

User Manual of Product 1:

Seagate BarraCuda 1 TB Internal Hard Drive HDD 3.5 Inches (8.8 cm) SATA 6 Gb/s 7200 RPM 64 MB Cache for Computer Desktop PC (ST1000DM010)

User Manual of Product 2:

Seagate Barracuda Q1 SSD 240GB Internal Solid State Drive – 6.35 cm (2.5 Inch) SATA 6Gb/s for PC Laptop Upgrade 3D QLC NAND (ZA240CV1A001)



BARRACUDA
COMPUTE

Product Manual

Standard models

ST3000DM008
ST2000DM006
ST1000DM010
ST500DM009

Self-Encryption models

ST3000DM009
ST2000DM007

100804187, Rev. H
May 2019

Document Revision History

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When referring to drive capacity, one gigabyte, or GB, equals one billion bytes and one terabyte, or TB, equals one trillion bytes. Your computer's operating system may use a different standard of measurement and report a lower capacity. In addition, some of the listed capacity is used for formatting and other functions, and thus will not be available for data storage. Actual quantities will vary based on various factors, including file size, file format, features and application software. Actual data rates may vary depending on operating environment and other factors. The export or re-export of hardware or software containing encryption may be regulated by the U.S. Department of Commerce, Bureau of Industry and Security (for more information, visit www.bis.doc.gov), and controlled for import and use outside of the U.S. Seagate reserves the right to change, without notice, product offerings or specifications.

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1.0 Introduction

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

Standard models		Self-Encryption models
ST3000DM008	ST1000DM010	ST3000DM009
ST2000DM006	ST500DM009	ST2000DM007

Note

Previous generations of Seagate Self-Encrypting Drive models were called Full Disk Encryption (FDE) models before a differentiation between drive-based encryption and other forms of encryption was necessary.

These drives provide the following key features:

- 7200 RPM spindle speed.
- Compliant with RoHS requirements in China and Europe.
- 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.
- Quiet operation.
- Seagate AcuTrac™ servo technology delivers dependable performance, even with hard drive track widths of only 75 nanometers.
- Seagate OptiCache™ technology boosts overall performance by as much as 45% over the previous generation.
- Seagate SmartAlign™ technology provides a simple, transparent migration to Advanced Format 4K sectors
- 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.
- Worldwide Name (WWN) capability uniquely identifies the drive.

1.1 About the SATA interface

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

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

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

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

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

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

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.

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

ST3000DM008 ST1000DM010
ST2000DM006 ST500DM009

Self-Encryption models

ST3000DM009
ST2000DM007

2.1 Specification summary tables

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

Table 1 Drive specifications summary for 3TB, 2TB, 1TB and 500GB models

Drive Specification*	ST3000DM008 & ST3000DM009	ST2000DM006 & ST2000DM007	ST1000DM010	ST500DM009
Formatted capacity (512 bytes/sector)**	3000GB (3TB);	2000GB (2TB);	1000GB (1TB);	500GB
Guaranteed sectors	5,860,533,168;	3,907,029,168;	1,953,525,168;	976,773,168
Heads	6	6 / 4	2	2/1
Disks	3	3 / 2	1	1
Bytes per sector (4K physical emulated at 512-byte sectors)	4096			
Default sectors per track	63			
Default read/write heads	16			
Default cylinders	16,383			
Recording density (max)	1807kFCI			
Track density (avg)	352ktracks/in			
Areal density (avg)	625Gb/in ²			
Spindle speed	7200 RPM			
Internal data transfer rate (max)	2147Mb/s			
Average data rate, read/write (MB/s)	156MB/s			
Maximum sustained data rate, OD read (MB/s)	210MB/s			
I/O data-transfer rate (max)	600MB/s			
Cache buffer	64MB			32 MB
Height (max)	26.1mm / 1.028 in		20.20mm / 0.795 in	
Width (max)	101.6mm /4.0 in (± 0.010 in)			
Length (max)	146.99mm / 5.787 in			
Weight (typical)	626g /1.38 lb	626g/1.38lb 535g / 1.18 lb	400g / 0.88lb	
Average latency	4.16ms			
Power-on to ready (typical)	<10.0s			
Power-on to ready (max)	<17.0s		<10.0s	<8.5s
Standby to ready (max)	<17.0s		<10.0s	<8.5s
Average seek, read (typical) Average seek, write (typical)	<8.5ms <9.5ms			
Startup current 12V	2.0A or 2.5A		2.0A	
Voltage tolerance (including noise)	5V: ±5% 12V: +10% / -7.5%			
Non-Operating ambient temperature (°C)	-40° to 70°			
Operating ambient temperature (min °C)	0°			
Operating temperature (Drive case max °C)	60° †			

Table 1 Drive specifications summary for 3TB, 2TB, 1TB and 500GB models (continued)

Drive Specification*	ST3000DM008 & ST3000DM009	ST2000DM006 & ST2000DM007	ST1000DM010	ST500DM009
Temperature gradient	20°C per hour max (operating) 30°C per hour max (non-operating)			
Relative humidity	5% to 95% (operating) 5% to 95% (non-operating)			
Relative humidity gradient (max)	30% per hour			
Wet bulb temperature (max)	26°C max (operating) 29°C max (non-operating)			
Altitude, operating	–304.8m to 3048m (–1000 ft to 10,000+ ft)			
Altitude, non-operating (below mean sea level, max)	–304.8m to 12,192m (–1000 ft to 40,000+ ft)			
Operational shock (max)	80 Gs at 2ms			
Non-operational shock (max)	300 Gs at 2ms		350 Gs at 2ms	
Vibration, operating	2Hz to 22Hz: 0.25 Gs, Limited displacement 22Hz to 350Hz: 0.50 Gs 350Hz to 500Hz: 0.25 Gs			
Vibration, non-operating	5Hz to 22Hz: 3.0 Gs 22Hz to 350Hz: 3.0 Gs 350Hz to 500Hz: 3.0 Gs			
Drive acoustics, sound power				
Idle***	2.4 bels (typical) 2.6 bels (max)		2.2 bels (typical) 2.3 bels (max)	
Seek	2.6 bels (typical) 2.7 bels (max)		2.3 bels (typical) 2.4 bels (max)	
Non-recoverable read errors	1 per 10 ¹⁴ bits read			
Annualized Failure Rate (AFR)	<1.0% based on 2400 POH			
Rated Workload	Average annualized workload rating: <55 TB/year. The AFR specification for the product assumes the I/O workload does not exceed the average annualized workload rate limit of 55 TB/year. Workloads exceeding the annualized rate may degrade the product AFR and impact reliability as experienced by the particular application. The average annualized workload rate limit is in units of TB per calendar year.			
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 “Is my Drive under Warranty”. Users will be asked to provide the drive serial number, model number (or part number) and country of purchase. The system will display the warranty information for the drive.			
Load/Unload cycles (25°C, 50% rel. humidity)	300,000		----	
Contact start-stop cycles (25°C, 50% rel. humidity)	-----		50,000	
Supports Hotplug operation per the Serial ATA Revision 3.2 specification	Yes			

* All specifications above are based on native configurations.

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

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

† Seagate does not recommend operating at sustained case temperatures above 60°C. Operating at higher temperatures will reduce useful life of the product.

2.2 Formatted capacity

Model	Formatted capacity*	Guaranteed sectors	Bytes per sector
ST3000DM008 & ST3000DM009	3000GB	5,860,533,168	4096 (512 bytes per sector emulated at the interface)
ST2000DM006 & ST2000DM007	2000GB	3,907,029,168	
ST1000DM010	1000GB	1,953,525,168	
ST500DM009	500GB	976,773,168	

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

2.2.1 LBA mode

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

See Section 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 Default logical geometry

- **Cylinders:** 16,383
- **Read/write heads:** 16
- **Sectors per track:** 63

LBA mode

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

2.4 Recording and interface technology

Interface	SATA
Recording method	TGMR
Recording density (kFCI)	1807
Track density (ktracks/inch avg)	352
Areal density (Gb/in ²)	625
Spindle speed (RPM)	7200 ± 0.2%
Internal data transfer rate (Mb/s max)	2147
Maximum sustained data transfer rate, OD read (MB/s)	210
Average data rate, read/write (MB/s)	156
I/O data-transfer rate (MB/s max)	600

2.5 Physical characteristics

Maximum height	
3TB and 2TB	26.1mm / 1.028 in
1TB and 500GB	20.20mm / 0.795 in
Maximum width (all models)	101.6mm / 4.0 in (± 0.010 in)
Maximum length (all models)	146.99mm / 5.787 in
Typical weight	
3TB	626g / 1.38 lb
2TB	626g / 1.38 lb - or - 535g / 1.18 lb
1TB and 500GB	400g / 0.88lb
Cache buffer	
3TB, 2TB and 1TB	64MB
500GB	32MB

2.6 Seek time

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

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

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

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.

2.7 Start/stop times

	3-disk (3TB models)	2-disk (2TB models)	1-disk (1TB models)	1-disk (500GB models)
Power-on to ready (in seconds)	15 (typical) 17 (max)		10 (typical) 12 (max)	8.5 (typical) 10 (max)
Power-on to ready (typical)	<10			
Standby to ready (in seconds)	15 (typical) 17 (max)		10 (typical) 12 (max)	8.5 (typical) 10 (max)
Ready to spindle stop (in seconds)	10 (typical) 11 (max)			

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

2.8 Power specifications

The drive receives DC power (+5V or +12V) through a native SATA power connector. Refer to [Figure 2 on page 23](#).

