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***RoHS Compliant***

# **Serial ATA Flash Drive**

***mSATA A1 Product Specifications***

**July 10<sup>th</sup>, 2014**

***Version 1.3***



***Apacer Technology Inc.***

1F, No.32, Zhongcheng Rd., Tucheng Dist., New Taipei City, Taiwan, R.O.C

Tel: +886-2-2267-8000 Fax: +886-2-2267-2261

www.apacer.com

## Serial ATA Flash Drive APSDMxxxxMXXN-XTX



### 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**
  - 4, 8, 16, 32, 64, 128 GB
- **Performance\***
  - Interface burst read/write: 600 MB/sec
  - Standard type:
    - Sustained read: up to 160 MB/sec
    - Sustained write: up to 155 MB/sec
  - High-speed type:
    - Sustained read: up to 530 MB/sec
    - Sustained write: up to 450 MB/sec
    - Random read 4K: up to 82,000 IOPS
    - Random write 4K: up to 77,000 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: SLC**
- **Temperature ranges**
  - Operating:
    - Standard: 0°C to 70°C
    - Extended: -40°C to 85°C
  - Storage: -40°C to 100°C
- **Supply voltage**
  - 3.3 V ± 5%
- **Power consumption (typical)\***
  - Standard type:
    - Active mode: 410 mA
    - Idle mode: 195 mA
  - High-speed
    - Active mode: 890 mA
    - Idle mode: 160 mA
- **Form factor**
  - JEDEC MO-300
- **Shock & Vibration\*\***
  - Shock: 1500 G
  - Vibration: 15 G
- **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 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. 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
4 GB	4,011,614,208	7,773	16	63	7,835,184
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

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	4 GB	8 GB	16 GB	32 GB	64 GB
<b>Sustained Read (MB/s)</b>	140	150	150	160	160
<b>Sustained Write (MB/s)</b>	55	80	80	150	155

**Table 1-3** Performance (high-speed)

Capacity Performance	32 GB	64 GB	128 GB
<b>Sustained Read (MB/s)</b>	530	530	530
<b>Sustained Write (MB/s)</b>	270	440	450
<b>Random Read IOPS (4K)</b>	81,000	82,000	82,000
<b>Random Write IOPS (4K)</b>	62,000	76,000	77,000

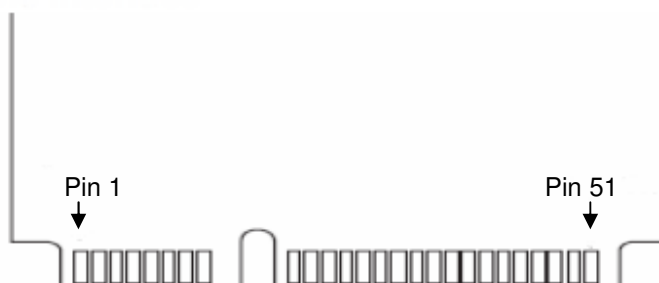
Note: Performance varies from flash configurations or host system settings.  
 IOPS: measured on 8GB span (16777216 sectors Disk Size), 32 Outstanding I/Os (QD=32), Full Random Data pattern, 4KB Align I/Os and test durations 15minutes.

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### 1.4 Pin Assignments

Pin assignment of the mSATA A1 is shown in Figure 1-1 and described in Table 1-4.



**Figure 1-1** Apacer mSATA A1 pin assignment

**Table 1-4** 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.

**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

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mSATA A1 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

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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

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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

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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

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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

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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

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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  $\mu$ 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 environmental specifications follow MIL-STD-810F, as indicated in the following table.

