FIRECUDA
GAMING

Seagate® FireCuda® 120 SSD

Product Manual

500 GB	ZA500GM10001
1000 GB	ZA1000GM10001
2000 GB	ZA2000GM10001
4000 GB	ZA4000GM10001

100867394, Rev B
May 2020

Revision History

Version and Date	Description of Changes
Rev B, May 2020	Update logo and gaming application.
Rev A, April 2020	First document release.

Contents

Seagate Technology Support Services

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

For Firmware Download and Tools Download for Secure Erase, visit: https://www.seagate.com/support/downloads/

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® FireCuda™ 120 SSD is a fast, dependable storage solution for gaming applications. The Seagate FireCuda 120 SSD offers SATA interface, fully compatible with SATA 3.2 6.0Gbps.

Table 1 The FireCuda 120 SSD Features

Feature	Description	
Capacity (User)	■ 500 GB, 1000 GB, 2000 GB, 4000 GB	
Certifications, Eco-Compliance	■ CE, UL, FCC, BSMI, KCC, Microsoft WHCK, VCCI, CB ■ RoHS	
Dimensions	■ (69.85±0.25) x (100±0.25) x (Max. 7) mm	SSD outer case can support suitable Z-height for various host situations.
Endurance	■ 500 GB 700 Total Bytes Written (TBW) ■ 1000 GB 1400 TBW ■ 2000 GB 2800 TBW ■ 4000 GB 5600TBW	Endurance rating valid for SSD Life Remaining > 1% (SMART E7h>1). See Section 2.5, *Reliability/Endurance*.
Form Factor	■ 2.5-inch Standard SSD	
Interface Compliance	■ Fully compliant with ATA-8/ACS-3 Standard ■ Compliant with SATA Revision 3.2 ■ Supported protocol AHCI and ASC2 command set ■ Compatible with SATA 1.5 Gbps, 3 Gbps, and 6Gbps interfaces ■ PIO, DMA, UDMA (up to 6 modes, dependent on host) supported ■ Native Command Queuing (NCQ): up to 32 commands ■ Data Set Management Command Trim support	
NAND	■ 3D TLC	
Operating Systems	■ Windows® 7 (64 bit), 8.1 (64 bit), and Windows 10 (64 bit) ■ Ubuntu 16.10	
Performance Random	■ Read: Up to 100,000 IOPS ■ Write: Up to 90,000 IOPS	Actual performance might vary depending on use conditions and environment. See Section 2.2, *Performance*.
Performance Sequential	■ Read: Up to 560MB/s ■ Write: Up to 540MB/s	Actual performance might vary depending on the capacity, use conditions and environment. See Section 2.2, *Performance*.
Power Consumption	■ Active mode: < 2800 mW ■ Idle mode: < 150 mW ■ DEVSLP: 5 mW	Based on 4000 GB SSD. Results vary with capacity and mode. See Section 2.3, *Power Consumption*.
Power Loss Data Protection	■ To protect your data, you must send a Standby Immediate command (0xE1h) before you remove power. The FireCuda 120 SSD does not provide data protection for a sudden power loss.	
Power Management	■ 2.5 inch: 5 V SATA Supply ■ Host-initiated power management ■ Device-initiated power management ■ HIPM/DEVSLP Mode	

Table 1 The FireCuda 120 SSD Features *(continued)*

Feature	Description	
Reliability	■ End-to-end data path protection ■ MTBF: 1.8 million hours ■ UBER: 1 error in 1016 bits read	
Shock and Vibration	Shock ■ Non-Operating: 1,500 G, at 0.5 ms	**See Section 2.4, *Environmental Conditions*.**
	Vibration ■ Non-Operating: 1.52 G_{RMS}, (20 to 80 Hz, Frequency)	
Temperature Range (Operating)	■ 0°C to 70°C ■ Temperature Sensor (SMART Attribute ID C2h)	
Voltage	■ 5V±5%	
Warranty	Five years, or when the device reaches Host TBW, whichever happens first. Endurance rating valid for SSD Life Remaining > 1% (SMART E7h>1).	
Weight	■ 50 g, 1.76 Oz ±5%	

