



SKYHAWK

SURVEILLANCE

SATA Product Manual

Standard model

ST8000VX0022

ST6000VX0023

ST4000VX007

ST3000VX010

ST2000VX008

ST1000VX005

100804836, Rev. K
November 2018

Document Revision History

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| | |
|---|----------|
| Seagate® Technology Support Services | 5 |
| <hr/> | |
| 1.0 Introduction | 6 |
| 1.1 About the SATA interface | 7 |
| <hr/> | |
| 2.0 Drive Specifications | 8 |
| 2.1 Specification summary tables | 8 |
| 2.2 Formatted capacity | 12 |
| 2.2.1 LBA mode | 12 |
| 2.3 Default logical geometry | 12 |
| 2.4 Seek time | 12 |
| 2.5 Start/stop times | 13 |
| 2.6 Power specifications | 13 |
| 2.6.1 Power consumption | 13 |
| 2.6.2 Typical current profile | 15 |
| 2.6.3 Conducted noise | 15 |
| 2.6.4 Voltage tolerance | 15 |
| 2.6.5 Power-management modes | 16 |
| 2.7 Environmental specifications | 16 |
| 2.7.1 Drive case temperature | 16 |
| 2.7.2 Temperature | 16 |
| 2.7.3 Temperature gradient | 17 |
| 2.7.4 Humidity | 17 |
| 2.7.5 Altitude | 17 |
| 2.7.6 Shock | 17 |
| 2.7.7 Vibration | 18 |
| 2.8 Acoustics | 18 |
| 2.8.1 Test for Prominent Discrete Tones (PDTs) | 18 |
| 2.9 Electromagnetic immunity | 19 |
| 2.10 Reliability - Mean Time Between Failure | 19 |
| 2.10.1 Storage | 19 |
| 2.11 Warranty | 19 |
| 2.12 Agency and Safety Certifications | 20 |
| 2.12.1 Safety certification | 20 |
| 2.12.2 Electromagnetic compatibility | 20 |
| 2.12.3 Electromagnetic compliance | 20 |
| 2.12.4 European Union (EU) CE Marking Requirements | 21 |
| 2.12.5 Australian RCM Compliance Mark | 21 |
| 2.12.6 Canada ICES-003 | 21 |
| 2.12.7 South Korean KC Certification Mark | 21 |
| 2.12.8 Morocco Commodity Mark | 21 |
| 2.12.9 Taiwanese BSMI | 22 |
| 2.12.10 FCC verification | 22 |
| 2.13 Environmental protection | 22 |
| 2.13.1 European Union Restriction of Hazardous Substance Law | 22 |
| 2.13.2 Restriction of Hazardous Substances in Electrical and Electronic Equipment | 22 |
| 2.13.3 China Requirements —China RoHS 2 | 23 |
| 2.13.4 Taiwan Requirements — Taiwan RoHS | 24 |
| 2.14 Corrosive environment | 24 |

| | | |
|------------|---|-----------|
| 3.0 | Configuring and Mounting the Drive | 25 |
| 3.1 | Handling and static-discharge precautions | 25 |
| 3.2 | Configuring the drive | 25 |
| 3.3 | SATA cables and connectors | 25 |
| 3.4 | Drive mounting | 26 |

| | | |
|------------|--|-----------|
| 4.0 | SATA Interface | 31 |
| 4.1 | Hot-Plug compatibility..... | 31 |
| 4.2 | SATA device plug connector pin definitions | 31 |
| 4.3 | Supported ATA commands | 32 |
| 4.3.1 | Identify Device command | 34 |
| 4.3.2 | Set Features command | 38 |
| 4.3.3 | S.M.A.R.T. commands..... | 39 |

Figures

| | | |
|----------|--|----|
| Figure 1 | Typical Current Profile for 2TB to 8TB models (5V & 12V) | 15 |
| Figure 2 | Attaching SATA cabling..... | 25 |
| Figure 3 | Mounting dimensions (8TB)..... | 26 |
| Figure 4 | Mounting dimensions (6TB)..... | 27 |
| Figure 5 | Mounting dimensions (4TB)..... | 28 |
| Figure 6 | Mounting dimensions (3TB - 2TB) | 29 |
| Figure 7 | Mounting dimensions (1TB)..... | 30 |

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1.0 Introduction

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

ST8000VX0022 ST6000VX0023 ST4000VX007 ST3000VX010 ST2000VX008 ST1000VX005

These drives provide the following key features:

- 24x7 capability
- Balance technology to support multiple drives in a system
- Compliant with RoHS requirements in China and Europe
- Full-track multiple-sector transfer capability without local processor intervention
- Low activity and idle power
- Low-RPM spindle speed
- Native Command Queuing with command ordering to increase performance in demanding applications
- Off-the-shelf compatibility
- Performance-tuned for RAID applications
- Rated for 1M hours MTBF
- 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
- Streaming video optimization - consistent command completion times & ERC support
- Support for S.M.A.R.T. drive monitoring and reporting
- Supports ATA8 streaming commands
- Supports latching SATA cables and connectors
- TGMR recording technology provides the drives with increased areal density.
- 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:

