

RoHS Compliant
SATA Flash Drive Series
Datasheet for SFD 253E

December 19, 2023

Revision 2.0

***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 3.1**
 - 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: 2W
 - Idle mode: 0.5W
- **Connector Type**
 - 7-pin signal connector
 - 15-pin power connector
- **Performance**
 - Burst transfer rate: 600 MB/sec
 - Sustained read: up to 470 MB/sec
 - Sustained write: up to 470 MB/sec
 - Random read (4K): up to 55,000 IOPS
 - Random write (4K): up to 60,000 IOPS
- **Intelligent endurance design**
 - Flash bad-block management
 - 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
 - *Power Failure Management*
 - *ATA Secure Erase*
 - *SMART Command*
 - *Trim Command*
- **Form factor Choices**
 - 2.5 inch
 - 9 mm thick enclosure - 100.00 x 70.00 x 9.40, unit: mm
- **RoHS compliant**
- **Shock and Vibration**
 - Shock: 1500g (approx.)
 - Vibration: 15g (approx.)
- **Hardware Pin enabled Erase Function**
- **Capacity**
 - 30, 60, 120, 240, 480, 600GB
- **NAND flash type: SLC**
- **MTBF (hours): >2,000,000**
- **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.)

Table of Contents

1 Product Description	5
1.1 General Description.....	5
1.2 Functional Block	5
1.3 Capacity Specification.....	5
1.4 Performance Specification	6
1.5 Pin Assignments.....	7
2. Software Interface	9
2.1 Command Set.....	9
3. Flash Management	10
3.1 Error Correction/Detection.....	10
3.2 Wear Leveling	10
3.3 Power Failure Management.....	10
3.4 ATA Secure Erase	10
3.5 TRIM Command Support.....	10
3.6 S.M.A.R.T. Technology	11
4. Environmental Specifications	13
4.1 Environments	13
4.2 Mean Time Between Failures (MTBF)	14
4.3 Certification and Compliance.....	14
4.4 Endurance.....	14
5. Special Features	15
5.1 Hardware Pin enabled Data Erase Function (Optional)	15
6. Electrical Specification	17
6.1 Operating Voltage	17
6.2 Power Consumption	17
7. Physical Characteristics	18
7.1 9.4mm Thickness Enclosure.....	18
8. Product Ordering Information.....	19
8.1 Product Code Designations	19
8.2 Valid Combinations.....	20
8.2.1 9mm Housing	20
9. Revision History	21

SATA Flash Drive – 2.5”

FMS-SFD253E9xxxx-XAMx



SATA Flash Drive – 2.5”

FMS-SFD253E9xxxx-XAMx



1 Product Description

1.1 General Description

Fortasa's SFD253E 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 SFD Series is the best drop-in replacement for high-maintenance HDD where reliability is of a major importance.

The SFD253E drive offers capacities of up to 600GB, 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 SLC NAND-flash, this SSD can work in highly demanding environment and withstand wide range of operating temperature from -40°C to +85°C.**

SFD253E 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 SFD253E 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 SFD253E 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 is 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
512GB	512,110,190,592	16383 ¹	16	63	1,000,215,216
640GB	640,137,738,240	16383 ¹	16	63	1,250,269,020

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.

SATA Flash Drive – 2.5”

FMS-SFD253E9xxxx-XAMx



1.4 Performance Specification

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

Table 1-2: Performance specifications

Capacity	32GB	64GB	128GB	256GB	512GB	640GB
Performance						
Sustained read (MB/s)	260	400	470	470	470	470
Sustained write (MB/s)	230	320	470	470	470	470
Random Read IOPS (4K)	25,000	55,000	55,000	55,000	55,000	55,000
Random Write IOPS (4K)	45,000	60,000	60,000	60,000	60,000	60,000

Note: Performance varies from flash configurations or host system settings.

