SEAGATE

EXOS™ ENTERPRISE

7E8 SATA Product Manual

5xxE models	**5xxE models**
Standard	**Self-Encryption (SED)**
ST8000NM000A	ST8000NM004A
ST6000NM021A	ST6000NM023A
ST4000NM002A	ST4000NM010A
ST2000NM001A	ST2000NM010A

SED (FIPS 140-2)	**Instant Secure Erase (ISE)**
ST8000NM008A	ST8000NM012A
ST6000NM025A	ST6000NM027A
ST4000NM012A	

* Default configuration is 512E for 512E / 4KN drives.
See **Section 2.2.1** to Fast Format to 4KN in seconds

Document Revision History

Revision	Date	Pages affected and Description of changes
Rev. A	03/27/2019	Initial release.
Rev. B	05/01/2019	fc & 8-9: Added Fast Format, notes and references 6-31: Updated section numbering 7 & 27: Updated drive weights 8 & 19: Updated Op-Shock to 300 Gs for all capacities 8 & 21: Updated AFR to 0.44% 21: Updated MTBF to 2M hrs 26: Added HDD/SSD Regulatory Compliance and Safety URL to Reference documents
Rev. C	05/23/2019	7 & 19: Updated Operating & Non-Operating shock statements 7: Updated Vibration specifications 10-13: Updated Tables 5-8 - DC power requirements
Rev. D	07/17/2019	fc, 5-7: Added ISE models
Rev. E	09/13/2019	6: Updated drive temperature entries to reflect drive reported 21: Updated Section 2.12.1 Safety certification
Rev. F	10/16/2019	16: Updated Section 2.5.3 Conducted noise immunity
Rev. G	01/09/2020	6-7: Corrected temperature & humidity gradients 6 & 16: Corrected 5V tolerance to ±5% 28: Renamed - Figure 6 Mounting configuration dimensions 8TB and 6TB models (Option 1) Added Figure 7 Mounting configuration dimensions 8TB and 6TB models (Option 2)

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Seagate® Technology Support Services

For information regarding online support and services, visit: http://www.seagate.com/contacts/

For information regarding Warranty Support, visit: http://www.seagate.com/support/warranty-and-replacements/

For information regarding data recovery services, visit: http://www.seagate.com/services-software/recover/

For Seagate OEM, Distribution partner and reseller portals, visit: http://www.seagate.com/partners/

1.0   Introduction

This manual describes the functional, mechanical and interface specifications for the following:
Seagate® Exos® 7E8 Serial ATA model drives:.

5xxE models			
Standard	**Self-Encrypting (SED)**	**SED (FIPS 140-2)**	**Instant Secure Erase (ISE)**
ST8000NM000A	ST8000NM004A	ST8000NM008A	ST8000NM012A
ST6000NM021A	ST6000NM023A	ST6000NM025A	ST6000NM027A
ST4000NM002A	ST4000NM010A	ST4000NM012A	
ST2000NM001A	ST2000NM010A		

These drives provide the following key features:
• 7200 RPM spindle speed.
• Full-track multiple-sector transfer capability without local processor intervention.
• High instantaneous (burst) data-transfer rates (up to 600MB per second).
• Native Command Queuing with command ordering to increase performance in demanding applications.
• Perpendicular recording technology provides the drives with increased areal density.
• PowerChoice™ for selectable power savings
• SeaTools™ diagnostic software performs a drive self-test that eliminates unnecessary drive returns.
• State-of-the-art cache and on-the-fly error-correction algorithms.
• Support for S.M.A.R.T. drive monitoring and reporting.
• Supports latching SATA cables and connectors.
• Tarnish-resistant components to help protect drive from environmental elements, increasing field reliability.
• Worldwide Name (WWN) capability uniquely identifies the drive.

Note	Seagate recommends validating the configuration with the selected HBA/ RAID controller manufacturer to ensure use of full capacity is supported.

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 users to install a Serial ATA host adapter and Serial ATA disk drive in the current system and expect all of the existing applications to work as normal.

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

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

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

The Serial ATA host adapter contains a set of registers that shadow the contents of the traditional device registers, referred to as the Shadow Register Block. All Serial ATA devices behave like Device 0 devices. For additional information about how Serial ATA emulates parallel ATA, refer to the "Serial ATA: High Speed Serialized AT Attachment" specification. The specification can be downloaded from www.serialata.org.

2.0   Drive specifications

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

5xxE models			
Standard	**Self-Encrypting (SED)**	**SED (FIPS 140-2)**	**Instant Secure Erase (ISE)**
ST8000NM000A	ST8000NM004A	ST8000NM008A	ST8000NM012A
ST6000NM021A	ST6000NM023A	ST6000NM025A	ST6000NM027A
ST4000NM002A	ST4000NM010A	ST4000NM012A	
ST2000NM001A	ST2000NM010A		

2.1   Specification summary tables

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

Table 1   Drive specifications summary

Drive specification	ST8000NM000A ST8000NM004A ST8000NM008A ST8000NM012A	ST6000NM021A ST6000NM023A ST6000NM025A ST6000NM027A	ST4000NM002A ST4000NM010A ST4000NM012A	ST2000NM001A ST2000NM010A
Formatted (512 bytes/sector)$^{\#}$	8TB	6TB	4TB	2TB
Guaranteed sectors	(see **Section 2.2**)			
Heads	10	8	6	3
Discs	5	4	3	2
Bytes per logical sector	512			
Bytes per physical sector	4096			
Recording density, KBPI (Kb/in max)	2509			
Track density, KTPI (ktracks/in, 0 skew)	371			
Areal density, (Gb/in^2, @ 0 skew mid-disk)	930			
Spindle speed (RPM)	7200			
Internal data transfer rate (Mb/s max)	2850			
Sustained data transfer rate OD (MiB/s max)	238 (249 MB/s max)	216 (226 MB/s max)		
I/O data-transfer rate (MB/s max)	600			
ATA data-transfer modes supported	PIO modes 0–4 Multiword DMA modes 0–2 Ultra DMA modes 0–6			
Cache buffer	256MB (262,144KB)			
Weight: (maximum)	716g (1.579 lb)	693g / (1.528 lb)	649g (1.431 lb)	620g (1.367 lb)
Average latency	4.16ms			
Power-on to ready (sec) (typ/max)	23/30			
Standby to ready (sec) (typ/max)	23/30			
Startup current (typical) 12V (peak)	2.6A (2.0A (optional configuration through Smart Command Transport)			
Voltage tolerance (including noise)	5V ±5% 12V ±10%			
Operating temperature†	5° to 60℃ (Drive Reported Temperature)			
Non-Operating temperature	−40° to 70℃ (Ambient Temperature, see sections **2.6.1** and **2.11**)			
Temperature gradient (℃ per hour max)	20℃ (operating) 20℃ (nonoperating)			

Drive specification	ST8000NM000A ST8000NM004A ST8000NM008A ST8000NM012A	ST6000NM021A ST6000NM023A ST6000NM025A ST6000NM027A	ST4000NM002A ST4000NM010A ST4000NM012A	ST2000NM001A ST2000NM010A
Relative humidity*	5% to 95% (operating) 5% to 95% (nonoperating)			
Relative humidity gradient	20% per hour max			
Altitude, operating	−304.8 m to 3,048 m (−1000 ft to 10,000+ ft)			
Altitude, nonoperating (below mean sea level, max)	−304.8 m to 12,192 m (−1000 ft to 40,000+ ft)			
Operational Shock (2 ms)	Read 70 Gs / Write 40 Gs			
Non-Operational Shock (2 ms)	300 Gs			
Linear Random Operating Vibration	5–500 Hz: 0.70 Grms			
Random Rotary Operating Vibration	20–1500Hz: 12.5 rads/s^2			
Linear Random Non-Operating Vibration	2–500 Hz: 2.27 Grms			
Drive acoustics, sound power (bels) Idle** Performance seek	2.8 (typical) 3.0 (max) During periods of drive idle, some offline activity may occur according to the SMART specification, which may increase acoustic and power to operational levels. 3.2 (typical) 3.4 (max)			
Nonrecoverable read errors	1 sector per 10^{15} bits read			
Annualized Failure Rate (AFR)*	0.44% based on 8760 POH			
Maximum Rated Workload*	Maximum rate of <550TB/year Workloads exceeding the annualized rate may degrade the drive MTBF and impact product reliability. The Annualized Workload Rate is in units of TB per year, or TB per 8760 power on hours. Workload Rate = TB transferred * (8760 / recorded power on hours).			
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 the "Is my Drive under Warranty" link. The following are required to be provided: 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 (command controlled)	600,000			
Supports Hotplug operation per Serial ATA Revision 3.3 specification	Yes			

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

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

*   See **Section 2.11, "Reliability"** for rated MTBF device operating condition requirements.

2.2 Formatted capacity

ST models	Formatted capacity*	Guaranteed sectors	Bytes per logical sector
ST8000NM000A, ST8000NM004A, ST8000NM008A, ST8000NM012A	8TB	15,628,053,168	512
ST6000NM021A, ST6000NM023A, ST6000NM025A, ST6000NM027A	6TB	11,721,045,168	
ST4000NM002A, ST4000NM010A, ST4000NM012A	4TB	7,814,037,168	
ST2000NM001A, ST2000NM010A	2TB	3,907,029,168	

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

2.2.1 Fast Format - logical sector size conversion

n   Drive supports either 512E or 4KN logical sector size formats

n   SET SECTOR CONFIGURATION EXT (B2h) command (ACS-4 Standard) quickly converts between 512 and 4096 byte logical sector size formats

n   The selected sector size change occurs immediately upon command completion

n   Default shipping format is 512E

Table 2   SET SECTOR CONFIGURATION EXT command inputs

Field	Description
FEATURE	COMMAND CHECK field
COUNT	Bit Description
	15 : 3 Reserved
	2:0 SECTOR CONFIGURATION DESCRIPTOR INDEX field
LBA	Reserved
DEVICE	Bit Description
	7 Obsolete
	6 N/A
	5 Obsolete
	4 Transport Dependent
	3:0 Reserved
COMMAND	7:0 B2h

n   COMMAND CHECK field value is taken from the DESCRIPTOR CHECK field in the descriptor specified by the SECTOR CONFIGURATION DESCRIPTOR INDEX field

n   SECTOR CONFIGURATION DESCRIPTOR INDEX field specifies the Sector Configuration descriptor in the Set Sector Configuration log page

Sector Configuration log (Log Address 2Fh)

The Sector Configuration log contains Sector Configuration descriptors. The Sector Configuration descriptors describe sector configurations. The sector configuration is specified using the SET SECTOR CONFIGURATION EXT command.

Table 3   Sector Configuration descriptors page format (log page 00h)

Offset	Type	Description
0...15	Bytes	Sector Configuration descriptor 0
16...31	Bytes	Sector Configuration descriptor 1
... ...		
112...127	Bytes	Sector Configuration descriptor 7
128...511	Bytes	Reserved

Table 4   Sector Configuration descriptors format

Offset	Type	Description
0	Byte	Sector Configuration descriptor flags
		Bit Description 7 DESCRIPTOR VALID bit 6:0 Reserved
1	Byte	LOGICAL TO PHYSICAL SECTOR RELATIONSHIP SETTING field
2...3	Word	DESCRIPTOR CHECK field
4...7	DWord	LOGICAL SECTOR SIZE SETTING field
8...15	Bytes	Reserved

2.2.2   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 6.3.1, "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   Recording and interface technology

Interface	Serial ATA (SATA)
Recording method	Perpendicular
Recording density, KBPI (Kb/in max)	2509
Track density, KTPI (ktracks/in, 0 Skew)	371
Areal density (Gb/in^2, @ 0 skew mid-disk)	930
Spindle speed (RPM) (± 0.2%)	7200
Internal data transfer rate (Mb/s max)	2850
Sustained data transfer rate (MiB/s max) 8TB models	238 (249 MB/s max)
Sustained data transfer rate (MiB/s max) 6TB, 4TB, 2TB models	216 (226 MB/s max)
I/O data-transfer rate (MB/s max)	600 (Ultra DMA mode 5)

2.4   Start/stop times

Power-on to Ready (sec) (typ/max)	23/30
Standby to Ready (sec) (typ/max)	23/30
Ready to spindle stop (sec) (max)	23

2.5   Power specifications

The drive receives DC power (+5V or +12V) through a native SATA power connector. See **Figure 5 on page 27**.

