

## DiamondMax™ 1750 UDMA

87000D8, 86480D8, 85250D6

84320D5, 83500D4, 83240D4

82560D3, 81750D2

Part #1381/A



All material contained herein Copyright © 1997 Maxtor Corporation. CrystalMax™, CrystalMax™ 1080, DiamondMax™, DiamondMax™ 1750 and MaxFax™ are trademarks of Maxtor Corporation. No Quibble® Service is a registered trademark of Maxtor Corporation. Other brands or products are trademarks or registered trademarks of their respective holders. Contents and specifications subject to change without notice. All rights reserved. Printed in the U.S.A. 6/97

### ***Corporate Headquarters***

510 Cottonwood Drive  
Milpitas, California 95035  
Tel: 408-432-1700  
Fax: 408-432-4510

### ***Research and Development Engineering Center***

2190 Miller Drive  
Longmont, Colorado 80501  
Tel: 303-651-6000  
Fax: 303-678-2165

*Revisions*

*Manual No. 1381*

REV	EC NO.	SECTION	DESCRIPTION	DATE
A	78533	All	Initial release	06/10/97

## Before You Begin

Thank you for your interest in the Maxtor DiamondMax™ 1750 AT hard disk drives. This manual provides technical information for OEM engineers and systems integrators regarding the installation and use of the 87000D8, 86480D8, 85250D6, 84320D5, 83500D4, 83240D4, 82560D3 and 81750D2.

Drive repair should be performed only at an authorized repair center. For repair information, contact the Maxtor Customer Service Center at 800-2MAXTOR or 408-432-1700.

Before unpacking the hard drive, please review Sections 1 through 4.

### CAUTION

**Maxtor DiamondMax 1750 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.

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

# Contents

## Section 1 — Introduction

Maxtor Corporation	1 - 1	
Products	1 - 1	
Support	1 - 1	
Manual Organization	1 - 1	
Abbreviations		1 - 1
Conventions	1 - 2	
Key Words	1 - 2	
Numbering	1 - 2	
Signal Conventions	1 - 2	

## Section 2 — Product Description

The 8700D8, 86480D8, 85250D6, 84320D5, 83500D4, 83240D4, 82560D3 and 81750D2	2 - 1	
Product Features	2 - 2	
Functional/Interface	2 - 2	
Zone Density Recording	2 - 2	
Read/Write Multiple Mode	2 - 2	
UltraDMA - Mode 2	2 - 2	
Multi-word DMA (EISA Type B) - Mode 2	2 - 2	
Sector Address Translation	2 - 2	
Logical Block Addressing	2 - 3	
Defect Management Zone	2 - 3	
On-the-Fly Hardware Error Correction Code (ECC)	2 - 3	
Software ECC Correction	2 - 3	
Automatic Head Park and Lock Operation	2 - 3	
Cache Management	2 - 4	
Buffer Segmentation	2 - 4	
Read-Ahead Mode	2 - 4	
Automatic Write Reallocation (AWR)	2 - 4	
Write Cache Stacking	2 - 4	
Major HDA Components	2 - 5	
Drive Mechanism	2 - 5	
Rotary Actuator	2 - 5	
Read/Write Electronics	2 - 5	
Read/Write Heads and Media	2 - 5	
Air Filtration System	2 - 5	
Microprocessor	2 - 5	
Subsystem Configuration	2 - 6	
Dual Drive Support	2 - 6	
Cable Select Option	2 - 6	
Jumper Location/Configuration	2 - 6	
4092 Cylinder Limitation	2 - 6	

## Section 3 — Product Specifications

Configuration		3 - 1
Performance	3 - 1	
Physical Dimensions	3 - 2	
Power Requirements	3 - 3	
Power Mode Definitions	3 - 3	
Environmental	3 - 3	
Shock and Vibration	3 - 4	
Reliability and Maintenance	3 - 4	

Data Reliability	3 - 4
Acoustic Noise	3 - 4
EPA Energy Star Compliance	3 - 4
EMC/EMI	3 - 5
Standard Test Methods	3 - 5
Safety Regulatory Compliance	3 - 5

## Section 4 — Handling and Installation

Pre-formatted Drive	4 - 1
Important Notice	4 - 1
Hard Drive Handling Precautions	4 - 1
Electro-Static Discharge (ESD)	4 - 1
Unpacking and Inspection	4 - 2
Repacking	4 - 3
Physical Installation	4 - 3
Drive Jumper Settings	4 - 4
Mounting Drive in System	4 - 4
Attaching IDE Interface and Power Cables	4 - 6
Attaching System Cables	4 - 7
System Setup	4 - 8
Hard Drive Preparation	4 - 10

## Section 5 — AT Interface Description

Interface Connector	5 - 1
Pin Description Summary	5 - 1
Pin Description Table	5 - 2
PIO Timing	5 - 3
DMA Timing	5 - 4
Ultra DMA Timing Parameters	5 - 5

## Section 6 — Host Software Interface

Task File Registers	6 - 1
Data Register	6 - 1
Error Register	6 - 1
Features Register	6 - 1
Sector Count Register	6 - 2
Sector Number Register	6 - 2
Cylinder Number Registers	6 - 2
Device/Head Register	6 - 2
Status Register	6 - 2
Command Register	6 - 3
Read Commands	6 - 3
Write Commands	6 - 3
Mode Set/Check Commands	6 - 3
Power Mode Commands	6 - 3
Initialization Commands	6 - 3
Seek, Format, and Diagnostic Commands	6 - 3
S.M.A.R.T. Commands	6 - 3
Summary	6 - 4
Control Diagnostic Registers	6 - 5
Alternate Status Register	6 - 5
Device Control Register	6 - 5
Digital Input Register	6 - 5
Reset and Interrupt Handling	6 - 6

## Section 7 — Interface Commands

Command Summary	7 - 1
Read Commands	7 - 2
Read Sector(s)	7 - 2
Read Verify Sector(s)	7 - 2
Read Sector Buffer	7 - 2
Read DMA	7 - 3
Read Multiple	7 - 3
Set Multiple	7 - 3
Write Commands	7 - 4
Write Sector(s)	7 - 4
Write Verify Sector(s)	7 - 4
Write Sector Buffer	7 - 4
Write DMA	7 - 5
Write Multiple	7 - 5
Ultra DMA	7 - 5
Set Feature Commands	7 - 5
Set Features Mode	7 - 5
Power Mode Commands	7 - 7
Standby Immediate	7 - 7
Idle Immediate	7 - 7
Standby	7 - 7
Idle	7 - 7
Check Power Mode	7 - 7
Set Sleep Mode	7 - 7
Default Power-on Condition	7 - 7
Initialization Commands	7 - 9
Identify Drive	7 - 9
Initialize Drive Parameters	7 - 12
Seek, Format, and Diagnostic Commands	7 - 13
S.M.A.R.T. Command Set	7 - 14

## Section 8 — Service and Support

Service Policy	8 - 1
No Quibble Service	8 - 1
Support	8 - 1

## Glossary

Glossary	GL - 1
----------	--------

## Figures

Figure	Title	Page
2 - 1	PCBA Jumper Locations and Configuration	2 - 6
3 - 1	Outline and Mounting Dimensions	3 - 2
4 - 1	Multi-pack Shipping Container	4 - 2
4 - 2	Single-pack Shipping Container (Option A)	4 - 3
4 - 3	Single-pack Shipping Container (Option B)	4 - 3
4 - 4	Master/Slave Jumper Detail	4 - 4
4 - 5	5.25-inch Mounting Brackets/Slider Rails	4 - 4
4 - 6	5.25-inch Installation	4 - 5
4 - 7	3.5-inch Installation	4 - 5
4 - 8	IDE Interface and Power Cabling Detail	4 - 6
4 - 9	System Interface Card Cabling	4 - 7
4 - 10	System Mother Board Cabling	4 - 7
4 - 11	J46 (4092 Cylinder Limitation) Detail	4 - 9
5 - 1	Data Connector	5 - 1
5 - 2	PIO Data Transfer to/from Device	5 - 3
5 - 3	Multi-word DMA Data Transfer	5 - 4
5 - 4	Initiating an Ultra DMA Data In Burst	5 - 5
5 - 5	Sustained Ultra DMA Data In Burst	5 - 6
5 - 6	Host Pausing an Ultra DMA Data In Burst	5 - 6
5 - 7	Device Terminating an Ultra DMA Data In Burst	5 - 7
5 - 8	Host Terminating an Ultra DMA Data In Burst	5 - 7
5 - 9	Initiating an Ultra DMA Data Out Burst	5 - 8
5 - 10	Sustained Ultra DMA Data Out Burst	5 - 8
5 - 11	Device Pausing an Ultra DMA Data Out Burst	5 - 9
5 - 12	Host Terminating an Ultra DMA Data Out Burst	5 - 9
5 - 13	Device Terminating an Ultra DMA Data Out Burst	5 - 10

## Introduction

### Maxtor Corporation

Maxtor Corporation has been providing high-quality computer storage products since 1982. Along the way, we've seen many changes in data storage needs. Not long ago, only a handful of specific users needed more than a couple hundred megabytes of storage. Today, downloading from the Internet and CD-ROMs, multimedia, networking and advanced office applications are driving storage needs even higher. Even home PC applications need capacities measured in gigabytes, not megabytes.

### Products

Maxtor's products meet those demanding storage capacity requirements with room to spare. They feature proven compatibility and reliability. While **DiamondMax™** 1750 UDMA is the latest addition to our family of high performance desktop hard drives, the CrystalMax™ and CrystalMax™ 1080 series hard drives deliver industry-leading capacity and value for most PC applications.

### Support

No matter which capacity, all Maxtor hard drives are supported by our commitment to total customer satisfaction and our *No Quibble® Service* guarantee. One call – or a visit to our home page on the Internet (<http://www.maxtor.com>) – puts you in touch with either technical support or customer service. We'll provide you the information you need quickly, accurately and in the form you prefer – a fax, a downloaded file or a conversation with a representative.

### Manual Organization

This hard disk drive reference manual is organized in the following method:

- Section 1 – Introduction
- Section 2 – Description
- Section 3 – Specifications
- Section 4 – Installation
- Section 5 – AT Interface
- Section 6 – Host Software Interface
- Section 7 – Interface Commands
- Section 8 – Service and Support
- Appendix – Glossary

### Abbreviations

ABBREV	DESCRIPTION	ABBREV	DESCRIPTION
ATA	AT attachment	MB	megabyte
bpi	bits per inch	Mbits/sec	megabits per second
CHS	cylinder - head - sector	MB/sec	megabytes per second
db	decibels	MHz	megahertz
dBA	decibels, A weighted	ms	millisecond
DMA	direct memory access	MSB	most significant bit
ECC	error correction code	mV	millivolts
fci	flux changes per inch	ns	nanoseconds
G	acceleration	P/O	programmed input/output
GB	gigabyte	RPM	revolutions per minute
Hz	hertz	tpi	tracks per inch
KB	kilobyte	μsec	microsecond
LBA	logical block address	V	volts
LSB	least significant bit	W	watts
mA	milliamperes		

## Conventions

If there is a conflict between text and tables, the table shall be accepted as being correct.

### Key Words

The names of abbreviations, commands, fields and acronyms used as signal names are in all uppercase type (e.g., IDENTIFY DRIVE). Fields containing only one bit are usually referred to as the “name” bit instead of the “name” field.

Names of drive registers begin with a capital letter (e.g., Cylinder High register).

### Numbering

Numbers that are not followed by a lowercase “b” or “h” are decimal values. Numbers that are followed by a lowercase “b” (e.g., 01b) are binary values. Numbers that are followed by a lowercase “h” (e.g., 3Ah) are hexadecimal values.

### Signal Conventions

Signal names are shown in all uppercase type.

All signals are either high active or low active signals. A dash character (-) at the end of a signal name indicates that the signal is low active. A low active signal is true when it is below ViL and is false when it is above ViH. A signal without a dash at the end indicates that the signal is high active. A high active signal is true when it is above ViH and is false when it is below ViL.

When a signal is asserted, it means the signal is driven by an active circuit to its true state.

When a signal is negated, it means the signal is driven by an active circuit to its false state.

When a signal is released, it means the signal is not actively driven to any state. Some signals have bias circuitry that pull the signal to either a true or false state when no signal driver is actively asserting or negating the signal. These instances are noted under the description of the signal.

---

## Product Description

Maxtor DiamondMax™ 1750 AT disk drives are 1-inch high, 3.5-inch diameter random access storage devices which incorporate an on-board UltraDMA/ATA controller. High capacity is achieved by a balanced combination of high areal recording density and the latest data encoding and servo techniques.

Maxtor's latest advancements in electronic packaging and integration methods have lowered the drive's power consumption and increased its reliability. Advanced magneto-resistive read/write heads, an state-of-the-art head/disk assembly using an integrated motor/spindle design allow up to four disks in a 3.5-inch package.

Exceptionally high data transfer rates and sub 10 ms access times make these performance series disk drives especially well-suited to high speed desktop and server applications.

### DiamondMax 1750 Key Features

*ANSI ATA-4 compliant PIO Mode 4 interface (Enhanced IDE)*

*Supports UltraDMA Mode 2 for 33 MB/sec data transfers*

*256 KB buffer with multi-adaptive cache manager*

*< 10 ms seek time*

*Zone density and I.D.-less recording*

*High reliability with > 500,000 hour MTBF*

*Outstanding shock resistance at 200 Gs*

*High durability with 50K constant start/stop cycles*

*Advanced multi-burst on-the-fly Error Correction Code (ECC)*

*Extended data integrity with ECC protected data and fault tolerant servo synchronization fields*

*Supports EPA Energy Star Standards (Green PC Friendly) with ATA powering savings commands*

*Auto park and lock actuator mechanism*

*Low power consumption*

*S.M.A.R.T. Capability*

*Note: Maxtor defines one megabyte as 10<sup>6</sup> or one million bytes and one gigabyte as 10<sup>9</sup> or one billion bytes.*

## Product Features

### Functional / Interface

Maxtor DiamondMax™ 1750 hard drives contain all necessary mechanical and electronic parts to interpret control signals and commands from an AT-compatible host computer. See Section 3, Product Specifications, for complete drive specifications.

#### Zone Density Recording

The disk capacity is increased with bit density management – common with Zone Density Recording. Each disk surface is divided into 16 circumferential zones. All tracks within a given zone contain a constant number of data sectors. The number of data sectors per track varies in different zones; the outermost zone contains the largest number of data sectors and the innermost contains the fewest.

#### Read/Write Multiple Mode

This mode is implemented per ANSI ATA/ATAPI-4 specification. Read/Write Multiple allows the host to transfer a set number of sectors without an interrupt request between them, reducing transfer process overhead and improving host performance.

#### UltraDMA - Mode 2

Maxtor DiamondMax 1750 hard drives fully comply with the new UltraDMA protocol, which greatly improves overall AT interface performance by significantly improving burst and sustained data throughput.

#### Multi-word DMA (EISA Type B) - Mode 2

Supports multi-word Direct Memory Access (DMA) EISA Type B mode transfers.

#### Sector Address Translation

All DiamondMax 1750 drives feature a universal translate mode. In an AT/EISA-class system, the drive may be configured to any specified combination of cylinders, heads and sectors (within the range of the drive's formatted capacity). DiamondMax 1750 drives power-up in a translate mode:

MODEL	CYLINDERS	HEADS	SECTORS	CAPACITY
87000D8	14,475	15	63	7,000 MB
86480D8	13,392	15	63	6,480 MB
85250D6	10,856	15	63	5,250 MB
84320D5	8,928	15	63	4,320 MB
83500D4	7,237	15	63	3,500 MB
83240D4	6,696	15	63	3,240 MB
82560D3	5,292	15	63	2,560 MB
81750D2	3,618	15	63	1,750 MB

### Logical Block Addressing

The Logical Block Address (LBA) mode can only be utilized in systems that support this form of translation. The cylinder, head and sector geometry of the drive, as presented to the host, differs from the actual physical geometry.

The host AT computer may access a drive of set parameters: number of cylinders, heads and sectors per track, plus cylinder, head and sector addresses. However, the drive can't use these host parameters directly because of zoned recording techniques. The drive translates the host parameters to a set of logical internal addresses for data access. The host drive geometry parameters are mapped into an LBA based on this formula:

$$\begin{aligned} \text{LBA} &= (\text{HSCA} - 1) + \text{HHDA} \times \text{HSPT} + \text{HNHD} \times \text{HSPT} \times \text{HCYA} \quad (1) \\ &= (\text{HSCA} - 1) + \text{HSPT} \times (\text{HHDA} + \text{HNHD} \times \text{HCYA}) \quad (2) \end{aligned}$$

where  
HSCA = Host Sector Address, HHDA = Host Head Address, HCYA = Host Cylinder Address, HNHD = Host Number of Heads  
HSPT = Host Sectors per Track

The LBA is checked for violating the drive capacity. If it does not, the LBA is converted to physical drive cylinder, head and sector values. The physical address is then used to access the data stored on the disk and other drive related operations.

