

Integral Industrial 2.5” SATA SSD (PS3109-S9) Specification Pseudo SLC

Version 1.9

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Product Overview

<ul style="list-style-type: none">● Capacity<ul style="list-style-type: none">▪ 2GB up to 128GB^{Note1}● SATA Interface<ul style="list-style-type: none">▪ SATA Revision 3.0▪ SATA 1.5Gbps, 3Gbps, and 6Gbps interface● Flash Interface<ul style="list-style-type: none">▪ Flash type: MLC▪ 1pcs to 4pcs of TSOP/BGA flash^{Note2}● Performance<ul style="list-style-type: none">▪ Read: up to 530 MB/s▪ Write: up to 195 MB/s● Power Consumption^{Note3}<ul style="list-style-type: none">▪ Active mode: $\leq 3,490\text{mW}$▪ Idle mode: $\leq 320\text{mW}$▪ DEVSLP mode: $\leq 5\text{mW}$	<ul style="list-style-type: none">● TBW (Terabytes Written)^{Note4}<ul style="list-style-type: none">▪ 2,116 TBW for 128GB● MTBF<ul style="list-style-type: none">▪ More than 2,000,000 hours● Advanced Flash Management<ul style="list-style-type: none">▪ Static and Dynamic Wear Leveling▪ Bad Block Management▪ TRIM▪ NCQ▪ SMART▪ Over-Provision▪ Firmware Update● Low Power Management<ul style="list-style-type: none">▪ DEVSLP Mode (Optional)▪ DIPM/HIPM Mode● Temperature Range<ul style="list-style-type: none">▪ Operation: $-40^{\circ}\text{C} \sim 85^{\circ}\text{C}$▪ Storage: $-40^{\circ}\text{C} \sim 85^{\circ}\text{C}$● RoHS compliant
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Notes:

1. Please see “1.13 Pseudo SLC” for details.
2. Please see “4.2 Power Consumption” for details.
3. Please see “TBW (Terabyte Written)” in Chapter 2” for details.

Performance and Power Consumption

Flash Process (nm)	Capacity		Flash Structure	Performance		Power Consumption		
				CrystalDiskMark		Read (mW)	Write (mW)	DEVSLP (mW)
				Read (MB/s)	Write (MB/s)			
	2GB	Check for availability	4GB x1, TSOP	115	45	705	690	4.9
	4GB	Check for availability	4GB x 2, TSOP	235	109	870	860	4.9
	8GB	Check for availability	4GB x 4, TSOP	476	170	1,200	1,050	4.9
	16GB	Check for availability	8GB x 4, TSOP	505	175	1,300	1,200	4.9
	32GB	Check for availability	32GB x 2, BGA	519	180	1,400	1,400	4.9
	64GB	INIS2564GPSLC	32GB x 4, BGA	519	190	1,550	1,600	4.9
	128GB	INIS25128GPSLC	64GB x 4, TSOP	505	175	1,300	1,200	4.9

NOTE:

For more details on Power Consumption, please refer to Chapter 4.2.

