SEAGATE

EXOS™ ENTERPRISE

7E10 SATA Product Manual

5xxE/4096* **Standard models**	**5xxE/4096*** **FIPS models**	**4KN** **Standard models**
ST10000NM017B	ST10000NM021B	ST10000NM002B
ST8000NM017B	ST8000NM021B	ST8000NM002B
ST6000NM019B	ST6000NM023B	ST6000NM004B
ST4000NM024B	ST4000NM028B	ST4000NM004B
ST2000NM017B		ST2000NM004B

5xxE/4096* **SED models**	**5xxE/4096*** **Non-Mirrored models**	**4KN** **SED models**
ST10000NM019B	ST10000NM025B	ST10000NM006B
ST8000NM019B	ST8000NM025B	ST8000NM006B
ST6000NM021B	ST6000NM027B	ST6000NM008B
ST4000NM026B		ST4000NM010B
ST2000NM019B		ST2000NM010B

5xxE/4096* **ISE models**		**4KN** **ISE models**
ST10000NM023B		ST10000NM014B
ST8000NM023B		ST8000NM014B
ST6000NM025B		ST6000NM016B
ST4000NM030B		ST4000NM022B
		ST2000NM014B

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

Document Revision History

Revision	Date	Pages affected and Description of changes
Rev. A	04/30/2021	Initial release..
Rev. B	08/03/2021	fc & 5: Revised model name to Non-Mirrored

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1.0 Introduction

This manual describes the functional, mechanical and interface specifications for the following:
Seagate® Exos™ 7E10 Serial ATA model drives:

512e/4kn models				
Standard	**SED**	**ISE**	**FIPS**	**Non-Mirrored**
ST10000NM017B	ST10000NM019B	ST10000NM023B	ST10000NM021B	ST10000NM025B
ST8000NM017B	ST8000NM019B	ST8000NM023B	ST8000NM021B	ST8000NM025B
ST6000NM019B	ST6000NM021B	ST6000NM025B	ST6000NM023B	ST6000NM027B
ST4000NM024B	ST4000NM026B	ST4000NM030B	ST4000NM028B	
ST2000NM017B	ST2000NM019B			

4KN models		
Standard	**SED**	**ISE**
ST10000NM002B	ST10000NM006B	ST10000NM014B
ST8000NM002B	ST8000NM006B	ST8000NM014B
ST6000NM004B	ST6000NM008B	ST6000NM016B
ST4000NM004B	ST4000NM010B	ST4000NM022B
ST2000NM004B	ST2000NM010B	ST2000NM014B

These drives provide the following key features:

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

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

1.1 About the Serial ATA interface

The Serial ATA interface provides several advantages over the traditional (parallel) ATA interface. The primary advantages include:

• Easy installation and configuration with true plug-and-play connectivity.
  It is not necessary to set any jumpers or other configuration options.
• Thinner and more flexible cabling for improved enclosure airflow and ease of installation.
• Scalability to higher performance levels.

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

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

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

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

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

2.0 Drive specifications

Unless otherwise noted, all specifications are measured under ambient conditions, at 25°C, and nominal power. For convenience, the phrases *the drive* and *this drive* are used throughout this manual to indicate the Exos 7E10 Serial ATA 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	ST10000NM002B ST10000NM006B ST10000NM014B ST10000NM017B ST10000NM019B ST10000NM021B ST10000NM023B ST10000NM025B	ST8000NM002B ST8000NM006B ST8000NM014B ST8000NM017B ST8000NM019B ST8000NM021B ST8000NM023B ST8000NM025B	ST6000NM004B ST6000NM008B ST6000NM016B ST6000NM019B ST6000NM021B ST6000NM023B ST6000NM025B ST6000NM027B	ST4000NM004B ST4000NM010B ST4000NM022B ST4000NM024B ST4000NM028B ST4000NM030B	ST2000NM004B ST2000NM010B ST2000NM014B ST2000NM017B ST2000NM019B
Formatted (512 bytes/sector)[#]	10TB	8TB	6TB	4TB	2TB
Guaranteed sectors	(see **Section 2.2**)				
Heads	10	8	6	4	3
Discs	5	4	3	2	
Bytes per logical sector	512				
Bytes per physical sector	4096				
Recording density, KBPI (Kb/in max)	2499				
Track density, KTPI (ktracks/in, 0 skew)	487				
Areal density, (Gb/in^2, @ 0 skew mid-disk)	1215				
Spindle speed (RPM)	7200				
Internal data transfer rate (Mb/s max)	2169				
Sustained data transfer rate OD (MiB/s max)	251 (263MB/s)	243 (255 MB/s)	229 (250 MB/s)		216 (226 MB/s)
I/O data-transfer rate (MB/s max)	600				
ATA data-transfer modes supported	PIO modes 0–4 Multiword DMA modes 0–2 Ultra DMA modes 0–6				
Cache buffer	256MB (262,144KB)				
Weight: (maximum)	720g (1.59 lb)	716g (1.58 lb)	650g (1.43 lb)	620g (1.37 lb)	
Average latency	4.16ms				
Power-on to ready (sec) (typ/max)[**]	23/30				
Standby to ready (sec) (typ/max)	23/30				
Startup current (typical) 12V (peak)	2.5A				
Voltage tolerance (including noise)	5V ±5% 12V ±10%				
Operating drive temperature[*]	5° to 60°C (Drive Reported Temperature)				
Non-Operating temperature	–40° to 70°C (Ambient Temperature, see sections **2.6.1** and **2.10**)				
Temperature gradient (°C per hour max)	20°C (operating) 20°C (nonoperating)				
Relative humidity[*]	5% to 95% (operating) 5% to 95% (nonoperating)				

