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Product Manual

**Pulsar™**

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**ST9200011FS**

**ST9100011FS**

**ST950011FS**

100596473  
Rev. A  
April 2010

## Revision history

Revision	Date	Sheets affected or comments
Rev. A	04/05/10	Initial release.

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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 may be used for formatting and other functions, and thus will not be available for data storage. Seagate reserves the right to change, without notice, product offerings or specifications.

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## 1.0 Introduction

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

ST9200011FS      ST9100011FS      ST950011FS

These drives provide the following key features:

- Single Layer Cell (SLC) NAND Flash storage.
- High instantaneous (burst) data-transfer rates (up to 300MB/s).
- Parallel flash access channels.
- State-of-the-art on-the-fly error-correction algorithms.
- Native Command Queueing with command ordering to increase performance in demanding applications.
- Highly integrated hardware functions.
- Power loss data protection.
- Data Set Management with Trim Support.
- Silent operation.
- 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 Serial ATA interface

The Serial ATA interface provides several advantages:

- 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.

The Serial ATA interface connects each drive in a point-to-point configuration with the Serial ATA host adapter. 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.

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

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

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

ST9200011FS      ST9100011FS      ST950011FS

Product data communicated in this manual is specific only to the model numbers listed in this manual. The data listed in this manual may not be predictive of future generation specifications or requirements. If you are designing a system which will use one of the models listed or future generation products and need further assistance, please contact your Customer Technical Support Engineer or our global support services group as shown in Section 5.0.

### 2.1 Specification summary tables

The specifications listed in the following table is for quick reference. For details on specification measurement or definition, see the appropriate section of this manual.

**Table 1: Drive specifications summary for 200, 100 and 50 GB models**

Drive specification	ST9200011FS	ST9100011FS	ST950011FS
Formatted GB (512 bytes/sector)*	200	100	50
Guaranteed logical block addresses (LBAs)	390,721,968	195,371,568	97,696,368
Emulated Bytes per LBA	512		
Sustained 128KB sequential read/write data transfer rate (MB/s max)	200/100	200/60	200/30
Peak 128KB sequential read/write data transfer rate (MB/s max)	240/220		
Sustained 4KB Random read/write command rate (IOPs)	25,000/5200		25,000/2600
Peak 4KB Random read/write command rate (IOPs)	30,000/25,000		
Flash Memory Type	NAND SLC		
I/O data-transfer rate (MB/s max)	300		
Height (mm max)	7.0 mm (0.276 in)		
Width (mm max)	70.1 mm (2.76 in)		
Length (mm max)	100.53 mm (3.958 in)		
Weight (max)	135 g (0.298 lb)		
Average latency	120 µs		
Power-on to ready (sec max)	10 sec		
Standby to ready (sec max)	2 sec		
Average LBA access time (µs typ)	~200 µs read; ~300 µs write		
Data Retention (typical minimum at 25C)	1 year		

Drive specification	ST9200011FS	ST9100011FS	ST950011FS
Sustainable 4KB Random IOPs for 5 year Endurance (65%/35% R/W 70% Duty Cycle)	10,500		
Startup current (typical) 5V (peak)	0.83 amps		
Voltage tolerance (including noise)	5V ± 5%		
Ambient temperature	5° to 60°C (operating) -40° to 70°C (nonoperating)		
Temperature gradient (°C per hour max)	20°C (operating) 20°C (nonoperating)		
Relative humidity	5% to 95% (operating) 5% to 95% (nonoperating)		
Relative humidity gradient	20% per hour max		
Wet bulb temperature (°C max)	37.7 (operating) 40.0 (nonoperating)		
Altitude, operating	-60.96 m to 3048 m (-200 ft. to 10,000+ ft.)		
Altitude, nonoperating (below mean sea level, max)	-60.96 m to 12,192 m (-200 ft to 40,000+ ft)		
Operational Shock (max at 0.5ms)	1500 Gs		
Non-Operational Shock (max at 0.5ms)	1500 Gs		
Vibration, random operating	20–2000 Hz: 16 Grms		
Vibration, random nonoperating	20–2000 Hz: 16 Grms		
Nonrecoverable read errors, max	1 LBA per 10 <sup>16</sup> bits read		
Annualized Failure Rate (AFR)	0.44%		
Warranty	To determine the warranty for a specific drive, use a web browser to access the following web page: <a href="http://support.seagate.com/customer/warranty_validation.jsp">support.seagate.com/customer/warranty_validation.jsp</a> You will be asked to provide the drive serial number, model number (or part number) and country of purchase. After submitting this information, the system will display the warranty information for your drive.		
Lifetime Power cycles	50,000		
Supports Hotplug operation per Serial ATA Revision 2.6 specification	Yes		

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

## 2.2 Formatted capacity

Model	Formatted capacity*	Guaranteed LBAs	Emulated LBA Size (Bytes)
ST9200011FS	200GB	390,721,968	512
ST9100011FS	100GB	195,371,568	
ST950011FS	50GB	97,696,368	

\*One GB equals one billion bytes when referring to 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 (LBAs) are consecutively numbered from 0 to  $n-1$ , where  $n$  is the number of guaranteed LBAs as defined above.

See Section 4.3.1, "Identify Device command" (words 60-61 and 100-103) for additional information about 48-bit addressing support of drives with capacities over 137GB.

## 2.3 Default logical geometry for ATA based systems

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

## 2.4 Performance, Recording and interface technology

### 2.4.1 Interface technology

	200GB	100GB	50GB
Interface	Serial ATA (SATA-II)		
Interface Speeds Supported	3Gb/s, 1.5Gb/s		
Maximum Burst Transfer Rate	300MB/s		
Hot Plug Support	Yes		
Native Command Queuing Support	Yes		
Trim Support	Yes		
Lifetime Endurance Throttling	Yes		

### 2.4.2 Recording technology

Flash Memory Type	NAND SLC
Emulated LBA Size (Bytes)	512
Native Programmable Page size (User Bytes)	4096
Default transfer alignment offset	0
Typical Data Retention with Power removed (at 25C)	1 year

### 2.4.3 Performance

	Notes	200GB	100GB	50GB
Maximum Burst Transfer Rate		300MB/s		
Peak sequential 128KB read/write data transfer rate (MB/s max)	[1]	240/220		
Sustained sequential 128KB read/write data transfer rate (MB/s)	[2]	200/100	200/60	200/30
Peak 4KB random read/write command rate (IOPs)	[3]	30,000/25,000		
Sustained 4KB random read/write command rate (IOPs)	[4]	25,000/5200		25,000/2600
Sustainable 4KB Random combined IOPS for 5 year Endurance (65%/35% R/W, 70% Duty Cycle)	[5]	10,500		

[1] Testing performed at Queue Depth = 32, Sequentially Preconditioned drive, using IOMeter 2008.6.28.

