some hard disks to encode data into magnetic pulses. RLL requires more processing, but stores almost 50% more data per disk than the MFM method.

ROM – Acronym for *read only memory*. Usually in the form of an ROM in the controller that contains programs that can be accessed and read but not modified by the system.

ROTARY ACTUATOR – The rotary actuator replaces the stepper motor used in the past by many hard disk manufacturers. The rotary actuator is perfectly balanced and rotates around a single pivot point. It allows closed-loop feedback positioning of the heads, which is more accurate than stepper motors.

ROTATIONAL LATENCY – The delay between when the controller starts looking for a specific block of data on a track and when that block rotates around to where it can be read by the read/write head. On the average, it is half of the time needed for a full rotation (about 8 ms.).

S

SCSI – Acronym for *Small Computer System Interface*, an American National Standards Institute (ANSI) version of Shugart Associates' SASI interface between the computer and controller. SCSI has grown in popularity and is one of the most flexible and intelligent interfaces available.

SECTOR – A section of space along a track on the disk, or the data that is stored in that section. Hard disks most often have sectors that are 512 data bytes long plus several bytes overhead for error correcting codes. Each sector is preceded by ID data known as a

header, which cannot be overwritten.

SEEK – A movement of the disk read/write head in or out to a specific track.

SERVO DATA – Magnetic markings written on the media that guide the read/write heads to the proper position.

SERVO SURFACE – A separate surface containing only positioning and disk timing information but no data.

SETTLE TIME – The interval between when a track to track movement of the head stops, and when the residual vibration and movement dies down to a level sufficient for reliable reading or writing.

SHOCK RATING – A rating (expressed in Gs) of how much shock a disk drive can sustain without damage.

SOFT ERROR – An error in reading data from the disk that does not recur if the same data is reread. Often caused by power fluctuations or noise spikes.

SOFT SECTORED – Disks that mark the beginning of each sector of data within a track by a magnetic pattern.

SPINDLE – The center shaft of the disk upon which the drive's platters are mounted.

SPUTTER – A type of coating process used to apply the magnetic coating to some high-performance disks. In sputtering, the disks are placed in a vacuum chamber and the coating is vaporized and deposited on the disks. The resulting surface is hard, smooth, and capable of storing data at high density. Maxtor disk drives use sputtered thin film disks.

STEPPER – A type of motor that moves in discrete amounts for each input electrical pulse. Stepper motors used to be widely used for read/write head positioner, since they can be geared to move the head one track per step. Stepper motors are not as fast or reliable as the rotary voice coil actuators which Maxtor disk drives use.

SUBSTRATE – The material the disk

platter is made of beneath the magnetic coating. Hard disks are generally made of aluminum or magnesium alloy (or glass, for optical disks) while the substrate of floppies is usually mylar.

SURFACE – The top or bottom side of the platter which is coated with the magnetic material for recording data. On some drives one surface may be reserved for positioning information.

T

THIN FILM – A type of coating, used for disk surfaces. Thin film surfaces allow more bits to be stored per disk.

TPI – Acronym for *tracks per inch.* The number of tracks or cylinders that are written in each inch of travel across the surface of a disk.

TRACK – One of the many concentric magnetic circle patterns written on a disk surface as a guide to where to store and read the data.

TRACK DENSITY – How closely the tracks are packed on a disk surface. The number is specified as tracks per inch (TPI).

TRACK TO TRACK SEEK TIME – The time required for the read/write heads to move to an adjacent track.

TRANSFER RATE – The rate at which the disk sends and receives data from the controller. Drive specifications usually reference a high number that is the burst mode rate for transferring data across the interface from the disk buffer to system RAM. Sustained data transfer is at a much lower rate because of system processing overhead, head switches, and seeks.

U

UNFORMATTED CAPACITY – The total number of bytes of data that could be fit onto a disk. Formatting the disk requires some of this space to record location, boundary definitions, and timing information. After formatting, user data can be stored on the remaining disk space, known as formatted capacity. The size of a Maxtor drive is expressed in formatted capacity.

V

VOICE COIL – A type of motor used to move the disk read/write head in and out to the right track. Voice-coil actuators work like loudspeakers with the force of a magnetic coil causing a proportionate movement of the head. Maxtor's actuator uses voice-coil technology, and thereby eliminates the high stress wearing parts found on stepper motor type actuators.

W

WEDGE SERVO – The position on every track that contains data used by the closed loop positioning control. This information is used to fine tune the position of the read/write heads exactly over the track center.

WINCHESTER DISKS – Hard disks that use a technology similar to an IBM model using Winchester as the code name. These disks use read/write heads that ride just above the magnetic surface, held up by the air flow created by the turning disk. When the disk stops turning, the heads land on the surface, which has a specially lubricated coating. Winchester disks must be sealed and have a filtration system since ordinary dust particles are large enough to catch between the head and the disk.

WRITE ONCE – In the context of optical disks, technologies that allow the drive to store data on a disk and read it back, but not to erase it.

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