fortasa memory systems

RoHS Compliant

M.2 A1 - 2280 SATA Flash Module Series

Datasheet for M.2 A1 2280 SATA 3 SLC Flash Module

November 3, 2017

Revision 1.0

This Specification Describes the Features and Capabilities of the Standard and Industrial Temperature M.2 SATA Modules

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

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M.2 2280 SATA Flash Module
FMS-M2A18xxxx-XAx

Features:

- **Standard Serial SATA 3.2**
  - SATA 3.2 command set compatible
  - Serial SATA 6.0 Gbps Interface
  - Backwards compatible with SATA 1.5 and 3.0 Gbps interfaces
  - ATA-8 compatible command set
- **NAND flash type: SLC**
- **MTBF (hours):** >2,000,000
- **Temperature ranges**
  - Operation:
    Standard: 0°C to 70°C
    Industrial: -40°C to 85°C
  - Storage: -40°C to 100°C
- **Performance**
  - Burst transfer rate: 600 MB/sec
    - Sustained read: up to 530 MB/sec
    - Sustained write: up to 245 MB/sec
- **Intelligent endurance design**
  - Built-in hardware ECC, enabling up to 72 bit correction per 1024 bytes
  - 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
  - *Power Failure Management*
  - *ATA Secure Erase*
  - *SMART Command*
  - *Trim Command*
- **Connector Type**
  - 75-pin SATA Based M.2 module pin-out
- **Form factor**
  - M.2 2280 SATA Module Form Factor
  - 80.00 x 22.00 x 1.50, unit: mm
- **Thermal Sensor for Temperature Management**
- **RoHS Recast compliant (complies with 2011/65/EU standard)**

- **Capacity**
  - Single Side
    16GB, 32GB
- **Low power consumption (typical)**
  - Supply voltage: 3.3 ± 5%V
    - Active mode: 425 mA
    - Idle mode: 75 mA

Table of Contents

M.2 2280 SATA Flash Module
FMS-M2A18xxxx-XAx

1 Product Description

1.1 General Description

Fortasa's M.2 A1 2280 is a high-performance, SATA interface, solid state drive (SSD) designed to replace a conventional SATA hard disk drive. This module supports standard SATA protocol and can be plugged into a standard SATA connector commonly found in rugged laptops, military devices, thin clients, Point of Sale (POS) terminals, telecom, medical instruments, surveillance systems and industrial PCs.

The M.2 A1 2280 module offers capacities of up to 32GB, providing full support for the SATA 6GBps high-speed interface standard. It can operate at sustained access rates of up to 480 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.**

M.2 A1 2280 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. It also offers Self-Monitoring Analysis and Reporting Technology (S.M.A.R.T.) feature that follows the ATA/ATAPI specifications and uses the standard SMART command B0h to read data from the drive. This capability monitors the drive accesses and provides the host with vital information about drive condition to schedule maintenance and service times.

1.2 Functional Block

The M.2 A1 2280 drive includes a SATA 6.0 Gps Flash Controller and flash media. The Flash controller integrates the flash management unit to support multi-channel, multi-bank flash arrays.

1.3 Capacity Specification

Standard capacity specification of the M.2 A1 2280 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
16GB	16,013,942,784	16383[1]	16	63	31,277,232
32GB	32,017,047,552	16383[1]	16	63	62,533,296

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

Please contact factory for any non-listed M.2 A1 SATA Module capacity or custom CHS requirement.

1.4 Performance Specification

Performances of the M.2 A1 2280 devices are listed in Table 1-2.

Table 1-2: Performance specifications

Performance \ Capacity	16GB	32GB
Sustained read (MB/s)	315	530
Sustained write (MB/s)	135	245
Random Read IOPS (4K)**	62,000	78,000
Random Write IOPS (4K)**	25,000	62,000

Note:
Sequential performance is based on CrystalDiskMark 5.2.1 with file size 1,000MB.
**Random performance measured using IOMeter with Queue Depth 32.

