SEAGATE

EXOS™
ENTERPRISE

X22 SATA Product Manual

512E* models
Standard
ST22000NM001E
ST20000NM004E

512E* models
Self-Encrypting
ST22000NM002E
ST20000NM005E

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

203812000, Rev. A
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Document Revision History

Revision	Date	Pages affected and Description of changes
Rev. A (Draft 1)	08/25/2022	Initial draft.
Rev. A (Draft 2)	08/26/2022	fc, 5, 7-9, 32 & 45: Added ISE models 5: Updated data buffer bullet to 512
Rev. A (Draft 3)	09/15/2022	fc, 5, 7, 23 & 28: Changed product name to Exos X22 fc, 5, 7-9, 32 & 45: Removed ISE models 7: Removed 20TB disk count 7 & 24: Corrected weight to 680g/1.499 lb 12: Updated Table 5 DC power requirements 28: Updated Table 8 Serial ATA connector pin definitions, Power Pin 3 Function & Definition

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1.0   Introduction

This manual describes the functional, mechanical and interface specifications for the following:
Seagate® Exos® X22 SATA drive models.

512E models	
Standard	**SED**
ST22000NM001E	ST22000NM002E
ST20000NM004E	ST20000NM005E

These drives provide the following key features:

- 512 MB data buffer.
- 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.
- PowerChoice™ for selectable power savings
- Perpendicular recording technology provides the drives with increased areal density.
- 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.
- T13 Fast Format conversion (see **Section 2.2.1**)
- Top Cover Attached motor for excellent vibration tolerance
- 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.

   NOTE   The Self-Encrypting Drive models indicated on the cover of this product manual
                     have provisions for "Security of Data at Rest" based on the standards defined by the
                     Trusted Computing Group (see www.trustedcomputinggroup.org).

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°C, and nominal power. For convenience, the phrases *the drive* and *this drive* are used throughout this manual to indicate the Exos X22 SATA drive models.

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	ST22000NM001E, ST22000NM002E	ST20000NM004E, ST20000NM005E
Formatted (512 bytes/sector)*	22TB	20TB
Guaranteed sectors	(see *Section 2.2*)	
Heads	20	18
Disks	10	
Bytes per logical sector	512	
Bytes per physical sector	4096	
Recording density, KBPI (Kb/in max)	2552	
Track density, KTPI (ktracks/in avg.)	512	
Areal density, (Gb/in^2 avg)	1260	
Spindle speed (RPM)	7200	
Internal data transfer rate (Mb/s max)	2951	
Sustained data transfer rate OD (MiB/s max)	272 (285 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	512MB (524,288KB)	
Weight: (maximum)	680g (1.499 lb)	
Average latency	4.16ms	
Power-on to ready (sec) (typ/max)	25/30	
Standby to ready (sec) (typ/max)	25/30	
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[†]	10° to 60°C (Drive Reported Temperature)	
Non-Operating temperature	–40° to 70°C (Ambient Temperature, see sections **2.6.1** and **2.14**)	

Drive specification	ST22000NM001E, ST22000NM002E	ST20000NM004E, ST20000NM005E
Temperature gradient (°C per hour max)	20°C (operating) 20°C (nonoperating)	
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)	40 Gs	
Non-Operational Shock (2 ms)	200 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)*	0.35% 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: 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	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.

*   See **Section 2.10, "Reliability"** for rated MTBF device operating condition requirements.

2.2   Formatted capacity

ST models	Formatted capacity*	Guaranteed sectors	Bytes per logical sector	Guaranteed sectors	Bytes per logical sector
ST22000NM001E, ST22000NM002E	22TB	42,970,644,480	512 (Default)	5,371,330,560	4096 (see **Section 2.2.1**)
ST20000NM004E, ST20000NM005E	20TB	39,063,650,304		4,882,956,288	

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

> **NOTE**   LBA Counts for drive capacities greater than 8TB are calculated based upon the SFF-8447 standard publication. ftp://ftp.seagate.com/sff/SFF-8447.PDF

2.2.1   Fast Format - logical sector size conversion

- Drive supports either 512E or 4KN logical sector size formats
- SET SECTOR CONFIGURATION EXT (B2h) command (ACS-4 Standard) quickly converts between 512 and 4096 byte logical sector size formats
- The selected sector size change occurs immediately upon command completion
- 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

- COMMAND CHECK field value is taken from the DESCRIPTOR CHECK field in the descriptor specified by the SECTOR CONFIGURATION DESCRIPTOR INDEX field
- 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 5.3.1, "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)	2552
Track density, KTPI (ktracks/in avg)	512
Areal density (Gb/in^2 avg)	1260
Spindle speed (RPM) (± 0.2%)	7200
Internal data transfer rate (Mb/s max)	2951
Sustained data transfer rate (MiB/s max)	272 (285 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 time is based on typical operating conditions, default full current spin-up profile, and clean shutdown prior to measurement. To ensure a clean shutdown a Flush Cache, Standby, or Standby Immediate command must be completed before removal of interface power.

Power-on to Ready (sec) (typ/max)	25/30
Standby to Ready (sec) (typ/max)	25/30
Ready to spindle stop (sec) (max)	20

NOTE   An unexpected power loss event, spin up at cold or hot temperature extremes may cause the drive to exceed the typical and max time to ready by 5 seconds. Extended time to ready is dependent on cache state and environmental conditions prior to the unexpected power loss and during the subsequent power on.

