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Product Manual

# Momentum® 5400.2 SATA

**ST9120821SB**

**ST9100824SB**

**ST98823SB**

**ST96812SB**

**ST94813SB**

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Rev. B  
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One gigabyte, or GB, equals one billion bytes and one terabyte, or TB, equals one trillion bytes when referring to hard drive capacity. Accessible capacity may vary depending on operating environment and formatting. Quantitative usage examples for various applications are for illustrative purposes. Actual quantities will vary based on various factors, including file size, file format, features and application software. Seagate reserves the right to change, without notice, product offerings or specifications.

# Contents

<b>1.0</b>	<b>Introduction</b>	<b>1</b>
1.1	About the Serial ATA interface	2
<b>2.0</b>	<b>Drive specifications</b>	<b>3</b>
2.1	Specification summary table	3
2.2	Formatted capacity	5
2.2.1	LBA mode	5
2.3	Default logical geometry	5
2.4	Physical organization	6
2.5	Recording and interface technology	6
2.6	Physical characteristics	6
2.7	Seek time	7
2.8	Time to ready	7
2.9	Power specifications	8
2.9.1	Power consumption	8
2.9.2	Deferred spinup	9
2.9.3	Conducted noise	10
2.9.4	Voltage tolerance	10
2.10	Environmental specifications	10
2.10.1	Ambient temperature	10
2.10.2	Temperature gradient	10
2.10.3	Humidity	10
2.10.4	Altitude	10
2.10.5	Shock	11
2.10.6	Vibration	11
2.11	Acoustics	12
2.12	Electromagnetic immunity	12
2.13	Reliability	13
2.14	Agency certification	13
2.14.1	Safety certification	13
2.14.2	Electromagnetic compatibility	13
2.14.3	FCC verification	14
2.15	Environmental protection	15
2.15.1	European Union Restriction of Hazardous Substances (RoHS)	15
2.16	Corrosive environment	15
<b>3.0</b>	<b>Configuring and mounting the drive</b>	<b>17</b>
3.1	Handling and static-discharge precautions	17
3.2	Configuring the drive	18
3.3	Serial ATA cables and connectors	18
3.4	Drive mounting	19
<b>4.0</b>	<b>Serial ATA (SATA) interface</b>	<b>21</b>
4.1	Hot-Plug compatibility	21
4.2	Serial ATA device plug connector pin definitions	21
4.3	Supported ATA commands	23
4.3.1	Identify Device command	26
4.3.2	Set Features command	29
4.3.3	S.M.A.R.T. commands	30
<b>5.0</b>	<b>Seagate Technology support services</b>	<b>31</b>



## List of Figures

Figure 1.	Momentum 5400.2 SATA disc drive . . . . .	1
Figure 2.	Typical +5V only startup and operation current profile . . . . .	9
Figure 3.	Serial ATA connectors . . . . .	18
Figure 4.	Attaching SATA cabling . . . . .	18
Figure 5.	Mounting dimensions—top, side and end view . . . . .	19



## 1.0 Introduction

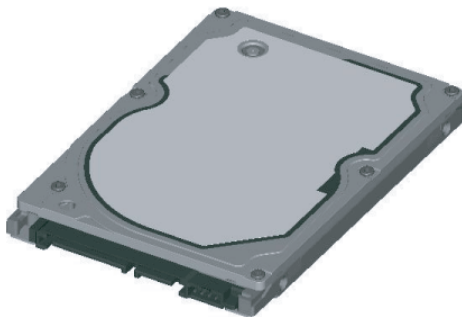
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This manual describes the functional, mechanical and interface specifications for the following Seagate Momentus® 5400.2 SATA Blade Server model drives:

- ST9120821SB
- ST9100824SB
- ST98823SB
- ST96812SB
- ST94813SB

These drives provide the following key features:

- 5,400 RPM spindle speed.
- 8 Mbyte buffer.
- High instantaneous (burst) data-transfer rates (up to 150 Mbytes per second).
- Tunneling Magnetoresistive (TMR) recording heads.
- State-of-the-art cache and on-the-fly error-correction algorithms.
- Full-track multiple-sector transfer capability without local processor intervention.
- Quiet operation.
- 800 Gs nonoperating shock and 250 Gs of operating shock.
- SeaTools diagnostic software performs a drive self-test that eliminates unnecessary drive returns.
- The 3D Defense System™, which includes Drive Defense, Data Defense and Diagnostic Defense, offers the industry's most comprehensive protection for disc drives.
- Support for S.M.A.R.T. drive monitoring and reporting.
- Support for Read Multiple and Write Multiple commands.



**Figure 1. Momentus 5400.2 SATA disc 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 disc drive in your current system and expect all of your existing applications to work as normal.

The Serial ATA interface connects each disc 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.

**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 <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 ST9120821SB, ST9100824SB, ST98823SB, ST96812SB, ST94813SB and ST93811AS models.

### 2.1 Specification summary table

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

**Table 1: Drive specifications**

Drive specification	ST9120821SB	ST9100824SB	ST98823SB	ST96812SB	ST94813SB
Formatted Gbytes (512 bytes/sector)*	120	100	80	60	40
Guaranteed sectors	234,441,648	195,371,568	156,301,488	117,210,240	78,140,160
Bytes per sector	512				
Default sectors per track	63				
Default read/write heads	16				
Default cylinders	16,383				
Physical read/write heads	4	4	3	2	2
Discs	2	2	2	1	1
Recording density in BPI (bits/inch max)	778k				
Track density TPI (tracks/inch max)	126k				
Areal density (Mbits/inch <sup>2</sup> max)	98.2				
Spindle speed (RPM)	5,400				
Internal transfer rate (Mbytes/sec max)	42				
I/O data transfer rate (Mbytes/sec max)	150				
ATA data-transfer modes supported	SATA 1.0, SATA II PIO modes 0–4 Multiword DMA modes 0–2 Ultra DMA modes 0–6				
Cache buffer	8 Mbytes				
Height (max)	9.5 +/- 0.2 mm (0.374 +/- .0078 inches)				
Width (max)	69.85 mm (2.75 +/- 0.0098 inches)				
Length (max)	100.5 +/- 1.6 mm (3.96 +/- 0.063 inches)				
Weight (typical)	100 grams (0.22 lb)				
Average latency (msec)	5.56				
Power-on to ready (typical)	3.5 sec				
Standby to ready (typical)	3.0 sec				
Startup current, (typical, peak)	+5V: 1.1A				

