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***Barracuda ATA Family***  
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***ST328040A, ST327240A, ST320430A***  
.....

***ST313620A, ST310220A, ST36810A***  
.....

***Ultra ATA Interface Drives***  
.....

***Product Manual***  
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## Introduction

This manual describes the functional, mechanical and interface specifications for the ST328040A, ST327240A, ST320430A, ST313620A, ST310220A, and the ST36810A. These drives provide the following key features:

- Low power consumption
- Quiet operation
- High instantaneous (burst) data-transfer rates (up to 66.6 Mbytes per second) using Ultra DMA mode 4
- 7,200-RPM and 512-Kbyte buffer combine for superior desktop performance
- 300 Gs nonoperating shock
- GMR recording heads and EPRML technology, which provide the drives with increased areal density
- State-of-the-art cache and on-the-fly error-correction algorithms
- Full-track multiple-sector transfer capability without local processor intervention
- Support for S.M.A.R.T. drive monitoring and reporting
- Support for Read Multiple and Write Multiple commands
- Support for autodetection of master/slave drives that use cable select (CSEL)

## Specification summary table

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

Drive Specification	ST328040A ST327270A	ST320430A	ST313620A	ST310220A	ST36810A
Guaranteed Mbytes ( $\times 10^6$ bytes)	28,520 27,333	20,520	13,666	10,242	6,833
Guaranteed sectors	55,704,096 53,385,552	40,079,088	26,692,776	20,005,650	13,346,235
Bytes per sector	512				
Default sectors per track	63				
Default read/write heads	16	16	16	16	15
Default cylinders	16,383	16,383	16,383	16,383	14,123
Physical read/write heads	8	6	4	3	2
Discs	4	3	2	2	1
Recording density KBPI (bits/inch max)	305				
Track density TPI (tracks/inch)	16,420				
Areal density (Mbits/inch <sup>2</sup> max)	5,100				
Spindle speed (RPM)	7,200				
Internal data-transfer rate (Mbits/sec max)	323				
I/O data-transfer rate (Mbytes/sec-max)	66.6				
ATA data-transfer-modes supported	PIO modes 0–4 Multiword DMA modes 0–2 Ultra DMA modes 0–4				
Cache buffer (Kbytes)	512				
Height (mm max)	26.1				

Drive Specification	ST328040A ST327270A	ST320430A	ST313620A	ST310220A	ST36810A
Width (mm max)	102				
Length (mm max)	147.0				
Weight (typical)	550 grams (1.2 lb)				
Average latency (msec)	4.16 msec				
Power-on to ready (sec typical)	12 sec				
Standby to ready (sec typical)	12 sec				
Startup current (typical) 12V (peak)	2.2 amps				
Track-to-track seek time (msec typical)	0.9				
Average seek time (read, msec typical)	8.0	7.6			
Full-stroke seek time (msec typical)	14.5	14.2			
Seek power (typical)	11.9 watts				
Read/Write power (typical)	8.5 watts	7.5 watts			
Idle mode (typical)	7.5 watts	6.8 watts			
Standby mode (typical)	1.2 watts				
Sleep mode (typical)	1.0 watts				
Voltage tolerance (including noise)	5V $\pm$ 5% – 0.7 amps max 12V $\pm$ 10% – 2.4 amps max				
Ambient temperature	0° to 55°C (op.), –40° to 70°C (nonop.)				
Temperature gradient (°C per hour-max)	20°C				
Relative humidity (op. and nonop.)	8% to 80% (op.) 5% to 90% (nonop.)				
Relative humidity gradient	30% per hour max				

Drive Specification	ST328040A ST327270A	ST320430A	ST313620A	ST310220A	ST36810A
Wet bulb temperature (°C max)	29.4 (op.), 40.0 (nonop.)				
Altitude, operating	-122 m to 3,048 m (-400 ft to 10,000+ ft)				
Altitude (meters below mean sea level, max)	-122 m to 12,192 m (-400 ft to 40,000+ ft)				
Shock, operating (Gs max at 2 msec)	63				
Shock, nonoperating (Gs max at 2 msec)	300 Gs				
Vibration, operating	0.5 Gs (0 to peak, 5-300 Hz)				
Vibration, nonoperating	5 Gs (0 to peak, 5-300 Hz)				
Drive acoustics Sound power (Bels) Idle mode Seek mode	3.5 (typical), 3.9 (max) 4.0 (typical), 4.3 (max)				
Nonrecoverable read errors	1 per 10 <sup>14</sup> bits read				
Mean time between failures (power-on hours)	500,000				
Contact start-stop cycles (25°C, 40% relative humidity)	50,000				
Service life (years)	5				

