

Contents

1. Overview.....	4
2. Introduction.....	1
2.1. General Description	1
2.2. PS3108 Controller Block Diagram	1
2.3. Product Block Diagram.....	2
2.4. Flash Management	2
3. Product Specifications	6
4. Environmental Specifications	8
4.1. Environmental Conditions.....	8
4.2. Shock.....	9
4.3. Vibration	9
4.4. Drop	9
4.5. Bending.....	9
4.6. Torque.....	10
4.7. Electrostatic Discharge (ESD)	10
4.8. MTBF	10
4.9. Compliance	10
5. Electrical Specifications	11
5.1. Supply Voltage	11
5.2. Power Consumption.....	11
6. Interface	12
6.1. Pin Assignment and Descriptions.....	12



- 7. Supported Commands 14
 - 7.1. ATA Command List 14
 - 7.2. Identify Device Data 15
- 8. Physical Dimension 18

1. Overview

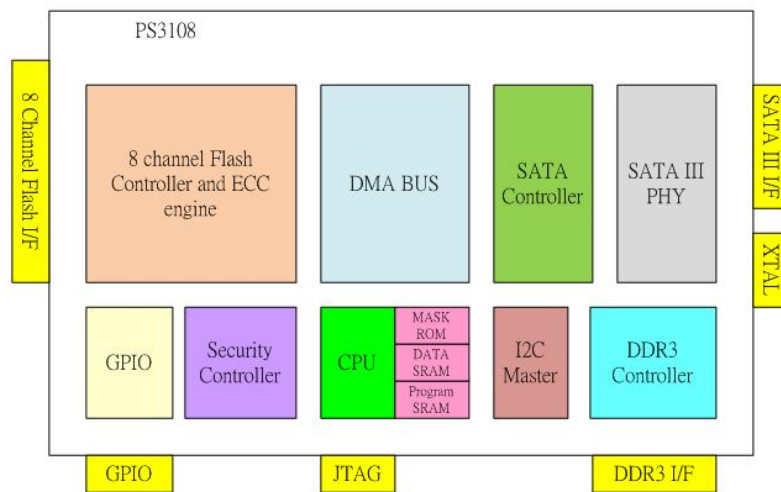
- **Capacity**
 - 32GB up to 512GB
- **SATA Interface**
 - SATA Revision 3.0
 - SATA 1.5Gbps, 3Gbps, and 6Gbps interface
- **Flash Interface**
 - Flash Type: SLC, MLC
 - 16pcs of TSOP flash
- **Performance**
 - Read: up to 500 MB/s
 - Write: up to 380 MB/s
- **Power Consumption**^{Note1}
 - Active mode: < 990mA
 - Idle mode: < 87mA
- **TBW (Terabyte Written)**^{Note2}
 - 1461 TBW for 512GB
- **MTBF**
 - More than 1,000,000 hours
- **Advanced Flash Management**
 - Wear Leveling
 - Bad Block Management
 - TRIM
 - SMART
 - Over-Provision
 - Firmware Update
- **Storage Temperature Range**
 - -40°C ~ 85°C
- **Operation Temperature Range**
 - Sliver grade: 0°C ~ 70°C
 - Diamond grade: -40°C ~ 85°C
- **RoHS compliant**

