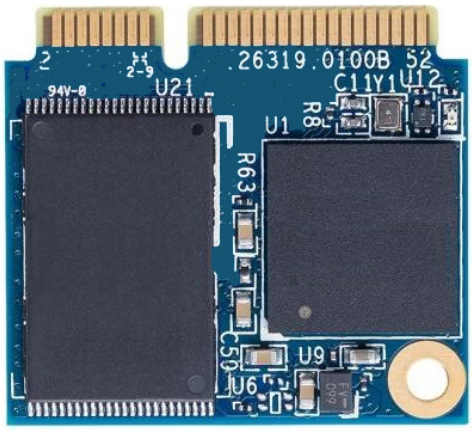
***RoHS Compliant***

# SATA Flash Drive Series

***Datasheet for mSATA mini A-M family***

**March 31, 2017**

Revision 1.5




***This Specification Describes the Features and Capabilities of the Standard and Industrial Temperature mini mSATA Flash Drives***

***Please Contact Fortasa Memory Systems Sales for any Custom Features Required For Your Specific Application***

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# Features:

- **Compliant with Serial SATA Revision 3.1**
  - SATA 1.5 and 2 command set compatible
  - Serial SATA 3 – 6.0 Gbps interface
  - ATA-8 compatible command set
- **Temperature ranges**
  - Operation:
    Standard Temperature: 0°C to 70°C
    Industrial Temperature: -40°C to 85°C
  - Storage: -40°C to 100°C
- **NAND flash type: MLC**
- **Performance**
  - Burst transfer rate: 600 MB/sec
  - Sustained Performance
    - Read: up to 280 MB/sec
    - Write: up to 180 MB/sec
    - Random read 4K: up to 47,000 IOPS
    - Random write 4K: up to 45,000 IOPS
- **Capacity**
  8, 16, 32, 64, 128GB
- **Low power consumption (typical)**
  - Supply voltage: 3.3 ± 5%V
  - Active mode: 490 mA
  - Idle mode: 110 mA
- **Endurance in Terabytes Written (TBW)**
  - 8 GB: 15.26 TBW
  - 16 GB: 28.38 TBW
  - 32 GB: 62.87 TBW
  - 64 GB: 132.81 TBW
  - 128 GB: 283.43 TBW
- **Connector Type**
  - 52-pin mSATA connector
- **Form factor**
  - mSATA Mini (29.85 x 26.80 x 3.95, unit: mm)
  - JEDEC MO-300B compliant
- **Intelligent endurance design**
  - Built-in hardware ECC, enabling up to 40-bit correction per 1Kbyte sector
  - Global 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
  - SMART Command
  - *Power Failure Management*
  - *ATA Secure Erase*
  - *Trim Command*
- **Thermal Sensor (optional**

# Table of Contents

# 1 Product Description

## 1.1 General Description

Fortasa's mSATA mini A-M is a high-performance, SATA interface, solid state drive (SSD) designed to replace a conventional SATA hard disk drive. mSATA supports standard SATA protocol and can be plugged into a standard mini PCIe connector commonly found in rugged laptops, military devices, thin clients, Point of Sale (POS) terminals, telecom, medical instruments, surveillance systems and industrial PCs. Complying with JEDEC MO-300B standard, the mini mSATA SSD is a widely adopted embedded storage due to compact size and exceptional performance.

The mSATA mini A-M drive offers capacities of up to 128 gigabytes, providing full support for the SATA 6.0Gbit high-speed interface standard. It can operate at sustained access rates of up to 280 megabytes per second, which is much faster than other solid-state or traditional HDD SATA drives currently available on the market. **Manufactured using Industrial Temperature rated MLC NAND-flash, this SSD can work in highly demanding environment and withstand wide range of operating temperature from -40°C to +85°C.**

mSATA mini A-M offers high reliability global data wear-leveling scheme to allow uniform use of all storage blocks, increasing the lifetime of Flash media and optimizing drive performance. The mSATA mini A-M also offers Self-Monitoring Analysis and Reporting Technology (S.M.A.R.T.) feature monitors the drive accesses and provides the host with vital information about drive condition to schedule maintenance and service times.

## 1.2 Capacity Specification

Standard capacity specification of the mSATA mini A-M Flash Drive product are shown in Table 1-1. The table lists the specific capacity and the default numbers of heads, sectors and cylinders (CHS) for each product line.

