Video 2.5 HDD

Product Manual

Standard models

ST500VT000
ST500VT001
ST320VT000
ST250VT000

100713733, Rev. J
Gen 2.1 - September 2017
## Document Revision History

<table>
<thead>
<tr>
<th>Revision</th>
<th>Date</th>
<th>Pages affected and Description of Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rev. A</td>
<td>07/24/2013</td>
<td>Initial release.</td>
</tr>
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<td>16.</td>
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</tr>
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<td>8: Added Power-off/Flush Command note after Table 1 8 &amp; 15: Revised Rated Workload statements 15: Added Section 2.11.2 Data loss under power interruption with write cache enabled</td>
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</tbody>
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When referring to drive capacity, one gigabyte, or GB, equals one billion bytes and one terabyte, or TB, equals one trillion bytes. Your computer’s operating system may use a different standard of measurement and report a lower capacity. In addition, some of the listed capacity is used for formatting and other functions, and thus will not be available for data storage. Actual quantities will vary based on various factors, including file size, file format, features and application software. Actual data rates may vary depending on operating environment and other factors. The export or re-export of hardware or software containing encryption may be regulated by the U.S. Department of Commerce, Bureau of Industry and Security (for more information, visit www.bis.doc.gov), and controlled for import and use outside of the U.S. Seagate reserves the right to change, without notice, product offerings or specifications.
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<th>Description</th>
<th>Page</th>
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<td>Figure 3</td>
<td>Mounting Dimensions (for standard models)</td>
<td>20</td>
</tr>
</tbody>
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For information regarding Warranty Support, visit: http://www.seagate.com/support/warranty-and-replacements/

For information regarding data recovery services, visit: http://www.seagate.com/services-software/recover/

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1.0 Introduction

This manual describes the functional, mechanical and interface specifications for the following: Seagate® Video 2.5 HDD model drives:

<table>
<thead>
<tr>
<th>Standard models</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST500VT000 - 1DK142</td>
</tr>
<tr>
<td>ST500VT001 - 1K6142</td>
</tr>
<tr>
<td>ST320VT000 - 1DK14C</td>
</tr>
<tr>
<td>ST250VT000 - 1DK141</td>
</tr>
</tbody>
</table>

These drives provide the following key features:

- 1000 Gs nonoperating shock and 400 Gs of operating shock.
- 16MB buffer. (ST500VT000, ST320VT000 and ST250VT000 models)
- 32MB buffer. (ST500VT001 model)
- 5400-RPM spindle speed.
- Full-track multiple-sector transfer capability without local processor intervention.
- High instantaneous (burst) data-transfer rates (up to 6Gb/s).
- Native Command Queuing (NCQ) with command ordering.
- Perpendicular recording technology.
- Quiet operation. Fluid Dynamic Bearing (FDB) motor.
- Reliability for 24x7 video applications.
- SeaTools™ diagnostic software performs a drive self-test that eliminates unnecessary drive returns.
- State-of-the-art cache and on-the-fly error-correction algorithms.
- Support for Read Multiple and Write Multiple commands.
- Support for S.M.A.R.T. drive monitoring and reporting.
- The 3D Defense System™, which includes Drive Defense, Data Defense and Diagnostic Defense, offers the industry's most comprehensive protection for disk drives.
- Worldwide Name (WWN) capability uniquely identifies the drive.

1.1 About the Serial ATA Interface

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

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

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

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

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

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

The Serial ATA host adapter contains a set of registers that shadow the contents of the traditional device registers, referred to as the Shadow Register Block. All Serial ATA devices behave like Device 0 devices. For additional information about how Serial ATA emulates parallel ATA, refer to the Serial ATA International Organization: Serial ATA (Revision 2.6). The specification can be downloaded from www.serialata.org.
2.0 Drive Specifications

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

The specification summaries listed in the following tables are for quick reference. For details on specification measurement or definition, refer to the appropriate section of this manual.

### Table 1 Drive Specifications Summary

<table>
<thead>
<tr>
<th>Drive Specification</th>
<th>ST500VT001</th>
<th>ST500VT000</th>
<th>ST320VT000</th>
<th>ST250VT000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formatted capacity (1)</td>
<td>500 GB</td>
<td>320 GB</td>
<td>250 GB</td>
<td></td>
</tr>
<tr>
<td>Guaranteed sectors</td>
<td>976,773,168</td>
<td>625,142,448</td>
<td>488,397,168</td>
<td></td>
</tr>
<tr>
<td>Heads</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disks</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bytes per sector</td>
<td>512 (logical) / 4096 (physical)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recording density</td>
<td>1875 Kb/in</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Track density</td>
<td>375 Ktracks/in avg</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Areal density</td>
<td>670 Gb/in² avg</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spindle speed</td>
<td>5400 RPM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sustained data transfer rate OD</td>
<td>100 MB/s max</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I/O data-transfer rate</td>
<td>600 MB/s max</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ATA data-transfer modes supported</td>
<td>PIO modes 0–4</td>
<td>Multiword DMA modes 0–2</td>
<td>Ultra DMA modes 0–6</td>
<td></td>
</tr>
<tr>
<td>Cache buffer</td>
<td>32MB</td>
<td>16MB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height</td>
<td>6.8 +/- 0.2 mm (0.268 +/- 0.008 in)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Width</td>
<td>69.85 +/- 0.25 mm (2.750 +/- 0.010 in)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>100.35 +0.20 / -0.25 mm (3.951 +0.008 / -0.010 in)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight (typical)</td>
<td>&lt;95 g (0.209 lb)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average latency</td>
<td>5.6 ms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Startup current (typical) 5V (peak)</td>
<td>1.0 A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage tolerance (including noise)</td>
<td>5V ± 5%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating temperature</td>
<td>0° to 60°C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonoperating temperature (Ambient)</td>
<td>–40° to 70°C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature gradient (max)</td>
<td>20°C per hour max (operating)</td>
<td>35°C per hour max (nonoperating)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relative humidity</td>
<td>5% to 95% (operating)</td>
<td>5% to 95% (nonoperating)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relative humidity gradient</td>
<td>30% per hour max</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wet bulb temperature (max)</td>
<td>37.7°C max (operating)</td>
<td>40.0°C max (nonoperating)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Altitude, operating</td>
<td>–304.8 m to 3048 m (–1000 ft to 10,000+ ft)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Altitude, nonoperating (below mean sea level, max)</td>
<td>–304.8 m to 12,192 m (–1000 ft to 40,000+ ft)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operational Shock</td>
<td>400 Gs at 2 ms max</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 1  Drive Specifications Summary (continued)