2. Specifications

2.1 Models and Capacity

Table 2 Models and Capacity

Model Names	User Capacity
ZA500GM10001	500 GB
ZA1000GM10001	1000 GB
ZA2000GM10001	2000 GB
ZA4000GM10001	4000 GB

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	500 GB	1000 GB	2000 GB	4000 GB
Sequential Read MB/s	560 MB/s	560 MB/s	560 MB/s	560 MB/s
Sequential Write MB/s	540 MB/s	540 MB/s	540 MB/s	540 MB/s
Random Read (IOPS)	100,000	100,000	100,000	100,000
Random Write (IOPS)	90,000	90,000	90,000	90,000

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.
- Performance is based on CrystalDiskMark v.6.0.0 ×64 on Windows 10 host.

2.3 Power Consumption

Table 4 Power Consumption

	500 GB	1000 GB	2000 GB	4000 GB
Read (mW)	2300	2400	2600	2800
Write (mW)	2300	2400	2600	2800
Idle (mW)	120	135	140	150
Slumber (mW)	35	55	60	65
DEVSLP (mW)	5	5	5	5

NOTE About power consumption:

- The average value of power consumption is based on 100% conversion efficiency.
- The measured power voltage is 5 V.
- Measured under ambient temperature.
- Sequential Read/Write is measured while testing 4000 MB five times by CrystalDiskMark.
- Power Consumption can differ according to flash configuration and platform.

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 C2h.

NOTE **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	■ 700 GB TBW ■ 1400 GB TBW ■ 2800 GB TBW ■ 5600 GB 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, SMART Attribute ID C2h.
- Endurance rating valid for SSD Life Remaining > 1% (SMART E7h>1).
- Endurance is characterized while running Client JESD219A workload (per JESD218A specification).

3. Mechanical Information

3.1 Dimensions and Weight

Weight: 50 g, 1.76 Oz +/- 5%

Height: Maximum, 7 mm+0.10/-0.30

Width: 69.85 mm±0.25 mm

Length: 100.10 mm±0.25 mm

Figure 1 FireCuda 120 SSD Enclosure

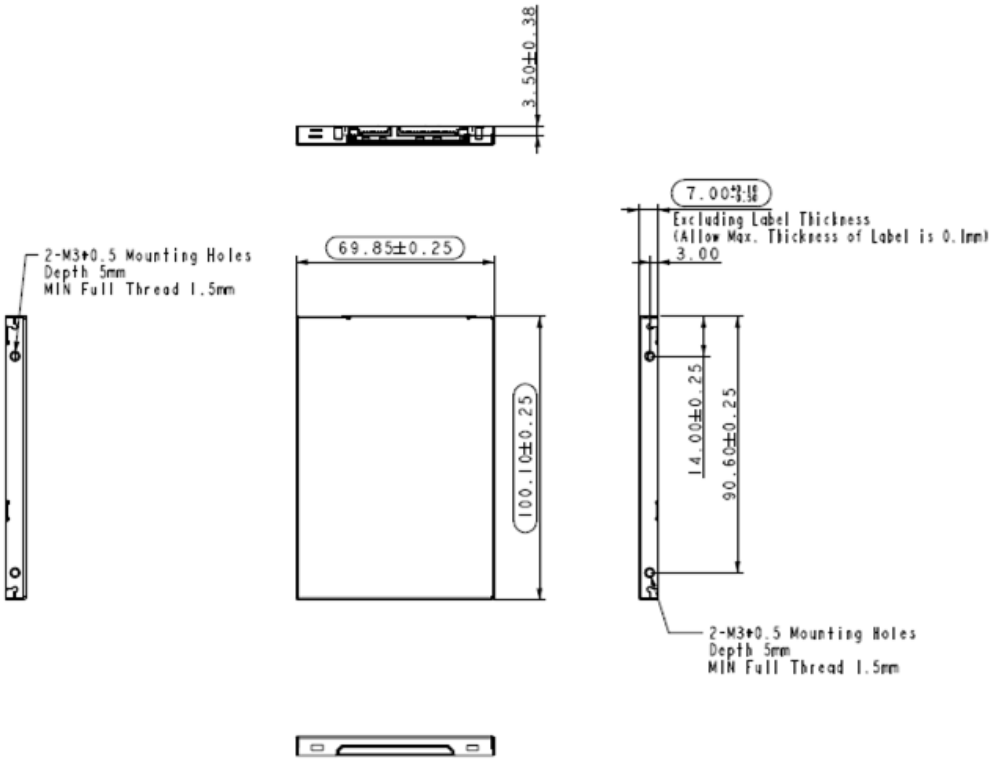
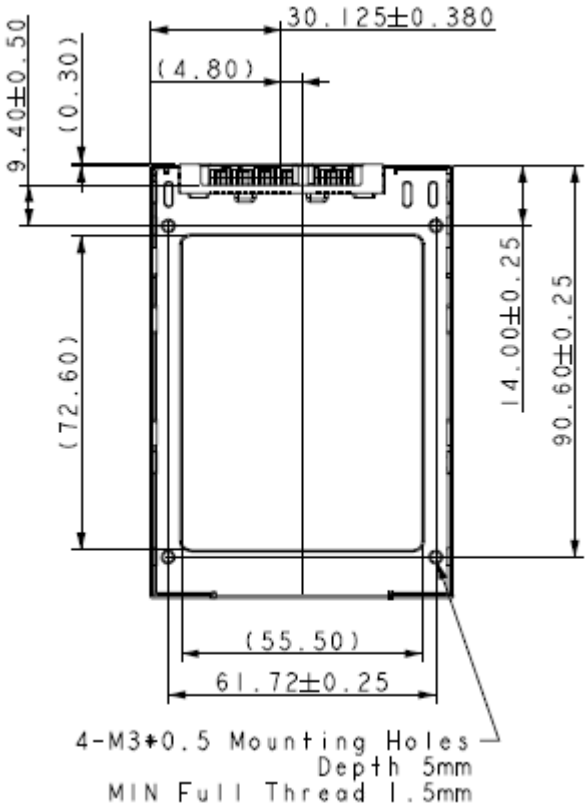


