



Product Manual

DiamondMax 23 Serial ATA

STM31000528AS
STM3750528AS

STM3500418AS
STM3250318AS

Revision history

| Revision | Date | Sheets affected or comments |
|----------|----------|-----------------------------|
| Rev. A | 02/05/09 | Initial release. |
| Rev. B | 02/12/09 | 5-7, 9-10, 12 & 14. |

Copyright © 2009 Seagate Technology LLC. All rights reserved. Printed in U.S.A.

Publication number: 100539323, Rev. B February 2009

Seagate, Seagate Technology and the Wave logo are registered trademarks of Seagate Technology LLC in the United States and/or other countries. DiamondMax, MaxBlast, Maxtor and the Maxtor logo are either trademarks or registered trademarks of Seagate Technology LLC or one of its affiliated companies in the United States and/or other countries. All other trademarks or registered trademarks are the property of their respective owners.

When referring to hard drive capacity, one gigabyte, or GB, equals one billion bytes and one terabyte, or TB, equals one trillion bytes. Your computer's operating system may use a different standard of measurement and report a lower capacity. In addition, some of the listed capacity is used for formatting and other functions, and thus will not be available for data storage. Seagate reserves the right to change, without notice, product offerings or specifications.

Contents

| | | |
|------------|---|-----------|
| 1.0 | Introduction | 1 |
| 1.1 | About the Serial ATA interface | 2 |
| 2.0 | Drive specifications | 3 |
| 2.1 | Formatted capacity | 8 |
| 2.1.1 | LBA mode | 8 |
| 2.2 | Default logical geometry | 8 |
| 2.3 | Recording and interface technology | 8 |
| 2.4 | Physical characteristics | 9 |
| 2.5 | Seek time | 9 |
| 2.6 | Start/stop times | 9 |
| 2.7 | Power specifications | 10 |
| 2.7.1 | Power consumption | 10 |
| 2.7.2 | Conducted noise | 11 |
| 2.7.3 | Voltage tolerance | 11 |
| 2.7.4 | Power-management modes | 11 |
| 2.8 | Environmental specifications | 12 |
| 2.8.1 | Ambient temperature | 12 |
| 2.8.2 | Temperature gradient | 12 |
| 2.8.3 | Humidity | 12 |
| 2.8.4 | Altitude | 12 |
| 2.8.5 | Shock | 13 |
| 2.8.6 | Vibration | 13 |
| 2.9 | Acoustics | 14 |
| 2.9.1 | Test for Prominent Discrete Tones (PDTs) | 14 |
| 2.10 | Electromagnetic immunity | 14 |
| 2.11 | Reliability | 15 |
| 2.11.1 | Annualized Failure Rate (AFR) and Mean Time Between Failures (MTBF) | 15 |
| 2.12 | Agency certification | 15 |
| 2.12.1 | Safety certification | 15 |
| 2.12.2 | Electromagnetic compatibility | 15 |
| 2.12.3 | FCC verification | 16 |
| 2.13 | Environmental protection | 17 |
| 2.13.1 | European Union Restriction of Hazardous Substances (RoHS) Directive | 17 |
| 2.13.2 | China Restriction of Hazardous Substances (RoHS) Directive | 17 |
| 2.14 | Corrosive environment | 17 |
| 3.0 | Configuring and mounting the drive | 19 |
| 3.1 | Handling and static-discharge precautions | 19 |
| 3.2 | Configuring the drive | 20 |
| 3.3 | Serial ATA cables and connectors | 20 |
| 3.4 | Drive mounting | 21 |
| 4.0 | Serial ATA (SATA) interface | 23 |
| 4.1 | Hot-Plug compatibility | 23 |
| 4.2 | Serial ATA device plug connector pin definitions | 24 |
| 4.3 | Supported ATA commands | 25 |
| 4.3.1 | Identify Device command | 27 |
| 4.3.2 | Set Features command | 31 |
| 4.3.3 | S.M.A.R.T. commands | 32 |
| 5.0 | Seagate Technology support services | 33 |

List of Figures

| | | |
|-----------|--|-----|
| Figure 1. | Serial ATA connectors | .20 |
| Figure 2. | Attaching SATA cabling | .20 |
| Figure 3. | Mounting dimensions (1000 and 750 GB models) | .21 |
| Figure 4. | Mounting dimensions (500 and 250 GB models) | .22 |

1.0 Introduction

This manual describes the functional, mechanical and interface specifications for the following Seagate DiamondMax® 23 Serial ATA model drives:

STM31000528AS

STM3750528AS

STM3500418AS

STM3250318AS

These drives provide the following key features:

- 7,200 RPM spindle speed.
- High instantaneous (burst) data-transfer rates (up to 300 Mbytes per second).
- Perpendicular recording, Tunneling Magnetoresistive (TMR) recording heads and EPRML technology, for increased areal density.
- State-of-the-art cache and on-the-fly error-correction algorithms.
- Native Command Queuing with command ordering to increase performance in demanding applications.
- Full-track multiple-sector transfer capability without local processor intervention.
- Quiet operation.
- Compliant with RoHS requirements in China and Europe.
- SeaTools diagnostic software performs a drive self-test that eliminates unnecessary drive returns.
- Support for S.M.A.R.T. drive monitoring and reporting.
- Supports latching SATA cables and connectors.
- Worldwide Name (WWN) capability uniquely identifies the drive.

1.1 About the Serial ATA interface

The Serial ATA interface provides several advantages over the traditional (parallel) ATA interface. The primary advantages include:

- Easy installation and configuration with true plug-and-play connectivity. It is not necessary to set any jumpers or other configuration options.
- Thinner and more flexible cabling for improved enclosure airflow and ease of installation.
- Scalability to higher performance levels.

In addition, Serial ATA makes the transition from parallel ATA easy by providing legacy software support. Serial ATA was designed to allow you to install a Serial ATA host adapter and Serial ATA disk drive in your current system and expect all of your existing applications to work as normal.

The Serial ATA interface connects each disk drive in a point-to-point configuration with the Serial ATA host adapter. There is no master/slave relationship with Serial ATA devices like there is with parallel ATA. If two drives are attached on one Serial ATA host adapter, the host operating system views the two devices as if they were both “masters” on two separate ports. This essentially means both drives behave as if they are Device 0 (master) devices.

Note. The host adapter may, optionally, emulate a master/slave environment to host software where two devices on separate Serial ATA ports are represented to host software as a Device 0 (master) and Device 1 (slave) accessed at the same set of host bus addresses. A host adapter that emulates a master/slave environment manages two sets of shadow registers. This is not a typical Serial ATA environment.

The Serial ATA host adapter and drive share the function of emulating parallel ATA device behavior to provide backward compatibility with existing host systems and software. The Command and Control Block registers, PIO and DMA data transfers, resets, and interrupts are all emulated.

The Serial ATA host adapter contains a set of registers that shadow the contents of the traditional device registers, referred to as the Shadow Register Block. All Serial ATA devices behave like Device 0 devices. For additional information about how Serial ATA emulates parallel ATA, refer to the “Serial ATA International Organization: Serial ATA Revision 2.6”. The specification can be downloaded from www.sata-io.org.

2.0 Drive specifications

Unless otherwise noted, all specifications are measured under ambient conditions, at 25°C, and nominal power. For convenience, the phrases *the drive* and *this drive* are used throughout this manual to indicate the following drive models:

STM31000528AS

STM3750528AS

STM3500418AS

STM3250318AS

Specification summary tables

The specifications listed in the following tables are for quick reference. For details on specification measurement or definition, see the appropriate section of this manual.

Table 1: Drive specifications summary for 1000 and 750 Gbyte models

| Drive specification | STM31000528AS | STM3750528AS |
|---|---|---------------|
| Formatted capacity (512 bytes/sector)* | 1000 Gbytes | 750 Gbytes |
| Guaranteed sectors | 1,953,525,168 | 1,465,149,168 |
| Heads | 4 | 3 |
| Discs | 2 | |
| Bytes per sector | 512 | |
| Default sectors per track | 63 | |
| Default read/write heads | 16 | |
| Default cylinders | 16,383 | |
| Recording density | 1413 kbits/in max | |
| Track density | 236 ktracks/in avg | |
| Areal density | 329 Gbits/in ² avg | |
| Spindle speed | 7,200 RPM | |
| Internal data transfer rate | 1695 Mbits/sec max | |
| Sustained data transfer rate OD | 125 Mbytes/sec max | |
| I/O data-transfer rate | 300 Mbytes/sec max | |
| ATA data-transfer modes supported | PIO modes 0–4 Multiword DMA modes 0–2 Ultra DMA modes 0–6 | |
| Cache buffer | 32 Mbytes | |
| Height (max) | 26.1 mm (1.028 inches) | |
| Width (max) | 101.6 mm (4.000 inches) +/- 0.010 inches | |
| Length (max) | 146.99 mm (5.787 inches) | |
| Weight (typical) | 622 grams (1.371lb.) | |
| Average latency | 4.16 msec | |
| Power-on to ready | <10.0 sec max | |
| Standby to ready | <10.0 sec max | |
| Track-to-track seek time | <1.0 msec typical read; <1.2 msec typical write | |
| Average seek, read | <8.5 msec typical | |
| Average seek, write | <9.5 msec typical | |
| Startup current (typical) 12V (peak) | 2.0 amps | |
| Voltage tolerance (including noise) | 5V +10% / -7.5% 12V +10% / -7.5% | |
| Ambient temperature | 0° to 60°C per hour max (operating) -40° to 70°C per hour max (nonoperating) | |
| Temperature gradient | 20°C per hour max (operating) 30°C per hour max (nonoperating) | |
| Relative humidity | 5% to 95% (operating) 5% to 95% (nonoperating) | |
| Relative humidity gradient | 30% per hour max | |
| Wet bulb temperature | 37.7°C max (operating) 40.0°C max (nonoperating) | |
| Altitude, operating | -304.8 m to 3,048 m (-1000 ft. to 10,000+ ft.) | |
| Altitude, nonoperating (below mean sea level, max) | -304.8 m to 12,192 m (-1000 ft. to 40,000+ ft.) | |
| Operational Shock | 70 Gs max at 2 msec | |
| Non-Operational Shock | 300 Gs max at 2 msec | |