## 1.0 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 ST328040A, ST327240A, ST320430A, ST313620A, ST310220A and the ST36810A.

### 1.1 Formatted capacity

Drive Model	Guaranteed Mbytes (1 Mbyte = 10 <sup>6</sup> bytes)	Guaranteed sectors	Bytes per sector
ST328040A	28,520	55,385,552	512
ST327240A	27,333	53,704,096	512
ST320430A	20,520	40,079,088	512
ST313620A	13,666	26,692,776	512
ST310220A	10,242	20,005,650	512
ST36810A	6,833	13,346,235	512

#### 1.1.1 Default logical geometry

CHS Mode	Cylinders	Read/Write heads	Sectors per track
ST328040A	16,383	16	63
ST327240A	16,383	16	63
ST320430A	16,383	16	63
ST313620A	16,383	16	63
ST310220A	16,383	16	63
ST36810A	14,123	15	63

#### LBA Mode

When addressing either drive 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.

## 1.2 Physical organization

Drive Model	Read/Write heads (GMR)	Number of discs
ST328040A/ST327240A	8	4
ST320430A	6	3
ST313620A	4	2
ST310220A	3	2
ST36810A	2	1

## 1.3 Recording and interface technology

Interface	ATA
Recording method	16/17 EPRML
Recording density KBPI (bits/inch)	305
Track density TPI (tracks/inch)	16,420
Areal density (Mbits/inch <sup>2</sup> max)	5,100
Spindle speed (RPM) ( $\pm$ 0.2%)	7,200
Internal data-transfer rate (Mbits/sec max)	323
I/O data-transfer rate (Mbytes/sec max)	16.6 (PIO mode 4) 66.6 (Ultra DMA mode 4)
Interleave	1:1
Cache buffer (Kbytes)	512

## 1.4 Physical characteristics

<b>Drive Specification</b>	<b>ST328040A, ST327240A, ST320430A, ST313620A, ST310220A, ST36810A</b>
Maximum height (mm) (inches)	26.1 1.028
Maximum width (mm) (inches)	101.8 4.020

Maximum length (mm) (inches)	147.0 5.78
Typical weight (grams) (pounds)	550 1.2

### 1.5 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.
- Full-stroke seek time is one-half the time needed to seek from the first data cylinder to the maximum data cylinder and back to the first data cylinder. The full-stroke typical value is determined by averaging 100 full-stroke seeks in both directions.

Typical seek times (msec)	Read	Write
Track-to-track	0.9	1.6
Average	*8.0/7.6	9.1
Full-stroke	*14.5/14.2	*17.5/16.9
Average latency: 4.16 msec	—	—
*8.0 average read, 14.5 full-stroke read and 17.5 full-stroke write applies to the ST328040A and ST327240A only.		

**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 or exceed 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.

### 1.6 Start/stop times

Power-on to Ready (sec)	12 (typical)
Standby to Ready (sec)	12 (typical)
Ready to spindle stop (sec)	11 (typical)

## 1.7 Power specifications

The drive receives DC power (+5V or +12V) through a four-pin standard drive power connector.

### 1.7.1 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 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 inactive.

- **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.



