

***RoHS Compliant***

M.2 - 2280 SATA Flash Module Series

***Datasheet for M.2 2280 SATA 3 BICS3 TLC NAND based  
Flash Module***

**March 17, 2020**

**Revision 1.6**

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

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## M.2 2280 SATA Flash Module FMS-M28xxxx-XAK3D



### Features:

- **Standard Serial SATA 3.1**
  - SATA 3.1 command set compatible
  - Serial SATA 3 – 6.0 Gbps interface
  - ATA-8 compatible command set
- **Low power consumption (typical)**
  - Supply voltage: 3.3V±5%
  - Active mode: 455mA
  - Idle mode: 80 mA
- **NAND flash type: 3D TLC (BiCS3)**
- **MTBF (hours):** >1,000,000
- **Temperature ranges**
  - Operation:
    - Standard: 0°C to 70°C
    - Industrial: -40°C to 85°C
  - Storage: -40°C to 100°C
- **Performance**
  - Performance
    - Sustained Read: up to 560 MB/sec
    - Sustained Write: up to 525 MB/sec
    - Random read 4K: up to 69,000 IOPS
    - Random write 4K: up to 74,000 IOPS
- **Intelligent endurance design**
  - Built-in hardware LDPC based ECC algorithm
  - 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*
- **Capacity**
  - Single Side: 30GB, 60GB, 120GB, 240GB, 480GB
  - Double Side: 960GB
- **Connector Type**
  - 75-pin SATA Based M.2 module pin-out
- **Form factor**
  - M.2 2280 SATA Module Form Factor
  - Single side: 80.00 x 22.00 x 2.30, unit: mm
  - Double side: 80.00 x 22.00 x 3.88, unit: mm
- **Thermal Sensor for Temperature Management**
- **RoHS Recast compliant (complies with 2011/65/EU standard)**
- **Security**
  - AES 256 Hardware Encryption
  - TCG OPAL SSC V2.0 Compliant
- **Endurance (in Drive Writes Per Day (DWPD))**
  - 30 GB: 3.09 DWPD
  - 60 GB: 3.24 DWPD
  - 120 GB: 3.21 DWPD
  - 240 GB: 3.14 DWPD
  - 480 GB: 3.34 DWPD
  - 960 GB: 3.14 DWPD
- **Environmental Compliance**
  - Shock – 1,500 G
  - Vibration – 15 G



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## 1 Product Description

### 1.1 General Description

Fortasa's M.2 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 2280 module offers capacities of up to 960GB, providing full support for the SATA 6GBps high-speed interface standard. It can operate at sustained access rates of up to 500 megabytes per second, which is much faster than other solid-state or traditional HDD SATA drives currently available on the market. **Manufactured using 3D BICS3 TLC NAND-flash, this SSD offers cost effective solution to high capacity storage needs and withstand wide range of operating temperature from -40°C to +85°C.**

M.2 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 Capacity Specification

Standard capacity specification of the mini mSATA A-D Flash Drive product is 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
30GB	30,016,659,456	16383 <sup>1</sup>	16	63	58,626,288
60GB	60,022,480,896	16383 <sup>1</sup>	16	63	117,231,408
120GB	120,034,123,776	16383 <sup>1</sup>	16	63	234,441,648
240GB	240,057,409,536	16383 <sup>1</sup>	16	63	468,862,128
480GB	408,103,981,056	16383 <sup>1</sup>	16	63	937,703,088
960GB	960,197,124,096	16383 <sup>1</sup>	16	63	1,875,385,008

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

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### 1.3 Performance Specification

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

**Table 1-2:** Performance specifications

<b>Performance \ Capacity</b>	<b>30GB</b>	<b>60GB</b>	<b>120GB</b>	<b>240GB</b>	<b>480GB</b>	<b>960GB</b>
<b>Sustained read (MB/s)</b>	220	435	560	560	560	560
<b>Sustained write (MB/s)</b>	135	260	490	510	520	525
<b>Random Read IOPS (4K)</b>	9,000	19,000	36,000	60,000	65,000	69,000
<b>Random Write IOPS (4K)</b>	28,000	57,000	73,000	73,000	75,000	74,000

