



# Seagate® BarraCuda® SATA

## Product Manual

### **Standard Models**

ST24000DM001

ST20000DM001

ST16000DM001

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## Revision History

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

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When referring to drive capacity, one gigabyte, or GB, equals one billion bytes and one terabyte, or TB, equals one trillion bytes. Your computer's operating system may use a different standard of measurement and report a lower capacity. In addition, some of the listed capacity is used for formatting and other functions, and thus will not be available for data storage. Actual quantities will vary based on various factors, including file size, file format, features and application software. Actual data rates may vary depending on operating environment and other factors. The export or re-export of hardware or software containing encryption may be regulated by the U.S. Department of Commerce, Bureau of Industry and Security (for more information, visit [www.bis.doc.gov](http://www.bis.doc.gov)), and controlled for import and use outside of the U.S. Seagate reserves the right to change, without notice, product offerings or specifications.

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## Seagate Technology Support Services

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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 <a href="#">Section 2.2 Formatted capacity</a> .		
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 Multiword DMA modes: 0 to 2 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 $\pm$ 5% 12V $\pm$ 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) 20°C per hour max (non-operating)		
Relative humidity	5% to 95% (operating) 5% to 95% (non-operating)		
Relative humidity gradient (max)	20% per hour		
Altitude, operating	–304m to 3048m (–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 to 12,192m (-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 <sup>2</sup>		
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) 3.0 bels (max)		
Seek	3.2 bels (typ) 3.4 bels (max)		
Non-recoverable read errors	1 per 10 <sup>14</sup> bits read		
Rated workload	Average annualized workload rating: <120 TB/year. 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 <a href="http://www.seagate.com/warranty">www.seagate.com/warranty</a> . 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 <a href="#">Section 2.2.1 LBA mode</a> )
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)**

<b>Operating</b>	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. The maximum allowable drive reported temperature is 140°F (60°C). Airflow may be required to achieve consistent nominal drive temperature values (see <a href="#">Section 3.3 Drive mounting</a> ). 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.
<b>Non-operating</b>	–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)**

<b>Operating</b>	5% to 95% non-condensing relative humidity with a maximum gradient of 20% per hour.
<b>Non-operating</b>	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)**

<b>Operating</b>	–304.8 to 3048 m (–1000 to 10,000+ ft)
<b>Non-operating</b>	–304.8 to 12,192 m (–1000 to 40,000+ ft)

## 2.7.4 Shock and Vibration

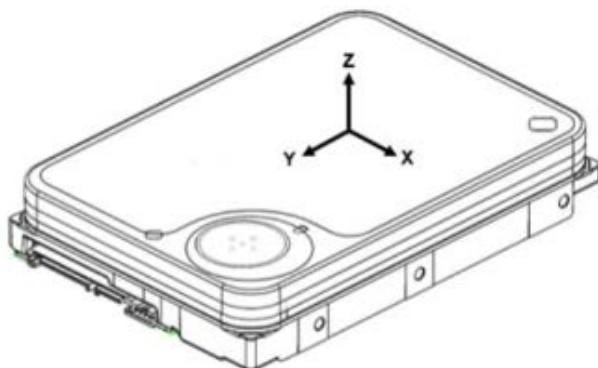
Shock and vibration measurements specified in this document are made directly on the drive itself and applied in the X, Y, and Z axis at the drive mounting point locations.

### 2.7.4.1 Shock

**Table 12 - Shock**

<b>Operating</b>	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 <a href="#">Figure 1, Drive orientation</a> .
<b>Non-operating</b>	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 <sup>2</sup> /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 <sup>2</sup>				
Frequency (Hz)	20	200	800	1500
(rad/sec <sup>2</sup> ) <sup>2</sup> /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 <sup>2</sup> /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:

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

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

	Idle*	Performance seek
All models	2.8 bels (typ) 3.0 bels (max)	3.2 bels (typ) 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: $\pm 4$ kV; Air: $\pm 8$ kV	B	EN61000-4-2: 95
Radiated RF immunity	80MHz to 1,000MHz, 3 V/m, 80% AM with 1kHz sine	A	EN61000-4-3: 96
Electrical fast transient	$\pm 1$ kV on AC mains, $\pm 0.5$ 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, 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 0% short, 5 seconds 40%, 0.10 seconds 70%, 0.01 seconds	C C C B	EN61000-4-11: 94