2. Introduction

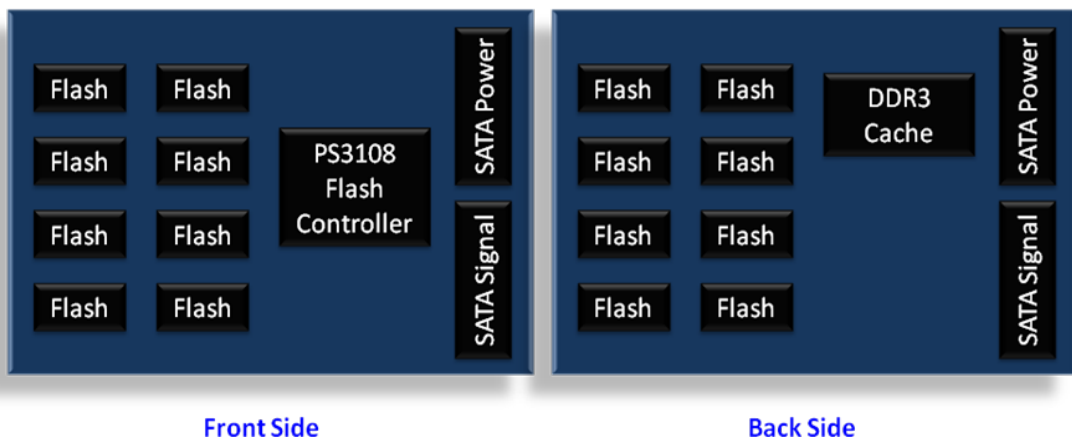
2.1. General Description

2.5" SATA Solid State Disk (SSD) delivers all the advantages of flash disk technology with Serial ATA III interface, including being fully compliant with standard 2.5-inch form factor, providing low power consumption compared to traditional hard drive and hot-swapping when removing/replacing/upgrading flash disks. The device is designed based on the standard 7-pin interface for data segment and 15-pin for power segment, as well as operating at a maximum operating frequency of 300MHz with 40MHz external crystal. Its capacity could provide a wide range up to 512GB. Moreover, it can reach up to 500MB/s read as well as 380MB/s write high performance based on Toshiba's 19nm Toggle NAND (with 256MB/512MB DDR3 enabled and measured by CrystalDiskMark v3.0).

2.2. PS3108 Controller Block Diagram



2.3. Product Block Diagram



2.4. Flash Management

- Error Correction Code (ECC)

Flash memory cells will deteriorate with use, which might generate random bit errors in the stored data. Thus, PS3108 SATA SSD applies the BCH ECC Algorithm, which can detect and correct errors occur during Read process, ensure data been read correctly, as well as protect data from corruption.

- 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 technique is applied to extend the lifespan of NAND Flash by evenly distributing write and erase cycles across the media.

It 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.

- **Bad Block Management**

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

- **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.

- **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.

- **Over-Provision**

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.

- **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.

- Flushing Mechanism for Power Loss Protection

Power Loss Protection is a mechanism to prevent data loss during unexpected power failure. DRAM is a volatile memory and frequently used as temporary cache or buffer between the controller and the NAND flash to improve the SSD performance. However, one major concern of the DRAM is that it is not able to keep data during power failure. Accordingly, the PS3108 applies the **GuaranteedFlush** Technology, which requests the controller to transfer data to the cache. For PS3108, DDR performs as a cache, and its sizes include 256MB or 512MB. Only when the data is fully committed to the NAND flash will the controller send acknowledgement (ACK) to the host. Such implementation can prevent false-positive performance and the risk of power cycling issues.

Additionally, it is critical for a controller to shorten the time the in-flight data stays in the cache. Thus, 's PS3108 applies an algorithm to reduce the amount of data resides in the cache to provide a better performance. This **SmartCacheFlush** technology allows incoming data to only have a "pit stop" in the cache and then move to the NAND flash at once. If the flash is jammed due to particular file sizes (random 4K), the cache will be treated as an "organizer", consolidating incoming data into groups before written into the flash to improve write amplification.

In sum, with this Flush Management, PS3108 proves to provide the reliability required by consumer, industrial, and enterprise-level application.

- Advanced Self-Defense Mechanism

- Secure Erase

Secure Erase is a standard ATA command and will write all "0xFF" to fully wipe all the data on hard drives and SSDs. When this command is issued, the SSD controller will empty its storage blocks and return to its factory default settings.

- Write Protect

When a SSD contains too many bad blocks and data are continuously written in, then the SSD might not be used anymore. Thus, Write Protect is a mechanism to prevent data from being written in and protect the accuracy of data that are already stored in the SSD.

- SSD Lifetime Management
 - Terabytes Written (TBW)

TBW (Terabytes Written) is a measurement of 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:

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

NAND Endurance: NAND endurance refers to the P/E (Program/Erase) cycle of a NAND flash. Typically, the P/E cycle of MLC is 3K.

SSD Capacity: The SSD capacity is the specific capacity in total of a SSD.

WLE: Wear Leveling Efficiency (WLE) represents the ratio of the average amount of erases on all the blocks to the erases on any block at maximum.

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.

