

RoHS Compliant

Serial ATA Flash Drive

SM220-300B mSATA mini Product Specifications (Toshiba 15nm)

March 31, 2017

Version 1.5



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

Features:

- **Serial ATA Compliance**
 - Serial ATA Revision 3.1
 - SATA 6.0 Gbps interface
 - Backward compatible with SATA 1.5/3.0 Gbps interfaces
 - ATA-8 command set
- **Capacity**
 - 8, 16, 32, 64, 128 GB
- **Performance***
 - Burst read/write: 600 MB/sec
 - Sustained read: Up to 280 MB/sec
 - Sustained write: Up to 180 MB/sec
 - Random read (4K): up to 47,000 IOPS
 - Random write (4K): up to 45,000 IOPS
- **Flash Management**
 - Built-in hardware ECC
 - Global Wear Leveling
 - Flash bad-block management
 - Flash Translation Layer: Page Mapping
 - S.M.A.R.T.
 - Power Failure Management
 - ATA Secure Erase
 - TRIM
- **NAND Flash Type: MLC**
- **MTBF: > 1,000,000 hours**
- **Temperature Range**
 - Operating:
 - Standard: 0°C to 70°C
 - Extended: -40°C to 85°C
 - Storage: -40°C to 100°C
- **Supply Voltage**
 - 3.3V ± 5%
- **Power Consumption***
 - Active: 490 mA
 - Idle: 110 mA
- **Form Factor****
 - mSATA mini
 - Dimensions (29.85 x 26.80 x 3.95, unit: mm)
- **Connector**
 - 52-pin mSATA connector
- **Shock & Vibration*****
 - Shock: 1,500G
 - Vibration: 15G
- **DRAM Cache for Enhanced Random Performance**
- **SATA Power Management Modes**
- **LED Indicators for Drive Behavior**
- **Thermal Sensor (optional)**
- **RoHS Compliant**

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

**With one screw hole

***Non-operating

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1. Product Description

1.1 Introduction

Apacer SM220-300B is a well-balanced solid-state disk (SSD) drive with compact form factor (mSATA mini) 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. 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 Functional Block Diagram

SM220-300B 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.

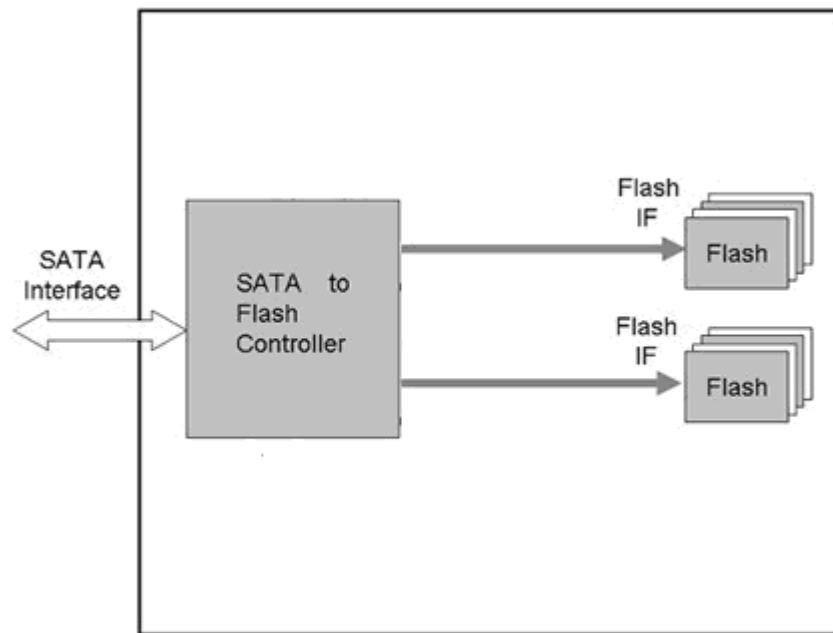


Figure 1-1 Functional Block Diagram

1.3 Capacity Specifications

Capacity specifications of SM220-300B product family are 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 Specifications

| 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 |

*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.

