2.5" SATA 6Gbps PM893

SAMSUNG Solid State Drive

Datasheet

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SATA SSD
MZ7L3240HCHQ-00A07 MZ7L3960HCJR-00A07   MZ7L33T8HBLT-00A07
MZ7L3480HCHQ-00A07 MZ7L31T9HBLT-00A07   MZ7L37T6HBLA-00A07

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Revision History

Revision No.	History	Draft Date	Remark	Editor	Review by
1.0	1. Initial release.	Apr. 06. 2021	Final	S.M.Lee	H.I.Choi

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SAMSUNG Solid State Drive PM893 Features

Part Number	Capacity[1]
MZ7L3240HCHQ-00A07	240GB
MZ7L3480HCHQ-00A07	480GB
MZ7L3960HCJR-00A07	960GB
MZ7L31T9HBLT-00A07	1920GB
MZ7L33T8HBLT-00A07	3840GB
MZ7L37T6HBLA-00A07	7680GB

FEATURES
· SATA 6Gbps
· 2.5" 7mmT
· Fully Complies with ATA/ATAPI-7 Standard
· Hardware based AES 256-bit Encryption Engine (optional)
· Support NCQ (up to 32 depth) Command Set
· Support TRIM Command
· RoHS Compliant

PERFORMANCE
· Data Transfer Rate

  - Sequential Read   Up to 520 MB/s[2]

  - Sequential Write   Up to 500 MB/s[2]

  - Random Read (8KB)   Up to 57 KIOPS[3]

  - Random Write (8KB)   Up to 12 KIOPS[3]

  - Random Read (4KB)   Up to 97 KIOPS[3]

  - Random Write (4KB)   Up to 26 KIOPS[3]

· IOPS Consistency (Read/Write @4KB)   95 / 90%
· Latency (Read @4KB, QD1)   120us
· Latency (Write @4KB, QD1)   (240GB) 70us
     45us

· Quality of Service(99.99%)
  - Read (4KB, QD=1)   0.5 ms
  - Write (4KB, QD=1)   0.3 ms
  - Read (4KB, QD=32)   0.9 ms
  - Write (4KB, QD=32)   3.2 ms

RELIABILITY
· Non-recoverable Read Error   1 sector per 10^{17} bits read
· MTBF   2,000,000 hours
· TBW

     (7680GB) 14,016 TB
     (3840GB) 7,008 TB
     (1920GB) 3,504 TB
     (960GB) 1,752 TB
     (480GB) 876 TB
     (240GB) 438 TB

ENVIRONMENTAL SPECIFICATIONS[4]
· Temperature
  - Operating   0 ~ 70 °C
  - Non-operating   -40 ~ 85 °C
· Humidity (non-condensing)   5 ~ 95%
  - Linear Shock (0.5ms duration with half sine wave)
    - Non-operating   1,500G
  - Vibration (20Hz to 2,000Hz, 4min/cycle, 4cycle/axis on 3axis)
    - Non-operating   20G

POWER REQUIREMENTS [5] [6]
· Supply Voltage   +5V ± 5%
· Voltage Ripple/Noise (max.)   100mV p-p
· Active (Read) (Typ.)   2.1 W
· Active (Write) (Typ.)   3.2 W
· Idle (Typ.)   1.3 W

PHYSICAL DIMENSION
· Width   100.20 ± 0.25 mm
· Depth   69.85 ± 0.25 mm
· Height   7.00 ± 0.00/-0.50 mm
· Weight   Up to 70 g

NOTE: Specifications are subject to change without notice.

1) 1MB = 1,000,000 Bytes, 1GB = 1,000,000,000 Bytes, Unformatted Capacity. User accessible capacity may vary depending on operating environment and formatting.
2) Performance measured using FIO 2.7 with queue depth 32, Z170 Intel SATA 6G port. Measurements are performed on whole LBA range. Write cache enabled. Performance vary depending on capacity
3) 1 MB/sec = 1,000,000 bytes/sec was used in sequential performance.
4) Operating Temperature (0 ~ 70°C / Tc) is measured at the hottest point on the case. Sufficient airflow is recommended to be operated properly on heavier workloads wthin device operating temperature.
5) Active Read power is measured on 4 KB random read.
    Active Write power is measured on 4 KB random write.
6) Idle power is measured with DIPM off.

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1.0 INTRODUCTION

1.1 General Description

This document describes the specification of the PM893 SSD which use SATA 6Gb/s interface. PM893 are fully consist of semiconductor device and using NAND Flash Memory which has a high reliability and a high technology for a storage media. As the SSD doesn't have a moving parts such as platter (disk) and head media, it gives a good solution for a storage device with a high performance, high capacity.

PM893 delivers 520MB/s for sequential read and 500MB/s for sequential write speed under up to 3.2W power.

1.2 Product List

Form factor	Density	Part Number
2.5" 7mmT	240GB	MZ7L3240HCHQ-00A07
	480GB	MZ7L3480HCHQ-00A07
	960GB	MZ7L3960HCJR-00A07
	1.92TB	MZ7L31T9HBLT-00A07
	3.84TB	MZ7L33T8HBLT-00A07
	7680GB	MZ7L37T6HBLA-00A07

1.3 Ordering Information

M Z X X X X X X X X X X - X X X X X
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

1. Memory (M)

2. Module Classification
Z: SSD

3. Form Factor
7: 2.5" 7mmT SATA

4. Line-Up
L : Client/SV (VNAND 3bit MLC)

5. SSD CTRL
3: Metis

6~8. SSD Density
7T6: 7.68TB
3T8: 3.84TB
1T9: 1.92TB
960: 960 GB
480: 480GB
240: 240GB

