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***Barracuda Serial ATA V Family***  
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***ST3120023AS***  
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***ST380023AS***  
.....

***ST360015AS***  
.....

***Product Manual, Volume 1***  
.....



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***ST3120023AS***  
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***ST360015AS***  
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***Product Manual, Volume 1***  
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## 1.0 Introduction

This manual describes the functional, mechanical and interface specifications for ST3120023AS, ST380023AS, and ST360015AS serial ATA interface drives.

### 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 disc drive in your current system and expect all of your existing applications to work as normal.

The serial ATA interface connects each disc 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: High Speed Serialized AT Attachment” specification. The specification can be downloaded from <http://www.serialata.com>.

## 1.2 Key features

These drives provide the following key features:

- 7,200 RPM spindle speed and 8 Mbyte buffer combine for superior desktop performance.
- High instantaneous (burst) data-transfer rates (up to 150 Mbytes per second).
- Giant magnetoresistive (GMR) recording heads and EPRML technology, which provide the drives with increased areal density.
- State-of-the-art cache and on-the-fly error-correction algorithms.
- Full-track multiple-sector transfer capability without local processor intervention.
- Quiet operation.
- 350 Gs nonoperating shock.
- The innovative, shock-absorbing SeaShield® cover protects the drive against electrostatic discharge (ESD) and other handling damage. It also includes installation instructions and jumper settings.
- SeaTools diagnostic software performs a drive self-test that eliminates unnecessary drive returns.
- The 3D Defense System™, which includes Drive Defense, Data Defense and Diagnostic Defense, offers the industry’s most comprehensive protection for disc drives.
- Support for S.M.A.R.T. drive monitoring and reporting.
- Support for Read Multiple and Write Multiple commands.

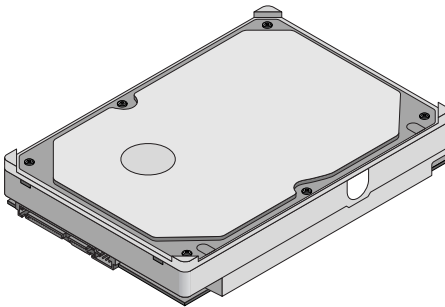


Figure 1. Barracuda Serial ATA V disc drive

## 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 ST3120023AS, ST380023AS and ST360015AS models.

### 2.1 Specification summary table

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

**Table 1: Drive specifications**

Drive specification	ST3120023AS	ST380023AS	ST360015AS
Formatted Gbytes (512 bytes/sector)	120	80	60
Guaranteed sectors	234,441,648	156,301,488	117,231,408
Bytes per sector	512		
Default sectors per track	63		
Default read/write heads	16		
Default cylinders	16,383		
Physical read/write heads	4	3	2
Discs	2	2	1
Recording density in BPI (bits/inch max)	542,000		
Track density TPI (tracks/inch max)	78,000		
Areal density (Mbits/inch <sup>2</sup> max)	42,200		
Spindle speed (RPM)	7,200		
Max. Internal transfer rate (Mbits/sec max)	570		
Sustained transfer rate (Mbytes/sec)	27 to 44		
I/O data transfer rate (Mbytes/sec max)	150		

Table 1: Drive specifications

Drive specification	ST3120023AS	ST380023AS	ST360015AS
ATA data-transfer modes supported	SATA 1.0 PIO modes 0–4 Multiword DMA modes 0–2 Ultra DMA modes 0–5		
Cache buffer	8 Mbytes		
Height (mm max)	26.1		
Width (mm max)	101.85		
Length (mm max)	147.0		
Weight (typical)	635 grams (1.4 lb)		
Average latency (msec)	4.16		
Power-on to ready (typical)	10 sec		
Standby to ready (typical)	10 sec		
Startup current (typical) 12V (peak)	2.8 amps		
Track-to-track seek time (msec typical)	1.0 (read), 1.2 (write)		
Average seek time (typical)	9.4 msec		9.0 msec
Average seek, read (typical)	9.4 msec		9.0 msec
Average seek, write (typical)	10.5 msec		10.0 msec
Seek power (typical)	13.5 watts		
Operating power (typical)	13 watts		
Idle mode (typical)	9.5 watts		
Standby mode	1.8 watts		
Sleep mode	1.8 watts		
Voltage tolerance (including noise)	5V ± 5% 12V ± 10%		
Ambient temperature	0° to 60°C (op.), –40° to 70°C (nonop.)		

Table 1: Drive specifications

Drive specification	ST3120023AS	ST380023AS	ST360015AS
Temperature gradient (°C per hour max)	20°C (op.) 30°C (nonop.)		
Relative humidity (op. and nonop.)	5% to 90% (op.) 5% to 95% (nonop.)		
Relative humidity gradient	30% per hour max		
Wet bulb temperature (°C max)	30 (op.), 40 (nonop.)		
Altitude, operating	-198.12 m to 3,048 m (-650 ft to 10,000+ ft)		
Altitude, nonoperating (meters below mean sea level, max)	-198.12 m to 12,192 m (-650 ft to 40,000+ ft)		
Shock, operating (Gs max at 2 msec)	63		
Shock, nonoperating (Gs max at 2 msec)	350 Gs		
Vibration, operating	0.5 Gs (0 to peak, 22–350 Hz)		
Vibration, nonoperating	5 Gs (0 to peak, 22–350 Hz)		
Drive acoustics Sound power (bels)			
Idle*	2.8 (typical) 3.0 (max)		2.1 (typ) <2.5 (max)
Quiet seek	2.8 (typical) 3.0 (max)		2.4 (typ) 2.8 (max)
Performance seek	3.3 (typical) 3.6 (max)		3.0 (typical) 3.4 (max)
Nonrecoverable read errors	1 per 10 <sup>14</sup> bits read		
Mean time between failures (power-on hours)	600,000		
Service life	5 Years		
Contact start-stop cycles (25°C, 40% relative humidity)	50,000		
SeaShield	Yes		

\*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.