1.5 Pin Assignments

This connector does not support hot plug capability. There are a total of 75 pins. 12 pin locations are used for mechanical key locations; this allows such a module to plug into both Key B and Key M connectors.
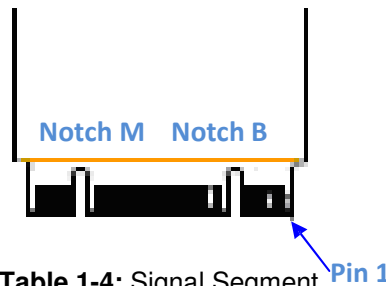
Figure 1-2: Micro-SATA connectors

Notch M   Notch B

Pin 1

Table 1-4: Signal Segment

Pin	Signal	Description
1	CONFIG_3	Ground (according to M.2 configurations for SSD-SATA definition)
2	3.3V	Supply Pin, 3.3V
3	GND	Ground
4	3.3V	Supply Pin, 3.3V
5	No Connect	No Connect
6	Not Available	Do Not Connect
7	Not Available	Do Not Connect
8	Not Available	Do Not Connect
9	No Connect	No Connect
10	DAS/DSS	Device Activity Signal/Disable Staggered Spin-up
11	No Connect	No Connect
12	Module key	
13	Module key	
14	Module key	
15	Module key	
16	Module key	
17	Module key	
18	Module key	
19	Module key	
20	Not Available	Do Not Connect
21	CONFIG_0	Ground (according to M.2 configurations for SSD-SATA definition)
22	Not Available	Do Not Connect
23	Not Available	Do Not Connect
24	Not Available	Do Not Connect

25	Not Available	Do Not Connect
26	Not Available	Do Not Connect
27	GND	Ground
28	Not Available	Do Not Connect
29	Not Available	Do Not Connect
30	Not Available	Do Not Connect
31	Not Available	Do Not Connect
32	Not Available	Do Not Connect
33	GND	Ground
34	Not Available	Do Not Connect
35	Not Available	Do Not Connect
36	Not Available	Do Not Connect
37	Not Available	Do Not Connect
38	Not Available	Do Not Connect
39	GND	Ground
40	Not Available	Do Not Connect
41	SATA-Rx+	Host receiver differential signal pair
42	Not Available	Do Not Connect
43	SATA-Rx-	Host receiver differential signal pair
44	Not Available	Do Not Connect
45	GND	Ground
46	Not Available	Do Not Connect
47	SATA-Tx-	Host transmitter differential pair
48	Not Available	Do Not Connect
49	SATA-Tx+	Host transmitter differential pair
50	Not Available	Do Not Connect
51	GND	Ground
52	Not Available	Do Not Connect
53	Not Available	Do Not Connect
54	Not Available	Do Not Connect
55	Not Available	Do Not Connect
56	Not Available	Do Not Connect
57	GND	Ground
58	Not Available	Do Not Connect
59	Not Available	Do Not Connect
60	Not Available	Do Not Connect
61	Not Available	Do Not Connect
62	Not Available	Do Not Connect
63	Not Available	Do Not Connect
64	Not Available	Do Not Connect

65	Not Available	Do Not Connect
66	Not Available	Do Not Connect
67	Not Available	Do Not Connect
68	SUSCLK	Not Used
69	CONFIG_1	Ground
70	3.3V	Supply Pin, 3.3V
71	GND	Ground
72	3.3V	Supply Pin, 3.3V
73	GND	Ground
74	3.3V	Supply Pin, 3.3V
75	CONFIG_2	Defines module type

2. Software Interface

2.1 Command Set

Table 2-1 summarizes the command set with the paragraphs that follow describing the individual commands and the task file for each.

