Product Manual

Seagate® Archive HDD

Standard Model	**Self-Encryption Drive Model**
ST5000AS0011	ST5000AS0001

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Document Revision History

Revision	Date	Pages affected
Rev. A	01/14/2014	Initial release.
Rev. B	01/21/2014	4 & 8.
Rev. C	10/16/2014	2-10, 12, 14 & 21-27.

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1.0   Introduction

This manual describes the functional, mechanical and interface specifications for the following:
Seagate® Archive HDD model drives:.

Standard models	Self-Encrypting (SED) models
ST5000AS0011	ST5000AS0001

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).

These drives provide the following key features:
- 5900 RPM spindle speed.
- TGMR recording technology provides the drive with increased areal density.
- High instantaneous (burst) data-transfer rates (up to 600MB per second).
- State-of-the-art cache and on-the-fly error-correction algorithms.
- Native Command Queuing with command ordering to increase performance in demanding applications.
- Full-track multiple-sector transfer capability without local processor intervention.
- Seagate AcuTrac™ servo technology delivers dependable performance even with hard drive track widths of only 75 nanometers.
- Seagate SmartAlign™ technology provides a simple, transparent migration to Advanced Format 4K sectors
- Quiet operation.
- Compliant with RoHS requirements in China and Europe
- SeaTools™ diagnostic software performs a drive self-test that eliminates unnecessary drive returns.
- Support for S.M.A.R.T. drive monitoring and reporting.
- Supports latching SATA cables and connectors.
- Worldwide Name (WWN) capability uniquely identifies the drive.
- Archive HDDs are not intended for surveillance or NAS applications and may experience lower performance in these environments. For NAS and Surveillance applications, Seagate NAS HDD and Surveillance HDD are suggested for better performance and reliability

1.1   About the SATA interface

The Serial ATA (SATA) interface provides several advantages over the traditional (parallel) ATA interface. The primary advantages include:
- Easy installation and configuration with true plug-and-play connectivity. It is not necessary to set any jumpers or other configuration options.
- Thinner and more flexible cabling for improved enclosure airflow and ease of installation.
- Scalability to higher performance levels.

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

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

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

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

The SATA host adapter contains a set of registers that shadow the contents of the traditional device registers, referred to as the Shadow Register Block. All SATA devices behave like Device 0 devices. For additional information about how SATA emulates parallel ATA, refer to the "Serial ATA International Organization: Serial ATA Revision 3.0". The specification can be downloaded from www.sata-io.org.

2.0 Drive Specifications

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

Standard models	Self-Encrypting (SED) models
ST5000AS0011	ST5000AS0001

2.1 Specification summary tables

The specifications listed in Table 1.

For details on specification measurement or definition, refer to the appropriate section of this manual.

Table 1   Drive specifications summary for 5TB model

Drive Specification*	ST5000AS0011 and ST5000AS0001
Formatted capacity (512 bytes/sector)*	5000GB (5TB)
Guaranteed sectors	9,767,541,168
Heads	8
Disks	4
Bytes per sector (4K physical emulated at 512-byte sectors)	4096
Recording density, KFCI (max)	1807
Track density, KTPI (ktracks/in avg.)	455
Areal density, (Gb/in2 avg)	826
Spindle speed (RPM)	5900
Internal data transfer rate (Mb/s max)	1813
Average data rate, read/write (MB/s)	146
Sustained data transfer rate OD (MB/s max)	180
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	128MB
Height (max)	26.1mm / 1.028 in
Width (max)	101.85mm /4.010 in
Length (max)	147.00mm / 5.787 in
Weight (typical)	655g (1.44 lb)
Average latency	5.1ms
Power-on to ready (sec max)	30.0
Standby to ready (sec max)	17.0
Average seek, read (ms typical) Average seek, write (ms typical)	<12.0 <12.0
Startup current (typical) 12V (peak)	2.0A
Voltage tolerance (including noise)	5V: ± 5% 12V: ±10%
Ambient Temperature	0 to 60°C (operating) -40 to 70°C (non-operating)
Temperature gradient (°C per hour max)	20°C (operating) 30°C (non-operating)
Relative humidity	5% to 90% (operating) 5% to 95% (non-operating)
Relative humidity gradient (per hour max)	30%

Table 1   Drive specifications summary for 5TB model (Continued)