## 2.10 Warranty

For warranty assistance, visit [www.seagate.com/warranty](http://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](http://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



Class 1 consumer laser product EN 50689: 2021  
Produit consommateur laser de classe 1 EN 50689: 2021

## 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.
- Handle the drive by its edges or frame only.
- The drive is extremely fragile—handle it with care. Do not press down on the top cover.
- Always rest the drive on a padded, antistatic surface until mounting 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 Serial ATA cables and connectors

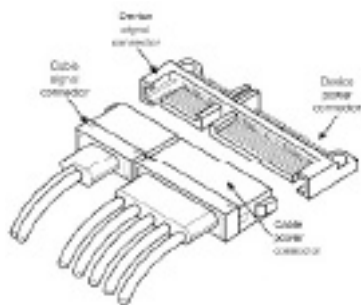
The Serial ATA interface cable consists of four conductors in two differential pairs, plus three ground connections. The cable size may be 30 to 26 AWG with a maximum length of one meter (39.37 in).

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:

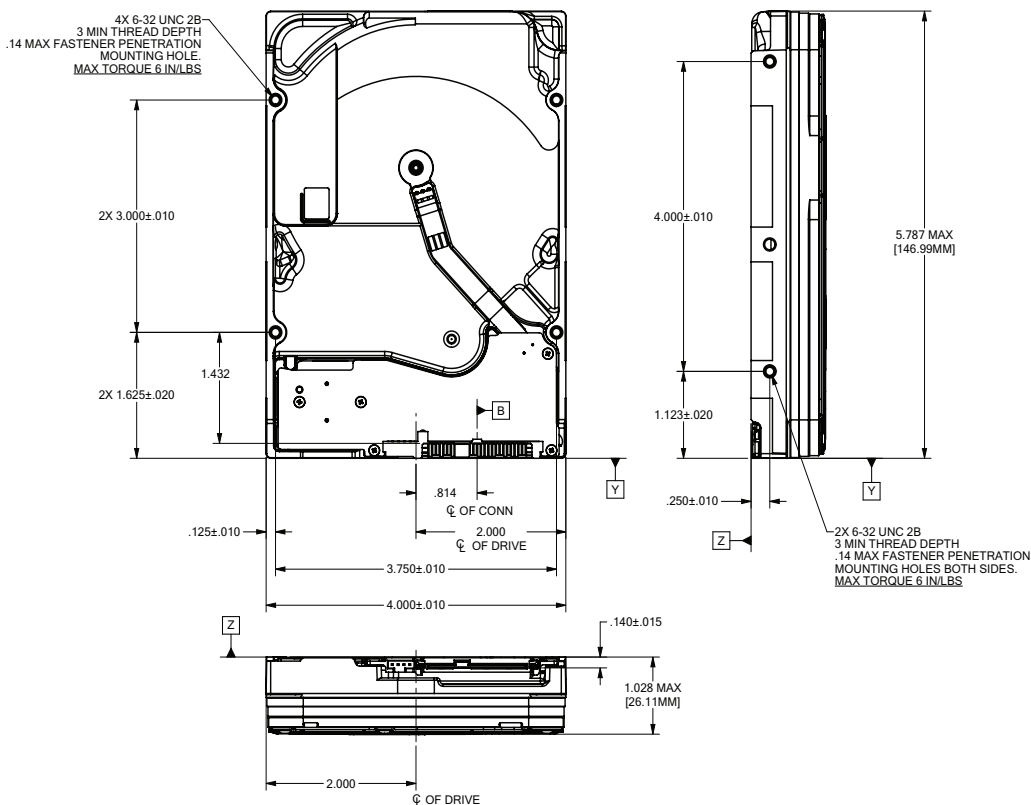
- Allow a minimum clearance of 0.030 in (0.76mm) around the entire perimeter of the drive for cooling.
- Use only 6-32 UNC mounting screws.
- The screws should be inserted no more than 0.140 in (3.56mm) into the bottom or side mounting holes.
- Do not overtighten the mounting screws (maximum torque: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

