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Product Manual

Barracuda ES+ Serial ATA

ST3750641NS

ST3750841NS

ST3500631NS

ST3500831NS

ST3400621NS

ST3400821NS

ST3320621NS

ST3320821NS

ST3250621NS

ST3250821NS

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Rev. B
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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.

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1.0 Introduction

This manual describes the functional, mechanical and interface specifications for the following Seagate Barracuda® ES+ Serial ATA model drives:

ST3750641NS	ST3500631NS	ST3400621NS	ST3320621NS	ST3250621NS
ST3750841NS	ST3500831NS	ST3400821NS	ST3320821NS	ST3250821NS

These drives provide the following key features:

- 7,200 RPM spindle speed.
- High instantaneous (burst) data-transfer rates (up to 300 Mbytes per second).
- Perpendicular recording technology provides the drives with increased areal density.
- State-of-the-art cache and on-the-fly error-correction algorithms.
- Native Command Queuing with command ordering to increase performance in demanding applications.
- Full-track multiple-sector transfer capability without local processor intervention.
- Quiet operation.
- SeaTools diagnostic software performs a drive self-test that eliminates unnecessary drive returns.
- Support for S.M.A.R.T. drive monitoring and reporting.
- Supports IOEDC.
- Supports latching SATA cables and connectors,

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.

1.2 IOEDC overview

- This is a protection scheme designed to protect the integrity of the user data sent to/from the host computer. It is a detection code, not a correction code.
- Detection code is utilized to report an error to a higher level system layer with the expectation that the system layer will be able to either retry the transfer of the bad data or correct the bad data through some other higher layer mechanism.
- For example, some RAID systems are capable of fixing bad data sent from a disc drive, providing the disc drive correctly identifies the bad data. IOEDC, consists of appending a two byte detection code (parity) to every 512 byte interface block (payload).

2.0 Drive specifications

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

ST3750641NS	ST3500631NS	ST3400621NS	ST3320621NS	ST3250621NS
ST3750841NS	ST3500831NS	ST3400821NS	ST3320821NS	ST3250821NS

2.1 Specification summary tables

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

Table 1: Drive specifications summary for 750 Gbyte models

Drive specification	ST3750641NS	ST3750841NS
Formatted Gbytes (512 bytes/sector)*	750	
Guaranteed sectors	1,465,149,168	
Heads	8	8
Discs	4	4
Bytes per sector	512	
Default sectors per track	63	
Default read/write heads	16	
Default cylinders	16,383	
Recording density, KBPI (kbits/in max)	926	
Track density, KTPI (ktracks/in avg.)	145	
Areal density, (Gbits/in ² avg)	128.2	
Spindle speed (RPM)	7,200	
Internal data transfer rate (Mbits/sec max)	1,030	
Sustained data transfer rate OD (Mbytes/sec max)	78	
I/O data-transfer rate (Mbytes/sec max)	300	
ATA data-transfer modes supported	PIO modes 0–4 Multiword DMA modes 0–2 Ultra DMA modes 0–6	
Cache buffer	16 Mbytes	8 Mbytes
Height (mm max)	26.1 mm (1.028 inches)	
Width (mm max)	101.6 mm (4.000 inches) +/- 0.010 inches	
Length (mm max)	146.99 mm (5.787 inches)	
Weight (max)	720 grams (1.58 lbs)	
Average latency	4.16 msec	
Power-on to ready (sec max)	15 sec	
Standby to ready (sec max)	15 sec	
Track-to-track seek time (msec typical)	<0.8 read; <1.0 write	
Average seek, read (msec typical)	<8.5	
Average seek, write (msec typical)	<9.5	
Startup current (typical) 12V (peak)	2.8 amps	
Voltage tolerance (including noise)	5V ± 5% 12V ± 10%	
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)	37.7 (operating) 37.7 (nonoperating)	
Altitude, operating	–60.96 m to 3,048 m (–200 ft. to 10,000+ ft.)	
Altitude, nonoperating (below mean sea level, max)	–60.96 m to 12,192 m (–200 ft. to 40,000+ ft.)	
Operational Shock (max at 2 msec)	63 Gs	
Non-Operational Shock (max at 2 msec)	300 Gs	

