



Seagate® BarraCuda® 510 SSD

Product Manual

User Capacity	Standard (TCG Pyrite) M.2 2280-S2-M Models	SED (TCG Opal) M.2 2280-S2-M Models
256 GB	ZP256CM30011	ZP256CM30031
512 GB	ZP512CM30011	ZP512CM30031

Revision History

Version and Date	Description of Changes
Rev A, February 2019	First document release.

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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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BarraCuda 510 SSDSeagate Technology Support Services

For Internal SSD Support, visit: <https://www.seagate.com/support/products/>

For information regarding online support and services, visit: <http://www.seagate.com/contacts/>

For information regarding Warranty Support, visit: <http://www.seagate.com/support/warranty-and-replacements/>

For information regarding data recovery services, visit:

<http://www.seagate.com/services-software/seagate-recovery-services/recover/>

For Seagate OEM and Distribution partner and Seagate reseller portal, visit: <http://www.seagate.com/partners>

1. Introduction

The Seagate® BarraCuda® 510 SSD is a versatile NVMe SSD that is optimized for maximum storage capacity with a wide range of application utilities. It is up to 6x faster than SATA SSDs and comes with TCG security to keep data safe and secure.

Table 1 The BarraCuda 510 SSD Features

Feature	Description	
Capacity (User)	<ul style="list-style-type: none"> 256 GB and 512 GB 	
Certifications, Eco-Compliance	<ul style="list-style-type: none"> CE, UL, FCC, BSMI, KCC, Microsoft WHQL, VCCI, CB RoHS 	
Dimensions	<ul style="list-style-type: none"> Length, Max (mm/in): 80.15 mm/3.156 in Width, Max (mm/in): 22.15 mm/0.872 in Height, Max (mm/in): 2.23 mm/0.088 in 	
Form Factor	<ul style="list-style-type: none"> M.2 2280-S2-M 	
Weight	<ul style="list-style-type: none"> 512 GB: 6.9g/0.0152lb 256 GB: 6.5g/0.0143lb 	
Endurance	<ul style="list-style-type: none"> 256 GB: 160 TB Total Bytes Written (TBW) 512 GB: 320 TB Total Bytes Written (TBW) 	See Section 2.5, Reliability/Endurance .
Interface Compliance	<ul style="list-style-type: none"> NVMe 1.3 PCI Express Base 3.1 	
NAND	<ul style="list-style-type: none"> TLC 	
Operating Systems	<ul style="list-style-type: none"> Windows® 7 (64 bit), 8 (64 bit), 8.1 (64 bit), and Windows 10 (64 bit) Ubuntu 18.04 CentOS versions 6 and 7 	
Performance Random	<ul style="list-style-type: none"> Read: Up to 350,000 IOPS Write: Up to 530,000 IOPS 	Actual performance might vary depending on use conditions and environment. See Section 2.2, Performance .
Performance Sequential	<ul style="list-style-type: none"> Read: Up to 3400 MB/s Write: Up to 2180 MB/s 	Actual performance might vary depending on the capacity, use conditions and environment. See Section 2.2, Performance .
Power Consumption	<ul style="list-style-type: none"> Active Power, Average (W): 512 GB: 4.1, 256 GB: 3.0 Idle Power PS3, Average (mW): 20 Low Power L1.2 mode (mW): 2 	See Section 2.3, Power Consumption .
Power Management	<ul style="list-style-type: none"> Supports ActiveStatePower Management (ASPM) Supports Autonomous Power StateTransition (APST) Supports L1.2 	
Security	<ul style="list-style-type: none"> TCG Pyrite supported on standard models AES-256 and TCG Opal 2.0 IEEE1667 supported on SED models 	
Reliability	<ul style="list-style-type: none"> End-to-end data path protection MTBF: 1.8 million hours UBER: 1 error in 10¹⁶ bits read 	

Table 1 The BarraCuda 510 SSD Features (continued)

Feature	Description	
Shock and Vibration	Shock <ul style="list-style-type: none"> ■ Non-Operating: 1,500 G, at 0.5 ms 	See Section 2.4, Environmental Conditions.
	Vibration <ul style="list-style-type: none"> ■ Non-Operating: 1.52 G_{RMS}, (20 to 80 Hz, Frequency) 	
Temperature Range	<ul style="list-style-type: none"> ■ Operating: 0°C to 70°C ■ Non-operating: -40°C to 85°C 	
Voltage	<ul style="list-style-type: none"> ■ 3.3 V±5% 	
Warranty	Five years, or when the device reaches Host TBW, whichever happens first. Endurance rating valid for SSD Life Remaining > 1%.	