3. Product Specifications

- Capacity
 - 32GB up to 512GB
 - Default supported capacityNote1: 60GB, 120GB, 240GB, 480GB (support 48-bit addressing mode)
 - On demand supported capacity: 32GB, 64GB, 128GB, 256GB, 512GB
- Electrical/Physical Interface
 - SATA Interface
 - Compliant with SATA Revision 3.0
 - Compatible with SATA 1.5Gbps, 3Gbps and 6Gbps interface
 - Support power management
 - Support expanded register for SATA protocol 48 bits addressing mode
 - Embedded BIST function for SATA PHY for low cost mass production
 - DDR3 IO
 - Support DDR3 I/O interface
 - 16-bit data bus
 - Clock rate: 480MHz
 - Capacity: 256/512MB
 - Flash IO
 - Support 1.8V and 3.3V voltage level
 - Support 3.3V for conventional Asynchronous Flash
- NAND Flash Interface
 - Toshiba 19nm MLC, Toggle1.0
 - Build-in hardware ECC circuit (up to 72bit/1KB)
 - Support all types of MLC large block: 8KB/page and 16K/page NAND Flash
 - Toggle 1.0 Interface: up to 8 channels for 133Mbps mode (120 MB/s)
 - Bus Width: 8/16 bit
 - Contain up to 16pcs of TSOP NAND Flash
- ECC Scheme
 - PS3108 2.5" SATA SSD can correct up to 72 bits error in 1K Byte data.

- Performance

Flash Type	Capacity	Flash Structure	Performance	
			Sequential (MB/s)	
			Read	Write
Toshiba 19nm Type –B MLC	32GB	4GB x 8	500	100
	64GB	8GB x 8	500	100
	64GB	4GB x 16	500	180
	128GB	16GB x 8	500	200
	256GB	32GB x 8	500	200
	256GB	16GB x 16	500	380
	512GB	32GB x 16	500	380

NOTES:

1. The performance is obtained from CrystalDiskMark with SATA 6Gbps host.
2. Samples are made of Toshiba 19nm Toggle NAND Flash.
3. Performance may vary from flash configuration, DDR configuration, and platform.
4. The table above is for your reference only. The criteria for MP (mass production) and for accepting goods shall be discussed based on different flash configuration.

- TBW (Terabytes Written)

Capacity	Flash Structure	TBW
64G	4GB x 16	178
128G	8GB x 16	353
256G	16GB x16	730
512GB	32GB x 16	1461

NOTES:

1. Samples are made of Toshiba 19nm Toggle NAND Flash.
2. The endurance of SSD could be estimated based on users' behaviors, NAND endurance cycles, and write amplification factor. It is not guaranteed by the flash vendor.

- Build-in 32-bit micro-controller
- Support SMART and TRIM commands

4. Environmental Specifications

4.1. Environmental Conditions

- Temperature and Humidity
 - Storage Temperature Range
 - -40°C ~ 85°C
- Operation Temperature Range
 - Silver grade: 0°C ~ 70°C
 - Diamond grade: -40°C ~ 85°C
- Humidity:
 - Silver grade: RH 93% under 40°C (in operation)
 - Diamond grade: RH 95% under 55°C (in operation)

PS3108 2.5'' SATA SSD High Temperature Test Condition

	Temperature	Humidity	Test Time
Operation (Silver)	70°C	0% RH	72 hours
Storage (Silver)	85°C	0% RH	72 hours

Result: No any abnormality is detected.

PS3108 2.5'' SATA SSD Low Temperature Test Condition

	Temperature	Humidity	Test Time
Operation (Silver)	0°C	0% RH	72 hours
Storage (Silver)	-40°C	0% RH	72 hours

Result: No any abnormality is detected.

PS3108 2.5'' SATA SSD High Humidity Test Condition

	Temperature	Humidity	Test Time
Operation (Silver)	40°C	93% RH	24 hours
Storage (Silver)	40°C	95% RH	72 hours

Result: No any abnormality is detected.

PS3108 2.5'' SATA SSD Temperature Cycle Test

	Temperature	Test Time	Cycle
Operation (Silver)	0°C	30 min	10 Cycles
	70°C	30 min	
Storage (Silver)	-40°C	30 min	10 Cycles
	85°C	30 min	

Result: No any abnormality is detected.