| Drive specification | STM31000528AS | STM3750528AS |
|--|---|--------------|
| Vibration, operating | 2–22 Hz: 0.25 Gs, Limited displacement 22–350 Hz: 0.50 Gs 350–500 Hz:: 0.25 Gs | |
| Vibration, nonoperating | 5–22 Hz: 2.0 Gs 22–350 Hz: 5.0 Gs 350–500 Hz:: 2.0 Gs | |
| Drive acoustics, sound power | | |
| Idle** | 2.6 bels (typical) 2.7 bels (max) | |
| Seek | 2.8 bels (typical) 3.0 bels (max) | |
| Nonrecoverable read errors | 1 per 10 ¹⁴ bits read | |
| Annualized Failure Rate (AFR) | 0.32% | |
| Warranty | To determine the warranty for a specific drive, use a web browser to access the following web page: support.seagate.com/customer/warranty_validation.jsp From this page, click on the "Verify Your Warranty" link. You will be asked to provide the drive serial number, model number (or part number) and country of purchase. The system will display the warranty information for your drive. | |
| Contact start-stop cycles | 50,000 at 25°C, 50% rel. humidity | |
| Supports Hotplug operation per the Serial ATA Revision 2.5 specification | Yes | |

*One Gbyte equals one billion bytes when referring to hard drive capacity. Accessible capacity may vary depending on operating environment and formatting.

**During periods of drive idle, some offline activity may occur according to the S.M.A.R.T. specification, which may increase acoustic and power to operational levels.

Table 2: Drive specifications summary for 500 and 250 Gbyte models

| Drive specification | STM3500418AS | STM3250318AS |
|---|---|--------------|
| Formatted capacity (512 bytes/sector)* | 500 Gbytes | 250Gbytes |
| Guaranteed sectors | 976,773,168 | 488,397,168 |
| Heads | 2 | 1 |
| Discs | 1 | |
| Bytes per sector | 512 | |
| Default sectors per track | 63 | |
| Default read/write heads | 16 | |
| Default cylinders | 16,383 | |
| Recording density | 1413 kbits/in max | |
| Track density | 236 ktracks/in avg | |
| Areal density | 329 Gbits/in ² avg | |
| Spindle speed | 7,200 RPM | |
| Internal data transfer rate | 1695 Mbits/sec max | |
| Sustained data transfer rate OD | 125 Mbytes/sec max | |
| I/O data-transfer rate | 300 Mbytes/sec max | |
| ATA data-transfer modes supported | PIO modes 0–4 Multiword DMA modes 0–2 Ultra DMA modes 0–6 | |
| Cache buffer | 16 Mbytes | 8 Mbytes |
| Height (max) | 19.98 mm (0.787 inches) | |
| Width (max) | 101.6 mm (4.000 inches) +/- 0.010 inches | |
| Length (max) | 146.99 mm (5.787 inches) | |
| Weight (typical) | 415 grams (0.915 lb.) | |
| Average latency | 4.16 msec | |
| Power-on to ready | <8.5 sec max | |
| Standby to ready | <8.5 sec max | |
| Track-to-track seek time | <1.0 msec typical read; <1.2 msec typical write | |
| Average seek, read | <8.5 msec typical | |
| Average seek, write | <9.5 msec typical | |
| Startup current (typical) 12V (peak) | 2.0 amps | |
| Voltage tolerance (including noise) | 5V +10% / -7.5% 12V +10% / -7.5% | |
| Ambient temperature | 0° to 60°C per hour max (operating) –40° to 70°C per hour max (nonoperating) | |
| Temperature gradient | 20°C per hour max (operating) 30°C per hour max (nonoperating) | |
| Relative humidity | 5% to 95% (operating) 5% to 95% (nonoperating) | |
| Relative humidity gradient | 30% per hour max | |
| Wet bulb temperature | 37.7°C max (operating) 40.0°C max (nonoperating) | |
| Altitude, operating | –304.8 m to 3,048 m (–1000 ft. to 10,000+ ft.) | |
| Altitude, nonoperating (below mean sea level, max) | –304.8 m to 12,192 m (–1000 ft. to 40,000+ ft.) | |
| Operational Shock | 70 Gs max at 2 msec | |
| Non-Operational Shock | 350 Gs max at 2 msec | |

| Drive specification | STM3500418AS | STM3250318AS |
|--|---|--------------|
| Vibration, operating | 2–22 Hz: 0.25 Gs, Limited displacement 22–350 Hz: 0.50 Gs 350–500 Hz:: 0.25 Gs | |
| Vibration, nonoperating | 5–22 Hz: 2.0 Gs 22–350 Hz: 5.0 Gs 350–500 Hz:: 2.0 Gs | |
| Drive acoustics, sound power | | |
| Idle** | 2.6 bels (typical) 2.7 bels (max) | |
| Seek | 2.8 bels (typical) 3.0 bels (max) | |
| Nonrecoverable read errors | 1 per 10 ¹⁴ bits read | |
| Annualized Failure Rate (AFR) | 0.32% | |
| Warranty | To determine the warranty for a specific drive, use a web browser to access the following web page: support.seagate.com/customer/warranty_validation.jsp From this page, click on the "Verify Your Warranty" link. You will be asked to provide the drive serial number, model number (or part number) and country of purchase. The system will display the warranty information for your drive. | |
| Contact start-stop cycles | 50,000 at 25°C, 50% rel. humidity | |
| Supports Hotplug operation per the Serial ATA Revision 2.5 specification | Yes | |

*One Gbyte equals one billion bytes when referring to hard drive capacity. Accessible capacity may vary depending on operating environment and formatting.

**During periods of drive idle, some offline activity may occur according to the S.M.A.R.T. specification, which may increase acoustic and power to operational levels.

2.1 Formatted capacity

| Model | Formatted capacity* | Guaranteed sectors | Bytes per sector |
|---------------|---------------------|--------------------|------------------|
| STM31000528AS | 1000 Gbytes | 1,953,525,168 | 512 |
| STM3750528AS | 750 Gbytes | 1,465,149,168 | |
| STM3500418AS | 500 Gbytes | 976,773,168 | |
| STM3250318AS | 250 Gbytes | 488,397,168 | |

*One Gbyte equals one billion bytes when referring to hard drive capacity. Accessible capacity may vary depending on operating environment and formatting.

2.1.1 LBA mode

When addressing these drives in LBA mode, all blocks (sectors) are consecutively numbered from 0 to $n-1$, where n is the number of guaranteed sectors as defined above.

See Section 4.3.1, "Identify Device command" (words 60-61 and 100-103) for additional information about 48-bit addressing support of drives with capacities over 137 Gbytes.

2.2 Default logical geometry

| Cylinders | Read/write heads | Sectors per track |
|-----------|------------------|-------------------|
| 16,383 | 16 | 63 |

LBA mode

When addressing these drives in LBA mode, all blocks (sectors) are consecutively numbered from 0 to $n-1$, where n is the number of guaranteed sectors as defined above.

2.3 Recording and interface technology

| | |
|---|-------------------|
| Interface | Serial ATA (SATA) |
| Recording method | Perpendicular |
| Recording density (kbits/inch max) | 1413 |
| Track density (ktracks/inch avg) | 236 |
| Areal density (Gbits/inch ² avg) | 329 |
| Spindle speed (RPM) | 7,200 ± 0.2% |
| Internal data transfer rate (Mbits/sec max) | 1695 |
| Sustained data transfer rate (Mbytes/sec max) | 125 |
| I/O data-transfer rate (Mbytes/sec max) | 300 |

2.4 Physical characteristics

| | |
|---------------------------------------|-----------------------------------|
| Maximum height (1000 - 750 GB models) | 26.1 mm (1.028 inches) |
| Maximum height (500 - 250 GB models) | 19.98 mm (0.787 inches) |
| Maximum width | 101.6 mm (4.000 +/- 0.010 inches) |
| Maximum length | 146.99 mm (5.787 inches) |
| Typical weight | |
| 1000 & 750 GB models | 622 grams (1.371 lbs) |
| 500 & 250 GB models | 415 grams (0.915 lbs) |
| Cache buffer | |
| 1000 - 750 GB models | 32 Mbytes (32,768 kbytes) |
| 500 GB models | 16 Mbytes (16,384 kbytes) |
| 250 GB models | 8 Mbytes (16,384 kbytes) |

2.5 Seek time

Seek measurements are taken with nominal power at 25°C ambient temperature. All times are measured using drive diagnostics. The specifications in the table below are defined as follows:

- Track-to-track seek time is an average of all possible single-track seeks in both directions.
- Average seek time is a true statistical random average of at least 5,000 measurements of seeks between random tracks, less overhead.

| Typical seek times (msec) | Read | Write |
|---------------------------|------|-------|
| Track-to-track | <1.0 | <1.2 |
| Average | <8.5 | <9.5 |
| Average latency: | 4.16 | |

Note. These drives are designed to consistently meet the seek times represented in this manual. Physical seeks, regardless of mode (such as track-to-track and average), are expected to meet the noted values. However, due to the manner in which these drives are formatted, benchmark tests that include command overhead or measure logical seeks may produce results that vary from these specifications.