<table>
<thead>
<tr>
<th>Drive Specification</th>
<th>ST500VT001</th>
<th>ST500VT000</th>
<th>ST320VT000</th>
<th>ST250VT000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Operational Shock</td>
<td>1000 Gs at 1 ms max</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Vibration, operating                        | 5–200 Hz: 2.0 Gs  
201–500 Hz: 1.0 Gs |
| Vibration, nonoperating                     | 5–500 Hz: 5.0 Gs |
| Nonrecoverable read errors                  | 1 per $10^{14}$ bits read |
| Annualized Failure Rate (AFR)               | 0.55% |
| Rated workload                              | Average annualized workload rating: <55 TB/year.  
The specifications for the product assumes the I/O workload does not exceed the average annualized workload rate limit of 55 TB/year. Workloads exceeding the annualized rate may degrade and impact reliability as experienced by the particular application. The average annualized workload rate limit is in units of TB per calendar year. |
| Warranty                                    | To determine the warranty for a specific drive, use a web browser to access the following web page:  
http://www.seagate.com/support/warranty-and-replacements/  
From this page, click on the "Is my Drive under Warranty" link. The following are required to be provided: the drive serial number, model number (or part number) and country of purchase. The system will display the warranty information for the drive. |
| Load-unload cycles                          | 600,000 at 25°C, 50% rel. humidity |
| Supports Hotplug operation per the Serial ATA Revision 3.2 specification | Yes |

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

If the drive is powered-off before issuing flush cache command, in some instances, the end user data in the DRAM cache might not be committed to the disk.

2.1  Formatted Capacity

<table>
<thead>
<tr>
<th>Model</th>
<th>Formatted Capacity$^{(1)}$</th>
<th>Guaranteed Sectors</th>
<th>Bytes per Sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>500GB model</td>
<td>500 GB</td>
<td>976,773,168</td>
<td></td>
</tr>
<tr>
<td>320GB model</td>
<td>320 GB</td>
<td>625,142,448</td>
<td>512 (logical) / 4096 (physical)</td>
</tr>
<tr>
<td>250GB model</td>
<td>250 GB</td>
<td>488,397,168</td>
<td></td>
</tr>
</tbody>
</table>

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

2.1.1  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.

Refer to Configuring and Mounting the Drive on page 19 (words 60-61 and 100-103) for additional information about 48-bit addressing support of drives with capacities over 137 GB.
## 2.2 Physical organization

<table>
<thead>
<tr>
<th>Drive model</th>
<th>Read/write heads</th>
<th>Number of disks</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST500VT000 and ST500VT001</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>ST320VT000</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>ST250VT000</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

## 2.3 Recording and Interface Technology

<table>
<thead>
<tr>
<th>Interface</th>
<th>Serial ATA (SATA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recording method</td>
<td>Perpendicular</td>
</tr>
<tr>
<td>Recording density</td>
<td>1875 Kb/in</td>
</tr>
<tr>
<td>Track density</td>
<td>375 ktracks/in avg</td>
</tr>
<tr>
<td>Areal density</td>
<td>670 Gb/in² avg</td>
</tr>
<tr>
<td>Spindle speed</td>
<td>5400 RPM +/- 0.2%</td>
</tr>
<tr>
<td>Sustained data transfer rate</td>
<td>100 MB/s max</td>
</tr>
<tr>
<td>I/O data-transfer rate</td>
<td>600 MB/s max</td>
</tr>
</tbody>
</table>

## 2.4 Physical Characteristics

<table>
<thead>
<tr>
<th>All models</th>
<th>Height</th>
<th>6.8 +/- 0.2 mm (0.268 +/- 0.008 in)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Width</td>
<td>69.85 +/- 0.25 mm (2.750 +/- 0.010 in)</td>
</tr>
<tr>
<td></td>
<td>Length</td>
<td>100.35 +/- 0.25 mm (3.951 +/- 0.010 in)</td>
</tr>
<tr>
<td></td>
<td>Typical weight</td>
<td>&lt;95 g (0.209 lb)</td>
</tr>
<tr>
<td>ST500VT000, ST320VT000 and ST250VT000</td>
<td>Cache buffer</td>
<td>16 MB (16,192 KB)</td>
</tr>
<tr>
<td>ST500VT001</td>
<td>Cache buffer</td>
<td>32MB (32,384 KB)</td>
</tr>
</tbody>
</table>

## 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.

<table>
<thead>
<tr>
<th>Table 2  Typical seek times</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical seek times (ms)</td>
</tr>
<tr>
<td>Track-to-track</td>
</tr>
<tr>
<td>Average</td>
</tr>
<tr>
<td>Average latency</td>
</tr>
</tbody>
</table>

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

Table 3  Start/stop times

<table>
<thead>
<tr>
<th>Typical seek times (ms)</th>
<th>Typical</th>
<th>Max @ 25°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power-on to ready</td>
<td>3.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Standby to ready</td>
<td>2.5</td>
<td>3.0</td>
</tr>
</tbody>
</table>

2.7  Power Specifications

The drive receives DC power (+5V) through a native SATA power connector (refer to Figure 2).

2.7.1  Power consumption

Power requirements for the drives are listed in the table in Table 4. Typical power measurements are based on an average of drives tested, under nominal conditions, at 25°C ambient temperature. These power measurements are done with Interface Power Management modes like HIPM and DIPM enabled.

- **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 disk surface and does not execute a read or write operation. Servo electronics are active. Seek mode power is measured based on three random seek operations every 100 ms. This mode is not typical.

- **Read/write power and current**
  Read/write power is measured with the heads on track, based on three 63 sector read or write operations every 100 ms.

- **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 4  DC Power Requirements

<table>
<thead>
<tr>
<th>Power Dissipation</th>
<th>+5V input average (25°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spinup (max)</td>
<td>1.00A</td>
</tr>
<tr>
<td>Seek average</td>
<td>1.40W</td>
</tr>
<tr>
<td>Write average</td>
<td>1.70W</td>
</tr>
<tr>
<td>Read average</td>
<td>1.30W</td>
</tr>
<tr>
<td>Idle, performance (1)</td>
<td>1.20W</td>
</tr>
<tr>
<td>Idle, active</td>
<td>0.70W</td>
</tr>
<tr>
<td>Idle, low power mode</td>
<td>0.45W</td>
</tr>
<tr>
<td>Standby(2)</td>
<td>0.18W</td>
</tr>
<tr>
<td>Sleep</td>
<td>0.18W</td>
</tr>
</tbody>
</table>

1. 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. Standby power is measured at steady state (after 200ms from transition)
2.7.1.1 Typical current profiles

The typical 5V startup and operation current profile is shown in Figure 1.

**Figure 1** Typical 5V Startup and Operation Current Profile

2.7.2 Conducted noise

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

- 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 20 MHz.