[2] Testing performed at Queue Depth = 32, Sequentially Preconditioned drive, using IOMeter 2006.7.27.

[3] Testing performed at Queue Depth = 32, Randomly Preconditioned drive, using IOMeter 2008.6.28.

[4] Testing performed at Queue Depth = 32, Randomly Preconditioned drive, using IOMeter 2006.7.27.

[5] Testing performed at Queue Depth = 32, Non-Preconditioned drive, using IOMeter 2006.7.27.

**Note.** IOMeter is available at <http://www.iometer.org/> or <http://sourceforge.net/projects/iometer/>. IOMeter is licensed under the Intel Open Source License and the GNU General Public License. Intel does not endorse any IOMeter results.

Peak performance is defined as the typical best case performance that the product will be able to achieve when the product is preconditioned as mentioned and host commands are aligned on 4KB boundaries.

Sustained performance is defined as the typical worst case performance that the product will be able to achieve when the product is preconditioned as mentioned and host commands are aligned on 4KB boundaries. Write values also take into account the worst case performance throttling that may occur to ensure the product meets specified reliability specifications.

Due to the nature of Flash memory technologies there are many factors that can result in values different than those stated in this specification. Some discrepancies can be caused by bandwidth limitations in the host adapter, operating system, or driver limitations. It is not the intent of this manual to cover all possible causes of performance discrepancies.

When evaluating performance of SSD devices, it is recommended to measure performance of the device in a method that resembles the targeted application using real world data and workloads. Test time should also be adequately large to ensure that sustainable metrics and measures are obtained.

### 2.5 Physical characteristics

Maximum height	7.0 mm (0.276 in)
Maximum width	70.1 mm (2.76 in)
Maximum length	100.53 mm (3.958 in)
Max weight	135 g (0.298 lb)

## 2.6 Access time

Access 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:

- Page-to-page access time is an average of all possible page-to-page accesses in both directions for a sequentially preconditioned drive.
- Average access time is a true statistical random average of at least 5000 measurements of accesses between programmable pages, less overhead, on a randomly preconditioned drive.

*Typical access times (µs)	Read	Write
Page-to-page	120	200
Average	200	300
Average latency:	120	

**Note.** These drives are designed to provide the highest possible performance under typical conditions. However, due to the nature of Flash memory technologies there are many factors that can result in values different than those stated in this specification.

## 2.7 Time to Ready

	ST9200011FS	ST9100011FS	ST950011FS
Power-on to Ready for non-Media related Commands (sec)	3 (max)		
Power-on to Ready for Media related commands (sec)	10 (max)		
Standby to Ready (sec)	2 (max)		
Ready to power removal (sec)	3 (max)		

Power-on to Ready for non-media related commands is defined as the time that it will take the drive to respond from the application power until it is ready to accept commands from the host that do not require access to the flash media. In some cases the drive may accept media access commands during this time, but the commands will not be completed or status returned to the host until the media can be accessed safely. Commands such as Check Power and Identify are examples of non-media related commands.

Power-on to Ready for media related commands is defined as the time that it will take the drive to respond from the application power until it is ready to accept commands from the host that require access to the flash media. Commands such as FPDMA Read Extended and FPDMA Write Extended are examples of media related commands. This value includes the time needed to charge the Power Loss Data Protection Circuit to a level that is adequate to protect customer data from unexpected power loss

## 2.8 Power specifications

The drive receives DC power (+5V) through a native SATA power connector. See Figure 2 on page 20.

### 2.8.1 Power consumption

Power requirements for the drives are listed in the table on page 9. Typical power measurements are based on an average of drives tested, under nominal conditions, using +5V input voltage at 35°C ambient temperature.

- **Startup power**

Startup power is measured from the time of power-on to the time that the drive reaches operating condition and can process media access commands.

- **Peak operating mode**

During peak operating mode, the drive is tested in various read and write access patterns to simulate the worst-case power consumption.

- **Idle mode power**

Idle mode power is measured with the drive powered up and ready for media access commands, with no media access commands having been received from the host.

- **Standby mode**

During Standby mode, the drive accepts commands, but not be able to immediately access the media because the drive electronics are in a partial power-down mode.

**Table 2: 200GB DC power requirements**

Parameter		200Gb (3.0GB)	
Regulation		+/-5%	
Voltage		+5 V	
		Current (A)	Power (W)
Average Idle Current	DC $\bar{x}$	0.15	0.75
Standby	DC $\bar{x}$	0.11	0.55
Average Sleep Current	DC $\bar{x}$	0.11	0.55
Maximum Start Current:			
DC (Peak DC)	3 $\sigma$	0.83	
AC (Peak AC)	3 $\sigma$	1.60	
Delayed Motor Start (DC max)	3 $\sigma$	0.11	0.55
Peak Operating Current (random read):			
Typical DC	DC $\bar{x}$	0.26	1.30
Maximum DC	3 $\sigma$	0.27	1.35
Maximum DC (peak)	3 $\sigma$	0.98	
Peak Operating Current (random write):			
Typical DC	DC $\bar{x}$	0.30	1.50
Maximum DC	3 $\sigma$	0.31	1.55
Maximum DC (peak)	3 $\sigma$	1.06	
Peak operating current (sequential read):			
Typical DC	DC $\bar{x}$	0.23	1.15
Maximum DC	3 $\sigma$	0.25	1.25
Maximum DC (peak)	3 $\sigma$	0.77	
Peak operating current (sequential write):			
Typical DC	DC $\bar{x}$	0.39	1.95
Maximum DC	3 $\sigma$	0.40	2.00
Maximum DC (peak)	3 $\sigma$	1.04	

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

**Table 3: 100GB DC power requirements**

Parameter		100Gb (3.0GB)	
Regulation		+/-5%	
Voltage		+5 V	
		Current (A)	Power (W)
Average Idle Current	DC $\bar{x}$	0.14	0.70
Standby	DC $\bar{x}$	0.11	0.55
Average Sleep Current	DC $\bar{x}$	0.10	0.50
Maximum Start Current:			
DC (Peak DC)	3 $\sigma$	0.80	
AC (Peak AC)	3 $\sigma$	1.48	
Delayed Motor Start (DC max)	3 $\sigma$	0.11	0.55
Peak Operating Current (random read):			
Typical DC	DC $\bar{x}$	0.16	0.80
Maximum DC	3 $\sigma$	0.17	0.85
Maximum DC (peak)	3 $\sigma$	0.67	
Peak Operating Current (random write):			
Typical DC	DC $\bar{x}$	0.26	1.30
Maximum DC	3 $\sigma$	0.27	1.35
Maximum DC (peak)	3 $\sigma$	0.97	
Peak operating current (sequential read):			
Typical DC	DC $\bar{x}$	0.23	1.15
Maximum DC	3 $\sigma$	0.24	1.20
Maximum DC (peak)	3 $\sigma$	0.77	
Peak operating current (sequential write):			
Typical DC	DC $\bar{x}$	0.38	1.90
Maximum DC	3 $\sigma$	0.40	2.00
Maximum DC (peak)	3 $\sigma$	1.04	

