Product Manual

# Seagate® Terascale HDD

**Standard Model**

ST4000NC001

**Instant Secure Erase Model**

ST4000NC000

## Document Revision History

| Revision | Date | Affected Pages |
|----------|------|----------------|
| Rev. A | 05/16/2013 | Initial release. |
| Rev. B | 05/30/2013 | 20. |
| Rev. C | 03/11/2014 | 0, 4, 15 & 25. |
| Rev. D | 06/19/2014 | 3, 5, 13, 15 & 19. |
| Rev. E | 08/01/2014 | 21-22. |

# Contents

# Figures

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# 1.0    Introduction

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

| Model Number | Seagate Instant Secure Erase (ISE) |
|--------------|-------------------------------------|
| ST4000NC001 | No |
| ST4000NC000 | Yes |

These drives provide the following key features:
- 5900 RPM spindle speed.
- PowerChoice™ for selectable power savings
- High instantaneous (burst) data-transfer rates (up to 600MB per second).
- Perpendicular recording technology provides the drives with increased areal density.
- State-of-the-art cache and on-the-fly error-correction algorithms.
- Native Command Queuing with command ordering to increase performance in demanding applications.
- Full-track multiple-sector transfer capability without local processor intervention.
- SeaTools™ diagnostic software performs a drive self-test that eliminates unnecessary drive returns.
- Support for S.M.A.R.T. drive monitoring and reporting.
- Supports latching SATA cables and connectors.
- Worldwide Name (WWN) capability uniquely identifies the drive.

## 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.

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

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

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

# 2.0 Drive Specifications

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

| Standard models | Seagate ISE models |
|---|---|
| ST4000NC001 | ST4000NC000 |

## 2.1 Specification summary tables

The specifications listed in **Table 1**.

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

*Table 1    Drive specifications summary*

| Drive Specification* | ST4000NC001 & ST4000NC000 |
|---|---|
| Formatted capacity (512 bytes/sector)* | 4000GB (4TB) |
| Guaranteed sectors | 7,814,037,168 |
| Heads | 8 |
| Disks | 4 |
| Bytes per sector | 4096 (512 byte emulation) |
| Recording density, KBPI (Kb/in max) | 1807 |
| Track density, KTPI (ktracks/in avg.) | 340 |
| Areal density, (Gb/in2 avg) | 625 |
| Spindle speed (RPM) | 5900 |
| Internal data transfer rate (Mb/s max) | 1813 |
| Sustained data transfer rate OD (MiB/s) | 130 to 160 |
| I/O data-transfer rate MB/s max) | 600 |
| ATA data-transfer modes supported | PIO modes 0–4<br>Multiword DMA modes 0–2<br>Ultra DMA modes 0–6 |
| Cache buffer | 64MB |
| Height (max) | 26.1mm / 1.028 in |
| Width (max) | 101.85mm /4.010 in |
| Length (max) | 147.00mm / 5.787 in |
| Weight (typical) | 606g (1.33 lb) |
| Average latency | 5.1ms |
| Power-on to ready (sec max) | 17.0 |
| Standby to ready (sec max) | 17.0 |
| Track-to-track seek time (ms typical) | 1.0 read<br>1.2 write |
| Average seek, read (ms typical)<br>Average seek, write (ms typical) | 16.0<br>16.0 |
| Startup current (typical) 12V (peak) | 2.0A |
| Voltage tolerance (including noise) | 5V: ± 5%<br>12V: ± 10% |
| Temperature gradient (°C per hour max) | 20°C (operating)<br>30°C (non-operating) |
| Relative humidity | 5% to 90% (operating)<br>5% to 95% (non-operating) |
| Relative humidity gradient (per hour max) | 30% |
| Altitude, operating | –304.80 m to 3048 m<br>(–1000 ft to 10,000+ ft) |
| Altitude, non-operating<br>(below mean sea level, max) | –304.80 m to 12,192 m<br>(–1000 ft to 40,000+ ft) |

*Table 1     Drive specifications summary (Continued)*

| Drive Specification* | ST4000NC001 & ST4000NC000 |
|---|---|
| Operational Shock (max @ 2 ms) | Read 70 Gs / Write 40 Gs |
| Non-Operational Shock (max @ 2 ms)) | 300 Gs |
| Vibration, operating | 5–22 Hz:     0.25 Gs, Limited displacement<br><br>22–350 Hz:   0.50 Gs<br>350–500 Hz:  0.25 Gs |
| Vibration, non-operating | 5Hz to 22Hz: 3.0 Gs<br>22Hz to 350Hz: 3.0 Gs<br>350Hz to 500Hz: 3.0 Gs |
| Drive acoustics, sound power (bels) | |
| Idle** | 2.3  (typical)<br>2.5     (max) |
| Performance seek | 2.8  (typical)<br>3.0     (max) |
| Non-recoverable read errors | 1 per $10^{14}$ bits read |
| Annualized Failure Rate (AFR) | 1.095% based on 8760 POH |
| 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/.<br>From this page, click on the "Check to see if the drive is under Warranty" link. The following are required to be provided: the drive serial number, model number (or part number) and country of purchase. The system will display the warranty information for the drive. |
| | |
| Load/Unload cycles (25°C, 50% rel. humidity) | 300,000 |
| Supports Hotplug operation per the Serial ATA Rev. 3.2 specification | Yes |