Drive Specification*	ST5000AS0011 and ST5000AS0001
Wet bulb temperature (max)	30.0°C max (operating) 40.0°C max (nonoperating)
Altitude, operating	–61 m to 3048 m (–200 ft to 10,000+ ft)
Altitude, non-operating (below mean sea level, max)	–61 m to 12,192 m (–200 ft to 40,000+ ft)
Operational Shock (max @ 2 ms)	80 Gs
Non-Operational Shock (max @ 2 ms))	300 Gs
Vibration, operating	2–22 Hz: 0.25 Gs, Limited displacement 22–350 Hz: 0.50 Gs 350–500 Hz: 0.25 Gs
Vibration, non-operating	5Hz to 22Hz: 3.0 Gs 22Hz to 350Hz: 3.0 Gs 350Hz to 500Hz: 3.0 Gs
Drive acoustics, sound power (bels)	
Idle**	2.3 (typical) 2.5 (max)
Performance seek	2.8 (typical) 3.0 (max)
Non-recoverable read errors	1 per 10^{14} bits read
Workload Rate Limit	Average rate of <180TB/year The AFR specification for the drive assumes the I/O workload does not exceed the Average Annualized Workload Rate Limit of <180TB/year. Workloads exceeding the annualized rate may degrade the drive AFR and impact product reliability. The Average Annualized Workload Rate Limit is in units of TB per year, or TB per 8760 power on hours. Workload Rate = TB transferred x (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 "Check to see if the drive is under Warranty" link. Users will be asked to provide the drive serial number, model number (or part number) and country of purchase. The system will display the warranty information for the drive.
Load/Unload cycles (25°C, 50% rel. humidity)	300,000
Supports Hotplug operation per the Serial ATA Rev. 3.2 specification	Yes

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

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

2.2   Formatted capacity

Model	Formatted capacity*	Guaranteed sectors	Bytes per sector
ST5000AS0011 and ST5000AS0001	5TB	9,767,541,168	4096 (512 byte emulation)

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

2.2.1   LBA mode

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

See Section 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, KFCI (max)	1807
Track density, KTPI (ktracks/in avg)	455
Areal density (Gb/in^2 avg)	826
Spindle speed (RPM) (± 0.2%)	5900
Internal data transfer rate (Mb/s max)	1813
Sustained data transfer rate, OD read (MB/s max)	180
Average data rate, read/write (MB/s)	146
I/O data-transfer rate (MB/s max)	600 (Ultra DMA mode 5)

2.4   Physical characteristics

Height (max)	26.11mm / 1.028 in
Width (max)	101.85mm / 4.010 in
Length (max)	147.00mm / 5.787 in
Weight: (maximum)	655g (1.44 lb)
Cache buffer	128MB (129,536KB)

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2.5 Seek time

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

- Track-to-track seek time is an average of all possible single-track seeks in both directions.
- Average seek time is a true statistical random average of at least 5000 measurements of seeks between random tracks, less overhead.

Typical seek times (ms)	Read	Write
Track-to-track	1.0	1.2
Average	<12.0	<12.0
Average latency	5.1	

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

2.6 Start/stop times

Power-on to ready (sec)	25 (typical) 30 (max)
Standby to ready (sec)	15 (typical) 17 (max)
Ready to spindle stop (sec)	10 (typical) 11 (max)

2.7 Power specifications

The drive receives DC power (+5V or +12V) through a native SATA power connector. Refer to **Figure 3 on page 15**.

2.7.1 Power consumption

Power requirements for the drives are listed in **Table 2:**. Typical power measurements are based on an average of drives tested, under nominal conditions, using 5.0V and 12.0V input voltage at 25°C ambient temperature.

- Spinup power

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

- Seek mode

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

- Read/write power and current

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

- Operating power and current

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

- Idle mode power

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

- Standby mode

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

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Table 2: **5TB Drive DC power requirements**

		6.0Gb mode	
Voltage		**+5V**	**+12V**
Regulation		**±5%**	**±5%**
Avg Idle Current *		0.12	0.21
Advanced Idle Current *			
Idle_A		0.11	0.21
Idle_B		0.12	0.21
Idle_C		0.12	0.21
Standby		0.11	0.005
Average Sleep Current		0.104	0.006
Maximum Start Current			
DC (peak DC)	3σ	0.3	1.21
AC (peak DC)	3σ	0.49	2.01
Peak operating current (random read):			
Typical DC		0.21	0.38
Maximum DC	3σ	0.21	0.39
Peak operating current (random write)			
Typical DC		0.44	0.28
Maximum DC	3σ	0.45	0.29
Peak operating current (sequential read)			
Typical DC		0.38	0.29
Maximum DC	3σ	0.44	0.31
Peak operating current (sequential write)			
Typical DC		0.34	0.30
Maximum DC	3σ	0.35	0.31

* 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.