**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):

- $+5V \pm 5\%$
2.7.4  Power management modes

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

<table>
<thead>
<tr>
<th>Power modes</th>
<th>Heads</th>
<th>Spindle</th>
<th>Buffer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active (operating)</td>
<td>Tracking</td>
<td>Rotating</td>
<td>Full power</td>
</tr>
<tr>
<td>Idle, performance</td>
<td>Tracking</td>
<td>Rotating</td>
<td>Self refresh—low power</td>
</tr>
<tr>
<td>Idle, active</td>
<td>Floating</td>
<td>Rotating</td>
<td>Self refresh—low power</td>
</tr>
<tr>
<td>Idle, low power</td>
<td>Parked</td>
<td>Rotating</td>
<td>Self refresh—low power</td>
</tr>
<tr>
<td>Standby</td>
<td>Parked</td>
<td>Stopped</td>
<td>Self refresh—low power</td>
</tr>
<tr>
<td>Sleep</td>
<td>Parked</td>
<td>Stopped</td>
<td>Self refresh—low power</td>
</tr>
</tbody>
</table>

- **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.
2.8 Environmental Specifications

This section provides the temperature, humidity, shock, and vibration specifications for Momentus drives.

Ambient temperature is defined as the temperature of the environment immediately surrounding the drive.

Above 1000 feet (305 meters), the maximum temperature is derated linearly by 1°C every 1000 feet.

The maximum allowable drive case temperature is 65°C (149°F)

**Table 5: Environmental specifications**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Operating</th>
<th>Non-Operating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient temperature</td>
<td>0° to 60°C (32° to 140°F)</td>
<td>-40° to 70°C (-40° to 158°F)</td>
</tr>
<tr>
<td>Temperature gradient</td>
<td>20°C per hour (68°F per hour) max, without condensation</td>
<td>35°C per hour (95°F per hour) max, without condensation</td>
</tr>
<tr>
<td>Humidity</td>
<td>5% to 95% non-condensing (30% per hour)</td>
<td>5% to 95% non-condensing (30% per hour)</td>
</tr>
<tr>
<td>Wet bulb</td>
<td>37.7°C (99.8°F) max</td>
<td>40°C (104°F) max</td>
</tr>
<tr>
<td>Altitude</td>
<td>-304.8m to 3048m (-1000ft to 10,000ft)</td>
<td>-304.8m to 12,192m (-1000ft to 40,000ft)</td>
</tr>
</tbody>
</table>

**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 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.

2.8.1.1 Operating shock

These drives comply with the performance levels specified in this document when subjected to a maximum operating shock of 400 Gs based on half-sine shock pulses of 2ms. Shocks should not be repeated more than one time per axis

2.8.1.2 Nonoperating shock

The nonoperating shock level that the drive can experience without incurring physical damage or degradation in performance when subsequently put into operation is 800 Gs based on a nonrepetitive half-sine shock pulse of 2 ms duration.

The nonoperating shock level that the drive can experience without incurring physical damage or degradation in performance when subsequently put into operation is 1000 Gs based on a nonrepetitive half-sine shock pulse of 1 ms duration.

2.8.2 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.

2.8.2.1 Operating vibration

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

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>Operating vibration</th>
</tr>
</thead>
<tbody>
<tr>
<td>5–200 Hz</td>
<td>2.0 Gs (0 to peak). Max displacement may apply below 10 Hz.</td>
</tr>
<tr>
<td>201–500 Hz</td>
<td>1.0 Gs (0 to peak).</td>
</tr>
</tbody>
</table>

2.8.2.2 Nonoperating vibration

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

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>Nonoperating vibration</th>
</tr>
</thead>
<tbody>
<tr>
<td>5–500 Hz</td>
<td>5.0 Gs (0 to peak). Max displacement may apply below 22 Hz.</td>
</tr>
</tbody>
</table>
2.9 Acoustics

Drive emission of sound is measured consistent with the ECMA-74 and its referenced standards. Testing is conducted at room temperature (approximately 25°C). Emission levels are reported as the total A-weighted sound power levels for steady state, idle, and active seeks modes of operation.

Table 6 Drive A-weighted Sound Power Levels (SWL, BA)

<table>
<thead>
<tr>
<th>Idle(1)</th>
<th>Performance Seek</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0 bels (typ)</td>
<td>2.2 bels (typ)</td>
</tr>
<tr>
<td>2.2 bels (max)</td>
<td>2.4 bels (max)</td>
</tr>
</tbody>
</table>

1. 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.

2.9.1 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 the lower limit for the threshold curve* 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.

*Defined as the median curve given by ISO 389-7 (Tf curve) minus 10dB at all frequencies.

2.10 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) environment as defined in Table 7.

Table 7 Radio Frequency Environments

<table>
<thead>
<tr>
<th>Test</th>
<th>Description</th>
<th>Performance Level</th>
<th>Reference Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrostatic discharge</td>
<td>Contact, HCP, VCP: ± 4 kV; Air: ± 8 kV</td>
<td>B</td>
<td>EN 61000-4-2: 95</td>
</tr>
<tr>
<td>Radiated RF immunity</td>
<td>80 to 1GHz, 3 V/m, 80% AM with 1 kHz sine</td>
<td>A</td>
<td>EN 61000-4-3: 96</td>
</tr>
<tr>
<td></td>
<td>900 MHz, 3 V/m, 50% pulse modulation @ 200 Hz</td>
<td></td>
<td>ENV 50204: 95</td>
</tr>
<tr>
<td>Electrical fast transient</td>
<td>± 1 kV on AC mains, ± 0.5 kV on external I/O</td>
<td>B</td>
<td>EN 61000-4-4: 95</td>
</tr>
<tr>
<td>Surge immunity</td>
<td>± 1 kV differential, ± 2 kV common, AC mains</td>
<td>B</td>
<td>EN 61000-4-5: 95</td>
</tr>
<tr>
<td>Conducted RF immunity</td>
<td>150 kHz to 80 MHz, 3 Vrms, 80% AM with 1 kHz sine</td>
<td>A</td>
<td>EN 61000-4-6: 97</td>
</tr>
<tr>
<td>Power Frequency H-field immunity</td>
<td>1 A/m, 50Hz/60Hz, 3 axes</td>
<td>A</td>
<td>EN 61000-4-8: 97</td>
</tr>
<tr>
<td>Voltage dips, interrupts</td>
<td>30% Reduction for 25 cycles</td>
<td>C</td>
<td>EN 61000-4-11: 94</td>
</tr>
<tr>
<td></td>
<td>&gt;95% Reduction for 250 cycles</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;95%, 0.5 cycles</td>
<td>B</td>
<td></td>
</tr>
</tbody>
</table>

2.11 Reliability

2.11.1 Annualized Failure Rate (AFR)

The product will achieve an Annualized Failure Rate (AFR) of 0.55% when operated in an environment of ambient air temperatures of 25°C. Operation at temperatures outside the specifications in Section 2.8, Environmental Specifications may increase the product AFR. AFR is a population statistics that is not relevant to individual units.

