SEAGATE

SKYHAWK AI™

SATA Product Manual

Rescue DATA RECOVERY SERVICES

Standard models

+Rescue*

ST20000VE000

ST20000VE002

* Seagate Rescue Data Recovery Services plan is only offered in selected regions only. Please check with reseller on availability

203249700, Rev. A
November 2021

Document Revision History

Revision	Date	Pages affected and Description of changes
Rev. A	11/29/2021	Initial release.

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Publication number: 203249700, Rev. A November 2021

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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), 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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1.0 Introduction

This manual describes the functional, mechanical and interface specifications for the following: Seagate® SkyHawk® AI Serial ATA +Rescue drive models.

512E models
Standard
ST20000VE000 ST20000VE002

These drives provide the following key features:

- 256 MB data buffer.
- 7200 RPM spindle speed.
- Full-track multiple-sector transfer capability without local processor intervention.
- High instantaneous (burst) data-transfer rates (up to 600MB per second).
- Native Command Queuing with command ordering to increase performance in demanding applications.
- PowerChoice™ for selectable power savings
- Perpendicular recording technology provides the drives with increased areal density.
- 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 S.M.A.R.T. drive monitoring and reporting.
- Supports latching SATA cables and connectors.
- Top Cover Attached motor for excellent vibration tolerance
- Worldwide Name (WWN) capability uniquely identifies the drive.

NOTE Seagate recommends validating the configuration with the selected HBA/RAID controller manufacturer to ensure use of full capacity is supported.

1.1 About the Serial ATA interface

The Serial ATA interface provides several advantages over the traditional (parallel) ATA interface. The primary advantages include:

- Easy installation and configuration with true plug-and-play connectivity.
  It is not necessary to set any jumpers or other configuration options.
- Thinner and more flexible cabling for improved enclosure airflow and ease of installation.
- Scalability to higher performance levels.

In addition, Serial ATA makes the transition from parallel ATA easy by providing legacy software support. Serial ATA was designed to allow users to install a Serial ATA host adapter and Serial ATA disk drive in the current system and expect all of the existing applications to work as normal.

The Serial ATA interface connects each disk drive in a point-to-point configuration with the Serial ATA host adapter. There is no master/slave relationship with Serial ATA devices like there is with parallel ATA. If two drives are attached on one Serial ATA host adapter, the host operating system views the two devices as if they were both "masters" on two separate ports. This essentially means both drives behave as if they are Device 0 (master) devices.

NOTE The host adapter may, optionally, emulate a master/slave environment to host software where two devices on separate Serial ATA ports are represented to host software as a Device 0 (master) and Device 1 (slave) accessed at the same set of host bus addresses. A host adapter that emulates a master/slave environment manages two sets of shadow registers. This is not a typical Serial ATA environment.

The Serial ATA host adapter and drive share the function of emulating parallel ATA device behavior to provide backward compatibility with existing host systems and software. The Command and Control Block registers, PIO and DMA data transfers, resets, and interrupts are all emulated.

The Serial ATA host adapter contains a set of registers that shadow the contents of the traditional device registers, referred to as the Shadow Register Block. All Serial ATA devices behave like Device 0 devices. For additional information about how Serial ATA emulates parallel ATA, refer to the "Serial ATA: High Speed Serialized AT Attachment" specification. The specification can be downloaded from www.serialata.org.

2.0 Drive specifications

Unless otherwise noted, all specifications are measured under ambient conditions, at 25°C, and nominal power. For convenience, the phrases *the drive* and *this drive* are used throughout this manual to indicate the SkyHawk AI Serial ATA +Rescue 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 1 Drive specifications summary

Drive specification	ST20000VE000 and ST20000VE002
Formatted (512 bytes/sector)*	20TB
Guaranteed sectors	(see ***Section 2.2***)
Heads	20
Disks	10
Bytes per logical sector	512
Bytes per physical sector	4096
Recording density, KBPI (Kb/in max)	2470
Track density, KTPI (ktracks/in avg.)	482
Areal density, (Gb/in^2 avg)	1146
Spindle speed (RPM)	7200
Internal data transfer rate (Mb/s max)	2899
Sustained data transfer rate OD (MiB/s max)	248 (260 MB/s max)
I/O data-transfer rate (MB/s max)	600
ATA data-transfer modes supported	PIO modes 0–4 Multiword DMA modes 0–2 Ultra DMA modes 0–6
Cache buffer	256MB (262,144KB)
Weight: (maximum)	680g (1.499 lb)
Average latency	4.16ms
Power-on to ready (sec) (typ/max)	25/30
Standby to ready (sec) (typ/max)	25/30
Startup current (typical) 12V (peak)	2.0A
Voltage tolerance (including noise)	5V ± 5% 12V ± 10%
Operating ambient temperature (min °C)*	0°C (Ambient)
Operating temperature (max °C)*	65°C (Drive Reported Temperature) †
Non-Operating temperature	–40° to 70°C (Ambient Temperature, see sections **2.6.1** and **2.14**)
Temperature gradient (°C per hour max)	20°C (operating) 20°C (nonoperating)

Drive specification	ST20000VE000 and ST20000VE002
Relative humidity*	5% to 95% (operating) 5% to 95% (nonoperating)
Relative humidity gradient	20% per hour max
Altitude, operating	–304.8 m to 3,048 m (–1000 ft to 10,000+ ft)
Altitude, nonoperating (below mean sea level, max)	–304.8 m to 12,192 m (–1000 ft to 40,000+ ft)
Operational Shock (2 ms Z-axis)	40 Gs typical
Non-Operational Shock (2 ms)	200 Gs
Linear Random Operating Vibration	5–500 Hz: 0.70 Grms
Random Rotary Operating Vibration	20–1500Hz: 12.5 rads/s^2
Linear Random Non-Operating Vibration	2–500 Hz: 2.27 Grms
Drive acoustics, sound power (bels)	
Idle	2.8 (typical) 3.0 (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.
Performance seek	3.2 (typical) 3.4 (max)
Nonrecoverable read errors	1 sector per 10^{15} bits read
Annualized Failure Rate (AFR)*	0.44% based on 8760 POH
Maximum Rated Workload*	Maximum rate of <550TB/year Workloads exceeding the annualized rate may degrade the drive MTBF and impact product reliability. The Annualized Workload Rate is in units of TB per year, or TB per 8760 power on hours. Workload Rate = TB transferred * (8760 / recorded power on hours).
Warranty	To determine the warranty for a specific drive, use a web browser to access the following web page: www.seagate.com/support/warranty-and-replacements/. From this page, click on the "Is my Drive under Warranty" link. The following are required to be provided: the drive serial number, model number (or part number) and country of purchase.The system will display the warranty information for the drive.
Load-unload cycles (command controlled)	600,000
Supports Hotplug operation per Serial ATA Revision 3.3 specification	Yes

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

* See **Section 2.10, "Reliability"** for rated MTBF device operating condition requirements.

** See **Section 2.4, "Start/stop times"** for additional information.

† Seagate does not recommend operating at sustained drive temperatures above 60°C. Operating at higher temperatures may affect drive health.

2.2 Formatted capacity

ST models	Formatted capacity*	Guaranteed sectors	Bytes per logical sector	Guaranteed sectors	Bytes per logical sector
ST20000VE000 and ST20000VE002	20TB	39,063,650,304	512 (Default)	4,882,956,288	4096 (see **Section 2.2.1**)

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

NOTE LBA Counts for drive capacities greater than 8TB are calculated based upon the SFF-8447 standard publication. ftp://ftp.seagate.com/sff/SFF-8447.PDF

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

Interface	Serial ATA (SATA)
Recording method	Perpendicular
Recording density, KBPI (Kb/in max)	2470
Track density, KTPI (ktracks/in avg)	482
Areal density (Gb/in^2 avg)	1146
Spindle speed (RPM) (± 0.2%)	7200
Internal data transfer rate (Mb/s max)	2899
Sustained data transfer rate (MiB/s max)	248
I/O data-transfer rate (MB/s max)	600 (Ultra DMA mode 5)

2.4 Start/stop times

Power-on to ready time is based on typical operating conditions, default full current spin-up profile, and clean shutdown prior to measurement. To ensure a clean shutdown a Flush Cache, Standby, or Standby Immediate command must be completed before removal of interface power.

Power-on to Ready (sec) (typ/max)	25/30
Standby to Ready (sec) (typ/max)	25/30
Ready to spindle stop (sec) (max)	20

NOTE An unexpected power loss event, spin up at cold or hot temperature extremes may cause the drive to exceed the typical and max time to ready by 5 to 20 seconds. Extended time to ready is dependent on cache state and environmental conditions prior to the unexpected power loss and during the subsequent power on.