2. Specifications

2.1 Models and Capacity

Table 2 Models and Capacity

User Capacity	Standard (TCG Pyrite) M.2 2280-S2-M Models	SED (TCG Opal) M.2 2280-S2-M Models
256 GB	ZP256CM30011	ZP256CM30031
512 GB	ZP512CM30011	ZP512CM30031

NOTE About capacity:

- Sector Size: 512 Bytes
- User-addressable LBA count = (97696368) + (1953504 x (Desired Capacity in Gb-50.0)) From International Disk Drive Equipment and Materials Association (IDEMA) (*LBA1-03_standard.doc*)

2.2 Performance

Table 3 Random and Sequential Read and Write Performance

Parameter	512 GB	256 GB
Sequential Read (Max, MB/s), 128KB	3400	3100
Sequential Write (Max, MB/s), 128KB	2180	1050
Random Read (Max, IOPS), 4KB QD32 T8	350,000	180,000
Random Write (Max, IOPS), 4KB QD32 T8	530,000	260,000

NOTE About performance:

- Fresh out of box (FOB) performance obtained on newly formatted drive. Performance may vary based on the SSD's firmware version, system hardware, and configuration.
- CrystalDiskMark 6.0.2, 1GB range, QD=32, Thread=1, 1GB range, QD=32, Thread=8 (random)
- Sequential Read/Write is measured while testing 1000 MB five times by CrystalDiskMark.

2.3 Power Consumption

Table 4 Power Consumption

	512 GB	256GB
Max. Average Read (mW)	5270	5010
Max. Average Write (mW)	4150	2970
Idle PS3 (mW)	16.5	16.5
L1.2 (mW)	2	2

NOTE

About power consumption:

- The average value of power consumption is based on 100% conversion efficiency.
- The measured power voltage is 3.3 V.
- Samples used BiCS3 3D Toggle TLC NAND flash and were measured under ambient temperature.
- Power Consumption can differ according to flash configuration and platform.
- Power consumption is measured during the sequential read and write (128KB) operations performed by Linux FIO3.7

2.4 Environmental Conditions

Table 5 Temperature, Humidity, Shock

Specification	Value
Temperature Operating (case temperature at specific airflow) Non-operating	0°C to 70°C -40°C to 85°C
Humidity Operating Non-operating (storage)	90% 93%
Shock Non-operating	1,500 G, duration 0.5 ms
Vibration Non-operating	1.52 G _{RMS} , (20Hz to 80Hz, Frequency)

NOTE

Temperature is measured without condensation. Operating mode temperature is measured by temperature sensor, SMART Attribute.

Storage: The drive can be stored for a maximum of 180 days in the original unopened Seagate shipping package or 60 days, unpackaged, in the defined non-operating limits. Storage can be extended to 1 year packaged or unpackaged under optimal environmental conditions (<40°C, <40% relative humidity non-condensing, and non-corrosive environment).

Shock and vibration results assume that the SSD is mounted securely with the input vibration applied to the SSD mounting. These specifications do not cover connection issues that may result from testing at this level. The measured specification is in root mean square (RMS) form.

- **Non-operating Shock.** The limits of non-operating shock applies to all conditions of handling and transportation. This includes both isolated SSD and integrated SSDs. Shock may be applied in the X, Y, or Z-axis.
- **Non-Operating Vibration.** The limits of non-operating vibration shall apply to all conditions of handling and transportation. This includes both isolated SSD and integrated SSDs. Vibration may be applied in the X, Y, or Z-axis.

2.5 Reliability/Endurance

Table 6 Reliability/Endurance

Specification	Value
Mean time between failures (MTBF)	1.8 million hours
Bit Error Rate	1 error in 10^{16} bits read
Endurance	<ul style="list-style-type: none"> ■ 256 GB: 160 TB Total Bytes Written (TBW) ■ 512 GB: 320 TB Total Bytes Written (TBW) ■

NOTE

About endurance:

- The SSD achieves the specified MTBF in an operational environment that complies with the operational temperature range specified in this manual. Operating temperatures are measured by temperature sensor.
- Endurance rating valid for SSD Life Remaining > 1%.
- Endurance is characterized while running Client JESD219A workload (per JESD218A specification).

3. Mechanical Information

Figure 1 BarraCuda 510 SSD Top Side View

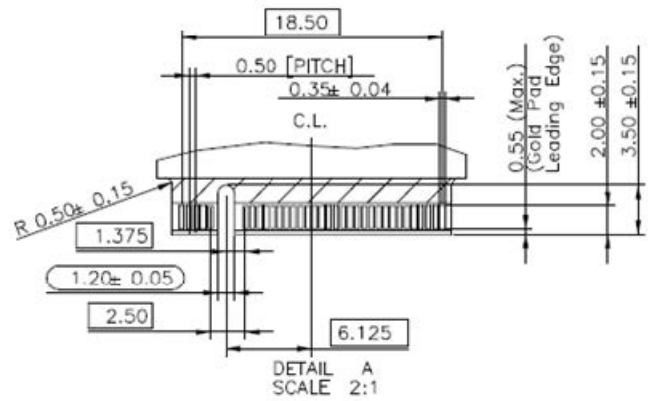
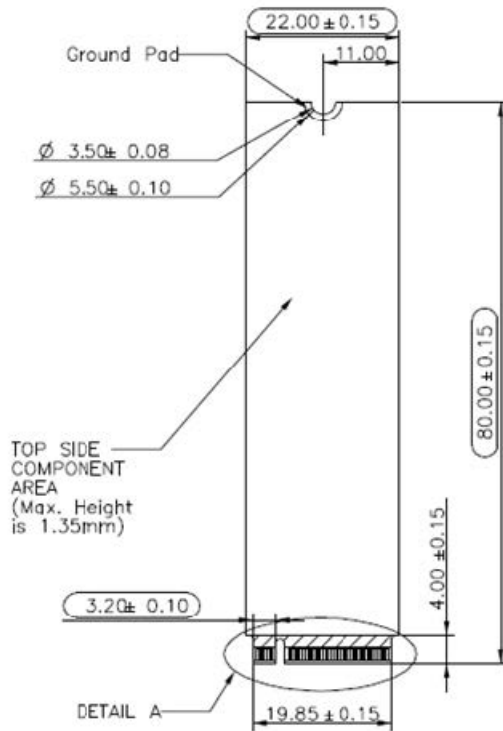