2.6 Start/stop times

| | 1000 and 750 GB models | 500 and 250 GB models |
|---------------------------------------|------------------------|-----------------------|
| Power-on to Ready (typ / max sec) | <10.0 | <8.5 |
| Standby to Ready (typ / max sec) | <10.0 | <8.5 |
| Ready to spindle stop (typ / max sec) | 10 | |

2.7 Power specifications

The drive receives DC power (+5V or +12V) through a native SATA power connector. See Figure 2 on page 20.

2.7.1 Power consumption

Power requirements for the drives are listed in the table on page 9. Typical power measurements are based on an average of drives tested, under nominal conditions, using 5.0V and 12.0V input voltage at 25°C ambient temperature.

- **Spinup power**

Spinup power is measured from the time of power-on to the time that the drive spindle reaches operating speed.

- **Read/write power and current**

Read/write power is measured with the heads on track, based on a 16-sector write followed by a 32-msec delay, then a 16-sector read followed by a 32-msec delay.

- **Operating power and current**

Operating power is measured using 40 percent random seeks, 40 percent read/write mode (1 write for each 10 reads) and 20 percent drive idle mode.

- **Idle mode power**

Idle mode power is measured with the drive up to speed, with servo electronics active and with the heads in a random track location.

- **Standby mode**

During Standby mode, the drive accepts commands, but the drive is not spinning, and the servo and read/write electronics are in power-down mode.

Table 3: DC power requirements

| Power dissipation (2-disc values shown) | Avg (watts 25° C) | Avg 5V typ amps | Avg 12V typ amps |
|---|-------------------|-----------------|------------------|
| Spinup | — | — | 2.0 (peak) |
| Idle* † | 5.0 | 0.168 | 0.337 |
| Idle* † (with offline activity) | 5.40 | 0.153 | 0.387 |
| Operating | 6.57 | 0.496 | 0.341 |
| Standby | 0.79 | 0.35 | 0.01 |
| Sleep | 0.79 | 0.35 | 0.01 |

Table 4: DC power requirements

| Power dissipation (1-disc values shown) | Avg (watts 25° C) | Avg 5V typ amps | Avg 12V typ amps |
|---|-------------------|-----------------|------------------|
| Spinup | — | — | 2.0 (peak) |
| Idle* † | 4.60 | 0.378 | 0.224 |
| Idle* † (with offline activity) | 4.50 | 0.250 | 0.240 |
| Operating | 6.19 | 0.656 | 0.243 |
| Standby | 0.79 | 0.35 | 0.01 |
| Sleep | 0.79 | 0.35 | 0.01 |

*During periods of drive idle, some offline activity may occur according to the S.M.A.R.T. specification, which may increase acoustic and power to operational levels

† 5W IDLE with DIPLM Enabled

2.7.2 Conducted noise

Input noise ripple is measured at the host system power supply across an equivalent 80-ohm resistive load on the +12 volt line or an equivalent 15-ohm resistive load on the +5 volt line.

- Using 12-volt power, the drive is expected to operate with a maximum of 120 mV peak-to-peak square-wave injected noise at up to 10 MHz.
- Using 5-volt power, the drive is expected to operate with a maximum of 100 mV peak-to-peak square-wave injected noise at up to 10 MHz.

Note. Equivalent resistance is calculated by dividing the nominal voltage by the typical RMS read/write current.

2.7.3 Voltage tolerance

Voltage tolerance (including noise):

5V +10% / -7.5%

12V +10% / -7.5%

2.7.4 Power-management modes

The drive provides programmable power management to provide greater energy efficiency. In most systems, you can control power management through the system setup program. The drive features the following power-management modes:

| Power modes | Heads | Spindle | Buffer |
|-------------|----------|----------|----------|
| Active | Tracking | Rotating | Enabled |
| Idle | Tracking | Rotating | Enabled |
| Standby | Parked | Stopped | Enabled |
| Sleep | Parked | Stopped | Disabled |

- **Active mode**

The drive is in Active mode during the read/write and seek operations.

- **Idle mode**

The buffer remains enabled, and the drive accepts all commands and returns to Active mode any time disk access is necessary.

- **Standby mode**

The drive enters Standby mode when the host sends a Standby Immediate command. If the host has set the standby timer, the drive can also enter Standby mode automatically after the drive has been inactive for a specifiable length of time. The standby timer delay is established using a Standby or Idle command. In Standby mode, the drive buffer is enabled, the heads are parked and the spindle is at rest. The drive accepts all commands and returns to Active mode any time disk access is necessary.

- **Sleep mode**

The drive enters Sleep mode after receiving a Sleep command from the host. In Sleep mode, the drive buffer is disabled, the heads are parked and the spindle is at rest. The drive leaves Sleep mode after it receives a Hard Reset or Soft Reset from the host. After receiving a reset, the drive exits Sleep mode and enters Standby mode with all current translation parameters intact.

- **Idle and Standby timers**

Each time the drive performs an Active function (read, write or seek), the standby timer is reinitialized and begins counting down from its specified delay times to zero. If the standby timer reaches zero before any drive activity is required, the drive makes a transition to Standby mode. In both Idle and Standby mode, the drive accepts all commands and returns to Active mode when disk access is necessary.

2.8 Environmental specifications

2.8.1 Ambient temperature

Ambient temperature is defined as the temperature of the environment immediately surrounding the drive. Actual drive case temperature should not exceed 69°C (156°F) within the operating ambient conditions.

| | |
|---------------|------------------------------|
| Operating: | 0° to 60°C (32° to 140°F) |
| Nonoperating: | –40° to 70°C (–40° to 158°F) |

2.8.2 Temperature gradient

| | |
|---------------|---|
| Operating: | 20°C per hour (68°F per hour max), without condensation |
| Nonoperating: | 30°C per hour (86°F per hour max) |

2.8.3 Humidity

2.8.3.1 Relative humidity

| | |
|---------------|--|
| Operating: | 5% to 95% noncondensing (30% per hour max) |
| Nonoperating: | 5% to 95% noncondensing (30% per hour max) |

2.8.3.2 Wet bulb temperature

| | |
|---------------|---------------------|
| Operating: | 37.7°C (99.9°F max) |
| Nonoperating: | 40°C (104°F max) |

2.8.4 Altitude

| | |
|---------------|---|
| Operating: | –304.8 m to 3,048 m (–1000 ft. to 10,000+ ft.) |
| Nonoperating: | –304.8 m to 12,192 m (–1000 ft. to 40,000+ ft.) |

2.8.5 Shock

All shock specifications assume that the drive is mounted securely with the input shock applied at the drive mounting screws. Shock may be applied in the X, Y or Z axis.

2.8.5.1 Operating shock

These drives comply with the performance levels specified in this document when subjected to a maximum operating shock of 70 Gs based on half-sine shock pulses of 2 msec during read operations. Shocks should not be repeated more than two times per second.

2.8.5.2 Nonoperating shock

1000 and 750 GB models

The nonoperating shock level that the drive can experience without incurring physical damage or degradation in performance when subsequently put into operation is 300 Gs based on a nonrepetitive half-sine shock pulse of 2 msec duration.

500 and 250GB models

The nonoperating shock level that the drive can experience without incurring physical damage or degradation in performance when subsequently put into operation is 350 Gs based on a nonrepetitive half-sine shock pulse of 2 msec duration.

2.8.6 Vibration

All vibration specifications assume that the drive is mounted securely with the input vibration applied at the drive mounting screws. Vibration may be applied in the X, Y or Z axis.

2.8.6.1 Operating vibration

The maximum vibration levels that the drive may experience while meeting the performance standards specified in this document are specified below.

| | |
|------------|--------------------------------|
| 2–22 Hz | 0.25 Gs (Limited displacement) |
| 22–350 Hz | 0.50 Gs |
| 350–500 Hz | 0.25 Gs |

2.8.6.2 Nonoperating vibration

The maximum nonoperating vibration levels that the drive may experience without incurring physical damage or degradation in performance when subsequently put into operation are specified below.

1000 GB, 750 GB and 500 GB models

| | |
|------------|-------------------------------|
| 5–22 Hz | 2.0 Gs (limited displacement) |
| 22–350 Hz | 5.0 Gs |
| 350–500 Hz | 2.0 Gs |

2.9 Acoustics

Drive acoustics are measured as overall A-weighted acoustic sound power levels (no pure tones). All measurements are consistent with ISO document 7779. Sound power measurements are taken under essentially free-field conditions over a reflecting plane. For all tests, the drive is oriented with the cover facing upward.

Note. For seek mode tests, the drive is placed in seek mode only. The number of seeks per second is defined by the following equation:

$$(\text{Number of seeks per second} = 0.4 / (\text{average latency} + \text{average access time}))$$

Table 5: Fluid Dynamic Bearing (FDB) motor acoustics

| | Idle* | Seek |
|------------|----------------------------------|----------------------------------|
| All models | 2.6 bels (typ) 2.7 bels (max) | 2.8 bels (typ) 3.0 bels (max) |

*During periods of drive idle, some offline activity may occur according to the S.M.A.R.T. specification, which may increase acoustic and power to operational levels.

2.9.1 Test for Prominent Discrete Tones (PDTs)

Seagate follows the ECMA-74 standards for measurement and identification of PDTs. An exception to this process is the use of the absolute threshold of hearing. Seagate uses this threshold curve (originated in ISO 389-7) to discern tone audibility and to compensate for the inaudible components of sound prior to computation of tone ratios according to Annex D of the ECMA-74 standards.