AFR specifications are based on the following assumptions for consumer electronics 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 2.8, Environmental Specifications may reduce the product reliability.
- Normal I/O duty cycle for consumer electronics environments. Operation at excessive I/O duty cycle may degrade product reliability.
Drive Specifications

The consumer electronics environment of power-on-hours, temperature, and I/O duty cycle affect the product AFR. The AFR will be degraded if used in an enterprise application.

<table>
<thead>
<tr>
<th>Nonrecoverable read errors</th>
<th>1 per $10^{14}$ bits read, max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load/Unload (U/UL)</td>
<td>600,000 software-controlled power on/off cycles</td>
</tr>
<tr>
<td></td>
<td>20,000 hard power on/off cycles</td>
</tr>
<tr>
<td>25°C, 50% relative humidity</td>
<td>Average annualized workload rating: &lt;55 TB/year. The specifications for the product assume the I/O workload does not exceed the average annualized workload rate limit of 55 TB/year. Workloads exceeding the annualized rate may degrade and impact reliability as experienced by the particular application. The average annualized workload rate limit is in units of TB per calendar year.</td>
</tr>
<tr>
<td>Rated workload</td>
<td>To determine the warranty for a specific drive, use a web browser to access the following web page: <a href="http://www.seagate.com/support/warranty-and-replacements/">http://www.seagate.com/support/warranty-and-replacements/</a> From this page, click on the “Is my Drive under Warranty” link. The following are required to be provided: the drive serial number, model number (or part number) and country of purchase. The system will display the warranty information for the drive.</td>
</tr>
<tr>
<td>Warranty</td>
<td></td>
</tr>
</tbody>
</table>

### 2.11.2 Data loss under power interruption with write cache enabled

Drive preserves its data during all operations except in cases where power to the drive is interrupted during write operations. This could result in either an uncorrected data error being reported, or the entire sector/track becoming unreadable. This can be permanently recovered by rewriting to the same location on the drive. Additionally any data present in the DRAM buffer will not be written to the disk media, additionally, the drive will not be able to return the original data.

In order to prevent this data loss, the host should issue a standby immediate or flush cache command before a controlled power off operation to 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

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

#### 2.12.2 European Union (EU) CE Marking Requirements

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

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

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

For compliance with the RoHS "Recast" Directive 2011/65/EU (RoHS 2), [See Section 2.13.1.1 on page 17](#).

#### 2.12.3 Australian RCM Compliance Mark

If these models have the RCM marking, they comply with the Australia/New Zealand Standard AS/NZ CISPR32 and meet the Electromagnetic Compatibility (EMC) Framework requirements of the Australian Communication and Media Authority (ACMA).
2.12.4 Canada ICES-003

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

2.12.5 South Korean KC Certification Mark

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

2.12.6 Morocco Commodity Mark

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

Seagate drives are tested for compliance and complies with the European Union (EU) Electromagnetic Compatibility (EMC) Directive 2014/30/EU and the Low Voltage Directive (LVD) 2014/35/EU. Accordingly, the drives also meet 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.

2.12.7 Taiwanese BSMI

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

For compliance with the Taiwan Bureau of Standards, Metrology and Inspection’s (BSMI) requirements, See Section 2.13.3 on page 18.

2.12.8 FCC verification

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

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

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

This equipment is designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television, which can be determined by turning the equipment on and off, users are encouraged to try one or more of the following corrective measures:
- Reorient the receiving antenna.
- Move the device to one side or the other of the radio or TV.
- Move the device farther away from the radio or TV.
- Plug the computer into a different outlet so that the receiver and computer are on different branch outlets.
If necessary, users should consult a dealer or an experienced radio/television technician for additional suggestions. Users may find helpful the following booklet prepared by the Federal Communications Commission: *How to Identify and Resolve Radio-Television Interference Problems*. This booklet is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Refer to publication number 004-000-00345-4.

### 2.13 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

##### 2.13.1.1 Restriction of Hazardous Substances in Electrical and Electronic Equipment

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

##### 2.13.1.2 Substances of Very High Concern (SVHC)

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

#### 2.13.2 China Requirements — China RoHS 2

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

### Table 8 China - Hazardous Substances

<table>
<thead>
<tr>
<th>部件名称</th>
<th>部件名称</th>
<th>有害物质 Hazardous Substances</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>铅 (Pb)</td>
<td>汞 (Hg)</td>
</tr>
<tr>
<td>硬盘驱动器 HDD</td>
<td>X</td>
<td>0</td>
</tr>
<tr>
<td>印刷电路板组装 PCBA</td>
<td>X</td>
<td>0</td>
</tr>
</tbody>
</table>

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.
2.13.3 Taiwan Requirements — Taiwan RoHS

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

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

Table 9 Taiwan - Restricted Substances

<table>
<thead>
<tr>
<th>Unit</th>
<th>Pb (Pb)</th>
<th>Hg (Hg)</th>
<th>Cd (Cd)</th>
<th>Cr+6</th>
<th>PBB</th>
<th>PBDE</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCBA</td>
<td>—</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Chassis or Cabinet</td>
<td>—</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Note 1. "O" indicates that the percentage content of the restricted substance does not exceed the percentage of reference value of presence.

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 Seagate products are especially sensitive to the presence of sulfide, chloride, and nitrate contaminants. Sulfur is found to be the most damaging. In addition, electronic components should never be exposed to condensing water on the surface of the printed circuit board assembly (PCBA) or exposed to an ambient relative humidity greater than 95%. Materials used in cabinet fabrication, such as vulcanized rubber, that can outgas corrosive compounds should be minimized or eliminated. The useful life of any electronic equipment may be extended by replacing materials near circuitry with sulfide-free alternatives.
3.0 Configuring and Mounting the Drive

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

3.1 Handling and Static-Discharge Precautions

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

<table>
<thead>
<tr>
<th>CAUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Keep the drive in the electrostatic discharge (ESD) bag until you are ready for installation to limit the drive's exposure to ESD.</td>
</tr>
<tr>
<td>• 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.</td>
</tr>
<tr>
<td>• Handle the drive by its edges or frame only.</td>
</tr>
<tr>
<td>• The drive is extremely fragile—handle it with care. Do not press down on the drive top cover.</td>
</tr>
<tr>
<td>• Always rest the drive on a padded, antistatic surface until you mount it in the computer.</td>
</tr>
<tr>
<td>• Do not touch the connector pins or the printed circuit board.</td>
</tr>
<tr>
<td>• 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.</td>
</tr>
</tbody>
</table>

3.2 Configuring the Drive

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

3.2.1 Serial ATA Cables and Connectors

The Serial ATA interface cable consists of four conductors in two differential pairs, plus three ground connections. The cable size may be 30 to 26 AWG with a maximum length of one meter (39.37 in). Refer to Table 10 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, you can connect the drive as shown in Figure 2.