Figure 2 BarraCuda 510 SSD Bottom Side View

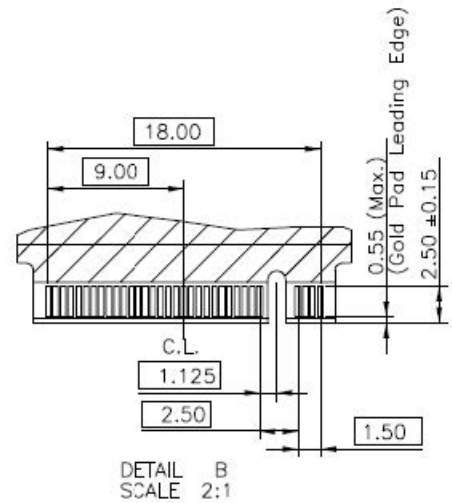
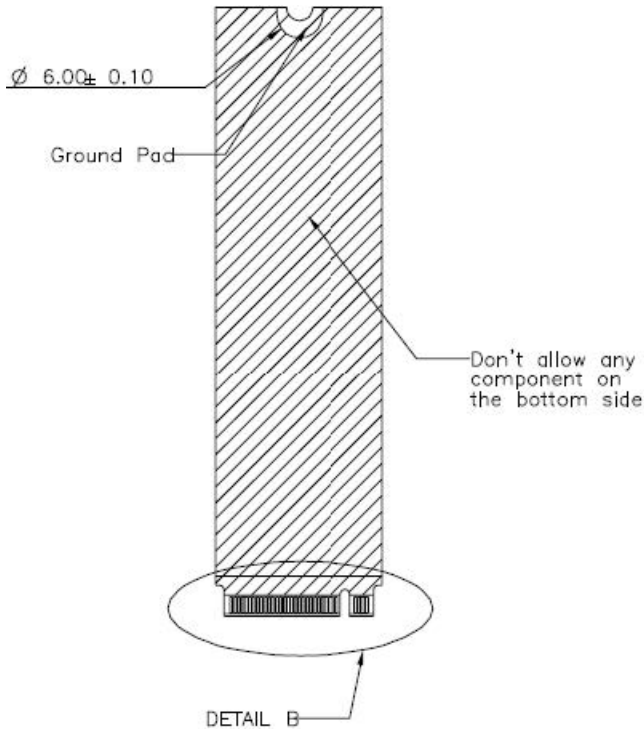
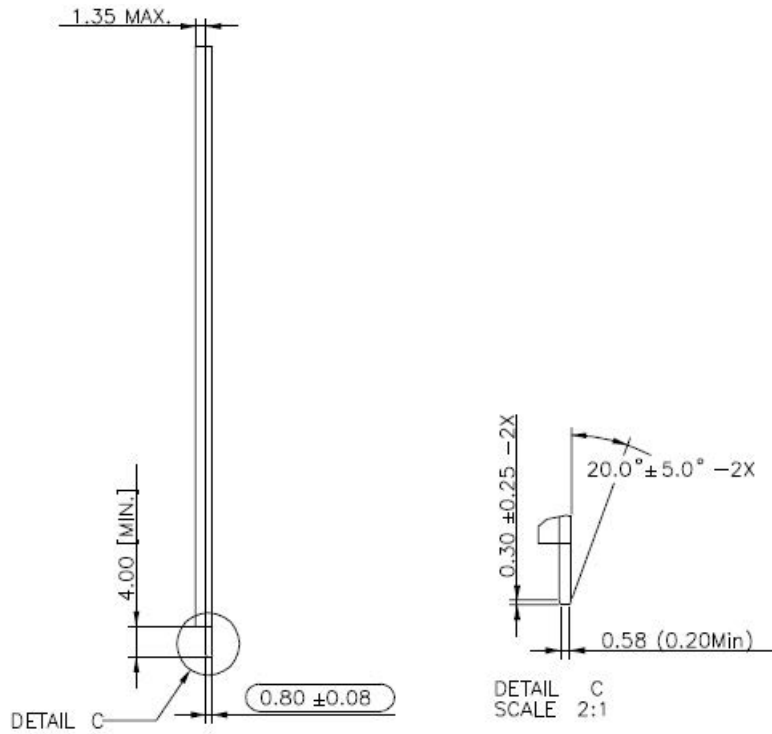


