RoHS Compliant

Serial ATA Flash Drive

mSATA M4 Product Specifications

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Version 1.3

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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
  - ATA modes support
- **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
- **MTBF >** 2,000,000 hours
- **Temperature ranges**
  - Operation: 0℃ to 70℃ (32 ~ 158℉)
  - Extended: -40℃ to 85℃ (-40° ~ 185℉)
  - Storage: -40℃ to 100℃ (-40° ~ 212℉)
- **Supply voltage**
  - 3.3V ± 5%
- **Power consumption (typical)***
  - Active mode: 490 mA
  - Idle mode: 150 mA
- **Form factor**
  - Mini PCIe form factor (50.8 x 29.85 x 3.40, unit: mm)
  - JEDEC MO-300 compliant
- **Connector**
  - 52-pin mSATA connector
- **Shock & Vibration****
  - Shock: 1500 G
  - Vibration: 15 G
- **RoHS compliant**

*Varies from capacities. The values addressed here are typical and may vary depending on settings and platforms.
**Non-operating

Table of Contents

1. Product Description

1.1 Introduction

Apacer's mSATA M4-M 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. mSATA M4-M leverages the advantages of standard SATA SSDs in terms of wide compatibilities and reliable performance. Though built with MLC, this SSD can work in highly demanding environment as it can withstand ambient temperature from -40℃ to +85℃ **(**for certain capacities only**).**

mSATA M4 drive is designed with a single-chip controller, offering capacities of up to 64 gigabytes and is compliant with the SATAⅡ 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 SATAⅡ 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.

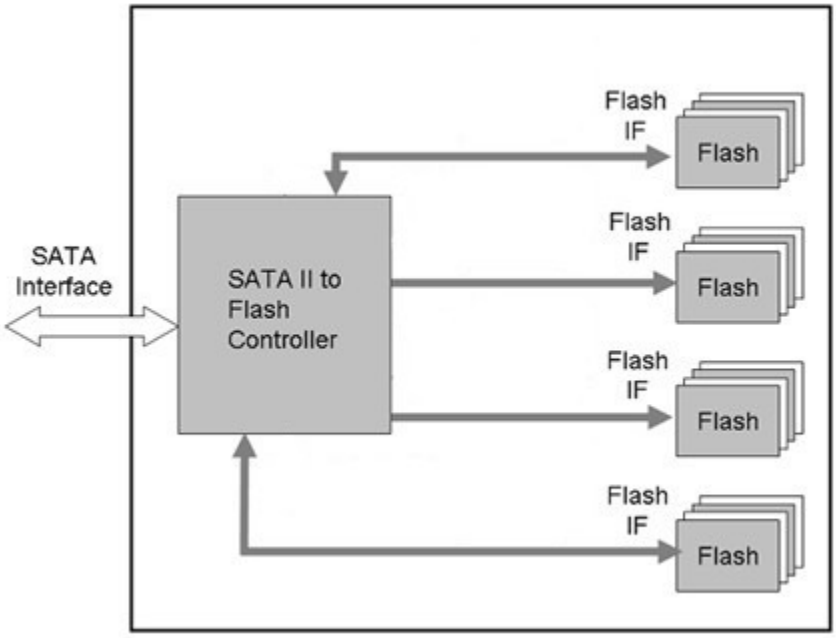


Figure 1-1 Apacer mSATA M4 block diagram

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.
**Notes: 1 GB = 1,000,000,000 bytes; 1 sector = 512 bytes.
LBA count addressed in the table above indicates total user storage capacity and will remain the same throughout the lifespan of the device. However, the total usable capacity of the SSD is most likely to be less than the total physical capacity because a small portion of the capacity is reserved for device maintenance usages.

1.5 Performance

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

Table 1-2 Performance specifications

Performance \ Capacity	4 GB	8 GB	16 GB	32 GB	64 GB
Sustained Read (MB/s)	145	155	155	160	165
Sustained Write (MB/s)	50	105	105	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.