## 2.2 Formatted capacity

Drive model	Formatted Gbytes	Guaranteed sectors	Bytes per sector
ST3120023AS	120	234,441,648	512
ST380023AS	80	156,301,488	512
ST360015AS	60	117,231,408	512

## 2.3 Default logical geometry

	Cylinders	Read/write heads	Sectors per track
ST3120023AS	16,383	16	63
ST380023AS	16,383	16	63
ST360015AS	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.



## 2.4 Physical organization

Drive model	Read/write heads	Number of discs
ST3120023AS	4	2
ST380023AS	3	2
ST360015AS	2	1

## 2.5 Recording and interface technology

Interface	Serial ATA (SATA)
Recording method	16/17 EPRML
Recording density BPI (bits/inch max)	542,000
Track density TPI (tracks/inch max)	78,000
Areal density (Mbits/inch <sup>2</sup> max)	42,200
Spindle speed (RPM) ( $\pm$ 0.2%)	7,200
Maximum Internal transfer rate (Mbits/sec)	570
Sustained transfer rate (Mbytes/sec)	27 to 44
I/O data-transfer rate (Mbytes/sec max)	16.6 (PIO mode 4) 100 (Ultra DMA mode 5) 150 (SATA 1.0)
Interleave	1:1
Cache buffer	8 Mbytes

## 2.6 Physical characteristics

Drive specification	
Maximum height(mm) (inches)	26.1 1.028
Maximum width(mm) (inches)	101.85 4.01
Maximum length(mm) (inches)	147.0 5.787
Typical weight(grams) (pounds)	635 1.40

## 2.7 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.

**Table 2: Typical seek times**

Typical seek times (msec)	Read	Write
Track-to-track	1.0	1.2
Average		
1 disc	9.4	10.5
2 disc	9.0	10.0
Average latency:	4.16	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.

## 2.8 Start/stop times

Power-on to Ready (sec)	10 (max)
Standby to Ready (sec)	10 (max)
Ready to spindle stop (sec)	10 (max)

## 2.9 Power specifications

The drive receives DC power (+5V or +12V) through a native SATA power connector. See Figures 5 and 6 on page 23.

### 2.9.1 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.

- **Seek mode**

During seek mode, the read/write actuator arm moves toward a specific position on the disc surface and does not execute a read or write operation. Servo electronics are active. Seek mode power represents the worst-case power consumption, using only random seeks with read or write latency time. This mode is not typical and is provided for worst-case information.

- **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**

<b>Power dissipation (watts, ST3120023AS)</b>	<b>Average (watts, 25° C)</b>	<b>5V typ amps</b>	<b>12V typ amps</b>
Spinup	—	—	2.8 (peak)
Idle	7.5	0.74	0.32
Idle* (with offline activity)	9.5	0.74	0.48
Operating 40% r/w. 40% seek, 20% inop.	13	0.74	0.79
Seeking	13.5	0.73	0.82
Standby	1.8	0.34	0.01
Sleep	1.8	0.34	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.