### 1.4 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

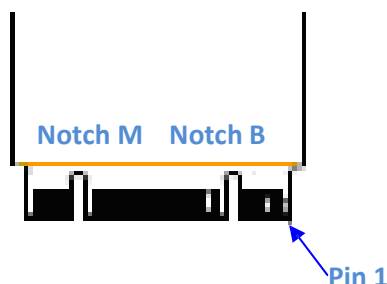


Table 1-4: Signal Segment

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. Status indicators via LED devices enabled by the system Active Low. A pulled-up LED with a series current limiting resistor should allow for 9mA output when On.
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

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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



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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

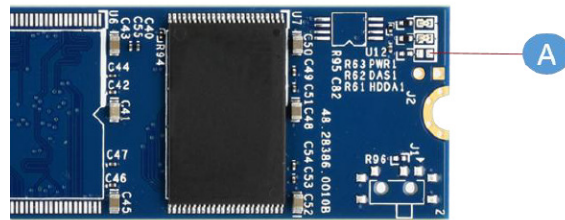
## 1.5 LED Indicator Behavior

The behavior of the M.2 2280 device LED indicators is described in Table 1-5.

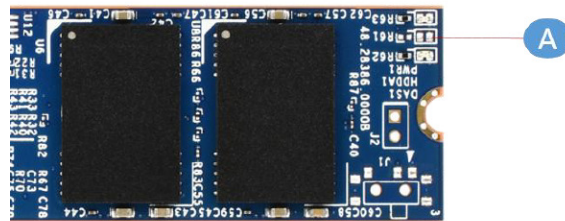
**Table 1-5: LED Behavior**

Location	Status	Description
LED A	DAS	LED blinks when the drive is being accessed

TSOP (30-60GB)



BGA (120-960GB)



## 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	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

**Table 7-2 Trusted Computing Feature Set**

Command	Code	Command	Code
Trusted Receive	5Ch	Trusted Send	5Eh
Trusted Receive DMA	5Dh	Trusted Send DMA	5Fh

Note: This feature set is only applicable to products implemented with AES and Opal functions.

### 3. Flash Management

#### 3.1 Error Correction/Detection

The M.2 2280 Flash Module implements a hardware LDPC (Low Density Parity Check) based ECC scheme to ensure data has been read correctly, and protect critical stored information from corruption.

#### 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
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
171 (0xAB)	Program Fail Count
172 (0xAC)	Erase Fail Count
175 (0xAF)	Bad Cluster Table Count
192 (0xC0)	Unexpected Power Loss Count
194 (0xC2)	Temperature
231 (0xE7)	Lifetime Left
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 M.2 2280 Module 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.

Note:

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

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### 3.8 Thermal Sensor

M.2 2280 Module 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.

### 3.9 AES 256-bit Encryption

M.2 2280 Module incorporates Advanced Encryption Standard (AES) 256-bit which is an industry standard in data security and has been adopted by U.S. government and now widely used for symmetric-key data encrypting in order to meet higher level of data security requirements.

### 3.10 TCG OPAL SSC V2.0 Compliant

OPAL SSC (Security Subsystem Class) is specified by Trusted Computing Group. It is to define key management and access control features for self-encrypting drives. This specification uses a concept of pre-boot partition for user authentication. It is an optional authentication method in addition to ATA security. However, due to restriction on OPAL SSC specification, ATA security command will be disabled under OPAL SSC mode.

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## 4. Environmental Specifications

### 4.1 Environments

Environmental specification of the M.2 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 (Operating)		7.69 GRMS, 20~2000 Hz/random (compliant with MIL-STD-810G)
Vibration (Non Operating)		4.02 GRMS, 20~2000 Hz/random (compliant with MIL-STD-810G)
Shock (Operating)		50G,11ms
Shock (Non-Operating)		1500G, 0.5ms (compliant with MIL-STD-883K)

### 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 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 2280 complies with the following standards:

- CE
- FCC
- MIL-STD-810
- RoHS Recast

### 4.4 Endurance

The endurance of a storage device is predicted by a JEDEC approved test methodology. The data, reported in Drive Writes Per Day (DWPD), 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 DWPD analysis and calculations.