9. NAND PKG
H: BGA (LF,HF)

10. Flash Generation
B : 3rd Generation
C : 4th Generarion

11~12. NAND Density
HQ: 1T QDP 4CE
JR : 2T ODP 2CE (FBI)
LT : 4T ODP 2CE (FBI)
LA : 8T HDP 2CE (FBI)

13. " - "

14. Default
"0"

15. HW revision
A: General

16. Packing type
A: General

17~18. Customer
07 : Generals

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2.0 PRODUCT SPECIFICATIONS

2.1 Interface and Compliance

- - SATA 3.3 6.0Gbps
- - Fully compatible with ATA/ATAPI-7 Standard
- - Compatible with ATA/ATAPI-8 ACS4 Mandatory Command
- - Native Command Queuing (NCQ) Command Set
- - Support Data Set Management Command

2.2 Drive Capacity

[Table 1] User Capacity and Addressable Sectors

	240GB	480GB	960GB	1.92TB	3.84TB	7.68TB
User-Addressable Sectors	468,862,128	937,703,088	1,875,385,008	3,750,748,848	7,501,476,528	15,002,931,888
Bytes per Sector	512 Bytes					

NOTE:
1. Megabyte (MB) = 1 Million bytes; 1 Gigabyte (GB) = 1 Billion bytes
2. Actual usable capacity may be less (due to formatting, partitioning, operating system, applications or otherwise).

2.3 Performance

[Table 2] Sequential Read / Write Performance

Read / Write	240GB	480GB	960GB	1.92TB	3.84TB	7.68TB
Sequential Read (128 KB)	520MB/s	520MB/s	520MB/s	520MB/s	520MB/s	520MB/s
Sequential Write (128 KB)	300MB/s	500MB/s	500MB/s	500MB/s	500MB/s	500MB/s

[Table 3] Sustained Random Read / Write Performance

Read / Write	240GB	480GB	960GB	1.92TB	3.84TB	7.68TB
Random Read IOPS (8 KB)	57K	57K	57K	57K	57K	57K
Random Write IOPS (8 KB)	4.9K	8.5K	12K	17K	19K	19K
Random Read IOPS (4 KB)	97K	97K	97K	97K	97K	97K
Random Write IOPS (4 KB)	10K	20K	26K	26K	26K	26K

NOTE:
1) Actual performance may vary depending on use conditions and environment.
2) Performance measured using FIO 2.7 with queue depth 32, Z170 Intel SATA 6G port.
3) Measurements are performed on whole LBA range.
4) Write cache enabled.
5) 1 MB/sec = 1,000,000 bytes/sec was used in sequential performance.

[Table 4] IOPS Consistency

IOPS Consistency	240GB	480GB	960GB	1.92TB	3.84TB	7.68TB
Random Read (4 KB)	98%	98%	98%	98%	98%	98%
Random Write (4 KB)	90%	90%	90%	90%	90%	90%

NOTE:
1) IOPS consistency measured using FIO with queue depth 32.
2) IOPS Consistency (%) = (99.9% IOPS) / (Average IOPS) x 100.

[Table 5] Latency

Latency	240GB	480GB	960GB	1.92TB	3.84TB	7.68TB
Read (4 KB)	120us	120us	120us	120us	120us	120us
Write (4 KB)	70us	45us	45us	45us	45us	45us

NOTE:
1) Latency is measured using FIO with queue depth 1 on 4KB random and write

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[Table 6] Quality of Service (QoS)

Quality of Service (99%)	240GB	480GB	960GB	1.92TB	3.84TB	7.68TB
Read (4 KB, QD=1)	0.25 ms	0.25 ms	0.25 ms	0.25 ms	0.25 ms	0.25 ms
Write (4 KB, QD=1)	0.15 ms	0.15 ms	0.15 ms	0.15 ms	0.15 ms	0.15 ms
Read (4 KB, QD=32)	1.5 ms	0.5 ms	0.5 ms	0.5 ms	0.5 ms	0.5 ms
Write (4 KB, QD=32)	2.7 ms	2.7 ms	2.7 ms	2.7 ms	2.7 ms	2.7 ms
Quality of Service (99.99 %)	**240GB**	**480GB**	**960GB**	**1.92TB**	**3.84TB**	**7.68TB**
Read (4 KB, QD=1)	0.5 ms	0.5 ms	0.5 ms	0.5 ms	0.5 ms	0.5 ms
Write (4 KB, QD=1)	0.3 ms	0.3 ms	0.3 ms	0.3 ms	0.3 ms	0.3 ms
Read (4 KB, QD=32)	2 ms	0.9 ms	0.9 ms	0.9 ms	0.9 ms	0.9 ms
Write (4 KB, QD=32)	3.2 ms	3.2 ms	3.2 ms	3.2 ms	3.2 ms	3.2 ms

NOTE:
1) QoS is measured using FIO 2.7 (99 and 99.99%) in Linux RHEL 6.5 (Kernel 2.6.32) with queue depth 1, 32 on 4KB random read and write.
2) QoS is measured as the maximum round-trip time taken for 99 and 99.99% of commands to host.

2.4 Supply Voltage

[Table 7] Supply Voltage

Item	Requirements
Allowable voltage	5.0 V ± 5%
Allowable noise / ripple	100 mV p-p or less

NOTE:
1) The measurement value of inrush current is also compatible with the standard specification of "Enterprise SSD Form Factor Version 1.0a"

[Table 8] Power Consumption

Read/Write	240GB	480GB	960GB	1.92TB	3.84TB	7.68TB
Active Write[1] (Typ.)	2.7W	3.2W	3.2W	3.2W	3.2W	3.2W
Active Read[2] (Typ.)	2.1W	2.1W	2.2W	2.2 W	2.2W	2.2W
Idle[3]	1.5W	1.5W	1.5W	1.5W	1.5W	1.5W

NOTE:
1) The measurement value of inrush current is also compatible with the standard specification of "Enterprise SSD Form Factor Version 1.0a" released by SSD Form Factor Working Group.