Drive specification	ST10000NM002B ST10000NM006B ST10000NM014B ST10000NM017B ST10000NM019B ST10000NM021B ST10000NM023B ST10000NM025B	ST8000NM002B ST8000NM006B ST8000NM014B ST8000NM017B ST8000NM019B ST8000NM021B ST8000NM023B ST8000NM025B	ST6000NM004B ST6000NM008B ST6000NM016B ST6000NM019B ST6000NM021B ST6000NM023B ST6000NM025B ST6000NM027B	ST4000NM004B ST4000NM010B ST4000NM022B ST4000NM024B ST4000NM028B ST4000NM030B	ST2000NM004B ST2000NM010B ST2000NM014B ST2000NM017B ST2000NM019B
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 (max at 2 ms - typical)	Read 70 Gs / Write 40 Gs				
Non-Operational Shock (max at 2 ms - typical)	300 Gs				
Linear Random Operating Vibration	5–500 Hz: 0.70 Grms				
Random Rotary Operating Vibration	20–1500Hz: 12.5 rads/s^2				
Linear Random Non-Operating Vibration	2–500 Hz: 2.27 Grms ref				
Drive acoustics, sound power (bels) Idle Performance seek	2.8 (typical) 3.0 (max) During periods of drive idle, some offline activity may occur according to the SMART specification, which may increase acoustic and power to operational levels. 3.2 (typical) 3.4 (max)				
Nonrecoverable read errors	1 sector per 10^{15} bits read				
Annualized Failure Rate (AFR)[*]	0.44% based on 8760 POH				
Maximum Rated Workload[*]	Maximum rate of <550TB/year Workloads exceeding the annualized rate may degrade the drive MTBF and impact product reliability. The Annualized Workload Rate is in units of TB per year, or TB per 8760 power on hours. Workload Rate = TB transferred * (8760 / recorded power on hours).				
Warranty	To determine the warranty for a specific drive, use a web browser to access the following web page: www.seagate.com/support/warranty-and-replacements/. From this page, click on the "Is my Drive under Warranty" link. The following are required to be provided: the drive serial number, model number (or part number) and country of purchase.The system will display the warranty information for the drive.				
Load-unload cycles (command controlled)	600,000				
Supports Hotplug operation per Serial ATA Revision 3.3 specification	Yes				

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

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

[**]   See **Section 2.4, "Start/stop times"** for additional information.

2.2 Formatted capacity

ST models	Formatted capacity*	Guaranteed sectors	Bytes per logical sector	Guaranteed sectors	Bytes per logical sector
ST10000NM002B, ST10000NM006B, ST10000NM014B, ST10000NM017B, ST10000NM019B, ST10000NM021B, ST10000NM023B, ST10000NM025B	10TB	19,532,873,728	512	2,441,609,216	4096 (see **Section 2.2.1**)
ST8000NM002B, ST8000NM006B, ST8000NM014B, ST8000NM017B, ST8000NM019B, ST8000NM021B, ST8000NM023B, ST8000NM025B	8TB	15,628,053,168		1,953,506,646	
ST6000NM004B, ST6000NM008B, ST6000NM016B, ST6000NM019B, ST6000NM021B, ST6000NM023B, ST6000NM025B, ST6000NM027B	6TB	11,721,045,168		1,465,130,646	
ST4000NM004B, ST4000NM010B, ST4000NM022B, ST4000NM024B, ST4000NM028B, ST4000NM030B	4TB	7,814,037,168		976,754,646	
ST2000NM004B, ST2000NM010B, ST2000NM014B, ST2000NM017B, ST2000NM019B	2TB	3,907,029,168		488,378,646	

* 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

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

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

n The selected sector size change occurs immediately upon command completion

n Default shipping format is 512E

Table 2   SET SECTOR CONFIGURATION EXT command inputs

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

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

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

Sector Configuration log (Log Address 2Fh)

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

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

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

Table 4   Sector Configuration descriptors format

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

2.2.2 LBA mode

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

See **Section 6.3.1, "Identify Device command"** (words 60-61 and 100-103) for additional information about 48-bit addressing support of drives with capacities over 137GB.

2.3 Recording and interface technology

Interface	Serial ATA (SATA)
Recording method	Perpendicular
Recording density, KBPI (Kb/in max)	2499
Track density, KTPI (ktracks/in, 0 Skew)	487
Areal density (Gb/in^2, @ 0 skew mid-disk)	1215
Spindle speed (RPM) (± 0.2%)	7200
Internal data transfer rate (Mb/s max)	2169
Sustained data transfer rate (MiB/s max) (10TB models)	251 (263 MB/s max)
Sustained data transfer rate (MiB/s max) (8TB models)	243 (255 MB/s max)
Sustained data transfer rate (MiB/s max) (6TB & 4TB models)	229 (250 MB/s max)
Sustained data transfer rate (MiB/s max) (2TB models)	216 (226 MB/s max)
I/O data-transfer rate (MB/s max)	600 (Ultra DMA mode 5)

2.4 Start/stop times

Power-on to ready 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)	23/30
Standby to Ready (sec) (typ/max)	23/30
Ready to spindle stop (sec) (max)	20

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 to 20 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 2 on page 24**.

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 (10TB)

		6.0Gb mode		
Voltage		**+5V**	**+12V**	**Watts**
Regulation		± 5%		**Total**
Avg Idle Current *		0.342	0.509	7.82
Advanced Idle Current *				
	Idle_A	0.351	0.508	7.85
	Idle_B	0.207	0.424	6.12
	Idle_C	0.206	0.221	3.68
	Standby	0.158	0.004	0.83
Maximum Start Current				
	DC (peak DC)	0.893	2.214	
	AC (Peak DC)	0.936	2.52	
Operating current (random read 4K16Q)				
	Typical DC	0.374	0.827	11.79
	Maximum DC	0.374	0.827	11.79
	Maximum DC (Peak)	1.054	2.015	
Operating current (random write 4K16Q)				
	Typical DC	0.428	0.574	9.03
	Maximum DC	0.428	0.574	9.03
	Maximum DC (Peak)	0.985	2.117	
Operating current (sequential read 64K16Q)				
	Typical DC	0.881	0.56	11.13
	Maximum DC	0.881	0.56	11.13
	Maximum DC (Peak)	1.073	0.739	
Operating current (sequential write 64K16Q)				
	Typical DC	0.854	0.561	11.00
	Maximum DC	0.854	0.561	11.00
	Maximum DC (Peak)	1.024	0.733	
Power Governor Operating current (random read 4K16Q)				
	Typical DC	0.382	0.704	10.36
	Maximum DC	0.382	0.704	10.36
	Maximum DC (Peak)	1.045	1.973	
Power Governor Operating current (random write 4K16Q)				
	Typical DC	0.438	0.528	8.53
	Maximum DC	0.438	0.528	8.53
	Maximum DC (Peak)	1.008	1.964	
Power Governor Operating current (sequential read 64K16Q)				
	Typical DC	0.882	0.559	11.11
	Maximum DC	0.882	0.559	11.11
	Maximum DC (Peak)	1.077	0.739	
Power Governor Operating current (sequential write 64K16Q)				
	Typical DC	0.856	0.559	10.99
	Maximum DC	0.856	0.559	10.99
	Maximum DC (Peak)	1.032	0.724	

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

Table 6   DC power requirements (8TB)