4.2. Shock

PS3108 2.5'' SATA SSD Shock Specification

	Acceleration Force	Half Sin Pulse Duration
Non-operational	1500G	0.5ms

Result: No any abnormality is detected when power on.

4.3. Vibration

PS3108 2.5'' SATA SSD Vibration Specification

	Condition		Vibration Orientation
	Frequency/Displacement	Frequency/Acceleration	
Non-operational	20Hz~80Hz/1.52mm	80Hz~2000Hz/20G	X, Y, Z axis/30 min for each

Result: No any abnormality is detected when power on.

4.4. Drop

PS3108 2.5'' SATA SSD Drop Specification

	Height of Drop	Number of Drop
Non-operational	110cm free fall	6 face of each unit

Result: No any abnormality is detected when power on.

4.5. Bending

PS3108 2.5'' SATA SSD Bending Specification

	Force	Action
--	-------	--------

Non-operational	≥ 10N	Hold 1min/5times
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Result: No any abnormality is detected when power on.

4.6. Torque

PS3108 2.5" SATA SSD Torque Specification

	Force	Action
Non-operational	0.5N-m or 5 deg	Hold 5min/5times

Result: No any abnormality is detected when power on.

4.7. Electrostatic Discharge (ESD)

PS3108 2.5" SATA SSD Contact ESD Specification

Device	Capacity	Temperature	Relative Humidity	+/- 4KV	Result
2.5" SSD	256GB	24.0°C	49% (RH)	Device functions are affected, but EUT will be back to its normal or operational state automatically.	PASS

4.8. MTBF

MTBF, an acronym for Mean Time Between Failures, is a measure of a device's reliability. Its value represents the average time between a repair and the next failure. The measure is typically in units of hours. The higher the MTBF value, the higher the reliability of the device. The predicted result of 's PS3108 2.5" SATA SSD is more than 1,000,000 hours.

4.9. Compliance

- RoHS
- SATA III (SATA Rev. 3.0)
- Up to ATA/ATAPI-8 (Including S.M.A.R.T)
- TCG OPAL SSC V1.0

5. Electrical Specifications

5.1. Supply Voltage

Supply Voltage of PS3108 2.5" SATA SSD

Parameter	Rating
Operating Voltage	5V+/-5%
Maximum Ripple	100mV, 0~30MHz

5.2. Power Consumption

Power Consumption of PS3108 2.5" SATA SSD

Flash Type	Capacity	Read	Write	Idle	Partial	Slumber
Toshiba 19nm	60GB	507	394	58	15	11
	120GB	505	586	58	14	10
Type-B MLC	240GB	507	993	58	16	12
	480GB	515	976	59	16	12

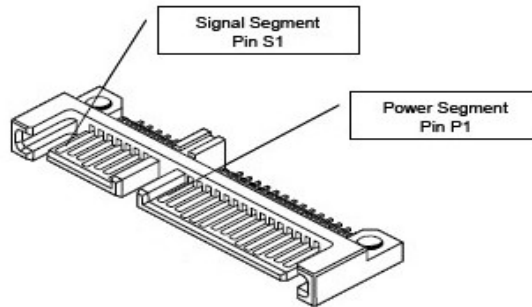
Unit: mA

NOTES:

1. Samples are made of Toshiba 19nm Toggle NAND Flash.
2. The operating voltage is 5V.
3. Power Consumption may vary from flash configuration, DDR configuration, or platform.

6. Interface

6.1. Pin Assignment and Descriptions



PS3108 2.5" SATA SSD Pin Assignment

Signal Segment Pin Assignment and Descriptions

Pin Number	Function
S1	GND
S2	A+ (Differential Signal Pair A)
S3	A – (Differential Signal Pair A)
S4	GND
S5	B – (Differential Signal Pair B)
S6	B+ (Differential Signal Pair B)
S7	GND

Power Segment Pin Assignment and Descriptions

Pin Number	Function
P1	Not Used (3.3V)
P2	Not Used (3.3V)
P3	DEVSLP
P4	GND
P5	GND
P6	GND
P7	5V pre-charge
P8	5V
P9	5V
P10	GND

P11	Reserved
P12	GND
P13	Not Used (12V pre-charge)
P14	Not Used (12V)
P15	Not Used (12V)

