DELKIN DEVICES®

Utility +

SATA III mSATA

Solid State Drive

Engineering Specification

Document Number: 401-0577-00

Revision: A

Product Overview

- **Capacity**
  - 128GB up to 1TB
- **SATA Interface**
  - SATA Revision 3.1
  - SATA Gen3 /Gen 2/Gen 1 interface
- **Flash Interface**
  - Flash type: 3D TLC
- **Performance**
  - Read: up to 550 MB/s
  - Write: up to 510 MB/s
- **Power Consumption**[Note1]
  - Active mode: < 1,750mW
  - Idle mode: < 210mW
- **MTBF**
  - More than 2,500,000 hours
- **Features**
  - Advanced Wear Leveling
  - Bad Block Management
  - TRIM
  - SMART
  - Over-Provisioning
- **Low Power Management**
  - DEVSLP Mode (Optional)
  - DIPM/HIPM Mode
- **Temperature Range**
  - Operation: -40°C ~ 85°C
  - Storage: -40°C ~ 85°C
- **RoHS compliant**

Notes:

1. Please see “4.2 Power Consumption” for details.

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1. INTRODUCTION

1.1. General Description

Delkin's Utility+ mSATA Solid State Drive (SSD) delivers all the advantages of flash disk technology with Serial ATA I/II/III interface and is fully compliant with the JEDEC MO-300B form factor standard. The mSATA draws significantly lower power compared to traditional hard drives. The drive is available in capacities from 128GB to 1TB and can reach speeds up to 550MB/s read as well as 510MB/s write (measured by CrystalDiskMark v5.0).

1.2. Product Block Diagram

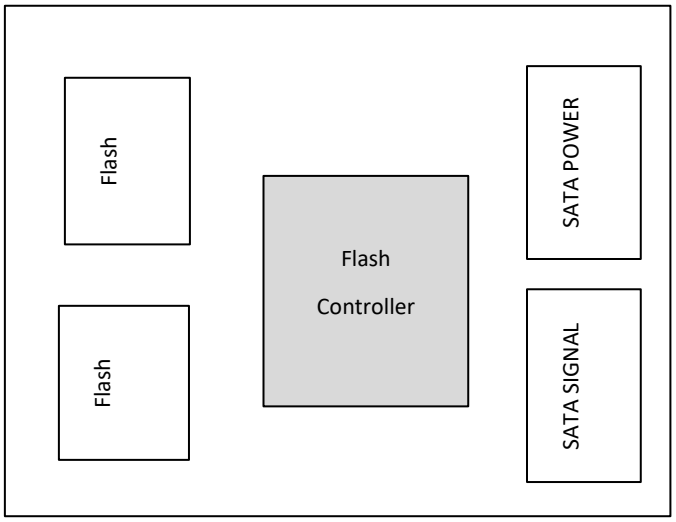


Figure 1-1 Top Side mSATA SSD Product Block Diagram

1.3. Flash Management

1.3.1. Error Correction Code (ECC)

Flash memory cells will deteriorate with use, which might generate random bit errors in the stored data. Thus, Delkin's Utility+ mSATA SSD applies the LDPC (Low Density Parity Check) algorithm, which can detect and correct errors occur during read process, ensure data been read correctly, as well as protect data from corruption.

1.3.2. 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 are updated more frequently than others, the lifetime of the device would be reduced significantly. Thus, Wear Leveling is applied to extend the

lifespan of NAND flash by evenly distributing write and erase cycles across the media.

Delkin utilizes advanced Wear Leveling algorithms, which can efficiently distribute 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.

1.3.3. 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 usage of the flash are named “Later Bad Blocks”. Delkin 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 data reliability.

1.3.4. 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 an erase action, which prevents unused data from occupying blocks.

1.3.5. SMART

SMART, an acronym for Self-Monitoring, Analysis and Reporting Technology, is an open standard that allows a 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.

1.3.6. Over-Provisioning

Over Provisioning refers to the inclusion of extra NAND capacity in a SSD, which is not visible or usable 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.

1.3.7. Thermal Throttling

The purpose of thermal throttling is to prevent any components in the SSD from over-heating during read and write operations. Firmware will apply different levels of throttling to achieve the purpose of protection efficiently and proactively via SMART reading.

