A decorative graphic on the left side of the page, featuring a dashed circle, a solid blue circle, and several overlapping curved lines in blue and grey.

Product Manual

NL35 Series® 7200.2 Serial ATA

ST3500841NS
ST3500641NS

100390104
Rev. C
August 2007

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One gigabyte, or GB, equals one billion bytes when referring to hard drive capacity. Accessible capacity may vary depending on operating environment and formatting. Seagate reserves the right to change, without notice, product offerings or specifications.

Contents

1.0	Introduction	1
1.1	About the Serial ATA interface	2
2.0	Drive specifications	3
2.1	Formatted capacity*	3
2.1.1	LBA mode	3
2.2	Default logical geometry	3
2.3	Recording and interface technology	4
2.4	Physical characteristics	4
2.5	Seek time	4
2.6	Start/stop times	5
2.7	Power specifications	5
2.7.1	Power consumption	5
2.7.2	Conducted noise	6
2.7.3	Voltage tolerance	6
2.7.4	Power-management modes	7
2.8	Environmental specifications	8
2.8.1	Ambient temperature	8
2.8.2	Temperature gradient	8
2.8.3	Humidity	8
2.8.4	Altitude	8
2.8.5	Shock	8
2.8.6	Vibration	9
2.9	Acoustics	9
2.10	Electromagnetic immunity	10
2.11	Reliability	10
2.12	Agency certification	11
2.12.1	Safety certification	11
2.12.2	Electromagnetic compatibility	11
2.12.3	FCC verification	11
2.13	Environmental protection	12
2.13.1	European Union Restriction of Hazardous Substances (RoHS)	12
2.14	Corrosive environment	13
3.0	Configuring and mounting the drive	15
3.1	Handling and static-discharge precautions	15
3.2	Configuring the drive	16
3.3	Serial ATA cables and connectors	16
3.4	Drive mounting	17
4.0	Serial ATA (SATA) interface	19
4.1	Hot-Plug compatibility	19
4.2	Serial ATA device plug connector pin definitions	20
4.3	Supported ATA commands	21
4.3.1	Identify Device command	23
4.3.2	Set Features command	26
4.3.3	S.M.A.R.T. commands	27
5.0	Seagate Technology support services	29

List of Figures

Figure 1.	Typical 12V startup and operation current profile	6
Figure 2.	Jumper options	16
Figure 3.	Attaching SATA cabling	16
Figure 4.	Mounting dimensions—top, side and end view	17

1.0 Introduction

This manual describes the functional, mechanical and interface specifications for the following Seagate NL35 Series 7200.2 Serial ATA model drives:

NL35 Series 7200.2 Serial ATA

- ST3500841NS
- ST3500641NS

These drives provide the following key features:

- 7,200 RPM spindle speed.
- 8 Mbyte buffer on ST3500841NS drives
16 Mbyte buffer on ST3500641NS drives
- High instantaneous (burst) data-transfer rates.
- Tunneling Magnetoresistive (TMR) recording heads.
- State-of-the-art cache and on-the-fly error-correction algorithms.
- Native Command Queuing with command ordering to increase performance in demanding applications.
- Full-track multiple-sector transfer capability without local processor intervention.
- Quiet operation.
- 350 Gs nonoperating shock.
- 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.
- Supports hotplug operation per SATA II specification.
- Supports S.M.A.R.T. Command Transport (SCT) to provide enterprise-like features in an industry-accepted transport mechanism. See Section 4.3.3.1 for additional information about SCT.
- Supports the Write Same command to allow large writes without host interface overhead.
- Supports Error Recovery Control to allow the host to put a soft time limit on read and write commands.
- One-Step Microcode Download which allows enterprise clients to download new drive code with a single download command using the host download utility.
- Workload management features to manage drive temperature and activity. This optimizes drive reliability in nearline environments with no user intervention required.

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 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 ST3500841NS and ST3500641NS models.

2.1 Formatted capacity*

Model	Formatted capacity	Guaranteed sectors	Bytes per sector
ST3500641NS and ST3500841NS	500 Gbytes	976,773,168	512

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

2.1.1 LBA mode

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

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.

2.2 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.

2.3 Recording and interface technology

Interface	Serial ATA (SATA)
Recording method	16/17 EPRML
Recording density BPI (bits/inch max)	790.7k
Track density TPI (tracks/inch avg)	134.4k
Areal density (Gbits/inch ² avg)	106.35
Spindle speed (RPM) (± 0.2%)	7,200
Internal data transfer rate (Mbits/sec max)	754
Sustained transfer rate (Mbytes/sec)	65
I/O data-transfer rate (Mbytes/sec max)	300
Interleave	1:1
Cache buffer	8 Mbytes (8,192 kbytes) on ST3500841NS drives 16 Mbytes (16,384 kbytes) on ST3500641NS drives.