7. Supported Commands

7.1. ATA Command List

ATA Command List

Op Code	Description	Op Code	Description
E5h	Check power mode	F6h	Security Disable Password
06h	Data Set management	F3h	Security Erase Prepare
B1H	DCO	F4h	Security Erase Unit
92h	Download Microcode PIO	F5h	Security Freeze Lock
93h	Download Microcode DMA	F1h	Security Set Password
90h	Execute drive diagnostic	F2h	Security Unlock
E7h	Flush cache	70h	Seek
Eah	Flush cache Ext	Efh	Set features
Ech	Identify device	F9h	Set Max Address
E3h	Idle	37h	Set Max Address Ext
E1h	Idle immediate	C6h	Set multiple mode
91h	Initialize drive parameters	E6h	Sleep
E4h	Read buffer	B0h	Smart
C9h	Read DMA (w/o retry)	E2h	Standby
C8h	Read DMA (w/retry)	E0h	Standby immediate
25h	Read DMA Ext	E8h	Write buffer
60h	Read FPDMA QUEUED	CBh	Write DMA (w/o retry)
2Fh	Read Log Ext	Cah	Write DMA (w/retry)
C4h	Read multiple	35h	Write DMA Ext
29h	Read multiple Ext	3Dh	Write DMA FUA Ext
F8h	Read native max address	61h	Write FPDMA QUEUED
27h	Read native max Ext	3Fh	Write Log Ext
21h	Read sector(s) (w/o retry)	C5h	Write multiple
20h	Read sector(s) (w/retry)	39h	Write multiple Ext
24h	Read sector(s) Ext	Ceh	Write multiple FUA Ext
42h	Read Verify Ext	31h	Write sector(s) (w/o retry)
41h	Read verify sector(s) (w/o retry)	30h	Write sector(s) (w/retry)
40h	Read verify sector(s) (w/retry)	34h	Write sector(s) Ext
10h	Recalibrate	45h	Write uncorrectable

7.2. Identify Device Data

The following table details the sector data returned by the IDENTIFY DEVICE command.

List of Device Identification

Word	F: Fixed V: Variable X: Both	Default Value	Description
0	F	0040h	General configuration bit-significant information
1	X	*1	Obsolete – Number of logical cylinders
2	V	C837h	Specific configuration
3	X	0010h	Obsolete – Number of logical heads (16)
4-5	X	00000000h	Retired
6	X	003Fh	Obsolete – Number of logical sectors per logical track (63)
7-8	V	00000000h	Reserved for assignment by the Compact Flash Association
9	X	0000h	Retired
10-19	F	Varies	Serial number (20 ASCII characters)
20-21	X	0000h	Retired
22	X	0000h	Obsolete
23-26	F	Varies	Firmware revision (8 ASCII characters)
27-46	F	Varies	Model number (xxxxxxx)
47	F	8010h	7:0- Maximum number of sectors transferred per interrupt on MULTIPLE commands
48	F	0000h	Reserved
49	F	2F00h	Capabilities
50	F	4000h	Capabilities
51-52	X	000000000h	Obsolete
53	F	0007h	Words 88 and 70:64 valid
54	X	*1	Obsolete – Number of logical cylinders
55	X	0010h	Obsolete – Number of logical heads (16)
56	X	003Fh	Obsolete – Number of logical sectors per track (63)
57-58	X	*2	Obsolete – Current capacity in sectors
59	F	0110h	Number of sectors transferred per interrupt on MULTIPLE commands
60-61	F	*3	Maximum number of sector (28bit LBA mode)
62	X	0000h	Obsolete
63	F	0407h	Multi-word DMA modes supported/selected
64	F	0003h	PIO modes supported