2.5 Power specifications

The drive receives DC power (+5V or +12V) through a native SATA power connector. **See Figure 3 on page 22** .

2.5.1 Power consumption

Power requirements for the drives are listed in **Table 2**. Typical power measurements are based on an average of drives tested, under nominal conditions, using 5.0V and 12.0V input voltage at 35°C ambient temperature.

Table 2 DC power requirements (20TB)

Power dissipation	Avg (watts 25° C)	Avg 5V typ amps	Avg 12V typ amps
Spin-Up	—	—	2.0
Idle	3.54	0.246	0.19
Operating	7.72	0.524	0.422
Standby	1.01	0.177	0.01
Sleep	1.01	0.177	0.01

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

2.5.1.1 Typical current profiles

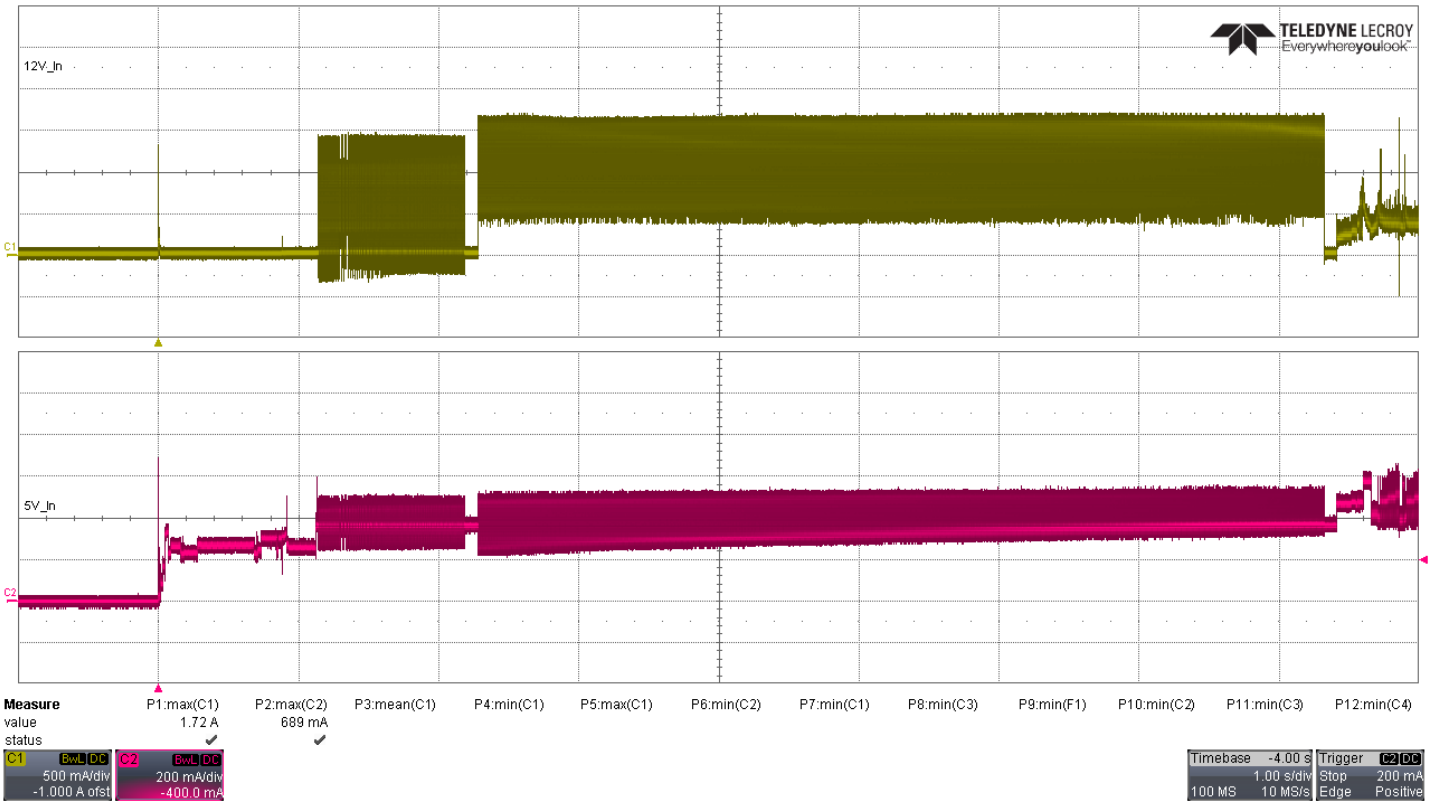


Figure 1. Typical 5V and 12V startup and operation current profiles

2.5.2 Conducted noise

Noise is specified as a periodic and random distribution of frequencies covering a band from DC to 10 MHz. Maximum allowed noise values given below are peak-to-peak measurements and apply at the drive power connector.

+5v = 250 mV pp from 100 Hz to 20 MHz.

+12v = 800 mV pp from 100 Hz to 8 KHz.
450 mV pp from 8 KHz to 20 KHz.
250 mV pp from 20 KHz to 5 MHz.

2.5.3 Voltage tolerance

Voltage tolerance (including noise):

5V ± 5% 12V ± 10%

2.5.4 Extended Power Conditions - PowerChoice™

Utilizing the load/unload architecture a programmable power management interface is provided to tailor systems for reduced power consumption and performance requirements.

The table below lists the supported power conditions available in PowerChoice. Power conditions are ordered from highest power consumption (and shortest recovery time) to lowest power consumption (and longest recovery time) as follows: Idle_a power >= Idle_b power >= Idle_c power >= Standby_z power. The further users go down in the table, the more power savings is actualized. For example, Idle_b results in greater power savings than the Idle_a power condition. Standby results in the greatest power savings.

Power Condition Name	Power Condition ID	Description
Idle_a	81_H	Reduced electronics
Idle_b	82_H	Heads unloaded. Disks spinning at full RPM
Idle_c	83_H	Heads unloaded. Disks spinning at reduced RPM
Standby_z	00_H	Heads unloaded. Motor stopped (disks not spinning)

Each power condition has a set of current, saved and default settings. Default settings are not modifiable. Default and saved settings persist across power-on resets. The current settings do not persist across power-on resets. At the time of manufacture, the default, saved and current settings are in the Power Conditions log match.

PowerChoice is invoked using one of two methods

- Automatic power transitions which are triggered by expiration of individual power condition timers. These timer values may be customized and enabled using the Extended Power Conditions (EPC) feature set using the standardized Set Features command interface.
- Immediate host commanded power transitions may be initiated using an EPC Set Features "Go to Power Condition" subcommand to enter any supported power condition. Legacy power commands Standby Immediate and Idle Immediate also provide a method to directly transition the drive into supported power conditions.

PowerChoice exits power saving states under the following conditions

- Any command which requires the drive to enter the PM0: Active state (media access)
- Power on reset

PowerChoice provides the following reporting methods for tracking purposes

Check Power Mode Command

- Reports the current power state of the drive

Identify Device Command

- EPC Feature set supported flag
- EPC Feature enabled flag is set if at least one Idle power condition timer is enabled

Power Condition Log reports the following for each power condition

- Nominal recovery time from the power condition to active
- If the power condition is Supported, Changeable, and Savable
- Default enabled state, and timer value
- Saved enabled state, and timer value
- Current enabled state, and timer value

S.M.A.R.T. Read Data Reports

- Attribute 192 - Emergency Retract Count
- Attribute 193 - Load/Unload Cycle Count

PowerChoice Manufacture Default Power Condition Timer Values

Default power condition timer values have been established to assure product reliability and data integrity. A minimum timer value threshold of two minutes ensures the appropriate amount of background drive maintenance activities occur. Attempting to set a timer values less than the specified minimum timer value threshold will result in an aborted EPC "Set Power Condition Timer" subcommand.

Power Condition Name	Manufacturer Default Timer Values
Idle_a	100 ms
Idle_b	2 min
Idle_c	4 min
Standby_z	15 min

Setting power condition timer values less than the manufacturer specified defaults or issuing the EPC "Go to Power Condition" subcommand at a rate exceeding the default timers may limit this products reliability and data integrity.

PowerChoice Supported Extended Power Condition Feature Subcommands

EPC Subcommand	Description
00_H	Restore Power Condition Settings
01_H	Go to Power Condition
02_H	Set Power Condition Timer
03_H	Set Power Condition State
04_H	Enable EPC Feature Set
05_H	Disable EPC Feature Set

PowerChoice Supported Extended Power Condition Identifiers

Power Condition Identifiers	Power Condition Name
00_H	Standby_z
01 - 80_H	Reserved
81_H	Idle_a
82_H	Idle_b
83_H	Idle_c
84 - FE_H	Reserved
FF_H	All EPC Power Conditions

2.6 Environmental limits

Temperature and humidity values experienced by the drive must be such that condensation does not occur on any drive part. Altitude and atmospheric pressure specifications are referenced to a standard day at 58.7°F (14.8°C).