Table 2-1: Command set

Command	Code	Command	Code
Check-Power-Mode	E5H	Security-Disable-Password	F6H
Data Set Management	06h	Security-Erase-Prepare	F3H
DCO	B1h	Security-Erase-Unit	F4H
Download Microcode PIO	92h	Security-Freeze-Lock	F5H
Download Microcode DMA	93h	Security-Set-Password	F1H
Execute-Drive-Diagnostic	90H	Security-Unlock	F2H
Flush-Cache	E7H	Seek	7XH
Identify-Drive	ECH	Set-Features	EFH
Idle	E3H	Set MAX Address	F9H
Idle-Immediate	E1H	Set MAX Address EXT	37H
Initialize-Drive-Parameters	91H	Set-Multiple-Mode	C6H
Read Buffer	E4	Set-Sleep-Mode	E6H
Read DMA (W retry)	C8H	SMART	B0H
Read DMA (W/O retry)	C9H	Stand-By	E2H
Read DMA EXT	25H	Stand-By-Immediate	E0H
Read FPDMA Queued	60H	Write Buffer	E8H
Read Log EXT	2FH	Write DMA	CAH or CBH
Read-Multiple	C4H	Write DMA EXT	35H
Read-Multiple EXT	29H	Write DMA FUA EXT	3DH
Read Native Max Address	F8H	Write FPDMA Queued	61H
Read Native Max Ext	27H	Write Log EXT	3FH
Read-Sector(s)	20H or 21H	Write-Multiple	C5H
Read-Sector(s) EXT	24H	Write-Multiple EXT	39H
Read-Verify-Sectors	40H or 41H	Write-Multiple FUA EXT	CEH
Read-Verify-EXT	42H	Write-Sector(s)	30H or 31H
Recalibrate	10H	Write-Sector(s) EXT	34H
		Write Uncorrectable	45H

3. Flash Management

3.1 Error Correction/Detection

The M.2 A1 2280 Module implements a hardware BCH-based ECC scheme to achieve up to 72 bit correction per 1024-bytes.

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 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 SATA Flash Drive products offer advanced data wear leveling which distributes Flash writes evenly across the 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 drive due to system power glitches.

3.4 ATA Secure Erase

Accomplished by the Secure Erase (SE) command, which added to the open 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. It is a positive easy-to-use data destroy command, amounting to electronic data shredding. Executing the command causes a drive to internally completely erase all possible user data. This command is carried out within disk drives, so no additional software is required. 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	Note
9 (0x09)	Power-on hours	General
12 (0x0C)	Power cycle count	General
163 (0xA3)	Max. erase count	General
164 (0xA4)	Avg. erase count	General
166 (0xA6)	Total later bad block count	General
167 (0xA7)	SSD Protect Mode (vendor specific)	0: R/W, 3: Read Only
168 (0xA8)	SATA PHY Error Count	Command Fail Count
175 (0xAF)	Bad Cluster Table Count	ECC Fail Count
192 (0xC0)	Unexpected Power Loss Count	ATA Standby Command
194 (0xC2)	Temperature	PCB Temperature
241 (0xF1)	Total sectors of write	LBA

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 M.2 A1 2280 Module supports 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 M.2 A1 2280 Flash Module 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 +85°C
Vibration (Non Operating)		Frequency/Displacement: 20Hz~80Hz/1.52mm Frequency/Acceleration: 80Hz~2000Hz/20G X, Y, Z axis/60mins
Shock (Non Operating)		1,500G, 0.5ms

4.2 Mean Time Between Failures (MTBF)

Mean Time Between Failures (MTBF) is predicted based on reliability data for the individual components in the Flash drive. Based on provided component data, M.2 A1 2280 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 M.2 A1 2280 complies with the following standards:
- CE
- FCC
- MIL-STD-810
- RoHS Recast

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

5.2 Power Consumption

Table 5-2 lists the M.2 A1 2280 power consumption.