**Table 1: Drive specifications**

Drive specification	ST9120821SB	ST9100824SB	ST98823SB	ST96812SB	ST94813SB
Track-to-track seek time (msec typical)	1.0 (read), 1.5 (write)				
Average seek, read (msec typical)	12.5				
Average seek, write (msec typical)	14.5				
Seek power (typical)	2.20 watts				
Read/write power (typical)	Read: 1.90 watts; Write: 2.30 watts				
Idle mode, low power (typical)	0.80 watts				
Standby mode (typical)	0.28 watts**				
Sleep mode (typical)	0.28 watts**				
Voltage tolerance (including noise)	+5.0V ± 5%				
Ambient temperature	5° to 55°C (operating), -40° to 70°C (nonoperating)				
Temperature gradient (°C per hour max)	20°C (operating) 30°C (nonoperating)				
Relative humidity	5% to 90% (operating) 5% to 95% (nonoperating)				
Relative humidity gradient	30% per hour max				
Wet bulb temperature (°C max)	30 (operating) 40 (nonoperating)				
Altitude, operating	-304.8 m to 3,048 m (-1000 ft to 10,000+ ft)				
Altitude, nonoperating (meters below mean sea level, max)	-304.8 m to 12,192 m (-1000 ft to 40,000+ ft)				
Shock, operating (Gs max at 2 msec)	250				
Shock, nonoperating (Gs max at 2 msec)	800				
Shock, nonoperating (Gs max at 1 msec)	900				
Shock, nonoperating (Gs max at 0.5 msec)	400				
Vibration, operating	1.0 G (0 to peak, 5–500 Hz)				
Vibration, nonoperating	5 Gs (0 to peak, 5–500 Hz)				
Drive acoustics, sound power (bels) Idle***	2.4 (typical) 2.6 (max)				
Performance seek	2.9 (typical) 3.1 (max)				
Nonrecoverable read errors	1 per 10 <sup>14</sup> bits read				
Annualized Failure Rate (AFR)	1.74% at maximum case temperature of 40°C and 8,760 power on hours (POH).				
Service life	5 Years				
Warranty	5 years on distribution units. 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/service/">www.seagate.com/support/service/</a> From this page, click on the “Verify Your Warranty” link. You will be asked to provide the drive serial number, model number (or part number) and country of purchase. The system will display the warranty information for your drive.				
Load/Unload (U/UL) cycles  25°C, 50% relative humidity  32°C, 80% relative humidity 5°C, 80% relative humidity 5°C, 10% relative humidity 55°C, 16% relative humidity	600,000 software-controlled power on/off cycles 20,000 hard power on/off cycles  600,000 software-controlled power on/off cycles 20,000 hard power on/off cycles				
Supports Hotplug operation per SATA II specification	Yes (requires COMPRESET from host after a hotplug event)				

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

\*\*Typical notebooks will pull power to the drive when entering S3 and S4; while in the S3 and S4 states, drive sleep and drive standby modes will not contribute to battery power consumption.

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

## 2.2 Formatted capacity

Model	Formatted capacity*	Guaranteed sectors	Bytes per sector
ST9120821SB	120 Gbytes	234,441,648	512
ST9100824SB	100 Gbytes	195,371,568	512
ST98823SB	80 Gbytes	156,301,488	512
ST96812SB	60 Gbytes	117,210,240	512
ST94813SB	40 Gbytes	78,140,160	512

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

### 2.2.1 LBA mode

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

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

## 2.3 Default logical geometry

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

### LBA mode

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

## 2.4 Physical organization

Drive model	Read/write heads	Number of discs
ST9120821SB	4	2
ST9100824SB	4	2
ST98823SB	3	2
ST96812SB	2	1
ST94813SB	2	1

## 2.5 Recording and interface technology

Interface	Serial ATA (SATA)
Recording method	16/17 EPRML
Recording density BPI (bits/inch max)	778k
Track density TPI (tracks/inch max)	126k
Areal density (Mbits/inch <sup>2</sup> max)	98.2
Spindle speed (RPM) ( $\pm 0.2\%$ )	5,400
Maximum Internal transfer rate (Mbytes/sec)	42
I/O data-transfer rate (Mbytes/sec max)	150 (SATA 1.0)
Interleave	1:1
Cache buffer	8 Mbytes (8,192 kbytes)

## 2.6 Physical characteristics

Drive specification		
Height	(mm) (inches)	9.5 +/-0.2 0.374 +/-0.0078
Width	(mm) (inches)	69.85 +/-0.25 2.75 +/-0.0098
Length	(mm) (inches)	100.5 +/-1.6 3.945 +/-0.0098
Typical weight	(grams) (pounds)	100 0.22

## 2.7 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 5,000 measurements of seeks between random tracks, less overhead.

**Table 2: Typical seek times**

Typical seek times (msec)	Read	Write
Track-to-track	1.0	1.5
Average	12.5	14.5
Full-stroke	22.0	24.0
Average latency	5.56	5.56

**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.

## 2.8 Time to ready

Time to ready	Typical	Max @ 25°C
Power-on to Ready (sec)	3.5	8.0
Standby to Ready (sec)	3.0	8.0

## 2.9 Power specifications

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

### 2.9.1 Power consumption

Power requirements for the drives are listed in the table on page 8. Typical power measurements are based on an average of drives tested, under nominal conditions, at 25°C ambient temperature, after 25 minutes of operation.

- **Spinup power**

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

- **Seek mode**

During seek mode, the read/write actuator arm moves toward a specific position on the disc surface and does not execute a read or write operation. Servo electronics are active. Seek mode power is measured based on three random seek operations every 100 msec. 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 msec.

- **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.