Caution	To maintain optimal performance drives should be run at nominal drive temperatures and humidity. See **Section 2.10, "Reliability"** for rated MTBF device operating condition requirements.

2.6.1 Temperature

a. Operating

32°F to 149°F (0°C ambient to 65°C drive reported) temperature range with a maximum temperature gradient of 36°F (20°C) per hour.

The maximum allowable drive reported temperature is 149°F (65°C).

Air flow may be required to achieve consistent nominal drive temperature values (see **Section 3.4**). 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

–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.

2.6.2 Humidity

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

2.6.2.1 Relative humidity

Operating:	5% to 95% non-condensing relative humidity with a maximum gradient of 20% per hour.
Nonoperating:	5% to 95% non-condensing relative humidity with a maximum gradient of 20% per hour.

2.6.3 Effective Altitude (sea level)

Operating:	–304.8 m to 3048 m (–1000 ft. to 10,000+ ft.)
Nonoperating:	–304.8 m to 12,192 m (–1000 ft. to 40,000+ ft.)

2.6.4 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.

2.6.4.1 Shock

a. Operating

The drive will operate without error while subjected to intermittent shock pulses not exceeding 40 Gs typical at a 2ms duration limited by Z-axis, shown in **Figure 2**.

b. Non-operating

The drive will operate without non-recoverable errors after being subjected to shock pulses not exceeding 200 Gs at a duration of 2ms.

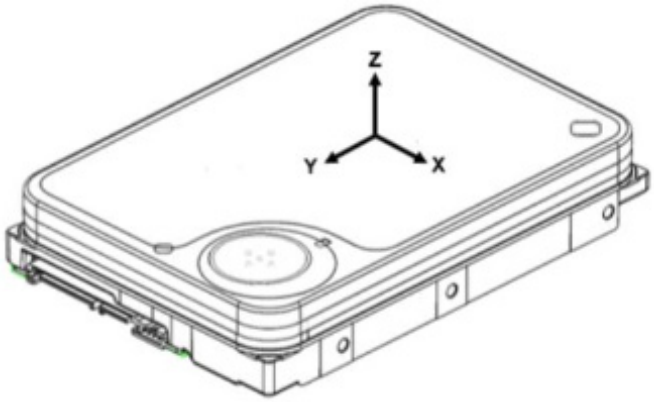


Figure 2. Drive orientation

2.6.4.2 Vibration

a. Linear Random Operating Vibration

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

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

b. 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.

PSD Profile 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

c. 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.

PSD Profile 2-500 Hz at 2.27 g rms				
Frequency (Hz)	**2**	**4**	**100**	**500**
G^2/Hz	0.001	0.030	0.030	0.001

2.7 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 3 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 S.M.A.R.T. specification, which may increase acoustic and power to operational levels.

2.8 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 the following table:

Table 4 Radio frequency environments

Test	Description	Performance level	Reference standard
Electrostatic discharge	Contact, HCP, VCP: ± 4 kV; Air: ± 8 kV	B	EN 61000-4-2: 95
Radiated RF immunity	80 to 1000 MHz, 3 V/m, 80% AM with 1 kHz sine 900 MHz, 3 V/m, 50% pulse modulation @ 200 Hz	A	EN 61000-4-3: 96 ENV 50204: 95
Electrical fast transient	± 1 kV on AC mains, ± 0.5 kV on external I/O	B	EN 61000-4-4: 95
Surge immunity	± 1 kV differential, ± 2 kV common, AC mains	B	EN 61000-4-5: 95
Conducted RF immunity	150 kHz to 80 MHz, 3 Vrms, 80% AM with 1 kHz sine	A	EN 61000-4-6: 97
Voltage dips, interrupts	0% open, 5 seconds 0% short, 5 seconds 40%, 0.10 seconds 70%, 0.01 seconds	C C C B	EN 61000-4-11: 94

2.10 Reliability

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

The production disk drive shall achieve an annualized failure-rate of 0.44% (MTBF of 2,000,000 hours) over a 5 year service life when used in Enterprise Storage field conditions as limited by the following:

- 8760 power-on hours per year.
- HDA temperature as reported by the drive <= 30°C
- Ambient wet bulb temp <= 26°C
- Typical workload
- The AFR (MTBF) is a population statistic not relevant to individual units
- ANSI/ISA S71.04-2013 G2 classification levels and dust contamination to ISO 14644-1 Class 8 standards (as measured at the device)

The MTBF specification for the drive assumes the operating environment is designed to maintain nominal drive temperature and humidity. Occasional excursions in operating conditions between the rated MTBF conditions and the maximum drive operating conditions may occur without significant impact to the rated MTBF. However continual or sustained operation beyond the rated MTBF conditions will degrade the drive MTBF and reduce product reliability.

Nonrecoverable read errors	1 per 10^{15} bits read, max
Load unload cycles (command controlled)	600,000 cycles
Maximum Rated Workload	Maximum rate of <550TB/year Workloads exceeding the annualized rate may degrade the drive MTBF and impact product reliability. The Annualized Workload Rate is in units of TB per year, or TB per 8760 power on hours. Workload Rate = TB transferred * (8760 / recorded power on hours).
Warranty	To determine the warranty for a specific drive, use a web browser to access the following web page: www.seagate.com/support/warranty-and-replacements/. From this page, click on the "Is my Drive under Warranty" link. The following are required to be provided: the drive serial number, model number (or part number) and country of purchase. The system will display the warranty information for the drive.
Preventive maintenance	None required.

2.11 HDD and SSD Regulatory Compliance and Safety

For the latest regulatory and compliance information see: www.seagate.com/support scroll down the page and click the Compliance, Safety and Disposal Guide link.

2.11.1 Regulatory Models

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

Regulatory Model Numbers: STL020

2.12 Corrosive environment

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 hard disk drives are especially sensitive to the presence of sulfide, chloride, and nitrate contaminants. Sulfur is found to be the most damaging. 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.

Seagate recommends that data centers be kept clean by monitoring and controlling the dust and gaseous contamination. Gaseous contamination should be within ANSI/ISA S71.04-2013 G2 classification levels (as measured on copper and silver coupons), and dust contamination to ISO 14644-1 Class 8 standards, and MTBF rated conditions as defined in the Annualized Failure Rate (AFR) and Mean Time Between Failure (MTBF) section.

2.13 Reference documents

Supported Standards

Serial ATA Revision 3.3 specification

ANSI Documents

INCITS 529-2018 ATA/ATAPI Command Set - 4 (ACS-4)

Specification for Acoustic Test Requirement and Procedures

Seagate part number: 30553-001

In case of conflict between this document and any referenced document, this document takes precedence.

2.14 Product warranty

Beginning on the date of shipment to the customer and continuing for the period specified in the purchase contract, Seagate warrants that each product (including components and subassemblies) that fails to function properly under normal use due to defect in materials or workmanship or due to nonconformance to the applicable specifications will be repaired or replaced, at Seagate's option and at no charge to the customer, if returned by customer at customer's expense to Seagate's designated facility in accordance with Seagate's warranty procedure. Seagate will pay for transporting the repair or replacement item to the customer. For more detailed warranty information, refer to the standard terms and conditions of purchase for Seagate products on the purchase documentation.

The remaining warranty for a particular drive can be determined by calling Seagate Customer Service at 1-800-468-3472. Users can also determine remaining warranty using the Seagate web site (www.seagate.com). The drive serial number is required to determine remaining warranty information.

Shipping

When transporting or shipping a drive, use only a Seagate-approved container. Keep the original box. Seagate approved containers are easily identified by the Seagate Approved Package label. Shipping a drive in a non-approved container voids the drive warranty.

Seagate repair centers may refuse receipt of components improperly packaged or obviously damaged in transit. Contact the authorized Seagate distributor to purchase additional boxes. Seagate recommends shipping by an air-ride carrier experienced in handling computer equipment.

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 1 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.

Product repair and return information

Seagate customer service centers are the only facilities authorized to service Seagate drives. Seagate does not sanction any third-party repair facilities. Any unauthorized repair or tampering with the factory seal voids the warranty.

2.15 Seagate® Rescue™ Data Recovery Service

If you suffer a data loss event within the Seagate Rescue Data Recovery warranty period, and you are eligible to participate in and submit a case under the Rescue program, contact SRS at **(1-800-723-1183)** in the US, or if you are calling from outside the US please visit our website for numbers in your local and language: www.seagate.com/contacts/contact-numbers/.