## 4.3 Supported ATA commands

The following table lists Serial ATA standard commands that the drive supports. For a detailed description of the ATA commands, refer to the Serial ATA International Organization: Serial ATA Revision 3.0 ([www.sata-io.org](http://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 <sub>H</sub> / 0000 <sub>H</sub>
Set Accessible Max Address Ext	78 <sub>H</sub> / 0001 <sub>H</sub>
Freeze Accessible Max Address Ext	78 <sub>H</sub> / 0002 <sub>H</sub>
Check Power Mode	E5 <sub>H</sub>
Configure Stream	51 <sub>H</sub>

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

Command name	Command code (in hex)
Download Microcode	92 <sub>H</sub>
Execute Device Diagnostics	90 <sub>H</sub>
Flush Cache	E7 <sub>H</sub>
Flush Cache Extended	EA <sub>H</sub>
Get Physical Element Status	12 <sub>H</sub>
Identify Device	EC <sub>H</sub>
Idle	E3 <sub>H</sub>
Idle Immediate	E1 <sub>H</sub>
Read Buffer	E4 <sub>H</sub>
Read FPDMA Queued	60 <sub>H</sub>
Read DMA	C8 <sub>H</sub>
Read DMA Extended	25 <sub>H</sub>
Read Log DMA Ext	47 <sub>H</sub>
Read Log Ext	2F <sub>H</sub>
Read Multiple	C4 <sub>H</sub>
Read Multiple Extended	29 <sub>H</sub>
Read Native Max Address	F8 <sub>H</sub>
Read Sectors	20 <sub>H</sub>
Read Sectors Extended	24 <sub>H</sub>
Read Stream DMA Ext	24 <sub>H</sub>
Read Verify Sectors	40 <sub>A</sub>
Read Verify Sectors Extended	42 <sub>H</sub>
Receive FPDMA Queued	65 <sub>H</sub>
Remove Element And Truncate	7C <sub>H</sub>
Restore Elements And Rebuild	7D <sub>H</sub>
Request Sense Data Ext	0B <sub>H</sub>
Sanitize Device - Crypto Scramble	B4 <sub>H</sub> / 0011 <sub>H</sub> (SED and ISE drives only)
Sanitize Device - Freeze Lock Ext	B4 <sub>H</sub> / 0020 <sub>H</sub>
Sanitize Device - Overwrite Ext	B4 <sub>H</sub> / 0014 <sub>H</sub>
Sanitize Device - Status Ext	B4 <sub>H</sub> / 0000 <sub>H</sub>
Security Disable Password	F6 <sub>H</sub>
Security Erase Prepare	F3 <sub>H</sub>
Security Erase Unit	F4 <sub>H</sub>
Security Freeze	F5 <sub>H</sub>
Security Set Password	F1 <sub>H</sub>
Security Unlock	F2 <sub>H</sub>
Send FPDMA Queued	64 <sub>H</sub>
Set Date & Time Ext	77 <sub>H</sub>
Set Features	EF <sub>H</sub>
Set Multiple Mode	C6 <sub>H</sub>

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

Command name	Command code (in hex)
Sleep	E6 <sub>H</sub>
SMART Disable Operations	B0 <sub>H</sub> / D9 <sub>H</sub>
SMART Enable/Disable Autosave	B0 <sub>H</sub> / D2 <sub>H</sub>
SMART Enable Operations	B0 <sub>H</sub> / D8 <sub>H</sub>
SMART Execute Offline	B0 <sub>H</sub> / D4 <sub>H</sub>
SMART Read Attribute Thresholds	B0 <sub>H</sub> / D1 <sub>H</sub>
SMART Read Data	B0 <sub>H</sub> / D0 <sub>H</sub>
SMART Read Log Sector	B0 <sub>H</sub> / D5 <sub>H</sub>
SMART Return Status	B0 <sub>H</sub> / DA <sub>H</sub>
SMART Save Attribute Values	B0 <sub>H</sub> / D3 <sub>H</sub>
SMART Write Log Sector	B0 <sub>H</sub> / D6 <sub>H</sub>
Standby	E2 <sub>H</sub>
Standby Immediate	E0 <sub>H</sub>
Write Buffer	E8 <sub>H</sub>
Write DMA	CA <sub>H</sub>
Write DMA Extended	35 <sub>H</sub>
Write DMA FUA Extended	3D <sub>H</sub>
Write FPDMA Queued	61 <sub>H</sub>
Write Log DMA Ext	57 <sub>H</sub>
Write Log Extended	3F <sub>H</sub>
Write Multiple	C5 <sub>H</sub>
Write Multiple Extended	39 <sub>H</sub>
Write Multiple FUA Extended	CE <sub>H</sub>
Write Sectors	30 <sub>H</sub>
Write Sectors Extended	34 <sub>H</sub>
Write Stream DMA Ext	3A <sub>H</sub>
Write Uncorrectable	45 <sub>H</sub>