Figure 3 BarraCuda 510 SSD Side View



Notes

Notes :

1. = Max Component Height
2. = No Component
3. = No Component / Signal Vias / Signal Copper / Printing
4. General Tolerance ±0.15mm
5. are critical dimensions

4. Pin and Signal Descriptions

Table 7 Pin Descriptions

Pin No.	PCIe Pin	Description
1	GND	CONFIG_3 = GND
2	3.3V	3.3V source
3	GND	Ground
4	3.3V	3.3V source
5	PETn3	PCIe TX Differential signal defined by the PCI Express M.2 spec
6	N/C	No connect
7	PETp3	PCIe TX Differential signal defined by the PCI Express M.2 spec
8	N/C	No connect
9	GND	Ground
10	LED1#	Open drain, active low signal. These signals are used to allow the add-in card to provide status indicators via LED devices that will be provided by the system.
11	PERn3	PCIe RX Differential signal defined by the PCI Express M.2 spec
12	3.3V	3.3V source
13	PERp3	PCIe RX Differential signal defined by the PCI Express M.2 spec
14	3.3V	3.3V source
15	GND	Ground
16	3.3V	3.3V source
17	PETn2	PCIe TX Differential signal defined by the PCI Express M.2 spec
18	3.3V	3.3V source
19	PETp2	PCIe TX Differential signal defined by the PCI Express M.2 spec
20	N/C	No connect
21	GND	Ground
22	N/C	No connect
23	PERn2	PCIe RX Differential signal defined by the PCI Express M.2 spec
24	N/C	No connect
25	PERp2	PCIe RX Differential signal defined by the PCI Express M.2 spec
26	N/C	No connect
27	GND	Ground
28	N/C	No connect
29	PETn1	PCIe TX Differential signal defined by the PCI Express M.2 spec
30	N/C	No connect

Table 7 Pin Descriptions (continued)

Pin No.	PCIe Pin	Description
31	PETp1	PCIe TX Differential signal defined by the PCI Express M.2 spec
32	N/C	No connect
33	GND	Ground
34	N/C	No connect
35	PERn1	PCIe RX Differential signal defined by the PCI Express M.2 spec
36	N/C	No connect
37	PERp1	PCIe RX Differential signal defined by the PCI Express M.2 spec
38	N/C	No connect
39	GND	Ground
40	SMB_CLK (I/O)(0/1.8V)	SMBus Clock; Open Drain with pull-up on platform
41	PETn0	PCIe TX Differential signal defined by the PCI Express M.2 spec
42	SMB_DATA (I/O)(0/1.8V)	SMBus Data; Open Drain with pull-up on platform.
43	PETp0	PCIe TX Differential signal defined by the PCI Express M.2 spec
44	ALERT#(O) (0/1.8V)	Alert notification to master; Open Drain with pull-up on platform; Active low.
45	GND	Ground
46	N/C	No connect
47	PERn0	PCIe RX Differential signal defined by the PCI Express M.2 spec
48	N/C	No connect
49	PERp0	PCIe RX Differential signal defined by the PCI Express M.2 spec
50	PERST#(I)(0/3.3V)	PE-Reset is a functional reset to the card as defined by the PCIe Mini CEM specification.
51	GND	Ground
52	CLKREQ#(I/O)(0/3.3V)	Clock Request is a reference clock request signal as defined by the PCIe Mini CEM specification; Also used by L1 PM Sub-states.
53	REFCLKn	PCIe Reference Clock signals (100 MHz) defined by the PCI Express M.2 spec.
54	PEWAKE#(I/O)(0/3.3V)	PCIe PME Wake. Open Drain with pull up on platform; Active Low.
55	REFCLKp	PCIe Reference Clock signals (100 MHz) defined by the PCI Express M.2 spec.
56	Reserved for MFG DATA	Manufacturing Data line. Used for SSD manufacturing only. Not used in normal operation. Pins should be left N/C in platform Socket.

Table 7 Pin Descriptions (continued)

Pin No.	PCIe Pin	Description
57	GND	Ground
58	Reserved for MFG CLOCK	Manufacturing Clock line. Used for SSD manufacturing only. Not used in normal operation. Pins should be left N/C in platform Socket.
59	Module Key M	Module Key
60	Module Key M	
61	Module Key M	
62	Module Key M	
63	Module Key M	
64	Module Key M	
65	Module Key M	
66	Module Key M	
67	N/C	No connect
68	SUSCLK(32KHz) (I)(0/3.3V)	32.768 kHz clock supply input that is provided by the platform chipset to reduce power and cost for the module.
69	N/C	PEDET (NC-PCIe)
70	3.3V	3.3V source
71	GND	Ground
72	3.3V	3.3V source
73	GND	Ground
74	3.3V	3.3V source
75	GND	Ground

5. SMART Support

The BarraCuda 510 SSD 510 supports the SMART command set.