**Figure 2 Attaching SATA Cabling**

Each cable is keyed to ensure correct orientation. Seagate Video 2.5 HDD drives support latching SATA connectors.
3.3 Drive Mounting

You can mount the drive in any orientation using four screws in the side-mounting holes or four screws in the bottom-mounting holes. Refer to Figure 3 for drive mounting dimensions. Follow these important mounting precautions when mounting the drive:

- Allow a minimum clearance of 0.030 in (0.76 mm) around the entire perimeter of the drive for cooling.
- Use only M3 x 0.5 mounting screws.
- Do not overtighten the mounting screws. Maximum torque: 4.0 in-lb (0.4519 N-m).
- Four (4) threads (0.080 in, 2.032 mm) minimum screw engagement recommended.
- Avoid excessive drive distortion when mounting. Refer to the following specifications for stiffness/deflection information:

<table>
<thead>
<tr>
<th>Top cover stiffness/deflection</th>
<th>10 mm probe: 1.02kgf or 5 mm probe: 0.92kgf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating: no performance degradation, emitted noise, mechanical damage, or hard errors</td>
<td>20 mm probe: 2.0kgf at any point of top cover 20 mm probe: 15.0kgf at top cover edges only</td>
</tr>
</tbody>
</table>

![Figure 3 Mounting Dimensions (for standard models)](image-url)
4.0 Serial ATA (SATA) Interface

These drives use the industry-standard Serial ATA interface that supports FIS data transfers. It supports ATA programmed input/output (PIO) modes 0–4; multiword DMA modes 0–2, and Ultra DMA modes 0–6. The drive also supports the use of the IORDY signal to provide reliable high-speed data transfers.

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

4.1 Hot-Plug Compatibility

Seagate Video 2.5 HDD drives incorporate connectors which enable you to hot plug these drives in accordance with the *Serial ATA: High Speed Serialized AT Attachment* specification revision 2.0. This specification can be downloaded from www.serialata.org. This device requires a COMRESET from the host after a hotplug event.

4.2 Serial ATA Device Plug Connector Pin Definitions

*Table 10* summarizes the signals on the Serial ATA interface and power connectors. Refer to the *Notes* below.

<table>
<thead>
<tr>
<th>Segment</th>
<th>Pin</th>
<th>Function</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signal</td>
<td>S1</td>
<td>Ground</td>
<td>2nd mate</td>
</tr>
<tr>
<td></td>
<td>S2</td>
<td>A+</td>
<td>Differential signal pair A from Phy</td>
</tr>
<tr>
<td></td>
<td>S3</td>
<td>A-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>S4</td>
<td>Ground</td>
<td>2nd mate</td>
</tr>
<tr>
<td></td>
<td>S5</td>
<td>B-</td>
<td>Differential signal pair B from Phy</td>
</tr>
<tr>
<td></td>
<td>S6</td>
<td>B+</td>
<td></td>
</tr>
<tr>
<td></td>
<td>S7</td>
<td>Ground</td>
<td>2nd mate</td>
</tr>
</tbody>
</table>

*Key and spacing separate signal and power segments*

<table>
<thead>
<tr>
<th>Segment</th>
<th>Pin</th>
<th>Function</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>P1</td>
<td>V33</td>
<td>3.3V power</td>
</tr>
<tr>
<td></td>
<td>P2</td>
<td>V33</td>
<td>3.3V power</td>
</tr>
<tr>
<td></td>
<td>P3</td>
<td>V33</td>
<td>3.3V power, pre-charge, 2nd mate</td>
</tr>
<tr>
<td></td>
<td>P4</td>
<td>Ground</td>
<td>1st mate</td>
</tr>
<tr>
<td></td>
<td>P5</td>
<td>Ground</td>
<td>2nd mate</td>
</tr>
<tr>
<td></td>
<td>P6</td>
<td>Ground</td>
<td>2nd mate</td>
</tr>
<tr>
<td></td>
<td>P7</td>
<td>V5</td>
<td>5V power, pre-charge, 2nd mate</td>
</tr>
<tr>
<td></td>
<td>P8</td>
<td>V5</td>
<td>5V power</td>
</tr>
<tr>
<td></td>
<td>P9</td>
<td>V5</td>
<td>5V power</td>
</tr>
<tr>
<td></td>
<td>P10</td>
<td>Ground</td>
<td>2nd mate</td>
</tr>
<tr>
<td></td>
<td>P11</td>
<td>Ground or LED signal</td>
<td>If grounded, drive does not use deferred spin</td>
</tr>
<tr>
<td></td>
<td>P12</td>
<td>Ground</td>
<td>1st mate</td>
</tr>
<tr>
<td></td>
<td>P13</td>
<td>V12</td>
<td>12V power, pre-charge, 2nd mate</td>
</tr>
<tr>
<td></td>
<td>P14</td>
<td>V12</td>
<td>12V power</td>
</tr>
<tr>
<td></td>
<td>P15</td>
<td>V12</td>
<td>12V power</td>
</tr>
</tbody>
</table>

*Notes*

1. All pins are in a single row, with a 1.27 mm (0.050 in) pitch.
2. The comments on the mating sequence apply to the case of backplane blindmate connector only. In this case, the mating sequences are:
   - the ground pins P4 and P12.
   - the pre-charge power pins and the other ground pins.
   - the signal pins and the rest of the power pins.
3. There are three power pins for each voltage. One pin from each voltage is used for pre-charge when installed in a blind-mate backplane configuration.
4. All used voltage pins (Vx) must be terminated.
## 4.3 Supported ATA Commands

Table 11 lists Serial ATA standard commands that the drive supports. For a detailed description of the ATA commands, refer to the *Serial ATA International Organization: Serial ATA* (Revision 2.6). Refer to [www.sata-io.org](http://www.sata-io.org).

Refer to **S.M.A.R.T. commands** on page 29 for details and subcommands used in the S.M.A.R.T. implementation.