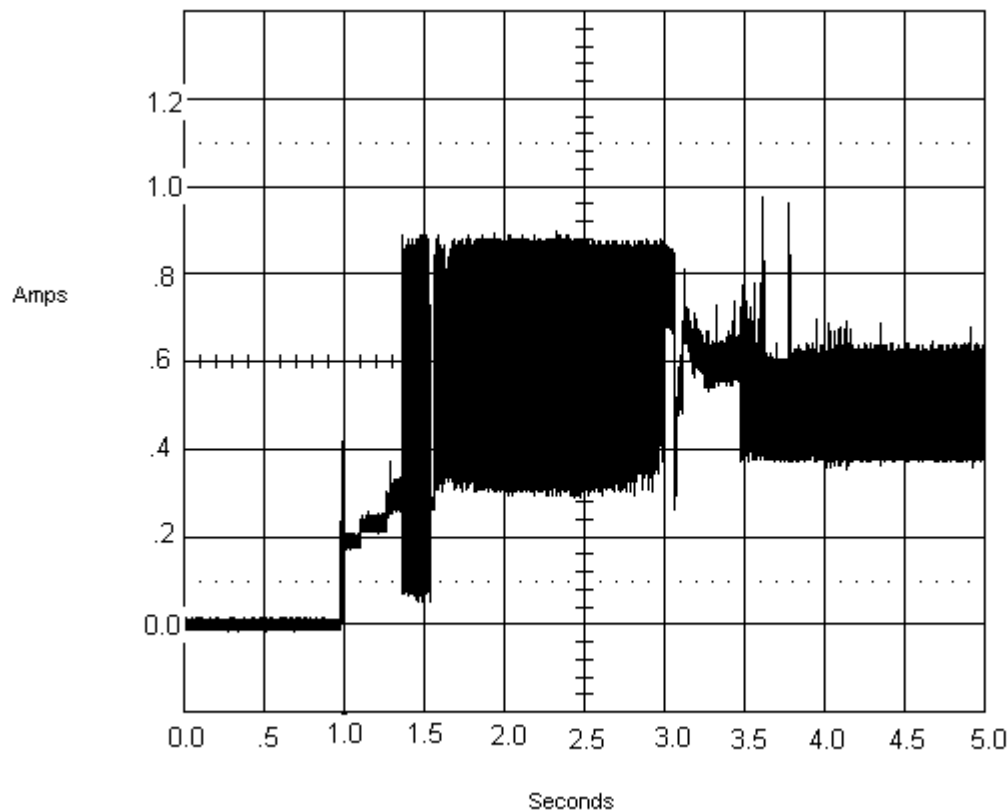
- **Standby mode**

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

**Table 3: DC power**

Power dissipation	+5V input average (25° C)
Spinup	1.1 A
Seek	2.20 watts
Read	1.90 watts
Write	2.30 watts
Idle, performance mode*	1.70 watts
Idle, active*	0.99 watts
Idle, low power mode*	0.80 watts
Standby	0.28 watts
Sleep	0.28 watts

\*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.



**Figure 2. Typical +5V only startup and operation current profile**

### 2.9.2 Deferred spinup

Momentum 5400.2 SATA drives provide a deferred spinup feature which storage subsystem controllers can use to sequence disc drive initialization. This is beneficial to systems which include multiple Serial ATA hard disc drives because it allows subsystem controllers to stagger the spinup of each drive to accommodate available power supply current. This feature does not impact time-to-ready in typical desktop systems.

To accommodate the deferred spinup of multiple disc drives in an enclosure, Momentum 5400.2 SATA disc drives will spin up only after power is applied to the drive and after successful PHY (Physical layer) initialization. PHY initialization occurs after the PHY enters the DP7:DR\_Ready state. This state is reached after a successful exchange of Out-Of-Band (OOB) signals with a functional host-side Serial ATA port. In desktop systems, SATA transceivers should initialize OOB as soon as power comes ready to guarantee the drive spins up quickly. Seagate disc drives will not spin up without an operational host-side Serial ATA transceiver.

#### Additional details

Upon system power up, PHY communication is initiated with a COMRESET signal, which is generated by the host-side transceiver. COMRESET is followed by a COMINIT signal generated by the disc drive transceiver. COMRESET and COMINIT are followed by an exchange of COMWAKE signals and Align primitives. The disc drive will spin up after the successful exchange of Align primitives cause the PHY to come ready.

For more details, refer to:

- Section 6.8 of the Serial ATA 1.0 High-Speed Serialized AT Attachment specification
- Section 6.2 of the Serial ATA II: Extensions to Serial ATA 1.0 specification
- SATA 1.0 design guides

**Note.** These specifications and guides are available on the Serial ATA web site ([www.serialata.org](http://www.serialata.org)).

### 2.9.3 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 10 MHz.

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

### 2.9.4 Voltage tolerance

Voltage tolerance (including noise):

5V  $\pm$  5%

## 2.10 Environmental specifications

### 2.10.1 Ambient temperature

Ambient temperature is defined as the temperature of the environment immediately surrounding the drive. Actual drive case temperature should not exceed 65°C (149°F) within the operating ambient conditions.

Above 1,000 feet (305 meters), the maximum temperature is derated linearly by 1°C every 1000 feet.

Operating:	5° to 40°C (41° to 104°F)
Nonoperating:	–40° to 70°C (–40° to 158°F)

### 2.10.2 Temperature gradient

Operating	20°C per hour (68°F per hour max), without condensation
Nonoperating	30°C per hour (86°F per hour max), without condensation

### 2.10.3 Humidity

#### 2.10.3.1 Relative humidity

Operating	5% to 90% noncondensing (30% per hour max)
Nonoperating	5% to 95% noncondensing (30% per hour max)

#### 2.10.3.2 Wet bulb temperature

Operating	30°C (86°F max)
Nonoperating	40°C (104°F max)

### 2.10.4 Altitude

Operating	–304.8 m to 3,048 m (–1,000 ft to 10,000+ ft)
Nonoperating	–304.8 m to 12,192 m (–1,000 ft to 40,000+ ft)



## 2.10.5 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.

### 2.10.5.1 Operating shock

These drives comply with the performance levels specified in this document when subjected to a maximum operating shock of 250 Gs based on half-sine shock pulses of 2 msec. Shocks should not be repeated more than two times per second.

### 2.10.5.2 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 800 Gs based on a nonrepetitive half-sine shock pulse of 2 msec duration.

The nonoperating shock level that the drive can experience without incurring physical damage or degradation in performance when subsequently put into operation is 900 Gs based on a nonrepetitive half-sine shock pulse of 1 msec duration.