1.4. Low Power Management

1.4.1. DEVSLP Mode (Optional)

With the increasing need of aggressive power/battery life, SATA interfaces include a new feature, Device Sleep (DEVSLP) mode, which helps further reduce the power consumption of the device. DEVSLP enables the device to completely power down the device PHY and other sub-systems, making the device reach a new level of lower power operation. The DEVSLP does not specify the exact power level a device can achieve in the DEVSLP mode, but the power usage can be dropped down to 5mW or less.

1.4.2. DIPM/HIPM Mode

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

1.5. Advanced Device Security Features

1.5.1. Secure Erase

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

1.5.2. Write Protect

When a SSD contains too many bad blocks and data is continuously written in, then the SSD may no longer be usable. 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.

1.6. SSD Lifetime Management

1.6.1. 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) x (SSD Capacity) x (WLE)] / WAF

NAND Endurance: NAND endurance refers to the P/E (Program/Erase) cycle of a NAND flash.

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

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.

1.7. An Adaptive Approach to Performance Tuning

1.7.1. Throughput

Based on the available space of the disk, Delkin SSD controller will regulate the read/write speed and manage the throughput performance. When significant free space remains, the firmware will continuously perform read/write activity. At this stage, there is still no need to implement garbage collection to allocate and release memory, which will accelerate read/write processing to improve the performance. However, when free space is used up, the controller will slow down the read/write processing, and implement garbage collection to release memory blocks. Hence, read/write performance will become slower.

1.7.2. Predict & Fetch

Normally, when the host tries to read data from the SSD, the SSD will only perform one read action after receiving one command. However, Delkin's controller applies ***Predict & Fetch*** to improve the read speed. When the host issues sequential read commands to the SSD, the SSD will automatically expect that the following will also be read commands. Thus, before receiving the next command, flash has already prepared the data. Accordingly, this accelerates the data processing time, and the host does not need to wait as long to receive data.

2. PRODUCT SPECIFICATIONS

- **Capacity**
  - From 128GB up to 1TB

- **Electrical/Physical Interface**
  - SATA Interface
    - Compliant with SATA Revision 3.1
    - Compatible with SATA Gen3/ Gen2/ Gen1 interface
    - AC coupling for transmitter and receiver
    - Self-calibrated and embedded termination resistor at transmitter
    - Supports power management
    - Supports expanded register for SATA protocol 48 bit addressing mode

- **ECC Scheme**
  - LDPC (Low Density Parity Check) ECC algorithm.

- **Operation Voltage Supply**
  - 3.3V ± 5%

- **Supports SMART and TRIM commands**

- **Performance and Power Consumption**

Capacity	Performance		Power Consumption		
	CrystalDiskMark		Read (mW)	Write (mW)	IDLE (mW)
	Read (MB/s)	Write (MB/s)			
128GB	550	450	1150	1250	210
256GB	550	485	1150	1350	210
512GB	550	500	1250	1600	210
1TB	550	510	1350	1750	210

NOTE:

1. The average value of power consumption is achieved based on 100% conversion efficiency.
2. Sequential R/W is measured while testing 4000MB sequential R/W 5 times by CyrstalDiskMark.
3. Power Consumption may differ according to flash configuration, SDR configuration, or platform.
4. Measurement environment: Room temperature: 20~25℃, humidity: 40~60%RH.
5. The performance was measured using CrystalDiskMark v5.0x64 with SATA 6Gbps host.
6. Performance may differ according to flash configuration, SDR configuration, and platform.
7. The table above is for reference only. The criteria for MP (mass production) and for accepting goods shall be discussed based on different flash configuration

• Endurance - TBW (Terabytes Written)

Capacity	TBW
128GB	65
256GB	220
512GB	540
1TB	1200

NOTES:

1. The test followed JEDEC 219A client endurance workload.
2. TBW may differ according to flash configuration, platform and data written.
3. The endurance of SSD could be estimated based on user behavior, NAND endurance cycles, and write amplification factor. It is not guaranteed by flash vendor.