2.5   Power specifications

The drive receives DC power (+5V or +12V) through a native SATA power connector. **See Figure 3 on page 23** .

2.5.1   Power consumption

Power requirements for the drives are listed in **Table 5**. Typical power measurements are based on an average of drives tested, under nominal conditions, using 5.0V and 12.0V input voltage at 35°C ambient temperature.

Table 5   DC power requirements (22TB and 20TB models)

		6.0Gb mode		
Voltage		+5V	+12V	Watts
Regulation		± 5%	± 10%	Total
Avg Idle Current *		0.299	0.353	5.74
Advanced Idle Current *				
	Idle_A	0.296	0.351	5.70
	Idle_B	0.253	0.211	3.80
	Idle_C	0.233	0.138	2.83
	Standby	0.168	0.007	0.93
Maximum Start Current				
	DC (peak DC)	0.841	2.095	
	AC (Peak DC)	0.960	2.440	
	Delayed motor start (max) DC	0.297	0.069	
Operating current (random read 4K16Q):				
	Typical DC	0.324	0.640	9.31
	Maximum DC	0.328	0.648	9.42
	Maximum DC (peak)	0.993	2.321	
Operating current (random write 4K16Q)				
	Typical DC	0.352	0.437	7.01
	Maximum DC	0.356	0.445	7.13
	Maximum DC (peak)	0.959	2.217	
Operating current (sequential read 64K16Q)				
	Typical DC	0.781	0.345	8.06
	Maximum DC	0.790	0.353	8.22
	Maximum DC (peak)	1.091	2.210	
Operating current (sequential write 64K16Q)				
	Typical DC	0.777	0.342	8.00
	Maximum DC	0.875	0.351	8.16
	Maximum DC (peak)	1.053	0.570	

Table 5   DC power requirements (22TB and 20TB models)

	6.0Gb mode		
Power Balance Operating current (random read 4K16Q):			
Typical DC	0.322	0.547	8.18
Maximum DC	0.327	0.554	8.30
Maximum DC (peak)	0.992	2.178	
Power Balance Operating current (random write 4K16Q)			
Typical DC	0.352	0.429	6.91
Maximum DC	0.358	0.436	7.03
Maximum DC (peak)	0.995	2.216	
Power Balance Operating current (sequential read 64K16Q)			
Typical DC	0.780	0.345	8.05
Maximum DC	0.791	0.353	8.21
Maximum DC (peak)	1.120	2.267	
Power Balance Operating current (sequential write 64K16Q)			
Typical DC	0.777	0.343	8.02
Maximum DC	0.787	0.352	8.18
Maximum DC (peak)	1.052	0.575	

*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.

2.5.1.1   Typical current profiles

Figure 1.   Typical 5V and 12V startup and operation current profiles

2.5.2   Conducted noise

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.

2.5.3   Voltage tolerance

Voltage tolerance (including noise):

5V   ± 5%   12V   ± 10%

2.5.4   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 ms
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 2.10, "Reliability"** for rated MTBF device operating condition requirements.

2.6.1   Temperature

a. Operating

50°F to 140°F (10°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.
Nonoperating:	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.)
Nonoperating:	–304.8 m to 12,192 m (–1000 ft. to 40,000+ ft.)

2.6.4   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.

2.6.4.1   Shock

a. Operating

The drive will operate without error while subjected to intermittent shock pulses not exceeding 40 Gs typical at a 2ms duration limited by Z-axis, shown in **Figure 2**.

b. Non-operating

The drive will operate without non-recoverable errors after being subjected to shock pulses not exceeding 200g at a duration of 2ms.
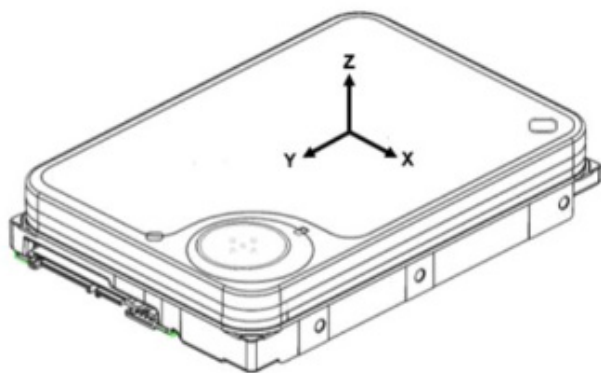
Figure 2.   Drive orientation

2.6.4.2   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

2.7   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 6   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.

2.8   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.

2.9   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 7   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

2.10   Reliability

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

The production disk drive shall achieve an annualized failure-rate of 0.35% (MTBF of 2,500,000 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 <= 30°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	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: 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.

2.11   HDD and SSD Regulatory Compliance and Safety

For the latest regulatory and compliance information see: www.seagate.com/support scroll down the page and click the Compliance, Safety and Disposal Guide link.

2.11.1   Regulatory Models

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

Regulatory Model Numbers: STL024

2.12   Corrosive environment

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.

