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RoHS Compliant

Serial ATA Flash Drive

mSATA A1 -M Product Specifications

May 14th, 2014

Version 1.5



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Serial ATA Flash Drive APSDMxxxxMXXN-XTMX



Features:

- **Compliance with SATA Revision 3.1**
 - Serial ATA Revision 3.1 specifications
 - SATA 6.0 Gbps interface
 - Backward compatible with SATA 1.5 and 3.0 Gbps interfaces
 - ATA-8 command set
- **Capacities**
 - Standard: 8, 16, 32, 64, 128 GB
 - High speed: 32, 64, 128, 256 GB
- **Performance***
 - Burst read/write: 600 MB/sec

Standard type:

 - Sustained read: up to 380 MB/sec
 - Sustained write: up to 175 MB/sec

High-speed type:

 - Sustained read: up to 530 MB/sec
 - Sustained write: up to 460 MB/sec
 - Random read 4K: up to 85,000 IOPS
 - Random write 4K: up to 79,000 IOPS
- **Flash Management**
 - Built-in hardware ECC, enabling up to 40 bit correction per 1K bytes
 - Static/dynamic wear leveling
 - Flash bad-block management
 - S.M.A.R.T.
 - Power Failure Management
 - ATA Secure Erase
 - TRIM
- **NAND Flash Type: MLC**
- **Temperature ranges**
 - Operating:
 - Standard: 0°C to 70°C
 - Enhanced: -25°C to 85°C
 - Storage: -40°C to 100°C
- **Endurance (in Terabytes Written: TBW)**
 - 8GB: 17 TBW
 - 16GB: 34 TBW
 - 32GB: 68 TBW
 - 64GB: 136 TBW
 - 128GB: 272 TBW
 - 256 GB: 545 TBW
- **Supply voltage**
 - 3.3 V \pm 5%
- **Power consumption (typical)***

Standard

 - Active mode: 485 mA
 - Idle mode: 95 mA

High-speed

 - Active mode: 930 mA
 - Idle mode: 80 mA
- **Form factor**
 - JEDEC MO-300
- **Shock & Vibration****
 - Shock: 1500 G
 - Vibration: 15 G
- **DRAM cache for enhanced random performance (for high speed type only)**
- **SATA power management modes**
- **Device Sleep mode (optional)**
- **Write Protect Switch (optional)**
- **RoHS compliant**

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

**Non-operating

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1. Product Description

1.1 Introduction

Apacer's mSATA A1-M is a well-balanced solid-state disk (SSD) drive with compact form factor (JEDEC MO-300) and great performance. Designed in SATA 6.0 Gbps interface, the mSATA SSD is able to deliver exceptional read/write speed, making it the ideal companion for heavy-loading embedded or server operations with space constraints for host computing systems. For data efficiency, the internal controlling unit of the mSATA SSD is engineered with DRAM for enhanced random performance (for high-speed type only). In regard of reliability, the drive comes with various implementations including powerful hardware ECC engine, power saving modes, wear leveling, flash block management, S.M.A.R.T., TRIM, and power failure management.

1.2 Capacity Specification

Table 1-1 Capacity specification

Capacity	Total Bytes	Cylinders	Heads	Sectors	Max LBA
8 GB	8,012,390,400	15,525	16	63	15,649,200
16 GB	16,013,942,784	16,383	16	63	31,277,232
32 GB	32,017,047,552	16,383	16	63	62,533,296
64 GB	64,023,257,088	16,383	16	63	125,045,424
128 GB	128,035,676,160	16,383	16	63	250,069,680
256 GB	256,060,514,304	16383	16	63	500,118,192

1. Display of total bytes varies from file systems. 2. Cylinders, heads or sectors are not applicable for these capacities. Only LBA addressing applies. 3. 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.

1.3 Performance

Table 1-2 Performance (standard)

Capacity Performance	8 GB	16 GB	32 GB	64 GB	128 GB
Sustained Read (MB/s)	100	200	365	380	380
Sustained Write (MB/s)	11	21	43	80	175

Table 1-3 Performance (high-speed)

Capacity Performance	32 GB	64 GB	128 GB	256 GB
Sustained Read (MB/s)	380	530	530	530
Sustained Write (MB/s)	80	145	305	460
Random Read IOPS (4K)	47,000	79,000	85,000	85,000
Random Write IOPS (4K)	18,000	34,000	72,000	79,000

Note: Performance varies from flash configurations or host system settings.
 IOPS: measured on 8GB span (16777216 sectors Disk Size), 32 Outstanding I/Os (QD=32), Full Random Data pattern, 4KB Align I/Os and test durations 15minutes.