Models ST328040A and ST327270A		Typical Amps RMS	
Power Mode	Typical Watts RMS	5V	12V
Spinup	—	—	2.2 (peak)
Seeking (Random, no read/write)	11.9	0.340	0.850
Operating (read/write)	8.5	0.485	0.505
Idle	7.5	0.310	0.496
Standby	1.2	0.194	0.019
Sleep	1.0	0.128	0.030

Models ST320430A, ST313620A, ST310220A and ST36810A		Typical Amps RMS	
Power Mode	Typical Watts RMS	5V	12V
Spinup	—	—	2.2 (peak)
Seeking (Random, no read/write)	11.9	0.340	0.850
Operating (read/write)	7.5	0.485	0.422
Idle	6.8	0.310	0.440
Standby	1.2	0.194	0.019
Sleep	1.0	0.128	0.030

### 1.7.1.1 Typical current profile

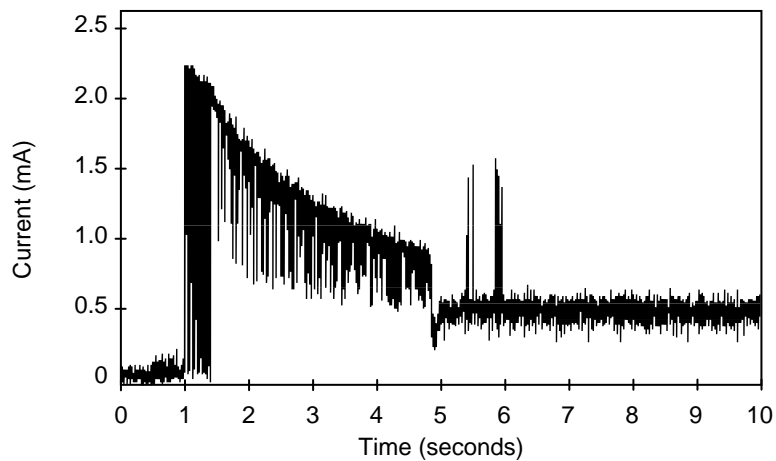


Figure 1. Typical startup and operation current profile

### 1.7.2 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.

### 1.7.3 Voltage tolerance

Voltage tolerance (including noise):

5V  $\pm$  5%                      0.7 amps max

12V  $\pm$  10%                     2.4 amps max

### 1.7.4 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 Active 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.

## **1.8 Environmental tolerances**

### **1.8.1 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. Recommended measurement locations are shown in Figure 3 on page 20.

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 55°C (32° to 131°F)
Nonoperating	−40° to 70°C (−40° to 158°F)

## 1.8.2 Temperature gradient

Operating/Nonoperating 20°C/hr (36°F/hour) max,  
without condensation

## 1.8.3 Humidity

### 1.8.3.1 Relative Humidity

Operating 8% to 80% noncondensing (30% per hour max)

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

### 1.8.3.2 Wet bulb temperature

Operating 29.4°C (84°F) max

Nonoperating 40.0°C (104°F) max

## 1.8.4 Altitude

Operating -122 m to 3,048 m (-400 ft to 10,000+ ft)

Nonoperating -122 m to 12,192 m (-400 ft to 40,000+ ft)

## 1.8.5 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.

### 1.8.5.1 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.

### 1.8.5.2 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 300 Gs (based on a nonrepetitive half-sine shock pulse of 2 msec duration).

## 1.8.6 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.

### 1.8.6.1 Operating vibration

The following table lists the maximum vibration levels that the drive may experience while meeting the performance standards specified in this document.

5–22 Hz	0.010-inch displacement (zero to peak)
22–300 Hz	0.5 Gs acceleration (zero to peak)

### 1.8.6.2 Nonoperating vibration

The following table lists the maximum nonoperating vibration that the drive may experience without incurring physical damage or degradation in performance when subsequently put into operation.

5–22 Hz	0.10-inch displacement (zero to peak)
22–300 Hz	5.0 Gs acceleration (zero to peak)

## 1.9 Drive acoustics

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

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

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

Acoustic mode	Idle mode	Seek mode
Sound power (bels)	3.5 (typ) 3.9 (max)	4.0 (typ) 4.3 (max)

## 1.10 Electromagnetic susceptibility

The drive operates without errors when subjected to the following:

Radiated noise	≤ 3 volt/meter, 30 Hz to 500 MHz
----------------	----------------------------------

Electrostatic discharge*	≤ 10 KVolts
Magnetic field strength	≤ 5 Gauss

\* Electrostatic discharge susceptibility is measured with the drive mounted in a representative computer system (mounted to a ground plane with an earth ground). Discharges are applied to the bezel or other external surfaces on the ground plane.