- **Spinup power**

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

- **Operating Read/Write power and current**

  Sequential read/write - 128 block transfer, QD=16, minimum 10 data points

  Random read/write - 8 block transfer, QD=16, minimum 10 data points

  Typical DC - average of average operating currents

  Maximum DC - average of max operating currents

- **Average Idle Current**

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

- **EPC Idle/Standby/Sleep mode**

  The current is measured in the desired EPC idle/standby state.

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2.7.1.1 Typical current profiles

5TB model current profile
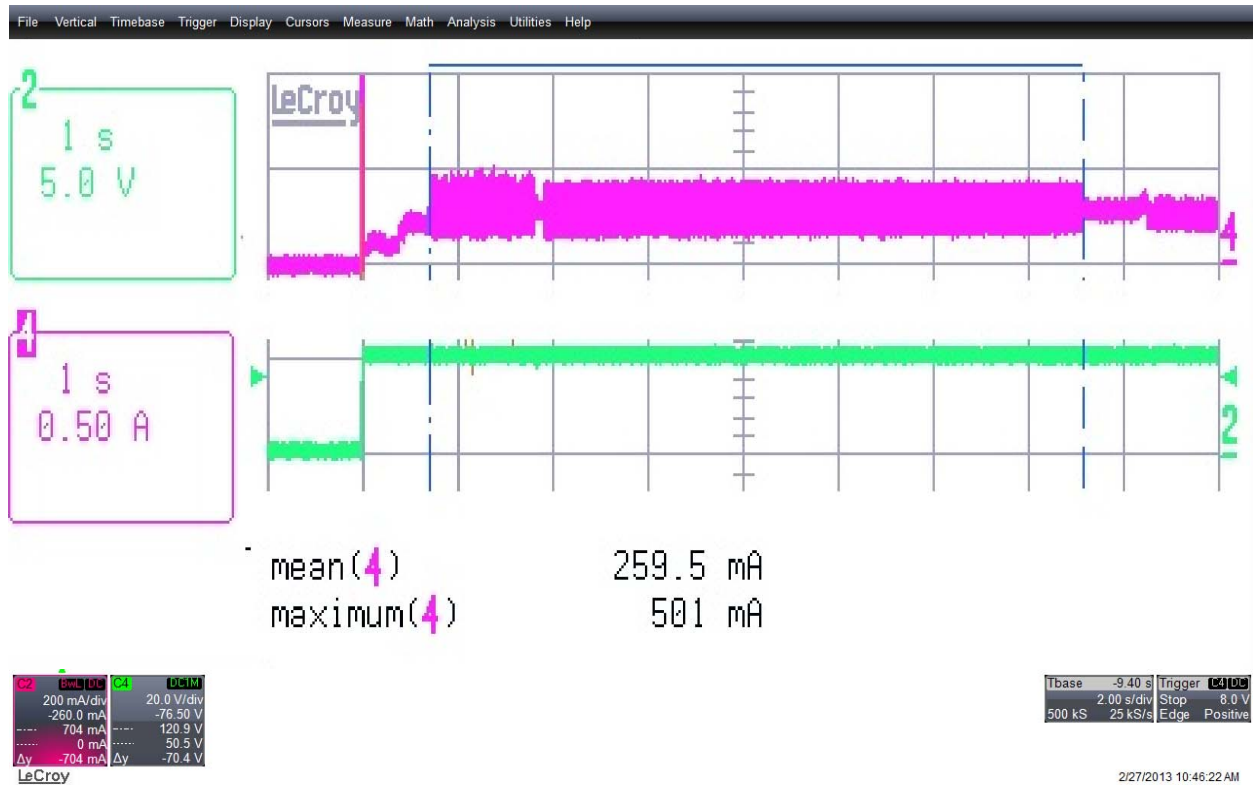
Figure 1 Typical 5TB model 5V - 6Gb/s startup and operation current profile
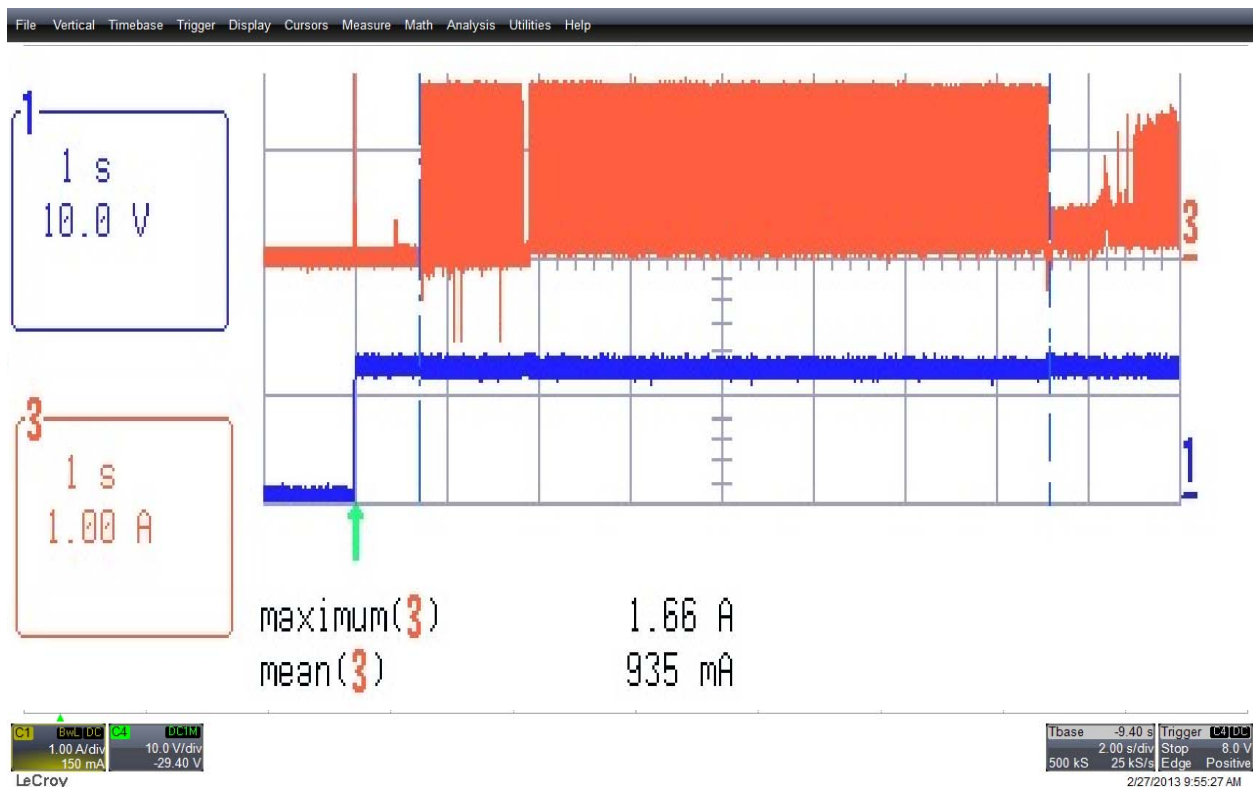
Figure 2 Typical 5TB model 12V - 6Gb/s startup and operation current profile