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

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

## 2.2        Formatted capacityy

| Model | Formatted capacity* | Guaranteed sectors | Bytes per sector |
|---|---|---|---|
| ST4000NC001<br>ST4000NC000 | 4TB | 7,814,037,168 | 4096<br>(512 byte emulation) |

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

## 2.2.1        LBA mode

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

See Section 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　　　　Recording and interface technology

| Interface | Serial ATA (SATA) |
|---|---|
| Recording method | Perpendicular |
| Recording density, KBPI (Kb/in max) | 1807 |
| Track density, KTPI (ktracks/in avg) | 340 |
| Areal density (Gb/in$^2$ avg) | 625 |
| Spindle speed (RPM) (± 0.2%) | 5900 |
| Internal data transfer rate (Mb/s max) | 1813 |
| Sustained data transfer rate (MiB/s) | 130 to 160 |
| I/O data-transfer rate (MB/s max) | 600 (Ultra DMA mode 5) |

## 2.4　　　　Physical characteristics

| Weight: (maximum) | 606g (1.33 lb) |
|---|---|
| Cache buffer | 64MB (64,768KB) |

## 2.5　　　　Seek time

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

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

| Typical seek times (ms) | Read | Write |
|---|---|---|
| Track-to-track | 1.0 | 1.2 |
| Average | 16.0 | 16.0 |
| Average latency | 5.1 | |

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

## 2.6　　　　Start/stop times

| Power-on to ready (sec) | 17 (max) |
|---|---|
| Standby to ready (sec) | 17 (max) |
| Ready to spindle stop (sec) | 20 (max) |

## 2.7          Power specifications

The drive receives DC power (+5V or +12V) through a native SATA power connector. Refer to **Figure 4 on page 18**.

### 2.7.1          Power consumption

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

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

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

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

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

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

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

**Table 2:** 4TB Drive DC power requirements

| | | 6.0Gb mode | |
|---|---|---|---|
| **Voltage** | | +5V | +12V |
| **Regulation** | | ±5% | ±5% |
| **Avg Idle Current \*** | | 0.27 | 0.27 |
| **Advanced Idle Current \*** | | | |
| Idle_A | | 0.182 | 0.282 |
| Idle_B | | 0.167 | 0.237 |
| Idle_C | | 0.167 | 0.104 |
| Standby | | 0.162 | 0.006 |
| **Average Sleep Current** | | 0.162 | 0.006 |
| **Maximum Start Current** | | | |
| DC (peak DC) | 3σ | 0.34 | 0.51 |
| AC (peak DC) | 3σ | 0.71 | 1.73 |
| **Peak operating current (random read):** | | | |
| Typical DC | | 0.29 | 0.42 |
| Maximum DC | 3σ | 0.29 | 0.42 |
| **Peak operating current (random write)** | | | |
| Typical DC | | 0.29 | 0.42 |
| Maximum DC | 3σ | 0.29 | 0.42 |
| **Peak operating current (sequential read)** | | | |
| Typical DC | | 0.48 | 0.30 |
| Maximum DC | 3σ | 0.50 | 0.30 |
| **Peak operating current (sequential write)** | | | |
| Typical DC | | 0.40 | 0.32 |
| Maximum DC | 3σ | 0.47 | 0.33 |

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

- **Spinup power**

    Spinup power is measured from the time of power-on to the time that the drive spindle reaches operating speed.
- **Operating Read/Write power and current**

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

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

    Typical DC - average of average operating currents

    Maximum DC - average of max operating currents
- **Average Idle Current**

    Idle mode power is measured with the drive up to speed, with servo electronics active and with the heads in a random track location.
- **EPC Idle/Standby/Sleep mode**