Figure 2 FireCuda 120 SSD



4. Pin and Signal Descriptions

4.1 Signal Pin Definitions

Table 7 Serial ATA Connector Pin Signal Definitions

Pin	Name	Definition
S1	Ground	Ground
S2	A+	Differential signal pair A+ and A-
S3	A-	
S4	Ground	Ground
S5	B-	Differential signal pair B- and B+
S6	B+	
S7	Ground	Ground

NOTE Key and spacing separate the signal and power segments.

4.2 Power Pin Definitions

Table 8 Power Pin Definitions

Pin	Function	Definition
P1	not used	Not Used (3.3 V)
P2	V33	Not Used (3.3 V)
P3	DEVSLP	SATA PHY Power Control
P4	GND	Ground
P5	GND	Ground
P6	GND	Ground
P7	V5	5 V Power, Precharge
P8	V5	5 V Power
P9	V5	5 V Power
P10	GND	Ground
P11	Reserved	Reserved
P12	GND	Ground
P13	not used	Not Used (12 V pre-charge)
P14	V12	Not Used (12 V)
P15	V12	Not Used (12 V)

NOTE About Power Pin Signal Definitions:

- Key and spacing separate the signal and power segments.
- Uses 5 V power only; 3.3 V (P1-P2) and 12 V (P13-P15) power are not used.

5. Supported ATA Command List

The FireCuda 120 SSD complies with ATA-8/ACS-3. All mandatory and many optional commands and features are supported.

5.1 ATA Feature Set

The following table summarizes the ATA feature set and commands that the FireCuda 120 SSD supports.

Table 9 ATA Feature Set

Feature	Supported
48-Bit Address feature set	Yes
General feature set	Yes
Native Command Queuing (NCQ) feature set	Yes
Power Management feature set	Yes
Security feature set	Yes
SMART feature set	Yes

5.2 ATA Command Description

The following table shows the ATA commands supported.