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



**Table 4: 50GB DC power requirements**

Parameter		50Gb (3.0GB)	
Regulation		+/-5%	
Voltage		+5 V	
		Current (A)	Power (W)
Average Idle Current	DC $\bar{x}$	0.13	0.65
Standby	DC $\bar{x}$	0.11	0.55
Average Sleep Current	DC $\bar{x}$	0.09	0.45
Maximum Start Current:			
DC (Peak DC)	3 $\sigma$	0.83	
AC (Peak AC)	3 $\sigma$	1.59	
Delayed Motor Start (DC max)	3 $\sigma$	0.11	0.55
Peak Operating Current (random read):			
Typical DC	DC $\bar{x}$	0.16	0.80
Maximum DC	3 $\sigma$	0.18	0.90
Maximum DC (peak)	3 $\sigma$	0.67	
Peak Operating Current (random write):			
Typical DC	DC $\bar{x}$	0.25	1.25
Maximum DC	3 $\sigma$	0.28	1.40
Maximum DC (peak)	3 $\sigma$	0.98	
Peak operating current (sequential read):			
Typical DC	DC $\bar{x}$	0.23	1.15
Maximum DC	3 $\sigma$	0.25	1.25
Maximum DC (peak)	3 $\sigma$	0.74	
Peak operating current (sequential write):			
Typical DC	DC $\bar{x}$	0.37	1.85
Maximum DC	3 $\sigma$	0.40	2.00
Maximum DC (peak)	3 $\sigma$	0.90	

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

### 2.8.1.1 Typical current profiles

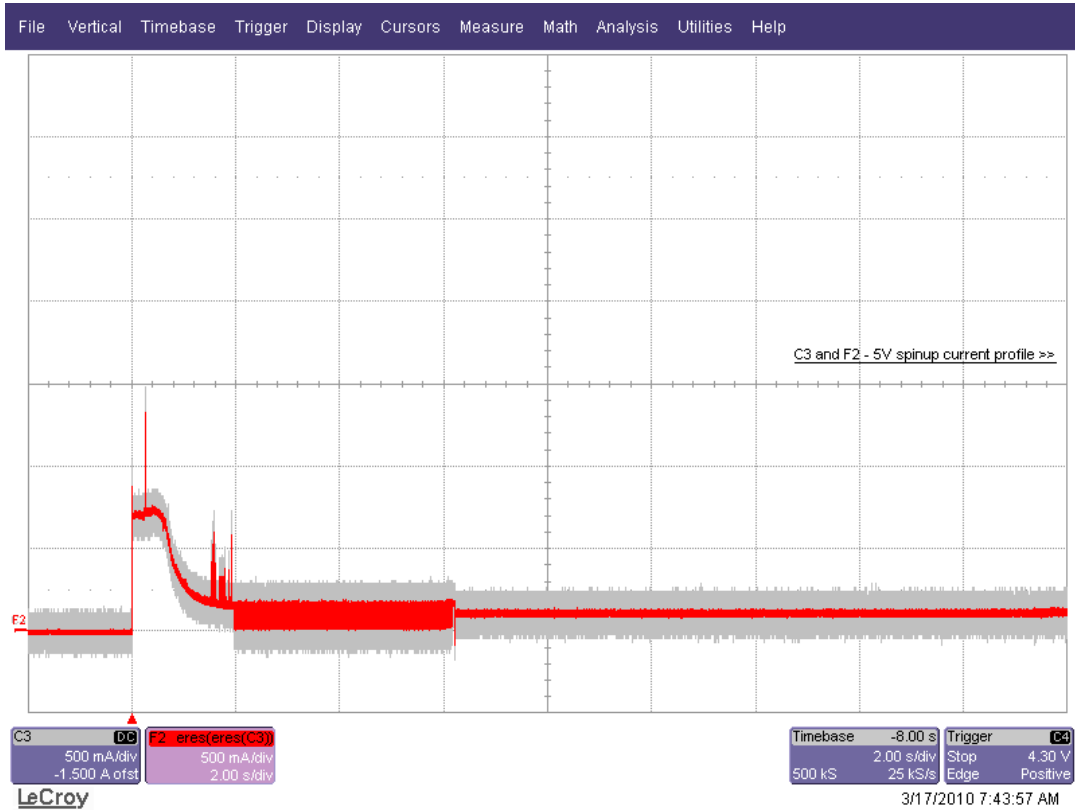


Figure 1. Typical 5V startup and operation current profile

### 2.8.2 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 250 mV peak-to-peak sine-wave injected noise at a frequency from 100Hz up to 20 MHz.

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

### 2.8.3 Voltage tolerance

Voltage tolerance (including noise):

5V  $\pm$ 5%

## 2.9 Environmental specifications

### 2.9.1 Ambient temperature

Ambient temperature is defined as the temperature of the environment immediately surrounding the drive. Actual drive case temperature should not exceed 60°C (140°F) within the operating ambient conditions.

Above 1000 feet (305 meters), the maximum temperature is derated linearly to 112°F (44°C) at 10,000 feet (3,048 meters).

Operating:	5° to 60°C (41° to 140°F)
Nonoperating:	-40° to 70°C (-40° to 158°F)

### 2.9.2 Temperature gradient

Operating:	20°C per hour (68°F per hour max), without condensation
Nonoperating:	20°C per hour (86°F per hour max)

### 2.9.3 Humidity

#### 2.9.3.1 Relative humidity

Operating:	5% to 95% noncondensing (20% per hour max)
Nonoperating:	5% to 95% noncondensing (20% per hour max)

#### 2.9.3.2 Wet bulb temperature

Operating:	37.7°C (99.9°F max)
Nonoperating:	40.0°C (104.0°F max)

### 2.9.4 Altitude

** Operating:	-60.96 m to 3,048 m (-200 ft. to 10,000+ ft.)
** Nonoperating:	-60.96 m to 12,192 m (-200 ft. to 40,000+ ft.)

\*\* Applies to atmospheric pressure only.

### 2.9.5 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.

#### 2.9.5.1 Operating shock

These drives comply with the performance levels specified in this document when subjected to a maximum operating shock of 1500 Gs based on half-sine shock pulses of 0.5ms. This specification does not cover connection issues that may result from testing at this level.

#### 2.9.5.2 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 1500 Gs based on a half-sine shock pulse of 0.5ms duration.

## 2.9.6 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.

### 2.9.6.1 Operating vibration

The maximum random vibration levels that the drive may experience while meeting the performance standards specified in this document are specified below. This specification does not cover connection issues that may result from testing at this level.