The nonoperating shock level that the drive can experience without incurring physical damage or degradation in performance when subsequently put into operation is 400 Gs based on a nonrepetitive half-sine shock pulse of 0.5 msec duration.

## 2.10.6 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.

### 2.10.6.1 Operating vibration

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

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5–500 Hz	1.0 Gs (0 to peak). Max displacement may apply below 10 Hz.
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### 2.10.6.2 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.

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5–500 Hz:	5.0 Gs (0 to peak). Max displacement may apply below 22 Hz.
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## 2.11 Acoustics

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

For seek mode tests, the drive is placed in seek mode only. The number of seeks per second is defined by the following equation:

(Number of seeks per second =  $0.4 / (\text{average latency} + \text{average access time})$ )

**Table 4: Drive level acoustics**

Idle*	Performance Seek
2.4 bels (typ) 2.6 bels (max)	2.9 bels (typ) 3.1 bels (max)

**Note.** \*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.

## 2.12 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 1,000 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

## 2.13 Reliability

Measurement type	Specification
Nonrecoverable read errors	1 per 10 <sup>14</sup> bits read, max.
Annualized Failure Rate (AFR)	1.74% at maximum case temperature of 40°C and 8,760 power on hours (POH).
Load/Unload (U/UL) 25°C, 50% relative humidity  32°C, 80% relative humidity 5°C, 80% relative humidity 5°C, 10% relative humidity 55°C, 16% relative humidity	600,000 software-controlled power on/off cycles 20,000 hard power on/off cycles  600,000 software-controlled power on/off cycles 20,000 hard power on/off cycles
Service Life	5 years
Warranty	5 years on distribution units. 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/service/">www.seagate.com/support/service/</a> From this page, click on the "Verify Your Warranty" link. You will be asked to provide the drive serial number, model number (or part number) and country of purchase. The system will display the warranty information for your drive.

## 2.14 Agency certification

### 2.14.1 Safety certification

The drives are recognized in accordance with UL 1950 and CSA C22.2 (950) and meet all applicable sections of IEC950 and EN 60950 as tested by TUV North America.

### 2.14.2 Electromagnetic compatibility

Hard drives that display the CE mark comply with the European Union (EU) requirements specified in the Electromagnetic Compatibility Directive (89/336/EEC). 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 Korea Ministry of Information and Communication (MIC) 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) Ministry of Information and Communication 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.

- EUT name (model numbers): ST9120821SB, ST9100824SB, ST98823SB, ST96812SB, and ST94813SB.

- Certificate numbers:

ST9120821SB	E-D011-05-2395(B)
ST9100824SB	E-D011-05-2395(B)
ST98823SB	E-D011-05-2395(B)
ST96812SB	E-D011-05-2395(B)
ST94813SB	E-D011-05-2395(B)

- Trade name or applicant: Seagate Technology
- Manufacturing date: June 2005
- 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/NZS3548 1995 and meet the Electromagnetic Compatibility (EMC) Framework requirements of the Australian Communication Authority (ACA).

### 2.14.3 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, disc 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.

## **2.15 Environmental protection**

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

### **2.15.1 European Union Restriction of Hazardous Substances (RoHS)**

The European Union Restriction of Hazardous Substances (RoHS) Directive restricts the presence of chemical substances, including Lead (Pb), in electronic products effective July 2006.

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 RoHS substances in these parts and materials. Our supplier contracts require compliance with our chemical substance restrictions, and our suppliers document their compliance with our requirements by providing material content declarations for all parts and materials for the disc drives documented in this publication. Current supplier declarations include disclosure of the inclusion of any RoHS-regulated substance in such parts or materials.

Seagate also has internal systems in place to ensure ongoing compliance with the RoHS Directive and all laws and regulations which restrict chemical content in electronic products. These systems include standard operating procedures that ensure that restricted substances are not utilized in our manufacturing operations, laboratory analytical validation testing, and an internal auditing process to ensure that all standard operating procedures are complied with.

## **2.16 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:**

- Keep the drive in the electrostatic discharge (ESD) bag until you are ready for installation to limit the drive's exposure to ESD.
- 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 only by its edges or frame.
- 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. Other labels are used to seal out dirt and contamination.

### 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. This means both drives behave as if they are Device 0 (master) devices.

Serial ATA drives are designed for easy installation with no jumpers, terminators, or other settings. It is not necessary to set any jumpers on this drive for proper operation. The jumper block adjacent to the signal connector is for factory use only.

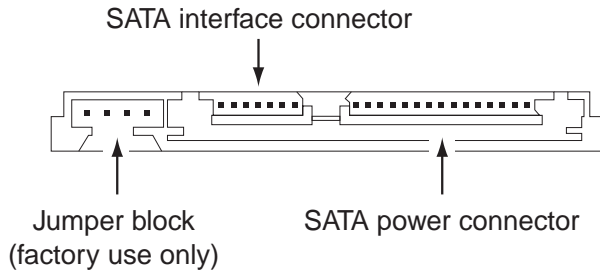


Figure 3. Serial ATA connectors

### 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 4.

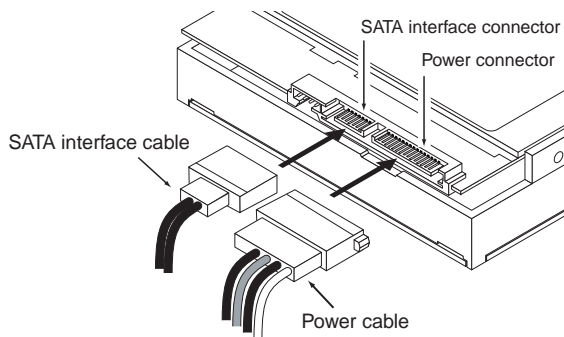


Figure 4. Attaching SATA cabling

Each cable is keyed to ensure correct orientation.



### 3.4 Drive mounting

You can mount the drive using four screws in the side-mounting holes or four screws in the bottom-mounting holes. See Figure 5 for drive mounting dimensions. Follow these important mounting precautions when mounting the drive:

- Allow a minimum clearance of 0.030 inches (0.76 mm) around the entire perimeter of the drive for cooling.
- Use only M3 UNC mounting screws.
- Do not overtighten the mounting screws (maximum torque: 4.0 inch-lb).
- Four (4) threads (0.080 inches) minimum screw engagement recommended.