2.8.1 Power consumption

Power requirements for the drives are listed in [Table 2](#) and [Table 3](#). Typical power measurements are based on an average of drives tested, under nominal conditions, using 5.0V and 12.0V input voltage at 25°C ambient temperature.

- **Spinup power**
Spinup power is measured from the time of power-on to the time that the drive spindle reaches operating speed.
- **Read/write power and current**
Read/write power is measured with the heads on track, based on a 16-sector write followed by a 32-ms delay, then a 16-sector read followed by a 32-ms delay.
- **Operating power and current**
Operating power is measured using 40 percent random seeks, 40 percent read/write mode (1 write for each 10 reads) and 20 percent drive idle mode.
- **Idle mode power**
Idle mode power is measured with the drive up to speed, with servo electronics active and with the heads in a random track location.
- **Standby mode**
During Standby mode, the drive accepts commands, but the drive is not spinning, and the servo and read/write electronics are in power-down mode.

Table 2 DC power requirements (3-disk: 3TB and 2TB models)

Power dissipation (3-disk values shown)	Avg (watts 25° C)	Avg 5V typ amps	Avg 12V amps
Spinup	—	—	2.0A or 2.5A
Idle2* †	5.40	0.190	0.377
Operating	8.00	0.510	0.462
Standby	0.75	0.136	0.005
Sleep	0.75	0.136	0.005

Table 3 DC power requirements (1-disk: 1TB and 500GB models)

Power dissipation (1-disk values shown)	Avg (watts 25° C)	Avg 5V typ amps	Avg 12V typ amps
Spinup	—	—	2.0
Perf Idle* †	4.6	0.378	0.224
Operating	5.3	0.656	0.243
Standby	0.94	0.350	0.010
Sleep	0.94	0.350	0.010

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

†5W IDLE with DIPLM Enabled

2.8.2 Conducted noise

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

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

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

Voltage tolerance (including noise):

- 5V $\pm 5\%$
- 12V +10% / -7.5%

2.8.4 Power-management modes

The drive provides programmable power management to provide greater energy efficiency. In most systems, users can control power management through the system setup program. The drive features the following power-management modes:

Power modes	Heads	Spindle	Buffer
Active	Tracking	Rotating	Enabled
Idle	Tracking	Rotating	Enabled
Standby	Parked	Stopped	Enabled
Sleep	Parked	Stopped	Disabled

- **Active mode**
The drive is in Active mode during the read/write and seek operations.
- **Idle mode**
The buffer remains enabled, and the drive accepts all commands and returns to Active mode any time disk access is necessary.
- **Standby mode**
The drive enters Standby mode when the host sends a Standby Immediate command. If the host has set the standby timer, the drive can also enter Standby mode automatically after the drive has been inactive for a specifiable length of time. The standby timer delay is established using a Standby or Idle command. In Standby mode, the drive buffer is enabled, the heads are parked and the spindle is at rest. The drive accepts all commands and returns to Active mode any time disk access is necessary.
- **Sleep mode**
The drive enters Sleep mode after receiving a Sleep command from the host. In Sleep mode, the drive buffer is disabled, the heads are parked and the spindle is at rest. The drive leaves Sleep mode after it receives a Hard Reset or Soft Reset from the host. After receiving a reset, the drive exits Sleep mode and enters Standby mode with all current translation parameters intact.
- **Idle and Standby timers**
Each time the drive performs an Active function (read, write or seek), the standby timer is reinitialized and begins counting down from its specified delay times to zero. If the standby timer reaches zero before any drive activity is required, the drive makes a transition to Standby mode. In both Idle and Standby mode, the drive accepts all commands and returns to Active mode when disk access is necessary.

2.9 Environmental specifications

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

Refer to [Section 3.4 Drive mounting](#) for base plate measurement location.

2.9.1 Ambient temperature

Non-Operating ambient temperature (°C)	–40° to 70°
Operating ambient temperature (min °C)	0°
Operating temperature (Drive case max °C)	60° †

† Seagate does not recommend operating at sustained case temperatures above 60°C. Operating at higher temperatures will reduce useful life of the product.

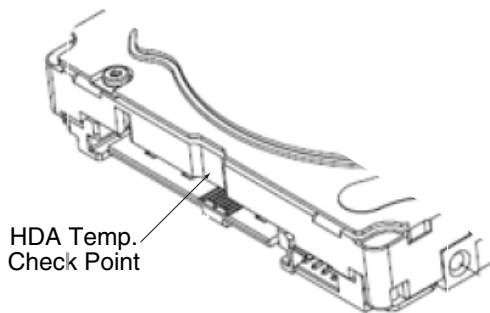


Figure 1 Location of the HDA temperature check point

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

2.9.2 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)

2.9.3 Humidity

2.9.3.1 Relative humidity

Operating	5% to 95% non-condensing (30% per hour max)
Non-operating	5% to 95% non-condensing (30% per hour max)

2.9.3.2 Wet bulb temperature

Operating	26°C / 78.8°F (rated)
Non-operating	29°C / 84.2°F (rated)

2.9.4 Altitude

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

2.9.5 Shock and Vibration

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

2.9.5.1 Operating shock

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

2.9.5.2 Non-operating shock

3TB and 2TB models

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.

1TB and 500GB models

The non-operating shock level that the drive can experience without incurring physical damage or degradation in performance when subsequently put into operation is 350 Gs based on a non-repetitive half-sine shock pulse of 2-ms duration.

2.9.5.3 Operating vibration

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

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

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

2.9.6 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

2.10 Acoustics

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

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 = $0.4 / (\text{average latency} + \text{average access time})$)
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Table 4 Fluid Dynamic Bearing (FDB) motor acoustics

	Idle*	Seek
3 Disks (3TB, 2TB)	2.4 bels (typical) 2.6 bels (max)	2.6 bels (typical) 2.7 bels (max)
2 Disks (2TB)		
1 Disk (1TB and 500GB)	2.2 bels (typical) 2.4 bels (max)	2.4 bels (typical) 2.5 bels (max)

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

2.10.1 Test for Prominent Discrete Tones (PDTs)

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

2.11 Electromagnetic immunity

When properly installed in a representative host system, the drive operates without errors or degradation in performance when subjected to the radio frequency (RF) environments defined in [Table 5](#).

Table 5 Radio frequency environments

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)

The production disk drive shall achieve an annualized failure-rate of <1.0% over a 5 year service life when used in Desktop Storage field conditions as limited by the following:

- 2400 power-on-hours per year.
- Typical workload

Nonrecoverable read errors	1 per 10 ¹⁴ bits read, max
Rated Workload	Average annualized workload rating: <55 TB/year. The AFR specification for the product assumes the I/O workload does not exceed the average annualized workload rate limit of 55 TB/year. Workloads exceeding the annualized rate may degrade the product AFR and impact reliability as experienced by the particular application. The average annualized workload rate limit is in units of TB per calendar year.
Warranty	To determine the warranty for a specific drive, use a web browser to access the following web page: http://www.seagate.com/support/warranty-and-replacements/ . From this page, click on the "Is my Drive under Warranty" link. The following are required to be provided: the drive serial number, model number (or part number) and country of purchase. The system will display the warranty information for the drive.
Preventive maintenance	None required.

2.12.2 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.

2.13 Agency and Safety Certifications

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

2.13.1 Safety certification

The drives are recognized in accordance with UL/cUL 60950-1 and EN 60950-1.

2.13.2 European Union (EU) CE Marking Requirements

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

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

Seagate drives are tested in representative end-user systems. Although CE-marked Seagate drives comply with all relevant regulatory requirements and standards for the drives, Seagate cannot guarantee that all system-level products into which the drives are installed comply with all regulatory requirements and standards applicable to the system-level products. The drive is designed for operation inside a properly designed system (e.g., enclosure designed for the drive), with properly shielded I/O cable (if necessary) and terminators on all unused I/O ports. Computer manufacturers and system integrators should confirm EMC compliance and provide CE marking for the system-level products.

For compliance with the RoHS "Recast" Directive 2011/65/EU (RoHS 2), [See Section 2.14.1 on page 20](#).

2.13.3 Australian RCM Compliance Mark

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

2.13.4 Canada ICES-003

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

2.13.5 South Korean KC Certification Mark

The South Korean KC Certification Mark means the drives comply with paragraph 1 of Article 11 of the Electromagnetic Compatibility control Regulation and meet the Electromagnetic Compatibility (EMC) Framework requirements of the Radio Research Agency (RRA) Communications Commission, Republic of Korea. These drives have been tested and comply with the Electromagnetic Interference/Electromagnetic Susceptibility (EMI/EMS) for Class B products. Drives are tested in a representative, end-user system by a Korean-recognized lab.

기종별	사용자안내문
B급 기기 (가정용 방송통신기자재)	이 기기는 가정용(B급) 전자파적합기기로서 주로 가정에서 사용하는 것을 목적으로 하며, 모든 지역에서 사용할 수 있습니다.

2.13.6 Morocco Commodity Mark

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

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

2.13.7 Taiwanese BSMI

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

For compliance with the Taiwan Bureau of Standards, Metrology and Inspection's (BSMI) requirements, [See Section 2.14.3 on page 22](#).

2.13.8 FCC verification

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

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

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

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

- Reorient the receiving antenna.
- Move the device to one side or the other of the radio or TV.
- Move the device farther away from the radio or TV.
- Plug the computer into a different outlet so that the receiver and computer are on different branch outlets.