Drive specification	ST3750641NS	ST3750841NS
Vibration, operating	5–22 Hz: 0.25 Gs, Limited displacement 22–350 Hz: 0.50 Gs 350–500 Hz: 0.25 Gs	
Vibration, nonoperating	5–22 Hz: 0.25 Gs, Limited displacement 22–350 Hz: 5.0 Gs 350–500 Hz: 1.0 Gs	
Drive acoustics, sound power (bels)		
Idle**	2.7 (typical) 3.0 (max)	
Performance seek	3.2 (typical) 3.9 (max)	
Nonrecoverable read errors	1 sector per 10 ¹⁵ bits read	
Annualized Failure Rate (AFR)	0.73%	
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.	
Contact start-stop cycles (25°C, 50% rel. humidity)	50,000	
Supports Hotplug operation per Serial ATA Revision 2.5 specification	Yes	

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

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

Table 2: Drive specifications summary for 500 Gbyte models

Drive specification	ST3500631NS	ST3500831NS
Formatted Gbytes (512 bytes/sector)*	500	
Guaranteed sectors	976,773,168	
Heads	6	
Discs	3	
Bytes per sector	512	
Default sectors per track	63	
Default read/write heads	16	
Default cylinders	16,383	
Recording density, KBPI (kbits/in max)	813	
Track density, KTPI (ktracks/in avg.)	145	
Areal density, (Gbits/in ² avg)	114.4	
Spindle speed (RPM)	7,200	
Internal data transfer rate (Mbits/sec max)	1,030	
Sustained data transfer rate OD (Mbytes/sec max)	72	
I/O data-transfer rate (Mbytes/sec max)	300	
ATA data-transfer modes supported	PIO modes 0–4 Multiword DMA modes 0–2 Ultra DMA modes 0–6	
Cache buffer	16 Mbytes	8 Mbytes
Height (mm max)	26.1 mm (1.028 inches)	
Width (mm max)	101.6 mm (4.000 inches) +/- 0.010 inches	
Length (mm max)	146.99 mm (5.787 inches)	
Weight (max)	635 grams (1.40 lbs)	
Average latency (msec)	4.16	
Power-on to ready (sec max)	15 sec	
Standby to ready (sec max)	15 sec	
Track-to-track seek time (msec typical)	<0.8 (read), <1.0 (write)	
Average seek, read (msec typical)	<8.5	
Average seek, write (msec typical)	<9.5	
Startup current (typical) 12V (peak)	2.8 amps	
Voltage tolerance (including noise)	5V ± 5% 12V ± 10%	
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)	37.7 (operating) 37.7 (nonoperating)	
Altitude, operating	–60.96 m to 3,048 m (–200 ft. to 10,000+ ft.)	
Altitude, nonoperating (below mean sea level, max)	–60.96 m to 12,192 m (–200 ft. to 40,000+ ft.)	
Operational Shock (max at 2 msec)	63 Gs	
Non-Operational Shock (max at 2 msec)	300 Gs	

Drive specification	ST3500631NS	ST3500831NS
Vibration, operating	5–22 Hz: 0.25 Gs, Limited displacement 22–350 Hz: 0.50 Gs 350–500 Hz: 0.25 Gs	
Vibration, nonoperating	5–22 Hz: 0.25 Gs, Limited displacement 22–350 Hz: 5.0 Gs 350–500 Hz: 1.0 Gs	
Drive acoustics, sound power (bels)		
Idle**	2.5 (typical) 2.8 (max)	
Performance seek	3.2 (typical) 3.5 (max)	
Nonrecoverable read errors	1 sector per 10 ¹⁵ bits read	
Annualized Failure Rate (AFR)	0.73%	
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.	
Contact start-stop cycles (25°C, 50% rel. humidity)	50,000	
Supports Hotplug operation per SATA II specification	Yes	

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

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

Table 3: Drive specifications summary for 400 Gbyte models

Drive specification	ST3400621NS	ST3400821NS
Formatted Gbytes (512 bytes/sector)*	400	
Guaranteed sectors	781,422,768	
Heads	5	
Discs	3	
Bytes per sector	512	
Default sectors per track	63	
Default read/write heads	16	
Default cylinders	16,383	
Recording density, KBPI (kbits/in max)	781	
Track density, KTPI (ktracks/in avg.)	145	
Areal density, (Gbits/in ² avg)	128.2	
Spindle speed (RPM)	7,200	
Internal data transfer rate (Mbits/sec max)	1,030	
Sustained data transfer rate OD (Mbytes/sec max)	72	
I/O data-transfer rate (Mbytes/sec max)	300	
ATA data-transfer modes supported	PIO modes 0–4 Multiword DMA modes 0–2 Ultra DMA modes 0–6	
Cache buffer	16 Mbytes	8 Mbytes
Height (mm max)	26.1 mm (1.028 inches)	
Width (mm max)	101.6 mm (4.000 inches) +/- 0.010 inches	
Length (mm max)	146.99 mm (5.787 inches)	
Weight (max)	635 grams (1.40 lbs)	
Average latency (msec)	4.16	
Power-on to ready (sec max)	15 sec	
Standby to ready (sec max)	15 sec	
Track-to-track seek time (msec typical)	<0.8 (read), <1.0 (write)	
Average seek, read (msec typical)	<8.5	
Average seek, write (msec typical)	<10.0	
Startup current (typical) 12V (peak)	2.8 amps	
Voltage tolerance (including noise)	5V ± 5% 12V ± 10%	
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)	37.7 (operating) 37.7 (nonoperating)	
Altitude, operating	–60.96 m to 3,048 m (–200 ft. to 10,000+ ft.)	
Altitude, nonoperating (below mean sea level, max)	–60.96 m to 12,192 m (–200 ft. to 40,000+ ft.)	
Operational Shock (max at 2 msec)	63 Gs	
Non-Operational Shock (max at 2 msec)	300 Gs	

