RoHS Compliant

Serial ATA Flash Drive

mSATA M4 -M Product Specifications

November 22nd, 2011

Version 1.0



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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

- 8, 16, 32, 64, 128 GB

• Performance*

Burst read/write: 300 MB/secSustained read: up to 155 MB/sec

Sustained write: up to 80 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: MLC

Data integrity under power-cycling

- No battery required for data storage

Temperature ranges

Operation: 0°C to 70°C (32 ~ 158°F)

Storage: -40°C to 100°C (-40° ~ 212°F)

Supply voltage

 $-5.0 V \pm 5\%$

Power consumption (typical)*

- Active mode: 310 mA

- Idle mode: 86 mA

Form factor

- Mini PCIe (50.8 x 29.85 x 3.60, 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.



Table of Contents

| 1. | Pro | duct Description | . 3 |
|----|------|-----------------------------------|-----|
| | 1.1 | Introduction | 3 |
| | 1.2 | Functional Block Diagram | 3 |
| | 1.3 | ATA Mode Support | 4 |
| | 1.4 | Capacity Specification | 4 |
| | 1.5 | Performance | 4 |
| | 1.6 | Pin Assignments | 5 |
| 2. | Sof | tware Interface | . 7 |
| | 2.1 | Command Set | 7 |
| 3. | Flas | sh Management | . 8 |
| | 3.1 | Error Correction/Detection | 8 |
| | 3.2 | Bad Block Management | 8 |
| | 3.3 | Wear Leveling | 8 |
| | 3.4 | Power Failure Management | 8 |
| | 3.5 | ATA Secure Erase | 8 |
| | 3.6 | S.M.A.R.T. | 9 |
| | 3.7 | TRIM | 9 |
| 4. | Env | rironmental Specifications | 10 |
| | 4.1 | Environments | .10 |
| | 4.2 | Mean Time Between Failures (MTBF) | .10 |
| | 4.3 | Certification and Compliance | .10 |
| 5. | Ele | ctrical Characteristics | 11 |
| | 5.1 | Operating Voltage | .11 |
| | 5.2 | Power Consumption | .11 |
| | 5.3 | Electrostatic Discharge | .11 |
| | 5.4 | Electrical Fast Transient/Burst | .12 |
| 6. | Phy | sical Characteristics | 13 |
| 7. | Pro | duct Ordering Information | 14 |
| | 7.1 | Product Code Designations | .14 |
| | 7.2 | Valid Combinations | .15 |



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. 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-M drive is designed with a single-chip controller, offering capacities of up to 128 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-M 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-M 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-M drive includes a single-chip SATA ☐ 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.

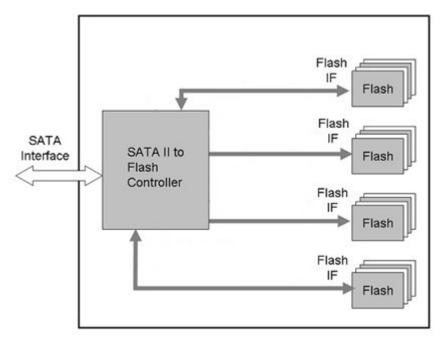


Figure 1-1 Apacer mSATA M4-M block diagram



1.3 ATA Mode Support

mSATA M4-M 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-M 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* |
|----------|-----------------|-----------|-------|---------|-------------|
| 8 GB | 7,012,196,352 | 13587 | 16 | 63 | 13,695,696 |
| 16 GB | 15,013,748,736 | 16383 | 16 | 63 | 29,323,728 |
| 32 GB | 32,017,047,552 | 16383 | 16 | 63 | 62,533,296 |
| 64 GB | 64,023,257,088 | 16383 | 16 | 63 | 125,045,424 |
| 128 GB | 126,718,663,680 | 16383 | 16 | 63 | 247,497,451 |

^{*}Display of total bytes varies from file systems.

1.5 Performance

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

Table 1-2 Performance specification

| Performance Capacity | 8 GB | 16 GB | 32 GB | 64 GB | 128 GB |
|------------------------|------|-------|-------|-------|--------|
| Sustained Read (MB/s) | 117 | 125 | 135 | 155 | 145 |
| Sustained Write (MB/s) | 26 | 26 | 38 | 80 | 80 |

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

^{**}Cylinders, heads or sectors are not applicable for these capacities. Only LBA addressing applies.



