RoHS Compliant

SATA Low Capacity Flash Drive Series

Datasheet for SAFD 25B-E

September 19, 2022

Revision 1.0

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

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

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Features:

- **Standard Serial SATA 3.2**
  - – Serial SATA 6.0 Gbps Interface
  - – Backward compatible with SATA 1.5 and 3.0 Gbps interfaces
  - – ATA command set-4 (ACS-4)
- **Low power consumption (typical)**
  - – Supply voltage: 5V±5%
    - – Active mode: 405 mA
    - – Idle mode: 60 mA
- **Connector Type**
  - – 7-pin signal connector
  - – 15-pin power connector
- **Performance**
  - – Burst transfer rate: 600 MB/sec
    - – Sustained read: up to 560 MB/sec
    - – Sustained write: up to 500 MB/sec
    - – Random read (4K): up to 94,000 IOPS
    - – Random write (4K): up to 84,000 IOPS
- **Capacity**
  - 240, 480, 960, 1920 GB
- **Intelligent endurance design**
  - – Built-in hardware ECC, based on Low Density Parity Check (LDPC) 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
  - – SMART Command
  - *– Power Failure Management*
  - *– ATA Secure Erase*
  - *– Trim Command*
- **Form factor**
  - – Dimensions for 7mm housing: 100.00 x 69.85 x 6.90, unit: mm
- **Thermal Sensor for Temperature Management**
- **Security**
  - – AES 256 Hardware Encryption
  - – Trusted Computing Group (TCG) Opal 2.0 (optional)
- **RoHS compliant**
- **NAND flash type: 3D TLC (BiCS5)**
- **MTBF (hours):** >3,000,000
- **Endurance (in drive writes per day: DWPD)**
  - – 240GB – 2.20 DWPD
  - – 480GB – 2.20 DWPD
  - – 960GB – 2.18 DWPD
  - – 1920GB – 2.20 DWPD
- **Temperature ranges**
  - – Operation:
    - Standard: 0°C to 70°C
    - Industrial: -40°C to 85°C
  - – Storage: -40°C to 100°C

Table of Contents

1 Product Description

1.1 General Description

Fortasa’s SAFD25B-E is a high-performance, SATA interface, solid state drive (SSD) designed to replace a conventional SATA hard disk drive. SAFD 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. Fortasa SAFD Series is the best drop-in replacement for high-maintenance HDD where reliability is of a major importance. Incorporating AES 256-bit Encryption Algorithm, the information stored in a SAFD25B-E drive is most secure.

The SAFD25B-Edrive offers capacities of up to 2 Terabyte, providing full support for the SATA 6GBps high-speed interface standard. It can operate at sustained access rates of up to 560 megabytes per second, which is much faster than other solid-state or traditional HDD SATA drives currently available on the market. **Manufactured using 3D BICS5 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.**

SAFD25B-Eis implemented using LDPC (Low Density Parity Check) ECC engine to extend SSD endurance and increase data reliability inside a flash chip. The SAFD25B-E 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 SAFD25B-Edrive 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 SATA 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
240GB	240,057,409,536	16383	16	63	468,862,128
480GB	480,103,981,056	16383	16	63	937,703,088
960GB	960,197,124,096	16383	16	63	1,875,385,008
1920GB	1,920,383,410,176	16383	16	63	3,750,748,848

*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.

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

1.4 Performance Specification

Performances of the SATA Flash Drive are listed in Table 1-2.

Table 1-2: Performance specifications

Performance \ Capacity	240GB	480GB	960GB	1920GB
Sustained read (MB/s)	560	560	560	560
Sustained write (MB/s)	470	485	500	490
Random Read IOPS (4K)	73,000	94,000	94,000	94,000
Random Write IOPS (4K)	83,000	84,000	84,000	83,000

Note:

- Results may differ from various flash configurations or host system setting.
- Sequential read/write is based on CrystalDiskMark 8.0.4 with file size 1,000MB.
- Random read/write is measured using IOMeter with Queue Depth 32.