		6.0Gb mode		
Voltage		**+5V**	**+12V**	**Watts**
Regulation		± 5%		**Total**
Avg Idle Current *		0.348	0.425	6.84
Advanced Idle Current *				
	Idle_A	0.365	0.431	6.99
	Idle_B	0.21	0.424	6.12
	Idle_C	0.21	0.195	3.39
	Standby	0.163	0.005	0.87
Maximum Start Current				
	DC (peak DC)	0.88	2.215	
	AC (Peak DC)	0.96	2.54	
Operating current (random read 4K16Q)				
	Typical DC	0.384	0.742	10.82
	Maximum DC	0.384	0.742	10.82
	Maximum DC (Peak)	1.009	1.863	
Operating current (random write 4K16Q)				
	Typical DC	0.426	0.501	8.14
	Maximum DC	0.426	0.501	8.14
	Maximum DC (Peak)	0.96	1.977	
Operating current (sequential read 64K16Q)				
	Typical DC	0.873	0.479	10.11
	Maximum DC	0.873	0.479	10.11
	Maximum DC (Peak)	1.081	0.655	
Operating current (sequential write 64K16Q)				
	Typical DC	0.809	0.481	9.81
	Maximum DC	0.809	0.481	9.81
	Maximum DC (Peak)	0.949	0.652	
Power Governor Operating current (random read 4K16Q)				
	Typical DC	0.389	0.687	10.19
	Maximum DC	0.389	0.687	10.19
	Maximum DC (Peak)	1.026	1.827	
Power Governor Operating current (random write 4K16Q)				
	Typical DC	0.436	0.456	7.65
	Maximum DC	0.436	0.456	7.65
	Maximum DC (Peak)	0.844	1.752	
Power Governor Operating current (sequential read 64K16Q)				
	Typical DC	0.872	0.478	10.09
	Maximum DC	0.872	0.478	10.09
	Maximum DC (Peak)	1.082	0.659	
Power Governor Operating current (sequential write 64K16Q)				
	Typical DC	0.811	0.476	9.77
	Maximum DC	0.811	0.476	9.77
	Maximum DC (Peak)	0.94	0.653	

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

Table 7   DC power requirements (6TB)

		6.0Gb mode		
Voltage		**+5V**	**+12V**	**Watts**
Regulation		**± 5%**		**Total**
Avg Idle Current *		0.317	0.356	5.86
Advanced Idle Current *				
	Idle_A	0.338	0.354	5.94
	Idle_B	0.188	0.296	4.49
	Idle_C	0.187	0.073	1.81
	Standby	0.153	0.003	0.80
Maximum Start Current				
	DC (peak DC)	0.827	2.225	
	AC (Peak DC)	0.912	2.52	
Operating current (random read 4K16Q)				
	Typical DC	0.36	0.725	10.49
	Maximum DC	0.36	0.725	10.49
	Maximum DC (Peak)	0.986	1.853	
Operating current (random write 4K16Q)				
	Typical DC	0.39	0.433	7.15
	Maximum DC	0.39	0.433	7.15
	Maximum DC (Peak)	0.927	2.013	
Operating current (sequential read 64K16Q)				
	Typical DC	0.819	0.403	8.94
	Maximum DC	0.819	0.403	8.94
	Maximum DC (Peak)	1.01	0.546	
Operating current (sequential write 64K16Q)				
	Typical DC	0.782	0.406	8.78
	Maximum DC	0.782	0.406	8.78
	Maximum DC (Peak)	0.898	0.535	
Power Governor Operating current (random read 4K16Q)				
	Typical DC	0.361	0.611	9.14
	Maximum DC	0.361	0.611	9.14
	Maximum DC (Peak)	0.98	1.814	
Power Governor Operating current (random write 4K16Q)				
	Typical DC	0.397	0.372	6.45
	Maximum DC	0.397	0.372	6.45
	Maximum DC (Peak)	0.90	1.728	
Power Governor Operating current (sequential read 64K16Q)				
	Typical DC	0.818	0.401	8.91
	Maximum DC	0.818	0.401	8.91
	Maximum DC (Peak)	1.013	0.54	
Power Governor Operating current (sequential write 64K16Q)				
	Typical DC	0.783	0.40	8.71
	Maximum DC	0.783	0.40	8.71
	Maximum DC (Peak)	0.904	0.523	

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

Table 8   DC power requirements (4TB & 2TB)

		6.0Gb mode		
Voltage		**+5V**	**+12V**	**Watts**
Regulation		± 5%		**Total**
Avg Idle Current *		0.334	0.284	5.07
Advanced Idle Current *				
	Idle_A	0.342	0.284	5.12
	Idle_B	0.194	0.239	3.84
	Idle_C	0.194	0.064	1.74
	Standby	0.158	0.005	0.85
Maximum Start Current				
	DC (peak DC)	0.822	2.182	
	AC (Peak DC)	0.92	2.48	
Operating current (random read 4K16Q)				
	Typical DC	0.368	0.62	9.28
	Maximum DC	0.368	0.62	9.28
	Maximum DC (Peak)	0.991	1.736	
Operating current (random write 4K16Q)				
	Typical DC	0.398	0.335	6.00
	Maximum DC	0.398	0.335	6.00
	Maximum DC (Peak)	0.841	1.891	
Operating current (sequential read 64K16Q)				
	Typical DC	0.832	0.322	8.03
	Maximum DC	0.832	0.322	8.03
	Maximum DC (Peak)	1.007	0.46	
Operating current (sequential write 64K16Q)				
	Typical DC	0.781	0.321	7.76
	Maximum DC	0.781	0.321	7.76
	Maximum DC (Peak)	0.898	0.535	
Power Governor Operating current (random read 4K16Q)				
	Typical DC	0.366	0.524	8.13
	Maximum DC	0.366	0.524	8.13
	Maximum DC (Peak)	0.987	1.719	
Power Governor Operating current (random write 4K16Q)				
	Typical DC	0.405	0.296	5.57
	Maximum DC	0.405	0.296	5.57
	Maximum DC (Peak)	0.893	1.61	
Power Governor Operating current (sequential read 64K16Q)				
	Typical DC	0.83	0.326	8.06
	Maximum DC	0.83	0.326	8.06
	Maximum DC (Peak)	1.002	0.457	
Power Governor Operating current (sequential write 64K16Q)				
	Typical DC	0.782	0.322	7.78
	Maximum DC	0.782	0.322	7.78
	Maximum DC (Peak)	0.895	0.436	