2.5.1   Power consumption

Power requirements for the drives are listed in **Table 5** through **Table 8**. 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.

Table 5   DC power requirements (8TB)

		6.0Gb mode		
Voltage		**+5V**	**+12V**	**Watts**
Regulation		**± 5%**		**Total**
Avg Idle Current *		0.241	0.536	7.64
Advanced Idle Current *				
	Idle_A	0.238	0.532	7.57
	Idle_B	0.182	0.447	6.27
	Idle_C	0.178	0.232	3.67
	Standby	0.169	0.092	0.92
Maximum Start Current				
	DC (peak DC)	0.761	2.155	
	AC (Peak DC)	0.888	2.840	
Delayed Motor Start (DC max)		0.216	0.028	
Operating current (random read 4K16Q)				
	Typical DC	0.413	0.896	12.81
	Maximum DC	0.413	0.896	12.81
	Maximum DC (Peak)	1.125	2.283	
Operating current (random write 4K16Q)				
	Typical DC	0.304	0.613	8.88
	Maximum DC	0.304	0.613	8.88
	Maximum DC (Peak)	0.741	2.394	
Operating current (sequential read 64K16Q)				
	Typical DC	0.745	0.573	10.61
	Maximum DC	0.745	0.573	10.61
	Maximum DC (Peak)	1.022	0.895	
Operating current (sequential write 64K16Q)				
	Typical DC	0.585	0.572	9.79
	Maximum DC	0.585	0.572	9.79
	Maximum DC (Peak)	0.766	0.893	
Power Governor Operating current (random read 4K16Q)				
	Typical DC	0.418	0.822	11.96
	Maximum DC	0.418	0.822	11.96
	Maximum DC (Peak)	1.130	2.121	
Power Governor Operating current (random write 4K16Q)				
	Typical DC	0.314	0.584	8.58
	Maximum DC	0.314	0.584	8.58
	Maximum DC (Peak)	0.787	2.280	
Power Governor Operating current (sequential read 64K16Q)				
	Typical DC	0.746	0.572	10.60
	Maximum DC	0.746	0.572	10.60
	Maximum DC (Peak)	1.046	0.918	
Power Governor Operating current (sequential write 64K16Q)				
	Typical DC	0.587	0.568	9.75
	Maximum DC	0.587	0.568	9.75
	Maximum DC (Peak)	0.749	0.887	

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

Table 6   6TB DC power requirements

		6.0Gb mode		
Voltage		**+5V**	**+12V**	**Watts**
Regulation		\u00b1 5%		**Total**
Avg Idle Current *		0.247	0.434	6.44
Advanced Idle Current *				
	Idle_A	0.247	0.434	6.45
	Idle_B	0.191	0.372	5.42
	Idle_C	0.185	0.198	3.31
	Standby	0.175	0.007	0.95
Maximum Start Current				
	DC (peak DC)	0.806	2.144	
	AC (Peak DC)	1.144	2.940	
Delayed Motor Start (DC max)		0.220	0.028	
Operating current (random read): 4K/Q16				
	Typical DC	0.423	0.815	11.90
	Maximum DC	0.425	0.824	12.01
	Maximum DC (Peak)	1.094	2.116	
Operating current (random write): 4K/Q16				
	Typical DC	0.319	0.523	7.88
	Maximum DC	0.321	0.530	7.97
	Maximum DC (Peak)	0.802	2.320	
Operating current (sequential read): 64K/Q16				
	Typical DC	0.753	0.475	9.46
	Maximum DC	0.756	0.480	9.54
	Maximum DC (Peak)	0.971	0.803	
Operating current (sequential write): 64K/Q16				
	Typical DC	0.610	0.474	8.73
	Maximum DC	0.613	0.478	8.81
	Maximum DC (Peak)	0.797	0.809	
Power Governor Operating current (random read 4K16Q)				
	Typical DC	0.426	0.736	10.96
	Maximum DC	0.427	0.737	10.98
	Maximum DC (Peak)	1.089	2.057	
Power Governor Operating current (random write 4K16Q)				
	Typical DC	0.324	0.483	7.41
	Maximum DC	0.325	0.491	7.52
	Maximum DC (Peak)	0.817	2.237	
Power Governor Operating current (sequential read 64K16Q)				
	Typical DC	0.753	0.473	9.44
	Maximum DC	0.757	0.478	9.52
	Maximum DC (Peak)	0.996	0.813	
Power Governor Operating current (sequential write 64K16Q)				
	Typical DC	0.611	0.470	8.70
	Maximum DC	0.616	0.476	8.79
	Maximum DC (Peak)	0.795	1.824	

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

Table 7   DC power requirements (4TB)

		6.0Gb mode		
Voltage		+5V	+12V	Watts
Regulation		± 5%		Total
Avg Idle Current *		0.222	0.346	5.26
Advanced Idle Current *				
	Idle_A	0.225	0.350	5.32
	Idle_B	0.169	0.296	4.40
	Idle_C	0.161	0.072	1.67
	Standby	0.153	0.005	0.82
Maximum Start Current				
	DC (peak DC)	0.707	2.098	
	AC (Peak DC)	0.792	2.880	
Delayed Motor Start (DC max)		0.200	0.024	
Peak operating current (random read)				
	Typical DC	0.394	0.731	10.74
	Maximum DC	0.394	0.731	10.74
	Maximum DC (Peak)	1.022	1.972	
Peak operating current (random write)				
	Typical DC	0.289	0.437	6.69
	Maximum DC	0.289	0.437	6.69
	Maximum DC (Peak)	0.725	1.982	
Peak operating current (sequential read)				
	Typical DC	0.701	0.398	8.28
	Maximum DC	0.701	0.398	8.28
	Maximum DC (Peak)	0.909	0.665	
Peak operating current (sequential write)				
	Typical DC	0.561	0.394	7.54
	Maximum DC	0.561	0.394	7.54
	Maximum DC (Peak)	0.719	.649	
Power Governor Operating current (random read 4K16Q)				
	Typical DC	0.394	0.658	9.86
	Maximum DC	0.394	0.658	9.86
	Maximum DC (Peak)	1.056	1.969	
Power Governor Operating current (random write 4K16Q)				
	Typical DC	0.292	0.399	6.25
	Maximum DC	0.292	0.399	6.25
	Maximum DC (Peak)	0.737	1.894	
Power Governor Operating current (sequential read 64K16Q)				
	Typical DC	0.700	0.398	8.28
	Maximum DC	0.700	0.398	8.28
	Maximum DC (Peak)	0.910	1.808	
Power Governor Operating current (sequential write 64K16Q)				
	Typical DC	0.563	0.394	7.54
	Maximum DC	0.563	0.394	7.54
	Maximum DC (Peak)	0.719	0.647	

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

Table 8   Drive DC power requirements (2TB)

		6.0Gb mode		
Voltage		**+5V**	**+12V**	**Watts**
Regulation		± 5%		**Total**
Avg Idle Current *		0.230	0.282	4.54
Advanced Idle Current *				
	Idle_A	0.230	0.284	4.56
	Idle_B	0.173	0.242	3.77
	Idle_C	0.168	0.064	1.60
	Standby	0.159	0.007	0.87
Maximum Start Current				
	DC (peak DC)	0.745	2.100	
	AC (Peak DC)	0.880	2.940	
Delayed Motor Start (DC max)		0.204	0.032	
Peak operating current (random read)				
	Typical DC	0.402	0.661	9.94
	Maximum DC	0.403	0.662	9.96
	Maximum DC (Peak)	1.080	1.896	
Peak operating current (random write)				
	Typical DC	0.297	0.367	5.89
	Maximum DC	0.297	0.371	5.93
	Maximum DC (Peak)	0.739	1.932	
Peak operating current (sequential read)				
	Typical DC	0.702	0.314	7.28
	Maximum DC	0.706	0.316	7.32
	Maximum DC (Peak)	0.969	0.576	
Peak operating current (sequential write)				
	Typical DC	0.579	0.310	6.62
	Maximum DC	0.580	0.312	6.65
	Maximum DC (Peak)	0.732	0.535	
Power Governor Operating current (random read 4K16Q)				
	Typical DC	0.403	0.591	9.09
	Maximum DC	0.403	0.597	9.17
	Maximum DC (Peak)	1.077	1.857	
Power Governor Operating current (random write 4K16Q)				
	Typical DC	0.300	0.337	5.54
	Maximum DC	0.302	0.346	5.66
	Maximum DC (Peak)	0.773	1.836	
Power Governor Operating current (sequential read 64K16Q)				
	Typical DC	0.701	0.313	7.26
	Maximum DC	0.704	0.313	7.28
	Maximum DC (Peak)	0.955	0.559	
Power Governor Operating current (sequential write 64K16Q)				
	Typical DC	0.579	0.308	6.59
	Maximum DC	0.579	0.309	6.60
	Maximum DC (Peak)	0.743	0.533	

*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.