65	F	0078h	Minimum Multiword DMA transfer cycle time per word
66	F	0078h	Manufacturer's recommended Multiword DMA transfer cycle time
67	F	0078h	Minimum PIO transfer cycle time without flow control
68	F	0078h	Minimum PIO transfer cycle time with IORDY flow control
69	F	0100h	Additional Supported (support download microcode DMA)
70	F	0000h	Reserved
71-74	F	0000000000000000h	Reserved for the IDENTIFY PACKET DEVICE command
75	F	001Fh	Queue depth
76	F	0706h	Serial SATA capabilities
77	F	0000h	Reserved for future Serial ATA definition
78	F	0044h	Serial ATA features supported
79	V	0040H	Serial ATA features enabled
80	F	01F8h	Major Version Number
81	F	0000h	Minor Version Number
82	F	346bh	Command set supported
83	F	70d9h	Command set supported
84	F	6023h	Command set/feature supported extension
85	V	3469h	Command set/feature enabled
86	V	bc01h	Command set/feature enabled
87	V	6023h	Command set/feature default
88	V	003Fh	Ultra DMA Modes
89	F	001Eh	Time required for security erase unit completion
90	F	001Eh	Time required for Enhanced security erase completion
91	V	0000h	Current advanced power management value
92	V	FFFEh	Master Password Revision Code
93	F	0000h	Hardware reset result. The contents of the bits (12:0) of this word can be changed only during the execution of hardware reset.
94	V	0000h	Vendor's recommended and actual acoustic management value
95	F	0000h	Stream Minimum Request Size
96	V	0000h	Streaming Transfer Time – DMA
97	V	0000h	Streaming Access Latency – DMA and PIO
98-99	F	0000h	Streaming Performance Granularity
100-103	V	*4	Maximum user LBA for 48 bit Address feature set
104	V	0000h	Streaming Transfer Time – PIO
105	F	0000h	Maximum number of 512-byte blocks per DATA SET MANAGEMENT command
106	F	4000h	Physical sector size/Logical sector size
107	F	0000h	Inter-seek delay for ISO-7779 acoustic testing in microseconds

108-111	F	0000000000000000h	Unique ID
112-115	F	0000000000000000h	Reserved
116	V	0000h	Reserved
117-118	F	00000000h	Words per logical Sector
119	F	4015h	Supported settings
120	F	4015h	Command set/Feature Enabled/Supported
121-126	F	0h	Reserved
127	F	0h	Removable Media Status Notification feature set support
128	V	0021h	Security status
129-159	X	0h	Vendor specific
160	F	0h	Compact Flash Association (CFA) power mode 1
161-167	X	0h	Reserved for assignment by the CFA
168	F	3h 2.5 inch 4h 1.8 inch 5h Less than 1.8 inch	Device Nominal Form Factor
169	F	0001h	DATA SET MANAGEMENT command is supported
170-173	F	0h	Additional Product Identifier
174-175		0h	Reserve
176-205	V	0h	Current media serial number
206	F	0h	SCT Command Transport{
207-208	F	0h	Reserved
209	F	4000h	Alignment of logical blocks within a physical block
210-211	V	0000h	Write-Read-Verify Sector Count Mode 3 (not support)
212-213	F	0000h	Write-Read-Verify Sector Count Mode 2 (not support)
214-216		0000h	NV Cache relate (not support)
217	F	0001h	Non-rotating media device
218	F	0h	Reserved
219	F	0h	NV Cache relate (not support)
220	V	0h	Write read verify feature set current mode
221		0h	Reserved
222	F	101Fh	Transport major version number
223	F	0h	Transport minor version number
224-229		0h	reserved
230-233		0h	Extend number of user addressable sectors
234		0001h	Minimum number of 512-byte data blocks per DOWNLOAD MICROCODE command for mode 03h
235		00FFh	Maximum number of 512-byte data blocks per DOWNLOAD MICROCODE command for mode 03h

236-254	F	0h	Reserved
255	X	XXA5h XX is variable	Integrity word (Checksum and Signature)