2.4 Physical characteristics

Maximum height (mm) (inches)	26.11 1.028
Maximum width (mm) (inches)	101.85 4.010
Maximum length (mm) (inches)	146.99 5.787
Maximum weight (grams) (pounds)	710 1.57

2.5 Seek time

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

- Track-to-track seek time is an average of all possible single-track seeks in both directions.
- Average seek time is a true statistical random average of at least 5,000 measurements of seeks between random tracks, less overhead.

Typical seek times (msec)	Read	Write
Track-to-track	0.8	1.0
Average	8.0	9.0
Average latency:	4.16	4.16

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

2.6 Start/stop times

Power-on to Ready (sec)	10 (max)
Standby to Ready (sec)	10 (max)
Ready to spindle stop (sec)	12 (max)

2.7 Power specifications

The drive receives DC power (+5V or +12V) through a native SATA power connector. See Figure 3 on page 16.

2.7.1 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 5.0V and 12.0V input voltage at 25°C ambient temperature.

- **Spinup power**

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

- **Seek mode**

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

- **Read/write power and current**

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

- **Operating power and current**

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

- **Idle mode power**

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

- **Standby mode**

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

Table 1: DC power requirements

Power dissipation	Average (25° C)
Spinup	2.9 Amps
Idle*	10.40 watts
Operating (40% r/w, 40% seek, 20% inop.)	13.00 watts
Seeking (random, 20% idle)	12.60 watts
Standby	0.80 watts
Sleep	0.80 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.

2.7.1.1 Typical current profile

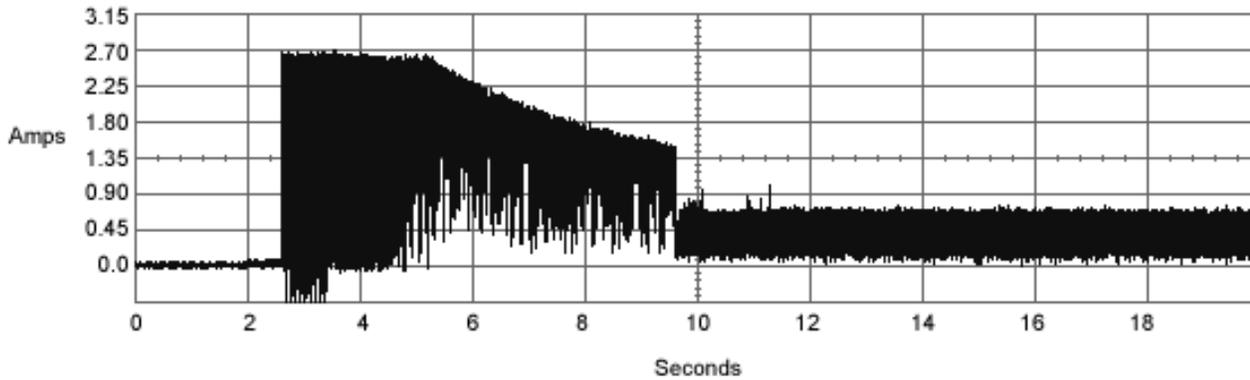


Figure 1. Typical 12V startup and operation current profile

2.7.2 Conducted noise

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

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

2.7.3 Voltage tolerance

Voltage tolerance (including noise):

5V \pm 5%

12V \pm 10%

2.7.4 Power-management modes

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

Power modes	Heads	Spindle	Buffer
Active	Tracking	Rotating	Enabled
Idle	Tracking	Rotating	Enabled
Standby	Parked	Stopped	Enabled
Sleep	Parked	Stopped	Disabled

- **Active mode**

The drive is in Active mode during the read/write and seek operations.

- **Idle mode**

The buffer remains enabled, and the drive accepts all commands and returns to Active mode any time disc access is necessary.

- **Standby mode**

The drive enters Standby mode when the host sends a Standby Immediate command. If the host has set the standby timer, the drive can also enter Standby mode automatically after the drive has been inactive for a specifiable length of time. The standby timer delay is established using a Standby or Idle command. In Standby mode, the drive buffer is enabled, the heads are parked and the spindle is at rest. The drive accepts all commands and returns to Active mode any time disc access is necessary.

- **Sleep mode**

The drive enters Sleep mode after receiving a Sleep command from the host. In Sleep mode, the drive buffer is disabled, the heads are parked and the spindle is at rest. The drive leaves Sleep mode after it receives a Hard Reset or Soft Reset from the host. After receiving a reset, the drive exits Sleep mode and enters Standby mode with all current translation parameters intact.