[Table 9] Inrush Current

Parameter	Requirements
Inrush Current	1.2A, <1sec

NOTE:
1) The measurement value of inrush current is also compatible with the standard specification of "Enterprise SSD Form Factor Version 1.0a" released by SSD Form Factor Working Group.

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2.5 Reliability

The reliability specification of the Samsung SSD PM893 follows JEDEC standard, which are included in JESD218 and JESD219 documents.

2.5.1 Mean Time Between Failures

MTBF is Mean Time Between Failure, and is the predicted elapsed time between inherent failures of a system during operation. MTBF can be calculated as the arithmetic average time between failures of a system.

[Table 10] MTBF Specifications

Parameter	240GB	480GB	960GB	1.92TB	3.84TB	7.68TB
MTBF			2,000,000 Hours			

NOTE:
1) MTBF is Mean Time Between Failure. As same word, annual failure ratio is 0.438%.

2.5.2 Uncorrectable Bit Error Rate

By definition, Uncorrectable Bit Error Rate (UBER) is a metric for the rate of occurrence of data errors, equal to the number of data errors per bits read as specified in the JESD218 document of JEDEC standard.

[Table 11] UBER Specifications

Parameter	240GB	480GB	960GB	1.92TB	3.84TB	7.68TB
UBER			1 sector per 10^{17} bits read			

2.5.3 Data Retention

By definition, data retention is the expected time period for retaining data in the SSD at the maximum rated endurance in power-off state as specified in the JESD218 document of JEDEC standard.

[Table 12] Data Retention Specifications

Parameter	240GB	480GB	960GB	1.92TB	3.84TB	7.68TB
Data Retention			3months			

NOTE:
1) Data retention was measured by assuming that SSD reaches the maximum rated endurance at 40'C in power-off state.

2.5.4 Endurance

By definition, the endurance of SSD in enterprise application is defined as the maximum number of drive writes per day that can meet the requirements specified in the JESD218 document of JEDEC standard.

[Table 13] Drive Write Per Day (DWPD) Specifications

Parameter	240GB	480GB	960GB	1.92TB	3.84TB	7.68TB
DWPD			1 drive writes per day over 5 years			

[Table 14] TBW (TeraBytes Written) Specifications

Parameter	240GB	480GB	960GB	1.92TB	3.84TB	7.68TB
TBW	438 TB	876 TB	1,752 TB	3,504 TB	7,008 TB	14,016 TB

NOTE:
1) TBW is measured while running 100 % random 4 KB writes across the entire SSD. (TBW = DWPD x 365 x 5 x User capacity).

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2.6 Environmental Specifications

2.6.1 Temperature

[Table 15] Environmental Specifications

Features		240GB	480GB	960GB	1.92TB	3.84TB	7.68TB
Temperature	Operating[1]	0 °C to 70 °C					
	Non-Operating	-40 °C to 85 °C					

NOTE:
1) Operating Temperature of the hottest point on the case (Tc). The drive will be working properly within the operating temperature range without deteriorating device reliability or any throttling. Sufficient airflow would be recommended to be operated properly on any heavier workloads within device operating temperature.
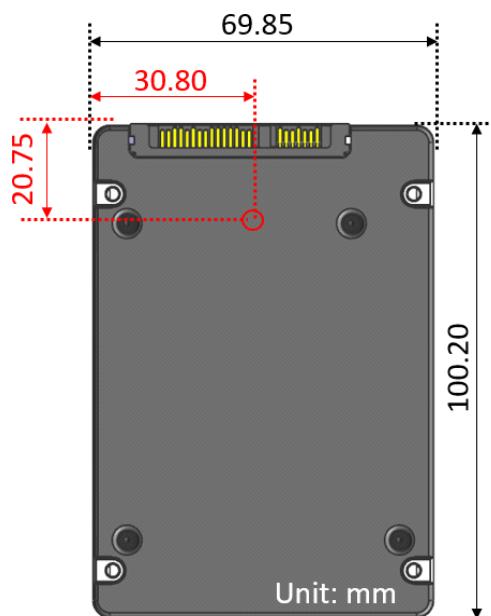

Figure 1. Tcase point

2.6.2 Dynamic Thermal Throttling

The dynamic thermal throttling (DTT) is implemented to prevent overheating. Table 16 shows the engaging and recovery temperature thresholds.

2.6.2.1 DTT Table

[Table 16] Dynamic Thermal throttling

Step	Engaging temperature[1,2]	Dis-engaging temperature	Performance[3]
DTT1	81°C	80°C	<90%
DTT2	83°C	82°C	<50%
DTT3	84°C	83°C	<25%
Critical (DTT4)	85°C	84°C	<1%
Shut-down[4]	95°C	N/A	N/A

NOTE:
1) All temperatures are based on $T_{composite}$ values
2) Recovering to the previous step as the temperature falls.
3) Throttling levels could be varying with workloads.
4) Hanged/Halted. Recovering after power cycle.

2.6.2.2 Composite Temperature (Tcomposite)

The $T_{composite}$ is defined by the correlation equations as the below.

$$T_{composite}=TS$$

Where, TS means the temperature of reading in the thermal sensor on SSD.