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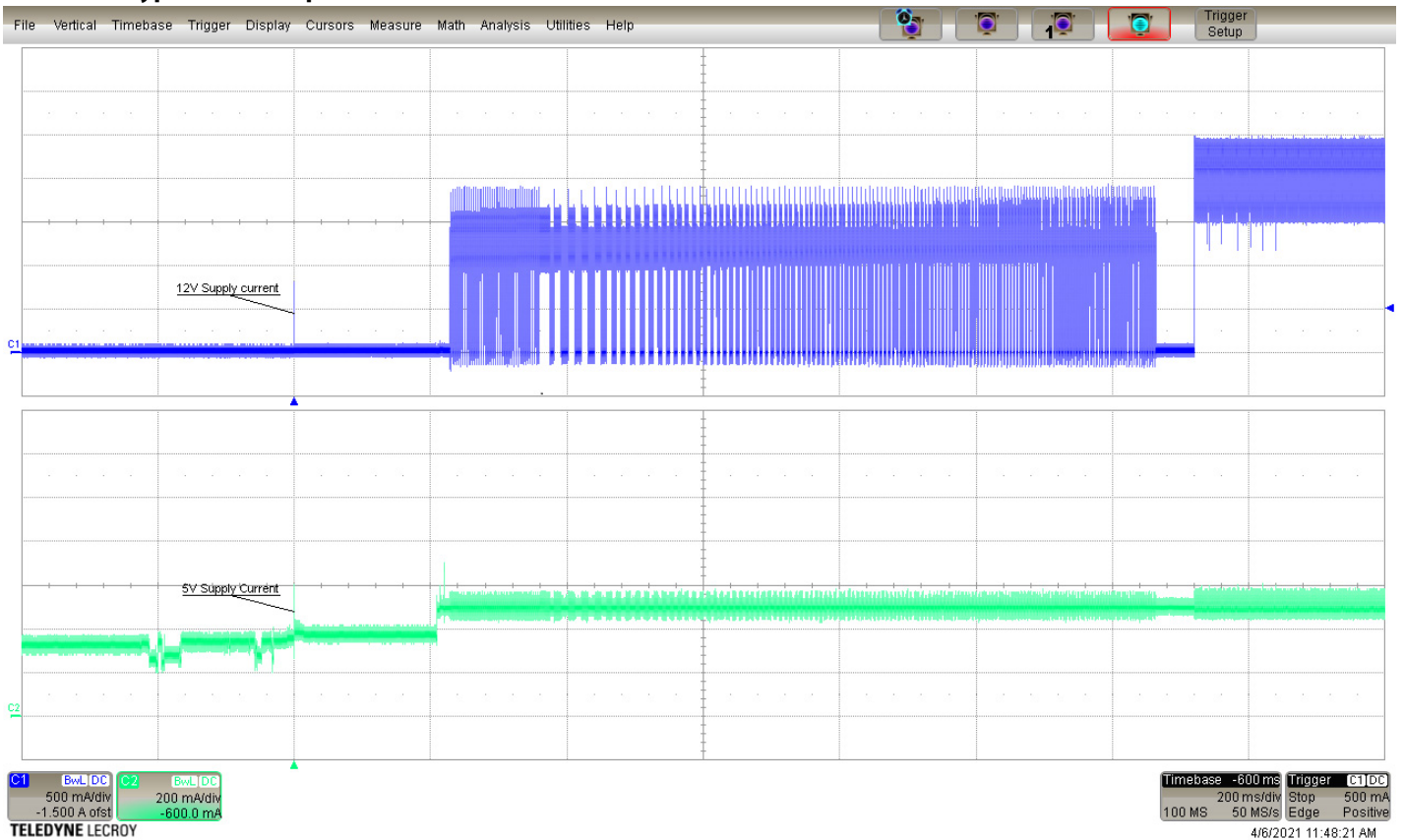
2.5.2 Typical current profiles

Figure 1.   10TB Typical startup and operation current profile

2.5.3 Conducted noise

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

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

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

2.5.4 Voltage tolerance

Voltage tolerance (including noise):

5V   ±5%12V ± 10%

2.5.5 Extended Power Conditions - PowerChoice™

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

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

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

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

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

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

PowerChoice provides the following reporting methods for tracking purposes

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

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

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

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

PowerChoice Manufacture Default Power Condition Timer Values

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

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

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

PowerChoice Supported Extended Power Condition Feature Subcommands

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

PowerChoice Supported Extended Power Condition Identifiers

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

2.6   Environmental limits

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

NOTE   To maintain optimal performance drives should be run at nominal drive temperatures and humidity.

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

2.6.1   Temperature

a. Operating

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

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

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

b. Non-operating

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

2.6.2   Humidity

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

2.6.2.1   Relative humidity

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

2.6.2.2   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.)

2.6.3 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.

2.6.3.1 Shock

a. Operating

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

b. Non-operating

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

2.6.3.2 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 9   Fluid Dynamic Bearing (FDB) motor acoustics

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

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

2.8   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 10   Radio frequency environments

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

2.10   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 0.44% (MTBF of 2,000,000 hours) over a 5 year service life when used in Enterprise Storage field conditions as limited by the following:

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

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

Nonrecoverable read errors	1 per 10^{15} bits read, max
Load unload cycles (command controlled)	600,000 cycles
Maximum Rated Workload	Maximum rate of <550TB/year Workloads exceeding the annualized rate may degrade the drive MTBF and impact product reliability. The Annualized Workload Rate is in units of TB per year, or TB per 8760 power on hours. Workload Rate = TB transferred * (8760 / recorded power on hours).
Warranty	To determine the warranty for a specific drive, use a web browser to access the following web page: 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 to 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: STL018

2.12   Corrosive environment

Seagate electronic drive components pass accelerated corrosion testing equivalent to 10 years exposure to light industrial environments containing sulfurous gases, chlorine and nitric oxide, classes G and H per ASTM B845. However, this accelerated testing cannot duplicate every potential application environment.

Users should use caution exposing any electronic components to uncontrolled chemical pollutants and corrosive chemicals as electronic drive component reliability can be affected by the installation environment. The silver, copper, nickel and gold films used in hard disk drives are especially sensitive to the presence of sulfide, chloride, and nitrate contaminants. Sulfur is found to be the most damaging. Materials used in cabinet fabrication, such as vulcanized rubber, that can outgas corrosive compounds should be minimized or eliminated. The useful life of any electronic equipment may be extended by replacing materials near circuitry with sulfide-free alternatives.

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

2.14   Reference documents

Supported standards

          Serial ATA Revision 3.3 specification

ANSI Documents

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

Self-Encrypting Drives Reference Manual

          Seagate part number: 100515636

Trusted Computing Group (TCG) Documents (apply to Self-Encrypting Drive models only)

          TCG Storage Architecture Core Specification, Rev. 1.0
          TCG Storage Security Subsystem Class Enterprise Specification, Rev. 1.0

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.