### 2.9.1.1 Typical current profile

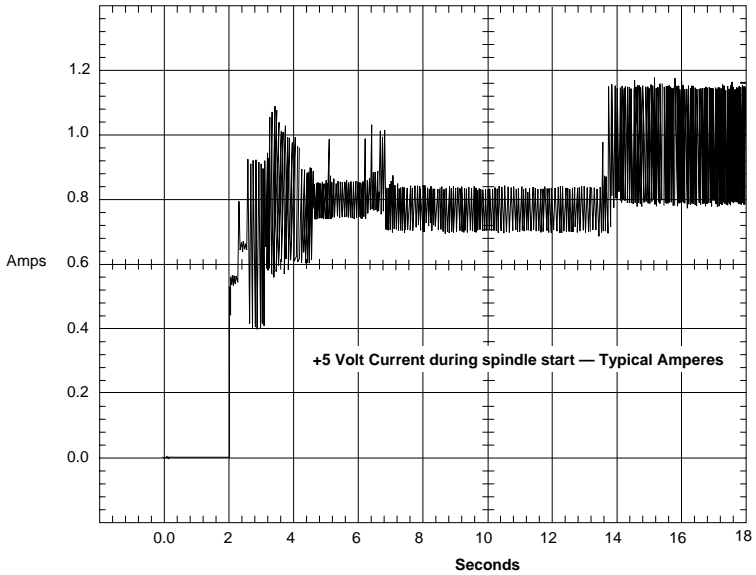


Figure 2. Typical 5V startup and operation current profile

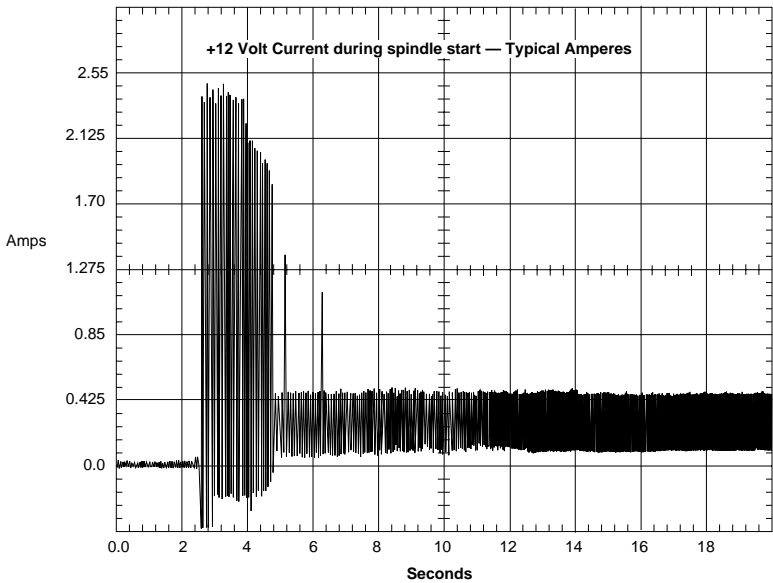


Figure 3. Typical 12V startup and operation current profile

### 2.9.2 Deferred spinup

Barracuda Serial ATA V drives provide a deferred spinup feature which storage subsystem controllers can use to sequence disc drive initialization. This is beneficial to systems which include multiple Serial ATA hard disc drives because it allows subsystem controllers to stagger the spinup of each drive to accommodate available power supply current. This feature does not impact time-to-ready in typical desktop systems.

To accommodate the deferred spinup of multiple disc drives in an enclosure, Barracuda Serial ATA V disc drives will spin up only after power is applied to the drive and after successful PHY (Physical layer) initialization. PHY initialization occurs after the PHY enters the DP7:DR\_Ready state. This state is reached after a successful exchange of Out-Of-Band (OOB) signals with a functional host-side Serial ATA port. In desktop systems, SATA transceivers should initialize OOB as soon as power comes ready to guarantee the drive spins up quickly. Seagate disc drives will not spin up without an operational host-side Serial ATA transceiver.

#### Additional details

Upon system power up, PHY communication is initiated with a COMRESET signal, which is generated by the host-side transceiver. COMRESET is followed by a COMINIT signal generated by the disc drive transceiver. COMRESET and COMINIT are followed by an exchange of COMWAKE signals and Align primitives. The disc drive will spin up after the successful exchange of Align primitives cause the PHY to come ready.

For more details, refer to:

- Section 6.8 of the Serial ATA 1.0 High-Speed Serialized AT Attachment specification
- Section 6.2 of the Serial ATA II: Extensions to Serial ATA 1.0 specification
- SATA 1.0 design guides

**Note.** These specifications and guides are available on the Serial ATA web site ([www.serialata.org](http://www.serialata.org)).

### 2.9.3 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.

#### 2.9.4 Voltage tolerance

Voltage tolerance (including noise):

5V  $\pm$  5%

12V  $\pm$  10%

#### 2.9.5 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 disc 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 disc 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 disc access is necessary.

## **2.10 Environmental specifications**

### **2.10.1 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. Recommended measurement locations are shown in Figure 3 on page 23.

Above 1,000 feet (305 meters), the maximum temperature is derated linearly to 112°F (44°C) at 10,000 feet (3,048 meters).

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



## 2.10.2 Temperature gradient

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

## 2.10.3 Humidity

### 2.10.3.1 Relative humidity

Operating	5% to 90% noncondensing (30% per hour max)
Nonoperating	5% to 95% noncondensing (30% per hour max)

### 2.10.3.2 Wet bulb temperature

Operating	30°C (86°F max)
Nonoperating	40.0°C (104°F max)

## 2.10.4 Altitude

Operating	-198.12 m to 3,048 m (-650 ft to 10,000+ ft)
Nonoperating	-198.12 m to 12,192 m (-650 ft to 40,000+ ft)

## 2.10.5 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.

### 2.10.5.1 Operating shock

These drives comply with the performance levels specified in this document when subjected to a maximum operating shock of 63 Gs based on half-sine shock pulses of 2 msec. Shocks should not be repeated more than two times per second.

### 2.10.5.2 Nonoperating shock

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.

## 2.10.6 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.

### 2.10.6.1 Operating vibration

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

5–22 Hz	0.25-inch displacement (zero to peak)
22–350 Hz	0.5 Gs acceleration (zero to peak)

### 2.10.6.2 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.

5–22 Hz	1.0-inch displacement (zero to peak)
22–350 Hz	5.0 Gs acceleration (zero to peak)

## 2.11 Drive 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.

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 4: Fluid Dynamic Bearing (FDB) motor acoustics**

Models	Acoustic mode		
	Idle*	Quiet seek	Performance seek
ST3120023AS	2.8 bels (typ)	2.8 bels (typ)	3.3 bels (typ)
ST380023AS	3.0 bels (max)	3.0 bels (max)	3.6 bels (max)
ST360015AS	2.1 bels (typ) <2.5 bels (max)	2.4 bels (typ) 2.8 bels (max)	3.0 bels (typ) 3.4 bels (max)

**Note.** 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.

## 2.12 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 5: Radio frequency environments**

Test	Description	Performance level	Reference standard
Electrostatic discharge	Contact, HCP, VCP: $\pm 4$ kV; Air: $\pm 8$ 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	$\pm 1$ kV on AC mains, $\pm 0.5$ kV on external I/O	B	EN 61000-4-4: 95
Surge immunity	$\pm 1$ kV differential, $\pm 2$ 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

## 2.13 Reliability

Nonrecoverable read errors	1 per 10 <sup>14</sup> bits read, max
Mean time between failures (MTBF)	600,000 power-on hours (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)
Preventive maintenance	None required

## 2.14 Agency certification

### 2.14.1 Safety certification

The drives are recognized in accordance with UL 1950 and CSA C22.2 (950) and meet all applicable sections of IEC950 and EN 60950 as tested by TUV North America.