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

2.14 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 Substance Law

2.14.1.1 Restriction of Hazardous Substances in Electrical and Electronic Equipment

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

2.14.1.2 Substances of Very High Concern (SVHC)

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

2.14.2 China Requirements —China RoHS 2



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

Table 6 China - Hazardous Substances

部件名称 Part Name	有害物质 Hazardous Substances					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr ⁺⁶)	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
硬盘驱动器 HDD	X	O	O	O	O	O
印刷电路板组装 PCBA	X	O	O	O	O	O

本表格依据 SJ/T 11364 的规定编制。
 This table is prepared in accordance with the provisions of SJ/T 11364-2014
 O: 表示该有害物质在该部件所有均质材料中的含量均在 GB/T 26572 规定的限量要求以下。
 O: Indicates that the hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement of GB/T26572.
 X: 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求。
 X: Indicates that the hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement of GB/T26572.

2.14.3 Taiwan Requirements — Taiwan RoHS

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

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

Table 7 Taiwan - Restricted Substances

設備名稱：硬碟設備，型號： Equipment Name: Hard Disk Device, Type Designation:						
單元 Unit	限用物質及其化學符號 Restricted Substance and its chemical symbol					
	鉛 (Pb)	汞 (Hg)	鎘 (Cd)	六價鉻 (Cr+6)	多溴聯苯 (PBB)	多溴二苯醚 (PBDE)
頂蓋 Top Cover	—	0	0	0	0	0
磁碟 Magnetic disk	—	0	0	0	0	0
電機底座組件 Motor Base Assembly	—	0	0	0	0	0
印刷電路板組裝 PCB Assembly	—	0	0	0	0	0
備考 1. "0" 係指該項限用物質之百分比含量未超出百分比含量基準值。 Note 1. "0" indicates that the percentage content of the restricted substance does not exceed the percentage of reference value of presence. 備考 2. "—" 係指該項限用物質為排除項目。 Note 2. "—" indicates that the restricted substance corresponds to the exemption.						

2.15 Corrosive environment

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

3.0 Configuring and Mounting the Drive

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

3.1 Handling and static-discharge precautions

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

Caution

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

3.2 Configuring the drive

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

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

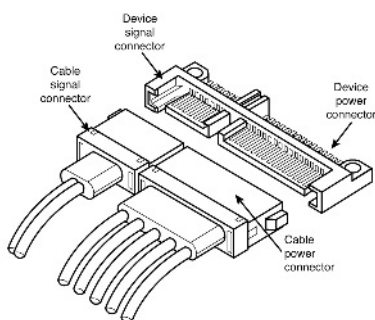
3.3 SATA cables and connectors

The SATA interface cable consists of four conductors in two differential pairs, plus three ground connections. The cable size may be 30 to 26 AWG with a maximum length of one meter (39.37 inches). See [Table 8](#) for connector pin definitions. Either end of the SATA signal cable can be attached to the drive or host.

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

For installations which require cables, users can connect the drive as illustrated in [Figure 2](#).

Figure 2 Attaching SATA cabling



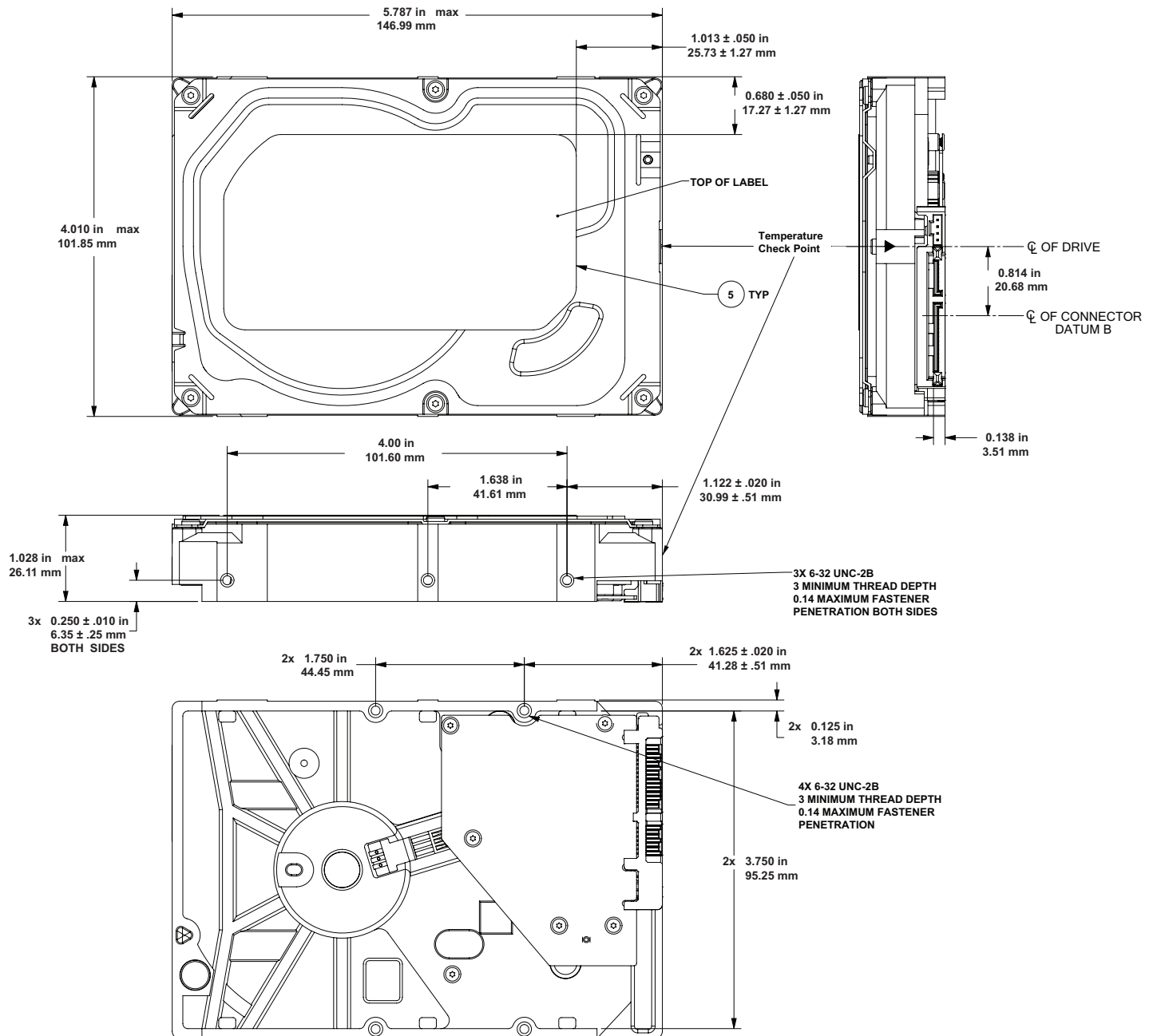
Each cable is keyed to ensure correct orientation. BarraCuda drives support latching SATA connectors.

3.4 Drive mounting

Users can mount the drive in any orientation using four screws in the side-mounting holes or four screws in the bottom-mounting holes. Refer to [Figure 3](#) through [Figure 6](#) 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 0.140 inch (3.56mm) into the bottom or side mounting holes.
- Do not overtighten the mounting screws (maximum torque: 6 inch-lb).

Figure 3 Mounting dimensions (2/3-disk: 2TB to 3TB models)