List of Device Identification for Each Capacity

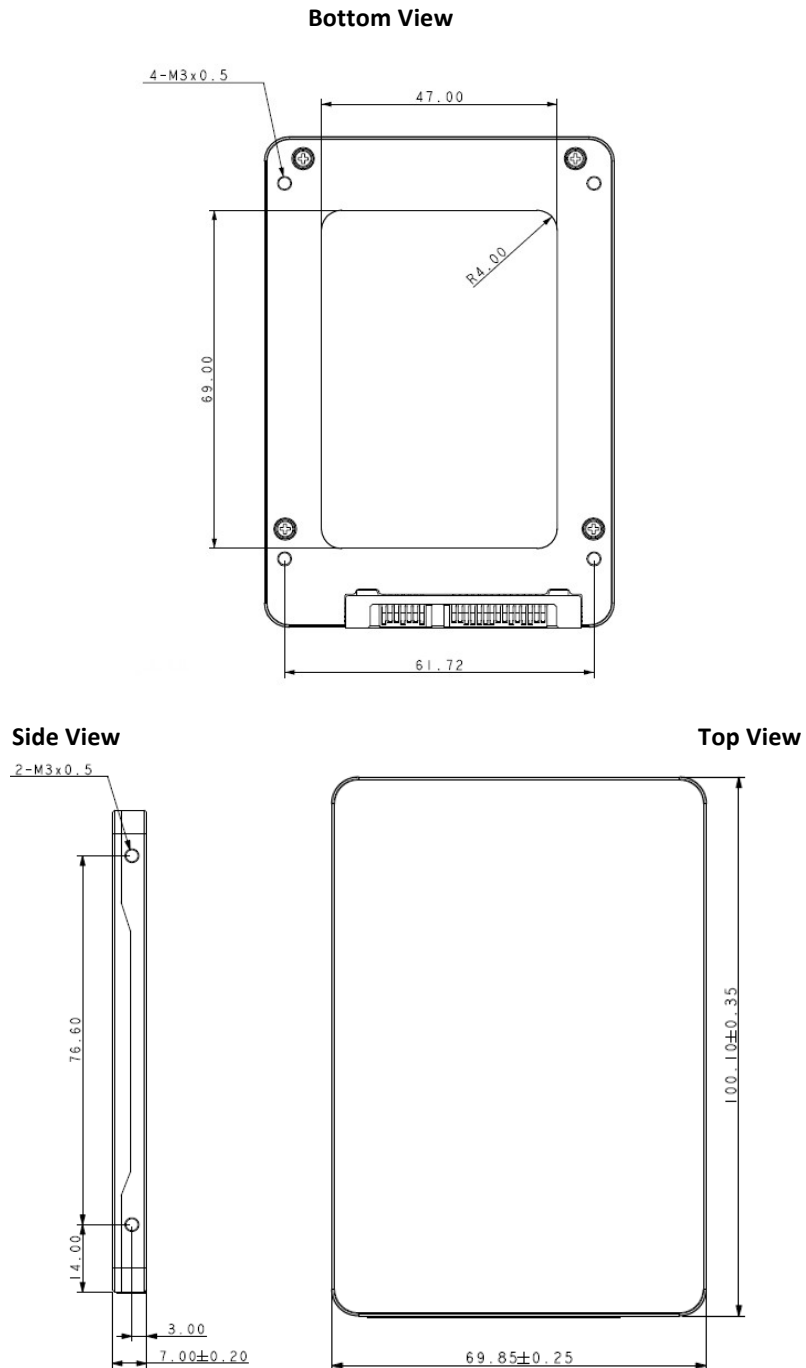
Capacity (GB)	*1 (Word 1/Word 54)	*2 (Word 57 - 58)	*3 (Word 60 - 61)	*4 (Word 100 - 103)
60	3FFFh	FBFC10h	6FCCF30h	6FCCF30h
120	3FFFh	FBFC10h	DF94BB0h	DF94BB0h
240	3FFFh	FBFC10h	FFFFFFFFh	1BF244B0h
480	3FFFh	FBFC10h	FFFFFFFFh	37E436B0h

8. Physical Dimension

Two kinds of housing dimension are supported:

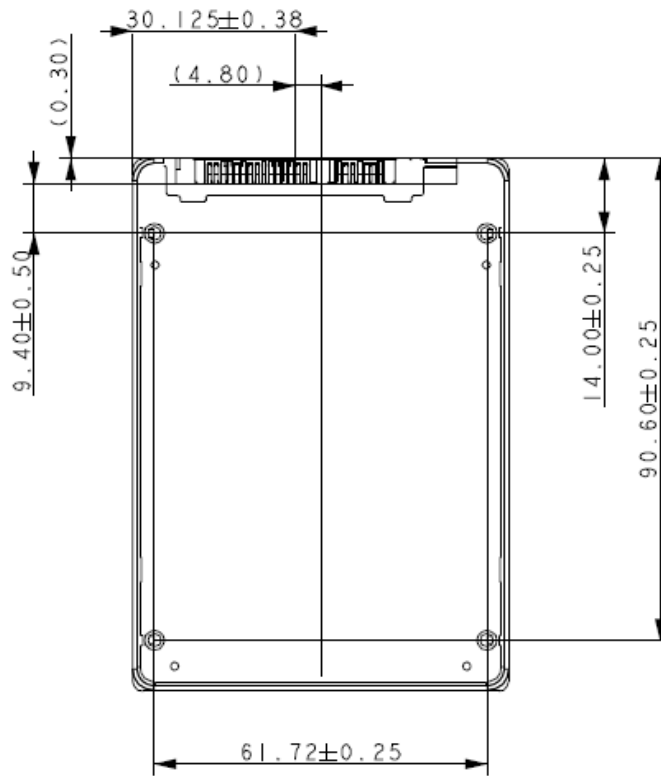
- 100.10mm(L) x 69.85mm(W) x 7.00mm(H)
- 100.10mm(L) x 69.90mm(W) x 9.50mm(H)