2.7.2　Conducted noise

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

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

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

2.7.3　Voltage tolerance

Voltage tolerance (including noise):

- 5V ± 5%
- 12V +10% / -7.5%

2.8　Environmental specifications

This section provides the temperature, humidity, shock, and vibration specifications for Desktop HDDs. Ambient temperature is defined as the temperature of the environment immediately surrounding the drive. Above 1000ft. (305 meters), the maximum temperature is derated linearly by 1°C every 1000 ft. Refer to **Section 3.4 Drive mounting** for base plate measurement location.

2.8.1　Ambient Temperature

Operating	0° to 60°C (32° to 140°F)
Non-operating	–40° to 70°C (–40° to 158°F)

2.8.2　Temperature gradient

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

2.8.3　Humidity

2.8.3.1　Relative humidity

Operating	5% to 90% non-condensing (30% per hour max)
Nonoperating	5% to 95% non-condensing (30% per hour max)

2.8.3.2　Wet bulb temperature

Operating	30°C (86°F max)
Non-operating	40°C (104°F max)

2.8.4 Altitude

Operating	–61 m to 3048 m (–200 ft. to 10,000+ ft.)
Non-operating	–61 m to 12,192 m (–200 ft. to 40,000+ ft.)

2.8.5 Shock

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

2.8.5.1 Operating shock

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

2.8.5.2 Non-operating shock

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

2.8.6 Vibration

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

2.8.6.1 Operating vibration

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

2Hz to 22Hz	0.25 Gs
22Hz to 350Hz	0.50 Gs
350Hz to 500Hz	0.25 Gs

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

2.8.6.2 Non-operating vibration

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

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

2.9 Acoustics

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

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

Table 3 Fluid Dynamic Bearing (FDB) motor acoustics

	Idle*	Performance Seek
4 Disks	2.3 bels (typical) 2.5 bels (max)	2.8 bels (typical) 3.0 bels (max)

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

2.10 Test for Prominent Discrete Tones (PDTs)

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

2.11 Electromagnetic immunity

When properly installed in a representative host system, the drive operates without errors or degradation in performance when subjected to the radio frequency (RF) environments defined in **Table 4**.