### 1.11 Reliability

Nonrecoverable read errors	1 per 10 <sup>14</sup> bits read, max
Mean time between failures	500,000 power-on hours (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)
Preventive maintenance	None required

### 1.12 Agency certification

#### 1.12.1 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.

#### 1.12.2 Electromagnetic compatibility

Hard drives that display the CE marking comply with European Union requirements specified in Electromagnetic Compatibility Directives. Testing is performed to standards EN 50082-1 and EN 55022-B.

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.

#### **Australian CE-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 Australia's Spectrum Management Agency (SMA).

### **1.12.3 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, Inc. 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 Prob-*

*lems.* 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.



## 2.0 Configuring and mounting the drive

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

### 2.1 Handling and static-discharge precautions

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

**Caution:**

- Keep the drive in its static-shielded bag until you are ready to complete the installation. Do not attach any cables to the drive while it is in its static-shielded bag.
- 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.

## 2.2 Jumper settings

### 2.2.1 Master/slave configuration

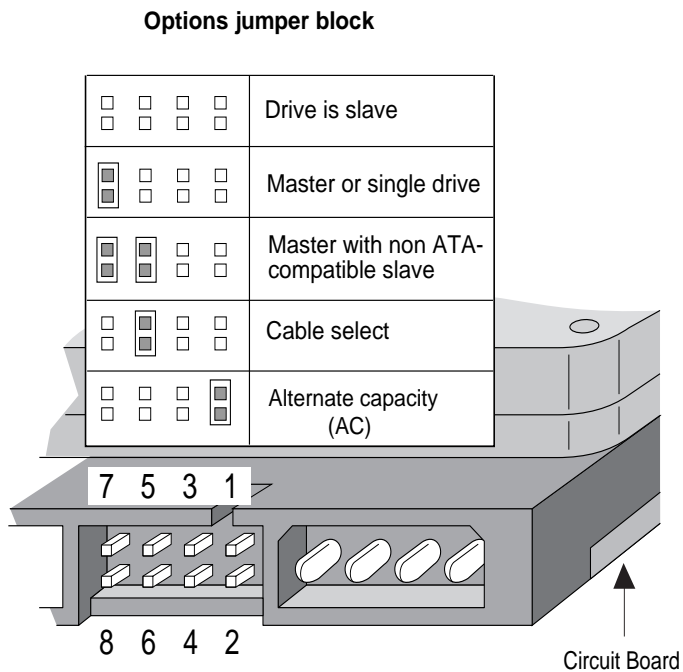
The options jumper block shown in Figure 2 is used to configure the drive for operation. It is the 6-pin dual header between the interface connector and the power connector. Use the following settings to configure the drive as a master or a slave.

**Master or single drive.** The drive is configured at the factory for a master or single-drive operation with a jumper set on pins 7 and 8.

**Drive as slave.** Remove all jumpers.

**Drive as master with a non-ATA-compatible slave.**

Use this jumper setting *only* if the drive does not work as a master with no jumpers installed.



**Figure 2. Master/slave jumper settings**

### 2.2.2 Cable-select option

Computers that use cable-select determine the master and slave drives by selecting or deselecting pin 28, CSEL, on the interface bus. Master and slave drives are determined by their physical position on the cable. To enable cable select, set a jumper on pins 5 and 6 as shown in Figure 2 on page 18. Refer to your computer manual to determine whether your computer supports this option.

### 2.2.3 Alternate capacity jumper

Some older computers may “hang” if their BIOS detects a hard drive that has more than 4,092 cylinders at startup. To eliminate this problem, the drive includes a capacity-limiting jumper which sets the drive’s default translation geometry to 4,092 cylinders. This limits the drive’s capacity to 2.1 Gbytes unless third-party software is used.

### 2.2.4 Ultra ATA/66 cable

An 80-conductor 40-pin cable is required to run Ultra DMA mode 3 and 4. This cable uses even-numbered conductors connected to the ground pins to improve signal integrity.