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2.6.3 Humidity

[Table 17] Humidity Specifications

Parameter		240GB	480GB	960GB	1.92TB	3.84TB	7.68TB
Humidity [1]	Non-Operating			5 to 95%			

NOTE:
1) Humidity is measured in non-condensing state

2.6.4 Shock and Vibration

[Table 18] Shock and Vibration Specifications

Parameter		240GB	480GB	960GB	1.92TB	3.84TB	7.68TB
Shock[1]	Non-Operating			1500G			
Vibration[2]	Non-Operating			20G			

NOTE:
1) Test condition for shock : 0.5ms duration with half sine wave
2) Test condition for vibration : 20Hz to 2,000Hz, 4min/cycle, 4cycle/axis on 3 axis

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3.0 MECHANICAL SPECIFICATION

[Table 19] Physical Dimensions and Weight

Model	Height (mm)	Width (mm)	Length (mm)	Weight (gram)
240/480/960GB 1.92/3,84/7.68TB	7.00 ±0.00 / -0.50	69.85 ± 0.25	100.20 ± 0.25	Up to 90g
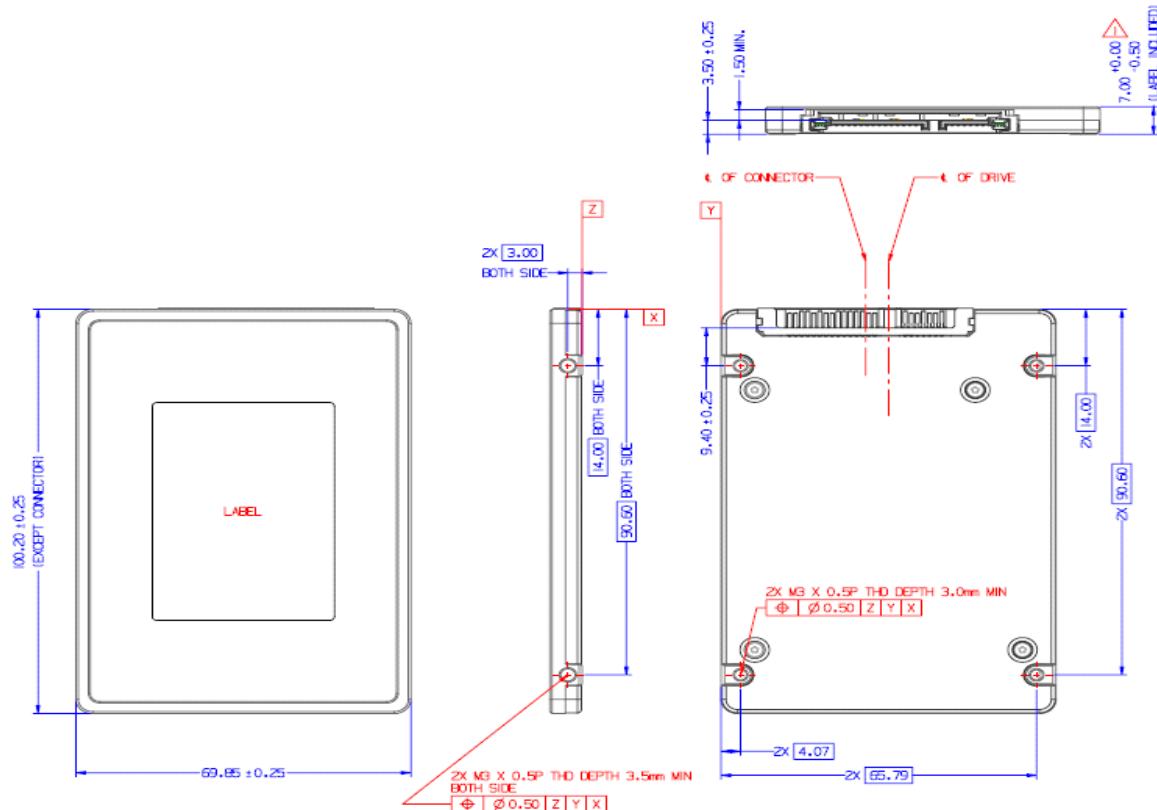
Figure 2. Physical Dimension

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# 4.0 ELECTRICAL INTERFACE SPECIFICATION

4.1 Serial ATA Interface Connector
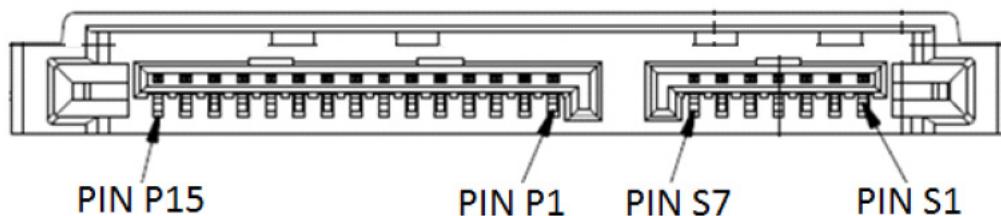
Figure 3. Drive Plug Connector

4.2 Pin Assignments

[Table 20] Pin Assignments

Word	No.	Plug Connector Pin definition	
Signal	S1	GND	2nd mate
	S2	A +	Differential signal A from Phy
	S3	A -	
	S4	GND	2nd mate
	S5	B -	Differential signal B from Phy
	S6	B +	
	S7	GND	2nd mate
Key and spacing separate signal and power segments			
Power	P1	Retired	3rd Mate
	P2	Retired	3rd Mate
	P3	DEVSLP/PWDIS	2nd mate (Not Support DEVSLP)
	P4	GND	1st mate
	P5	GND	2nd mate
	P6	GND	2nd mate
	P7	V5	5 V power, pre-charge, 2nd mate
	P8	V5	5 V power
	P9	V5	5 V power
	P10	GND	2nd mate
	P11	DAS / DSS	Device Activity Signal
	P12	GND	1st mate
	P13	V12	12 V power, pre-charge, 2nd mate (Unused)
	P14	V12	12 V power (Unused)
	P15	V12	12 V power (Unused)