### Defect Management Zone (DMZ)

Each drive model has a fixed number of spare sectors per drive, all of which are located at the end of the drive. Upon detection of a bad sector that has been reassigned, the next sequential sector is used.

For example, if sector 3 is flagged, data that would have been stored there is "pushed down" and recorded in sector 4. Sector 4 then effectively becomes sector 3, as sequential sectors are "pushed down" across the entire drive. The first spare sector makes up for the loss of sector 3, and so maintains the sequential order of data. This push down method assures maximum performance.

### On-the-Fly Hardware Error Correction Code (ECC)

10 bits, single burst, guaranteed

### Software ECC Correction

64 bits, single burst, guaranteed; 28 bits, double bursts, guaranteed

### Automatic Park and Lock Operation

Immediately following power down, dynamic braking of the spinning disks delays momentarily allowing the read/write heads to move to an inner mechanical stop. A small fixed magnet holds the rotary actuator in place as the disk spins down. The rotary actuator is released only when power is again applied.

## Cache Management

### Buffer Segmentation

The data buffer is organized into two segments: the data buffer and the micro controller scratch pad. The data buffer is dynamically allocated for read and write data depending on the commands received. A variable number of read and write buffers may exist at the same time.

### Read-Ahead Mode

Normally, this mode is active. Following a read request, disk read-ahead begins on the first sector and continues sequentially until the allocated buffer is full. If a read request is received during the read-ahead operation, the buffer is examined to determine if the request is in the cache. If a cache hit occurs, read-ahead mode continues without interruption and the host transfer begins immediately.

### Automatic Write Reallocation (AWR)

This feature is part of the write cache and reduces the risk of data loss during deferred write operations. If a disk error occurs during the disk write process, the disk task stops and the suspect sector is reallocated to a pool of alternate sectors located at the end of the drive. Following reallocation, the disk write task continues until it is complete.

### Write Cache Stacking

Normally, this mode is active. Write cache mode accepts the host write data into the buffer until the buffer is full or the host transfer is complete. A command complete interrupt is generated at the end of the transfer.

A disk write task begins to store the host data to disk. Host write commands continue to be accepted and data transferred to the buffer until either the write command stack is full or the data buffer is full. The drive may reorder write commands to optimize drive throughput.

## Major HDA Components

### Drive Mechanism

A brush-less DC direct drive motor rotates the spindle at 5,200 RPM ( $\pm 0.1\%$ ). The dynamically balanced motor/spindle assembly ensures minimal mechanical run-out to the disks. A dynamic brake provides a fast stop to the spindle motor upon power removal. The speed tolerance includes motor performance and motor circuit tolerances.

### Rotary Actuator

All DiamondMax™ 1750 drives employ a rotary voice coil actuator which consists of a moving coil, an actuator arm assembly and stationary magnets. The actuator moves on a low-mass, low-friction center shaft. The low friction contributes to fast access times and low power consumption.

### Read/Write Electronics

An integrated circuit mounted within the sealed head disk assembly (near the read/write heads) provides up to eight head selection (depending on the model), read pre-amplification and write drive circuitry.

### Read/Write Heads and Media

Low mass, low force magneto-resistive read/write heads record data on 3.5-inch diameter disks. Maxtor uses a sputtered thin film medium on all disks for DiamondMax 1750 drives.

### Air Filtration System

All DiamondMax 1750 drives are assembled in a Class 100 controlled environment. Over the life of the drive, a 0.1 micron filter and breather filter located within the sealed head disk assembly (HDA) maintain a clean environment to the heads and disks. DiamondMax 1750 drives are designed to operate in a typical office setting with minimum environmental control.

### Microprocessor

The microprocessor controls the following functions for the drive electronics:

- Command execution
- Cache management
- Data correction and error recovery
- Diagnostic execution
- Data sequencing
- Head positioning (including error recovery)
- Host interface
- Index detection
- Spindle speed control
- Seeks
- Servo

## Subsystem Configuration

### Dual Drive Support

Two drives may be accessed via a common interface cable, using the same range of I/O addresses. The drives are jumpered as device 0 or 1 (Master/Slave), and are selected by the drive select bit in the Device/Head register of the task file.

All Task File registers are written in parallel to both drives. The interface processor on each drive decides whether a command written to it should be executed; this depends on the type of command and which drive is selected. Only the drive selected executes the command and activates the data bus in response to host I/O reads; the drive not selected remains inactive.

A master/slave relationship exists between the two drives: device 0 is the master and device 1 the slave. When J50 is closed (factory default, figure 2-1), the drive assumes the role of master; when open, the drive acts as a slave. In single drive configurations, J50 must be closed.

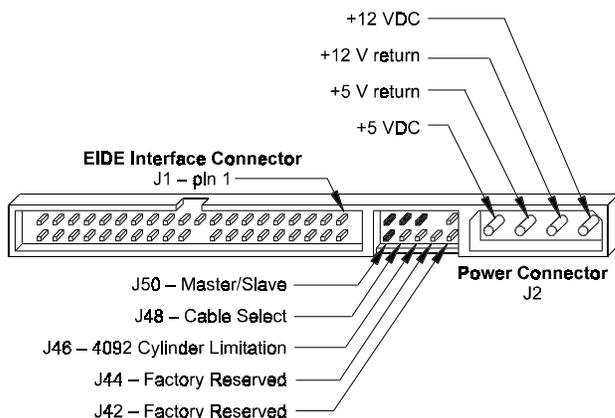
### Cable Select Option

CSEL (cable select) is an optional feature per ANSI ATA specification. Drives configured in a multiple drive system are identified by CSEL's value:

- If CSEL is grounded, then the drive address is 0.
- If CSEL is open, then the drive address is 1.

## Jumper Location/Configuration

Darkened jumper pins indicate factory-installed (default) shunts.



JUMPER CONFIGURATION	J50	J48	J46	J44	J42
Master/Slave					
Only drive in single drive system*	<b>J</b>				
Master in dual drive system*	<b>J</b>				
Slave in dual drive system	<b>O</b>				
Cable Select					
Disabled*		<b>O</b>			
Enabled		<b>J</b>			
4092 Cylinder Limitation					
Disabled*			<b>O</b>		
Enabled			<b>J</b>		
Factory Reserved				<b>O</b>	
Factory Reserved					<b>O</b>
Key					
* = Default <b>J</b> = Jumpered <b>O</b> = Open					

Figure 2-1  
PCBA Jumper Location and Configuration

## 4092 Cylinder Limitation

On some older BIOS', primarily those that auto-configure the disk drive, a hang may occur when the drive cylinder value exceeds 4096. The 4092 Cylinder Limitation jumper reduces the capacity in the Identify Drive to 4092 allowing large capacity drives to work with older BIOS'. A software driver is required to access the full capacity of the drive.

## Product Specifications

### Configuration

MODEL	87000D8	86480D8	85250D6	84320D5	83500D4	83240D4	82560D3	81750D2
Formatted Capacity (LBA Mode)	7,000 MB	6,480 MB	5,250 MB	4,320 MB	3,500 MB	3,240 MB	2,560 MB	1,750 MB
Integrated Controller/Interface	ATA-4/EIDE							
Encoding Method	RLL 8,9							
Interleave	1:1							
Servo System	Embedded							
Buffer Size/Type	256 KB/EDO DRAM							
Data Zones per Surface	16							
Data Surfaces/Heads	8	8	6	5	4	4	3	2
Aerial Density	1,200 Mb/in <sup>2</sup>							
Tracks per Surface (Cylinders)	7,825							
Track Density	7,797 tpi							
Flux Density	138-172 kfci							
Recording Density	123-153 kbpi							
Bytes per Sector/Block	512							
Sectors per Track	156-249							
Sectors per Drive	13,678,880	12,656,250	10,259,160	8,437,500	6,839,440	6,328,125	5,001,728	3,419,720

### Performance

MODEL	87000D8	86480D8	85250D6	84320D5	83500D4	83240D4	82560D3	81750D2
Seek Times (Typical)								
Track to Track	1.2 ms							
Average	< 10.0 ms							
Maximum	18 ms							
Average Latency	5.77 ms							
Rotational Speed (±0.1%)	5,200 RPM							
Controller Command Overhead	< 0.5 ms							
Data Transfer Rate								
To/from Interface (UltraDMA - Mode 2)	33.0 MB/sec							
To/from Interface (PIO 4/Multi-word DMA - Mode 2)	16.7 MB/sec							
To/from Media	Up to 14.0 MB/sec							
Start Time (0 to Drive Ready)	7.3 sec typical							

Physical Dimensions

Height	1.00 inches	[25.4 mm]
Length	5.75 inches	[146.1 mm]
Width	4.00 inches	[101.6 mm]
Weight	1.2 pounds	[0.5 kg]

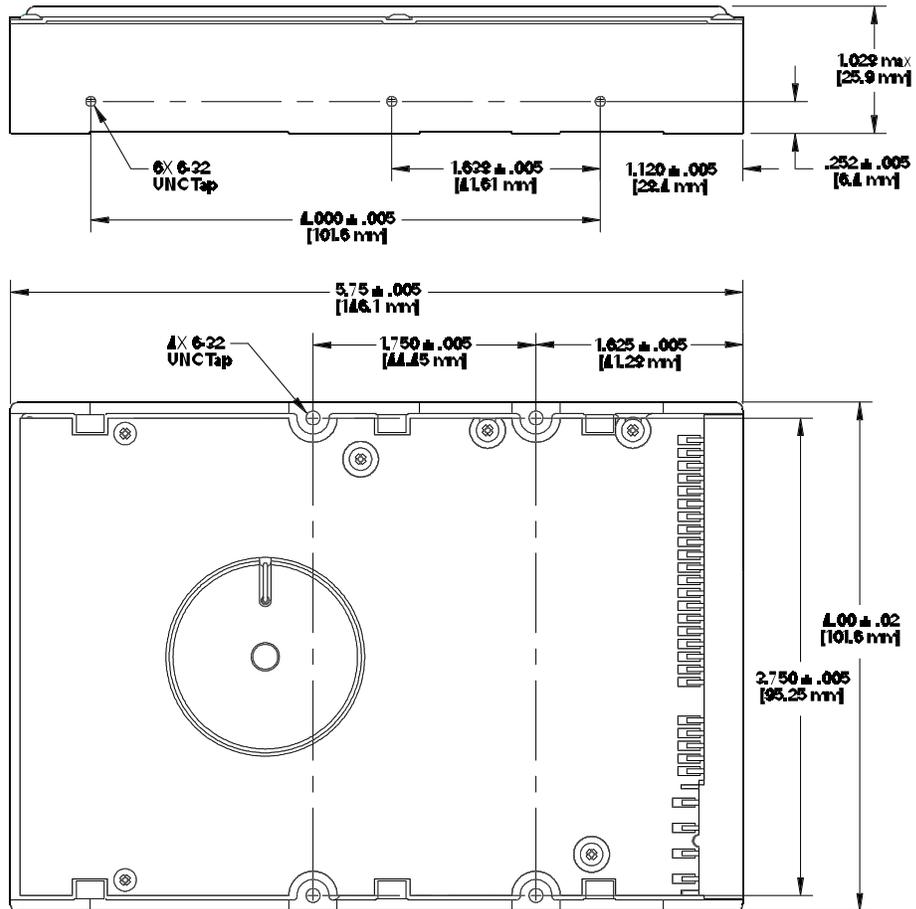


Figure 3 - 1  
Outline and Mounting Dimensions

## Power Requirements (Average)

MODE	12V ± 8%	5V ± 5%	POWER
Spin-up (peak)	1058 mA	260 mA	12.7 W
Active	234 mA	400 mA	4.8 W
Seek	530 mA	418 mA	8.5 W
Read/Write	237 mA	430 mA	5.0 W
Idle	232 mA	224 mA	3.9 W
Standby	2 mA	140 mA	0.7 W
Sleep	2 mA	80 mA	0.4 W

## Power Mode Definitions

### Active

The drive is spinning and most circuitry is powered on. The drive is capable of responding to read commands in the shortest possible time. Read/Write heads are positioned over the data area.

### Idle

The drive is spinning, the actuator is parked and powered off and all other circuitry is powered on. The drive is capable of responding to read commands within 40 ms.

### Read/Write

Data is being read from or written to the drive.

### Spin-up

The drive is spinning up following initial application of power and has not yet reached full speed.

### Sleep

This is the lowest power state. The interface becomes inactive. A software or hardware reset is required to return the drive to Active.

### Standby

The spin motor is not spinning. The drive will leave this mode upon receipt of a command that requires disk access. The time-out value for this mode is programmable. The buffer is active to accept write data.

### Seek

A random access operation by the disk drive.

## Environmental

PARAMETER	OPERATING	NON-OPERATING/STORAGE
Temperature	5° C to 55° C	Low temperature (-40° C) per MILSTD-810E, Method 502.3. High temperature (71° C) per MILSTD-810E, Method 501.3, Climatic Category; Hot-induced conditions.
Thermal Gradient (maximum)	25° C per hour	25° C per hour
Relative Humidity		5% to 95% (Non-condensing)
Wet Bulb		27° C maximum
Altitude	-200 to 10,000 feet (with any naturally occurring temperature and humidity within this range)	Per MILSTD-810E, Method 500.3, Low pressure (altitude) Test Procedure I. Storage; Test Condition 2, Transport aircraft cargo compartment pressure.

## Shock and Vibration

PARAMETER	OPERATING	NON-OPERATING
Mechanical Shock	20 Gs, 2.0 ms, no errors	200 Gs, 2.0 ms, no damage
Random Vibration	Per MIL-STD-810E, Method 514.4, Basic transportation, Vertical axis PSD profile. 10 Hz at 0.0125 G <sup>2</sup> /Hz 40 Hz at 0.0125 G <sup>2</sup> /Hz 500 Hz at 0.000125 G <sup>2</sup> /Hz	Per MIL-STD-810E, Method 514.4, Basic transportation, Vertical axis PSD profile. 10 Hz at 0.015 G <sup>2</sup> /Hz 40 Hz at 0.015 G <sup>2</sup> /Hz 500 Hz at 0.00015 G <sup>2</sup> /Hz
Swept Sine Vibration 5 - 20 Hz 21 - 300 Hz	0.049 inches double amplitude 1.0 G peak amplitude	

## Reliability and Maintenance

### MTBF – > 500,000 hours

Maxtor does not differentiate between various usage profiles. (.e. power-on hours, power saving modes, non-operating periods or operating temperatures within the published specification.)

### Start/Stop Cycles – 50,000 (minimum)

This indicates the minimum cycles for reliable start/stop function at a ≥ 60% confidence level.

### AFR – 1.7%

The annualized average failure rate (AFR) applies to the period prior to the expiration of component design life, and is based on failures chargeable to Maxtor. Determination of the AFR takes into account: a.) in-warranty field failure returns less quality acceptance-related failures and b.) an AFR equaling an exponentially weighted moving and average monthly failure rate multiplied by 12.

### Component Design Life – 5 years (minimum)

Component design life is defined as a.) the time period before identified wear-out mechanisms impact the failure rate, or b.) the time period up to the wear-out point at which useful component life expires.

### Quality Acceptance Rate – 99.85% (<1,500 DPPM)

The quality acceptance rate indicates the percentage of Maxtor products successfully installed by our customers, and/or the number of defective parts per million (DPPM) encountered during the entire installation process.

### Preventative Maintenance – None

## Data Reliability

Data Errors (non-recoverable)\* – < 1 per 10<sup>13</sup> bits read

Seek Errors – < 1 per 10<sup>6</sup> seeks

\*Average data error rate allowed with all error recovery features activated.

## Acoustic Noise

Recorded during Active/Idle mode.  
**Sound power** (per ISO 7779, 10 microphone)

**Average**  
37 dBA

## EPA Energy Star Compliance

Maxtor Corporation supports the goals of the U.S. Environmental Protection Agency’s Energy Star program to reduce the electrical power consumption of computer equipment.

## EMC/EMI

### Radiated Electromagnetic Field Emissions - EMC Compliance

The hard disk drive mechanism is designed as a subassembly for installation into a suitable enclosure and is therefore not subject to Subpart J of Part 15 of FCC Rules (47CFR15) or the Canadian Department of Communications Radio Interference Regulations. Although not required, the disk mechanism has been tested within a suitable end-use product and found to comply with Class B limits of the FCC Rules and Regulations of the Canadian Department of Communications.

The CE Marking indicates conformity with the European Union Low Voltage Directive (73/23/EEC) when the disk mechanism is installed in a typical personal computer. Maxtor recommends that testing and analysis for EMC compliance be performed with the disk mechanism installed within the user's end-use application.

### Canadian Emissions Statement

This digital apparatus does not exceed the Class B limits for radio noise emissions from digital apparatus as set out in the radio interference regulations of the Canadian department of communications.

Le present appareil numerique n'emet pas de bruit radioelectriques depassant les limites applicables aux appareils numeriques de Class B prescrites dans le reglement sur le brouillage radioelectrique edicte par le ministere des communications du Canada.

### Radiated Magnetic Field Emissions

Minimum of VDE Class B and MIL-STD-461/462, Method RE01 (stand-alone test configuration).

### Radiated Electromagnetic Field Immunity

IEC 801-3, Class 2 compliance.