5.1 SMART Attributes

The following table lists SMART Attributes and Descriptions.

Table 8 SMART Attributes (Log Identifier 02h)

Bytes Index	Bytes	Description
[0]	1	Critical Warning
[2:1]	2	Composite Temperature
[3]	1	Available Spare
[4]	1	Available Spare Threshold
[5]	1	Percentage Used
[31:6]	26	Reserved
[47:32]	16	Data Units Read
[63:48]	16	Data Units Written
[79:64]	16	Host Read Commands
[95:80]	16	Host Write Commands
[111:96]	16	Controller Busy Time
[127:112]	16	Power Cycles
[143:128]	16	Power On Hours
[159:144]	16	Unsafe Shutdowns
[175:160]	16	Media and Data Integrity Errors
[191:176]	16	Number of Error Information Log Entries
[195:192]	4	Warning Composite Temperature Time
[199:196]	4	Critical Composite Temperature Time

6. Feature Details

6.1 Flash Management

6.1.1 Error Correction Code (ECC)

Flash memory cells will deteriorate with use, which might generate random bit errors in the stored data. Thus, BarraCuda 510 SSD 510 applies the 340bit/2KB LDPC(Low Density Parity Check) of ECC algorithm, which can detect and correct errors that occur during read process, ensure data has been read correctly, as well as protect data from corruption.

6.1.2 Wear Leveling

NAND flash devices can only undergo a limited number of program/erase cycles, and in most cases, the flash media are not used evenly. If some areas get updated more frequently than others, the lifetime of the device would be reduced significantly. Thus, Wear Leveling is applied to extend the lifespan of NAND Flash by evenly distributing write and erase cycles across the media.

Seagate provides advanced Wear Leveling algorithm, which can efficiently spread out the flash usage through the whole flash media area. Moreover, by implementing both dynamic and static Wear Leveling algorithms, the life expectancy of the NAND flash is greatly improved.

6.1.3 Bad Block Management

Bad blocks are blocks that do not function properly or contain more invalid bits causing stored data to become unstable, and their reliability is not guaranteed. Blocks that are identified and marked as bad by the manufacturer are referred to as “Early Bad Blocks”. Bad blocks that are developed during the lifespan of the flash are named “Later Bad Blocks”. Seagate implements an efficient bad block management algorithm to detect the factory- produced bad blocks and manages bad blocks that appear with use. This practice prevents data being stored into bad blocks and further improves the data reliability.

6.1.4 TRIM

TRIM is a feature which helps improve the read/write performance and speed of solid-state drives (SSD). Unlike hard disk drives (HDD), SSDs are not able to overwrite existing data, so the available space gradually becomes smaller with each use. With the TRIM command, the operating system can inform the SSD which blocks of data are no longer in use and can be removed permanently. Thus, the SSD will perform the erase action, which prevents unused data from occupying blocks all the time.

6.1.5 SMART

SMART, an acronym for Self-Monitoring, Analysis and Reporting Technology, is an open standard that allows a hard disk drive to automatically detect its health and report potential failures. When a failure is recorded by SMART, users can choose to replace the drive to prevent unexpected outage or data loss. Moreover, SMART can inform users of impending failures while there is still time to perform proactive actions, such as copy data to another device.

6.1.6 Over Provisioning

Over Provisioning refers to the inclusion of extra NAND capacity in a SSD, which is not visible and cannot be used by users. With Over Provisioning, the performance and IOPS (Input/output Operations per Second) are improved by providing the controller additional space to manage P/E cycles, which enhances the reliability and endurance as well. Moreover, the write amplification of the SSD becomes lower when the controller writes data to the flash.

6.1.7 Firmware Upgrade

Firmware can be considered as a set of instructions on how the device communicates with the host. Firmware will be upgraded when new features are added, compatibility issues are fixed, or read/write performance gets improved.

6.1.8 Thermal Throttling

The purpose of thermal throttling is to prevent any components in a SSD from over-heating during read and write operations. The device is designed with an on-die and an on-board thermal sensor, and with its accuracy, firmware can apply different levels of throttling to achieve the purpose of protection efficiently and proactively via SMART reading.

Table 9 Current version: Thermal Throttling 2.0

Item	Content
Smart reporting temperature	Flash normalized case temperature
Reference of temp. reading	On-board thermal sensor, Controller on-die thermal sensor
tmt1 threshold	68°C per Smart reported
tmt2 threshold	70°C per Smart reported
Protect threshold	80°C per Smart reported
Protect controller threshold	110°C from on-die thermal sensor
Fatal threshold	120°C from on-die thermal sensor
Resume performance threshold	60°C per Smart reported
Temperature polling frequency	Every 1 sec
TMT1_state impact	-10% CE
TMT2_state impact	-30% CE

6.2 Advanced Device Security Features

6.2.1 NVMe format

Secure Erase is a standard NVMe format command and it writes all "0xFF" to fully wipe all the data on the SSDs. When this command is issued, the SSD controller erases its storage blocks and return to its factory default settings.