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1. INTRODUCTION



1.1. Controller Block Diagram

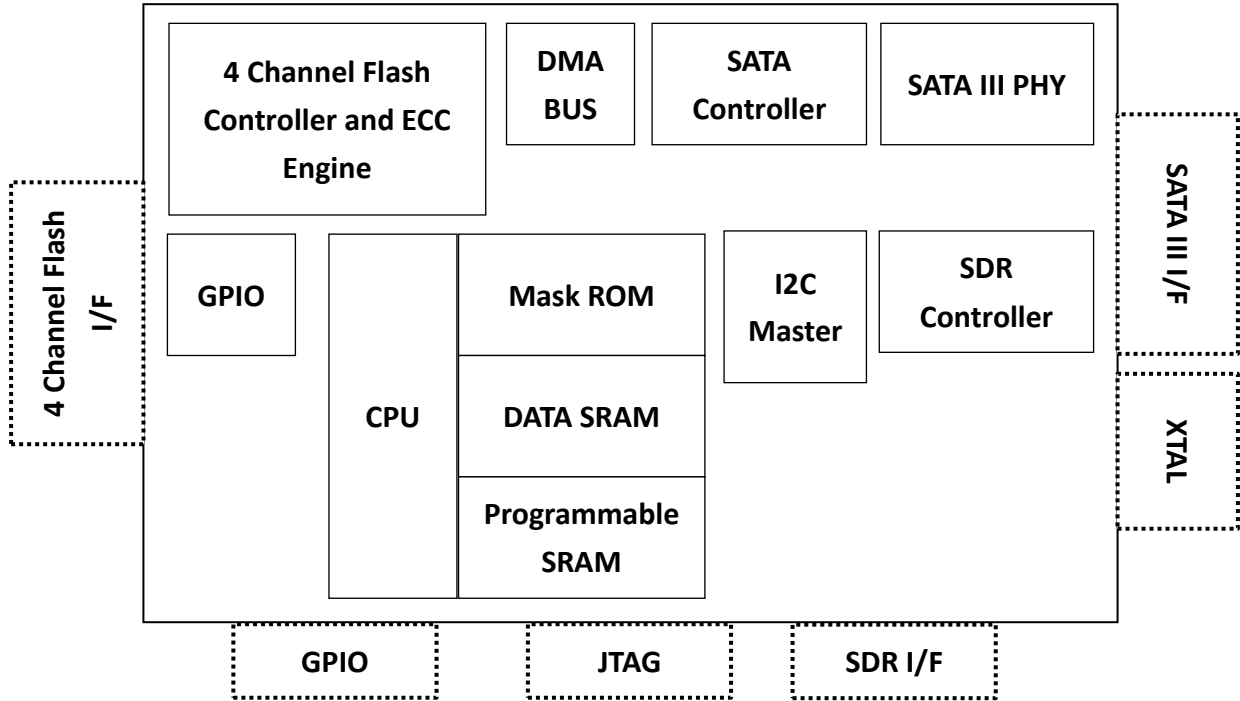


Figure 1-1 PS3109 2.5'' SATA SSD Controller Block Diagram

1.2. Product Block Diagram

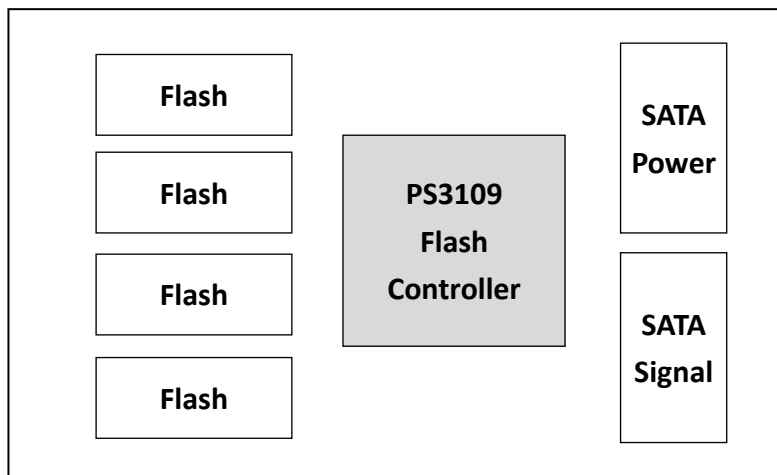
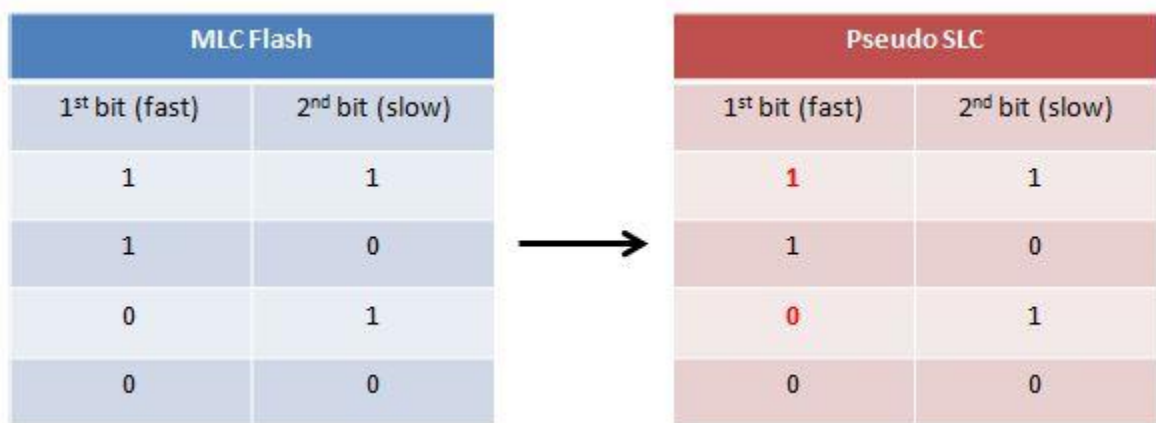