### 2.14.2 Electromagnetic compatibility

Hard drives that display the CE mark comply with the European Union (EU) requirements specified in the Electromagnetic Compatibility Directive (89/336/EEC). 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.

Seagate uses an independent laboratory to confirm compliance with the EC directives specified in the previous paragraph. 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 Korea Ministry of Information and Communication (MIC) 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) Ministry of Information and Communication 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.

- EUT name (model numbers):  
ST3120023AS  
ST380023AS  
ST360015AS
- Certificate numbers:  
ST3120023AS            E-H011-02-4134 (B)  
ST380023AS            E-H011-02-4133 (B)  
ST360015AS            E-H011-02-4135 (B)
- Trade name or applicant: Seagate Technology
- Manufacturing date: Pending
- Manufacturer/nationality: Singapore

Australian C-Tick (N176)

If these models have the C-Tick marking, they comply with the Australia/New Zealand Standard AS/NZS3548 1995 and meet the Electromagnetic Compatibility (EMC) Framework requirements of the Australian Communication Authority (ACA).

### 2.14.3 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 Technology LLC has tested this device in enclosures as described above to ensure that the total assembly (enclosure, disc 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 non-certified 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.

## 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:

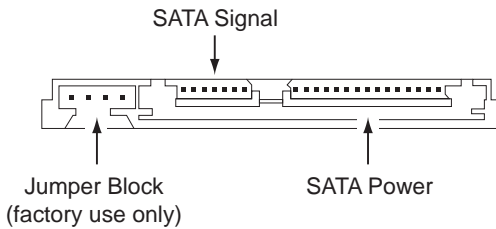
**Caution:**

- The SeaShell™ replaces electrostatic discharge (ESD) bags. The SeaShell package is a shock-ribbed, transparent clamshell enclosure that limits a drive's exposure to ESD and also protects against external shocks and stresses. The design permits attaching cables, software loading and label/barcode scanning without removing the drive from the SeaShell. This minimizes handling damage. Keep the drive in the SeaShell package until you are ready for installation.
- The drive has a cover called SeaShield. Do not remove this permanent cover—it protects the drive from electrostatic discharge (ESD) and minor impact damage. The SeaShield cover also includes installation instructions and jumper settings. Removing the SeaShield voids the warranty.
- 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 in a point-to-point configuration with the serial ATA host adapter. There is no master/slave relationship because each drive is considered a master in a point-to-point relationships. 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 means both drives behave as if they are Device 0 (master) devices.

Serial ATA drives are designed for easy installation with no jumpers, terminators, or other settings. It is not necessary to set any jumpers on this drive for proper operation. The jumper block adjacent to the signal connector is for factory use only.



**Figure 4. Serial ATA connectors**

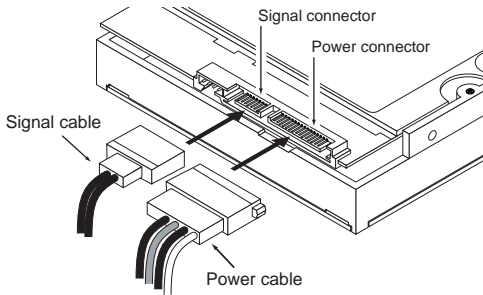
### 3.3 Serial ATA cables and connectors

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 6 for connector pin definitions. Either end of the SATA signal cable can be attached to the drive or host.

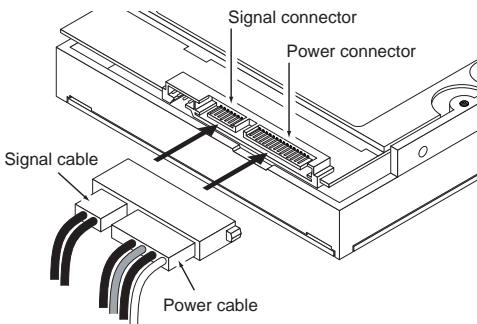
For direct backplane connection, the drive connectors are inserted directly into the host receptacle. The drive and the host receptacle incorporate features that enable the direct connection to be hot pluggable and blind mateable.



For installations which require cables, you can connect the drive using cabling which separates the power connector and the SATA signal connector as illustrated in Figure 5, or you can connect the drive using cabling which integrates both cables in one molded connector as illustrated in Figure 6.



**Figure 5. SATA cabling with separate power and signal attachments**



**Figure 6. SATA cabling with combined power and signal attachment**

Each cable is keyed to ensure correct orientation.

### 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 7 on page 24 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 0.200 inch (5.08 mm) into the bottom mounting holes and no more than 0.14 inch (3.55 mm) into the side

mounting holes.

- Do not overtighten the mounting screws (maximum torque: 6 inch-lb).
- Do not use a drive interface cable that is more than 18 inches long.