1. Test Environments: ASUS Z87-A Motherboard, 4GB DDR3 RAM, Windows 10 x64
2. Benchmarking program: ATTO (Transfer unit size-256KB)

1.5 Pin Assignments

Figure 1-2: Micro-SATA connectors

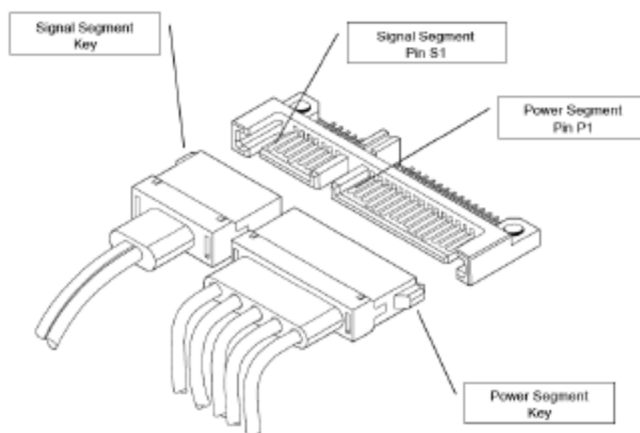


Table 1-3: Signal Segment

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**	Not Used / HW Erase Trigger Pin Input (optional)
P5	Ground
P6	Ground
P7	5V
P8	5V
P9	5V
P10	Ground
P11	Reserved DNU
P12	Ground
P13	Not Used (12V)
P14**	Reserved / HW Erase Output
P15	Not Used (12V)

** - Optional Pin Configuration for HW Erase Enabled SSD only

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 72 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 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.

3.6 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
D2h	Enable/Disable Attribute Autosave
D3h	Save Attribute Values
D4h	Execute Off-line Immediate
D5h	Read Log (optional)
D6h	Write Log (optional)
D8h	Enable Operations
D9h	Disable operations
DAh	Return Status
DBh	Enable/Disable Automatic Off Line

SMART attribute ID list

ID (Hex)	Attribute Name
01	Read Error Rate
09	Power-On Hours
0C	Power Cycle Count
0D	Soft Read Error Rate
AF	Program Failure Block Count
B0	Erase Failure Block Count
B8	Init Bad Block Count
B9	Running Bad Block Count
C0	Unexpected Power Shutdown Count
C2	Temperature
C7	Read Failure Block Count
C8	Write Command Total Count
C9	Read Command Total Count
CA	Total Written Sectors Requested by Host
CB	Total Sectors Written Count
CC	Total Read Sectors Requested by Host
D1	Ssd Life Left(Remaining Drive Life)
D2	Minimum Erase Count
D3	Maximum Erase Count
D4	Average Erase Count
D5	Maximum Program Erase Count
DD	BadBlock Full Flag

SATA Flash Drive – 2.5”

FMS-SFD253E9xxxx-XAMx



DF	Sata Error CRC Count
E0	SATA Error Handshake Count
E1	SATA Offline Count
E2	Load Limit Count
E3	Device Status
E4	Temperature History
E5	Temperature Sensor Initialization Failure
E6	Total Free Blocks count

4. Environmental Specifications

4.1 Environments

Environmental specification of the SATA Flash Drive series follows the MIL-STD-810G 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
Altitude		80,000 ft

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 2,000,000 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 SFD253E complies with the following standards:

- CE
- FCC
- RoHS
- MIL-STD-810G

4.4 Endurance

The endurance of a storage device is predicted by a JEDEC approved test methodology. The data, reported in TeraBytes Written (TBW), 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	TBW
32GB	900
64GB	1,800
128GB	3,600
256GB	7,200
512GB	14,400
640GB	18,000

Notes:

This estimation complies with JEDEC JESD-219A random client workload.

- Flash vendor guaranteed SLC NAND P/E cycle: 60K
- WAF may vary from capacity, flash configurations and writing behavior on each platform.
- 1 Terabyte = 1,024GB
- TBW (TeraBytes Written) is estimate of the maximum size of data (in TeraBytes) that could be written to the SSD during it's lifetime

