

RoHS Compliant
SATA Flash Drive Series
Datasheet for SAFD 25N-M

May 23, 2016

Revision 2.3

***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 3.1**
 - SATA 3.1 command set compatible
 - Serial SATA 6.0 Gbps Interface
 - Backward compatible with SATA 1.5 and 3.0 Gbps interfaces
 - ATA-8 compatible command set
- **Low power consumption (typical)**
 - Supply voltage: 5V±5%
 - Active mode: 680 mA
 - Idle mode: 50 mA
- **Connector Type**
 - 7-pin signal connector
 - 15-pin power connector
- **Performance**
 - Burst transfer rate: 600 MB/sec
 - Sustained read: up to 525 MB/sec
 - Sustained write: up to 455 MB/sec
 - Random read (4K): up to 86,000 IOPS
 - Random write (4K): up to 79,000 IOPS
- **Intelligent endurance design**
 - Built-in hardware ECC, enabling up to 40 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*
- **Form factor Choices**
 - 2.5 inch
 - 7mm thick enclosure - 100.00 x 69.85 x 6.90, unit: mm
 - 9mm thick enclosure - 100.00 x 69.85 x 9.30, unit: mm
- **RoHS compliant**
- **Shock and Vibration**
 - Shock: 1500g (approx.)
 - Vibration: 15g (approx.)
- **Military Erase (Optional)**
- **Thermal Sensor (Optional)**
- **Capacity**
 - 32, 64, 128, 256 GB
- **NAND flash type: MLC**
- **MTBF (hours): >1,000,000**
- **Endurance (in Terabytes Written: TBW)**
 - 32GB: 68 TBW
 - 64GB: 136 TBW
 - 128GB: 272 TBW
 - 256 GB: 545 TBW
- **Temperature ranges**
 - Operation:
 - Standard: 0°C to 70°C (32° ~ 158°F)
 - Industrial: -40°C to 85°C (-40° ~ 185°F)
 - Storage: -40°C to 100°C (-40° ~ 212°F)
- **Shock and Vibration**
 - Shock: 1500g (approx.)
 - Vibration: 15g (approx.)



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1 Product Description

1.1 General Description

Fortasa’s SAFD25N-M 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.

The SAFD25N-M drive offers capacities of up to 256 gigabytes, providing full support for the SATA 6GBps high-speed interface standard. It can operate at sustained access rates of up to 550 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 MLC NAND-flash, this SSD can work in highly demanding environment and withstand wide range of operating temperature from -40°C to +85°C.**

SAFD25N-M 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 SAFD25N-M 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 SAFD25N-M 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 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
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
256GB	256,060,514,304	16383 ¹	16	63	500,118,192

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.

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1.4 Performance Specification

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

Table 1-2: Performance specifications

Performance	Capacity			
	32GB	64GB	128GB	128GB
Sustained read (MB/s)	380	515	520	525
Sustained write (MB/s)	85	145	300	455
Random Read IOPS (4K)	46,000	79,000	85,000	86,000
Random Write IOPS (4K)	19,000	35,000	71,000	79,000

Note: Performance varies from flash configurations or host system settings.
IOPS: measured on 8GB span (16777216 sectors Disk Size), 32 Outstanding I/Os (QD=32), Full Random Data pattern, 4KB Align I/Os and test durations 15minutes