20–2000 Hz	16 Grms
------------	---------

### 2.9.6.2 Nonoperating vibration

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

20–2000 Hz	16 Grms
------------	---------

## 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) environments defined in the following table:

**Table 5: Radio frequency environments**

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

## 2.11 Reliability

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

The product shall achieve an Annualized Failure Rate - AFR - of 0.44%. AFR and MTBF are population statistics that are not relevant to individual units.

AFR and MTBF specifications are based on the following assumptions:

- 8760 power-on-hours per year.
- 250 average power cycles per year.
- Operations at nominal voltages.
- Systems will provide adequate cooling to ensure the case temperatures do not exceed specification.

### 2.11.2 Reliability specifications

Unrecoverable read error rate during typical product lifetime	1 LBA per $10^{16}$ bits read, max
Unrecoverable read error rate as product approaches end of useful life	1 LBA per $10^{15}$ bits read, max [1]
Annualized Failure Rate (AFR)	0.44%
Power cycles	50,000 cycles (at nominal voltage and temperature, with 60 cycles per hour and a 50% duty cycle)
Warranty	To determine the warranty for a specific drive, use a web browser to access the following web page: <a href="http://support.seagate.com/customer/warranty_validation.jsp">support.seagate.com/customer/warranty_validation.jsp</a> You will be asked to provide the drive serial number, model number (or part number) and country of purchase. After submitting this information, the system will display the warranty information for your drive.
Preventive maintenance	None required.
Typical Data Retention with Power removed (at 25C)	1 year [2]
Endurance	5 years [3]

[1] As NAND Flash devices age with use, the capability of the media to retain a programmed value begins to deteriorate. This deterioration is affected by the number of times a particular memory cell is programmed and subsequently erased. As deterioration continues, the memory will reach a point at which the amount of deterioration will exceed the error recovery capabilities of the drive. Therefore an unrecoverable error rate is provided to indicate the expected error rate as the device nears the end of its useful life due to the deterioration.

[2] As NAND Flash devices age with use, the capability of the media to retain a programmed value begins to deteriorate. This deterioration is affected by the number of times a particular memory cell is programmed and subsequently erased. When a device is new, it has a powered off data retention capability of up to ten years. With use the retention capability of the device is reduced. Temperature also has an effect on how long a Flash component can retain its programmed value with power removed. At high temperature the retention capabilities of the device are reduced. Data retention is not an issue with power applied to the SSD. The SSD drive contains firmware and hardware features that can monitor and refresh memory cells when power is applied.

[3] Endurance is the expected life of a product when subjected to a specified workload at a specified operating and storage temperature. For the specific workload and performance to achieve this level of endurance, please reference section 2.4.3.

## **2.12 Agency certification**

### **2.12.1 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.

### **2.12.2 Electromagnetic compatibility**

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.

Seagate uses an independent laboratory to confirm compliance with the EC directives specified in the previous paragraph. 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.

- Certificate number: STX-ST9200011FS (B)
- Trade name or applicant: Seagate Technology LLC
- Manufacturing date: February 23, 2010 (Date of Certification)
- Manufacturer/nationality: USA, Singapore and China

#### **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).

### **2.12.3 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 Technology LLC has tested this device in enclosures as described above to ensure that the total assembly (enclosure, 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, you 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, you should consult your dealer or an experienced radio/television technician for additional suggestions. You 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 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.

### 2.13.2 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
CHASSIS	X	O	O	O	O	O

"O" indicates the hazardous and toxic substance content of the part (at the homogenous 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 homogenous 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标准所定义的阈值。

## **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

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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.
- Handle the drive by its edges or frame *only*.
- The drive is fragile—handle it with care. Do not press down on the drive top cover.
- Always rest the drive on a padded, antistatic surface until you mount it in the computer.
- Do not touch the connector pins or the printed circuit board.
- Do not remove the factory-installed labels from the drive or cover them with additional labels. Removal voids the warranty. Some factory-installed labels contain information needed to service the drive.

### 3.2 Configuring the drive

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

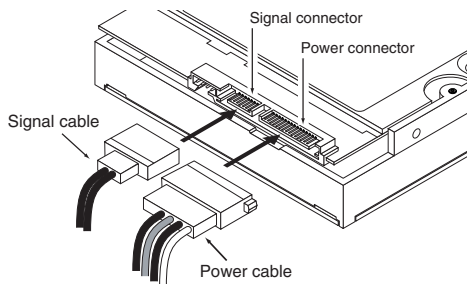
Serial ATA drives are designed for easy installation. If you connect the drive and receive a “drive not detected” error, your SATA equipped motherboard or host adapter may use a chipset that does not support SATA 3.0Gb speed autonegotiation. You will need to install a SATA host adapter that supports autonegotiation.

### 3.3 Serial ATA cables and connectors

The Serial ATA interface cable consists of four conductors in two differential pairs, plus three ground connections. The cable size may be 30 to 26 AWG with a maximum length of one meter (39.37 inches). See Table 6 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 illustrated in Figure 2.



**Figure 2. Attaching SATA cabling**

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

### 3.4 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. See Figure 3 for drive mounting dimensions. Follow these important mounting precautions when mounting the drive:

- Allow a minimum clearance of 0.030 in (0.76 mm) around the entire perimeter of the drive for cooling as a guideline. Please refer to Section 3.5 for final cooling requirements.
- Use only M3 x 0.5 metric mounting screws.
- Four (4) threads (0.080 in) minimum screw engagement recommended. Also ensure maximum screw length does not bottom out in mounting holes.
- Do not overtighten the mounting screws (maximum torque: 4.5 in-lb,  $\pm 0.45$  in-lb).