1.5 Pin Assignments

Figure 1-2: Micro-SATA connectors

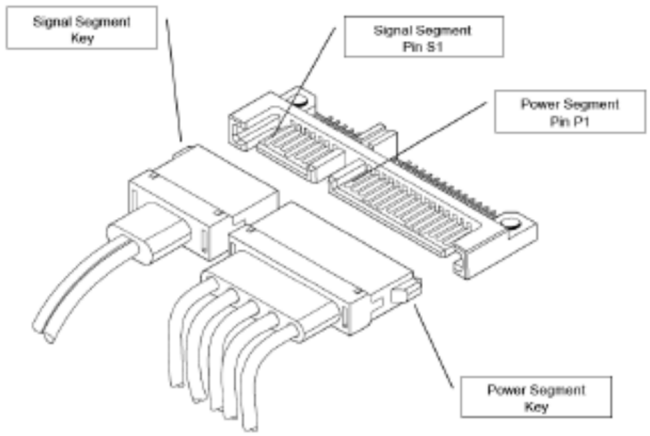


Table 1-3: Signal Segment

Pin	Signal	Description
S1	Ground	
S2	RxP	Serial Data Receiver
S3	RxN	
S4	Ground	
S5	TxN	Serial Data Transmitter
S6	TxP	
S7	Ground	

Table 1-4: Power Segment

Pin	Signal
P1	Not Used (3.3V)
P2	Not Used (3.3V)
P3	Not Used (3.3V)
P4	Reserved, DNU
P5	Ground
P6	Ground
P7	5V
P8	5V
P9	5V
P10	Ground
P11	Reserved, DNU
P12	Ground
P13	Not used (12V)
P14	Not Used (12V)
P15	Not Used (12V)

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 SATA Flash Drive 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 SATA 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 SATA 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.

Note: The Flash controller unit of this product model is designed with an External DRAM as a write cache for improved performance and data efficiency. Though unlikely to happen in most cases, the data cached in the volatile DRAM might be potentially affected if a sudden power loss / brown-out condition takes place before the cached data is flushed into non-volatile NAND flash memory.

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 with “0x00” values. This command is carried out within the drive, 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)	Average 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 Fail Count
192 (0xC0)	Unexpected Power Loss Count
194 (0xC2)	Temperature
231 (0xE7)	Lifetime Left
241 (0xF1)	Total LBA Written

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 SAFD25B-E 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

SAFD25B-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

SAFD25B-Eincorporates 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.

4. Environmental Specifications

4.1 Environments

Environmental specification of the SATA 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		Operation: 7.69(Grms), 20~2000(Hz)/random (compliant with MIL-STD-810G) Non-operation: 4.02(Grms), 15~2000(Hz)/random (compliant with MIL-STD-810G)
Shock-		Operation: Acceleration, 50(G)/11(ms)/half sine (compliant with MIL-STD-202G) Non-operation: Acceleration,1,500(G)/0.5(ms)/half sine (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 SAFD drive. Based on provided component data, SATA Flash Drive 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 SAFD25B-Ecomplies with the following standards:

- CE
- FCC
- RoHS

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, 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.

Capacity	DWPD
240GB	2.20
480GB	2.20
960GB	2.18
1920GB	2.20

Note:

- This estimation complies with JEDEC JESD-219, enterprise endurance workload of random data with payload size distribution.
- 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 = 1,024 GB
- DWPD (Drive Write 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: 3 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	5.0 V ±5% (4.75-5.25 V)
Industrial	-40°C to +85°C	5.0 V ±5% (4.75-5.25 V)

5.2 Power Consumption

Table 5-2 lists the SAFD 25B-E power consumption.

Table 5-2 Typical power consumption

Capacity / Performance	240GB	480GB	960GB	1920GB
Active Mode (mA)	365	405	405	405
Idle Mode (mA)	55	55	60	60

Note:

- All values are typical and may vary depending on flash configurations or host system settings.
- Active power is an average power measurement performed using CrystalDiskMark with 128KB sequential read/write transfers.

6. Physical Characteristics

6.1 7mm Thickness Enclosure

Figure 6-1 illustrates the overall dimensions of the SAFD drive packaged in a 7mm Housing, as listed in Table 6-1.