**Note.** The drive supports both host and drive cable detection. The host detects the 80-conductor cable by sampling pin 34, CBLID–, on the interface bus. The drive detects the 80-conductor cable by sensing a capacitor at the host side through the CBLID– signal. The result is reported in a Fast Rise Detected bit (bit 13 of word 93 in the Identify drive parameter block).

## 2.3 Drive mounting

You can mount the drive in any orientation using four screws in the side-mounting holes or four screws in the bottom-mounting holes. See Figure 4 on page 20 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 0.200 inch (5.58 mm) into the bottom mounting holes and no more than 0.14 inch (5.0 mm) into the side mounting holes.
- Do not overtighten the mounting screws (maximum torque: 6 inch-lb).
- Do not use a drive interface cable that is more than 18 inches long.

Note. Dimensions are shown in mm (inches)

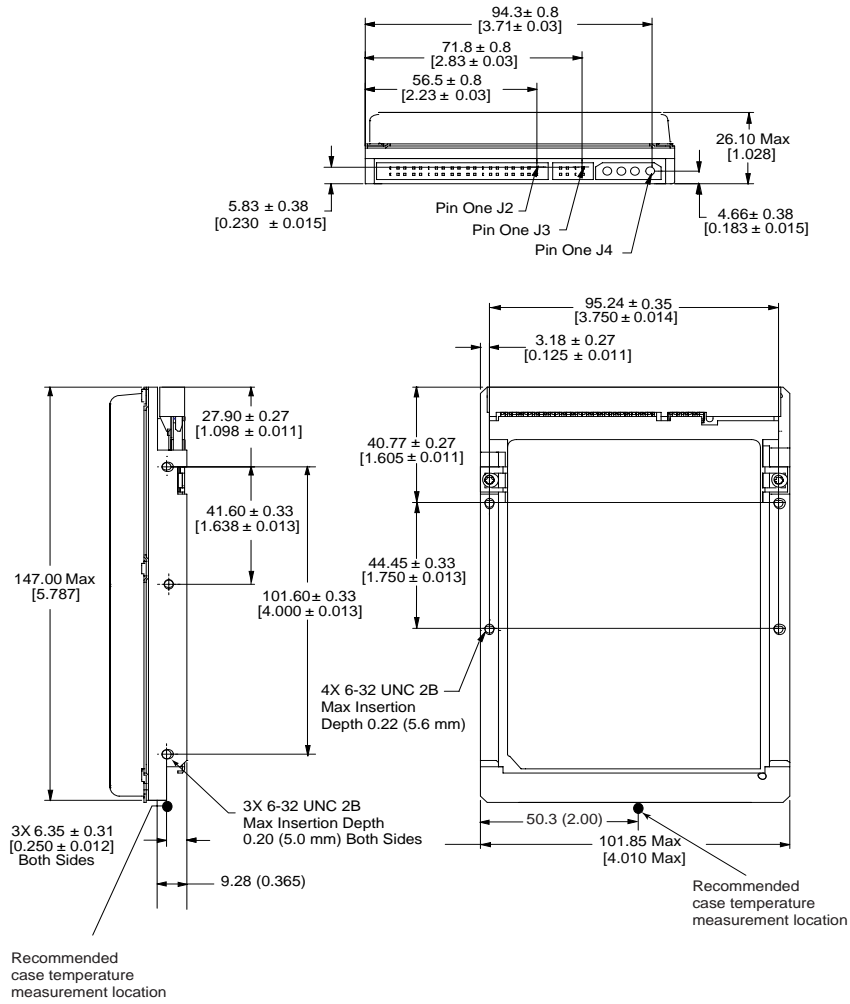


Figure 3. Mounting dimensions—top, side and end view

### 3.0 ATA interface

These drives use the industry-standard ATA task file interface that supports 16-bit data transfers. It supports ATA programmed input/output (PIO) modes 0–4; multiword DMA modes 0–2, and Ultra DMA modes 0–4. The drive also supports the use of the IORDY signal to provide reliable high-speed data transfers.

You can use a daisy-chain cable to connect two drives to a single AT host bus. For detailed information about the ATA interface, refer to the draft of *AT Attachment with Packet Interface Extension (ATA/ATAPI-4)*, *NCITS T13 1153D*, subsequently referred to as the *Draft ATA-4 Standard*.