In addition, you may visit rescueandreplace.seagate.com/contact.jsp to obtain information regarding how to contact a recovery expert online or by telephone from your location. An SRS representative will review your case to confirm your eligibility, and to assess whether your data may be recoverable by remote recovery services or whether you will need to send your device to SRS for in-lab servicing.

Rescue™ General Terms

These Rescue™ General Terms together with the Rescue™ FAQ's make up the Rescue™ Program Terms. By submitting a case under the Rescue™ program ("Program") you agree to be bound by the Program Terms, including these General Terms and the FAQ. You must be a legal resident of the US to participate in the Program.

Communications

All communications relating to your request will be available on our web site in your account and sent via e-mail to the address you provide to us unless you request, in writing, to receive such communications via regular mail.

Personal Data

You must provide true, accurate and complete information about yourself as prompted by the request form, including, without limitation, your name, address, e-mail address, and telephone number, as applicable (collectively, "Personal Data"). You must maintain and promptly update your Personal Data. You acknowledge that we may send you important information and notices regarding your requests by e-mail and that we shall have no liability associated with or arising from your failure to maintain accurate Personal Data.

Capacity; Legal Rights; Indemnity

You represent to SRS that you are of the legal age of majority in your state or country of residence, with the full capacity to agree to these Program Terms. You warrant that you are the legal owner or the authorized representative of the legal owner of the device you submit to SRS (the "Device") and data. You warrant that the data on the Device is legal and that you have the unrestricted legal right to (a) give us remote access to the data, (b) have the data recovered and reproduced on a backup medium, (c) receive the recovered data, and (d) agree to these Program Terms. You will defend and indemnify us (including our directors, officers, employees, agents, delegates, and contractors) from any claims or actions relating to the Device or data, or your rights or lack of rights thereto.

Confidentiality

We will protect the confidentiality of your data against unauthorized disclosure using the same degree of care as we use to protect our own confidential information.

Disclaimer of Warranties, Representations and Guarantees

WE PROVIDE THE PROGRAM AND ANY SERVICES PROVIDED OR ATTEMPTED HEREUNDER "AS IS," WITH ALL FAULTS, AT YOUR SOLE RISK. WE DO NOT EXTEND ANY EXPRESS WARRANTIES, REPRESENTATIONS, CONDITIONS OR GUARANTEES REGARDING OUR RESCUE SERVICES OR ANY RESULTS THEREOF. TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW AND SUBJECT TO ANY STATUTORY WARRANTIES THAT CANNOT BE EXCLUDED, WE EXPRESSLY DISCLAIM ALL IMPLIED WARRANTIES, INCLUDING ANY IMPLIED WARRANTY OR CONDITION OF MERCHANTABILITY, WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE, OR WARRANTY OF ACCURACY OR COMPLETENESS WITH RESPECT TO THIS PROGRAM AND SERVICES. This Program and Disclaimer is unrelated to, and does not affect any warranties relating to your Device that we or the seller may have extended to you.

Limitation of Liability

WE WILL NOT BE LIABLE FOR ANY HARM CAUSED, UNLESS YOU PROVE THAT WE CAUSED SUCH HARM INTENTIONALLY. WITHOUT LIMITING THE GENERALITY OF THE FOREGOING, WE WILL NOT BE LIABLE FOR THE CONDITION, EXISTENCE, OR LOSS OF THE DATA YOU SEND US OR THE DATA WE RECOVER (IF ANY), ANY LOSS OF REVENUE OR LOSS OF PROFITS, OR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES HOWEVER CAUSED. TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW, THIS LIMITATION SHALL APPLY TO ANY AND ALL DAMAGES, REGARDLESS OF THE LEGAL THEORY ON WHICH THEY ARE ASSERTED (INCLUDING, WITHOUT LIMITATION, CONTRACT, BREACH OF CONTRACT, AND TORT), AND REGARDLESS OF WHETHER WE HAVE BEEN ADVISED OF THE POSSIBILITY OF LOSS OR DAMAGES - UNLESS YOU PROVE THAT SRS CAUSED

DAMAGES TO YOU INTENTIONALLY. TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW, THE AMOUNT OF OUR LIABILITY WILL NOT EXCEED THE TOTAL PRICE YOU ACTUALLY PAY FOR THE DEVICE, THE ESSENTIAL PURPOSE OF WHICH IS TO LIMIT OUR LIABILITY ARISING FROM OR RELATED TO THE PROGRAM AND ANY DATA RECOVERY SERVICES. THIS ALLOCATION OF RISK IS REFLECTED IN THE PRICE CHARGED FOR THIS PROGRAM OR SERVICES, IF ANY. YOU ACKNOWLEDGE THAT THE PRICE OF THIS PROGRAM WOULD BE MUCH GREATER IF WE UNDERTOOK MORE EXTENSIVE LIABILITY. THIS PARAGRAPH WILL APPLY NOTWITHSTANDING ANY OTHER PROVISIONS IN THESE TERMS, OR THE FAILURE OF ANY REMEDY.

Compliance with Laws

You agree to comply with all such laws and regulations and all other applicable laws, statutes, ordinances and regulations relating to the Program. You acknowledge that violations of these Program Terms could subject you to criminal or civil penalties. The goods licensed or provided, or services provided, through the Program, which may include technology and software, are subject to the customs and export control laws and regulations of the U.S. and may also be subject to the customs and export laws and regulations of the country in which the products are manufactured or received. Further, under U.S. law, such goods may not be sold, leased or otherwise transferred to restricted countries, or used by a restricted end-user or an end-user engaged in activities related to weapons of mass destruction including, without limitation, activities related to designing, developing, producing or using nuclear weapons, materials, or facilities, missiles or supporting missile projects, or chemical or biological weapons. You acknowledge you are not a restricted end-user or involved in any of the restricted activities above, and that you will comply with and abide by these laws and regulations. Seagate reserves the right to refuse service to or the return of any storage devices that have been determined to violate these regulations.

Cancellation

You may cancel the Program at any time by contacting SRS at 1-800-SEAGATE (1-800-475-0143) in the US, or at such other number available at services.seagate.com/contact.aspx, or you simply may refrain from submitting a request for Rescue services. These Program Terms remain applicable to your and SRS's rights and obligations with respect to any services requested by you under this Program.

Assignment

You may not assign your rights or obligations under these Program Terms without SRS' express written consent.

Dispute Resolution

The parties will attempt to resolve any dispute arising out of or related to these Program Terms or any data recovery services requested or attempted hereunder through good faith negotiation. To the extent permitted by applicable law, if the parties are unable to resolve the dispute through good faith negotiation, then the dispute will be submitted to final and binding arbitration with the Judicial Arbitration and Mediation Services. Each party will bear its own costs in arbitration, provided that Seagate reserves the right, in its discretion, to pre-pay certain fees you may incur in connection with the arbitration subject to refund if you do not prevail. **Both parties waive their rights to a jury trial.** All proceedings will take place in Santa Clara County, California, USA. The laws of the State of California will exclusively govern these Program Terms and our provision of any data recovery services, without regard to California's conflicts of laws rules. You consent to the exclusive jurisdiction of the courts located in Santa Clara County, California, USA.

Severability

If any provision of these Program Terms is held invalid, illegal or unenforceable, such provision shall be enforced to the fullest extent permitted by applicable law and the validity, legality and enforceability of the remaining provisions shall not be affected thereby.

Legal Effect

These Program Terms describe certain legal rights. You may have other rights under applicable law. These Program Terms do not change your rights under applicable law if such laws do not permit these Program Terms to do so. Also, the Program and these Program Terms are in addition and unrelated to any rights you may have under a Seagate warranty statement.

SRS Companies

The following SRS companies may provide the services described in these Program Terms: (a) Seagate Technology LLC, with offices at 3101 Jay Street, Suite 110, Santa Clara, California 95054; (b) Seagate Technology Canada Inc., with offices at 2421 Bristol Circle, Suite A100, Oakville, Ontario, Canada L6H 5S9; and/or (c) Seagate Technology (Netherlands) B.V., with offices at Koolhovenlaan 1, 1119 PA, Schiphol-Rijk, The Netherlands.

3.0 Configuring and mounting the drive

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

3.1 Handling and static-discharge precautions

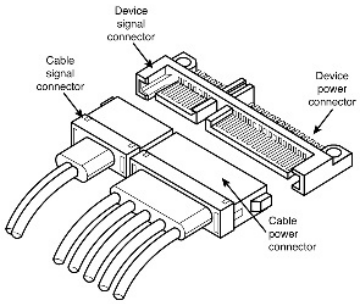
After unpacking, and before installation, the drive may be exposed to potential handling and electrostatic discharge (ESD) hazards. Observe the following standard handling and static-discharge precautions:

Caution	• Before handling the drive, put on a grounded wrist strap, or ground oneself 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 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 Configuring the drive

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

3.3 Serial ATA cables and connectors



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

See **Table 5** 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 3**.

