SAS 12Gb/s
2.5” SSD
Manual

The SAS SSD is a non-volatile, solid-state storage device. With its 12Gb/s SAS interface and industry-standard form factors, it is a drop in replacement for hard disk drives. The SSD delivers extremely high levels of performance, reliability and ruggedness for I/O intensive or environmentally challenging applications.

Revision History

Date	Revision	Description	Checked by
5/11/16	A	Initial release	
6/6/16	B	Add PN per rev_AA of decoder	

Legal Information

Legal Information

Ordering Information: 2.5” SAS SSD Solid-State Drive

Part Numbers	SAS Interface	Application	Useable Capacity (GB)[1]	NAND Technology	Temperature Range	NAND
VSF22515T323CyVSx	12Gb/s	Enterprise	15300	MLC	(0 to +60'c)	Samsung
VSF2253T8423CCVSx	12Gb/s	Enterprise	3840	MLC	(0 to +60'c)	Samsung
VSF22591T9223CZVSx	12Gb/s	Enterprise	1920	MLC	(0 to +60'c)	Samsung
VSF225960G23CZVSx	12Gb/s	Enterprise	960	MLC	(0 to +60'c)	Samsung
VSF225480G23CCVSx	12Gb/s	Enterprise	480	MLC	(0 to +60'c)	Samsung

Notes:

- Usable capacity based on specification LBA1-03a and level of over-provisioning applied to wear leveling, bad sectors, index tables etc.
- 1 GB = 1,000,000,000 Byte
- One Sector = 512 Byte.
- “x” is a wild card to indicate NAND Vendor/ Die revision or a customer specific BOM and/or manufacturing location
- SFF-8680 standard connector

Enterprise SSD – An Enterprise SSD contains hardware and firmware that detect and manage power failures. This allows the drive to flush the controller cache and harden data to NAND flash to prevent data is loss.

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1 INTRODUCTION

1.1 General Description

This document describes the specification of the VIKING SAS SSD which uses a SAS 12Gb/s interface. Supporting a SAS 12Gb/s interface shows much faster performance than previous SAS 6G SSDs. VIKING SAS SSDs 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 in a Enterprise server and Storage for a storage device with a high performance, high capacity. VIKING SAS SSDs deliver 1400MB/s for sequential read and 930MB/s for sequential write speed under up to 12W power. By combining the enhanced reliability Samsung NAND Flash memory silicon with NAND Flash management technologies, VIKING SAS SSDs deliver an extended endurance of up to 1 Drive Writes Per Day (DWPD) for 5 years, which is suitable for enterprise applications, in 2.5-inch form factor capacities of 480GB, 9600GB, 1920GB and 3840GB. Because of SAS 12Gb/s interface has backward compatibility with SAS, you can use VIKING SAS SSDs as 6Gbps speed for older systems SAS 6G interfaces. In addition, VIKING SAS SSDs support Power Loss Protection which can guarantee that data issued by the host system are written to the storage media without any loss in the event of sudden power off or sudden power failure.

1.2 Features

- SAS 12 Gb/s interface
- Fully complies Active-Active Dual Port,
- V3 NAND, PLP
- Enhanced Power-Loss Data Protection with Tantal capacitors
- Samsung REX SSD Controller
- TCG-compliant Self-Encryption Drive (Optional)
- Hardware based AES 256-bit Encryption Engine (optional)
- End-to-End Data Protection
- Support 16 Initiator with TCQ (Up to 128Q-depth) Command Set
- 8 RRDY provide
- Auto good response
- Supports Tag-overlap check and reserved field check
- Compliant with SCSI Specification (SAS-3, SPL-3, SBC-4, SPC-4, SAM-5)
- Compliant with TCG Enterprise Specification Rev. 1.01 (Optional)
- RoHS Compliant
- Support T10 DIP

2 PRODUCT SPECIFICATION

2.1 Capacity

Support the high capacity product compared previous models and help the same system implement higher capacity than previous status. Viking SSDs fulfills IDEMA (The International Disk Drive Equipment and Materials Association) rule to represent a maximum LBA in SSD. According to the IDEMA rule (LBA1-03), the maximum LBA numbers can be represented are the following table.