2.13   Reference documents

Supported Standards
              Serial ATA Revision 3.3 specification

ANSI Documents
              INCITS 529-2018   ATA/ATAPI Command Set - 4 (ACS-4)

Specification for Acoustic Test Requirement and Procedures
              Seagate part number: 30553-001

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

2.14   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
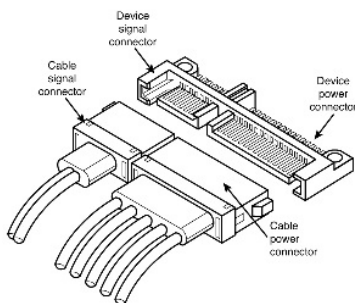
The Serial ATA interface cable consists of four conductors in two differential pairs, plus three ground connections. The cable size may be 30 to 26 AWG with a maximum length of one meter (39.37 in).

See **Table 8** 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 3**.

Figure 3.   Attaching SATA cabling

Each cable is keyed to ensure correct orientation. Exos X22 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 4** 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 4** for detailed mounting configuration dimensions. See **Section 3.4**, "Drive mounting."

Weight:	22TB & 20TB	1.499 lb	680 g

NOTE   These dimensions conform to the Small Form Factor Standard documented in SFF-8301 and SFF-8323, found at www.snia.org/technology-communities/sff/specifications
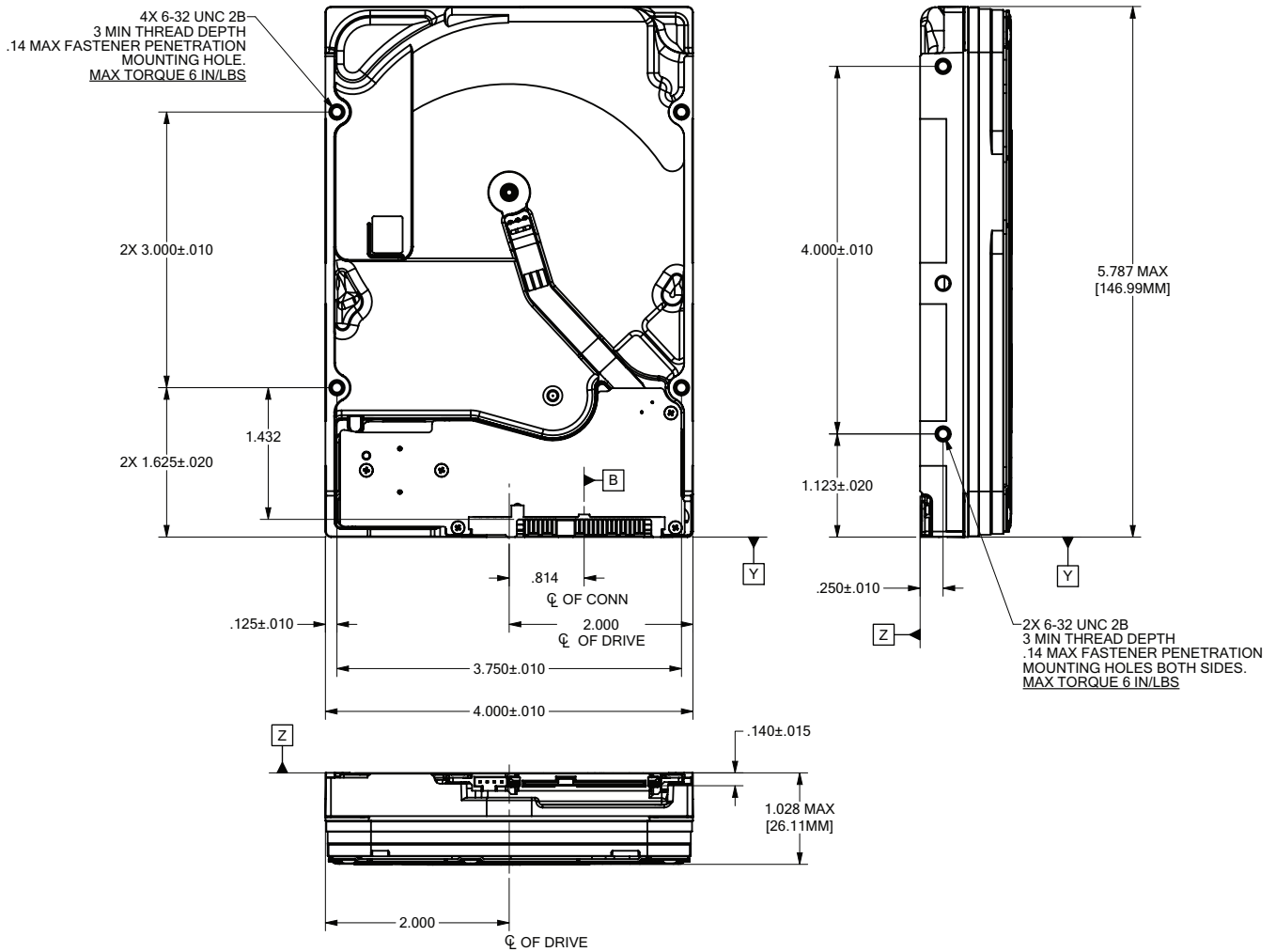

Figure 4.   Mounting configuration dimensions
NOTE   The image is for mechanical dimension reference only and may not represent the actual drive.

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 2.13**.

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 keys with 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 4.5**).

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 9**:

- 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.