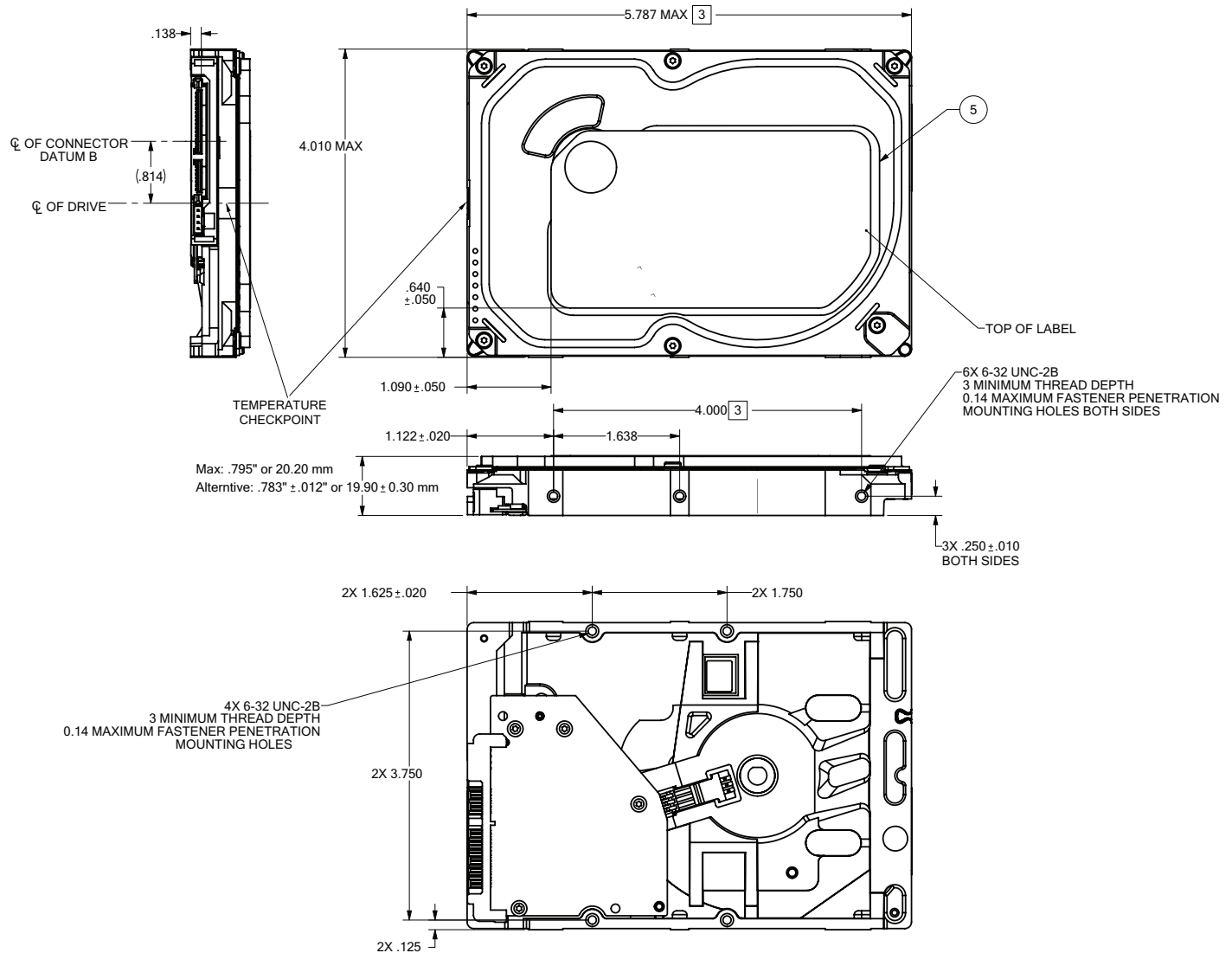


Note

Drawings are for mounting hole reference only.
PCBA show in pictorial only and can vary based on specific customer configurations.

Seagate utilizes three base decks for 1TB and 500GB capacities, as shown below.

Figure 4 Mounting dimensions (configuration 1)



Note

Drawings are for mounting hole reference only.
PCBA show in pictorial only and can vary based on specific customer configurations.

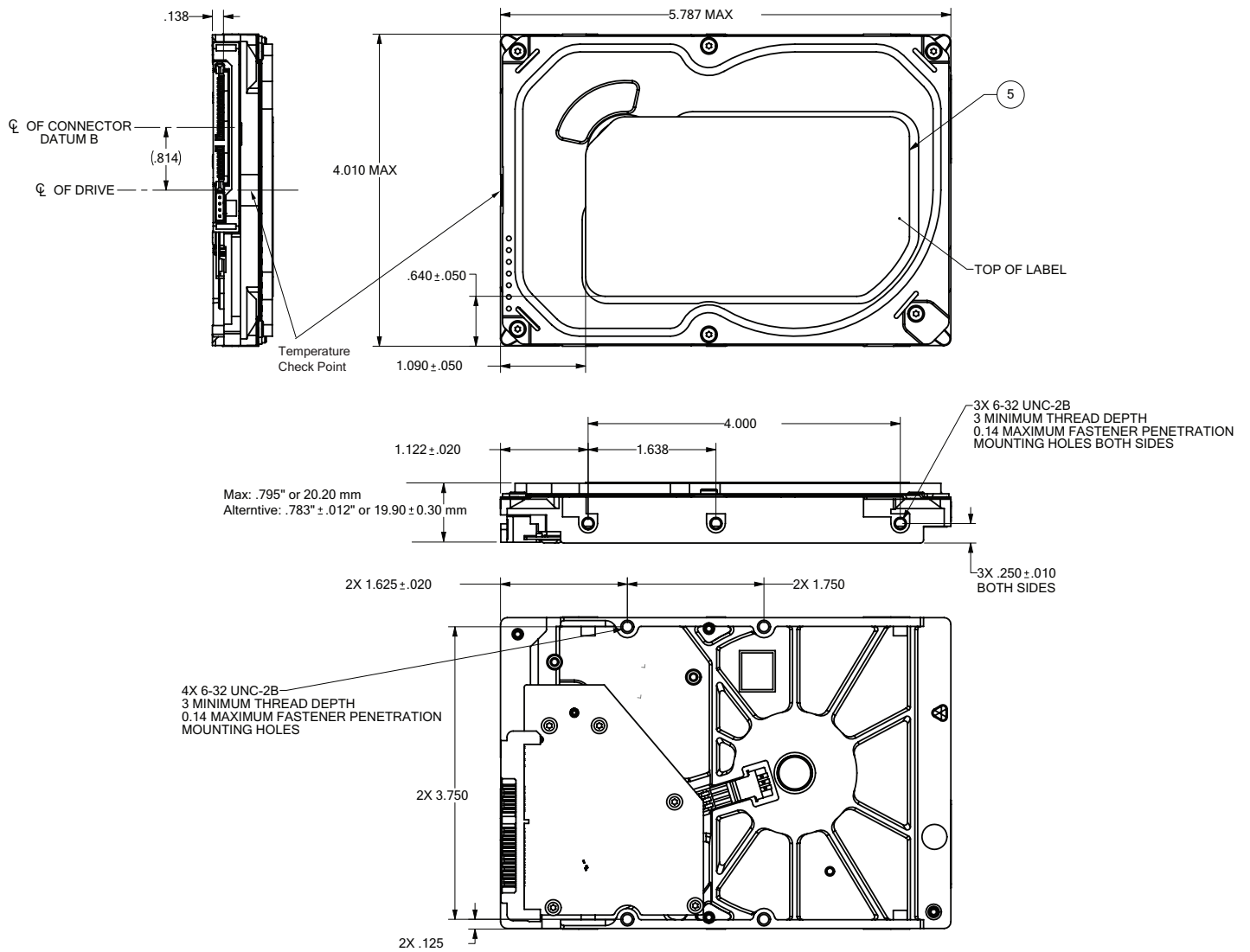
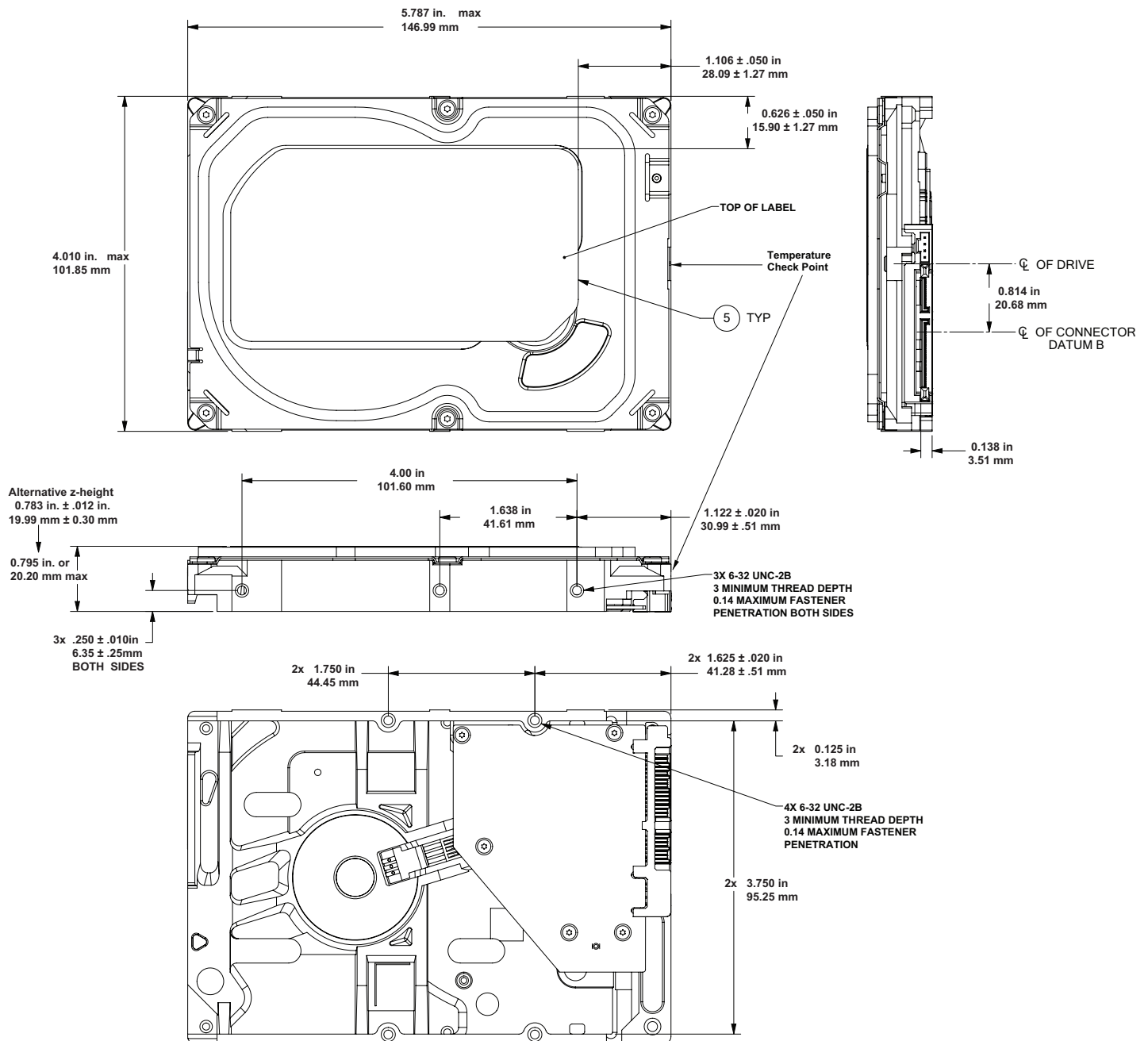
Figure 5 Mounting dimensions (configuration 2)

Figure 6 Mounting dimensions (configuration 3)**Note**

Drawings are for mounting hole reference only.
PCBA show in pictorial only and can vary based on specific customer configurations.