- **Idle and Standby timers**

Each time the drive performs an Active function (read, write or seek), the standby timer is reinitialized and begins counting down from its specified delay times to zero. If the standby timer reaches zero before any drive activity is required, the drive makes a transition to Standby mode. In both Idle and Standby mode, the drive accepts all commands and returns to Active mode when disc access is necessary.

2.8 Environmental specifications

2.8.1 Ambient temperature

Ambient temperature is defined as the temperature of the environment immediately surrounding the drive. Actual drive case temperature should not exceed 69°C (156°F) within the operating ambient conditions.

Above 1,000 feet (305 meters), the maximum temperature is derated linearly to 112°F (44°C) at 10,000 feet (3,048 meters).

Operating:	0° to 60°C (32° to 140°F)
Nonoperating:	−40° to 70°C (−40° to 158°F)

2.8.2 Temperature gradient

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

2.8.3 Humidity

2.8.3.1 Relative humidity

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

2.8.3.2 Wet bulb temperature

Operating:	37.7°C (99.9°F max)
Nonoperating:	40°C (104°F max)

2.8.4 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.)

2.8.5 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.

2.8.5.1 Operating shock

These drives comply with the performance levels specified in this document when subjected to a maximum operating shock of 63 Gs based on half-sine shock pulses of 2 msec. Shocks should not be repeated more than two times per second.

2.8.5.2 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 350 Gs based on a nonrepetitive half-sine shock pulse of 2 msec duration.

2.8.6 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.

2.8.6.1 Operating vibration

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

5–22 Hz	0.25 Gs (Limited displacement)
23–350 Hz	0.50 Gs
351–500 Hz	0.25 Gs

2.8.6.2 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.

5–22 Hz	0.25 Gs (Limited displacement)
23–350 Hz	5.0 Gs
351–500 Hz	1.0 Gs

2.9 Acoustics

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

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

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

Table 2: Fluid Dynamic Bearing (FDB) motor acoustics

Idle*	Quiet seek
2.8 bels (typ) 2.86 bels (max)	2.9 bels (typ) 2.93 bels (max)

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

2.10 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 3: Radio frequency environments

Test	Description	Performance level	Reference standard
Electrostatic discharge	Contact, HCP, VCP: ± 4 kV; Air: ± 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	± 1 kV on AC mains, ± 0.5 kV on external I/O	B	EN 61000-4-4: 95
Surge immunity	± 1 kV differential, ± 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

Nonrecoverable read errors	1 per 10^{14} bits read, max
Annualized Failure Rate (AFR)	0.34% (nominal power, 25°C ambient temperature)
Contact start-stop cycles	50,000 cycles (at nominal voltage and temperature, with 60 cycles per hour and a 50% duty cycle)
Warranty	5 years on distribution units. To determine the warranty for a specific drive, use a web browser to access the following web page: www.seagate.com/support/service/ 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.
Preventive maintenance	None required.

2.12 Agency certification

2.12.1 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.

2.12.2 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): ST3500641NS and ST3500841NS
- Certificate numbers: ST3500641NS E-H011-05-3453 (B)
 ST3500841NS E-H011-05-3453 (B)
- Trade name or applicant: Seagate Technology
- Manufacturing date: October 2005
- Manufacturer/nationality: 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).

2.12.3 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, 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.

2.13 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)

Compliance statement

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.

2.14 Corrosive environment

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

3.0 Configuring and mounting the drive

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

3.1 Handling and static-discharge precautions

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

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 extremely fragile—handle it with care. Do not press down on the drive top cover.
- Always rest the drive on a padded, antistatic surface until 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. It is usually not necessary to set any jumpers on the drive for proper operation; however, 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 speed autonegotiation. If you have a motherboard or host adapter that does not support autonegotiation:

- Install a jumper as shown in Figure 2 below to limit the data transfer rate to 1.5 Gbits per second (and leave the drive connected to the SATA-equipped motherboard or host adapter that doesn't support autonegotiation) or
- Install a SATA host adapter that supports autonegotiation, leave the drive jumper block set to “Normal operation” (see Figure 2 below), and connect the drive to that adapter. This option has the benefit of not limiting the drive to a 1.5 Gbits/sec transfer rate.

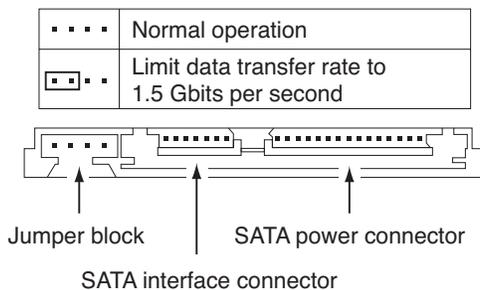


Figure 2. Jumper options

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 4 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 3.