NOTE:
1. Uses 5 V power only. 3.3 V and 12 V power are not used

4.3 P3 Electrical Specification

Parameter	Value	Parameter	Value
Absolute Maximum Input Voltage	3.6V	VIH(HIGH Level Input Voltage)	2.03V
VIL(LOW Level Input Voltage)	1.98V	Deglitch Time	50us

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5.0 COMMAND DESCRIPTIONS

5.1 Supported ATA Commands

[Table 21] Supported ATA Commands Summary

Command Name	Command Code (Hex)	Command Name	Command Code (Hex)
CHECK POWER MODE	E5h / 98h	SEND FPDMA QUEUED	64h
DEVICE CONFIGURATION	B1h	SET DATE N TIME	77h
DOWNLOAD MICROCODE	92h	SET FEATURES	EFh
DOWNLOAD MICROCODE DMA	93h	SET MAX ADDRESS	F9h
EXECUTE DEVICE DIAGNOSTIC	90h	SET MAX ADDRESS EXT	37h
FLUSH CACHE	E7h	SET MULTIPLE MODE	C6h
FLUSH CACHE EXT	EAh	SLEEP	E6h / 99h
IDENTIFY DEVICE	ECh	S.M.A.R.T.	B0h
IDLE	E3h / 97h	STANDBY	E2h / 96h
IDLE IMMEDIATE	E1h / 95h	STANDBY IMMEDIATE	E0h / 94h
INITIALIZE DEVICE PARMETERS	91h	TRIM	06h
READ BUFFER	E4h	WRITE BUFFER	E8h
READ BUFFER DMA	E9h	WRITE BUFFER DMA	EBh
READ DMA	C8h	WRITE DMA	CAh
READ DMA (w/o retry)	C9h	WRITE DMA (w/o retry)	CBh
READ DMA EXT	25h	WRITE DMA EXT	35h
READ FPDMA QUEUED	60h	WRITE DMA FUA EXT	3Dh
READ LOG DMA EXT	47h	WRITE FPDMA QUEUED	61h
READ LOG EXT	2Fh	WRITE LOG DMA EXT	57h
READ MULTIPLE	C4h	WRITE LOG EXT	3Fh
READ MULTIPLE EXT	29h	WRITE MULTIPLE	C5h
READ NATIVE MAX ADDRESS	F8h	WRITE MULTIPLE EXT	39h
READ NATIVE MAX ADDRESS EXT	27h	WRITE MULTIPLE FUA EXT	CEh
READ SECTORS	20h	WRITE SECTORS	30h
READ SECTORS (w/o retry)	21h	WRITE SECTORS (w/o retry)	31h
READ SECTORS EXT	24h	WRITE SECTORS EXT	34h
READ VERIFY SECTORS	40h	WRITE UNCORRECTABLE EXT	45h
READ VERIFY SECTORS (w/o retry)	41h	TRUSTED NON DATA	5Bh
READ VERIFY SECTORS EXT	42h	TRUSTED RECEIVE	5Ch
RECALIBRATE	10h	TRUSTED RECEIVE DMA	5Dh
NCQ NONDATA	63h	TRUSTED SEND	5Eh
SANITIZE DEVICE	B4h	TRUSTED SEND DMA	5Fh
SECURITY DISABLE PASSWORD	F6h		
SECURITY ERASE PREPARE	F3h		
SECURITY ERASE UNIT	F4h		
SECURITY FREEZE LOCK	F5h		
SECURITY SET PASSWORD	F1h		
SECURITY UNLOCK	F2h		
SEEK	70h		

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5.2 Individual Attribute Data Structure

The following defines the 12 bytes that make up the information for each Attribute entry in the Device Attribute Data Structure.

[Table 22] Attribute Entry in Device Attribute Data Structure

Byte	Descriptions
0	Attribute ID number 01-FFh
1 - 2	Status flag bit 0 (pre-failure / advisory bit) bit 0 = 0: If attribute value is less than the threshold, the drive is in advisory condition. Product life period may expired. bit 0 = 1: If attribute value is less than the threshold, the drive is in pre-failure condition. The drive may have failure. bit 1 (on-line data collection bit) bit 1 = 0: Attribute value will be changed during off-line data collection operation. bit 1 = 1: Attribute value will be changed during normal operation. bit 2 (Performance Attribute bit) bit 3 (Error rate Attribute bit) bit 4 (Event Count Attribute bit) bit 5 (Self-Preserving Attribute bit) bit 6 - 15 Reserved
3	Attribute value 01h - FDh *1 00h, FEh, FFh = Not in use 01h = Minimum value 64h = Initial value Fdh = Maximum value
4	Worst Ever normalized Attribute Value (valid values from 01h - FEh)
5 - 10	Raw Attribute Value Attribute specific raw data (FFFFFFh - reserved as saturated value)
11	Reserved (00h)
*1 For ID = 199 CRC Error Count	

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The device supports following Attribute ID Numbers.