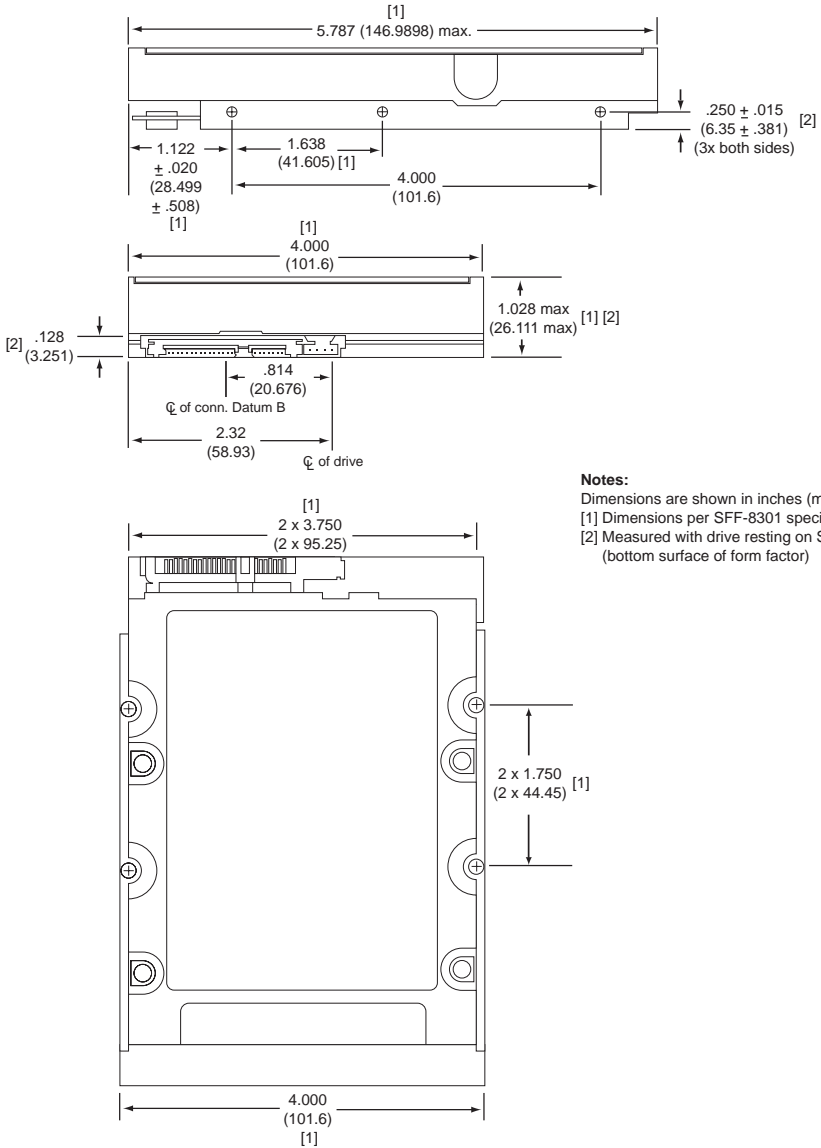


Figure 7. Mounting dimensions—top, side and end view

## 4.0 Serial ATA (SATA) interface

These drives use the industry-standard Serial ATA interface that supports 16-bit data transfers. It supports ATA programmed input/output (PIO) modes 0–4; multiword DMA modes 0–2, and Ultra DMA modes 0–5. The drive also supports the use of the IORDY signal to provide reliable high-speed data transfers.

For detailed information about the Serial ATA interface, refer to the “Serial ATA: High Speed Serialized AT Attachment” specification. The specification can be downloaded from <http://www.serialata.com..>

#### 4.1 Serial ATA device plug connector pin definitions

Table 6 summarizes the signals on the Serial ATA interface and power connectors..

**Table 6: Serial ATA connector pin definitions**

Segment	Pin	Function	Definition
<b>Signal</b>	S1	Ground	2nd mate
	S2	A+	Differential signal pair A from Phy
	S3	A-	
	S4	Ground	2nd mate
	S5	B-	Differential signal pari B from Phy
	S6	B+	
	S7	Ground	2nd mate
Key and spacing separate signal and power segments			
<b>Power</b>	P1	V <sub>33</sub>	3.3V power
	P2	V <sub>33</sub>	3.3V power
	P3	V <sub>33</sub>	3.3V power, pre-charge, 2nd mate
	P4	Ground	1st mate
	P5	Ground	2nd mate
	P6	Ground	2nd mate
	P7	V <sub>5</sub>	5V power, pre-charge, 2nd mate
	P8	V <sub>5</sub>	5V power
	P9	V <sub>5</sub>	5V power
	P10	Ground	2nd mate
	P11	Reserved	<ol style="list-style-type: none"> <li>The pin corresponding to P11 in the back-plane receptacle connector is also reserved</li> <li>The corresponding pin to be mated with P11 in the power cable receptacle connector shall always be grounded</li> </ol>
	P12	Ground	1st mate.
	P13	V <sub>12</sub>	12V power, pre-charge, 2nd mate
	P14	V <sub>12</sub>	12V power
	P15	V <sub>12</sub>	12V power

**Notes:**

1. All pins are in a single row, with a 1.27 mm (0.050") pitch.
2. 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 pints and the other ground pins.
  - the signal pins and the rest of the power pins.
3. 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.
4. All used voltage pins ( $V_x$ ) must be terminated.

## 4.2 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: High Speed Serialized AT Attachment specification. See “S.M.A.R.T. commands” on page 37. for details and subcommands used in the S.M.A.R.T. implementation.

**Table 7: Supported ATA commands**

Command name	Command code (in hex)
<b>ATA-standard commands</b>	
Device Configuration Restore	B1h/C0h
Device Configuration Freeze Lock	B1h/C1h
Device Configuration Identify	B1h/C2h
Device Configuration Set	B1h/C3h
Download Microcode	92h
Execute Device Diagnostics	90h
Flush Cache	E7h
Identify Device	ECh
Initialize Device Parameters	91h
Read Buffer	E4h
Read DMA	C8h
Read DMA without Retries	C9h
Read Long with Retries	22h
Read Long without Retries	23h
Read Multiple	C4h
Read Native Max Address	F8h
Read Sectors	20h
Read Sectors without Retries	21h
Read Verify Sectors	40h
Read Verify Sectors without Retries	41h
Seek	70h
Set Features	EFh
Set Max Address	F9h

