RoHS Compliant

mSATA Flash Drive A1 Series
Datasheet for mSATA MO-300 Compliant Flash module

December 26, 2019

Revision 1.2

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

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

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mSATA Flash Drive
FMS-MSA1xxxGA-xT

Features:

- **Compliant with Serial SATA Revision 3.1**
  - Serial SATA 3 – 6.0 Gbps interface
  - SATA 1.5 and 3.0 command set compatible
  - 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: SLC**
- **Performance**
  - Burst transfer rate: 600 MB/sec
  - Sustained Performance
    - Read: up to 555 MB/sec
    - Write: up to 450 MB/sec
    - Random read 4K: up to 86,000 IOPS
    - Random write 4K: up to 74,000 IOPS
- **Connector Type**
  - 52-pin mSATA connector
- **Form factor**
  - Mini PCIe (50.8 x 29.85 x 3.60, unit: mm)
  - JEDEC MO-300 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 for Temperature Management**
- **Optional Write Protect Switch**

- **Capacity**
  - 2, 4, 8, 16, 32, 64, 128GB
- **Low power consumption (typical)**
  - Supply voltage: 3.3 ± 5%V
  - Active mode: 665 mA
  - Idle mode: 95 mA
- **Endurance in Terabytes Written (TBW)**
  - 2 GB: 800 TBW
  - 4 GB: 160 TBW
  - 8 GB: 320 TBW
  - 16 GB: 641 TBW
  - 32 GB: 1,282 TBW
  - 64 GB: 2,565 TBW
  - 128 GB: 5,131 TBW

Table of Contents

1 Product Description

1.1 General Description

Fortasa's mSATA A1 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-300 standard, the mSATA SSD is a widely adopted embedded storage with compact size and exceptional performance.

The mSATA A1 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 555 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 SLC NAND-flash, this SSD can work in highly demanding environment and withstand wide range of operating temperature from -40°C to +85°C.**

mSATA A1 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 A1 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 A1 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).

Table 1-1: Capacity specifications

Capacity	Total Bytes	Cylinders	Heads	Sectors	Max LBA
2GB	2,011,226,112	3,897	16	63	3,928,176
4GB	4,011,614,208	7,773	16	63	7,835,184
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

Performance of the mSATA A1 Flash Drive is listed in Tables 1-2.

Table 1-2: Performance specifications

Performance \ Capacity	2GB	4GB	8GB	16GB	32GB	64GB	128GB
Sustained read (MB/s)	60	125	135	125	555	555	545
Sustained write (MB/s)	28	55	110	75	255	440	450
Random Read IOPS	13,000	25,000	25,000	23,000	79,000	81,000	86,000
Random Write IOPS	1,000	3,000	6,000	13,000	58,000	72,000	74,000

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

1.4 Pin Assignments

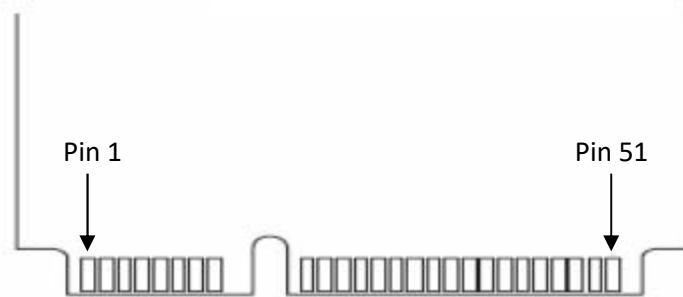Pin assignment of the mSATA A1 is shown in Figure 1-2 and described in Table 1-3.

**Figure 1-2:** mSATA A1 pin assignment

mSATA Flash Drive
FMS-MSA1xxxGA-xT

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*	Detection	Zero Ohm Resistor
26	Ground	Return Current Path	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.