2.10 Electromagnetic immunity

When properly installed in a representative host system, the drive operates without errors or degradation in performance when subjected to the radio frequency (RF) environments defined in the following table:

Table 6: Radio frequency environments

| Test | Description | Performance level | Reference standard |
|---------------------------|--|-------------------|-----------------------------------|
| Electrostatic discharge | Contact, HCP, VCP: ± 4 kV; Air: ± 8 kV | B | EN 61000-4-2: 95 |
| Radiated RF immunity | 80 to 1,000 MHz, 3 V/m, 80% AM with 1 kHz sine 900 MHz, 3 V/m, 50% pulse modulation @ 200 Hz | A | EN 61000-4-3: 96 ENV 50204: 95 |
| Electrical fast transient | ± 1 kV on AC mains, ± 0.5 kV on external I/O | B | EN 61000-4-4: 95 |
| Surge immunity | ± 1 kV differential, ± 2 kV common, AC mains | B | EN 61000-4-5: 95 |
| Conducted RF immunity | 150 kHz to 80 MHz, 3 Vrms, 80% AM with 1 kHz sine | A | EN 61000-4-6: 97 |
| Voltage dips, interrupts | 0% open, 5 seconds 0% short, 5 seconds 40%, 0.10 seconds 70%, 0.01 seconds | C C C B | EN 61000-4-11: 94 |

2.11 Reliability

2.11.1 Annualized Failure Rate (AFR) and Mean Time Between Failures (MTBF)

The product shall achieve an Annualized Failure Rate (AFR) of 0.32% (MTBF of 0.75 million hours) when operated in an environment of ambient air temperatures of 25°C. Operation at temperatures outside the specifications in Section 2.8 may increase the product AFR (decrease MTBF). AFR and MTBF are population statistics that are not relevant to individual units.

AFR and MTBF specifications are based on the following assumptions for desktop personal computer environments:

- 2400 power-on-hours per year.
- 10,000 average motor start/stop cycles per year.
- Operations at nominal voltages.
- Temperatures outside the specifications in Section 2.8 may reduce the product reliability.
- Normal I/O duty cycle for desktop personal computers. Operation at excessive I/O duty cycle may degrade product reliability.

The desktop personal computer environment of power-on-hours, temperature, and I/O duty cycle affect the product AFR and MTBF. The AFR and MTBF will be degraded if used in an enterprise application

| | |
|-------------------------------|---|
| Nonrecoverable read errors | 1 per 10 ¹⁴ bits read, max |
| Annualized Failure Rate (AFR) | 0.32% (nominal power, 25°C ambient temperature) |
| Contact start-stop cycles | 50,000 cycles (at nominal voltage and temperature, with 60 cycles per hour and a 50% duty cycle) |
| Warranty | To determine the warranty for a specific drive, use a web browser to access the following web page: support.seagate.com/customer/warranty_validation.jsp From this page, click on the “Verify Your Warranty” link. You will be asked to provide the drive serial number, model number (or part number) and country of purchase. The system will display the warranty information for your drive. |
| Preventive maintenance | None required. |

2.12 Agency certification

2.12.1 Safety certification

These products are certified to meet the requirements of UL60950-1, CSA60950-1 and EN60950 and so marked as to the certify agency.

2.12.2 Electromagnetic compatibility

Hard drives that display the CE mark comply with the European Union (EU) requirements specified in the Electromagnetic Compatibility Directive (2004/108/EC) as put into place 20 July 2007. Testing is performed to the levels specified by the product standards for Information Technology Equipment (ITE). Emission levels are defined by EN 55022, Class B and the immunity levels are defined by EN 55024.

Drives are tested in representative end-user systems. Although CE-marked Seagate drives comply with the directives when used in the test systems, we cannot guarantee that all systems will comply with the directives. The drive is designed for operation inside a properly designed enclosure, with properly shielded I/O cable (if necessary) and terminators on all unused I/O ports. Computer manufacturers and system integrators should confirm EMC compliance and provide CE marking for their products.

Korean RRL

If these drives have the Korean Communications Commission (KCC) logo, they comply with paragraph 1 of Article 11 of the Electromagnetic Compatibility control Regulation and meet the Electromagnetic Compatibility (EMC) Framework requirements of the Radio Research Laboratory (RRL) Communications Commission, Republic of Korea.

These drives have been tested and comply with the Electromagnetic Interference/Electromagnetic Susceptibility (EMI/EMS) for Class B products. Drives are tested in a representative, end-user system by a Korean-recognized lab.

- Family name: DiamondMax 23
- Certificate number: STX-720012 (B)

Australian C-Tick (N176)

If these models have the C-Tick marking, they comply with the Australia/New Zealand Standard AS/NZ CISPR22 and meet the Electromagnetic Compatibility (EMC) Framework requirements of the Australian Communication Authority (ACA).

2.12.3 FCC verification

These drives are intended to be contained solely within a personal computer or similar enclosure (not attached as an external device). As such, each drive is considered to be a subassembly even when it is individually marketed to the customer. As a subassembly, no Federal Communications Commission verification or certification of the device is required.

Seagate has tested this device in enclosures as described above to ensure that the total assembly (enclosure, disk drive, motherboard, power supply, etc.) does comply with the limits for a Class B computing device, pursuant to Subpart J, Part 15 of the FCC rules. Operation with noncertified assemblies is likely to result in interference to radio and television reception.

Radio and television interference. This equipment generates and uses radio frequency energy and if not installed and used in strict accordance with the manufacturer's instructions, may cause interference to radio and television reception.

This equipment is designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television, which can be determined by turning the equipment on and off, you are encouraged to try one or more of the following corrective measures:

- Reorient the receiving antenna.
- Move the device to one side or the other of the radio or TV.
- Move the device farther away from the radio or TV.
- Plug the computer into a different outlet so that the receiver and computer are on different branch outlets.

If necessary, you should consult your dealer or an experienced radio/television technician for additional suggestions. You may find helpful the following booklet prepared by the Federal Communications Commission: *How to Identify and Resolve Radio-Television Interference Problems*. This booklet is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Refer to publication number 004-000-00345-4.

2.13 Environmental protection

Seagate designs its products to meet environmental protection requirements worldwide, including regulations restricting certain chemical substances.

2.13.1 European Union Restriction of Hazardous Substances (RoHS) Directive

A new law, the European Union Restriction of Hazardous Substances (RoHS) Directive, restricts the presence of chemical substances, including Lead, Cadmium, Mercury, Hexavalent Chromium, PBB and PBDE, in electronic products, effective July 2006. This drive is manufactured with components and materials that comply with the RoHS Directive.

2.13.2 China Restriction of Hazardous Substances (RoHS) Directive 中国限制危险物品的指令

This product has an Environmental Protection Use Period (EPUP) of 20 years. The following table contains information mandated by China's "Marking Requirements for Control of Pollution Caused by Electronic Information Products" Standard.



该产品具有20年的环境保护使用周期（EPUP）。下表包含了中国“电子产品所导致的污染的控制的记号要求”所指定的信息。

| Name of Parts 部件名称 | Toxic or Hazardous Substances or Elements 有毒有害物质或元素 | | | | | |
|-----------------------|---|----------------------|----------------------|---|---|---|
| | Lead 铅 (Pb) | Mercury 汞 (Hg) | Cadmium 镉 (Cd) | Hexavalent Chromium 六价铬 (Cr6+) | Polybrominated Diphenyl 多溴联苯 (PBB) | Polybrominated Diphenyl Ether 多溴二苯醚 (PBDE) |
| PCBA | X | O | O | O | O | O |
| HDA | X | O | O | O | O | O |

"O" indicates the hazardous and toxic substance content of the part (at the homogenous material level) is lower than the threshold defined by the China RoHS MCV Standard.

“O”表示该部件（于同类物品程度上）所含的危险和有毒物质低于中国RoHS MCV标准所定义的门槛值。

"X" indicates the hazardous and toxic substance content of the part (at the homogenous material level) is over the threshold defined by the China RoHS MCV Standard.

“X”表示该部件（于同类物品程度上）所含的危险和有毒物质超出中国RoHS MCV标准所定义的门槛值。

2.14 Corrosive environment

Seagate electronic drive components pass accelerated corrosion testing equivalent to 10 years exposure to light industrial environments containing sulfurous gases, chlorine and nitric oxide, classes G and H per ASTM B845. However, this accelerated testing cannot duplicate every potential application environment. Users should use caution exposing any electronic components to uncontrolled chemical pollutants and corrosive chemicals as electronic drive component reliability can be affected by the installation environment. The silver, copper, nickel and gold films used in Seagate products are especially sensitive to the presence of sulfide, chloride, and nitrate contaminants. Sulfur is found to be the most damaging. In addition, electronic components should never be exposed to condensing water on the surface of the printed circuit board assembly (PCBA) or exposed to an ambient relative humidity greater than 95%. Materials used in cabinet fabrication, such as vulcanized rubber, that can outgas corrosive compounds should be minimized or eliminated. The useful life of any electronic equipment may be extended by replacing materials near circuitry with sulfide-free alternatives.

3.0 Configuring and mounting the drive

This section contains the specifications and instructions for configuring and mounting the drive.

3.1 Handling and static-discharge precautions

After unpacking, and before installation, the drive may be exposed to potential handling and electrostatic discharge (ESD) hazards. Observe the following standard handling and static-discharge precautions:

Caution:

- Before handling the drive, put on a grounded wrist strap, or ground yourself frequently by touching the metal chassis of a computer that is plugged into a grounded outlet. Wear a grounded wrist strap throughout the entire installation procedure.
- Handle the drive by its edges or frame *only*.
- The drive is extremely fragile—handle it with care. Do not press down on the drive top cover.
- Always rest the drive on a padded, antistatic surface until you mount it in the computer.
- Do not touch the connector pins or the printed circuit board.
- Do not remove the factory-installed labels from the drive or cover them with additional labels. Removal voids the warranty. Some factory-installed labels contain information needed to service the drive. Other labels are used to seal out dirt and contamination.