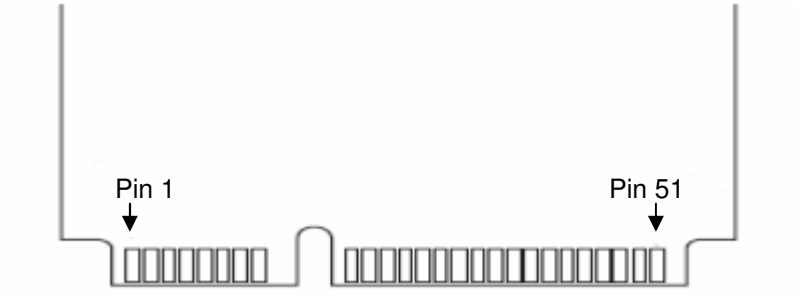


Figure 1-2 Apacer mSATA M4 pin assignment

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

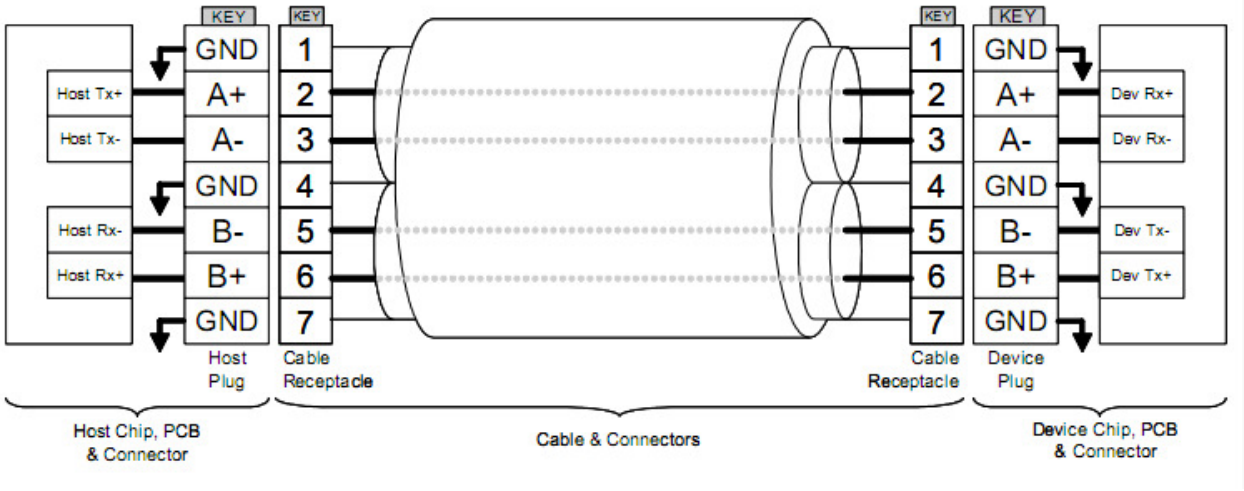


Figure 1-3 SATA Cable/Connector Connection Diagram

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

Contemporary process technology is unable to guarantee total reliability of NAND flash memory array. When a flash memory device leaves factory, it comes with a highly minimal number of initial bad block during production or out-of-factory as there is no currently known technology that produce flash chips free of bad blocks. On the other hand, bad blocks may develop during program/erase cycles. When host performs program/erase command on a block, bad block may appear in Status Register. Since bad blocks are inevitable, the solution is to keep them in control. Apacer flash devices are programmed with ECC, block mapping technique and S.M.A.R.T to reduce invalidity or error. Once bad blocks are detected, data in those blocks will be transferred to free blocks and error will be corrected by designated algorithms.

3.3 Wear Leveling

Flash memory devices differ from Hard Disk Drives (HDDs) in terms of how blocks are utilized. For HDDs, when a change is made to stored data, like erase or update, the controller mechanism on HDDs will perform overwrites on blocks. On the other hand, NAND flash storage adopts flash as their primary media. Unlike HDDs, flash blocks cannot be overwritten and each P/E cycle wears down the lifespan of blocks gradually. Repeatedly program/erase cycles performed on the same memory cells will eventually cause some blocks to age faster than others. This would bring flash storages to their end of service term earlier. Wear leveling is an important mechanism that level out the wearing of blocks so that the wearing-down of blocks can be almost evenly distributed. This will increase the lifespan of SSDs. Commonly used wear leveling types are Static and Dynamic.

3.4 Power Failure Management

Power Failure Management ensures data transmission when experiencing unstable power supply. When power disruption takes places, NAND Flash will have to cache multiple write-to-flash cycles to securely store data. This urgent operation requires about several milliseconds to get it done. When the supplied voltage is below a certain percentage of the required, the flash controller will be signaled by a detector IC component with low power detection signal and then the firmware will communicate the controller to flush all the data into the cache of Flash storage area. This can prevent incomplete data transmission. The crucial part lies in the strength of the capacitor of the SSD. The capacitor must be able to hold up some milliseconds of remaining time before the power is totally out, for the urgent write-back-into-flash operations to complete.

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 the abbreviation for Self-Monitoring, Analysis and Reporting Technology, an open standard allowing disk drives to automatically monitor their own health and report potential problems. It provides users critical drive status information and attributes parameters for anticipation purposes. Ideally, this should prevent unexpected drive failure and data loss.