Table 6-1 SAFD dimensions

Dimension	Millimeters (mm)
Height	6.90 ± 0.20
Width	69.85 ± 0.25
Length	100.00 ± 0.33

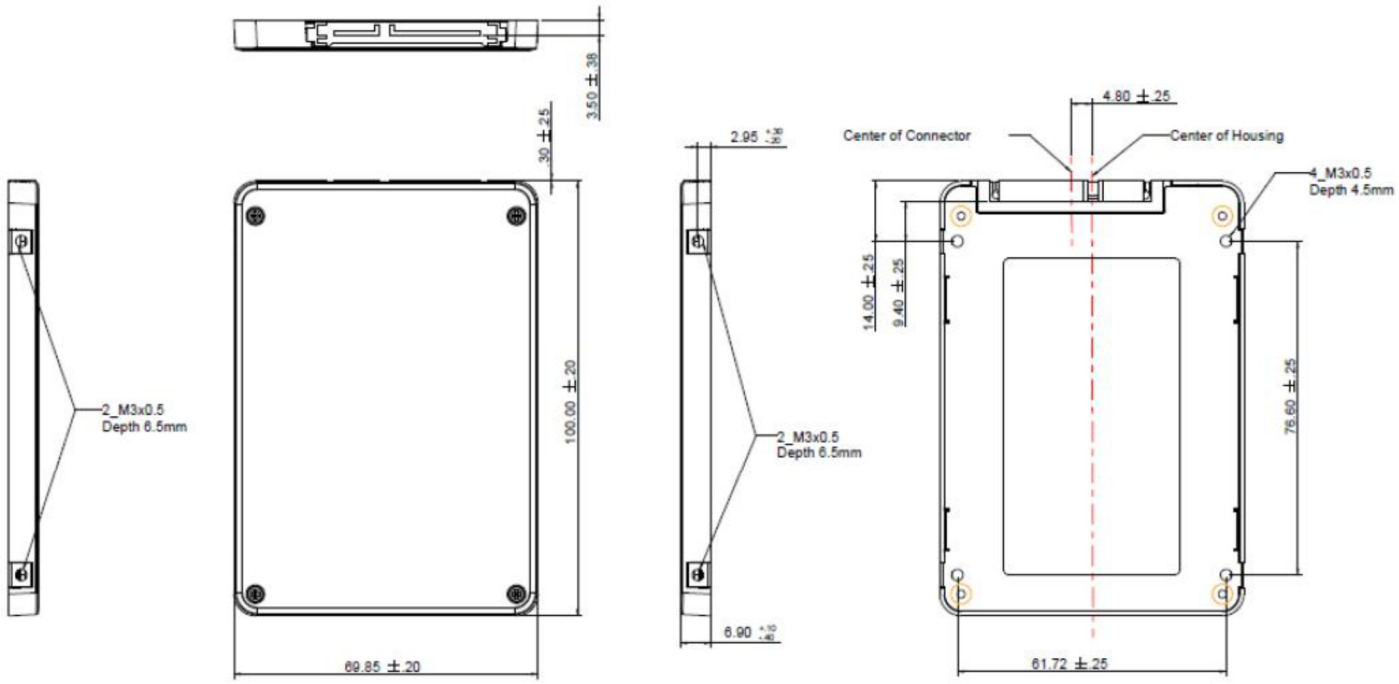
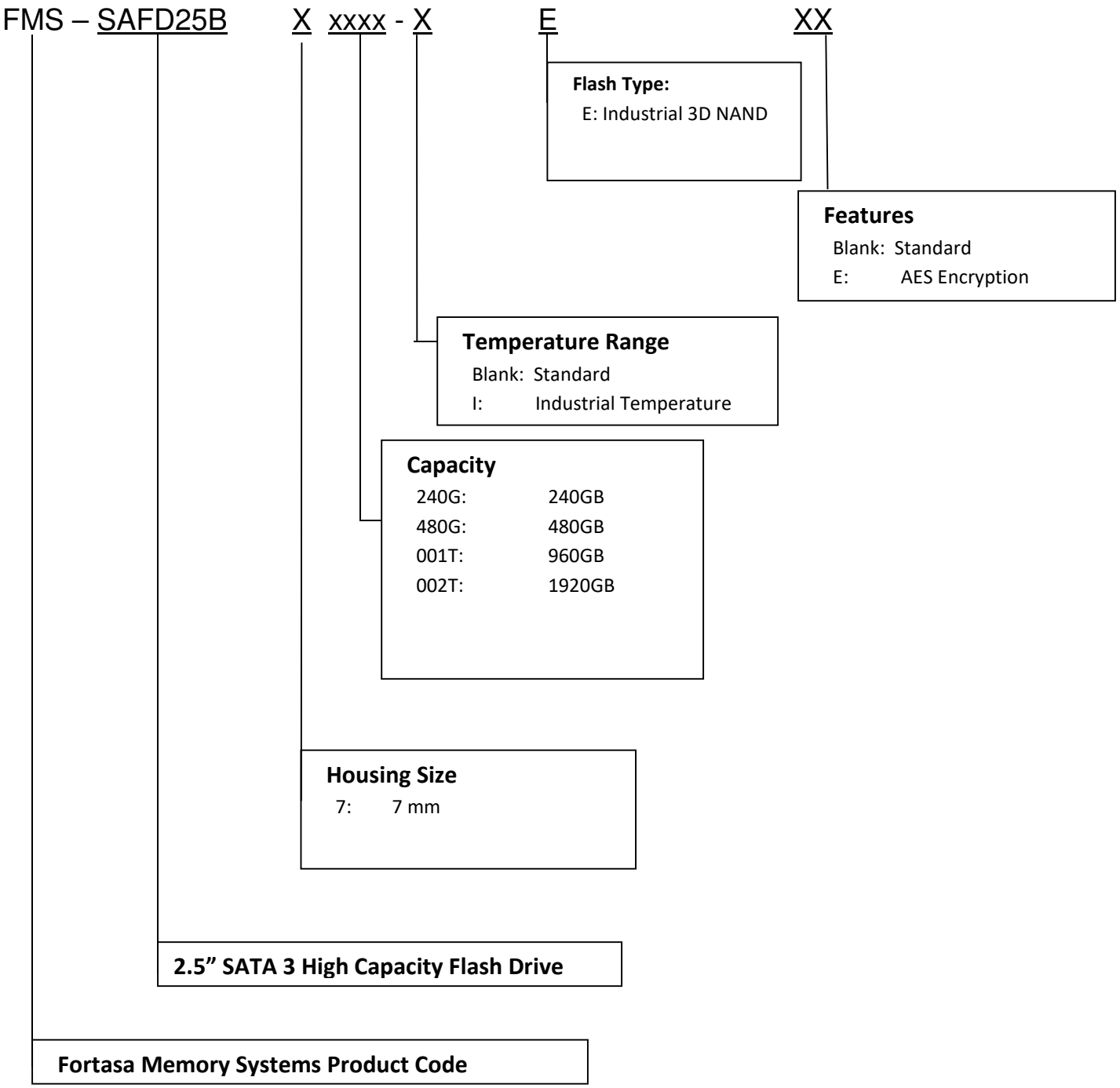


Figure 6-1 SFD25B-E with 7mm Housing physical dimensions

7. Product Ordering Information

7.1 Product Code Designations



7.2 Valid Combinations

7mm Housing

Standard Configuration

Capacity	Standard Temperature Model Numbers	Industrial Temperature Model Numbers
240GB	FMS-SAFD25B7240G-E	FMS-SAFD25B7240G-IE
480GB	FMS-SAFD25B7480G-E	FMS-SAFD25B7480G-IE
960GB	FMS-SAFD25B7001T-E	FMS-SAFD25B7001T-IE
1920GB	FMS-SAFD25B7002T-E	FMS-SAFD25B7002T-IE

AES Encryption

Capacity	Standard Temperature Model Numbers	Industrial Temperature Model Numbers
240GB	FMS-SAFD25B7240G-EE	FMS-SAFD25B7240G-IEE
480GB	FMS-SAFD25B7480G-EE	FMS-SAFD25B7480G-IEE
960GB	FMS-SAFD25B7001T-EE	FMS-SAFD25B7001T-IEE
1920GB	FMS-SAFD25B7002T-EE	FMS-SAFD25B7002T-IEE

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	9/19/2022	Initial Release	