512bytes logical block size: Maximum LBA = (97,696,368) + (1,953,504 * (Advertised Capacity in Gigabytes - 50))

4096bytes logical block size: Maximum LBA = (12,212,046) + (244,188 * (Advertised Capacity in Gigabytes - 50))

Table 2-1: User Capacity and Addressable Sectors

Cacacity[1)]	Max LBA[2)]			
	512B	520B	4096B	4160B
480GB	937,703,088	937,703,088	117,212,886	117,212,886
960GB	1,875,385,008	1,875,385,008	234,423,126	234,423,126
1920GB	3,750,748,848	3,750,748,848	468,843,606	468,843,606
3840GB	7,501,476,528	7,501,476,528	937,684,566	937,684,566

NOTE:
1) One Gigabyte(GB) = 1,000,000,000 Bytes, User accessible capacity may vary depending on operating environment and formatting.
2) 1Sector = 512bytes, LBA Count is based on the IDEMA standard.
2) Capacity shown in Table 2-1 represents the total usable capacity of the SSD which may be less than the total physical capacity. A certain area in physical capacity, not in the area shown to the user, might be used for the purpose of NAND flash management.

2.2 Performance

Table 2-2: Sequential Read/Write Performance

Max. Performance[1)]	480GB	960GB	1920GB	3840GB
Sequential Read	1350 MB/s	1350 MB/s	1350 MB/s	1400 MB/s
Sequential Write	500 MB/s	750 MB/s	750 MB/s	930 MB/s

NOTE:
1) Measured performance with IOMeter 2006, 128KB data size and 32-Queue depth on active-active mode, and with no pre-condition
2) Actual performance may vary depending on use conditions and environment
3) Performance measured using IOMeter2006 with queue depth 128.
4) Performance is measured at dual port.

Table 2-3: Sustained Random Read/Write Performance

Max. Performance[1)]	480GB	960GB	1920GB	3840GB
Random Read (QD = 64)	190K IOPS	190K IOPS	190K IOPS	200K IOPS
Random Write (QD = 64)	17K IOPS	30K IOPS	37K IOPS	22K IOPS

NOTE:
1) Performed with IOMeter 2006, 4KB data size and 64-Queue depth on active-active mode
2) Clean means the test is performed without any pre-written condition
3) Sustained Testing performed with 1 time full LBA range write operation prior to the test
4) Actual performance may vary depending on use conditions and environment
5) Performance is measured at dual port.

2.3 Power Consumption (12V Supply Voltage)

VIKING SAS SSDs are implemented in standardized 2.5-inch form factor and gets 12V power as well as 5V power through the indicated pins (#P13~15 for 12V and #P7~P9 for 5V in SFF-8680 connector plug) from the host system. For 12V and 5V, the allowable voltage tolerance and noise level in SSD are described in Table 2-4, the power consumption in Table 2-5.

Table 2-4: Maximum Voltage Ratings[1]

Operating Voltage	480GB	960GB	1920GB	3840GB
5V	±5%			
12V	±5%			

NOTE:
1) The components inside SSD were designed to endure the range of voltage fluctuations, which might be induced by the host system

Table 2-5: Power Consumption

Parameter		Specifications
Active	Read	12 W
	Write	12 W
Idle		4 W

NOTE:
1) The active and idle power is defined as the highest averaged power value, which is the maximum RMS average value
2) The measurement condition for active power is assumed for 100% sequential read and write
3) The idle state is defined as the state that the host system can issue any commands into SSD at any time
4) Active power is measured using IOMeter2006
5) Idle power is measured using DRIVE MASTER 2010.

2.4 Reliability

The reliability specification follows JEDEC standard, which are included in JESD218A and JESD219A documents.