Figure 1-2 PS3109 2.5'' SATA SSD Product Block Diagram

1.3. Pseudo SLC

Pseudo SLC can be considered as an extended version of the MLC. While MLC contains both fast and slow pages, pseudo SLC only applies fast pages for programming. The concept of pseudo SLC is demonstrated in the two tables below. The first and second bits of a memory cell represent a fast and slow page respectively, as shown in the left table. Since only fast pages are programmed when applying pseudo SLC, the bits highlighted in red are used, as shown in the right table. Accordingly, because only fast pages are programmed, pseudo SLC provides better performance and endurance than MLC. Moreover, pseudo SLC performs similarly to the SLC, yet more cost effective.



2. PRODUCT SPECIFICATIONS



- **Capacity**
 - From 2GB up to 128GB for Pseudo SLC Application (support 48-bit addressing mode)
- **Electrical/Physical Interface**
 - SATA Interface
 - ◆ Compliant with SATA Revision 3.0
 - ◆ Compatible with SATA 1.5Gbps, 3Gbps and 6Gbps interface
 - ◆ NCQ support up to queue depth = 32
 - ◆ Support power management
 - ◆ Support expanded register for SATA protocol 48 bits addressing mode
 - ◆ Embedded BIST function for SATA PHY for low cost mass production
- **Supported NAND Flash**
 - Toshiba A19 nm / 15 nm MLC, Toggle1.0 and Toggle2.0
 - For pSLC 128GB solution only, Integral uses our own sorted Toshiba BGA flash.
 - Build-in hardware ECC circuit (up to 72bit/1KB)
 - Support all types of SLC/MLC large block: 8KB/page and 16K/page NAND Flash
 - Support ONFI 2.3 interface: 4 channels at maximum
 - Bus Width: 8/16 bit
 - Contain 1pc to 4pcs of TSOP/BGA Flash
- **ECC Scheme**
 - PS3109 2.5" SATA SSD can correct up to 72 bits error in 1K Byte data.
- **UART function**
- **GPIO**
- **Support SMART and TRIM commands**

- Performance – see page 3
- TBW (Terabytes Written)

Capacity	Flash Structure	TBW
2GB	4GBx 1	33
4GB	4GBx 2	66
8GB	4GB x 4	132
16GB	32GB x 1 8GB x 4	264
32GB	64GB x 1 16GB x 4 32GB x 2	529
64GB	32GB x 4 64GB x 2	1,058
128GB	64GB x 4	2,116

NOTES:

1. Samples were built using Toshiba A19 nm / 15 nm Toggle MLC NAND Flash.
2. TBW may differ according to flash configuration, SDR configuration, and platform.

3. ENVIRONMENTAL SPECIFICATIONS



3.1. Environmental Conditions

3.1.1. Temperature and Humidity

- Temperature:
 - ◆ Storage: -40°C to 85°C
 - ◆ Operational: -40°C to 85°C
- Humidity:
 - ◆ RH 95% under 55°C (operational)

Table 3-1 High Temperature Test Condition

	Temperature	Humidity	Test Time
Operation	85°C	0% RH	72 hours
Storage	85°C	0% RH	168 hours

Result: No any abnormality is detected.

Table 3-2 Low Temperature Test Condition

	Temperature	Humidity	Test Time
Operation	-40°C	0% RH	72 hours
Storage	-40°C	0% RH	168 hours

Result: No any abnormality is detected.

Table 3-3 High Humidity Test Condition

	Temperature	Humidity	Test Time
Operation	55°C	95% RH	72 hours
Storage	55°C	95% RH	96 hours

Result: No any abnormality is detected.

Table 3-4 Temperature Cycle Test

	Temperature	Test Time	Cycle
Operation	-40°C	30 min	20 cycles
	85°C	30 min	
Storage	-40°C	30 min	50 cycles
	85°C	30 min	

Result: No any abnormality is detected.

3.1.2. Shock

Table 3-5 PS3109 2.5" SATA SSD Shock Specification

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

Result: No any abnormality is detected when power on.

