SEAGATE

BARRACUDA™

# Seagate® BarraCuda® SATA

## Product Manual

**Standard Models**

ST24000DM001

ST20000DM001

ST16000DM001

210203200, Rev A
March 2025

## Revision History

| Version and Date | Description of Changes |
|---|---|
| Rev A, March 2025 | Initial release of the document. |

# Contents

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# 1. Introduction

This manual describes the functional, mechanical, and interface specifications for the following: Seagate® BarraCuda® SATA drive models.

**Table 1 - Standard Models**

| Standard Models |
|---|
| ST24000DM001 |
| ST20000DM001 |
| ST16000DM001 |

These drives provide the following key features:

- Compliant with RoHS requirements in China and Europe
- High instantaneous (burst) data-transfer rates (up to 600MB per second)
- Native Command Queuing with command ordering to increase performance in demanding applications
- Quiet operation
- SeaTools diagnostic software performs a drive self-test that eliminates unnecessary drive returns
- State-of-the-art cache and on-the-fly error-correction algorithms
- Support for SMART drive monitoring and reporting
- Supports latching SATA cables and connectors
- Worldwide Name (WWN) capability uniquely identifies the drive

# 2. 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 Seagate BarraCuda SATA drive models.

## 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 2 - Drive specifications summary for 24TB, 20TB, and 16TB models**

| Drive Specification* | ST24000DM001 | ST20000DM001 | ST16000DM001 |
|---|---|---|---|
| Formatted capacity (512 bytes/sector)** | 24TB | 20TB | 16TB |
| Guaranteed sectors | See Section 2.2 *Formatted capacity*. | | |
| Heads | 20 | | |
| Disks | 10 | | |
| Bytes per logical sector | 512 | | |
| Bytes per physical sector | 4096 | | |
| SATA interface transfer rate | 600 MB/s | | |
| Maximum data transfer rate | 190 MB/s | | |
| ATA data-transfer modes supported | PIO modes: 0 to 4<br>Multiword DMA modes: 0 to 2<br>Ultra DMA modes 0 to 6 | | |
| Cache buffer | 512MB | | |
| Height (max) | 26.11mm / 1.028 in | | |
| Width (max) | 101.85mm / 4.010 in | | |
| Length (max) | 147mm / 5.787 in | | |
| Weight (typ) | 695g / 1.532 lb | | |
| Average latency | 4.16ms | | |
| Power-on to Ready (typ/max) | 30s / 60s | | |
| Standby to Ready (typ/max) | 30s / 60s | | |
| Startup current (typical) 12V | 2.0A | | |
| Voltage tolerance (including noise) | 5V ±5%<br>12V ±10% | | |
| Non-operating temperature (ambient) | –40°C to 70°C | | |
| Operating temperature | 10°C to 60°C (drive reported temperature) | | |
| Temperature gradient | 20°C per hour max (operating)<br>20°C per hour max (non-operating) | | |
| Relative humidity | 5% to 95% (operating)<br>5% to 95% (non-operating) | | |
| Relative humidity gradient (max) | 20% per hour | | |
| Altitude, operating | –304m to 3048m<br>(–1000 ft to 10,000 ft) | | |

**Table 2 - Drive specifications summary for 24TB, 20TB, and 16TB models *(continued)***

| Drive Specification* | ST24000DM001 | ST20000DM001 | ST16000DM001 |
|---|---|---|---|
| Altitude, non-operating (below mean sea level, max) | –304m to12,192m (–1000 ft to 40,000 ft) | | |
| Operational shock (2ms) | 30 *g* | | |
| Non-operational shock (2ms) | 200 *g* | | |
| Random rotary operating vibration | 20–1500Hz: 12.5 rads/s$^2$ | | |
| Linear random operating vibration | 5–500 Hz: 0.70 Grms | | |
| Linear random non-operating vibration | 2–500 Hz: 2.27 Grms | | |
| Drive acoustics, sound power | | | |
| Idle*** | 2.8 bels (typ)<br>3.0 bels (max) | | |
| Seek | 3.2 bels (typ)<br>3.4 bels (max) | | |
| Non-recoverable read errors | 1 per $10^{14}$ bits read | | |
| Rated workload | Average annualized workload rating: <120 TB/year.<br>The specifications for the product assumes the I/O workload does not exceed the average annualized workload rate limit of 120TB/year. Workloads exceeding the annualized rate may degrade and impact reliability as experienced by the particular application. The average annualized workload rate limit is in units of TB per calendar year. | | |
| Warranty | For warranty assistance, visit www.seagate.com/warranty. Enter the drive serial number and country of purchase. The system will display the warranty information for the drive. | | |
| Load/unload cycles | 600,000 | | |
| Supports hotplug operation per the Serial ATA Revision 3.2 specification | Yes | | |

* All specifications above are based on native configurations.