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

### 2.7.1.1 Typical current profiles

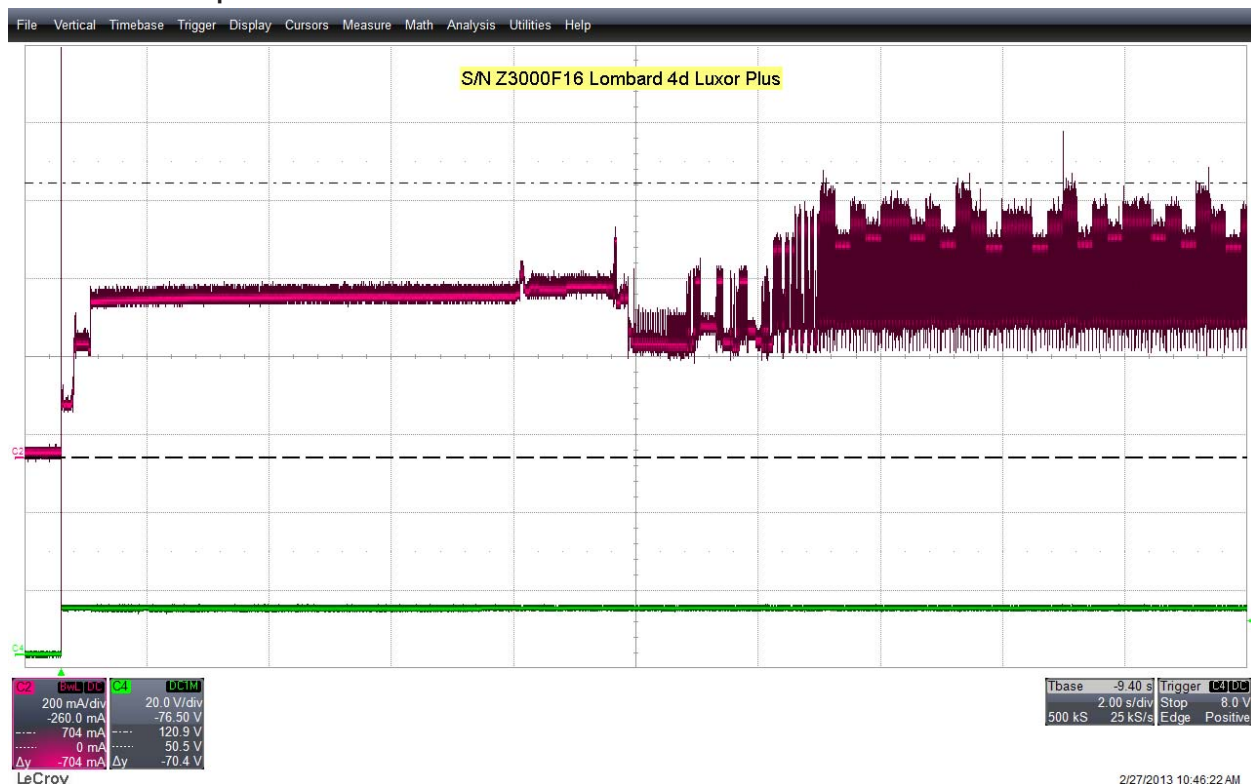**4TB model current profile**



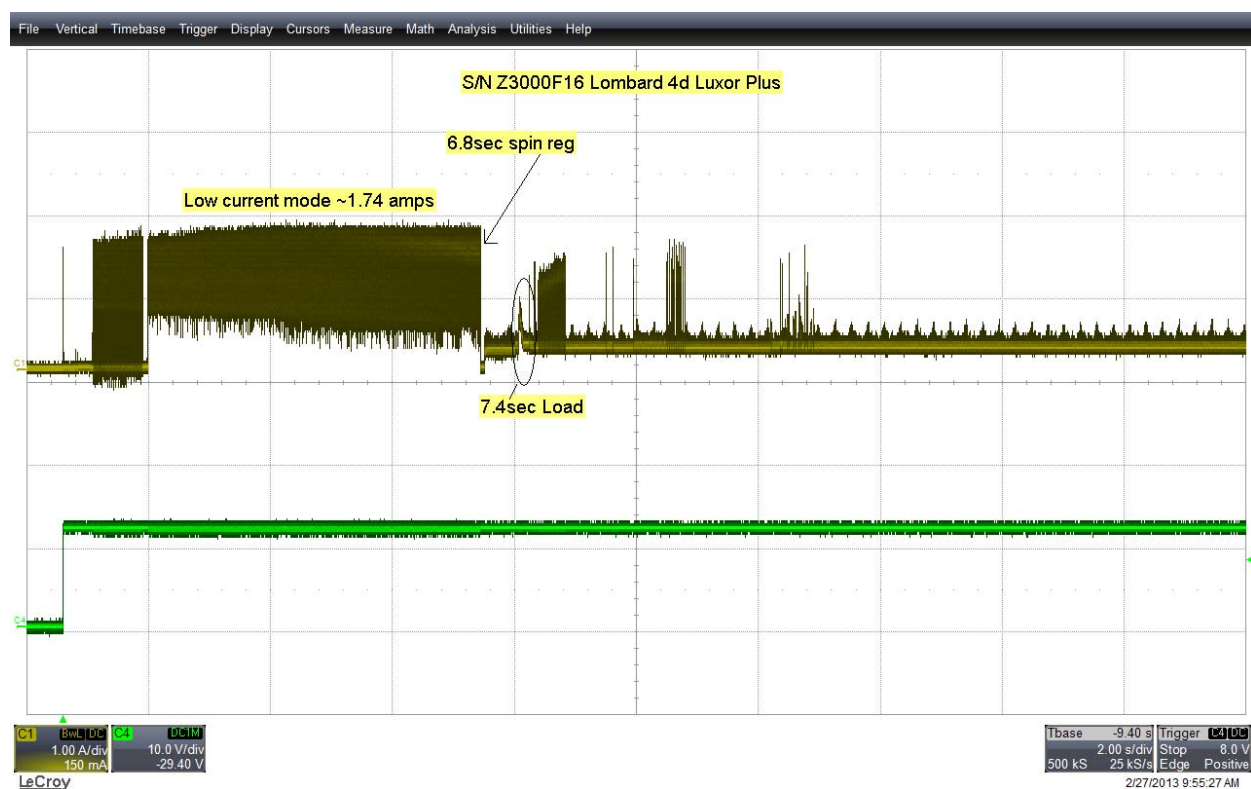*Figure 1    Typical 4TB model 5V - 6Gb/s startup and operation current profile*



