RoHS Compliant

Serial ATA Flash Drive

mSATA M4 Product Specifications

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Version 1.2

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Features:

- **Standard Serial ATA 2.6 (Gen. 2)**
  - Serial ATA 2.6 (Gen. 2)
  - SATA Ⅱ, 3.0 Gbps
  - ATA-compatible command set
- **Capacities**
  - 4, 8, 16, 32, 64 GB
- **Performance***
  - Burst read/write: 300 MB/sec
  - Sustained read: up to 165 MB/sec
  - Sustained write: up to 150 MB/sec
- **Intelligent endurance design**
  - Built-in hardware ECC, enabling up to 16/24 bit correction per 1K bytes
  - Static wear-leveling scheme together with dynamical block allocation to significantly increase the lifetime of a flash device and optimize the disk performance
  - Flash bad-block management
  - S.M.A.R.T.
  - Power Failure Management
  - ATA Secure Erase
  - TRIM
- **NAND Flash Type:** SLC
- **Data integrity under power-cycling**
  - No battery required for data storage
- **Temperature ranges**
  - Operation: 0°C to 70°C (32 ~ 158°F)
  - Extended: -40°C to 85°C (-40° ~ 185°F)
  - Storage: -40°C to 100°C (-40° ~ 212°F)
- **Supply voltage**
  - 3.3V ± 5%
- **Power consumption (typical)***
  - Active mode: 510 mA
  - Idle mode: 150 mA
- **Form factor**
  - Mini PCIe form factor (50.8 x 29.85 x 1.00**, unit: mm)
  - JEDEC MO-300 compliant
- **Connector**
  - 52-pin mSATA connector
- **Shock & Vibration**
  - Shock: 50g (approx.)
  - Vibration: 15g (approx.)
- **RoHS compliant**

***Varies from capacities. The values addressed here are typical and may vary depending on settings and platforms.
**Only the thickness of the module, excluding the thickness of the attached flash chips and connector head. Please see “Physical characteristics” for details.

Table of Contents

1. Product Description

1.1 Introduction

Apacer's mSATA M4 is a solid-state disk (SSD) drive in mini PCIe form factor that contains a controller, embedded firmware, and flash media along with a male connector. Using NAND flash memory devices, the mSATA flash drive interfaces with the host allowing data to be seamlessly transferred between the host and the flash devices.

mSATA M4 drive is designed with a single-chip controller, offering capacities of up to 64 gigabytes and is compliant with the SATA Ⅱ high-speed interface standard. Complying with JEDEC MO-300 standard, this mSATA SSD is the widely adopted embedded storage with compact size and exceptional performance.

In addition to block management through dynamical allocation, mSATA M4 adopts the Apacer-specific global wear-leveling scheme to allow uniform use of all storage blocks, ensuring that the lifespan of a flash media can be significantly increased and the disk performance is optimized as well. mSATA M4 provides the S.M.A.R.T. feature that follows the SATA Rev. 2.6, ATA/ATAPI-7 specifications and uses the standard SMART command B0h to read data from the drive. This feature protects the user from unscheduled downtime by monitoring and storing critical drive performance.

1.2 Functional Block Diagram

mSATA M4 drive includes a single-chip SATA Ⅱ Controller and the flash media, as well as the SATA standard interface. The controller integrates the flash management unit with the controller itself to support multi-channel, multi-bank flash arrays. Figure 1-1 shows the functional block diagram.