### Radiated Magnetic Field Immunity

Per MIL-STD-461/462, Method RD01 (15 Hz to 100 kHz, stand-alone test configuration).

## Standard Test Methods

Traditional hard drive specifications are open to incorrect interpretation, but MIL-STD test methods accurately measure how products perform in real-world conditions. These methods have gained worldwide acceptance since they reflect actual environments, have well-defined test requirements, are easily understood and provide repeatable results. They objectively demonstrate to our customers the reliable, durable design of Maxtor hard drives. Each MIL-STD specification provides the basic method and condition information needed for reference by a knowledgeable Test and Qualification Engineer.

Acoustic specifications such as sound pressure are misleading because the test methods used are not controlled by recognizable standards. The sound pressure measurement itself is the least meaningful indicator of noise emissions as it relates to the human ear. The specification of sound power, loudness and sharpness are considered the most accurate acoustic measurement methodologies recognized by the leading acoustic measurement experts. ISO 7779, sound power, ISO 532B, loudness and sharpness (proposed ANSI standard by Eberhard Zwicker) are repeatable test methods providing results reproducible in any properly equipped acoustic lab.

## Safety Regulatory Compliance

All Maxtor DiamondMax™ 1750 drives comply with relevant product safety standards such as CE, CUL, TUV and UL rules and regulations. As delivered, DiamondMax 1750 hard disk drives are designed for system integration before they are used.

## Handling and Installation

### Pre-formatted Drive

This Maxtor hard drive has been low-level formatted at the factory. Do not use a low-level formatting program.

### Important Notice

There are a number of system BIOS's currently in use which do not support hard drives with more than 4095 cylinders (2.1 gigabytes). This section contains information describing the conditions which may identify this limitation. In order to obtain the full capacity of your Maxtor drive, you will need to follow the suggested installation instructions.

### Hard Drive Handling Precautions

Please take a moment to observe the following handling cautions:

- During handling, *NEVER* drop, jar, or bump a drive. Handle the drive by its sides and avoid touching the printed circuit board assembly (PCBA).
- Hard drives are sensitive to electrostatic discharge (ESD) damage. Use proper ESD practices by grounding yourself and the computer system the hard drive will be installed in.
- Allow the hard drive to reach room temperature *BEFORE* installing it in your computer system.
- NEVER* switch DC power onto the drive by plugging an electrically live DC source cable into the drive's connector. *NEVER* connect a live connector to the hard drive's IDE interface connector.

### Electro-Static Discharge (ESD)

To avoid some of the problems associated with ESD, Maxtor advises that anyone handling a disk drive use a wrist strap with an attached wire connected to an earth ground. Failure to observe these precautions voids the warranty.

Manufacturers frequently experience "unsolved" component/hardware malfunctions often caused by ESD. To reduce the incidence of ESD-related problems, Maxtor recommends that any electronics manufacturing plans include a comprehensive ESD program, the basic elements and functions of which are outlined here:

ESD Program Element	<i>ESD Program Function</i>
Management	<i>Institute and maintain</i>
Chief coordinator	<i>Organize and enforce</i>
Multi-department committee	<i>Evaluate and improve</i>
Employee training	<i>Educate and inform</i>

ESD program supplies typically include: wrist- and foot-worn grounding straps; counter-top and floor antistatic matting; wrist strap testers; ESD video and training materials. Sources for such supplies include:

Static Control Systems – 3M 225-4S, 3M Center St. Paul, MN 55144	Charleswater 93 Border St. West Newton, MA 02165-9990
--	---

Maxtor also offers a complete video training package, "Care and Handling of Maxtor Disk Drives." Contact your Maxtor representative for details.

## Unpacking and Inspection

Retain any packing material for reuse. Inspect the shipping container for evidence of damage in transit. Notify the carrier immediately in case of damage to the shipping container.

As they are removed, inspect drives for evidence of shipping damage or loose hardware. If a drive is damaged (and no container damage is evident), notify Maxtor immediately for drive disposition.

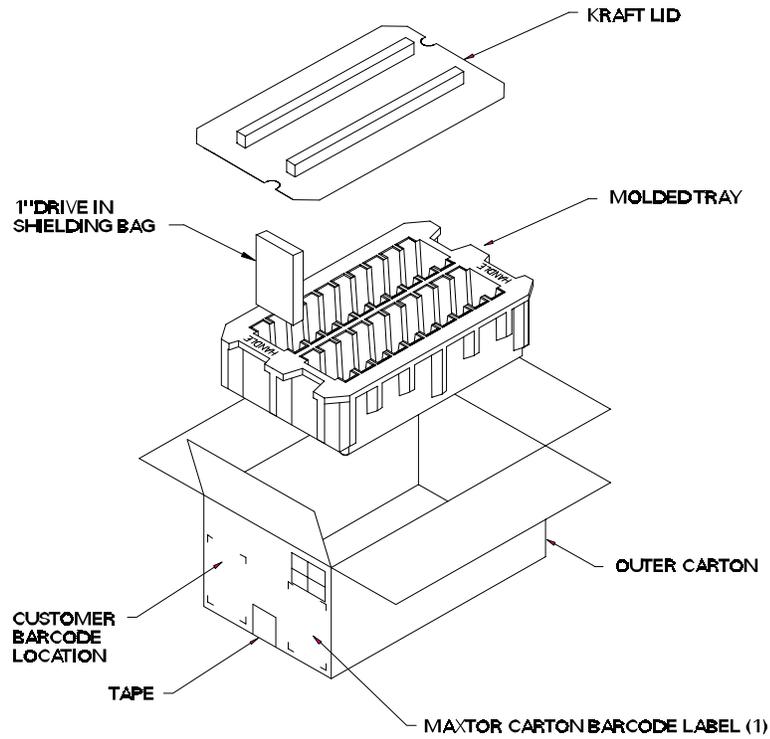


Figure 4 - 1  
Multi-pack Shipping Container

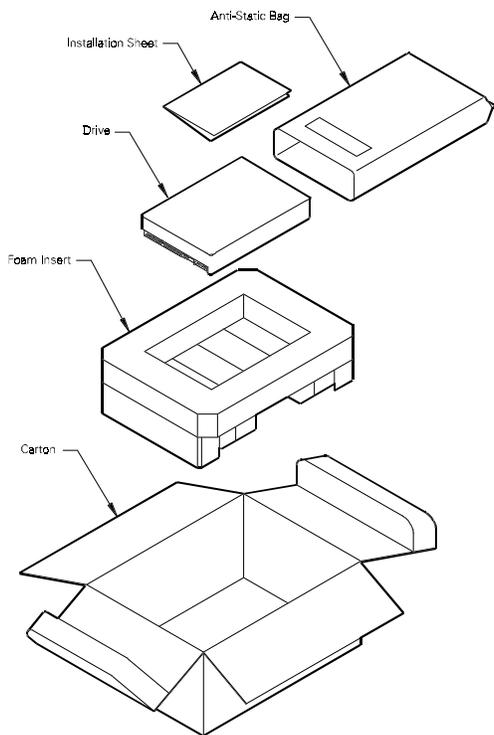


Figure 4 - 2  
Single Pack Shipping Container (Option A)

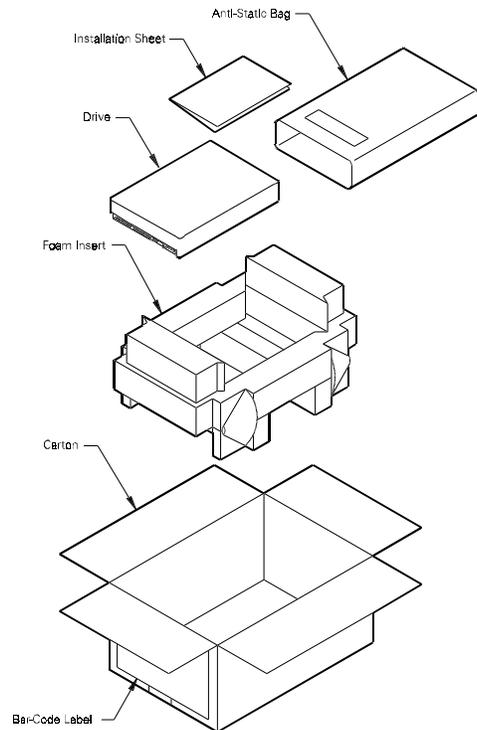


Figure 4 - 3  
Single Pack Shipping Container (Option B)

## Repacking

If a Maxtor drive requires return, repack it using Maxtor packing materials, including the antistatic bag.

## Physical Installation

### Recommended Mounting Configuration

The DiamondMax™ 1750 drive design allows greater shock tolerance than that afforded by larger, heavier drives. The drive may be mounted in any attitude using four size 6-32 screws with 1/8-inch maximum penetration and a maximum torque of 5-inch pounds. See Figure 3-1 for mounting dimensions. Allow adequate ventilation to the drive to ensure reliable operation.

## Drive Jumper Settings

Figure 4-4 shows the valid jumper settings for the Maxtor hard drive. A spare jumper shunt is shipped between J46 and J48.

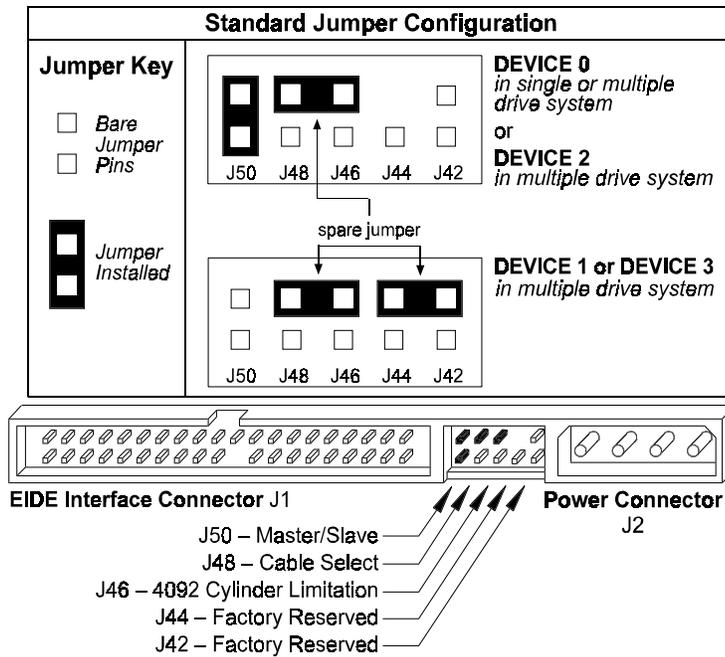


Figure 4 - 4  
Master/Slave Jumper Detail

## Mounting Drive in System

Turn the computer OFF, disconnect the power cord and remove the cover. Refer to your computer user's manual for additional information.

### Installing 5.25-inch Mounting Brackets

Mounting brackets are only needed when the drive will be installed in a 5.25-inch drive bay. This step is not necessary when installing the drive in a 3.5-inch bay. See Figure 4-5 below.

### Mounting Rails

Mounting rails are attached to the mounting bracket for systems requiring this feature. See Figure 4-5 below.

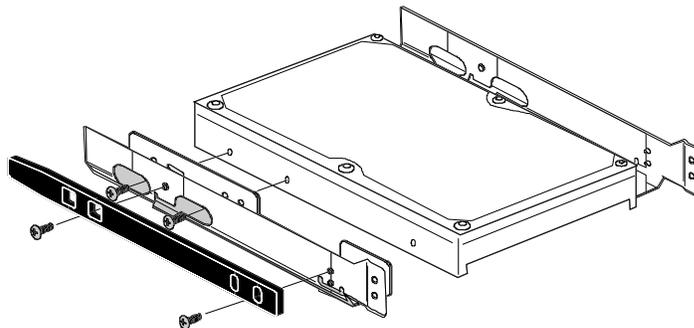


Figure 4 - 5  
5.25-inch Mounting Brackets/Slider Rails

**Note:** The following figures are examples of typical computer systems and mounting placements. The computer system the Maxtor hard drive is being installed in may have implemented a different mounting and placement methodology.

#### Mounting Drive in 5.25-inch Bay

If the Maxtor hard drive will be mounted in a 5.25-inch bay, install it as shown in Figure 4-6 below.

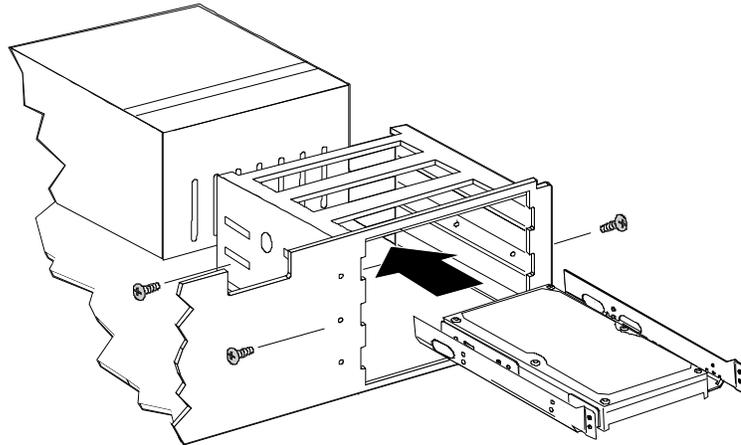


Figure 4 - 6  
5.25-inch Installation

#### Mounting Drive in 3.5-inch Bay

If the Maxtor hard drive will be mounted in a 3.5-inch bay, install it as shown in Figure 4-7 below.

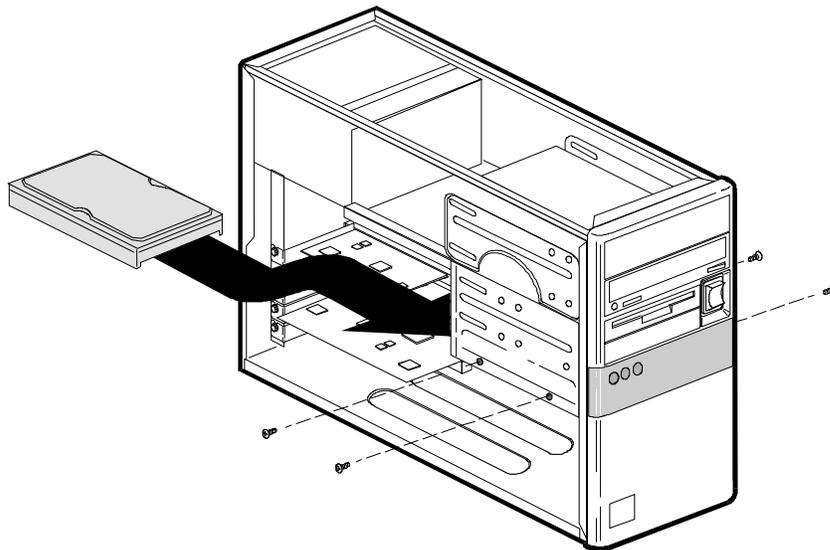


Figure 4 - 7  
3.5-inch Installation

## Attaching IDE Interface and Power Cables

In order for your computer to recognize that the Maxtor hard drive is in the system, the IDE interface and power cables must be connected to the hard drive, the mother board or the IDE hard drive interface card.

- 1 Attach an available IDE interface connector to **J1** (see Figure 4-8 below) on the Maxtor hard drive. This connector is keyed and will only fit in one orientation. Do not force the connector.

The striped or colored edge of the IDE interface cable indicates pin 1. Pin 1 on the IDE interface cable should match pin 1 on the drive connector. On the Maxtor hard drive, pin 1 is closest to the power connector.

- 2 Connect an available power connector to **J2** (see Figure 4-8 below) on the Maxtor hard drive. This connector is keyed and will only fit in one orientation. Do not force the connector.

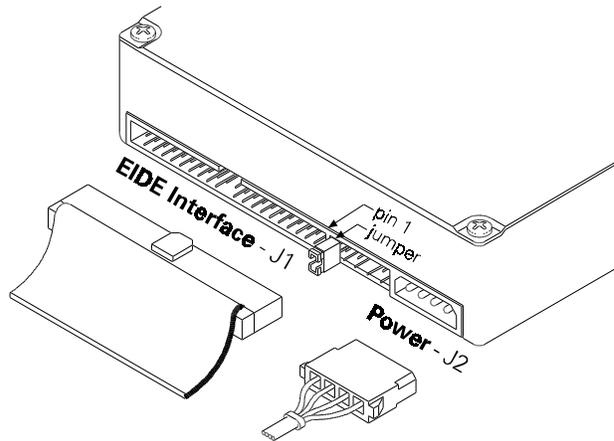


Figure 4 - 8  
IDE Interface and Power Cabling Detail

After attaching the IDE interface cable and the power cable to the Maxtor hard drive, verify that all other cables connected to other devices, the mother board or interface cards are correctly seated.

## Attaching System Cables

Attach the 40-pin IDE interface cable from the Maxtor hard drive to the IDE connector on the IDE interface card.