#### 3.1 ATA interface signals and connector pins

Figure 4 on page 22 summarizes the signals on the ATA interface connector that the drive supports. For a detailed description of these signals, refer to the *Draft ATA-4 Standard*.

Drive pin #	Signal name	Host pin # and signal description
1	Reset	1 Hardware Reset
2	Ground	2 Ground
3	DD7	3 Host Data Bus Bit 7
4	DD8	4 Host Data Bus Bit 8
5	DD6	5 Host Data Bus Bit 6
6	DD9	6 Host Data Bus Bit 9
7	DD5	7 Host Data Bus Bit 5
8	DD10	8 Host Data Bus Bit 10
9	DD4	9 Host Data Bus Bit 4
10	DD11	10 Host Data Bus Bit 11
11	DD3	11 Host Data Bus Bit 3
12	DD12	12 Host Data Bus Bit 12
13	DD2	13 Host Data Bus Bit 2
14	DD13	14 Host Data Bus Bit 13
15	DD1	15 Host Data Bus Bit 1
16	DD14	16 Host Data Bus Bit 14
17	DD0	17 Host Data Bus Bit 0
18	DD15	18 Device Data (15:0)
19	Ground	19 Ground
20	(removed)	20 (No Pin)
21	DMARQ	21 DMA Request
22	Ground	22 Ground
23	D <sub>IOW</sub> STOP	23 Device I/O Write: Stop Ultra DMA Burst
24	Ground	24 Ground
25	D <sub>IOR</sub>	25 Device I/O Read: Host Ultra DMA Ready: Host Ultra DMA Data Strobe
26	Ground	26 Ground
27	IORDY	27 I/O Channel Ready
	DDMARDY	Device Ultra DMA Ready
	DSTROBE	Device Ultra DMA Data Strobe
28	CSEL	28 Cable Select
29	DMACK	29 DMA Acknowledge
30	Ground	30 Ground
31	INTRQ	31 Device Interrupt
32	IOCS16	32 Reserved
33	DA1	33 Host Address Bus Bit 1
34	PDIAG	34 Passed Diagnostics
	CBLID	Cable Assembly Type Identifier
35	DA0	35 Device Address (2:0)
36	DA2	36 Device Address (2:0)
37	CS0	37 Chip Select (1:0)
38	CS1	38 Chip Select (1:0)
39	DASP	39 Drive Active/Slave Present
40	Ground	40 Ground

Pins 28, 34 and 39 are used for master-slave communication (details shown below).

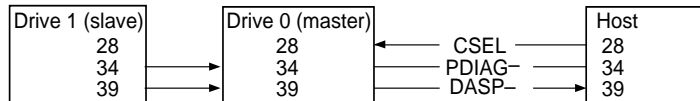


Figure 4. I/O pins and supported ATA signals

### 3.1.1 Supported ATA commands

The following table lists ATA-standard commands that the drive supports. For a detailed description of the ATA commands, refer to the *Draft ATA-4 Standard*. See Section 3.2.4 on page 30 for details and subcommands used in the S.M.A.R.T. implementation.

Command name	Command code (in hex)
<b>ATA-standard commands</b>	
Download Microcode	92 <sub>H</sub>
Execute Device Diagnostics	90 <sub>H</sub>
Flush Cache	E7 <sub>H</sub>
Format Track	50 <sub>H</sub>
Identify Device	EC <sub>H</sub>
Initialize Device Parameters	91 <sub>H</sub>
Read Buffer	E4 <sub>H</sub>
Read DMA	C8 <sub>H</sub> , C9 <sub>H</sub>
Read Multiple	C4 <sub>H</sub>
Read Sectors	20 <sub>H</sub> , 21 <sub>H</sub>
Read Verify Sectors	40 <sub>H</sub> , 41 <sub>H</sub>
Recalibrate	10 <sub>H</sub>
Seek	70 <sub>H</sub>
Set Features	EF <sub>H</sub>
Set Multiple Mode	C6 <sub>H</sub>
S.M.A.R.T.	B0 <sub>H</sub>
Write Buffer	E8 <sub>H</sub>
Write DMA	CA <sub>H</sub> , CB <sub>H</sub>
Write Multiple	C5 <sub>H</sub>
Write Sectors	30 <sub>H</sub> , 31 <sub>H</sub>