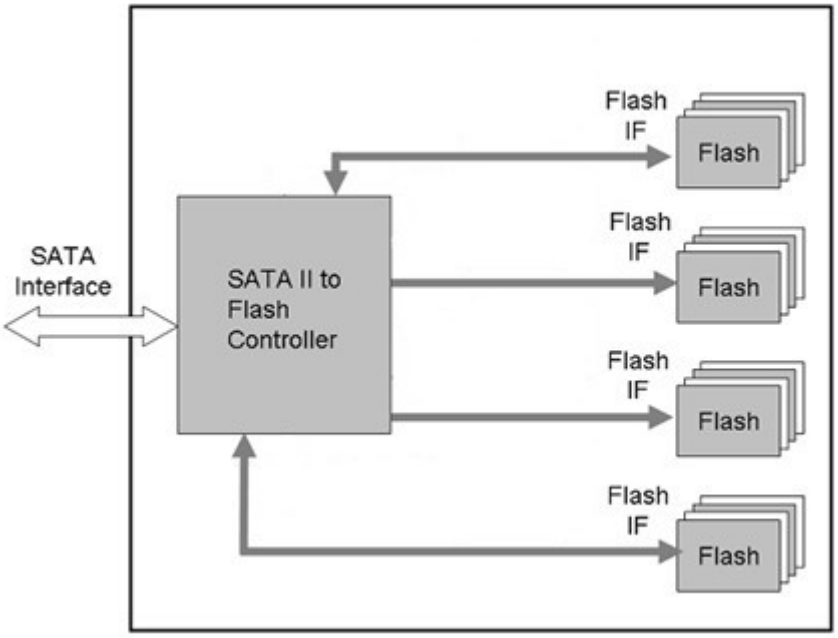


Figure 1-1 Apacer mSATA M4 block diagram

1.3 ATA Mode Support

mSATA M4 provides ATA mode support as follows:

- Up to PIO mode-4
- Up to Multiword DMA mode-2
- Up to UDMA mode-5

1.4 Capacity Specification

Capacity specification of mSATA M4 product family is available as shown in Table 1-1. It lists the specific capacity, the default numbers of logical cylinders and heads, and the number of logical sectors per track for each product line.

Table 1-1 Capacity specification

Capacity	Total Bytes*	Cylinders	Heads	Sectors	Max LBA*
4 GB	4,011,614,208	7773	16	63	7,835,184
8 GB	8,012,390,400	15525	16	63	15,649,200
16 GB	16,013,942,784	16383	16	63	31,277,232
32 GB	32,017,047,552	16383	16	63	62,533,296
64 GB	64,023,257,088	16383	16	63	125,045,424

*Display of total bytes varies from file systems.
**Cylinders, heads or sectors are not applicable for these capacities. Only LBA addressing applies.

1.5 Performance

Performance of mSATA M4 is shown in Table 1-2.

Table 1-2 Performance specification

Capacity / Performance	4 GB	8 GB	16 GB	32 GB	64 GB
Sustained Read (MB/s)	150	160	160	160	165
Sustained Write (MB/s)	50	95	95	145	150

Note: Performance varies from flash configurations and/or platform settings.

1.6 Pin Assignments

in assignment of the mSATA M4 is shown in Figure 1-2 and described in Table 1-3.

