DELKIN DEVICES®

mSATA Solid State Drive
Mini-SATA Embedded Flash Module

Engineering Specification

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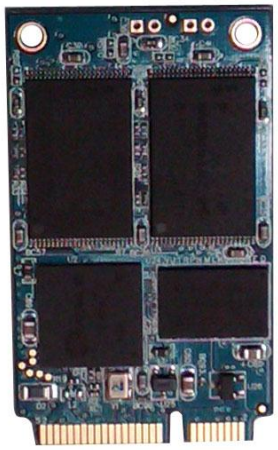

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1 General Specifications

Delkin's mSATA SSD drive combines solid state reliability with SATA connectivity for significant performance advantages over traditional hard disk drives. Manufactured to JEDEC MO-300B form factor specifications, the mSATA SSD is suited to embedded industrial applications where space is restricted. Its shock, vibration, and temperature ratings permit application in extreme environments. The drives can achieve sustained read/write rates of up to 120/90MB/s and feature storage capacities from 4GB to 64GB.

Table 1. Specification Summary

Specification	Value
Model number	See Table 2
Capacity	SLC: 4GB – 64GB MLC: 8GB – 128GB
Form factor	50.8 x 29.85 x 4.0mm (L x W x H)
Interface	SATA revision 2.6, compatible with SATA 1.5Gb/s and 3.0Gb/s interface rates. Flash I/O: 3.3V for Asynchronous Flash
Interface connector	miniPCIe 52-pin
Hot swappable	Yes
Environmental certifications	RoHS, WHQL, EMI, EMC, ESD, and CE/FCC
Performance	
Interface burst speed	1.5 or 3.0 Gb/s
Sustained read (512 byte)	Up to 145 MB/s (varies by configuration)
Sustained write (512 byte)	Up to 130 MB/s (varies by configuration)
Reliability/Data Integrity	
MTBF	2,000,000 power on hours
Data reliability	1 in 10^{14} bits, read
Endurance	Refer to Table 3 on page 7
Power	
Supply voltage (allowable)	3.3V ±10%
Typical current:	
Idle	170 mA
Slumber	40 mA
Read	250 mA
Write	350 mA
Environmental	
Storage temperature (°C)	-50 ~ 100°C
Operating temperature options (°C):	
• MLC Commercial	0 ~ 70°C
• SLC Commercial	0 ~ 70°C
• SLC Industrial	-40 ~ 85°C
Relative humidity (non-condensing)	95% under 55°C

Vibration (operating/non-operating)	20G (80 – 2000 Hz)
Shock (operating/non-operating)	1,500G/0.5 ms
Acoustic noise	0 dB
Altitude	80,000 feet max.
Physical Dimensions	
Height	4 mm
Width	29.85 mm
Length	50.8 mm

1.1 Interfaces

Figure 1 below provides a functional block diagram showing the interaction of mSATA SSD components.