**Table 4-2: DWPD Values**

Capacity	DWPD
30GB	3.09
60GB	3.24
120GB	3.21
240GB	3.14
480GB	3.34
960GB	3.14

Notes:

- This estimation complies with JEDEC JESD-219A random enterprise workload.
- Flash vendor guaranteed 3D NAND TLC P/E cycle: 3K
- WAF may vary from capacity, flash configurations and writing behavior on each platform.
- 1 Terabyte = 1,024GB
- DWPD (Drive Writes Per Day) is calculated based on the number of times that user overwrites the entire capacity of an SSD per day of its lifetime during the warranty period. (3D NAND TLC warranty: 2 years)

## 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 2280 power consumption.

**Table 5-2** Typical power consumption

Performance \ Capacity	Capacity					
	30GB	60GB	120GB	240GB	480GB	960GB
<b>Active Mode (mA)</b>	285	345	400	410	410	455
<b>Idle Mode (mA)</b>	80	80	65	65	65	70

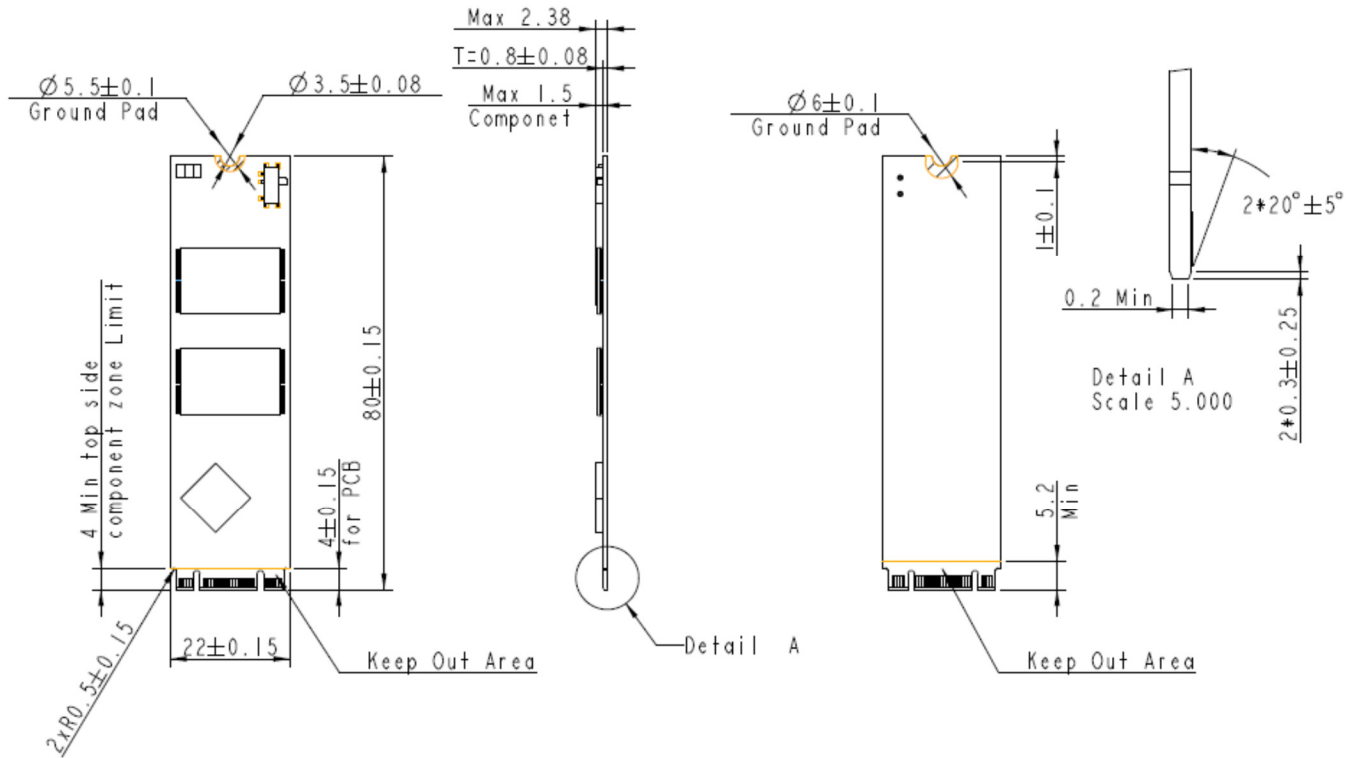


## 6. Physical Characteristics

### 6.1 Physical Dimensions

#### 6.1.1 TSOP Single Side (30-60GB)

Figure 6-1 illustrates the overall physical dimensions of the M.2 2280 drive for 30GB and 60GB module capacity.