1.4 Performance Specifications

Performance of SM220-300B is shown in Table 1-2.

Table 1-2 Performance Specifications

| Capacity \ Performance | 8 GB | 16 GB | 32 GB | 64 GB | 128 GB |
|-------------------------------|--------|--------|--------|--------|--------|
| Sustained Read (MB/s) | 115 | 220 | 220 | 280 | 260 |
| Sustained Write (MB/s) | 26 | 50 | 45 | 90 | 180 |
| Random Read IOPS (4K) | 15,000 | 26,000 | 25,000 | 46,000 | 47,000 |
| Random Write IOPS (4K) | 4,000 | 10,000 | 11,000 | 22,000 | 45,000 |

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

1.5 Pin Assignments

Pin assignment of the SM220-300B is shown in Figure 1-2 and described in Table 1-3.

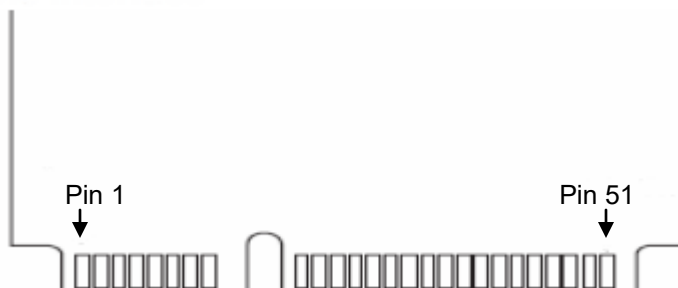
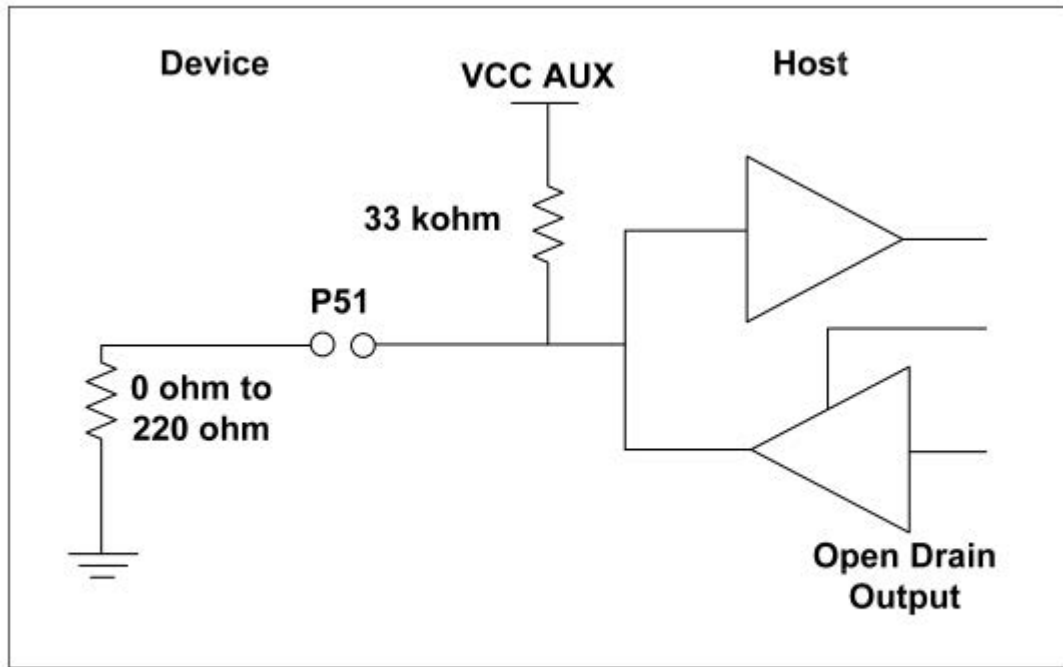