**Table 4-1** mSATA A1 environmental specifications

Environment	Specification
Temperature	0°C to 70°C (Operating); -40°C to 85°C (Extended)
	-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 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 A1 complies with the following standards:

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

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## 5. Electrical Characteristics

### 5.1 Operating Voltage

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

**Table 5-1** mSATA A1 operating voltage

Parameter	Conditions
Supply voltage	3.3V ±5%

### 5.2 Power Consumption

**Table 5-2** Power consumption (standard)

Mode \ Capacity	4 GB	8 GB	16 GB	32 GB	64 GB
Active (mA)	290	375	375	375	410
Idle (mA)	195	195	195	195	195

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

Modes \ Capacity	32 GB	64 GB	128 GB
Active (mA)	450	680	890
Idle (mA)	160	160	160

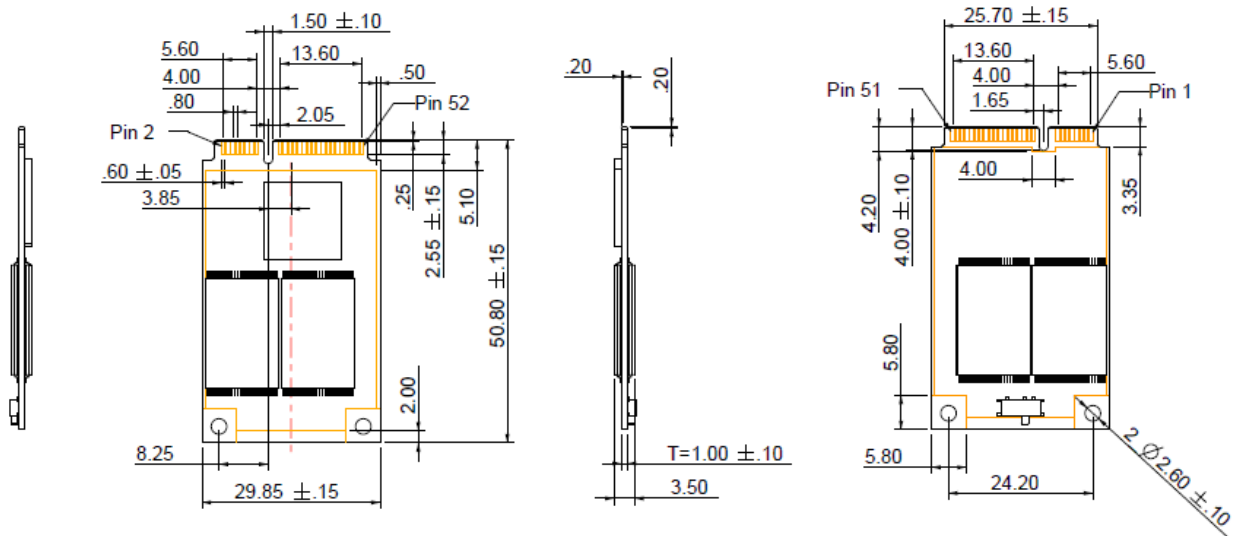
Note: Results were conducted by estimates and may differ from various flash configurations or host system setting

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## 6. Mechanical Specifications