**One GB equals one billion bytes and 1TB equals one trillion 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 SMART specification, which may increase acoustic and power to operational levels.

**NOTE** If the drive is powered-off before issuing flush cache command, in some instances, the end user data in the DRAM cache might not be committed to the disk.

## 2.2 Formatted capacity

**Table 3 - Formatted capacity**

| ST models | Formatted capacity * | Guaranteed sectors | Bytes per sector |
|---|---|---|---|
| ST24000DM001 | 24TB | 46,875,541,504 | 512 (see Section 2.2.1 *LBA mode*) |
| ST20000DM001 | 20TB | 39,063,650,304 | |
| ST16000DM001 | 16TB | 31,251,759,104 | |

* One GB 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 137GB.

## 2.3 Recording and interface technology

**Table 4 - Recording and interface technology**

| Interface | Serial ATA (SATA) |
|---|---|
| Recording method | CMR |
| Data transfer rate (MB/s max) | up to 190 |

## 2.4 Physical characteristics

**Table 5 - Dimensions and weight**

| **Dimensions** | |
|---|---|
| Maximum height | 26.11mm / 1.028 in |
| Maximum width | 101.85mm / 4.010 in |
| Maximum length | 147mm / 5.787 in |
| **Typical weight** | |
| 30/28/26/24/22/20/16TB | 695g / 1.532 lb |
| **Cache buffer** | |
| Cache buffer | 512MB |

## 2.5 Start/stop times

**Table 6 - Start/stop times**

| Standard models | ST24000DM001 | ST20000DM001 | ST16000DM001 |
|---|---|---|---|
| Power-on to Ready (typ/max) | 30s / 60s | | |
| Standby to Ready (typ/max) | 30s / 60s | | |
| Ready to Spindle Stop (typ/max) | 20s / 20s | | |

**NOTE** Time-to-ready may be longer than normal if the drive power is removed without going through normal OS power-down procedures.

## 2.6 Power specifications

The drive receives DC power (+5V or +12V) through a native SATA power connector. Refer to Figure 2, *Attaching SATA cabling*, on page 16.

### 2.6.1 Power consumption

Power requirements for the drives are listed in Table 7, *DC power requirements*. 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. These power measurements are done with DIPM enabled.

- Spin-up current is measured from the time of power-on to the time that the drive spindle reaches operating speed.
- Read/Write current is measured with the heads on track, based on three 64 sector read or write operations every 100 ms.
- The drive supports three idle modes: Performance Idle mode, Active Idle mode, and Low Power Idle mode. Refer to Section 2.6.4 *Power-management modes* for power-management modes.

**Table 7 - DC power requirements**

| Power dissipation | Avg (watts, 25° C) | Avg 5V (amps, typ) | Avg 12V (amps, typ) |
|---|---|---|---|
| Spin up | | 0.895 | 2.000 |
| Idle, Low Power | 6.18 | 0.288 | 0.395 |
| Read/Write | 8.958 | 0.578 | 0.506 |
| Standby | 1.220 | 0.208 | 0.015 |
| Sleep | 1.220 | 0.208 | 0.015 |

### 2.6.2 Conducted noise

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

- Using 12V power, the drive is expected to operate with a maximum of 120 mV peak-to-peak sine-wave injected noise at up to 10MHz.
- Using 5V power, the drive is expected to operate with a maximum of 100 mV peak-to-peak sine-wave injected noise at up to 10MHz.

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

### 2.6.3 Voltage tolerance

Voltage tolerance (including noise):

+5v = ± 5%

+12v = ± 10%

### 2.6.4 Power-management modes

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

**Table 8 - Power management modes**

| Power modes | Heads | Spindle | Electronics |
|---|---|---|---|
| Active | Tracking | Rotating | Full Power |
| Idle, Performance | Tracking | Rotating | Full Power |
| Idle, Active | Floating | Rotating | Partial Power |
| Idle, Low Power | Parked | Rotating | Partial Power |
| Standby | Parked | Stopped | Low Power |
| Sleep | Parked | Stopped | Low Power |

**Active mode**

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

**Idle mode**

The electronics remain powered, and the drive accepts all commands and returns to Active mode when disk access is necessary.

**Standby mode**

The drive enters Standby mode immediately when the host sends a Standby Immediate command. If the host has set the standby timer, the drive enters 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 electronics are in low power mode, the heads are parked, and the spindle is at rest. The drive accepts all commands and returns to Active mode when disk access is necessary.

**Sleep mode**

The drive enters Sleep mode after receiving a Sleep command from the host. In Sleep mode, the electronics are in low power mode, 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.