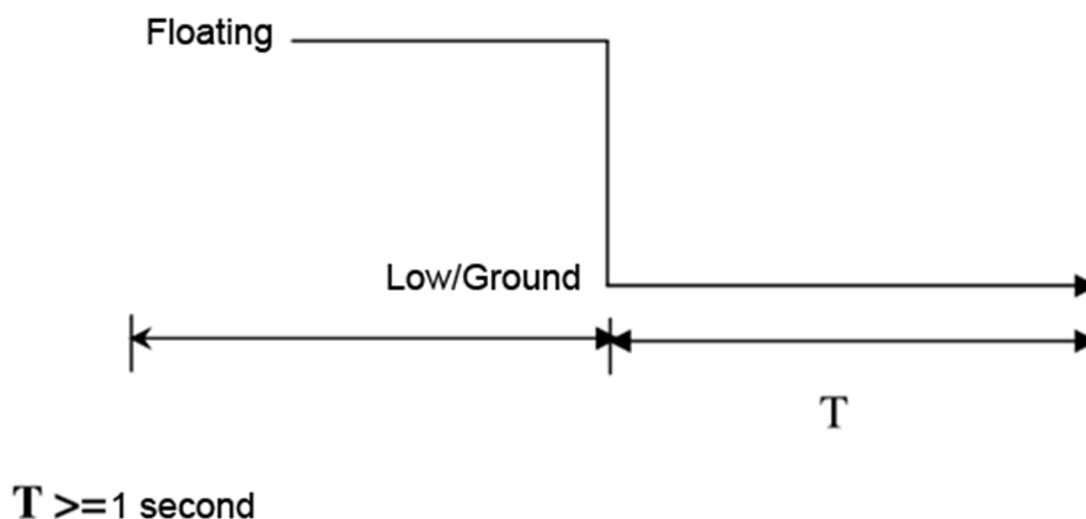
5. Special Features

5.1 Hardware Pin enabled Data Erase Function (Optional)

Fortasa Hardware Implementation for Data Erase Function is activated directly by the system without any system software processing overhead. Activation on hardware level is totally independent from host operating system. A hardware erase mechanism is implemented by utilizing a GPIO (General Purpose Input Output) pin that once pulled low triggers a full data erase function. When the Hardware Erase pin is floating the SSD operation is normal and data can be read from or written to the SSD. When the HW Erase pin is pulled to GND and held for more than 1 second the data erase algorithm will be initiated. See the timing diagram below.

GPIO Timing Table

Timing	Behavior
T	1 second or greater



SATA Flash Drive – 2.5” FMS-SFD253E9xxx-XAMx



For Fortasa SSDs with HW Data Erase enabled feature the following Erase Algorithm will transpire:

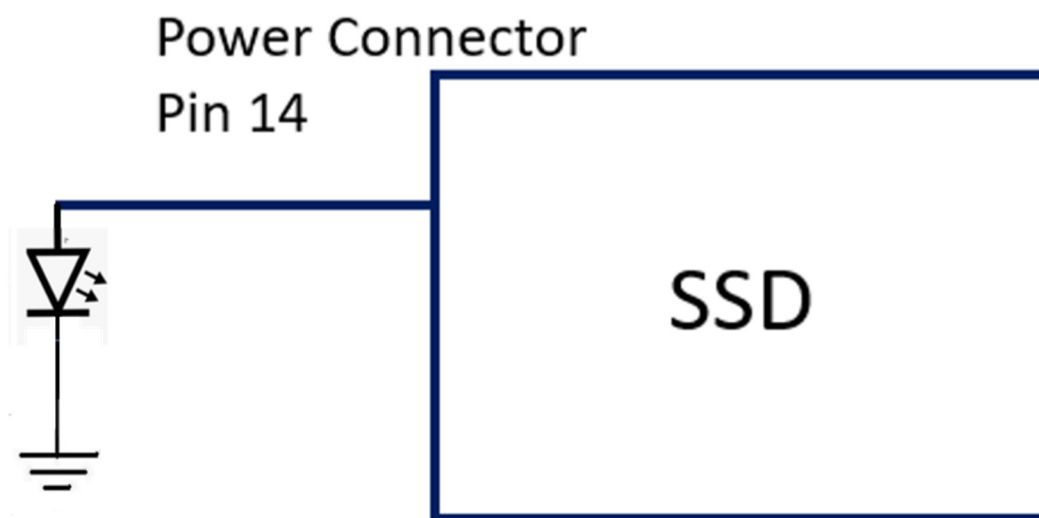
- 1) All User Data will be formatted to “FF”.
- 2) FAT File structure related data will be formatted to “FF”.
- 3) Any OS Format related data will be formatted to “FF”.

The following information stored on the SSD will remain intact and recoverable:

- 1) Bad Block Information
- 2) SMART command related Information
- 3) Low Level Format for drive recovery

The data erase rate is approximately 8GB/sec. Once the erase algorithm is completed, the system needs to be powered down. On the subsequent power up the SSD needs to be low level formatted to be used again. After the Data Erase feature has been triggered, the drive can still be re-formatted and reused. However, data stored pre-issuance of Date Erase will not be recoverable.