**Table 1-1:** Capacity specifications

| Capacity | Total Bytes | Cylinders | Heads | Sectors | Max LBA |
|---|---|---|---|---|---|
| 8GB | 8,012,390,400 | 15525 | 16 | 63 | 15,649,200 |
| 16GB | 16,013,942,784 | 16383[1] | 16 | 63 | 31,277,232 |
| 32GB | 32,017,047,552 | 16383[1] | 16 | 63 | 62,533,296 |
| 64GB | 64,023,257,088 | 16383[1] | 16 | 63 | 125,045,424 |
| 128GB | 128,035,676,160 | 16383[1] | 16 | 63 | 250,069,680 |

1. Cylinders, heads or sectors are not applicable for these capacities. Only LBA addressing applies.

***Please contact factory for any non-listed SATA Flash Drive capacity or custom CHS requirement.***

## 1.3 Performance Specification

Performances of the mSATA mini A-M Flash Drive are listed in Tables 1-2.

**Table 1-2:** Performance specifications

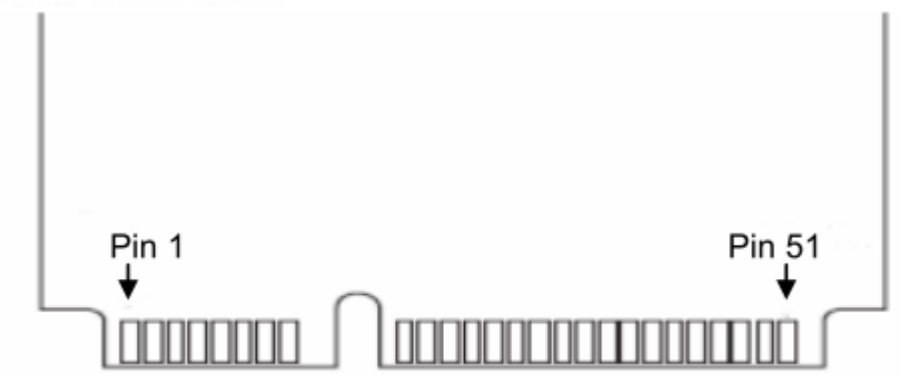
| Performance \ Capacity | 8GB | 16GB | 32GB | 64GB | 128GB |
|---|---|---|---|---|---|
| Sustained read (MB/s) | 115 | 220 | 220 | 280 | 260 |
| Sustained write (MB/s) | 26 | 50 | 45 | 90 | 180 |
| Random Read IOPS (4K) | 15,000 | 26,000 | 25,000 | 46,000 | 47,000 |
| Random Write IOPS (4K) | 4,000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

Note: Performance varies from flash configurations or host system settings.

## 1.4 Pin Assignments

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

**Figure 1-2:** mSATA mini A-M pin assignment



| Pin | Assignment | Description | Pin | Assignment | Description |
|---|---|---|---|---|---|
| 1 | N/A | N/A | 27 | Ground | Return Current Path |
| 2 | 3.3V | 3.3V source | 28 | N/A | N/A |
| 3 | N/A | N/A | 29 | Ground | Return Current Path |
| 4 | Ground | 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 | Ground | Return Current Path |
| 9 | Ground | Return Current Path | 35 | Ground | Return Current Path |
| 10 | N/A | N/A | 36 | Reserved | No Connect |
| 11 | N/A | N/A | 37 | Ground | 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 | Ground | Return Current Path |
| 15 | Ground | 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 | Ground | Return Current Path |
| 18 | Ground | 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 | Ground | 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 | Ground | Return Current Path |
| 25 | Tx- | SATA Differential | 51 | GND | GND |
| 26 | Ground | Return Current Path | 52 | 3.3V | 3.3V source |

**Table 1-3:** Pin Assignment Description

# 2. Software Interface

## 2.1 Command Set

Table 2-1 summarizes the mSATA mini A-M command set.

**Table 2-1:** Command set

| Command | Code | Command | Code |
|---|---|---|---|
| Check-Power-Mode | E5H | Recalibrate | 10H |
| Execute-Drive-Diagnostic | 90H | Security-Freeze-Lock | F5H |
| Flush-Cache | E7H | Security-Set-Password | F1H |
| Identify-Drive | ECH | Security-Unlock | F2H |
| Idle | E3H | Seek | 7xH |
| Idle-Immediate | E1H | Set-Features | EFH |
| Initialize-Drive-Parameters | 91H | SMART | B0H |
| Read DMA | C8H | Set-Multiple-Mode | C6H |
| Read DMA EXT | 25H | Set-Sleep-Mode | E6H |
| Read FPDMA Queued | 60H | Stand-By | E2H |
| Read Log DMA EXT | 47H | Stand-By-Immediate | E0H |
| Read Log EXT | 2FH | Write DMA | CAH |
| Read-Multiple | C4H | Write DMA EXT | 35H |
| Read-Sector | 20H or 21H | Write Log DMA EXT | 57H |
| Read-Verify-Sectors | 40H or 41H | Write FPDMA Queued | 61H |
| Security-Disable-Password | F6H | Write Log EXT | 3FH |
| Security-Erase-Prepare | F3H | Write-Multiple | C5H |
| Security-Erase-Unit | F4H | Write-Sector | 30H or 31H |