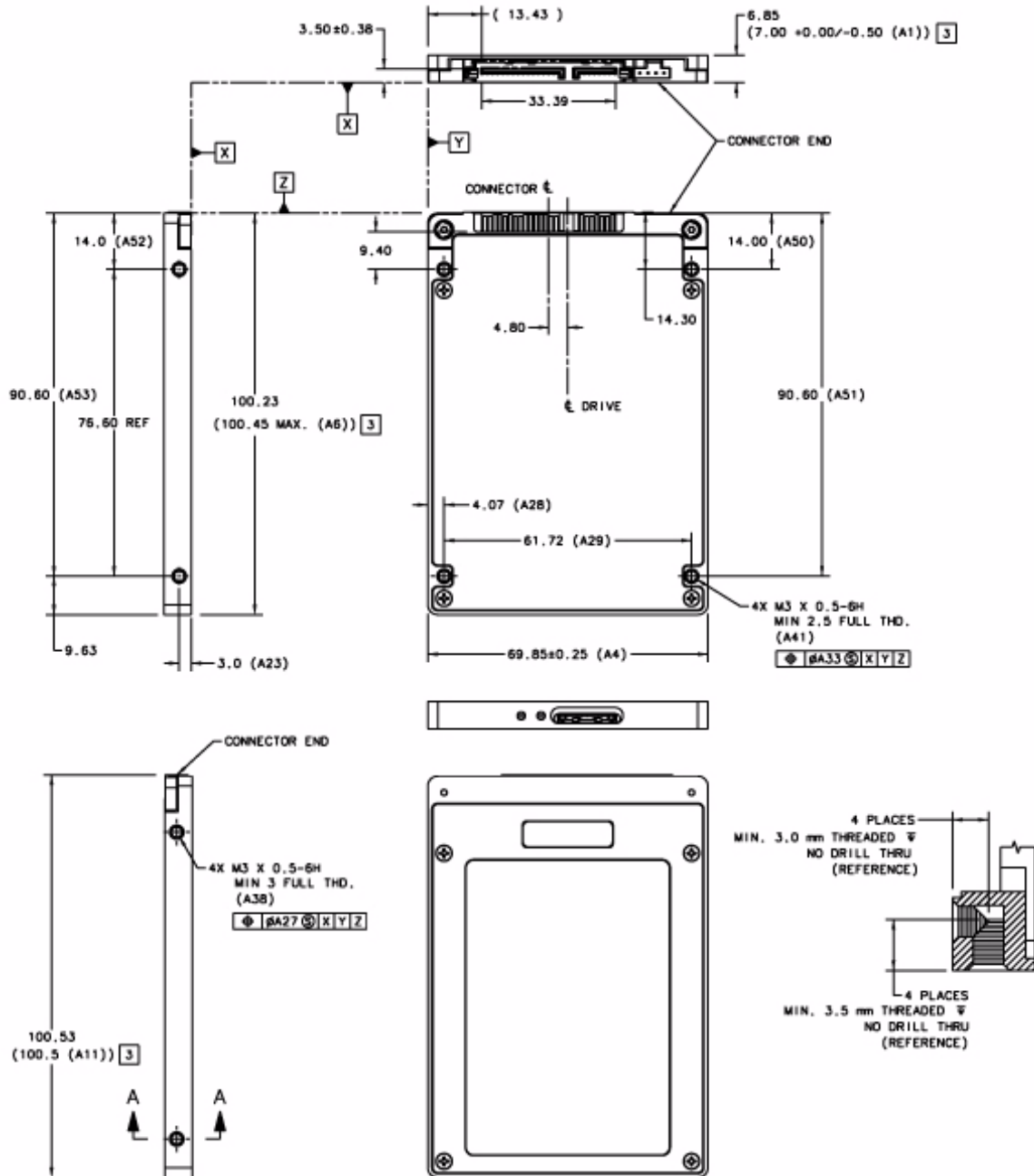


Figure 3. Mounting dimensions—top, side and end view

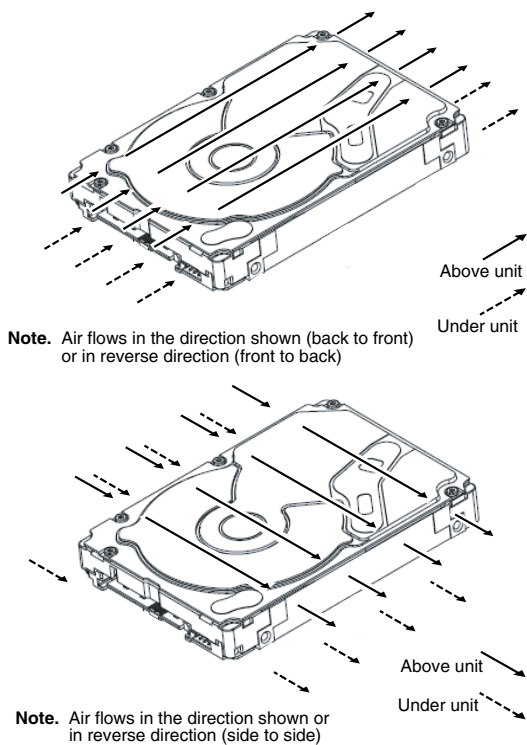
### 3.5 Cooling

Cabinet cooling must be designed by the customer so that the ambient temperature immediately surrounding the drive will not exceed temperature conditions specified in Section 2.9.1, "Ambient temperature."

The rack, cabinet, or drawer environment for the drive must provide heat removal. You should confirm that adequate heat removal is provided using the temperature measurement guidelines described in Section 2.9.1.

Forced air flow may be required to keep temperatures at or below the temperatures specified in Section 2.9.1 in which case the drive should be oriented, or air flow directed, so that the least amount of air flow resistance is created while providing air flow to the drive. Also, the shortest possible path between the air inlet and exit should be chosen to minimize the travel length of air heated by the drive and other heat sources within the rack, cabinet, or drawer environment.

If forced air is determined to be necessary, possible air-flow patterns are shown in Figure 4. The air-flow patterns are created by one or more fans, either forcing or drawing air as shown in the illustrations. Conduction, convection, or other forced air-flow patterns are acceptable as long as the temperature measurement guidelines of Section 2.9.1 are met.



**Figure 4. Air flow**

## **4.0 Serial ATA (SATA) interface**

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

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

### **4.1 Hot-Plug compatibility**

Pulsar drives incorporate connectors which enable you to hot plug these drives in accordance with the Serial ATA II: Extension to Serial ATA 1.0a specification. This specification can be downloaded from [www.serial-ata.org](http://www.serial-ata.org).

## 4.2 Serial ATA device plug connector pin definitions

Table 6 summarizes the signals on the Serial ATA interface and power connectors.

**Table 6: Serial ATA connector pin definitions**

Segment	Pin	Function	Definition
<b>Signal</b>	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

<b>Power</b>	P1	V <sub>33</sub>	not used
	P2	V <sub>33</sub>	not used
	P3	V <sub>33</sub>	not used
	P4	Ground	1st mate
	P5	Ground	2nd mate
	P6	Ground	2nd mate
	P7	V <sub>5</sub>	5V power, pre-charge, 2nd mate
	P8	V <sub>5</sub>	5V power
	P9	V <sub>5</sub>	5V power
	P10	Ground	2nd mate
	P11	Ground or LED signal	If grounded, drive ignores this signal
	P12	Ground	1st mate.
	P13	V <sub>12</sub>	not used
	P14	V <sub>12</sub>	not used
	P15	V <sub>12</sub>	not used

### Notes:

- All pins are in a single row, with a 1.27 mm (0.050") pitch.
- The comments on the mating sequence apply to the case of backplane blindmate connector only. In this case, the mating sequences are:
  - the ground pins P4 and P12.
  - the pre-charge power pins and the other ground pins.
  - the signal pins and the rest of the power pins.
- There are three power pins for each voltage. One pin from each voltage is used for pre-charge when installed in a blind-mate backplane configuration.
- All used voltage pins (V<sub>x</sub>) must be terminated.

### 4.3 Supported ATA commands

The following table lists Serial ATA standard commands that the drive supports. For a detailed description of the ATA commands, refer to the Serial ATA: High Speed Serialized AT Attachment specification. See “S.M.A.R.T. commands” on page 35 for details and subcommands used in the S.M.A.R.T. implementation.