*Figure 2    Typical 4TB model 12V - 6Gb/s startup and operation current profile*

## 2.7.2        Conducted noise

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

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

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

## 2.7.3        Voltage tolerance

Voltage tolerance (including noise):

- 5V ± 5%
- 12V ± 10%

## 2.7.4        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_a | ID Biased | Rotating | Enabled |
| Idle_b | Parked | Rotating | Enabled |
| Idle_c | Parked | Rotating at lower RPM | 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.

### 2.7.4.1 Extended Power Conditions - PowerChoice™

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

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

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

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

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

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

**PowerChoice provides the following reporting methods for tracking purposes**

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

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

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

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

**PowerChoice Manufacture Default Power Condition Timer Values**

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

| Power Condition Name | Manufacturer Default Timer Values |
|---|---|
| Idle_a | 2 min |
| Idle_b | 4 min |
| Idle_c | 10 min |
| Standby_z | 15 min |

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

**PowerChoice Supported Extended Power Condition Feature Subcommands**

| EPC Subcommands | Descriptions |
|---|---|
| 00$_H$ | Restore Power Condition Settings |
| 01$_H$ | Go to Power Condition |
| 02$_H$ | Set Power Condition Timer |
| 03$_H$ | Set Power Condition State |

**PowerChoice Supported Extended Power Condition Identifiers**

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

## 2.8 Environmental limits

Temperature and humidity values experienced by the drive must be such that condensation does not occur on any drive part. Altitude and atmospheric pressure specifications are referenced to a standard day at 58.7°F (14.8°C). Maximum wet bulb temperature is 82°F (28°C).

| Note | The recommended storage period: |
|------|---------------------------------|
|      | • 1 year under controlled conditions of 34°C 90%RH or less |
|      | • 90 days in uncontrolled storage conditions |

### 2.8.1 Ambient temperature

**a** Operating

The drive meets the operating specifications over a 41°F to 140°F (5°C to 60°C) drive case temperature range with a maximum temperature gradient of 36°F (20°C) per hour.

The maximum allowable drive case temperature is 60°C. See **Figure 3** for HDA case temperature measurement location

The MTBF specification for the drive assumes the operating environment is designed to maintain nominal case temperature. The rated MTBF is based upon a sustained case temperature of 104°F (40°C). Occasional excursions in operating temperature between the rated MTBF temperature and the maximum drive operating case temperature may occur without impact to the rated MTBF. However, continual or sustained operation at case temperatures beyond the rated MTBF temperature will degrade the drive MTBF and reduce product reliability.

Air flow may be required to achieve consistent nominal case temperature values (see Section **3.4**). To confirm that the required cooling is provided for the electronics and HDA, place the drive in its final mechanical configuration, and perform random write/read operations. After the temperatures stabilize, measure the case temperature of the drive.

