



# Desktop SSHD

Product Manual

ST4000DX001    ST1000DX001

ST2000DX001

100726566, Rev. F  
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## Document Revision History

Revision	Date	Description of Change
Rev. A	04/30/2013	Initial release
Rev. B	06/07/2013	Added 4TB model and related specifications throughout.
Rev. C	03/18/2014	Revised: Copyright text (below); Warranty URL & text (pages 4 & 12); Replaced MTBF w/AFR in Rated Workload text (page 4)
Rev. D	05/08/2014	Add metric "mm" values to mechanical drawings (pages 16-17)
Rev. E	07/17/2014	Edit Words 82, 83, 85 & 86 values, add Word 91 and edit AAM note. (pages 22-23)
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# 1.0 Introduction

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This manual describes the functional, mechanical and interface specifications for the following Seagate® Desktop SSHD model drives:

ST4000DX001      ST2000DX001      ST1000DX001

These drives provide the following key features:

- 8GB NAND flash
- 5900 and 7200 RPM spindle speed
- High instantaneous (burst) data-transfer rates (up to 600MB per second)
- TGMR recording technology provides the drives with increased areal density.
- State-of-the-art cache and on-the-fly error-correction algorithms
- Native Command Queueing with command ordering to increase performance in demanding applications
- Full-track multiple-sector transfer capability without local processor intervention
- Seagate AcuTrac™ servo technology delivers dependable performance, even with hard drive track widths of only 75 nanometers.
- Seagate OptiCache™ technology boosts overall performance by as much as 45% over the previous generation.
- Seagate SmartAlign™ technology provides a simple, transparent migration to Advanced Format 4K sectors.
- 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 SATA interface

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

The SATA interface connects each disk drive in a point-to-point configuration with the SATA host adapter. There is no master/slave relationship with SATA devices like there is with parallel ATA. If two drives are attached on one SATA 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.

The SATA 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 SATA host adapter contains a set of registers that shadow the contents of the traditional device registers, referred to as the Shadow Register Block. All SATA devices behave like Device 0 devices. For additional information about how SATA emulates parallel ATA, refer to the "Serial ATA International Organization: Serial ATA Revision 3.2. The specification can be downloaded from [www.sata-io.org](http://www.sata-io.org).

<b>Note</b>	The host adapter may, optionally, emulate a master/slave environment to host software where two devices on separate SATA 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 SATA environment.
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## 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:

ST4000DX001

ST2000DX001

ST1000DX001

### 2.1 Specification summary tables

The specifications listed in **Table 1** are for quick reference. For details on specification measurement or definition, refer to the appropriate section of this manual.

**Table 1** *Drive specifications summary for 4TB, 2TB and 1TB models*

Drive Specification*	ST4000DX001	ST2000DX001	ST1000DX001
Formatted capacity (512 bytes/sector)**	4000GB (4TB)	2000GB (2TB)	1000GB (1TB)
Guaranteed sectors	7,814,037,168	3,907,029,168	1,953,525,168
Heads	8	4	2
Disks	4	2	1
NAND flash Commercial Multilevel Cell (cMLC)/size		cMLC/8GB	
Bytes per sector (4K physical emulated at 512-byte sectors)		4096	
Default sectors per track		63	
Default read/write heads		16	
Default cylinders		16,383	
Recording density (max)		1807kFCI	
Track density (avg)		340ktracks/in	
Areal density (avg)		625Gb/in <sup>2</sup>	
Spindle speed	5900 RPM	7200 RPM	
Internal data transfer rate (max)	1813Mb/s	2147Mb/s	
Average data rate, read/write (MB/s)	146MB/s	156MB/s	
Maximum sustained data rate, OD read (MB/s)	180MB/s	210MB/s	
I/O data-transfer rate (max)		600MB/s	
Cache buffer		64MB	
Height (max)	26.1mm / 1.028 in		20.17mm / 0.7825 in
Width (max)		101.6mm / 4.0 in ( $\pm$ 0.010 in)	
Length (max)		146.99mm / 5.787 in	
Weight (typical)	610g / 1.345 lb	535g / 1.18 lb	400g / 0.88 lb
Average latency	5.1ms		4.16ms
Power-on to ready (max) <sup>‡</sup>	<1.0s		<1.0s
Standby to ready (max) <sup>‡</sup>	<1.0s		<1.0s
Average seek, read (typical)	<12.0ms typical		<8.5ms (read)
Average seek, write (typical)	<12.0ms typical		<9.5ms (write)
Startup current 12V		2.0A	
Voltage tolerance (including noise)	5V: $\pm$ 5% 12V: $\pm$ 10%		5V: $\pm$ 5% 12V: +10% / -7.5%
Ambient temperature		0° to 60°C (operating) -40° to 70°C (nonoperating)	
Temperature gradient		20°C per hour max (operating) 30°C per hour max (nonoperating)	