1.5 Pin Assignments

Figure 1-2: Micro-SATA connectors

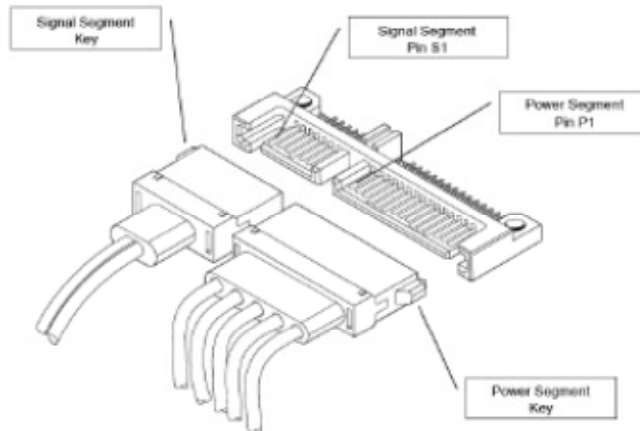


Table 1-3: Signal Segment

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	Unused or Device Sleep *
P4	Ground
P5	Ground
P6	Ground
P7	5V
P8	5V
P9	5V
P10	Ground
P11	DAS
P12	Ground
P13	Not used (12V)
P14	Not Used (12V)
P15	Not Used (12V)

*P3 can be configured as Device Sleep trigger by Configuration Option

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
Execute-Drive-Diagnostic	90H	Security-Erase-Prepare	F3H
Flush-Cache	E7H	Security-Erase-Unit	F4H
Identify-Drive	ECH	Security-Freeze-Lock	F5H
Idle	E3H	Security-Set-Password	F1H
Idle-Immediate	E1H	Security-Unlock	F2H
Initialize-Drive-Parameters	91H	Seek	7XH
Read DMA	C8H	Set-Features	EFH
Read DMA EXT	25H	Set-Multiple-Mode	C6H
Read FPDMA Queued	60H	Set-Sleep-Mode	E6H
Read Log DMA EXT	47H	SMART	B0H
Read Log EXT	2FH	Stand-By	E2H
Read-Multiple	C4H	Stand-By-Immediate	E0H
Read-Sector	20H or 21H	Write DMA	CAH
Read-Verify-Sectors	40H or 41H	Write DMA EXT	35H
Recalibrate	10H	Write FPDMA Queued	61H
Write Log DMA EXT	57H	Write Log EXT	3FH
Write-Multiple	C5H	Write-Sector	30H or 31H

3. Flash Management

3.1 Error Correction/Detection

The SATA Flash Drive implements a hardware BCH-based ECC scheme to achieve up to 40 bit correction per 1024-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 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. 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
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 SAFD 25N-M devices support 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

SAFD 25N-M 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 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		Sine wave: 5~55~5 Hz (X, Y, Z) Random: 10-2000 Hz, 16.3 G (X, Y, Z)
Shock-Operating		Acceleration: 1,500 G, 0.5 ms Peak acceleration: 50 G, 11 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, SATA Flash Drive 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 SAFD25N-M complies with the following standards:

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

4.4 Endurance

The endurance of a storage device is predicted by TeraBytes Written based on several factors related to usage, such as the amount of data written into the drive, block management conditions, and daily workload for the drive. Thus, key factors, such as Write Amplifications and the number of P/E cycles, can influence the lifespan of the drive.

Capacity	TeraBytesWritten (TBW)
16 GB	34
32 GB	68
64 GB	136
128 GB	272
256 GB	545

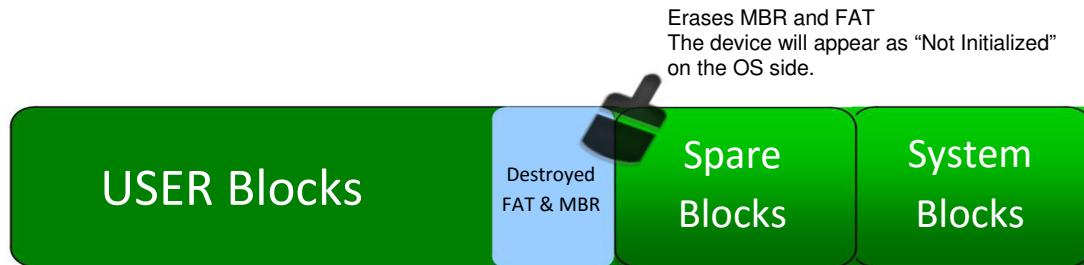
Notes:

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

5. Special Features

5.1 Quick Erase

All physical memory blocks of the Flash Memory are categorized into either User Blocks, Spare Blocks or System Blocks. Most of the physical blocks are in the User Blocks category, where the host has read and write access and can store various types of files. Spare Blocks are specifically dedicated for wear leveling and bad block swapping. A small number of blocks are dedicated as System Blocks and are reserved to store system firmware and management data. Typically, the host is unaware of the size and allocation of these blocks so a Logical Block Addressing (LBA) scheme is developed to interface the host OS as logical presentation of physical block addresses. Since it is extremely time-consuming to erase all the physical blocks, a Quick Erase function was developed for cases when there a quick drive erasure is required in a shortest amount of time. Fortasa Quick Erase implementation destroys FAT table and the MBR (Master Boot Record). With the MBR and FAT table erased, the drive appears as uninitialized and mapping links between LBA and physical blocks are erased. In order to access the drive, full re-initialization and FAT table rebuild are necessary.



Command code: 84h

Protocol: Non-data command

Register	7	6	5	4	3	2	1	0
Features	Subcommand code							
Sector Count	NA							
LBA Low	41h							
LBA Mid	50h							
LBA High	52h							
Device	obs	NA	obs	DEV			NA	
Command	84h							

Subcommand code

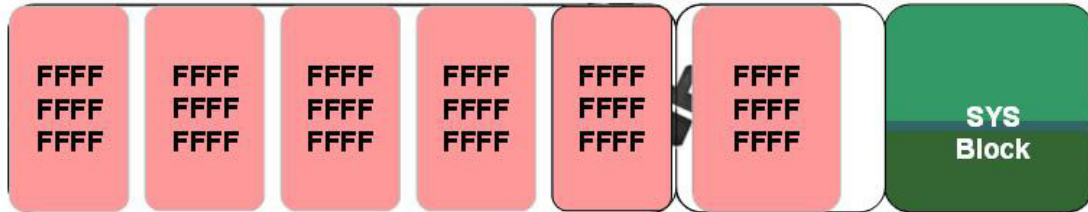
Mode	Subcommand code
Quick Erase	0x50

Auto-Resume:

- If a power interruption occurs during Quick Erase procedure, the device restarts the procedure on the next power-up.

5.2 Full Erase

Full Erase sanitizes the LBA and eliminates all the physical blocks in User Block and Free Block. Drive will have to be reinitialized after completion of the erase action. The drive will behave as a raw disk as cells in the drive would display “FF” (or “00”).



Erase and overwrite with “FF” pattern

Command code: 84h

Protocol: Non-data command

Register	7	6	5	4	3	2	1	0
Features	Subcommand code							
Sector Count	NA							
LBA Low	41h							
LBA Mid	50h							
LBA High	52h							
Device	obs	NA	obs	DEV	NA			
Command	84h							

Subcommand code

Mode	Subcommand code
Full Erase	0x51

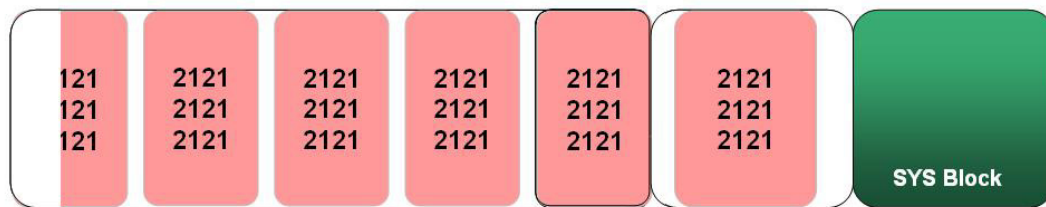
Auto-Resume:

- If a power interruption occurs during Quick Erase procedure, the device restarts the procedure on the next power-up.