• Part Numbers

3D TLC mSATA (-40 to 85°C Operating Temperature)

Capacity	Part Number
128GB	ME1HFTTM5-3N000-2
256GB	ME2HFTUM5-3N000-2
512GB	ME5HFTVM5-3N000-2
1TB	ME1TFTVM5-3N000-2

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 90% under 55°C (operational)

3.1.2. Shock & Vibration

- Shock Specification
  - 1500G, G0-p/0.5ms duration

- Vibration Specification
  - 20Hz ~ 80Hz/1.52mm displacement, 80Hz~2000Hz / 20Gp-p

3.1.3. Electrostatic Discharge (ESD)

- +/- 4KV contact

3.1.4. EMI Compliance

- FCC : ANSI C63.4
- CE: EN 55032, CISPR32
- BSMI : CNS 13438
- VCCI : VCCI-CISPR32

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 Delkin's mSATA SSD is more than 2,500,000 hours.

3.3. Certification & Compliance

- RoHS

4. ELECTRICAL SPECIFICATIONS

4.1. Supply Voltage

Table 4-1 Supply Voltage

Parameter	Rating
Operating Voltage	3.3V, +/- 5% (3.14 - 3.46V)
Rise Time (Max./Min.)	100ms / 0.1ms
Fall Time (Max./Min.)	5s / 10ms
Min. Off Time	1s

4.2. Power Consumption

Table 4-2 Power Consumption

Capacity	Read	Write	Partial	Slumber	Idle
128GB	1,150	1,250	65	25	210
256GB	1,150	1,350	65	25	210
512GB	1,250	1,600	65	27	210
1TB	1,350	1,750	65	27	210

Unit: mW

NOTES:

1. 1The average value of power consumption is achieved based on 100% conversion efficiency.
2. Sequential R/W is measured while testing 4000MB sequential R/W 5 times by CyrstalDiskMark.
3. Power Consumption may differ according to flash configuration, SDR configuration, or platform.
4. Measurement environment: Room temperature: 20~25℃, humidity: 40~60%RH..

5. INTERFACE

5.1. Pin Assignment and Descriptions

Table 5-1 Pin Assignment and Description for mSATA

Pin Number	mSATA Pin	Description
1	NC	No Connect
2	+3.3V	3.3V Source
3	NC	No Connect
4	DGND	Digital GND
5	NC	No Connect
6	NC	No Connect
7	NC	No Connect
8	NC	No Connect
9	DGND	Digital GND
10	NC	No Connect
11	NC	No Connect
12	NC	No Connect
13	NC	No Connect
14	NC	No Connect
15	DGND	Digital GND
16	NC	No Connect
17	NC	No Connect
18	DGND	Digital GND
19	NC	No Connect
20	NC	No Connect
21	SATA GND	SATA Ground Return Pin
22	NC	No Connect
23	TXP (out)	Host Receiver Differential Signal Pair
24	+3.3V	3.3V Source
25	TXN (out)	Host Receiver Differential Signal Pair
26	SATA GND	SATA Ground Return Pin
27	SATA GND	SATA Ground Return Pin
28	NC	No Connect
29	SATA GND	SATA Ground Return Pin
30	NC	No Connect
31	RXN (in)	Host Transmitter Differential Signal Pair
32	NC	No Connect
33	RXP (in)	Host Transmitter Differential Signal Pair

34	DGND	Digital GND
35	SATA GND	SATA Ground Return Pin
36	NC	No Connect
37	SATA GND	SATA Ground Return Pin
38	NC	No Connect
39	+3.3V	3.3V Source
40	DGND	Digital GND
41	+3.3V	3.3V Source
42	NC	No Connect
43	NC	No Connect
44	DEVSLP	Enter/Exit DevSleep
45	NC	Reserved Pin
46	NC	No Connect
47	NC	Reserved Pin
48	NC	No Connect
49	DAS	Device Activity Signal
50	DGND	Digital GND
51	GND	Default Connect to GND
52	+3.3V	3.3V Source