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1.4 Pin Assignments

Pin assignment of the mSATA A1-M is shown in Figure 1-2 and described in Table 1-3.



Figure 1-2 Apacer mSATA A1-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 or DEVSLP*
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	DAS	Device Activity Signal
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

*Pin44 can be configured as Device Sleep enabling pin by option.

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2. Software Interface

2.1 Command Set

Table 2-1 summarizes the ATA commands supported by mSATA A1-M.

Table 2-1: Command set

Code	Command	Code	Command
E5h	Check Power Mode	F6h	Security Disable Password
90h	Execute Diagnostics	F3h	Security Erase Prepare
E7h	Flush Cache	F4h	Security Erase Unit
ECh	Identify Device	F5h	Security Freeze Lock
E3h	Idle	F1h	Security Set Password
E1h	Idle Immediate	F2h	Security Unlock
91h	Initialize Device Parameters	7xh	Seek
C8h	Read DMA	EFh	Set Features
25h	Read DMA EXT	C6h	Set Multiple Mode
60h	Read FPDMA Queued	E6h	Sleep
47h	Read Log DMA EXT	B0h	S.M.A.R.T.
2Fh	Read Log EXT	E2h	Standby
C4h	Read Multiple	E0h	Standby Immediate
20 or	Read Sector(s)	CAh	Write DMA
40 or	Read Verify Sector(s)	35h	Write DMA EXT
10h	Recalibrate	61h	Write FPDMA Queued
57h	Write Log DMA EXT	3Fh	Write Log EXT
C5h	Write Multiple	30h or	Write Sector(s)

2.2 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.

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Apacer memory products come with S.M.A.R.T. commands and subcommands for users to obtain information of drive status and to predict potential drive failures. Users can take advantage of the following commands/subcommands to monitor the health of the drive.

Code	SMART Subcommand
D0h	READ DATA
D1h	READ ATTRIBUTE THRESHOLDS
D2h	Enable/Disable Attribute Autosave
D4h	Execute Off-line Immediate
D5h	Read Log (optional)
D6h	Write Log (optional)
D8h	Enable Operations
D9h	Disable operations
DAh	Return Status

General SMART attribute structure

Byte	Description
0	ID (Hex)
1 – 2	Status flag
3	Value
4	Worst
5*-11	Raw Data

*Byte 5: LSB

SMART attribute ID list

ID (Hex)	Attribute Name
9 (0x09)	Power-on hours
12 (0x0C)	Power cycle count
163 (0xA3)	Max. erase count
164 (0xA4)	Avg. erase count
166 (0xA6)	Total later bad block count
167 (0xA7)	SSD Protect Mode (vendor specific)
168 (0xA8)	SATA PHY Error Count
175 (0xAF)	Bad Cluster Table Count
192 (0xC0)	Unexpected Power Loss Count
194 (0xC2)	Temperature
241 (0xF1)	Total sectors of write

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3. Flash Management

3.1 Error Correction/Detection

mSATA A1-M implements a hardware ECC scheme, based on the BCH algorithm. It can detect and correct up to 40 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.

Note: The controller unit of this product model is designed with a DRAM as a write cache for improved performance and data efficiency. Though unlikely to happen in most cases, the data cached in the volatile DRAM might be potentially affected if a sudden power loss takes place before the cached data is flushed into non-volatile NAND flash memory.

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.

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3.6 TRIM

TRIM is a SATA command that helps improve the read/write performance and efficiency of solid-state drives (SSD). The command enables the host operating system to inform SSD controller which blocks contain invalid data, mostly because of the erase commands from host. The invalid will be discarded permanently and the SSD will retain more space for itself.

3.7 SATA Power Management

By complying with SATA 6.0 Gb/s specifications, the SSD supports the following SATA power saving modes:

- ACTIVE: PHY ready, full power, Tx & Rx operational
- PARTIAL: Reduces power, resumes in under 10 μ s (microseconds)
- SLUMBER: Reduces power, resumes in under 10 ms (milliseconds)
- HIPM: Host-Initiated Power Management
- DIPM: Device-Initiated Power Management
- AUTO-SLUMBER: Automatic transition from partial to slumber.
- Device Sleep (DevSleep or DEVSLP): PHY powered down; power consumption \leq 5 mW; host assertion time \leq 10 ms; exit timeout from this state \leq 20 ms (unless specified otherwise in SATA Identify Device Log).