5.3 Military Erase

Fortasa Military Erase feature set includes a list of globally certified drive purge methods that comply with the military and industrial standards, such as NSA 9-12. Most of the options sanitize MBR, FAT table as well as user & free blocks by erasing and overwriting every memory block with specifically defined data. These certified erase features are widely utilized, providing conformance in secure data erasure. The standards included in MIL Erase are DoD 5220.22-M, NSA Manual 130-2, USA-AF AFSSI 5020, USA-Army 380-19, USA Navy NAVSO P-5239-26, NISPOMSUP Chap 8, Sect. 8-501, IREC (IRIG) 106, and NSA 9-12 (Gen.2).

EX. NSA 9-12



Command code: 80h

Protocol: Non-data command

Register	7	6	5	4	3	2	1	0
Features	Subcommand							
Sector Count	Parameter 1							
LBA Low	Parameter 2							
LBA Mid	Parameter 3							
LBA High	80h							
Device	obs	NA	obs	DEV			NA	
Command	80h							

Auto-Resume:

- If a power interruption occurs during Purge procedure, the device restarts the procedure on the next power-up.

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Subcommand Layout

Bits 6-7 define the parameter count.

Value	Description
00b	No parameter is selected, execute default Purge procedure
01b	1 parameter is selected; defined in bits 4-5
10b	2 parameters are selected; defined in bits 2-3 and 4-5
11b	3 parameters are selected; defined in bits 0-1, 2-3 and 4-5

Bits 0-1, 2-3 and 4-5 define the Executive Mode.

Parameter1 corresponds to the subcommand in bits 4-5.

Parameter2 corresponds to the subcommand in bits 2-3.

Parameter3 corresponds to the subcommand in bits 0-1.

Value	Description
00b	Reserved
01b	Erase
10b	Erase + Write random data
11b	Erase + Write a character

The following table lists the subcommand code and the related parameters.

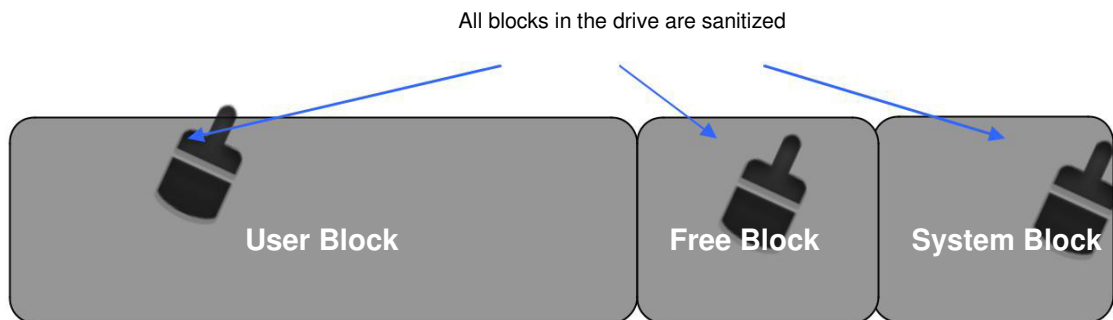
Mode	Subcommand code	Parameter		
		1	2	3
DoD 5220.22-M	0xB4 (10110100b)	char	0x00	0x00
NSA Manual 130-2	0xAC (10101100b)	0x02	char	0x00
USA-AF AFSSI 5020	0x60 (01100000b)	0x01	0x00	0x00
USA-Army 380-19	0xEF (11101111b)	0x01	char	~char
USA Navy NAVSO P-5239-26	0xA4 (10100100b)	0x01	0x00	0x00
NISPOMSUP Chap 8, Sect. 8-501	0xFE (11111110b)	char	~char	0x01
IREC (IRIG) 106	0xFD (11111101b)	0x55	0xAA	0x00
NSA 9-12 (Gen2)	0x70 (01110000b)	0x21	0x00	0x00

The following table lists purge procedure details and respective proposed standard.