6. SUPPORTED COMMANDS

6.1. ATA Command List

Table 6-1 ATA Command List

Op Code	Description	Op Code			Description
00h	NOP	E1h			Idle Immediate
06h	Data Set Management	E2h			Standby
10h-1Fh	Recalibrate	E3h			Idle
20h	Read Sectors	E4h			Read Buffer
21h	Read Sectors without Retry	E5h			Check Power Mode
24h	Read Sectors EXT	E6h			Sleep
25h	Read DMA EXT	E7h			Flush Cache
27h	Read Native Max Address EXT	E8h			Write Buffer
29h	Read Multiple EXT	E9h			READ BUFFER DMA
2Fh	Read Log EXT	EAh			Flush Cache EXT
30h	Write Sectors	EBh			Write Buffer DMA
31h	Write Sectors without Retry	ECh			Identify Device
34h	Write Sectors EXT	EFh			Set Features
35h	Write DMA EXT	90h			Execute Device Diagnostic
37h	Set Native Max Address EXT	91h			Initialize Device Parameters
39h	Write Multiple EXT	92h			Download Microcode
3Dh	Write DMA FUA EXT	93h			Download Microcode DMA
3Fh	Write Long EXT	B0h			SMART
40h	Read Verify Sectors	EFh	02h		Enable volatile write cache
41h	Read Verify Sectors without Retry	EFh	03h		Set transfer mode
42h	Read Verify Sectors EXT	EFh	05h		Enable the APM feature set
47h	Read Log DMA EXT	EFh	10h		Enable use of SATA features et
57h	Write Log DMA EXT	EFh	10h	02h	Enable DMA Setup FIS Auto-Activate optimization
60h	Read FPDMA Queued	EFh	10h	03h	Enable Device-initiated interface power state (DIPM) transitions
61h	Write FPDMA Queued	EFh	10h	06h	Enable Software Settings Preservation (SSP)
70h-76h	Seek	EFh	10h	07h	Enable Device Automatic Partial to Slumber transitions
79h-7Fh	Seek	EFh	10h	09h	Enable Device Sleep
C9h	Read DMA without Retry	EFh	55h		Disable read look-ahead
CAh	Write DMA	EFh	66h		Disable reverting to power-on defaults
CBh	Write DMA without Retry	EFh	82h		Disable volatile write cache
CEh	Write Multiple FUA EXT	EFh	85h		Disable the APM feature set

Op Code			Description	Op Code			Description
E0h			Standby Immediate	EFh	90h		Disable use of SATA feature set
C4h			Read Multiple	EFh	90h	02h	Disable DMA Setup FIS Auto-Activate optimization
C5h			Write Multiple	EFh	90h	03h	Disable Device-initiated interface power state (DIPM) transitions
C6h			Set Multiple Mode	EFh	90h	06h	Disable Software Settings Preservation (SSP)
C8h			Read DMA	EFh	90h	07h	Disable Device Automatic Partial to Slumber transitions
B0h	D0h		SMART READ DATA	EFh	90h	09h	Disable Device Sleep
B0h	D2h	00h	SMART READ ATTRIBUTE THRESHOLDS	EFh	90h	02h	Disable DMA Setup FIS Auto-Activate optimization
B0h	D2h	F1h	SMART ENABLE ATTRIBUTE AUTOSAVE	EFh	90h	03h	Disable Device-initiated interface power state (DIPM) transitions
B0h	D4h		SMART EXECUTE OFF-LINE IMMEDIATE	EFh	90h	06h	Disable Software Settings Preservation (SSP)
B0h	D5h		SMART READ LOG	EFh	90h	07h	Disable Device Automatic Partial to Slumber transitions
B0h	D6h		SMART WRITE LOG	EFh	90h	09h	Disable Device Sleep
B0h	D8h		SMART ENABLE OPERATIONS	EFh	AAh		Enable read look-ahead
B0h	D9h		SMART DISABLE OPERATIONS	EFh	CCh		Enable reverting to power-on defaults
B0h	DAh		SMART RETURN STATUS	F1h			Security Set Password
B1h	C0h		DEVICE CONFIGURATION RESTORE	F2h			Security Unlock
B1h	C2h		DEVICE CONFIGURATION IDENTIFY	F3h			Security Erase Prepare
B1h	C3h		DEVICE CONFIGURATION SET	F4h			Security Erase Unit
B1h	C4h		DEVICE CONFIGURATION IDENTIFY DMA	F5h			Security Freeze Lock
B1h	C5h		DEVICE CONFIGURATION SET DMA	F6h			Security Disable Password
F9h	01h		SET MAX SET PASSWORD	F8h			Read Native Max Address
F9h	02h		SET MAXLOCK	F9h			Set Max Address
F9h	03h		SET MAX UNLOCK				
F9h	04h		SET MAX FREEZE LOCIK				