Apacer devices use the standard SMART command B0h to read data out from the drive to activate our S.M.A.R.T. feature that complies with the ATA/ATAPI-7 specifications. Based on the SFF-8035i Rev. 2.0 specifications, S.M.A.R.T. Attribute IDs shall include initial bad block count, bad block count, spare block count, maximum erase count, average erase count and power cycle. When the S.M.A.R.T. Utility running on the host, it analyzes and reports the disk status to the host before the device reaches 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 the following table.

Table 4-1 mSATA M4-M environmental specifications

Environment	Specification
Temperature	0℃ to 70℃ (Operating), -40℃ to 85℃ (Extended)
	-40℃ to 100℃ (Non-operating)
Vibration	Non-operating : Sine wave, 15(G), 10~2000(Hz), Operating : Random, 7.69 (Grms), 20~2000(Hz)
Shock	Non-operating: Acceleration, 1,500 G, 0.5 ms Operating: 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. The prediction result for the mSATA M4 is more than 2,000,000 hours.

Notes about MTBF:

The prediction is based on Bellcore analysis method by assuming device failure rate can be generated by the sum of failure rates in each component.Notes about the MTBF:

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)

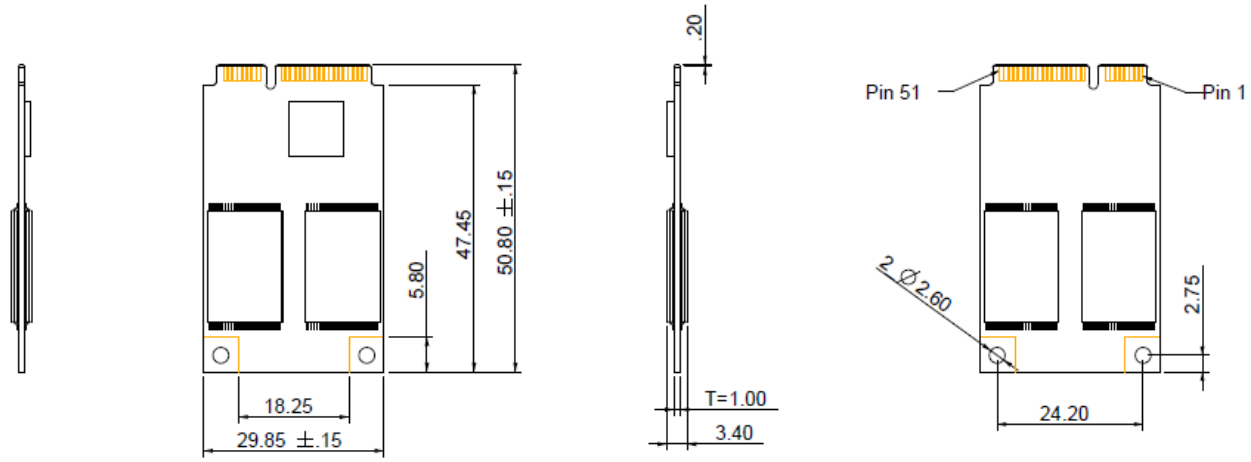
5.2 Power Consumption

Table 5-2 Power consumption (typical)

Mode \ Capacity	4 GB	8 GB	16 GB	32 GB	64 GB
Active (mA)	395	430	490	450	480
Standby (mA)	130	140	150	140	140

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

6. Physical Characteristics



Unit: mm
Tolerance: ± 0.2

7. Product Ordering Information

7.1 Product Code Designations

A P SDM x x x x M 5 A N – C X X

Temperature Range
Blank: Standard
W: Extended Temperature

Flash Type
T: Toshiba
C: Micron

Version Control

Configuration
N: Standard

Apacer Brand

Solution Version

Package Modifier
M= Mini PCIe form factor (JEDEC, MO-300)

Capacity:

004G:	4 GB
008G	8 GB
016G:	16 GB
032G:	32 GB
064G	64 GB

SATA Disk Module

Apacer Product Code

7.2 Valid Combinations

mSATA M4

Capacity	Standard	Extended Temperature
4GB	APSDM004GM5AN-CT	APSDM004GM5AN-CTW
8GB	APSDM008GM5AN-CT	APSDM008GM5AN-CTW
16GB	APSDM016GM5AN-CT	APSDM016GM5AN-CTW
32GB	APSDM032GM5AN-CC	APSDM032GM5AN-CCW
64GB	APSDM064GM5AN-CC	APSDM064GM5AN-CCW

Note: Please consult with Apacer sales representatives for availabilities.

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
1.3	Added Endurance and Random Read/Write sections	05/04/2012
1.4	Revised mechanical drawing Updated Product Ordering Information due to firmware upgrade	08/15/2012

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