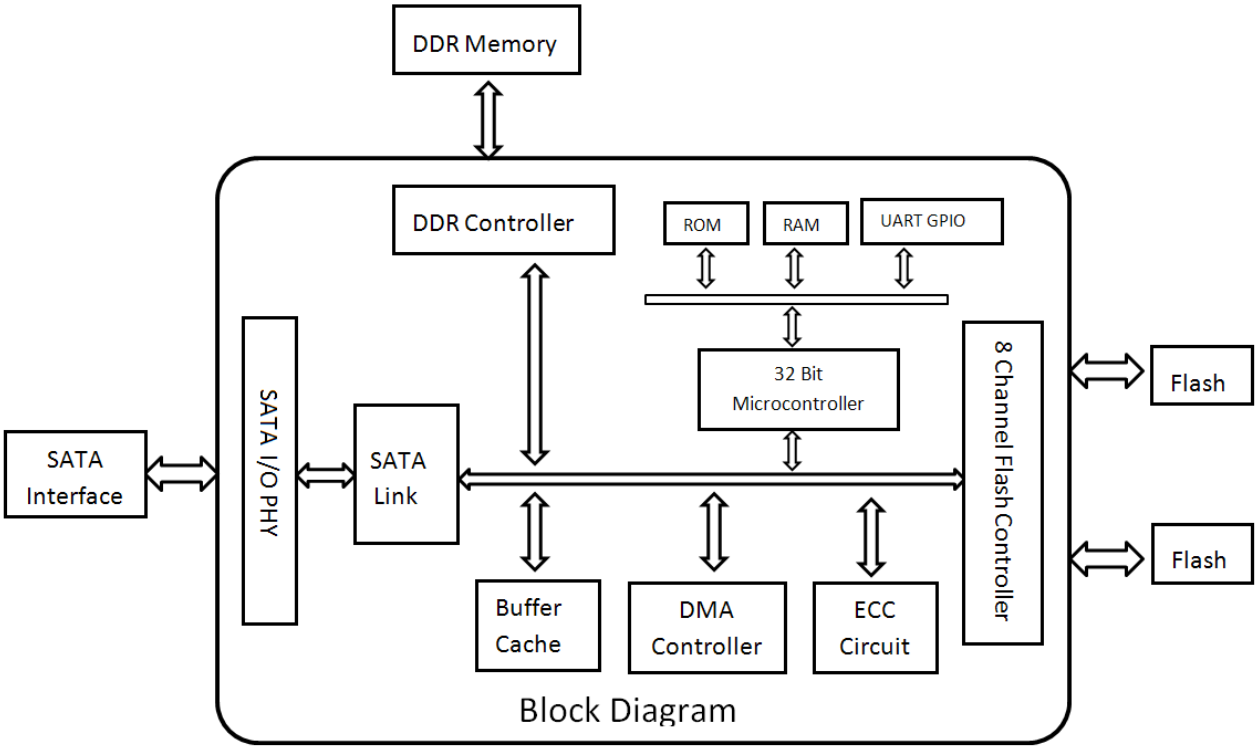

Figure 1. mSATA Flash Controller Block Diagram

1.1.1 Electrical / Physical Interfaces

- SATA Interface—supports SATA 1.5Gbps and 3Gbps interface
- DDR1 IO—supports DDR1 I/O interface to onboard SDRAM cache
- Flash IO—Asynchronous Flash (3.3V)

1.1.2 Controller Features

- **SATA II**
  - SATA Revision 2.6 compliant
  - Compatible with SATA 1.5Gbps and 3Gbps interface
  - Power management supported
  - Support expanded register for SATA protocol 48 bits addressing mode
- **NAND flash interface**
  - Built-in hardware ECC circuit (up to 40bit/1KB)
  - Support all types of SLC and MLC Large Block 8KB/page NAND Flash
  - Flash: 4 channels bus width: 8-bit or 16-bit each channel
  - Contains 4 pieces TSOP Flash
- **DDR1 interface**
  - 16-bit data bus
  - Data Rate: 300Mbps
  - Support Capacity : 64MB
- **Built-in 32-bit micro-controller**
  - Universal Asynchronous Receiver/Transceiver (UART)
  - General Purpose Input/Output (GPIO) for additional control options.

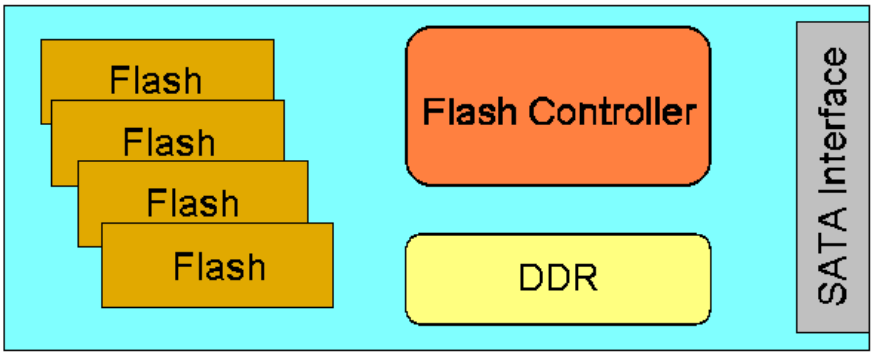

Figure 2. Delkin mSATA SSD block diagram with DDR cache buffer

1.2 Part Number Availability

Delkin mSATA Solid State Drives are available in the product grades and capacities shown in the table below. Drives are also available that feature Delkin's Tekta™ infusion process (conformal coating) for greater protection in extreme environments.