Command name	Command code (in hex)
<b>ATA-standard power-management commands</b>	
Check Power Mode	98 <sub>H</sub> or E5 <sub>H</sub>
Idle	97 <sub>H</sub> or E3 <sub>H</sub>
Idle Immediate	95 <sub>H</sub> or E1 <sub>H</sub>
Sleep	99 <sub>H</sub> or E6 <sub>H</sub>
Standby	96 <sub>H</sub> or E2 <sub>H</sub>
Standby Immediate	94 <sub>H</sub> or E0 <sub>H</sub>
<b>ATA-standard security commands</b>	
Security Set Password	F1 <sub>H</sub>
Security Unlock	F2 <sub>H</sub>
Security Erase Prepare	F3 <sub>H</sub>
Security Erase Unit	F4 <sub>H</sub>
Security Freeze Lock	F5 <sub>H</sub>
Security Disable Password	F6 <sub>H</sub>

### 3.1.2 Identify Drive command

The Identify Drive command (command code EC<sub>H</sub>) transfers information about the drive to the host following power up. The data is organized as a single 512-byte block of data, whose contents are shown in the table on page 25. All reserved bits or words should be set to zero. Parameters listed with an “x” are drive-specific or vary with the state of the drive. See Section 1 of this manual for default parameter settings.

The following commands contain drive-specific features that may not be included in the *Draft ATA-4 Standard*.



Word	Description	Value
0	Configuration information: • Bit 15: 0 = ATA; 1 = ATAPI • Bit 7: removable media • Bit 6: removable controller • Bit 0: reserved	0C5A <sub>H</sub>
1	Number of logical cylinders	ST328040A, ST327240A ST320430A, ST313620A, ST310220A = 16,383 ST36810A = 14,123
2	ATA-reserved	0000 <sub>H</sub>
3	Number of logical heads	ST328040A, ST327240A, ST320430A, ST313620A, ST310220A = 16 ST36810A = 15
4	Retired	0000 <sub>H</sub>
5	Retired	0000 <sub>H</sub>
6	Number of logical sectors per logical track: 63	003F <sub>H</sub>
7–9	Retired	0000 <sub>H</sub>
10–19	Serial number: (20 ASCII characters, 0000 <sub>H</sub> = none)	ASCII
20	Retired	0000 <sub>H</sub>
21	Retired	0400 <sub>H</sub>
22	Obsolete	0000 <sub>H</sub>
23–26	Firmware revision (8 ASCII character string, padded with blanks to end of string)	x.xx
27–46	Drive model number: (40 ASCII characters, padded with blanks to end of string)	ST328040A ST327240A ST320430A ST313620A ST310220A ST36810A

Word	Description	Value
47	(Bits 7–0) Maximum sectors per interrupt on Read multiple and Write multiple (16)	8010 <sub>H</sub>
48	Reserved	0000 <sub>H</sub>
49	Standard Standby timer, IORDY supported and may be disabled	2F00 <sub>H</sub>
50	ATA-reserved	0000 <sub>H</sub>
51	PIO data-transfer cycle timing mode	0200 <sub>H</sub>
52	Retired	0200 <sub>H</sub>
53	Words 54–58, 64–70 and 88 are valid	0007 <sub>H</sub>
54	Number of current logical cylinders	xxxx <sub>H</sub>
55	Number of current logical heads	xxxx <sub>H</sub>
56	Number of current logical sectors per logical track	xxxx <sub>H</sub>
57–58	Current capacity in sectors	xxxx <sub>H</sub>
59	Number of sectors transferred during a Read Multiple or Write Multiple command	xxxx <sub>H</sub>
60–61	Total number of user-addressable LBA sectors available	ST328040A = 55,704,096 ST327240A = 53,385,552 ST320430A = 40,079,088 ST313620A = 26,692,776 ST310220A = 20,005,650 ST36810A = 13,346,235
62	Retired	0000 <sub>H</sub>
63	Multiword DMA active and modes supported (see note following this table)	xx07 <sub>H</sub>