**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 disk access is necessary.

## 2.7 Environmental specifications

This section provides the temperature, humidity, shock, and vibration specifications for Seagate BarraCuda SATA drives. Ambient temperature is defined as the temperature of the environment immediately surrounding the drive. Above 1000 ft (305m), the maximum temperature is derated linearly by 1°C every 1000 ft. Refer to Section 3.3 *Drive mounting* for base plate measurement location.

### 2.7.1 Temperature

**Table 9 - Temperature ranges (operating/non-operating)**

| | |
|---|---|
| **Operating** | 50 to 140°F (10 to 60°C drive reported) temperature range with a maximum temperature gradient of 36°F (20°C) per hour as reported by the drive.<br>The maximum allowable drive reported temperature is 140°F (60°C).<br>Airflow may be required to achieve consistent nominal drive temperature values (see Section 3.3 *Drive mounting*). To confirm that the required cooling is provided for the electronics and HDA, place the drive in its final mechanical configuration, and perform random write/read operations. After the temperatures stabilize, monitor the current drive temperature using the SMART temperature attribute 194 or Device Statistics log 04h page 5. |
| **Non-operating** | –40° to 158°F (–40° to 70°C) package ambient with a maximum gradient of 36°F (20°C) per hour. This specification assumes that the drive is packaged in the shipping container designed by Seagate for use with drive. |

### 2.7.2 Humidity

The values below assume that no condensation on the drive occurs. Maximum wet bulb temperature is 84.2°F (29°C).

**Table 10 - Relative humidity (operating/non-operating)**

| | |
|---|---|
| **Operating** | 5% to 95% non-condensing relative humidity with a maximum gradient of 20% per hour. |
| **Non-operating** | 5% to 95% non-condensing relative humidity with a maximum gradient of 20% per hour. |

### 2.7.3 Effective Altitude

**Table 11 - Effective altitude (sea level)**

| | |
|---|---|
| **Operating** | –304.8 to 3048 m (–1000 to 10,000+ ft) |
| **Non-operating** | –304.8 to 12,192 m (–1000 to 40,000+ ft) |

### 2.7.4 Shock and Vibration

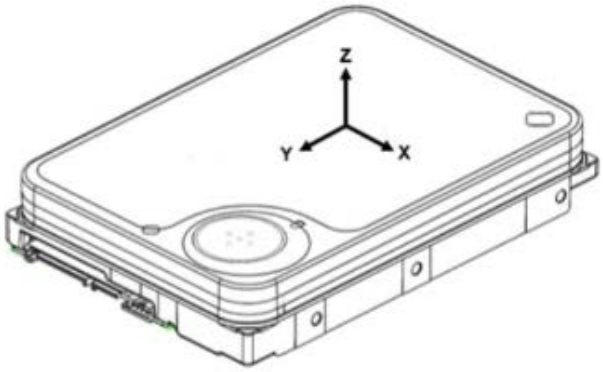
Shock and vibration measurements specified in this document are made directly on the drive itself and applied in the X, Y, and Z axis at the drive mounting point locations.

### 2.7.4.1 Shock

**Table 12 - Shock**

| | |
|---|---|
| **Operating** | The drive will operate without error while subjected to intermittent shock pulses not exceeding 30 *g* typical at a 2ms duration limited by Z-axis, shown in Figure 1, *Drive orientation*. |
| **Non-operating** | The drive will operate without non-recoverable errors after being subjected to shock pulses not exceeding 200 g at a duration of 2ms. |

**Figure 1 Drive orientation**




### 2.7.4.2 Vibration

#### Linear random operating vibration

The drive will operate without non-recoverable errors while being subjected to the random power spectral density noise specified below.

**Table 13 - Linear random operating vibration**

| PSD OF 5-500 Hz random noise at 0.70 g rms | | | | | |
|---|---|---|---|---|---|
| Frequency (Hz) | 5 | 20 | 200 | 250 | 500 |
| G^2/Hz | 0.00025 | 0.00210 | 0.00210 | 0.00020 | 0.00020 |

#### Random rotary operating vibration

The drive will exhibit greater than 90% throughput for sequential and random write operations while subjected to the shaped random power spectral density noise specified below.

**Table 14 - Random rotary operating vibration**

| PSD OF 20-1500 Hz at 12.5 rad/sec^2 | | | | |
|---|---|---|---|---|
| Frequency (Hz) | 20 | 200 | 800 | 1500 |
| (rad/sec^2)^2/Hz | 5.53E-02 | 5.53E-02 | 3.49E-01 | 6.14E-04 |

**Linear random non-operating vibration**

The drive will not incur physical damage or have non-recoverable errors after being subjected to the power spectral density noise specified below.