Table 4 Radio frequency environments

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

2.12   Reliability

2.12.1   Annualized Failure Rate (AFR) and Mean Time Between Failure (MTBF)

The product shall achieve an Annualized Failure Rate (AFR) of <1% (MTBF of 800K hours) when operated at an nominal power and typical case temperatures of 40°C. Operation at temperatures outside the specifications in **Section 2.8 Environmental specifications** may increase the product AFR (decrease MTBF). AFR and MTBF are population statistics that are not relevant to individual units.

AFR and MTBF specifications are based on the following assumptions for business critical storage system environments:

*   8760 power-on-hours per year.
*   Operations at nominal voltages.
*   Temperatures outside the specifications in **Section 2.8 Environmental specifications** may reduce the product reliability.
*   A workload rate below the average annualized specified limits. Operation at excessive I/O duty cycle may degrade product reliability.

The enterprise application nearline environment of power-on-hours, temperature, and I/O duty cycle affect the product AFR and MTBF.

Nonrecoverable read errors	1 per 10^{14} bits read, max
Annualized Failure Rate (AFR)	<1% (nominal power, 25°C air temperature)
Load unload cycles	300,000 cycles
Workload rate limit	Average rate of <180TB/year The AFR specification for the drive assumes the I/O workload does not exceed the Average Annualized Workload Rate Limit of <180TB/year. Workloads exceeding the annualized rate may degrade the drive AFR and impact product reliability. The Average Annualized Workload Rate Limit is in units of TB per year, or TB per 8760 power on hours. Workload Rate = TB transferred x (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 the "Check to see if the drive is under Warranty" link. Users will be asked to provide the drive serial number, model number (or part number) and country of purchase. The system will display the warranty information for the drive.
Preventive maintenance	None required.

2.13   Agency certification

2.13.1   Safety certification

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

2.13.2   Electromagnetic compatibility

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

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

Korean RRL

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

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

- Family name: Seagate Archive HDD
- Certificate number: MSIP-REM-STX-ArchiveHDD
- Date of certification: 2014-Feb-04

Australian C-Tick (N176)

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

2.13.3   FCC verification

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

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

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

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

• Reorient the receiving antenna.

• Move the device to one side or the other of the radio or TV.

• Move the device farther away from the radio or TV.

• Plug the computer into a different outlet so that the receiver and computer are on different branch outlets.

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

2.14 Environmental protection

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

2.14.1 European Union Restriction of Hazardous Substances (RoHS) Directive

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

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

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

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

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

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

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

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

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

2.15 Corrosive environment

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

3.0 Configuring and Mounting the Drive

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

3.1 Handling and static-discharge precautions

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

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

3.2 Configuring the drive

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

3.3 SATA cables and connectors

The SATA interface cable consists of four conductors in two differential pairs, plus three ground connections. The cable size may be 30 to 26 AWG with a maximum length of one meter (39.37 inches). See **Table 5** 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
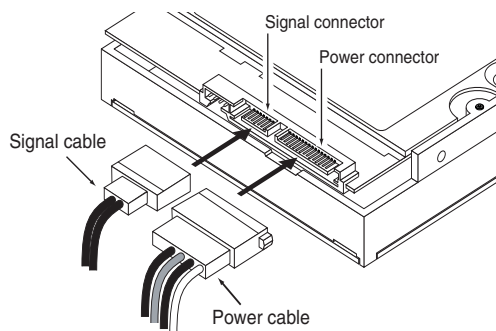
Each cable is keyed to ensure correct orientation. Seagate Archive HDD drives support latching SATA connectors.

3.4   Drive mounting

Users can mount the drive in any orientation using four screws in the side-mounting holes or four screws in the bottom-mounting holes. Refer to **Figure 4** for drive mounting dimensions. Follow these important mounting precautions when mounting the drive:

• Allow a minimum clearance of 0.030 inches (0.76mm) around the entire perimeter of the drive for cooling.

• Use only 6-32 UNC mounting screws.

• The screws should be inserted no more than 0.150 inch (3.81mm) into the bottom or side mounting holes.

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

Weight: (maximum)	655g (1.44 lb)