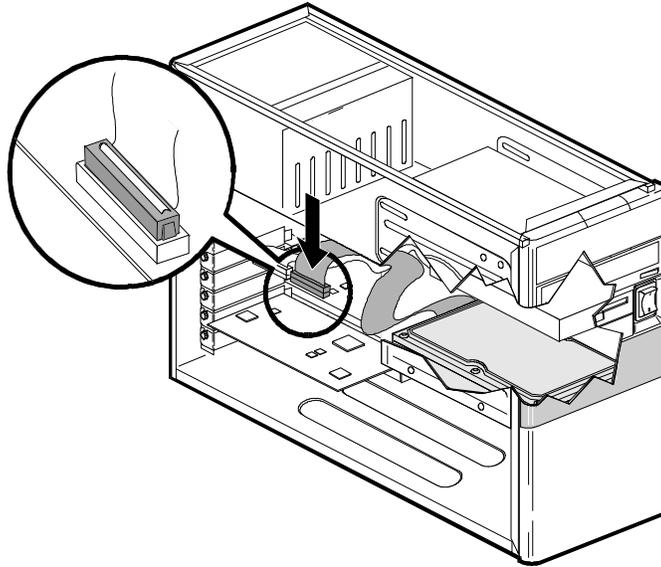


Figure 4 - 9  
System Interface Card Cabling

OR

Attach the 40-pin IDE interface cable from the Maxtor hard drive to the IDE connector on the mother board.

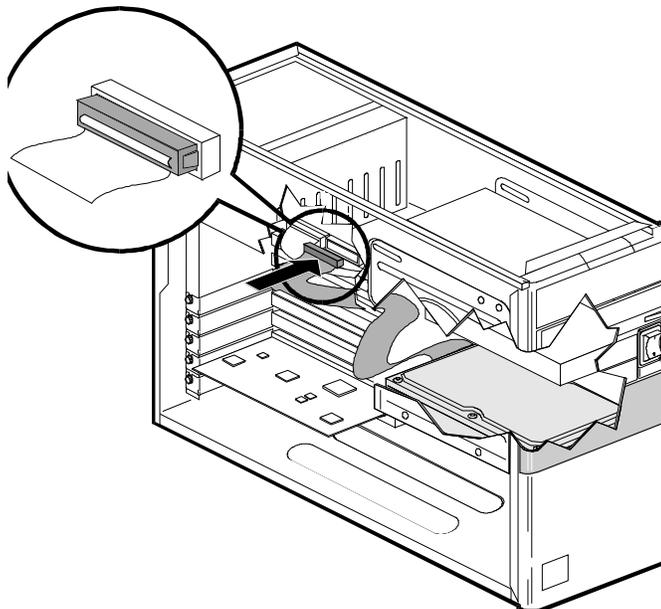


Figure 4 - 10  
System Mother board Cabling

## System Setup

The following procedures are designed for systems using the DOS 5.0 (or higher) or Windows 95 operating systems. For other operating systems (e.g., OS2®, UNIX®, LINUX and Novell NetWare®), refer to the operating system user's manual for the BIOS setting and other installation requirements

### Setting the BIOS (CMOS)

In order for the computer system to recognize the new Maxtor hard drive, it is necessary to set the system BIOS with the correct information about the hard drive.

The SETUP (BIOS) program identifies the system configuration information (e.g., floppy disk drives, hard disk drives, video, etc.) used by the computer during system boot. This includes the information about what kind and how many hard drives are attached to the system. When entering the settings for the new Maxtor hard drive, be careful not to change any of the other BIOS settings, or other parts of the system may not work correctly.

Most of the systems with newer BIOS' (typically with a date of July 1994 or newer), support large capacity hard drives. It is necessary to determine if the system provides support for large capacity hard drives before entering the settings, as this affects how to correctly set the BIOS parameters for the new Maxtor hard drive.

If you are unsure of how to access the system BIOS and/or program the BIOS settings, refer to the computers user's manual for detailed instructions.

### Set the BIOS (CMOS) parameters as follows:

1. Turn the system ON. During the system start-up sequence, run the SETUP (BIOS) program or similar commands to access the system BIOS.

**NOTE:** Newer systems will typically display a message (e.g., press DEL to Enter Setup) identifying how to access the SETUP (BIOS) program.

2. Once the SETUP (BIOS) program is active, do one of the following to set the hard drive BIOS parameters.
  - a) If the SETUP program provides an "AUTO DETECT" capability, use this feature to detect the Maxtor hard drive. After the SETUP program has detected the hard drive, verify that the Logical Block Addressing (LBA) mode is enabled for this drive. If the SETUP program does not provide an "AUTO DETECT" capability, set the drive parameters as defined in b) below.

**Comment:** When LBA is enabled, some BIOS programs will change the values of the cylinders and heads by dividing the cylinders by 2, 4, 8 or 16 and multiplying the heads by the same value. This does not change the capacity of the hard drive.

- b) If the SETUP program does not provide an "AUTO DETECT" capability, the drive parameters must be set using the User Definable Type (UDT). Select the appropriate UDT for the Maxtor hard drive and set the cylinder, head and sector values for the model being installed from the table below. Only the values listed in the table must be entered. Other values may be entered as zero (0). Set the LBA mode to enabled for this drive. If the SETUP program does not provide the UDT, set the drive parameters as defined in c) below.

### Drive Parameters

MODEL	CYLINDERS	HEADS	SECTORS	CAPACITY
87000D8	14,475	15	63	7,000 MB
86480D8	13,392	15	63	6,480 MB
85250D6	10,856	15	63	5,250 MB
84320D5	8,928	15	63	4,320 MB
83500D4	7,237	15	63	3,500 MB
83240D4	6,696	15	63	3,240 MB
82560D3	5,292	15	63	2,560 MB
81750D2	3,618	15	63	1,750 MB

- c) If the system has an older BIOS which does not provide a UDT, set the BIOS for the Maxtor hard drive to **Type 9**. If this BIOS setting is used or the BIOS does not support LBA, the drive must be prepared using Max•Blast software.
- 3. After the drive parameters are entered, follow the SETUP program procedures to save the settings and exit the SETUP program. After changing BIOS settings, saving the values and exiting, the SETUP program should force the system to re-boot.

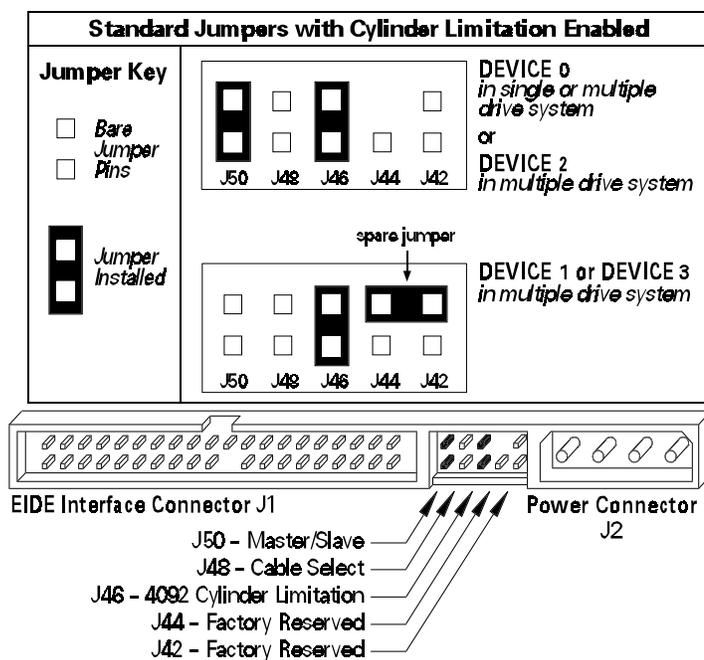
Boot the system to the bootable Max•Blast installation software diskette received with the hard drive or with a DOS 5.0 (or higher) or Windows 95 system diskette. If the system boots normally, proceed to the “Hard Drive Preparation” section.

### System Hangs During Boot

If after installing the Maxtor hard drive in the system or after setting the system BIOS the system hangs during the boot process, the system may have a BIOS limitation. This may occur for drives with capacities larger than 2.1 GB.

If the system locks up before accessing the BIOS SETUP program or if it locks up during the boot process after setting the system BIOS, the system may have a BIOS with a cylinder limitation. If this happens, perform the following:

- 1 Turn the system OFF.
- 2 Install jumper **J46** on the drive using the spare jumper shipped across pins J46 and J48 or if the drive is installed as a Slave, store the spare jumper across J42 and J44.



- 3 If the BIOS was set to AUTO DETECT, re-boot the system and use Max•Blast installation software to complete the hard drive installation. If other BIOS settings were used, access the system BIOS SETUP program and set the BIOS parameters to **Type 9** for the Maxtor hard drive then re-boot the system and use Max•Blast installation software to complete the hard drive installation. NOTE: When this jumper is installed, the Maxtor hard drive must be prepared using Max•Blast.

## Special Note for Windows NT Users

If the cylinder reduction jumper is installed, Max•Blast (version 9.00M or newer) installation software will not work with Windows NT and the hard drive capacity will be limited to 2.1 GB. If the cylinder reduction jumper is not installed, Max•Blast software will work with Windows NT.

It is recommended that the system BIOS be upgraded to one that correctly supports hard drives with capacities >2.1 GB. Once the BIOS is upgraded, the cylinder reduction jumper is not required. Contact the system manufacturer for assistance in obtaining and installing the correct BIOS upgrade for hard drives with capacities exceeding 2.1 GB.

## Hard Drive Preparation

To complete the installation of the Maxtor hard drive, the drive must be partitioned and formatted.

1. Boot the system.
  - a) Using the Max•Blast diskette received with the hard drive, place the diskette in the A: drive and turn the system on. Proceed to Step 2.
  - b) If a Max•Blast diskette was not included with the hard drive:
    - 1) Boot the system with a DOS 5.0 (or higher) or Windows 95 system diskette
    - 2) Place the diskette with the downloaded version of Max•Blast in the appropriate floppy drive.
    - 3) Type "**EZMAX**" and press the [Enter] key.
2. The Max•Blast installation software will load and the first screen of the program will display. Follow the on-screen prompts to complete the hard drive installation.

## AT Interface Description

### Interface Connector

All DiamondMax™ 1750 AT drives have a 40-pin ATA interface connector mounted on the PCBA. The drive may connect directly to the host; or it can also accommodate a cable connection (maximum cable length: 18 inches).

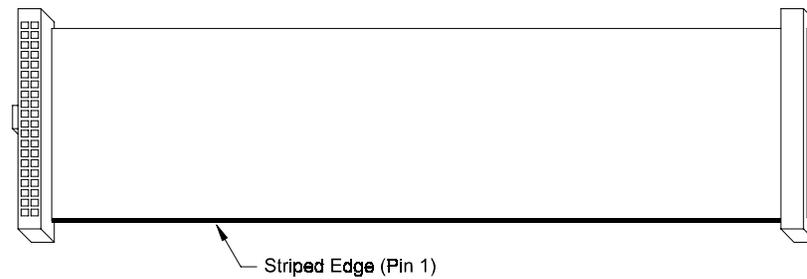


Figure 5-1  
Data Connector

### Pin Description Summary

PIN	SIGNAL	PIN	SIGNAL
01	Reset -	02	Ground
03	DD7	04	DD8
05	DD6	06	DD9
07	DD5	08	DD10
09	DD4	10	DD11
11	DD3	12	DD12
13	DD2	14	DD13
15	DD1	16	DD14
17	DD0	18	DD15
19	Ground	20	(keypin)
21	DMARQ	22	Ground
23	DIOW -:STOP	24	Ground
25	DIOR -:HDMARDY:HSTROBE	26	Ground
27	IORDY:DDMARDY:DSTROBE	28	CSEL
29	DMACK -	30	Ground
31	INTRQ	32	IOCS16 Obsolete
33	DA1	34	PDIAG -
35	DA0	36	DA2
37	CS0 -	38	CS1 -
39	DASP -	40	Ground

## Pin Description Table

PIN NAME	PIN	I/O	SIGNAL NAME	SIGNAL DESCRIPTION
RESET -	01	I	Host Reset	Reset signal from the host system. Active during power up and inactive after.
DD0	17	I/O	Host Data Bus	16 bit bi-directional data bus between host and drive. Lower 8 bits used for register and ECC byte transfers. All 16 bits used for data transfers.
DD1	15	I/O		
DD2	13	I/O		
DD3	11	I/O		
DD4	09	I/O		
DD5	07	I/O		
DD6	05	I/O		
DD7	03	I/O		
DD8	04	I/O		
DD9	06	I/O		
DD10	08	I/O		
DD11	10	I/O		
DD12	12	I/O		
DD13	14	I/O		
DD14	16	I/O		
DD15	18	I/O		
DMARQ	21	O	DMA Request	This signal is used with DMACK for DMA transfers. By asserting this signal, the drive indicates that data is ready to be transferred to and from the host.
DLOW - STOP	23	I	Host I/O Write	Rising edge of Write strobe clocks data from the host data bus to a register on the drive.
DIOR - HDMARDY - HSTROBE	25	I	Host I/O Read	Read strobe enables data from a register on the drive onto the host data bus. DMA ready during UltraDMA data in bursts. Data strobe during UltraDMA data out bursts.
IORDY DDMARDY - DSTROBE	27	O	I/O Channel Ready	This signal may be driven low by the drive to insert wait states into host I/O cycles. DMA ready during UltraDMA data out bursts. Data strobe during UltraDMA data in bursts.
CSEL	28		Cable Select	Used for Master/Slave selection via cable. Requires special cabling on host system and installation of Cable Select jumper.
DMACK -	29	I	DMA Acknowledge	This signal is used with DMARQ for DMA transfers. By asserting this signal, the host is acknowledging the receipt of data or is indicating that data is available.
INTRQ	31	O	Host Interrupt Request	Interrupt to the host asserted when the drive requires attention from the host.
IOCS16	32		Device 16 bit I/O	Obsolete
PDIAG -	34	I/O	Passed Diagnostic	Output by drive when in Slave mode; Input to drive when in Master mode.
DA0	35	I	Host Address Bus	3 bit binary address from the host to select a register in the drive.
DA1	33	I		
DA2	36	I		
CS0 -	37	I	Host Chip Select 0	Chip select from the host used to access the Command Block registers in the drive. This signal is a decode of I/O addresses 1F0 - 1F7 hex.
CS1 -	38	I	Host Chip Select 1	Chip select from the host used to access the Control registers in the drive. This signal is a decode of I/O addresses 3F6 - 3F7 hex.
DASP -	39	I/O	Drive Active/Drive 1 Present	Time-multiplexed, open collector output which indicates that a drive is active, or that device 1 is present.
GND	02	N/A	Ground	Signal ground.
	19			
	22			
	24			
	26			
	30			
40				
KEY	20	N/A	Key	Pin used for keying the interface connector.