2.4.1 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 2-6: MTBF Specifications

Parameter	480GB	960GB	1920GB	3840GB
MTBF	2,000,000 hours[1)]			

NOTE:
1) AFR (Annual Failure Ratio) is 0.44%

2.4.2 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 2-7: UBER Specifications

Parameter	480GB	960GB	1920GB	3840GB
UBER	1 sector per 10^{17} bits read			

2.4.3 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 2-8: Data Retention Specifications

Parameter	480GB	960GB	1920GB	3840GB
Data Retention[1)]	3month			

NOTE:
1) Measured , assuming SSD reaches the maximum rated endurance at 40'c in power-off state.

2.4.4 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.

Configuration	Drive Writes Per Day	User Capacity
Configuration 1	3 DWPD for 5 years	400 GB
Configuration 2	10 DWPD for 5 years	400 GB
Configuration 3	1 DWPD for 5 years	480 GB
Configuration 4	3 DWPD for 5 years	800 GB
Configuration 5	10 DWPD for 5 years	800 GB
Configuration 6	1 DWPD for 5 years	960 GB
Configuration 7	3 DWPD for 5 years	1600 GB
Configuration 8	10 DWPD for 5 years	1600 GB
Configuration 9	1 DWPD for 5 years	1920 GB
Configuration 10	3 DWPD for 5 years	3200 GB
Configuration 11	3 DWPD for 5 years	3200 GB
Configuration 12	1 DWPD for 5 years	3840 GB
Configuration 13	1 DWPD for 5 years	6400 GB
Configuration 14	1 DWPD for 5 years	6400 GB

Configuration 15	3 DWPD for 5 years	12800 GB

NOTE:
1) Per Viking PM, 6-7-16

Table 2-9: Drive Write Per Day (DWPD) Specifications

Parameter	480GB	960GB	1920GB	3840GB
DWPD	1 drive writes per day within 5years			

Table 2-10: TBW (TeraBytes Written)

Parameter	480GB	960GB	1920GB	3840GB
TBW(TB)[1)]	876	1,752	3,504	7,008

NOTE:
2) TBW = DWPD x 365 x 5 x User capacity

2.5 Environmental Specifications

2.5.1 Temperature

Table 2-11: Temperature Specifications

Parameter		480GB	960GB	1920GB	3840GB
Temperature	Operating[1)]	0 to 60 °C			
	Non-Operating[2)]	-40 to 85 °C			

NOTE:
1) Operating Temperature: Tc (Tcase) measured at the hottest point on the SSD case
2) Non-Operating Temperature: Ta (Tambient) . Ambient Temperature (Mechanical reliability)

2.5.2 Humidity

Table 2-12: Humidity Specifications

Parameter		480GB	960GB	1920GB	3840GB
Humidity	Non-Operating	5 to 95%			

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

2.5.3 Shock and Vibration

Table 2-13: Shock and Vibration Specifications

Parameter		480GB	960GB	1920GB	3840GB
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: 10Hz to 2,000Hz, 15mins/axis on 3axis

2.5.4 Altitude

Table 2-14: Altitude Specifications

Parameter	480GB	960GB	1920GB	3840GB
Altitude[1)]	-1,000 to 15,000 feet			

NOTE:
1) Relative to sea level

3 MECHANICAL SPECIFICATION

3.1 Physical Information

The physical case is a 2.5-inch form factor that follows the standardized dimensions defined by SSD Form Factor Work Group

Table 3-1: Physical Dimensions and Weight

Parameter	480GB	960GB	1920GB	3840GB
Width (mm)	69.85±0.25			
Length (mm)	100.20±0.25			
Thickness (mm)	14.80±0.2			
Weight (g)	140			