**Table 15 - Linear random non-operating vibration**

| PSD Profile 2-500 Hz at 2.27 Grms | | | | |
|---|---|---|---|---|
| Frequency (Hz) | 2 | 4 | 100 | 500 |
| G^2/Hz | 0.001 | 0.030 | 0.030 | 0.001 |

## 2.8 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:

Number of seeks per second = 0.4 / (average latency + average access time)

**Table 16 - Fluid Dynamic Bearing (FDB) motor acoustics**

| | Idle* | Performance seek |
|---|---|---|
| All models | 2.8 bels (typ)<br>3.0 bels (max) | 3.2 bels (typ)<br>3.4 bels (max) |

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

### 2.8.1 Test for Prominent Discrete Tones (PDTs)

Seagate follows the ECMA-74 standards for measurement and identification of PDTs. An exception to this process is the use of the absolute threshold of hearing. Seagate uses this threshold curve (originated in ISO 389-7) to discern tone audibility and to compensate for the inaudible components of sound prior to computation of tone ratios according to Annex D of the ECMA-74 standards.

## 2.9 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 17.

**Table 17 - Radio frequency environments**

| Test | Description | Performance level | Reference standard |
|---|---|---|---|
| Electrostatic discharge | Contact, HCP, VCP: ± 4 kV; Air: ± 8 kV | B | EN61000-4-2: 95 |
| Radiated RF immunity | 80MHz to 1,000MHz, 3 V/m,<br>80% AM with 1kHz sine | A | EN61000-4-3: 96 |
| Electrical fast transient | ± 1 kV on AC mains, ± 0.5 kV on external I/O | B | EN61000-4-4: 95 |

**Table 17 - Radio frequency environments**

| Test | Description | Performance level | Reference standard |
|---|---|---|---|
| Surge immunity | ± 1 kV differential, ± 2 kV common,<br>AC mains | B | EN61000-4-5: 95 |
| Conducted RF immunity | 150kHz to 80MHz, 3 Vrms, 80% AM with 1kHz sine | A | EN61000-4-6: 97 |
| Voltage dips, interrupts | 0% open, 5 seconds<br>0% short, 5 seconds<br>40%, 0.10 seconds<br>70%, 0.01 seconds | C<br>C<br>C<br>B | EN61000-4-11: 94 |

## 2.10 Warranty

For warranty assistance, visit www.seagate.com/warranty. Enter the drive serial number and country of purchase. The system will display the warranty information for the drive.

### 2.10.1 Data loss under power interruption with write cache enabled

Drive preserves its data during all operations except in cases where power to the drive is interrupted during write operations. This could result in either an uncorrected data error being reported, or the entire sector/track becoming unreadable. This can be permanently recovered by rewriting to the same location on the drive. Additionally, any data present in the DRAM buffer will not be written to the disk media, and the drive will not be able to return the original data.

In order to prevent this data loss, the host should issue a Standby Immediate or Flush Cache command before a controlled power off operation to the drive.

### 2.10.2 Storage

Maximum storage periods are 180 days within original unopened Seagate shipping package or 60 days unpackaged within the defined non-operating limits (refer to environmental section in this manual). Storage can be extended to one year packaged or unpackaged under optimal environmental conditions (25°C, <40% relative humidity non-condensing, and non-corrosive environment). During any storage period the drive non-operational temperature, humidity, wet bulb, atmospheric conditions, shock, vibration, magnetic, and electrical field specifications should be followed.

## 2.11 HDD and SSD Regulatory Compliance and Safety

For the latest regulatory and compliance information, go to www.seagate.com/support. Scroll down and click the Compliance, Safety, and Disposal Guide link.

### 2.11.1 Regulatory models

The following regulatory model number represents all features and configurations within the series:

STL026

### 2.11.2 Safety certification

The drives are recognized in accordance with:
UL/cUL 62368 -1, EN 62368 -1, IEC 60825.1:2014/A11:2021, and 21 CFR 1010.2/1040.10



## 2.12 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. 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. Wear a grounded wrist strap throughout the entire installation procedure.<br>• Handle the drive by its edges or frame only.<br>• The drive is extremely fragile—handle it with care. Do not press down on the top cover.<br>• Always rest the drive on a padded, antistatic surface until mounting it in the computer.<br>• Do not touch the connector pins or the printed circuit board.<br>• 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 Serial ATA cables and connectors

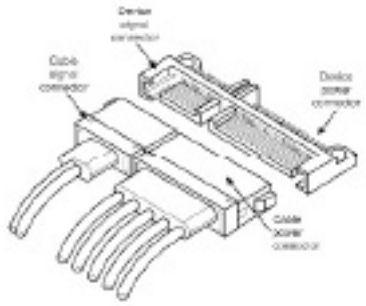
The Serial ATA interface cable consists of four conductors in two differential pairs, plus three ground connections. The cable size may be 30 to 26 AWG with a maximum length of one meter (39.37 in).