Measurements shown in Figure 5 are in inches.

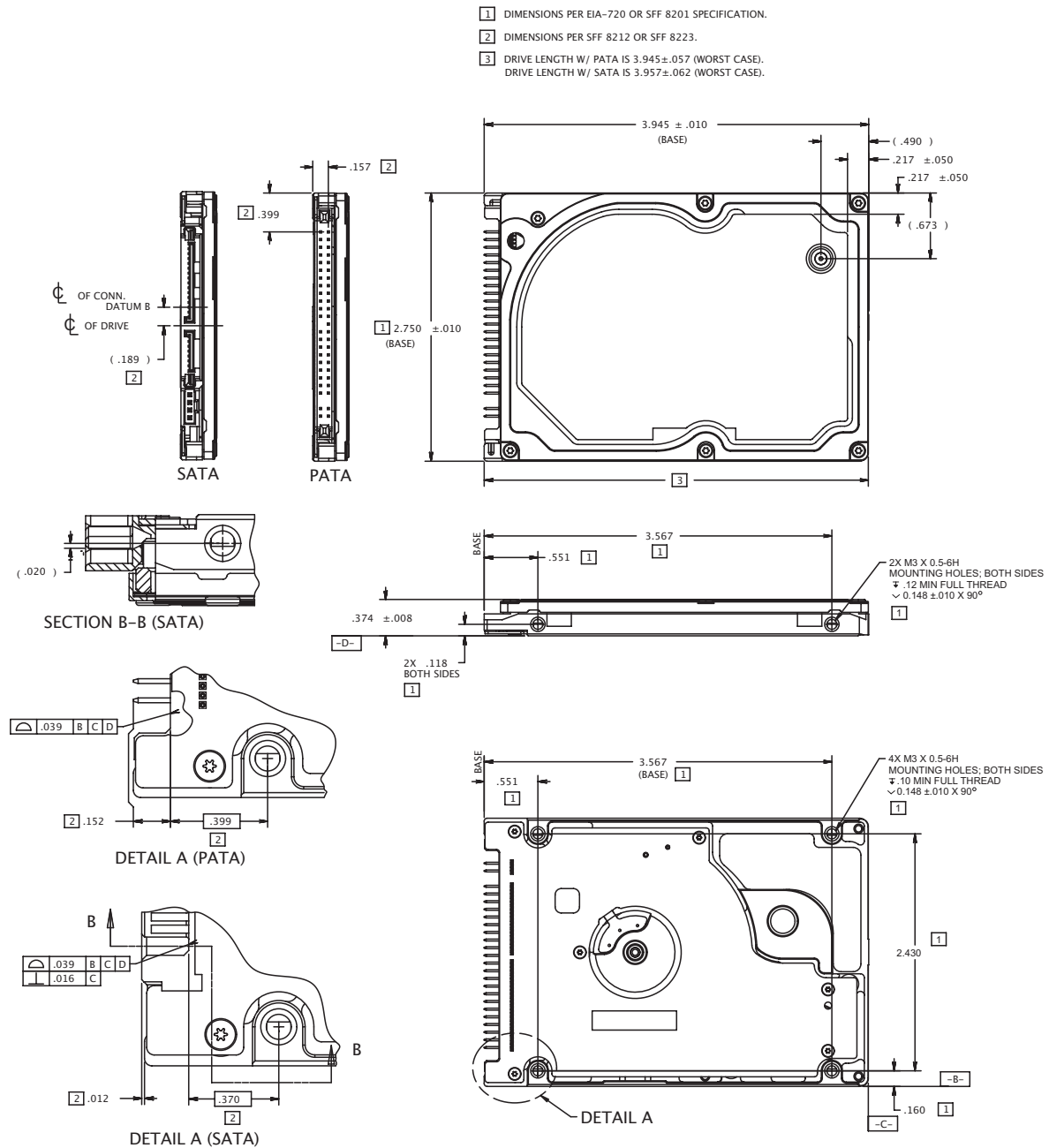


Figure 5. Mounting dimensions—top, side and end view



## 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. 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

Momentum 5400.2 SATA 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 <http://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 6 summarizes the signals on the Serial ATA interface and power connectors..

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

Segment	Pin	Function	Definition
	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+	
<b>Signal</b>	S7	Ground	2nd mate

Key and spacing separate signal and power segments

---

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

Segment	Pin	Function	Definition
Power	P1	V <sub>33</sub>	3.3V power
	P2	V <sub>33</sub>	3.3V power
	P3	V <sub>33</sub>	3.3V power, pre-charge, 2nd mate
	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	Reserved	The pin corresponding to P11 in the backplane receptacle connector is also reserved The corresponding pin to be mated with P11 in the power cable receptacle connector shall always be grounded
	P12	Ground	1st mate.
	P13	V <sub>12</sub>	12V power, pre-charge, 2nd mate
	P14	V <sub>12</sub>	12V power
	P15	V <sub>12</sub>	12V power

**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 30 for details and subcommands used in the S.M.A.R.T. implementation.

Command name	Command code (in hex)
<b>ATA-standard commands</b>	
Device Configuration Restore	B1h/C0h
Device Configuration Freeze Lock	B1h/C1h
Device Configuration Identify	B1h/C2h
Device Configuration Set	B1h/C3h
Download Microcode	92h
Execute Device Diagnostics	90h
Flush Cache	E7h
Flush Cache Extended	EAh
Identify Device	ECh
Initialize Device Parameters	91h
Read Buffer	E4h
Read DMA	C8h
Read DMA Extended	25h
Read DMA without Retries	C9h
Read Long with Retries	22h
Read Long without Retries	23h
Read Multiple	C4h
Read Multiple Extended	29h
Read Native Max Address	F8h
Read Native Max Address Extended	27h
Read Sectors	20h
Read Sectors Extended	24h
Read Sectors without Retries	21h
Read Verify Sectors	40h
Read Verify Sectors Extended	42h
Read Verify Sectors without Retries	41h
Seek	70h
Set Features	EFh
Set Max Address	F9h