Table 2. Delkin mSATA SSD Capacities and Part Numbers

Capacity*	Product Grade	Delkin Part Number
8GB	MLC Commercial (0 to +70C)	MD08NFWTS–XN000–D
16GB	MLC Commercial (0 to +70C)	MD16NFXTS–XN000–D
32GB	MLC Commercial (0 to +70C)	MD32NFFTS–XN000–D
64GB	MLC Commercial (0 to +70C)	MD64NHETS–XN000–D
128GB	MLC Industrial (-40 to +85C)	MD1HNHDTS–XN000–D
2GB	SLC Commercial (0 to +70C)	MA02TFHTT–XN000–D
4GB	SLC Commercial (0 to +70C)	MA04TFNTT–XN000–D
8GB	SLC Commercial (0 to +70C)	MA08TFNTT–XN000–D
16GB	SLC Commercial (0 to +70C)	MA16TFPTT–XN000–D or MA16MGGTT–XN000–D or MA16MHSTT–XN000-D
32GB	SLC Commercial (0 to +70C)	MA32MGGTT–XN000–D
64GB	SLC Commercial (0 to +70C)	MA64MGMTT–XN000–D
2GB	SLC Industrial (-40 to +85C)	ME02TFHTT–XN000–D
4GB	SLC Industrial (-40 to +85C)	ME04TFNTT–XN000–D
8GB	SLC Industrial (-40 to +85C)	ME08TFNTT–XN000–D
16GB	SLC Industrial (-40 to +85C)	ME16TFPTT–XN000–D or ME16MGGTT–XN000–D or ME16MHSTT–XN000-D
32GB	SLC Industrial (-40 to +85C)	ME32MGGTT–XN000–D
64GB	SLC Industrial (-40 to +85C)	ME64MGMTT–XN000–D

*Note: Usable capacities are within 10% of the gross capacity figures shown above, which is typical with all NAND flash devices, as a small portion of the total is needed for controller firmware and spare block reserves.

1.3Reliability

Endurance

The table below provides estimates of drive endurance (expressed as Terabytes Written or TBW, or Gigabytes Written or GBW) based on specific workload scenarios, using a theoretical model that takes into account the specific flash specifications in each drive configuration. Contact Delkin for endurance estimates for other specific workload scenarios.

Table 3. Delkin mSATA Endurance Estimates by Part Number

		Sequential Write Size, 24/7 Operation	
Part Number(s)	Description	1000 Bytes/Sec	5000 Bytes/Sec
MD08NFWTS–XN000–D	8GB MLC Commercial	852 GBW	1 TBW
MD16NFXTS–XN000–D	16GB MLC Commercial	928 GBW	2 TBW
MD32NFFTS–XN000–D	32GB MLC Commercial	992 GBW	5 TBW
MD64NHETS–XN000–D	64GB MLC Commercial	1 TBW	9 TBW
MD1HNHDTS–XN000–D	128GB MLC Commercial or Industrial	3 TBW	17 TBW
MA02TFHTT–XN000–D ME02TFHTT–XN000–D	2GB SLC Commercial or Industrial	2 TBW	8 TBW
MA04TFNTT–XN000–D ME04TFNTT–XN000–D	4GB SLC Commercial or Industrial	5 TBW	16 TBW
MA08TFNTT–XN000–D ME08TFNTT–XN000–D	8GB SLC Commercial or Industrial	10 TBW	29 TBW
MA16TFPTT–XN000–D ME16TFPTT–XN000–D	16GB SLC Commercial or Industrial	8 TBW	52 TBW
MA16MHSTT–XN000-D ME16MHSTT–XN000-D	16GB SLC Commercial or Industrial	9 TBW	52 TBW
MA16MGGTT–XN000–D ME16MGGTT–XN000–D	16GB SLC Commercial or Industrial	9 TBW	52 TBW
MA32MGGTT–XN000–D ME32MGGTT–XN000–D	32GB SLC Commercial or Industrial	19 TBW	104 TBW
MA64MGMTT–XN000–D ME64MGMTT–XN000–D	64GB SLC Commercial or Industrial	39 TBW	187 TBW

The figures provided are estimates and not guarantees of endurance. Actual results may vary depending on usage, operating temperature and other conditions.

2 Electrical Specifications

2.1 Pin and Signal Assignments

Table 4. Power and signal pin-out

Pin #	mSATA	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

Pin #	mSATA	Description
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 Receiver 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	NC	No Connect
45	NC	Reserved pin
46	NC	No Connect
47	NC	Reserved pin
48	NC	No Connect
49	DA/DSS (option)	Option for LED output
50	DGND	Digital GND
51	GND	Default connect to GND
52	+3.3V	3.3V Source

2.2 Supply Voltage

Table 5. Supply voltage

Parameter	Rating
Operating Voltage	3.3V

2.3 Power Consumption

Table 6. Power Consumption (Current Draw)

Parameter	Value (mA)
Idle	190
Slumber	40
Read	250
Write	350

Note: Values based on 32GB (64Gbit MLC x4) statistics.