[Table 23] SMART Attributes

ID (Word)	Attribute Name	Status Flag	Threshold (%)
5	Reallocated Sector Count	110011	10
9	Power-on Hours	110010	-
12	Power-on Count	110010	-
177	Wear Leveling Count	010011	5
179	Used Reserved Block Count (total)	010011	10
180	Unused Reserved Block Count (total)	010011	10
181	Program Fail Count (total)	110010	10
182	Erase Fail Count (total)	110010	10
183	Runtime Bad Count (total)	010011	10
184	End to End Error data path Error Count	110011	97
187	Uncorrectable Error Count	110010	-
190	Air Flow Temperature	110010	-
194	Temperature	100010	-
195	ECC Error Rate	011010	-
197	Pending Sector Count	110010	-
199	CRC Error Count	111110	-
202	SSD Mode Status	110011	10
235	Power Recovery Count	010010	-
241	Total LBA Written	110010	-
242	Total LBA Read	110010	-
243	SATA Downshift Control	110010	-
244	Thermal Throttle Status	110010	-
245	Timed Workload Media Wear	110010	-
246	Timed Workload Host Read / Write Ratio	110010	-
247	Timed Workload Timer	110010	-
251	NAND Writes	110010	

NOTE:
1. Any nonzero value in the Attribute ID Number indicates an active attribute.

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6.0 IDENTIFY DEVICE DATA

[Table 24] Identify Device Data

Word	240GB	480GB	960GB	1.92TB	3.84TB	7.68TB	General Information
0	0040h	0040h	0040h	0040h	0040h	0040h	Obsolete
1	3FFFh	3FFFh	3FFFh	3FFFh	3FFFh	3FFFh	Obsolete
2	C837h	C837h	C837h	C837h	C837h	C837h	Obsolete
3	0010h	0010h	0010h	0010h	0010h	0010h	Retired
4-5	0000h	0000h	0000h	0000h	0000h	0000h	Obsolete
6	003Fh	003Fh	003Fh	003Fh	003Fh	003Fh	Obsolete
7-8	0000h	0000h	0000h	0000h	0000h	0000h	Reserved for the Compact Flash Association
9	0000h	0000h	0000h	0000h	0000h	0000h	Retired
10-19	XXXXh	XXXXh	XXXXh	XXXXh	XXXXh	XXXXh	Serial Number (ATA string)
20-21	0000h	0000h	0000h	0000h	0000h	0000h	Obsolete
22	0000h	0000h	0000h	0000h	0000h	0000h	Obsolete
23-26	XXXXh	XXXXh	XXXXh	XXXXh	XXXXh	XXXXh	Firmware Revision (ATA string)
27-46	XXXXh	XXXXh	XXXXh	XXXXh	XXXXh	XXXXh	Model Number
47	8010h	8010h	8010h	8010h	8010h	8010h	Read / Write Multiple Support
48	4001h	4001h	4001h	4001h	4001h	4001h	Trusted Computing Feature Set Options
49	2F00h	2F00h	2F00h	2F00h	2F00h	2F00h	Capabilities
50	4000h	4000h	4000h	4000h	4000h	4000h	Capabilities
51-52	0200h	0200h	0200h	0200h	0200h	0200h	Obsolete
53	0007h	0007h	0007h	0007h	0007h	0007h	Obsolete
54	3FFFh	3FFFh	3FFFh	3FFFh	3FFFh	3FFFh	Obsolete
55	0010h	0010h	0010h	0010h	0010h	0010h	Obsolete
56	003Fh	003Fh	003Fh	003Fh	003Fh	003Fh	Obsolete
57	FC10h	FC10h	FC10h	FC10h	FC10h	FC10h	Obsolete
58	00FBh	00FBh	00FBh	00FBh	00FBh	00FBh	Obsolete
59	BD10h	BD10h	BD10h	BD10h	BD10h	BD10h	Multiple Logical Setting
60	FFFFh	FFFFh	FFFFh	FFFFh	FFFFh	FFFFh	Obsolete
61	0FFFh	0FFFh	0FFFh	0FFFh	0FFFh	0FFFh	Obsolete
62	0000h	0000h	0000h	0000h	0000h	0000h	Obsolete
63	0007h	0007h	0007h	0007h	0007h	0007h	Multi-word DMA Transfer
64	0003h	0003h	0003h	0003h	0003h	0003h	PIO Transfer Modes Supported
65	0078h	0078h	0078h	0078h	0078h	0078h	Minimum Multiword DMA Transfer Cycle Time per Word (ns)
66	0078h	0078h	0078h	0078h	0078h	0078h	Manufacturer's Recommended Multiword DMA Cycle Time (ns)
67	0078h	0078h	0078h	0078h	0078h	0078h	Minimum PIO Transfer Cycle Time without IORDY Flow Control (ns)
68	0078h	0078h	0078h	0078h	0078h	0078h	Minimum PIO Transfer Cycle Time with IORDY Flow Control (ns)
69	4F30h	4F30h	4F30h	4F30h	4F30h	4F30h	Additional Supported
70-74	0000h	0000h	0000h	0000h	0000h	0000h	Reserved
75	001Fh	001Fh	001Fh	001Fh	001Fh	001Fh	Queue Dept
76	850Eh	850Eh	850Eh	850Eh	850Eh	850Eh	Serial ATA Capabilities
77	0066h	0066h	0066h	0066h	0066h	0066h	Serial ATA Additional Capabilities
78	0064h	0064h	0064h	0064h	0064h	0064h	Serial ATA Features Supported
79	0060h	0060h	0060h	0060h	0060h	0060h	Serial ATA Features Enabled
80	0FFCh	0FFCh	0FFCh	0FFCh	0FFCh	0FFCh	Major Version Number
81	005Eh	005Eh	005Eh	005Eh	005Eh	005Eh	Minor Version Number
82	746Bh	746Bh	746Bh	746Bh	746Bh	746Bh	Commands and Feature Sets Supported
83	7D01h	7D01h	7D01h	7D01h	7D01h	7D01h	Commands and Feature Sets Supported
84	4163h	4163h	4163h	4163h	4163h	4163h	Commands and Feature Sets Supported or Enabled