### 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:  Bit 15: 0 = ATA; 1 = ATAPI • Bit 7: removable media • Bit 6: removable controller • Bit 0: reserved	0C5A <sub>H</sub>
1	Number of logical cylinders	16,383
2	Specific configuration:  37C8h Device requires SET FEATURES subcommand to spin-up after power-up and IDENTIFY DEVICE data is incomplete. 738Ch Device requires SET FEATURES subcommand to spin-up after power-up and IDENTIFY DEVICE data is complete. 8C73h Device does not require SET FEATURES subcommand to spin-up after power-up and IDENTIFY DEVICE data is incomplete. C837h Device does not require SET FEATURES subcommand to spin-up after power-up and IDENTIFY DEVICE data is complete.	C837 <sub>H</sub>
3	Number of logical heads	16
4	Retired	0000 <sub>H</sub>
5	Retired	0000 <sub>H</sub>
6	Number of logical sectors per logical track: 63	003F <sub>H</sub>
7–9	Retired	0000 <sub>H</sub>
10–19	Serial number: (20 ASCII characters, 0000 <sub>H</sub> = none)	ASCII
20	Retired	0000 <sub>H</sub>
21	Retired	0000 <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)	
47	(Bits 7–0) Maximum sectors per interrupt on Read multiple and Write multiple (16)	8010 <sub>H</sub>
48	Trusted Computing feature set options:  15 Shall be cleared to zero 14 Shall be set to one 13:1 Reserved for the Trusted Computing Group 0 Trusted Computing feature set is supported	4000 <sub>H</sub>
49	Standard Standby timer, IORDY supported and may be disabled	2F00 <sub>H</sub>
50	Capabilities	4000 <sub>H</sub>
51	PIO data-transfer cycle timing mode	0200 <sub>H</sub>
52	Retired (Obsolete)	0200 <sub>H</sub>

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

Word	Description	Value
53	15:8 Free-fall Control Sensitivity 7:3 Reserved 2 the fields reported in word 88 are valid 1 the fields reported in words (70:64) are valid 0 Obsolete	0007 <sub>H</sub>
54-58	Obsolete	xxxx <sub>H</sub>
59	15 The BLOCK ERASE EXT command is supported 14 The OVERWRITE EXT command is supported 13 The CRYPTO SCRAMBLE EXT command is supported 12 The Sanitize feature set is supported 11:9 Reserved 8 Multiple logical sector setting is valid 7:0 Current setting for number of logical sectors that shall be transferred per DRQ data block on READ/WRITE Multiple commands	5D10 <sub>H</sub>
60-61	Total number of user-addressable LBA sectors available (see <a href="#">Section 2.2 Formatted capacity</a> for related information) *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 <sub>H</sub>
63	Multiword DMA active and modes supported (see note following this table)	xx07 <sub>H</sub>
64	Advanced PIO modes supported (modes 3 and 4 supported)	0003 <sub>H</sub>
65	Minimum multiword DMA transfer cycle time per word (120 nsec)	0078 <sub>H</sub>
66	Recommended multiword DMA transfer cycle time per word (120 nsec)	0078 <sub>H</sub>
67	Minimum PIO cycle time without IORDY flow control (240 nsec)	0078 <sub>H</sub>
68	Minimum PIO cycle time with IORDY flow control (120 nsec)	0078 <sub>H</sub>
69	Additional Supported	000C <sub>H</sub>
70-74	ATA-reserved	0000 <sub>H</sub>
75	Queue depth	001F <sub>H</sub>
76	SATA capabilities	8D0E <sub>H</sub>
77	Reserved for future SATA definition	004x <sub>H</sub>
78	SATA features supported	xxCC <sub>H</sub>
79	SATA features enabled	0040 <sub>H</sub>
80	Major version number	1FE0 <sub>H</sub>
81	Minor version number	FFFF <sub>H</sub>
82	Command sets supported	306B <sub>H</sub>
83	Command sets supported	7561 <sub>H</sub>
84	Command sets support extension (see note following this table)	6173 <sub>H</sub>
85	Command sets enabled	3069 <sub>H</sub>
86	Command sets enabled	B441 <sub>H</sub>
87	Command sets enable extension	6173 <sub>H</sub>
88	Ultra DMA support and current mode (see note following this table)	xx7F <sub>H</sub>
89	Security erase time	xxxx <sub>H</sub>
90	Enhanced security erase time	xxxx <sub>H</sub>
92	Master password revision code	FFFE <sub>H</sub>