## PIO Timing

TIMING PARAMETERS		MODE 0	MODE 1	MODE 2	MODE 3	MODE 4
t0	Cycle Time (min)	600 ns	383 ns	240 ns	180 ns	120 ns
t1	Address valid to DIOR-/DIOW- setup (min)	70 ns	50 ns	30 ns	30 ns	25 ns
t2	DIOR-/DIOW- 16-bit (min)	165 ns	125 ns	100 ns	80 ns	70 ns
t2i	DIOR-/DIOW- recovery time (min)				70 ns	25 ns
t3	DIOW- data setup (min)	60 ns	45 ns	30 ns	30 ns	20 ns
t4	DIOW- data hold (min)	30 ns	20 ns	15 ns	10 ns	10 ns
t5	DIOR- data setup (min)	50 ns	35 ns	20 ns	20 ns	20 ns
t6	DIOW- data hold (min)	5 ns				
t6Z	DIOR- data tristate (max)	30 ns				
t9	DIOR-/DIOW- to address valid hold (min)	20 ns	15 ns	10 ns	10 ns	10 ns
tRd	Read Data Valid to IORDY active (min)	0	0	0	0	0
tA	IORDY Setup Time	35 ns				
tB	IORDY Pulse Width (max)	1250 ns				

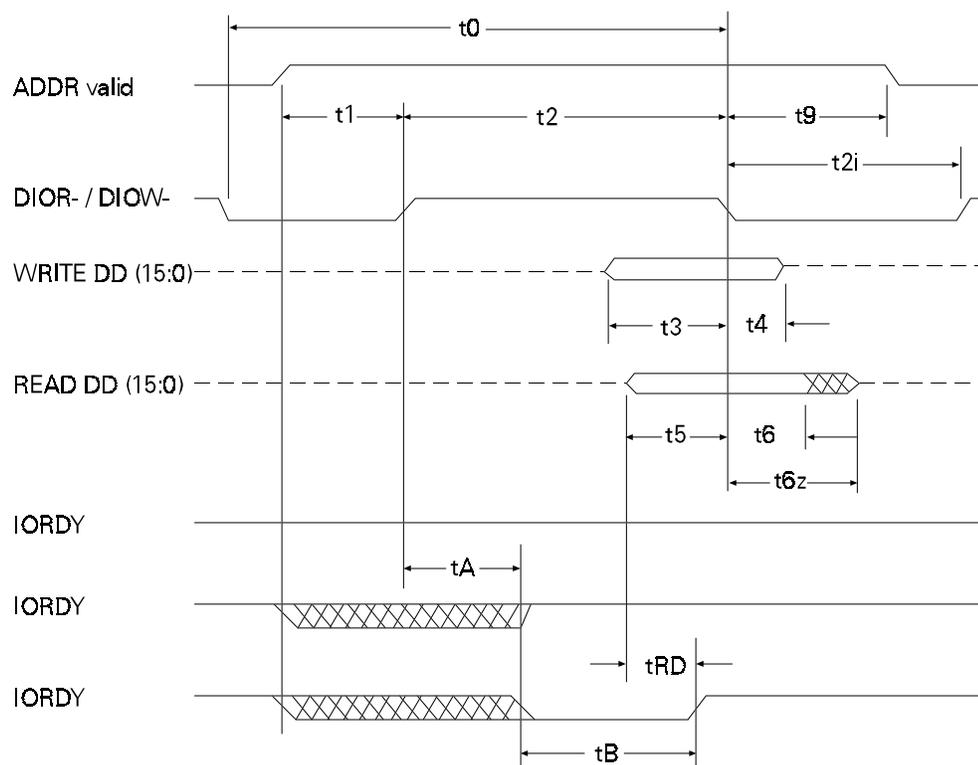


Figure 5 - 2  
PIO Data Transfer To/From Device

## DMA Timing

TIMING PARAMETERS		MODE 0	MODE 1	MODE 2
t0	Cycle Time (min)	480 ns	150 ns	120 ns
tC	DMACK to DMARQ delay			
tD	DIOR-/DIOW- (min)	215 ns	80 ns	70 ns
tE	DIOR- data access (min)	150 ns	60 ns	
tF	DIOR- data hold (min)	5 ns	5 ns	5 ns
tG	DIOR-/DIOW- data setup (min)	100 ns	30 ns	20 ns
tH	DIOW- data hold (min)	20 ns	15 ns	10 ns
tI	DMACK to DIOR-/DIOW- setup (min)	0	0	0
tJ	DIOR-/DIOW- to DMACK hold (min)	20 ns	5 ns	5 ns
tKr	DIOR- negated pulse width (min)	50 ns	50 ns	25 ns
tKw	DIOW- negated pulse width (min)	215 ns	50 ns	25 ns
tLr	DIOR- to DMARQ delay (max)	120 ns	40 ns	35 ns
tLw	DIOW- to DMARQ delay (max)	40 ns	40 ns	35 ns
tZ	DMACK- to tristate (max)	20 ns	25 ns	25 ns

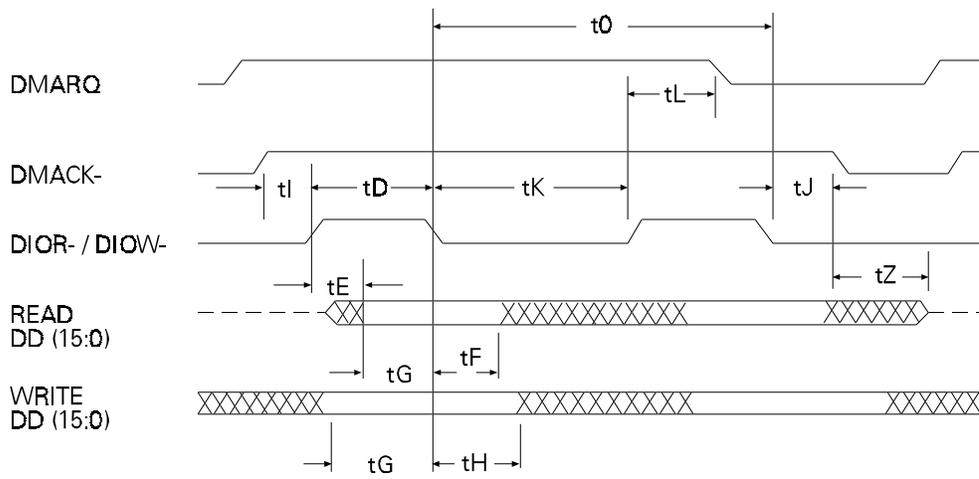


Figure 5 - 3  
Multi-word DMA Data Transfer

## Ultra DMA Timing

TIMING PARAMETERS (all times in ns)	MODE 0		MODE 1		MODE 2	
	MIN	MAX	MIN	MAX	MIN	MAX
$t_{CYC}$	Cycle Time (from STROBE edge to STROBE edge)					
$t_{2CYC}$	Two cycle time (from rising edge to next rising edge or from falling edge to next falling edge of STROBE)					
$t_{DS}$	Data setup time (at recipient)					
$t_{DH}$	Data hold time (at recipient)					
$t_{DVS}$	Data valid setup time at sender (time from data bus being valid until STROBE edge)					
$t_{DVH}$	Data valid hold time at sender (time from STROBE edge until data may go invalid)					
$t_{FS}$	First STROBE (time for device to send first STROBE)					
$t_{LI}$	Limited interlock time (time allowed between an action by one agent, either host or device, and the following action by the other agent)					
$t_{MLI}$	Interlock time with minimum					
$t_{IL}$	Unlimited interlock time					
$t_{AZ}$	Maximum time allowed for outputs to release					
$t_{ZAH}$	Minimum delay time required for output drivers turning on (from released state)					
$t_{ZAD}$	Envelope time (all control signal transitions are within the DMACK envelope by this much time)					
$t_{ENV}$	STROBE to DMARDY (response time to ensure the synchronous pause case when the recipient is pausing)					
$t_{RFS}$	Ready-to-final-STROBE time (no more STROBE edges may be sent this long after receiving DMARDY negation)					
$t_{RP}$	Ready-to-pause time (time until a recipient may assume that the sender has paused after negation of DMARDY)					
$t_{IORDY}$	Pull-up time before allowing IORDY to be released					
$t_{ZORDY}$	Minimum time device shall wait before driving IORDY					
$t_{ACK}$	Setup and hold times before assertion and negation of DMACK-					
$t_{SS}$	Time from STROBE edge to STOP assertion when the sender is stopping					