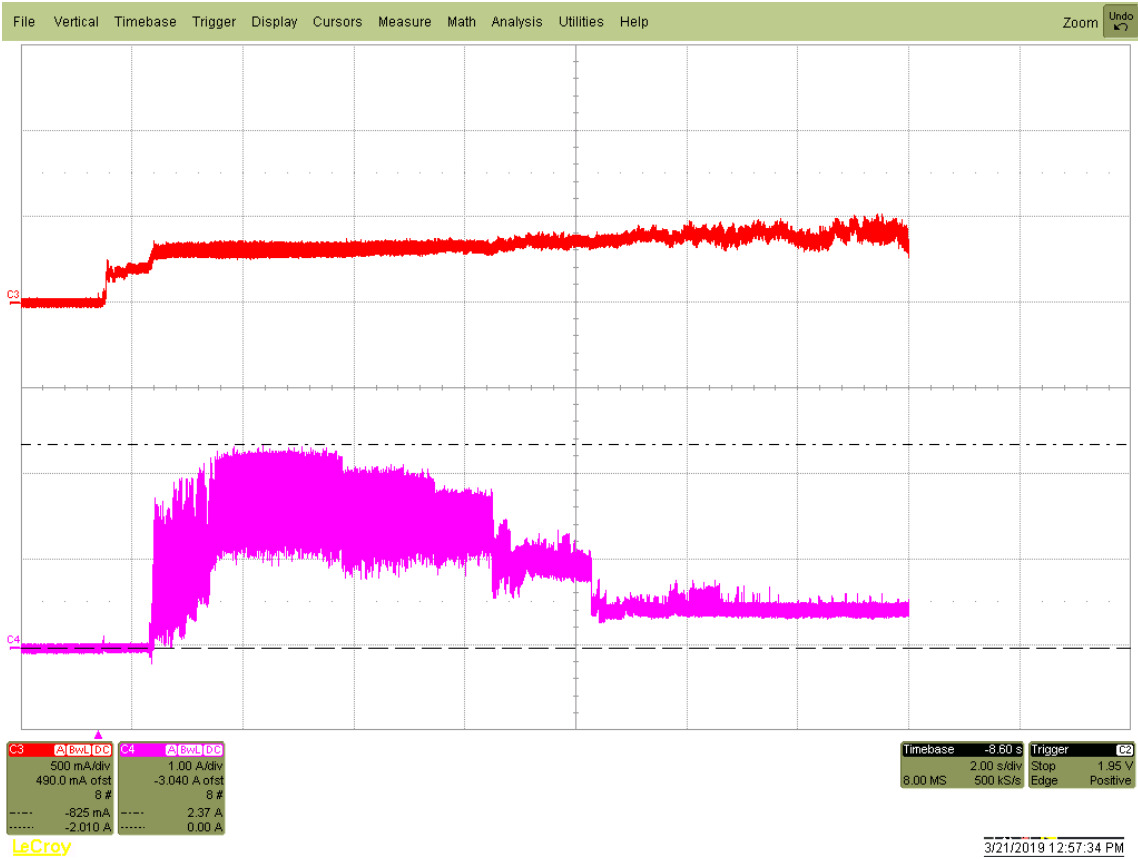## 2.5.2   Typical current profiles

Figure 1.   8TB Typical startup and operation current profile
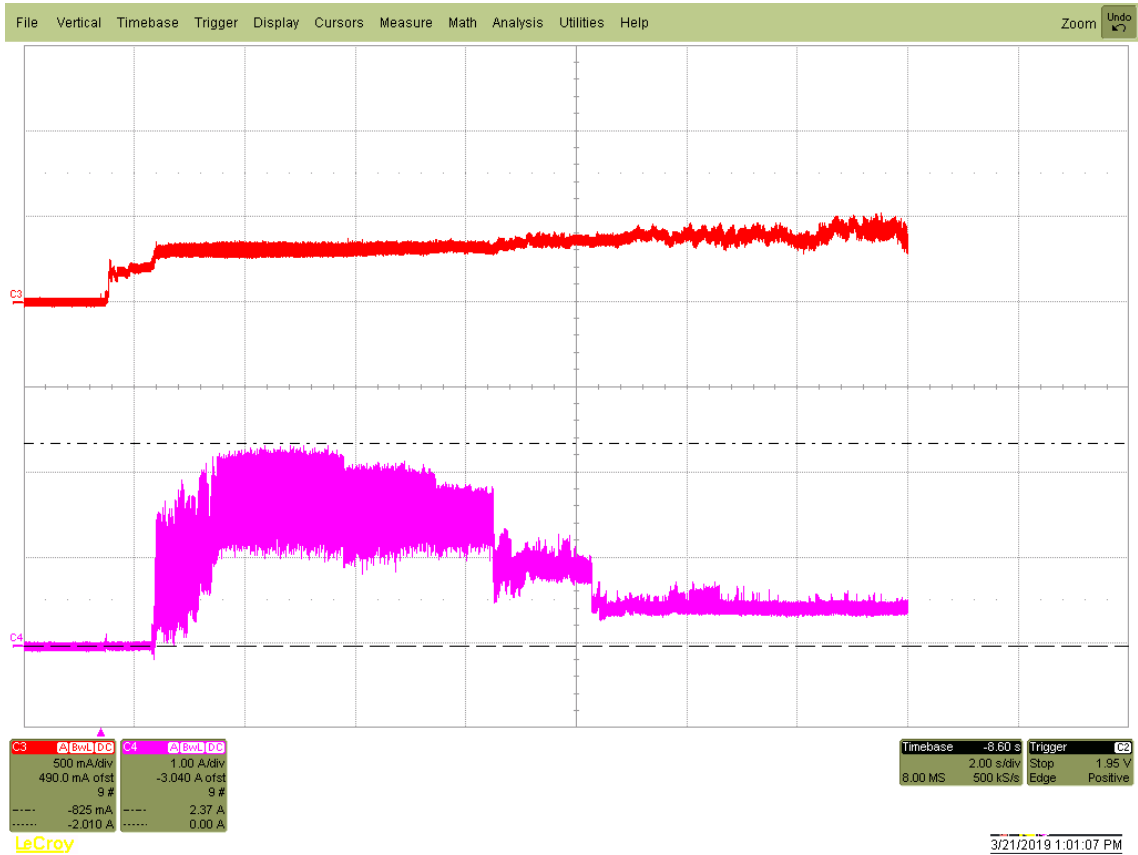

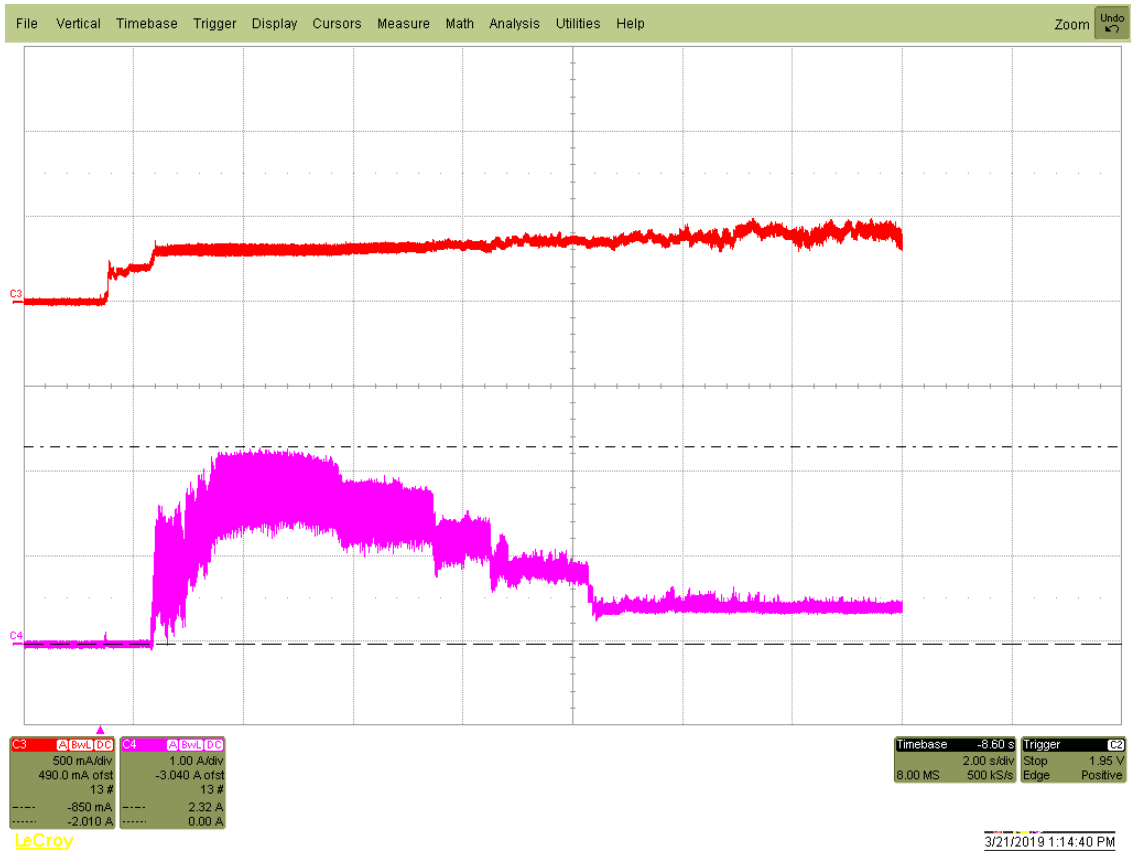**Figure 2.   6TB Typical startup and operation current profile**

Figure 3.   **4TB Typical startup and operation current profile**
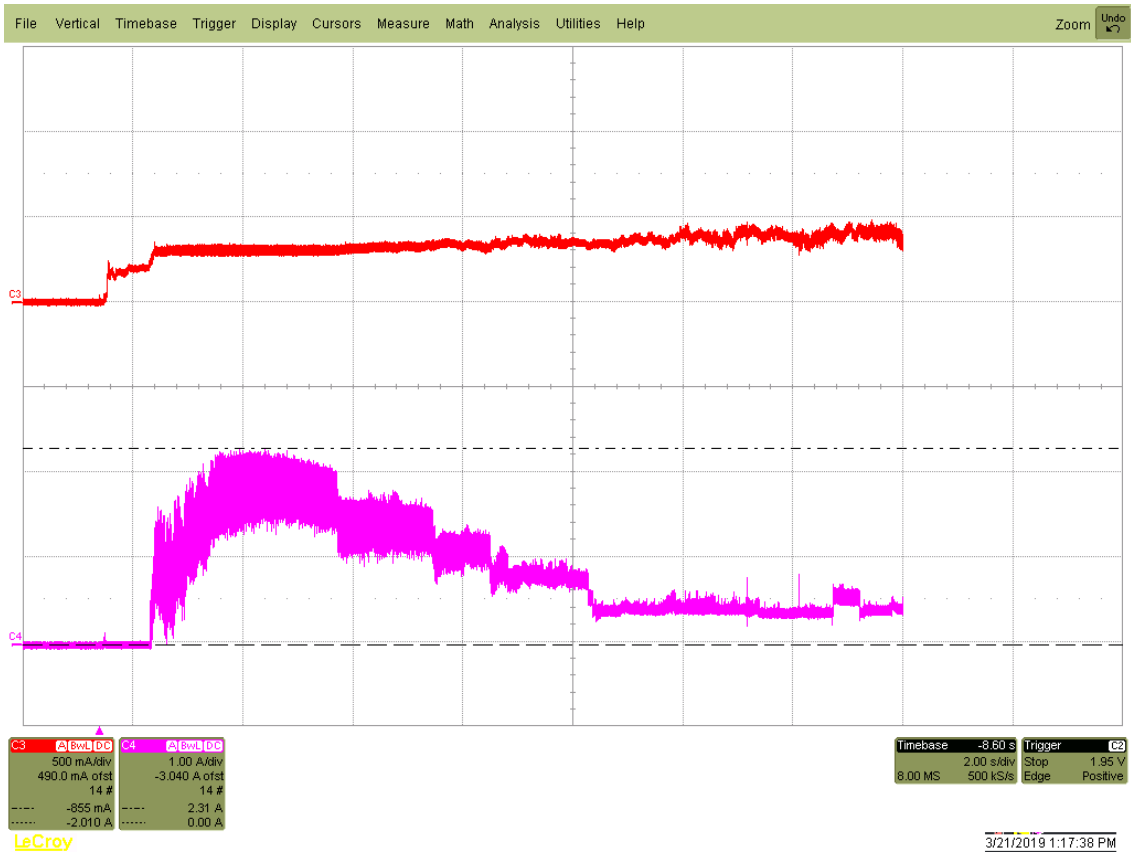
Figure 4.   **2TB Typical startup and operation current profile**

2.5.3   Conducted noise immunity

Noise is specified as a periodic and random distribution of frequencies covering a band from DC to 10 MHz. Maximum allowed noise values given below are peak-to-peak measurements and apply at the drive power connector.

+5v   =   250 mV pp from 100 Hz to 20 MHz.

+12v   =   800 mV pp from 100 Hz to 8 KHz.
               450 mV pp from 8 KHz to 20 KHz.
               250 mV pp from 20 KHz to 5 MHz.