Table 10 ATA Command Description

Op-Code		Support	Command Description	Op-Code			Support	Command Description
00h		Y	NOP	B6h	12h	—	—	NV Cache: QUERY NV CACHE PINNED SET DMA EXT
03h		—	CFA Request Extended Error	B6h	13h	—		NV Cache: QUERY NV CACHE MISSES DMA EXT
06h		Y	Data Set Management	B6h	14h	—	—	NV Cache: FLUSH NV CACHE
08h		—	Device Reset	C4h	—	—	Y	Read Multiple
0Bh		—	Request Sense Data EXT	C5h	—	—	Y	Write Multiple
10h		Y	Recalibrate	C6h	—	—	Y	Set Multiple Mode
11h to 1Fh		—	Recalibrate	C7	—	—		Read DMA Queued
20h		Y	Read Sectors	C8h	—	—	Y	Read DMA
21h		Y	Read Sectors without Retry	9h	—	—	—	Read DMA Without Retry
22h		—	Read Long	CAh	—	—	Y	Write DMA
23h		—	Read Long Without Retry	CBh	—	—	Y	Write DMA Without Retry
24h		Y	Read Sectors EXT	CCh	—	—	—	Write DMA Code
25h		Y	Read DMA EXT	CDh	—	—	—	CFA Write Multiple Without Erase
26h	—	—	Read DMA Queued EXT	CEh	—	—	Y	Write Multiple FUA EXT

Table 10 ATA Command Description *(continued)*

Op-Code		Support	Command Description	Op-Code			Support	Command Description
27h	—	Y	Read Native Max Address EXT	D1h	—	—	—	Check Media Card Type
29h	—	Y	Read Multiple EXT	DAh	—	—	—	Get Media Status
2Ah	—	—	Read Stream DMA EXT	DEh	—	—	—	Media Lock
2Bh	—	—	Read Stream EXT	DFh	—	—	—	Media Unlock
2Fh	—	Y	Read Log EXT	E0h	—	—	Y	Standby Immediate
30h	—	Y	Write Sectors	E1h	—	—	Y	Idle Immediate
31h	—	Y	Write Sectors without Retry	E2h	—	—	Y	Standby
32h	—	—	Write Long	E3h	—	—	Y	Idle
33h	—	—	Write Long Without Retry	E4h	—	—	Y	Read Buffer
34h	—	Y	Write Sectors EXT	E5h	—	—	Y	Check Power Mode
35h	—	Y	Write DMA EXT	E6h	—	—	Y	Sleep
36h	—		Write DMA Queued EXT	E7h	—	—	Y	Flush Cache
37h	—	Y	Set Max Address EXT	E8h	—	—	Y	Write Buffer
38h	—	—	CFA Write Sectors Without Erase	E9h	—	—	Y	Read Buffer DMA
39h	—	Y	Write Multiple EXT	EAh	—	—	Y	Flush Cache EXT
3Ah	—	—	Write Stream DMA EXT	EBh	—	—	Y	Write Buffer DMA
3Bh	—	—	Write Stream EXT	ECh	—	—	Y	Identify Device
3Ch	—	—	Write Verify	EDh	—	—	—	Media Eject
3Dh	—	Y	Write DMA FUA EXT	EEh	—	—	—	Identify Device DMA
3Eh	—	—	Write DMA Queued FUA EXT	EFh	01h	—	—	Set Features: Enable 8-bit PIO Transfer Mode (CFA feature set only)
3Fh	—	Y	Write Log EXT	EFh	02h	—	Y	Set Features: Enable Write Cache
40h	—	Y	Read Verify Sectors	EFh	03h	—	Y	Set Features: Set transfer mode based on value in Count field.
41h	—	Y	Read Verify Sectors without Retry	EFh	05h	—	—	Set Features: Enable advanced power management.
42h	—	Y	Read Verify Sector(s) EXT	EFh	06h	—	—	Set Features: Enable Power-Up In Standby feature set.
44h	—	—	Reserved	EFh	07h	—	—	Set Features: Power-Up In Standby feature set device spin-up.
45h	—	O	Write Uncorrectable EXT	EFh	0Ah	—	—	Set Features: Enable CFA power mode 1.
47h	—	Y	Read Log DMA EXT	EFh	0Bh	—	—	Set Features: Enable Write-Read-Verify feature set
50h	—	—	Format Track	EFh	10h	01h	—	Set Features: Enable use of Serial ATA feature