ST8000VX0022 ST6000VX0023 ST4000VX007 ST3000VX010 ST2000VX008 ST1000VX005

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 8TB and 6TB models

| Drive Specification* | ST8000VX0022 | ST6000VX0023 |
|--|--|-----------------------|
| Formatted capacity (512 bytes/sector)** | 8000GB (8TB) | 6000GB (6TB) |
| Guaranteed sectors | 15,628,053,168 | 11,721,045,168 |
| Heads | 12 | 10 |
| Disks | 6 | 5 |
| 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) | 2177KBPI | 1984KBPI |
| Track density (avg) | 370KTPI | |
| Areal density (avg) | 802Gb/in ² | 732Gb/in ² |
| Internal data transfer rate (max) | 1981Mb/s | |
| Maximum sustained data rate, OD read (MB/s) | 210MB/s | |
| ATA data-transfer modes supported | PIO modes: 0 to 4 Multiword DMA modes: 0 to 2 Ultra DMA modes 0 to 6 | |
| I/O data-transfer rate (max) | 600MB/s | |
| Cache buffer | 256MB | |
| Height (max) | 26.1mm / 1.028 in | |
| Width (max) | 101.6mm / 4.010 in | |
| Length (max) | 146.99mm / 5.787 in | |
| Weight (max) | 780g / 1.72 lb | 705g / 1.55 lb |
| Average latency | 4.0ms | |
| Average seek, read (typical) | <8.5ms | |
| Average seek, write (typical) | <9.5ms | |
| Startup current (typical) 12V | 1.8A | |
| Voltage tolerance (including noise) | 5V: ±5% 12V: ±10% | |
| Non-Operating (Ambient °C) | -40 to 70 | |
| Operating ambient temperature (min °C) | 5 | |
| Operating temperature (drive case max °C) | 70 [†] | |
| Temperature gradient | 20°C per hour max (operating) 30°C per hour max (nonoperating) | |
| Relative humidity | 5% to 90% (operating) 5% to 95% (nonoperating) | |
| Relative humidity gradient (max) | 30% per hour | |

Table 1 Drive specifications summary for 8TB and 6TB models (continued)

| Drive Specification* | ST8000VX0022 | ST6000VX0023 |
|--|---|--------------|
| Wet bulb temperature (max) | 26°C max (operating) 29°C max (nonoperating) | |
| Altitude, operating | -304m to 3048m (-1000 ft to 10,000 ft) | |
| Altitude, non-operating (below mean sea level, max) | -304m to 12,192m (-1000ft to 40,000+ ft) | |
| Operational Shock (max) | 70 Gs at 2ms | |
| Non-Operational Shock (max) | 250 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*** | 2.7 bels (typical) 2.8 bels (max) | |
| Seek | 2.8 bels (typical) 2.9 bels (max) | |
| Non-recoverable read errors | 1 per 10 ¹⁵ bits read | |
| Mean time between failures (MTBF), hours | 1M | |
| Rated Workload | Average annualized workload rating: <180 TB/year. The AFR specification for the product assumes the I/O workload does not exceed the average annualized workload rate limit of 180 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 | |
| Supports Hotplug operation per the Serial ATA Revision 3.2 specification | Yes | |

The following table footnotes apply to **Table 1** and **Table 2**:

- * 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.

Table 2 Drive specifications summary for 4TB - 1TB models

| Drive Specification* | ST4000VX007 | ST3000VX010 | ST2000VX008 | ST1000VX005 |
|--|--|-----------------------|------------------------|-----------------------|
| Formatted capacity (512 bytes/sector)** | 4000GB (4TB) | 3000GB (3TB) | 2000GB (2TB) | 1000GB (1TB) |
| Guaranteed sectors | 7,814,037,168 | 5,860,533,168 | 3,907,029,168 | 1,953,525,168 |
| Heads | 6 | 6/5 | 4 | 2 |
| Disks | 3 | 3 | 2 | 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) | 2089kBPI | 1740kBPI | 1807kFCI | |
| Track density (avg) | 388ktracks/in | 346ktracks/in | 352ktracks/in | |
| Areal density (avg) | 810Gb/in ² | 613Gb/in ² | 625Gfc/in ² | |
| Internal data transfer rate (max) | 2107Mb/s | 1813Mb/s | 2147Mb/s | |
| Maximum sustained data rate, OD read (MB/s) | 190MB/s | 180MB/s | | |
| ATA data-transfer modes supported | PIO modes: 0 to 4 Multiword DMA modes: 0 to 2 Ultra DMA modes 0 to 6 | | | |
| I/O data-transfer rate (max) | 600MB/s | | | |
| Cache buffer | 64MB | | | |
| Height (max) | 26.1mm / 1.028 in | | | 20.20mm / 0.795 in |
| Width (max) | 101.6mm / 4.010 in | | | |
| Length (max) | 146.99mm / 5.787 in | | | |
| Weight (max) | 635g / 1.345 lb | 610g / 1.40 lb | 535g / 1.18 lb | 415g / 0.915 lb |
| Average latency | 5.1ms | | | |
| Power-on to ready (max) | <17.0s | | | <6.0s |
| Standby to ready (max) | <17.0s | | | <6.0s |
| Average seek, read (typical) | <12.0ms | | | <8.5ms |
| Average seek, write (typical) | <12.0ms | | | <19.5ms |
| Startup current (typical) 12V | 1.8A | | | 1.2A |
| Voltage tolerance (including noise) | 5V: ±5% 12V: ±10% | | | |
| Non-Operating (Ambient °C) | -40 to 70 | | | |
| Operating ambient temperature (min °C) | 0 | | | |
| Operating temperature (drive case max °C) | 70 † | | | |
| Temperature gradient | 20°C per hour max (operating) 30°C per hour max (nonoperating) | | | |
| Relative humidity | 5% to 90% (operating) 5% to 95% (nonoperating) | | | |
| Relative humidity gradient (max) | 30% per hour | | | |
| Wet bulb temperature (max) | 26°C max (operating) 29°C max (nonoperating) | | | |
| Altitude, operating | -304m to 3048m (-1000 ft to 10,000 ft) | | | |
| Altitude, non-operating (below mean sea level, max) | -304m to 12,192m (-1000ft to 40,000+ ft) | | | |
| Operational Shock (max) | 80 Gs at 2ms | | | |

Table 2 Drive specifications summary for 4TB - 1TB models (continued)

| Drive Specification* | ST4000VX007 | ST3000VX010 | ST2000VX008 | ST1000VX005 |
|--|---|-------------|--------------------------------------|-------------|
| Non-Operational Shock (max) | 300 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*** | 2.3 bels (typical) 2.4 bels (max) | | 1.9 bels (typical) 2.0 bels (max) | |
| Seek | 2.5 bels (typical) 2.6 bels (max) | | 2.1 bels (typical) 2.2 bels (max) | |
| Non-recoverable read errors | 1 per 10 ¹⁴ bits read | | | |
| Mean time between failures (MTBF), hours | 1M | | | |
| Rated Workload | Average annualized workload rating: <180 TB/year. The AFR specification for the product assumes the I/O workload does not exceed the average annualized workload rate limit of 180 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 | | | |