Figure 1-2 Pin Assignment

Table 1-3 Pin Assignment Description

| Pin | Type | Description | Pin | Type | Description |
|-----|----------|--|-----|-------------|--|
| 1 | Reserved | No Connect | 27 | GND | Ground |
| 2 | +3.3V | 3.3V source | 28 | Reserved | No Connect |
| 3 | Reserved | No Connect | 29 | GND | Ground |
| 4 | GND | Ground | 30 | Reserved | No Connect |
| 5 | Reserved | No Connect | 31 | -A | Host Transmitter Differential Signal Pair |
| 6 | Reserved | No Connect | 32 | Reserved | No Connect |
| 7 | Reserved | No Connect | 33 | +A | Host Transmitter Differential Signal Pair |
| 8 | Reserved | No Connect | 34 | GND | Ground |
| 9 | GND | Ground | 35 | GND | Ground |
| 10 | Reserved | No Connect | 36 | Reserved | No Connect |
| 11 | Reserved | No Connect | 37 | GND | Ground |
| 12 | Reserved | No Connect | 38 | Reserved | No Connect |
| 13 | Reserved | No Connect | 39 | +3.3V | 3.3V source |
| 14 | Reserved | No Connect | 40 | GND | Ground |
| 15 | GND | Ground | 41 | +3.3V | 3.3V source |
| 16 | Reserved | No Connect | 42 | Reserved | No Connect |
| 17 | Reserved | No Connect | 43 | Device Type | No Connect |
| 18 | GND | Ground | 44 | Reserved | No Connect |
| 19 | Reserved | No Connect | 45 | Reserved | No Connect |
| 20 | Reserved | No Connect | 46 | Reserved | No Connect |
| 21 | GND | Ground | 47 | Reserved | No Connect |
| 22 | Reserved | No Connect | 48 | Reserved | No Connect |
| 23 | +B | Host Receiver Differential Signal Pair | 49 | DAS/DSS | Device Activity Signal/Disable Staggered Spin-up |
| 24 | +3.3V | 3.3V Source | 50 | GND | Ground |
| 25 | -B | Host Receiver Differential Signal Pair | 51* | Detect | 0 ohm |
| 26 | GND | Ground | 52 | +3.3V | 3.3V source |

*Notes about Pin51: It is a presence detection pin that shall be connected to GND by a 0 ohm to 220 ohm Resistor on device. Please see the diagram below.



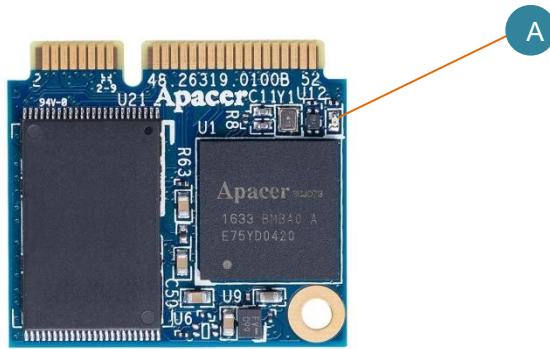
BI-directional host-side implementation of P51 for compatibility with non-mSATA devices (Informative)

1.6 LED Indicator Behavior

The behavior of the SM220-300B LED indicators is described in Table 1-4.

Table 1-4 LED Behavior

| Location | Status | Description |
|----------|----------|---|
| LED A | Blinking | LED blinking when SSD read/write access |



2. Software Interface

2.1 Command Set

Table 2-1 summarizes the ATA commands supported by SM220-300B.

Table 2-1 Command Set

| Code | Command | Code | Command |
|------------|------------------------------|------------|-----------------------|
| E5h | Check Power Mode | F4h | Security Erase Unit |
| 90h | Execute Diagnostics | F5h | Security Freeze Lock |
| E7h | Flush Cache | F1h | Security Set Password |
| ECh | Identify Device | F2h | Security Unlock |
| E3h | Idle | 7Xh | Seek |
| E1h | Idle Immediate | Efh | Set Features |
| 91h | Initialize Device Parameters | C6h | Set Multiple Mode |
| C8h | Read DMA | E6h | Sleep |
| 25h | Read DMA EXT | B0h | SMART |
| 60h | Read FPDMA Queued | E2h | Standby |
| 47h | Read Log DMA EXT | E0h | Standby Immediate |
| 2Fh | Read Log EXT | Cah | Write DMA |
| C4h | Read Multiple | 35h | Write DMA EXT |
| 20h or 21h | Read Sectors | 61h | Write FPDMA Queued |
| 40h or 41h | Read Verify Sectors | 57h | Write Log DMA EXT |
| 10h | Recalibrate | 3Fh | Write Log EXT |
| F6h | Security Disable Password | C5h | Write Multiple |
| F3h | Security Erase Prepare | 30h or 31h | Write Sectors |

