

RoHS Compliant

Serial ATA Flash Drive

mSATA Mini M4 Product Specifications

June 25th, 2013

Version 1.2



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Features:

- **Standard Serial ATA Interface**
 - Serial ATA Revision 2.6
 - SATA 3.0 Gbps
 - ATA-compatible command set
 - ATA modes support
- **Capacities**
 - 2, 4, 8, 16, 32 GB
- **Performance***
 - Burst read/write: 300 MB/sec
 - Sustained read: up to 85 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: SLC**
- **MTBF > 2,000,000 hours**
- **Temperature ranges**
 - Operating: 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: 340 mA
 - Idle mode: 120 mA
- **Form factor**
 - mSATA Mini
 - Dimension: 29.85 x 26.80 x 1.00**, unit: mm
- **Connector**
 - 52-pin mSATA connector
- **Shock & Vibration*****
 - Shock: 1500G
 - Vibration: 15G
- **RoHS compliant**
- **Write Protect (optional)**
 - Enabled by onboard hardware switch

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

**Only the thickness of the module

***Non-operating

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1. Product Description

1.1 Introduction

Apacer's mSATA Mini M4 is the pioneering solid-state disk (SSD) to appear in the new mSATA mini form factor. The size of mSATA Mini M4 is further slimmed down from its previous mSATA M4 release. Since it is the trend that host computing systems are becoming more and more compact, this mSATA mini SSD will take space efficiency to a new level, while maintaining its capabilities in terms of capacities and performance that are comparable to those built with standard SATA form factor.

mSATA Mini M4 drive is designed with a powerful controller, offering capacities of up to 32 gigabytes and is compliant with the SATA 3.0 Gbps high-speed interface standard. Designed in mSATA Mini form factor, this SSD will definitely be the choice for industrial embedded applications with its compact size and exceptional performance.

In addition, mSATA Mini 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. The SSD provides the S.M.A.R.T. feature that follows the SATA Rev. 2.6, ATA/ATAPI 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 Mini M4 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.

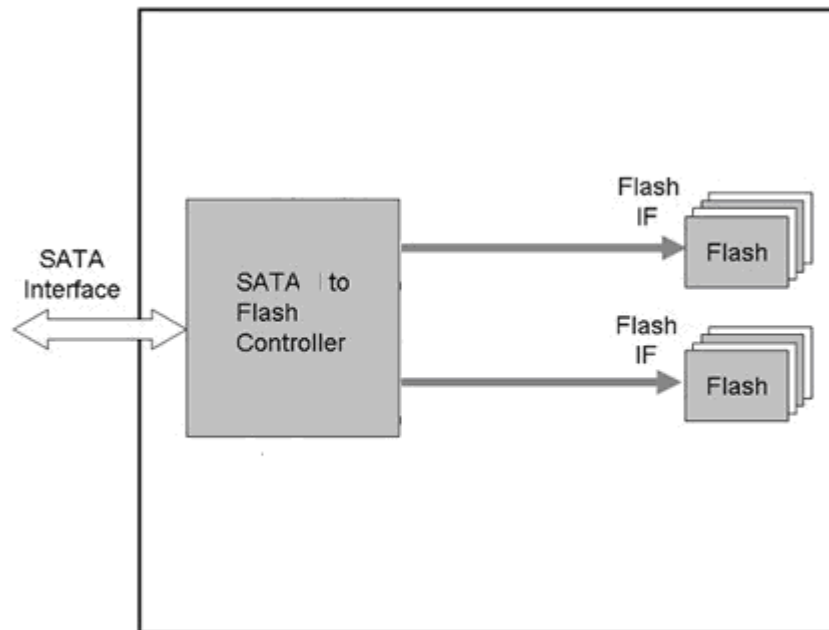


Figure 1-1 Apacer mSATA Mini M4 block diagram

1.3 ATA Mode Support

mSATA Mini 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 Mini 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* |
|----------|----------------|-----------|-------|---------|------------|
| 2 GB | 2,011,226,112 | 3897 | 16 | 63 | 3,928,176 |
| 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 |

*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 Mini M4 is shown in Table 1-2.