6.2.2 Physical Presence SID (PSID)

The Physical Presence SID (PSID) is defined by TCG OPAL as a 32-character string and its purpose is to revert the SSD back to its manufacturing setting when the drive is set via TCG Opal (SED) or TCG Pyrite (non-SED). The PSID code is printed on the SSD's label. All user data will be erased when reverting the drive back to manufacturing settings.

6.2.3 Manufacturer's Secure ID (MSID)

The Manufacturer's Secure ID (MSID) is defined by TCG OPAL as a 32-character string and is assigned during the manufacturing process, which is a password that cannot be changed by the host system. MSID can be obtained electronically from the drive across the interface. On acquiring the SSD, the user must set a new password. If a new password is not set the SSD might be potentially taken control by anyone who can reset the MSID. Such an attack on the drive is known as Denial of Service (DoS) since the rightful owner has been locked out.

6.2.4 Sanitize Operation

The Sanitize feature is an alternative to the existing secure erase capabilities through the Format NVM command and makes a robust data security by ensuring the user data from the drive's media, caches and the Controller Memory Buffer are all wiped by the block erase operations, overwriting or destroying the encryption key. The following table illustrates the types of Sanitize Operations supported.

Table 10 Supported Sanitize Operations

Drive Security Type	AES-256 Encryption	Sanitize Operation			TCG Commands		IEEE 1667
		Overwrite	Block Erase	Crypto Erase	PSID Revert Process	Instant Security Erase	Windows eDrive
SED (TCG Opal)	Yes	Yes	Yes	Yes ^a	Yes	Yes ^b	Yes ^c
Non-SED (TCG Pyrite)	No	Yes	Yes	No	Yes	No	No

- Crypto Erase is a feature that erases all the data of the AES encrypted data structure by resetting the cryptographic key of the disk. The previously encrypted data becomes nonrecoverable.
- The Instant Security Erase is a feature that erases all the data of the SED drive with the Opal-activated encrypted data structure by resetting the SSD with the PSID. Since the key is reset, the previously encrypted data cannot be accessed.
- IEEE 1667 is supported but needs to be activated by SeaChest_Security tool when required to prevent unintended eDrive implementation and the following requirement of reverting by PSID before being able to re-install the Operation System.

6.3 SSD Lifetime Management

6.3.1 Total Bytes Written (TBW)

TBW (Terabytes Written) is a measurement of the SSDs' expected lifespan, which represents the amount of data written to the device. To calculate the TBW of a SSD, the following equation is applied:

$$TBW = [(NAND\ Endurance) \times (SSD\ Capacity)] / WAF$$

NAND Endurance: NAND endurance refers to the P/E (Program/Erase) cycle of a NAND flash. SSD Capacity: The SSD capacity is the specific capacity in total of a SSD.

WAF: Write Amplification Factor (WAF) is a numerical value representing the ratio between the amount of data that a SSD controller needs to write and the amount of data that the host's flash controller writes. A better WAF, which is near 1, guarantees better endurance and lower frequency of data written to flash memory.

TBW in this document is based on JEDEC 219 workload.

6.3.2 Media Wear Indicator

Actual life indicator reported by SMART Attribute byte index [5], Percentage Used, recommends User to replace drive when reaching to 100%.

6.3.3 Read Only Mode (End of Life)

When drive is aged by cumulated program/erase cycles, media worn-out may cause increasing numbers of later bad block. When the number of available spare is less the threshold(5%, SMART attribute log ID 02h Byte4), the drive will notify Host through AER event and Critical Warning to enter Read Only Mode to prevent further data corruption. User should start to replace the drive with another one immediately.

6.4 An Adaptive Approach to Performance Tuning

6.4.1 Throughput

Based on the available space of the disk, the drive will regulate the read/write speed and manage the performance of throughput. When there still remains a lot of space, the firmware will continuously perform read/write action. There is still no need to implement garbage collection to allocate and release memory, which will accelerate the read/write processing to improve the performance. Contrarily, when the space is being used up, the drive will slow down the read/write processing, and implement garbage collection to release memory. Hence, read/write performance will become slower.

6.4.2 Predict & Fetch

Normally, when the Host tries to read data from the PCIe SSD, the PCIe SSD will only perform one read action after receiving one command. However, the drive applies Predict & Fetch to improve the read speed. When the host issues sequential read commands to the PCIe SSD, the PCIe SSD will automatically expect that the following will also be read commands. Thus, before receiving the next command, flash has already prepared the data. Accordingly, this accelerates the data processing time, and the host does not need to wait so long to receive data.

6.4.3 SLC Caching

The firmware design of the device currently adopts dynamic caching to deliver better performance for better endurance and consumer user experience. The SLC caching size is set up to 24 GB across capacities.