Table 10 ATA Command Description *(continued)*

Op-Code		Support	Command Description	Op-Code			Support	Command Description
51h	—	—	Configure Stream	EFh	10h	02h	Y	Set Features: Enable DMA Setup FIS Auto-Activate optimization
57h	—	Y	Write Log DMA EXT	EFh	10h	03h	Y	Set Features: Enable Device-initiated interface power state (DIPM) transitions.
60h	—	Y	Read FPDMA Queued	EFh	10h	04h	—	Set Features: Enable use of Serial ATA feature
61h	—	Y	Write FPDMA Queued	EFh	10h	05h	—	Set Features: Enable use of Serial ATA feature
70h	—	Y	Seek	EFh	10h	06h	O	Set Features: Enable Software Settings Preservation (SSP)
71-76h	—	—	Seek	EFh	10h	07h	Y	Set Features: Enable Device Automatic Partial to Slumber transitions
77h	—	Y	Set Date And Time Ext	EFh	10h	09h	O	Set Features: Enable Device Sleep
78h	—	Y	Accessible Max Address Configuration	EFh	42h	—	—	Set Features: Enable Automatic Acoustic Management feature set.
79-7Fh	—	—	Seek	EFh	43h	-	—	Set Features: Set Maximum Host Interface Sector Times.
87h	—	—	CFA Translate Sector	EFh	44h	—	-—	Set Features: Vendor Specific ECC byte
90h	—	Y	Execute Device Diagnostic	EFh	55h	—	Y	Set Features: Disable read look-ahead feature
91h	—	Y	Initialize Device Parameters	EFh	5Dh	—	—	Set Features: Enable release interrupt
92h	—	Y	Download Microcode	EFh	5Eh	—	—	Set Features: Enable service interrupt
93h	—	Y	Download Microcode DMA	EFh	5Fh	—	—	Set Features: Enable NDRQ Feature
94h	—	—	Standby Immediate	EFh	66h	—	Y	Set Features: Disable reverting to power-on defaults
95h	—	—	Idle Immediate	EFh	81h	—	—	Set Features: Disable 8-bit PIO transfer mode (CFA feature set only)
96h	—	—	Standby	EFh	82h	—	Y	Set Features: Disable write cache
97h	—	—	Idle	EFh	85h		Y	Set Features: Disable advanced power management
98h	—	—	Check Power Mode	EFh	86h		—	Set Features: Disable Power-Up In Standby feature set
99h	—	—	Sleep	EFh	8Ah		—	Set Features: Disable CFA power mode
A0h	—	—	Packet	EFh	8Bh		—	Set Features: Disable Write-Read-Verify feature set
A1h			Identify Packet Device	Efh	90h	01h		Set Features: Disable use of Serial ATA feature.
A2h	—	—	Service	Efh	90h	02h	Y	Set Features: Disable DMA Setup FIS Auto-Activate optimization.
B0h	D0h	Y	SMART: Read Data	EFh	90h	03h	Y	Set Features: Disable Device-initiated interface power state (DIPM) transitions.
B0h	D1h	Y	SMART: Read Attribute Thresholds	EFh	90h	04h	—	Set Features: Disable use of Serial ATA feature.
B0h	D2h	Y	SMART: Enable/disable Autosave	EFh	90h	05h	-	Set Features: Disable use of Serial ATA feature