### Table 11 Supported ATA commands

<table>
<thead>
<tr>
<th>ATA-standard commands names</th>
<th>Command code (in hex)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device Configuration Restore</td>
<td>B1h/C0h</td>
</tr>
<tr>
<td>Device Configuration Freeze Lock</td>
<td>B1h/C1h</td>
</tr>
<tr>
<td>Device Configuration Identify</td>
<td>B1h/C2h</td>
</tr>
<tr>
<td>Device Configuration Set</td>
<td>B1h/C3h</td>
</tr>
<tr>
<td>Download Microcode</td>
<td>92h</td>
</tr>
<tr>
<td>Execute Device Diagnostics</td>
<td>90h</td>
</tr>
<tr>
<td>Flush Cache</td>
<td>E7h</td>
</tr>
<tr>
<td>Flush Cache Extended</td>
<td>EAh</td>
</tr>
<tr>
<td>Identify Device</td>
<td>ECh</td>
</tr>
<tr>
<td>Initialize Device Parameters</td>
<td>91h</td>
</tr>
<tr>
<td>Read Buffer</td>
<td>E4h</td>
</tr>
<tr>
<td>Read DMA</td>
<td>C8h</td>
</tr>
<tr>
<td>Read DMA Extended</td>
<td>25h</td>
</tr>
<tr>
<td>Read DMA without Retries</td>
<td>C9h</td>
</tr>
<tr>
<td>Read Long with Retries</td>
<td>22h</td>
</tr>
<tr>
<td>Read Long without Retries</td>
<td>23h</td>
</tr>
<tr>
<td>Read Multiple</td>
<td>C4h</td>
</tr>
<tr>
<td>Read Multiple Extended</td>
<td>29h</td>
</tr>
<tr>
<td>Read Native Max Address</td>
<td>F8h</td>
</tr>
<tr>
<td>Read Native Max Address Extended</td>
<td>27h</td>
</tr>
<tr>
<td>Read Sectors</td>
<td>20h</td>
</tr>
<tr>
<td>Read Sectors Extended</td>
<td>24h</td>
</tr>
<tr>
<td>Read Sectors without Retries</td>
<td>21h</td>
</tr>
<tr>
<td>Read Verify Sectors</td>
<td>40h</td>
</tr>
<tr>
<td>Read Verify Sectors Extended</td>
<td>42h</td>
</tr>
<tr>
<td>Read Verify Sectors without Retries</td>
<td>41h</td>
</tr>
<tr>
<td>Seek</td>
<td>70h</td>
</tr>
<tr>
<td>Set Features</td>
<td>EFh</td>
</tr>
<tr>
<td>Set Max Address</td>
<td>F9h</td>
</tr>
<tr>
<td><strong>Note:</strong> Individual Set Max commands are identified by the value placed in the Set Max Features register as defined to the right.</td>
<td><strong>Address:</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Password:</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Lock:</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Unlock:</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Freeze Lock:</strong></td>
</tr>
<tr>
<td>Set Max Address Ext</td>
<td>37h</td>
</tr>
<tr>
<td>Set Multiple Mode</td>
<td>C6h</td>
</tr>
<tr>
<td>S.M.A.R.T. Disable Operations</td>
<td>B0h/D9h</td>
</tr>
<tr>
<td>S.M.A.R.T. Enable/Disable Autosave</td>
<td>B0h/D2h</td>
</tr>
</tbody>
</table>
### Supported ATA commands

<table>
<thead>
<tr>
<th>ATA-standard commands names</th>
<th>Command code (in hex)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S.M.A.R.T. Enable Operations</td>
<td>B0h/D8h</td>
</tr>
<tr>
<td>S.M.A.R.T. Enable/Disable Auto Offline</td>
<td>B0h/D8h</td>
</tr>
<tr>
<td>S.M.A.R.T. Enable One Attribute Modification</td>
<td>B0h/E0h</td>
</tr>
<tr>
<td>S.M.A.R.T. Execute Offline</td>
<td>B0h/D4h</td>
</tr>
<tr>
<td>S.M.A.R.T. Free Fall Protection Host Interface</td>
<td>FEh</td>
</tr>
<tr>
<td>S.M.A.R.T. Read Attribute Thresholds</td>
<td>B0h/D1h</td>
</tr>
<tr>
<td>S.M.A.R.T. Read Data</td>
<td>B0h/D0h</td>
</tr>
<tr>
<td>S.M.A.R.T. Read Log Sector</td>
<td>B0h/D5h</td>
</tr>
<tr>
<td>S.M.A.R.T. Return Status</td>
<td>B0h/DAh</td>
</tr>
<tr>
<td>S.M.A.R.T. Save Attribute Values</td>
<td>B0h/D3h</td>
</tr>
<tr>
<td>S.M.A.R.T. Write Attribute Thresholds</td>
<td>B0h/D7h</td>
</tr>
<tr>
<td>S.M.A.R.T. Write Attribute Values</td>
<td>B0h/E1h</td>
</tr>
<tr>
<td>S.M.A.R.T. Write Log Sector</td>
<td>B0h/D6h</td>
</tr>
<tr>
<td>Write Buffer</td>
<td>E8h</td>
</tr>
<tr>
<td>Write DMA</td>
<td>CAh</td>
</tr>
<tr>
<td>Write DMA Extended</td>
<td>35h</td>
</tr>
<tr>
<td>Write DMA without Retries</td>
<td>CBh</td>
</tr>
<tr>
<td>Write Long with Retries</td>
<td>32h</td>
</tr>
<tr>
<td>Write Long without Retries</td>
<td>33h</td>
</tr>
<tr>
<td>Write Multiple</td>
<td>CSb</td>
</tr>
<tr>
<td>Write Multiple Extended</td>
<td>39h</td>
</tr>
<tr>
<td>Write Sectors</td>
<td>30h, 31h</td>
</tr>
<tr>
<td>Write Sectors Extended</td>
<td>34h</td>
</tr>
</tbody>
</table>

### ATA-standard power-management commands

<table>
<thead>
<tr>
<th>ATA-standard power-management commands</th>
<th>Command code (in hex)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check Power Mode</td>
<td>E5h</td>
</tr>
<tr>
<td>Idle</td>
<td>E3h</td>
</tr>
<tr>
<td>Idle Immediate</td>
<td>E1h</td>
</tr>
<tr>
<td>Sleep</td>
<td>E6h</td>
</tr>
<tr>
<td>Standby</td>
<td>E2h</td>
</tr>
<tr>
<td>Standby Immediate</td>
<td>E0h</td>
</tr>
</tbody>
</table>

### ATA-standard security commands

<table>
<thead>
<tr>
<th>ATA-standard security commands</th>
<th>Command code (in hex)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Security Set Password</td>
<td>F1h</td>
</tr>
<tr>
<td>Security Unlock</td>
<td>F2h</td>
</tr>
<tr>
<td>Security Erase Prepare</td>
<td>F3h</td>
</tr>
<tr>
<td>Security Erase Unit</td>
<td>F4h</td>
</tr>
<tr>
<td>Security Freeze Lock</td>
<td>F5h</td>
</tr>
<tr>
<td>Security Disable Password</td>
<td>F6h</td>
</tr>
</tbody>
</table>
### 4.3.1 Identify Device command

The Identify Device command (command code EC) transfers information about the drive to the host following power up. The data is organized as a single 512-byte block of data, whose contents are shown in Table 12. 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. Refer to Drive Specifications on page 7 for default parameter settings.