See Table 18, *Serial ATA connector pin definitions* 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, users can connect the drive as illustrated in Figure 2, *Attaching SATA cabling*.

**Figure 2 Attaching SATA cabling**



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

## 3.3 Drive mounting

Users can mount the drive in any orientation using four screws in the side-mounting holes or four screws in the bottom-mounting holes. See Figure 3, *Mounting configuration dimensions* for drive mounting dimensions. Follow these important mounting precautions when mounting the drive:

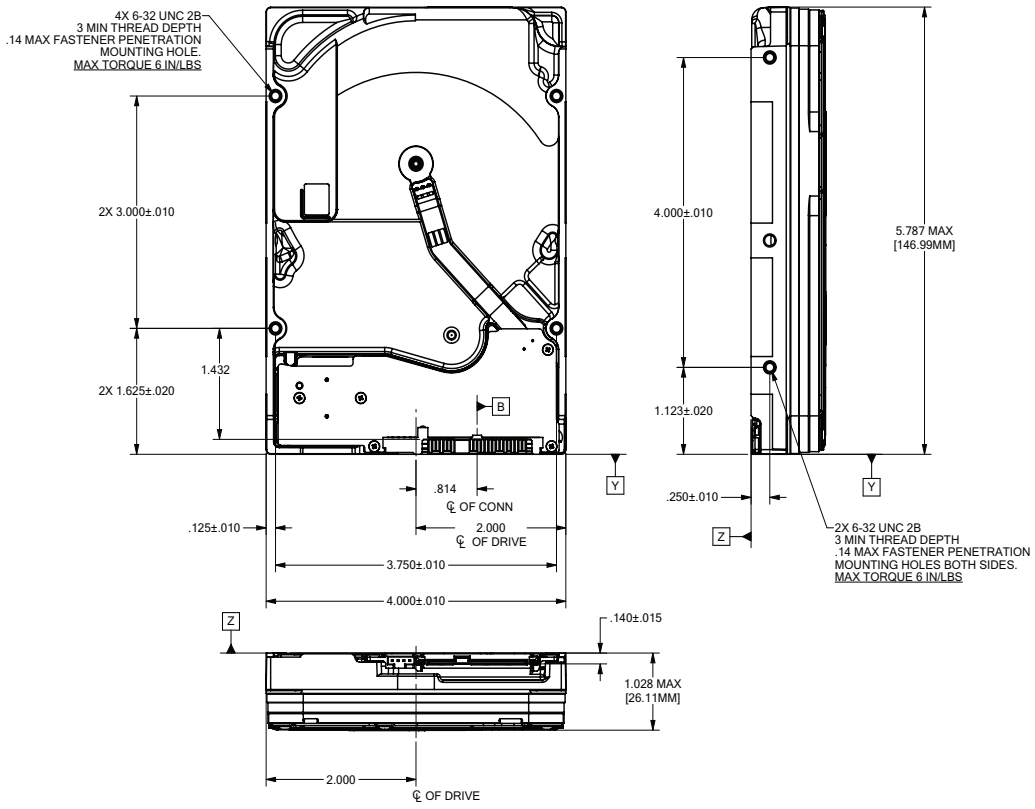
- Allow a minimum clearance of 0.030 in (0.76mm) around the entire perimeter of the drive for cooling.
- Use only 6-32 UNC mounting screws.
- The screws should be inserted no more than 0.140 in (3.56mm) into the bottom or side mounting holes.
- Do not overtighten the mounting screws (maximum torque: 6 in-lb).

### 3.3.1 Mechanical specifications

Refer to Figure 3, *Mounting configuration dimensions* for detailed mounting configuration dimensions.

**NOTE** These dimensions conform to the Small Form Factor Standard documented in SFF-8301 and SFF-8323, found at www.snia.org/technology-communities/sff/specifications.

**Figure 3 Mounting configuration dimensions**




**NOTE** The image is for mechanical dimension reference only and may not represent the actual drive.

# 4. 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

Seagate BarraCuda SATA drives incorporate connectors which enable users to hot plug these drives in accordance with the Serial ATA Revision 3.2 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 2.5 *Start/stop times*) prior to changing the plane of operation. This time is required to ensure data integrity. |
|---|---|

## 4.2 Serial ATA device plug connector pin definitions

Table 18, *Serial ATA connector pin definitions* summarizes the signals on the Serial ATA interface and power connectors.