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 "data at rest". These drives are compliant with the Trusted Computing Group (TCG) Opal Storage Specifications as detailed in the following:

- TCG Storage Architecture Core Specification, Version 2.0 (see www.trustedcomputinggroup.org)
- 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 a standards 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. Seagate Secure SEDs also support TCG Single User Mode, which can be disabled.

4.1 Data Encryption

Encrypting drives use one inline encryption engine within each drive employing AES-256 algorithms 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 in volatile temporary storage (DRAM), which is external to the encryption engine. A unique data encryption key is used for each of the drive's possible 16 data bands (see [Section 4.5 Data Bands \(TBD\)](#)).

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 the user provides the correct credentials to prove that they are 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.

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 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 (TBD)

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.

4.6 Cryptographic Erase

A valuable 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 the older key, the user data can never be recovered. This is done in a matter of seconds and is very useful if the drive is to be scrapped or repurposed.

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 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 2.8 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 [Table 9](#):

- 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

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

5.2 SATA device plug connector pin definitions

Table 8 summarizes the signals on the SATA interface and power connectors.

Table 8 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

- All pins are in a single row, with a 1.27 mm (0.050 in) pitch.
- 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.
- 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 3.2 (<http://www.sata-io.org>).

See “S.M.A.R.T. commands” on page 38 for details and subcommands used in the S.M.A.R.T. implementation.

Table 9 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 9 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 31. 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 10 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
59	Number of sectors transferred during a Read Multiple or Write Multiple command	xxxx _H

Table 10 Identify Device commands (continued)

Word	Description	Value
60–61	Total number of user-addressable LBA sectors available (see Section 2.2 for related information) *Note: The maximum value allowed in this field is: 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)	xx07 _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	30xx _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)	xx7F _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
95–99	ATA-reserved	0000 _H

Table 10 Identify Device commands (continued)

Word	Description	Value
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: 0000FFFFFFFFFh.	ST3000DM008 = 5,860,533,168 ST3000DM009 = 5,860,533,168 ST2000DM006 = 3,907,029,168 ST2000DM007 = 3,907,029,168 ST1000DM010 = 1,953,525,168 ST500DM009 = 976,773,168
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 11 Set Features command

02 _H	Enable write cache (<i>default</i>).
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 (<i>default</i>)
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 (<i>default</i>).
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 D4_H) that eliminates unnecessary drive returns. The diagnostic software ships with all new drives and is also available at:

<http://seatools.seagate.com>.

This drive is shipped with S.M.A.R.T. features 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 12 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.



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Seagate® BarraCuda™ 120 SSD

Product Manual

250 GB	ZA250CM10003
500 GB	ZA500CM10003
1000 GB	ZA1000CM10003
2000 GB	ZA2000CM10003

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September 2019

Revision History

Version and Date	Description of Changes
Rev A, September 2019	First document release.

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Seagate Technology Support Services

For Internal SSD Support, visit: <https://www.seagate.com/support/products/>

For Firmware Download and Tools Download for Secure Erase, visit: <https://www.seagate.com/support/downloads/>

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

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1. Introduction

The Seagate® BarraCuda™ 120 SSD is a fast, dependable storage solution for everyday compute applications. The Seagate BarraCuda 120 SSD offers SATA interface, fully compatible with SATA 3.2 6.0Gbps.

Table 1 The BarraCuda 120 SSD Features

Feature	Description	
Capacity (User)	250 GB, 500 GB, 1000 GB, 2000 GB	
Certifications, Eco-Compliance	- CE, UL, FCC, BSMI, KCC, Microsoft WHQL, VCCI, CB - RoHS	
Dimensions	(69.85±0.25) x (100±0.25) x (Max. 7) mm	SSD outer case can support suitable Z-height for various host situations.
Endurance	250 GB 150 Total Bytes Written (TBW) 500 GB 300 TBW 1000 GB 600 TBW 2000 GB 1170 TBW	Endurance rating valid for SSD Life Remaining > 1% (SMART E7h>1). See Section 2.5, Reliability/Endurance .
Form Factor	2.5-inch Standard SSD	
Interface Compliance	- Fully compliant with ATA-8/ACS-3 Standard - Compliant with SATA Revision 3.2 - Supported protocol AHCI and ASC2 command set - Compatible with SATA 1.5 Gbps, 3 Gbps, and 6Gbps interfaces - PIO, DMA, UDMA (up to 6 modes, dependent on host) supported - Native Command Queuing (NCQ): up to 32 commands - Data Set Management Command Trim support	
NAND	3D TLC	
Operating Systems	- Windows® 7 (64 bit), 8.1 (64 bit), and Windows 10 (64 bit) - Ubuntu 16.10	
Performance Random	- Read: Up to 90,000 IOPS - Write: Up to 90,000 IOPS	Actual performance might vary depending on use conditions and environment. See Section 2.2, Performance .
Performance Sequential	- Read: Up to 560MB/s - Write: Up to 540MB/s	Actual performance might vary depending on the capacity, use conditions and environment. See Section 2.2, Performance .
Power Consumption	- Active mode: < 2780 mW - Idle mode: < 128 mW - DEVSLP: 5 mW	Based on 250 GB SSD. Results vary with capacity and mode. See Section 2.3, Power Consumption .
Power Loss Data Protection	To protect your data, you must send a Standby Immediate command (0xE1h) before you remove power. The BarraCuda 120 SSD does not provide data protection for a sudden power loss.	
Power Management	2.5 inch: 5 V SATA Supply - Host-initiated power management - Device-initiated power management - HIPM/DEVSLP Mode	
Reliability	- End-to-end data path protection - MTBF: 1.8 million hours - UBER: 1 error in 10¹⁶ bits read	

Table 1 The BarraCuda 120 SSD Features (*continued*)

Feature	Description	
Shock and Vibration	Shock ■ Non-Operating: 1,500 G, at 0.5 ms	See Section 2.4, Environmental Conditions .
	Vibration ■ Non-Operating: 1.52 G_{RMS}, (20 to 80 Hz, Frequency)	
Temperature Range (Operating)	■ 0°C to 70°C ■ Temperature Sensor (SMART Attribute ID C2h)	
Voltage	■ 5V±5%	
Warranty	Five years, or when the device reaches Host TBW, whichever happens first. Endurance rating valid for SSD Life Remaining > 1% (SMART E7h>1).	
Weight	■ 50 g, 1.76 Oz ±5%	

2. Specifications

2.1 Models and Capacity

Table 2 Models and Capacity

Model Names	User Capacity
ZA250CM10003	250 GB
ZA500CM10003	500 GB
ZA1000CM10003	1000 GB
ZA2000CM10003	2000 GB

NOTE About capacity:

- Sector Size: 512 Bytes
- User-addressable LBA count = ((97696368) + (1953504 x (Desired Capacity in Gb-50.0)) From International Disk Drive Equipment and Materials Association (IDEMA) (*LBA1-03_standard.doc*)

2.2 Performance

Table 3 Random and Sequential Read and Write Performance

Parameter	250GB	500 GB	1000 GB	2000 GB
Sequential Read MB/s	560	560	560	560
Sequential Write MB/s	540	540	540	540
Random Read (IOPS)	90,000	90,000	90,000	90,000
Random Write (IOPS)	90,000	90,000	90,000	90,000

NOTE About performance:

- Fresh out of box (FOB) performance obtained on newly formatted drive. Performance may vary based on the SSD's firmware version, system hardware, and configuration.
- Performance is based on CrystalDiskMark v.6.0.0 x64 on Windows 10 host.

2.3 Power Consumption

Table 4 Power Consumption

	250 GB	500 GB	1000 GB	2000 GB
Read (mW)	2250	2250	2450	2600
Write (mW)	2450	2450	2650	2780
Idle (mW)	115	114	120	128
Slumber (mW)	28.8	28.8	30.6	38.4
DEVSLP (mW)	5	5	5	5

NOTE

About power consumption:

- The average value of power consumption is based on 100% conversion efficiency.
- The measured power voltage is 5 V.
- Measured under ambient temperature.
- Sequential Read/Write is measured while testing 4000 MB five times by CrystalDiskMark.
- Power Consumption can differ according to flash configuration and platform.

2.4 Environmental Conditions

Table 5 Temperature, Humidity, Shock

Specification	Value
Temperature	
Operating (case temperature at specific airflow)	0°C to 70°C
Non-operating	-40°C to 85°C
Humidity	
Operating	90%
Non-operating (storage)	93%
Shock	
Non-operating	1,500 G, duration 0.5 ms
Vibration	
Non-operating	1.52 G _{RMS} , (20Hz to 80Hz, Frequency)

NOTE

Temperature is measured without condensation. Operating mode temperature is measured by temperature sensor, SMART Attribute C2h.

NOTE

Shock and vibration results assume that the SSD is mounted securely with the input vibration applied to the SSD mounting. These specifications do not cover connection issues that may result from testing at this level. The measured specification is in root mean square (RMS) form.

- **Non-operating Shock.** The limits of non-operating shock applies to all conditions of handling and transportation. This includes both isolated SSD and integrated SSDs. Shock may be applied in the X, Y, or Z-axis.
- **Non-Operating Vibration.** The limits of non-operating vibration shall apply to all conditions of handling and transportation. This includes both isolated SSD and integrated SSDs. Vibration may be applied in the X, Y, or Z-axis.