**b** Non-operating

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

*Figure 3 Location of the HDA temperature check point*



HDA Temp.
Check Point
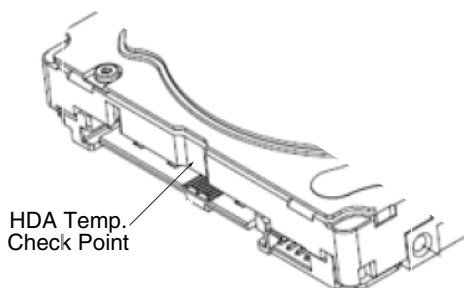
| Note | Image is for reference only, may not represent actual drive |
|------|-------------------------------------------------------------|

### 2.8.2 Humidity

#### 2.8.2.1 Relative humidity

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

### 2.8.3 Altitude

| Operating | –304.80 m to 3048 m (–1000 ft. to 10,000+ ft.) |
|-----------|-------------------------------------------------|
| Non-operating | –304.80 m to 12,192 m (–1000 ft. to 40,000+ ft.) |

### 2.8.4　Shock

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

#### 2.8.4.1　Operating shock

These drives comply with the performance levels specified in this document when subjected to a maximum operating shock of 70 Gs (read) and 40 Gs (write) based on half-sine shock pulses of 2 ms during read operations. Shocks should not be repeated more than two times per second.

#### 2.8.4.2　Non-operating shock

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

### 2.8.5　Vibration

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

#### 2.8.5.1　Operating vibration

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

| 5Hz to 22Hz | 0.25 Gs |
|---|---|
| 22Hz to 350Hz | 0.50 Gs |
| 350Hz to 500Hz | 0.25 Gs |
| 20 - 1500Hz *(RROV) | 12.5 rads/s2 w/RVFF |

* Rotary Random Operating 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.

#### 2.8.5.2　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.

| 10Hz to 500Hz Linear Random | 4.9 Grms ref |
|---|---|

### 2.9　Acoustics

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

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

*Table 3　Fluid Dynamic Bearing (FDB) motor acoustics*

| Idle* | Performance Seek |
|---|---|
| 2.3 bels (typical) 2.5 bels (max) | 2.8 bels (typical) 3.0 bels (max) |

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

## 2.10    Test for Prominent Discrete Tones (PDTs)

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

## 2.11    Electromagnetic immunity

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

*Table 4    Radio frequency environments*

| Test | Description | Performance level | Reference standard |
|------|-------------|-------------------|--------------------|
| Electrostatic discharge | Contact, HCP, VCP: ± 4 kV; Air: ± 8 kV | B | EN61000-4-2: 95 |
| Radiated RF immunity | 80MHz to 1,000MHz, 3 V/m,<br>80% AM with 1kHz sine<br>900MHz, 3 V/m, 50% pulse modulation @ 200Hz | A | EN61000-4-3: 96<br>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,<br>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<br>0% short, 5 seconds<br>40%, 0.10 seconds<br>70%, 0.01 seconds | C<br>C<br>C<br>B | EN61000-4-11: 94 |

## 2.12    Reliability

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

The product shall achieve an Annualized Failure Rate (AFR) of 1.1% (MTBF of 800 thousand hours) when operated at nominal power and typical case temperatures of 40°C. Operation at temperatures outside the specifications in Section 2.8 may increase the product AFR (decrease MTBF). AFR and MTBF are population statistics that are not relevant to individual units.

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

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

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

| | |
|---|---|
| Nonrecoverable read errors | 1 per $10^{14}$ bits read, max |
| Annualized Failure Rate (AFR) | 1.1% (nominal power, 40°C case temperature) |
| Load unload cycles | 300,000 cycles |
| Rated Workload | Average rate of <180TB/year<br>The MTBF specification for the drive assumes the I/O workload does not exceed the Average Annualized Workload Rate Limit of <180TB/year. Workloads exceeding the annualized rate may degrade the drive MTBF and impact product reliability. The Average Annualized Workload Rate Limit is in units of TB per year, or TB per 8760 power on hours.<br>Workload Rate = TB transferred x (8760 / recorded power on hours). |
| Warranty | To determine the warranty for a specific drive, use a web browser to access the following web page: http://www.seagate.com/support/warranty-and-replacements/.<br>From this page, click on the "Check to see if the drive is 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. |

## 2.13　Agency certification

### 2.13.1　Safety certification

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

### 2.13.2　Electromagnetic compatibility

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

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

**Korean RRL**

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

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

- Family name:　　　　　　　　　Seagate Terascale HDD

- Certificate number:　　　　　　KCC-REM-STX-TerascaleHDD

- Date of certification:　　　　　2013-05-27

**Australian C-Tick (N176)**

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

### 2.13.3　FCC verification

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

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

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

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

- Reorient the receiving antenna.

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

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

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

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

## 2.14        Environmental protection

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

### 2.14.1        European Union Restriction of Hazardous Substances (RoHS) Directive

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

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

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

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

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

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

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

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

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

## 2.15        Corrosive environment

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

## 2.16        Product warranty

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

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

**Shipping**

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

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

**Storage**

The maximum recommended storage period for the drive in a non-operational environment is 90 days. Drives should be stored in the original unopened Seagate shipping packaging whenever possible. Once the drive is removed from the Seagate original packaging the recommended maximum period between drive operation cycles is 30 days. During any storage period the drive non-operational temperature, humidity, wet bulb, atmospheric conditions, shock, vibration, magnetic and electrical field specifications should be followed.