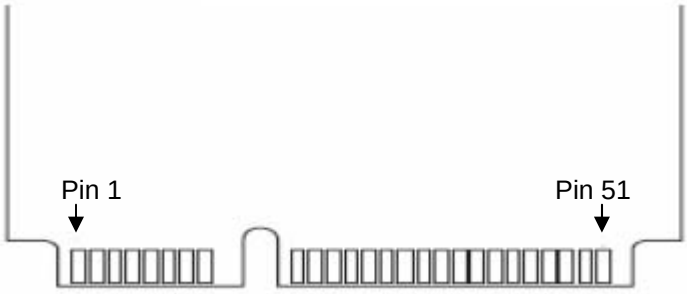


Figure 1-2 Apacer mSATA M4 pin assignment

Table 1-3 Pin Assignment Description

Pin #	Assignment	Description	Pin #	Assignment	Description
1	N/A	N/A	27	GND	Return Current Path
2	+3.3V	3.3V source	28	N/A	N/A
3	N/A	N/A	29	GND	Return Current Path
4	GND	Return Current Path	30	N/A	N/A
5	N/A	N/A	31	Rx-	SATA Differential
6	N/A	N/A	32	N/A	N/A
7	N/A	N/A	33	Rx+	SATA Differential
8	N/A	N/A	34	GND	Return Current Path
9	GND	Return Current Path	35	GND	Return Current Path
10	N/A	N/A	36	Reserved	No Connect
11	N/A	N/A	37	GND	Return Current Path
12	N/A	N/A	38	Reserved	No Connect
13	N/A	N/A	39	+3.3V	3.3V source
14	N/A	N/A	40	GND	Return Current Path
15	GND	Return Current Path	41	+3.3V	3.3V source
16	N/A	N/A	42	N/A	N/A
17	N/A	N/A	43	GND	Return Current Path
18	GND	Return Current Path	44	N/A	N/A
19	N/A	N/A	45	Reserved	N/A
20	N/A	N/A	46	N/A	N/A
21	GND	Return Current Path	47	Reserved	N/A
22	N/A	N/A	48	N/A	N/A
23	Tx+	SATA Differential	49	DA/DSS	Device Activity / Disable Staggered Spin Up
24	+3.3V	3.3V source	50	GND	Return Current Path
25	Tx-	SATA Differential	51	Presence Detection	Shall be pulled to GND by device
26	GND	Return Current Path	52	+3.3V	3.3V source

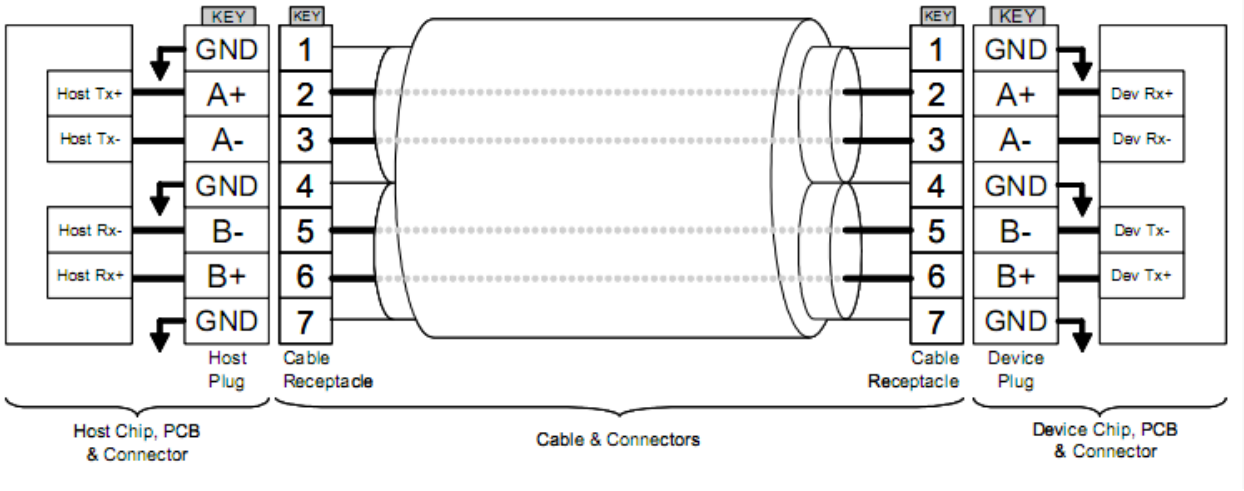


Figure 1-3 SATA Cable/Connector Connection Diagram

The connector on the left represents the Host with TX/RX differential pairs connected to a cable. The connector on the right shows the Device with TX/RX differential pairs also connected to the cable. Notice also the ground path connecting the shielding of the cable to the Cable Receptacle.

2. Software Interface

2.1 Command Set

Table 2-1 summarizes the ATA commands supported by mSATA M4.