3.2 Configuring the drive

Each drive on the Serial ATA interface connects point-to-point with the Serial ATA host adapter. There is no master/slave relationship because each drive is considered a master in a point-to-point relationship. If two drives are attached on one Serial ATA host adapter, the host operating system views the two devices as if they were both “masters” on two separate ports. Both drives behave as if they are Device 0 (master) devices.

Serial ATA drives are designed for easy installation. It is usually not necessary to set any jumpers on the drive for proper operation; however, if you connect the drive and receive a “drive not detected” error, your SATA-equipped motherboard or host adapter may use a chipset that does not support SATA speed autonegotiation. If you have a motherboard or host adapter that does not support autonegotiation:

- Install a jumper as shown in Figure 1 below to limit the data transfer rate to 1.5 Gbits per second (and leave the drive connected to the SATA-equipped motherboard or host adapter that doesn't support autonegotiation) or
- Install a SATA host adapter that supports autonegotiation, leave the drive jumper block set to “Normal operation” (see Figure 1 below), and connect the drive to that adapter. This option has the benefit of not limiting the drive to a 1.5 Gbits/sec transfer rate.

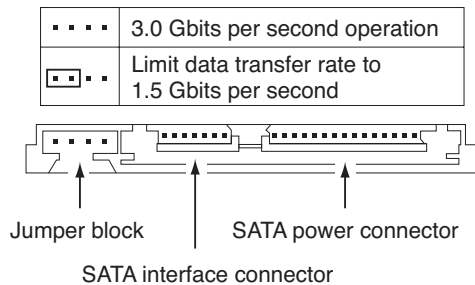


Figure 1. Serial ATA connectors

3.3 Serial ATA cables and connectors

The Serial ATA interface cable consists of four conductors in two differential pairs, plus three ground connections. The cable size may be 30 to 26 AWG with a maximum length of one meter (39.37 inches). See Table 7 for connector pin definitions. Either end of the SATA signal cable can be attached to the drive or host.

For direct backplane connection, the drive connectors are inserted directly into the host receptacle. The drive and the host receptacle incorporate features that enable the direct connection to be hot pluggable and blind mateable.

For installations which require cables, you can connect the drive as illustrated in Figure 2.

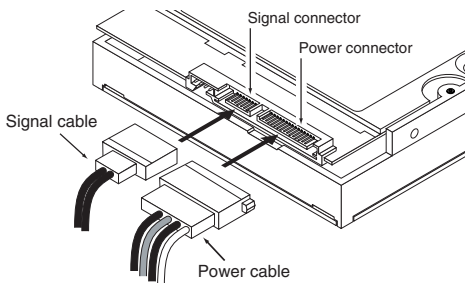


Figure 2. Attaching SATA cabling

Each cable is keyed to ensure correct orientation. DiamondMax 23 Serial ATA drives support latching SATA connectors.

3.4 Drive mounting

You can mount the drive in any orientation using four screws in the side-mounting holes or four screws in the bottom-mounting holes. See Figure 3 for drive mounting dimensions. Follow these important mounting precautions when mounting the drive:

- Allow a minimum clearance of 0.030 inches (0.76 mm) around the entire perimeter of the drive for cooling.
- Use only 6-32 UNC mounting screws.
- The screws should be inserted no more than 0.150 inch (3.81 mm) into the bottom or side mounting holes.
- Do not overtighten the mounting screws (maximum torque: 6 inch-lb).

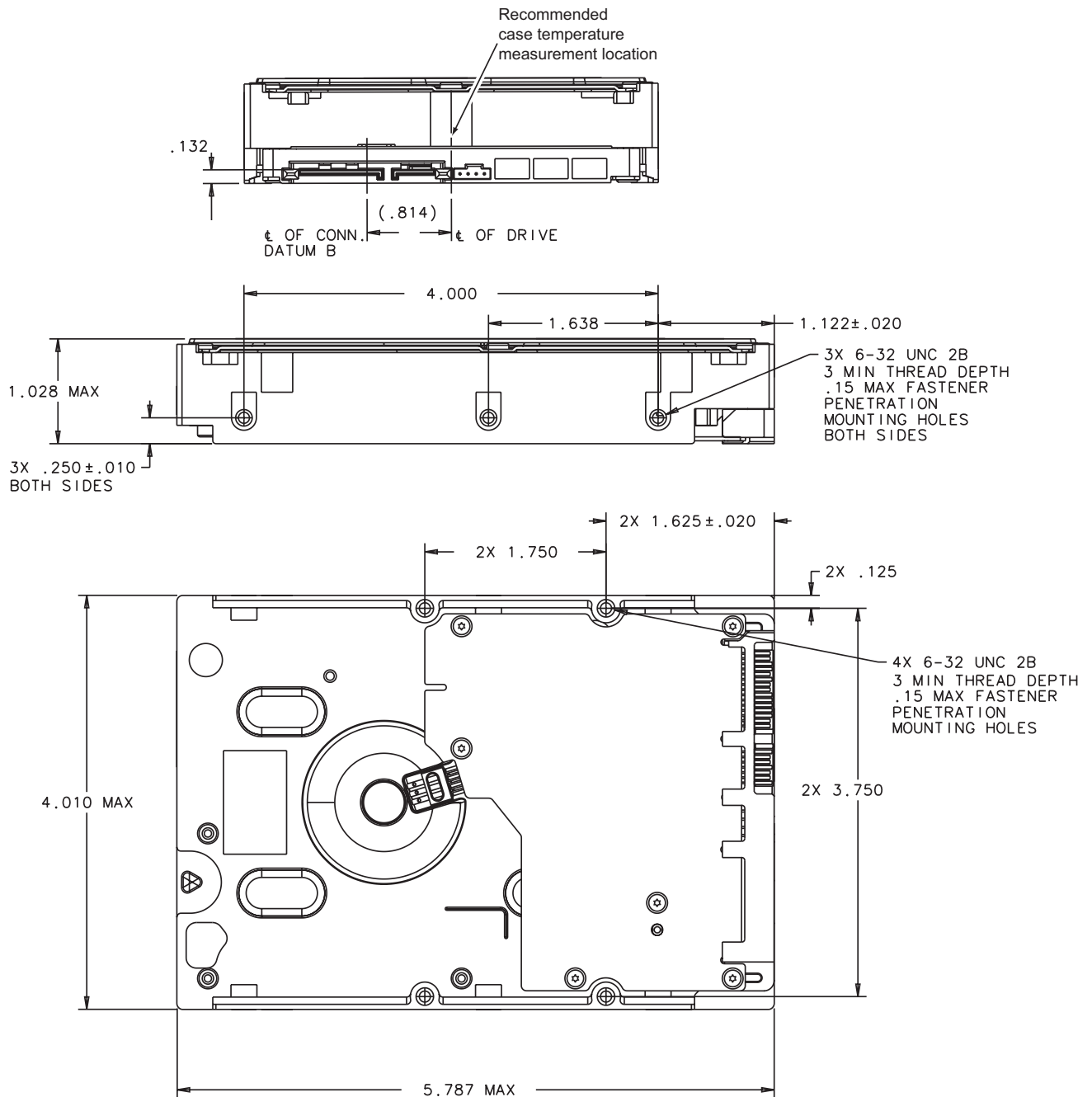


Figure 3. Mounting dimensions (1000 and 750 GB models)