### 6.1 Dimensions (Standard type)

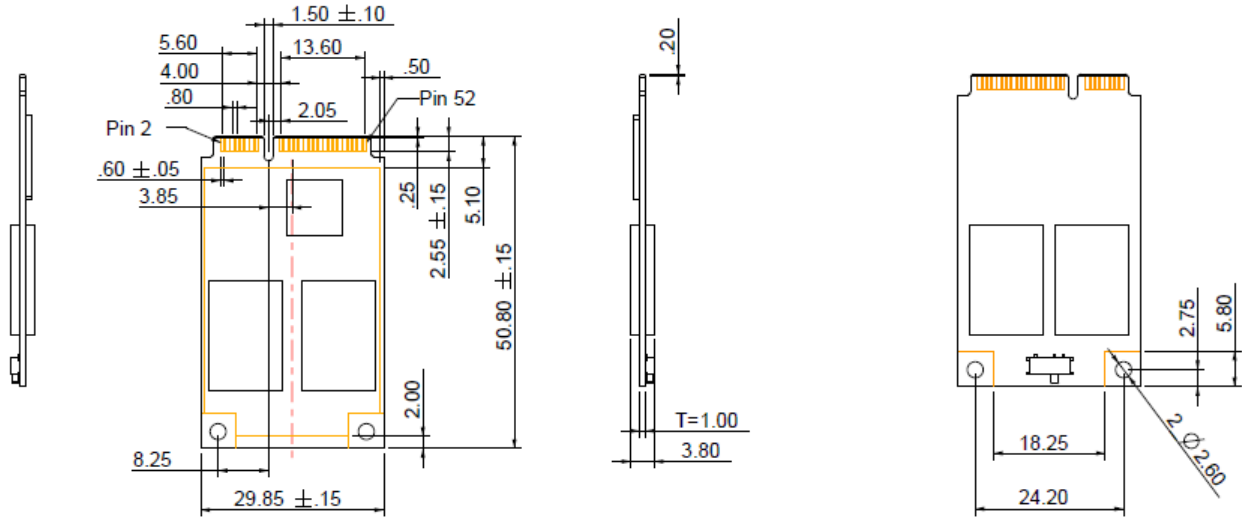


Unit: mm  
 Tolerance: ± 0.2

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**6.2 Dimensions (High-speed type)**



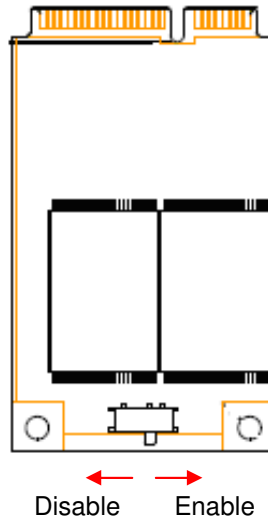
Unit: mm  
 Tolerance:  $\pm 0.2$

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### 6.3 Write Protect Switch (optional)

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Description of Apacer Write Protect:

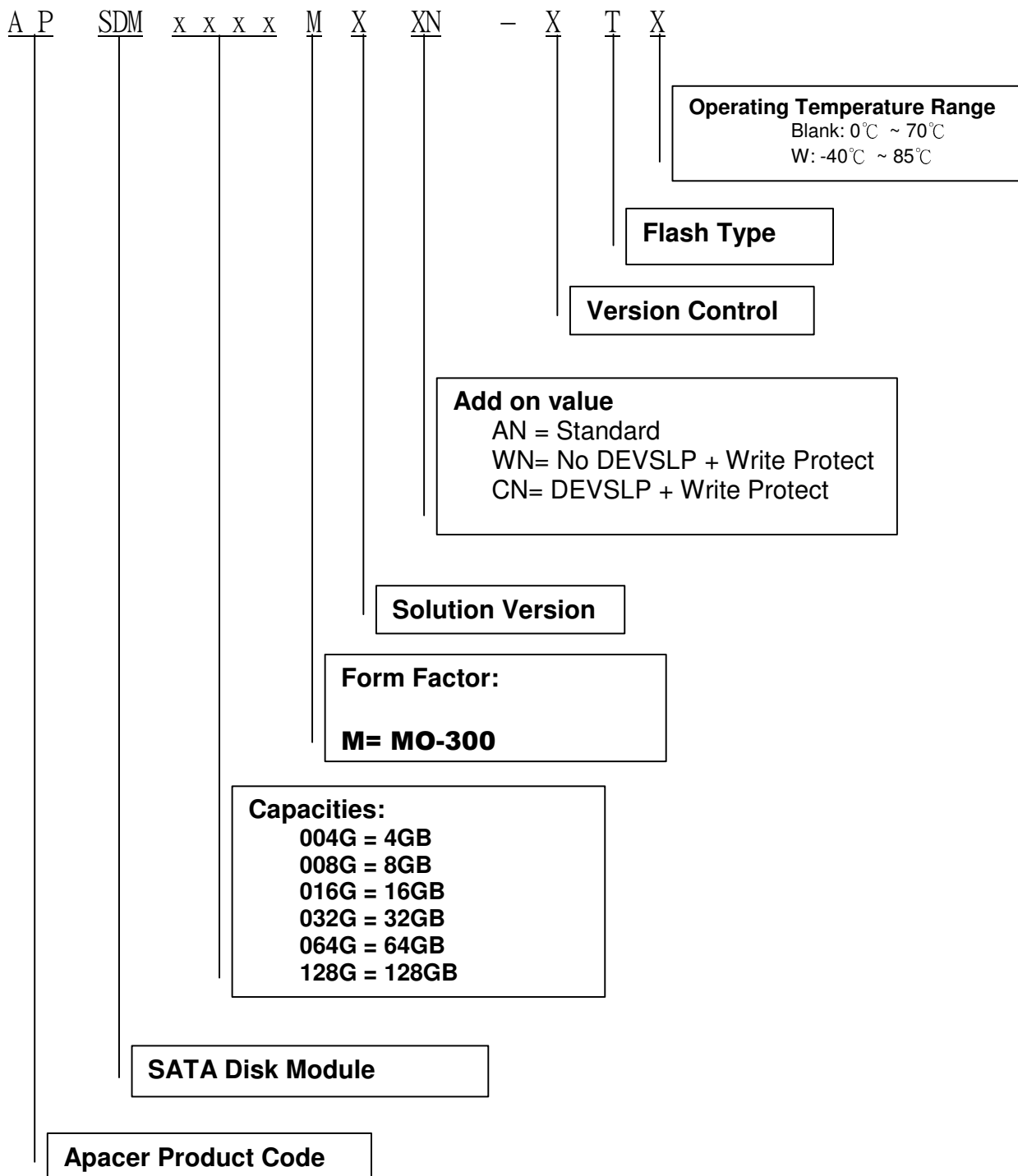
Apacer implements the Virtual Write scheme that allows write commands to go through the flash controller and data temporarily stored, but no data has been actually written into the flash. Since the Virtual Write scheme runs at device level, it requires no software or driver installation and is independent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