**Table 7: Supported ATA commands**

<b>Command name</b>	<b>Command code (in hex)</b>
Set Multiple Mode	C6h
S.M.A.R.T. Disable Operations	B0h/D9h
S.M.A.R.T. Enable/Disable Autosave	B0h/D2h
S.M.A.R.T. Enable Operations	B0h/D8h
S.M.A.R.T. Enable/Disable Auto Offline	B0h/DBh
S.M.A.R.T. Enable One Attribute Modification	B0h/E0h
S.M.A.R.T. Execute Offline	B0h/D4h
S.M.A.R.T. Read Attribute Thresholds	B0h/D1h
S.M.A.R.T. Read Data	B0h/D0h
S.M.A.R.T. Read Log Sector	B0h/D5h
S.M.A.R.T. Return Status	B0h/DAh
S.M.A.R.T. Save Attribute Values	B0h/D3h
S.M.A.R.T. Write Attribute Thresholds	B0h/D7h
S.M.A.R.T. Write Attribute Values	B0h/E1h
S.M.A.R.T. Write Log Sector	B0h/D6h
Write Buffer	E8h
Write DMA	CAh
Write DMA without Retries	CBh
Write Long with Retries	32h
Write Long without Retries	33h
Write Multiple	C5h
Write Sectors	30h, 31h

Table 7: Supported ATA commands

Command name	Command code (in hex)
<b>ATA-standard power-management commands</b>	
Check Power Mode	98h or E5h
Idle	97h or E3h
Idle Immediate	95h or E1h
Sleep	99h or E6h
Standby	96h or E2h
Standby Immediate	94h or E0h
<b>ATA-standard security commands</b>	
Security Set Password	F1h
Security Unlock	F2h
Security Erase Prepare	F3h
Security Erase Unit	F4h
Security Freeze Lock	F5h
Security Disable Password	F6h

#### 4.2.1 Identify Device command

The Identify Device command (command code EC<sub>H</sub>) 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 the table on page 27. 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.



**Table 8: Drive-specific commands**

Word	Description	Value
0	Configuration information: <ul style="list-style-type: none"> <li>• Bit 15: 0 = ATA; 1 = ATAPI</li> <li>• Bit 7: removable media</li> <li>• Bit 6: removable controller</li> <li>• Bit 0: reserved</li> </ul>	0C5A <sub>H</sub>
1	Number of logical cylinders	16,383
2	ATA-reserved	0000 <sub>H</sub>
3	Number of logical heads	16
4	Retired	0000 <sub>H</sub>
5	Retired	0000 <sub>H</sub>
6	Number of logical sectors per logical track: 63	003F <sub>H</sub>
7–9	Retired	0000 <sub>H</sub>
10–19	Serial number: (20 ASCII characters, 0000 <sub>H</sub> = none)	ASCII
20	Retired	0000 <sub>H</sub>
21	Retired	0400 <sub>H</sub>
22	Obsolete	0000 <sub>H</sub>
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)	ST3120023AS ST380023AS ST360015AS
47	(Bits 7–0) Maximum sectors per interrupt on Read multiple and Write multiple (16)	8010 <sub>H</sub>
48	Reserved	0000 <sub>H</sub>
49	Standard Standby timer, IORDY supported and may be disabled	2F00 <sub>H</sub>
50	ATA-reserved	0000 <sub>H</sub>
51	PIO data-transfer cycle timing mode	0200 <sub>H</sub>
52	Retired	0200 <sub>H</sub>
53	Words 54–58, 64–70 and 88 are valid	0007 <sub>H</sub>
54	Number of current logical cylinders	xxxx <sub>H</sub>

Table 8: Drive-specific commands

Word	Description	Value
55	Number of current logical heads	xxxx <sub>H</sub>
56	Number of current logical sectors per logical track	xxxx <sub>H</sub>
57–58	Current capacity in sectors	xxxx <sub>H</sub>
59	Number of sectors transferred during a Read Multiple or Write Multiple command	xxxx <sub>H</sub>
60–61	Total number of user-addressable LBA sectors available (see Section 7.2.3 for related information)	ST3120023AS = 234,441,648 ST380023AS = 156,301,488 ST360015AS = 117,231,408
62	Retired	0000 <sub>H</sub>
63	Multiword DMA active and modes supported (see note following this table)	xx07 <sub>H</sub>
64	Advanced PIO modes supported (modes 3 and 4 supported)	0003 <sub>H</sub>
65	Minimum multiword DMA transfer cycle time per word (120 nsec)	0078 <sub>H</sub>
66	Recommended multiword DMA transfer cycle time per word (120 nsec)	0078 <sub>H</sub>
67	Minimum PIO cycle time without IORDY flow control (240 nsec)	00F0 <sub>H</sub>
68	Minimum PIO cycle time with IORDY flow control (120 nsec)	0078 <sub>H</sub>
69–74	ATA-reserved	0000 <sub>H</sub>
75	Queue depth	0000 <sub>H</sub>
76–79	ATA-reserved	0000 <sub>H</sub>
80	Major version number	003E <sub>H</sub>
81	Minor version number	0000 <sub>H</sub>
82	Command sets supported	306B <sub>H</sub>
83	Command sets supported	4001 <sub>H</sub>
84	Command sets support extension	4000 <sub>H</sub>
85	Command sets enabled	30xx <sub>H</sub>