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

2.5.4   Voltage tolerance

Voltage tolerance (including noise):

5V ± 5%   12V ± 10%

2.5.5   Extended Power Conditions - PowerChoice™

Utilizing the load/unload architecture a programmable power management interface is provided to tailor systems for reduced power consumption and performance requirements.

The table below lists the supported power conditions available in PowerChoice. Power conditions are ordered from highest power consumption (and shortest recovery time) to lowest power consumption (and longest recovery time) as follows: Idle_a power >= Idle_b power >= Idle_c power >= Standby_z power. The further users go down in the table, the more power savings is actualized. For example, Idle_b results in greater power savings than the Idle_a power condition. Standby results in the greatest power savings.

Power Condition Name	Power Condition ID	Description
Idle_a	81_H	Reduced electronics
Idle_b	82_H	Heads unloaded. Disks spinning at full RPM
Idle_c	83_H	Heads unloaded. Disks spinning at reduced RPM
Standby_z	00_H	Heads unloaded. Motor stopped (disks not spinning)

Each power condition has a set of current, saved and default settings. Default settings are not modifiable. Default and saved settings persist across power-on resets. The current settings do not persist across power-on resets. At the time of manufacture, the default, saved and current settings are in the Power Conditions log match.

PowerChoice is invoked using one of two methods
*   Automatic power transitions which are triggered by expiration of individual power condition timers. These timer values may be customized and enabled using the Extended Power Conditions (EPC) feature set using the standardized Set Features command interface.
*   Immediate host commanded power transitions may be initiated using an EPC Set Features "Go to Power Condition" subcommand to enter any supported power condition. Legacy power commands Standby Immediate and Idle Immediate also provide a method to directly transition the drive into supported power conditions.

PowerChoice exits power saving states under the following conditions
*   Any command which requires the drive to enter the PM0: Active state (media access)
*   Power on reset

PowerChoice provides the following reporting methods for tracking purposes

Check Power Mode Command
*   Reports the current power state of the drive

Identify Device Command
*   EPC Feature set supported flag
*   EPC Feature enabled flag is set if at least one Idle power condition timer is enabled

Power Condition Log reports the following for each power condition
- Nominal recovery time from the power condition to active
- If the power condition is Supported, Changeable, and Savable
- Default enabled state, and timer value
- Saved enabled state, and timer value
- Current enabled state, and timer value

S.M.A.R.T. Read Data Reports
- Attribute 192 - Emergency Retract Count
- Attribute 193 - Load/Unload Cycle Count

PowerChoice Manufacture Default Power Condition Timer Values

Default power condition timer values have been established to assure product reliability and data integrity. A minimum timer value threshold of two minutes ensures the appropriate amount of background drive maintenance activities occur. Attempting to set a timer values less than the specified minimum timer value threshold will result in an aborted EPC "Set Power Condition Timer" subcommand.

Power Condition Name	Manufacturer Default Timer Values
Idle_a	100 msec
Idle_b	2 min
Idle_c	4 min
Standby_z	15 min

Setting power condition timer values less than the manufacturer specified defaults or issuing the EPC "Go to Power Condition" subcommand at a rate exceeding the default timers may limit this products reliability and data integrity.

PowerChoice Supported Extended Power Condition Feature Subcommands

EPC Subcommand	Description
00_H	Restore Power Condition Settings
01_H	Go to Power Condition
02_H	Set Power Condition Timer
03_H	Set Power Condition State
04_H	Enable EPC Feature Set
05_H	Disable EPC Feature Set

PowerChoice Supported Extended Power Condition Identifiers

Power Condition Identifiers	Power Condition Name
00_H	Standby_z
$01 - 80_H$	Reserved
81_H	Idle_a
82_H	Idle_b
83_H	Idle_c
$84 - FE_H$	Reserved
FF_H	All EPC Power Conditions

2.6   Environmental limits

Temperature and humidity values experienced by the drive must be such that condensation does not occur on any drive part. Altitude and atmospheric pressure specifications are referenced to a standard day at 58.7°F (14.8°C).

Note	To maintain optimal performance drives should be run at nominal drive temperatures and humidity. See **Section 2.11, "Reliability"** for rated MTBF device operating condition requirements.

2.6.1   Temperature

a. Operating

41°F to 140°F (5°C to 60°C) temperature range with a maximum temperature gradient of 36°F (20°C) per hour as reported by the drive.

The maximum allowable drive reported temperature is 140°F (60°C).

Air flow may be required to achieve consistent nominal drive temperature values (see **Section 3.4**). To confirm that the required cooling is provided for the electronics and HDA, place the drive in its final mechanical configuration, and perform random write/ read operations. After the temperatures stabilize, monitor the current drive temperature using the SMART temperature attribute 194 or Device Statistics log 04h page 5.

b. Non-operating

−40° to 158°F (−40° to 70°C) package ambient with a maximum gradient of 36°F (20°C) per hour. This specification assumes that the drive is packaged in the shipping container designed by Seagate for use with drive.

2.6.2   Humidity

The values below assume that no condensation on the drive occurs. Maximum wet bulb temperature is 84.2°F (29°C).

2.6.2.1   Relative humidity

Operating:	5% to 95% non-condensing relative humidity with a maximum gradient of 20% per hour.
Non-operating:	5% to 95% non-condensing relative humidity with a maximum gradient of 20% per hour.

2.6.3   Effective Altitude (sea level)

Operating:	−304.8 m to 3048 m (−1000 ft. to 10,000+ ft.)
Non-operating:	−304.8 m to 12,192 m (−1000 ft. to 40,000+ ft.)

2.7 Shock and Vibration

Shock and vibration measurements specified in this document are made directly on the drive itself and applied in the X, Y, and Z axis at the drive mounting point locations.

2.7.1 Shock

a. Operating

The drive will operate without error while subjected to intermittent shock pulses not exceeding 70 Gs (read) and 40 Gs (write) at a duration of 2ms.

b. Non-operating

The drive will operate without non-recoverable errors after being subjected to shock pulses not exceeding 300g at a duration of 2ms.

2.7.2 Vibration

a. Linear Random Operating Vibration

The drive will operate without non-recoverable errors while being subjected to the random power spectral density noise specified below.

PSD of 5-500 Hz random noise at 0.70 g rms					
Frequency (Hz)	5	20	200	250	500
G^2/Hz	0.00025	0.00210	0.00210	0.00020	0.00020

b. Random Rotary Operating Vibration

The drive will exhibit greater than 90% throughput for sequential and random write operations while subjected to the shaped random power spectral density noise specified below.

PSD Profile 20-1500 Hz at 12.5 rad/sec^2				
Frequency (Hz)	20	200	800	1500
(rad/sec^2)^2/Hz	5.53E-02	5.53E-02	3.49E-01	6.14E-04

c. Linear Random Non-Operating Vibration

The drive will not incur physical damage or have non-recoverable errors after being subjected to the power spectral density noise specified below.

PSD Profile 2-500 Hz at 2.27 g rms				
Frequency (Hz)	2	4	100	500
G^2/Hz	0.001	0.030	0.030	0.001

2.8 Acoustics

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

Note	For seek mode tests, the drive is placed in seek mode only. The number of seeks per second is defined by the following equation: (Number of seeks per second = 0.4 / (average latency + average access time

Table 9   Fluid Dynamic Bearing (FDB) motor acoustics

	Idle*	Performance seek
All models	2.8 bels (typ) 3.0 bels (max)	3.2 bels (typ) 3.4 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.

2.9 Test for Prominent Discrete Tones (PDTs)

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

2.10 Electromagnetic immunity

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

Table 10   Radio frequency environments

Test	Description	Performance level	Reference standard
Electrostatic discharge	Contact, HCP, VCP: ± 4 kV; Air: ± 8 kV	B	EN 61000-4-2: 95
Radiated RF immunity	80 to 1000 MHz, 3 V/m, 80% AM with 1 kHz sine 900 MHz, 3 V/m, 50% pulse modulation @ 200 Hz	A	EN 61000-4-3: 96 ENV 50204: 95
Electrical fast transient	± 1 kV on AC mains, ± 0.5 kV on external I/O	B	EN 61000-4-4: 95
Surge immunity	± 1 kV differential, ± 2 kV common, AC mains	B	EN 61000-4-5: 95
Conducted RF immunity	150 kHz to 80 MHz, 3 Vrms, 80% AM with 1 kHz sine	A	EN 61000-4-6: 97
Voltage dips, interrupts	0% open, 5 seconds 0% short, 5 seconds 40%, 0.10 seconds 70%, 0.01 seconds	C C C B	EN 61000-4-11: 94

2.11   Reliability

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

The production disk drive shall achieve an annualized failure-rate of 0.44% (MTBF of 2,000,000 hours) over a 5 year service life when used in Enterprise Storage field conditions as limited by the following:

- 8760 power-on hours per year.
- HDA temperature as reported by the drive <= 40°C
- Ambient wet bulb temp <= 26°C
- Typical workload
- The AFR (MTBF) is a population statistic not relevant to individual units
- ANSI/ISA S71.04-2013 G2 classification levels and dust contamination to ISO 14644-1 Class 8 standards (as measured at the device)

The MTBF specification for the drive assumes the operating environment is designed to maintain nominal drive temperature and humidity. Occasional excursions in operating conditions between the rated MTBF conditions and the maximum drive operating conditions may occur without significant impact to the rated MTBF. However continual or sustained operation beyond the rated MTBF conditions will degrade the drive MTBF and reduce product reliability.

Nonrecoverable read errors	1 per 10^{15} bits read, max
Load unload cycles (command controlled)	600,000 cycles
Maximum Rated Workload	Maximum rate of <550TB/year Workloads exceeding the annualized rate may degrade the drive MTBF and impact product reliability. The Annualized Workload Rate is in units of TB per year, or TB per 8760 power on hours. Workload Rate = TB transferred * (8760 / recorded power on hours).
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 the "Is my Drive under Warranty" link. The following are required to be provided: the drive serial number, model number (or part number) and country of purchase. The system will display the warranty information for the drive.
Preventive maintenance	None required.

2.12   Agency and Safety Certifications

Each Hard Drive and Solid State Drive ("drives") has a product label that includes certifications that are applicable to that specific drive. The following information provides an overview of requirements that may be applicable to the drive.

2.12.1   Safety certification

These products are certified to meet the requirements of UL/cUL 60950-1, EN 60950-1, and may also include, IEC 62368, UL 62368 and EN 62368.

The security features of Self-Encrypting Drive models are based on the "TCG Storage Architecture Core Specification" and the "TCG Storage Workgroup Security Subsystem Class: Enterprise_A" specification with additional vendor-unique features as noted in this product manual.

2.12.2   Regulatory Models

The following regulatory model number represent all features and configurations within the series:

Regulatory Model Numbers: STL010

2.12.3 European Union (EU) CE Marking Requirements

Drives that display the CE mark comply with the European Union (EU) requirements specified in the Electromagnetic Compatibility Directive (2014/30/EU) put into force on 20 April 2016. Testing is performed to the levels specified by the product standards for Information Technology Equipment (ITE). Emission levels are defined by EN 55032:2012, Class B and the immunity levels are defined by EN 55024:2010.

The drives also meet the requirements of The Low Voltage Directive (LVD) 2014/35/EU.

Seagate drives are tested in representative end-user systems. Although CE-marked Seagate drives comply with all relevant regulatory requirements and standards for the drives, Seagate cannot guarantee that all system-level products into which the drives are installed comply with all regulatory requirements and standards applicable to the system-level products. The drive is designed for operation inside a properly designed system (e.g., enclosure designed for the drive), 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 the system-level products.