**Product repair and return information**

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

# 3.0 Configuring and Mounting the Drive

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

## 3.1 Handling and static-discharge precautions

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

| | |
|---|---|
| **Caution** | • Before handling the drive, put on a grounded wrist strap, or ground yourself 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.<br><br>• Handle the drive by its edges or frame *only*.<br><br>• The drive is extremely fragile—handle it with care. Do not press down on the drive top cover.<br><br>• Always rest the drive on a padded, antistatic surface until mounting it in the computer.<br><br>• Do not touch the connector pins or the printed circuit board.<br><br>• Do not remove the factory-installed labels from the drive or cover them with additional labels. Removal voids the warranty. Some factory-installed labels contain information needed to service the drive. Other labels are used to seal out dirt and contamination. |

## 3.2 Configuring the drive

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

## 3.3 SATA cables and connectors

The SATA interface cable consists of four conductors in two differential pairs, plus three ground connections. The cable size may be 30 to 26 AWG with a maximum length of one meter (39.37 inches). See **Table 5** for connector pin definitions. Either end of the SATA signal cable can be attached to the drive or host.

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

For installations which require cables, users can connect the drive as illustrated in **Figure 4**.

*Figure 4    Attaching SATA cabling*
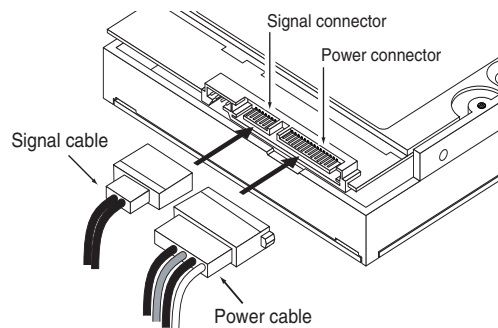


Each cable is keyed to ensure correct orientation. Seagate Terascale HDD drives support latching SATA connectors.

## 3.4 Drive mounting

Users can mount the drive in any orientation using four screws in the side-mounting holes or four screws in the bottom-mounting holes. Refer to **Figure 5** for drive mounting dimensions. Follow these important mounting precautions when mounting the drive:

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

- Use only 6-32 UNC mounting screws.