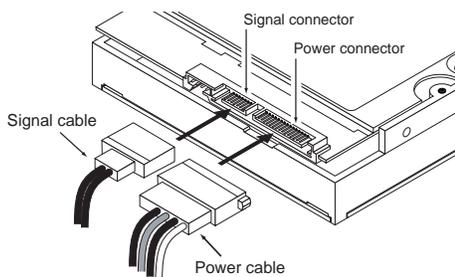


Figure 3. Attaching SATA cabling

Each cable is keyed to ensure correct orientation. NL35 Series 7200.2 Serial ATA 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 4 on page 17 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 6-32 UNC mounting screws.
- The screws should be inserted no more than 0.150 inch (3.81 mm) into the bottom or side mounting holes.
- Do not overtighten the mounting screws (maximum torque: 6 inch-lb).

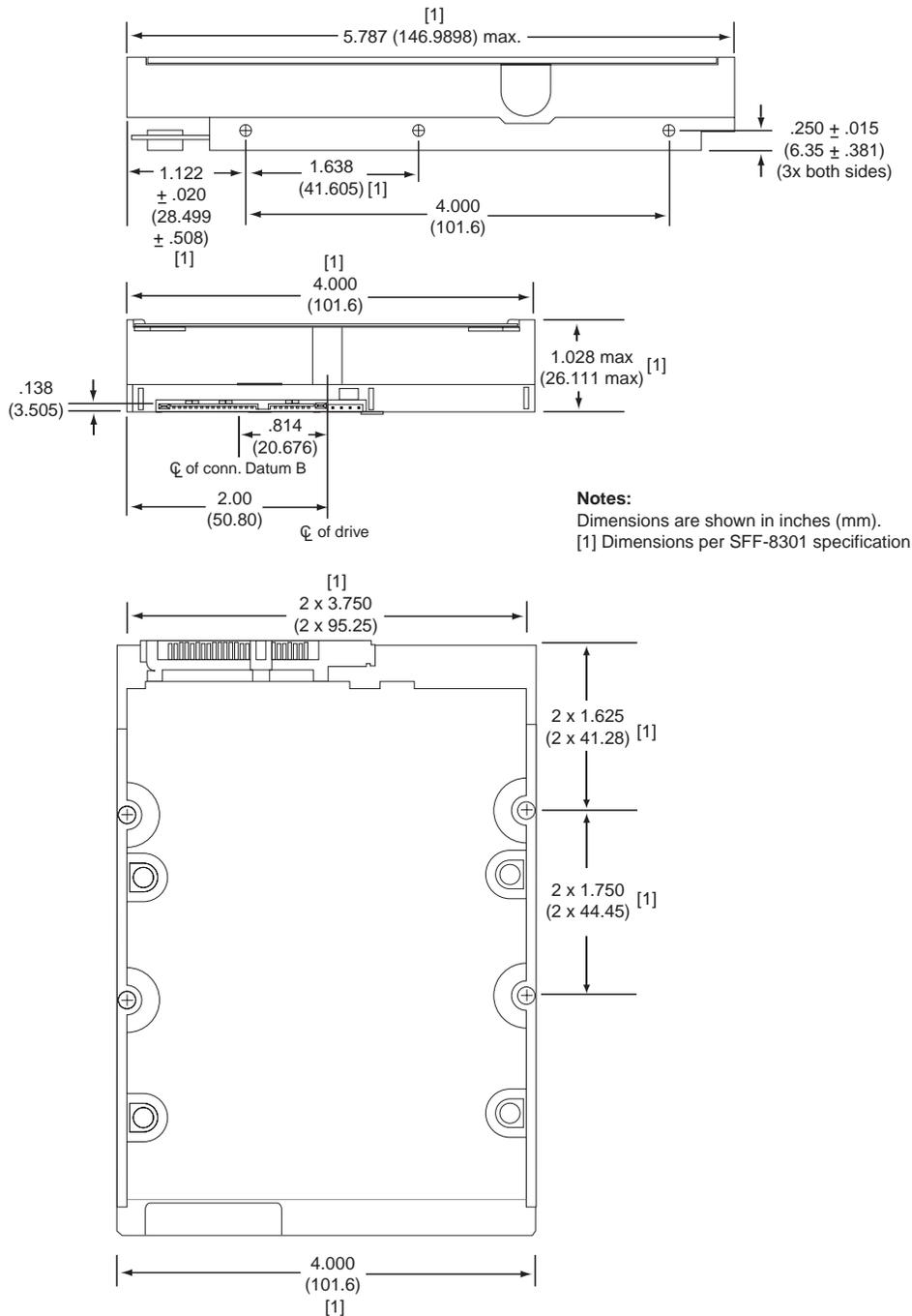


Figure 4. Mounting dimensions—top, side and end view

4.0 Serial ATA (SATA) interface

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

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

4.1 Hot-Plug compatibility

NL35 Series 7200.2 Serial ATA 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.serialata.org.