**Table 1 Drive specifications summary for 4TB, 2TB and 1TB models (continued)**

Drive Specification*	ST4000DX001	ST2000DX001	ST1000DX001
Relative humidity	5% to 90% (operating) 5% to 95% (nonoperating)	5% to 95% (operating) 5% to 95% (nonoperating)	
Relative humidity gradient (max)		30% per hour	
Wet bulb temperature (max)		37.7°C max (operating) 40.0°C max (nonoperating)	
Altitude, operating		-304m to 3048m (-1000 ft to 10,000 ft)	
Altitude, nonoperating (below mean sea level, max)		-304m to 12,192m (-1000 ft to 40,000+ ft)	
Operational shock (max)		80 Gs at 10ms	
Nonoperational shock (max)	300 Gs at 2ms	350 Gs at 2ms	
Vibration, operating		2Hz to 22Hz: 0.25 Gs, Limited displacement 22Hz to 350Hz: 0.50 Gs 350Hz to 500Hz: 0.25 Gs	
Vibration, nonoperating		5Hz to 22Hz: 3.0 Gs 22Hz to 350Hz: 3.0 Gs 350Hz to 500Hz: 3.0 Gs	
Drive acoustics, sound power			
Idle***	2.3 bels (typical) 2.5 bels (max)	2.4 bels (typical) 2.6 bels (max)	2.2 bels (typical) 2.4 bels (max)
Seek	2.8 bels (typical) 3.0 bels (max)	2.6 bels (typical) 2.7 bels (max)	2.4 bels (typical) 2.5 bels (max)
Non-recoverable read errors		1 per $10^{14}$ bits read	
Rated workload	Average rate of <55TB/year. The AFR specification for the drive assumes the I/O workload does not exceed the average annualized workload rate limit of 55TB/year. Workloads exceeding the annualized rate may degrade the drive AFR and impact product reliability. The average annualized workload rate limit is in units of TB per year, or TB per 8760 power-on hours. Workload rate limit = TB transferred $\times$ (8760/recoded power-on hours).		
Warranty	To determine the warranty for a specific drive, use a web browser to access the following web page: <a href="http://www.seagate.com/support/warranty-and-replacements/">http://www.seagate.com/support/warranty-and-replacements/</a> From this page, click on "Check to see if the drive is under Warranty". Users 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 the drive.		
Load/Unload cycles (25°C, 50% rel. humidity)	300,000		
Supports Hotplug operation per the Serial ATA Revision 3.2 specification	Yes		

\*All specifications above are based on native configurations.

\*\* One GB equals one billion bytes and 1TB equals one trillion 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.

† Hybrid time-to-ready specification assumes all needed data files are pinned to flash, Windows 8 environment, and fast BIOS implemented.

## 2.2 Formatted capacity

Model	Formatted capacity*	Guaranteed sectors	Bytes per sector
ST4000DX001	4000GB	7,814,037,168	4K
ST2000DX001	2000GB	3,907,029,168	
ST1000DX001	1000GB	1,953,525,168	

\*One GB equals one billion bytes and 1TB equals one trillion bytes when referring to hard drive capacity. Accessible capacity may vary depending on operating environment and formatting.

## 2.2.1 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 137GB.

## 2.3 Default logical geometry

- Cylinders: 16,383
- Read/write heads: 16
- Sectors per track: 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 Recording and interface technology

<b>Interface</b>	SATA	
<b>Recording method</b>	TGMR	
<b>Recording density (kFCI)</b>	1807	
<b>Track density (ktracks/inch avg)</b>		
	1TB and 2TB	352
	4TB	340
<b>Areal density (Gb/in<sup>2</sup>)</b>	625	
<b>Spindle speed (RPM)</b>		
	1TB and 2TB	7200 ± 0.2%
	4TB	5900 ± 0.2%
<b>Internal data transfer rate (Mb/s max)</b>		
	1TB and 2TB	2147
	4TB	1813
<b>Maximum sustained data transfer rate, OD read (MB/s)</b>		
	1TB and 2TB	210
	4TB	180
<b>Average data rate, read/write (MB/s)</b>		
	1TB and 2TB	156
	4TB	146
<b>I/O data-transfer rate (MB/s max)</b>	600	

## 2.5 Physical characteristics

<b>Maximum height</b>	
4TB and 2TB	26.1mm / 1.028 in
1TB	20.17mm / 0.7825 in
<b>Maximum width (all models)</b>	101.6mm / 4.0 in ( $\pm$ 0.010 in)
<b>Maximum length (all models)</b>	146.99mm / 5.787 in
<b>Typical weight</b>	
4TB	610g / 1.345 lb
2TB	535g / 1.18 lb
1TB	400g / 0.88 lb
<b>Cache buffer</b>	64MB (64,768kb)

## 2.6 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 5000 measurements of seeks between random tracks, less overhead.