Table 1-3: Pin Assignment Description

Device VCC AUX **Host**

33 kohm

P51

0 ohm to
220 ohm

Open Drain
Output
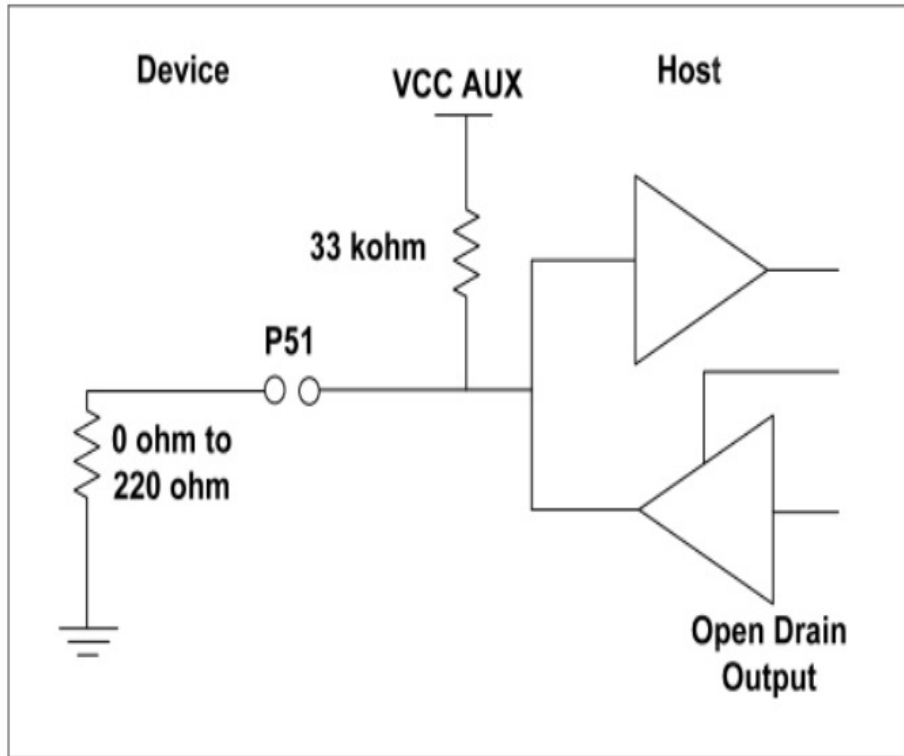
Bi-directional host-side implementation of P51 for compatibility with non-mSATA devices (informative)

1.5 LED Indicator Behavior

The behavior of the mSATA A1-M LED indicators is described in Table 1-4.

Table 1-4: LED Behavior

Location	Status	Description
LED A	Blinking	Accessing Drive
	Static	Write Protect is enabled (only available for models supporting write protection)
LED B	Static	PHY Is Connected