2.15   Product warranty

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

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

Shipping

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

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

Storage

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

Product repair and return information

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

3.0 Configuring and mounting the drive

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

3.1 Handling and static-discharge precautions

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

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

3.2 Configuring the drive

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

3.3 Serial ATA cables and connectors

The Serial ATA interface cable consists of four conductors in two differential pairs, plus three ground connections. The cable size may be 30 to 26 AWG with a maximum length of one meter (39.37 in). See **Table 11** for connector pin definitions. Either end of the SATA signal cable can be attached to the drive or host.

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

For installations which require cables, users can connect the drive as illustrated in **Figure 2**.
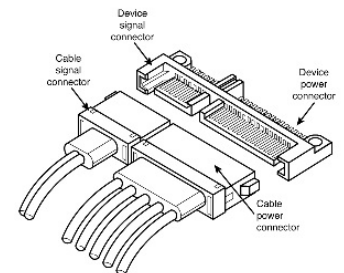

Figure 2.   Attaching SATA cabling

Each cable is keyed to ensure correct orientation. Exos 7E10 Serial ATA 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 3** 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 3** for detailed mounting configuration dimensions. See **Section 3.4**, "Drive mounting."

Weight:	10TB models		1.59 lb	720g
	8TB models		1.58 lb	716g
	6TB models		1.43 lb	650g
	4TB and 2TB models		1.37 lb	620g

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

Figure 3.   Mounting configuration dimensions 5-disk models

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

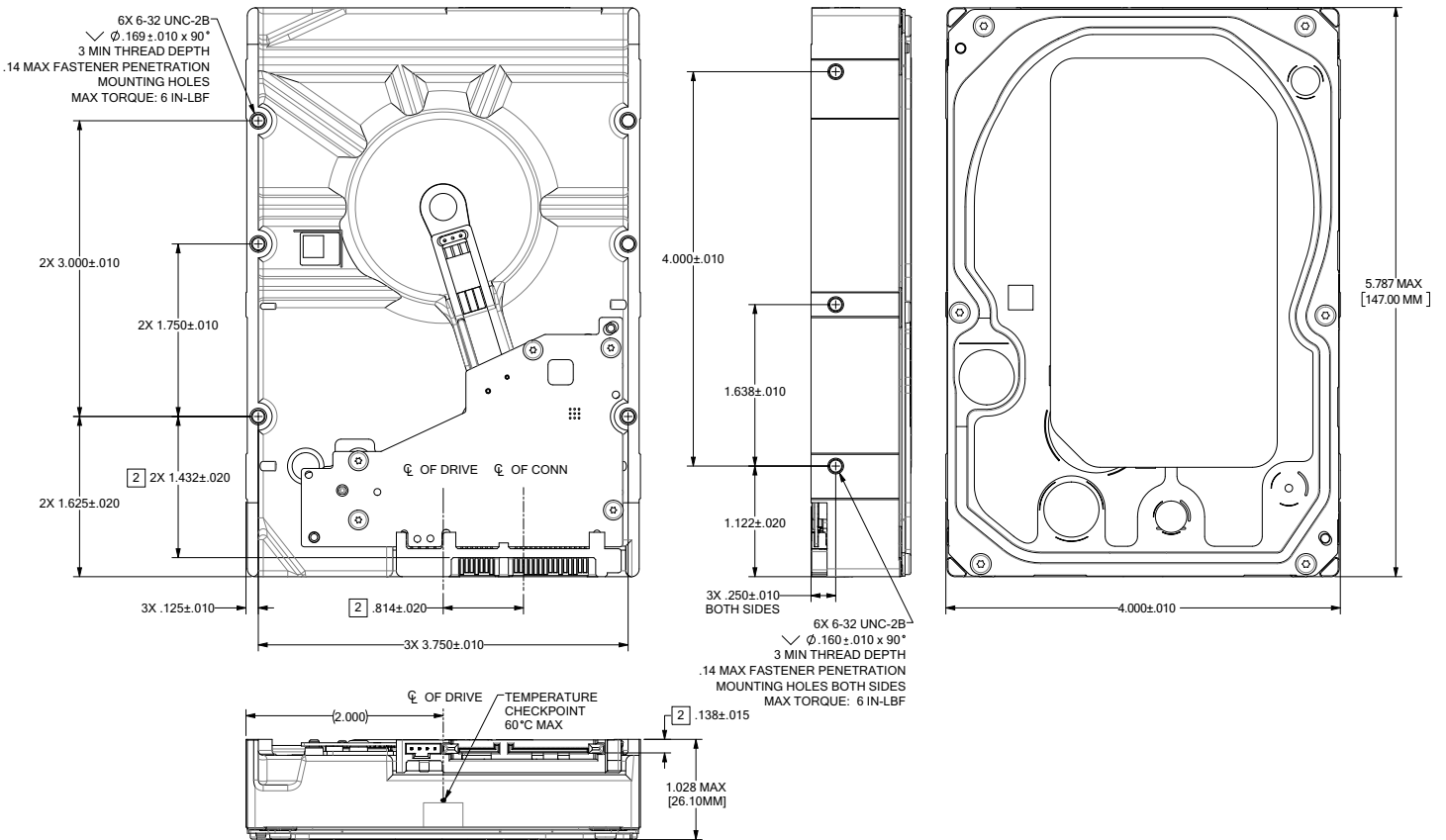**Figure 4.   Mounting configuration dimensions 4-disk models**