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

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

| Weight: (maximum) | 606g (1.33 lb) |
|---|---|

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

***Figure 5    Mounting dimensions***
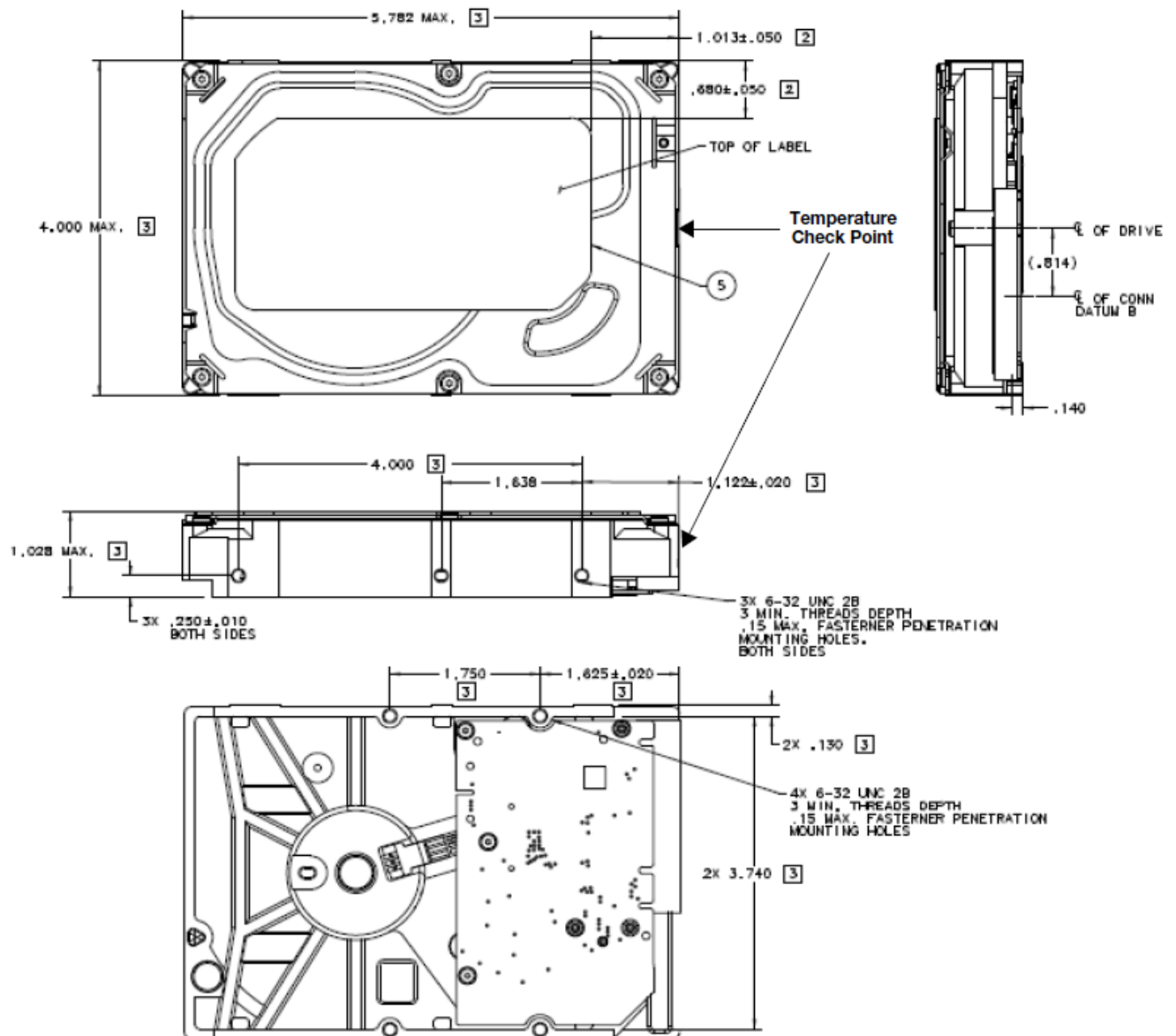


| **Note** | PCBA may not be representative of the actual PCBA on drive. |
|---|---|

# 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

Seagate   Terascale HDD drives incorporate connectors which enable users to hot plug these drives in accordance with the SATA Revision 3.0 specification. This specification can be downloaded from www.serialata.org.

| Caution | The drive motor must come to a complete stop **(Ready to spindle stop time indicated in Section 3.7)** prior to changing the plane of operation.This time is required to insure data integrity. |
|---|---|

## 4.2    SATA device plug connector pin definitions

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

*Table 5    SATA connector pin definitions*

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

**Notes**

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

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

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

## 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 3.0 (http://www.sata-io.org).

See "S.M.A.R.T. commands" on page 27 for details and subcommands used in the S.M.A.R.T. implementation.

| Command name | Command code (in hex) |
|---|---|
| Check Power Mode | E5$_H$ |
| Download Microcode | 92$_H$ |
| Execute Device Diagnostics | 90$_H$ |
| Flush Cache | E7$_H$ |
| Flush Cache Extended | EA$_H$ |
| Identify Device | EC$_H$ |
| Idle | E3$_H$ |
| Idle Immediate | E1$_H$ |
| Read Buffer | E4$_H$ |
| Read DMA | C8$_H$ |
| Read DMA Extended | 25$_H$ |
| Read FPDMA Queued | 60$_H$ |
| Read Log Ext | 2F$_H$ |
| Read Log DMA Ext | 47$_H$ |
| 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$_H$ |
| Sanitize Device - Status Ext | B4$_H$ / 0000$_H$ |
| Sanitize Device - Crypto Scramble Ext | B4$_H$ / 0011$_H$ |
| Sanitize Device - Freeze Lock Ext | B4$_H$ / 0020$_H$ |
| Security Disable Password | F6$_H$ |
| Security Erase Prepare | F3$_H$ |
| Security Erase Unit | F4$_H$ |
| Security Freeze Lock | F5$_H$ |
| Security Set Password | F1$_H$ |
| Security Unlock | F2$_H$ |
| Seek | 70$_H$ |

| 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:<br>Password:<br>Lock:<br>Unlock:<br>Freeze Lock: | 00$_H$<br>01$_H$<br>02$_H$<br>03$_H$<br>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 FPDMA Queued | 61$_H$ | | |
| Write Log Extended | 3F$_H$ | | |
| Write Log DMA Ext | 57$_H$ | | |
| 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 on page 21. All reserved bits or words should be set to zero. Parameters listed with an "x" are drive-specific or vary with the state of the drive.