Command name	Command code (in hex)	
Note: Individual Set Max 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 Multiple Mode	C6h	
S.M.A.R.T. Disable Operations	B0h/D9h	
S.M.A.R.T. Enable/Disable Autosave	B0h/D2h	
S.M.A.R.T. Enable Operations	B0h/D8h	
S.M.A.R.T. Enable/Disable Auto Offline	B0h/DBh	
S.M.A.R.T. Enable One Attribute Modification	B0h/E0h	
S.M.A.R.T. Execute Offline	B0h/D4h	
S.M.A.R.T. Read Attribute Thresholds	B0h/D1h	
S.M.A.R.T. Read Data	B0h/D0h	
S.M.A.R.T. Read Log Sector	B0h/D5h	
S.M.A.R.T. Return Status	B0h/DAh	
S.M.A.R.T. Save Attribute Values	B0h/D3h	
S.M.A.R.T. Write Attribute Thresholds	B0h/D7h	
S.M.A.R.T. Write Attribute Values	B0h/E1h	
S.M.A.R.T. Write Log Sector	B0h/D6h	
Write Buffer	E8h	
Write DMA	CAh	
Write DMA Extended	35h	
Write DMA without Retries	CBh	
Write Long with Retries	32h	
Write Long without Retries	33h	
Write Multiple	C5h	
Write Sectors	30h, 31h	
Write Sectors Extended	34h	
<b>ATA-standard power-management commands</b>		
Check Power Mode	98h or E5h	
Idle	97h or E3h	
Idle Immediate	95h or E1h	
Sleep	99h or E6h	
Standby	96h or E2h	
Standby Immediate	94h or E0h	
<b>ATA-standard security commands</b>		

<b>Command name</b>	<b>Command code (in hex)</b>
Security Set Password	F1h
Security Unlock	F2h
Security Erase Prepare	F3h
Security Erase Unit	F4h
Security Freeze Lock	F5h
Security Disable Password	F6h

### 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 the table on page 27. 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	Configuration information: • Bit 15: 0 = ATA; 1 = ATAPI • Bit 7: removable media • Bit 6: removable controller • Bit 0: reserved	0C5A <sub>H</sub>
1	Number of logical cylinders	16,383
2	ATA-reserved	0000 <sub>H</sub>
3	Number of logical heads	16
4	Retired	0000 <sub>H</sub>
5	Retired	0000 <sub>H</sub>
6	Number of logical sectors per logical track: 63	003F <sub>H</sub>
7–9	Retired	0000 <sub>H</sub>
10–19	Serial number: (20 ASCII characters, 0000 <sub>H</sub> = none)	ASCII
20	Retired	0000 <sub>H</sub>
21	Retired	0400 <sub>H</sub>
22	Obsolete	0000 <sub>H</sub>
23–26	Firmware revision (8 ASCII character string, padded with blanks to end of string)	x.xx
27–46	Drive model number: (40 ASCII characters, padded with blanks to end of string)	ST9120821SB ST9100824SB ST98823SB ST96812SB ST94813SB
47	(Bits 7–0) Maximum sectors per interrupt on Read multiple and Write multiple (16)	8010 <sub>H</sub>
48	Reserved	0000 <sub>H</sub>
49	Standard Standby timer, IORDY supported and may be disabled	2F00 <sub>H</sub>
50	ATA-reserved	0000 <sub>H</sub>
51	PIO data-transfer cycle timing mode	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	xxxx <sub>H</sub>
55	Number of current logical heads	xxxx <sub>H</sub>



Word	Description	Value
56	Number of current logical sectors per logical track	xxxx <sub>H</sub>
57–58	Current capacity in sectors	xxxx <sub>H</sub>
59	Number of sectors transferred during a Read Multiple or Write Multiple command	xxxx <sub>H</sub>
60–61	Total number of user-addressable LBA sectors available (see Section 2.2 for related information)	ST9120821SB = 234,441,648 ST9100824SB = 195,371,568 ST98823SB = 156,301,488 ST96812SB = 117,210,240 ST94813SB = 78,140,160
62	Retired	0000 <sub>H</sub>
63	Multiword DMA active and modes supported (see note following this table)	xx07 <sub>H</sub>
64	Advanced PIO modes supported (modes 3 and 4 supported)	0003 <sub>H</sub>
65	Minimum multiword DMA transfer cycle time per word (120 nsec)	0078 <sub>H</sub>
66	Recommended multiword DMA transfer cycle time per word (120 nsec)	0078 <sub>H</sub>
67	Minimum PIO cycle time without IORDY flow control (240 nsec)	00F0 <sub>H</sub>
68	Minimum PIO cycle time with IORDY flow control (120 nsec)	0078 <sub>H</sub>
69–74	ATA-reserved	0000 <sub>H</sub>
75	Queue depth	0000 <sub>H</sub>
76	Serial ATA capabilities	0508 <sub>H</sub>
77	ATA-reserved	0000 <sub>H</sub>
78	Serial ATA features supported	0048 <sub>H</sub>
79	Serial ATA features enabled	0040 <sub>H</sub>
80	Major version number	003E <sub>H</sub>
81	Minor version number	0000 <sub>H</sub>
82	Command sets supported	306B <sub>H</sub>
83	Command sets supported	4001 <sub>H</sub>
84	Command sets support extension	4000 <sub>H</sub>
85	Command sets enabled	30xx <sub>H</sub>
86	Command sets enabled	0001 <sub>H</sub>
87	Command sets enable extension	4000 <sub>H</sub>
88	Ultra DMA support and current mode (see note following this table)	xx7F <sub>H</sub>
89	Security erase time	0000 <sub>H</sub>
90	Enhanced security erase time	0000 <sub>H</sub>
92	Master password revision code	FFFE <sub>H</sub>

Word	Description	Value
93	Hardware reset value (see description following this table)	xxxx <sub>H</sub>
94	Auto acoustic management setting	xxxx <sub>H</sub>
95–99	ATA-reserved	0000 <sub>H</sub>
100–103	Total number of user-addressable LBA sectors available (see Section 2.2 for related information) These words are required for drives that support the 48-bit addressing feature. Maximum value: 0000FFFFFFFF <sub>H</sub> .	ST9120821SB = 234,441,648 ST9100824SB = 195,371,568 ST98823SB = 156,301,488 ST96812SB = 117,210,240 ST94813SB = 78,140,160
104–127	ATA-reserved	0000 <sub>H</sub>
128	Security status	0001 <sub>H</sub>
129–159	Seagate-reserved	xxxx <sub>H</sub>
160–254	ATA-reserved	0000 <sub>H</sub>
255	Integrity word	xxA5 <sub>H</sub>