3 Command Descriptions

3.1 Supported ATA Commands

The commands listed in the following table are supported by the mSATA SSD.

Table 7. Supported ATA Commands

Command Name	Command Code (Hex)	Command Name	Command Code (Hex)
Check power mode	E5h	Security Erase Prepare	F3h
Check power mode	98h	Security Erase Unit	F4h
Download Microcode	92h	Security Freeze Lock	F5h
Execute drive diagnostic	90h	Security Set Password	F1h
Flush cache	E7h	Security Unlock	F2h
Flush cache Ext	Eah	Seek	7xh
Identify device	Ech	Set features	Efh
Idle	E3h	Set Max Address Ext	37h
Idle immediate	E1h	Set multiple mode	C6h
Idle immediate	95h	Sleep	E6h
Idle	97h	Sleep	99h
Initialize drive parameters	91h	Smart	B0h
NOP	00h	Standby	E2h
Read buffer	E4h	Standby immediate	E0h
Read DMA (w/retry)	C8h	Standby immediate	94h
Read DMA (w/o retry)	C9h	Standby	96h
Read Log Ext	2Fh	Write buffer	E8h
Read multiple	C4h	Write DMA (w/retry)	Cah
Read multiple Ext	29h	Write DMA (w/o retry)	CBh
Read sector(s) (w/retry)	20h	Write Log Ext	3Fh

Command Name	Command Code (Hex)	Command Name	Command Code (Hex)
Read sector(s) (w/o retry)	21h	Write multiple	C5h
Read sector(s) Ext	24h	Write sector(s) (w/retry)	30h
Read DMA Ext	25h	Write sector(s) (w/o retry)	31h
Read verify sector(s) (w/retry)	40h	Write sector(s) Ext	34h
Read verify sector(s) (w/o retry)	41h	Write DMA Ext	35h
Read FPDMA Ext	60h	Write sector(s) (w/o erase)	38h
Read Verify Ext	42h	Write FPDMA Ext	61h
Recalibrate	1xh	Write multiple Ext	39h
Security Disable Password	F6h		

3.2 Identity Device Data

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

Table 8. Device Sector Data

Word	F: Fixed V: Variable X: Both	Default Value	Description
0	F	045Ah	General configuration bit-significant information
1	X	3FFFh	Obsolete - Number of logical cylinders(16383)
2	V	0000h	Specific configuration
3	X	0010h	Obsolete - Number of logical heads (16)
4-5	X	02007E00h	Retired
6	X	003Fh	Obsolete - Number of logical sectors per logical track (63)
7-8	V	0h	Reserved for assignment by the Compact Flash Association
9	X	0h	Retired
10-19	F	Varies	Serial number (20 ASCII characters)
20-21	X	0h	Retired
22	X	0h	Obsolete

Word	F: Fixed V: Variable X: Both	Default Value	Description
23-26	F	Varies	Firmware revision (8 ASCII characters)
27-46	F	Varies	Model number (xxxxxxxx)
47	F	8001h	7:0 - Maximum number of sectors transferred per interrupt on MULTIPLE commands.
48	F	0h	Reserved
49	F	0F00h	Capabilities
50	F	4000h	Capabilities
51-52	X	00000200h	Obsoleted
53	F	0007h	Words 88 and 70:64 valid
54	X	3FFFh	Obsolete - Number of logical cylinders (16383)
55	X	0010h	Obsolete - Number of logical heads (16)
56	X	003Fh	Obsolete - Number of logical sectors per track (63)
57-58	X	00FBFC10h	Obsolete
59	F	0100h	Number of sectors transferred per interrupt on MULTIPLE commands
60-61	F	037DFF40h (32G) xxxxxxxxh (64G)	Total number of user addressable sectors
62	X	0h	Obsolete
63	F	0007h	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
69-70	F	0h	Reserved
71-74	F	0h	Reserved for the IDENTIFY PACKET DEVICE command
75	F	0h	Queue depth
76	F	0002h	Serial SATA capabilities
77	F	0h	Reserved for future Serial ATA definition