**Table 7: Supported ATA commands**

Command name	Command code (in hex)
Check Power Mode	E5 <sub>H</sub>
Data Set Management with Trim Support	06 <sub>H</sub>
Download Microcode	92 <sub>H</sub>
Execute Device Diagnostics	90 <sub>H</sub>
Flush Cache	E7 <sub>H</sub>
Flush Cache Extended	EA <sub>H</sub>
Identify Device	EC <sub>H</sub>
Idle	E3 <sub>H</sub>
Idle Immediate	E1 <sub>H</sub>
Initialize Device Parameters	91 <sub>H</sub>
Read Buffer	E4 <sub>H</sub>
Read DMA	C8 <sub>H</sub>
Read DMA Extended	25 <sub>H</sub>
Read FPDMA Queued	60 <sub>H</sub>
Read Log Ext	2F <sub>H</sub>
Read Multiple	C4 <sub>H</sub>
Read Multiple Extended	29 <sub>H</sub>
Read Native Max Address	F8 <sub>H</sub>
Read Native Max Address Extended	27 <sub>H</sub>
Read Sectors	20 <sub>H</sub>
Read Sectors Extended	24 <sub>H</sub>
Read Verify Sectors	40 <sub>H</sub>
Read Verify Sectors Extended	42 <sub>H</sub>
Security Disable Password	F6 <sub>H</sub>
Security Erase Prepare	F3 <sub>H</sub>
Security Erase Unit	F4 <sub>H</sub>
Security Freeze	F5 <sub>H</sub>
Security Set Password	F1 <sub>H</sub>
Security Unlock	F2 <sub>H</sub>
Set Features	EF <sub>H</sub>
Set Max Address	F9 <sub>H</sub>

Command name	Command code (in hex)
Note: Individual Set Max Address commands are identified by the value placed in the Set Max Features register as defined to the right.	Address: 00 <sub>H</sub> Password: 01 <sub>H</sub> Lock: 02 <sub>H</sub> Unlock: 03 <sub>H</sub> Freeze Lock: 04 <sub>H</sub>
Set Max Address Extended	37 <sub>H</sub>
Set Multiple Mode	C6 <sub>H</sub>
Sleep	E6 <sub>H</sub>
S.M.A.R.T. Disable Operations	B0 <sub>H</sub> / D9 <sub>H</sub>
S.M.A.R.T. Enable/Disable Autosave	B0 <sub>H</sub> / D2 <sub>H</sub>
S.M.A.R.T. Enable Operations	B0 <sub>H</sub> / D8 <sub>H</sub>
S.M.A.R.T. Execute Offline	B0 <sub>H</sub> / D4 <sub>H</sub>
S.M.A.R.T. Read Attribute Thresholds	B0 <sub>H</sub> / D1 <sub>H</sub>
S.M.A.R.T. Read Data	B0 <sub>H</sub> / D0 <sub>H</sub>
S.M.A.R.T. Read Log Sector	B0 <sub>H</sub> / D5 <sub>H</sub>
S.M.A.R.T. Return Status	B0 <sub>H</sub> / DA <sub>H</sub>
S.M.A.R.T. Save Attribute Values	B0 <sub>H</sub> / D3 <sub>H</sub>
S.M.A.R.T. Write Log Sector	B0 <sub>H</sub> / D6 <sub>H</sub>
Standby	E2 <sub>H</sub>
Standby Immediate	E0 <sub>H</sub>
Write Buffer	E8 <sub>H</sub>
Write DMA	CA <sub>H</sub>
Write DMA Extended	35 <sub>H</sub>
Write DMA FUA Extended	3D <sub>H</sub>
Write FPDMA Queued	61 <sub>H</sub>
Write Log Extended	3F <sub>H</sub>
Write Multiple	C5 <sub>H</sub>
Write Multiple Extended	39 <sub>H</sub>
Write Multiple FUA Extended	CE <sub>H</sub>
Write Sectors	30 <sub>H</sub>
Write Sectors Extended	34 <sub>H</sub>
Write Uncorrectable	55 <sub>H</sub>



### 4.3.1 Identify Device command

The Identify Device command (command code EC<sub>H</sub>) 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 7 on page 25. All reserved bits or words should be set to zero. Parameters listed with an “x” are drive-specific or vary with the state of the drive. See Section 2.0 on page 3 for default parameter settings.

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

Word	Description	Value
0	General configuration	0040 <sub>H</sub>
1	Number of logical cylinders (obsolete) 16,383	3FFF <sub>H</sub>
2	Specific configuration	C837 <sub>H</sub>
3	Number of logical heads (obsolete) 16	0010 <sub>H</sub>
4-5	Retired	0000 <sub>H</sub>
6	Number of logical sectors per logical track (obsolete) 63	003F <sub>H</sub>
7-8	Reserved for CompactFlash Association	0000 <sub>H</sub>
9	Retired	0000 <sub>H</sub>
10-19	Serial number: (ATA ASCII string padded with spaces (20 <sub>H</sub> ))	ASCII
20-21	Retired	0000 <sub>H</sub>
22	Obsolete	0004 <sub>H</sub>
23-26	Firmware revision (ATA ASCII string padded with spaces (20h))	ASCII
27-46	Model number (ATA ASCII string padded with spaces (20h))	ASCII
47	(Bits 7-0) Maximum number of logical sectors that shall be transferred per DRQ data block on READ/WRITE MULTIPLE commands. 16	8010 <sub>H</sub>
48	Reserved for Trusted Computing feature set options	0000 <sub>H</sub>
49	Capabilities – Standby Timer, IORDY Support, etc	2F00 <sub>H</sub>
50	Capabilities Continued	4000 <sub>H</sub>
51	PIO data transfer cycle timing option (Obsolete)	0200 <sub>H</sub>
52	Retired	0200 <sub>H</sub>
53	Words 54-58, 64-70 and 88 are valid	0007 <sub>H</sub>
54	Number of current logical cylinders (Obsolete)	3FFF <sub>H</sub>
55	Number of current logical heads (Obsolete)	0010 <sub>H</sub>
56	Number of current logical sectors per logical track (Obsolete)	003F <sub>H</sub>
57-58	Current capacity in sectors (Obsolete)	FC10 <sub>H</sub> 00FB <sub>H</sub>
59	Number of LBAs transferred per Read Multiple or Write Multiple. Sanitize Command Support	0101 <sub>H</sub>
60-61	Total number of user addressable logical sectors for 28-bit commands Note: The maximum value allowed in this field is: 0FFFFFFFh. If this field contains 0FFFFFFFh and the device has user addressable LBAs greater than or 137GB, then words 100..103 contain the total number of user addressable LBAs	XXXXXXXX <sub>H</sub> *
62	Obsolete	0000 <sub>H</sub>
63	Multiword DMA active and modes supported (see note following this table)	0007 <sub>H</sub>