3.1.3. Vibration

Table 3-6 PS3109 2.5" SATA SSD Vibration Specification

	Condition		Vibration Orientation
	Frequency/Displacement	Frequency/Acceleration	
Operational	20Hz~80Hz/1.52mm	80Hz~2000Hz/20G	X, Y, Z axis/60 min for each

Result: No any abnormality is detected when power on.

3.1.4. Drop

Table 3-7 PS3109 2.5" SATA SSD Drop Specification

	Height of Drop	Number of Drop
Non-operational	80 cm free fall	6 face of each unit, 2 times each

Result: No any abnormality is detected when power on.

3.1.5. Bending

Table 3-8 PS3109 2.5" SATA SSD Bending Specification

	Force	Action
Non-operational	≥50N	Hold 1min/5times

Result: No any abnormality is detected when power on.

3.1.6. Electrostatic Discharge (ESD)

Table 3-9 PS3109 2.5" SATA SSD Contact ESD Specification

Device	Capacity	Temperature	Relative Humidity	+/- 4KV	Result
2.5" SSD	128GB	24.0°C	49% (RH)	Device functions are affected, but EUT will be back to its normal or operational state automatically.	PASS

3.1.7. EMI Compliance

- FCC: CISPR22

- CE: EN55022
- BSMI 13438

3.2. 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 Integral's PS3109 2.5" SATA SSD is more than 2,000,000 hours.

3.3. Certification & Compliance

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

4. ELECTRICAL SPECIFICATIONS



4.1. Supply Voltage

Table 4-1 Supply Voltage of PS3109 2.5" SATA SSD

Parameter	Rating
Operating Voltage	5V

4.2. Power Consumption

Table 4-2 Power Consumption of PS3109 2.5" SATA SSD

Flash Process (nm)	Capacity	Flash Structure	Flash Type	Read	Write	Partial	Slumber	Idle	DEVSLP
A19nm	2GB	4GB x 1	TSOP	1,285	1,195	55	35	310	4.9
	4GB	4GB x 2	TSOP	1,845	1,220	55	30	315	4.9
	8GB	4GB x4	TSOP	1,785	1,930	55	30	315	4.8
	16GB	8GB x 4	TSOP	2,485	2,270	55	30	315	4.9
	32GB	16GB x 4	TSOP	1,785	1,905	55	30	310	4.8
	64GB	32GB x 4	BGA	3,000	2,340	50	30	305	4.8
			TSOP	1,920	1,580	62	40	310	4.9
15 nm	2GB	4GB x 1	TSOP	705	690	55	35	280	4.9
	4GB	4GB x 2	TSOP	870	860	50	35	285	4.9
	8GB	4GB x 4	TSOP	1,200	1,050	50	38	325	4.9
	16GB	32GB x 1	TSOP	880	870	50	35	300	4.9
		8GB x 4	TSOP	1,300	1,200	55	34	310	4.9
	32GB	64GB x 1	TSOP	880	870	55	35	300	4.9
		32GB x 2	TSOP	1,100	1,200	55	44	325	4.9
		16GB x 4	TSOP	1,250	1,270	58	34	320	4.9
		32GB x 2	BGA	1,400	1,400	50	30	310	4.9
	64GB	32GB x 4	TSOP	1,300	1,200	53	30	310	4.9
		64GB x 2	TSOP	1,100	1,200	52	30	310	4.9
		32GB x 4	BGA	1,550	1,600	55	35	280	4.9
	128GB	64GB x 4	TSOP	1,300	1,200	50	35	310	4.9
		64GB x 4	BGA	1,600	1,660	50	38	325	4.9

Unit: mW

NOTES:

1. It's average value of power consumption based on 100% conversion efficiency.
2. The measured power voltage is 5V.
3. Samples were built using Toshiba A19 nm / 15 nm Toggle MLC NAND Flash and measured under normal temperature.
4. Sequential R/W is measured while testing 4000MB sequential R/W 5 times by CrystalDiskMark. DEVSLP is measured while entering device sleep mode for 5 minutes.
5. Power Consumption may differ according to flash configuration, SDR configuration, or platform.