Word	F: Fixed V: Variable X: Both	Default Value	Description
78	F	0000h	Serial ATA features supported
79	V	0000H	Serial ATA features enabled
80	F	00F8h	Major Version Number
81	F	0021h	Minor Version Number
82	F	7429h	Command set supported
83	F	7008h	Command set supported
84	F	4000h	Command set/feature supported extension
85	V	7028h	Command set/feature enabled
86	V	3000h	Command set/feature enabled
87	V	4000h	Command set/feature default
88	V	007Fh	Ultra DMA Modes
89	F	0000h	Time required for security erase unit com
90	F	0000h	Time required for Enhanced security erase completion
91	V	0h	Current advanced power management value
92	V	0000h	Master Password Revision Code
93	F	0h	Hardware reset result. The contents of the bits (12:0) of this word shall change only during the execution of a hardware reset.
94	V	0h	Vendor's recommended and actual acoustic management value
95	F	0h	Stream Minimum Request Size
96	V	0h	Streaming Transfer Time - DMA
97	V	0h	Streaming Access Latency - DMA and PIO
98-99	F	0h	Streaming Performance Granularity
100-103	V	xxxxxxxxh (32G) xxxxxxxxh (64G) xxxxxxxxh (128G) xxxxxxxxh (256G)	Maximum user LBA for 48-bit Address feature set
104	V	0h	Streaming Transfer Time - PIO
105	F	0h	Reserved
106	F	0h	Physical sector size/Logical sector size

Word	F: Fixed V: Variable X: Both	Default Value	Description
107	F	0h	Inter-seek delay for ISO-7779 acoustic testing in microseconds
108-111	F	0h	Unique ID
112-115	F	0h	Reserved
116	V	0h	Reserved
117-118	F	0h	Words per logical Sector
119	F	0h	Supported settings
120	F	0h	Command set/Feature Enabled/Supported
121-126	F	0h	Reserved
127	F	0h	Removable Media Status Notification feature set support
128	V	0h	Security status
129-159	X	0h	Vendor specific
160	F	0h	Compact Flash Association (CFA) power mode 1
161-175	X	0h	Reserved for assignment by the CFA
176-205	V	0h	Current media serial number
206-216	F	0h	Reserved
217	F	0h	Non-rotating media device
218-221	F	0h	Reserved
222	F	0h	Reserved
223-233	F	0h	Reserved
234	F	0h	Reserved
235	F	0h	Reserved
236-	F	0h	Reserved

Word	F: Fixed V: Variable X: Both	Default Value	Description
255			
255	X	Varies	Integrity word (Checksum and Signature)

3.3 SMART Command Set

The controller used in the Delkin Devices SlimSATA and mSATA modules supports the SMART command set and defines some vendor-specific data to report spare/bad block numbers in each memory management unit.

Table 9. Smart Command Set

Value	Command	Value	Command
D0h	Read Data	D5h	Reserved
D1h	Read Attribute Threshold	D6h	Reserved
D2h	Enable / Disable Autosave	D7h	Enable SMART Operations
D3h	Save Attribute Values	D8h	Disable SMART Operations
D4h	Execute OFF-LINE Immediate	DAh	Return Status

If the reserved size is below the threshold, the status can be read from the Cylinder Register using the Return Status command (DAh.)

3.4 SMART Data Structure

The following 512 bytes make up the device SMART data structure. Users can obtain the data using the “Read Data” command (D0h.)

Table 10. Smart Data Structure

Byte	F / V	Description
0 – 1	X	Revision code
2 – 361	X	Vendor specific
362	V	Off-line data collection status
363	X	Self-test execution status byte
364 – 365	V	Total time in seconds to complete off-line data collection activity
366	X	Vendor specific
367	F	Off-line data collection capability
368 – 369	F	SMART capability
370	F	Error logging capability • 7-1 Reserved • 0 1= Device error logging supported
371	X	Vendor specific
372	F	Short self-test routine recommended polling time (in minutes)
373	F	Extended self-test routine recommended polling time (in minutes)
374	F	Conveyance self-test routine recommended polling time (in minutes)
375 – 385	R	Reserved
386 – 395	F	Firmware Revision / Date Code
396 – 397	F	Number of initial invalid blocks (396 = MSB, 397 = LSB)
398 – 399	F	Reserved
400 – 406	F	Controller
407 – 415	X	Vendor specific
416	F	Reserved
417	F	Program / write the strong page only
418 – 419	V	Number of spare blocks

420 – 445	F	Reserved
446 – 510	X	Vendor specific
511	V	Data structure checksum

Notes:

1. F = content (byte) is fixed and does not change
2. V = content (byte) is variable and may change depending on the state of the device or the commands executed by the device
3. X = content (byte) is vendor specific and may be fixed or variable
4. R = content (byte) is reserved and shall be zero.