Drive specification	ST3400621NS	ST3400821NS
Vibration, operating	5–22 Hz: 0.25 Gs, Limited displacement 22–350 Hz: 0.50 Gs 350–500 Hz: 0.25 Gs	
Vibration, nonoperating	5–22 Hz: 0.25 Gs, Limited displacement 22–350 Hz: 5.0 Gs 350–500 Hz: 1.0 Gs	
Drive acoustics, sound power (bels)		
Idle**	2.5 (typical) 2.8 (max)	
Performance seek	3.2 (typical) 3.5 (max)	
Nonrecoverable read errors	1 sector per 10 ¹⁵ bits read	
Annualized Failure Rate (AFR)	0.73%	
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.	
Contact start-stop cycles (25°C, 50% rel. humidity)	50,000	
Supports Hotplug operation per SATA II specification	Yes	

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

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

Table 4: Drive specifications summary for 320 Gbyte models

Drive specification	ST3320621NS	ST3320821NS
Formatted Gbytes (512 bytes/sector)*	320	
Guaranteed sectors	625,142,448	
Heads	4	
Discs	2	
Bytes per sector	512	
Default sectors per track	63	
Default read/write heads	16	
Default cylinders	16,383	
Recording density, KBPI (kbits/in max)	781	
Track density, KTPI (ktracks/in avg.)	145	
Areal density, (Gbits/in ² avg)	114.4	
Spindle speed (RPM)	7,200	
Internal data transfer rate (Mbits/sec max)	1,030	
Sustained data transfer rate OD (Mbytes/sec max)	72	
I/O data-transfer rate (Mbytes/sec max)	300	
ATA data-transfer modes supported	PIO modes 0–4 Multiword DMA modes 0–2 Ultra DMA modes 0–6	
Cache buffer	16 Mbytes	8 Mbytes
Height (mm max)	26.1 mm (1.028 inches)	
Width (mm max)	101.6 mm (4.000 inches) +/- 0.010 inches	
Length (mm max)	146.99 mm (5.787 inches)	
Weight (max)	635 grams (1.40 lbs)	
Average latency (msec)	4.16	
Power-on to ready (sec max)	15 sec	
Standby to ready (sec max)	15 sec	
Track-to-track seek time (msec typical)	<0.8 (read), <1.0 (write)	
Average seek, read (msec typical)	<8.5	
Average seek, write (msec typical)	<10.0	
Startup current (typical) 12V (peak)	2.8 amps	
Voltage tolerance (including noise)	5V ± 5% 12V ± 10%	
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)	37.7 (operating) 37.7 (nonoperating)	
Altitude, operating	–60.96 m to 3,048 m (–200 ft. to 10,000+ ft.)	
Altitude, nonoperating (below mean sea level, max)	–60.96 m to 12,192 m (–200 ft. to 40,000+ ft.)	
Operational Shock (max at 2 msec)	63 Gs	
Non-Operational Shock (max at 2 msec)	350 Gs	

Drive specification	ST3320621NS	ST3320821NS
Vibration, operating	5–22 Hz: 0.25 Gs, Limited displacement 22–350 Hz: 0.50 Gs 350–500 Hz: 0.25 Gs	
Vibration, nonoperating	5–22 Hz: 0.25 Gs, Limited displacement 22–350 Hz: 5.0 Gs 350–500 Hz: 1.0 Gs	
Drive acoustics, sound power (bels)		
Idle**	2.5 (typical) 2.8 (max)	
Performance seek	3.2 (typical) 3.5 (max)	
Nonrecoverable read errors	1 sector per 10 ¹⁵ bits read	
Annualized Failure Rate (AFR)	0.73%	
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.	
Contact start-stop cycles (25°C, 50% rel. humidity)	50,000	
Supports Hotplug operation per SATA II specification	Yes	