Table 10 ATA Command Description *(continued)*

Op-Code		Support	Command Description	Op-Code			Support	Command Description
B0h	D3h	Y	SMART: Save Attribute Values	EFh	90h	06h	Y	Set Features: Disable Software Settings Preservation (SSP)
B0h	D4h	Y	SMART: Execute Off-line Immediate	EFh	90h	07h	Y	Set Features: Disable Device Automatic Partial to Slumber transitions
B0h	D5h	Y	SMART: Read Log	EFh	90h	09h	O	Set Features: Disable Device Sleep
B0h	D6h	Y	SMART: Write Log	EFh	AAh		Y	Set Features: Enable read look-ahead feature
B0h	D8h	Y	SMART: Enable Operations	EFh	BBh		-	Set Features: Default ECC byte
B0h	D9h	Y	SMART: Disable Operations	EFh	C2h		-	Set Features: Disable Automatic Acoustic Management feature set
B0h	DAh	Y	SMART: Return Status	EFh	C3h		-	Set Features: Enable/Disable the Sense Data Reporting feature set
B0h	DBh	Y	SMART: Enable/disable Automatic Off-line	EFh	CCh		Y	Set Features: Enable reverting to power-on defaults
B0h	E0h	-	SMART: Vendor specific	EFh	DDh		-	Set Features: Disable release interrupt
B1h	C0h	Y	DEVICE CONFIGURATION: Restore	EFh	DEh		-	Set Features: Disable SERVICE interrupt
B1h	C1h	Y	DEVICE CONFIGURATION: Freeze Lock	EFh	DFh		-	Set Features: Disable NDRQ Feature
B1h	C2h	Y	DEVICE CONFIGURATION: Identify	F1h			Y	Security Set Password
B1h	C3h	Y	DEVICE CONFIGURATION: Set	F2h			Y	Security Unlock
B1h	C4h	Y	DEVICE CONFIGURATION: Identify DMA	F3h			Y	Security Erase Prepare
B1h	C5h	Y	DEVICE CONFIGURATION: Set DMA	F4h			Y	Security Erase Unit
B4h	0000 h	O	SANITIZE DEVICE: Sanitize Status Ext	F5h			Y	Security Freeze Lock
B4h	0011 h	O	SANITIZE DEVICE: Crypto Scramble Ext	F6h			Y	Security Disable Password
B4h	0012 h	O	SANITIZE DEVICE: Block Erase Ext	F8h			Y	Read Native Max Address
B4h	0014 h	O	SANITIZE DEVICE: Overwrite Ext	F9h	00h		Y	SET MAX: Set Max Address
B4h	0020 h	O	SANITIZE DEVICE: SANITIZE FREEZE LOCK EXT	F9h	01h		Y	SET MAX: SET MAX PASSWORD
B4h	0040 h	O	SANITIZE DEVICE: SANITIZE ANTIFREEZE LOCK EXT	F9h	02h		Y	SET MAX: SET MAX LOCK
B6h	00h	-	NV Cache: SET NV CACHE POWER MODE EXT	F9h	03h		Y	SET MAX: SET MAX UNLOCK
B6h	01h	-	NV Cache: RETURN FROM NV CACHE POWER MODE EXT	F9h	04h		Y	SET MAX: SET MAX FREEZE LOCK
B6h	10h	-	NV Cache: ADD LBA(S) TO NV CACHE PINNED SET DMA EXT	F9h	05h		Y	SET MAX: SET MAX SET PASSWORD DMA
B6h	11h	-	NV Cache: REMOVE LBA(S) FROM NV CACHE PINNED SET DMA EXT	F9h	06h		Y	SET MAX: SET MAX UNLOCK DMA

6. SMART Support

The FireCuda 120 SSD supports the SMART command set.

6.1 SMART ID

The following table lists SMART IDs and Descriptions.

Table 11 SMART Attribute IDs and Descriptions

Description	0	1	2	3	4	5	6	7	8	9	10	11	Threshold
	ID	Flag		Value	Worse	DATA							
Number of Accumulation of Uncorrectable Error	01h	0Bh	00h	64h	64h	UNC error count from Host		0	0	0	0	0	32h
Power-On hours Count	09h	12h	00h	64h	64h	Power on hour		0	0	0	0	0	00h
Drive Power Cycle Count	0Ch	12h	00h	64h	64h	Power on/off cycles				0	0	0	00h
Spare Blocks Available	10h	12h	00h	64h	64h	Spare Blocks Available by plane		0	0	0	0	0	00h
Remaining Spare Blocks	11h	12h	00h	64h	64h	Remaining Spare Blocks by plane		0	0	0	0	0	00h
SATA PHY Error Count	A8h	12h	00h	64h	64h	SATA PHY error count				0	0	0	00h
Bad Block Count (Early / Later)	AAh	03h	00h	Note[a]		Early Bad Block count by all plane		0	0	Later Bad Block count by all plane		0	0Ah
Erase count (average, max, erase count)	ADh	12h	00h	64h	64h	Max Erase Count		Average Erase Count		Least Erase Count		0	00h
Unexpected Power Loss count	AEh	12h	00h	64h	64h	Number of accidental power loss count				0	0	0	00h
Wear Range delta	B1h	00h	00h	00h	00h	Note[b]	0	0	0	0	0	0	00h
Unexpected Power Loss Count	C0h	12h	00h	64h	64h	number of accidental power loss count				0	0	0	00h
Temperature (only Toshiba or thermo sensor embedded)	C2h	23h	00h	127-Curre nt Temp	127-Highest value	Current Temp		Lowest Temp		Highest Temp		0	39h