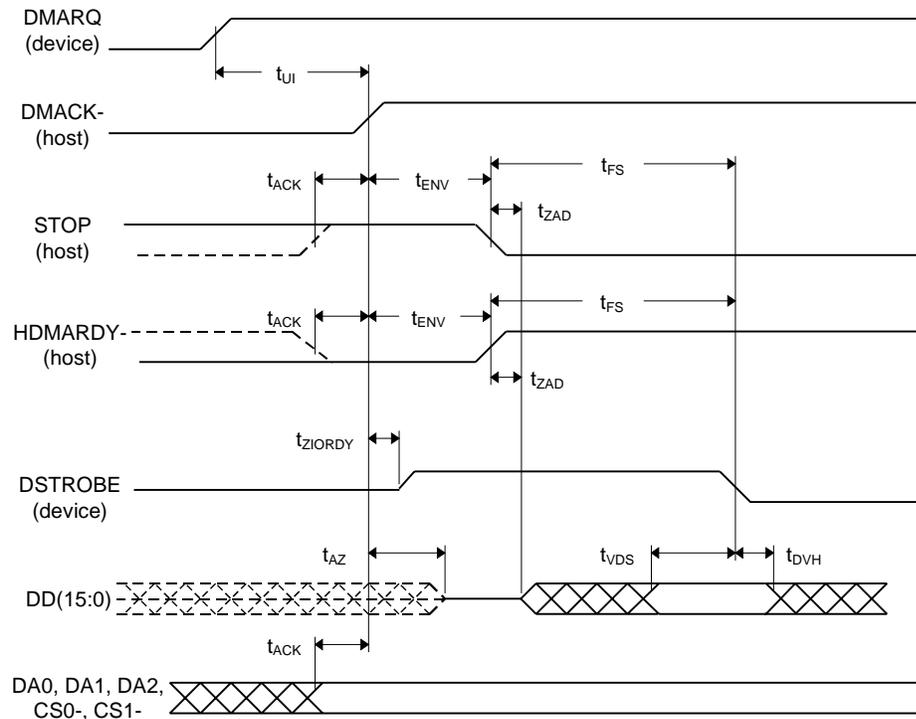


Figure 5 - 4  
Initiating an Ultra DMA Data In Burst

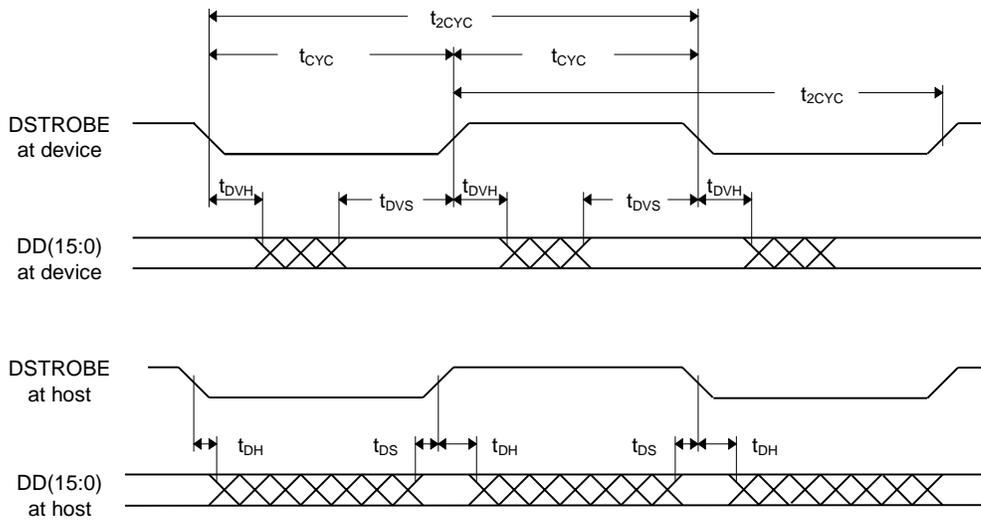


Figure 5 - 5  
Sustained Ultra DMA Data In Burst

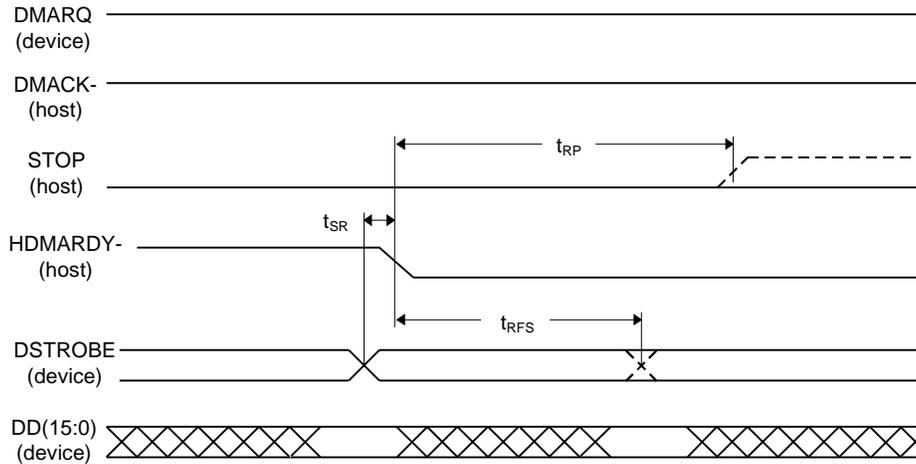


Figure 5 - 6  
Host Pausing an Ultra DMA Data In Burst

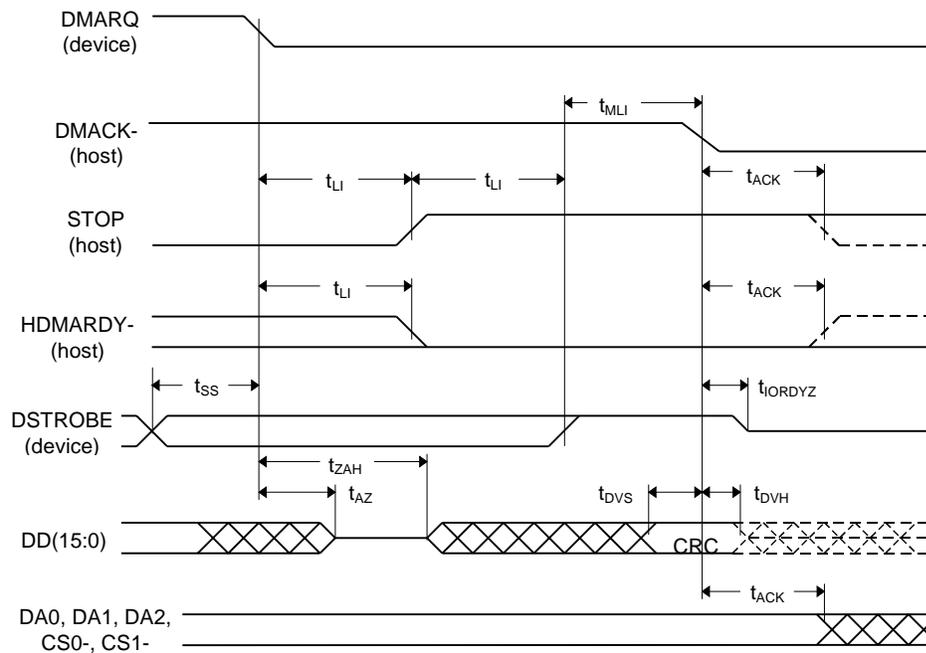


Figure 5 - 7  
Device Terminating an Ultra DMA Data In Burst

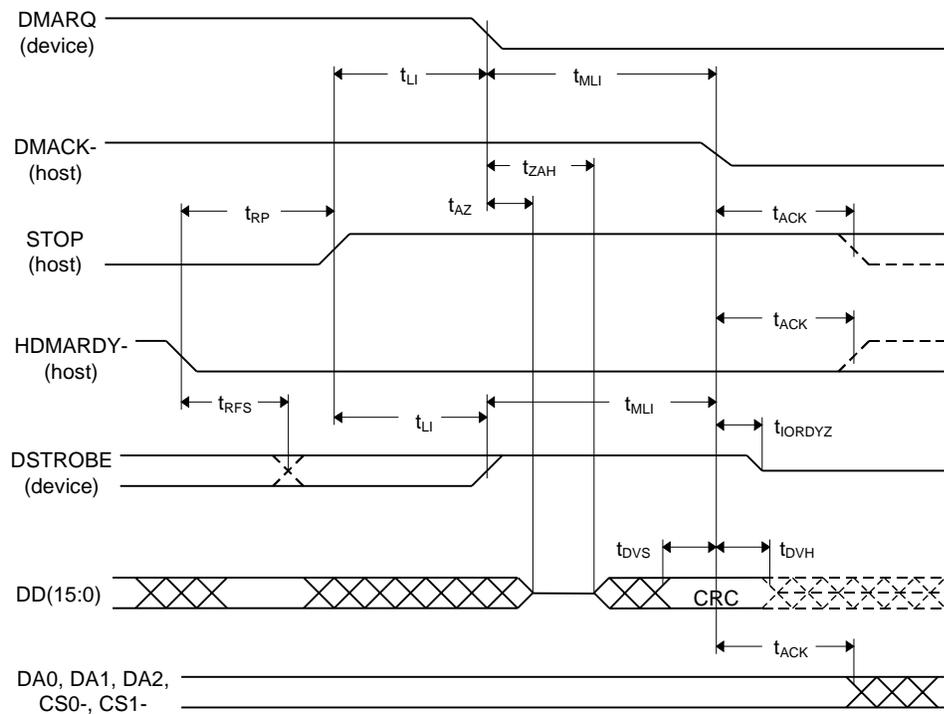


Figure 5 - 8  
Host Terminating an Ultra DMA Data In Burst

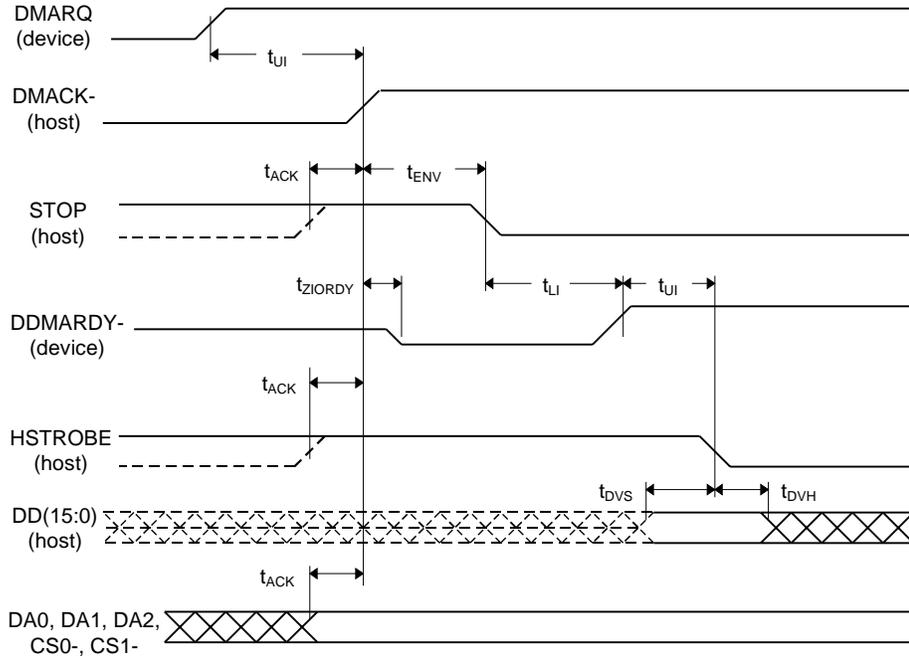


Figure 5 - 9  
Initiating an Ultra DMA Data Out Burst

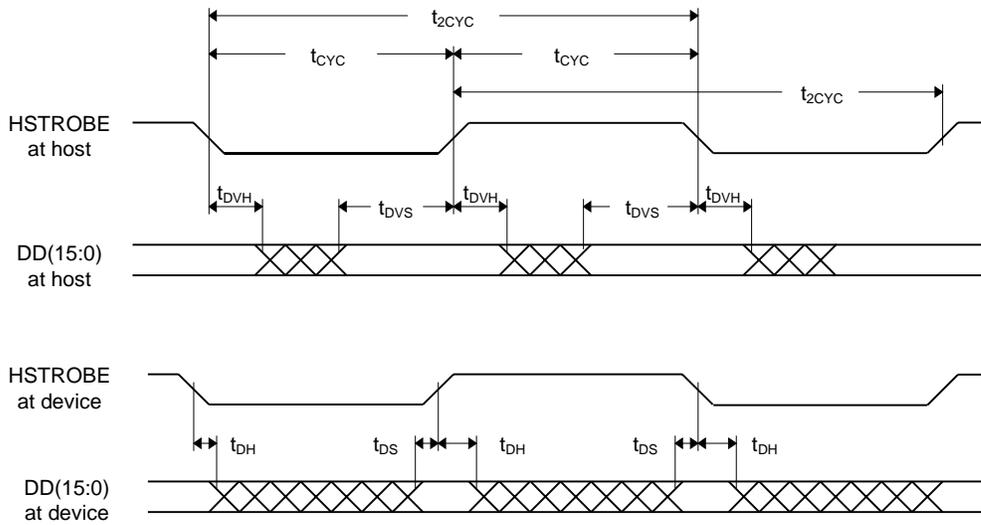


Figure 5 - 10  
Sustained Ultra DMA Data Out Burst

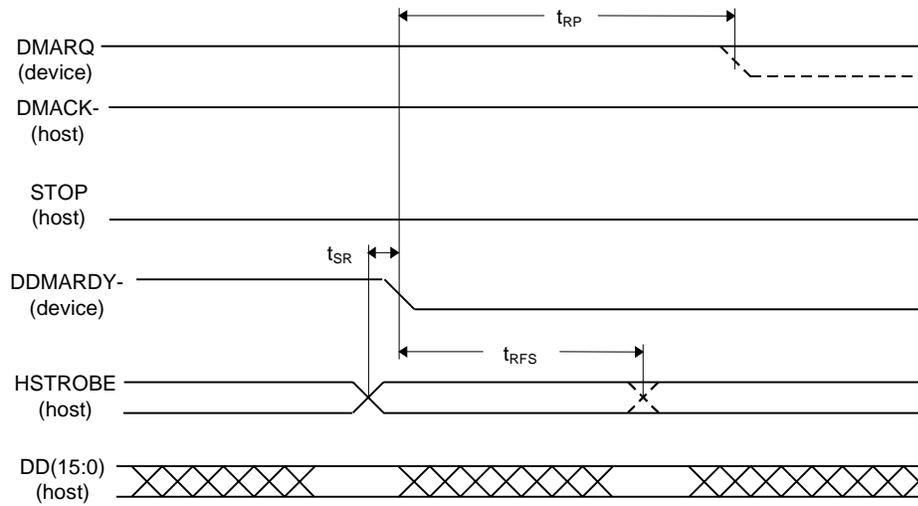


Figure 5 - 11  
Device Pausing an Ultra DMA Data Out Burst

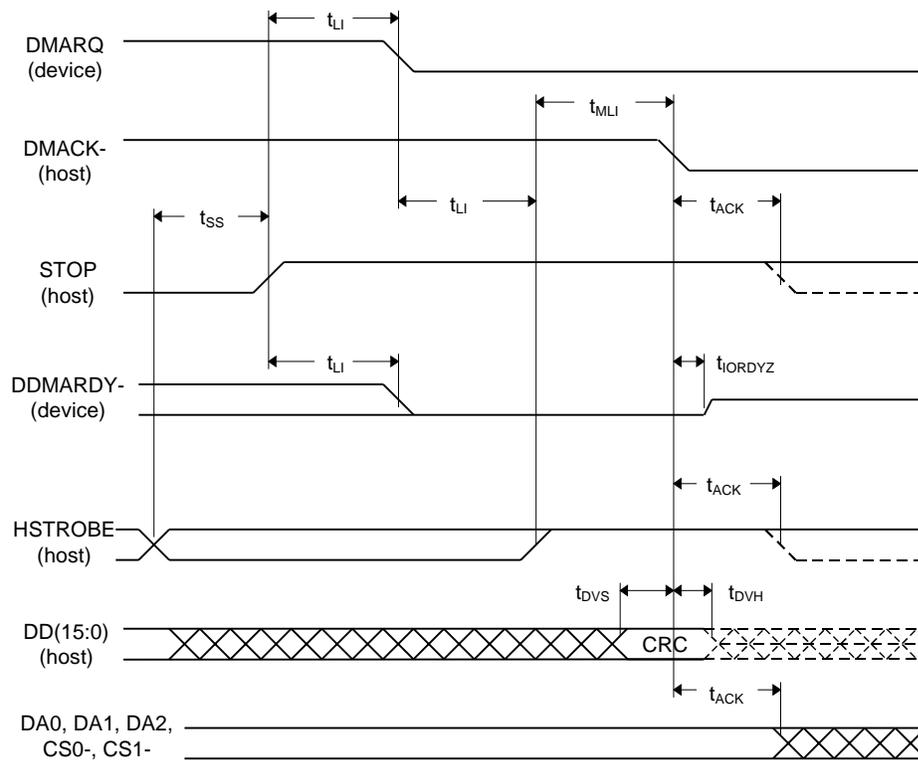


Figure 5 - 12  
Host Terminating an Ultra DMA Data Out Burst

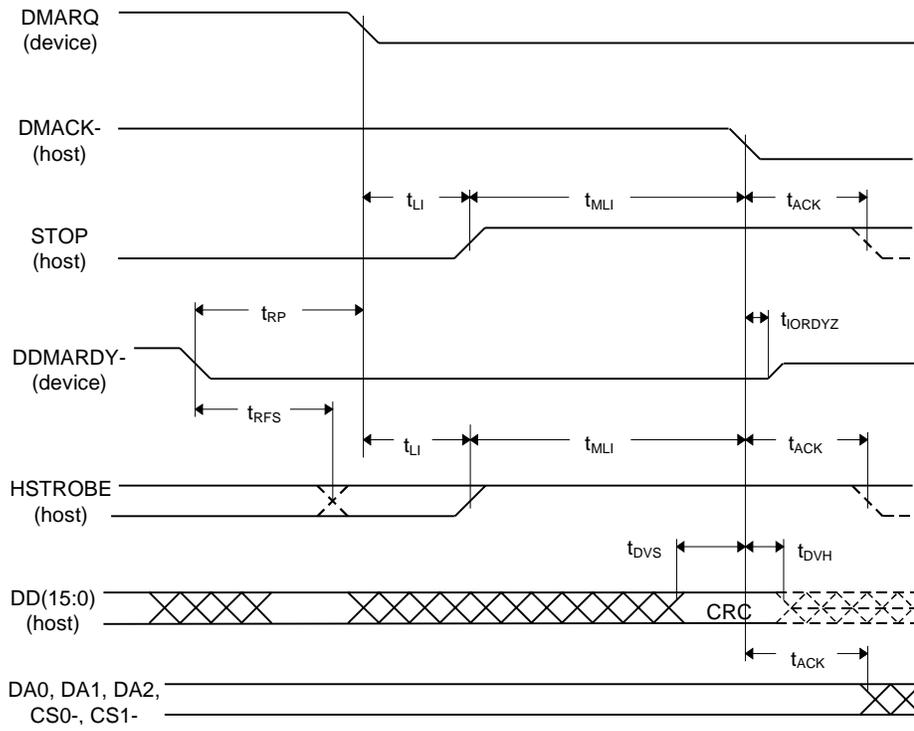


Figure 5 - 13  
Device Terminating an Ultra DMA Data Out Burst

## Host Software Interface

The host communicates with the drive through a set of controller registers accessed via the host's I/O ports. These registers divide into two groups: the Task File, used for passing commands and command parameters and the Control/Diagnostic registers.

### Task File Registers

The Task File consists of eight registers used to control fixed disk operations. The host accesses each register by the I/O port address shown in this Task File register map:

I/O PORT	READ	WRITE
1F0h	Data Register	Data Register
1F1h	Error Register	Features Register
1F2h	Sector Count	Sector Count
1F3h	Sector Number	Sector Number
1F4h	Cylinder Low	Cylinder Low
1F5h	Cylinder High	Cylinder High
1F6h	Drive/Head (SDH)	Drive/Head (SDH)
1F7h	Status Register	Command Register

### Data Register

Provides access to the drive's sector buffer for read and write operations. With the exception of ECC byte transfers (which, during Read long and Write long commands, are 8 bits wide), data transfers through the Data register are all 16 bits wide.

### Error Register

A read-only register containing specific information regarding the previous command. Data interpretation differs depending on whether the controller is in operational or diagnostic mode. A power up, reset, software reset, or receipt of a diagnostic command sets the controller into diagnostic mode. This mode invalidates contents of the Status register. The contents of the Error register reflect a completion code.

Issuing any command (apart from a Diagnostic command) places the controller into *operational mode*. In operational mode, the Error register is valid only when the Error bit in the Status register is set. The bit definitions for operational mode follow:

7	6	5	4	3	2	1	0
0	ECC	0	IDNF	0	ABRT	TK0	AMNF
Interface CRC	Data ECC Error	Not Used	ID Not Found	Not Used	Aborted Command	Track 0 Error	Address Mark Not Found

**Interface CRC** – An interface CRC error occurred during an Ultra DMA transfer.

**Data ECC Error** – An non-correctable ECC error occurred during a Read Sector command.

**Firmware Problem** – Indicates a firmware problem was detected, (e.g., invalid interrupt, divide overflow).

**ID Not Found** – Either a matching ID field not found, or a CRC error occurred.

**Aborted Command** – Invalid commands, write fault, no seek complete, or drive not ready.

**Track 0 Error** – Track 0 was not found during execution of a Restore command.

**Address Mark Not Found** – The Address Mark could not be found after an ID match.

### Features Register

Enables or disables features through the Set Features command.

### Sector Count Register

Holds the number of sectors to be sent during a Read or Write command, and the number of sectors per track during a Format command. A value of zero in this register implies a transfer of 256 sectors. A multi-sector operation decrements the Sector Count register. If an error occurs during such an operation, this register contains the remaining number of sectors to be transferred.

### Sector Number Register

Holds the starting sector number for any disk operation. The register is updated as each sector is processed in a multi-sector operation.

### Cylinder Number Registers

Two 8-bit Cylinder Number registers (Low and High) specify the starting cylinder for disk operation.

### Device/Head Register

Used to specify the drive and head number to be operated on during any disk operations. Within the context of a Set Parameters command, this register specifies the maximum number of heads on the drive.

Bit definitions follow:

7	6	5	4	3	2	1	0
1	LBA	1	DRV	HS3	HS2	HS1	HS0
	LBA Mode		Drive Select	Head Select	Head Select	Head Select	Head Select

**Select LBA Mode** – Enabling this bit for commands not supported by LBA mode will abort the selected command. When set, the Task File register contents are defined as follows for the Read/Write and translate command:

CONTENTS	LBA BITS
Sector Number	0 - 7
Cylinder Low	8 - 15
Cylinder High	16 - 23
Drive/Head	24 - 27

**Drive Select** – Set to 0 to select the master drive; set to 1 to select the slave drive.

**Head Select** – Specifies the binary coded address of the head to be selected.

### Status Register

Contains results of the last command executed, and the drive's status. The other seven Task File registers may be read only when bit 7 (BUSY) of the Status register is low. Reading any of the Task File registers when BUSY is high returns the value of the Status register. Reading the Status register also clears any interrupt request to the host. Bit definitions follow:

7	6	5	4	3	2	1	0
BUSY	DRDY	DF	DSC	DRQ	0	0	ERR
Controller Busy	Device Ready	Device Fault	Device Seek Complete	Data Request			Error

**Controller Busy** – Goes active when a command is written to the Command register, indicating controller task execution. After a command, this bit resets.

**Device Ready** – Indicates that the drive is ready for commands. If drive ready is not present, all commands abort.

**Device Fault** – Indicates the drive's detection of a write fault condition, causing all commands to abort.

**Device Seek Complete** – Signifies a seek completion, and that the drive is on track.

**Data Request** – Indicates that the drive's sector buffer is ready for data transfer.

**Error** – The Error bit sets when the previous command has completed with a non-recoverable error.

## Command Register

Contains code for the command to be performed. Additional command information should be written to the task file before the Command register is loaded. When this register is written, the BUSY bit in the Status register sets, and interrupt request to the host clears; invalid commands abort. (Detailed information on interface commands is given in Section 7.) Hex values for valid command formats follow:

### Read Commands

Read Sector(s)	20h	Normal reads; retries enabled
	21h	Normal reads; retries disabled
	22h	Read Long; retries enabled
	23h	Read Long; retries disabled
Read Verify Sector(s)	40h	Retries enabled
	41h	Retries disabled
Read Sector Buffer	E4h	
Read Multiple	C4h	
Read DMA	C8h	
	C9h	No retries

### Write Commands

Write Sector(s)	30h	Normal writes; retries enabled
	31h	Normal writes; retries disabled
	32h	Write Long; retries enabled
	33h	Write Long; retries disabled
Write Verify Sector(s)	3Ch	
Write Sector Buffer	E8h	
Write Multiple	C5h	
Write DMA	CAh	
	CBh	No retries

### Mode Set/Check Commands

Set Features	EFh
Set Multiple Mode	C6h

### Power Mode Commands

Standby Immediate	94/E0h	Stops drive spindle; do not change time-out value
Idle Immediate	95/E1h	Starts spindle; do not change time-out value
Standby	96/E2h	Stops spindle; change time-out value
Idle	97/E3h	Starts spindle; change time-out value
Check Power Mode	98/E5h	
Set Sleep Mode	99/E6h	

### Initialization Commands

Identify Drive	ECh
Initialize Drive Parameters	91h
Re-calibrate	1xh

### Seek, Format, and Diagnostic Commands

Seek	7xh
Format Track	50h
Execute Drive Diagnostic	90h

### S.M.A.R.T. Commands

Execute S.M.A.R.T.	B0h
--------------------	-----

## Summary

COMMAND NAME	COMMAND CODE								PARAMETERS USED				
	b7	b6	b5	b4	b3	b2	b1	b0	F	SC	SN	C	SDH
Recalibrate	0	0	0	1	x	x	x	x	N	N	N	N	D
Read Sector(s)	0	0	1	0	0	0	L	x	N	Y	Y	Y	Y
Read DMA	1	1	0	0	1	0	0	x	N	Y	Y	Y	Y
Write Sector(s)	0	0	1	1	0	0	L	x	N	Y	Y	Y	Y
Write DMA	1	1	0	0	1	0	1	x	N	Y	Y	Y	Y
Write Verify Sector(s)	0	0	1	1	1	1	0	0	N	Y	Y	Y	Y
Read Verify Sector(s)	0	1	0	0	0	0	0	x	N	Y	Y	Y	Y
Format Track	0	1	0	1	0	0	0	0	N	N	N	Y	Y
Seek	0	1	1	1	x	x	x	x	N	N	Y	Y	Y
Execute Diagnostic	1	0	0	1	0	0	0	0	N	N	N	N	D
Initialize Parameters	1	0	0	1	0	0	0	1	N	Y	N	N	Y
Read Sector Buffer	1	1	1	0	0	1	0	0	N	N	N	N	D
Write Sector Buffer	1	1	1	0	1	0	0	0	N	N	N	N	D
Identify Drive	1	1	1	0	1	1	0	0	N	N	N	N	D
Set Features	1	1	1	0	1	1	1	1	Y	N	N	N	D
Read Multiple	1	1	0	0	0	1	0	0	N	Y	Y	Y	Y
Write Multiple	1	1	0	0	0	1	0	1	N	Y	Y	Y	Y
Set Multiple Mode	1	1	0	0	0	1	1	0	N	Y	N	N	D

KEY	EXPLANATION
L	Long bit
	If L = 1, Read/Write Long commands are performed If L = 0, normal Read/Write commands are performed
SC	Sector count register
SN	Sector number register
C	Cylinder register
F	Features register
SDH	Drive/Head register
Y	Indicates that the register contains a valid parameter for a cited command. Within the Drive/Head register, Y indicates that both the drive and head parameters are used.
D	Signifies that the drive parameter, not the head parameter, is valid.
X	Don't care
N	Not required

## Control Diagnostic Registers

These I/O port addresses reference three Control/Diagnostic registers:

I/O PORT	READ	WRITE
3F6h	Alternate Status	Fixed Disk Control
3F7h	Digital Input	Not used

### Alternate Status Register

Contains the same information as the Status register in the Task File. However, this register may be read at any time without clearing a pending interrupt.