7. Safety, Standards, and Compliance

Each Hard Drive and Solid State Drive ("device") has a product label that includes certifications that are applicable to that specific drive. The following information provides an overview of requirements that may be applicable to the drive.

7.1 Regulatory Model Numbers

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

- STA015

7.2 Agency and Safety Certifications

7.2.1 Safety Certification

These products are certified to meet the requirements of UL/cUL 60950-1, EN 60950-1, and may also include, IEC 62368, UL 62368 and EN 62368.

7.2.2 Electromagnetic Compatibility

The device, as delivered, is designed for system integration and installation into a suitable enclosure prior to use. The drive is supplied as a subassembly and is not subject to Subpart B of Part 15 of the FCC Rules.

The design characteristics of the drive serve to minimize radiation when installed in an enclosure that provides reasonable shielding. The device is capable of meeting the Class B limits of the FCC Rules and Regulations of the Canadian Department of Communications when properly packaged; however, it is the user's responsibility to assure that the device meets the appropriate EMI requirements in their system.

7.2.3 Electromagnetic Susceptibility

The device as delivered is tested to meet susceptibility requirements in a representative enclosure. It is the responsibility of those integrating the drive within their systems to perform those tests required and design their system to ensure that equipment operating in the same system as the drive or external to the system does not adversely affect the performance of the device.

7.2.4 Electromagnetic Compliance

Seagate uses an independent laboratory to confirm compliance with the EMC directives and standards. The device was tested in a representative system for typical applications. Although the test system with this Seagate model complies with the directives/standards, we cannot guarantee that all systems will comply. The computer manufacturer or system integrator shall confirm EMC compliance and provide the appropriate marking for their product.

7.2.5 European Union (EU) CE Marking Requirements

Devices that display the CE mark comply with the European Union (EU) requirements specified in the Electromagnetic Compatibility Directive (2014/30/EU). Testing is performed to the levels specified by the product standards for Information Technology Equipment (ITE). Emission levels are defined by EN 55032:2012, Class B and the immunity levels are defined by EN 55024.

The devices also meet the requirements of The Low Voltage Directive (LVD) 2014/35/EU.

Although CE-marked Seagate devices comply with all relevant regulatory requirements and standards for the drives, Seagate cannot guarantee that all system-level products into which the devices are installed comply with all regulatory requirements and standards applicable to the system-level products. The device is designed for operation inside a properly designed system (e.g., enclosure designed for the device), with properly shielded I/O cable (if necessary) and terminators on all unused I/O ports. Computer manufacturers and system integrators should confirm EMC compliance and provide CE marking for the system-level products.

For compliance with the RoHS "Recast" Directive 2011/65/EU (RoHS 2), see [Section 7.3.1 on page 24](#).

7.2.6 Australian and New Zealand RCM Compliance Mark

If the device has the RCM marking, it complies with the Australia/New Zealand Standard AS/NZ CISPR32 and meets the Electromagnetic Compatibility (EMC) Framework requirements of the Australian Communications and Media Authority (ACMA).

7.2.7 Canada ICES-003

If the device has the ICES-003 Issue 6 marking, it complies with the requirements of ICES tested per ANSI C63.4-2014 or CAN/CSA-CISPR 22-10.

7.2.8 South Korean Certification Mark

If the device has the Korean Communications Commission (KCC) logo, they comply with KN32 and KN35.

기종별	사용자안내문
B급 기기 (가정용 방송통신기자재)	이 기기는 가정용(B급) 전자파적합기기로서 주로 가정에서 사용하는 것을 목적으로 하며, 모든 지역에서 사용할 수 있습니다.

7.2.9 Morocco Commodity Mark

Seagate drives are tested for compliance and comply with the European Union (EU) Electromagnetic Compatibility (EMC) Directive 2014/30/EU and the Low Voltage Directive (LVD) 2014/35/EU. Accordingly, the drives also meet the requirements of Morocco's Order of the Minister of Industry, Trade, Investment and Digital Economy No. 2574-14 of 29 Ramadan 1436 (16 July 2015) on electromagnetic compatibility of equipment.

For devices with the Morocco Mark, Seagate has added the Moroccan Commodity Mark to the devices provided to the OEM for the sale of Customer Kits produced by our OEM customers that are intended to be incorporated into the OEM's finished system-level product by an end user. The Customer Kits are considered 'devices' under Morocco's Order of the Minister of Industry, Trade, Investment and Digital Economy No. 2574-14 of 29 Ramadan 1436 (16 July 2015) on electromagnetic compatibility of equipment.

7.2.10 Taiwanese BSMI

Devices with the Taiwanese certification mark comply with Chinese National Standard, CNS13438 (2006.6) and CNS 15663 (2013.7).

For compliance with the Taiwan Bureau of Standards, Metrology and Inspection's (BSMI) RoHS requirements, [see Section 7.3.3 on page 26](#).