**Table 18 - 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 | | | |

**Table 18 - Serial ATA connector pin definitions *(continued)***

| Segment | Pin | Function | Definition |
|---|---|---|---|
| Power | P1 | V33 | 3.3V power |
| | P2 | V33 | 3.3V power |
| | P3 | V33 | 3.3V power, pre-charge, 2nd mate |
| | P4 | Ground | 1st mate |
| | P5 | Ground | 2nd mate |
| | P6 | Ground | 2nd mate |
| | P7 | V5 | 5V power, pre-charge, 2nd mate |
| | P8 | V5 | 5V power |
| | P9 | V5 | 5V power |
| | P10 | Ground | 2nd mate |
| | P11 | Ground or LED signal | If grounded, drive does not use deferred spin |
| | P12 | Ground | 1st mate |
| | P13 | V12 | 12V power, pre-charge, 2nd mate |
| | P14 | V12 | 12V power |
| | P15 | V12 | 12V power |

Notes:

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

## 4.3 Supported ATA commands

The following table lists Serial ATA standard commands that the drive supports. For a detailed description of the ATA commands, refer to the Serial ATA International Organization: Serial ATA Revision 3.0 (www.sata-io.org). See Section 4.3.3 *SMART commands* for details and subcommands used in the SMART implementation.

**Table 19 - SATA standard commands**

| Command name | Command code (in hex) |
|---|---|
| Accessible Max Address Configuration | |
| Get Native Max Address Ext | $78_H$ / $0000_H$ |
| Set Accessible Max Address Ext | $78_H$ / $0001_H$ |
| Freeze Accessible Max Address Ext | $78_H$ / $0002_H$ |
| Check Power Mode | $E5_H$ |
| Configure Stream | $51_H$ |

**Table 19 - SATA standard commands *(continued)***

| Command name | Command code (in hex) |
|---|---|
| Download Microcode | $92_H$ |
| Execute Device Diagnostics | $90_H$ |
| Flush Cache | $E7_H$ |
| Flush Cache Extended | $EA_H$ |
| Get Physical Element Status | $12_H$ |
| Identify Device | $EC_H$ |
| Idle | $E3_H$ |
| Idle Immediate | $E1_H$ |
| Read Buffer | $E4_H$ |
| Read FPDMA Queued | $60_H$ |
| Read DMA | $C8_H$ |
| Read DMA Extended | $25_H$ |
| Read Log DMA Ext | $47_H$ |
| Read Log Ext | $2F_H$ |
| Read Multiple | $C4_H$ |
| Read Multiple Extended | $29_H$ |
| Read Native Max Address | $F8_H$ |
| Read Sectors | $20_H$ |
| Read Sectors Extended | $24_H$ |
| Read Stream DMA Ext | $24_H$ |
| Read Verify Sectors | $40_A$ |
| Read Verify Sectors Extended | $42_H$ |
| Receive FPDMA Queued | $65_H$ |
| Remove Element And Truncate | $7C_H$ |
| Restore Elements And Rebuild | $7D_H$ |
| Request Sense Data Ext | $0B_H$ |
| Sanitize Device - Crypto Scramble | $B4_H$ / $0011_H$ (SED and ISE drives only) |
| Sanitize Device - Freeze Lock Ext | $B4_H$ / $0020_H$ |
| Sanitize Device - Overwrite Ext | $B4_H$ / $0014_H$ |
| Sanitize Device - Status Ext | $B4_H$ / $0000_H$ |
| Security Disable Password | $F6_H$ |
| Security Erase Prepare | $F3_H$ |
| Security Erase Unit | $F4_H$ |
| Security Freeze | $F5_H$ |
| Security Set Password | $F1_H$ |
| Security Unlock | $F2_H$ |
| Send FPDMA Queued | $64_H$ |
| Set Date & Time Ext | $77_H$ |
| Set Features | $EF_H$ |
| Set Multiple Mode | $C6_H$ |

**Table 19 - SATA standard commands *(continued)***

| Command name | Command code (in hex) |
|---|---|
| Sleep | $E6_H$ |
| SMART Disable Operations | $B0_H$ / $D9_H$ |
| SMART Enable/Disable Autosave | $B0_H$ / $D2_H$ |
| SMART Enable Operations | $B0_H$ / $D8_H$ |
| SMART Execute Offline | $B0_H$ / $D4_H$ |
| SMART Read Attribute Thresholds | $B0_H$ / $D1_H$ |
| SMART Read Data | $B0_H$ / $D0_H$ |
| SMART Read Log Sector | $B0_H$ / $D5_H$ |
| SMART Return Status | $B0_H$ / $DA_H$ |
| SMART Save Attribute Values | $B0_H$ / $D3_H$ |
| SMART Write Log Sector | $B0_H$ / $D6_H$ |
| Standby | $E2_H$ |
| Standby Immediate | $E0_H$ |
| Write Buffer | $E8_H$ |
| Write DMA | $CA_H$ |
| Write DMA Extended | $35_H$ |
| Write DMA FUA Extended | $3D_H$ |
| Write FPDMA Queued | $61_H$ |
| Write Log DMA Ext | $57_H$ |
| 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 Extended | $34_H$ |
| Write Stream DMA Ext | $3A_H$ |
| Write Uncorrectable | $45_H$ |

### 4.3.1 Identify Device command

The Identify Device command (command code ECH) 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 Section 4.3 *Supported ATA commands*, on page 19. 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.