Note:

1. The behaviors of power management features would depend on host/device settings.
2. Device Sleep mode is optional, depending on product ordering selections.

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4. Reliability Specifications

4.1 Environmental

mSATA A1-M environmental specifications follow MIL-STD-810F, as indicated in the following table.

Table 4-1 mSATA A1-M environmental specifications

Environment	Specification
Temperature	0°C to 70°C (standard) / -25°C to 85°C (enhanced)
	-40°C to 100°C (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 SATA drive. The prediction result for the mSATA A1-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 A1-M complies with the following standards:

- CE
- FCC
- RoHS
- MIL-STD-810F

4.4 Endurance

The endurance of a storage device is predicted by TeraBytes Written based on several factors related to usage, such as the amount of data written into the drive, block management conditions, and daily workload for the drive. Thus, key factors, such as Write Amplifications and the number of P/E cycles, can influence the lifespan of the drive.

Capacity	TeraBytes Written
8 GB	17
16 GB	34
32 GB	68
64 GB	136
128 GB	272
256 GB	545

Notes:

- The measurement assumes the data written to the SSD for test is under a typical and constant rate.
- The measurement follows the standard metric: 1 TB (Terabyte) = 1000 GB.

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5. Electrical Characteristics

5.1 Operating Voltage

Table 5-1 lists the supply voltage for mSATA A1-M.

Table 5-1 mSATA A1-M operating voltage

Parameter	Conditions
Supply voltage	3.3V \pm 5%

5.2 Power Consumption

Table 5-2 Power consumption (standard)

Mode \ Capacity	8 GB	16 GB	32 GB	64 GB	128 GB
Active (mA)	225	250	305	350	485
Idle (mA)	95	95	95	95	95

Table 5-3: Typical power consumption (high-speed)

Modes \ Capacity	32 GB	64 GB	128 GB	256 GB
Active (mA)	340	420	680	930
Idle (mA)	75	80	80	80

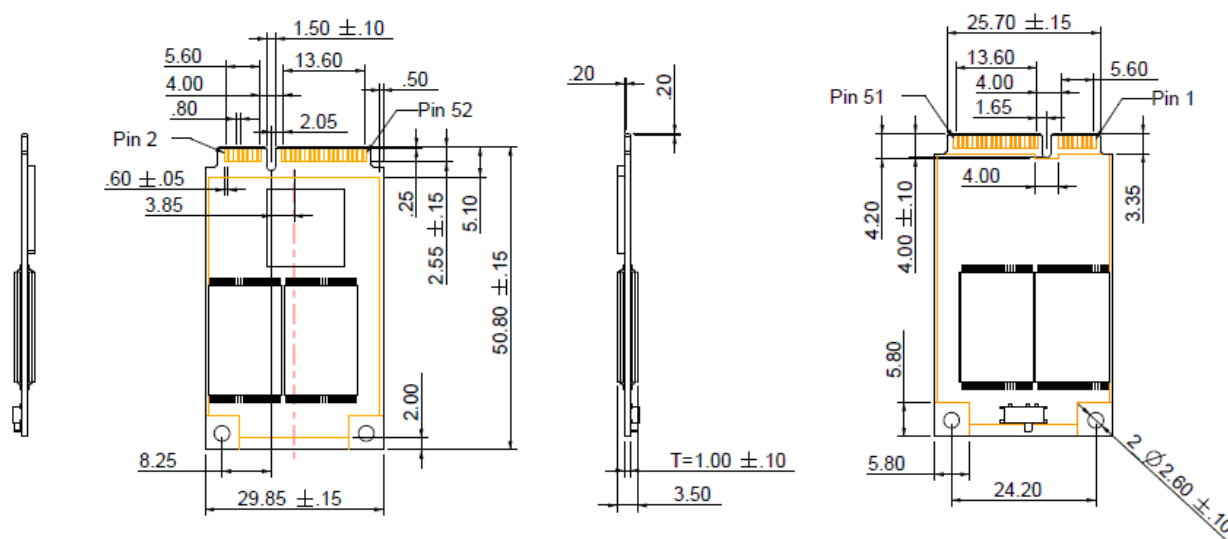
Note: Results may differ from various flash configurations or host system setting

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6. Mechanical Specifications