Figure 3. Attaching SATA cabling

Each cable is keyed to ensure correct orientation. SkyHawk AI Serial ATA +Rescue drives support latching SATA connectors.

3.4 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 4** 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).

3.4.1 Mechanical specifications

Refer to **Figure 4** for detailed mounting configuration dimensions. See **Section 3.4**, "Drive mounting."

Weight:	1.499 lb	680 g

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

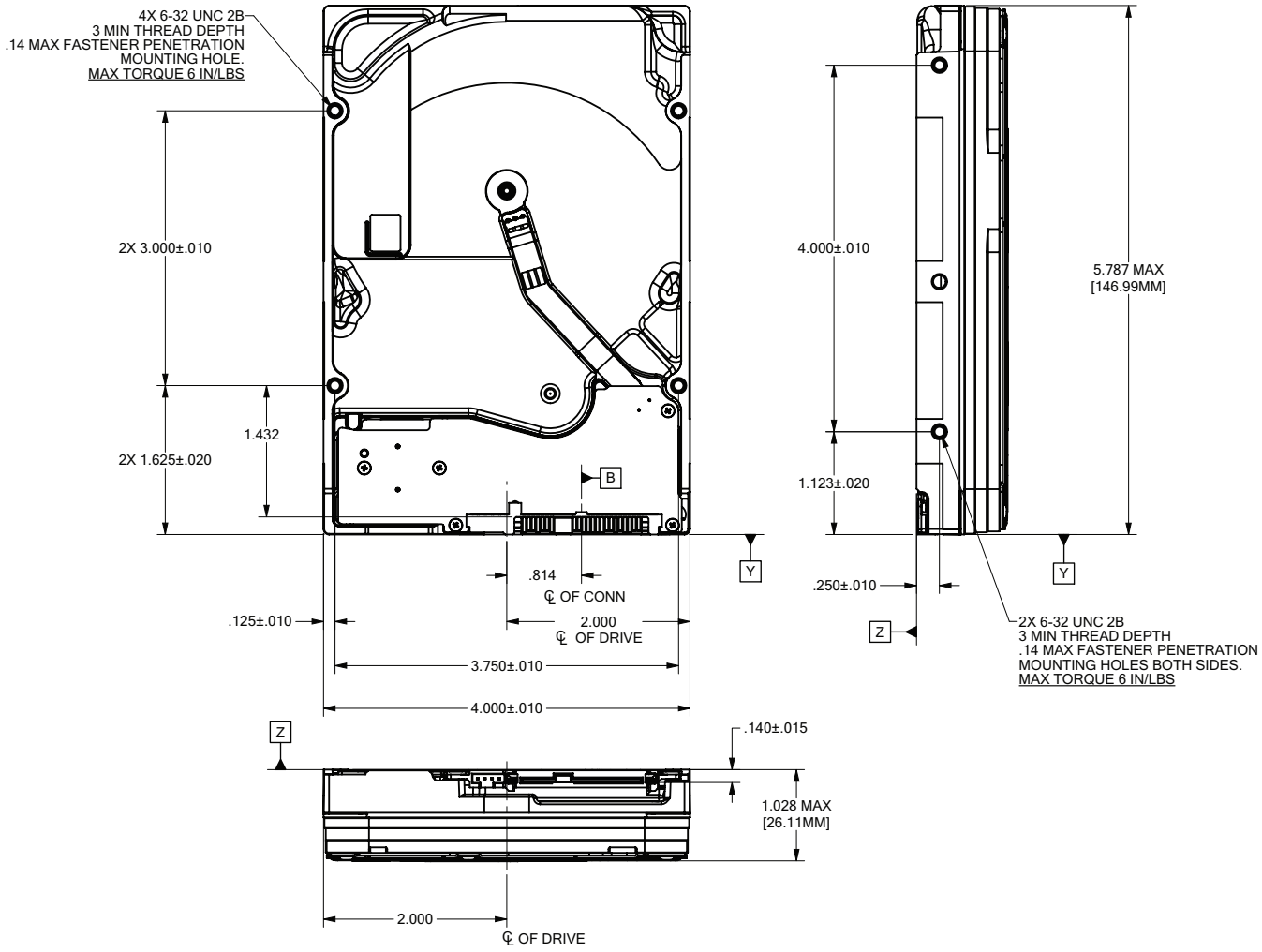


Figure 4. Mounting configuration dimensions

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

4.0 Serial ATA (SATA) interface

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

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

4.1 Hot-Plug compatibility

SkyHawk AI Serial ATA +Rescue drives incorporate connectors which enable users to hot plug these drives in accordance with the Serial ATA Revision 3.3 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 2.4)** prior to changing the plane of operation. This time is required to insure data integrity.

4.2 Serial ATA device plug connector pin definitions

Table 5 summarizes the signals on the Serial ATA interface and power connectors.

Table 5 Serial ATA connector pin definitions

Segment	Pin	Function	Definition
Signal	S1	Ground	2nd mate
	S2	A+	Differential signal pair A from Phy
	S3	A-	
	S4	Ground	2nd mate
	S5	B-	Differential signal pair B from Phy
	S6	B+	
	S7	Ground	2nd mate
Key and spacing separate signal and power segments			
Power	P1	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”) pitch.
2. The comments on the mating sequence apply to the case of backplane blindmate connector only. In this case, the mating sequences are:
   - the ground pins P4 and P12.
   - the pre-charge power pins and the other ground pins.
   - the signal pins and the rest of the power pins.
3. There are three power pins for each voltage. One pin from each voltage is used for pre-charge when installed in a blind-mate backplane configuration.
4. All used voltage pins (V_x) must be terminated.

4.3 Supported ATA commands

The following table lists Serial ATA standard commands that the drive supports. For a detailed description of the ATA commands, refer to the Serial ATA: High Speed Serialized AT Attachment specification. **See "S.M.A.R.T. commands" on page 49** for details and subcommands used in the S.M.A.R.T. implementation.

Table 6 Supported ATA 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
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 DMA	$C8_H$
Read DMA Extended	25_H
Read FPDMA Queued	60_H
Read Log DMA Ext	47_H
Read Log Ext	$2F_H$
Read Multiple	$C4_H$
Read Multiple Extended	29_H
Read Sectors	20_H
Read Sectors Extended	24_H
Read Stream DMA Ext	$2A_H$
Read Verify Sectors	40_H
Read Verify Sectors Extended	42_H
Receive FPDMA Queued	65_H
Request Sense Data Ext	$0B_H$
Remove Element And Truncate	$7C_H$

Command name	Command code (in hex)
Restore Elements And Rebuild	$7D_H$
Sanitize Device - Crypto Scramble	$B4_H$ / 0011_H (SED and ISE drives only)
Sanitize Device - Overwrite Ext	$B4_H$ / 0014_H
Sanitize Device - Freeze Lock Ext	$B4_H$ / 0020_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	$F2_H$
Seek	70_H
Send FPDMA Queued	64_H
Set Date & Time Ext	77_H
Set Features	EF_H
Set Multiple Mode	$C6_H$
Set Sector Configuration Ext	$B2_H$
Sleep	$E6_H$
S.M.A.R.T. Disable Operations	$B0_H$ / $D9_H$
S.M.A.R.T. Enable/Disable Autosave	$B0_H$ / $D2_H$
S.M.A.R.T. Enable Operations	$B0_H$ / $D8_H$
S.M.A.R.T. Execute Offline	$B0_H$ / $D4_H$
S.M.A.R.T. Read Attribute Thresholds	$B0_H$ / $D1_H$
S.M.A.R.T. Read Data	$B0_H$ / $D0_H$
S.M.A.R.T. Read Log Sector	$B0_H$ / $D5_H$
S.M.A.R.T. Return Status	$B0_H$ / DA_H
S.M.A.R.T. Save Attribute Values	$B0_H$ / $D3_H$
S.M.A.R.T. Write Log Sector	$B0_H$ / $D6_H$
Standby	$E2_H$
Standby Immediate	$E0_H$
Trusted Send	$5E_H$ (SED drives only)
Trusted Send DMA	$5F_H$ (SED drives only)
Trusted Receive	$5C_H$ (SED drives only)
Trusted Receive DMA	$5D_H$ (SED drives only)
Write Buffer	$E8_H$
Write DMA	CA_H

Command name	Command code (in hex)
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 Extended	45_H

4.3.1 Identify Device command

The Identify Device command (command code EC_H) transfers information about the drive to the host following power up. The data is organized as a single 512-byte block of data, whose contents are shown in **Table 6** on **page 26**. All reserved bits or words should be set to zero. Parameters listed with an "x" are drive-specific or vary with the state of the drive. **see Section 2.0 on page 7**for default parameter settings.