4.2 Serial ATA device plug connector pin definitions

Table 4 summarizes the signals on the Serial ATA interface and power connectors..

Table 4: Serial ATA connector pin definitions

Segment	Pin	Function	Definition
Signal	S1	Ground	2nd mate
	S2	A+	Differential signal pair A from Phy
	S3	A-	
	S4	Ground	2nd mate
	S5	B-	Differential signal pair B from Phy
	S6	B+	
	S7	Ground	2nd mate

Key and spacing separate signal and power segments

Power	P1	V ₃₃	3.3V power
	P2	V ₃₃	3.3V power
	P3	V ₃₃	3.3V power, pre-charge, 2nd mate
	P4	Ground	1st mate
	P5	Ground	2nd mate
	P6	Ground	2nd mate
	P7	V ₅	5V power, pre-charge, 2nd mate
	P8	V ₅	5V power
	P9	V ₅	5V power
	P10	Ground	2nd mate
	P11	Ground or LED signal	If grounded, drive does not use deferred spin
	P12	Ground	1st mate.
	P13	V ₁₂	12V power, pre-charge, 2nd mate
	P14	V ₁₂	12V power
	P15	V ₁₂	12V power

Notes:

1. All pins are in a single row, with a 1.27 mm (0.050") pitch.
2. The comments on the mating sequence apply to the case of backplane blindmate connector only. In this case, the mating sequences are:
 - the ground pins P4 and P12.
 - the pre-charge power pins and the other ground pins.
 - the signal pins and the rest of the power pins.
3. There are three power pins for each voltage. One pin from each voltage is used for pre-charge when installed in a blind-mate backplane configuration.
4. All used voltage pins (V_x) 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 27 for details and subcommands used in the S.M.A.R.T. implementation.

Table 5: Supported ATA commands

Command name	Command code (in hex)
Check Power Mode	98 _H or E5 _H
Device Configuration Freeze Lock	B1 _H / C1 _H
Device Configuration Identify	B1 _H / C2 _H
Device Configuration Restore	B1 _H / C0 _H
Device Configuration Set	B1 _H / C3 _H
Device Reset	08 _H
Download Microcode	92 _H
Execute Device Diagnostics	90 _H
Flush Cache	E7 _H
Flush Cache Extended	EA _H
Format Track	50 _H
Identify Device	EC _H
Idle	97 _H or E3 _H
Idle Immediate	95 _H or E1 _H
Initialize Device Parameters	91 _H
Read Buffer	E4 _H
Read DMA	C8 _H
Read DMA Extended	25 _H
Read DMA Without Retries	C9 _H
Read Log Ext	2F _H
Read Multiple	C4 _H
Read Multiple Extended	29 _H
Read Native Max Address	F8 _H
Read Native Max Address Extended	27 _H
Read Sectors	20 _H
Read Sectors Extended	24 _H
Read Sectors Without Retries	21 _H
Read Verify Sectors	40 _H
Read Verify Sectors Extended	42 _H
Read Verify Sectors Without Retries	41 _H
Recalibrate	10 _H
Security Disable Password	F6 _H
Security Erase Prepare	F3 _H

Command name	Command code (in hex)
Security Erase Unit	F4 _H
Security Freeze	F5 _H
Security Set Password	F1 _H
Security Unlock	F2 _H
Seek	70 _H
Set Features	EF _H
Set Max Address Note: Individual Set Max Address commands are identified by the value placed in the Set Max Features register as defined to the right.	F9 _H Address: 00 _H Password: 01 _H Lock: 02 _H Unlock: 03 _H Freeze Lock: 04 _H
Set Max Address Extended	37 _H
Set Multiple Mode	C6 _H
Sleep	99 _H or E6 _H
S.M.A.R.T. Disable Operations	B0 _H / D9 _H
S.M.A.R.T. Enable/Disable Autosave	B0 _H / D2 _H
S.M.A.R.T. Enable Operations	B0 _H / D8 _H
S.M.A.R.T. Execute Offline	B0 _H / D4 _H
S.M.A.R.T. Read Attribute Thresholds	B0 _H / D1 _H
S.M.A.R.T. Read Data	B0 _H / D0 _H
S.M.A.R.T. Read Log Sector	B0 _H / D5 _H
S.M.A.R.T. Return Status	B0 _H / DA _H
S.M.A.R.T. Save Attribute Values	B0 _H / D3 _H
S.M.A.R.T. Write Log Sector	B0 _H / D6 _H
Standby	96 _H or E2 _H
Standby Immediate	94 _H or E0 _H
Write Buffer	E8 _H
Write DMA	CA _H
Write DMA Extended	35 _H
Write DMA FUA Extended	CD _H
Write DMA Without Retries	CB _H
Write Log Extended	3F _H
Write Multiple	C5 _H
Write Multiple Extended	39 _H
Write Multiple FUA Extended	CE _H
Write Sectors	30 _H
Write Sectors Without Retries	31 _H
Write Sectors Extended	34 _H