Typical seek times (ms)	Read	Write
Track-to-track	1.0	1.2
Average	8.5	9.5
Average latency		4.16

<b>Note</b>	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.
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## 2.7 Start/stop times

Time-to-ready may be longer than normal if the drive power is removed without going through normal OS powerdown procedures.

	<b>4-disk</b> (4TB)	<b>2-disk</b> (2TB)	<b>1-disk</b> (1TB)
Power-on to ready* (in seconds)	<1	<1	<1
Standby to ready* (in seconds)	<1	<1	<1
Ready to spindle stop (in seconds)	10 (typical) 11 (max)	10 (typical) 11 (max)	10 (typical) 11 (max)

\* Hybrid time-to-ready specification assumes all needed data files are pinned to flash, Windows 8 environment, and fast BIOS implemented

## 2.8 Power specifications

The drive receives DC power (+5V or +12V) through a native SATA power connector. Refer to [Figure 2 on page 18](#).

### 2.8.1 Power consumption

Power requirements for the drives are listed in [Table 1](#), [Table 2](#) and [Table 3](#). 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-ms delay, then a 16-sector read followed by a 32-ms 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.

**Figure 1 DC power requirements (4-disk: 4TB model)**

<b>Power dissipation (4-disk values shown)</b>	<b>Avg (watts 25° C)</b>	<b>Avg 5V typ amps</b>	<b>Avg 12V typ amps</b>
Spinup	—	—	2.0
Idle* †	6.20	0.50	0.31
Operating	7.50	0.48	0.43
Standby	0.750	0.138	0.005
Sleep	0.750	0.138	0.005

**Table 2 DC power requirements (2-disk: 2TB model)**

Power dissipation (2-disk values shown)	Avg (watts 25° C)	Avg 5V typ amps	Avg 12V amps
Spinup	—	—	2.0A
Idle2* †	4.50	0.196	0.296
Operating	6.70	0.525	0.340
Standby	0.75	0.136	0.005
Sleep	0.75	0.136	0.005

**Table 3 DC power requirements (1-disk: 1TB model)**

Power dissipation (1-disk values shown)	Avg (watts 25° C)	Avg 5V typ amps	Avg 12V amps
Spinup	—	—	2.0
Idle2* †	3.36	0.152	0.216
Operating	5.90	0.500	0.329
Standby	0.63	0.111	0.006
Sleep	0.63	0.111	0.006

\*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

### 2.8.2 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 10MHz.
- 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 10MHz.

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

### 2.8.3 Voltage tolerance

Voltage tolerance (including noise):

- 5V ±5%
- 12V +10% / -7.5%

## 2.8.4 Power-management modes

The drive provides programmable power management to provide greater energy efficiency. In most systems, users 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.

## 2.9 Environmental specifications

This section provides the temperature, humidity, shock, and vibration specifications. Ambient temperature is defined as the temperature of the environment immediately surrounding the drive. Above 1000ft. (305 meters), the maximum temperature is derated linearly by 1°C every 1000 ft.

Refer to [Section 3.4 on page 19](#) for base plate measurement location.

### 2.9.1 Ambient temperature

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

### 2.9.2 Temperature gradient

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

### 2.9.3 Humidity

#### 2.9.3.1 Relative humidity

<b>Operating</b>	5% to 95% non-condensing (30% per hour max)
<b>Nonoperating</b>	5% to 95% non-condensing (30% per hour max)

#### 2.9.3.2 Wet bulb temperature

<b>Operating</b>	37.7°C (99.9°F max)
<b>Nonoperating</b>	40°C (104°F max)

### 2.9.4 Altitude

<b>Operating</b>	-304.8m to 3048m (-1000 ft. to 10,000+ ft.)
<b>Nonoperating</b>	-304.8m to 12,192m (-1000 ft. to 40,000+ ft.)