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: Retired / Obsolete / Reserved	Default Value	Description
0	F	0040h	General configuration bit-significant information
1	X	***1**	Obsolete
2	F	C837h	Specific configuration
3	X	***2**	Obsolete
4-5	X	0000h	Retired
6	X	***3**	Obsolete
7-8	X	0000h	Reserved for assignment by the Compact Flash Association
9	X	0000h	Retired
10-19	V	Varies	Serial number (ATA string)
20-21	X	0000h	Retired
22	X	***4**	Obsolete
23-26	V	Varies	Firmware revision (ATA string)
27-46	V	Varies	Model number (ATA string)
47	X	***5**	Obsolete
48	F	4000h	Trusted Computing feature set options
49	F	2F00h	Capabilities
50	F	4000h	Capabilities
51-52	X	***6**	Obsolete
53	F	0007h	Word 88 and 70:64 are valid
54-58	X	***7**	Obsolete
59	F	DD10h	Number of sectors transferred per interrupt on MULTIPLE commands
60-61	V	Varies	Maximum number of sector (28bit LBA mode)
62	X	***8**	Obsolete
63	F	0407h	Multiword DMA modes supported/selected
64	F	0003h	PIO mode 3 and mode 4 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

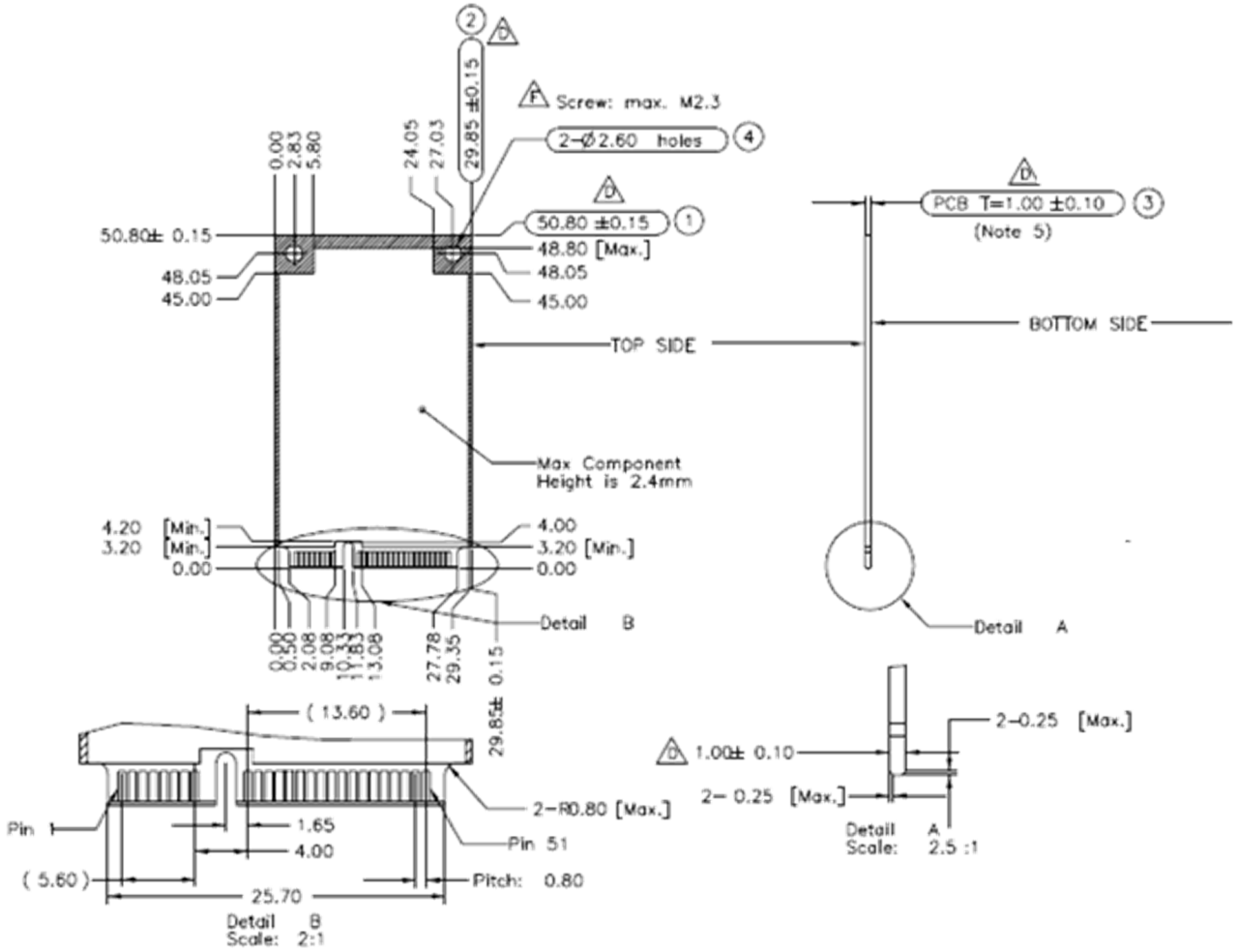
68	F	0078h	Minimum PIO transfer cycle time with IORDY flow control
69	F	9F00h	Additional Supported (support download microcode DMA)
70	X	0000h	Reserved
71-74	X	0000h	Reserved for the IDENTIFY PACKET DEVICE command