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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°C ~ 70°C)

Capacity	NO DEVSLP	DEVSLP
4GB	APSDM004GMBAN-AT	APSDM004GMBAN-BT
8GB	APSDM008GMBAN-AT	APSDM008GMBAN-BT
16GB	APSDM016GMBAN-AT	APSDM016GMBAN-BT
32GB	APSDM032GMBAN-AT	APSDM032GMBAN-BT
64GB	APSDM064GMBAN-AT	APSDM064GMBAN-BT

#### 7.2.1.2 Standard Speed / Operating Temperature (-40°C ~ 85°C)

Capacity	NO DEVSLP	DEVSLP
4GB	APSDM004GMBAN-ATW	APSDM004GMBAN-BTW
8GB	APSDM008GMBAN-ATW	APSDM008GMBAN-BTW
16GB	APSDM016GMBAN-ATW	APSDM016GMBAN-BTW
32GB	APSDM032GMBAN-ATW	APSDM032GMBAN-BTW
64GB	APSDM064GMBAN-ATW	APSDM064GMBAN-BTW

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

Capacity	NO DEVSLP	DEVSLP
32GB	APSDM032GM4AN-3AT	APSDM032GM4AN-3BT
64GB	APSDM064GM9AN-3AT	APSDM064GM9AN-3BT
128GB	APSDM128GM9AN-3AT	APSDM128GM9AN-3BT

#### 7.2.1.4 High Speed / Operating Temperature (-40°C ~ 85°C)

Capacity	NO DEVSLP	DEVSLP
32GB	APSDM032GM4AN-3ATW	APSDM032GM4AN-3BTW
64GB	APSDM064GM9AN-3ATW	APSDM064GM9AN-3BTW
128GB	APSDM128GM9AN-3ATW	APSDM128GM9AN-3BTW