## 2.9.5 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.

### 2.9.5.1 Operating shock

These drives comply with the performance levels specified in this document when subjected to a maximum operating shock of 80 Gs based on half-sine shock pulses of 2ms during read operations. Shocks should not be repeated more than two times per second. A maximum operating shock of 80 Gs based on half-sine shock pulses of 10ms during read operations applies to the

### 2.9.5.2 Nonoperating shock

#### 2TB and 4TB 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 non-repetitive half-sine shock pulse of 2 ms in duration.

#### 1TB model

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 non-repetitive half-sine shock pulse of 2 ms in duration.

### 2.9.5.3 Operating vibration

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

2Hz to 22Hz	0.25 Gs (Limited displacement)
22Hz to 350Hz	0.50 Gs
350Hz to 500Hz	0.25 Gs

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. Throughput may vary if improperly mounted.

## 2.9.6 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.

5Hz to 22Hz	3.0 Gs (Limited displacement)
22Hz to 350Hz	3.0 Gs
350Hz to 500Hz	3.0 Gs

## 2.10 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.

<b>Note</b>	For seek mode tests, the drive is placed in seek mode only. The number of seeks per second is defined by the following equation: (Number of seeks per second = 0.4 / (average latency + average access time
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**Table 4 Fluid Dynamic Bearing (FDB) motor acoustics**

	<b>Idle*</b>	<b>Seek</b>
<b>4-Disk</b> (4TB)	2.3 bels (typical) 2.5 bels (max)	2.8 bels (typical) 3.0 bels (max)
<b>2 Disks</b> (2TB)	2.4 bels (typical) 2.6 bels (max)	2.6 bels (typical) 2.7 bels (max)
<b>1 Disk</b> (1TB)	2.2 bels (typical) 2.3 bels (max)	2.3 bels (typical) 2.4 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.

### 2.10.1 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.

## 2.11 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 [Table 5](#).

**Table 5 Radio frequency environments**

<b>Test</b>	<b>Description</b>	<b>Performance level</b>	<b>Reference standard</b>
Electrostatic discharge	Contact, HCP, VCP: $\pm 4$ kV; Air: $\pm 8$ kV	B	EN61000-4-2: 95
Radiated RF immunity	80MHz to 1,000MHz, 3 V/m, 80% AM with 1kHz sine 900MHz, 3 V/m, 50% pulse modulation @ 200Hz	A	EN61000-4-3: 96 ENV50204: 95
Electrical fast transient	$\pm 1$ kV on AC mains, $\pm 0.5$ kV on external I/O	B	EN61000-4-4: 95
Surge immunity	$\pm 1$ kV differential, $\pm 2$ kV common, AC mains	B	EN61000-4-5: 95
Conducted RF immunity	150kHz to 80MHz, 3 Vrms, 80% AM with 1kHz sine	A	EN61000-4-6: 97
Voltage dips, interrupts	0% open, 5 seconds 0% short, 5 seconds 40%, 0.10 seconds 70%, 0.01 seconds	C C C B	EN61000-4-11: 94

## 2.12 Warranty

To determine the warranty for a specific drive, use a web browser to access the following web page:  
<http://www.seagate.com/support/warranty-and-replacements/>

From this page, click on "Check to see if the drive is under Warranty". Users 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 the drive.

## 2.13 Agency certification

### 2.13.1 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.

### 2.13.2 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: Desktop SSHD
- Certificate number: in process

#### 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).

### 2.13.3 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 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, users 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, users should consult the dealer or an experienced radio/television technician for additional suggestions. Users 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.

## 2.14 Environmental protection

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

### 2.14.1 European Union Restriction of Hazardous Substances (RoHS) Directive

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.

### 2.14.2 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	0	0	0	0	0
HDA	X	0	0	0	0	0

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

“0”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 homogeneous 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。

## 2.15 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 oneself 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 mounting 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 SATA interface connects point-to-point with the SATA 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 SATA 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.

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

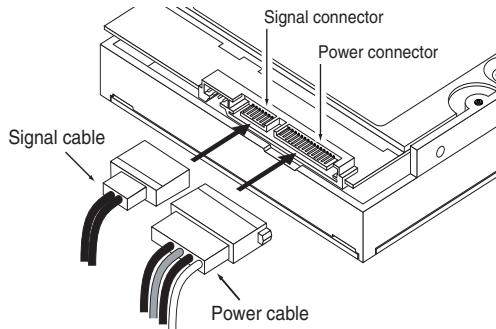
### 3.3 SATA cables and connectors

The SATA 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, users can connect the drive as illustrated in [Figure 2](#).

**Figure 2** Attaching SATA cabling



Each cable is keyed to ensure correct orientation. Desktop SSHD drives support latching SATA connectors.