**Note.** See the bit descriptions below for words 63, 88, 93 and 94 of the Identify Drive data:

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

Bit	Word 63
0	Multiword DMA mode 0 is supported.
1	Multiword DMA mode 1 is supported.
2	Multiword DMA mode 2 is supported.
8	Multiword DMA mode 0 is currently active.
9	Multiword DMA mode 1 is currently active.
10	Multiword DMA mode 2 is currently active.
Bit	Word 88
0	Ultra DMA mode 0 is supported.
1	Ultra DMA mode 1 is supported.
2	Ultra DMA mode 2 is supported.
3	Ultra DMA mode 3 is supported.
4	Ultra DMA mode 4 is supported.
8	Ultra DMA mode 0 is currently active.
9	Ultra DMA mode 1 is currently active.
10	Ultra DMA mode 2 is currently active.
11	Ultra DMA mode 3 is currently active.
12	Ultra DMA mode 4 is currently active.
13	Ultra DMA mode 5 is currently active.

Bit	Word 93
13	1 = 80-conductor cable detected, CBLID above V <sub>IH</sub> 0 = 40-conductor cable detected, CBLID below V <sub>IL</sub>

### 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 7: 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
55 <sub>H</sub>	Disable read look-ahead (read cache) feature.
82 <sub>H</sub>	Disable write cache
AA <sub>H</sub>	Enable read look-ahead (read cache) feature ( <i>default</i> ).
F1 <sub>H</sub>	Report full capacity available

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

### 4.3.3 S.M.A.R.T. commands

S.M.A.R.T. provides near-term failure prediction for disc drives. When S.M.A.R.T. is enabled, the drive monitors predetermined drive attributes that are susceptible to degradation over time. If self-monitoring determines that a failure is likely, S.M.A.R.T. makes a status report available to the host. Not all failures are predictable. S.M.A.R.T. predictability is limited to the attributes the drive can monitor. For more information on S.M.A.R.T. commands and implementation, see the *Draft ATA-5 Standard*.

SeaTools diagnostic software activates a built-in drive self-test (DST S.M.A.R.T. command for D4<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 8: 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
D1 <sub>H</sub>	Vendor-specific
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
D7 <sub>H</sub>	Vendor-specific
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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### Internet

For information regarding Seagate products and services, visit [www.seagate.com](http://www.seagate.com). Worldwide support is available 24 hours daily by email for your questions.

### Presales Support:

Presales@Seagate.com

### Technical Support:

DiscSupport@Seagate.com

### Warranty Support:

<http://www.seagate.com/support/service/index.html>

### mySeagate

my.seagate.com is the industry's first Web portal designed specifically for OEMs and distributors. It provides self-service access to critical applications, personalized content and the tools that allow our partners to manage their Seagate account functions. Submit pricing requests, orders and returns through a single, password-protected Web interface-anytime, anywhere in the world.

### spp.seagate.com

spp.seagate.com supports Seagate resellers with product information, program benefits and sales tools. You may register for customized communications that are not available on the web. These communications contain product launch, EOL, pricing, promotions and other channel-related information. To learn more about the benefits or to register, go to spp.seagate.com, any time, from anywhere in the world.

## Seagate Service Centers

### Presales Support

Our Presales Support staff can help you determine which Seagate products are best suited for your specific application or computer system, as well as product availability and compatibility.

### Technical Support

Seagate technical support is available to assist you online at [support.seagate.com](http://support.seagate.com) or through one of our call centers. Have your system configuration information and your "ST" model number available.

**SeaTDD™ (+1-405-324-3655)** is a telecommunications device for the deaf (TDD). You can send questions or comments 24 hours daily and exchange messages with a technical support specialist during normal business hours for the call center in your region.

## Customer Service Operations

### Warranty Service

Seagate offers worldwide customer support for Seagate products. Seagate distributors, OEMs and other direct customers should contact their Seagate Customer Service Operations (CSO) representative for warranty-related issues. Resellers or end users of drive products should contact their place of purchase or Seagate warranty service for assistance. Have your serial number and model or part number available.

### Data Recovery Services

Seagate offers data recovery services for all formats and all brands of storage media. Our data recovery services labs are currently located throughout the world. . Additional information, including an online request form and data loss prevention resources, is available at <http://services.seagate.com/index.aspx>

### Authorized Service Centers

Seagate Service Centers are available on a global basis for the return of defective products. Contact your customer support representative for the location nearest you.

### USA/Canada/Latin America support services

For an extensive list of telephone numbers to technical support, presales and warranty service in USA/Canada/Latin America, including business hours, go to the "Contact Us" page on [www.seagate.com](http://www.seagate.com).

## Global Customer Support

### Presales, Technical, and Warranty Support

Call Center	Toll-free	Direct dial
USA, Canada, and Mexico	1-800-SEAGATE	+1-405-324-4700

### Data Recovery Services

Call Center	Toll-free	Direct dial	FAX
USA, Canada, and Mexico	1-800-475-01435	+1-905-474-2162	1-800-475-0158 +1-905-474-2459

## Europe, the Middle East and Africa Support Services

For an extensive list of telephone numbers to technical support, presales and warranty service in Europe, the Middle East and Africa, go to the "Contact Us" page on [www.seagate.com](http://www.seagate.com).

## Asia/Pacific Support Services

For an extensive list of telephone numbers to technical support, presales and warranty service in Asia/Pacific, go to the "Contact Us" page on [www.seagate.com](http://www.seagate.com).