75	F	001Fh	Queue depth
76	F	C50Eh	Serial SATA capabilities
77	F	0006h	Serial ATA Additional Capabilities
78	F	004Ch	Serial ATA features supported
79	F	0040h	Serial ATA features enabled
80	F	0FF8h	Major Version Number
81	F	0000h	Minor Version Number
82	F	746Bh	Commands and feature sets supported
83	F	7D09h	Commands and feature sets supported
84	F	4163h	Commands and feature sets supported
85	F	7469h	Commands and feature sets supported or enabled
86	F	BC01h	Commands and feature sets supported or enabled
87	F	4163h	Commands and feature sets supported or enabled
88	F	007Fh	Ultra DMA Modes
89	F	000Ah	Time required for Security Erase Unit command
90	F	001Eh	Time required for Security Erase Unit command
91	F	0000h	Current APM level value
92	F	FFFEh	Master Password Identifier
93	F	0000h	Hardware reset result. For SATA devices, word 93 shall be set to the value 0000h.
94	X	*9	Obsolete
95	F	0000h	Stream Minimum Request Size
96	F	0000h	Streaming Transfer Time – DMA
97	F	0000h	Streaming Access Latency – DMA and PIO
98-99	F	0000h	Streaming Performance Granularity
100-103	V	Varies	Number of User Addressable Logical Sectors
104	F	0000h	Streaming Transfer Time – PIO
105	F	0004h	Maximum number of 512-byte blocks per DATA SET MANAGEMENT command