A. Dimension: 100.10mm(L) x 69.85mm(W) x 7.00mm(H)



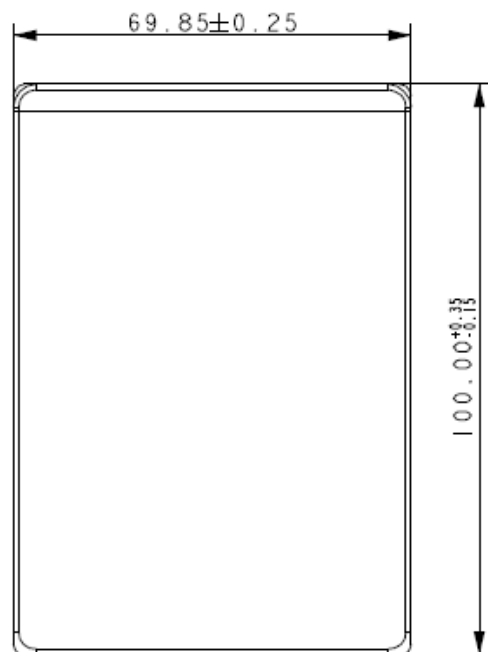
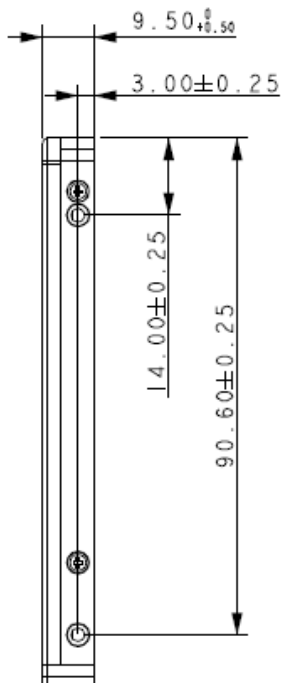
B. Dimension: 100.10mm(L) x 69.9mm(W) x 9.50mm(H)

Bottom View



Side View

Top View



Warning

- Do not bend, crush, drop, or place heavy objects on top of the Product. Do not use tweezers, pliers, or similar items that could damage the Product. Take particular care when inserting or removing the Product. Stop using the Product when the Product does not work properly. Failure to follow these instructions could result in fire, damage to the

Product and/or other property, and/or personal injury including burns and electric shock.

- Keep out of reach of small children. Accidental swallowing may cause suffocation or injury. Contact a doctor immediately if you suspect a child has swallowed the Product. .
- Do not directly touch the interface pins, put them in contact with metal, strike them with hard objects, or cause them to short. Do not expose to static electricity.
- Do not disassemble or modify the Product. This may cause electric shock, damage to the Product, or fire.

Notes on usage

- The Product contains nonvolatile semiconductor memory. Do not use the Product in accordance with a method of usage other than that written in the manual. This may cause the destruction or loss of data.
- To protect against accidental data loss, you should back up your data frequently on more than one type of storage media. **** Corporation assumes no liability for destruction or loss of data recorded on the Card for any reason.
- When used over a long period of time or repeatedly, the reading, writing and deleting capabilities of the Product will eventually fail, and the performance speed of the Product may decrease below the original speed specific to the Product's applicable class.
- If the Product is to be transferred or destroyed, note that the data it contained may still be recoverable unless it is permanently deleted by third-party deletion software or similar means beforehand.

Product applications and design.

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