Table 1-2 Performance specifications

| Capacity | 2 GB | 4 GB | 8 GB | 16 GB | 32 GB |
|------------------------|------|------|------|-------|-------|
| Performance | | | | | |
| Sustained Read (MB/s) | 75 | 80 | 80 | 85 | 85 |
| Sustained Write (MB/s) | 28 | 55 | 55 | 80 | 80 |

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

1.6 Pin Assignments

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



Figure 1-2 Apacer mSATA Mini 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 |

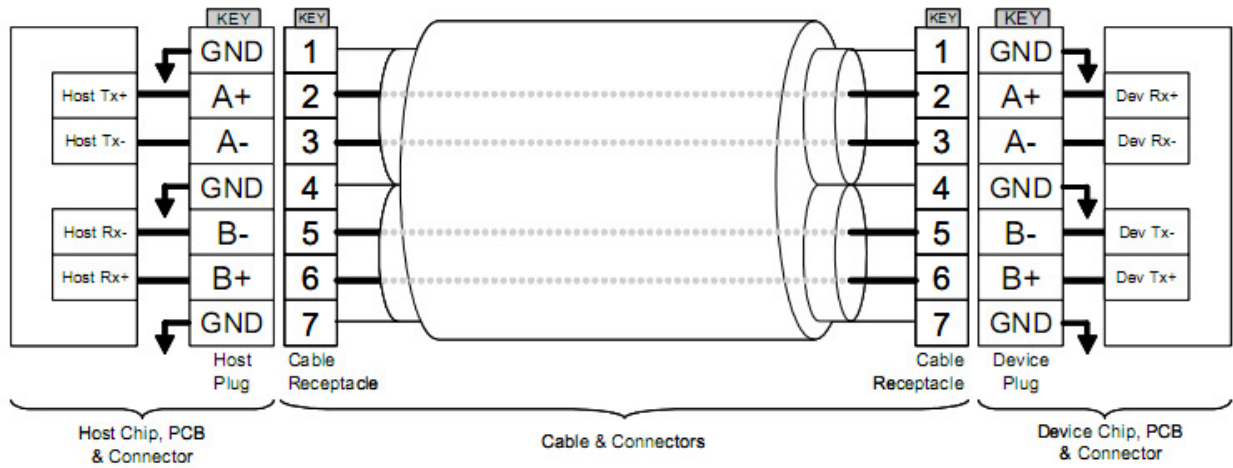


Figure 1-3 SATA Cable/Connector Connection Diagram

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 Mini 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 Mini 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

Current production technology is unable to guarantee total reliability of NAND flash memory array. When a flash memory device leaves factory, it comes with a minimal number of initial bad blocks during production or out-of-factory as there is no currently known technology that produce flash chips free of bad blocks. In addition, 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. 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 sooner. 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 plays a crucial role when experiencing unstable power supply. Power disruption may occur when users are storing data into the SSD. In this urgent situation, the controller would run multiple write-to-flash cycles to store the metadata for later block rebuilding. This urgent operation requires about several milliseconds to get it done. At the next power up, the firmware will perform a status tracking to retrieve the mapping table and resume previously programmed NAND blocks to check if there is any incompleteness of transmission.

3.5 ATA Secure Erase

ATA Secure Erase is an ATA disk purging command currently embedded in most of the storage drives. Defined in ATA specifications, (ATA) Secure Erase is part of Security Feature Set that allows storage drives to erase all user data areas. The erase process usually runs on the firmware level as most of the ATA-based storage media currently in the market are built-in with this command. ATA Secure Erase can securely wipe out the user data in the drive and protects it from malicious attack.

3.6 S.M.A.R.T.

S.M.A.R.T. is an abbreviation for Self-Monitoring, Analysis and Reporting Technology, a self-monitoring system that provides indicators of drive health as well as potential disk problems. It serves as a warning for users from unscheduled downtime by monitoring and displaying critical drive information. Ideally, this should allow taking proactive actions to prevent drive failure and make use of S.M.A.R.T. information for future product development reference.

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 specifications. S.M.A.R.T. Attribute IDs shall include initial bad block count, total later bad block count, maximum erase count, average erase count, power on hours 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.