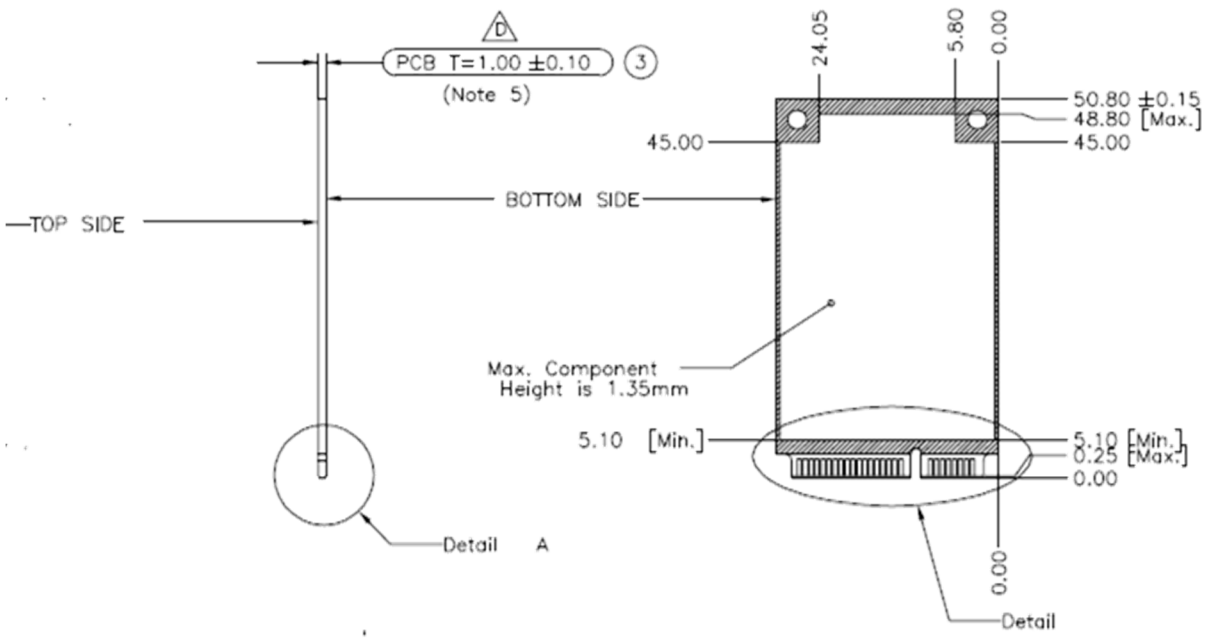
106	F	4000h	Physical sector size/Logical sector size
107	F	0000h	Inter-seek delay for ISO-7779 acoustic testing
108-111	V	Varies	World Wide Name
112-115	X	0000h	Reserved
116	X	*10	Obsolete
117-118	F	0000h	Logical sector size
119	F	4018h	Commands and feature sets supported
120	F	4018h	Commands and feature sets supported or enabled
121-126	X	0000h	Reserved for expanded supported and enabled settings
127	X	*11	Obsolete
128	F	0021h	Security status
129-159	V	Varies	Vendor specific
160-167	X	0000h	Reserved for CFA
168	V	Varies	Device Nominal Form Factor
169	F	0001h	DATA SET MANAGEMENT command support
170-173	F	0000h	Additional Product Identifier
174-175	X	0000h	Reserved
176-205	F	0000h	Current media serial number
206	F	0000h	SCT Command Transport
207-208	X	0000h	Reserved
209	F	4000h	Alignment of logical sectors within a physical sector
210-211	F	0000h	Write-Read-Verify Sector Mode 3 Count (not support)
212-213	F	0000h	Write-Read-Verify Sector Mode 2 Count (not support)
214-216	X	*12	Obsolete
217	F	0001h	Nominal media rotation rate
218	X	0000h	Reserved
219	X	*13	Obsolete
220	V	0000h	Write-Read-Verify feature set current mode
221	X	0000h	Reserved
222	F	107Fh	Transport major version number
223	F	0000h	Transport minor version number
224-229	X	0000h	Reserved
230-233	F	0000h	Extend number of user addressable sectors
234	F	0001h	Minimum number of 512-byte data blocks per Download Microcode operation

235	F	FFFEh	Minimum number of 512-byte data blocks per Download Microcode operation
236-254	X	0000h	Reserved
255	F	Varies	Integrity word (Checksum and Signature) Bit[15:8] Checksum

7. PHYSICAL DIMENSIONS

Dimension: 50.8mm (L) x 29.85mm (W) x 4.00mm (H)





Notes :

1. ▩ = Max Component Height is
2. ▨ = No Component
3. ▧ = No Component / Signal Vias / Signal Copper/Print
4. General Tolerance : ±0.1mm
5. (D) Card Thickness applies accross tab and includes plating and/or metalization
6. (E) Check Point: ① ~ ④
7. (F) Screw Max. Size M2.3

WARNING: This product may contain chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm. For more information go to www.p65warnings.ca.gov.