For compliance with the RoHS "Recast" Directive 2011/65/EU (RoHS 2), **See Section 2.13.1 on page 23** .

2.12.4 Australian RCM Compliance Mark

If these models have the RCM marking, they comply with the Australia/New Zealand Standard AS/NZ CISPR32 and meet the Electromagnetic Compatibility (EMC) Framework requirements of the Australian Communication and Media Authority (ACMA).

2.12.5 Canada ICES-003

If this model has the ICES-003:2016 marking it complies with requirements of ICES tested per ANSI C63.4-2014.

2.12.6 South Korean KC Certification Mark

The South Korean KC Certification Mark means the drives 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 Agency (RRA) 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.

기 종 별	사 용 자 안 내 문
B 급 기기 (가정용 방송통신기자재)	이 기기는 가정용(B 급) 전자파적합기기로서 주로 가정에서 사용하는 것을 목적으로 하며, 모든 지역에서 사용할 수 있습니다.

2.12.7 Morocco Commodity Mark

To satisfy our OEM customers, Seagate has added the Moroccan Commodity Mark to the drives provided to the OEM for the sale of Customer Kits produced by our OEM customers that are intended to be incorporated into the OEM's finished system-level product by an end user. The Customer Kits are considered 'devices' under Morocco's Order of the Minister of Industry, Trade, Investment and Digital Economy No. 2574-14 of 29 Ramadan 1436 (16 July 2015) on electromagnetic compatibility of equipment.

Seagate drives are tested for compliance and complies with the European Union (EU) Electromagnetic Compatibility (EMC) Directive 2014/30/EU and the Low Voltage Directive (LVD) 2014/35/EU. Accordingly, the drives also meets the requirements of Morocco's Order of the Minister of Industry, Trade, Investment and Digital Economy No. 2574-14 of 29 Ramadan 1436 (16 July 2015) on electromagnetic compatibility of equipment.

2.12.8 Taiwanese BSMI

Drives with the Taiwanese certification mark comply with Chinese National Standard, CNS13438.

For compliance with the Taiwan Bureau of Standards, Metrology and Inspection's (BSMI) requirements, **See Section 2.13.3 on page 25** .

2.12.9 FCC verification

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

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

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

This equipment is designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television, which can be determined by turning the equipment on and off, 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 a 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.

2.13 Environmental protection

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

2.13.1 European Union Restriction of Hazardous Substance Law

2.13.1.1 Restriction of Hazardous Substances in Electrical and Electronic Equipment

Seagate drives are designed to be compliant with the European Union RoHS "Recast" Directive 2011/65/EU (RoHS 2) as amended by Directive (EU) 2015/863. The RoHS2 restricts the use of certain hazardous substances such as Lead, Cadmium, Mercury, Hexavalent Chromium, Polybrominated Biphenyls (PBB) and Polybrominated Diphenyl Ether (PBDE), BisBis(2-Ethylhexyl) phthalate (DEHP), Benzyl butyl phthalate (BBP), Dibutyl phthalate (DBP), and Diisobutyl phthalate (DIBP) in electrical and electronic equipment (EEE).

2.13.1.2 Substances of Very High Concern (SVHC)

The European Union REACH (Registration, Evaluation, Authorization and Restriction of Chemicals) Regulation (EC) 1907/2006 regulates chemicals shipped into and used in Europe. A number of parts and materials in Seagate products are procured from external suppliers. We rely on the representations of our suppliers regarding the presence of REACH substances in these articles and materials. Our supplier contracts require compliance with our chemical substance restrictions, and our suppliers document their compliance with our requirements by providing full-disclosure material content declarations that disclose inclusion of any REACH-regulated substance in such articles or materials. Product-specific REACH declarations are available upon request through your Seagate Sales Representative.

2.13.2 China Requirements —China RoHS 2

China RoHS 2 refers to the Ministry of Industry and Information Technology Order No. 32, effective July 1, 2016, titled Management Methods for the Restriction of the Use of Hazardous Substances in Electrical and Electronic Products. To comply with China RoHS 2, Seagate determines this product's Environmental Protection Use Period (EPUP) to be 20 years in accordance with the *Marking for the Restricted Use of Hazardous Substances in Electronic and Electrical Products,* SJT 11364-2014.

Table 11 China - Hazardous Substances

部件名称 Part Name	有害物质 Hazardous Substances					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr^{+6})	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
硬盘驱动器 HDD	X	O	O	O	O	O
印刷电路板组装 PCBA	X	O	O	O	O	O
本表格依据 SJ/T 11364 的规定编制。 This table is prepared in accordance with the provisions of SJ/T 11364-2014 O：表示该有害物质在该部件所有均质材料中的含量均在 GB/T 26572 规定的限量要求以下。 O：Indicates that the hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement of GB/T26572. X：表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求。 X：Indicates that the hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement of GB/T26572.						

2.13.3　　　Taiwan Requirements — Taiwan RoHS

Taiwan RoHS refers to the Taiwan Bureau of Standards, Metrology and Inspection's (BSMI) requirements in standard CNS 15663, Guidance to reduction of the restricted chemical substances in electrical and electronic equipment. Seagate products must comply with the "Marking of presence" requirements in Section 5 of CNS 15663, effective January 1, 2018. This product is Taiwan RoHS compliant.

The following table meets the Section 5 "Marking of presence" requirements.

Table 12 Taiwan - Restricted Substances

設備名稱：硬碟設備，型號： Equipment Name: Hard Disk Device, Type Designation:						
單元 Unit	限用物質及其化學符號 Restricted Substance and its chemical symbol					
	鉛 (Pb)	汞 (Hg)	鎘 (Cd)	六價鉻 (Cr+6)	多溴聯苯 (PBB)	多溴二苯醚 (PBDE)
頂蓋 Top Cover	—	O	O	O	O	O
磁碟 Magnetic disk	—	O	O	O	O	O
電機底座組件 Motor Base Assembly	—	O	O	O	O	O
印刷電路板組裝 PCB Assembly	—	O	O	O	O	O
備考 1. "O" 係指該項限用物質之百分比含量未超出百分比含量基準值。 **Note 1.**　"O" indicates that the percentage content of the restricted substance does not exceed the percentage of reference value of presence. 備考 2. "—" 係指該項限用物質為排除項目。 **Note 2.**　"—" indicates that the restricted substance corresponds to the exemption.						

2.13　　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 hard disk drives are especially sensitive to the presence of sulfide, chloride, and nitrate contaminants. Sulfur is found to be the most damaging. 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.

Seagate recommends that data centers be kept clean by monitoring and controlling the dust and gaseous contamination. Gaseous contamination should be within ANSI/ISA S71.04-2013 G2 classification levels (as measured on copper and silver coupons), and dust contamination to ISO 14644-1 Class 8 standards, and MTBF rated conditions as defined in the Annualized Failure Rate (AFR) and Mean Time Between Failure (MTBF) section.

2.14   Reference documents

Supported standards

> Serial ATA Revision 3.3 specification

ANSI Documents

SFF-8301	3.5" Drive Form Factor with Serial Connector
INCITS 522-2014	SCSI Protocol Layer-4 (SPL-4) Rev. 08

Specification for Acoustic Test Requirement and Procedures

> Seagate part number: 30553-001

HDD and SSD Regulatory Compliance and Safety

> www.seagate.com/files/www-content/forms/compliance/regulatory-compliance-and-safety-100838899-A.pdf

In case of conflict between this document and any referenced document, this document takes precedence.

2.15   Product warranty

Beginning on the date of shipment to the customer and continuing for the period specified in the purchase contract, Seagate warrants that each product (including components and subassemblies) that fails to function properly under normal use due to defect in materials or workmanship or due to nonconformance to the applicable specifications will be repaired or replaced, at Seagate's option and at no charge to the customer, if returned by customer at customer's expense to Seagate's designated facility in accordance with Seagate's warranty procedure. Seagate will pay for transporting the repair or replacement item to the customer. For more detailed warranty information, refer to the standard terms and conditions of purchase for Seagate products on the purchase documentation.

The remaining warranty for a particular drive can be determined by calling Seagate Customer Service at 1-800-468-3472. Users can also determine remaining warranty using the Seagate web site (www.seagate.com). The drive serial number is required to determine remaining warranty information.

Shipping

When transporting or shipping a drive, use only a Seagate-approved container. Keep the original box. Seagate approved containers are easily identified by the Seagate Approved Package label. Shipping a drive in a non-approved container voids the drive warranty.

Seagate repair centers may refuse receipt of components improperly packaged or obviously damaged in transit. Contact the authorized Seagate distributor to purchase additional boxes. Seagate recommends shipping by an air-ride carrier experienced in handling computer equipment.

Storage

Maximum storage periods are 180 days within original unopened Seagate shipping package or 60 days unpackaged within the defined non-operating limits (refer to environmental section in this manual). Storage can be extended to 1 year packaged or unpackaged under optimal environmental conditions (25°C, <40% relative humidity non-condensing, and non-corrosive environment). During any storage period the drive non-operational temperature, humidity, wet bulb, atmospheric conditions, shock, vibration, magnetic and electrical field specifications should be followed.

Product repair and return information

Seagate customer service centers are the only facilities authorized to service Seagate drives. Seagate does not sanction any third-party repair facilities. Any unauthorized repair or tampering with the factory seal voids the warranty.

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

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 in). See **Table 13** 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 5**.
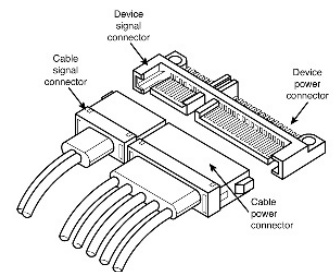
Figure 5.   Attaching SATA cabling

Each cable is keyed to ensure correct orientation. Exos 7E8 SATA 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. See **Figure 6** for drive mounting dimensions. Follow these important mounting precautions when mounting the drive:

• Allow a minimum clearance of 0.030 in (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 0.140 in (3.56mm) into the bottom or side mounting holes.

• Do not overtighten the mounting screws (maximum torque: 6 in-lb).

3.4.1 Mechanical specifications

Refer to **Figure 6** for detailed mounting configuration dimensions.

Weight:	8TB	1.579 lb	716g
	6TB	1.528 lb	693g
	4TB	1.431 lb	649g
	2TB	1.367 lb	620g

Note	These dimensions conform to the Small Form Factor Standard documented in SFF-8301 and SFF-8323, found at www.sffcommittee.org

Figure 6.   Mounting configuration dimensions 8TB and 6TB models (Option 1)

Note	The image is for mechanical dimension reference only and may not represent the actual drive.

Figure 7.   Mounting configuration dimensions 8TB and 6TB models (Option 2)

Note	The image is for mechanical dimension reference only and may not represent the actual drive.