4.3.1 Identify Device command

The Identify Device command (command code EC_H) transfers information about the drive to the host following power up. The data is organized as a single 512-byte block of data, whose contents are shown in Table 5 on page 21. All reserved bits or words should be set to zero. Parameters listed with an “x” are drive-specific or vary with the state of the drive. 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 _H
1	Number of logical cylinders	16,383
2	ATA-reserved	0000 _H
3	Number of logical heads	16
4	Retired	0000 _H
5	Retired	0000 _H
6	Number of logical sectors per logical track: 63	003F _H
7–9	Retired	0000 _H
10–19	Serial number: (20 ASCII characters, 0000 _H = none)	ASCII
20	Retired	0000 _H
21	Retired	0400 _H
22	Obsolete	0000 _H
23–26	Firmware revision (8 ASCII character string, padded with blanks to end of string)	x.xx
27–46	Drive model number: (40 ASCII characters, padded with blanks to end of string)	ST3500641NS ST3500841NS
47	(Bits 7–0) Maximum sectors per interrupt on Read multiple and Write multiple (16)	8010 _H
48	Reserved	0000 _H
49	Standard Standby timer, IORDY supported and may be disabled	2F00 _H
50	ATA-reserved	0000 _H
51	PIO data-transfer cycle timing mode	0200 _H
52	Retired	0200 _H
53	Words 54–58, 64–70 and 88 are valid	0007 _H
54	Number of current logical cylinders	xxxx _H
55	Number of current logical heads	xxxx _H
56	Number of current logical sectors per logical track	xxxx _H
57–58	Current capacity in sectors	xxxx _H
59	Number of sectors transferred during a Read Multiple or Write Multiple command	xxxx _H

Word	Description	Value
60–61	Total number of user-addressable LBA sectors available (see Section 2.1 for related information) *Note: The maximum value allowed in this field is: 0FFFFFFFh (268,435,455 sectors, 137 Gbytes). Drives with capacities over 137 Gbytes will have 0FFFFFFFh in this field and the actual number of user-addressable LBAs specified in words 100-103. This is required for drives that support the 48-bit addressing feature.	0FFFFFFFh*
62	Retired	0000 _H
63	Multiword DMA active and modes supported (see note following this table)	xx07 _H
64	Advanced PIO modes supported (modes 3 and 4 supported)	0003 _H
65	Minimum multiword DMA transfer cycle time per word (120 nsec)	0078 _H
66	Recommended multiword DMA transfer cycle time per word (120 nsec)	0078 _H
67	Minimum PIO cycle time without IORDY flow control (240 nsec)	00F0 _H
68	Minimum PIO cycle time with IORDY flow control (120 nsec)	0078 _H
69–74	ATA-reserved	0000 _H
75	Queue depth	0000 _H
76	Serial ATA capabilities	xxxx _H
77	Reserved for future Serial ATA definition	xxxx _H
78	Serial ATA features supported	xxxx _H
79	Serial ATA features enabled	xxxx _H
80	Major version number	003E _H
81	Minor version number	0000 _H
82	Command sets supported	364B _H
83	Command sets supported	7C03 _H
84	Command sets support extension	4003 _H
85	Command sets enabled	30xx _H
86	Command sets enabled	0001 _H
87	Command sets enable extension	4000 _H
88	Ultra DMA support and current mode (see note following this table)	xx3F _H
89	Security erase time	0000 _H
90	Enhanced security erase time	0000 _H
92	Master password revision code	FFFE _H
93	Hardware reset value (see description following this table)	xxxx _H
95–99	ATA-reserved	0000 _H
100–103	Total number of user-addressable LBA sectors available (see Section 2.1 for related information). These words are required for drives that support the 48-bit addressing feature. Maximum value: 0000FFFFFFFFFh.	ST3500641NS = 976,773,168 ST3500841NS = 976,773,168
104–127	ATA-reserved	0000 _H
128	Security status	0001 _H

Word	Description	Value
129–159	Seagate-reserved	xxxx _H
160–254	ATA-reserved	0000 _H
255	Integrity word	xxA5 _H

Note. Advanced Power Management (APM) and Automatic Acoustic Management (AAM) features are not supported

Note. See the bit descriptions below for words 63, 88, and 93 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.
5	Ultra DMA mode 5 is supported.
6	Ultra DMA mode 6 is supported.
8	Ultra DMA mode 0 is currently active.
9	Ultra DMA mode 1 is currently active.
10	Ultra DMA mode 2 is currently active.
11	Ultra DMA mode 3 is currently active.
12	Ultra DMA mode 4 is currently active.
13	Ultra DMA mode 5 is currently active.
14	Ultra DMA mode 6 is currently active.