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

**Table 20 - Identify Device commands**

| Word | Description | Value |
|---|---|---|
| 0 | Configuration information:<br><br>Bit 15: 0 = ATA; 1 = ATAPI<br>• Bit 7: removable media<br>• Bit 6: removable controller<br>• Bit 0: reserved | $0C5A_H$ |
| 1 | Number of logical cylinders | 16,383 |
| 2 | Specific configuration:<br><br>37C8h Device requires SET FEATURES subcommand to spin-up after power-up and IDENTIFY DEVICE data is incomplete.<br>738Ch Device requires SET FEATURES subcommand to spin-up after power-up and IDENTIFY DEVICE data is complete.<br>8C73h Device does not require SET FEATURES subcommand to spin-up after power-up and IDENTIFY DEVICE data is incomplete.<br>C837h Device does not require SET FEATURES subcommand to spin-up after power-up and IDENTIFY DEVICE data is complete. | $C837_H$ |
| 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 | $0000_H$ |
| 22 | Obsolete | $0000_H$ |
| 23–26 | Firmware revision<br>(8 ASCII character string, padded with blanks to end of string) | x.xx |
| 27–46 | Drive model number:<br>(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 | Trusted Computing feature set options:<br><br>15 Shall be cleared to zero<br>14 Shall be set to one<br>13:1 Reserved for the Trusted Computing Group<br>0 Trusted Computing feature set is supported | $4000_H$ |
| 49 | Standard Standby timer, IORDY supported and may be disabled | $2F00_H$ |
| 50 | Capabilities | $4000_H$ |
| 51 | PIO data-transfer cycle timing mode | $0200_H$ |
| 52 | Retired (Obsolete) | $0200_H$ |

**Table 20 - Identify Device commands *(continued)***

| Word | Description | Value |
|---|---|---|
| 53 | 15:8 Free-fall Control Sensitivity<br>7:3 Reserved<br>2 the fields reported in word 88 are valid<br>1 the fields reported in words (70:64) are valid<br>0 Obsolete | $0007_H$ |
| 54-58 | Obsolete | $xxxx_H$ |
| 59 | 15 The BLOCK ERASE EXT command is supported<br>14 The OVERWRITE EXT command is supported<br>13 The CRYPTO SCRAMBLE EXT command is supported<br>12 The Sanitize feature set is supported<br>11:9 Reserved<br>8 Multiple logical sector setting is valid<br>7:0 Current setting for number of logical sectors that shall be transferred per DRQ data block on READ/WRITE Multiple commands | $5D10_H$ |
| 60–61 | Total number of user-addressable LBA sectors available<br>(see Section 2.2 *Formatted capacity* for related information)<br>*Note: The maximum value allowed in this field is 0FFFFFFFh (268,435,455 sectors, 137GB). Drives with capacities over 137GB 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 | Obsolete | $0000_H$ |
| 63 | Multiword DMA active and modes supported<br>(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) | $0078_H$ |
| 68 | Minimum PIO cycle time with IORDY flow control (120 nsec) | $0078_H$ |
| 69 | Additional Supported | $000C_H$ |
| 70–74 | ATA-reserved | $0000_H$ |
| 75 | Queue depth | $001F_H$ |
| 76 | SATA capabilities | $8D0E_H$ |
| 77 | Reserved for future SATA definition | $004x_H$ |
| 78 | SATA features supported | $xxCC_H$ |
| 79 | SATA features enabled | $0040_H$ |
| 80 | Major version number | $1FE0_H$ |
| 81 | Minor version number | $FFFF_H$ |
| 82 | Command sets supported | $306B_H$ |
| 83 | Command sets supported | $7561_H$ |
| 84 | Command sets support extension (see note following this table) | $6173_H$ |
| 85 | Command sets enabled | $3069_H$ |
| 86 | Command sets enabled | $B441_H$ |
| 87 | Command sets enable extension | $6173_H$ |
| 88 | Ultra DMA support and current mode (see note following this table) | $xx7F_H$ |
| 89 | Security erase time | $xxxx_H$ |
| 90 | Enhanced security erase time | $xxxx_H$ |
| 92 | Master password revision code | $FFFE_H$ |