3.2 Form Factor

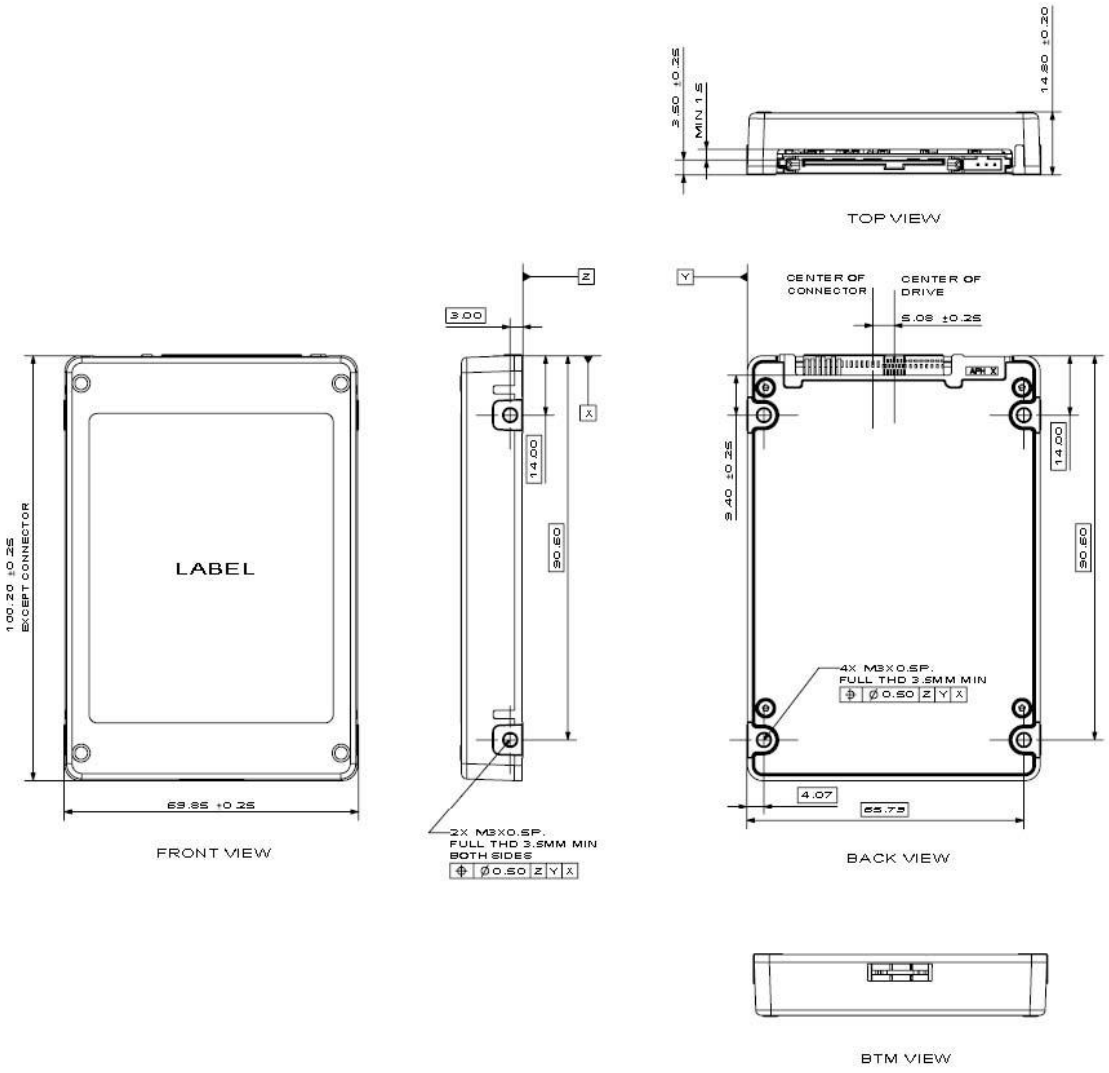
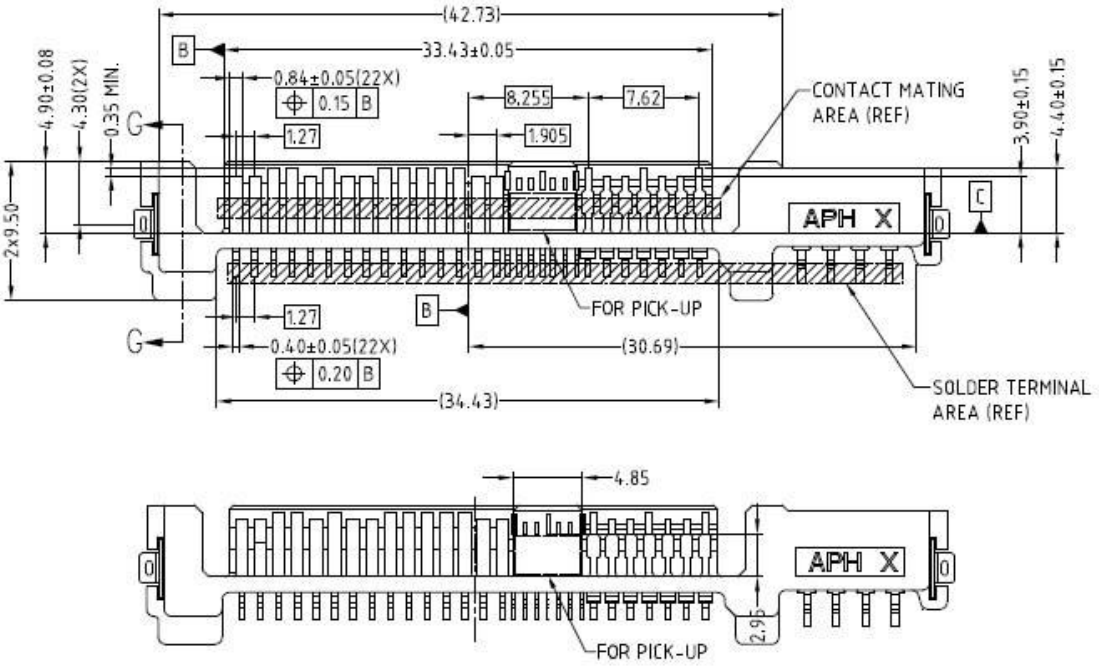