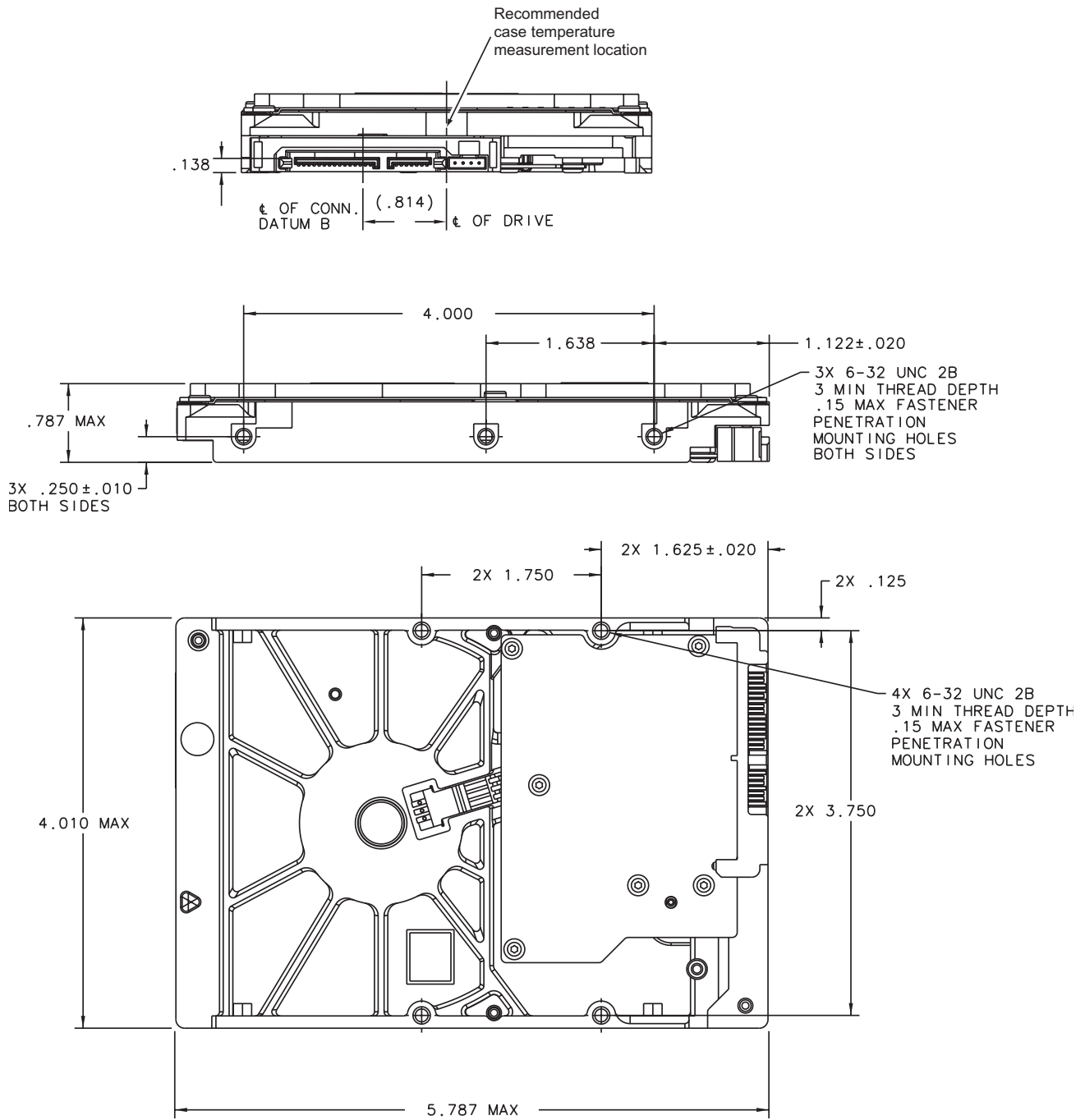


Figure 4. Mounting dimensions (500 and 250 GB models)

4.0 Serial ATA (SATA) interface

These drives use the industry-standard Serial ATA interface that supports FIS data transfers. It supports ATA programmed input/output (PIO) modes 0–4; multiword DMA modes 0–2, and Ultra DMA modes 0–6.

For detailed information about the Serial ATA interface, refer to the “Serial ATA: High Speed Serialized AT Attachment” specification.

4.1 Hot-Plug compatibility

DiamondMax 23 Serial ATA drives incorporate connectors which enable you to hot plug these drives in accordance with the Serial ATA Revision 2.6 specification. This specification can be downloaded from www.serial-io.org.

4.2 Serial ATA device plug connector pin definitions

Table 7 summarizes the signals on the Serial ATA interface and power connectors..

Table 7: Serial ATA connector pin definitions

| Segment | Pin | Function | Definition |
|---------------|-----|----------|-------------------------------------|
| Signal | S1 | Ground | 2nd mate |
| | S2 | A+ | Differential signal pair A from Phy |
| | S3 | A- | |
| | S4 | Ground | 2nd mate |
| | S5 | B- | Differential signal pair B from Phy |
| | S6 | B+ | |
| | S7 | Ground | 2nd mate |

Key and spacing separate signal and power segments

| | | | |
|--------------|-----|----------------------|---|
| Power | P1 | V ₃₃ | 3.3V power |
| | P2 | V ₃₃ | 3.3V power |
| | P3 | V ₃₃ | 3.3V power, pre-charge, 2nd mate |
| | P4 | Ground | 1st mate |
| | P5 | Ground | 2nd mate |
| | P6 | Ground | 2nd mate |
| | P7 | V ₅ | 5V power, pre-charge, 2nd mate |
| | P8 | V ₅ | 5V power |
| | P9 | V ₅ | 5V power |
| | P10 | Ground | 2nd mate |
| | P11 | Ground or LED signal | If grounded, drive does not use deferred spin |
| | P12 | Ground | 1st mate. |
| | P13 | V ₁₂ | 12V power, pre-charge, 2nd mate |
| | P14 | V ₁₂ | 12V power |
| | P15 | V ₁₂ | 12V power |

Notes:

- All pins are in a single row, with a 1.27 mm (0.050") pitch.
- The comments on the mating sequence apply to the case of backplane blindmate connector only. In this case, the mating sequences are:
 - the ground pins P4 and P12.
 - the pre-charge power pins and the other ground pins.
 - the signal pins and the rest of the power pins.
- There are three power pins for each voltage. One pin from each voltage is used for pre-charge when installed in a blind-mate backplane configuration.
- All used voltage pins (V_x) must be terminated.

4.3 Supported ATA commands

The following table lists Serial ATA standard commands that the drive supports. For a detailed description of the ATA commands, refer to the Serial ATA International Organization: Serial ATA Revision 2.6 (<http://www.sata-io.org>). See “S.M.A.R.T. commands” on page 32 for details and subcommands used in the S.M.A.R.T. implementation.

Table 8: Supported ATA commands

| Command name | Command code (in hex) |
|-------------------------------------|-----------------------------------|
| Check Power Mode | E5 _H |
| Device Configuration Freeze Lock | B1 _H / C1 _H |
| Device Configuration Identify | B1 _H / C2 _H |
| Device Configuration Restore | B1 _H / C0 _H |
| Device Configuration Set | B1 _H / C3 _H |
| Device Reset | 08 _H |
| Download Microcode | 92 _H |
| Execute Device Diagnostics | 90 _H |
| Flush Cache | E7 _H |
| Flush Cache Extended | EA _H |
| Format Track | 50 _H |
| Identify Device | EC _H |
| Idle | E3 _H |
| Idle Immediate | E1 _H |
| Initialize Device Parameters | 91 _H |
| Read Buffer | E4 _H |
| Read DMA | C8 _H |
| Read DMA Extended | 25 _H |
| Read DMA Without Retries | C9 _H |
| Read Log Ext | 2F _H |
| Read Multiple | C4 _H |
| Read Multiple Extended | 29 _H |
| Read Native Max Address | F8 _H |
| Read Native Max Address Extended | 27 _H |
| Read Sectors | 20 _H |
| Read Sectors Extended | 24 _H |
| Read Sectors Without Retries | 21 _H |
| Read Verify Sectors | 40 _H |
| Read Verify Sectors Extended | 42 _H |
| Read Verify Sectors Without Retries | 41 _H |
| Recalibrate | 10 _H |
| Security Disable Password | F6 _H |
| Security Erase Prepare | F3 _H |

| Command name | Command code (in hex) |
|---|--|
| Security Erase Unit | F4 _H |
| Security Freeze | F5 _H |
| Security Set Password | F1 _H |
| Security Unlock | F2 _H |
| Seek | 70 _H |
| Set Features | EF _H |
| Set Max Address Note: Individual Set Max Address commands are identified by the value placed in the Set Max Features register as defined to the right. | F9 _H Address: 00 _H Password: 01 _H Lock: 02 _H Unlock: 03 _H Freeze Lock: 04 _H |
| Set Max Address Extended | 37 _H |
| Set Multiple Mode | C6 _H |
| Sleep | E6 _H |
| S.M.A.R.T. Disable Operations | B0 _H / D9 _H |
| S.M.A.R.T. Enable/Disable Autosave | B0 _H / D2 _H |
| S.M.A.R.T. Enable Operations | B0 _H / D8 _H |
| S.M.A.R.T. Execute Offline | B0 _H / D4 _H |
| S.M.A.R.T. Read Attribute Thresholds | B0 _H / D1 _H |
| S.M.A.R.T. Read Data | B0 _H / D0 _H |
| S.M.A.R.T. Read Log Sector | B0 _H / D5 _H |
| S.M.A.R.T. Return Status | B0 _H / DA _H |
| S.M.A.R.T. Save Attribute Values | B0 _H / D3 _H |
| S.M.A.R.T. Write Log Sector | B0 _H / D6 _H |
| Standby | E2 _H |
| Standby Immediate | E0 _H |
| Write Buffer | E8 _H |
| Write DMA | CA _H |
| Write DMA Extended | 35 _H |
| Write DMA FUA Extended | CD _H |
| Write DMA Without Retries | CB _H |
| Write Log Extended | 3F _H |
| Write Multiple | C5 _H |
| Write Multiple Extended | 39 _H |
| Write Multiple FUA Extended | CE _H |
| Write Sectors | 30 _H |
| Write Sectors Without Retries | 31 _H |
| Write Sectors Extended | 34 _H |

4.3.1 Identify Device command

The Identify Device command (command code EC_H) transfers information about the drive to the host following power up. The data is organized as a single 512-byte block of data, whose contents are shown in Table 8 on page 25. All reserved bits or words should be set to zero. Parameters listed with an “x” are drive-specific or vary with the state of the drive. See Section 2.0 on page 3 for default parameter settings.