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85	7469h	7469h	7469h	7469h	7469h	7469h	Commands and Feature Sets Supported or Enabled
86	BC01h	BC01h	BC01h	BC01h	BC01h	BC01h	Commands and Feature Sets Supported or Enabled
87	4163h	4163h	4163h	4163h	4163h	4163h	Commands and Feature Sets Supported or Enabled
88	407Fh	407Fh	407Fh	407Fh	407Fh	407Fh	Ultra DMA Modes
89	0010h	0010h	0010h	0010h	0010h	0010h	Normal Security Erase Unit Time
90	0010h	0010h	0010h	0010h	0010h	0010h	Enhanced Security Erase Unit Time
91	0000h	0000h	0000h	0000h	0000h	0000h	Advanced Power Management Level
92	FFFEh	FFFEh	FFFEh	FFFEh	FFFEh	FFFEh	Master Password Revision Code
93	0000h	0000h	0000h	0000h	0000h	0000h	Hardware Reset Result
94	0000h	0000h	0000h	0000h	0000h	0000h	Obsolete
95	0000h	0000h	0000h	0000h	0000h	0000h	Stream Minimum Request Size
96	0000h	0000h	0000h	0000h	0000h	0000h	Streaming Transfer Time - DMA
97	0000h	0000h	0000h	0000h	0000h	0000h	Streaming Access Latency - DMA and PIO
98-99	0000h	0000h	0000h	0000h	0000h	0000h	Streaming Performance Granularity (DWord)
100-103	XXXXh	XXXXh	XXXXh	XXXXh	XXXXh	XXXXh	Total Number of User 48-Bit LBA
104	0000h	0000h	0000h	0000h	0000h	0000h	Streaming Transfer Time - PIO
105	0008h	0008h	0008h	0008h	0008h	0008h	Maximum Number of 512-byte Data Blocks of LBA Range Entries per DATA SET MANAGEMENT Command
106	6003h	6003h	6003h	6003h	6003h	6003h	Pysical Sector Size / Logical Sector Size
107	0000h	0000h	0000h	0000h	0000h	0000h	Inter-seek Delay for ISO 7779 Standard Acoustic Testing
108	5002h	5002h	5002h	5002h	5002h	5002h	World Wide Name
109	538Eh	538Eh	538Eh	538Eh	538Eh	538Eh	World Wide Name
110-111	XXXXh	XXXXh	XXXXh	XXXXh	XXXXh	XXXXh	World Wide Name
112-115	0000h	0000h	0000h	0000h	0000h	0000h	Reserved
116	0000h	0000h	0000h	0000h	0000h	0000h	Reserved for TLC
117-118	0000h	0000h	0000h	0000h	0000h	0000h	Logical Sector Size (Dword)
119	401Eh	401Eh	401Eh	401Eh	401Eh	401Eh	Commands and Feature Sets Supported
120	401Ch	401Ch	401Ch	401Ch	401Ch	401Ch	Commands and Feature Sets Supported or Enabled
121-126	0000h	0000h	0000h	0000h	0000h	0000h	Reserved for Expanded Supported and Enabled Settings
127	0000h	0000h	0000h	0000h	0000h	0000h	Obsolete
128	0021h	0021h	0021h	0021h	0021h	0021h	Security Status
129-159	0000h	0000h	0000h	0000h	0000h	0000h	Vendor Specific
160	0000h	0000h	0000h	0000h	0000h	0000h	CFA Power Mode
161-167	0000h	0000h	0000h	0000h	0000h	0000h	Reserved for the Compact Flash Association
168	0007h	0007h	0007h	0007h	0007h	0007h	Device Nominal Form Factor
169	0001h	0001h	0001h	0001h	0001h	0001h	DATA SET MANAGEMENT is Supported
170-173	2020h	2020h	2020h	2020h	2020h	2020h	Additional Product Identifier (ATA string)
174-175	0000h	0000h	0000h	0000h	0000h	0000h	Reserved
176-205	0000h	0000h	0000h	0000h	0000h	0000h	Current Media Serial Number
206	003Dh	003Dh	003Dh	003Dh	003Dh	003Dh	SCT Command Transport
207-208	0000h	0000h	0000h	0000h	0000h	0000h	Reserved for CE-ATA
209	4000h	4000h	4000h	4000h	4000h	4000h	Alignment of Logical Blocks within a Physical Block
210-211	0000h	0000h	0000h	0000h	0000h	0000h	Write-Read-Verify Sector Count Mode 3
212-213	0000h	0000h	0000h	0000h	0000h	0000h	Write-Read-Verify Sector Count Mode 2
214	0000h	0000h	0000h	0000h	0000h	0000h	Obsolete
215-216	0000h	0000h	0000h	0000h	0000h	0000h	Obsolete
217	0001h	0001h	0001h	0001h	0001h	0001h	Nominal Media Rotation Rate
218	0000h	0000h	0000h	0000h	0000h	0000h	Reserved
219	0000h	0000h	0000h	0000h	0000h	0000h	Obsolete
220	0000h	0000h	0000h	0000h	0000h	0000h	Write Read Verify Mode