Figure 5.   Mounting configuration dimensions 3-disk models

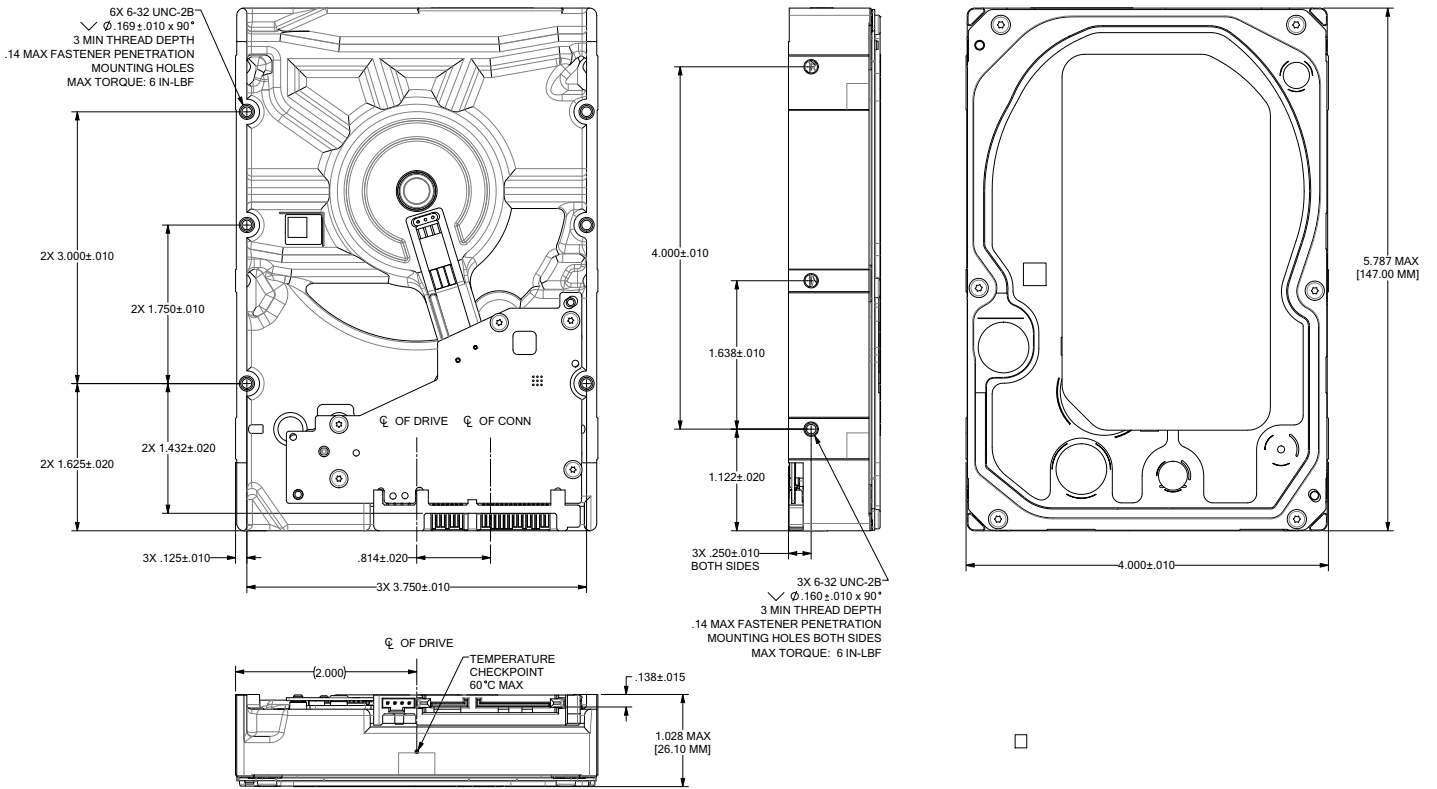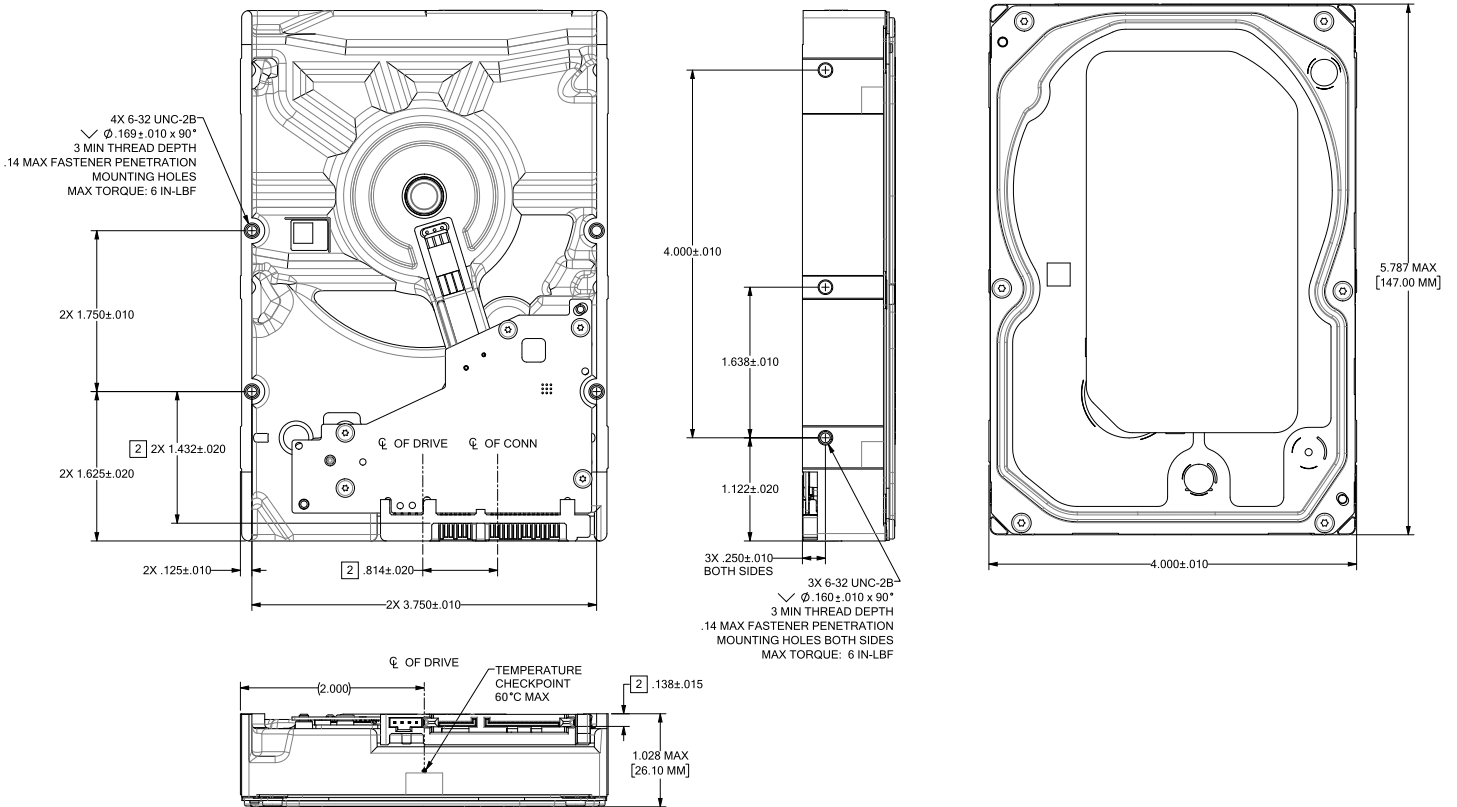| Note	The image is for mechanical dimension reference only and may not represent the actual drive.