4.3.2 Set Features command

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

Table 6: Set Features command values

02 _H	Enable write cache (<i>default</i>).
03 _H	Set transfer mode (based on value in Sector Count register). Sector Count register values:
00 _H	Set PIO mode to default (PIO mode 2).
01 _H	Set PIO mode to default and disable IORDY (PIO mode 2).
08 _H	PIO mode 0
09 _H	PIO mode 1
0A _H	PIO mode 2
0B _H	PIO mode 3
0C _H	PIO mode 4 (<i>default</i>)
20 _H	Multiword DMA mode 0
21 _H	Multiword DMA mode 1
22 _H	Multiword DMA mode 2
40 _H	Ultra DMA mode 0
41 _H	Ultra DMA mode 1
42 _H	Ultra DMA mode 2
43 _H	Ultra DMA mode 3
44 _H	Ultra DMA mode 4
45 _H	Ultra DMA mode 5
46 _H	Ultra DMA mode 6
10 _H	Enable use of SATA features
55 _H	Disable read look-ahead (read cache) feature.
82 _H	Disable write cache
90 _H	Disable use of SATA features
AA _H	Enable read look-ahead (read cache) feature (<i>default</i>).
F1 _H	Report full capacity available

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

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

S.M.A.R.T. provides near-term failure prediction for 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_H) that eliminates unnecessary drive returns. The diagnostic software ships with all new drives and is also available at: <http://seatools.seagate.com>.

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

Table 7: S.M.A.R.T. commands

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

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

4.3.3.1 S.M.A.R.T. Command Transport (SCT)

NL35 Series 7200.2 Serial ATA drives implement SCT technologies to enable the drive to perform in a nearline storage environment.

The command transport uses log sectors to pass-through commands, to inquire about status, and to control data flow. For detailed information about SCT, refer to the T13 working draft 1701DT-N, Rev. 5 (or later). T13 working draft publications are available in PDF form at the following URL:

<http://www.t13.org/docs2005/DT1701r5-SCT.pdf>

Or, for the latest list of downloadable working drafts, go to the following URL and download the latest revision:

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Data Recovery Services

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Index

A

- ACA 11
- acceleration 9
- acoustics 9
- Active 7
- Active mode 7
- actuator arm 5
- AFR 10
- Agency certification 11
- altitude 8
- Ambient temperature 8
- ambient temperature 4, 5
- Annualized Failure Rate 10
- Areal density 4
- ATA commands 21
- Australia/New Zealand Standard AS/NZS3548 1995 11
- Australian Communication Authority (ACA) 11
- Australian C-Tick 11
- Average latency 4
- Average seek time 4

B

- buffer 4
- Bytes per sector 3

C

- cables and connectors 16
- Cache 4
- capacity 3
- case temperature 8
- CE mark 11
- certification 11
- Check Power Mode 21
- Class B computing device 11
- compatibility 11
- Conducted noise 6
- Conducted RF immunity 10
- Configuring the drive 15
- connectors 16
- Corrosive environment 13
- CSA C22.2 (950) 11
- cycles 10
- Cylinders 3

D

- data-transfer rates 1
- DC power 5
- Default logical geometry 3
- Device Configuration Freeze Lock 21

- Device Configuration Identify 21
- Device Configuration Restore 21
- Device Configuration Set 21
- Device Reset 21
- dimensions 17
- disc surface 5
- Download Microcode 21

E

- Electrical fast transient 10
- Electromagnetic compatibility 11
- Electromagnetic Compatibility (EMC) 11
- Electromagnetic Compatibility control Regulation 11
- Electromagnetic Compatibility Directive (89/336/EEC) 11
- Electromagnetic immunity 10
- Electrostatic discharge 10
- electrostatic discharge (ESD) 15
- EN 55022, Class B 11
- EN 55024 11
- EN 60950 11
- Environmental specifications 8
- EPRML 4
- error-correction algorithms 1
- errors 10
- ESD 15
- EU 11
- European Union (EU) requirements 11
- Execute Device Diagnostics 21

F

- FCC verification 11
- features 1
- Federal Communications Commission 11
- Flush Cache 21
- Flush Cache Extended 21
- Format Track 21
- Formatted capacity 3