2-16GB   32-128GB
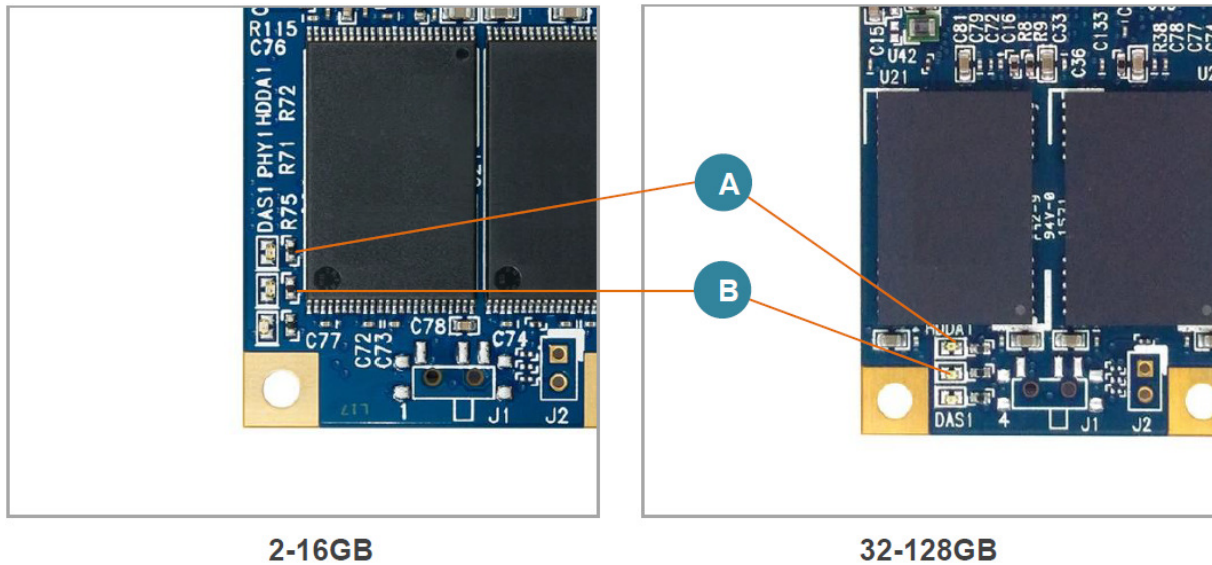
2. Software Interface

2.1 Command Set
Table 2-1 summarizes the mSATA A1 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 A1 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 A1 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 A1 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.

3.8 Thermal Sensor

mSATA A1 contains a Thermal Sensor that measures module temperature. The module temperature can be obtained by polling SMART Command attribute ID 194 (0xC2). When the device temperature reaches a pre-set temperature threshold, the module performance will be reduced to limit the power draw and prevent the module from overheating.

4. Environmental Specifications

4.1 Environments

Environmental specification of the mSATA A1 Flash Drive series follows the MIL-STD-810 F 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) Random: 10-2000 Hz, 7.7Grms (X, Y, Z)
Shock		Operating: 50 G, 11 ms Non-operating: 1500 G, 0.5 ms

4.2 Mean Time Between Failures (MTBF)

Mean Time Between Failures (MTBF) is predicted based on reliability data for the individual components in the SAFD drive. Based on provided component data, mSATA A1 Flash Drive is rated at 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

The mSATA A1 complies with the following standards:

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

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
2GB	80
4GB	160
8GB	320
16GB	641
32GB	1,282
64GB	2,565
128GB	5,131

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.
- The estimated values are based on JEDEC Enterprise endurance workload comprised of random data with the payload size distribution with sequential write behavior.

6. Optional Features

6.1 Write Protect Switch

Fortasa 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.

Write Protect Switch

Disable   Enable (Read only)