2.5 Reliability/Endurance

Table 6 Reliability/Endurance

Specification	Value
Mean time between failures (MTBF)	1.8 million hours
Bit Error Rate	1 error in 10^{16} bits read
Endurance	■ 250 GB: 150 TBW ■ 500 GB: 300 T BW ■ 1000 GB: 600 TBW ■ 2000 GB 1170 TBW

NOTE

About endurance:

- The SSD achieves the specified MTBF in an operational environment that complies with the operational temperature range specified in this manual. Operating temperatures are measured by temperature sensor, SMART Attribute ID C2h.
- Endurance rating valid for SSD Life Remaining > 1% (SMART E7h>1).
- Endurance is characterized while running Client JESD219A workload (per JESD218A specification).

3. Mechanical Information

3.1 Dimensions and Weight

Weight: 50 g, 1.76 Oz +/- 5%

Height: Maximum, 7 mm+0.10/-0.30

Width: 69.85 mm±0.25 mm

Length: 100.10 mm±0.25 mm

Figure 1 BarraCuda 120 SSD Enclosure

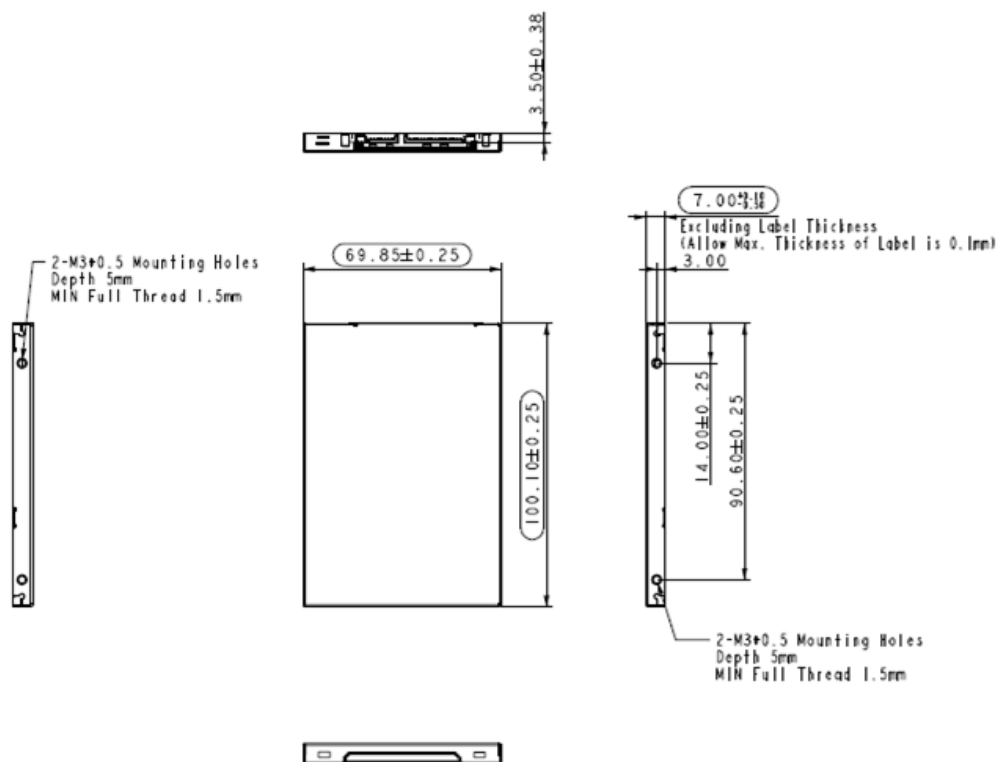
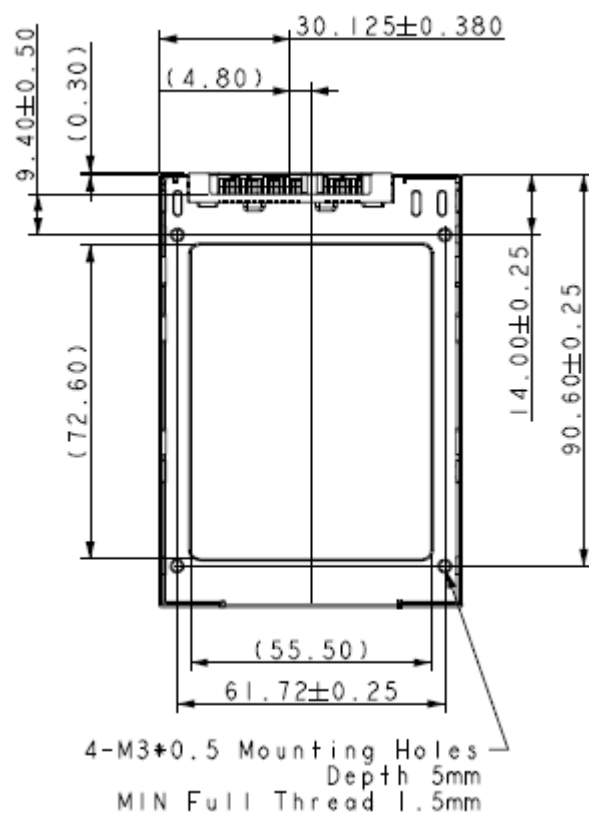


Figure 2 BarraCuda 120 SSD



4. Pin and Signal Descriptions

4.1 Signal Pin Definitions

Table 7 Serial ATA Connector Pin Signal Definitions

Pin	Name	Definition
S1	Ground	Ground
S2	A+	Differential signal pair A+ and A-
S3	A-	
S4	Ground	Ground
S5	B-	Differential signal pair B- and B+
S6	B+	
S7	Ground	Ground

NOTE Key and spacing separate the signal and power segments.

4.2 Power Pin Definitions

Table 8 Power Pin Definitions

Pin	Function	Definition
P1	not used	Not Used (3.3 V)
P2	V33	Not Used (3.3 V)
P3	DEVSLP	SATA PHY Power Control
P4	GND	Ground
P5	GND	Ground
P6	GND	Ground
P7	V5	5 V Power, Precharge
P8	V5	5 V Power
P9	V5	5 V Power
P10	GND	Ground
P11	Reserved	Reserved
P12	GND	Ground
P13	not used	Not Used (12 V pre-charge)
P14	V12	Not Used (12 V)
P15	V12	Not Used (12 V)

NOTE About Power Pin Signal Definitions:

- Key and spacing separate the signal and power segments.
- Uses 5 V power only; 3.3 V (P1-P2) and 12 V (P13-P15) power are not used.

5. Supported ATA Command List

The BarraCuda 120 SSD complies with ATA-8/ACS-3. All mandatory and many optional commands and features are supported.

5.1 ATA Feature Set

The following table summarizes the ATA feature set and commands that the BarraCuda 120 SSD supports.

Table 9 ATA Feature Set

Feature	Supported
48-Bit Address feature set	Yes
General feature set	Yes
Native Command Queuing (NCQ) feature set	Yes
Power Management feature set	Yes
Security feature set	Yes
SMART feature set	Yes

5.2 ATA Command Description

The following table shows the ATA commands supported.

Table 10 ATA Command Description

Op-Code	Support	Command Description	Op-Code	Support	Command Description
00h	Y	NOP	B6h 12h —	—	NV Cache: QUERY NV CACHE PINNED SET DMA EXT
03h	—	CFA Request Extended Error	B6h 13h —	—	NV Cache: QUERY NV CACHE MISSES DMA EXT
06h	Y	Data Set Management	B6h 14h —	—	NV Cache: FLUSH NV CACHE
08h	—	Device Reset	C4h — —	Y	Read Multiple
0Bh	—	Request Sense Data EXT	C5h — —	Y	Write Multiple
10h	Y	Recalibrate	C6h — —	Y	Set Multiple Mode
11h to 1Fh	—	Recalibrate	C7 — —	—	Read DMA Queued
20h	Y	Read Sectors	C8h — —	Y	Read DMA
21h	Y	Read Sectors without Retry	9h — —	—	Read DMA Without Retry
22h	—	Read Long	CAh — —	Y	Write DMA
23h	—	Read Long Without Retry	CBh — —	Y	Write DMA Without Retry
24h	Y	Read Sectors EXT	CCh — —	—	Write DMA Code
25h	Y	Read DMA EXT	CDh — —	—	CFA Write Multiple Without Erase
26h	—	Read DMA Queued EXT	CEh — —	Y	Write Multiple FUA EXT

Table 10 ATA Command Description (continued)