### Device Control Register

Contains the software Reset bit and the Enable bit to enable interrupt requests to the host. Bit definitions follow:

7	6	5	4	3	2	1	0
0	0	0	0	0	SRST	IEN	0
					Reset	IRQ Enable	

**Reset** – Setting the software Reset bit holds the drive in the reset state. Clearing the bit re-enables the drive. The software Reset bit must be held active for a minimum of 5  $\mu$ sec.

**IRQ Enable** – Setting the Interrupt Request Enable to 0 enables the IRQ 14 signal to the host. When this bit is set to 1, IRQ14 is tri-stated, and interrupts to the host are disabled. Any pending interrupt occurs when the bit is set to 0. The default state of this bit after power up is 0 (interrupt enabled).

### Digital Input Register

Contains information about the state of the drive. Bit definitions follow:

7	6	5	4	3	2	1	0
x	-WG	-HS3	-HS2	-HS1	-HS0	-DS1	DS0
Reserved	Write Gate	Head Select 3	Head Select 2	Head Select 1	Head Select 0	Drive Select 1	Drive Select 0

Bit 7 of the host data bus is not driven when this register is read.

**-Write Gate** – Reflects the state of the active low write gate signal on the drive.

**-Head Select 3 through -Head Select 0** – Represents the ones complement of the currently selected head number.

**-Drive Select 1** – Is 0 if drive 1 selected; 1 otherwise.

**-Drive Select 0** – Is 0 if drive 0 selected; 1 otherwise.

## Reset and Interrupt Handling

### Reset Handling

One of three different conditions may cause a reset: power on, hardware reset or software reset. All three cause the interface processor to initialize itself and the Task File registers of the interface. A reset also causes a set of the Busy bit in the Status register. The Busy bit does not clear until the reset clears and the drive completes initialization. Completion of a reset operation does not generate a host interrupt.

Task File registers are initialized as follows:

Error	1
Sector Count	1
Sector Number	1
Cylinder Low	0
Cylinder High	0
Drive/Head	0

### Interrupt Handling

The drive requests data transfers to and from the host by asserting its IRQ 14 signal. This signal interrupts the host if enabled by bit 1 (IRQ enable) of the Fixed Disk Control register.

Clear this interrupt by reading the Status register, writing the Command register, or by executing a host hardware or software reset.

---

## Interface Commands

The following section describes the commands (and any parameters necessary to execute them), as well as Status and Error register bits affected.

### Read Commands

- Read Sector(s)
- Read Verify Sector(s)
- Read Sector Buffer
- Read DMA
  - Multi-word DMA
  - Ultra DMA
- Read Multiple
- Set Multiple

### Write Commands

- Write Sector(s)
- Write Verify Sector(s)
- Write Sector Buffer
- Write DMA
  - Multi-word DMA
  - Ultra DMA
- Write Multiple

### Set Feature Commands

- Set Features Mode

### Power Mode Commands

- Standby Immediate
- Idle Immediate
- Standby
- Idle
- Check Power Mode
- Set Sleep Mode
- Default Power-on Condition

### Initialization Commands

- Identify Drive
- Initialize Drive Parameters

### Seek, Format and Diagnostic Commands

- Seek
- Format Track
- Execute Drive Diagnostic

### S.M.A.R.T. Commands

- Execute S.M.A.R.T.

## Read Commands

### Read Sector(s)

Reads from 1 to 256 sectors, as specified in the Command Block, beginning at the specified sector. (A sector count of 0 requests 256 sectors.) Immediately after the Command register is written, the drive sets the BSY bit and begins execution of the command. If the drive is not already on the desired track, an implied seek is performed.

Once at the desired track, the drive searches for the data address mark of the requested sector. The data address mark must be recognized within a specified number of bytes, or the Data Address Mark Not Found error will be reported. Assuming the data address mark is found:

1. The data field is read into the sector buffer.
2. Error bits are set (if an error was encountered).
3. The DRQ bit is set.
4. An interrupt is generated.

The DRQ bit is always set, regardless of the presence or absence of an error condition after the sector. Upon command completion, the Command Block registers contain the numbers of the cylinder, head and sector of the last sector read. Back-to-back sector read commands set DRQ and generate an interrupt when the sector buffer is filled at the completion of each sector. The drive is then ready for the data to be read by the host. DRQ is reset and BSY is set immediately when the host empties the sector buffer.

If an error occurs during Read Sector commands, the read terminates at the sector where the error occurred. The host may then read the Command Block to determine the nature of that error, and the sector where it happened. If the error type is a correctable or a non-correctable data error, the flawed data is loaded into the sector buffer.

A Read Long command sets the Long bit in the command code and returns the data and the ECC bytes in the data field of the specified sector. During a Read Long, the drive does not check the ECC bytes to determine if there has been a data error. The Read Long command is limited to single sector requests.

### Read Verify Sector(s)

Identical to the Read Sector(s) command, except that:

1. DRQ is never set,
2. No data is transferred back to the host and
3. The long bit is not valid.

The drive sets BSY when the Command register is written; the drive resets BSY and generates an interrupt once the requested sectors have been verified. Upon command completion, the Command Block registers contain the numbers of cylinder, head, and last sector verified.

If an error occurs during the execution of Read Verify Sector(s) commands, the read terminates at the sector where the error happened. The Command Block registers then contain the numbers of the cylinder, head, and sector information where the error occurred.

### Read Sector Buffer

Allows the host to read the contents of the drive's sector buffer. When the command is received, the drive:

1. Sets BSY,
2. Sets up the sector buffer for a read operation,
3. Sets DRQ,
4. Resets BSY and
5. Generates an interrupt.

The host may then read up to 256 words of data from the buffer.

## Read DMA

### Multi-word DMA

Identical to the Read Sector(s) command, except that

1. The host initializes a slave-DMA channel prior to issuing the command,
2. Data transfers are qualified by DMARQ and are performed by the slave-DMA channel and
3. The drive issues only one interrupt per command to indicate that data transfer has terminated and status is available.

### Ultra DMA

With the Ultra DMA Read protocol, the control signal (DSTROBE) that latches data from DD(15:0) is generated by the devices which drives the data onto the bus. Ownership of DD(15:0) and this data strobe signal are given DSTROBE to the drive during an Ultra DMA data in burst.

During an Ultra DMA Read burst, the drive always moves data onto the bus, and, after a sufficient time to allow for propagation delay, cable settling, and setup time, the sender shall generate a DSTROBE edge to latch the data. Both edges of DSTROBE are used for data transfers.

Any unrecoverable error encountered during execution of a Read DMA command terminates data transfer after the transfer of all sectors prior to the sector where the error was detected. The sector in error is not transferred. The drive generates an interrupt to indicate that data transfer has terminated and status is available. The error posting is identical to the Read Sector(s) command.

## Read Multiple

Performs similarly to the Read Sector(s) command, except that for each READ MULTIPLE command data transfers are multiple sector blocks and the Long bit is not valid.

Execution is also similar to that of the READ SECTOR(S) command, except that:

1. Several sectors are transferred to the host as a block, without intervening interrupts.
2. DRQ qualification of the transfer is required only at the start of each block, not of each sector.

The block count consists of the number of sectors to be transferred as a block. (The block count is programmed by the Set Multiple Mode command, which must be executed prior to the Read Multiple command.) READ LONG command is limited to single sector requests.

When the Read Multiple command is issued, the Sector Count register contains the number of sectors requested — not the number of blocks or the block count. If the number of sectors is not evenly divisible by the block count, as many full blocks as possible are transferred, followed by a final, partial block transfer. This final, partial block transfer is for N sectors, where  $N = (\text{sector count}) \bmod (\text{block count})$

The Read Multiple operation will be rejected with an Aborted Command error if attempted:

1. Before the Set Multiple Mode command has been executed, or
2. When Read Multiple commands are disabled.

The controller reports disk errors encountered during Read Multiple commands at the start of the block or partial block transfer. However, DRQ still sets, and the transfer occurs normally, along with the transfer of any corrupt data. Remaining block data from the following the sector in error is not valid.

Subsequent blocks or partial blocks transfer only if the error was a correctable data error. All other errors cause the command to stop after transfer of the block which contained the error. Interrupts are generated when DRQ is set at the beginning of each block or partial block.

## Set Multiple Mode

Enables the controller to perform Read and Write Multiple operations, and establishes the block count for these commands. Before issuing this command, the Sector Count register should be loaded with the number of sectors per block. The drives support block sizes of 2, 4, 8 and 16 sectors.

When this command is received, the controller sets BSY and examines the Sector Count register contents. If they contain a valid and supported block count value, that value is loaded for all subsequent Read and Write Multiple commands, and execution of those commands is enabled. An invalid and unsupported block count in the register results in an Aborted Command error and the disallows Read Multiple and Write Multiple commands.

If the Sector Count register contains 0 when the Set Multiple Mode command is issued, Read Multiple and Write Multiple commands are disabled; no error is returned. Once the appropriate action has been taken, the controller resets BSY and generates an interrupt. At power up, or after a hardware or software reset, Read Multiple and Write Multiple commands are disabled by default.

## Write Commands

### Write Sector(s)

Writes from 1 to 256 sectors, beginning at a sector specified in the Command Block. (A sector count of 0 requests 256 sectors.)

When the Command register is written, the drive sets the DRQ bit and waits for the host to fill the sector buffer with the data to be written. An interrupt is not generated to start the first buffer fill operation.

Once the buffer is full, the drive resets DRQ, sets BSY, and begins command execution. If the drive is not already on the desired track, an implied seek is performed.

The data loaded in the buffer is written to the data field of the sector, followed by the ECC bytes. Upon command completion, the Command Block registers contain the cylinder, head and sector number of the last sector written. The next time the buffer is ready to be filled during back-to-back Write Sector commands, DRQ is set and an interrupt is generated.

After the host fills the buffer, DRQ is reset and BSY is set. If an error occurs, Write Sector operations terminate at the sector containing the error.

The Command Block registers then contain the numbers of the cylinder, head and sector where the error occurred. The host may read the Command Block to determine the nature of that error, and on which sector it happened. A Write Long may be executed by setting the Long bit in the command code. The Write Long command writes the data and the ECC bytes directly from the sector buffer; the drive itself does not generate the ECC bytes. Restrict Write Long commands to PIO Mode 0.

### Write Verify Sector(s)

Identical to the Write Sector(s) command, except that the requested sectors are verified immediately after being written. The verify operation reads (without transferring), and checks for data errors. Any errors encountered during this operation are reported.

### Write Sector Buffer

Allows the host to overwrite the contents of the drive's sector buffer with a selected data pattern. When this command is received, the drive:

1. Sets BSY,
2. Sets up the sector buffer for a write operation,
3. Sets DRQ,
4. Resets BSY and
5. Generates an interrupt.

The host may then write up to 256 words of data to the buffer.

## Write Multiple

Performs similarly to the Write Sector(s) command, except that:

1. The controller sets BSY immediately upon receipt of the command,
2. Data transfers are multiple sector blocks and
3. The Long bit and Retry bit is not valid.

Command execution differs from Write Sector(s) because:

1. Several sectors transfer to the host as a block without intervening interrupts.
2. DRQ qualification of the transfer is required at the start of the block, not on each sector.

The block count consists of the number of sectors to be transferred as a block and is programmed by the Set Multiple Mode command, which must be executed prior to the Write Multiple command. When the Write Multiple command is issued, the Sector Count register contains the number of sectors requested — not the number of blocks or the block count.

If the number of sectors is not evenly divisible by the block count, as many full blocks as possible are transferred, followed by a final, partial block transfer. This final, partial block transfer is for  $N$  sectors, where  $N = (\text{sector count}) \bmod (\text{block count})$

The Write Multiple operation will be rejected with an Aborted Command error if attempted:

1. Before the Set Multiple Mode command has been executed, or
2. When Write Multiple commands are disabled.

All disk errors encountered during Write Multiple commands report after the attempted disk write of the block or partial block in which the error occurred.

The write operation ends with the sector in error, even if it was in the middle of a block. When an error occurs, subsequent blocks are not transferred. When DRQ is set at the beginning of each full and partial block, interrupts are generated.

## Write DMA

### Multi-word DMA

Identical to the Write Sector(s) command, except that:

1. The host initializes a slave-DMA channel prior to issuing the command,
2. Data transfers are qualified by DMARQ and are performed by the slave-DMA channel and
3. The drive issues only one interrupt per command to indicate that data transfer has terminated at status is available.

### Ultra DMA

With the Ultra DMA Write protocol, the control signal (HSTROBE) that latches data from DD(15:0) is generated by the devices which drives the data onto the bus. Ownership of DD(15:0) and this data strobe signal are given to the host for an Ultra DMA data out burst.

During an Ultra DMA Write burst, the host always moves data onto the bus, and, after a sufficient time to allow for propagation delay, cable settling, and setup time, the sender shall generate a HSTROBE edge to latch the data. Both edges of HSTROBE are used for data transfers.

Any error encountered during Write DMA execution results in the termination of data transfer. The drive issues an interrupt to indicate that data transfer has terminated and status is available in the error register. The error posting is the same as that of the Write Sector(s) command.

## Set Feature Commands

### Set Features Mode

Enables or disables features supported by the drive. When the drive receives this command it:

1. Sets BSY,
2. Checks the contents of the Features register,
3. Clears BSY and
4. Generates an interrupt.

If the value of the register is not a feature supported by the drive, the command is aborted. The acceptable values in the Features register are defined as follows:

VALUE	DESCRIPTION
02h*	Enabled write cache
03h	Set transfer mode based on value in Sector Count register
44h	Length of data appended on Read Long/Write Long commands specified in the Identify Device information
55h	Disable read look-ahead feature
66h*	Disable reverting to power-on defaults
82h	Disable write cache
AAh*	Enable read look-ahead feature
BBh*	4 bytes of Maxtor specific data appended on Read Long/Write Long commands
CCh	Enable reverting to power-on defaults
* Enabled at power up by default.	

## Power Mode Commands

### Standby Immediate – 94h/E0h

Spin down and do not change time out value. This command will spin the drive down and cause the drive to enter the STANDBY MODE immediately. If the drive is already spun down, the spin down sequence is not executed.

### Idle Immediate – 95h/E1h

Spin up and do not change time out value. This command will spin up the spin motor if the drive is spun down, and cause the drive to enter the IDLE MODE immediately. If the drive is already spinning, the spin up sequence is not executed. The actuator is parked and some circuits are powered off.

### Standby – 96h/E2h

Spin down and change time out value. This command will spin the drive down and cause the drive to enter the STANDBY MODE immediately. If the drive is already spun down, the spin down sequence is not executed. A non-zero value placed in the sector count register will enable the Automatic Power Down sequence. The timer will begin counting down when the drive returns to the IDLE MODE. A value of zero placed in the sector count register will disable the Automatic Power Down sequence.

### Idle – 97h/E3h

Spin up and change time out value. This command will spin-up the spin motor if the drive is spun-down. If the drive is already spinning, the spin up sequence is not executed. A non-zero value placed in the Sector Count register will enable the Automatic Power Down sequence and their timer will begin counting down immediately. A value of zero placed in the Sector Count register will disable the Automatic Power Down sequence. The actuator is parked and some circuits are powered off.

### Check Power Mode – 98h/E5h

This command returns a code in the Sector Count register that determines the current Power Mode status of the drive. If the drive is in, going to, or recovering from the STANDBY MODE the drive sets the Sector Count register to 00h. If the drive is in the IDLE MODE or ACTIVE MODE, the drive sets the Sector Count register to FFh.

### Set Sleep Mode – 99h/E6h

This command will spin the drive down and cause the drive to enter the SLEEP MODE immediately. If the drive is already spun down, the spin down sequence is not executed.

*Note: The only way to recover from SLEEP MODE is with a software reset or a hardware reset.*

### Default Power-on Condition

The drive's default power on condition is the ACTIVE MODE.

Upon receiving a Power Mode command, except the SLEEP MODE command, the drive sets BSY and performs the requested power operation. Once the requested Power Mode change has begun, the drive resets BSY and generates an interrupt - without waiting for the drive to spin up or spin down. Upon receiving a SLEEP MODE command the drive is spun down, and when it is stopped, the drive resets BSY and generates an interrupt.

When enabling the Automatic Power Down sequence, the value placed in the Sector Count register is multiplied by five seconds to obtain the Time-out Interval value. If no drive commands are received from the host within the Time-out Interval, the drive automatically enters the STANDBY mode. The minimum value is 5 seconds.