**Figure 6-1** M.2 2280 physical dimensions for 30GB and 60GB capacities

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## 6.1.2 BGA (120-960GB)

### 6.1.2.1 Single Side (120-480GB)

Figure 6-2 illustrates the overall physical dimensions of the M.2 2280 drive for 120GB to 480GB module capacity range.

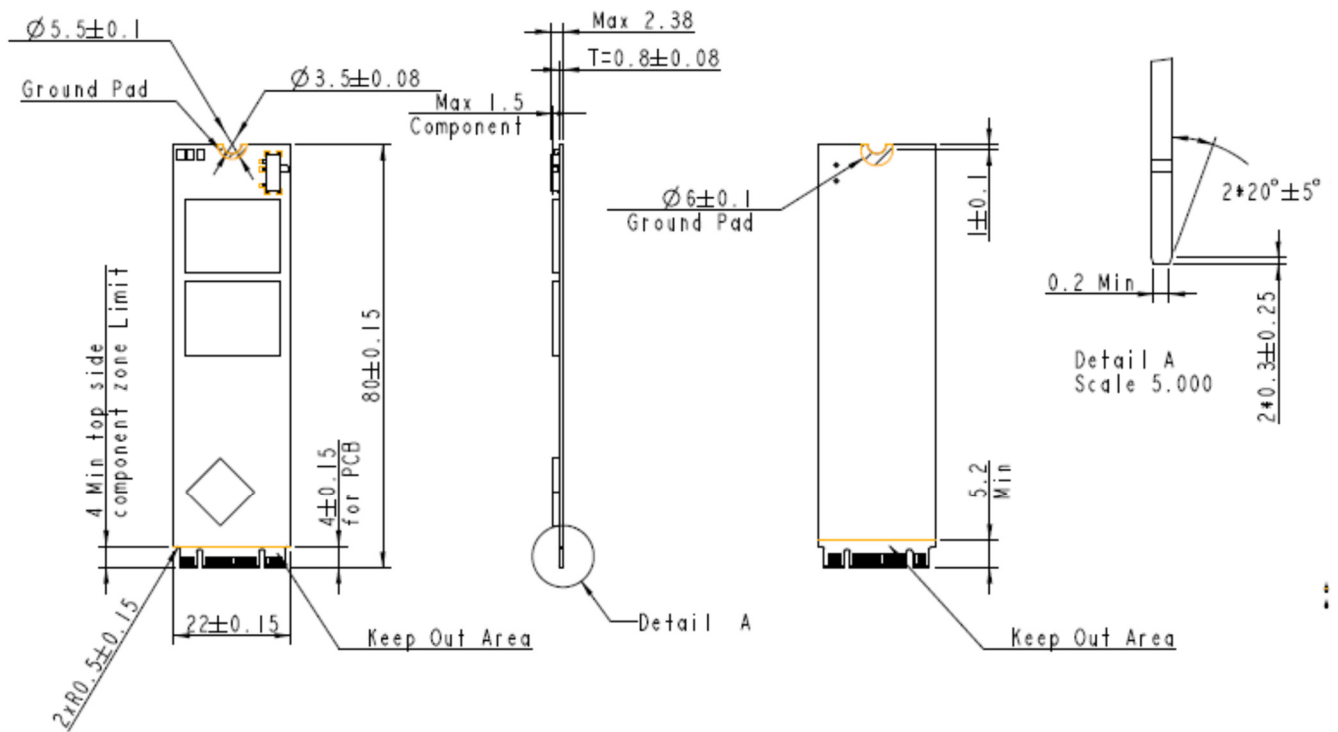


Figure 6-2 M.2 2280 physical dimensions for 120GB and 480GB capacity range

# M.2 2280 SATA Flash Module FMS-M28xxxx-XAK3D



## 6.1.2.2 Double Side (960GB)

Figure 6-3 illustrates the overall physical dimensions of the M.2 2280 drive for 960GB module capacity.