Table 2-1: Command set

Code	Command	Code	Command
E5h	Check Power Mode	F3h	Security Erase Prepare
06h	Data Set Management	F4h	Security Erase Unit
90h	Execute Device Diagnostic	F5h	Security Freeze Lock
E7h	Flush Cache	F1h	Security Set Password
EAh	Flush Cache EXT	F2h	Security Unlock
Ech	Identify Device	70h	Seek
E3h	Idle	Efh	Set Features
E1h	Idle Immediate	C6h	Set Multiple Mode
91h	Initialize Device Parameters	E6h	Sleep
C8h	Read DMA	B0h	SMART
25h	Read DMA EXT	E2h	Standby
C4h	Read Multiple	E0h	Standby Immediate
29h	Read Multiple EXT	Cah	Write DMA
20h	Read Sector	35h	Write DMA EXT
24h	Read Sector EXT	C5h	Write Multiple
40h	Read Verify Sectors	39h	Write Multiple EXT
42h	Read Verify Sectors EXT	30h	Write Sector
10h	Recalibrate	34h	Write Sector EXT
F6h	Security Disable Password		

3. Flash Management

3.1 Error Correction/Detection

mSATA M4 implements a hardware ECC scheme, based on the BCH algorithm. It can detect and correct up to 16 bits or 24 bits error in 1K bytes.

3.2 Bad Block Management

Although bad blocks on the flash media are already identified by the flash manufacturer, they can also be accumulated over time during operation. mSATA M4's controller maintains a table that lists those normal blocks with disk data, the free blocks for wear leveling, and bad blocks with errors. When a normal block is detected broken, it is replaced with a free block and listed as a bad block. When a free block is detected broken, it is then removed from the free block list and marked as a bad block.

During device operation, this ensures that newly accumulated bad blocks are transparent to the host. The device will stop file write service once there are only two free blocks left such that the read function is still available for copying the files from the disk into another.

3.3 Wear Leveling

The NAND flash devices are limited by a certain number of write cycles. When using a FAT-based file system, frequent FAT table updates are required. If some area on the flash wears out faster than others, it would significantly reduce the lifetime of the whole SSD, even if the erase counts of others are far from the write cycle limit. Thus, if the write cycles can be distributed evenly across the media, the lifetime of the media can be prolonged significantly. This scheme is called wear leveling.

Apacer's wear-leveling scheme is achieved both via buffer management and Apacer-specific static wear leveling. They both ensure that the lifetime of the flash media can be increased, and the disk access performance is optimized as well.

3.4 Power Failure Management

The Low Power Detection on the controller initiates crucial data saving before the power supplied to the device is too low. This feature prevents the device from crash and ensures data integrity during an unexpected power-off.

3.5 ATA Secure Erase

Accomplished by the Secure Erase (SE) command, which added to the open ANSI standards that control disk drives, "ATA Secure Erase" is built into the disk drive itself and thus far less susceptible to malicious software attacks than external software utilities. It is a positive easy-to-use data destroy command, amounting to electronic data shredding. Executing the command causes a drive to internally completely erase all possible user data. This command is carried out within disk drives, so no additional software is required. Once executed, neither data nor the erase counter on the device would be recoverable, which blurs the accuracy of device lifespan. The process to erase will not be stopped until finished while encountering power failure, and will be continued when power is back on.

3.6 S.M.A.R.T.

S.M.A.R.T. is an acronym for Self-Monitoring, Analysis and Reporting Technology, an open standard allowing disk drives to automatically monitor their own health and report potential problems. It protects the user from unscheduled downtime by monitoring and storing critical drive performance and calibration parameters. Ideally, this should allow taking proactive actions to prevent impending drive failure.

Apacer mSATA M4 uses the standard SMART command B0h to read data from the drive for SMART feature as the SATA Rev.2.6 ATA/ATAPI-7 specifications. Based on the SFF-8035i Rev. 2.0 specifications, Apacer SMART defines vendor-specified SMART Attribute IDs (A0h, A1h, A2h, A3h, A4h-A5h) in mSATA M4. They represent initial back block count, bad block count, spare block count, maximum erase count, and average erase counts respectively. When the Apacer SMART Utility running on the host, it analyzes and reports the disk status to the host before mSATA M4 is in critical condition.