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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APMxxxGNEAN-4ETM1XX



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 |

3. Flash Management

3.1 Error Correction/Detection

SM220-300B 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 Global 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. Global wear leveling is an important mechanism that levels out the wearing of all blocks so that the wearing-down of all blocks can be almost evenly distributed. This will increase the lifespan of SSDs.

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 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 Flash Translation Layer – Page Mapping

Page mapping is an advanced flash management technology whose essence lies in the ability to gather data, distribute the data into flash pages automatically, and then schedule the data to be evenly written. Page-level mapping uses one page as the unit of mapping. The most important characteristic is that each logical page can be mapped to any physical page on the flash memory device. This mapping algorithm allows different sizes of data to be written to a block as if the data is written to a data pool and it does not need to take extra operations to process a write command. Thus, page mapping is adopted to increase random access speed and improve SSD lifespan, reduce block erase frequency, and achieve optimized performance and lifespan.

3.8 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

Note: The behaviors of power management features would depend on host/device settings.

4. Environmental Specifications

4.1 Environments

SM220-300B environmental specifications follow the US Military Standard MIL-STD-810F, as shown in table below.

Table 4-1 Environmental Specifications

| Environment | Specifications |
|-------------|--|
| Temperature | 0°C to 70°C (Standard); -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 mSATA. The prediction result for the SM220-300B is more than 1,000,000 hours.

Note: 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

SM220-300B complies with the following standards:

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

5. Electrical Characteristics

5.1 Operating Voltage

Table 5-1 lists the supply voltage for SM220-300B.

Table 5-1 Operating Voltage

| Parameter | Conditions |
|----------------|----------------------------|
| Supply Voltage | 3.3V ± 5% (3.135 – 3.465V) |

5.2 Power Consumption

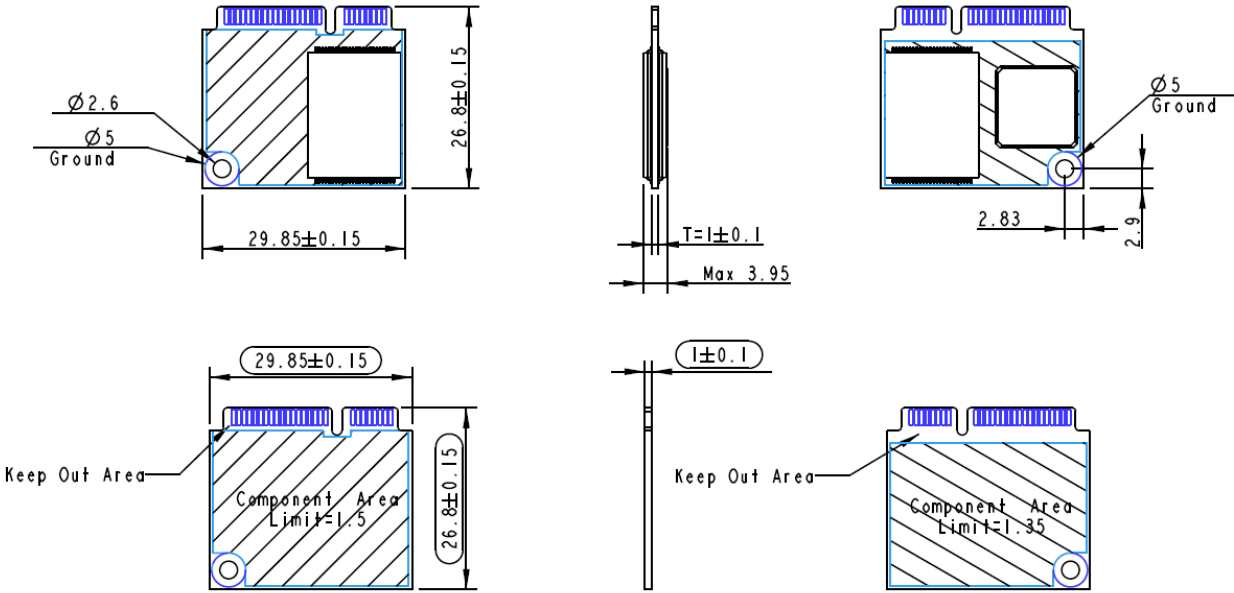
Table 5-2 Power Consumption (typical)