Op-Code			Support	Command Description	Op-Code			Support	Command Description
27h	—	Y		Read Native Max Address EXT	D1h	—	—	—	Check Media Card Type
29h	—	Y		Read Multiple EXT	DAh	—	—	—	Get Media Status
2Ah	—	—		Read Stream DMA EXT	DEh	—	—	—	Media Lock
2Bh	—	—		Read Stream EXT	DFh	—	—	—	Media Unlock
2Fh	—	Y		Read Log EXT	E0h	—	—	Y	Standby Immediate
30h	—	Y		Write Sectors	E1h	—	—	Y	Idle Immediate
31h	—	Y		Write Sectors without Retry	E2h	—	—	Y	Standby
32h	—	—		Write Long	E3h	—	—	Y	Idle
33h	—	—		Write Long Without Retry	E4h	—	—	Y	Read Buffer
34h	—	Y		Write Sectors EXT	E5h	—	—	Y	Check Power Mode
35h	—	Y		Write DMA EXT	E6h	—	—	Y	Sleep
36h	—	—		Write DMA Queued EXT	E7h	—	—	Y	Flush Cache
37h	—	Y		Set Max Address EXT	E8h	—	—	Y	Write Buffer
38h	—	—		CFA Write Sectors Without Erase	E9h	—	—	Y	Read Buffer DMA
39h	—	Y		Write Multiple EXT	EAh	—	—	Y	Flush Cache EXT
3Ah	—	—		Write Stream DMA EXT	EBh	—	—	Y	Write Buffer DMA
3Bh	—	—		Write Stream EXT	ECh	—	—	Y	Identify Device
3Ch	—	—		Write Verify	EDh	—	—	—	Media Eject
3Dh	—	Y		Write DMA FUA EXT	EEh	—	—	—	Identify Device DMA
3Eh	—	—		Write DMA Queued FUA EXT	EFh	01h	—	—	Set Features: Enable 8-bit PIO Transfer Mode (CFA feature set only)
3Fh	—	Y		Write Log EXT	EFh	02h	—	Y	Set Features: Enable Write Cache
40h	—	Y		Read Verify Sectors	EFh	03h	—	Y	Set Features: Set transfer mode based on value in Count field.
41h	—	Y		Read Verify Sectors without Retry	EFh	05h	—	—	Set Features: Enable advanced power management.
42h	—	Y		Read Verify Sector(s) EXT	EFh	06h	—	—	Set Features: Enable Power-Up In Standby feature set.
44h	—	—		Reserved	EFh	07h	—	—	Set Features: Power-Up In Standby feature set device spin-up.
45h	—	O		Write Uncorrectable EXT	EFh	0Ah	—	—	Set Features: Enable CFA power mode 1.
47h	—	Y		Read Log DMA EXT	EFh	0Bh	—	—	Set Features: Enable Write-Read-Verify feature set
50h	—	—		Format Track	EFh	10h	01h	—	Set Features: Enable use of Serial ATA feature

Table 10 ATA Command Description (continued)

Op-Code			Support	Command Description	Op-Code			Support	Command Description
51h	—	—		Configure Stream	EFh	10h	02h	Y	Set Features: Enable DMA Setup FIS Auto-Activate optimization
57h	—	Y		Write Log DMA EXT	EFh	10h	03h	Y	Set Features: Enable Device-initiated interface power state (DIPM) transitions.
60h	—	Y		Read FPDMA Queued	EFh	10h	04h	—	Set Features: Enable use of Serial ATA feature
61h	—	Y		Write FPDMA Queued	EFh	10h	05h	—	Set Features: Enable use of Serial ATA feature
70h	—	Y		Seek	EFh	10h	06h	O	Set Features: Enable Software Settings Preservation (SSP)
71-76h	—	—		Seek	EFh	10h	07h	Y	Set Features: Enable Device Automatic Partial to Slumber transitions
77h	—	Y		Set Date And Time Ext	EFh	10h	09h	O	Set Features: Enable Device Sleep
78h	—	Y		Accessible Max Address Configuration	EFh	42h	—	—	Set Features: Enable Automatic Acoustic Management feature set.
79-7Fh	—	—		Seek	EFh	43h	-	—	Set Features: Set Maximum Host Interface Sector Times.
87h	—	—		CFA Translate Sector	EFh	44h	—	—	Set Features: Vendor Specific ECC byte
90h	—	Y		Execute Device Diagnostic	EFh	55h	—	Y	Set Features: Disable read look-ahead feature
91h	—	Y		Initialize Device Parameters	EFh	5Dh	—	—	Set Features: Enable release interrupt
92h	—	Y		Download Microcode	EFh	5Eh	—	—	Set Features: Enable service interrupt
93h	—	Y		Download Microcode DMA	EFh	5Fh	—	—	Set Features: Enable NDRQ Feature
94h	—	—		Standby Immediate	EFh	66h	—	Y	Set Features: Disable reverting to power-on defaults
95h	—	—		Idle Immediate	EFh	81h	—	—	Set Features: Disable 8-bit PIO transfer mode (CFA feature set only)
96h	—	—		Standby	EFh	82h	—	Y	Set Features: Disable write cache
97h	—	—		Idle	EFh	85h		Y	Set Features: Disable advanced power management
98h	—	—		Check Power Mode	EFh	86h		—	Set Features: Disable Power-Up In Standby feature set
99h	—	—		Sleep	EFh	8Ah		—	Set Features: Disable CFA power mode
A0h	—	—		Packet	EFh	8Bh		—	Set Features: Disable Write-Read-Verify feature set
A1h				Identify Packet Device	Efh	90h	01h		Set Features: Disable use of Serial ATA feature.
A2h	—	—		Service	Efh	90h	02h	Y	Set Features: Disable DMA Setup FIS Auto-Activate optimization.
B0h	D0h	Y		SMART: Read Data	EFh	90h	03h	Y	Set Features: Disable Device-initiated interface power state (DIPM) transitions.
B0h	D1h	Y		SMART: Read Attribute Thresholds	EFh	90h	04h	—	Set Features: Disable use of Serial ATA feature.
B0h	D2h	Y		SMART: Enable/disable Autosave	EFh	90h	05h	-	Set Features: Disable use of Serial ATA feature

Table 10 ATA Command Description (continued)

Op-Code		Support	Command Description	Op-Code		Support	Command Description
B0h	D3h	Y	SMART: Save Attribute Values	EFh	90h 06h	Y	Set Features: Disable Software Settings Preservation (SSP)
B0h	D4h	Y	SMART: Execute Off-line Immediate	EFh	90h 07h	Y	Set Features: Disable Device Automatic Partial to Slumber transitions
B0h	D5h	Y	SMART: Read Log	EFh	90h 09h	O	Set Features: Disable Device Sleep
B0h	D6h	Y	SMART: Write Log	EFh	AAh	Y	Set Features: Enable read look-ahead feature
B0h	D8h	Y	SMART: Enable Operations	EFh	BBh	-	Set Features: Default ECC byte
B0h	D9h	Y	SMART: Disable Operations	EFh	C2h	-	Set Features: Disable Automatic Acoustic Management feature set
B0h	DAh	Y	SMART: Return Status	EFh	C3h	-	Set Features: Enable/Disable the Sense Data Reporting feature set
B0h	DBh	Y	SMART: Enable/disable Automatic Off-line	EFh	CCh	Y	Set Features: Enable reverting to power-on defaults
B0h	E0h	-	SMART: Vendor specific	EFh	DDh	-	Set Features: Disable release interrupt
B1h	C0h	Y	DEVICE CONFIGURATION: Restore	EFh	DEh	-	Set Features: Disable SERVICE interrupt
B1h	C1h	Y	DEVICE CONFIGURATION: Freeze Lock	EFh	DFh	-	Set Features: Disable NDRQ Feature
B1h	C2h	Y	DEVICE CONFIGURATION: Identify	F1h		Y	Security Set Password
B1h	C3h	Y	DEVICE CONFIGURATION: Set	F2h		Y	Security Unlock
B1h	C4h	Y	DEVICE CONFIGURATION: Identify DMA	F3h		Y	Security Erase Prepare
B1h	C5h	Y	DEVICE CONFIGURATION: Set DMA	F4h		Y	Security Erase Unit
B4h	0000h	O	SANITIZE DEVICE: Sanitize Status Ext	F5h		Y	Security Freeze Lock
B4h	0011h	O	SANITIZE DEVICE: Crypto Scramble Ext	F6h		Y	Security Disable Password
B4h	0012h	O	SANITIZE DEVICE: Block Erase Ext	F8h		Y	Read Native Max Address
B4h	0014h	O	SANITIZE DEVICE: Overwrite Ext	F9h	00h	Y	SET MAX: Set Max Address
B4h	0020h	O	SANITIZE DEVICE: SANITIZE FREEZE LOCK EXT	F9h	01h	Y	SET MAX: SET MAX PASSWORD
B4h	0040h	O	SANITIZE DEVICE: SANITIZE ANTIFREEZE LOCK EXT	F9h	02h	Y	SET MAX: SET MAX LOCK
B6h	00h	-	NV Cache: SET NV CACHE POWER MODE EXT	F9h	03h	Y	SET MAX: SET MAX UNLOCK
B6h	01h	-	NV Cache: RETURN FROM NV CACHE POWER MODE EXT	F9h	04h	Y	SET MAX: SET MAX FREEZE LOCK
B6h	10h	-	NV Cache: ADD LBA(S) TO NV CACHE PINNED SET DMA EXT	F9h	05h	Y	SET MAX: SET MAX SET PASSWORD DMA
B6h	11h	-	NV Cache: REMOVE LBA(S) FROM NV CACHE PINNED SET DMA EXT	F9h	06h	Y	SET MAX: SET MAX UNLOCK DMA

6. SMART Support

The BarraCuda 120 SSD supports the SMART command set.

6.1 SMART ID

The following table lists SMART IDs and Descriptions.