The following commands contain drive-specific features that may not be included in the Serial ATA specification.

| Word | Description | Value |
|-------|--|-------------------|
| 0 | Configuration information: • Bit 15: 0 = ATA; 1 = ATAPI • Bit 7: removable media • Bit 6: removable controller • Bit 0: reserved | 0C5A _H |
| 1 | Number of logical cylinders | 16,383 |
| 2 | ATA-reserved | 0000 _H |
| 3 | Number of logical heads | 16 |
| 4 | Retired | 0000 _H |
| 5 | Retired | 0000 _H |
| 6 | Number of logical sectors per logical track: 63 | 003F _H |
| 7–9 | Retired | 0000 _H |
| 10–19 | Serial number: (20 ASCII characters, 0000 _H = none) | ASCII |
| 20 | Retired | 0000 _H |
| 21 | Retired | 0400 _H |
| 22 | Obsolete | 0000 _H |
| 23–26 | Firmware revision (8 ASCII character string, padded with blanks to end of string) | x.xx |
| 27–46 | Drive model number: (40 ASCII characters, padded with blanks to end of string) | |
| 47 | (Bits 7–0) Maximum sectors per interrupt on Read multiple and Write multiple (16) | 8010 _H |
| 48 | Reserved | 0000 _H |
| 49 | Standard Standby timer, IORDY supported and may be disabled | 2F00 _H |
| 50 | ATA-reserved | 0000 _H |
| 51 | PIO data-transfer cycle timing mode | 0200 _H |
| 52 | Retired | 0200 _H |
| 53 | Words 54–58, 64–70 and 88 are valid | 0007 _H |
| 54 | Number of current logical cylinders | xxxx _H |
| 55 | Number of current logical heads | xxxx _H |
| 56 | Number of current logical sectors per logical track | xxxx _H |
| 57–58 | Current capacity in sectors | xxxx _H |
| 59 | Number of sectors transferred during a Read Multiple or Write Multiple command | xxxx _H |

| Word | Description | Value |
|---------|---|---|
| 60–61 | Total number of user-addressable LBA sectors available (see Section 2.1 for related information) *Note: The maximum value allowed in this field is: 0FFFFFFFh (268,435,455 sectors, 137 Gbytes). Drives with capacities over 137 Gbytes will have 0FFFFFFFh in this field and the actual number of user-addressable LBAs specified in words 100-103. This is required for drives that support the 48-bit addressing feature. | 0FFFFFFFh* |
| 62 | Retired | 0000 _H |
| 63 | Multiword DMA active and modes supported (see note following this table) | xx07 _H |
| 64 | Advanced PIO modes supported (modes 3 and 4 supported) | 0003 _H |
| 65 | Minimum multiword DMA transfer cycle time per word (120 nsec) | 0078 _H |
| 66 | Recommended multiword DMA transfer cycle time per word (120 nsec) | 0078 _H |
| 67 | Minimum PIO cycle time without IORDY flow control (240 nsec) | 00F0 _H |
| 68 | Minimum PIO cycle time with IORDY flow control (120 nsec) | 0078 _H |
| 69–74 | ATA-reserved | 0000 _H |
| 75 | Queue depth | 0000 _H |
| 76 | Serial ATA capabilities | xxxx _H |
| 77 | Reserved for future Serial ATA definition | xxxx _H |
| 78 | Serial ATA features supported | xxxx _H |
| 79 | Serial ATA features enabled | xxxx _H |
| 80 | Major version number | 003E _H |
| 81 | Minor version number | 0000 _H |
| 82 | Command sets supported | 364B _H |
| 83 | Command sets supported | 7C03 _H |
| 84 | Command sets support extension (see note following this table) | 4003 _H See Word 108-111 note. (4003H = 0100000000000011 binary) |
| 85 | Command sets enabled | 30xx _H |
| 86 | Command sets enabled | 0001 _H |
| 87 | Command sets enable extension | 4000 _H |
| 88 | Ultra DMA support and current mode (see note following this table) | xx3F _H |
| 89 | Security erase time | 0000 _H |
| 90 | Enhanced security erase time | 0000 _H |
| 92 | Master password revision code | FFFE _H |
| 93 | Hardware reset value | xxxx _H |
| 95–99 | ATA-reserved | 0000 _H |
| 100–103 | Total number of user-addressable LBA sectors available (see Section 2.1 for related information). These words are required for drives that support the 48-bit addressing feature. Maximum value: 0000FFFFFFFFFh. | STM31000528AS = 1,953,525,168 STM3750528AS = 1,465,149,168 STM3500418AS = 976,773,168 STM3250318AS = 488,397,168 |
| 104–107 | ATA-reserved | 0000 _H |

| Word | Description | Value |
|---------|---|--------------------------------------|
| 108–111 | The mandatory value of the world wide name (WWN) for the drive. NOTE: This field is valid if word 84, bit 8 is set to 1 indicating 64-bit WWN support. | Each drive will have a unique value. |
| 112–127 | ATA-reserved | 0000 _H |
| 128 | Security status | 0001 _H |
| 129–159 | Seagate-reserved | xxxx _H |
| 160–254 | ATA-reserved | 0000 _H |
| 255 | Integrity word | xxA5 _H |

Note. Advanced Power Management (APM) and Automatic Acoustic Management (AAM) features are not supported

Note. See the bit descriptions below for words 63, 84, and 88 of the Identify Drive data.

| Description (if bit is set to 1) | |
|----------------------------------|--|
| | Word 63 |
| 0 | Multiword DMA mode 0 is supported. |
| 1 | Multiword DMA mode 1 is supported. |
| 2 | Multiword DMA mode 2 is supported. |
| 8 | Multiword DMA mode 0 is currently active. |
| 9 | Multiword DMA mode 1 is currently active. |
| 10 | Multiword DMA mode 2 is currently active. |
| | Word 84 |
| 0 | SMART error loggin is supported. |
| 1 | SMART self-test is supported. |
| 2 | Media serial number is supported. |
| 3 | Media Card Pass Through Command feature set is supported. |
| 4 | Streaming feature set is supported. |
| 5 | GPL feature set is supported. |
| 6 | WRITE DMA FUA EXT and WRITE MULTIPLE FUA EXT commands are supported. |
| 7 | WRITE DMA QUEUED FUA EXT command is supported. |
| 8 | 64-bit World Wide Name is supported. |
| 9-10 | Obsolete. |
| 11-12 | Reserved for TLC. |
| 13 | IDLE IMMEDIATE command with IUNLOAD faeture is supported. |
| 14 | Shall be set to 1. |
| 15 | Shall be cleared to 0. |

| | Bit | Word 88 |
|--|------------|---------------------------------------|
| | 0 | Ultra DMA mode 0 is supported. |
| | 1 | Ultra DMA mode 1 is supported. |
| | 2 | Ultra DMA mode 2 is supported. |
| | 3 | Ultra DMA mode 3 is supported. |
| | 4 | Ultra DMA mode 4 is supported. |
| | 5 | Ultra DMA mode 5 is supported. |
| | 6 | Ultra DMA mode 6 is supported. |
| | 8 | Ultra DMA mode 0 is currently active. |
| | 9 | Ultra DMA mode 1 is currently active. |
| | 10 | Ultra DMA mode 2 is currently active. |
| | 11 | Ultra DMA mode 3 is currently active. |
| | 12 | Ultra DMA mode 4 is currently active. |
| | 13 | Ultra DMA mode 5 is currently active. |
| | 14 | Ultra DMA mode 6 is currently active. |

4.3.2 Set Features command

This command controls the implementation of various features that the drive supports. When the drive receives this command, it sets BSY, checks the contents of the Features register, clears BSY and generates an interrupt. If the value in the register does not represent a feature that the drive supports, the command is aborted. Power-on default has the read look-ahead and write caching features enabled. The acceptable values for the Features register are defined as follows:

Table 9: Set Features command values

| | |
|-----------------|---|
| 02 _H | Enable write cache (<i>default</i>). |
| 03 _H | Set transfer mode (based on value in Sector Count register). Sector Count register values: |
| 00 _H | Set PIO mode to default (PIO mode 2). |
| 01 _H | Set PIO mode to default and disable IORDY (PIO mode 2). |
| 08 _H | PIO mode 0 |
| 09 _H | PIO mode 1 |
| 0A _H | PIO mode 2 |
| 0B _H | PIO mode 3 |
| 0C _H | PIO mode 4 (<i>default</i>) |
| 20 _H | Multiword DMA mode 0 |
| 21 _H | Multiword DMA mode 1 |
| 22 _H | Multiword DMA mode 2 |
| 40 _H | Ultra DMA mode 0 |
| 41 _H | Ultra DMA mode 1 |
| 42 _H | Ultra DMA mode 2 |
| 43 _H | Ultra DMA mode 3 |
| 44 _H | Ultra DMA mode 4 |
| 45 _H | Ultra DMA mode 5 |
| 46 _H | Ultra DMA mode 6 |
| 10 _H | Enable use of SATA features |
| 55 _H | Disable read look-ahead (read cache) feature. |
| 82 _H | Disable write cache |
| 90 _H | Disable use of SATA features |
| AA _H | Enable read look-ahead (read cache) feature (<i>default</i>). |
| F1 _H | Report full capacity available |

Note. At power-on, or after a hardware or software reset, the default values of the features are as indicated above.

4.3.3 S.M.A.R.T. commands

S.M.A.R.T. provides near-term failure prediction for disk drives. When S.M.A.R.T. is enabled, the drive monitors predetermined drive attributes that are susceptible to degradation over time. If self-monitoring determines that a failure is likely, S.M.A.R.T. makes a status report available to the host. Not all failures are predictable. S.M.A.R.T. predictability is limited to the attributes the drive can monitor. For more information on S.M.A.R.T. commands and implementation, see the *Draft ATA-5 Standard*.

SeaTools diagnostic software activates a built-in drive self-test (DST S.M.A.R.T. command for D4_H) that eliminates unnecessary drive returns. The diagnostic software ships with all new drives and is also available at: <http://seatools.seagate.com>.

This drive is shipped with S.M.A.R.T. features disabled. You must have a recent BIOS or software package that supports S.M.A.R.T. to enable this feature. The table below shows the S.M.A.R.T. command codes that the drive uses.

Table 10: S.M.A.R.T. commands

| Code in features register | S.M.A.R.T. command |
|---------------------------|--|
| D0 _H | S.M.A.R.T. Read Data |
| D2 _H | S.M.A.R.T. Enable/Disable Attribute Autosave |
| D3 _H | S.M.A.R.T. Save Attribute Values |
| D4 _H | S.M.A.R.T. Execute Off-line Immediate (runs DST) |
| D5 _H | S.M.A.R.T. Read Log Sector |
| D6 _H | S.M.A.R.T. Write Log Sector |
| D8 _H | S.M.A.R.T. Enable Operations |
| D9 _H | S.M.A.R.T. Disable Operations |
| DA _H | S.M.A.R.T. Return Status |

Note. If an appropriate code is not written to the Features Register, the command is aborted and 0x04 (abort) is written to the Error register.