Figure 3-1: Mechanical Outline

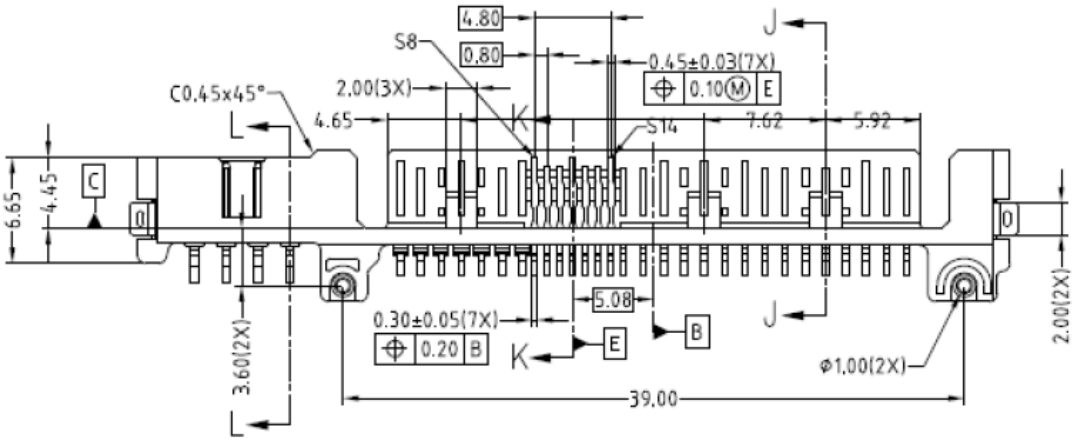
NOTE:
1) Do not disassemble the SSD, damage the SSD, or remove the sticker or the label affixed on the product. Any product that has had its case opened or its label damaged or removed shall not be covered by the warranty.