2.2 Formatted capacity

| Model | Formatted capacity* | Guaranteed sectors | Bytes per sector |
|--------------|---------------------|--------------------|------------------|
| ST8000VX0022 | 8000GB | 15,628,053,168 | 4096 |
| ST6000VX0023 | 6000GB | 11,721,045,168 | |
| ST4000VX007 | 4000GB | 7,814,037,168 | |
| ST3000VX010 | 3000GB | 5,860,533,168 | |
| ST2000VX008 | 2000GB | 3,907,029,168 | |
| ST1000VX005 | 1000GB | 1,953,525,168 | |

*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 4.3.1, "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 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 (1TB - 4TB models) | <12.0 | <12.0 |
| Average (6TB and 8TB models) | 8.5 | 9.5 |
| Average latency (1TB - 4TB models) | 5.1 | |
| Average latency (6TB and 8TB models) | 4.0 | |

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.

2.5 Start/stop times

The start/stop times listed below are for all models.

| | 8TB models | 6TB models | 2TB, 3TB and 4TB models | 1TB models |
|------------------------------------|------------|-------------------------|-------------------------|------------|
| Power-on to ready (in seconds) | 30 (max) | 23 (typical) / 30 (max) | 15 (typical) / 17 (max) | <6 (max) |
| Standby to ready (in seconds) | 30 (max) | | 15 (typical) / 17 (max) | <6 (max) |
| Ready to spindle stop (in seconds) | 12 (max) | 23 (max) | 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.

2.6 Power specifications

The drive receives DC power (+5V or +12V) through a native SATA power connector. Refer to [Figure 2 on page 25](#).

2.6.1 Power consumption

Power requirements for the drives are listed in [Table 6](#). 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 3 DC power requirements for 1TB models

| Power dissipation (1-disk values shown) | Avg (watts 25°C) | Avg 5V typ amps | Avg 12V typ amps |
|---|------------------|-----------------|------------------|
| Spinup | — | — | 1.2 |
| Idle* † | 2.502 | 0.152 | 0.145 |
| Operating | 3.676 | 0.385 | 0.145 |
| Standby | 0.58 | 0.096 | 0.0084 |
| Sleep | 0.58 | 0.096 | 0.0084 |

Table 4 DC power requirements for 2TB models

| Power dissipation (2-disk values shown) | Avg (watts 25°C) | Avg 5V typ amps | Avg 12V typ amps |
|---|------------------|-----------------|------------------|
| Spinup | — | — | 1.8 |
| Idle* † | 3.56 | 0.171 | 0.225 |
| Operating | 4.30 | 0.308 | 0.233 |
| Standby | 0.50 | 0.09 | 0.005 |
| Sleep | 0.50 | 0.09 | 0.005 |

Table 5 DC power requirements for 3TB and 4TB models

| Power dissipation (4-disk values shown) | Avg (watts 25°C) | Avg 5V typ amps | Avg 12V typ amps |
|---|------------------|-----------------|------------------|
| Spinup | — | — | 1.8 |
| Idle* † | 3.95 | 0.116 | 0.28 |
| Operating | 4.80 | 0.288 | 0.283 |
| Standby | 0.50 | 0.09 | 0.005 |
| Sleep | 0.50 | 0.09 | 0.005 |

Table 6 DC power requirements for 6TB & 8TB models

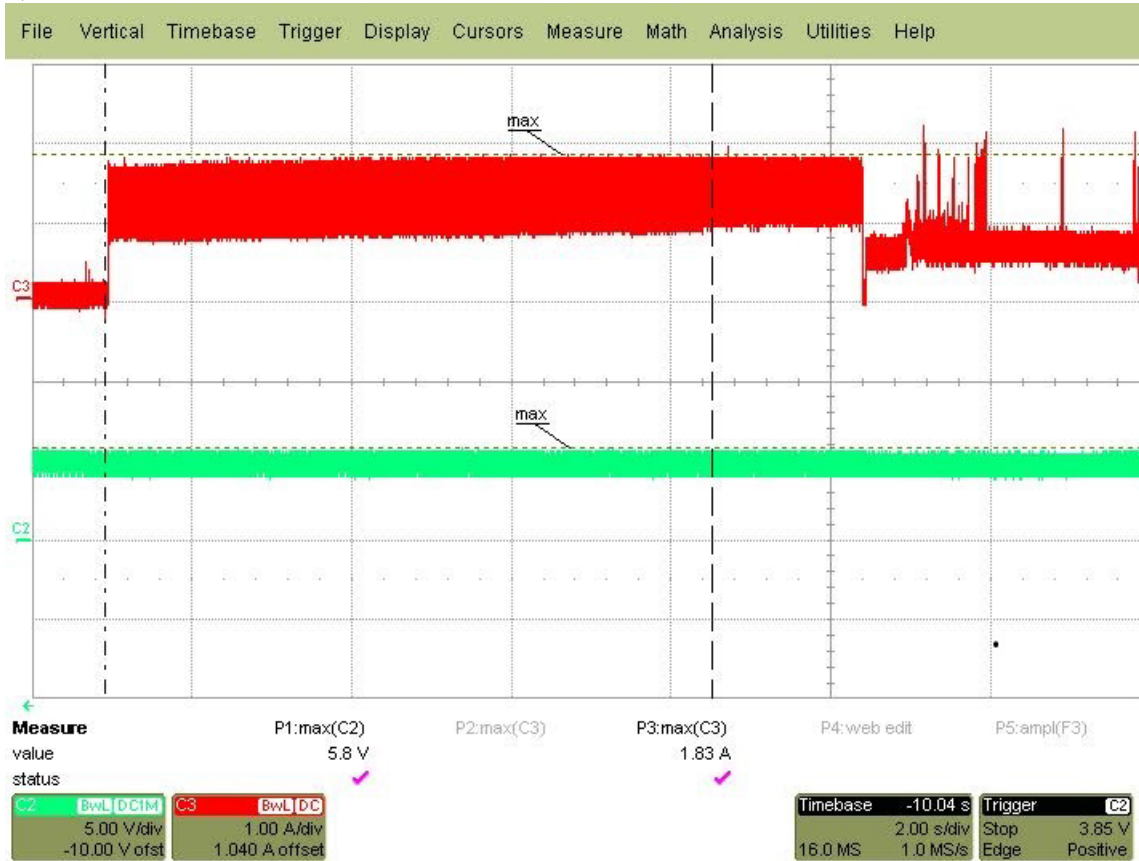
| Power dissipation (6-disk values shown) | Avg (watts 25° C) | Avg 5V typ amps | Avg 12V typ amps |
|---|-------------------|-----------------|------------------|
| Spinup | — | — | 1.8 |
| Idle* † | 7.60 | 0.191 | 0.553 |
| Operating | 8.80 | 0.23 | 0.54 |
| Standby | 0.60 | 0.09 | 0.01 |
| Sleep | 0.60 | 0.09 | 0.01 |