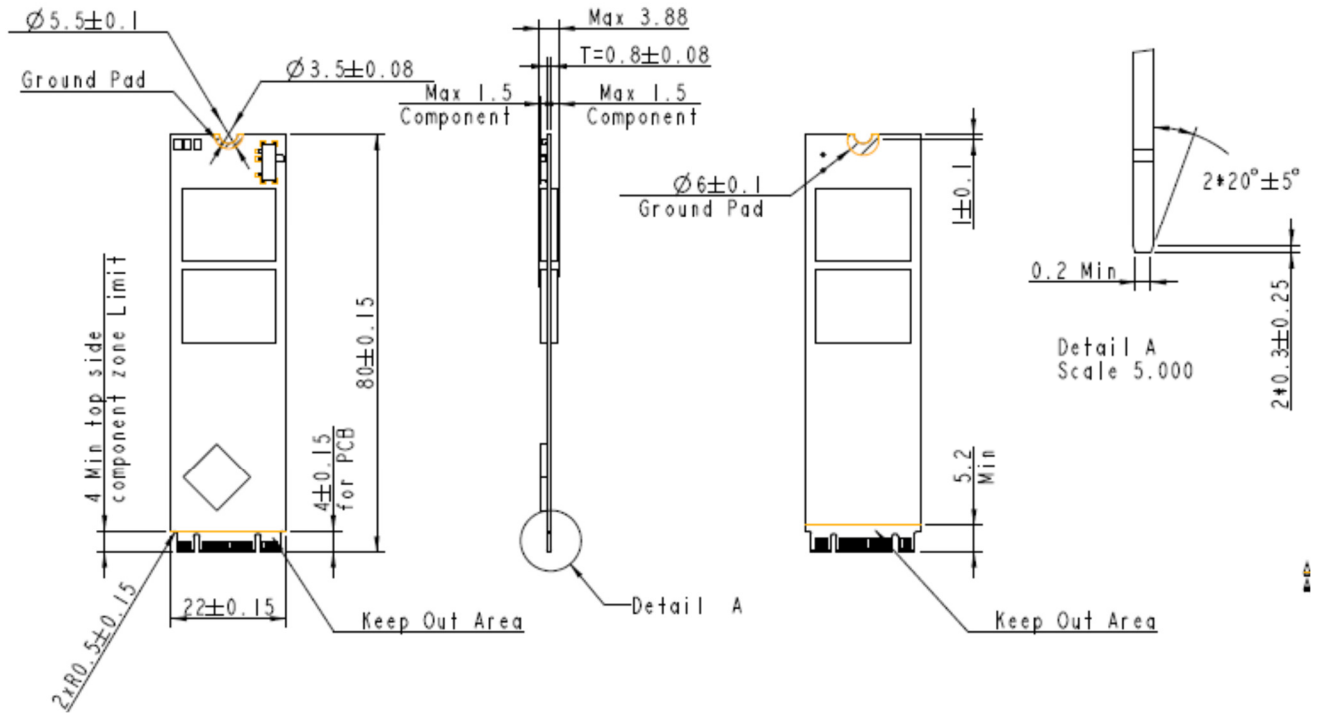
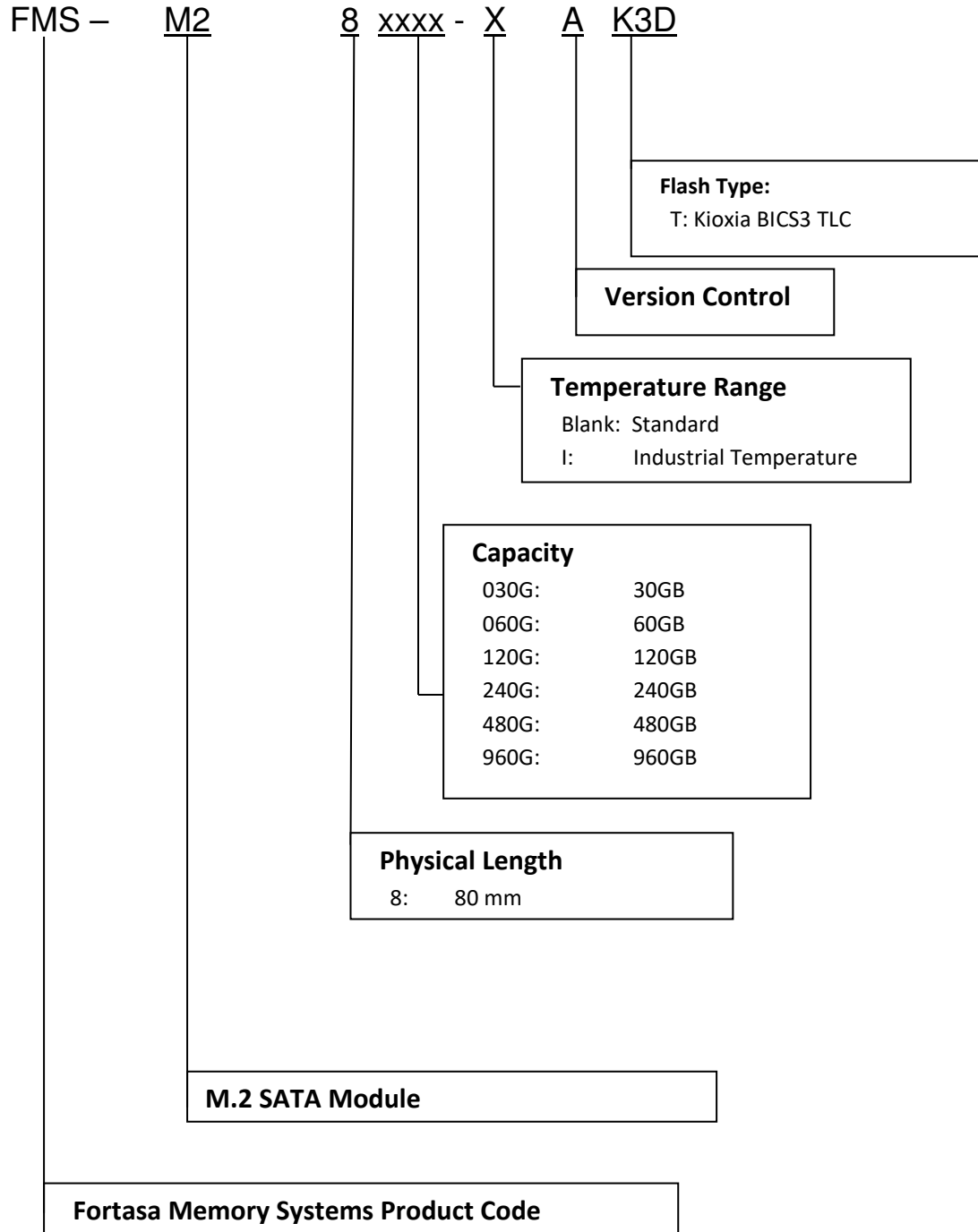