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

6. Electrical Specification

6.1 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 6-1: Operating range

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

6.2 Power Consumption
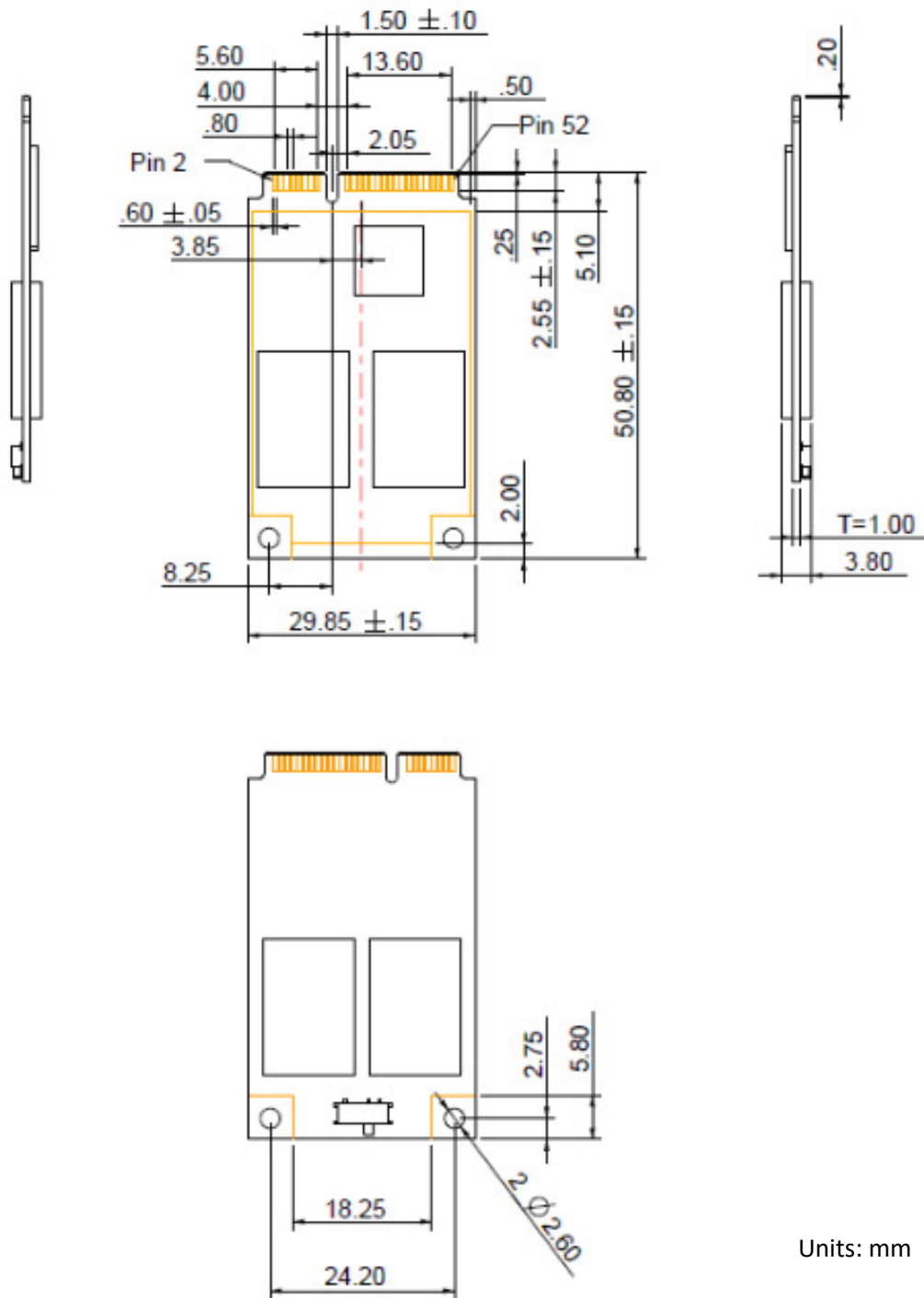
Tables 6-2 lists the mSATA A1 power consumption.

Table 6-2 mSATA A1 power consumption (typical)

Performance / Capacity	2GB	4GB	8GB	16GB	32GB	64GB	128GB
Active Mode (mA)	215	270	380	265	425	625	665
Idle Mode (mA)	80	80	85	80	80	80	80