* Idle1. 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

2.6.2 Typical current profile

Figure 1 Typical Current Profile for 2TB to 8TB models (5V & 12V)



2.6.3 Conducted noise

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

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

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

2.6.4 Voltage tolerance

Voltage tolerance (including noise):

- 5V ±5%
- 12V ±10%

2.6.5 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.

2.7 Environmental specifications

This section provides the temperature, humidity, shock, and vibration specifications for NAS HDDs. This section provides the temperature, humidity, shock, and vibration specifications.

2.7.1 Drive case temperature

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. Drive case temperature should be measured at the location indicated in [Figure 6](#).

2.7.2 Temperature

| | |
|--|------------------------------|
| Non-operating (Ambient) | -40° to 70°C (-40° to 158°F) |
| Operating ambient (min °C) (8TB & 6TB models) | 5° (41°F) |
| Operating ambient (min °C) (1-4TB models) | 0° (32°F) |
| Operating (Drive case max °C) | 70 † (158°F) |

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

2.7.3 Temperature gradient

| | |
|----------------------|---|
| Operating | 20°C per hour (36°F per hour max), without condensation |
| Non-operating | 30°C per hour (54°F per hour max) |

2.7.4 Humidity

2.7.4.1 Relative humidity

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

2.7.4.2 Wet bulb temperature

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

2.7.5 Altitude

| | |
|----------------------|---|
| Operating | -304m to 3048m (-1000 ft. to 10,000 ft.) |
| Non-operating | -304m to 12,192m (-1000 ft. to 40,000+ ft.) |

2.7.6 Shock

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

2.7.6.1 Operating shock

1TB - 4TB

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 2ms during read operations. Shocks should not be repeated more than 2 times per second.

6TB and 8TB

These drives comply with the performance levels specified in this document when subjected to a maximum operating shock of 70 Gs based on half-sine shock pulses of 2ms during read operations. Shocks should not be repeated more than 2 times per second.

2.7.6.2 Non-operating shock

1TB-4TB

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 2ms duration.

6TB and 8TB

The non-operating shock level that the drive can experience without incurring physical damage or degradation in performance when subsequently put into operation is 250 Gs based on a non-repetitive half-sine shock pulse of 2ms duration.

2.7.7 Vibration

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

2.7.7.1 Operating vibration

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

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

2.7.7.2 Non-operating vibration

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

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

2.8 Acoustics

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

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

Table 7 Fluid Dynamic Bearing (FDB) motor acoustics

| | Idle* | Seek |
|------------------|--------------------------------------|--------------------------------------|
| 1TB & 2TB models | 1.9 bels (typ) 2.0 bels (max) | 2.1 bels (typ) 2.2 bels (max) |
| 3TB & 4TB models | 2.3 bels (typical) 2.4 bels (max) | 2.5 bels (typical) 2.6 bels (max) |
| 6TB & 8TB models | 2.7 bels (typical) 2.8 bels (max) | 2.8 bels (typical) 2.9 bels (max) |

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

2.8.1 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.

2.9 Electromagnetic immunity

When properly installed in a representative host system, the drive operates without errors or degradation in performance when subjected to the radio frequency (RF) environments defined in [Table 8](#).

Table 8 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 |

2.10 Reliability - Mean Time Between Failure

The product will achieve a Mean Time Between Failure Rate (MTBF) of 1,000,000 hours when operated in an environment of ambient air temperatures of 25°C. Operation at temperatures outside the specifications shown in [Section 2.7](#) may decrease the product MTBF. MTBF is a population statistic that is not relevant to individual units.

- MTBF specifications are based on the following assumptions for NAS environments:
- 8760 power-on hours per year
- 10,000 average motor start/stop cycles per year
- Operations at nominal voltages
- Temperatures outside the specifications in [Section 2.7](#) may reduce the product reliability.

Operation at excessive I/O duty cycle may degrade product reliability. The NAS environment of power-on hours, temperature, and I/O duty cycle affect the product MTBF. The MTBF will be degraded if used in an enterprise application.

2.10.1 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.

2.11 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.

2.12 Agency and Safety Certifications

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

2.12.1 Safety certification

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

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

Regulatory Model Numbers: STR008 = 8TB

STR00C = 6TB

SKR001 = 3TB & 4TB

STR009 = 1TB

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

2.12.2 Electromagnetic compatibility

The drive, as delivered, is designed for system integration and installation into a suitable enclosure prior to use. The drive is supplied as a subassembly and is not subject to Subpart B of Part 15 of the FCC Rules and Regulations.

The design characteristics of the drive serve to minimize radiation when installed in an enclosure that provides reasonable shielding. The drive is capable of meeting the Class B limits of the FCC Rules and Regulations when properly packaged; however, it is the user's responsibility to assure that the drive meets the appropriate EMI requirements in their system. Shielded I/O cables may be required if the enclosure does not provide adequate shielding. If the I/O cables are external to the enclosure, shielded cables should be used, with the shields grounded to the enclosure and to the host controller.

2.12.2.1 Electromagnetic susceptibility

The drive as delivered is tested to meet susceptibility requirements in a representative enclosure. It is the responsibility of those integrating the drive within their systems to perform those tests required and design their system to ensure that equipment operating in the same system as the drive or external to the system does not adversely affect the performance of the drive. See [Section 2.6, "Power specifications"](#).