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

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

Table 5: Drive specifications summary for 250 Gbyte models

Drive specification	ST3250621NS	ST3250821NS
Formatted Gbytes (512 bytes/sector)*	250	
Guaranteed sectors	488,397,168	
Heads	3	
Discs	2	
Bytes per sector	512	
Default sectors per track	63	
Default read/write heads	16	
Default cylinders	16,383	
Recording density, KBPI (kbits/in max)	813	
Track density, KTPI (ktracks/in avg.)	145	
Areal density, (Gbits/in ² avg)	114.4	
Spindle speed (RPM)	7,200	
Internal data transfer rate (Mbits/sec max)	1,030	
Sustained data transfer rate OD (Mbytes/sec max)	72	
I/O data-transfer rate (Mbytes/sec max)	300	
ATA data-transfer modes supported	PIO modes 0–4 Multiword DMA modes 0–2 Ultra DMA modes 0–6	
Cache buffer	16 Mbytes	8 Mbytes
Height (mm max)	26.1 mm (1.028 inches)	
Width (mm max)	101.6 mm (4.000 inches) +/- 0.010 inches	
Length (mm max)	146.99 mm (5.787 inches)	
Weight (max)	580 grams (1.28 lb.)	
Average latency (msec)	4.16	
Power-on to ready (sec max)	11 sec	
Standby to ready (sec max)	15 sec	
Track-to-track seek time (msec typical)	<0.8 (read), <1.0 (write)	
Average seek, read (msec typical)	<8.5	
Average seek, write (msec typical)	<10.0	
Startup current (typical) 12V (peak)	2.8 amps	
Voltage tolerance (including noise)	5V ± 5% 12V ± 10%	
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)	37.7 (operating) 37.7 (nonoperating)	
Altitude, operating	–60.96 m to 3,048 m (–200 ft. to 10,000+ ft.)	
Altitude, nonoperating (below mean sea level, max)	–60.96 m to 12,192 m (–200 ft. to 40,000+ ft.)	
Operational Shock (max at 2 msec)	63 Gs	
Non-Operational Shock (max at 2 msec)	350 Gs	

Drive specification	ST3250621NS	ST3250821NS
Vibration, operating	5–22 Hz: 0.25 Gs, Limited displacement 22–350 Hz: 0.50 Gs 350–500 Hz: 0.25 Gs	
Vibration, nonoperating	5–22 Hz: 0.25 Gs, Limited displacement 22–350 Hz: 5.0 Gs 350–500 Hz: 1.0 Gs	
Drive acoustics, sound power (bels)		
Idle**	2.5 (typical) 2.8 (max)	
Performance seek	3.2 (typical) 3.5 (max)	
Nonrecoverable read errors	1 sector per 10 ¹⁵ bits read	
Annualized Failure Rate (AFR)	0.73%	
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.	
Contact start-stop cycles (25°C, 50% rel. humidity)	50,000	
Supports Hotplug operation per SATA II specification	Yes	

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

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

2.2 Formatted capacity

Model	Formatted capacity*	Guaranteed sectors	Bytes per sector
ST3750641NS	750 Gbytes	1,465,149,168	512
ST3750841NS	750 Gbytes	1,465,149,168	512
ST3500631NS	500 Gbytes	976,773,168	512
ST3500831NS	500 Gbytes	976,773,168	512
ST3400621NS	400 Gbytes	781,422,768	512
ST3400821NS	400 Gbytes	781,422,768	512
ST3320621NS	320 Gbytes	625,142,448	512
ST3320821NS	320 Gbytes	625,142,448	512
ST3250621NS	250 Gbytes	488,397,168	512
ST3250821NS	250 Gbytes	488,397,168	512

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

2.2.1 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 Recording and interface technology

	750GB	500GB	400GB	320GB	250GB
Interface	Serial ATA (SATA)				
Recording method	Perpendicular				
Recording density, KBPI (kbits/inch max)	926	813	781		813
Track density, KTPI (ktracks/inch avg)	145				
Areal density (Gbits/inch ² avg)	128.2	114.4			
Spindle speed (RPM) (± 0.2%)	7,200				
Internal data transfer rate (Mbits/sec max)	1,030				
Sustained data transfer rate (Mbytes/sec max)	78	72			
I/O data-transfer rate (Mbytes/sec max)	300 (Ultra DMA mode 5)				