5.0 Seagate Technology support services

Online services

Internet

For information regarding Seagate products and services, visit www.seagate.com.

Worldwide support is available 24 hours daily by email for your questions.

Presales Support:

Presales@Seagate.com

Technical Support:

DiscSupport@Seagate.com

Warranty Support:

http://www.seagate.com/www/en-us/support/warranty_&_returns_assistance

mySeagate

my.seagate.com is the industry's first Web portal designed specifically for OEMs and distributors. It provides self-service access to critical applications, personalized content and the tools that allow our partners to manage their Seagate account functions. Submit pricing requests, orders and returns through a single, password-protected Web interface-anytime, anywhere in the world.

spp.seagate.com

spp.seagate.com supports Seagate resellers with product information, program benefits and sales tools. You may register for customized communications that are not available on the web. These communications contain product launch, EOL, pricing, promotions and other channel-related information. To learn more about the benefits or to register, go to spp.seagate.com, any time, from anywhere in the world.

Global Customer Support

Presales Support

Our Presales Support staff can help you determine which Seagate products are best suited for your specific application or computer system, as well as product availability and compatibility.

Technical Support

Seagate technical support is available to assist you online at support.seagate.com or through one of our call centers. Have your system configuration information and your "ST" model/product number available.

Customer Service Operations

Warranty Service

Seagate offers worldwide customer support for Seagate products. Seagate distributors, OEMs and other direct customers should contact their Seagate Customer Service Operations (CSO) representative for warranty-related issues. Resellers or end users of drive products should contact their place of purchase or Seagate warranty service for assistance. Have your serial number and model or part number available.

Data Recovery Services

Seagate offers data recovery services for all formats and all brands of storage media. Our data recovery services labs are currently located throughout the world. . Additional information, including an online request form and data loss prevention resources, is available at <http://services.seagate.com/index.aspx>.

Authorized Service Centers

Seagate Service Centers are available on a global basis for the return of defective products. See www.seagate.com for the service center near you.

USA/Canada/Latin America support services

For an extensive list of telephone numbers to technical support, presales and warranty service in USA/Canada/Latin America, including business hours, go to the "Contact Us" page on www.seagate.com.

Global Customer Support

Presales, Technical, and Warranty Support

| Call Center | Toll-free | Direct dial |
|-------------------------|---------------|-----------------|
| USA, Canada, and Mexico | 1-800-SEAGATE | +1-405-324-4700 |

Data Recovery Services

| Call Center | Toll-free | Direct dial | FAX |
|-------------------------|----------------|-----------------|-----------------------------------|
| USA, Canada, and Mexico | 1-800-475-0143 | +1-905-474-2162 | 1-800-475-0158 +1-905-474-2459 |

Europe, the Middle East and Africa Support Services

For an extensive list of telephone numbers to technical support, presales and warranty service in Europe, the Middle East and Africa, go to the "Contact Us" page on www.seagate.com.

Asia/Pacific Support Services

For an extensive list of telephone numbers to technical support, presales and warranty service in Asia/Pacific, go to the "Contact Us" page on www.seagate.com.

Index

A

- ACA 16
- acceleration 13
- acoustics 14
- Active 11
- Active mode 11
- AFR 15
- Agency certification 15
- altitude 12
- Ambient temperature 12
- ambient temperature 9, 10
- Annualized Failure Rate 15
- Annualized Failure Rate (AFR) 15
- areal density 1, 8
- ATA commands 25
- Australia/New Zealand Standard AS/NZ CISPR22 16
- Australian Communication Authority (ACA) 16
- Australian C-Tick 16
- Average latency 9
- Average seek time 9

B

- buffer 9

C

- cables and connectors 20
- cache 9
- capacity 8
- case temperature 12
- CE mark 15
- certification 15
- Check Power Mode 25
- China RoHS directive 17
- compatibility 15
- Conducted noise 11
- Conducted RF immunity 14
- Configuring the drive 19
- connectors 20
- Corrosive environment 17
- CSA60950-1 15
- cycles 15
- Cylinders 8

D

- data-transfer rates 1
- DC power 10
- Default logical geometry 8
- density 8
- Device Configuration Freeze Lock 25
- Device Configuration Identify 25

- Device Configuration Restore 25
- Device Configuration Set 25
- Device Reset 25
- dimensions 21, 22
- dissipation 10
- Download Microcode 25
- duty cycle 15

E

- Electrical fast transient 14
- Electromagnetic compatibility 15
- Electromagnetic Compatibility (EMC) 16
- Electromagnetic Compatibility control Regulation 16
- Electromagnetic Compatibility Directive (2004/108/EC) 15
- Electromagnetic immunity 14
- Electrostatic discharge 14
- electrostatic discharge (ESD) 19
- EN 55022, Class B 15
- EN 55024 15
- EN60950 15
- enclosures 16
- Environmental specifications 12
- EPRML 1
- error-correction algorithms 1
- errors 15
- ESD 19
- EU 15
- EU RoHS directive 17
- European Union (EU) requirements 15
- Execute Device Diagnostics 25

F

- FCC verification 16
- features 1
- Flush Cache 25
- Flush Cache Extended 25
- Format Track 25
- Formatted capacity 8

G

- geometry 8
- Gs 13
- guaranteed sectors 8

H

- Handling precautions 19
- heads 8
- height 9
- humidity 12

I

- I/O data-transfer rate 8

I/O duty cycle 15
Identify Device 25
Identify Device command 27
Idle 11, 25
Idle Immediate 25
Idle mode 10, 11
Information Technology Equipment (ITE) 15
Initialize Device Parameters 25
Input noise ripple 11
input voltage 10
interface 8, 23
interference 16
internal data-transfer rate OD 8
is 9
ISO document 7779 14
ITE 15

K

KCC 16
Korean Communications Commission 16
Korean RRL 16

L

latency 9
LBA mode 8
length 9
logical geometry 8

M

maintenance 15
master/slave 2
Mean Time Between Failures 15
mounting 21
mounting screws 13
mounting the drive 19
MTBF 15

N

noise 11
nominal power 9
Nonoperating shock 13
Nonoperating vibration 13
Nonrecoverable read errors 15

O

operating 10
Operating power 10
Operating shock 13
Operating vibration 13

P

Physical characteristics 9

point-to-point 2, 20
Power consumption 10
power dissipation 10
Power modes 11
Power specifications 10
Power-management modes 11
Power-on to Ready 9
power-on-hours 15
precautions 19
printed circuit board 19
programmable power management 11
prominent discrete tone 14

Q

quick reference 3

R

Radiated RF immunity 14
radio and television interference 16
radio frequency (RF) 14
random seeks 10
Read Buffer 25
Read DMA 25
Read DMA Extended 25
Read DMA without Retries 25
read errors 15
Read Log Ext 25
Read Multiple 25
Read Multiple Extended 25
Read Native Max Address 25
Read Native Max Address Extended 25
Read Sectors 25
Read Sectors Extended 25
Read Sectors Without Retries 25
Read Verify Sectors 25
Read Verify Sectors Extended 25
Read Verify Sectors Without Retries 25
Read/write heads 8
Read/write power 10
Recalibrate 25
recording density 8
recording method 8
Recording technology 8
relative humidity 12
Reliability 15
RF 14
RMS read/write current 11
RoHS 17
RRL 16

S

S.M.A.R.T. Disable Operations 26
S.M.A.R.T. Enable Operations 26
S.M.A.R.T. Enable/Disable Autosave 26

- S.M.A.R.T. Execute Offline 26
- S.M.A.R.T. implementation 25
- S.M.A.R.T. Read Attribute Thresholds 26
- S.M.A.R.T. Read Data 26
- S.M.A.R.T. Read Log Sector 26
- S.M.A.R.T. Return Status 26
- S.M.A.R.T. Save Attribute Values 26
- S.M.A.R.T. Write Log sector 26
- Safety certification 15
- SATA 23
- screws 13
- sectors 8
- Sectors per track 8
- Security Disable Password 25
- Security Erase Prepare 25
- Security Erase Unit 26
- Security Freeze 26
- Security Set Password 26
- Security Unlock 26
- Seek 26
- Seek time 9
- Serial ATA (SATA) interface 23
- serial ATA ports 2
- servo electronics 10
- Set Features 26
- Set Max Address 26
- Set Max Address Extended 26
- Set Multiple Mode 26
- Shock 13
- single-track seeks 9
- Sleep 10, 11, 26
- Sleep mode 11
- sound 14
- Specification summary table 3
- spindle speed 8
- Spinup 10
- Spinup power 10
- Standby 10, 11, 26
- Standby Immediate 26
- Standby mode 10, 11
- standby timer 11
- Standby to Ready 9
- Start/stop times 9
- start-stop cycles 15
- static-discharge 19
- subassembly 16
- support services 33
- Surge immunity 14

T

- technical support services 33
- temperature 9, 12
- temperature gradient 12
- timer 11
- timers 11

- track density 8
- Track-to-track 9
- Track-to-track seek time 9
- tunneling magnetoresistive (TMR) recording heads 1

U

- UL60950-1 15

V

- Vibration 13
- voltage 10
- Voltage dips, interrupts 14
- Voltage tolerance 11

W

- Warranty 15
- weight 9
- wet bulb temperature 12
- width 9
- Write Buffer 26
- Write DMA 26
- Write DMA Extended 26
- Write DMA FUA Extended 26
- Write DMA Without Retries 26
- Write Log Extended 26
- Write Multiple 26
- Write Multiple Extended 26
- Write Multiple FUA Extended 26
- Write Sectors 26
- Write Sectors Extended 26
- Write Sectors Without Retries 26



Seagate Technology LLC
920 Disc Drive, Scotts Valley, California 95066-4544, USA
Publication Number: 100539323, Rev. B, Printed in U.S.A.