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

5.0 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.

5.1 Hot-Plug compatibility

Exos X22 SATA drives incorporate connectors which enable users to hot plug these drives in accordance with the Serial ATA Revision 3.3 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.

5.2 Serial ATA device plug connector pin definitions

Table 8 summarizes the signals on the Serial ATA interface and power connectors.

Table 8   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	V33	3.3V power
	P2	V33	3.3V power
	P3	V33 (DEVSLP/PWDIS)	3.3V power, 2nd mate ENTER/EXIT DevSleep \ ENTER/EXIT Power Disable
	P4	Ground	1st mate
	P5	Ground	2nd mate
	P6	Ground	2nd mate
	P7	V5	5V power, pre-charge, 2nd mate
	P8	V5	5V power
	P9	V5	5V power
	P10	Ground	2nd mate
	P11	Ground or LED signal	If grounded, drive does not use deferred spin
	P12	Ground	1st mate.
	P13	V12	12V power, pre-charge, 2nd mate
	P14	V12	12V power
	P15	V12	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.

5.3   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 52** for details and subcommands used in the S.M.A.R.T. implementation.

Table 9   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	$E5_H$
Configure Stream	51_H
Download Microcode	92_H
Execute Device Diagnostics	90_H
Flush Cache	$E7_H$
Flush Cache Extended	EA_H
Get Physical Element Status	12_H
Identify Device	EC_H
Idle	$E3_H$
Idle Immediate	$E1_H$
Read Buffer	$E4_H$
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	$C4_H$

Command name	Command code (in hex)
Read Multiple Extended	29$_H$
Read Sectors	20$_H$
Read Sectors Extended	24$_H$
Read Stream DMA Ext	2A$_H$
Read Verify Sectors	40$_H$
Read Verify Sectors Extended	42$_H$
Receive FPDMA Queued	65$_H$
Request Sense Data Ext	0B$_H$
Remove Element And Truncate	7C$_H$
Restore Elements And Rebuild	7D$_H$
Sanitize Device - Crypto Scramble	B4$_H$ / 0011$_H$ (SED and ISE drives only)
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$_H$
Seek	70$_H$
Send FPDMA Queued	64$_H$
Set Date & Time Ext	77$_H$
Set Features	EF$_H$
Set Multiple Mode	C6$_H$
Set Sector Configuration Ext	B2$_H$
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$_H$

Command name	Command code (in hex)
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 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 Extended	34_H
Write Stream DMA Ext	$3A_H$
Write Uncorrectable Extended	45_H

5.3.1   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 9** on **page 29**. 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 7** for default parameter settings.

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

Table 10   Identify Device command

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	Obsolete	16,383
2	ATA-reserved	C837$_H$
3	Obsolete	16
4	Retired	0000$_H$
5	Retired	0000$_H$
6	Obsolete	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)	ST22000NM001E ST22000NM002E ST20000NM004E ST20000NM005E
47	(Bits 7–0) Maximum sectors per interrupt on Read multiple and Write multiple (16)	8010$_H$ (512e) / 8002$_H$ (4KN)
48	Trusted computing feature set supported bit 0 (SED only)	4000$_H$
49	Standard Standby timer, IORDY supported and may be disabled	2F00$_H$
50	Capabilities	4000$_H$
51-52	Obsolete	xxxx$_H$
53-56	Words 64–70 and 88 are valid	xxxx$_H$
57–58	Obsolete	xxxx$_H$
59	(Bit 15: 0) Block Erase Ext Not Supported - N (Bit 14: 1) Overwrite Ext Supported - Y (Bit 13: X) Crypto Scramble Ext Supported (SED Only) - N (Bit 12: 1) Sanitize feature set supported - Y (Bit 11: 1) Commands allowed during sanitize op as specified in ACS-3 - Y (Bit 10: 1) Sanitize Antifreeze Lock Ext command supported - Y	5D10$_H$ (512E) / 5D02$_H$ (4KN)

Table 10   Identify Device command

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: 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	Obsolete	0000_H
63	Multiword DMA active and modes supported (see note following this table)	$xx07_H$
64	Advanced PIO modes supported (modes 3 and 4 supported)	0003_H
65	Minimum multiword DMA transfer cycle time per word (120 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 (240 ns)	0078_H
68	Minimum PIO cycle time with IORDY flow control (120 ns)	0078_H
69	Additional supported	$000C_H$
70–74	ATA-reserved	0000_H
75	Queue depth	$001F_H$
76	Serial ATA capabilities	$8D0E_H$
77	(Bit 6:1) Send/Receive FPDMA Queued Commands Supported	$xx4x_H$
78	Serial ATA features supported	$00CC_H$
79	Serial ATA features enabled	$xxxx_H$
80	Major version number	$0FE0_H$ (ACS-4)
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)	$xx7F_H$
89	Security erase time	$xxxx_H$
90	Enhanced security erase time	$xxxx_H$
92	Master password revision code	$FFFE_H$
93	Hardware reset value	$xxxx_H$
95–99	ATA-reserved	0000_H
100–103	Total number of user-addressable LBA sectors available. These words are required for drives that support the 48-bit addressing feature. Maximum value: 0000FFFFFFFFFFFFh.	(see **Section 2.2**)
104–105	ATA-reserved	0000_H

Table 10   Identify Device command

Word	Description	Value
106	Physical/Logical sector size	6003$_H$ (512E) / 5000$_H$ (4KN)
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$_H$
160–167	ATA-reserved	0000$_H$
168	Device Nominal Form Factor	3.5"
169–205	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$_H$
207-216	ATA-reserved	0000$_H$
217	Nominal media rotation rate	7200
218-221	ATA-reserved	0000$_H$
222	Transport Major Version	11FF$_H$ (SATA 3.3)
223	Transport Minor Version	0000$_H$
224-229	ATA-reserved	0000$_H$
230-233	Extended Number of User Accessible Sectors	(see **Section 2.2**)
234-254	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.