2.5 *Physical characteristics

Maximum height	26.1 mm (1.028 inches)
Maximum width	101.6 mm (4.000 +/- 0.010 inches)
Maximum length	146.99 mm (5.787 inches)
Max weight	
ST3750641NS and ST3750841NS	720 grams (1.59 lbs)
ST3500631NS, ST3500831NS, ST3400621NS, ST3400821NS, ST3320621NS and ST3320821NS	635 grams (1.4 lbs)
ST3250621NS and ST3250821NS	580 grams (1.28 lbs)
Cache buffer	
ST3750641NS ST3500631NS ST3400621NS ST3320621NS ST3250621NS	16 Mbytes (16,384 kbytes)
ST3750841NS ST3500831NS ST3400821NS ST3320821NS ST3250821NS	8 Mbytes (8,192 kbytes)

2.6 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 (ST3750641NS, ST3750841NS, ST3500631NS and ST3500831NS)	<8.5	<9.5
Average (ST3400621NS, ST3400821NS, ST3320621NS, ST3320821NS, ST3250621NS and ST3250821NS)	<8.5	<10.0
Average latency:	4.16	

*Measured in performance mode.

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.

2.7 Start/stop times

Power-on to Ready (sec) (ST3750641NS, ST3750841NS, ST3500631NS, ST3500831NS, ST3400621NS, ST3400821NS, ST3320621NS and ST3320821NS)	15 (max)
Power-on to Ready (sec) (ST3250621NS and ST3250821NS)	11 (max)
Standby to Ready (sec)	15 (max)
Ready to spindle stop (sec)	10 (max)

2.8 Power specifications

The drive receives DC power (+5V or +12V) through a native SATA power connector. See Figure 4 on page 28.

2.8.1 Power consumption

Power requirements for the drives are listed in the table on page 9. Typical power measurements are based on an average of drives tested, under nominal conditions, using 5.0V and 12.0V input voltage at 25°C ambient temperature.

- **Spinup power**

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

- **Seek mode**

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

- **Read/write power and current**

Read/write power is measured with the heads on track, based on a 16-sector write followed by a 32-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 6: DC power requirements

Power dissipation (4-disc values shown)	Avg (watts 25° C)	Avg 5V typ amps	Avg 12V typ amps
Spinup	—	—	2.80 (peak)
Idle*	9.30	0.611	0.520
Idle* (with offline activity)	10.40	0.719	0.567
Operating (40% r/w, 40% seek, 20% inop.)	13.00	0.772	0.762
Seeking (random, 20% idle)	12.60	0.613	0.795
Standby	0.80	0.106	0.023
Sleep	0.80	0.106	0.023

* 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.