Table 5-2 Typical power consumption

Performance \ Capacity	16GB	32GB
Active Mode (mA)	325	423
Idle Mode (mA)	75	75

6. Physical Characteristics

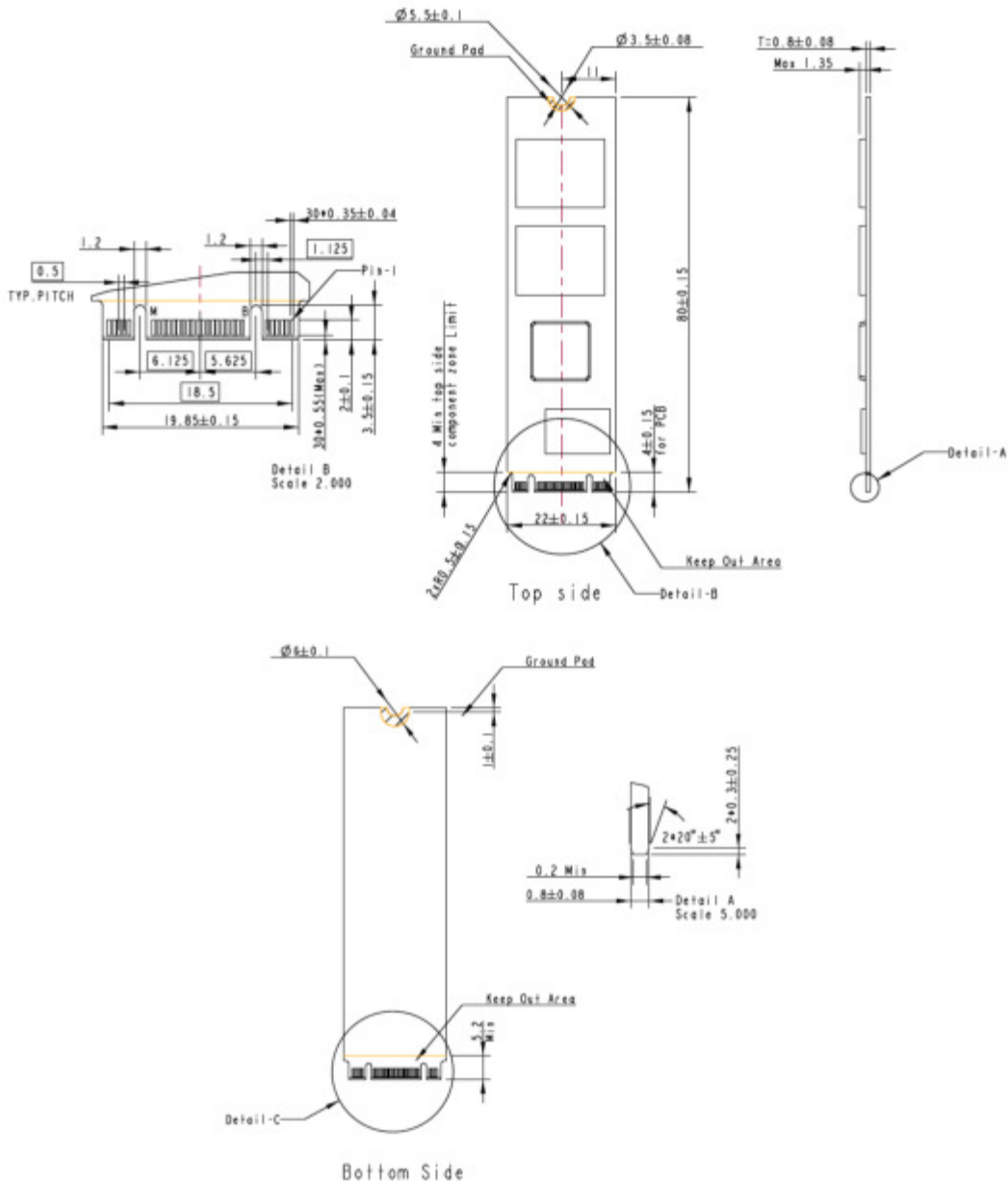Figure 6-1 illustrates the overall physical dimensions of the M.2 A1 2280 drive.