6.1 Dimensions (Standard type)

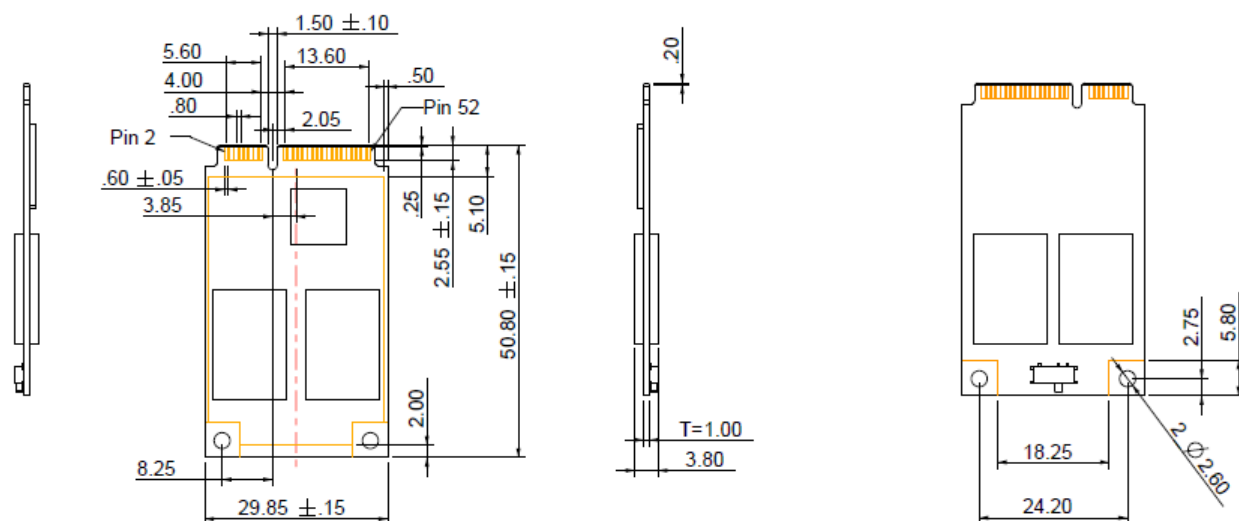


Unit: mm
Tolerance: ± 0.2

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6.2 Dimensions (High-speed type)



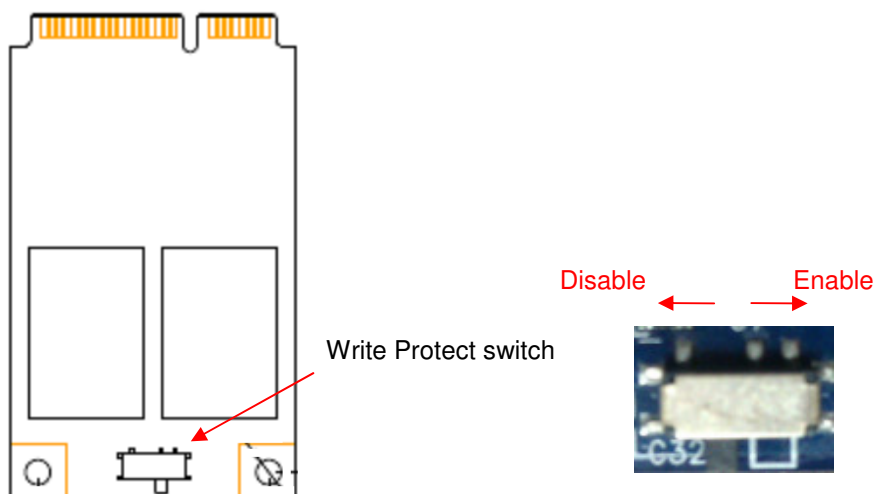
Unit: mm
Tolerance: ± 0.2

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6.2 Write Protect Switch (optional)

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. Once the system is reset and rebooted, the temporarily stored data will be lost and nowhere to be found in the system. Since the Virtual Write scheme runs at device level, it requires no software or driver installation and is independent from the host OS.