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

**Table 12 Identify Device command**

<table>
<thead>
<tr>
<th>Word</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Configuration information:</td>
<td>0C5AH</td>
</tr>
<tr>
<td></td>
<td>• Bit 15: 0 = ATA; 1 = ATAPI</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Bit 7: removable media</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Bit 6: removable controller</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Bit 0: reserved</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Number of logical cylinders</td>
<td>16,383</td>
</tr>
<tr>
<td>2</td>
<td>Specific configuration</td>
<td>C837H</td>
</tr>
<tr>
<td>3</td>
<td>Number of logical heads</td>
<td>16</td>
</tr>
<tr>
<td>4</td>
<td>Retired</td>
<td>0000H</td>
</tr>
<tr>
<td>5</td>
<td>Retired</td>
<td>0000H</td>
</tr>
<tr>
<td>6</td>
<td>Number of logical sectors per logical track: 63</td>
<td>003Fh</td>
</tr>
<tr>
<td>7–9</td>
<td>Retired</td>
<td>0000H</td>
</tr>
<tr>
<td>10–19</td>
<td>Serial number: (20 ASCII characters, 0000H = none)</td>
<td>ASCII</td>
</tr>
<tr>
<td>20</td>
<td>Retired</td>
<td>0000H</td>
</tr>
<tr>
<td>21</td>
<td>Retired</td>
<td>8000H</td>
</tr>
<tr>
<td>22</td>
<td>Obsolete</td>
<td>0004H</td>
</tr>
<tr>
<td>23–26</td>
<td>Firmware revision:</td>
<td>x.xx</td>
</tr>
<tr>
<td></td>
<td>• (8 ASCII character string, padded with blanks to end of string)</td>
<td></td>
</tr>
<tr>
<td>27–46</td>
<td>Drive model number:</td>
<td>ST500VT000</td>
</tr>
<tr>
<td></td>
<td>• (40 ASCII characters, padded with blanks to end of string)</td>
<td>ST500VT001</td>
</tr>
<tr>
<td></td>
<td>• ST320VT000</td>
<td>ST320VT000</td>
</tr>
<tr>
<td></td>
<td>• ST250VT000</td>
<td>ST250VT000</td>
</tr>
<tr>
<td>47</td>
<td>(Bits 7–0) Maximum sectors per interrupt on Read multiple and Write multiple (16)</td>
<td>8010H</td>
</tr>
<tr>
<td>48</td>
<td>Trusted Computing Feature set options</td>
<td>0000H</td>
</tr>
<tr>
<td>49</td>
<td>Standard Standby timer, IORDY supported and may be disabled</td>
<td>2F00H</td>
</tr>
<tr>
<td>50</td>
<td>Capabilities</td>
<td>4000H</td>
</tr>
<tr>
<td>51</td>
<td>PIO data-transfer cycle timing mode</td>
<td>0200H</td>
</tr>
<tr>
<td>52</td>
<td>Retired</td>
<td>0200H</td>
</tr>
<tr>
<td>53</td>
<td>Words 54–58, 64–70 and 88 are valid</td>
<td>0007H</td>
</tr>
<tr>
<td>54</td>
<td>Number of current logical cylinders</td>
<td>xxxxxH</td>
</tr>
<tr>
<td>55</td>
<td>Number of current logical heads</td>
<td>xxxxxH</td>
</tr>
<tr>
<td>56</td>
<td>Number of current logical sectors per logical track</td>
<td>xxxxxH</td>
</tr>
<tr>
<td>57–58</td>
<td>Current capacity in sectors</td>
<td>xxxxxH</td>
</tr>
<tr>
<td>59</td>
<td>Number of sectors transferred during a Read Multiple or Write Multiple command</td>
<td>xxxxxH</td>
</tr>
</tbody>
</table>
Table 12  Identify Device command

<table>
<thead>
<tr>
<th>Word</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
</table>
| 60–61 | Total number of user-addressable sectors                                   | ST500VT000 = 0FFFFFFFh  
|       | This field contains a value that is one greater than the total number of   | ST320VT000 = 0FFFFFFFh  
|       | user-addressable sectors. The maximum value that shall be placed in this   | ST250VT000 = 0FFFFFFFh  
|       | field is 0FFFFFFFh. The 0FFFFFFFh value applies to all capacities over      |                                                                  |
|       | 137GB (see Section 2.1 for related information).                            |                                                                  |
| 62    | Retired                                                                     | 0000H                                                                 |
| 63    | Multiword DMA active and modes supported (see note following this table)   | xx07H                                                                 |
| 64    | Advanced PIO modes supported (modes 3 and 4 supported)                      | 0003H                                                                 |
| 65    | Minimum multiword DMA transfer cycle time per word (120 ns)                | 0078H                                                                 |
| 66    | Recommended multiword DMA transfer cycle time per word (120 ns)            | 0078H                                                                 |
| 67    | Minimum PIO cycle time without IORDY flow control (240 ns)                 | 0078H                                                                 |
| 68    | Minimum PIO cycle time with IORDY flow control (120 ns)                    | 0078H                                                                 |
| 69–74 | ATA-reserved                                                                | 0000H                                                                 |
| 75    | Queue depth                                                                 | 001Fh                                                                 |
| 76    | Serial ATA capabilities                                                     | 0D06H                                                                 |
| 77    | ATA-reserved                                                                | 0000H                                                                 |
| 78    | Serial ATA features supported                                               | 0048H                                                                 |
| 79    | Serial ATA features enabled                                                 | 0048H                                                                 |
| 80    | Major version number                                                        | 01F0H                                                                 |
| 81    | Minor version number                                                        | 0029H                                                                 |
| 82    | Command sets supported                                                      | 7468H                                                                 |
| 83    | Command sets supported                                                      | 7D69H                                                                 |
| 84    | Command sets support extension                                              | 61E3H                                                                 |
| 85    | Command sets enabled                                                        | 7469                                                                 |
| 86    | Command sets enabled                                                        | BC49H                                                                 |
| 87    | Command sets enable extension                                               | 61E3H                                                                 |
| 88    | Ultra DMA support and current mode (see note following this table)         | xx7FH                                                                 |
| 89    | Security erase time                                                         | xxxxFH                                                                |
| 90    | Enhanced security erase time                                                | xxxxFH                                                                |
| 91    | Current APM values                                                         | 8080H                                                                 |
| 92    | Master password revision code                                               | FFFEH                                                                 |
| 93    | Hardware reset value (see description following this table)                | xxxxFH                                                                |
| 94    | Auto acoustic management setting                                            | xxxxFH                                                                |
| 95    | Stream Min. Request Size                                                   | 0000H                                                                 |
| 96    | Streaming Transfer Time - DMA                                              | 0000H                                                                 |
| 97    | Streaming Access Latency - DMA and PIO                                     | 0000H                                                                 |
| 98–99 | Streaming Performance Granularity                                           | 0000H                                                                 |
### Table 12 Identify Device command