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

Table 7 Identify Device command

Word	Description	Value
0	Configuration information: • Bit 15: 0 = ATA; 1 = ATAPI • Bit 7: removable media • Bit 6: removable controller • Bit 0: reserved	$0C5A_H$
1	Obsolete	16,383
2	ATA-reserved	$C837_H$
3	Obsolete	16
4	Retired	0000_H
5	Retired	0000_H
6	Obsolete	$003F_H$
7–9	Retired	0000_H
10–19	Serial number: (20 ASCII characters, 0000_H = none)	ASCII
20-21	Retired	0000_H
22	Obsolete	0000_H
23–26	Firmware revision (8 ASCII character string, padded with blanks to end of string)	x.xx
27–46	Drive model number: (40 ASCII characters, padded with blanks to end of string)	ST20000VE000 ST20000VE002
47	(Bits 7–0) Maximum sectors per interrupt on Read multiple and Write multiple (16)	8010_H (512e) / 8002_H (4KN)
48	Trusted computing feature set supported bit 0 (SED only)	4000_H
49	Standard Standby timer, IORDY supported and may be disabled	$2F00_H$
50	Capabilities	4000_H
51-52	Obsolete	$xxxx_H$
53-56	Words 64–70 and 88 are valid	$xxxx_H$
57–58	Obsolete	$xxxx_H$
59	(Bit 15: 0) Block Erase Ext Not Supported - N (Bit 14: 1) Overwrite Ext Supported - Y (Bit 13: X) Crypto Scramble Ext Supported (SED Only) - N (Bit 12: 1) Sanitize feature set supported - Y (Bit 11: 1) Commands allowed during sanitize op as specified in ACS-3 - Y (Bit 10: 1) Sanitize Antifreeze Lock Ext command supported - Y	$5D10_H$ (512E) / $5D02_H$ (4KN)

Table 7 Identify Device command

Word	Description	Value
60–61	Total number of user-addressable LBA sectors available (see **Section 2.2** for related information) ***Note:** The maximum value allowed in this field is: 0FFFFFFFh (268,435,455 sectors, 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 (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 ns)	0078_H
66	Recommended multiword DMA transfer cycle time per word (120 ns)	0078_H
67	Minimum PIO cycle time without IORDY flow control (240 ns)	0078_H
68	Minimum PIO cycle time with IORDY flow control (120 ns)	0078_H
69	Additional supported	$000C_H$
70–74	ATA-reserved	0000_H
75	Queue depth	$001F_H$
76	Serial ATA capabilities	$8D0E_H$
77	(Bit 6:1) Send/Receive FPDMA Queued Commands Supported	$xx4x_H$
78	Serial ATA features supported	$00CC_H$
79	Serial ATA features enabled	$xxxx_H$
80	Major version number	$0FE0_H$ (ACS-4)
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	$FFFE_H$
93	Hardware reset value	$xxxx_H$
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**)
104–105	ATA-reserved	0000_H

Table 7 Identify Device command

Word	Description	Value
106	Physical/Logical sector size	6003_H (512E) / 5000_H (4KN)
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	$409C_H$
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	3.5“
169–205	ATA-reserved	0000_H
206	SCT Command Transport command set. If bit 0 is set to one, then the device supports SCT Command Transport. Bits 7:2 indicate individual SCT feature support.	$xxBD_H$
207-216	ATA-reserved	0000_H
217	Nominal media rotation rate	7200
218-221	ATA-reserved	0000_H
222	Transport Major Version	$11FF_H$ (SATA 3.3)
223	Transport Minor Version	0000_H
224-229	ATA-reserved	0000_H
230-233	Extended Number of User Accessible Sectors	(see **Section 2.2**)
234-254	ATA-reserved	0000_H
255	Integrity word	$xxA5_H$

NOTE See the bit descriptions below for words 63, 84, and 88 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 84**
	0	SMART error logging is supported.
	1	SMART self-test is supported.
	2	Media serial number is not supported.
	3	Media Card Pass Through Command feature set is not supported.
	4	Streaming feature set is supported.
	5	GPL feature set is supported.
	6	WRITE DMA FUA EXT and WRITE MULTIPLE FUA EXT commands are supported.
	7	WRITE DMA QUEUED FUA EXT command is not supported.
	8	64-bit World Wide Name is supported.
	9-10	Obsolete.
	11-12	Reserved for TLC.
	13	IDLE IMMEDIATE command with IUNLOAD 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 Identify Device Data log

The IDENTIFY DEVICE Data log (log 30H) transfers information about the drive. The data is organized as a set of 512-byte blocks of data, whose contents are shown in **Table 1 on page 7**. 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 may contain drive-specific features that may are included in the Serial ATA specification

Table 8 Identify Device Data log

Page (hex)	QWord Offset (dec)	Bits	Description	Value (hex)
00	List of supported pages			
	0..7	63:24	Reserved	
		23:16	Page number	00
		15:0	Revision number	0001
	8		Number of entries in the following list	09
	9		Page number of the 1st supported ID data log page	00
	10		Page number of the 2nd supported ID data log page	01
	11		Page number of the next supported ID data log page	02
	12		Page number of the next supported ID data log page	03
	13		Page number of the next supported ID data log page	04
	14		Page number of the next supported ID data log page	05
	15		Page number of the next supported ID data log page	06
	16		Page number of the next supported ID data log page	08
	17		Page number of the last supported ID data log page	00
	18..511		Reserved	
01	Copy of IDENTIFY DEVICE data			
	0..511		Copy of IDENTIFY DEVICE command data	

Table 8 Identify Device Data log (Continued)

02	Capacity			
	0..7	Capacity page information header (QWord)		
		63	Shall be set to 1	1
		62:24	Reserved	
		23:16	Page number	02
		15:0	Revision number	0001
	8..15	Device Capacity (QWord)		
		63	Shall be set to 1	1
		62:48	Reserved	0
		47:0	accessible capacity	(see **Section 2.2**)
	16..23	Physical/Logical Sector Size (QWord)		
		63	Contents of the QWord are valid	1
		62	logical to physical sector relationship supported	1 (512E) / 0 (4KN)
		61	logical sector size supported bit	1 (4KN) / 0 (512E)
		60:22	Reserved	0
		19:16	logical to physical sector relationship	0 (4KN) / 3 (512E)
		15:0	logical sector offset	4000_H
	24..31	Logical Sector Size (QWord)		
		63	Contents of the QWord are valid	1
		62:32	Reserved	0
		31:0	Logical Sector Size	4096b (4KN)
	32..39	Nominal Buffer Size (QWord)		
		63	Contents of the QWord are valid	1
		62:0	buffer size	256
	40..511		Reserved	0
03	Supported Capabilities			
	0..7	Supported Capabilities page information header (QWord)		
		63	Shall be set to 1	1
		62:24	Reserved	
		23:16	Page number	03
	8..15	Supported Capabilities (QWord)		
		63	Shall be set to 1	1
		62:55	Reserved	0
		54	advanced background operation supported	0
		53	persistent sense data reporting	0
		52	sff-8447 reporting	1

Table 8 Identify Device Data log (Continued)

		51	definitive ending pattern supported	1
		50	data set management xl supported	0
		49	set sector configuration supported	1
		48	zero ext supported	0
		47	successful ncq command sense data supported	0
		46	dlc supported	0
		45	request sense device default supported	1
		44	dsn supported	1
		43	low power standby supported	0
		42	set epc power source supported	0
		41	amax addr supported	1
		40	Reserved for CFA	0
		39	drat supported	0
		38	lps misalignment reporting supported	0
		37	Reserved	0
		36	read buffer dma supported	0
		35	write buffer dma supported	0
		34	Reserved	0
		33	download microcode dma supported	0
		32	28-bit supported	0
		31	rzat supported	0
		30	Reserved	0
		29	nop supported	0
		28	read buffer supported	1
		27	write buffer supported	1
		26	Reserved	0
		25	read look-ahead supported	1
		24	volatile write cache supported	1
		23	smart supported	1
		22	flush cache ext supported	1
		21	Reserved	0
		20	48-bit supported	1
		19	Reserved	0
		18	spin-up supported	1
		17	puis supported	1
		16	apm supported	1
		15	Reserved for CFA	0

Table 8 Identify Device Data log (Continued)