Organization	Function description
DoD 5220.22-M	<ul style="list-style-type: none"> • Erase the blocks + overwrite with single character • Erase the blocks
NSA Manual 130-2	<ul style="list-style-type: none"> • Erase the blocks + overwrite with random data (1st) • Erase the blocks + overwrite with random data (2nd) • Erase the blocks + overwrite with single character
USA-AF AFSSI 5020	<ul style="list-style-type: none"> • Erase the blocks + overwrite with random data
USA-Army 380-19	<ul style="list-style-type: none"> • Erase the blocks + overwrite with random data • Erase the blocks + overwrite with single character • Erase the blocks + overwrite with complement of the character
USA Navy NAVSO P-5239-26	<ul style="list-style-type: none"> • Erase the blocks + overwrite with random data • Erase the blocks
NISPOMSUP Chap 8, Sect. 8-501	<ul style="list-style-type: none"> • Overwrite with single character • Overwrite with complement of the character • Overwrite with random data
IREC (IRIG) 106	<ul style="list-style-type: none"> • Erase the blocks + overwrite with 0x55 • Erase the blocks + overwrite with 0xAA • Erase the blocks
NSA 9-12 (Gen2)	<ul style="list-style-type: none"> • Erase the blocks + overwrite with 0x21

5.3 Self Destruction (Suicide) Erase

Self Destruction Erase is the ultimate disk termination solution. The purpose of this feature is not only for destroying the FAT, MBR, User and Spare Blocks, but more importantly, Flash Controller firmware, mapping/allocation table and other maintenance mechanisms in the System Block in an SSD. With the System Block totally terminated, the SSD can no longer function as storage media and will not be recognized by any host.



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Command code: 84h

Protocol: Non-data command

Register	7	6	5	4	3	2	1	0
Features	Subcommand							
Sector Count	NA							
LBA Low	41h							
LBA Mid	50h							
LBA High	52h							
Device	obs	NA	obs	DEV			NA	
Command	84h							

Subcommand code

Mode	Subcommand code
Self Destruction	0x48

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	Conditions
Standard	0°C to +70°C	5.0 V ±10% (4.5-5.5 V)
Industrial	-40°C to 85°C	5.0 V ±10% (4.5-5.5 V)

6.2 Power Consumption

Table 6-2 lists the SAFD 25N-M power consumption.

Table 6-2 Typical power consumption

Performance \ Capacity	32GB	64GB	128GB	256GB
	Active Mode (mA)	240	300	470
Idle Mode (mA)	50	50	50	50