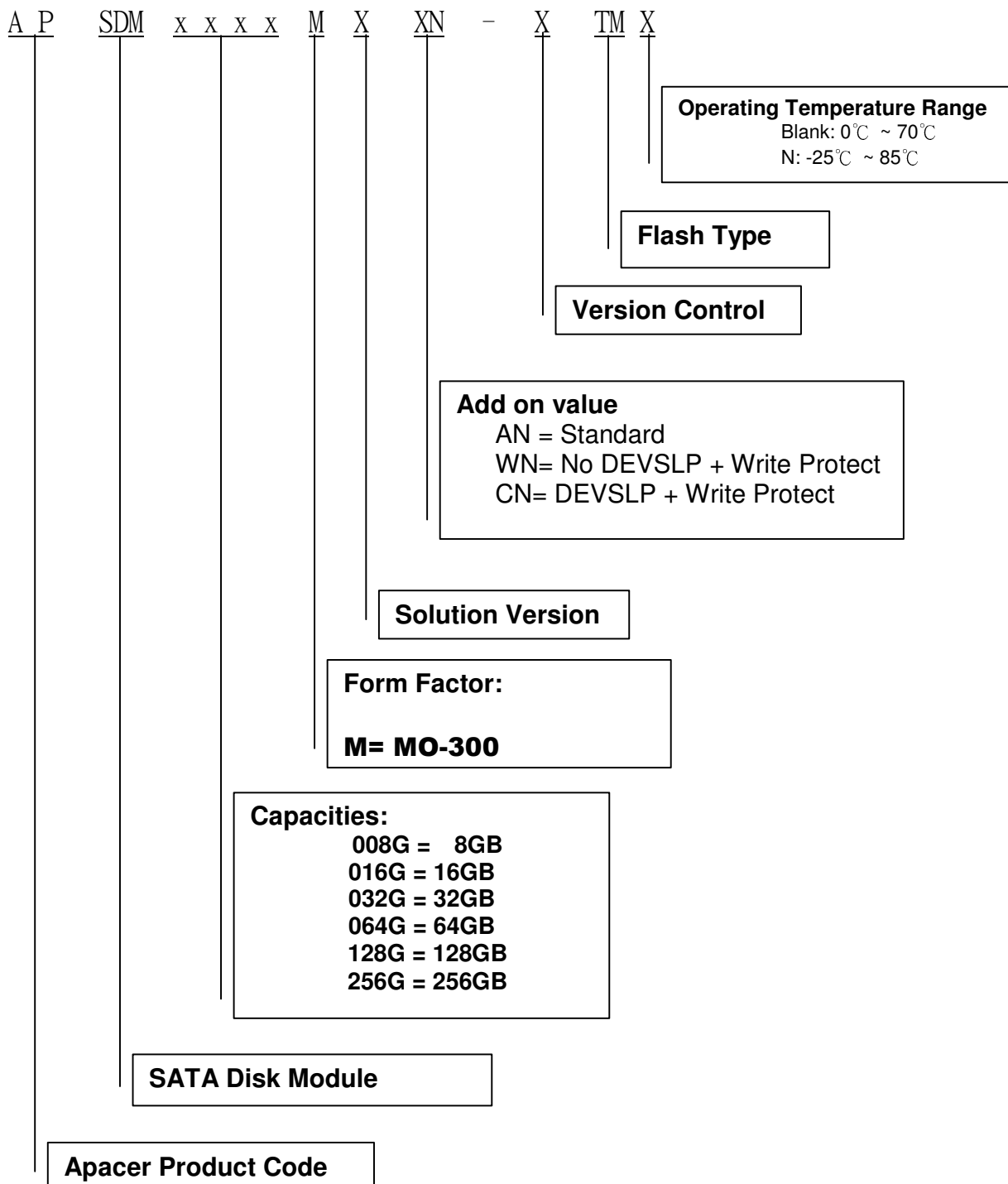
Note: Write Protect is optional and the image is for reference only.

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7. Product Ordering Information

7.1 Product Code Designations



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7.2 Valid Combinations

A. No Write Protect

7.2.1.1 Standard Speed / Operating Temperature (0℃ ~ 70℃)

Capacity	NO DEVSLP	DEVSLP
8GB	APSDM008GMBAN-ATM	APSDM008GMBAN-BTM
16GB	APSDM016GMBAN-ATM	APSDM016GMBAN-BTM
32GB	APSDM032GMBAN-ATM	APSDM032GMBAN-BTM
64GB	APSDM064GMBAN-ATM	APSDM064GMBAN-BTM
128GB	APSDM128GMBAN-ATM	APSDM128GMBAN-BTM