Note: Results are estimated and may differ from various flash configurations or host system setting
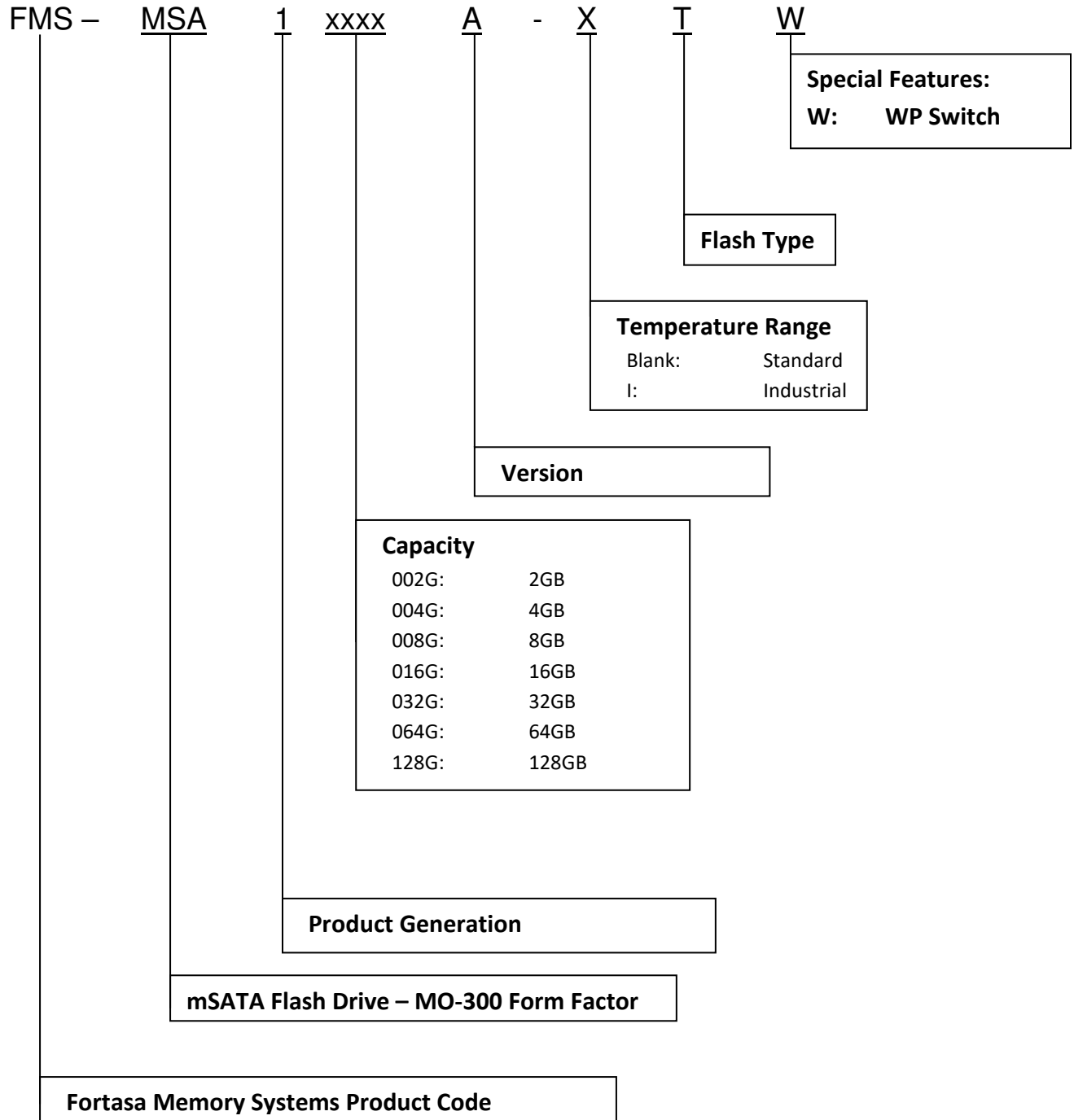
7. Physical Characteristics

7.1 Dimensions

Units: mm

8. Product Ordering Information

8.1 Product Code Designations

FMS –   MSA   1   xxxx   A   -   X   T   W

Special Features:			
W:	WP Switch		

Flash Type

Temperature Range	
Blank:	Standard
I:	Industrial

Version

Capacity	
002G:	2GB
004G:	4GB
008G:	8GB
016G:	16GB
032G:	32GB
064G:	64GB
128G:	128GB

Product Generation

mSATA Flash Drive – MO-300 Form Factor

Fortasa Memory Systems Product Code

8.2 Valid Combinations

mSATA A1

Capacity	Standard Temperature	Industrial Temperature
2GB	FMS-MSA1002GA-T	FMS-MSA1002GA-IT
4GB	FMS-MSA1004GA-T	FMS-MSA1004GA-IT
8GB	FMS-MSA1008GA-T	FMS-MSA1008GA-IT
16GB	FMS-MSA1016GA-T	FMS-MSA1016GA-IT
32GB	FMS-MSA1032GA-T	FMS-MSA1032GA-IT
64GB	FMS-MSA1064GA-T	FMS-MSA1064GA-IT
128GB	FMS-MSA1128GA-T	FMS-MSA1128GA-IT

mSATA A1 – Write Protect Switch (Optional)

Capacity	Standard Temperature	Industrial Temperature
4GB	FMS-MSA1004GA-TW	FMS-MSA1004GA-ITW
8GB	FMS-MSA1008GA-TW	FMS-MSA1008GA-ITW
16GB	FMS-MSA1016GA-TW	FMS-MSA1016GA-ITW
32GB	FMS-MSA1032GA-TW	FMS-MSA1032GA-ITW
64GB	FMS-MSA1064GA-TW	FMS-MSA1064GA-ITW
128GB	FMS-MSA1128GA-TW	FMS-MSA1128GA-ITW

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

9. Revision History

Revision	Date	Description	Comments
1.0	6/4/2018	Initial Release	
1.1	7/9/2018	Added 2GB Support	
1.2	12/26/2019	Added Endurance on Features Page	