3.7 TRIM

Made of millions of NAND flash cells, SSD can be written into groups called pages in 4K size generally, but can only be erased in larger groups called blocks of 128 pages or 512KB. These stipulations are partially the source of many performance issues. Until an address gets used again, the SSD has to keep track of every last bit of data that's written on it. The ATA-TRIM instruction tilts the balance in favor of the SSD. TRIM addresses a major part of the performance degradation issue over time that plagues all SSDs. A TRIM enabled drive running an OS with TRIM support will stay closer to its peak performance over time.

4. Environmental Specifications

4.1 Environments

mSATA M4 environmental specifications follow the US Military Standard MIL-STD-810F, as shown in below table.

Table 4-1 mSATA M4-M environmental specifications

Environment	Specification
Temperature	0°C to 70°C (Operating), -40°C to 85°C (Extended)
	-40°C to 100°C (Non-operating)
Humidity	5% to 95% RH (Non-condensing)
Vibration	Sine wave : 15(G), 10~2000(Hz), Random : 7.7(Grms), 20~2000(Hz)
Shock – Operating	Acceleration: 1,500 G, 0.5 ms Peak acceleration: 50 G, 11 ms

4.2 Mean Time Between Failures (MTBF)

Mean Time Between Failures (MTBF) is predicted based on reliability data for the individual components in mSATA drive. Although many component of MTBF are given in databases and often these values are not really accurate, the prediction result for the mSATA M4 is more than 2,000,000 hours.

Notes about the MTBF:

The MTBF is predicated and calculated based on “Telcordia Technologies Special Report, SR-332, Issue 2” method.

4.3 Certification and Compliance

mSATA M4 complies with the following standards:

- CE – EN55022/55024
- FCC 47CFR Part15 Class B
- RoHS
- MIL-STD-810F
- SATA II (SATA Rev. 2.6)
- Up to ATA/ATAPI-7 (including S.M.A.R.T.)

5. Electrical Characteristics

5.1 Operating Voltage

Table 5-1 lists the supply voltage for mSATA M4.

Table 5-1 mSATA M4 operating voltage

Parameter	Conditions
Supply voltage	3.3V ±5% (3.135 - 3.465 V)

5.2 Power Consumption

Table 5-2 Power consumption (typical)

Mode \ Capacity	4 GB	8 GB	16 GB	32 GB	64 GB
Active (mA)	395	510	510	430	465
Standby (mA)	135	150	150	125	130

Note: Power consumption may vary from flash configurations and/or platform settings.

5.3 Electrostatic Discharge

Electrostatic discharge

Item	Amount of Discharge	Voltage	Required Criteria	Complied To Criteria (A,B,C)
Air Discharge	10	+8kV	B	A
	10	-8kV	B	A
Contact Discharge	25	+4kV	B	A
	25	-4kV	B	A
Indirect Discharge (HCP)	25	+4kV	B	A
	25	-4kV	B	A
Indirect Discharge (VCP Front)	25	+4kV	B	A
	25	-4kV	B	A
Indirect Discharge (VCP Left)	25	+4kV	B	A

	25	-4kV	B	A
Indirect Discharge (VCP Back)	25	+4kV	B	A
	25	-4kV	B	A
Indirect Discharge (VCP Right)	25	+4kV	B	A
	25	-4kV	B	A

5.4 Electrical Fast Transient/Burst

Electrical Fast Transient/Burst

Inject Line	Polarity	Voltage kV	Inject Time (Second)	Inject Method	Required Criteria	Complied to Criteria
L-N-PE	±	1kV	60	Direct	B	A