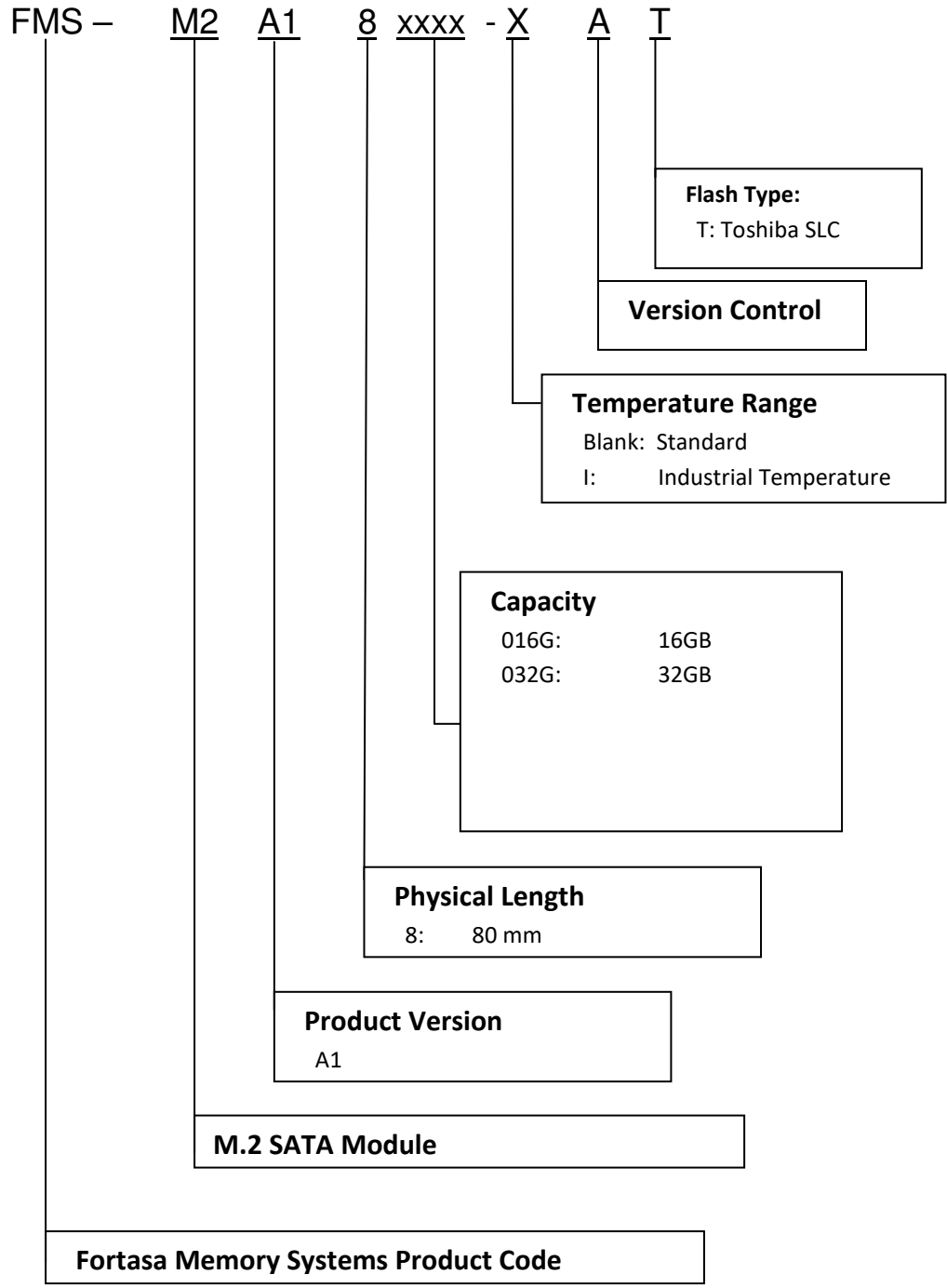**Figure 6-1** M.2 A1 2280 physical dimensions - Single Side Design

7. Product Ordering Information

7.1 Product Code Designations

FMS –   M2   A1   8 xxxx - X   A   T

Flash Type:
T: Toshiba SLC

Version Control

Temperature Range
Blank: Standard
I: Industrial Temperature

Capacity
016G: 16GB
032G: 32GB

Physical Length
8:      80 mm

Product Version
A1

M.2 SATA Module

Fortasa Memory Systems Product Code

7.2 Valid Combinations

AES Encryption Disabled

Capacity	Standard Temperature Model Numbers	Industrial Temperature Model Numbers
16GB	FMS-M2A18016G-AT	FMS-M2A18016G-IAT
32GB	FMS-M2A18032G-AT	FMS-M2A18032G-IAT

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	11/3/2017	Initial Release	