	Bit	Word 63
	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 not supported.
	3	Media Card Pass Through Command feature set is not 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 not 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.

Description (if bit is set to 1)

5.3.2   Identify Device Data log

The IDENTIFY DEVICE Data log (log 30H) transfers information about the drive. The data is organized as a set of 512-byte blocks of data, whose contents are shown in **Table 1 on page 7**. 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 may contain drive-specific features that may are included in the Serial ATA specification

Table 11 Identify Device Data log

Page (hex)	QWord Offset (dec)	Bits	Description	Value (hex)
00	List of supported pages			
	0..7	63:24	Reserved	
		23:16	Page number	00
		15:0	Revision number	0001
	8		Number of entries in the following list	09
	9		Page number of the 1st supported ID data log page	00
	10		Page number of the 2nd supported ID data log page	01
	11		Page number of the next supported ID data log page	02
	12		Page number of the next supported ID data log page	03
	13		Page number of the next supported ID data log page	04
	14		Page number of the next supported ID data log page	05
	15		Page number of the next supported ID data log page	06
	16		Page number of the next supported ID data log page	08
	17		Page number of the last supported ID data log page	00
	18..511		Reserved	
01	Copy of IDENTIFY DEVICE data			
	0..511		Copy of IDENTIFY DEVICE command data	

Table 11 Identify Device Data log *(continued)*

02	Capacity				
	0..7	Capacity page information header (QWord)			
		63	Shall be set to 1		1
		62:24	Reserved		
		23:16	Page number		02
		15:0	Revision number		0001
	8..15	Device Capacity (QWord)			
		63	Shall be set to 1		1
		62:48	Reserved		0
		47:0	accessible capacity		(see **Section 2.2**)
	16..23	Physical/Logical Sector Size (QWord)			
		63	Contents of the QWord are valid		1
		62	logical to physical sector relationship supported		1 (512E) / 0 (4KN)
		61	logical sector size supported bit		1 (4KN) / 0 (512E)
		60:22	Reserved		0
		19:16	logical to physical sector relationship		0 (4KN) / 3 (512E)
		15:0	logical sector offset		4000$_H$
	24..31	Logical Sector Size (QWord)			
		63	Contents of the QWord are valid		1
		62:32	Reserved		0
		31:0	Logical Sector Size		4096b (4KN)
	32..39	Nominal Buffer Size (QWord)			
		63	Contents of the QWord are valid		1
		62:0	buffer size		256
	40..511		Reserved		0
03	Supported Capabilities				
	0..7	Supported Capabilities page information header (QWord)			
		63	Shall be set to 1		1
		62:24	Reserved		
		23:16	Page number		03
	8..15	Supported Capabilities (QWord)			
		63	Shall be set to 1		1
		62:55	Reserved		0
		54	advanced background operation supported		0
		53	persistent sense data reporting		0
		52	sff-8447 reporting		1

Table 11 Identify Device Data log *(continued)*

		51	definitive ending pattern supported	1
		50	data set management xl supported	0
		49	set sector configuration supported	1
		48	zero ext supported	0
		47	successful ncq command sense data supported	0
		46	dlc supported	0
		45	request sense device default supported	1
		44	dsn supported	1
		43	low power standby supported	0
		42	set epc power source supported	0
		41	amax addr supported	1
		40	Reserved for CFA	0
		39	drat supported	0
		38	lps misalignment reporting supported	0
		37	Reserved	0
		36	read buffer dma supported	0
		35	write buffer dma supported	0
		34	Reserved	0
		33	download microcode dma supported	0
		32	28-bit supported	0
		31	rzat supported	0
		30	Reserved	0
		29	nop supported	0
		28	read buffer supported	1
		27	write buffer supported	1
		26	Reserved	0
		25	read look-ahead supported	1
		24	volatile write cache supported	1
		23	smart supported	1
		22	flush cache ext supported	1
		21	Reserved	0
		20	48-bit supported	1
		19	Reserved	0
		18	spin-up supported	1
		17	puis supported	1
		16	apm supported	1
		15	Reserved for CFA	0