**Table 8: Drive-specific commands**

Word	Description	Value
86	Command sets enabled	0001 <sub>H</sub>
87	Command sets enable extension	4000 <sub>H</sub>
88	Ultra DMA support and current mode (see note following this table)	xx3F <sub>H</sub>
89	Security erase time	0000 <sub>H</sub>
90	Enhanced security erase time	0000 <sub>H</sub>
91	Advanced power management value	0040 <sub>H</sub>
92	Master password revision code	FFFE <sub>H</sub>
93	Hardware reset value (see description following this table)	xxxx <sub>H</sub>
94	Auto acoustic management setting	xxxx <sub>H</sub>
95–127	ATA-reserved	0000 <sub>H</sub>
128	Security status	0001 <sub>H</sub>
129–159	Seagate-reserved	xxxx <sub>H</sub>
160–254	ATA-reserved	0000 <sub>H</sub>
255	Integrity word	xxA5 <sub>H</sub>

See the bit descriptions below for words 63, 88, 93 and 94 of the Identify Drive data:

Description (if bit is set to 1)

**Bit      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.

**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.
- 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.

**Bit      Word 93**

- 13     1=80-conductor cable detected, CBLID above  $V_{IH}$   
0=40-conductor cable detected, CBLID below  $V_{IL}$

**Bit      Word 94**

- 0–7    Current AAM setting
- 8–15   AAM Power on default

## 4.2.2 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 <sub>H</sub>	Enable write cache ( <i>default</i> ).
03 <sub>H</sub>	Set transfer mode (based on value in Sector Count register). Sector Count register values:
00 <sub>H</sub>	Set PIO mode to default (PIO mode 2).
01 <sub>H</sub>	Set PIO mode to default and disable IORDY (PIO mode 2).
08 <sub>H</sub>	PIO mode 0
09 <sub>H</sub>	PIO mode 1
0A <sub>H</sub>	PIO mode 2
0B <sub>H</sub>	PIO mode 3
0C <sub>H</sub>	PIO mode 4 ( <i>default</i> )
20 <sub>H</sub>	Multiword DMA mode 0
21 <sub>H</sub>	Multiword DMA mode 1
22 <sub>H</sub>	Multiword DMA mode 2
40 <sub>H</sub>	Ultra DMA mode 0
41 <sub>H</sub>	Ultra DMA mode 1
42 <sub>H</sub>	Ultra DMA mode 2
43 <sub>H</sub>	Ultra DMA mode 3
44 <sub>H</sub>	Ultra DMA mode 4
45 <sub>H</sub>	Ultra DMA mode 5
05 <sub>H</sub>	Enable advanced power management
42 <sub>H</sub>	Auto acoustic management
FE <sub>H</sub>	Performance seek
80 <sub>H</sub>	Quiet acoustic seek
55 <sub>H</sub>	Disable read look-ahead (read cache) feature.
82 <sub>H</sub>	Disable write cache

**Table 9: Set Features command values**

AA <sub>H</sub>	Enable read look-ahead (read cache) feature ( <i>default</i> ).
F1 <sub>H</sub>	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.

### 4.2.3 S.M.A.R.T. commands

S.M.A.R.T. provides near-term failure prediction for disc 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<sub>H</sub>) 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 <sub>H</sub>	S.M.A.R.T. Read Data
D1 <sub>H</sub>	Vendor-specific
D2 <sub>H</sub>	S.M.A.R.T. Enable/Disable Attribute Autosave
D3 <sub>H</sub>	S.M.A.R.T. Save Attribute Values
D4 <sub>H</sub>	S.M.A.R.T. Execute Off-line Immediate (runs DST)
D5 <sub>H</sub>	S.M.A.R.T. Read Log Sector
D6 <sub>H</sub>	S.M.A.R.T. Write Log Sector
D7 <sub>H</sub>	Vendor-specific
D8 <sub>H</sub>	S.M.A.R.T. Enable Operations
D9 <sub>H</sub>	S.M.A.R.T. Disable Operations
DA <sub>H</sub>	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*

**www.seagate.com** for information about Seagate products and services. Worldwide support is available 24 hours daily by e-mail for your disc or tape questions.

#### *Presales Support:*

Disc: [www.seagate.com/support/email/email\\_presales.html](http://www.seagate.com/support/email/email_presales.html) or  
[DiscPresales@Seagate.com](mailto:DiscPresales@Seagate.com)

Tape: [www.seagate.com/support/email/email\\_tape\\_presales.html](http://www.seagate.com/support/email/email_tape_presales.html) or  
[Tape\\_Sales\\_Support@Seagate.com](mailto:Tape_Sales_Support@Seagate.com)

#### *Technical Support:*

Disc: [www.seagate.com/support/email/email\\_disc\\_support.html](http://www.seagate.com/support/email/email_disc_support.html) or  
[DiscSupport@Seagate.com](mailto:DiscSupport@Seagate.com)

Tape: [www.seagate.com/support/email/email\\_tape\\_support.html](http://www.seagate.com/support/email/email_tape_support.html) or  
[TapeSupport@Seagate.com](mailto:TapeSupport@Seagate.com)

### **Reseller Marketplace**

Reseller Marketplace is the storage industry's first collaborative, e-commerce marketplace offering resellers the fastest, most efficient online purchasing process for Seagate storage solutions. The Reseller Marketplace at [marketplace.seagate.com](http://marketplace.seagate.com), an exclusive service for US resellers participating in the Seagate Partner Program (SPP), is designed to streamline the purchasing process of Seagate solutions and provide unprecedented value to Seagate resellers through real-time pricing and availability, fast and easy comparison shopping, and seamless integration with key distributors for a one-stop shopping experience.

For support, questions and comments: [reseller.seagate.com/benefits/T1.html](http://reseller.seagate.com/benefits/T1.html) or 1-877-271-3285 (toll-free) 9 A.M. to 7 P.M. (eastern time) Monday through Friday.

### **Tape Purchases**

US customers can purchase Seagate data cartridges, tape supplies, accessories, and select Seagate tape drive products 24 hours daily at [buytape.seagate.com](http://buytape.seagate.com).