4 Mechanical Specifications

4.1 Mechanical Form Factor

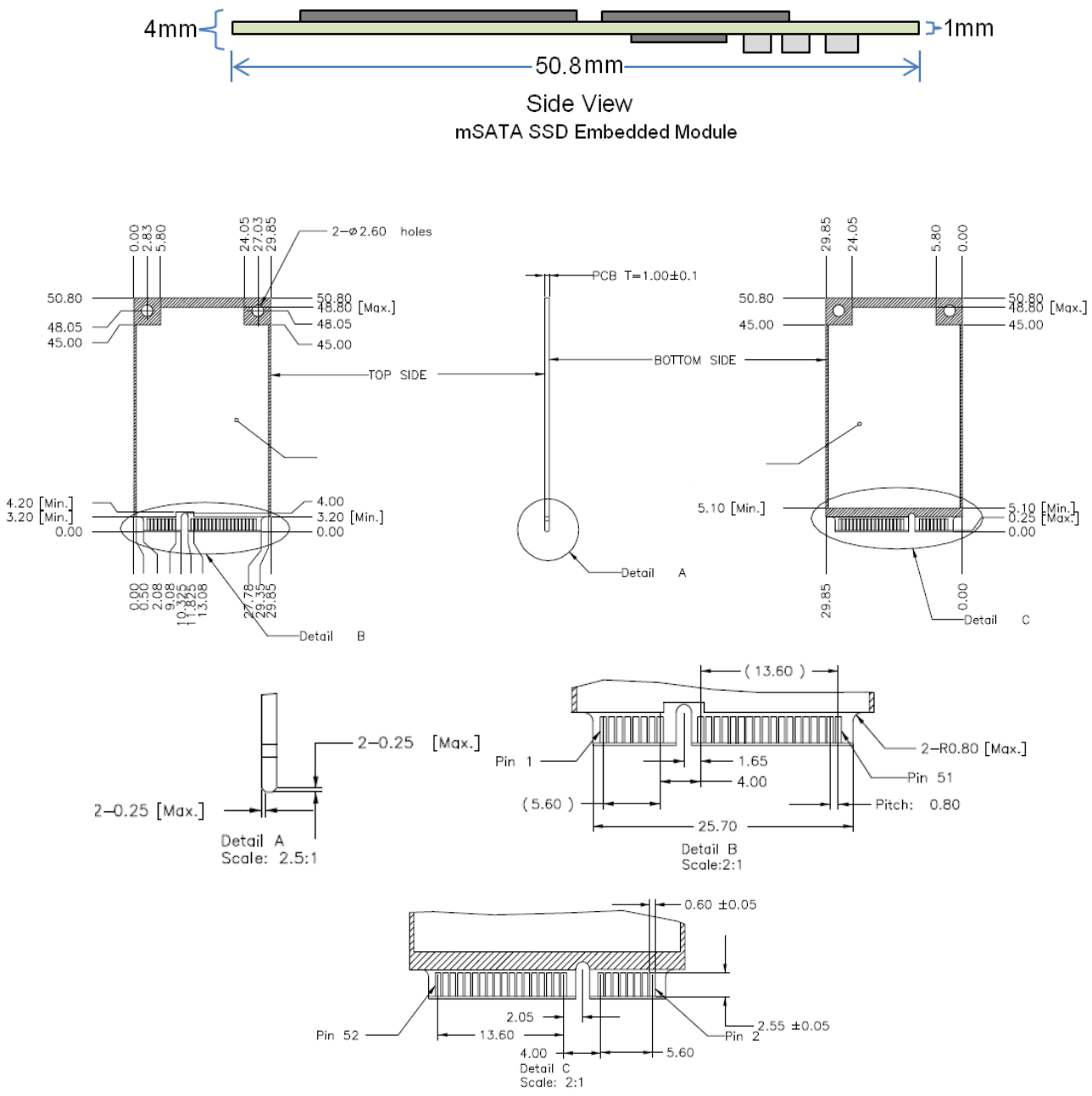

Figure 3. mSATA Embedded Module Mechanical Description

4.2 Physical Dimensions

Table 11. mSATA SSD Physical Dimensions

Dimension	Measurement
Height	4mm
Width	29.85mm
Length	50.8mm