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221	0000h	0000h	0000h	0000h	0000h	0000h	Reserved
222	10FFh	10FFh	10FFh	10FFh	10FFh	10FFh	Transport Major Version Number
223	0000h	0000h	0000h	0000h	0000h	0000h	Transport Minor Version Number
224-229	0000h	0000h	0000h	0000h	0000h	0000h	Reserved
230-233	0000h	0000h	0000h	0000h	0000h	0000h	Extended Number of User Addressable Sectors
234	0000h	0000h	0000h	0000h	0000h	0000h	Minimum Number of 512-byte Data Blocks per DOWNLOAD MICROCODE Command for Mode 03h
235	1400h	1400h	1400h	1400h	1400h	1400h	Maximum Number of 512-byte Data Blocks per DOWNLOAD MICROCODE Command for Mode 03h
236-242	0000h	0000h	0000h	0000h	0000h	0000h	Reserved
243	4000h	4000h	4000h	4000h	4000h	4000h	FDE Security Features
244-254	0000h	0000h	0000h	0000h	0000h	0000h	Reserved
255	XXA5h	XXA5h	XXA5h	XXA5h	XXA5h	XXA5h	Integrity Word

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7.0 SPOR SPECIFICATION (Sudden Power Off and Recovery)

7.1 Data Recovery in Sudden Power Off

If power interruption is detected, SSD dumps all cached user data and meta data to NAND Flash. SSD could protect even the user data in DRAM from sudden power off while SSD is used with cache on. Commonly, data is protected all of the operation period.

7.2 Time to Ready Sequence

In normal power-off recovery status, SSD needs less than 10 seconds for 240GB to 3.84TB drives and less than 15 seconds for 7.68TB drives to reach operating mode where SSD works perfectly with cache-on state. SSD is ready to respond Identify Device command during FTL OPEN. When the sudden power-off occurs, the user data in DRAM will be dumped into to NAND

Flash using the stored power in the capacitor. In sudden power-off recovery condition, FTL meta data (including mapping data) will be loaded and rebuilt perfectly for initial max. 10 seconds for 240GB to 3.84TB drives and 15 seconds for 7.68TB drives. During this period, Identify Device command is still supported. It is called SPOR (Sudden Power Off and Recovery).
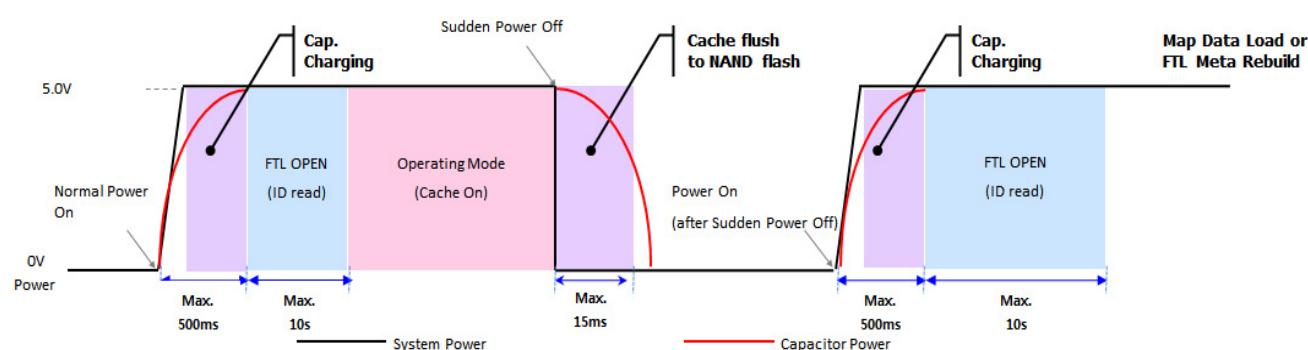

Figure 4. Time to Ready Sequence

[Table 25] Device Ready Time for Normal Read / Write Operation after Sudden Power Off

	240GB	480GB	960GB	1.92TB	3.84TB	7.68TB
Max. Open Time (sec)			10s			15s

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8.0 PRODUCT COMPLIANCE

[Table 26] Certifications and Declarations

Category	Certifications
CE	Comunaute Europeenne
BSMI	Bureau of Standards, Metrology and Inspection
KC	Korea Certification
VCCI	Voluntary Control Council for Interference
RCM	Regulatory Compliance Mark Standards Australia
FCC	Federal Communications Commission
IC	Industry Canada
UL	Underwriters Laboratories, Inc.
TUV	Technischer Uberwachungs Verine e.V
CB	Scheme of the IECEE for Mutual Recognition of Test Certificates for Electrical Equipment

Caution: Any changes or modifications in construction of this device which are not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

NOTE:
This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide rea-sonable protection against harmful interference in a residential installation This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications, However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encour-aged to try to correct the interference by one or more of the following measures:
- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio / TV technician for help.
Modifications not expressly approved by the manufacturer could void the user's authority to operated the equipment under FCC rules.

1. 기자재 명칭 : SSD (Solid State Drive)
2. 모델명(Model): 라벨 별도 표기
3. 제조연월 : 라벨 별도 표기
4. 제조자 : 삼성전자(주)
5. 제조국가 : 대한민국
6. 상호명 : 삼성전자(주)

Industry Canada ICES-003 Compliance Label:
CAN ICES-3 (B)/NMB-3(B)

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9.0 REFERENCES

[Table 27] Standards References

Item	Website
Serial ATA Revision 3.3	http://www.sata-io.org
ATA/ATAPI Command Set - 4 (ACS-4)	http://www.t13.org
SFF-8223, 2.5-inch Drive with Serial Attachment Connector	http://www.sffcommittee.org
SFF-8201, 2.5-inch drive form factor	http://www.sffcommittee.org
Solid-State Drive (SSD) Requirements and Endurance test Method (JESD218)	https://www.jedec.org/standards-documents/docs/jesd218B01
Solid-State Drive (SSD) Endurance Workloads (JESD219)	https://www.jedec.org/standards-documents/docs/jesd219A

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