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

Figure 4 Mounting dimensions
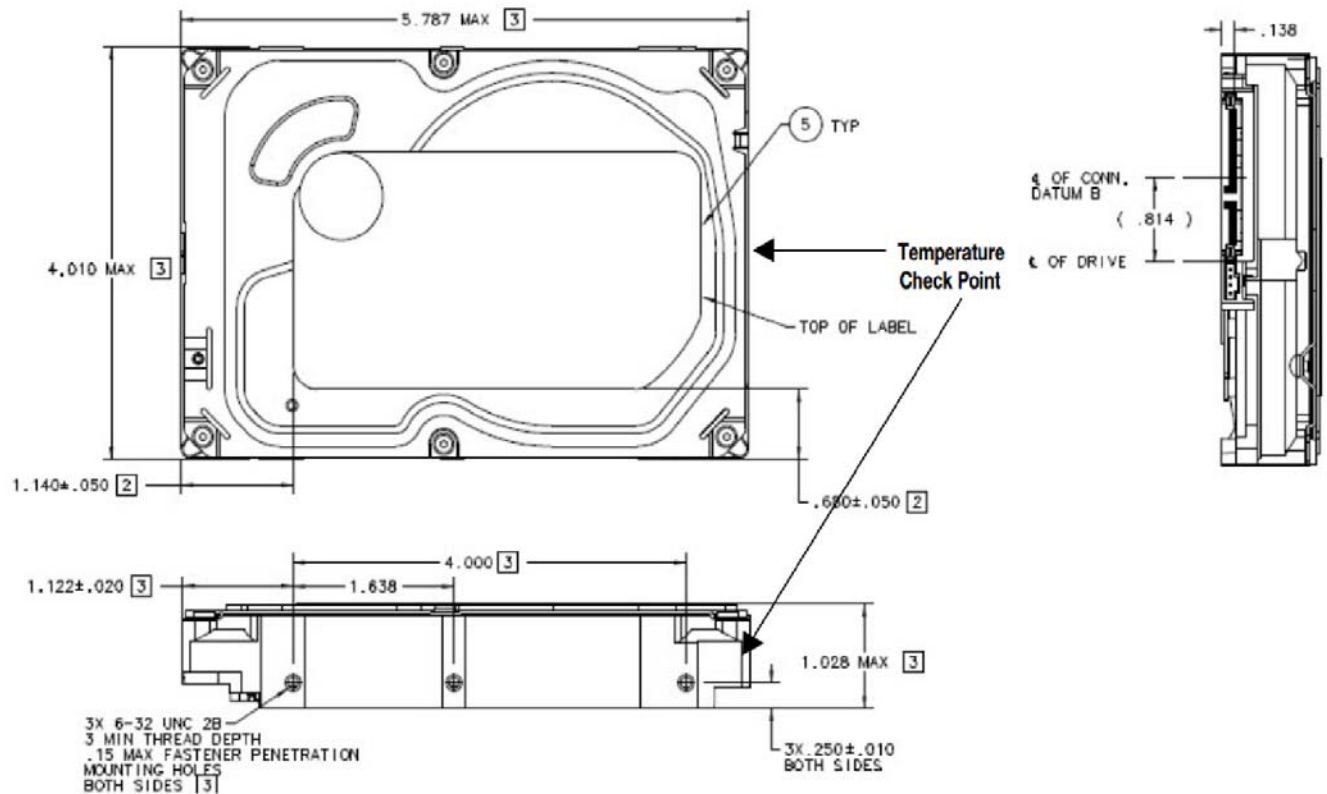
Note	This image may not be representative of the actual drive.

4.0 About (SED) 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) Opal Storage Specifications as detailed in the following:

Trusted Computing Group (TCG) Documents (apply to Self-Encrypting Drive models only)
        TCG Storage Architecture Core Specification, Version 2.0
        TCG Storage Security Subsystem Class Opal Specification, Version 2.0
        (see www.trustedcomputinggroup.org)

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

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 SATA 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 drive employing AES-256 data encryption in Cipher Block Chaining (CBC) 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 engine is 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 Data Bands**).

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 Drive Locking**). 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 Admin or User passwords.

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.

4.2.4   ATA Enhanced Security

The drive can utilize the system's BIOS through the ATA Security API for cases that do not require password management and additional security policies.

Furthermore, the drive's ATA Security Erase Unit command shall support both Normal and Enhanced Erase modes with the following modifications/additions:

Normal Erase: Normal erase feature shall be performed by changing the Data Encryption Key (DEK) of the drive, followed by an overwrite operation that repeatedly writes a single sector containing random data to the entire drive. This write operation bypasses the media encryption. On reading back the overwritten sectors, the host will receive a decrypted version, using the new DEK of the random data sector (the returned data will not match what was written).

Enhanced Erase: Enhanced erase shall be performed by changing the Data Encryption Key of the drive.

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 Default password**, 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.

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 additional bands (Band1 to Band15) by specifying a start LBA and an LBA range. The real estate for this band is taken from the Global Band.

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. The host may change the Encryption Key (see **Section 4.6 Cryptographic Erase**) 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 2.7, "Power specifications" 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 Section 5.3, "Supported ATA commands":

- Trusted Send
- Trusted Receive

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.