# 3. Flash Management

## 3.1 Error Correction/Detection

The mSATA mini A-M implements a hardware BCH-based ECC scheme to achieve up to 40-bits of error in 1K byte page.

## 3.2 Wear Leveling

All NAND flash devices are limited by a finite number of write cycles. Under a standard file system, frequent file table updates are mandatory. As a painful side effect of OS file overhead, some areas of flash address space wear out faster than others. As these certain sections get a substantially higher write occurrence the whole Flash Drive can wear out very quickly. This uneven wear would significantly reduce the lifetime of the whole device, even if majority of the Flash sectors are far from the write cycle limit. Fortasa's mSATA mini A-M Flash Drive products offer advanced data wear leveling which distributes Flash writes evenly across the SATA Flash Drive memory space. By utilizing this advanced wear leveling feature, the lifetime of the media can be significantly extended.

## 3.3 Power Failure Management

The Low Power Detection on the Flash controller initiates cached data saving before the power supply to the device drops too low for operation. This feature prevents the device from system crash and ensures data integrity during an unexpected brownout. This feature makes sure that there are no catastrophic failures of the SATA Flash Drive due to system power glitches.

## 3.4 ATA Secure Erase

Accomplished by the Secure Erase (SE) command, which is part of the 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. Execution of this command amounts to electronic data shredding and causes the SSD to internally completely erase all possible user data. Aside from user data, all data erase counters and other internal controller information stored on the Flash media will be also permanently deleted. The erase process will not stop until it is completed. In case of power failure, the erase process will continue when the power is reapplied to the device.

## 3.5 S.M.A.R.T. Technology

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.

| 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 |

## 3.6 TRIM Command Support

Over time the performance of SSD degrades as user continually writes and erases data. The ATA-TRIM command "formats" the SSD to optimize the drive performance. A TRIM enabled SSD running an OS with TRIM support will stay closer to its peak performance without much performance variance.

## 3.7 SATA Power Management

The mSATA mini A-M devices support the following SATA power saving modes:

- ACTIVE: PHY ready, full power, Tx & Rx operational
- PARTIAL: Reduces power, resumes in under 10 µs (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.

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

# 4. Environmental Specifications

## 4.1 Environments

Environmental specification of the mSATA mini A-M Flash Drive series follows the MIL-STD-810F standard as shown in Table 4-1.

**Table 4-1:** Environmental specifications

| Environment | | Specification |
|---|---|---|
| **Temperature** | Operation | 0°C to 70°C (Standard); -40°C to 85°C (Industrial) |
| | Storage | -40°C to 100°C |
| **Vibration** | | Sine wave: 10~2000 Hz, 15G (X, Y, Z)<br>Random: 10-2000 Hz, 7.7Grms (X, Y, Z) |
| **Shock** | | Operating: 50 G, 11 ms<br>Non-operating: 1500 G, 0.5 ms |
| **Humidity** | | RH 90% under 40°C |

## 4.2 Mean Time Between Failures (MTBF)

Mean Time Between Failures (MTBF) is predicted based on reliability data for the individual components in the mSATA drive. Based on provided component data, mSATA mini A-M Flash Drive is rated at 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

The mSATA mini A-M complies with the following standards:

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

## 4.4 Endurance

The endurance of a storage device is predicted by a JEDEC approved test methodology. The data, reported in TeraBytes Written, is based on several factors related to device architecture and product usage, such as the amount of data written into the drive, block management conditions, and daily workload for the drive. Please contact Sales to learn more about the TBW analysis and calculations.

| Capacity | TBW |
|---|---|
| 8GB | 15.26 |
| 16GB | 28.38 |
| 32GB | 62.87 |
| 64GB | 132.81 |
| 128GB | 283.43 |

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.