**Table 20 - Identify Device commands *(continued)***

| Word | Description | Value |
|---|---|---|
| 93 | Hardware reset value | $xxxx_H$ |
| 94 | Obsolete | $xxxx_H$ |
| 95–99 | ATA-reserved | $0000_H$ |
| 100–103 | Total number of user-addressable LBA sectors available. These words are required for drives that support the 48-bit addressing feature. Maximum value: 0000FFFFFFFFFFFFh. | See Section 2.2 *Formatted capacity* |
| 104-105 | ATA-reserved | $0000_H$ |
| 106 | Physical sector size / logical sector size | $6003_H$ |
| 107 | ATA-reserved | $0000_H$ |
| 108-111 | The mandatory value of the world wide name (WWN) for the drive. **NOTE:** This field is valid if word 84, bit 8 is set to 1 indicating 64-bit WWN support. | Each drive will have a unique value. |
| 112-118 | ATA-reserved | $0000_H$ |
| 119 | Commands and feature sets supported | $43DE_H$ |
| 120 | Commands and feature sets supported or enabled | $40DC_H$ |
| 121-127 | ATA-reserved | $0000_H$ |
| 128 | Security status | $0021_H$ |
| 129–159 | Seagate-reserved | $xxxx_H$ |
| 160–167 | ATA-reserved | $0000_H$ |
| 168 | Device Nominal Form Factor | $0002_H$ |
| 169-205 | ATA-reserved | $0000_H$ |
| 206 | SCT Command Transport | $50BD_H$ |
| 207-208 | ATA-reserved | $0000_H$ |
| 209 | Alignment of logical blocks within a physical block | $4000_H$ |
| 210-216 | ATA-reserved | $0000_H$ |
| 217 | Nominal media rotation rate | $1C20_H$ |
| 218-221 | ATA-reserved | $0000_H$ |
| 222 | Transport major version number | $11FF_H$ |
| 223-229 | ATA-reserved | $0000_H$ |
| 230-233 | Extended Number of User Addressable Sectors | See Section 2.2 *Formatted capacity* |
| 234–254 | ATA-reserved | $0000_H$ |
| 255 | Integrity word | $xxA5_H$ |

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

**NOTE** See the bit descriptions below for words 63, 84, and 88 of the Identify Drive data.

**Table 21 - Bit descriptions for words 63, 84, and 88 of the Identify Drive data**

| Description (if bit is set to 1) | |
|---|---|
| Bit | Word 63 |

**Table 21 - Bit descriptions for words 63, 84, and 88 of the Identify Drive data *(continued)***

| | | Description (if bit is set to 1) |
|---|---|---|
| | 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 84 |
| | 0 | SMART error login is supported. |
| | 1 | SMART self-test is supported. |
| | 2 | Reserved. |
| | 3 | Obsolete. |
| | 4 | Streaming feature set is supported. |
| | 5 | GPL feature set is supported. |
| | 6 | WRITE DMA FUA EXT command is supported. |
| | 7 | Obsolete. |
| | 8 | World Wide Name is supported. |
| | 9-12 | Obsolete. |
| | 13 | IDLE IMMEDIATE command with UNLOAD feature is supported. |
| | 14 | Shall be set to 1. |
| | 15 | Shall be cleared to 0. |
| 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 22 - Set Features command**

| | |
|---|---|
| $02_H$ | Enable write cache *(default)* |
| $03_H$ | Set transfer mode (based on value in Sector Count register)<br>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 *(default)* |
| | $20_H$ 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 |
| $06_H$ | Enable the PUIS feature set |
| $07_H$ | PUIS feature set device spin-up |
| $10_H$ | Enable use of SATA features |
| $55_H$ | Disable read look-ahead (read cache) feature |
| $82_H$ | Disable write cache |
| $86_H$ | Disable the PUIS feature set |
| $90_H$ | Disable use of SATA features |
| $AA_H$ | Enable read look-ahead (read cache) feature *(default)* |
| $F1_H$ | 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 SMART commands

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

SeaTools diagnostic software activates a built-in drive self-test (DST SMART command for $D4_H$) that eliminates unnecessary drive returns. The diagnostic software ships with all new drives and is also available at www.seagate.com/support/downloads/seatools.

This drive is shipped with SMART features disabled. Users must have a recent BIOS or software package that supports SMART to enable this feature. The table below shows the SMART command codes that the drive uses.

**Table 23 - SMART commands**

| Code in features register | SMART command |
|---|---|
| $D0_H$ | SMART Read Data |
| $D2_H$ | SMART Enable/Disable Attribute Autosave |
| $D3_H$ | SMART Save Attribute Values |
| $D4_H$ | SMART Execute Off-line Immediate (runs DST) |
| $D5_H$ | SMART Read Log Sector |
| $D6_H$ | SMART Write Log Sector |
| $D8_H$ | SMART Enable Operations |
| $D9_H$ | SMART Disable Operations |
| $DA_H$ | SMART 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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***Publication Number: 210203200, Rev A***
***March 2025***