Note: attribute IDs may vary from product models due to various solution design and supporting capabilities.

3.7 TRIM

TRIM, though in capital letters usually, is a memory computation command rather than an abbreviation. It is mainly a SATA command that enables the operating system to inform the SSD (Solid State Drive) which blocks of previously stored data are no longer valid, due to erases by the host or operating system, such as file deletions or disk formatting. Once notified, SSD will begin the discard of the invalid LBAs and retain more space for itself, in fact, the discarded is no longer recoverable.

When an LBA is replaced by the operating system, as with overwrite of a file, the SSD is informed that the originally occupied LBA is determined as no longer in use or invalid. The SSD will not save those blocks in garbage collected sectors. Noticeably, a file deletion command by host or operating system never actually erases the actual content, rather, just the file is marked as deleted. This issue is even specifically noticeable for flash based memory devices, such as SSDs. In fact, an SSD will keep garbage collecting the invalid, previously occupied LBAs, if it is not informed that these LBAs can be erased. Thus, the SSD would experience a significant performance downfall.

4. Environmental Specifications

4.1 Environments

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

Table 4-1 mSATA Mini 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 | 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. The prediction result for the mSATA Mini 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.

4.3 Certification and Compliance

mSATA Mini M4 complies with the following standards:

- CE – EN55022/55024
- FCC 47CFR Part15 Class B
- RoHS
- MIL-STD-810F

5. Electrical Characteristics

5.1 Operating Voltage

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

Table 5-1 mSATA Mini M4 operating voltage

| Parameter | Conditions |
|----------------|---------------------------------|
| Supply voltage | 3.3V \pm 5% (3.135 - 3.465 V) |

5.2 Power Consumption

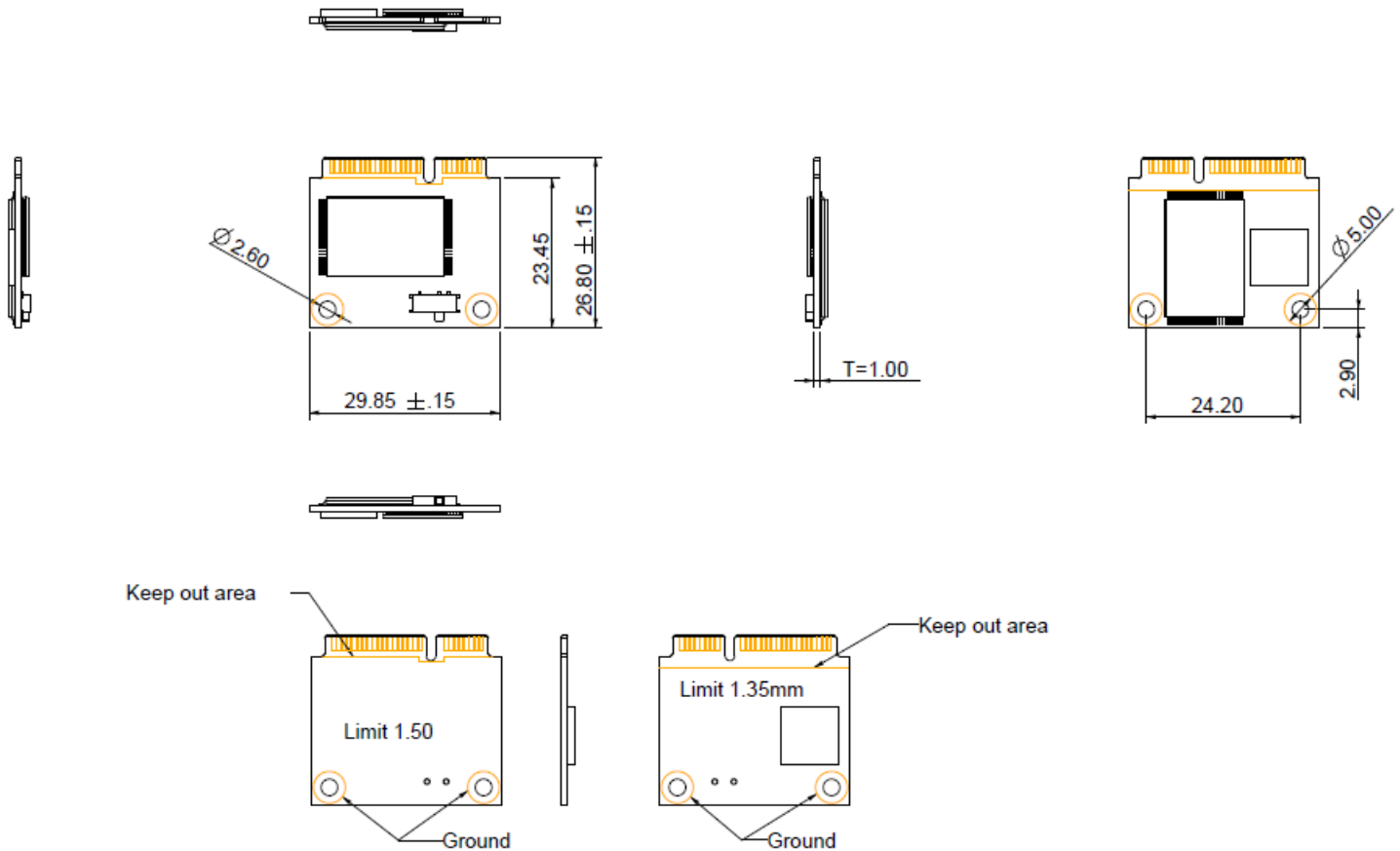
Table 5-2 Power consumption (typical)