<table>
<thead>
<tr>
<th>Word</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>100–103</td>
<td>Total number of user-addressable LBA sectors available</td>
<td>ST500VT000 = 976,773,168 ST500VT001 = 976,773,168 ST320VT000 = 625,142,448 ST250VT000 = 488,397,168</td>
</tr>
<tr>
<td></td>
<td>(see Section 3.2 for related information)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>These words are required for drives that support the 48-bit addressing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>feature. Maximum value: 0000FFFFFFFFFFFFh.</td>
<td></td>
</tr>
<tr>
<td>104</td>
<td>Streaming Transfer Time - PIO</td>
<td>0000H</td>
</tr>
<tr>
<td>105</td>
<td>Reserved</td>
<td>0000H</td>
</tr>
<tr>
<td>106</td>
<td>Physical sector size / Logical sector size</td>
<td>6003H</td>
</tr>
<tr>
<td>107</td>
<td>Seagate reserved</td>
<td>0000H</td>
</tr>
<tr>
<td>108–111</td>
<td>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.</td>
<td>Each drive will have a unique value.</td>
</tr>
<tr>
<td>112–118</td>
<td>ATA-reserved</td>
<td>0000H</td>
</tr>
<tr>
<td>119</td>
<td>Free Fall Protection support (bit 5)</td>
<td>1 = Free Fall Protection supported</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 = Free Fall Protection not supported</td>
</tr>
<tr>
<td>120</td>
<td>Free Fall Protection enable/disable (bit 5)</td>
<td>1 = Free Fall Protection feature is enabled</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 = Free Fall Protection feature is disabled</td>
</tr>
<tr>
<td>121–127</td>
<td>ATA-reserved</td>
<td>0000H</td>
</tr>
<tr>
<td>128</td>
<td>Security status</td>
<td>0021H</td>
</tr>
<tr>
<td>129–159</td>
<td>Seagate-reserved</td>
<td>xxxxH</td>
</tr>
<tr>
<td>160–221</td>
<td>ATA-reserved</td>
<td>0000H</td>
</tr>
<tr>
<td>222</td>
<td>Transport major version number</td>
<td>101FH</td>
</tr>
<tr>
<td>223–254</td>
<td>ATA-reserved</td>
<td>0000H</td>
</tr>
<tr>
<td>255</td>
<td>Integrity word</td>
<td>xxA5H</td>
</tr>
</tbody>
</table>

**Note**: See the bit descriptions below for words 63, 88 and 93 of the Identify Drive data. (on next page)
### Table 13 Bit Descriptions

<table>
<thead>
<tr>
<th>Bit</th>
<th>Word 63</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Multiword DMA mode 0 is supported.</td>
</tr>
<tr>
<td>1</td>
<td>Multiword DMA mode 1 is supported.</td>
</tr>
<tr>
<td>2</td>
<td>Multiword DMA mode 2 is supported.</td>
</tr>
<tr>
<td>8</td>
<td>Multiword DMA mode 0 is currently active.</td>
</tr>
<tr>
<td>9</td>
<td>Multiword DMA mode 1 is currently active.</td>
</tr>
<tr>
<td>10</td>
<td>Multiword DMA mode 2 is currently active.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bit</th>
<th>Word 88</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Ultra DMA mode 0 is supported.</td>
</tr>
<tr>
<td>1</td>
<td>Ultra DMA mode 1 is supported.</td>
</tr>
<tr>
<td>2</td>
<td>Ultra DMA mode 2 is supported.</td>
</tr>
<tr>
<td>3</td>
<td>Ultra DMA mode 3 is supported.</td>
</tr>
<tr>
<td>4</td>
<td>Ultra DMA mode 4 is supported.</td>
</tr>
<tr>
<td>5</td>
<td>Ultra DMA mode 5 is supported.</td>
</tr>
<tr>
<td>6</td>
<td>Ultra DMA mode 6 is supported.</td>
</tr>
<tr>
<td>8</td>
<td>Ultra DMA mode 0 is currently active.</td>
</tr>
<tr>
<td>9</td>
<td>Ultra DMA mode 1 is currently active.</td>
</tr>
<tr>
<td>10</td>
<td>Ultra DMA mode 2 is currently active.</td>
</tr>
<tr>
<td>11</td>
<td>Ultra DMA mode 3 is currently active.</td>
</tr>
<tr>
<td>12</td>
<td>Ultra DMA mode 4 is currently active.</td>
</tr>
<tr>
<td>13</td>
<td>Ultra DMA mode 5 is currently active.</td>
</tr>
<tr>
<td>14</td>
<td>Ultra DMA mode 6 is currently active.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bit</th>
<th>Word 93</th>
</tr>
</thead>
</table>
| 13  | 1 = 80-conductor cable detected, CBLID above VIH  
     | 0 = 40-conductor cable detected, CBLID below VIL |
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 command values

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>02H</td>
<td>Enable write cache (default).</td>
</tr>
<tr>
<td>03H</td>
<td>Set transfer mode (based on value in Sector Count register). Sector Count register values: 00H Set PIO mode to default (PIO mode 2). 01H Set PIO mode to default and disable IORDY (PIO mode 2). 08H PIO mode 0 09H PIO mode 1 0AH PIO mode 2 0BH PIO mode 3 0CH PIO mode 4 (default) 20H Multiword DMA mode 0 21H Multiword DMA mode 1 22H Multiword DMA mode 2 40H Ultra DMA mode 0 41H Ultra DMA mode 1 42H Ultra DMA mode 2 43H Ultra DMA mode 3 44H Ultra DMA mode 4 45H Ultra DMA mode 5 46H Ultra DMA mode 6 55H Disable read look-ahead (read cache) feature. 82H Disable write cache AAH Enable read look-ahead (read cache) feature (default). C1H Disable the Free Fall Protection feature (41H above enables the Free Fall Protection feature) F1H Report full capacity available</td>
</tr>
</tbody>
</table>

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. You must have a recent BIOS or software package that supports S.M.A.R.T. to enable this feature. The table below shows the S.M.A.R.T. command codes that the drive uses.

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

<table>
<thead>
<tr>
<th>Code in features register</th>
<th>S.M.A.R.T. command</th>
</tr>
</thead>
<tbody>
<tr>
<td>D0H</td>
<td>S.M.A.R.T. Read Data</td>
</tr>
<tr>
<td>D2H</td>
<td>S.M.A.R.T. Enable/Disable Attribute Autosave</td>
</tr>
<tr>
<td>D3H</td>
<td>S.M.A.R.T. Save Attribute Values</td>
</tr>
<tr>
<td>D4H</td>
<td>S.M.A.R.T. Execute Off-line Immediate (runs DST)</td>
</tr>
<tr>
<td>D5H</td>
<td>S.M.A.R.T. Read Log Sector</td>
</tr>
<tr>
<td>D6H</td>
<td>S.M.A.R.T. Write Log Sector</td>
</tr>
<tr>
<td>D8H</td>
<td>S.M.A.R.T. Enable Operations</td>
</tr>
<tr>
<td>D9H</td>
<td>S.M.A.R.T. Disable Operations</td>
</tr>
<tr>
<td>DAH</td>
<td>S.M.A.R.T. Return Status</td>
</tr>
</tbody>
</table>

**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.