Table 11 SMART Attribute IDs and Descriptions

Description	0	1	2	3	4	5	6	7	8	9	10	11	Threshold
	ID	Flag		Value	Worse	DATA							
Number of Accumulation of Uncorrectable Error	01h	0Bh	00h	64h	64h	UECC error count from Host		0	0	0	0	0	32h
Power-On hours Count	09h	12h	00h	64h	64h	Power on hour		0	0	0	0	0	00h
Drive Power Cycle Count	0Ch	12h	00h	64h	64h	Power on/off cycles				0	0	0	00h
Spare Blocks Available	10h	12h	00h	64h	64h	Spare Blocks Available by plane		0	0	0	0	0	00h
Remaining Spare Blocks	11h	12h	00h	64h	64h	Remaining Spare Blocks by plane		0	0	0	0	0	00h
SATA PHY Error Count	A8h	12h	00h	64h	64h	SATA PHY error count				0	0	0	00h
Bad Block Count (Early / Later)	AAh	03h	00h	Note ^a		Early Bad Block count by all plane		0	0	Later Bad Block count by all plane		0	0Ah
Erase count (average, max, erase count)	ADh	12h	00h	64h	64h	Max Erase Count		Average Erase Count		Least Erase Count		0	00h
Unexpected Power Loss count	AEh	12h	00h	64h	64h	Number of accidental power loss count				0	0	0	00h
Wear Range delta	B1h	00h	00h	00h	00h	Note ^b	0	0	0	0	0	0	00h
Unexpected Power Loss Count	C0h	12h	00h	64h	64h	number of accidental power loss count				0	0	0	00h
Temperature (only Toshiba or thermo sensor embedded)	C2h	23h	00h	128-Curre nt Temp	128-Highest value	Current Temp		Lowest Temp		Highest Temp		0	39h

Table 11 SMART Attribute IDs and Descriptions (continued)

Description	0	1	2	3	4	5	6	7	8	9	10	11	Threshold
	ID	Flag		Value	Worse	DATA							
Number of accumulation CRC error (read/write data FIS CRC error)	DAh	0Bh	00h	64h	64h	CRC Error Count				0	0	0	32h
SSD life remaining	E7h	13h	00h	64h	64h	Note ^c	0	0	0	0	Throttling level	0	00h
Read Failure Block Count	E8h	13h	00h	64h	64h	Flash Read Fail Count				Raw Read Error Rate	0	0	00h
Lifetime Writes to Flash (G Unit)	E9h	0Bh	00h	64h	64h	Lifetime Writes to Flash by GByte						0	00h
Lifetime Writes to Flash (Sector Unit)	EBh	0Bh	00h	64h	64h	Lifetime Writes to Flash by Sector						0	00h
Host Writes (G Unit)	F1h	12h	00h	64h	64h	Lifetime Writes from Host by Gbyte						0	00h
Host Reads (G Unit)	F2h	12h	00h	64h	64h	Lifetime Reads from Host by Gbyte						0	00h

- a. Bad Block Count (Early / Later) ID170. Value = (Remaining Spare Blocks by plane)/(Spare Blocks Available by plane) *100. This formula calculates percentage of spare block. Value is between 100 and 0.
- b. Wear Range Delta ID 177. Value = (max erase count - least erase count) / (P-E Cycle) *100 (percentage).
- c. SSD Life Remaining ID 231. Value = 100 - ((average erase count / Rated PE Cycle) * 100).

7. Feature Details

7.1 Flash Management

7.1.1 Error Correction Code (ECC)

Flash memory cells deteriorate with use, which might generate random bit errors in the stored data. The BarraCuda 120 SSD applies the 340 bit/2 KB LDPC (Low Density Parity Check) of ECC algorithm, which detects and corrects errors that occur during read process, ensures data is read correctly, and protects data from corruption.

7.1.2 Wear Leveling

NAND flash devices can undergo only a limited number of program/erase cycles. Commonly, areas of the flash media are not used evenly. If some areas are updated more frequently than others, this reduces the lifetime of the device. Wear Leveling extends the life of the NAND Flash by evenly distributing write and erase cycles across the media.

Seagate's advanced Wear Leveling algorithm spreads the flash usage throughout the whole flash media area. Implementing dynamic and static Wear Leveling algorithms improves the life expectancy of the NAND flash.

7.1.3 Bad Block Management

Bad blocks do not function properly and they can contain more invalid bits. This can make stored data unstable and bad block reliability is not guaranteed. Blocks identified and marked as bad by the manufacturer are called "Early Bad Blocks". Bad blocks that develop during the lifespan of the Flash are called "Later Bad Blocks". Seagate's bad block management algorithm detects the factory-produced bad blocks and manages bad blocks that appear with use. This practice prevents data from being stored in bad blocks and improves data reliability

7.1.4 TRIM

The TRIM feature improves the read/write performance and speed of SSDs. SSDs cannot overwrite existing data, so the available space becomes smaller with each data block use. The TRIM command tells the SSD (through the operating system) which data blocks can be removed permanently because they are no longer in use. The SSD erases these unused data blocks.

7.1.5 SMART

SMART, stands for Self-Monitoring, Analysis, and Reporting Technology, is an open standard that allows an SSD to automatically detect its health and report potential failures. When SMART records a failure, users can replace the drive to prevent unexpected outage or data loss. SMART can also inform users of impending failures while there is still time to copy data to another device.

7.1.6 Over Provisioning

Over Provisioning (OP) preserves an additional area beyond user capacity in a SSD, which is not visible to users and cannot be used by them. With Over Provisioning, the performance and IOPS (Input/Output Operations per Second) are improved by providing the controller additional space to manage P/E cycles, which enhances the reliability and endurance as well. Moreover, the write amplification of the SSD becomes lower when the controller writes data to the flash.

7.1.7 Firmware Upgrade

Firmware is a set of instructions on how the device communicates with the host. Firmware can be upgraded when new features are added, compatibility issues are fixed, or read/write performance gets improved.

7.1.8 Thermal Throttling

The purpose of thermal throttling is to prevent any components in a SSD from over-heating during read and write operations. the BarraCuda 120 SSD is designed with an on-board thermal sensor and with its accuracy, firmware can apply different levels of throttling to achieve the purpose of protection efficiently and proactively via SMART 12 reading.

7.1.9 Low Power Management

7.1.9.1 DIPM/HIPM/DEVSLP Mode

SATA interfaces contain two low power management states for power saving: Partial and Slumber modes. For Partial mode, the device has to resume to full operation within 10 microseconds, whereas the device will spend 10 milliseconds to become fully operational in the Slumber mode. SATA interfaces allow low power modes to be initiated by Host (HIPM, Host Initiated Power Management) or Device (DIPM, Device Initiated Power Management). As for HIPM, Partial or Slumber mode can be invoked directly by the software. For DIPM, the device will send requests to enter Partial or Slumber mode.

7.2 Advanced Device Security Features

7.2.1 Secure Erase

Secure Erase is a standard ATA command and it writes all of "0xFF" to fully wipe all the data on hard drives and SSDs. When this command is issued, the SSD controller erases its storage blocks and returns to its factory default settings

7.2.2 SSD Lifetime Management

Total Bytes Written (TBW)

TBW measures the lifespan of the SSD. This measurement represents the amount of data written to the device. To calculate the TBW of a SSD, use the following equation:

$$TBW = [(NAND\ Endurance) \times (SSD\ Capacity)] / [WAF]$$

NAND Endurance: NAND endurance refers to the P/E (Program/Erase) cycle of a NAND flash.

SSD Capacity: The SSD capacity is the specific capacity in total of a SSD.

WAF: Write Amplification Factor (WAF) is a numerical value representing the ratio between the amount of data that a SSD controller needs to write and the amount of data that the host's flash controller writes. A better WAF, which is near 1, guarantees better endurance and lower frequency of data written to flash memory.

TBW in this document is based on JEDEC 218/219 workload.

7.2.3 Media Wear Indicator

Actual life indicator reported by SMART Attribute 231 (E7h) Life Remaining by percentage, recommends User to replace drive before reaching 0%.

7.2.4 Read Only Mode (End of Life)

When the SSD is aged by program/erase cycles, media wear-out may cause increasing numbers of bad blocks. When the number of usable good blocks falls outside a defined usable range, the drive notifies the host through AER event and Critical Warning to enter Read Only Mode to prevent further data corruption. When this happens, the user should replace the SSD with another one immediately.

7.3 Adaptive Approach to Performance Tuning

7.3.1 Throughput

Based on the available space of the disk, the BarraCuda 120 SSD regulates the read/write speed and manages the performance of throughput. When there is a lot of space, the firmware continuously performs read/write actions. There is no need yet to implement garbage collection to allocate and release memory to accelerate the read/write processing and improve performance. When there is less available space, the SSD slows down the read/write processing and implements garbage collection to release memory.

7.3.2 Predict and Fetch

When the Host tries to read data from the SSD, the SSD performs only one read action after receiving one command. However, the BarraCuda 120 SSD applies Predict and Fetch to improve the read speed. When the host issues sequential read commands to the SSD, the SSD automatically expects that the following is also read commands. Therefore, before receiving the next command, flash has already prepared the data. This accelerates data processing time, and the host needs to wait less time to receive data.

7.3.3 SLC Caching

The BarraCuda 120 SSD firmware design adopts dynamic caching to deliver better performance, endurance and user experience.

8. Safety, Standards, and Compliance

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

NOTE

The most up to date information on Safety, Standards, and Compliance for this product is available in the Seagate HDD and SSD Regulatory Compliance and Safety document. You can find this document here:

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

8.1 Regulatory Model Numbers

The following regulatory model number represents all features and configurations in the series:

- STA021

8.2 Reference Documents

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

Table 12 Reference Documents

Date	Title
Apr. 2007	SATA-IO Commands for ATA-8
Feb. 2011	<i>Solid-State Drive (SSD) Requirements and Endurance Test Method(JESD218A)</i>
Jul. 2011	Serial ATA Revision 3.1
Jul. 2011	IDEMA (LBA1-03_standard.doc)
Jul. 2012	SOLID-STATE DRIVE (SSD) Endurance Workload(JESD219A)
Oct. 2013	ATA/ATAPI Command Set -2 (ACS-3) Revision 5



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