Figure 6-3 M.2 2280 physical dimensions for 960GB capacity

**7. Product Ordering Information**

**7.1 Product Code Designations**



## M.2 2280 SATA Flash Module FMS-M28xxxx-XAK3D



### 7.2 Valid Combinations

Capacity	Standard Temperature Model Numbers	Industrial Temperature Model Numbers
30GB	FMS-M28030G-AK3D	FMS-M28030G-IAK3D
60GB	FMS-M28060G-AK3D	FMS-M28060G-IAK3D
120GB	FMS-M28120G-AK3D	FMS-M28120G-IAK3D
240GB	FMS-M28240G-AK3D	FMS-M28240G-IAK3D
480GB	FMS-M28480G-AK3D	FMS-M28480G-IAK3D
960GB	FMS-M28960G-AK3D	FMS-M28960G-IAK3D

**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

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## 8. Revision History

Revision	Date	Description	Comments
1.0	4/24/2019	Initial Release	
1.1	5/2/2019	Added AES Encryption Feature	
1.2	5/6/2019	Updated TSOP Single Side specification	
1.3	10/24/2019	Updated Command Set Table	
1.4	12/12/2020	Updated Product Ordering Information	
1.5	2/10/2020	Modified Total Bytes in Capacity Specifications	
1.6	3/17/2020	Updated SMART Command Definition	

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