		14	download microcode supported	1
		13	unload supported	1
		12	write fua ext supported	1
		11	gpl supported	1
		10	streaming supported	1
		9	Reserved	0
		8	smart self-test supported	1
		7	smart error logging supported	1
		6	epc supported	1
		5	sense data supported	1
		4	free-fall supported	0
		3	dm mode 3 supported	1
		2	gpl dma supported	1
		1	write uncorrectable supported	1
		0	wrv supported	1
	16..23	DOWNLOAD MICROCODE Capabilities (QWord)		
		63	Contents of the QWord are valid	1
		62:36	Reserved	0
		35	dm clears nonactivated deferred data	0
		34	dm offsets deferred supported	1
		33	dm immediate supported	1
		32	dm offsets immediate supported	1
		31:16	dm maximum transfer size	0000_H
		15:0	dm minimum transfer size	0000_H
	24..31	Nominal Media Rotation Rate (QWord)		
		63	Shall be set to one	1
		62:16	Reserved	0
		15:0	nominal media rotation rate	7200
	32..39	Form Factor (QWord)		
		63	Contents of the QWord are valid	1
		62:4	Reserved	0
		3:0	nominal form factor	3.5″
	40..47	Write-Read-Verify Sector Count Mode 3 (QWord)		
		63	Contents of the QWord are valid	1
		62:32	Reserved	0
		31:0	wrm mode 3 count	0

Table 8 Identify Device Data log (Continued)

	48..55	Write-Read-Verify Sector Count Mode 2 (QWord)		
		63	Contents of the QWord are valid	1
		62:32	Reserved	0
		31:0	wrm mode 2 count	0
	56..71	World wide name (DQWord)		
		127	Shall be set to one	1
		126:64	Reserved	0
		63:0	world wide name	unique
	72..79	DATA SET MANAGEMENT (QWord)		
		63	Shall be set to one	1
		62:32	Reserved	0
		31:16	max pages per dsm command	0
		15:8	logical block markups supported	0
		7:1	Reserved	0
		0	trim supported	0
	80..95	Utilization Per Unit Time (DQWord)		
		127	Shall be set to one	1
		126:120	Reserved	0
		119:112	utilization type	Combined Writes and Reads
		111:104	utilization units	TB
		103:96	utilization interval	Per Year
		95:34	Reserved	0
		63:32	utilization b	
		31:0	utilization a	550
	96..103	Utilization Usage Rate Support (QWord)		
		63	Contents of the QWord are valid	0
		62:24	Reserved	0
		23	setting rate basis supported	0
		22:9	Reserved	0
		8	since power on rate basis supported	0
		7:5	Reserved	0
		4	power on hours rate basis supported	0
		3:1	Reserved	0
		0	date/time rate basis supported	0

Table 8 Identify Device Data log (Continued)

	104..111	Zoned Capabilities (QWord)		
		63	Contents of the QWord are valid	0
		62:2	Reserved	0
		1:0	zoned	0
	112..119	Supported ZAC Capabilities (QWord)		
		63	Contents of the QWord are valid	0
		62:5	Reserved	0
		4	non-data reset write pointers ext supported	0
		3	non-data finish zone ext supported	0
		2	non-data close zone ext supported	0
		1	non-data open zone ext supported	0
		0	report zones ext supported	0
	120..127	Advanced Background Operations Capabilities (QWord)		
		63	Contents of the QWord are valid	0
		62	abo foreground mode supported	0
		61	abo ir mode supported	0
		60:48	Reserved	0
		47:16	abo minimum fraction	0
		15:0	abo minimum supported timelimit	0
	128..135	Advanced Background Operations Recommendations (QWord)		
		63	Contents of the QWord are valid	0
		62:32	Reserved	0
		31:16	device maintenance polling time	0
		15:0	abo recommended abo start interval	0
	136..143	Queue Depth (QWord)		
		63	Contents of the QWord are valid	0
		62:5	Reserved	0
		4:0	queue depth	32

Table 8 Identify Device Data log (Continued)

	144..151	Supported SCT Capabilities (QWord)		
		63	Contents of the QWord are valid	0
		62:27	Reserved	0
		26	sct write same function 103 supported	1
		25	sct write same function 102 supported	1
		24	sct write same function 101 supported	1
		23:19	Reserved	0
		18	sct write same function 3 supported	1
		17	sct write same function 2 supported	1
		16	sct write same function 1 supported	1
		15:6	Reserved	0
		5	sct data tables supported	1
		4	sct feature control supported	1
		3	sct error recovery control supported	1
		2	sct write same supported	1
		1	Reserved	0
		0	sct supported	1
	152..159	Depopulation Capabilities (QWord)		
		63	Contents of the QWord are valid	1
		62:3	Reserved	0
		2	restore elements and rebuild supported	1
		1	get physical element status supported	1
		0	remove element and truncate supported	1
	160..167	35	Depopulation Execution Time (QWord)	
			Bit Description: 63 Contents of the QWord are valid	1
			62:0 DEPOPULATION TIME field (see 9.10.5.19)	(Unique per drive)
	168..503	Reserved		
	504..511	Vendor Specific Supported Capabilities (QWord)		
		63	Contents of the QWord are valid	0
		62:0	Vendor specific	
04	Current Settings			
	0..7	Current Settings page information header (QWord)		
		63	Shall be set to 1	1
		62:24	Reserved	0
		23:16	Page number	04

Table 8 Identify Device Data log (Continued)

	8..15	Current Settings (QWord)		
		63	Shall be set to one	1
		62:19	Reserved	0
		18	successful ncq command sense data enabled	0
		17	dlc enabled	0
		16	dsn enabled	0
		15	epc enabled	1
		14	Reserved	0
		13	volatile write cache enabled	1
		12	Reserved	0
		11	reverting to defaults enabled	0
		10	sense data enabled	0
		9	Reserved	0
		8	non-volatile write cache	1
		7	read look-ahead	1
		6	smart enabled	1
		5	Reserved	0
		4	Reserved	0
		3	puis enabled	0
		2	apm enabled	0
		1	free-fall enabled	0
		0	wrv enabled	0
	16..23	Feature Settings (QWord)		
		63	Contents of the QWord are valid	1
		62:18	Reserved	0
		17:16	power source	0
		15:8	apm level	0
		7:0	wrv mode	0
	24..31	DMA Host Interface Sector Times (QWord)		
		63	Contents of the QWord are valid	1
		62:16	Reserved	0
		15:0	dma sector time	0
	32..39	PIO Host Interface Sector Times (QWord)		
		63	Contents of the QWord are valid	1
		62:16	Reserved	0
		15:0	pio sector time	0

Table 8 Identify Device Data log (Continued)

	40..47	Streaming Minimum Request Size (QWord)		
		63	Contents of the QWord are valid	1
		62:16	Reserved	0
		15:0	stream min request size	1000_H
	48..55	Streaming Access Latency (QWord)		
		63	Contents of the QWord are valid	1
		62:16	Reserved	0
		15:0	stream access latency	0
	56..63	Streaming Performance Granularity (QWord)		
		63	Contents of the QWord are valid	1
		62:16	Reserved	0
		15:0	stream granularity	2710_H
	64..71	Free-fall Control Sensitivity (QWord)		
		63	Contents of the QWord are valid	1
		62:16	Reserved	0
		15:0	free-fall sensitivity	0
	72..79	Device Maintenance Schedule (QWord)		
		63	Contents of the QWord are valid	0
		62:58	Reserved	0
		57:48	minimum inactive time in milliseconds	0
		47:32	time scheduled for device maintenance	0
		31:16	time to performance degradation	0
		15:0	minimum inactive time	0
	80..87	Advanced Background Operations Settings (QWord)		
		63	Contents of the QWord are valid	0
		62:8	Reserved	0
		7:0	abo_status	0
	88..511	Reserved		

Table 8 Identify Device Data log (Continued)

05	Strings			
	0..7	Supported Capabilities page information header (QWord)		
		63	Shall be set to 1	1
		62:24	Reserved	
		23:16	Page number	05
	8..27	SERIAL NUMBER (ATA String)		$XXXXXXXX_H$
	28..31	Reserved		
	32..39	FIRMWARE REVISION (ATA String)		$XXXX_H$
	40..47	Reserved		
	48..87	MODEL NUMBER (ATA String)		ST20000VE000 ST20000VE002
	88..95	Reserved		
	96..103	ADDITIONAL PRODUCT IDENTIFIER (ATA String)		0
	104..511	Reserved		
06	Security			
	0..7	Security page information header (QWord)		
		63	Shall be set to 1	1
		62:24	Reserved	
		23:16	Page number	06
	8..15	Master Password Identifier (QWord)		
		63	Contents of the QWord are valid	1
		62:16	Reserved	0
		15:0	master password identifier	$FFFE_H$
	16..23	Security Status (QWord)		
		63	Contents of the QWord are valid	1
		62:7	Reserved	0
		6	security supported	1
		5	master password capability	0
		4	enhanced security erase supported	1
		3	security count expired	0
		2	security frozen	0
		1	security locked	0
		0	security enabled	0