Table 11 SMART Attribute IDs and Descriptions *(continued)*

Description	0	1	2	3	4	5	6	7	8	9	10	11	Threshold
	ID	Flag		Value	Worse	DATA							
Number of accumulation CRC error (read/write data FIS CRC error)	DAh	0Bh	00h	64h	64h	CRC Error Count				0	0	0	32h
SSD life remaining	E7h	13h	00h	64h	64h	Note[c]	0	0	0	0	Throttling level	0	00h
Read Failure Block Count	E8h	13h	00h	64h	64h	Flash Read Fail Count				Raw Read Error Rate	0	0	00h
Lifetime Writes to Flash (G Unit)	E9h	0Bh	00h	64h	64h	Lifetime Writes to Flash by GByte						0	00h
Lifetime Writes to Flash (Sector Unit)	EBh	0Bh	00h	64h	64h	Lifetime Writes to Flash by Sector						0	00h
NAND read (Sectors)	EAh	0Bh	00h	64h	64h	NAND read (Sectors)						0	00h
Host Writes (G Unit)	F1h	12h	00h	64h	64h	Lifetime Writes from Host by Gbyte						0	00h
Host Reads (G Unit)	F2h	12h	00h	64h	64h	Lifetime Reads from Host by Gbyte						0	00h

a. Bad Block Count (Early / Later) ID170. Value = (Remaining Spare Blocks by plane)/(Spare Blocks Available by plane) *100. This formula calculates percentage of spare block. Value is between 100 and 0.

b. Wear Range Delta ID 177. Value = (max erase count - least erase count) / (P-E Cycle) *100 (percentage).

c. SSD Life Remaining ID 231. Value = 100 - ((average erase count / Rated PE Cycle) * 100).

7. Feature Details

7.1 Flash Management

7.1.1 Error Correction Code (ECC)

Flash memory cells deteriorate with use, which might generate random bit errors in the stored data. The FireCuda 120 SSD applies the 340 bit/2 KB LDPC (Low Density Parity Check) of ECC algorithm, which detects and corrects errors that occur during read process, ensures data is read correctly, and protects data from corruption.

7.1.2 Wear Leveling

NAND flash devices can undergo only a limited number of program/erase cycles. Commonly, areas of the flash media are not used evenly. If some areas are updated more frequently than others, this reduces the lifetime of the device. Wear Leveling extends the life of the NAND Flash by evenly distributing write and erase cycles across the media.

Seagate's advanced Wear Leveling algorithm spreads the flash usage throughout the whole flash media area. Implementing dynamic and static Wear Leveling algorithms improves the life expectancy of the NAND flash.

7.1.3 Bad Block Management

Bad blocks do not function properly and they can contain more invalid bits. This can make stored data unstable and bad block reliability is not guaranteed. Blocks identified and marked as bad by the manufacturer are called "Early Bad Blocks". Bad blocks that develop during the lifespan of the Flash are called "Later Bad Blocks". Seagate's bad block management algorithm detects the factory-produced bad blocks and manages bad blocks that appear with use. This practice prevents data from being stored in bad blocks and improves data reliability

7.1.4 TRIM

The TRIM feature improves the read/write performance and speed of SSDs. SSDs cannot overwrite existing data, so the available space becomes smaller with each data block use. The TRIM command tells the SSD (through the operating system) which data blocks can be removed permanently because they are no longer in use. The SSD erases these unused data blocks.

7.1.5 SMART

SMART, stands for Self-Monitoring, Analysis, and Reporting Technology, is an open standard that allows an SSD to automatically detect its health and report potential failures. When SMART records a failure, users can replace the drive to prevent unexpected outage or data loss. SMART can also inform users of impending failures while there is still time to copy data to another device.

7.1.6 Over Provisioning

Over Provisioning (OP) preserves an additional area beyond user capacity in a SSD, which is not visible to users and cannot be used by them. 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.