Table 11 Identify Device Data log *(continued)*

		14	download microcode supported	1
		13	unload supported	1
		12	write fua ext supported	1
		11	gpl supported	1
		10	streaming supported	1
		9	Reserved	0
		8	smart self-test supported	1
		7	smart error logging supported	1
		6	epc supported	1
		5	sense data supported	1
		4	free-fall supported	0
		3	dm mode 3 supported	1
		2	gpl dma supported	1
		1	write uncorrectable supported	1
		0	wrv supported	1
		DOWNLOAD MICROCODE Capabilities (QWord)		
		63	Contents of the QWord are valid	1
		62:36	Reserved	0
		35	dm clears nonactivated deferred data	0
	16..23	34	dm offsets deferred supported	1
		33	dm immediate supported	1
		32	dm offsets immediate supported	1
		31:16	dm maximum transfer size	0000_H
		15:0	dm minimum transfer size	0000_H
		Nominal Media Rotation Rate (QWord)		
	24..31	63	Shall be set to one	1
		62:16	Reserved	0
		15:0	nominal media rotation rate	7200
		Form Factor (QWord)		
	32..39	63	Contents of the QWord are valid	1
		62:4	Reserved	0
		3:0	nominal form factor	3.5"
		Write-Read-Verify Sector Count Mode 3 (QWord)		
	40..47	63	Contents of the QWord are valid	1
		62:32	Reserved	0
		31:0	wrm mode 3 count	0

Table 11 Identify Device Data log *(continued)*

		Write-Read-Verify Sector Count Mode 2 (QWord)		
	48..55	63	Contents of the QWord are valid	1
		62:32	Reserved	0
		31:0	wrm mode 2 count	0
		World wide name (DQWord)		
	56..71	127	Shall be set to one	1
		126:64	Reserved	0
		63:0	world wide name	unique
		DATA SET MANAGEMENT (QWord)		
		63	Shall be set to one	1
		62:32	Reserved	0
	72..79	31:16	max pages per dsm command	0
		15:8	logical block markups supported	0
		7:1	Reserved	0
		0	trim supported	0
		Utilization Per Unit Time (DQWord)		
		127	Shall be set to one	1
		126:120	Reserved	0
		119:112	utilization type	Combined Writes and Reads
	80..95	111:104	utilization units	TB
		103:96	utilization interval	Per Year
		95:34	Reserved	0
		63:32	utilization b	
		31:0	utilization a	550
		Utilization Usage Rate Support (QWord)		
		63	Contents of the QWord are valid	0
		62:24	Reserved	0
		23	setting rate basis supported	0
		22:9	Reserved	0
	96..103	8	since power on rate basis supported	0
		7:5	Reserved	0
		4	power on hours rate basis supported	0
		3:1	Reserved	0
		0	date/time rate basis supported	0

Table 11 Identify Device Data log *(continued)*

	104..111	Zoned Capabilities (QWord)		
		63	Contents of the QWord are valid	0
		62:2	Reserved	0
		1:0	zoned	0
	112..119	Supported ZAC Capabilities (QWord)		
		63	Contents of the QWord are valid	0
		62:5	Reserved	0
		4	non-data reset write pointers ext supported	0
		3	non-data finish zone ext supported	0
		2	non-data close zone ext supported	0
		1	non-data open zone ext supported	0
		0	report zones ext supported	0
	120..127	Advanced Background Operations Capabilities (QWord)		
		63	Contents of the QWord are valid	0
		62	abo foreground mode supported	0
		61	abo ir mode supported	0
		60:48	Reserved	0
		47:16	abo minimum fraction	0
		15:0	abo minimum supported timelimit	0
	128..135	Advanced Background Operations Recommendations (QWord)		
		63	Contents of the QWord are valid	0
		62:32	Reserved	0
		31:16	device maintenance polling time	0
		15:0	abo recommended abo start interval	0
	136..143	Queue Depth (QWord)		
		63	Contents of the QWord are valid	0
		62:5	Reserved	0
		4:0	queue depth	32

Table 11 Identify Device Data log *(continued)*

		Supported SCT Capabilities (QWord)		
		63	Contents of the QWord are valid	0
		62:27	Reserved	0
		26	sct write same function 103 supported	1
		25	sct write same function 102 supported	1
		24	sct write same function 101 supported	1
		23:19	Reserved	0
		18	sct write same function 3 supported	1
	144..151	17	sct write same function 2 supported	1
		16	sct write same function 1 supported	1
		15:6	Reserved	0
		5	sct data tables supported	1
		4	sct feature control supported	1
		3	sct error recovery control supported	1
		2	sct write same supported	1
		1	Reserved	0
		0	sct supported	1
		Depopulation Capabilities (QWord)		
		63	Contents of the QWord are valid	1
	152..159	62:3	Reserved	0
		2	restore elements and rebuild supported	1
		1	get physical element status supported	1
		0	remove element and truncate supported	1
		35	Depopulation Execution Time (QWord)	
	160..167		Bit Description: 63 Contents of the QWord are valid	1
			62:0 DEPOPULATION TIME field (see 9.10.5.19)	(Unique per drive)
	168..503	Reserved		
		Vendor Specific Supported Capabilities (QWord)		
	504..511	63	Contents of the QWord are valid	0
		62:0	Vendor specific	
04	Current Settings			
		Current Settings page information header (QWord)		
		63	Shall be set to 1	1
	0..7	62:24	Reserved	0
		23:16	Page number	04