# 5. Electrical Specification

## 5.1 Operating Voltage

***Caution:*** **Absolute Maximum Stress Ratings –** Applied conditions greater than those listed under "Absolute Maximum Stress Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these conditions or conditions greater than those defined in the operational sections of this data sheet is not implied. Exposure to absolute maximum stress rating conditions may affect device reliability.

**Table 5-1:** Operating range

| Range | Ambient Temperature | 3.3V |
|---|---|---|
| Standard | 0°C to +70°C | 3.3V ±5% (3.135 - 3.465 V) |
| Industrial | -40°C to +85°C | |

## 5.2 Power Consumption

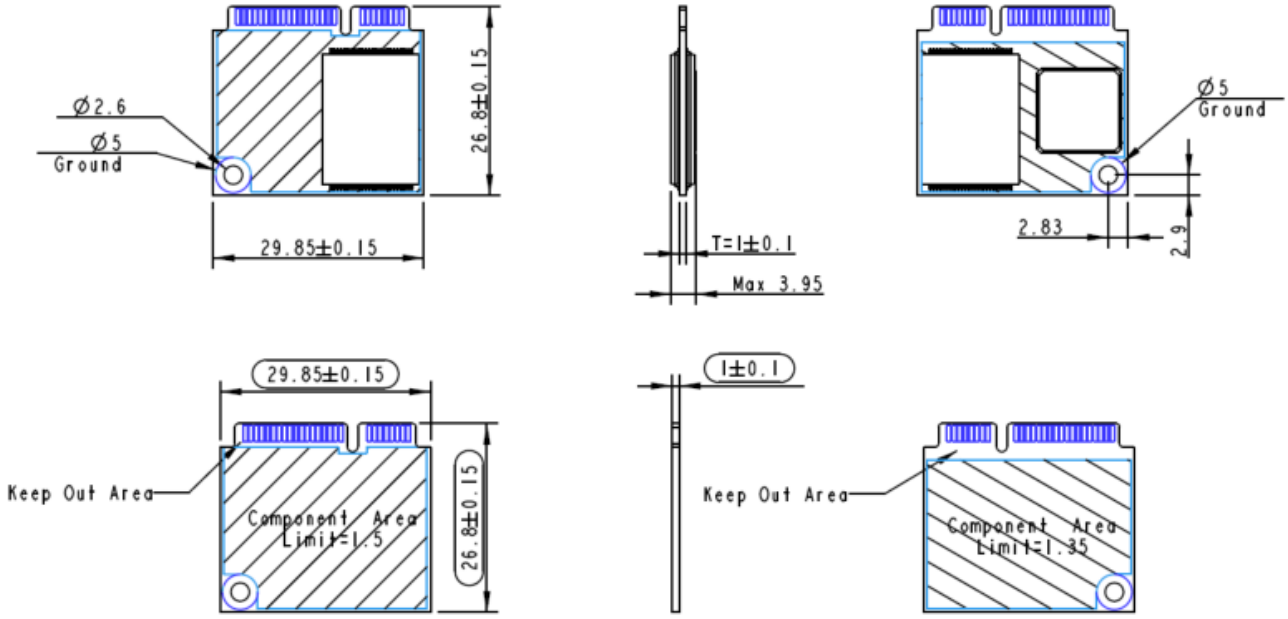
Tables 5-2 lists the mSATA mini A-M power consumption.

**Table 5-2** mSATA mini A-M power consumption (typical)

| Capacity / Performance | 8GB | 16GB | 32GB | 64GB | 128GB |
|---|---|---|---|---|---|
| Active Mode (mW) | 175 | 265 | 325 | 485 | 490 |
| Idle Mode (mW) | 80 | 100 | 100 | 100 | 110 |