2.12.3 Electromagnetic compliance

Seagate uses an independent laboratory to confirm compliance with the directives/standards for CE Marking and RCM Marking. The drive was tested in a representative system for typical applications and comply with the Electromagnetic Interference/ Electromagnetic Susceptibility (EMI/EMS) for Class B products. The selected system represents the most popular characteristics for test platforms.

Although the test system with this Seagate model complies with the directives/standards, we cannot guarantee that all systems will comply. The computer manufacturer or system integrator shall confirm EMC compliance and provide the appropriate marking for their product.

2.12.4 European Union (EU) CE Marking Requirements

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

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

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

For compliance with the RoHS "Recast" Directive 2011/65/EU (RoHS 2), [See Section 2.13.2 on page 22](#) .

2.12.5 Australian RCM Compliance Mark

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

2.12.6 Canada ICES-003

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

2.12.7 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 |
|-----------------------|--|
| B급기기 (가정용 방송통신기자재) | 이 기기는 가정용(B급) 전자파적합기기로서 주로 가정에서 사용하는 것을 목적으로 하며, 모든 지역에서 사용할 수 있습니다. |

2.12.8 Morocco Commodity Mark

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

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

2.12.9 Taiwanese BSMI

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

For compliance with the Taiwan Bureau of Standards, Metrology and Inspection's (BSMI) requirements, [See Section 2.13.4 on page 24](#).

2.12.10 FCC verification

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

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

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

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

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

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

2.13 Environmental protection

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

2.13.1 European Union Restriction of Hazardous Substance Law

2.13.2 Restriction of Hazardous Substances in Electrical and Electronic Equipment

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

2.13.2.1 Substances of Very High Concern (SVHC)

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

2.13.3 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 9 China - Hazardous Substances

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

2.13.4 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 10 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. | | | | | | |

2.14 Corrosive environment

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

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

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

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 | <ul style="list-style-type: none"> • 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 <i>only</i>. • 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 11](#) for connector pin definitions. Either end of the SATA signal cable can be attached to the drive or host.

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

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

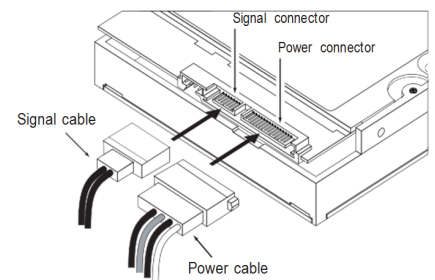


Figure 2 Attaching SATA cabling

Each cable is keyed to ensure correct orientation. SkyHawk 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 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 (8TB)

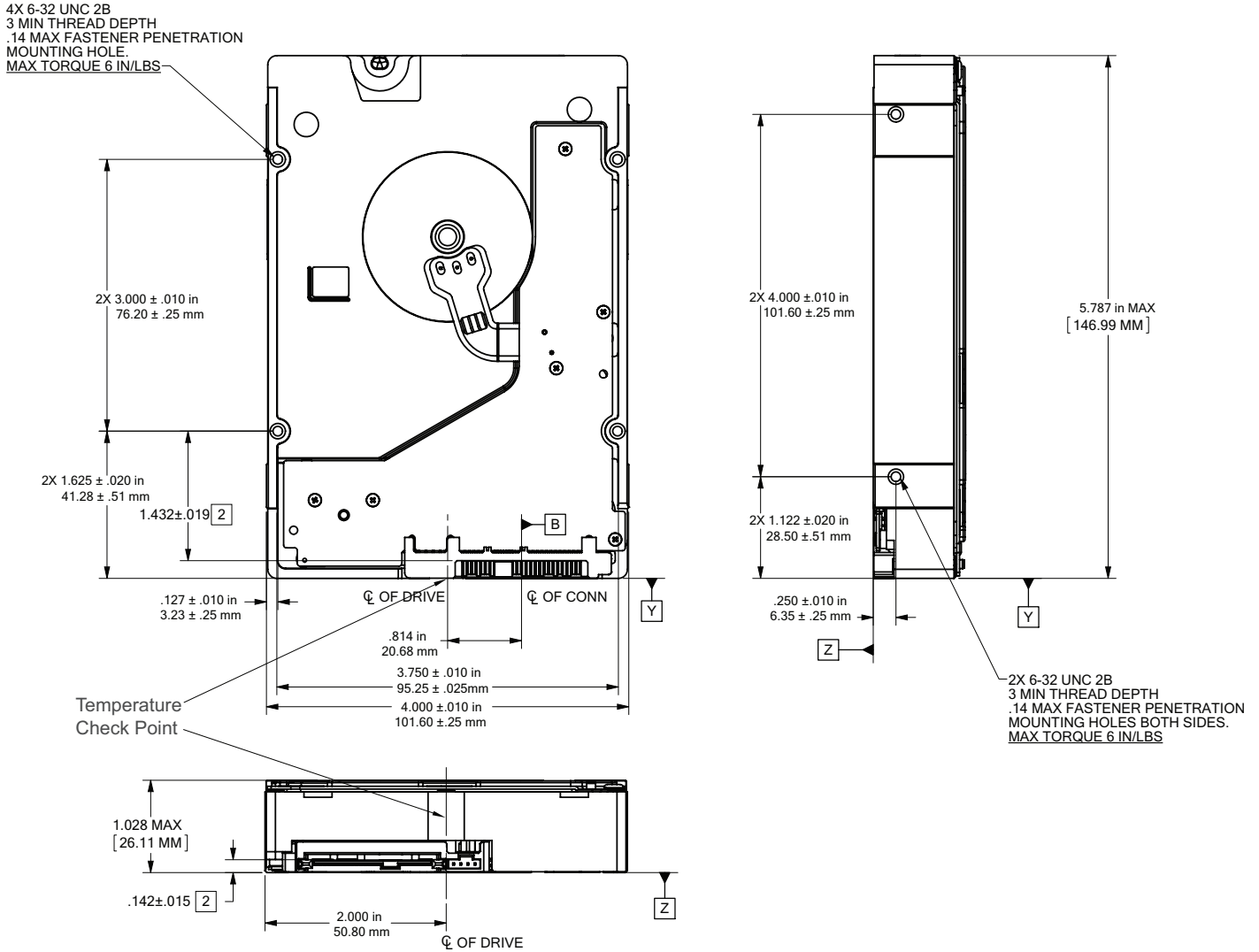


Figure 4 Mounting dimensions (6TB)