### 3.4 Drive mounting

Users can mount the drive in any orientation using four screws in the side-mounting holes or four screws in the bottom-mounting holes. Refer to [Figure 3](#) and [Figure 4](#) for drive mounting dimensions. Follow these important mounting precautions when mounting the drive:

- Allow a minimum clearance of 0.030 inches (0.76mm) 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 (3.81mm) into the bottom or side mounting holes.
- Do not overtighten the mounting screws (maximum torque: 6 inch-lb).

**Figure 3** Mounting dimensions (4TB & 2TB models)

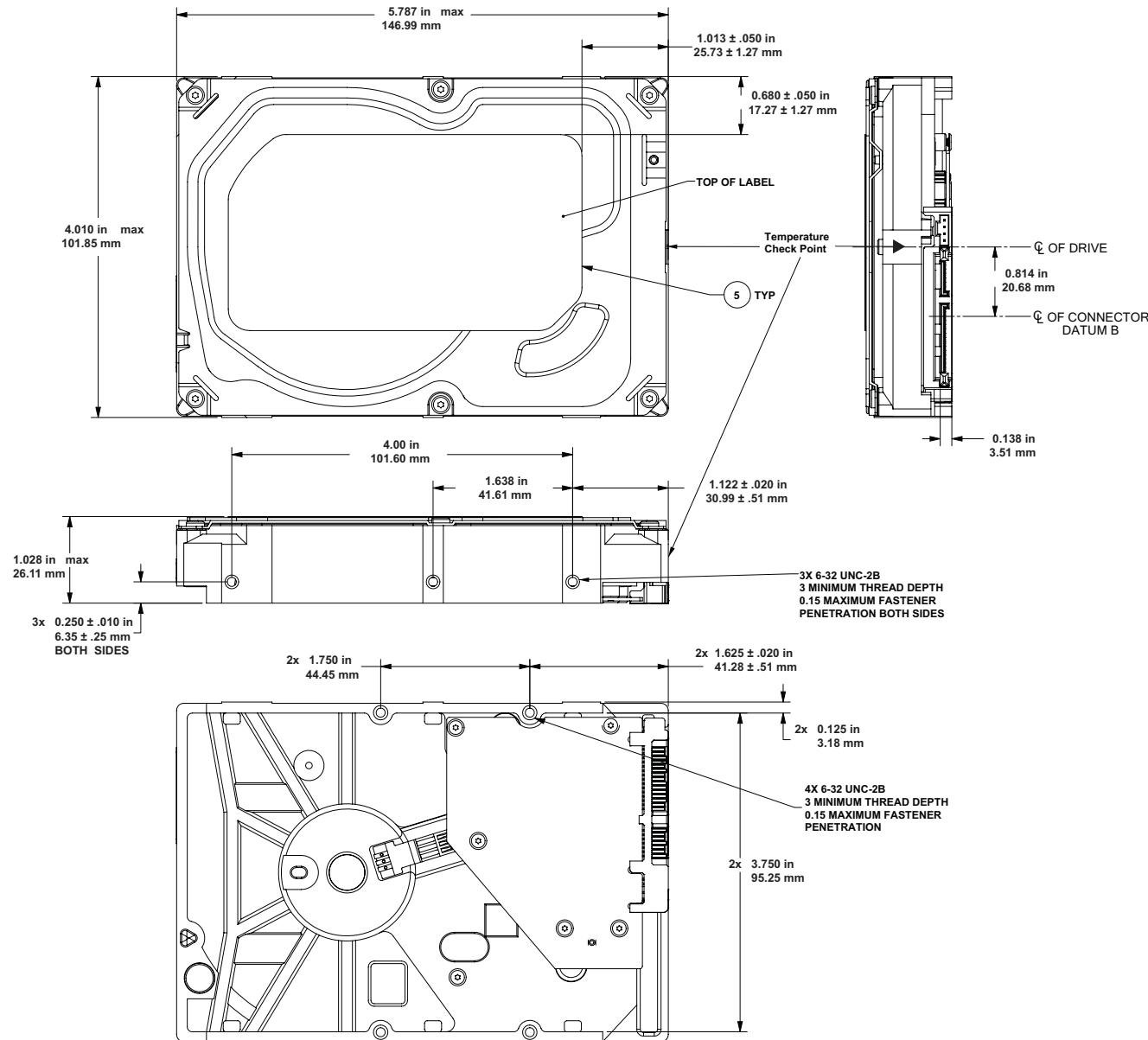
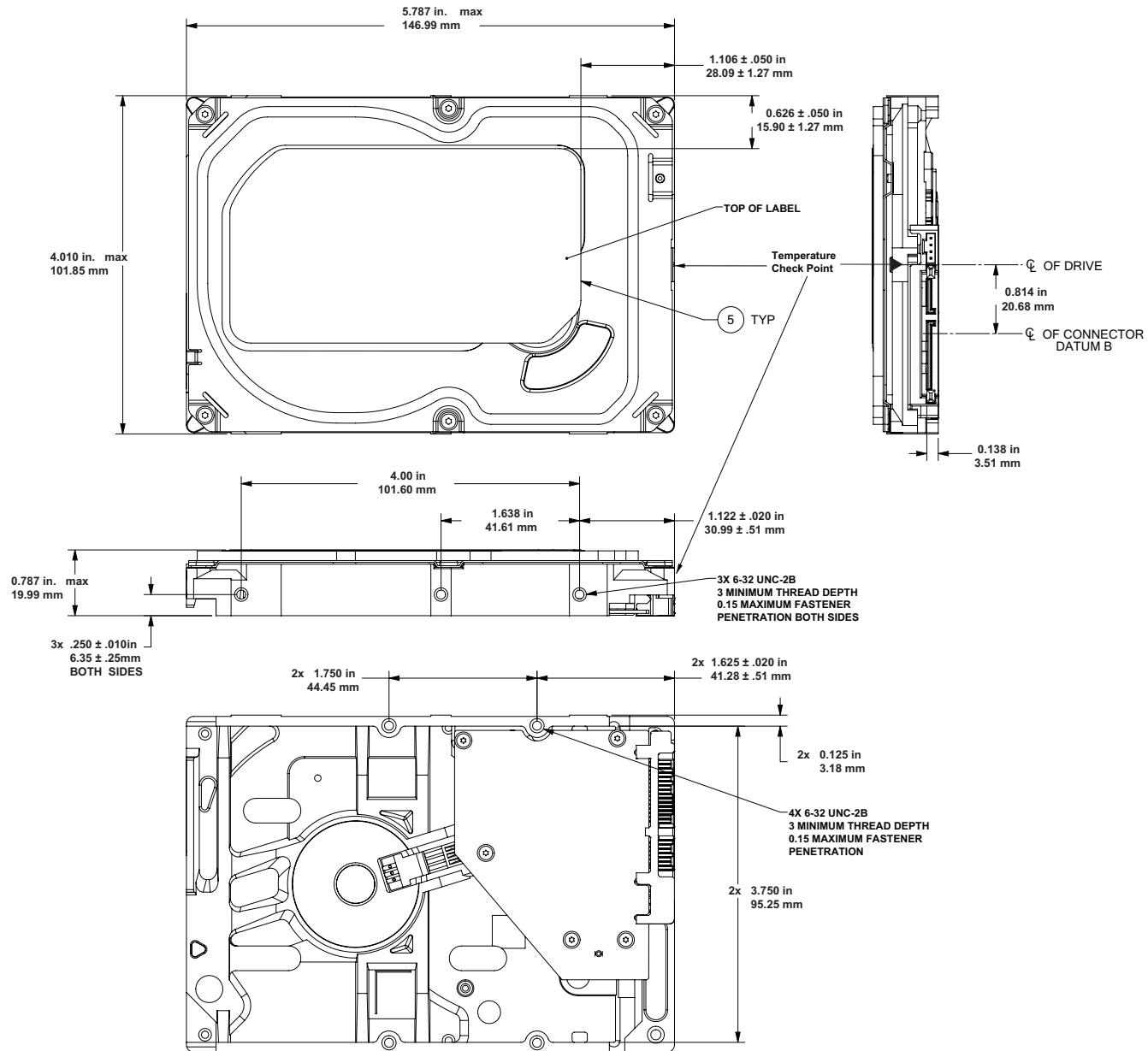