Notes about 5.3 Electrostatic Discharge & 5.4 Electrical Fast Transient/Burst

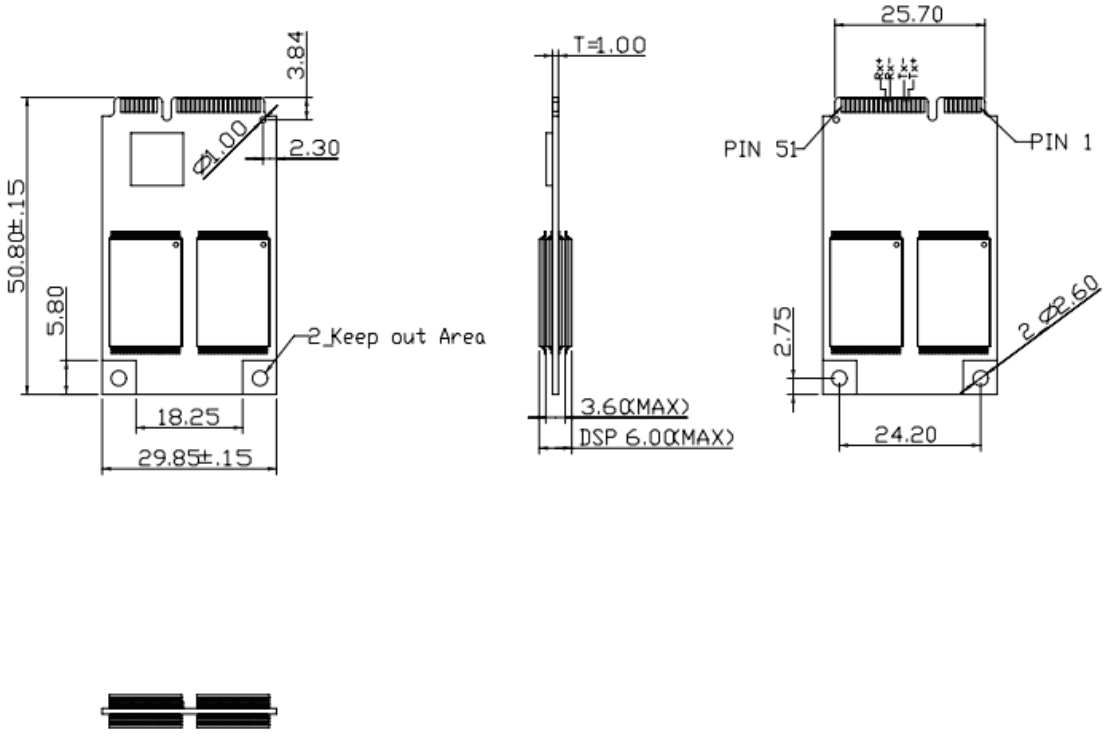
The tests performed are from lowest level up to the highest level as required by standard, but only highest level is shown on the report.

Meet criteria A: Operate as intended during and after the test
Meet criteria B: Operate as intended after the test
Meet criteria C: Loss/Error of function

Additional Information:
EUT stopped operation and could / could not be reset by operator at kV.
No false alarms or other malfunctions were observed during or after the test.

The Contact discharges were applied at least total 200 discharges at a minimum of four test points.