### **Automated Services**

**SeaFONE® (1-800-SEAGATE)** is the Seagate toll-free number (1-800-732-4283) to access our automated self-help services. Using a touch-tone phone, you can find answers to service phone numbers, commonly asked questions, troubleshooting tips and specifications for disc drives and tape drives 24

hours daily. International callers can reach this service by dialing +1-405-936-1234.

**SeaFAX® (1-800-SEAGATE)** is the Seagate automated FAX delivery system. Using a touch-tone phone, you can obtain technical support information by return FAX 24 hours daily.

## **Presales Support**

### **Presales Support**

Our Presales Support staff can help you determine which Seagate products are best suited for your specific application or computer system.

## **Technical Support**

If you need help installing your drive, consult your dealer. Dealers are familiar with their unique system configurations and can help you with system conflicts and other technical issues. If you need additional help, you can talk to a Seagate technical support specialist. Before calling, note your system configuration and drive model number (ST#####).

**SeaTDD™ (+1-405-936-1687)** is a telecommunications device for the deaf (TDD). You can send questions or comments 24 hours daily and exchange messages with a technical support specialist from 8:00 A.M. to 11:45 A.M. and 1:00 P.M. to 6:00 P.M. (central time) Monday through Friday.

## **Customer Service (CSO)**

### **Warranty Service**

Seagate offers worldwide customer support for Seagate drives. Seagate direct OEM, Distribution and System Integrator customers should contact their Seagate service center representative for warranty information. Other customers should contact their place of purchase.

### **Authorized Service Centers**

If you live outside the US, you can contact an Authorized Service Center for service.

## USA/Canada/Latin America Support Services

### Presales Support

Call Center	Toll-free	Direct dial	FAX
<i>Disc:</i>	1-877-271-3285	+405-936-1210	+1-405-936-1683
<i>Tape:</i>	1-800-626-6637	+1-714-641-2500	+1-714-641-2410

### Technical Support (SeaFONE)

1-800-SEAGATE or +1-405-936-1234 (for specific product phone number)

FAX: *Disc:* +1-405-936-1685; *Tape and Server Appliance:* +1-405-936-1683

**SeaFAX** 1-800-SEAGATE

**SeaTDD** +1-405-936-1687

### Warranty Service

Call Center	Toll-free	Direct dial	FAX / Internet
USA, Mexico and Latin America	1-800-468-3472	+1-405-936-1456	+1-405-936-1462
Canada			
<i>Memofix</i> <sup>1</sup>	1-800-636-6349	+1-905-660-4936	+1-905-660-4951 www.memofix.com
<i>Adtech</i> *	1-800-624-9857	+1-905-812-8099	+1-905-812-7807 www.adtech1.com
Brazil			
<i>MA Centro de Serviçoes</i> *	—	+55-21-2509-7267	+55-21-2507-6672 e-mail: centro.de.servicos.brasil@seagate.com

## European Support Services

For European customer support, dial the toll-free number for your specific country for presales support, technical support, SeaFAX and warranty service.

If your country is not listed here, dial our European call center at +31-20-316-7222 from 8:30 A.M. to 5:00 P.M. (European central time) Monday through Friday. The European call center is located in Amsterdam, The Netherlands.

### Call Center

Austria	0 800-20 12 90
Belgium	0 800-74 876
Denmark	80 88 12 66
France	0 800-90 90 52
Germany	0 800-182 6831

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<sup>1</sup>Authorized Service Centers

Ireland	1 800-55 21 22
Italy	800-790695
Netherlands	0 800-732 4283
Norway	800-113 91
Poland	00 800-311 12 38
Spain	900-98 31 24
Sweden	0 207 90 073
Switzerland	0 800-83 84 11
Turkey	00 800-31 92 91 40
United Kingdom	0 800-783 5177

## FAX Services—All European Countries

Presales/Technical Support/Warranty Service 31-20-653-3513

## Africa/Middle East Support Services

For presales, technical support, warranty service and FAX services in Africa and the Middle East, dial our European call center at +31-20-316-7222 from 8:30 A.M. to 5:00 P.M. (European central time) Monday through Friday, or send a FAX to +31-20-653-3513. The European call center is located in Amsterdam, The Netherlands.

## Asia/Pacific Support Services

For Asia/Pacific presales and technical support, dial the toll-free number for your specific country. The Asia/Pacific toll-free numbers are available from 6:00 A.M. to 10:45 A.M. and 12:00 P.M. to 6:00 P.M. (Australian eastern time) Monday through Friday. If your country is not listed here, direct dial one of our technical support locations.

Call Center	Toll-free	Direct dial	FAX
Australia	1800-14-7201	—	—
China	—	—	+86-10-6871-4316
Hong Kong	800-90-0474	—	+852-2368 7173
India <sup>1</sup>	1-600-33-1104	—	—
Indonesia	001-803-1-003-2165	—	—
Japan	—	—	+81-3-5462-2979
Malaysia	1-800-80-2335	—	—
New Zealand	0800-443988	—	—
Singapore	800-1101-150	—	+65-6488-7525
Taiwan	—	+886-2-2514-2237	+886-2-2715-2923
Thailand	001-800-11-0032165	—	—

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<sup>1</sup>Authorized Service Center

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## Warranty Service

<b>Call Center</b>	<b>Toll-free</b>	<b>Direct dial</b>	<b>FAX</b>
Asia/Pacific	—	+65-6485-3595	+65-6485-4860
Australia	1800-12-9277	—	—
Japan	—	+81-3-5462-2904	+81-3-5462-2979



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