4.0   About self-encrypting drives

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

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

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

- Trusted Send
- Trusted Receive

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

4.1   Data encryption

Encrypting drives use one inline encryption engine for each port, employing AES-256 bit data encryption 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 14 Data Bands may be defined in a similar way (Band2 through Band15) 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 12**:
- Trusted Send (5Eh) or Trusted Send DMA (5Fh)
- Trusted Receive (5Ch) or Trusted Receive DMA (5D)

4.10   RevertSP

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

4.11   ATA Security Erase Unit Command on SED SATA drives

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

4.12   Sanitize Device - CRYPTO SCRAMBLE EXT

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

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

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

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

5.0   About FIPS

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

Purpose

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

Seagate Enterprise SEDs

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

Level 2 security

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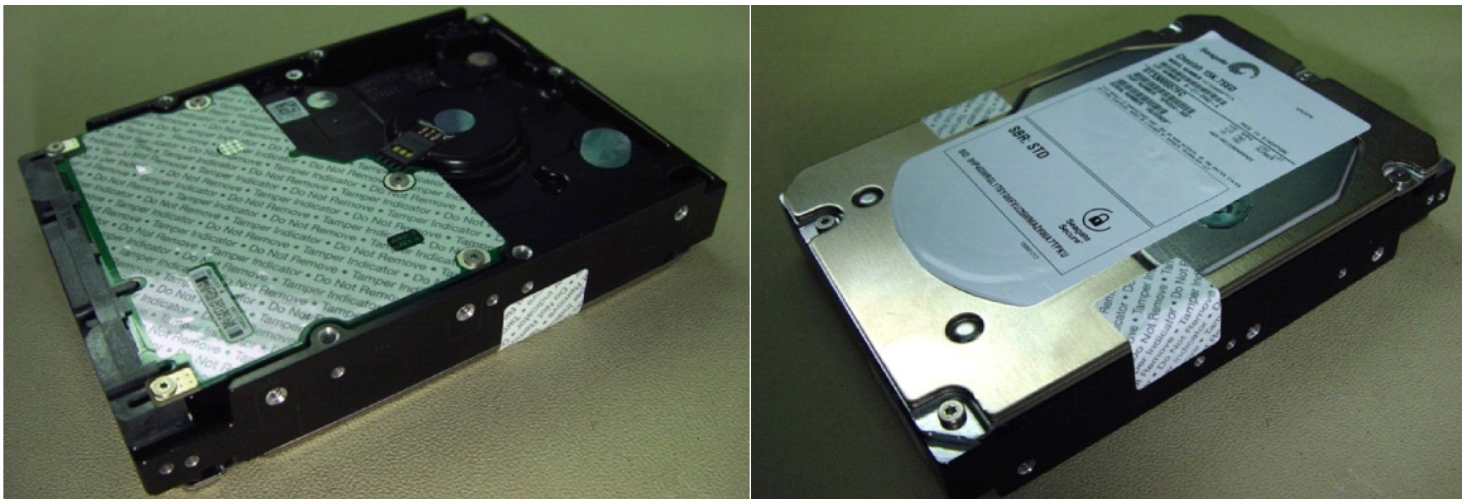.

Figure 6.   Example of FIPS tamper evidence labels.

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

6.0 Serial ATA (SATA) interface

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

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

6.1 Hot-Plug compatibility

Exos 7E10 Serial ATA drives incorporate connectors which enable users to hot plug these drives in accordance with the Serial ATA Revision 3.2 specification. This specification can be downloaded from www.serialata.org.

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

6.2 Serial ATA device plug connector pin definitions

Table 11 summarizes the signals on the Serial ATA interface and power connectors.

Table 11   Serial ATA connector pin definitions

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

Notes:

1. All pins are in a single row, with a 1.27mm (0.050") pitch.

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

3. There are three power pins for each voltage. One pin from each voltage is used for pre-charge when installed in a blind-mate backplane configuration.

4. All used voltage pins (V_x) must be terminated.

6.3 Supported ATA commands

The following table lists Serial ATA standard commands that the drive supports. For a detailed description of the ATA commands, refer to the Serial ATA: High Speed Serialized AT Attachment specification. **See "S.M.A.R.T. commands" on page 39.** for details and subcommands used in the S.M.A.R.T. implementation.

Table 12   Supported ATA commands

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

Command name	Command code (in hex)
Seek	70$_H$
Set Date & Time Ext	77$_H$
Set Features	EF$_H$
Set Multiple Mode	C6$_H$
Sleep	E6$_H$
S.M.A.R.T. Disable Operations	B0$_H$ / D9$_H$
S.M.A.R.T. Enable/Disable Autosave	B0$_H$ / D2$_H$
S.M.A.R.T. Enable Operations	B0$_H$ / D8$_H$
S.M.A.R.T. Execute Offline	B0$_H$ / D4$_H$
S.M.A.R.T. Read Attribute Thresholds	B0$_H$ / D1$_H$
S.M.A.R.T. Read Data	B0$_H$ / D0$_H$
S.M.A.R.T. Read Log Sector	B0$_H$ / D5$_H$
S.M.A.R.T. Return Status	B0$_H$ / DA$_H$
S.M.A.R.T. Save Attribute Values	B0$_H$ / D3$_H$
S.M.A.R.T. Write Log Sector	B0$_H$ / D6$_H$
Standby	E2$_H$
Standby Immediate	E0$_H$
Trusted Send	5E$_H$ (SED drives only)
Trusted Send DMA	5F$_H$ (SED drives only)
Trusted Receive	5C$_H$ (SED drives only)
Trusted Receive DMA	5D$_H$ (SED drives only)
Write Buffer	E8$_H$
Write Buffer DMA	EB$_H$
Write DMA	CA$_H$
Write DMA Extended	35$_H$
Write DMA FUA Extended	3D$_H$
Write FPDMA Queued	61$_H$
Write Log DMA Ext	57$_H$
Write Log Extended	3F$_H$
Write Multiple	C5$_H$
Write Multiple Extended	39$_H$
Write Multiple FUA Extended	CE$_H$
Write Sectors	30$_H$
Write Sectors Without Retries	31$_H$
Write Sectors Extended	34$_H$
Write Uncorrectable	45$_H$