| Mode \ Capacity | 2 GB | 4 GB | 8 GB | 16 GB | 32 GB |
|-----------------|------|------|------|-------|-------|
| Active (mA) | 260 | 310 | 310 | 315 | 340 |
| Standby (mA) | 80 | 105 | 110 | 120 | 120 |

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

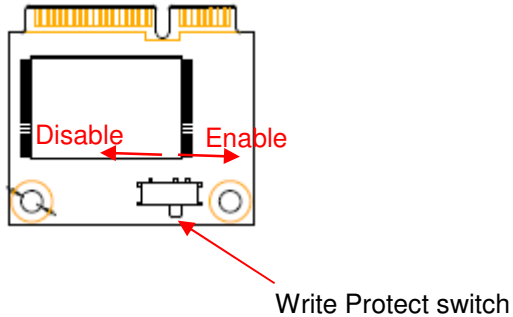
6. Physical Characteristics

6.1 Mechanical Drawing



Unit: mm
Tolerance: ± 0.2

6.2 Write Protect Switch (optional)

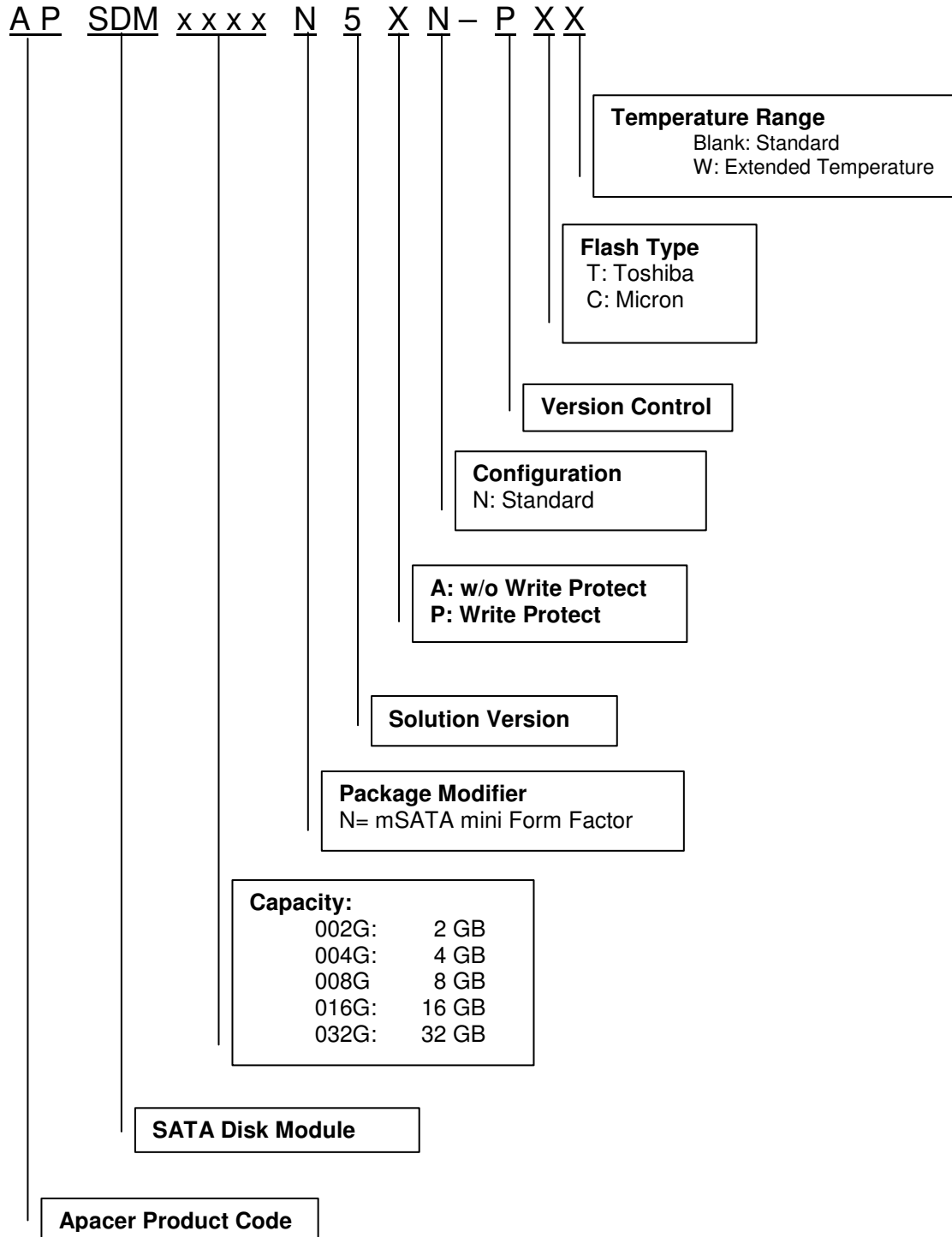


Description of Apacer Write Protect:

Apacer implements the Virtual Write scheme that allows write commands to go through the flash controller and data temporarily stored, but no data has been actually written into the flash. Since the Virtual Write scheme runs at device level, it requires no software or driver installation and is independent from the host OS.

7. Product Ordering Information

7.1 Product Code Designations



7.2 Valid Combinations

mSATA mini M4

| Capacity | Standard | Extended Temperature |
|----------|------------------|----------------------|