7. Physical Characteristics

7.1 7mm Thickness Enclosure

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

Table 7-1 SAFD dimensions

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

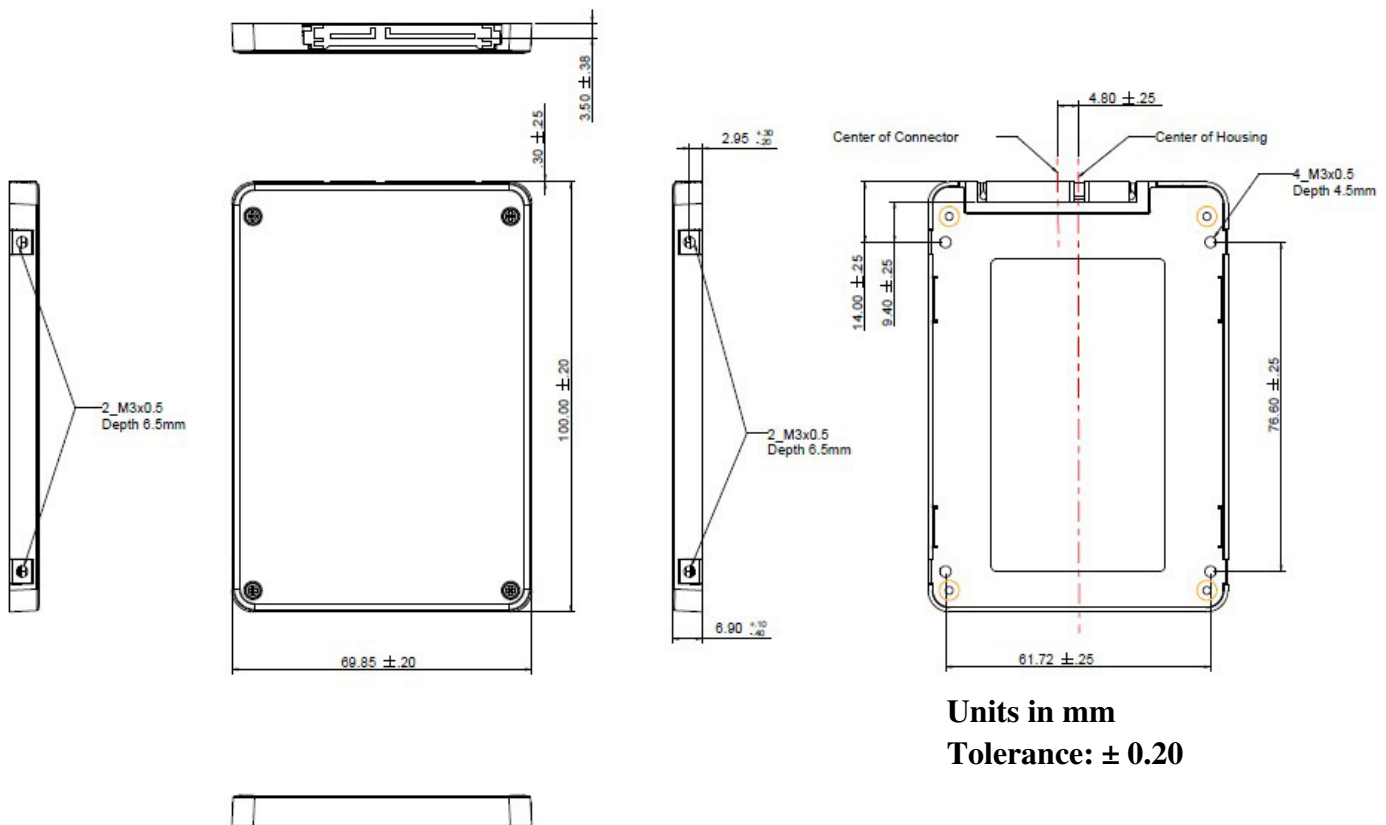


Figure 7-1 SFD25N-M with 7mm Housing physical dimensions

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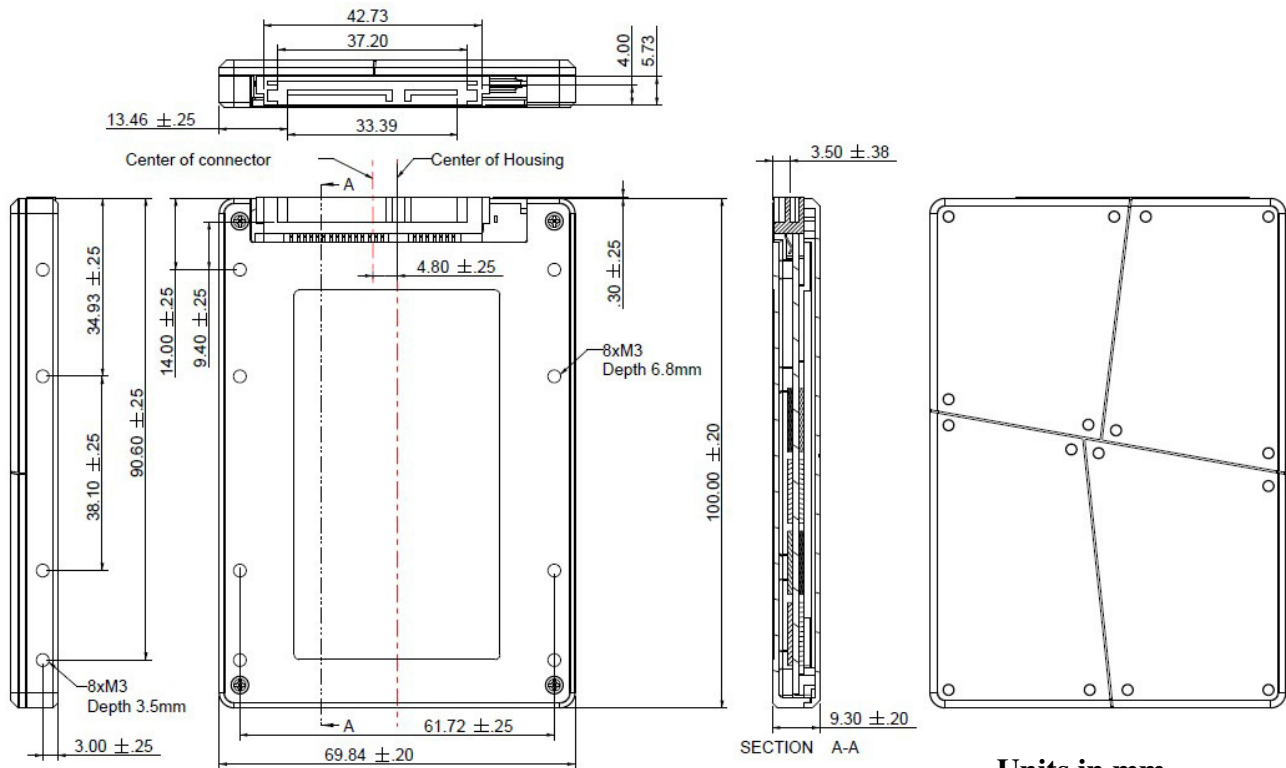