7.1.7 Firmware Upgrade

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

7.1.8 Thermal Throttling

The purpose of thermal throttling is to prevent any components in a SSD from over-heating during read and write operations. the FireCuda 120 SSD is designed with 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 12 reading.

7.1.9 Low Power Management

7.1.9.1 DIPM/HIPM/DEVSLP Mode

SATA interfaces contain two low power management states for power saving: Partial and Slumber modes. For Partial mode, the device has to resume to full operation within 10 microseconds, whereas the device will spend 10 milliseconds to become fully operational in the Slumber mode. SATA interfaces allow low power modes to be initiated by Host (HIPM, Host Initiated Power Management) or Device (DIPM, Device Initiated Power Management). As for HIPM, Partial or Slumber mode can be invoked directly by the software. For DIPM, the device will send requests to enter Partial or Slumber mode.

7.2 Advanced Device Security Features

7.2.1 Secure Erase

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

7.2.2 SSD Lifetime Management

Total Bytes Written (TBW)

TBW measures the lifespan of the SSD. This measurement represents the amount of data written to the device. To calculate the TBW of a SSD, use the following equation:

TBW = [(NAND Endurance) x (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 218/219 workload.

7.2.3 Media Wear Indicator

Actual life indicator reported by SMART Attribute 231 (E7h) Life Remaining by percentage, recommends User to replace drive before reaching 0%.

7.2.4 Read Only Mode (End of Life)

When the SSD is aged by program/erase cycles, media wear-out may cause increasing numbers of bad blocks. When the number of usable good blocks falls outside a defined usable range, the drive notifies the host through AER event and Critical Warning to enter Read Only Mode to prevent further data corruption. When this happens, the user should replace the SSD with another one immediately.

7.3 Adaptive Approach to Performance Tuning

7.3.1 Throughput

Based on the available space of the disk, the FireCuda 120 SSD regulates the read/write speed and manages the performance of throughput. When there is a lot of space, the firmware continuously performs read/write actions. There is no need yet to implement garbage collection to allocate and release memory to accelerate the read/write processing and improve performance. When there is less available space, the SSD slows down the read/write processing and implements garbage collection to release memory.

7.3.2 Predict and Fetch

When the Host tries to read data from the SSD, the SSD performs only one read action after receiving one command. However, the FireCuda 120 SSD applies Predict and Fetch to improve the read speed. When the host issues sequential read commands to the SSD, the SSD automatically expects that the following is also read commands. Therefore, before receiving the next command, flash has already prepared the data. This accelerates data processing time, and the host needs to wait less time to receive data.

7.3.3 SLC Caching

The FireCuda 120 SSD firmware design adopts dynamic caching to deliver better performance, endurance and user experience.

8. Safety, Standards, and Compliance

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

NOTE ***The most up to date information on Safety, Standards, and Compliance for this product is available in the Seagate HDD and SSD Regulatory Compliance and Safety document. You can find this document here:***
https://www.seagate.com/files/www-content/forms/compliance/100860164_B.pdf

8.1 Regulatory Model Numbers

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

- STA022

8.2 Reference Documents

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

Table 12 Reference Documents

Date	Title
Apr. 2007	SATA-IO Commands for ATA-8
Feb. 2011	*Solid-State Drive (SSD) Requirements and Endurance Test Method(JESD218A)*
Jul. 2011	Serial ATA Revision 3.1
Jul. 2011	IDEMA (LBA1-03_standard.doc)
Jul. 2012	SOLID-STATE DRIVE (SSD) Endurance Workload(JESD219A)
Oct. 2013	ATA/ATAPI Command Set -2 (ACS-3) Revision 5

Seagate Technology LLC
AMERICAS Seagate Technology LLC 47488 Kato Road, Fremont, California 94538, United States, 510-661-1000
ASIA/PACIFIC Seagate Singapore International Headquarters Pte. Ltd. 7000 Ang Mo Kio Avenue 5, Singapore 569877, 65-6485-3888
EUROPE, MIDDLE EAST AND AFRICA Seagate Technology (Netherlands) B.V. Koolhovenlaan 1, 1119 NB Schiphol-Rijk, Netherlands, 31-20-316-7300
Publication Number: 100867394, Rev B
May 2020