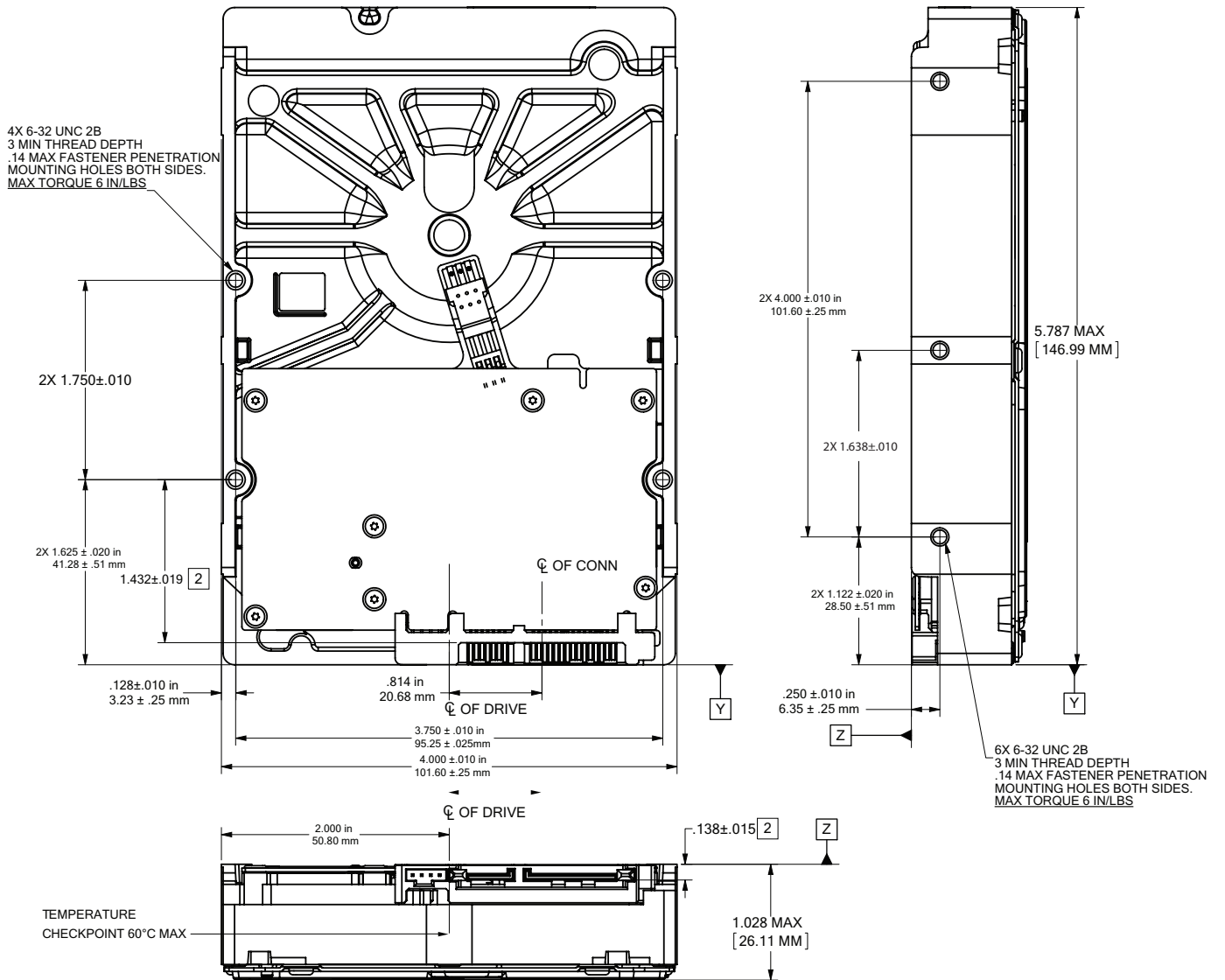


Figure 5 Mounting dimensions (4TB)