BREATHER HOLE
DO NOT COVER

6X 6-32 UNC-2B
.14 THREAD DEPTH
∨ ∅ 0.169 ± 0.16 x 90°
MAX TORQUE: 6 IN-LBS

2X 1.750±.010

2X 1.432±.020

2X 1.625±.020

℄ OF DRIVE   ℄ OF CONN

2X .125±.010   .814±.020

2X 3.750±.010

4.000±.010

1.638±.010

1.122±.020

3X .250±.010
BOTH SIDES

6X 6-32 UNC-2B
.14 THREAD DEPTH
∨ ∅ 0.160 ± 0.10 x 90°
MAX TORQUE: 6 IN-LBS

5.787 MAX
[147.00 MM]

4.000±.010
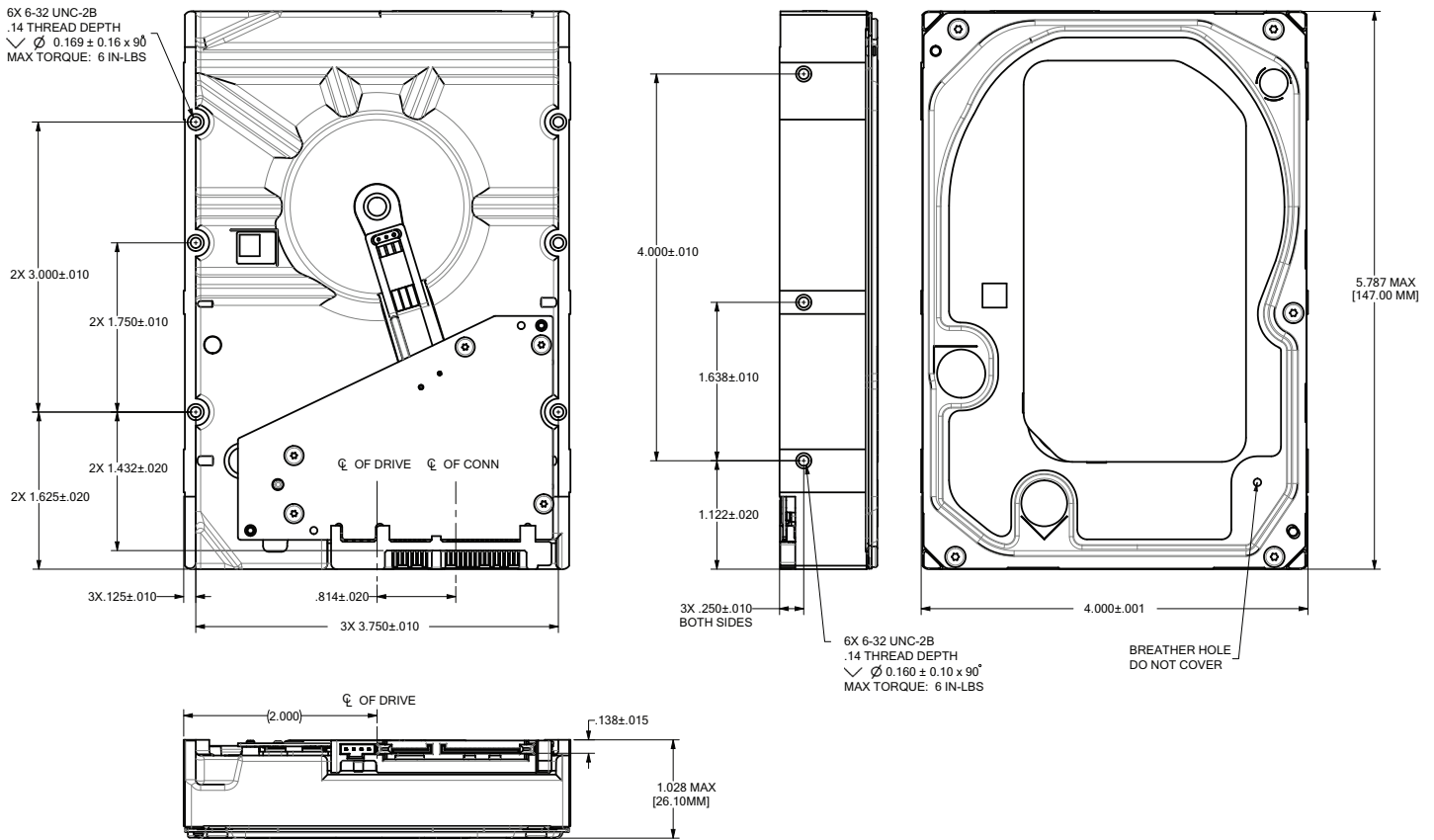
℄ OF DRIVE

(2.000)

.138±.015

1.028 MAX
[26.10 MM]

Figure 8.   Mounting configuration dimensions 4TB and 2TB models

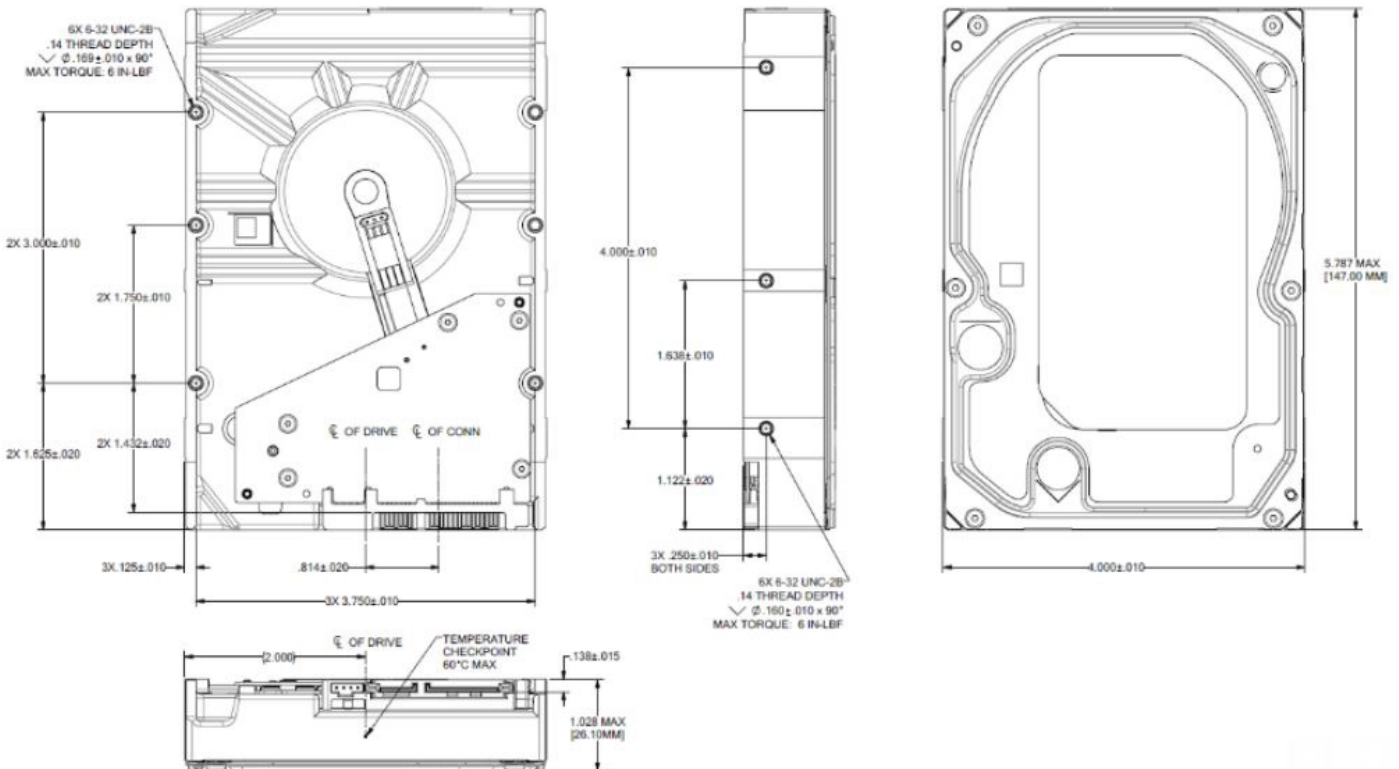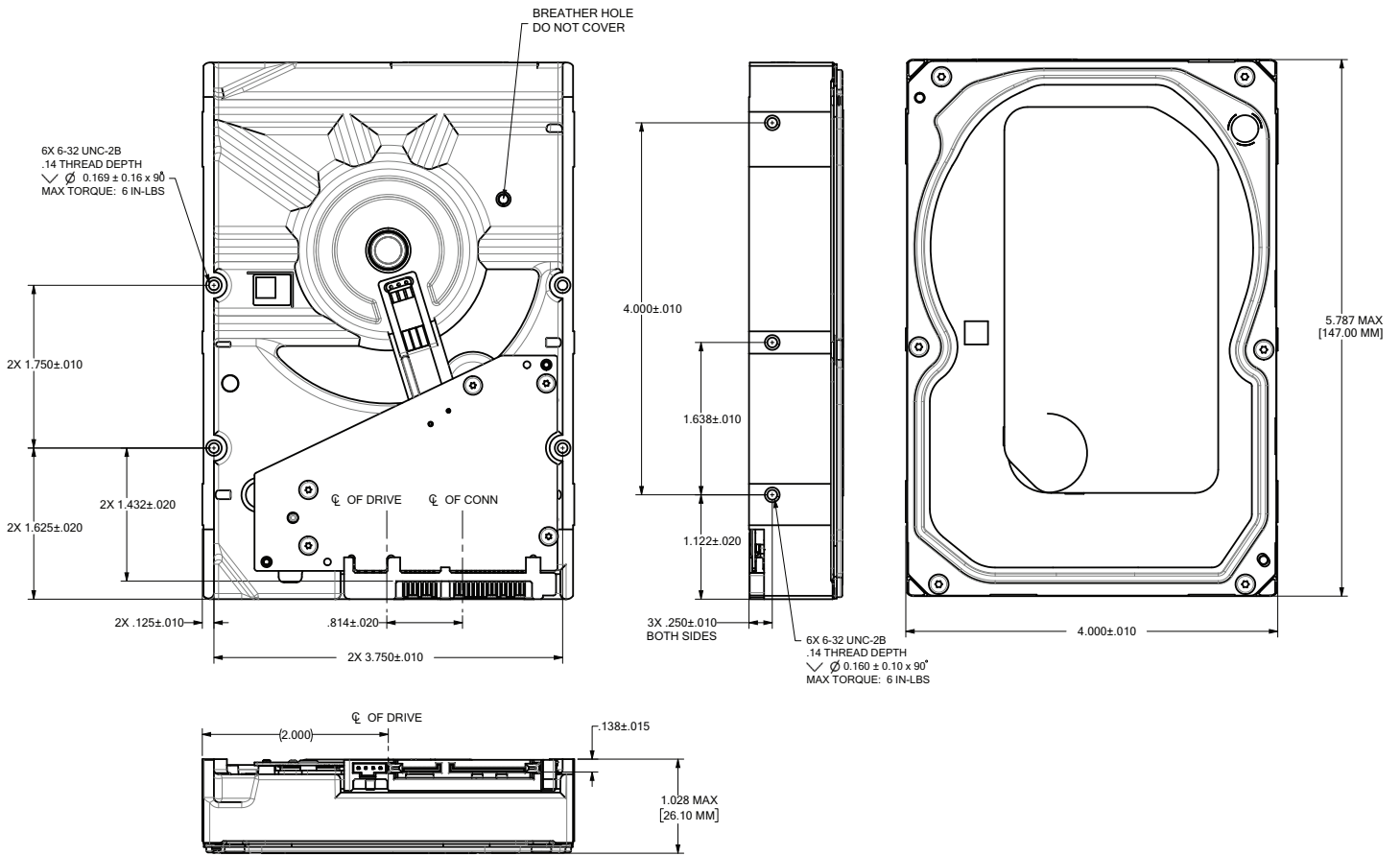| Note	The image is for mechanical dimension reference only and may not represent the actual drive.

4.0   About self-encrypting drives

Self-encrypting drives (SEDs) offer encryption and security services for the protection of stored data, commonly known as "protection of data at rest." These drives are compliant with the Trusted Computing Group (TCG) Enterprise Storage Specifications as detailed in **Section 2.14**.