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

| Word | Description | Value |
|------|-------------|-------|
| 0 | Configuration information:<br>Bit 15: 0 = ATA; 1 = ATAPI<br>• Bit 7: removable media<br>• Bit 6: removable controller<br>• Bit 0: reserved | 0C5A$_H$ |
| 1 | Number of logical cylinders | 16,383 |
| 2 | ATA-reserved | C837$_H$ |
| 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 | 0000$_H$ |
| 22 | Obsolete | 0004$_H$ |
| 23–26 | Firmware revision (8 ASCII character string, padded with blanks to end of string) | xxxx |
| 27–46 | Drive model number:<br>(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 | 4000$_H$ |
| 49 | Standard Standby timer, IORDY supported and may be disabled | 2F00$_H$ |
| 50 | ATA-reserved | 4000$_H$ |
| 51 | PIO data-transfer cycle  timing mode | 0200$_H$ |
| 52 | Retired | 0200$_H$ |
| 53 | Words 54–58, 64–70 and 88 are valid | 0007$_H$ |
| 54 | 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$_H$ |
| 60–61 | Total number of user-addressable LBA sectors available<br>(see Section 2.2 for related information)<br>*Note: The maximum value allowed in this field is: 0FFFFFFFh<br>(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$_H$ |

| Word | Description | Value |
|---|---|---|
| 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 | $03F0_H$ |
| 81 | Minor version number | $001F_H$ |
| 82 | Command sets supported | $346B_H$ |
| 83 | Command sets supported | $7501_H$ |
| 84 | Command sets support extension (see note following this table) | 6163H   See Word 108-111 note. (6163H = 0110000101100011 binary) |
| 85 | Command sets enabled | $3469_H$ |
| 86 | Command sets enabled | $B401_H$ |
| 87 | Command sets enable  extension | $6163_H$ |
| 88 | Ultra DMA support and current mode (see note following this table) | $xx7F_H$ |
| 89 | Security erase time | $8100_H$ |
| 90 | Enhanced security erase time | $8100_H$ |
| 92 | Master password revision code | $FFFE_H$ |
| 93 | Hardware reset value | $0000_H$ |
| 95–99 | ATA-reserved | $0000_H$ |
| 100–103 | Total number of user-addressable LBA sectors available (see Section 2.2 for related information). These words are required for drives that support the 48-bit addressing feature. Maximum value: 0000FFFFFFFFFFFFh. | ST4000NC001 = 7,814,037,168 ST4000NC000 = 7,814,037,168 |
| 104–107 | ATA-reserved | $xxxx_H$ |
| 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 | $xxxx_H$ |
| 128 | Security status | $0021_H$ |
| 129–159 | Seagate-reserved | $xxxx_H$ |
| 160–205 | ATA-reserved | $0000_H$ |
| 206 | SCT Command Transport command set. If bit 0 is set to one, then the device supports SCT Command Transport. Bits 7:2 indicate individual SCT feature support. | $xxBD_H$ |
| 207–254 | ATA-reserved | $0000_H$ |
| 255 | Integrity word | $xxA5_H$ |

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

| | Bit | Word 63 |
|---|---|---|
| | **Bit** | **Word 63** |
| | 0 | Multiword DMA mode 0 is supported. |
| | 1 | Multiword DMA mode 1 is supported. |
| | 2 | Multiword DMA mode 2 is supported. |
| | 8 | Multiword DMA mode 0 is currently active. |
| | 9 | Multiword DMA mode 1 is currently active. |
| | 10 | Multiword DMA mode 2 is currently active. |
| | **Bit** | **Word 84** |
| | 0 | SMART error 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. |

**Description (if bit is set to 1)**

| 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:

| $02_H$ | Enable write cache *(default)*. |
|--------|--------------------------------|
| $03_H$ | Set transfer mode (based on value in Sector Count register). <br> Sector Count register values: |
| | $00_H$  Set PIO mode to default (PIO mode 2). |
| | $01_H$  Set PIO mode to default and disable IORDY (PIO mode 2). |
| | $08_H$  PIO mode 0 |
| | $09_H$  PIO mode 1 |
| | $0A_H$  PIO mode 2 |
| | $0B_H$  PIO mode 3 |
| | $0C_H$  PIO mode 4 *(default)* |
| | $20_H$  Multiword DMA mode 0 |
| | $21_H$  Multiword DMA mode 1 |
| | $22_H$  Multiword DMA mode 2 |
| | $40_H$  Ultra DMA mode 0 |
| | $41_H$  Ultra DMA mode 1 |
| | $42_H$  Ultra DMA mode 2 |
| | $43_H$  Ultra DMA mode 3 |
| | $44_H$  Ultra DMA mode 4 |
| | $45_H$  Ultra DMA mode 5 |
| | $46_H$  Ultra DMA mode 6 |
| $10_H$ | Enable use of SATA features |
| $55_H$ | Disable read look-ahead (read cache) feature. |
| $82_H$ | Disable write cache |
| $90_H$ | Disable use of SATA features |
| $AA_H$ | Enable read look-ahead (read cache) feature *(default)*. |
| $F1_H$ | Report full capacity available |

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

## 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 D4H) that eliminates unnecessary drive returns. The diagnostic software ships with all new drives and is also available at: http://www.seagate.com/support/downloads/seatools/.

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

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

| Note | If an appropriate code is not written to the Features Register, the command is aborted and 0$x$04 (abort) is written to the Error register. |
|---|---|

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