4 INTERFACE SPECIFICATION

4.1 Connector Dimension and Pin Location



[TOP VIEW]



[Bottom VIEW]

Figure 4-1: Layout of 2.5-inch Form Factor Connector Pins

4.2 Pin Assignments and Definition

Table 4-1: Pin Assignments

Pin#	Assignment	Description
S1	GND	Ground
S2	S0T+ (A+)	SAS 0 Transmit
S3	S0T- (A-)	SAS 0 Transmit
S4	GND	Ground
S5	S0R- (B-)	SAS 0 Receive
S6	S0R+ (B+)	SAS 0 Receive
S7	GND	Ground
S8	GND	Ground
S9	S1T+	SAS 1 Transmit
S10	S1T-	SAS 1 Transmit
S11	GND	Ground
S12	S1R-	SAS 1 Receive
S13	S1R+	SAS 1 Receive
S14	GND	Ground
P1	3.3V	Not Used
P2	3.3V	Not Used
P3	3.3V	Power Disable
P4	GND	Ground
P5	GND	Ground
P6	GND	Ground
P7	5V	5V power
P8	5V	5V power
P9	5V	5V power
P10	GND	Ground
P11	Activity	Device Activity Signal
P12	GND	Ground
P13	12V	12V power
P14	12V	12V power
P15	12V	12V power

5 SUPPORTED COMMAND SET

5.1 Supported SAS/SCSI Commands

This chapter provides the information regarding of the supported commands by the drive as listed below. For more detailed command description, refer to "Samsung REX SSD SAS Command Code Specification"

Table 5-1: Supported SAS/SCSI Commands

Command Name	Command Code (Hex)	Command Name
Format Unit	04h	SBC–3 Actual implementation different from SBC definition
Inquiry	12h	SPC–4
Log Select	4Ch	SBC–3 and SPC–4
Log Sense	4Dh	SBC–3 and SPC–4
Mode Select 6	15h	SPC–4
Mode Select 10	55h	SPC–4
Mode Sense 6	1Ah	SPC–4
Mode Sense 10	5Ah	SPC–4
Persistent Reserve In	5Eh	SPC–4
Persistent Reserve Out	5Fh	SPC–4
Read 6	08h	SBC–3
Read 10	28h	SBC–3
Read 12	A8h	SBC–3
Read 16	88h	SBC–3
Read 32	7Fh/0009h	SBC–3
Read Buffer	3Ch	SPC-4
Read Capacity 10	25h	SBC–3
Read Capacity 16	9Eh/10h	SBC–3
Read Defect Data 10	37h	SBC–3 Actual implementation different from SBC definition
Read Defect Data 12	B7h	SBC–3 Actual implementation different from SBC definition
Read Long 10	3Eh	SBC–3 Actual implementation different from SBC definition
Read Long 16	9Eh/11h	SBC–3
Reassign Blocks	07h	SBC–3
Receive Diagnostic Pages	1Ch	SPC-4
Release 6	17h	SPC-2 Based implementation supported
Release 10	57h	SPC-2 Based implementation supported
Report Identifying Information	A3h/05h	SPC–4
Report LUNS	A0h	SPC–4
Report Supported Operation Codes	A3h/0Ch	SPC–4
Report Supported Task Mgt. Functions	A3h/0Dh	SPC–4
Report Timestamp	A3h/0Fh	SPC-4
Request Sense	03h	SPC–4
Reserve 6	16h	SPC-2 Based implementation supported
Reserve 10	56h	SPC-2 Based implementation supported
Sanitize	48h	SBC-3
Send Diagnostics	1Dh	SPC–4
Start Stop Unit	1Bh	SBC-3
Set Identifying Information	A4h/06h	SPC–4
Set Timestamp	A4h/0Fh	SPC-4
Synchronize Cache 10	35h	SBC–3 Actual implementation different from SBC definition.
Synchronize Cache 16	91h	SBC–3 Actual implementation different from SBC definition.
Test Unit Ready	00h	SPC–4

Unmap	42h	SBC–3
Verify 10	2Fh	SBC–3
Verify 12	AFh	SBC–3
Verify 16	8Fh	SBC–3
Verify 32	7Fh/000Ah	SBC–3
Write 6	0Ah	SBC–3
Write 10	2Ah	SBC–3
Write 12	AAh	SBC–3
Write 16	8Ah	SBC–3
Write 32	7Fh/000Bh	SBC–3
Write and Verify 10	2Eh	SBC–3
Write and Verify 12	AEh	SBC–3
Write and Verify 16	8Eh	SBC–3
Write and Verify 32	7Fh/000Ch	SBC–3
Write Buffer	3Bh	SPC–4
Write Long 10	3Fh	SBC–3 Actual implementation different from SBC definition.
Write Long 16	9Fh/11h	SBC–3 Actual implementation different from SBC definition.
Write Same 10	41h	SBC–3
Write Same 16	93h	SBC–3
Write Same 32	7Fh/00Dh	SBC–3