1.6 Pin Assignments

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

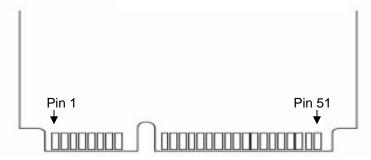


Figure 1-2 Apacer mSATA M4-M pin assignment

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 | Тх- | SATA Differential | 51 | Presence Detection | Shall be pulled to GND by device |
| 26 | GND | Return Current Path | 52 | +3.3V | 3.3V source |



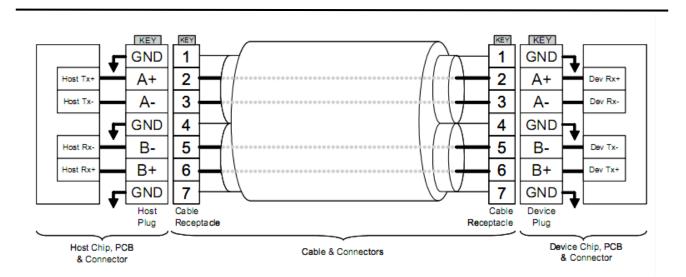


Figure 1-3 SATA Cable/Connector Connection Diagram

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-M.

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-M 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-M'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-M 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-M. 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-M 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-M 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 |
|-------------------|--|
| Tamananatura | 0°C to 70°C (Operating) |
| Temperature | -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-M is more than 1,000,000 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-M 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-M.

Table 5-1 mSATA M4-M operating voltage

| Parameter | Conditions |
|----------------|-----------------------|
| Supply voltage | 5V ±5% (4.75-5.25 V) |

5.2 Power Consumption

Table 5-2 Power consumption (typical)

| Mode | 8 GB | 16 GB | 32 GB | 64 GB | 128GB |
|--------------|------|-------|-------|-------|-------|
| Active (mA) | 200 | 202 | 210 | 280 | 310 |
| Standby (mA) | 70 | 76 | 83 | 83 | 86 |

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 Diacharas | 10 | +8kV | В | А |
| Air Discharge | 10 | -8kV | В | А |
| Contact | 25 | +4kV | В | А |
| Discharge | 25 | -4kV | В | А |
| Indirect | 25 | +4kV | В | А |
| Discharge (HCP) | 25 | -4kV | В | А |
| Indirect | 25 | +4kV | В | А |
| Discharge (VCP Front) | 25 | -4kV | В | А |
| Indirect Discharge (VCP Left) | 25 | +4kV | В | А |



| | 25 | -4kV | В | A |
|--------------------------|----|------|---|---|
| Indirect Discharge | 25 | +4kV | В | А |
| (VCP Back) | 25 | -4kV | В | А |
| Indirect | 25 | +4kV | В | А |
| Discharge (VCP Right) | 25 | -4kV | В | А |

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 | В | А |

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:

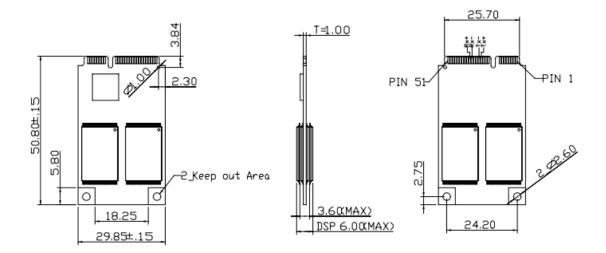
EUT stopped operation and could / could not be reset by operator at kV. No false alarms or other malfunctions were observed during or after the test.

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



6. Physical Characteristics







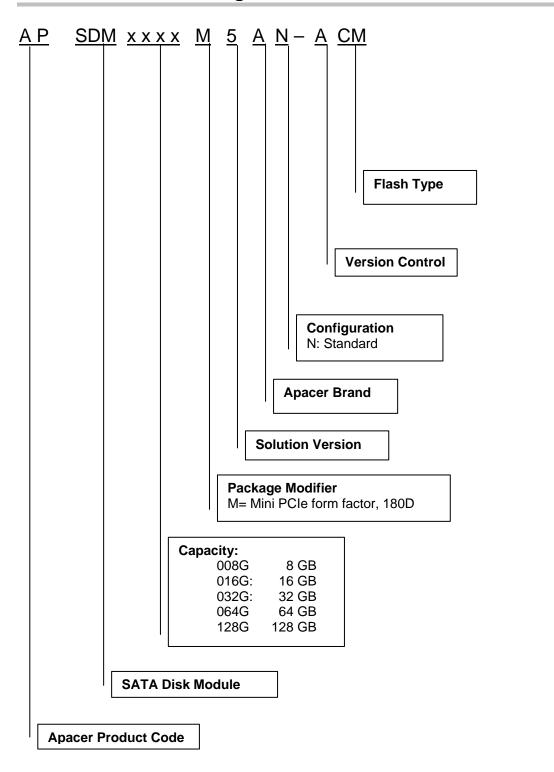
Unit: mm

Tolerance: ± 0.2



7. Product Ordering Information

7.1 Product Code Designations





7.2 Valid Combinations

mSATA M4-M

| Capacity | Model Number |
|----------|-------------------|
| 8GB | APSDM008GM5AN-ACM |
| 16GB | APSDM016GM5AN-ACM |
| 32GB | APSDM032GM5AN-ACM |
| 64GB | APSDM064GM5AN-ACM |
| 128GB | APSDM128GM5AN-ACM |

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 | 11/22/2011 |



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