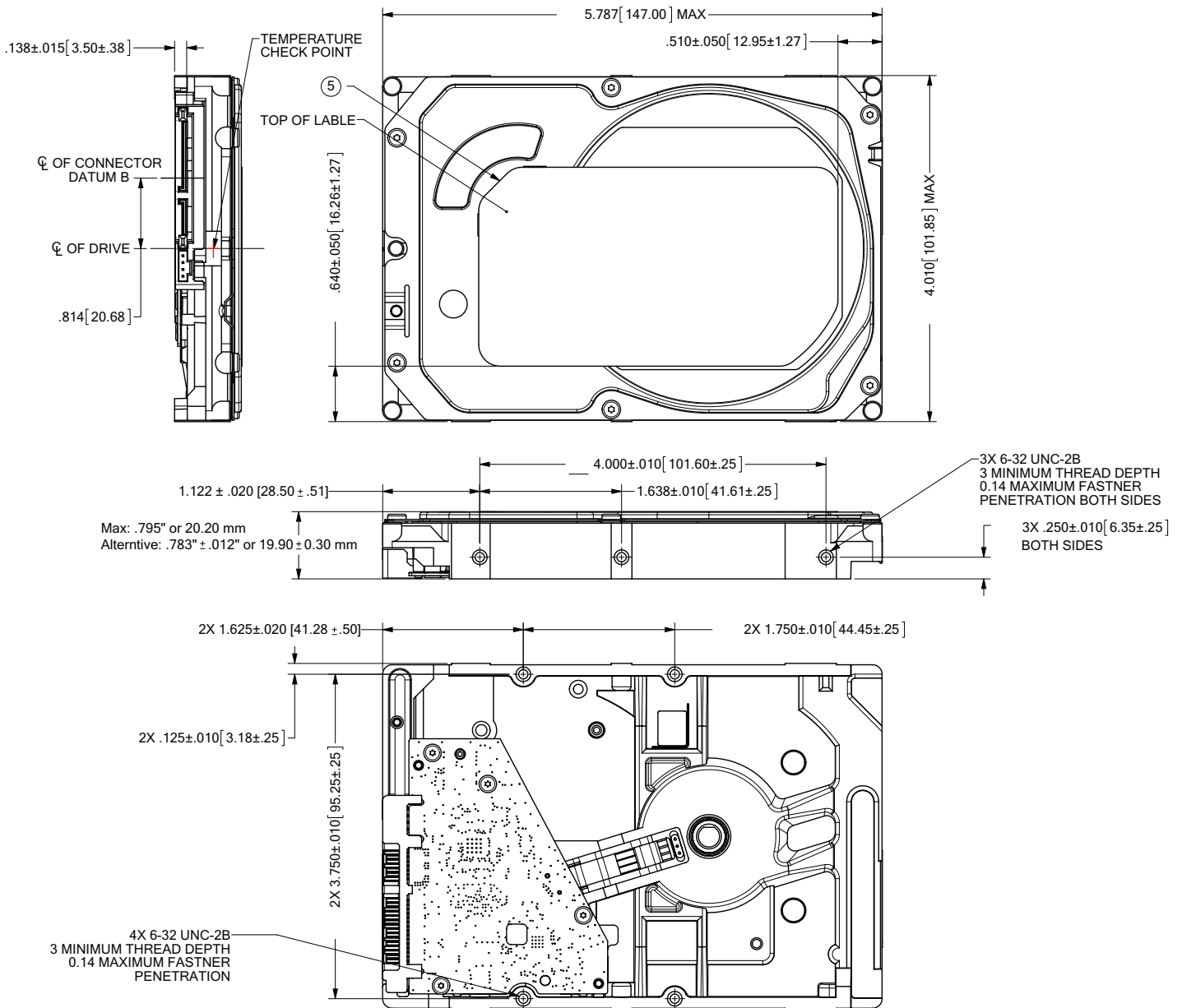


Figure 6 Mounting dimensions (3TB - 2TB)

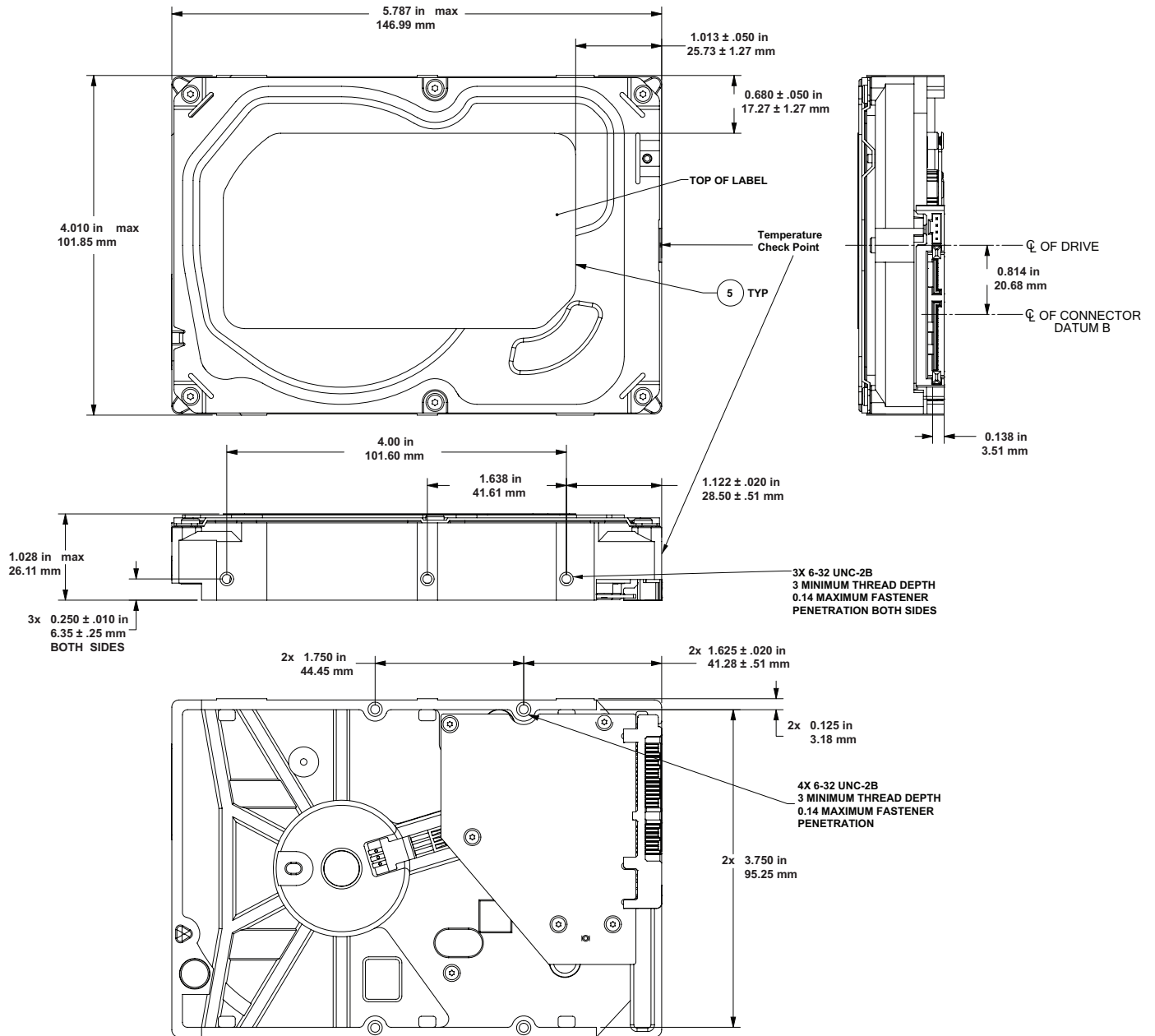
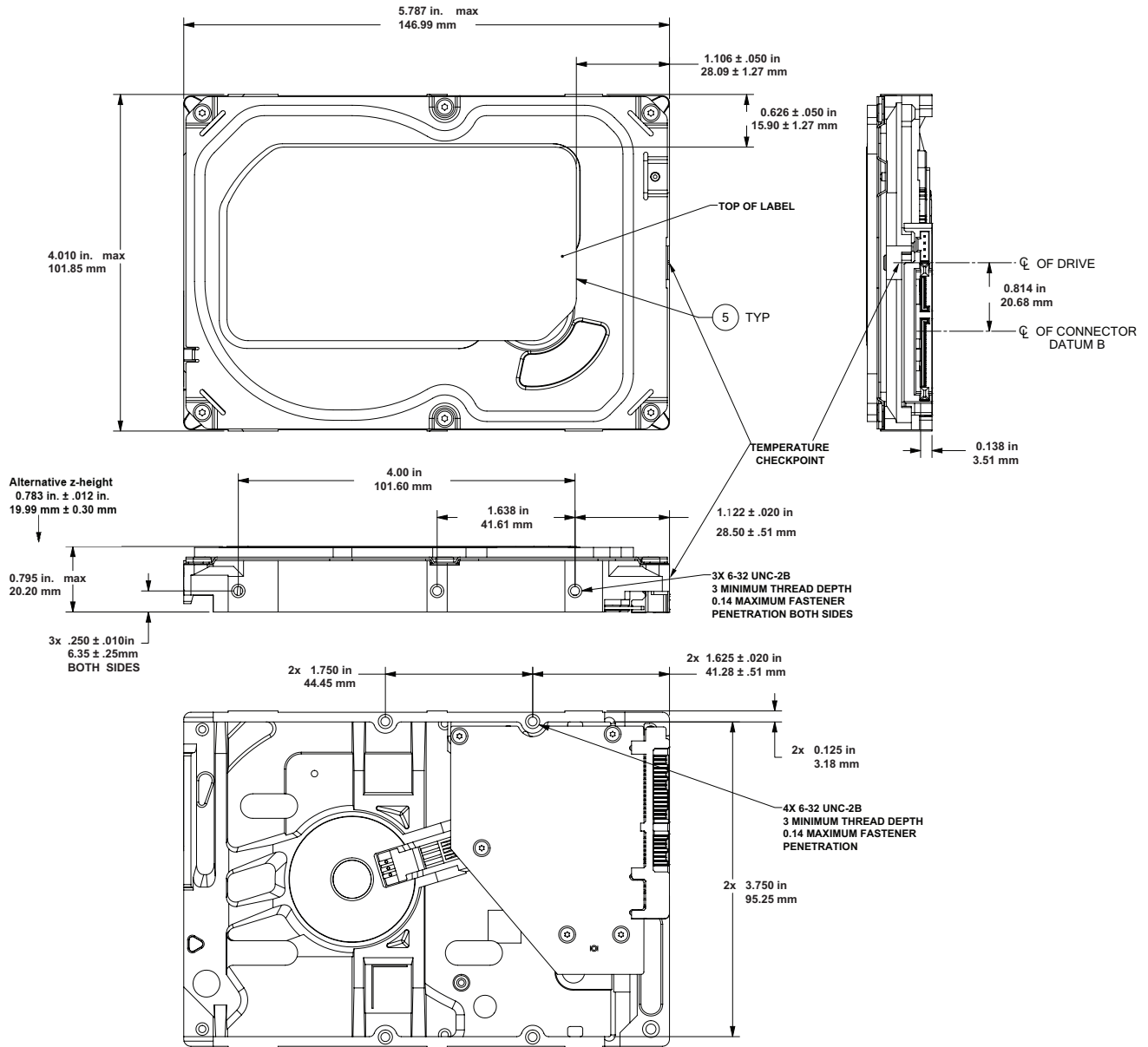