5.0 SATA Interface

These drives use the industry-standard Serial ATA (SATA) interface that supports FIS data transfers. It supports ATA programmed input/output (PIO) modes 0 to 4; multiword DMA modes 0 to 2, and Ultra DMA modes 0 to 6. For detailed information about the SATA interface, refer to the "Serial ATA: High Speed Serialized AT Attachment" specification.

5.1 Hot-Plug compatibility

Seagate Archive HDD drives incorporate connectors which enable users to hot plug these drives in accordance with the SATA Revision 3.0 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 2.6) prior to changing the plane of operation.This time is required to insure data integrity.

5.2 SATA device plug connector pin definitions

Table 5 summarizes the signals on the SATA interface and power connectors.

Table 5   SATA 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 1.27 mm (0.050") pitch.

2. The comments on the mating sequence apply to the case of backplane blindmate connector only.
    In this case, the mating sequences are:
    - the ground pins P4 and P12.
    - the pre-charge power pins and the other ground pins.
    - the signal pins and the rest of the power pins.

3. There are three power pins for each voltage.
    One pin from each voltage is used for pre-charge when installed in a blind-mate backplane configuration.
    - All used voltage pins (V_x) must be terminated.

5.3 Supported ATA commands

The following table lists SATA standard commands that the drive supports.
For a detailed description of the ATA commands, refer to the Serial ATA International Organization:
Serial ATA Revision 3.0 (http://www.sata-io.org).

See "S.M.A.R.T. commands" on page 28 for details and subcommands used in the S.M.A.R.T. implementation.

Table 6   SATA standard commands

Command name	Command code (in hex)
Check Power Mode	$E5_H$
Device Configuration Freeze Lock	$B1_H$ / $C1_H$
Device Configuration Identify	$B1_H$ / $C2_H$
Device Configuration Restore	$B1_H$ / $C0_H$
Device Configuration Set	$B1_H$ / $C3_H$
Device Reset	08_H
Download Microcode	92_H
Execute Device Diagnostics	90_H
Flush Cache	$E7_H$
Flush Cache Extended	EA_H
Format Track	50_H
Identify Device	EC_H
Idle	$E3_H$
Idle Immediate	$E1_H$
Initialize Device Parameters	91_H
Read Buffer	$E4_H$
Read DMA	$C8_H$
Read DMA Extended	25_H
Read DMA Without Retries	$C9_H$
Read Log Ext	$2F_H$
Read Multiple	$C4_H$
Read Multiple Extended	29_H
Read Native Max Address	$F8_H$
Read Native Max Address Extended	27_H
Read Sectors	20_H
Read Sectors Extended	24_H
Read Sectors Without Retries	21_H
Read Verify Sectors	40_H
Read Verify Sectors Extended	42_H
Read Verify Sectors Without Retries	41_H
Recalibrate	10_H
Security Disable Password	$F6_H$
Security Erase Prepare	$F3_H$
Security Erase Unit	$F4_H$

Table 6   SATA standard commands (Continued)

Command name	Command code (in hex)		
Security Freeze	$F5_H$		
Security Set Password	$F1_H$		
Security Unlock	$F2_H$		
Seek	70_H		
Set Features	EF_H		
Set Max Address	$F9_H$		
Note: Individual Set Max Address commands are identified by the value placed in the Set Max Features register as defined to the right.	Address: Password: Lock: Unlock: Freeze Lock:	00_H 01_H 02_H 03_H 04_H	
Set Max Address Extended	37_H		
Set Multiple Mode	$C6_H$		
Sleep	$E6_H$		
S.M.A.R.T. Disable Operations	$B0_H$ / $D9_H$		
S.M.A.R.T. Enable/Disable Autosave	$B0_H$ / $D2_H$		
S.M.A.R.T. Enable Operations	$B0_H$ / $D8_H$		
S.M.A.R.T. Execute Offline	$B0_H$ / $D4_H$		
S.M.A.R.T. Read Attribute Thresholds	$B0_H$ / $D1_H$		
S.M.A.R.T. Read Data	$B0_H$ / $D0_H$		
S.M.A.R.T. Read Log Sector	$B0_H$ / $D5_H$		
S.M.A.R.T. Return Status	$B0_H$ / DA_H		
S.M.A.R.T. Save Attribute Values	$B0_H$ / $D3_H$		
S.M.A.R.T. Write Log Sector	$B0_H$ / $D6_H$		
Standby	$E2_H$		
Standby Immediate	$E0_H$		
Write Buffer	$E8_H$		
Write DMA	CA_H		
Write DMA Extended	35_H		
Write DMA FUA Extended	$3D_H$		
Write DMA Without Retries	CB_H		
Write Log Extended	$3F_H$		
Write Multiple	$C5_H$		
Write Multiple Extended	39_H		
Write Multiple FUA Extended	CE_H		
Write Sectors	30_H		
Write Sectors Without Retries	31_H		
Write Sectors Extended	34_H		
Write Uncorrectable	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 on page 21. All reserved bits or words should be set to zero. Parameters listed with an "x" are drive-specific or vary with the state of the drive.