6 SPOR SPECIFICATION

This chapter provides the information regarding of the SPOR (Sudden Power Off and Recovery) feature of the SSD.

6.1 Data Recovery in Sudden Power Off

If power irruption is detected, SSD dumps all cached 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 operation period.

6.2 Time to Ready Sequence

SSD gives drive ready signal finishing FTL OPEN when is maximum 40 seconds.
Sudden Power Off Write Main Map

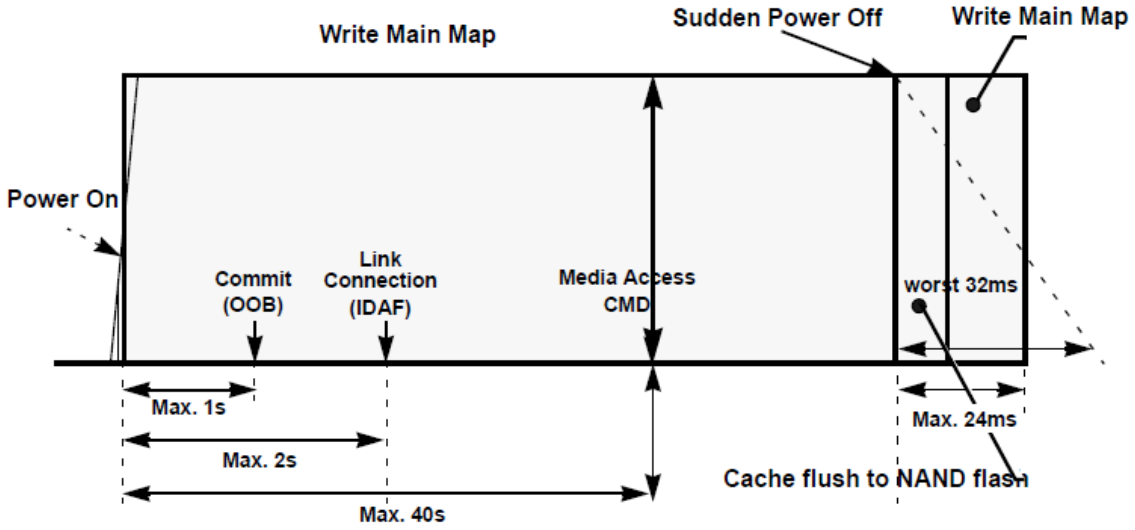


Figure 6-1: Time to Ready Sequence

7 PRODUCT COMPLIANCE

7.1 Product Regulatory Compliance and Certifications

Table 7-1: Standards Reference

Category	Certification
CE	Comunaute Europeenne
BSMI	Bureau of Standards, Metrology and Inspection
KCC	KCC Korea Communications commission
VCCI	Voluntary Control Council for Interference
C- Tick	Radio Telecommunication Labeling
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 reasonable 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 encouraged 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.

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)

8 REFERENCES

Table 8-1: References

Item	Website
Serial Attached SCSI (SAS-3)	http://www.t10.org/
SCSI Architecture Model-5 (SAM-5)	http://www.t10.org/
SCSI Primary Commands-4 (SPC-4)	http://www.t10.org/
SCSI Block Commands-4 (SBC-4) Standard	http://www.t10.org/
SFF-8680	ftp://ftp.seagate.com/sff/SFF-8680.PDF
Enterprise SSD Form Factor Version 1.0a	http://www.ssdformfactor.org/
Solid-State Drive Requirements and Endurance Test Method (JESD218A)	http://www.jedec.org/standards-documents/docs/jesd218a