Table 11 Identify Device Data log *(continued)*

		Current Settings (QWord)		
		63	Shall be set to one	1
		62:19	Reserved	0
		18	successful ncq command sense data enabled	0
		17	dlc enabled	0
		16	dsn enabled	0
		15	epc enabled	1
		14	Reserved	0
		13	volatile write cache enabled	1
		12	Reserved	0
		11	reverting to defaults enabled	0
	8..15	10	sense data enabled	0
		9	Reserved	0
		8	non-volatile write cache	1
		7	read look-ahead	1
		6	smart enabled	1
		5	Reserved	0
		4	Reserved	0
		3	puis enabled	0
		2	apm enabled	0
		1	free-fall enabled	0
		0	wrv enabled	0
		Feature Settings (QWord)		
		63	Contents of the QWord are valid	1
		62:18	Reserved	0
	16..23	17:16	power source	0
		15:8	apm level	0
		7:0	wrv mode	0
		DMA Host Interface Sector Times (QWord)		
		63	Contents of the QWord are valid	1
	24..31	62:16	Reserved	0
		15:0	dma sector time	0
		PIO Host Interface Sector Times (QWord)		
		63	Contents of the QWord are valid	1
	32..39	62:16	Reserved	0
		15:0	pio sector time	0

Table 11 Identify Device Data log *(continued)*

	40..47	Streaming Minimum Request Size (QWord)		
		63	Contents of the QWord are valid	1
		62:16	Reserved	0
		15:0	stream min request size	1000$_H$
	48..55	Streaming Access Latency (QWord)		
		63	Contents of the QWord are valid	1
		62:16	Reserved	0
		15:0	stream access latency	0
	56..63	Streaming Performance Granularity (QWord)		
		63	Contents of the QWord are valid	1
		62:16	Reserved	0
		15:0	stream granularity	2710$_H$
	64..71	Free-fall Control Sensitivity (QWord)		
		63	Contents of the QWord are valid	1
		62:16	Reserved	0
		15:0	free-fall sensitivity	0
	72..79	Device Maintenance Schedule (QWord)		
		63	Contents of the QWord are valid	0
		62:58	Reserved	0
		57:48	minimum inactive time in milliseconds	0
		47:32	time scheduled for device maintenance	0
		31:16	time to performance degradation	0
		15:0	minimum inactive time	0
	80..87	Advanced Background Operations Settings (QWord)		
		63	Contents of the QWord are valid	0
		62:8	Reserved	0
		7:0	abo_status	0
	88..511	Reserved		

Table 11 Identify Device Data log *(continued)*

	Strings			
05		Supported Capabilities page information header (QWord)		
	0..7	63	Shall be set to 1	1
		62:24	Reserved	
		23:16	Page number	05
	8..27	SERIAL NUMBER (ATA String)		XXXXXXXX$_H$
	28..31	Reserved		
	32..39	FIRMWARE REVISION (ATA String)		XXXX$_H$
	40..47	Reserved		
	48..87	MODEL NUMBER (ATA String)		ST22000NM001E ST22000NM002E ST20000NM004E ST20000NM005E
	88..95	Reserved		
	96..103	ADDITIONAL PRODUCT IDENTIFIER (ATA String)		0
	104..511	Reserved		
06	Security			
	0..7	Security page information header (QWord)		
		63	Shall be set to 1	1
		62:24	Reserved	
		23:16	Page number	06
	8..15	Master Password Identifier (QWord)		
		63	Contents of the QWord are valid	1
		62:16	Reserved	0
		15:0	master password identifier	FFFE$_H$
	16..23	Security Status (QWord)		
		63	Contents of the QWord are valid	1
		62:7	Reserved	0
		6	security supported	1
		5	master password capability	0
		4	enhanced security erase supported	1
		3	security count expired	0
		2	security frozen	0
		1	security locked	0
		0	security enabled	0

Table 11 Identify Device Data log *(continued)*

	24..31	Time required for an Enhanced Erase mode SECURITY ERASE UNIT command (QWord)		
		63	Contents of the QWord are valid	1
		62:16	Reserved	0
		15	enhanced security erase time format	1
		14:0	enhanced security erase time	(Unique per drive)
	32..39	Time required for an Normal Erase mode SECURITY ERASE UNIT command (QWord)		
		63	Contents of the QWord are valid	1
		62:16	Reserved	0
		15	normal security erase time format	1
		14:0	normal security erase time	(Unique per drive)
	40..47	Trusted Computing Feature Set (QWord)		
		63	Contents of the QWord are valid	1
		62:1	Reserved	0
		0	trusted computing supported	0 (1, SED drives only)
	48..55	Security Capabilities (QWord)		
		63	Contents of the QWord are valid	1
		62:8	Reserved	0
		7	restricted sanitize overrides security	0
		6	acs-3 commands allowed by sanitize	1
		5	sanitize antifreeze lock supported	1
		4	block erase supported	0
		3	overwrite supported	1
		2	crypto scramble supported	0 (1, SED and ISE drives only)
		1	sanitize supported	1
		0	encrypt all supported	0
	56..511	Reserved		
07	Parallel ATA			
	000..511		(Not supported for SATA drives)	all zeros