# 6. Physical Characteristics

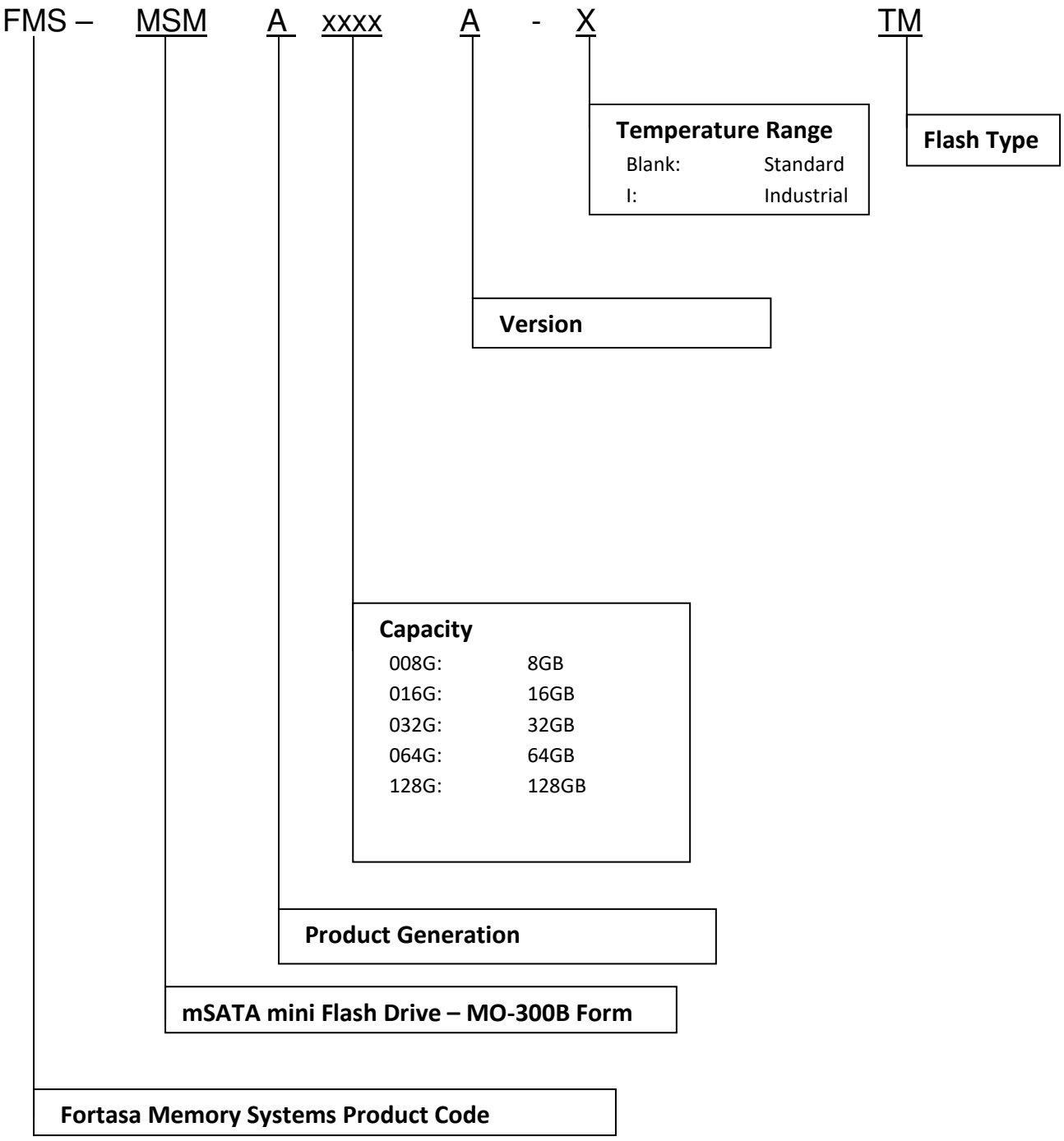
## 6.1 Dimensions




Note: There is only one screw hole.

# 7. Product Ordering Information

## 7.1 Product Code Designations



## 7.2 Valid Combinations

**mSATA mini A-M**

| Capacity | Standard Temperature | Industrial Temperature |
|---|---|---|
| **8GB** | FMS-MSMA008GA-TM | FMS-MSMA008GA-ITM |
| **16GB** | FMS-MSMA016GA-TM | FMS-MSMA016GA-ITM |
| **32GB** | FMS-MSMA032GA-TM | FMS-MSMA032GA-ITM |
| **64GB** | FMS-MSMA064GA-TM | FMS-MSMA064GA-ITM |
| **128GB** | FMS-MSMA128GA-TM | FMS-MSMA128GA-ITM |

**Note:** Valid combinations are those products in mass production or will be in mass production. Consult your Fortasa sales representative to confirm availability of valid combinations and to determine availability of new product combinations

## 8. Revision History

| Revision | Date | Description | Comments |
|---|---|---|---|
| 1.0 | 11/17/2016 | Initial Release | |
| 1.1 | 11/23/2016 | Revised Performance for 64GB modules | |
| 1.2 | 2/16/2017 | Revised Product Ordering Information | |
| 1.3 | 2/16/2017 | Added Thermal Sensor as optional feature | |
| 1.4 | 3/30/2017 | Updated product ordering information | |
| 1.5 | 3/31/2017 | Added Note to Mechanical Specification | |