# Index

## A

- ACA 14
- acoustics 4, 12
- Address 23
- Agency certification 13
- Altitude 10
- Altitude, nonoperating 4
- Altitude, operating 4
- Ambient temperature 4, 10
- ambient temperature 7
- Annualized Failure Rate (AFR) 4
- Areal density 3, 6
- ATA commands 23
- ATA data-transfer modes supported 3
- Australia/New Zealand Standard AS/NZS3548 1995 14
- Australian Communication Authority (ACA) 14
- Australian C-Tick 14
- Average seek time 7
- Average seek, read 4
- Average seek, write 4

## B

- bels 4
- BPI 3
- buffer 3, 6
- Bytes per sector 3, 5

## C

- cables and connectors 18
- Cache 3
- cache 6
- capacity 5
- case temperature 10
- CE mark 13
- certification 13
- Check Power Mode 24
- chemical substances 15
- Class B computing device 14
- compatibility 13
- Conducted noise 10
- Conducted RF immunity 12
- Configuring the drive 17
- connectors 18
- CSA C22.2 (950) 13
- current 3
- cycles 13
- Cylinders 5
- cylinders 3

## D

- data-transfer rates 1
- DC power 8
- Default logical geometry 5
- Default sectors per track 3
- density 3
- Device Configuration Freeze Lock 23
- Device Configuration Restore 23
- Device Configuration Set 23
- Diagnostics 23
- dimensions 19
- Discs 3
- dissipation 8
- Download Microcode 23

## E

- ead/write heads 3
- Electrical fast transient 12
- Electromagnetic compatibility 13
- Electromagnetic Compatibility Directive (89/336/EEC) 13
- Electromagnetic immunity 12
- Electrostatic discharge 12
- electrostatic discharge (ESD) 17
- EN 55022, Class B 13
- EN 55024 13
- EN 60950 13
- Environmental protection 15
- Environmental specifications 10
- EPRML 6
- error-correction algorithms 1
- errors 4, 13
- ESD 17
- EU 13
- European Union (EU) requirements 13
- European Union Restriction of Hazardous Substances 15
- evice Configuration Identify 23
- Execute Device Diagnostics 23

## F

- FCC verification 14
- features 1
- Federal Communications Commission 14
- Flush Cache 23
- Flush Cache Extended 23
- Formatted capacity 5
- Formatted Gbytes 3
- Freeze Lock 23

## G

- Gbytes 5
- geometry 5

gradient 4  
Guaranteed sectors 3, 5  
guaranteed sectors 5

## H

handling 17  
Handling precautions 17  
heads 3, 5  
Height 3  
height 6  
Humidity 10  
humidity 4

## I

I/O data-transfer rate 3, 6  
Identify 23  
Identify Device 23  
Identify Device command 26  
Idle 8, 24  
Idle Immediate 24  
Idle mode 4  
Idle mode power 8  
IEC950 13  
Information Technology Equipment (ITE) 13  
Initialize Device Parameters 23  
Input noise ripple 10  
Interface 6  
interface 21  
Interleave 6  
Internal data transfer rate 3  
Internal data-transfer rate 6  
is 7  
ISO document 7779 12  
ITE 13

## K

Korean RRL 14

## L

latency 3  
LBA mode 5  
Length 3  
length 6  
Load/Unload 13  
logical geometry 5

## M

master/slave 2  
Max Address 23  
maximum temperature 10  
Mean time between failures (MTBF) 13  
Microcode 23  
mounting 19

mounting screws 11  
mounting the drive 17

## N

noise 10  
nominal power 7  
Nonoperating shock 11  
Nonoperating vibration 11  
Nonrecoverable read errors 4  
nonrecoverable read errors 13

## O

Operating shock 11  
Operating vibration 11

## P

Physical characteristics 6  
Physical organization 6  
Physical read/write heads 3  
point-to-point 2, 18  
Power consumption 8  
power dissipation 8  
power on/off cycles 13  
Power specifications 8  
Power-on to Ready 7  
Power-on to ready 3  
precautions 17, 19

## Q

quick reference 3

## R

Radiated RF immunity 12  
Radio and television interference 14  
radio frequency (RF) 12  
random track location 8  
Read Buffer 23  
Read DMA 23  
Read DMA Extended 23  
Read DMA without Retries 23  
read errors 4, 13  
Read Long with Retries 23  
Read Long without Retries 23  
Read Multiple 23  
Read Multiple Extended 23  
Read Native Max Address 23  
Read Native Max Address Extended 23  
Read Sectors 23  
Read Sectors Extended 23  
Read Sectors without Retries 23  
Read Verify Sectors 23  
Read Verify Sectors Extended 23  
Read Verify Sectors without Retries 23



- Read/write heads 5
- Read/write power 4
- read/write power and current 8
- Recording density 3, 6
- Recording method 6
- Recording technology 6
- Relative humidity 4, 10
- Reliability 13
- resistance 10
- Retries 23
- RF 12
- RoHS 15
- RPM 3
- RRL 14

## S

- S.M.A.R.T. 24
- S.M.A.R.T. implementation 23
- Safety certification 13
- SATA 6, 21
- screws 11, 19
- sector 5
- sectors 5
- Sectors per track 5
- sectors per track 3
- Security Disable Password 25
- Security Erase Prepare 25
- Security Erase Unit 25
- Security Freeze Lock 25
- Security Set Password 25
- Security Unlock 25
- Seek 23
- seek mode 8
- Seek power 4
- Seek time 7
- seek time 4
- Seeking 8
- Serial ATA 6
- Serial ATA (SATA) interface 21
- serial ATA ports 2
- Service Life 13
- servo electronics 8
- Set Features 23
- Set Max Address 23
- Set Multiple Mode 24
- Shock 11
- Shock, nonoperating 4
- Shock, operating 4
- single-track seeks 7
- Sleep 8, 24
- Sleep mode 4
- sound power 4
- Specification summary table 3
- Spindle speed 3, 6
- Spinup 8

- spinup power 8
- Standby 8, 24
- Standby Immediate 24
- Standby mode 4, 8
- Standby to Ready 7
- Standby to ready 3
- Start/stop times 7
- Startup current 3
- static-discharge 17
- support services 31
- Surge immunity 12

## T

- technical support services 31
- temperature 4, 7, 10
- Temperature gradient 4, 10
- TMR 1
- TPI 3
- Track density 3, 6
- Track-to-track seek time 4, 7
- TUV North America 13

## U

- UL 1950 13

## V

- Vibration 11
- Vibration, nonoperating 4
- Vibration, operating 4
- Voltage dips, interrupts 12
- Voltage tolerance 4, 10

## W

- Warranty 13
- Weight 3
- weight 6
- Wet bulb temperature 4, 10
- Width 3
- width 6
- Write Buffer 24
- Write DMA 24
- Write DMA Extended 24
- Write Long with Retries 24
- Write Long without Retries 24
- Write Multiple 24
- Write Sectors 24







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