

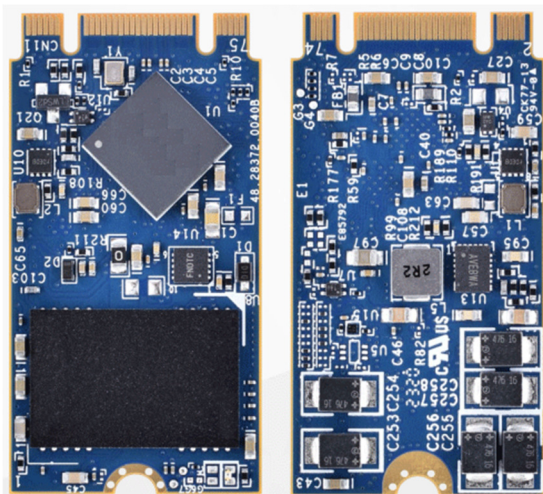
RoHS Compliant

M.2 A-E - 2242 SATA Flash Module Series

***Datasheet for M.2 A-E 2242 SATA 3 3D TLC
based Flash Module with DataProtect capacitors***

January 29, 2024

Revision 1.0



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

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

M.2 2242 SATA Flash Module FMS-SM2A4xxxx-XED



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 command set-4 (ACS-4)
- **Low power consumption (typical)**
 - Supply voltage: 3.3V±5%
 - Active mode: 405 mA (max)
 - Idle mode: 70 mA
- **NAND flash type: 3D NAND – BICS5 TLC**
- **MTBF (hours): >3,000,000**
- **Performance**
 - Burst transfer rate: 600 MB/sec
 - Sustained read: up to 560 MB/sec
 - Sustained write: up to 510 MB/sec
 - Random read 4K: up to 55,000 IOPS
 - Random write 4K: up to 71,000 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*
- **Form factor**
 - M.2 2242-D5-B-M
 - Dimensions: 42.00 x 22.00 x 3.88(max), unit: mm
- **Connector Type**
 - 75-pin SATA Based M.2 module pin-out
- **DataProtect Technology** - Implementation of Tantalum Capacitors to serve as backup power supply, capable of withstanding extended ambient temperature
- **AES-256 Hardware On-The-Fly Encryption Security**
- **Thermal Sensor for Temperature Management**
- **RoHS Recast compliant (complies with 2011/65/EU standard)**
- **Temperature ranges**
 - Operation:
 - Standard: 0°C to 70°C
 - Industrial: -40°C to 85°C
 - Storage: -40°C to 100°C
- **Capacity**
 - 120, 240, 480GB
- **Endurance (in drive writes per day: DWPD)**
 - 120 GB: 2.13 DWPD
 - 240 GB: 1.99 DWPD
 - 480 GB: 2.02 DWPD



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1 Product Description

1.1 General Description

Fortasa's M.2 A-E 2242 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 A-E 2242 module offers capacities of up to 480GB, 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 Industrial Temperature rated 3D TLC 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 A-E 2242 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 A-E 2242 drive incorporates 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 A-E 2242 drive 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
120GB	120,034,123,776	16383	16	63	234,441,648
240GB	240,057,409,536	16383	16	63	468,862,128
480GB	480,103,981,056	16383	16	63	937,703,088

*Display of total bytes varies from file systems, which means not all of the bytes can be used for storage.

**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.

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1.4 Performance Specification

Performances of the M.2 A-E 2242 devices are listed in Table 1-2.

Table 1-2: Performance specifications

Performance	Capacity		
	120GB	240GB	480GB
Sustained read (MB/s)	560	560	560
Sustained write (MB/s)	220	385	510
Random Read IOPS (4K)	16,000	35,000	55,000
Random Write IOPS (4K)	48,000	71,000	70,000

Note:

Results may differ from various flash configurations or host system setting.

*Sequential performance is based on CrystalDiskMark 5.2.1 with file size 1,000MB.

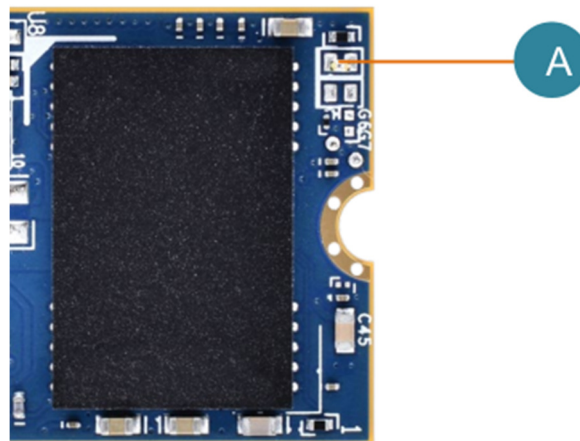
**Random performance measured using IOMeter with Queue Depth 32.