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

Word	Description	Value
93	Hardware reset value	xxxx <sub>H</sub>
94	Obsolete	xxxx <sub>H</sub>
95–99	ATA-reserved	0000 <sub>H</sub>
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: 0000FFFFFFFF <sub>H</sub> .	See <a href="#">Section 2.2 Formatted capacity</a>
104–105	ATA-reserved	0000 <sub>H</sub>
106	Physical sector size / logical sector size	6003 <sub>H</sub>
107	ATA-reserved	0000 <sub>H</sub>
108–111	The mandatory value of the world wide name (WWN) for the drive. <b>NOTE:</b> 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 <sub>H</sub>
119	Commands and feature sets supported	43DE <sub>H</sub>
120	Commands and feature sets supported or enabled	40DC <sub>H</sub>
121–127	ATA-reserved	0000 <sub>H</sub>
128	Security status	0021 <sub>H</sub>
129–159	Seagate-reserved	xxxx <sub>H</sub>
160–167	ATA-reserved	0000 <sub>H</sub>
168	Device Nominal Form Factor	0002 <sub>H</sub>
169–205	ATA-reserved	0000 <sub>H</sub>
206	SCT Command Transport	50BD <sub>H</sub>
207–208	ATA-reserved	0000 <sub>H</sub>
209	Alignment of logical blocks within a physical block	4000 <sub>H</sub>
210–216	ATA-reserved	0000 <sub>H</sub>
217	Nominal media rotation rate	1C20 <sub>H</sub>
218–221	ATA-reserved	0000 <sub>H</sub>
222	Transport major version number	11FF <sub>H</sub>
223–229	ATA-reserved	0000 <sub>H</sub>
230–233	Extended Number of User Addressable Sectors	See <a href="#">Section 2.2 Formatted capacity</a>
234–254	ATA-reserved	0000 <sub>H</sub>
255	Integrity word	xxA5 <sub>H</sub>

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

**NOTE**

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

### 4.3.3 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<sub>H</sub>) that eliminates unnecessary drive returns. The diagnostic software ships with all new drives and is also available at [www.seagate.com/support/downloads/seatools](http://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 <sub>H</sub>	SMART Read Data
D2 <sub>H</sub>	SMART Enable/Disable Attribute Autosave
D3 <sub>H</sub>	SMART Save Attribute Values
D4 <sub>H</sub>	SMART Execute Off-line Immediate (runs DST)
D5 <sub>H</sub>	SMART Read Log Sector
D6 <sub>H</sub>	SMART Write Log Sector
D8 <sub>H</sub>	SMART Enable Operations
D9 <sub>H</sub>	SMART Disable Operations
DA <sub>H</sub>	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.



**Seagate Technology LLC**

*AMERICAS Seagate Technology LLC, 47488 Kato Road, Fremont, California 94538, USA, [www.seagate.com](http://www.seagate.com)*

*ASIA/PACIFIC Seagate Singapore International Headquarters Pte. Ltd. 90 Woodlands Avenue 7, Singapore 737911*

*EUROPE, MIDDLE EAST AND AFRICA Seagate Technology NL BV, Tupolevlaan, 105, 119 PA Schiphol-Rijk. NL*

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