TIMER VALUE	TIME-OUT PERIOD
0	Time-out disabled
1 - 240	(value * 5) seconds
241 - 251	((value - 240) * 30) minutes
252	21 minutes
253	Vendor unique period = 10 hours
254	Reserved
255	21 minutes, 15 seconds

While the drive is in STANDBY MODE, any commands received from the host are accepted and executed as they would in normal operation, except that the spin motor is started if required to execute a disk command. Under these conditions, the drive will set BSY when command processing would normally begin and will leave BSY set until the drive comes up to speed and the disk command can be executed. Disk commands issued while the drive is in STANDBY MODE, restarts the Time-out Interval after completing the command. A reset must be issued before attempting to issue any commands while the drive in SLEEP MODE.

## Initialization Commands

### Identify Drive

Allows the host to receive parameter information from the drive.  
When the command is received, the drive:

1. Sets BSY,
2. Stores the required parameter information in the sector buffer,
3. Sets the DRQ bit and
4. Generates an interrupt.

The host may then read the information out of the sector buffer. Parameter words in the buffer follow. Note that all reserved bits or words should be zeroes.

WORD	CONTENT DESCRIPTION
0	General configuration
	15 = device (0 = ATA, 1 = ATAPI)
	14-8 = not used
	7, 1 = removable media data
	6, 1 = not removable controller and/or device
	5-1 = reserved
	0
1	Number of cylinders
2	Reserved
3	Number of logical heads
4-5	Not used
6	Number of logical sectors per track
7-9	Not used
10 - 19	Drive serial number (40 ASCII characters)
20	Not used
21	Buffer size in 512 byte increments (0000h = not specified)
22	Number of Maxtor specific bytes available on Read/Write Long commands
23 - 26	Firmware revision (8 ASCII characters)
27 - 46	Model number (40 ASCII characters)
47	Maximum number of sectors that can be transferred per interrupt on read and write multiple commands
48	Reserved
49	Capabilities
	15 - 14 = reserved
	13 = standby timer (1 = values as specified in this standard are supported, 0 = values are Maxtor specific)
	12 = reserved (advanced PIO mode support)
	11, 1 = IORDY supported, 0 = IORDY may be supported
	10, 1 = IORDY can be disabled
	9-8 = reserved
	7-0 = not used

INTERFACE COMMANDS

WORD	CONTENT DESCRIPTION
50	Reserved
51	15-8 = PIO data transfer mode
	7-0 = not used
52	15-8 = DMA data transfer mode
	7-0 = not used
53	15 = reserved
	2, 1 = the fields supported in words 88 are valid, 0 = the fields supported in words 88 are not valid
	1, 1 = the fields reports in words 64-70 are valid, 0 = the fields reports in words 64-70 are not valid
	0, 1 = the fields reports in words 54-58 are valid, 0 = the fields reports in words 54-58 are not valid
54	Number of current logical cylinders
55	Number of current logical heads
56	Number of logical sectors per track
57 - 58	Current capacity in sectors
59	15-9 = reserved
	8, 1 = multiple sector setting is valid
	7-0xxh = current setting for number of sectors that can per transferred per interrupt on Read/Write Multiple command
60 - 61	Total number of user addressable sectors (LBA mode only)
62	Reserved
63	15-8 = Multi-word DMA transfer mode active
	7-0 = Multi=word DMA transfer modes supported
64	15-8 = reserved
	7-0 = advanced PIO transfer modes supported
65	Minimum multi-word DMA transfer cycle time (15-0 = cycle time in nanoseconds)
66	Manufacturer's recommended multi-word DMA transfer cycle time (15-0 = cycle time in nanoseconds)
67	Minimum PIO transfer cycle time without flow control (15-0 = cycle time in nanoseconds)
68	Minimum PIO transfer cycle time with IORDY flow control (15-0 = cycle time in nanoseconds)
69-79	Reserved
80	15-5 = reserved
	4, 1 = supports ATA-4
	3, 1 = supports ATA-3
	2, 1 = supports ATA-2
	1, 1 = supports ATA-1
	0, reserved
81	Minor version number
82	Command set supported. If words 82 and 83 = 0000h or FFFFh command set notification not supported.
	15, 1 = supports the Identify Device DMA command
	14, 1 = supports the NOP command
	13, 1 = supports the Write Buffer command
	12, 1 = supports the Read Buffer command
	11, 1 = supports the Read Buffer command
	10, 1 = supports Host-Protected Area feature set
	9, 1 = supports the Device Reset command
	8, 1 = supports Service Interrupt
	7, 1 = supports Release Interrupt
	6, 1 = supports Look Ahead
	5, 1 = supports Write Cache
	4, 1 = supports the Packet command feature set
	3, 1 = supports the Power Management feature command
2, 1 = supports the Removable feature command	
1, 1 = supports the Security featurecommand	
0, 1 = supports the SMART feature set	

WORD	CONTENT DESCRIPTION
83	Command sets supported. If words 82, 83 and 84 = 0000h or FFFFh command set notification not supported. 15 = shall be cleared to zero 14 = shall be set to one 13-1 = reserved 0, 1 = supports Download Microcode command
84	Command set extensions supported. If words 84, 85 and 86 = 0000h or FFFFh command set notification not supported. 15 = shall be cleared to zero 14 = shall be set to one 13-0 = reserved
85	Command set enabled. If words 84, 85 and 86 = 0000h or FFFFh command set notification not supported. 15, 1 = Identify Device DMA command enabled 14, 1 = NOP command enabled 13, 1 = Write Buffer command enabled 12, 1 = Read Buffer command enabled 11, 1 = Write Verify command enabled 10, 1 = Host Protected Area feature set enabled 9, 1 = Device Reset command enabled 8, 1 = Service Interrupt enabled 7, 1 = Release Interrupt enabled 6, 1 = Look Ahead enabled 5, 1 = Write Cache enabled 4, 1 = Packet command feature set enabled 3, 1 = Power Mangement feature set enabled 2, 1 = Removable feature set enabled 1, 1 = Security feature set enabled 0, 1 = SMART feature set enabled
86	Command sets enabled. If words 85, 86 and 87 = 0000h or FFFFh command set notification not supported. 15 = shall be cleared to zero 14 = shall be set to one 13-1 = reserved 0, 1 = supports Download Microcode command
87	Command sets enabled. If words 85, 86 and 87 = 0000h or FFFFh command set notification not supported. 15 = shall be cleared to zero 14 = shall be set to one 13-0 = reserved
88	Ultra DMA 15-11 Reserved 10 1 = Ultra DMA Mode 2 is selected 0 = Ultra DMA Mode 2 is not selected 9 1 = Ultra DMA Mode 1 is selected 0 = Ultra DMA Mode 1 is not selected 8 1 = Ultra DMA Mode 0 is selected 0 = Ultra DMA Mode 0 is not selected 7-3 Reserved 2 1 = Ultra DMA Modes 2 and below are supported 0 = Ultra DMA Mode 2 is not supported 1 1 = Ultra DMA Modes 1 and below are supported 0 = Ultra DMA Mode1 is not supported 0 1 = Ultra DMA Modes 0 is supported 0 = Ultra DMA Mode 0 is not supported
127	Reserved
128	Security Status 15-9 Reserved 8 Security Level 0 = High, 1 = Maximum 7-5 Reserved 4 1 = Security count expired 3 1 = Security frozen 2 1 = Security locked 1 1 = Security enabled 0 1 = Security supported
129-130	Reserved
131	Spin at power-up, but 0 is asserted when no spin at power-up is enabled.
132-159	Maxtor-specific (not used)
160-255	Reserved

### Initialize Drive Parameters

Enables the drive to operate as any logical drive type. The drive will always be in the translate mode because of Zone Density Recording, which varies the number of sectors per track depending on the zone. Through setting the Sector Count Register and Drive Head Register, this command lets the host alter the drive's logical configuration. As a result, the drive can operate as any equal to or less than capacity drive type. Do not exceed the total number of sectors available on the drive:

When this command is executed, the drive reads the Sector Counter Register and the Drive Head Register (and so determines the number of the logical sectors per track and maximum logical head number per cylinder and will calculate the number of logical cylinders.)

Upon receipt of the command, the drive:

1. Sets BSY,
2. Saves the parameters,
3. Resets BSY and
4. Generates an interrupt.

To specify maximum heads, write 1 less than the maximum (e.g. write 4 for a 5 head drive). To specify maximum sectors, specify the actual number of sectors (e.g. 17 for a maximum of 17 sectors/track).

The sector count and head values are not checked for validity by this command. If they are invalid, no error will be posted until an illegal access is made by some other command.

Moves the read/write heads from anywhere on the disk to cylinder 0.

When this command is received, the drive:

1. Sets BSY and
2. Issues a seek to cylinder zero.

The drive waits for the seek to complete, then the drive:

1. Updates status,
2. Resets BSY and
3. Generates an interrupt.

If the drive cannot reach cylinder 0, the Error bit is set in the Status register, and the Track 0 bit is set in the Error register.

*NOTE: If a maximum head and sector number is selected – such that the number of cylinders will exceed 65,535 – then the maximum cylinder value will be reduced to 65,535.*

## Seek, Format and Diagnostic Commands

### Seek

Initiates a seek to the track, and selects the head specified in the Command block.

1. Sets BSY in the Status register,
2. Initiates the Seek,
3. Resets BSY and
4. Generates an interrupt.

The drive does not wait for the seek to complete before returning the interrupt. If a new command is issued to a drive during the execution of a Seek command, the drive will wait (with BSY active) for the Seek to complete before executing the new command.

### Format Track

Formats the track specified in the Command Block. Shortly after the Command register is written, the drive sets the bit, and waits for the host to fill the sector buffer with the interleave table. When the buffer is full, the drive resets DRQ, sets BSY and begins command execution. If the drive is not already on the desired track, an implied seek is performed. Once at the desired track the data fields are written with all zeroes.

### Execute Drive Diagnostic

Commands the drive to implement the internal diagnostic tests. (These tests are executed only upon command receipt; they do not run automatically at power up or after a reset.)

The drive sets BSY immediately upon receiving this command. The following table presents the codes and their descriptions. Note that the value in the Error register should be viewed as a unique 8 bit Code.

ERROR CODE	DESCRIPTION
01	No error detected
00	Master drive failed
80, 82	Master and slave drives failed
81	Slave drive failed

*Note: If a slave drive fails diagnostics, the master drive OR's 80h with its own status, and loads that code into the Error register. If a slave drive passes diagnostics (or a slave is absent), the master drive OR's 00 with its own status and loads that code into the Error register.*

## S.M.A.R.T. Command Set

### Execute S.M.A.R.T.

The Self-Monitoring Analysis and Reporting Technology (S.M.A.R.T.) command has been implemented to improve the data integrity and data availability of hard disk drives. In some cases, a S.M.A.R.T. capable device will predict an impending failure with sufficient time to allow users to backup their data and replace the drive before data loss or loss of service.

The S.M.A.R.T. sub-commands (listed below) comprise the ATA S.M.A.R.T. feature set that provide access to S.M.A.R.T. attribute values, attribute thresholds and other logging and reporting information.

Prior to writing a S.M.A.R.T. command to the device's command register, key values must be written by the host into the device's Cylinder Low and Cylinder High registers, or the command will be aborted. For any S.M.A.R.T. sub-command, if a device register is not specified as being written with a value by the host, then the value in that register is undefined and will be ignored by the device. The key values are:

Key	Register
4Fh	Cylinder Low (1F4h)
C2h	Cylinder High (1F5h)

The S.M.A.R.T. sub-commands use a single command code (B0h) and are differentiated from one another by the value placed in the Features register. In order to issue a command, the host must write the sub-command-specific code to the device's Features register before writing the command code to the command register. The sub-commands and their respective codes are:

D0h	S.M.A.R.T. Read Attribute Value This feature returns 512 bytes of attribute information to the host.
D1h	S.M.A.R.T. Read Attribute Thresholds This feature returns 512 bytes of warranty failure thresholds to the host.
D2h	Enable/Disable Autosave To enable this feature, set the sector count register to F1h (enable) or 0 (disable). Attribute values are automatically saved to non-volatile storage on the device after five minutes of idle time and before entering idle, sleep or standby modes. This feature is defaulted to "enabled" when S.M.A.R.T. is enabled via the S.M.A.R.T. Enable Operations commands. The autosave feature will not impact host system performance and does not need to be disabled.
D3h	S.M.A.R.T. Save Attribute Value This feature saves the current attribute values to non-volatile storage.
D4h	Perform Off-Line Data Collection Data is collected from random seeks, timed pattern seek times and head margin tests.
D8h	Enable S.M.A.R.T.
D9h	Disable S.M.A.R.T.
DAh	S.M.A.R.T. Return Status This feature allows the host to assess the status of a S.M.A.R.T. capable device by comparing all saved attribute values with their corresponding warranty failure thresholds. If no thresholds are exceeded, the drive is declared to have a positive health status. If any warranty failure threshold is exceeded, the drive is declared to have a negative health status. Executing this sub-command results in all attribute values being saved to non-volatile storage on the device.
DBh	Enable/Disable Automatic Off-Line To enable this feature, set the Sector Count register to F1h or 0 to disable.

## Service and Support

### Service Policy

Repairs to any DiamondMax™ 1750 drive should be made only at an authorized Maxtor repair facility. Any unauthorized repairs or adjustments to the drive void the warranty.

To consistently provide our customers with the best possible products and services, Maxtor developed the Total Customer Satisfaction (TCS) program. Through the ongoing TCS process, Maxtor employees take direct responsibility for every customer's level of satisfaction – with Maxtor technology, price, quality, delivery, service and support.

### No Quibble® Service

Another TCS feature is Maxtor's *No Quibble*® Service policy. By minimizing paperwork and processing, *No Quibble* Service dramatically cuts the turnaround time normally required for repairs and returns. Here's how it works:

1. Customer calls 1-800-2MAXTOR for a Return Material Authorization (RMA) number and provides a credit card number,
2. Maxtor ships a replacement drive within 48 hours, and
3. Customer returns the original drive and credit card draft is destroyed.

## Support

### Technical Assistance

Highly-trained technicians are available 6 a.m. to 6 p.m. (MST) Monday through Friday to provide detailed technical support.

U.S. and Canada	Language support: English, Spanish
Voice	800-2MAXTOR, press 1 (800-262-9867)
E-mail	Technical_Assistance@maxtor.com
Fax	303-678-2260
Outside U.S. and Canada	303-678-2015
Europe	Language support: English, French, German
Voice	+ 353 1 204 11 11
E-mail	Eurotech_Assistance@maxtor.com
Fax	+ 353 1 286 14 19
Asia/Pacific	Contact your local Maxtor Sales Office for assistance
Voice	Apactech_Assistance@maxtor.com
E-mail	Language support: English

### MaxInfo Service

Use a touch-tone phone to listen to technical information about Maxtor products and the top Q&A's from our 24-hour automated voice system.

U.S. and Canada	800-2MAXTOR (800-262-9867)
	Press 1, wait for announcement, press 1.
Outside U.S. and Canada	303-678-2015, press 1

### MaxFax™ Service

Use a touch-tone phone to order Technical Reference Sheets, Drive Specifications, Installation Sheets and other documents from our 24-hour automated fax retrieval system. Requested items are sent to your fax machine.

U.S. and Canada Phone	Language support: English, Spanish 800-2MAXTOR, press 3 (800-262-9867)
Outside U.S. and Canada Europe Phone	303-678-2618 Language support: English, French, German + 353 1 204 11 22
Asia/Pacific Phone	Language support: English + 61 2 9369 4733

### Internet

Browse the Maxtor home page on Internet, download files from our FTP site.

Home Page <http://www.maxtor.com>

### Bulletin Board Service

A 24-hour seven-day-a-week Bulletin Board Service (BBS) is available. Use the BBS to access and download information and utilities maintained in the Maxtor data files, including utilities, drive specifications and jumper options. Modem settings are 14,400 Baud or lower, 8, 1, N.

U.S. and Canada Data Phone	Language support: English 303-678-2222
Europe Data Phone	Language support: English, French, German + 49 89 963 131
Asia/Pacific Data Phone	Language support: English + 61 2 9369 4293

### Customer Service

All Maxtor products are backed by *No Quibble® Service*, the benchmark for service and support in the industry. Customer Service is available 6 a.m. to 5 p.m. (PT) Monday through Friday.

U.S. and Canada Voice E-mail Fax	Language support: English, Spanish 800-2MAXTOR, press 2 (800-262-9867) RMA@maxtor.com 408-922-2050
Europe Voice E-mail Fax	Language support: English, French, German + 353 1 204 11 11 Eurotech_Assistance@maxtor.com + 353 1 286 14 19
Asia/Pacific	Call Singapore Customer Service from the countries listed below. Customer Service is available 8 a.m. to 5:30 p.m. (Singapore time is GMT +8).

<b>From</b>	<b>Dial</b>
Australia	1-800-124-328
Hong Kong	+800-3387
Indonesia	+001-800-65-6500
Japan	+0031-65-3616
Korea	+088-65-800-6500
Malaysia	1-800-1126
New Zealand	+0800-44-6542
Singapore	1-800-481-6788
Taiwan	+0080-65-1062
Thailand	+001-800-65-6500