5. INTERFACE



5.1. Pin Assignment and Descriptions

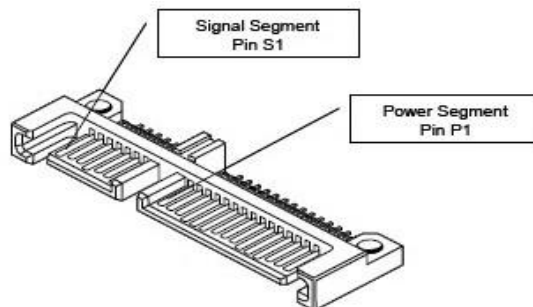


Figure 5-1 PS3109 2.5'' SATA SSD Pin Assignment

Table 5-1 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

Table 5-2 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)

6. SUPPORTED COMMANDS



6.1. ATA Command List

Table 6-1 ATA Command List

Op Code	Description	Op Code	Description
00h	NOP	97h	IDLE
06h	Data Set Management	98h	CHECK POWER MODE
10h-1Fh	Recalibrate	99h	SLEEP
20h	Read Sectors	B0h	SMART
21h	Read Sectors without Retry	B1h	DEVICE CONFIGURATION
24h	Read Sectors EXT	C4h	Read Multiple
25h	Read DMA EXT	C5h	Write Multiple
27h	Read Native Max Address EXT	C6h	Set Multiple Mode
29h	Read Multiple EXT	C8h	Read DMA
2Fh	Read Log EXT	C9h	Read DMA without Retry
30h	Write Sectors	CAh	Write DMA
31h	Write Sectors without Retry	CBh	Write DMA without Retry
34h	Write Sectors EXT	CEh	Write Multiple FUA EXT
35h	Write DMA EXT	E0h	Standby Immediate
37h	Set Native Max Address EXT	E1h	Idle Immediate
38h	CFA WRITE SECTORS WITHOUT ERASE	E2h	Standby
39h	Write Multiple EXT	E3h	Idle
3Dh	Write DMA FUA EXT	E4h	Read Buffer
3Fh	Write Long EXT	E5h	Check Power Mode
40h	Read Verify Sectors	E6h	Sleep
41h	Read Verify Sectors without Retry	E7h	Flush Cache
42h	Read Verify Sectors EXT	E8h	Write Buffer
45h	WRITE UNCORRECTABLE EXT	EAh	Flush Cache EXT
60h	Read FPDMA Queued	ECh	Identify Device
61h	Write FPDMA Queued	EFh	Set Features
70h-7Fh	Seek	F1h	Security Set Password
90h	Execute Device Diagnostic	F2h	Security Unlock
91h	Initialize Device Parameters	F3h	Security Erase Prepare
92h	Download Microcode	F4h	Security Erase Unit
93h	DOWNLOAD MICROCODE DMA	F5h	Security Freeze Lock

94h	STANDBY IMMEDIATE	F6h	Security Disable Password
95h	IDLE IMMEDIATE	F8h	Read Native Max Address
96h	STANDBY	F9h	Set Max Address

6.2. Identify Device Data

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

Table 6-2 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 (xxxxxxxx)
47	F	8010h	7:0- Maximum number of sectors transferred per interrupt on MULTIPLE commands
48	F	4000h	Trusted Computing feature set options(not support)
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
Word	F: Fixed V: Variable X: Both	Default Value	Description
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	450eh	Serial SATA capabilities
77	F	0084h	Serial ATA Additional Capabilities
78	F	014Ch	Serial ATA features supported
79	V	0040h	Serial ATA features enabled
80	F	07F8h	Major Version Number
81	F	0000h	Minor Version Number
82	F	346bh	Command set supported
83	F	7d09h	Command set supported
84	F	6063h	Command set/feature supported extension
85	V	3469h	Command set/feature enabled
86	V	bc01h	Command set/feature enabled
87	V	6063h	Command set/feature default
88	V	003Fh	Ultra DMA Modes
89	V	0001h or 1eh	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
Word	F: Fixed V: Variable X: Both	Default Value	Description
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	0008h	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	4014h	Supported settings
120	F	4014h	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
129-140	X	0h	Vendor specific
141	X	0001h	Vendor specific
142-159	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	Device Nominal Form Factor

		inch	
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
Word	F: Fixed V: Variable X: Both	Default Value	Description
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	107Fh	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		FFFEh	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)