7.2 9mm Thickness Enclosure

Figure 7-2 illustrates the overall dimensions of the SAFD drive packaged in a 9mm Housing, as listed in Table 7-2.

Table 7-2 SAFD dimensions

Dimension	Millimeters (mm)
Height	9.30 ± 0.20
Width	69.84 ± 0.20
Length	100.00 ± 0.20



Units in mm
Tolerance: ± 0.20

Figure 7-1 SFD25N-M with 9mm Housing physical dimensions

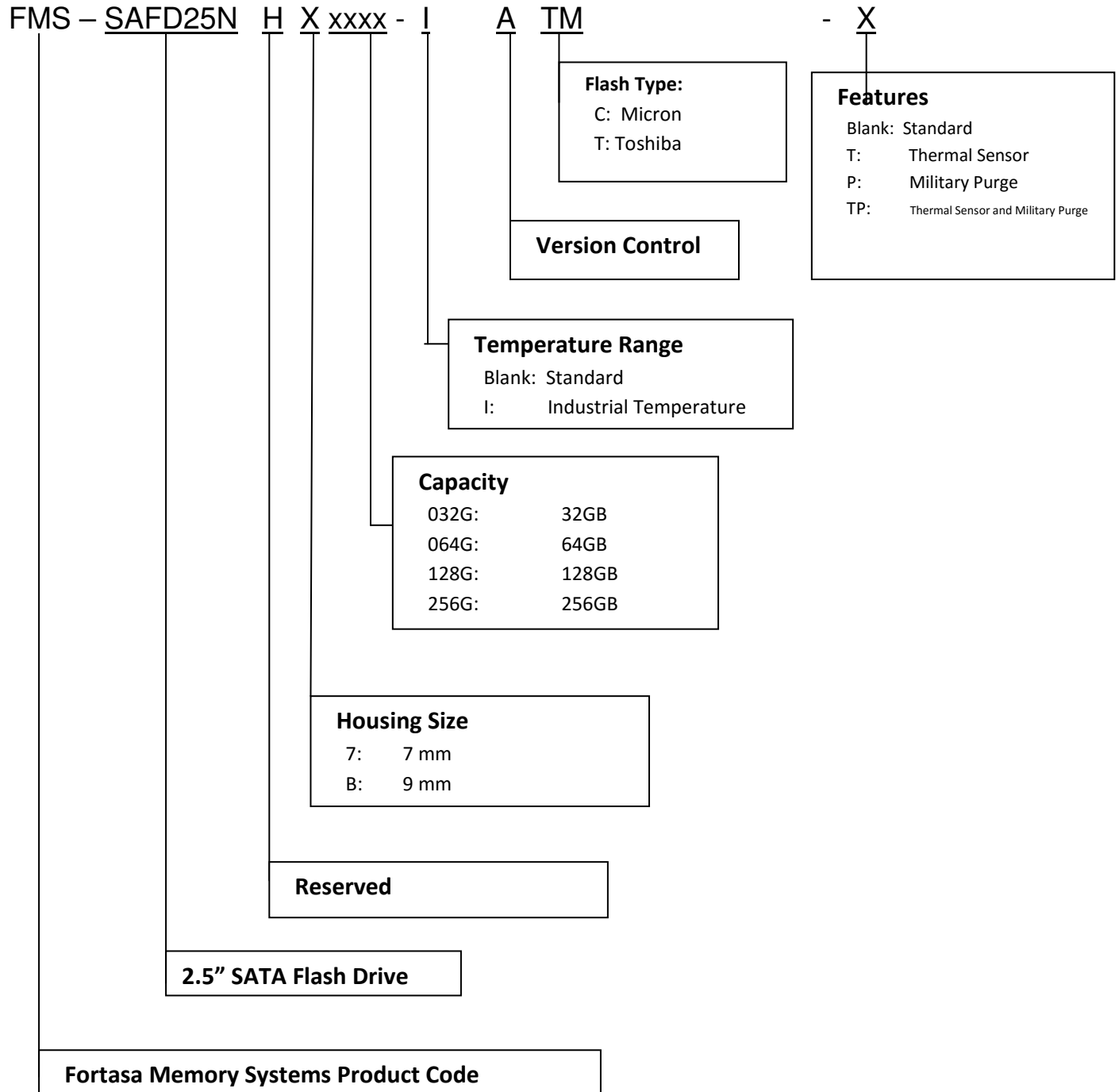
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8. Product Ordering Information