| 2GB | APSDM002GN5AN-PT | APSDM002GN5AN-PTW |
| 4GB | APSDM004GN5AN-PT | APSDM004GN5AN-PTW |
| 8GB | APSDM008GN5AN-PT | APSDM008GN5AN-PTW |
| 16GB | APSDM016GN5AN-PC | APSDM016GN5AN-PCW |
| 32GB | APSDM032GN5AN-PC | APSDM032GN5AN-PCW |

mSATA mini M4 with Write Protect

| Capacity | Standard | Extended Temperature |
|----------|------------------|----------------------|
| 2GB | APSDM002GN5PN-PT | APSDM002GN5PN-PTW |
| 4GB | APSDM004GN5PN-PT | APSDM004GN5PN-PTW |
| 8GB | APSDM008GN5PN-PT | APSDM008GN5PN-PTW |
| 16GB | APSDM016GN5PN-PC | APSDM016GN5PN-PCW |
| 32GB | APSDM032GN5PN-PC | APSDM032GN5PN-PCW |

Note: Please consult with Apacer sales representatives for availabilities.

Revision History

| Revision | Description | Date |
|----------|---|------------|
| 1.0 | Official release | 08/13/2012 |
| 1.1 | Added Write Protect option | 11/07/2012 |
| 1.2 | Upgraded Product Ordering Information due to firmware upgrade | 06/25/2013 |

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