Figure 4 Mounting dimensions (1TB models)



## 4.0 SATA Interface

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

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

### 4.1 Hot-Plug compatibility

Desktop SSHD drives incorporate connectors which enable users to hot plug these drives in accordance with the SATA Revision 3.2 specification. This specification can be downloaded from [www.serialata.org](http://www.serialata.org).

### 4.2 SATA device plug connector pin definitions

**Table 6** summarizes the signals on the SATA interface and power connectors.

**Table 6 SATA 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 pair B from Phy
	S6	B+	
	S7	Ground	2nd mate
<b>Key and spacing separate signal and power segments</b>			
<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	Ground or LED signal	If grounded, drive does not use deferred spin
	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 in) 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 pins 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.
  - All used voltage pins (V<sub>x</sub>) must be terminated.

## 4.3 Supported ATA commands

The following table lists SATA standard commands that the drive supports.

For a detailed description of the ATA commands, refer to the Serial ATA International Organization: Serial ATA Revision 3.2 (<http://www.sata-io.org>).

See "S.M.A.R.T. commands" on page 29 for details and subcommands used in the S.M.A.R.T. implementation.

**Table 7 SATA standard commands**

Command name	Command code (in hex)
Check Power Mode	E5 <sub>H</sub>
Device Configuration Freeze Lock	B1 <sub>H</sub> / C1 <sub>H</sub>
Device Configuration Identify	B1 <sub>H</sub> / C2 <sub>H</sub>
Device Configuration Restore	B1 <sub>H</sub> / C0 <sub>H</sub>
Device Configuration Set	B1 <sub>H</sub> / C3 <sub>H</sub>
Device Reset	08 <sub>H</sub>
Download Microcode	92 <sub>H</sub>
Execute Device Diagnostics	90 <sub>H</sub>
Flush Cache	E7 <sub>H</sub>
Flush Cache Extended	EA <sub>H</sub>
Format Track	50 <sub>H</sub>
Identify Device	EC <sub>H</sub>
Idle	E3 <sub>H</sub>
Idle Immediate	E1 <sub>H</sub>
Initialize Device Parameters	91 <sub>H</sub>
Read Buffer	E4 <sub>H</sub>
Read DMA	C8 <sub>H</sub>
Read DMA Extended	25 <sub>H</sub>
Read DMA Without Retries	C9 <sub>H</sub>
Read Log Ext	2F <sub>H</sub>
Read Multiple	C4 <sub>H</sub>
Read Multiple Extended	29 <sub>H</sub>
Read Native Max Address	F8 <sub>H</sub>
Read Native Max Address Extended	27 <sub>H</sub>
Read Sectors	20 <sub>H</sub>
Read Sectors Extended	24 <sub>H</sub>
Read Sectors Without Retries	21 <sub>H</sub>
Read Verify Sectors	40 <sub>H</sub>
Read Verify Sectors Extended	42 <sub>H</sub>
Read Verify Sectors Without Retries	41 <sub>H</sub>
Recalibrate	10 <sub>H</sub>
Security Disable Password	F6 <sub>H</sub>
Security Erase Prepare	F3 <sub>H</sub>
Security Erase Unit	F4 <sub>H</sub>
Security Freeze	F5 <sub>H</sub>
Security Set Password	F1 <sub>H</sub>
Security Unlock	F2 <sub>H</sub>

**Table 7 SATA standard commands (continued)**

Command name	Command code (in hex)
Seek	70 <sub>H</sub>
Set Features	EF <sub>H</sub>
Set Max Address	F9 <sub>H</sub>
Note: Individual Set Max Address commands are identified by the value placed in the Set Max Features register as defined to the right.	Address: 00 <sub>H</sub> Password: 01 <sub>H</sub> Lock: 02 <sub>H</sub> Unlock: 03 <sub>H</sub> Freeze Lock: 04 <sub>H</sub>
Set Max Address Extended	37 <sub>H</sub>
Set Multiple Mode	C6 <sub>H</sub>
Sleep	E6 <sub>H</sub>
S.M.A.R.T. Disable Operations	B0 <sub>H</sub> / D9 <sub>H</sub>
S.M.A.R.T. Enable/Disable Autosave	B0 <sub>H</sub> / D2 <sub>H</sub>
S.M.A.R.T. Enable Operations	B0 <sub>H</sub> / D8 <sub>H</sub>
S.M.A.R.T. Execute Offline	B0 <sub>H</sub> / D4 <sub>H</sub>
S.M.A.R.T. Read Attribute Thresholds	B0 <sub>H</sub> / D1 <sub>H</sub>
S.M.A.R.T. Read Data	B0 <sub>H</sub> / D0 <sub>H</sub>
S.M.A.R.T. Read Log Sector	B0 <sub>H</sub> / D5 <sub>H</sub>
S.M.A.R.T. Return Status	B0 <sub>H</sub> / DA <sub>H</sub>
S.M.A.R.T. Save Attribute Values	B0 <sub>H</sub> / D3 <sub>H</sub>
S.M.A.R.T. Write Log Sector	B0 <sub>H</sub> / D6 <sub>H</sub>
Standby	E2 <sub>H</sub>
Standby Immediate	E0 <sub>H</sub>
Write Buffer	E8 <sub>H</sub>
Write DMA	CA <sub>H</sub>
Write DMA Extended	35 <sub>H</sub>
Write DMA FUA Extended	3D <sub>H</sub>
Write DMA Without Retries	CB <sub>H</sub>
Write Log Extended	3F <sub>H</sub>
Write Multiple	C5 <sub>H</sub>
Write Multiple Extended	39 <sub>H</sub>
Write Multiple FUA Extended	CE <sub>H</sub>
Write Sectors	30 <sub>H</sub>
Write Sectors Without Retries	31 <sub>H</sub>
Write Sectors Extended	34 <sub>H</sub>
Write Uncorrectable	45 <sub>H</sub>

### 4.3.1 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 [on page 22](#). 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.