| Mode \ Capacity | 8 GB | 16 GB | 32 GB | 64 GB | 128 GB |
|-----------------|------|-------|-------|-------|--------|
| Active (mA) | 175 | 265 | 325 | 485 | 490 |
| Standby (mA) | 80 | 100 | 100 | 100 | 110 |

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

6. Mechanical Specifications

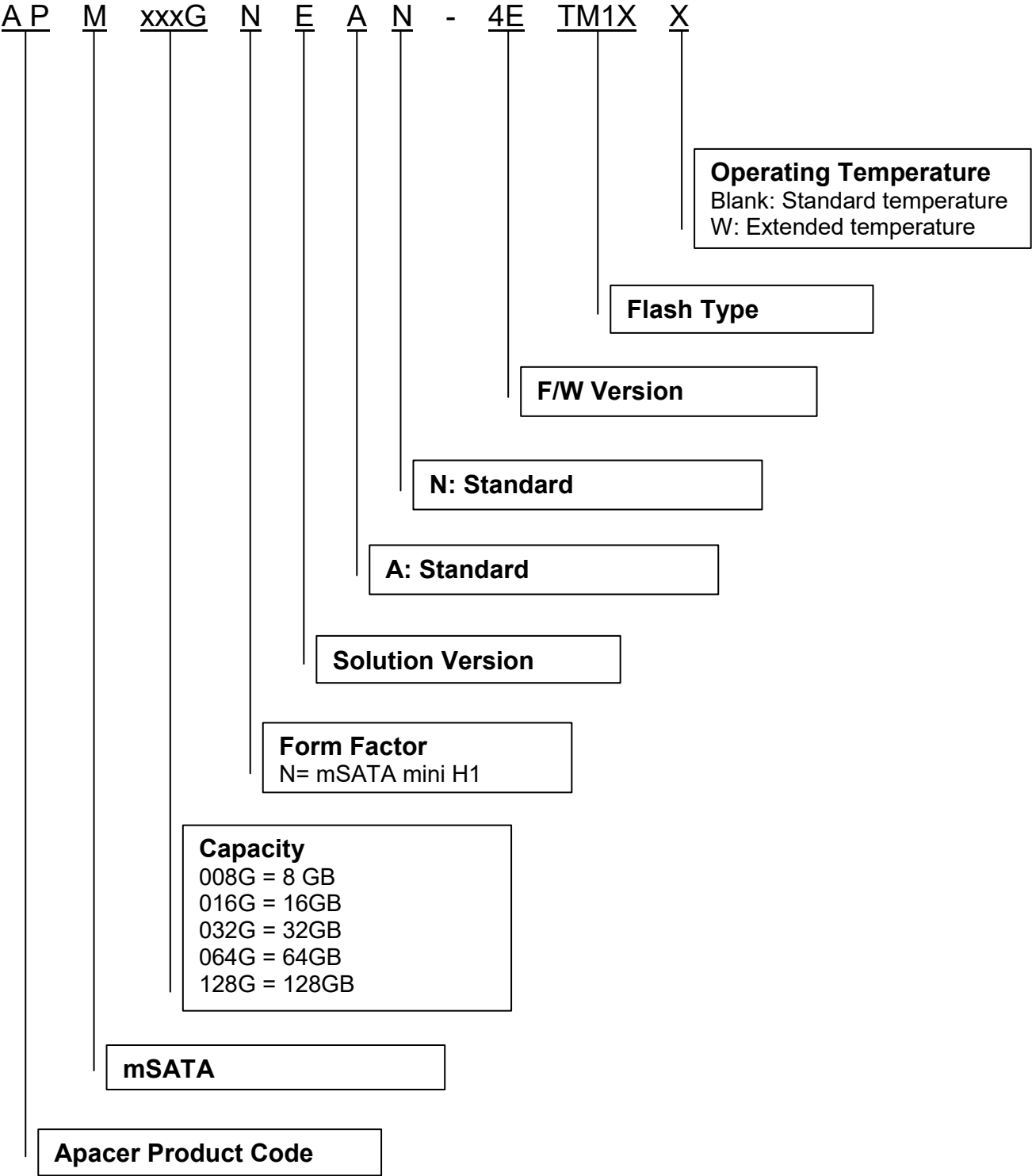
6.1 Dimensions



Note: There is only one screw hole.

7. Product Ordering Information

7.1 Product Code Designation



7.2 Valid Combinations

| Capacity | Standard Temperature | Extended Temperature |
|----------|----------------------|----------------------|
| 8GB | APM008GNEAN-4ETM1 | APM008GNEAN-4ETM1W |
| 16GB | APM016GNEAN-4ETM1 | APM016GNEAN-4ETM1W |
| 32GB | APM032GNEAN-4ETM1 | APM032GNEAN-4ETM1W |
| 64GB | APM064GNEAN-4ETM1 | APM064GNEAN-4ETM1W |
| 128GB | APM128GNEAN-4ETM1G | APM128GNEAN-4ETM1GW |

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 |
|----------|---|------------|
| 1.0 | Official release | 11/17/2016 |
| 1.1 | - Updated performance and power consumption values - Updated product ordering information for 64GB | 11/23/2016 |
| 1.2 | - Added LED Indicators for Drive Behavior on Features page - Added 1.6 LED Indicator Behavior - Updated mechanical specifications | 2/8/2017 |
| 1.3 | Added Thermal Sensor as an optional feature on Features page | 2/16/2017 |
| 1.4 | Updated product ordering information | 3/30/2017 |