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**B. Write Protect**

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

Capacity	NO DEVSLP	DEVSLP
4GB	APSDM004GMBWN-AT	APSDM004GMBCN-BT
8GB	APSDM008GMBWN-AT	APSDM008GMBCN-BT
16GB	APSDM016GMBWN-AT	APSDM016GMBCN-BT
32GB	APSDM032GMBWN-AT	APSDM032GMBCN-BT
64GB	APSDM064GMBWN-AT	APSDM064GMBCN-BT

**7.2.2.2 Standard Speed / Operating Temperature (-40°C ~ 85°C)**

Capacity	NO DEVSLP	DEVSLP
4GB	APSDM004GMBWN-ATW	APSDM004GMBCN-BTW
8GB	APSDM008GMBWN-ATW	APSDM008GMBCN-BTW
16GB	APSDM016GMBWN-ATW	APSDM016GMBCN-BTW
32GB	APSDM032GMBWN-ATW	APSDM032GMBCN-BTW
64GB	APSDM064GMBWN-ATW	APSDM064GMBCN-BTW

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

Capacity	NO DEVSLP	DEVSLP
32GB	APSDM032GM4WN-3AT	APSDM032GM4CN-3BT
64GB	APSDM064GM9WN-3AT	APSDM064GM9CN-3BT
128GB	APSDM128GM9WN-3AT	APSDM128GM9CN-3BT

**7.2.2.4 High Speed / Operating Temperature (-40°C ~ 85°C)**

Capacity	NO DEVSLP	DEVSLP
32GB	APSDM032GM4WN-3ATW	APSDM032GM4CN-3BTW
64GB	APSDM064GM9WN-3ATW	APSDM064GM9CN-3BTW
128GB	APSDM128GM9WN-3ATW	APSDM128GM9CN-3BTW

**Note:** please contact Apacer sales representatives for availabilities.

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## Revision History

Revision	Description	Date
0.1	Preliminary	02/07/2014
1.0	Official release	02/25/2014
1.1	Removed "DSS" from pin 49	03/14/2014
1.2	Updated mechanical drawing	05/15/2014
1.3	Added high-speed models	07/10/2014

## Serial ATA Flash Drive APSDMxxxxMXXN-XTX



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### Global Presence

#### Taiwan (Headquarters)

**Apacer Technology Inc.**  
Apacer Technology Inc.  
1F., No.32, Zhongcheng Rd., Tucheng Dist.,  
New Taipei City 236, Taiwan R.O.C.  
Tel: 886-2-2267-8000  
Fax: 886-2-2267-2261  
[amtsales@apacer.com](mailto:amtsales@apacer.com)

#### U.S.A.

**Apacer Memory America, Inc.**  
386 Fairview Way, Suite102,  
Milpitas, CA 95035  
Tel: 1-408-518-8699  
Fax: 1-408-935-9611  
[sa@apacerus.com](mailto:sa@apacerus.com)

#### Japan

**Apacer Technology Corp.**  
5F, Matsura Bldg., Shiba, Minato-Ku  
Tokyo, 105-0014, Japan  
Tel: 81-3-5419-2668  
Fax: 81-3-5419-0018  
[jpsservices@apacer.com](mailto:jpsservices@apacer.com)

#### Europe

**Apacer Technology B.V.**  
Science Park Eindhoven 5051 5692 EB Son,  
The Netherlands  
Tel: 31-40-267-0000  
Fax: 31-40-267-0000#6199  
[sales@apacer.nl](mailto:sales@apacer.nl)

#### China

**Apacer Electronic (Shanghai) Co., Ltd**  
1301, No.251, Xiaomujiao Road, Shanghai,  
200032, China  
Tel: 86-21-5529-0222  
Fax: 86-21-5206-6939  
[sales@apacer.com.cn](mailto:sales@apacer.com.cn)

#### India

**Apacer Technologies Pvt Ltd,**  
# 535, 1st Floor, 8th cross, JP Nagar 3rd Phase,  
Bangalore – 560078, India  
Tel: 91-80-4152-9061  
[sales\\_india@apacer.com](mailto:sales_india@apacer.com)