Table 6-3 List of Device Identification for Each Capacity

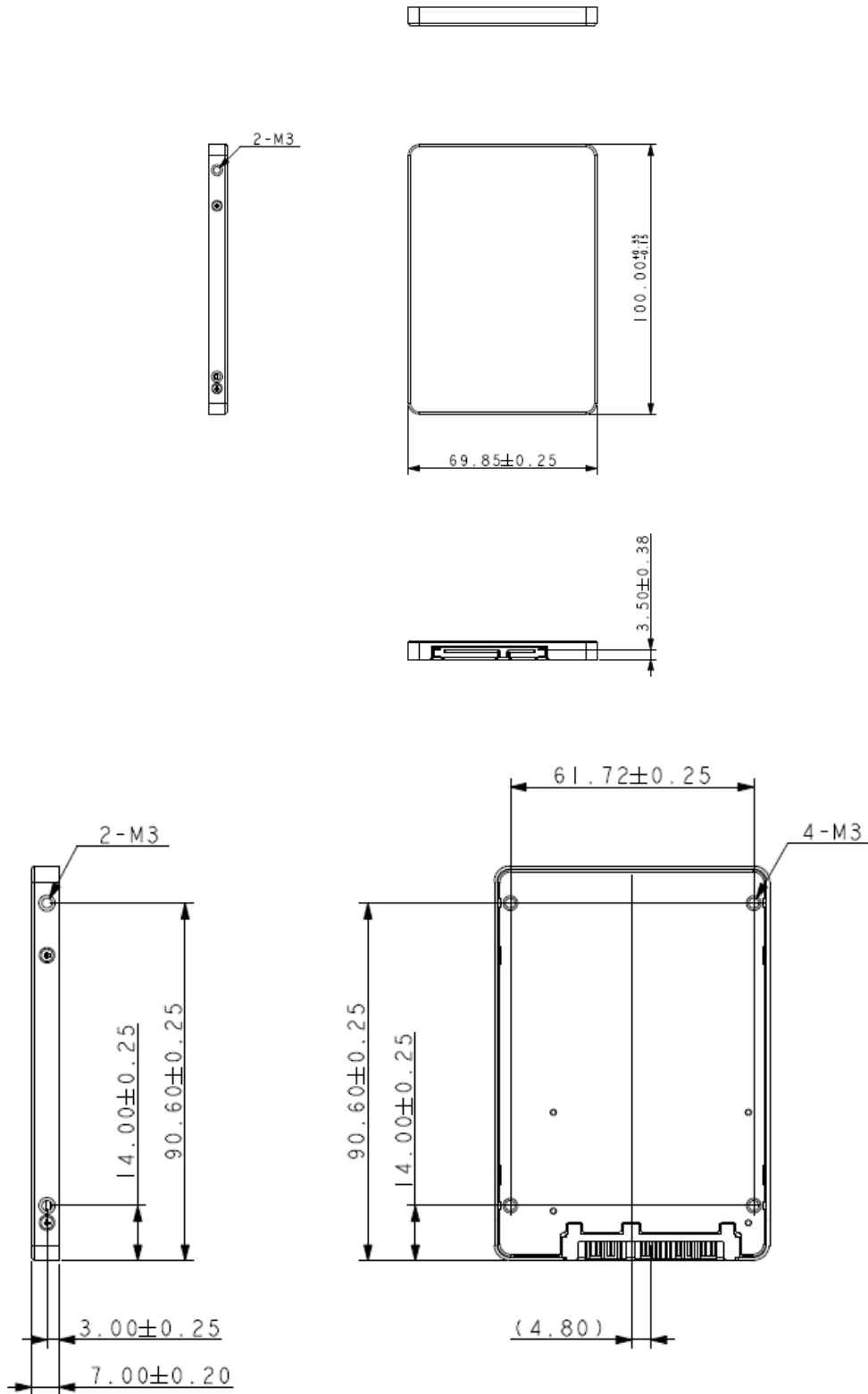
Capacity (GB)	*1 (Word 1/Word 54)	*2 (Word 57 - 58)	*3 (Word 60-61)	*4 (Word 100-103)
2	F39h	3BF070h	3BF070h	3BF070h
4	1E5Dh	778E30h	778E30h	778E30h
8	3CA5h	EEC9B0h	EEC9B0h	EEC9B0h

16	3FFFh	FBFC10h	1DD40B0h	1DD40B0h
32	3FFFh	FBFC10h	3BA2EB0h	3BA2EB0h
64	3FFFh	FBFC10h	7740AB0h	7740AB0h
128	3FFFh	FBFC10h	EE7C2B0h	EE7C2B0h

7. PHYSICAL DIMENSION



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



PCB Dimension: 39.00mm(L) x 54.00mm(W) x 0.85mm(H)

Screw: M1.5 (Max)

Note:Please assembly PCB with proper housing according to the PCB specifications