8.1 Product Code Designations



8.2 Valid Combinations

8.2.1 7mm Housing

Capacity	Standard Temperature Model Numbers	Industrial Temperature Model Numbers
32GB	FMS-SAFD25NH7032G-ATM	FMS-SAFD25NH7032G-IATM
64GB	FMS-SAFD25NH7064G-ATM	FMS-SAFD25NH7064G-IATM
128GB	FMS-SAFD25NH7128G-ATM	FMS-SAFD25NH7128G-IATM
256GB	FMS-SAFD25NH7256G-ATM	FMS-SAFD25NH7256G-IATM

8.2.2 9mm Housing

Capacity	Standard Temperature Model Numbers	Industrial Temperature Model Numbers
32GB	FMS-SAFD25NHB032G-ATM	FMS-SAFD25NHB032G-IATM
64GB	FMS-SAFD25NHB064G-ATM	FMS-SAFD25NHB064G-IATM
128GB	FMS-SAFD25NHB128G-ATM	FMS-SAFD25NHB128G-IATM
256GB	FMS-SAFD25NHB256G-ATM	FMS-SAFD25NHB256G-IATM

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	11/17/2013	Initial Release	
1.1	11/21/2013	Updated performance and power consumption due to changes in components	
1.2	12/16/2013	Added Device Sleep option to power segment pin3 Updated 7mm type mechanical specifications Added Endurance (TBW) section	
1.3	4/21/2014	Added 256GB Capacity	
1.4	5/17/2014	Updated performance and power consumption due to firmware upgrade	
1.5	6/26/2014	Corrected Part Numbers	
1.6	9/19/2014	Added Thermal Sensor feature	
1.7	4/7/2015	Removed Standard type and enhanced temperature grade support	
1.8	8/21/2015	Revised product ordering information - added extended temperature support	
1.9	12/15/2015	Revised product ordering information	
2.0	2/15/2016	Revised product ordering information due to FW change	
2.1	3/23/2016	Added environmental specs	
2.2	3/25/2016	Revised product ordering information	
2.3	5/23/2016	Added Military Erase Option	