Word	Description	Value
64	Advanced PIO modes supported. SATA = 0003h	0003 <sub>H</sub>
65	Minimum Multiword DMA transfer cycle time per word (120ns)	0078 <sub>H</sub>
66	Recommended Multiword DMA transfer cycle time (120ns)	0078 <sub>H</sub>
67	Minimum PIO transfer cycle time without flow control (120ns)	0078 <sub>H</sub>
68	Minimum PIO transfer cycle time with IORDY flow control (120ns)	0078 <sub>H</sub>
69	Additional Features and Commands supported. Trim Features supported, DMA commands supported	4000 <sub>H</sub>
70	Reserved	0000 <sub>H</sub>
71–74	Reserved for ATAPI	0000 <sub>H</sub>
75	Queue depth	001F <sub>H</sub>
76	Serial ATA Capabilities Supported	0706 <sub>H</sub>
77	Reserved for Serial ATA	0000 <sub>H</sub>
78	Serial ATA features supported	004C <sub>H</sub>
79	Serial ATA features enabled	0040 <sub>H</sub>
80	Major version number	01FC <sub>H</sub>
81	Minor version number	0028 <sub>H</sub>
82	Commands and feature sets supported	746B <sub>H</sub>
83	Commands and feature sets supported	7501 <sub>H</sub>
84	Commands and feature sets supported	6193 <sub>H</sub>
85	Commands and feature sets supported or enabled	7069 <sub>H</sub>
86	Commands and feature sets supported or enabled	B401 <sub>H</sub>
87	Commands and feature sets supported or enabled	6163 <sub>H</sub>
88	Ultra DMA support and current mode (see note following this table)	207F <sub>H</sub>
89	Security erase time	0000 <sub>H</sub>
90	Enhanced security erase time	0000 <sub>H</sub>
91	Current APM level value	00FE <sub>H</sub>
92	Master password Identifier	0000 <sub>H</sub>
93	Hardware reset result	0000 <sub>H</sub>
94	Reserved	0000 <sub>H</sub>
95–99	ATA-reserved	0000 <sub>H</sub>
100–103	Total Number of User Addressable Logical Blocks for 48-bit commands. These words are required for drives that support the 48-bit addressing feature. Maximum value: 0000FFFFFFFFFFFFh	200GB model = 390,721,968 100GB model = 195,371,568 50GB model = 97,696,368
104	Reserved for Streaming Command Set	0000 <sub>H</sub>
105	Maximum number of 512-byte blocks of LBA Range Entries (see 4.18.3.2) per DATA SET MANAGEMENT command	0001 <sub>H</sub>
106	Physical sector size / logical sector size	4000 <sub>H</sub>
107	Inter-seek delay for ISO 7779 standard acoustic testing	0000 <sub>H</sub>
108–111	World wide name	XXXX <sub>H</sub>

<b>Word</b>	<b>Description</b>	<b>Value</b>
112–115	Reserved	0000 <sub>H</sub>
116	Reserved for TLC	0000 <sub>H</sub>
117–118	Logical sector size (DWord)	0000 <sub>H</sub>
119	Commands and feature sets supported	4010 <sub>H</sub>
120	Commands and feature sets supported or enabled	4010 <sub>H</sub>
121–126	Reserved for expanded supported and enabled settings	0000 <sub>H</sub>
127	Obsolete	0000 <sub>H</sub>
128	Security status	0001 <sub>H</sub>
129–159	Vendor specific	0000 <sub>H</sub>
160–167	Reserved for the CompactFlash Association	0000 <sub>H</sub>
168	Device Nominal Form Factor	0000 <sub>H</sub>
169	DATA SET MANAGEMENT features supported	0001 <sub>H</sub>
170–173	Additional Product Identifier (ATA String)	0000 <sub>H</sub>
174–175	Reserved	0000 <sub>H</sub>
176–205	Reserved	0000 <sub>H</sub>
206	SCT Command Transport	1025 <sub>H</sub>
207–208	Reserved for CE-ATA	0000 <sub>H</sub>
209	Alignment of logical blocks within a physical block	4000 <sub>H</sub>
210–211	Write-Read-Verify Sector Count Mode 3	0000 <sub>H</sub>
212–213	Write-Read-Verify Sector Count Mode 2 (DWord)	0000 <sub>H</sub>
214	NV Cache Capability	0000 <sub>H</sub>
215-216	NV Cache Size in Logical Blocks (DWord)	0000 <sub>H</sub>
217	Nominal media rotation rate	0001 <sub>H</sub>
218	Reserved	0000 <sub>H</sub>
219	NV Cache Options	0000 <sub>H</sub>
220	Write-Read-Verify feature set	0000 <sub>H</sub>
221	Reserved	0000 <sub>H</sub>
222	Transport major version number	1010 <sub>H</sub>
223	Transport minor version number	FFFF <sub>H</sub>
224-233	Reserved	0000 <sub>H</sub>
234	Minimum number of 512-byte data blocks per DOWNLOAD MICROCODE command for mode 03h	0000 <sub>H</sub>
235	Maximum number of 512-byte data blocks per DOWNLOAD MICROCODE command for mode 03h	0000 <sub>H</sub>
236-254	Reserved	0000 <sub>H</sub>
255	Integrity word (XXA5 <sub>H</sub> )	xxA5 <sub>H</sub>

**Note.** See the bit descriptions below for words 49, 50, 69, 76, 78, 82-86, 119 and 119-120 of the Identify Drive data.

<b>Description (if bit is set to 1)</b>	
<b>Bit</b>	<b>Word 49</b>
8	DMA Supported
9	Shall be set to 1
10	IORDY May be disabled
11	IORDY supported
13	Standby Timer Values supported
<b>Bit</b>	<b>Word 50</b>
14	Shall be set to 1
<b>Bit</b>	<b>Word 69</b>
5	Shall be set to 1
6	Optional ATA 28-bit commands supported
8	Download Microcode DMA supported
9	Set Max Password DMA and Set Max Unlock DMA supported
10	Write Buffer DMA Supported
11	Read Buffer DMA Supported
12	DEVICE CONFIGURATION IDENTIFY DMA and DEVICE CONFIGURATION SET DMA are supported
13	Long Physical Sector Alignment Error Reporting Control is supported
14	Deterministic read after Trim is supported
<b>Bit</b>	<b>Word 76</b>
0	Shall be cleared to zero
1	Supports SATA Gen1 Signaling Speed (1.5Gb/s)
2	Supports SATA Gen2 Signaling Speed (3.0Gb/s)
3-7	Reserved for Serial ATA
8	Supports the NCQ feature set
9	Supports receipt of host initiated power management requests
10	Supports Phy Event Counters
11	Supports Unload while NCQ commands are outstanding
12	Supports NCQ priority information
13-15	Reserved for Serial ATA
<b>Bit</b>	<b>Word 78</b>
0	Shall be cleared to zero
1	Device supports non-zero buffer offsets
2	Device supports DMA Setup auto-activation
3	Device supports initiating power management
4	Device supports in-order data delivery
5	Reserved for Serial ATA