**Time-to -ready for this spinup power level will be longer and is governed by individual system design.

2.8.1.1 Typical current profiles

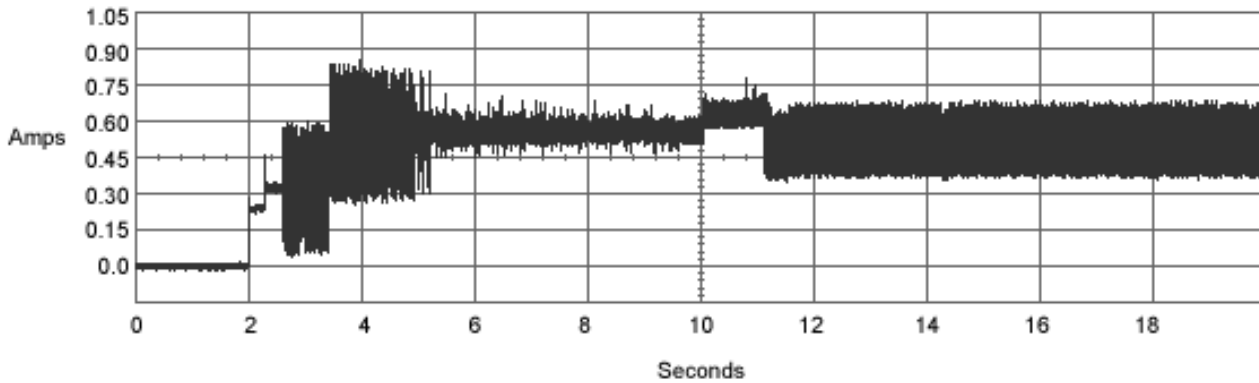


Figure 1. Typical 5V startup and operation current profile

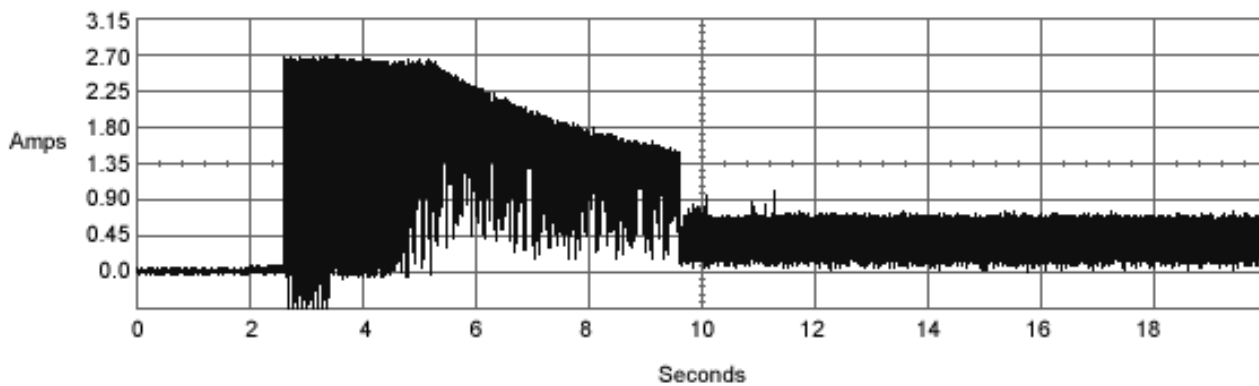


Figure 2. Typical 12V startup and operation current profile

2.8.2 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.

2.8.3 Voltage tolerance

Voltage tolerance (including noise):

5V \pm 5%

12V \pm 10%

2.8.4 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.

2.9 Environmental specifications

2.9.1 Ambient temperature

Ambient temperature is defined as the temperature of the environment immediately surrounding the drive. Actual drive case temperature should not exceed 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:	5° to 55°C (41° to 131°F)
Nonoperating:	–40° to 70°C (–40° to 158°F)

2.9.2 Temperature gradient

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

2.9.3 Humidity

2.9.3.1 Relative humidity

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

2.9.3.2 Wet bulb temperature

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

2.9.4 Altitude

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

2.9.5 Shock

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

2.9.5.1 Operating shock

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

2.9.5.2 Nonoperating shock

The nonoperating shock level that the drive can experience without incurring physical damage or degradation in performance when subsequently put into operation is 300 Gs for 750GB, 500GB and 400 GB models and 350 Gs for 320 GB and 250 GB models, based on a nonrepetitive half-sine shock pulse of 2 msec duration.

2.9.6 Vibration

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

2.9.6.1 Operating vibration

The maximum 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)
22–350 Hz	0.50 Gs
350–500 Hz	0.25 Gs

2.9.6.2 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)
22–350 Hz	5.0 Gs
350–500 Hz	1.0 Gs

2.10 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 7: Fluid Dynamic Bearing (FDB) motor acoustics

	Idle*	Performance seek
ST3750641NS, ST3750841NS	2.7 bels (typ) 3.0 bels (max)	3.2 bels (typ) 3.9 bels (max)
ST3500631NS, ST3500831NS, ST3400621NS, ST3400821NS ST3320621NS, ST3320821NS, ST3250621NS, ST3250821NS	2.5 bels (typ) 2.8 bels (max)	3.2 bels (typ) 3.5 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.

2.11 Electromagnetic immunity

When properly installed in a representative host system, the drive operates without errors or degradation in performance when subjected to the radio frequency (RF) environments defined in the following table:

Table 8: 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

2.12 Reliability

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

The product shall achieve an Annualized Failure Rate (AFR) of 0.73% (MTBF of 1.2 million hours) when operated in an environment that ensures the HDA case temperatures do not exceed 40°C. Operation at case temperatures outside the specifications in Section 2.9 may increase the product AFR (decrease MTBF). AFR and MTBF are population statistics that are not relevant to individual units.

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

- 8,760 power-on-hours per year.
- 250 average motor start/stop cycles per year.
- Operations at nominal voltages.
- Systems will provide adequate cooling to ensure the case temperatures do not exceed 40°C. Temperatures outside the specifications in Section 2.9 will increase the product AFR and decrease MTBF.

Nonrecoverable read errors	1 per 10 ¹⁵ bits read, max
Annualized Failure Rate (AFR)	0.73% (nominal power, 40°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.

2.13 Agency certification

2.13.1 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.

2.13.2 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.

- Barracuda ES
- Certificate number: STX-L3510 (B)

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).

2.13.3 FCC verification

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

Seagate 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.