| 1.5 | - Modified form factor on Features page and 1.1 Introduction - Added a note to 6. Mechanical Specifications | 3/31/2017 |

Global Presence

| | |
|------------------------------|---|
| Taiwan (Headquarters) | 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 |
| U.S.A. | Apacer Memory America, Inc. 46732 Lakeview Blvd., Fremont, CA 94538 Tel: 1-408-518-8699 Fax: 1-510-249-9551 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 jpservices@apacer.com |
| Europe | Apacer Technology B.V. Science Park Eindhoven 5051 5692 EB Son, The Netherlands Tel: 31-40-267-0000 Fax: 31-40-290-0686 sales@apacer.nl |
| China | Apacer Electronic (Shanghai) Co., Ltd Room D, 22/FL, No.2, Lane 600, JieyunPlaza, Tianshan RD, Shanghai, 200051, China Tel: 86-21-6228-9939 Fax: 86-21-6228-9936 sales@apacer.com.cn |
| India | Apacer Technologies Pvt Ltd, Unit No.201, "Brigade Corner", 7 th Block Jayanagar, Yediyur Circle, Bangalore – 560082, India Tel: 91-80-4152-9061 Fax: 91-80-4170-0215 sales_india@apacer.com |

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Офис по работе с юридическими лицами:

105318, г.Москва, ул.Щербаковская д.3, офис 1107, 1118, ДЦ «Щербаковский»

Телефон: +7 495 668-12-70 (многоканальный)

Факс: +7 495 668-12-70 (доб.304)

E-mail: info@moschip.ru

Skype отдела продаж:

moschip.ru

moschip.ru_4

moschip.ru_6

moschip.ru_9