1.5 LED Indicator Behavior

The behavior of the M.2 A-E Flash Drive device LED indicators is described in Table 1-3.

Table 1-3: LED Behavior

Location	Status	Description
LED A	HDDA1	LED blinks when the drive is being accessed



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1.6 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

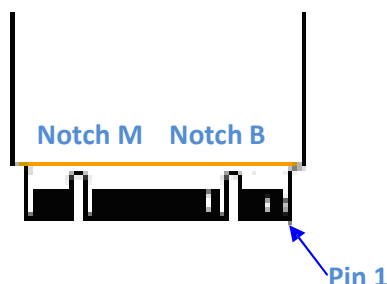


Table 1-4: Signal Segment

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	Do Not Connect
10	DAS/DSS	Device Activity Signal/Disable Staggered Spin-up
11	No Connect	Do Not 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	Do Not Connect
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

Table 2-2: 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 A-E implements a hardware ECC scheme, based on the Low Density Parity Check (LDPC). LDPC is a new class of linear block error correcting code which has substantial coding gain over previously common BCH code due to LDPC code integrating both hard decoding and soft decoding algorithms. With the reduced bit error rate, LDPC can extend SSD endurance and increase data reliability.

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

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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 A-E 2242 Module 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
- 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 A-E 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

mSATA A-E 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.

4. Environmental Specifications

4.1 Environments

Environmental specification of the M.2 A-E 2242 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)		50(G)/11(ms)/half sine (compliant with MIL-STD-202G)
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 A-E 2242 is rated at more than 3,000,000 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 A-E 2242 complies with the following standards:

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

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4.4 Endurance

The endurance of a storage device is predicted by a JEDEC approved test methodology. The data, reported in Data 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 this analysis and calculations.

Capacity	DWPD
120GB	2.13
240GB	1.99
480GB	2.02

Notes:

This estimation complies with JEDEC JESD-219A random client 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 the number of times that user can overwrite 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 A-E 2242 power consumption.

Table 5-2 Typical power consumption

Performance \ Capacity	120GB	240GB	480GB
	Active Mode (mA)	375	370
Idle Mode (mA)	70	65	70

Note: Results may differ from various flash configurations or host system setting

6. Physical Characteristics

6.1 Physical Dimensions

Figure 6-1 illustrates the overall physical dimensions of the M.2 A-E 2242 drive.