Figure 7 Mounting dimensions (1TB)



4.0 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.

4.1 Hot-Plug compatibility

SkyHawk 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.

4.2 SATA device plug connector pin definitions

Table 11 summarizes the signals on the SATA interface and power connectors.

Table 11 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.

4.3 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 39 for details and subcommands used in the S.M.A.R.T. implementation.

Table 12 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 |
| Security Freeze | F5 _H |
| Security Set Password | F1 _H |
| Security Unlock | F2 _H |
| Seek | 70 _H |

Table 12 SATA standard commands (continued)

| Command name | Command code (in hex) | |
|---|-----------------------------------|-----------------|
| 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: | 00 _H |
| | Password: | 01 _H |
| | Lock: | 02 _H |
| | Unlock: | 03 _H |
| | Freeze Lock: | 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 | |

4.3.1 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 32. All reserved bits or words should be set to zero. Parameters listed with an “x” are drive-specific or vary with the state of the drive.

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

Table 13 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 13 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 | Stream Min. Request Size | 0000 _H |
| 96 | Streaming Transfer Time - DMA | 0000 _H |
| 97 | Streaming Access Latency - DMA and PIO | 0000 _H |
| 98–99 | Streaming Performance Granularity | 2710 _H /0000 _H |

Table 13 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. | ST1000VX005 = 1,953,525,168 ST2000VX008 = 3,907,029,168 ST3000VX010 = 5,860,533,168 ST4000VX007 = 7,814,037,168 ST6000VX0023 = 11,721,045,168 ST8000VX0022 = 15,628,053,168 |
| 104 | Streaming Transfer Time - PIO | 0000 _H |
| 105–107 | 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. |

4.3.2 Set Features command

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

Table 14 Set Features commands

| | |
|-----------------|---|
| 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 |
| 06 _H | Enable the PUIS feature set |
| 07 _H | PUIS feature set device spin-up |
| 10 _H | Enable use of SATA features |
| 55 _H | Disable read look-ahead (read cache) feature |
| 82 _H | Disable write cache |
| 86 _H | Disable the PUIS feature set |
| 90 _H | Disable use of SATA features |
| AA _H | Enable read look-ahead (read cache) feature (<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.

4.3.3 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 enabled. **Table 15** below shows the S.M.A.R.T. command codes that the drive uses.

Table 15 S.M.A.R.T. commands

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

Note

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



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