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

**Table 8 Identify Device 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>	0C5AH
1	Number of logical cylinders	16,383
2	ATA-reserved	0000H
3	Number of logical heads	16
4	Retired	0000H
5	Retired	0000H
6	Number of logical sectors per logical track: 63	003FH
7–9	Retired	0000H
10–19	Serial number: (20 ASCII characters, 0000H = none)	ASCII
20	Retired	0000H
21	Retired	0400H
22	Obsolete	0000H
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)	8010H
48	Reserved	0000H
49	Standard Standby timer, IORDY supported and may be disabled	2F00H
50	ATA-reserved	0000H
51	PIO data-transfer cycle timing mode	0200H
52	Retired	0200H
53	Words 54–58, 64–70 and 88 are valid	0007H
54	Number of current logical cylinders	xxxxH
55	Number of current logical heads	xxxxH
56	Number of current logical sectors per logical track	xxxxH
57–58	Current capacity in sectors	xxxxH
59	Number of sectors transferred during a Read Multiple or Write Multiple command	xxxxH

**Table 8 Identify Device commands (continued)**

Word	Description	Value
60–61	Total number of user-addressable LBA sectors available (see Section 2.2 for related information) *Note: The maximum value allowed in this field is: 0FFFFFFh (268,435,455 sectors, 137GB). Drives with capacities over 137GB will have 0FFFFFFh 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.	0FFFFFFh*
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)	0078 <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	001F <sub>H</sub>
76	SATA capabilities	xxxx <sub>H</sub>
77	Reserved for future SATA definition	xxxx <sub>H</sub>
78	SATA features supported	xxxx <sub>H</sub>
79	SATA features enabled	xxxx <sub>H</sub>
80	Major version number	01F0 <sub>H</sub>
81	Minor version number	0028 <sub>H</sub>
82	Command sets supported	346B <sub>H</sub>
83	Command sets supported	7D09 <sub>H</sub>
84	Command sets support extension (see note following this table)	4163 <sub>H</sub>
85	Command sets enabled	3469 <sub>H</sub>
86	Command sets enabled	BC09 <sub>H</sub>
87	Command sets enable extension	4163 <sub>H</sub>
88	Ultra DMA support and current mode (see note following this table)	xx7F <sub>H</sub>
89	Security erase time	0039 <sub>H</sub>
90	Enhanced security erase time	0039 <sub>H</sub>
91	Current Advanced Power Management Value	8080 <sub>H</sub>
92	Master password revision code	FFFE <sub>H</sub>
93	Hardware reset value	xxxx <sub>H</sub>
94	Automatic acoustic management	8080 <sub>H</sub>
95–99	ATA-reserved	0000 <sub>H</sub>
100–103	Total number of user-addressable LBA sectors available (see Section 2.2 for related information). These words are required for drives that support the 48-bit addressing feature. Maximum value: 0000FFFFFFFh.	ST4000DX001 = 7,814,037,168 ST2000DX001 = 3,907,029,168 ST1000DX001 = 1,953,525,168

**Table 8 Identify Device commands (continued)**

Word	Description	Value
104–107	ATA-reserved	0000 <sub>H</sub>
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 <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	xA5 <sub>H</sub>

**Note** 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)		
	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 84
	0	SMART error login 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 feature is supported.
	14	Shall be set to 1.
	15	Shall be cleared to 0.

	<b>Bit</b>	<b>Word 88</b>
	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**

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
	46 <sub>H</sub> Ultra DMA mode 6
06 <sub>H</sub>	Enable the PUIS feature set.
07 <sub>H</sub>	PUIS feature set device spin up.
10 <sub>H</sub>	Enable use of SATA features
55 <sub>H</sub>	Disable read look-ahead (read cache) feature.
82 <sub>H</sub>	Disable write cache
86 <sub>H</sub>	Disable the PUIS feature set
90 <sub>H</sub>	Disable use of SATA features
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.

### 4.3.3 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<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 enabled. 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
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
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.



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