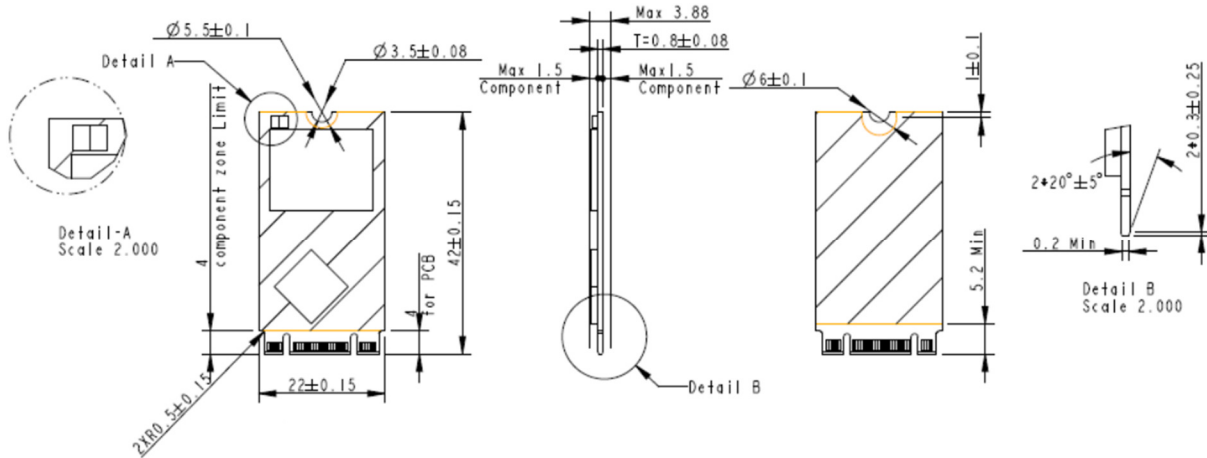


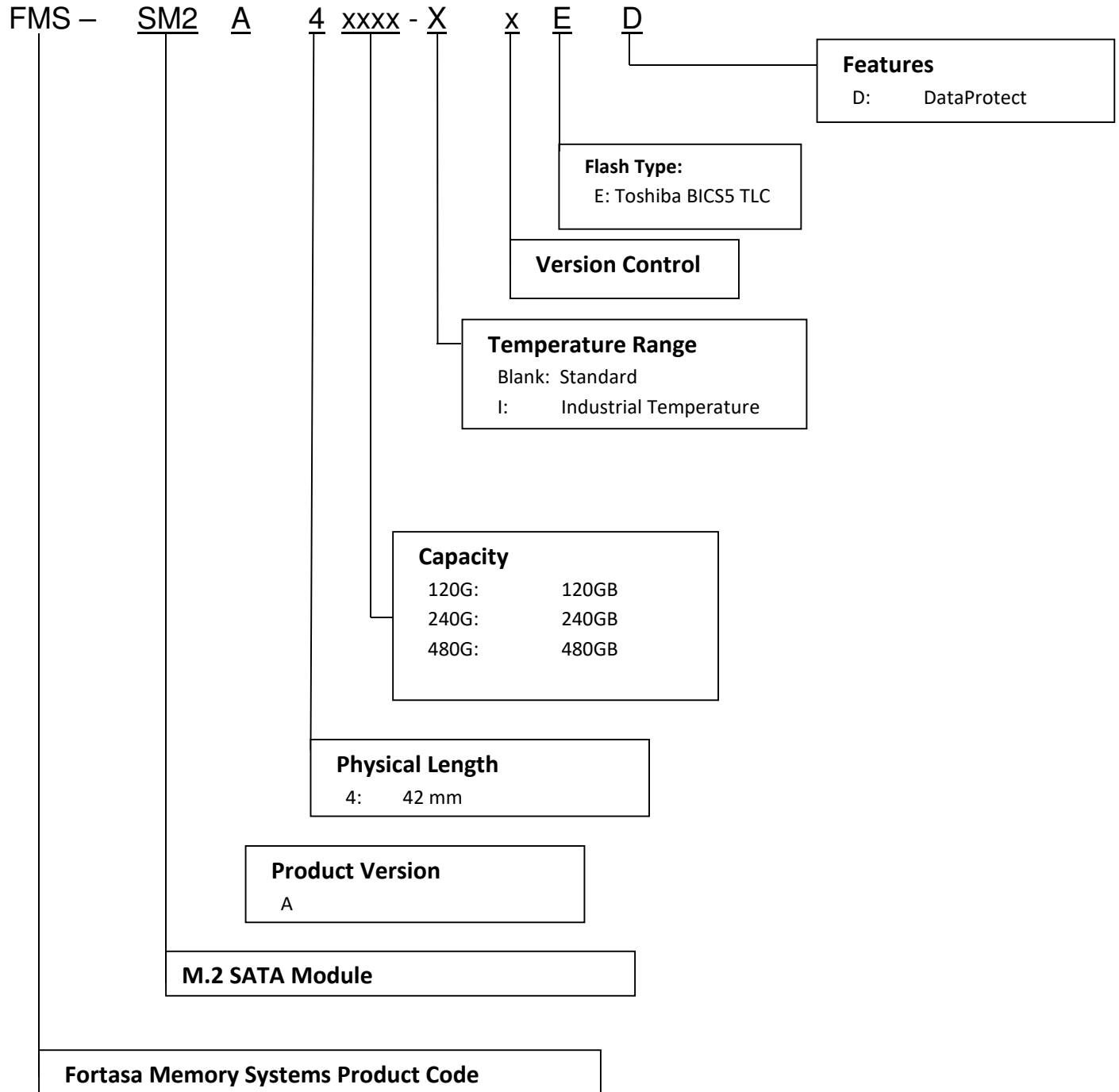
Figure 6-1 M.2 A-E 2242 physical dimensions

6.2 Physical Information

Parameter	Unit	120GB	240GB	480GB
Length	mm	42 ± 0.15		
Width		22 ± 0.15		
Height (Max.)		3.88		
Weight	g ± 5%	3.58	3.57	3.65

7. Product Ordering Information

7.1 Product Code Designations



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7.2 Valid Combinations

Capacity	Standard Temperature Model Numbers	Industrial Temperature Model Numbers
120GB	FMS-SM2A4120G-ED	FMS-SM2A4120G-IED
240GB	FMS-SM2A4240G-ED	FMS-SM2A4240G-IED
480GB	FMS-SM2A4480G-ED	FMS-SM2A4480G-IED

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	1/29/2024	Initial Release	

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