The Trusted Computing Group (TCG) is an organization sponsored and operated by companies in the computer, storage and digital communications industry. Seagate's SED models comply with the standards published by the TCG.

To use the security features in the drive, the host must be capable of constructing and issuing the following two ATA commands:

* Trusted Send
* Trusted Receive

These commands are used to convey the TCG protocol to and from the drive in their command payloads.

4.1   Data encryption

Encrypting drives use one inline encryption engine for each port, employing AES-256 bit data encryption in AES-XTS mode to encrypt all data prior to being written on the media and to decrypt all data as it is read from the media. The encryption engines are always in operation and cannot be disabled.

The 32-byte Data Encryption Key (DEK) is a random number which is generated by the drive, never leaves the drive, and is inaccessible to the host system. The DEK is itself encrypted when it is stored on the media and when it is in volatile temporary storage (DRAM) external to the encryption engine. A unique data encryption key is used for each of the drive's possible16 data bands (see Section 7.5).

4.2   Controlled access

The drive has two security providers (SPs) called the "Admin SP" and the "Locking SP." These act as gatekeepers to the drive security services. Security-related commands will not be accepted unless they also supply the correct credentials to prove the requester is authorized to perform the command.

4.2.1   Admin SP

The Admin SP allows the drive's owner to enable or disable firmware download operations (see **Section 4.4**). Access to the Admin SP is available using the SID (Secure ID) password or the MSID (Manufacturers Secure ID) password.

4.2.2   Locking SP

The Locking SP controls read/write access to the media and the cryptographic erase feature. Access to the Locking SP is available using the BandMasterX or EraseMaster passwords. Since the drive owner can define up to 16 data bands on the drive, each data band has its own password called BandMasterX where X is the number of the data band (0 through 15).

4.2.3   Default password

When the drive is shipped from the factory, all passwords are set to the value of MSID. This 32-byte random value can only be read by the host electronically over the interface. After receipt of the drive, it is the responsibility of the owner to use the default MSID password as the authority to change all other passwords to unique owner-specified values.

4.3 Random number generator (RNG)

The drive has a 32-byte hardware RNG that it is uses to derive encryption keys or, if requested to do so, to provide random numbers to the host for system use, including using these numbers as Authentication Keys (passwords) for the drive's Admin and Locking SPs.

4.4 Drive locking

In addition to changing the passwords, as described in **Section 4.2.3**, the owner should also set the data access controls for the individual bands.

The variable "LockOnReset" should be set to "PowerCycle" to ensure that the data bands will be locked if power is lost. In addition "ReadLockEnabled" and "WriteLockEnabled" must be set to true in the locking table in order for the bands "LockOnReset" setting of "PowerCycle" to actually lock access to the band when a "PowerCycle" event occurs. This scenario occurs if the drive is removed from its cabinet. The drive will not honor any data read or write requests until the bands have been unlocked. This prevents the user data from being accessed without the appropriate credentials when the drive has been removed from its cabinet and installed in another system.

When the drive is shipped from the factory, the firmware download port is unlocked.

4.5 Data bands

When shipped from the factory, the drive is configured with a single data band called Band 0 (also known as the Global Data Band) which comprises LBA 0 through LBA max. The host may allocate Band1 by specifying a start LBA and an LBA range. The real estate for this band is taken from the Global Band. An additional 30 Data Bands may be defined in a similar way (Band2 through Band31) but before these bands can be allocated LBA space, they must first be individually enabled using the EraseMaster password.

Data bands cannot overlap but they can be sequential with one band ending at LBA (x) and the next beginning at LBA (x+1).

Each data band has its own drive-generated encryption key and its own user-supplied password. The host may change the Encryption Key (see **Section 4.6**) or the password when required. The bands should be aligned to 4K LBA boundaries.

4.6 Cryptographic erase

A significant feature of SEDs is the ability to perform a cryptographic erase. This involves the host telling the drive to change the data encryption key for a particular band. Once changed, the data is no longer recoverable since it was written with one key and will be read using a different key. Since the drive overwrites the old key with the new one, and keeps no history of key changes, the user data can never be recovered. This is tantamount to an instantaneous data erase and is very useful if the drive is to be scrapped or redispositioned.

4.7 Authenticated firmware download

In addition to providing a locking mechanism to prevent unwanted firmware download attempts, the drive also only accepts download files which have been cryptographically signed by the appropriate Seagate Design Center.

Three conditions must be met before the drive will allow the download operation:

1. The download must be an SED file. A standard (base) drive (non-SED) file will be rejected.

2. The download file must be signed and authenticated.

3. As with a non-SED drive, the download file must pass the acceptance criteria for the drive. For example it must be applicable to the correct drive model, and have compatible revision and customer status.

4.8   Power requirements

The standard drive models and the SED drive models have identical hardware, however the security and encryption portion of the drive controller ASIC is enabled and functional in the SED models. This represents a small additional drain on the 5V supply of about 30mA and a commensurate increase of about 150mW in power consumption. There is no additional drain on the 12V supply. See the tables in **Section 2.5** for power requirements on the standard (non-SED) drive models.

4.9   Supported commands

The SED models support the following two commands in addition to the commands supported by the standard (non-SED) models as listed in **Table 14**:
- Trusted Send (5Eh) or Trusted Send DMA (5Fh)
- Trusted Receive (5Ch) or Trusted Receive DMA (5D)

4.10   RevertSP

SED models will support the RevertSP feature which erases all data in all bands on the device and returns the contents of all SPs (Security Providers) on the device to their original factory state. In order to execute the RevertSP method the unique PSID (Physical Secure ID) printed on the drive label must be provided. PSID is not electronically accessible and can only be manually read from the drive label or scanned in via the 2D barcode.

4.11   ATA Security Erase Unit Command on SED SATA drives

The ATA SECURITY ERASE UNIT command shall support both the Normal and Enhanced erase modes with the following modifications/additions:
- Normal Erase: Normal erase shall be accomplished by changing the media encryption key for the drive followed by an overwrite operation that repeatedly writes a single sector containing random data to the entire drive. The write operation shall bypass the media encryption. On reading back the overwritten sectors, the host will receive a decrypted version, using the new encryption key, of the random data sector (the returned data will not match what was written).
- Enhanced Erase: Enhanced erase shall be accomplished by changing the media encryption key for the drive.

4.12   Sanitize Device - CRYPTO SCRAMBLE EXT

This command cryptographically erases all user data on the drive by destroying the current data encryption key and replacing it with a new data encryption key randomly generated by the drive. Sanitize Device is a command field B4h and Feature field 0011h (CRYPTO SCRAMBLE EXT).

The drive shall support the Sanitize Feature Set as defined in ANSI/INCITS ACS-2 with the exceptions and/or modifications described in this section.

The drive shall not support the OVERWRITE EXT and BLOCK ERASE EXT sub-commands.

Support of the SANITIZE FREEZE LOCK EXT command shall be determined on a customer-specific basis. OEM drives shall support the command.

5.0   About FIPS

The Federal Information Processing Standard (FIPS) Publication 140-2 is a U.S. Government Computer Security Standard used to accredit cryptographic modules. It is titled 'Security Requirements for Cryptographic Modules (FIPS PUB 140-2)' and is issued by the National Institute of Standards and Technology (NIST).

Purpose

This standard specifies the security requirements that will be satisfied by a cryptographic module utilized within a security system protecting sensitive but unclassified information. The standard provides four increasing, qualitative levels of security: Level 1, Level 2, Level 3 and Level 4. These levels are intended to cover the wide range of potential applications and environments in which cryptographic modules may be employed.

Seagate Enterprise SEDs

The SEDs referenced in this Product Manual have been validated by CMVP and have been thoroughly tested by a NVLAP accredited lab to satisfy FIPS 140-2 Level 2 requirements. In order to operate in FIPS Approved Mode of Operation, these SEDs require security initialization. For more information, refer to 'Security Rules' section in the 'Security Policy' document uploaded on the NIST website. To reference the product certification visit - http://csrc.nist.gov/groups/STM/cmvp/documents/140-1/1401vend.htm and search for "Seagate".

Level 2 security

Security Level 2 enhances the physical security mechanisms of a Security Level 1 cryptographic module by adding the requirement for tamper-evidence, which includes the use of tamper-evident coatings or seals on removable covers of the module. Tamper-evident coatings or seals are placed on a cryptographic module so that the coating or seal must be broken to attain physical access to the critical security parameters (CSP) within the module. Tamper-evident seals are placed on covers to protect against unauthorized physical access. In addition Security Level   2   requires,   at   a   minimum,   role-based   authentication   in   which   a cryptographic module authenticates the authorization of an operator to assume a specific role and perform a corresponding set of services
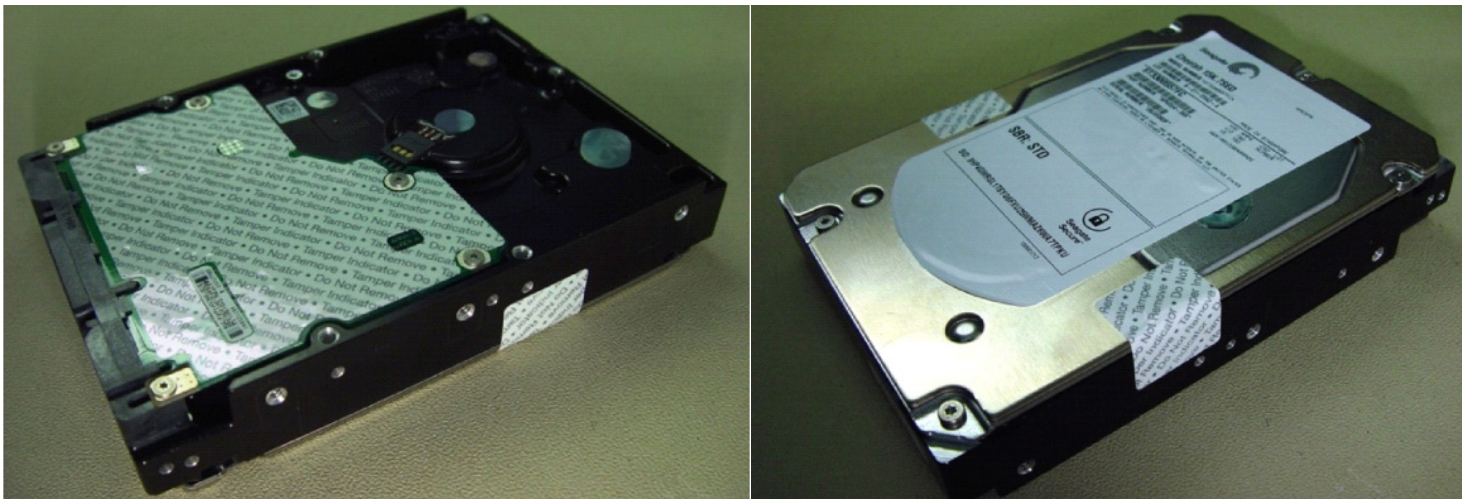.

Figure 9.   Example of FIPS tamper evidence labels.

| Note | Image is for reference only, may not represent actual drive |

6.0   Serial ATA (SATA) interface

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

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

6.1   Hot-Plug compatibility

Exos 7E8 SATA drives incorporate connectors which enable users to hot plug these drives in accordance with the Serial ATA Revision 3.2 specification. This specification can be downloaded from www.serialata.org.

Caution	The drive motor must come to a complete stop **(Ready to spindle stop time indicated in Section 2.4)** prior to changing the plane of operation. This time is required to insure data integrity.