	6	Device supports Software Settings Preservation
	7-15	Reserved for Serial ATA
	<b>Bit</b>	<b>Word 82</b>
	0	The SMART feature set is supported
	1	The Security feature set is supported
	2	Obsolete
	3	Mandatory Power Management feature set is supported
	4	PACKET feature set is supported
	5	Volatile write cache is supported
	6	Read look-ahead is supported
	7	Release interrupt is supported
	8	SERVICE interrupt is supported
	9	DEVICE RESET command is supported
	10	HPA feature set is supported
	11	Obsolete
	12	WRITE BUFFER command is supported
	13	READ BUFFER command is supported
	14	NOP command is supported
	15	Obsolete
	<b>Bit</b>	<b>Word 83</b>
	0	DOWNLOAD MICROCODE command is supported
	1	Obsolete
	2	CFA feature set is supported
	3	APM feature set is supported
	4	Obsolete
	5	PUIS feature set is supported
	6	SET FEATURES subcommand is required to spin-up after power-up
	7	Reserved
	8	SET MAX security extension is supported
	9	AAM feature set is supported
	10	48-bit Address feature set is supported
	11	DCO feature set is supported
	12	Mandatory FLUSH CACHE command is supported
	13	FLUSH CACHE EXT command is supported
	14	Shall be set to one
	15	Shall be cleared to zero
	<b>Bit</b>	<b>Word 84</b>
	0	SMART error logging is supported
	1	SMART self-test is supported

	2	Media serial number is supported
	3	Media Card Pass Through Command feature set is supported
	4	Streaming feature set is supported
	5	GPL feature set is supported
	6	WRITE DMA FUA EXT and WRITE MULTIPLE FUA EXT commands are supported
	7	Obsolete
	8	64-bit World wide name is supported
	9-10	Obsolete
	11-12	Reserved for TLC
	13	IDLE IMMEDIATE command with UNLOAD feature is supported
	14	Shall be set to one
	15	Shall be cleared to zero
	<b>Bit</b>	<b>Word 85</b>
	9	DEVICE RESET command is not supported
	10	HPA feature set is supported
	11	Obsolete
	12	WRITE BUFFER command is supported
	13	READ BUFFER command is supported
	14	NOP command is supported
	15	Obsolete
	<b>Bit</b>	<b>Word 86</b>
	0	DOWNLOAD MICROCODE command is supported
	1	Obsolete
	2	CFA feature set is supported
	6	SET FEATURES subcommand is required to spin-up after power-up
	10	The 48-bit Address features set is supported
	11	The DCO feature set is supported
	12	FLUSH CACHE command supported
	13	FLUSH CACHE EXT command supported
	15	Words 119..120 are valid
	<b>Bit</b>	<b>Word 87</b>
	0	SMART error logging is supported
	1	SMART self-test supported
	3	The Media Card Pass Through Command feature set is supported
	5	The GPL feature set is supported
	6	WRITE DMA FUA EXT and WRITE MULTIPLE FUA EXT commands are supported
	8	The 64-bit World wide name is supported
	13	The IDLE IMMEDIATE command with UNLOAD FEATURE is supported

	14	Shall be set to one
	15	Shall be cleared to zero
	<b>Bit</b>	<b>Word 119</b>
	0	Reserved
	1	Write-Read-Verify feature set is supported
	2	WRITE UNCORRECTABLE EXT command is supported
	3	READ LOG DMA EXT and WRITE LOG DMA EXT commands are supported
	4	DOWNLOAD MICROCODE command with mode 3 is supported
	5	Free-fall Control feature set is supported
	6	Extended Status Reporting feature set is supported
	7	Extended Power Conditions feature set is supported
	8-13	Reserved
	14	Shall be set to one
	15	Shall be cleared to zero
	<b>Bit</b>	<b>Word 119</b>
	2	WRITE UNCORRECTABLE EXT command is supported
	3	READ LOG DMA EXT and WRITE LOG DMA EXT commands are supported
	4	DOWNLOAD MICROCODE command with mode 3 is supported
	14	Shall be set to one
	15	Shall be cleared to zero

### 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 8: Set Features command values**

02 <sub>H</sub>	Enable write cache ( <i>default</i> ).
03 <sub>H</sub>	Set transfer mode (based on value in Sector Count register). Sector Count register values:
00 <sub>H</sub>	Set PIO mode to default (PIO mode 2).
01 <sub>H</sub>	Set PIO mode to default and disable IORDY (PIO mode 2).
08 <sub>H</sub>	PIO mode 0
09 <sub>H</sub>	PIO mode 1
0A <sub>H</sub>	PIO mode 2
0B <sub>H</sub>	PIO mode 3
0C <sub>H</sub>	PIO mode 4 ( <i>default</i> )
20 <sub>H</sub>	Multiword DMA mode 0
21 <sub>H</sub>	Multiword DMA mode 1
22 <sub>H</sub>	Multiword DMA mode 2
40 <sub>H</sub>	Ultra DMA mode 0
41 <sub>H</sub>	Ultra DMA mode 1
42 <sub>H</sub>	Ultra DMA mode 2
43 <sub>H</sub>	Ultra DMA mode 3
44 <sub>H</sub>	Ultra DMA mode 4
45 <sub>H</sub>	Ultra DMA mode 5
46 <sub>H</sub>	Ultra DMA mode 6
10 <sub>H</sub>	Enable use of SATA features
02 <sub>H</sub>	DMA Setup FIS Auto-Activate optimization
03 <sub>H</sub>	Device-initiated interface power state transitions
06 <sub>H</sub>	Software Settings Preservation
55 <sub>H</sub>	Disable read look-ahead (read cache) feature
66 <sub>H</sub>	Disable reverting to power-on defaults
82 <sub>H</sub>	Disable write cache
90 <sub>H</sub>	Disable use of SATA features
02 <sub>H</sub>	DMA Setup FIS Auto-Activate optimization
03 <sub>H</sub>	Device-initiated interface power state transitions
06 <sub>H</sub>	Software Settings Preservation
AA <sub>H</sub>	Enable read look-ahead (read cache) feature ( <i>default</i> ).
CC <sub>H</sub>	Enable reverting to power-on defaults

**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 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-8 Standard*.

SeaTools diagnostic software activates a built-in drive self-test (DST S.M.A.R.T. command for D4<sub>H</sub>) that eliminates unnecessary drive returns. The diagnostic software ships with all new drives and is also available at: <http://seatools.seagate.com>.

This drive is shipped with S.M.A.R.T. features disabled. 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 9: S.M.A.R.T. commands**

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

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



## 5.0 Seagate Technology support services

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