Table 8 Identify Device Data log (Continued)

	24..31	Time required for an Enhanced Erase mode SECURITY ERASE UNIT command (QWord)		
		63	Contents of the QWord are valid	1
		62:16	Reserved	0
		15	enhanced security erase time format	1
		14:0	enhanced security erase time	(Unique per drive)
	32..39	Time required for an Normal Erase mode SECURITY ERASE UNIT command (QWord)		
		63	Contents of the QWord are valid	1
		62:16	Reserved	0
		15	normal security erase time format	1
		14:0	normal security erase time	(Unique per drive)
	40..47	Trusted Computing Feature Set (QWord)		
		63	Contents of the QWord are valid	1
		62:1	Reserved	0
		0	trusted computing supported	0 (1, SED drives only)
	48..55	Security Capabilities (QWord)		
		63	Contents of the QWord are valid	1
		62:8	Reserved	0
		7	restricted sanitize overrides security	0
		6	acs-3 commands allowed by sanitize	1
		5	sanitize antifreeze lock supported	1
		4	block erase supported	0
		3	overwrite supported	1
		2	crypto scramble supported	0 (1, SED and ISE drives only)
		1	sanitize supported	1
		0	encrypt all supported	0
	56..511	Reserved		
07	Parallel ATA			
	000..511		(Not supported for SATA drives)	all zeros
08	Serial ATA			

Table 8 Identify Device Data log (Continued)

	0..7	Serial ATA page information header (QWord)		
		63	Shall be set to 1	1
		62:24	Reserved	
		23:16	Page number	08
	8..15	SATA Capabilities		
		63	Shall be set to one	1
		62:32	Reserved	0
		31	power disable feature always enabled	0
		30	power disable feature supported	0
		29	rebuild assist supported	0
		28	dipm ssp preservation supported	0
		27	hybrid information supported	0
		26	devsleep to reducedpwrstate capability supported	0
		25	device sleep supported	0
		24	ncq autosense supported	1
		23	software settings preservation supported	1
		22	hardware feature control supported	0
		21	in-order data delivery supported	0
		20	device initiated power management supported	1
		19	dma setup auto-activation supported	1
		18	nonzero buffer offsets supported	0
		17	send and receive queued commands supported	1
		16	ncq non-data command supported	0
		15	ncq streaming supported	0
		14	read log dma ext as equivalent to read log ext supported	1
		13	device automatic partial to slumber transitions supported	0
		12	host automatic partial to slumber transitions supported	0
		11	ncq priority information supported	0
		10	unload while ncq commands are outstanding supported	1
		9	sata phy event counters log supported	1
		8	receipt of host initiated power management requests supported	0
		7	ncq feature set supported	1
		6:3	Reserved	0
		2	sata gen3 signaling speed supported	1
		1	sata gen2 signaling speed supported	1
		0	sata gen1 signaling speed supported	1

Table 8 Identify Device Data log (Continued)

	16..23	Current SATA Settings (QWord)		
		63	Shall be set to one	1
		62:14	Reserved	0
		13	hybrid enabled	0
		12	rebuild assist enabled	0
		11	power disable feature enabled	0
		10	device sleep enabled	0
		9	automatic partial to slumber transitions enabled	0
		8	software settings preservation enabled	1
		7	hardware feature control is enabled	0
		6	in-order data delivery enabled	0
		5	device initiated power management enabled	0
		4	dma setup auto-activation enabled	1
		3	nonzero buffer offsets enabled	0
		2:0	current negotiated serial ata signal speed	(6.0, 3.0, 1.5) Gb/s
	24..39	Reserved		
	40..41	CURRENT HARDWARE FEATURE CONTROL IDENTIFIER (Word)		
	42..43	SUPPORTED HARDWARE FEATURE CONTROL IDENTIFIER (Word)		
	44..47	Reserved		
	48..55	Device Sleep Timing Variables (QWord)		
		63	devslp timing variables supported	0
		62:16	Reserved	0
		15:8	devsleep exit timeout (deto)	0
		7:5	Reserved	0
		4:0	minimum devslp assertion time (mdat)	0
	56..511	Reserved		

4.3.3 Device Statistics log

The Device Statistics log (log 04H) transfers information about the drive. The data is organized as a set of 512-byte blocks of data, whose contents are shown in **Table 1 on page 7**. 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 may contain drive-specific features that are included in the SATA specifications.

Table 9 Device Statistics log

Page (hex)	Statistic	Supported
00	List of supported log pages	Yes
01	General Statistics	
	Lifetime Power-on Resets	Yes
	Power-on Hours	Yes
	Logical Sectors Written	Yes
	Number of Write Commands	Yes
	Logical Sectors Read	Yes
	Number of Read Commands	Yes
	Pending Error Count	Yes
	Workload Utilization	No
	Utilization Usage Rate	No
	Resource Availability	No
	Random Write Resources Used	No
02	Free Fall Statistics	
	Number of Free-Fall Events Detected	No
	Overlimit Shock Events	No
03	Rotating Media Statistics	
	Spindle Motor Power-on Hours	Yes
	Head Flying Hours	Yes
	Head Loaded Events	Yes
	Number of Reallocated Logical Sectors	Yes
	Read Recovery Attempts	Yes
	Number of Mechanical Start Failures	Yes
	Number of Reallocation Candidate Logical Sectors	Yes
	Number of High Priority Unload Events	Yes
04	General Errors Statistics	
	Number of Reported Uncorrectable Errors	Yes
	Number of Resets Between Command Acceptance and Command Completion	Yes
	Physical Element Status Changed	Yes

Table 9 Device Statistics log

05	Temperature Statistics	
	Current Temperature	Yes
	Average Short Term Temperature	Yes
	Average Long Term Temperature	Yes
	Highest Temperature	Yes
	Lowest Temperature	Yes
	Highest Average Short Term Temperature	Yes
	Lowest Average Short Term Temperature	Yes
	Highest Average Long Term Temperature	Yes
	Lowest Average Long Term Temperature	Yes
	Time in Over-Temperature	Yes
	Specified Maximum Operating Temperature	Yes
	Time in Under-Temperature	Yes
	Specified Minumum Operating Temperature	Yes
06	Transport Statistics	
	Number of Hardware Resets	Yes
	Number of ASR Events	Yes
	Number of Interface CRC Errors	Yes
07	Solid State Device Statistics	
	Percentage Used Endurance Indicator	No
08	Zoned Device Statistics	
	Maximum Open Zones	No
	Maximum Explicitly Open Zones	No
	Maximum Implicitly Open Zones	No
	Minimum Empty Zones	No
	Maximum Non Sequential Zones	No
	Zones Emptied	No
	Suboptimal Write Commands	No
	Commands Exceeding Optimal Limit	No
	Failed Explicit Opens	No
	Read Rule Violations	No
	Write Rule Violations	No
09..FE	Reserved	
FF	Vendor Specific Statistics	
	TBD	x

4.3.4 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 10 Set Features command values

02_H Enable write cache *(default)*.

03_H Set transfer mode (based on value in Sector Count register).
Sector Count register values:

- 00_H Set PIO mode to default (PIO mode 2).
- 01_H Set PIO mode to default and disable IORDY (PIO mode 2).
- 08_H PIO mode 0
- 09_H PIO mode 1
- $0A_H$ PIO mode 2
- $0B_H$ PIO mode 3
- $0C_H$ PIO mode 4 *(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

10_H Enable use of SATA features

55_H Disable read look-ahead (read cache) feature.

82_H Disable write cache

90_H Disable use of SATA features

AA_H Enable read look-ahead (read cache) feature *(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.

4.3.5 S.M.A.R.T. commands

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

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

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

Table 11 S.M.A.R.T. commands

Code in features register	S.M.A.R.T. command
$D0_H$	S.M.A.R.T. Read Data
$D2_H$	S.M.A.R.T. Enable/Disable Attribute Autosave
$D3_H$	S.M.A.R.T. Save Attribute Values
$D4_H$	S.M.A.R.T. Execute Off-line Immediate (runs DST)
$D5_H$	S.M.A.R.T. Read Log Sector
$D6_H$	S.M.A.R.T. Write Log Sector
$D8_H$	S.M.A.R.T. Enable Operations
$D9_H$	S.M.A.R.T. Disable Operations
DA_H	S.M.A.R.T. Return Status

NOTE If an appropriate code is not written to the Features Register, the command is aborted and 0*x*04 (abort) is written to the Error register.



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Publication Number: 203249700, Rev. A
November 2021