6.2   Serial ATA device plug connector pin definitions

Table 13 summarizes the signals on the Serial ATA interface and power connectors.

Table 13   Serial ATA connector pin definitions

Segment	Pin	Function	Definition
Signal	S1	Ground	2nd mate
	S2	A+	Differential signal pair A from Phy
	S3	A-	
	S4	Ground	2nd mate
	S5	B-	Differential signal pair B from Phy
	S6	B+	
	S7	Ground	2nd mate
Key and spacing separate signal and power segments			
Power	P1	V_{33}	3.3V power
	P2	V_{33}	3.3V power
	P3	V_{33}	3.3V power, pre-charge, 2nd mate
	P4	Ground	1st mate
	P5	Ground	2nd mate
	P6	Ground	2nd mate
	P7	V_5	5V power, pre-charge, 2nd mate
	P8	V_5	5V power
	P9	V_5	5V power
	P10	Ground	2nd mate
	P11	Ground or LED signal	If grounded, drive does not use deferred spin
	P12	Ground	1st mate.
	P13	V_{12}	12V power, pre-charge, 2nd mate
	P14	V_{12}	12V power
	P15	V_{12}	12V power

Notes:

1. All pins are in a single row, with a 1.27mm (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 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.
4. All used voltage pins (V_x) must be terminated.

6.3 Supported ATA commands

The following table lists Serial ATA standard commands that the drive supports. For a detailed description of the ATA commands, refer to the Serial ATA: High Speed Serialized AT Attachment specification. **See "S.M.A.R.T. commands" on page 41** for details and subcommands used in the S.M.A.R.T. implementation.

Table 14   Supported ATA commands

Command name			Command code (in hex)
Accessible Max Address Configuration			
		Get Native Max Address Ext	78_H / 0000_H
		Set Accessible Max Address Ext	78_H / 0001_H
		Freeze Accessible Max Address Ext	78_H / 0002_H
Check Power Mode			$E5_H$
Download Microcode			92_H
Execute Device Diagnostics			90_H
Flush Cache			$E7_H$
Flush Cache Extended			EA_H
Identify Device			EC_H
Idle			$E3_H$
Idle Immediate			$E1_H$
NoP			00_H
Read Buffer			$E4_H$
Read Buffer DMA			$E9_H$
Read DMA			$C8_H$
Read DMA Extended			25_H
Read FPDMA Queued			60_H
Read Log DMA Ext			47_H
Read Log Ext			$2F_H$
Read Multiple			$C4_H$
Read Multiple Extended			29_H
Read Sectors			20_H
Read Sectors Extended			24_H
Read Sectors Without Retries			21_H
Read Verify Sectors			40_H
Read Verify Sectors Extended			42_H
Read Verify Sectors Without Retries			41_H
Request Sense Data Ext			$0B_H$
Sanitize Device - Overwrite Ext			$B4_H$ / 0014_H
Sanitize Device - Freeze Lock Ext			$B4_H$ / 0020_H
Sanitize Device - Status Ext			$B4_H$ / 0000_H
Security Disable Password			$F6_H$
Security Erase Prepare			$F3_H$
Security Erase Unit			$F4_H$
Security Freeze			$F5_H$
Security Set Password			$F1_H$
Security Unlock			$F2_H$

Command name	Command code (in hex)
Seek	70_H
Set Date & Time Ext	77_H
Set Features	EF_H
Set Multiple Mode	$C6_H$
Sleep	$E6_H$
S.M.A.R.T. Disable Operations	$B0_H$ / $D9_H$
S.M.A.R.T. Enable/Disable Autosave	$B0_H$ / $D2_H$
S.M.A.R.T. Enable Operations	$B0_H$ / $D8_H$
S.M.A.R.T. Execute Offline	$B0_H$ / $D4_H$
S.M.A.R.T. Read Attribute Thresholds	$B0_H$ / $D1_H$
S.M.A.R.T. Read Data	$B0_H$ / $D0_H$
S.M.A.R.T. Read Log Sector	$B0_H$ / $D5_H$
S.M.A.R.T. Return Status	$B0_H$ / DA_H
S.M.A.R.T. Save Attribute Values	$B0_H$ / $D3_H$
S.M.A.R.T. Write Log Sector	$B0_H$ / $D6_H$
Standby	$E2_H$
Standby Immediate	$E0_H$
Trusted Send	$5E_H$ (SED drives only)
Trusted Send DMA	$5F_H$ (SED drives only)
Trusted Receive	$5C_H$ (SED drives only)
Trusted Receive DMA	$5D_H$ (SED drives only)
Write Buffer	$E8_H$
Write Buffer DMA	EB_H
Write DMA	CA_H
Write DMA Extended	35_H
Write DMA FUA Extended	$3D_H$
Write FPDMA Queued	61_H
Write Log DMA Ext	57_H
Write Log Extended	$3F_H$
Write Multiple	$C5_H$
Write Multiple Extended	39_H
Write Multiple FUA Extended	CE_H
Write Sectors	30_H
Write Sectors Without Retries	31_H
Write Sectors Extended	34_H
Write Uncorrectable	45_H

6.3.1 Identify Device command

The Identify Device command (command code EC$_H$) transfers information about the drive to the host following power up. The data is organized as a single 512-byte block of data, whose contents are shown in **Table 14 on page 35**. 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 6** for default parameter settings.

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

Table 15   Identify Device commands

Word	Description	Value
0	Configuration information: • Bit 15: 0 = ATA; 1 = ATAPI • Bit 7: removable media • Bit 6: removable controller • Bit 0: reserved	0C5A$_H$
1	Number of logical cylinders	16,383
2	ATA-reserved	0000$_H$
3	Number of logical heads	16
4	Retired	0000$_H$
5	Retired	0000$_H$
6	Number of logical sectors per logical track: 63	003F$_H$
7–9	Retired	0000$_H$
10–19	Serial number: (20 ASCII characters, 0000$_H$ = none)	ASCII
20-21	Retired	0000$_H$
22	Obsolete	0000$_H$
23–26	Firmware revision (8 ASCII character string, padded with blanks to end of string)	x.xx
27–46	Drive model number: (40 ASCII characters, padded with blanks to end of string)	
47	(Bits 7–0) Maximum sectors per interrupt on Read multiple and Write multiple (16)	8010$_H$
48	Trusted computing feature set options	4000$_H$
49	Standard Standby timer, IORDY supported and may be disabled	2F00$_H$
50	ATA-reserved	0000$_H$
51	PIO data-transfer cycle timing mode	0200$_H$
52	Retired	0200$_H$
53	Words 54–58, 64–70 and 88 are valid	0007$_H$
54-58	Obsolete	xxxx$_H$
59	Number of sectors transferred during a Read Multiple or Write Multiple command	xxxx$_H$
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: 0FFFFFFFh (268,435,455 sectors, 137GB). Drives with capacities over 137GB will have 0FFFFFFFh in this field and the actual number of user-addressable LBAs specified in words 100-103. This is required for drives that support the 48-bit addressing feature.	0FFFFFFFh*
62	Retired	0000$_H$
63	Multiword DMA active and modes supported (see note following this table)	x407$_H$
64	Advanced PIO modes supported (modes 3 and 4 supported)	0003$_H$
65	Minimum multiword DMA transfer cycle time per word (120 ns)	0078$_H$
66	Recommended multiword DMA transfer cycle time per word (120 ns)	0078$_H$
67	Minimum PIO cycle time without IORDY flow control (120 ns)	0078$_H$

Table 15   Identify Device commands

Word	Description	Value
68	Minimum PIO cycle time with IORDY flow control (120 ns)	0078_H
69	Additional supported	00008_H
70–74	ATA-reserved	0000_H
75	Queue depth	$001F_H$
76	Serial ATA capabilities	$8D0E_H$
77	Reserved for future Serial ATA definition	$xxxx_H$
78	Serial ATA features supported	$xxxx_H$
79	Serial ATA features enabled	$xxxx_H$
80	Major version number	$0FE0_H$
81	Minor version number	$FFFF_H$
82	Command sets supported	$306B_H$
83	Command sets supported	7561_H
84	Command sets support extension (see note following this table)	6173_H
85	Command sets enabled	3069_H
86	Command sets enabled	$B441_H$
87	Command sets enable extension	6173_H
88	Ultra DMA support and current mode (see note following this table)	$007F_H$
89	Security erase time	$xxxx_H$
90	Enhanced security erase time	$xxxx_H$
92	Master password revision code	$FFFE_H$
93	Hardware reset value	$xxxx_H$
94	Obsolete	0000_H
95	Stream Minimum Request Size	$0x1000_H$
96	Streaming Transfer Time	$0x0000_H$
97	Streaming Access Latency	$0x0000_H$
98-99	Streaming Performance Granularity	$0x0000\ 2710_H$
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: 0000FFFFFFFFFFFFh.	8TB 5xx models = 15,628,053,168 6TB 5xx models = 11,721,045,168 4TB 5xx models = 7,814,037,168 2TB 5xx models = 3,907,029,168
104–105	ATA-reserved	0000_H
106	Physical/Logical sector size	6003_H
107	ATA-reserved	0000_H
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.
112–118	ATA-reserved	0000_H
119	Commands and feature sets supported	$43DE_H$
120	Commands and feature sets supported or enabled	$409C_H$
121-127	ATA-reserved	0000_H
128	Security status	0021_H
129–159	Seagate-reserved	$xxxx_H$

Table 15 Identify Device commands

Word	Description	Value
160–205	ATA-reserved	0000$_H$
206	SCT Command Transport command set. If bit 0 is set to one, then the device supports SCT Command Transport. Bits 7:2 indicate individual SCT feature support.	xxBD$_H$
207-254	ATA-reserved	0000$_H$
255	Integrity word	xxA5$_H$

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

6.3.2　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 16　Set Features command values

02_H 　　　Enable write cache *(default)*.

03_H 　　　Set transfer mode (based on value in Sector Count register).
　　　　　　Sector Count register values:

　　　　　00_H　Set PIO mode to default (PIO mode 2).

　　　　　01_H　Set PIO mode to default and disable IORDY (PIO mode 2).

　　　　　08_H　PIO mode 0

　　　　　09_H　PIO mode 1

　　　　　$0A_H$　PIO mode 2

　　　　　$0B_H$　PIO mode 3

　　　　　$0C_H$　PIO mode 4 *(default)*

　　　　　20_H　Multiword DMA mode 0

　　　　　21_H　Multiword DMA mode 1

　　　　　22_H　Multiword DMA mode 2

　　　　　40_H　Ultra DMA mode 0

　　　　　41_H　Ultra DMA mode 1

　　　　　42_H　Ultra DMA mode 2

　　　　　43_H　Ultra DMA mode 3

　　　　　44_H　Ultra DMA mode 4

　　　　　45_H　Ultra DMA mode 5

　　　　　46_H　Ultra DMA mode 6

10_H 　　　Enable use of SATA features

55_H 　　　Disable read look-ahead (read cache) feature.

82_H 　　　Disable write cache

90_H 　　　Disable use of SATA features

AA_H 　　　Enable read look-ahead (read cache) feature *(default)*.

$F1_H$ 　　　Report full capacity available

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

6.3.3 S.M.A.R.T. commands

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

SeaTools diagnostic software activates a built-in drive self-test (DST S.M.A.R.T. command for D4$_H$) that eliminates unnecessary drive returns. The diagnostic software ships with all new drives and is also available at:
http://www.seagate.com/support/downloads/seatools/.

This drive is shipped with S.M.A.R.T. features disabled. Users 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 17   S.M.A.R.T. commands

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

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

SEAGATE