6.3.1 Identify Device command

The Identify Device command (command code EC$_H$) transfers information about the drive to the host following power up. The data is organized as a single 512-byte block of data, whose contents are shown in **Table 12** on **page 32**. 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 13   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	Number of logical cylinders (obsoleted)	16,383
2	ATA-reserved	C837$_H$
3	Number of logical heads (obsoleted)	16
4-5	Retired	0000$_H$
6	Number of logical sectors per logical track: 63 (obsoleted)	003F$_H$
7–9	Retired	0000$_H$
10–19	Serial number: (20 ASCII characters, 0000$_H$ = none)	Reported in 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)	Reported in ASCII
27–46	Drive model number: (40 ASCII characters, padded with blanks to end of string)	Reported in ASCII
47	(Bits 7–0) Maximum sectors per interrupt on Read multiple and Write multiple (16)	8010$_H$
48	Trusted computing feature set options	4000$_H$
49	Standard Standby timer, IORDY supported and may be disabled	2F00$_H$
50	ATA-reserved	4000$_H$
51	PIO data-transfer cycle timing mode	0200$_H$
52	Retired	0200$_H$
53	Words 54–58, 64–70 and 88 are valid	0007$_H$
54-58	Obsolete	*xxxx*$_H$
59	Number of sectors transferred during a Read Multiple or Write Multiple command	x5D10$_H$
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)	x0007$_H$
64	Advanced PIO modes supported (modes 3 and 4 supported)	0003$_H$
65	Minimum multiword DMA transfer cycle time per word (120 ns)	0078$_H$

Table 13   Identify device command

Word	Description	Value
66	Recommended multiword DMA transfer cycle time per word (120 ns)	0078$_H$
67	Minimum PIO cycle time without IORDY flow control (120 ns)	0078$_H$
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	Reserved for future Serial ATA definition	0044$_H$
78	Serial ATA features supported	00CC$_H$
79	Serial ATA features enabled	0040$_H$
80	Major version number	0FE0$_H$
81	Minor version number	FFFF$_H$
82	Command sets supported	306B$_H$
83	Command sets supported	7561$_H$
84	Command sets support extension (see note following this table)	6173$_H$
85	Command sets enabled	3069$_H$
86	Command sets enabled	B441$_H$
87	Command sets enable extension	6173$_H$
88	Ultra DMA support and current mode (see note following this table)	207F$_H$
89	Security erase time	81B4$_H$
90	Enhanced security erase time	81B4$_H$
92	Master password revision code	FFFE$_H$
93	Hardware reset value	*xxxx*$_H$
94	Obsolete	*xx*FE$_H$
95	Stream Minimum Request Size	0x1000$_H$
96	Streaming Transfer Time	0x0000$_H$
97	Streaming Access Latency	0x0000$_H$
98-99	Streaming Performance Granularity	0x0000 2710$_H$
100–103	Total number of user-addressable LBA sectors available (see **Section 2.2** for related information). These words are required for drives that support the 48-bit addressing feature. Maximum value: 0000FFFFFFFFFFFFh.	10TB 5xx models = 19,532,873,728 10TB 4kn models = 2,441,609,216 8TB 5xxe models = 15,628,053,168 8TB 4kn models = 1,953,506,646 6TB 5xxe models = 11,721,045,168 6TB 4kn models = 1,465,130,646 4TB 5xxe models = 7,814,037,168 4TB 4kn models = 976,754,646 2TB 5xxe models = 3,907,029,168 2TB 4kn models = 488,378,646
104–105	ATA-reserved	0000$_H$
106	Physical/Logical sector size	6003$_H$

Table 13   Identify device command

Word	Description	Value
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$_H$
160–205	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$_H$
207-208	ATA-reserved	0000$_H$
209	Alignment of logical blocks and physical blocks	4000$_H$
210-221	Vendor specific	xxxx$_H$
222	Transport major version number	x11FF$_H$
223-254	ATA-reserved	0000$_H$
255	Integrity word	xxA5$_H$

	Bit	Word 63
Description (if bit is set to 1)		
	Bit	**Word 63**
	0	Multiword DMA mode 0 is supported.
	1	Multiword DMA mode 1 is supported.
	2	Multiword DMA mode 2 is supported.
	8	Multiword DMA mode 0 is currently active.
	9	Multiword DMA mode 1 is currently active.
	10	Multiword DMA mode 2 is currently active.
	Bit	**Word 84**
	0	SMART error logging is supported.
	1	SMART self-test is supported.
	2	Media serial number is supported.
	3	Media Card Pass Through Command feature set is supported.
	4	Streaming feature set is supported.
	5	GPL feature set is supported.
	6	WRITE DMA FUA EXT and WRITE MULTIPLE FUA EXT commands are supported.
	7	WRITE DMA QUEUED FUA EXT command is supported.
	8	64-bit World Wide Name is supported.
	9-10	Obsolete.
	11-12	Reserved for TLC.
	13	IDLE IMMEDIATE command with IUNLOAD feature is supported.
	14	Shall be set to 1.
	15	Shall be cleared to 0.
	Bit	**Word 88**
	0	Ultra DMA mode 0 is supported.
	1	Ultra DMA mode 1 is supported.
	2	Ultra DMA mode 2 is supported.
	3	Ultra DMA mode 3 is supported.
	4	Ultra DMA mode 4 is supported.
	5	Ultra DMA mode 5 is supported.
	6	Ultra DMA mode 6 is supported.
	8	Ultra DMA mode 0 is currently active.
	9	Ultra DMA mode 1 is currently active.
	10	Ultra DMA mode 2 is currently active.
	11	Ultra DMA mode 3 is currently active.
	12	Ultra DMA mode 4 is currently active.
	13	Ultra DMA mode 5 is currently active.
	14	Ultra DMA mode 6 is currently active.

6.3.2 Set Features command

This command controls the implementation of various features that the drive supports. When the drive receives this command, it sets BSY, checks the contents of the Features register, clears BSY and generates an interrupt. If the value in the register does not represent a feature that the drive supports, the command is aborted. Power-on default has the read look-ahead and write caching features enabled. The acceptable values for the Features register are defined as follows

Table 14   Set Features command values

02_H	Enable write cache *(default)*.
03_H	Set transfer mode (based on value in Sector Count register).
	Sector Count register values:

	00_H	Set PIO mode to default (PIO mode 2).
	01_H	Set PIO mode to default and disable IORDY (PIO mode 2).
	08_H	PIO mode 0
	09_H	PIO mode 1
	$0A_H$	PIO mode 2
	$0B_H$	PIO mode 3
	$0C_H$	PIO mode 4 *(default)*
	20_H	Multiword DMA mode 0
	21_H	Multiword DMA mode 1
	22_H	Multiword DMA mode 2
	40_H	Ultra DMA mode 0
	41_H	Ultra DMA mode 1
	42_H	Ultra DMA mode 2
	43_H	Ultra DMA mode 3
	44_H	Ultra DMA mode 4
	45_H	Ultra DMA mode 5
	46_H	Ultra DMA mode 6

10_H	Enable use of SATA features
55_H	Disable read look-ahead (read cache) feature.
82_H	Disable write cache
90_H	Disable use of SATA features
AA_H	Enable read look-ahead (read cache) feature *(default)*.
$F1_H$	Report full capacity available

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

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

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

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

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

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

SEAGATE