<b>Word</b>	<b>Description</b>	<b>Value</b>
64	Advanced PIO modes supported (modes 3 and 4 supported)	0003 <sub>H</sub>
65	Minimum multiword DMA transfer cycle time per word (120 nsec)	0078 <sub>H</sub>
66	Recommended multiword DMA transfer cycle time per word (120 nsec)	0078 <sub>H</sub>
67	Minimum PIO cycle time without IORDY flow control (240 nsec)	00F0 <sub>H</sub>
68	Minimum PIO cycle time with IORDY flow control (120 nsec)	0078 <sub>H</sub>
69–74	ATA-reserved	0000 <sub>H</sub>
75	Queue depth	0000 <sub>H</sub>
76–79	ATA-reserved	0000 <sub>H</sub>
80	Major version number	001E <sub>H</sub>
81	Minor version number	0000 <sub>H</sub>
82	Command sets supported	306B <sub>H</sub>
83	Command sets supported	4001 <sub>H</sub>
84	Command sets support extension	4000 <sub>H</sub>
85	Command sets enabled	30xx <sub>H</sub>
86	Command sets enabled	0001 <sub>H</sub>
87	Command sets enable extension	4000 <sub>H</sub>
88	Ultra DMA support and current mode (see note following this table)	xx1F <sub>H</sub>

Word	Description	Value
89	Security erase time	0000 <sub>H</sub>
90	Enhanced security erase time	0000 <sub>H</sub>
91–92	ATA-reserved	0000 <sub>H</sub>
93	Hardware Reset Value (see description following this table)	4000 <sub>H</sub>
94–127	ATA-reserved	0000 <sub>H</sub>
129–159	Seagate-reserved	xxxx <sub>H</sub>
160–255	ATA-reserved	0000 <sub>H</sub>

**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
- 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.

**Bit Word 93**

- 13 1=80-conductor cable detected, CBLID above  $V_{IH}$   
0=40-conductor cable detected, CBLID below  $V_{IL}$

**3.1.3 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:

- 02<sub>H</sub> Enable write cache (*default*).
- 03<sub>H</sub> Set transfer mode (based on value in Sector Count register).  
Sector Count register values:
  - 00<sub>H</sub> Set PIO mode to default (PIO mode 2).
  - 01<sub>H</sub> Set PIO mode to default and disable IORDY (PIO mode 2).
  - 08<sub>H</sub> PIO mode 0
  - 09<sub>H</sub> PIO mode 1
  - 0A<sub>H</sub> PIO mode 2
  - 0B<sub>H</sub> PIO mode 3
  - 0C<sub>H</sub> PIO mode 4 (*default*)
  - 20<sub>H</sub> Multiword DMA mode 0
  - 21<sub>H</sub> Multiword DMA mode 1
  - 22<sub>H</sub> Multiword DMA mode 2
  - 40<sub>H</sub> Ultra DMA mode 0
  - 41<sub>H</sub> Ultra DMA mode 1

- 42<sub>H</sub> Ultra DMA mode 2
- 43<sub>H</sub> Ultra DMA mode 3
- 44<sub>H</sub> Ultra DMA mode 4
- 55<sub>H</sub> Disable read look-ahead (read cache) feature.
- 82<sub>H</sub> Disable write cache.
- AA<sub>H</sub> Enable read look-ahead (read cache) feature (*default*).

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

### 3.1.4 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-4 Standard*.

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.

Code in Features Register	S.M.A.R.T. Command
D0 <sub>H</sub>	S.M.A.R.T. Read Data
D1 <sub>H</sub>	Vendor-specific
D2 <sub>H</sub>	S.M.A.R.T. Enable/Disable Attribute Autosave
D3 <sub>H</sub>	S.M.A.R.T. Save Attribute Values
D4 <sub>H</sub>	S.M.A.R.T. Execute Off-line Immediate
D7 <sub>H</sub>	Vendor-specific
D8 <sub>H</sub>	S.M.A.R.T. Enable Operations
D9 <sub>H</sub>	S.M.A.R.T. Disable Operations
DA <sub>H</sub>	S.M.A.R.T. Return Status

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









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