7.2.1.2 Standard Speed / Operating Temperature (-25℃ ~ 85℃)

Capacity	NO DEVSLP	DEVSLP
8GB	APSDM008GMBAN-ATMN	APSDM008GMBAN-BTMN
16GB	APSDM016GMBAN-ATMN	APSDM016GMBAN-BTMN
32GB	APSDM032GMBAN-ATMN	APSDM032GMBAN-BTMN
64GB	APSDM064GMBAN-ATMN	APSDM064GMBAN-BTMN
128GB	APSDM128GMBAN-ATMN	APSDM128GMBAN-BTMN

7.2.2.1 High Speed / Operating Temperature (0℃ ~ 70℃)

Capacity	NO DEVSLP	DEVSLP
32GB	APSDM032GM4AN-2ATM	APSDM032GM4AN-2BTM
64GB	APSDM064GM9AN-2ATM	APSDM064GM9AN-2BTM
128GB	APSDM128GM9AN-2ATM	APSDM128GM9AN-2BTM
256GB	APSDM256GM9AN-2ATM	APSDM256GM9AN-2BTM

7.2.2.2 High Speed / Operating Temperature (-25℃ ~ 85℃)

Capacity	NO DEVSLP	DEVSLP
32GB	APSDM032GM4AN-2ATMN	APSDM032GM4AN-2BTMN
64GB	APSDM064GM9AN-2ATMN	APSDM064GM9AN-2BTMN
128GB	APSDM128GM9AN-2ATMN	APSDM128GM9AN-2BTMN
256GB	APSDM256GM9AN-2ATMN	APSDM256GM9AN-2BTMN

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B. Write Protect

7.2.3.1 Standard Speed / Operating Temperature (0°C ~ 70°C)

Capacity	NO DEVSLP	DEVSLP
8GB	APSDM008GMBWN-ATM	APSDM008GMBCN-BTM
16GB	APSDM016GMBWN-ATM	APSDM016GMBCN-BTM
32GB	APSDM032GMBWN-ATM	APSDM032GMBCN-BTM
64GB	APSDM064GMBWN-ATM	APSDM064GMBCN-BTM
128GB	APSDM128GMBWN-ATM	APSDM128GMBCN-BTM

7.2.3.2 Standard Speed / Operating Temperature (-25°C ~ 85°C)

Capacity	NO DEVSLP	DEVSLP
8GB	APSDM008GMBWN-ATMN	APSDM008GMBCN-BTMN
16GB	APSDM016GMBWN-ATMN	APSDM016GMBCN-BTMN
32GB	APSDM032GMBWN-ATMN	APSDM032GMBCN-BTMN
64GB	APSDM064GMBWN-ATMN	APSDM064GMBCN-BTMN
128GB	APSDM128GMBWN-ATMN	APSDM128GMBCN-BTMN

7.2.4.1 High Speed / Operating Temperature (0°C ~ 70°C)

Capacity	NO DEVSLP	DEVSLP
32GB	APSDM032GM4WN-2ATM	APSDM032GM4CN-2BTM
64GB	APSDM064GM9WN-2ATM	APSDM064GM9CN-2BTM
128GB	APSDM128GM9WN-2ATM	APSDM128GM9CN-2BTM
256GB	APSDM256GM9WN-2ATM	APSDM256GM9CN-2BTM

7.2.4.2 High Speed / Operating Temperature (-25°C ~ 85°C)

Capacity	NO DEVSLP	DEVSLP
32GB	APSDM032GM4WN-2ATMN	APSDM032GM4CN-2BTMN
64GB	APSDM064GM9WN-2ATMN	APSDM064GM9CN-2BTMN
128GB	APSDM128GM9WN-2ATMN	APSDM128GM9CN-2BTMN
256GB	APSDM256GM9WN-2ATMN	APSDM256GM9CN-2BTMN

Note: please contact Apacer sales representatives for availabilities.

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Revision History

Revision	Description	Date
0.1	Preliminary release	05/17/2013
0.2	Updated performance and power consumption Removed 16GB information	09/17/2013
0.3	Added IOPS Integrates categories of standard and high-speed types	10/16/2013
0.4	Revised the capacity information for 128GB	11/07/2013
0.5	Updated performance and power consumption after a re-test	11/08/2013
1.0	Official release	12/10/2013
1.1	Revised Product Ordering Information with the addition of standard type with DEVSLP feature	02/20/2014
1.2	Removed "DSS" from pin49	03/14/2014
1.3	Added write protect switch	04/07/2014
1.4	Added Enhanced temperature grade into the specifications	04/28/2014
1.5	Updated performance and power consumption due to firmware upgrade	05/14/2014

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