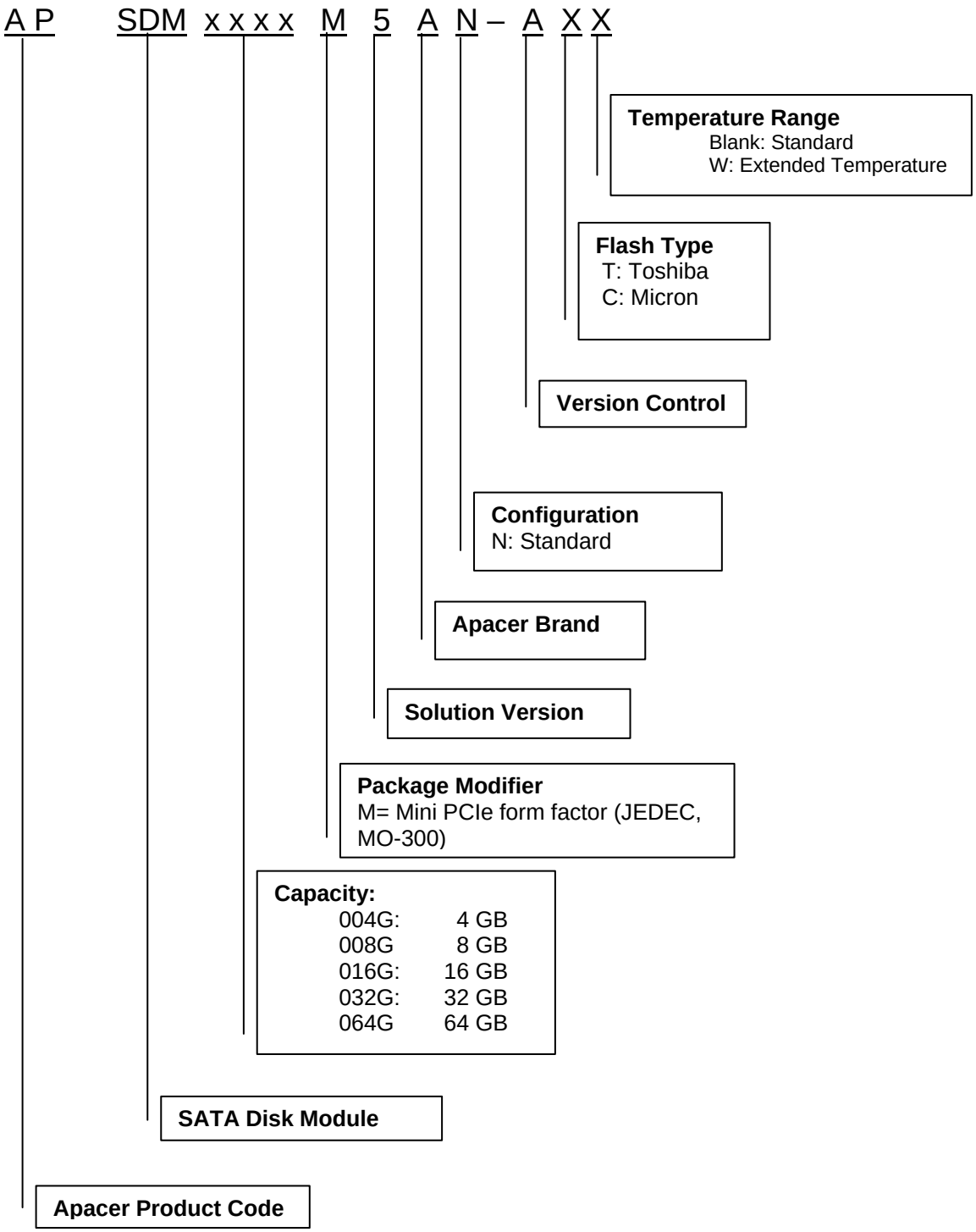
6. Physical Characteristics



Unit: mm
Tolerance: ± 0.2

7. Product Ordering Information

7.1 Product Code Designations



7.2 Valid Combinations

mSATA M4

Capacity	Standard	Extended Temperature
4GB	APSDM004GM5AN-AT	APSDM004GM5AN-ATW
8GB	APSDM008GM5AN-AT	APSDM008GM5AN-ATW
16GB	APSDM016GM5AN-AT	APSDM016GM5AN-ATW
32GB	APSDM032GM5AN-AC	APSDM032GM5AN-ACW
64GB	APSDM064GM5AN-AC	APSDM064GM5AN-ACW

Note: Valid combinations are those products in mass production or will be in mass production. Consult your Apacer sales representative to confirm availability of valid combinations and to determine availability of new combinations.

Revision History

Revision	Description	Date
0.1	Preliminary release	11/07/2011
1.0	Official release	12/02/2011
1.1	Updated Electrical Specification and supply voltage information: from 5V to 3.3V	1/2/2012
1.2	Revised capacity information	1/16/2012

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