G

- Gbytes 3
- geometry 3
- Gs 9
- Guaranteed sectors 3
- guaranteed sectors 3

H

- Handling precautions 15
- heads 3
- humidity 8

I

- I/O data-transfer rate 4

- Identify Device 21
- Identify Device command 23
- Idle 7, 21
- Idle Immediate 21
- Idle mode 5, 7
- IEC950 11
- Information Technology Equipment (ITE) 11
- Initialize Device Parameters 21
- Input noise ripple 6
- input voltage 5
- Interface 4
- interface 19
- Interleave 4
- Internal data-transfer rate 4
- is 4
- ISO document 7779 9
- ITE 11

K

- Korea Ministry of Information and Communication (MIC) 11
- Korean RRL 11

L

- latency 4
- latency time 5
- LBA mode 3
- logical geometry 3

M

- maintenance 10
- master/slave 2
- maximum temperature 8
- MIC 11
- mounting 17
- mounting screws 8
- mounting the drive 15

N

- noise 6
- nominal power 4
- Nonoperating shock 8
- Nonoperating vibration 9
- Nonrecoverable read errors 10

O

- Operating power 5
- Operating shock 8
- Operating vibration 9

P

- Physical characteristics 4

- point-to-point 2, 16
- Power consumption 5
- power consumption 5
- Power dissipation 5
- Power modes 7
- Power specifications 5
- Power-management modes 7
- Power-on to Ready 5
- precautions 15
- printed circuit board 15
- programmable power management 7

R

- Radiated RF immunity 10
- Radio and television interference 12
- radio frequency (RF) 10
- random seeks 5
- Read Buffer 21
- Read DMA 21
- Read DMA Extended 21
- Read DMA without Retries 21
- read errors 10
- Read Log Ext 21
- Read Multiple 21
- Read Multiple Extended 21
- Read Native Max Address 21
- Read Native Max Address Extended 21
- Read Sectors 21
- Read Sectors Extended 21
- Read Sectors Without Retries 21
- Read Verify Sectors 21
- Read Verify Sectors Extended 21
- Read Verify Sectors Without Retries 21
- read/write actuator arm 5
- Read/write heads 3
- Read/write power 5
- Ready to spindle stop 5
- Recalibrate 21
- Recording density 4
- Recording method 4
- Recording technology 4
- relative humidity 8
- Reliability 10
- RF 10
- RMS read/write current 6
- RoHS 12
- RRL 11

S

- S.M.A.R.T. Disable Operations 22
- S.M.A.R.T. Enable Operations 22
- S.M.A.R.T. Enable/Disable Autosave 22
- S.M.A.R.T. Execute Offline 22
- S.M.A.R.T. implementation 21

- S.M.A.R.T. Read Attribute Thresholds 22
- S.M.A.R.T. Read Data 22
- S.M.A.R.T. Read Log Sector 22
- S.M.A.R.T. Return Status 22
- S.M.A.R.T. Save Attribute Values 22
- S.M.A.R.T. Write Log sector 22
- Safety certification 11
- SATA 4, 19
- screws 8
- sector 3
- sectors 3
- Sectors per track 3
- Security Disable Password 21
- Security Erase Prepare 21
- Security Erase Unit 22
- Security Freeze 22
- Security Set Password 22
- Security Unlock 22
- Seek 22
- seek mode 5
- Seek mode power 5
- Seek time 4
- Seeking 5
- Serial ATA 4
- Serial ATA (SATA) interface 19
- serial ATA ports 2
- Servo electronics 5
- servo electronics 5
- Set Features 22
- Set Max Address 22
- Set Max Address Extended 22
- Set Multiple Mode 22
- Shock 8
- single-track seeks 4
- Sleep 5, 7, 22
- Sleep mode 7
- Spindle speed 4
- spindle stop 5
- Spinup 5
- Spinup power 5
- Standby 5, 7, 22
- Standby Immediate 22
- Standby mode 5, 7
- standby timer 7
- Standby to Ready 5
- Start/stop times 5
- start-stop cycles 10
- static-discharge 15
- support services 29
- Surge immunity 10

T

- technical support services 29
- temperature 4, 8
- temperature gradient 8

- timer 7
- timers 7
- Track density 4
- Track-to-track 4
- Track-to-track seek time 4
- Tunneling Magnetoresistive (TMR) heads 1
- TUV North America 11

U

- UL 1950 11

V

- Vibration 9
- voltage 5
- Voltage dips, interrupts 10
- Voltage tolerance 6

W

- wet bulb temperature 8
- Write Buffer 22
- Write DMA 22
- Write DMA Extended 22
- Write DMA FUA Extended 22
- Write DMA Without Retries 22
- Write Log Extended 22
- Write Multiple 22
- Write Multiple Extended 22
- Write Multiple FUA Extended 22
- Write Sectors 22
- Write Sectors Extended 22
- Write Sectors Without Retries 22



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