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

Table 7   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	Retired	0000$_H$
21	Retired	0400$_H$
22	Obsolete	0000$_H$
23–26	Firmware revision (8 ASCII character string, padded with blanks to end of string)	x.xx
27–46	Drive model number: (40 ASCII characters, padded with blanks to end of string)	
47	(Bits 7–0) Maximum sectors per interrupt on Read multiple and Write multiple (16)	8010$_H$
48	Reserved	0000$_H$
49	Standard Standby timer, IORDY supported and may be disabled	2F00$_H$
50	ATA-reserved	0000$_H$
51	PIO data-transfer cycle timing mode	0200$_H$
52	Retired	0200$_H$
53	Words 54–58, 64–70 and 88 are valid	0007$_H$
54	Number of current logical cylinders	xxxx$_H$
55	Number of current logical heads	xxxx$_H$
56	Number of current logical sectors per logical track	xxxx$_H$
57–58	Current capacity in sectors	xxxx$_H$

Table 7   Identify Device commands (Continued)

Word	Description	Value
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)	*xx*07$_H$
64	Advanced PIO modes supported (modes 3 and 4 supported)	0003$_H$
65	Minimum multiword DMA transfer cycle time per word (120 nsec)	0078$_H$
66	Recommended multiword DMA transfer cycle time per word (120 nsec)	0078$_H$
67	Minimum PIO cycle time without IORDY flow control (240 nsec)	0078$_H$
68	Minimum PIO cycle time with IORDY flow control (120 nsec)	0078$_H$
69–74	ATA-reserved	0000$_H$
75	Queue depth	001F$_H$
76	SATA capabilities	*xxxx*$_H$
77	Reserved for future SATA definition	*xxxx*$_H$
78	SATA features supported	*xxxx*$_H$
79	SATA features enabled	*xxxx*$_H$
80	Major version number	01F0$_H$
81	Minor version number	0028$_H$
82	Command sets supported	364B$_H$
83	Command sets supported	7F09$_H$
84	Command sets support extension (see note following this table)	4163$_H$
85	Command sets enabled	30*xx*$_H$
86	Command sets enabled	BE09$_H$
87	Command sets enable extension	4163$_H$
88	Ultra DMA support and current mode (see note following this table)	*xx*7F$_H$
89	Security erase time	0039$_H$
90	Enhanced security erase time	0039$_H$
92	Master password revision code	FFFE$_H$
93	Hardware reset value	*xxxx*$_H$
94	Automatic acoustic management	8080$_H$

Table 7   Identify Device commands (Continued)

Word	Description	Value
95–99	ATA-reserved	0000$_H$
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.	ST5000DM000 = 9,767,541,168 ST2500DM001 = 9,767,541,168
104–107	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.
112–127	ATA-reserved	0000$_H$
128	Security status	0001$_H$
129–159	Seagate-reserved	*xxxx*$_H$
160–254	ATA-reserved	0000$_H$
255	Integrity word	xxA5$_H$

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

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

Description (if bit is set to 1)		
	Bit	**Word 63**
	0	Multiword DMA mode 0 is supported.
	1	Multiword DMA mode 1 is supported.
	2	Multiword DMA mode 2 is supported.
	8	Multiword DMA mode 0 is currently active.
	9	Multiword DMA mode 1 is currently active.
	10	Multiword DMA mode 2 is currently active.
	Bit	**Word 84**
	0	SMART error login is supported.
	1	SMART self-test is supported.
	2	Media serial number is supported.
	3	Media Card Pass Through Command feature set is supported.
	4	Streaming feature set is supported.
	5	GPL feature set is supported.
	6	WRITE DMA FUA EXT and WRITE MULTIPLE FUA EXT commands are supported.
	7	WRITE DMA QUEUED FUA EXT command is supported.
	8	64-bit World Wide Name is supported.
	9-10	Obsolete.

	11-12	Reserved for TLC.
	13	IDLE IMMEDIATE command with IUNLOAD feature is supported.
	14	Shall be set to 1.
	15	Shall be cleared to 0.
	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.

5.3.2 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 8   Set Features command

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
06_H	Enable the PUIS feature set
07_H	PUIS feature set device spin-up
10_H	Enable use of SATA features
55_H	Disable read look-ahead (read cache) feature
82_H	Disable write cache
86_H	Disable the PUIS feature set
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.

5.3.3 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 D4H) 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. The system 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.

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.