2.14 Environmental protection

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

2.14.1 European Union Restriction of Hazardous Substances (RoHS) Directive

Seagate designs its products to meet environmental protection requirements worldwide, including regulations restricting certain chemical substances. A new law, the European Union Restriction of Hazardous Substances (RoHS) Directive, restricts the presence of chemical substances, including Lead, Cadmium, Mercury, Hexavalent Chromium, PBB and PBDE, in electronic products, effective July 2006. This drive is manufactured with components and materials that comply with the RoHS Directive.

2.14.2 China Restriction of Hazardous Substances (RoHS) Directive

2.14.2 中国限制危险物品的指令

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



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

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

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

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

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

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

2.15 Corrosive environment

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

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

Serial ATA drives are designed for easy installation. 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 3 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 3 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.

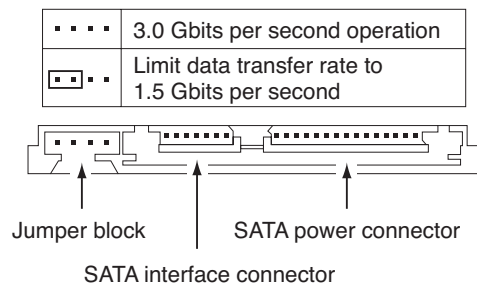


Figure 3. Serial ATA connectors

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 9 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.

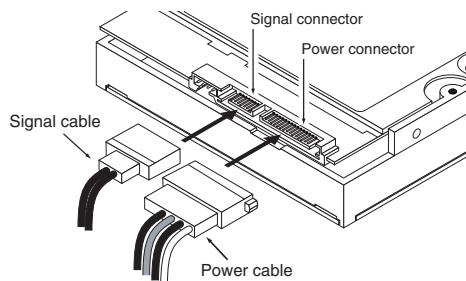


Figure 4. Attaching SATA cabling

Each cable is keyed to ensure correct orientation. Barracuda ES+ 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 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 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).