Table 11 Identify Device Data log *(continued)*

08	Serial ATA			
	0..7	Serial ATA page information header (QWord)		
		63	Shall be set to 1	1
		62:24	Reserved	
		23:16	Page number	08
	8..15	SATA Capabilities		
		63	Shall be set to one	1
		62:32	Reserved	0
		31	power disable feature always enabled	0
		30	power disable feature supported	0
		29	rebuild assist supported	0
		28	dipm ssp preservation supported	0
		27	hybrid information supported	0
		26	devsleep to reducedpwrstate capability supported	0
		25	device sleep supported	0
		24	ncq autosense supported	1
		23	software settings preservation supported	1
		22	hardware feature control supported	0
		21	in-order data delivery supported	0
		20	device initiated power management supported	1
		19	dma setup auto-activation supported	1
		18	nonzero buffer offsets supported	0
		17	send and receive queued commands supported	1
		16	ncq non-data command supported	0
		15	ncq streaming supported	0
		14	read log dma ext as equivalent to read log ext supported	1
		13	device automatic partial to slumber transitions supported	0
		12	host automatic partial to slumber transitions supported	0
		11	ncq priority information supported	0
		10	unload while ncq commands are outstanding supported	1
		9	sata phy event counters log supported	1
		8	receipt of host initiated power management requests supported	0
		7	ncq feature set supported	1
		6:3	Reserved	0
		2	sata gen3 signaling speed supported	1
		1	sata gen2 signaling speed supported	1
		0	sata gen1 signaling speed supported	1

Table 11 Identify Device Data log *(continued)*

		Current SATA Settings (QWord)		
16..23		63	Shall be set to one	1
		62:14	Reserved	0
		13	hybrid enabled	0
		12	rebuild assist enabled	0
		11	power disable feature enabled	0
		10	device sleep enabled	0
		9	automatic partial to slumber transitions enabled	0
		8	software settings preservation enabled	1
		7	hardware feature control is enabled	0
		6	in-order data delivery enabled	0
		5	device initiated power management enabled	0
		4	dma setup auto-activation enabled	1
		3	nonzero buffer offsets enabled	0
		2:0	current negotiated serial ata signal speed	(6.0, 3.0, 1.5) Gb/s
24..39	Reserved			
40..41	CURRENT HARDWARE FEATURE CONTROL IDENTIFIER (Word)			
42..43	SUPPORTED HARDWARE FEATURE CONTROL IDENTIFIER (Word)			
44..47	Reserved			
48..55		Device Sleep Timing Variables (QWord)		
		63	devslp timing variables supported	0
		62:16	Reserved	0
		15:8	devsleep exit timeout (deto)	0
		7:5	Reserved	0
		4:0	minimum devslp assertion time (mdat)	0
56..511	Reserved			

5.3.3 Device Statistics log

The Device Statistics log (log 04H) transfers information about the drive. The data is organized as a set of 512-byte blocks of data, whose contents are shown in **Table 1 on page 7**. 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 may contain drive-specific features that are included in the SATA specifications.

Table 12   Device Statistics log

Page (hex)	Statistic	Supported
00	List of supported log pages	Yes
01	General Statistics	
	Lifetime Power-on Resets	Yes
	Power-on Hours	Yes
	Logical Sectors Written	Yes
	Number of Write Commands	Yes
	Logical Sectors Read	Yes
	Number of Read Commands	Yes
	Pending Error Count	Yes
	Workload Utilization	No
	Utilization Usage Rate	No
	Resource Availability	No
	Random Write Resources Used	No
02	Free Fall Statistics	
	Number of Free-Fall Events Detected	No
	Overlimit Shock Events	No
03	Rotating Media Statistics	
	Spindle Motor Power-on Hours	Yes
	Head Flying Hours	Yes
	Head Loaded Events	Yes
	Number of Reallocated Logical Sectors	Yes
	Read Recovery Attempts	Yes
	Number of Mechanical Start Failures	Yes
	Number of Reallocation Candidate Logical Sectors	Yes
	Number of High Priority Unload Events	Yes
04	General Errors Statistics	
	Number of Reported Uncorrectable Errors	Yes
	Number of Resets Between Command Acceptance and Command Completion	Yes
	Physical Element Status Changed	Yes

Table 12   Device Statistics log

05	Temperature Statistics	
	Current Temperature	Yes
	Average Short Term Temperature	Yes
	Average Long Term Temperature	Yes
	Highest Temperature	Yes
	Lowest Temperature	Yes
	Highest Average Short Term Temperature	Yes
	Lowest Average Short Term Temperature	Yes
	Highest Average Long Term Temperature	Yes
	Lowest Average Long Term Temperature	Yes
	Time in Over-Temperature	Yes
	Specified Maximum Operating Temperature	Yes
	Time in Under-Temperature	Yes
	Specified Minumum Operating Temperature	Yes
06	Transport Statistics	
	Number of Hardware Resets	Yes
	Number of ASR Events	Yes
	Number of Interface CRC Errors	Yes
07	Solid State Device Statistics	
	Percentage Used Endurance Indicator	No
08	Zoned Device Statistics	
	Maximum Open Zones	No
	Maximum Explicitly Open Zones	No
	Maximum Implicitly Open Zones	No
	Minimum Empty Zones	No
	Maximum Non Sequential Zones	No
	Zones Emptied	No
	Suboptimal Write Commands	No
	Commands Exceeding Optimal Limit	No
	Failed Explicit Opens	No
	Read Rule Violations	No
	Write Rule Violations	No
09..FE	Reserved	
FF	Vendor Specific Statistics	
	TBD	x

5.3.4   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 13 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.

5.3.5   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: 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 14 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 0*x*04 (abort) is written to the Error register.