7.3 Environmental Protection

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

7.3.1 European Union Restriction of Hazardous Substance Law

7.3.1.1 Restriction of Hazardous Substances in Electrical and Electronic Equipment

Seagate devices are designed to be compliant with the European Union RoHS "Recast" Directive 2011/65/EU (RoHS 2) as amended by Directive (EU) 2015/863. The RoHS2 restricts the use of certain hazardous substances such as Lead, Cadmium, Mercury, Hexavalent Chromium, Polybrominated Biphenyls (PBB) and Polybrominated Diphenyl Ether (PBDE), BisBis(2-Ethylhexyl) phthalate (DEHP), Benzyl butyl phthalate (BBP), Dibutyl phthalate (DBP), and Diisobutyl phthalate (DIBP) in electrical and electronic equipment (EEE).

7.3.1.2 Substances of Very High Concern (SVHC)

The European Union REACH (Registration, Evaluation, Authorization and Restriction of Chemicals) Regulation (EC) 1907/2006 regulates chemicals shipped into and used in Europe. A number of parts and materials in Seagate products are procured from external suppliers. We rely on the representations of our suppliers regarding the presence of REACH substances in these articles and materials. Our supplier contracts require compliance with our chemical substance restrictions, and our suppliers document their compliance with our requirements by providing full-disclosure material content declarations that disclose inclusion of any REACH-regulated substance in such articles or materials. Product-specific REACH declarations are available upon request through your Seagate Sales Representative.

7.3.2 China Requirements —China RoHS 2



China RoHS 2 refers to the Ministry of Industry and Information Technology Order No. 32, effective July 1, 2016, titled Management Methods for the Restriction of the Use of Hazardous Substances in Electrical and Electronic Products. To comply with China RoHS 2, Seagate determines this product's Environmental Protection Use Period (EPUP) to be 20 years in accordance with the *Marking for the Restricted Use of Hazardous Substances in Electronic and Electrical Products*, SJT 11364-2014.

Table 11 China - Hazardous Substances

部件名称 Part Name	有害物质 Hazardous Substances					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr ⁺⁶)	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
印刷电路板组装 PCBA	X	O	O	O	O	O

本表格依据 SJ/T 11364 的规定编制。

This table is prepared in accordance with the provisions of SJ/T 11364-2014

O: 表示该有害物质在该部件所有均质材料中的含量均在 GB/T 26572 规定的限量要求以下。

O: Indicates that the hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement of GB/T26572.

X: 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求。

X: Indicates that the hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement of GB/T26572.

7.3.3 Taiwan Requirements — Taiwan RoHS

Taiwan RoHS refers to the Taiwan Bureau of Standards, Metrology and Inspection's (BSMI) requirements in standard CNS 15663, Guidance to reduction of the restricted chemical substances in electrical and electronic equipment. Seagate products must comply with the "Marking of presence" requirements in Section 5 of CNS 15663, effective January 1, 2018. This product is Taiwan RoHS compliant.

The following table meets the Section 5 "Marking of presence" requirements.

Table 12 Taiwan - Restricted Substances

設備名稱：固態硬碟， Equipment Name: 2.5 inch SSDs		型號（型式） Type Designation (Type)				
單元 Unit	限用物質及其化學符號 Restricted Substance and its chemical symbol					
	鉛 Lead (Pb)	汞 Mercury (Hg)	鎘 Cadmium (Cd)	六價鉻 Hexavalent Chromium (Cr ⁺⁶)	多溴聯苯 Polybrominated biphenyls (PBB)	多溴二苯醚 Polybrominated diphenyl ethers (PBDE)
快閃記憶體 Flash Memory	○	○	○	○	○	○
連接器 Connector	○	○	○	○	○	○
外殼 Product Cover	○	○	○	○	○	○
印刷電路板總成 PCB Assembly	—	○	○	○	○	○
備考1. "超出0.1 wt %" 及 "超出0.01 wt %" 係指限用物質之百分比含量超出百分比含量基準值。 Note 1: "Exceeding 0.1 wt %" and "exceeding 0.01 wt %" indicate that the percentage content of the restricted substance exceeds the reference percentage value of presence condition.						
備考2. "○" 係指該項限用物質之百分比含量未超出百分比含量基準值。 Note 2. "O" indicates that the percentage content of the restricted substance does not exceed the percentage of reference value of presence.						
備考3. "—" 係指該項限用物質為排除項目。 Note 3. "-" indicates that the restricted substance corresponds to the exemption.						

7.4 Reference Documents

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

- PCIe Specifications
 - PCIe - PCI Express Electromechanical specification, revision 3.0
 - NVMe - Non Volatile Memory Express specification 1.3
 - PCIe CEM - PCI Express Card Electromechanical specification, revision 1.1
 - PCI Express M.2 Specification, revision 1.1
- Trusted Computing Group (TCG) Documents
 - Storage Work Group Security Subsystem Class: Opal, Version 2.00
- Solid State Drive Requirements and Endurance Test Methods
 - JESD218
 - JESD219
- Seagate Documentation
 - SeaTools™ SSD GUI User Guide - Publication Number: 100837824
 - SeaChest Utilities User Guides



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Publication Number: 100847099, Rev. A

February, 2019