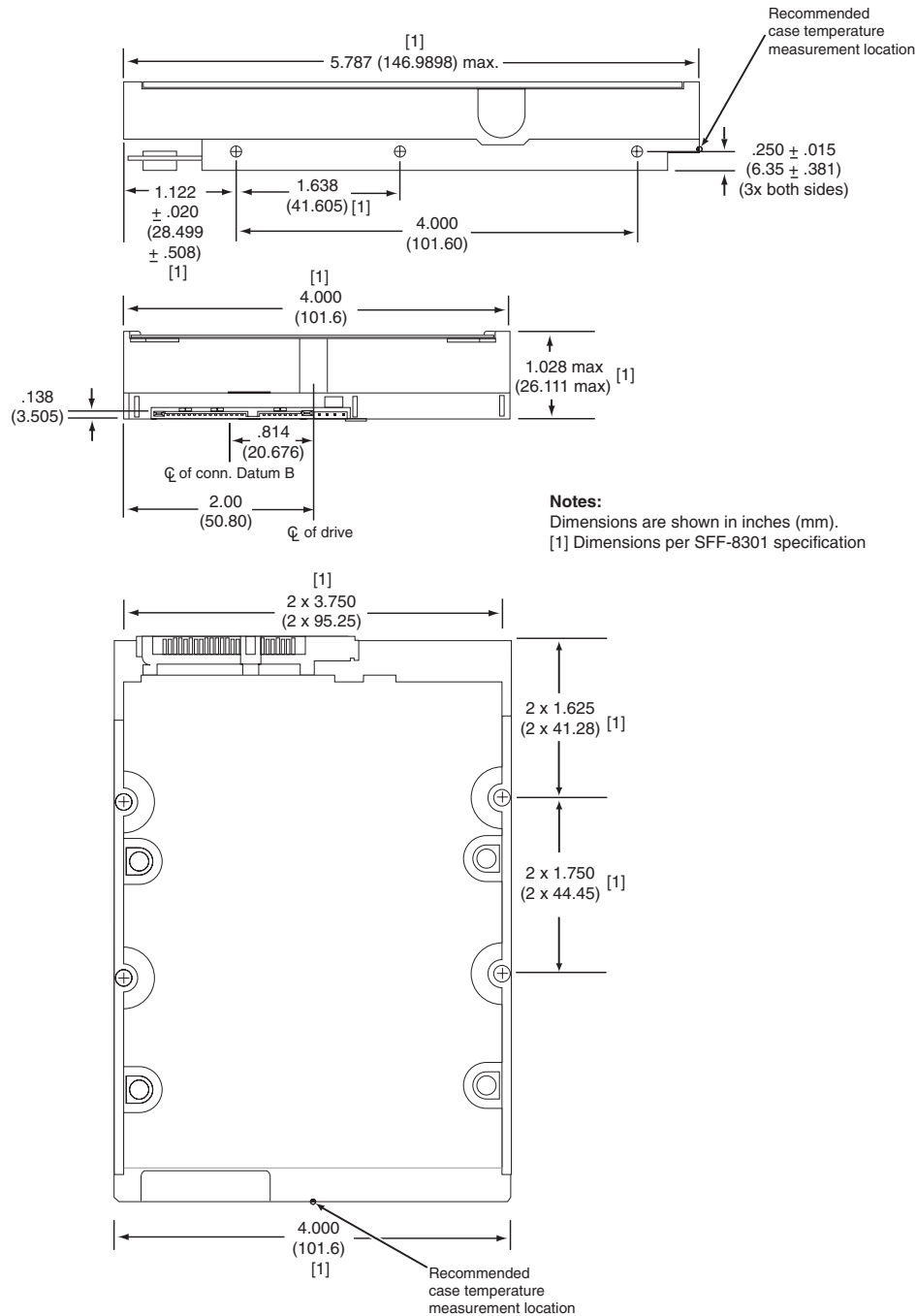


Figure 5. Mounting dimensions—top, side and end view

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

Barracuda ES+ 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.

Caution:

The drive motor must come to a complete stop (**Ready to spindle stop time indicated in Section 2.7**) prior to changing the plane of operation. This time is required to insure data integrity.

4.2 Serial ATA device plug connector pin definitions

Table 9 summarizes the signals on the Serial ATA interface and power connectors.

Table 9: 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:

- 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_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 39 for details and subcommands used in the S.M.A.R.T. implementation.

Table 10: 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 10 on page 33. 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: <ul style="list-style-type: none"> • 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)	
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 2.2 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 2.2 for related information). These words are required for drives that support the 48-bit addressing feature. Maximum value: 0000FFFFFFFFFh.	750 GB models = 1,465,149,168 500 GB models = 976,773,168 400 GB models = 781,422,768 320 GB models = 625,142,448 250 GB models = 488,397,168
104–127	ATA-reserved	0000 _H

Word	Description	Value
128	Security status	0001 _H
129–159	Seagate-reserved	xxxx _H
160–254	ATA-reserved	0000 _H
255	Integrity word	xxA5 _H

Note. Advanced Power Management (APM) is supported. APM is disabled by default but you may enable APM using the SATA set features commands. Use the time settings stated below:

Enable Idle 1 Options:

Word 0x53 set to 0x7D09
 Word 0xE3 set to 0x1388 // 5 seconds
 Word 0xE4 set to 0x2710 // 10 seconds
 Word 0xE5 set to 0x0015 // 21 seconds
 Word 0xE6 set to 0x0025 // 37 seconds
 Word 0x5B set to 0xFEFE

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 11: 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 IOEDC during Write/Read commands

IOEDC during Write Commands

- IOEDC is checked when data is transferred from: A) FIFO to Buffer, B) FIFO to Disk, during the write operation.
- For A), Attribute 199 is incremented, no Critical Event Log entry is made, no ATA Error is returned, attribute 184 increments signaling a IOEDC error occurred and 51/84 (CRC Error) is reported to the host.
- For B), non-cached writes reports 51/10 (ID Not Found) to the host. Cached writes can only post an error to the host if a Flush Cache Extended command is issued reporting a 51/04 with error location in Extended Task File, Critical Event is logged and attribute 184 which counts IOEDC errors is incremented.
- If IOEDC is triggered during the transfer from FIFO to disc, the data will be re-transferred from buffer up to disc 4 times. If IOEDC still fails the drive will write uncorrectable data to Media. When a subsequent read is issued to this located a hard error (uncorrectable) will be returned to the host, not unnecessarily failing IOEDC, causing a host level retry.

IOEDC during Read Commands

- IOEDC is checked when data is transferred from : C) Buffer to FIFO and D) FIFO to Host Controller Interface, during the read operation.
- For C and D), the drive will report 51/84 (Interface CRC Error), no Critical Event entry is made, SMART attributes 199 (CRC Error) and 184 (IOEDC error counter) will be incremented.
- IOEDC cannot be checked during the data transfer from disc to buffer during a read because the data sent to buffer is not ECC-corrected. Thus the two bytes of IOEDC parity data are not available until all the data is in the buffer.

4.3.4 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>.

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 12: 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.

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