Pin 14 can be used to monitor the HW Erase operation. See the drawing below for proper LED connection to pin 14. The LED will remain on while the SSD erase operation is active.



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 $\pm$ 10% (4.5-5.5 V)
Industrial	-40°C to 85°C	5.0 V $\pm$ 10% (4.5-5.5 V)

6.2 Power Consumption

Table 6-2 lists the SFD253E power consumption.

Table 6-2 Typical power consumption

Capacity Performance	32GB	64GB	128GB	256GB	512GB	640B
Active Mode (W)	2	2	2	2	2	2
Idle Mode (mA)	0.3	0.3	0.3	0.3	0.3	0.3

Notes:

1. Measurement device: The General Ammeter
2. Benchmarking program: IOMeter 2008 (unit size=256KB, Outstanding I/O per target=32, Duration=1 hours)

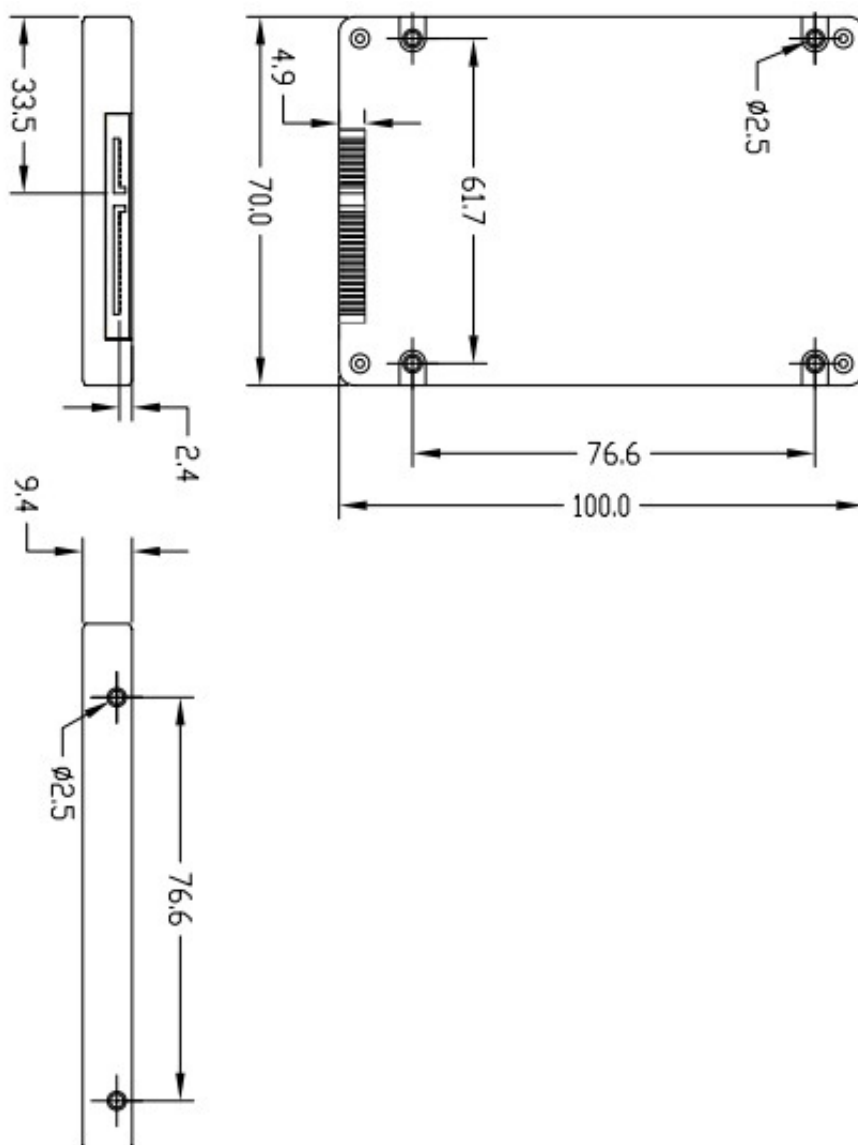
7. Physical Characteristics

7.1 9.4mm Thickness Enclosure

Figure 7-1 illustrates the overall dimensions of the SFD 253E drive packaged in a 9.4 mm Housing, as listed in Table 7-1.

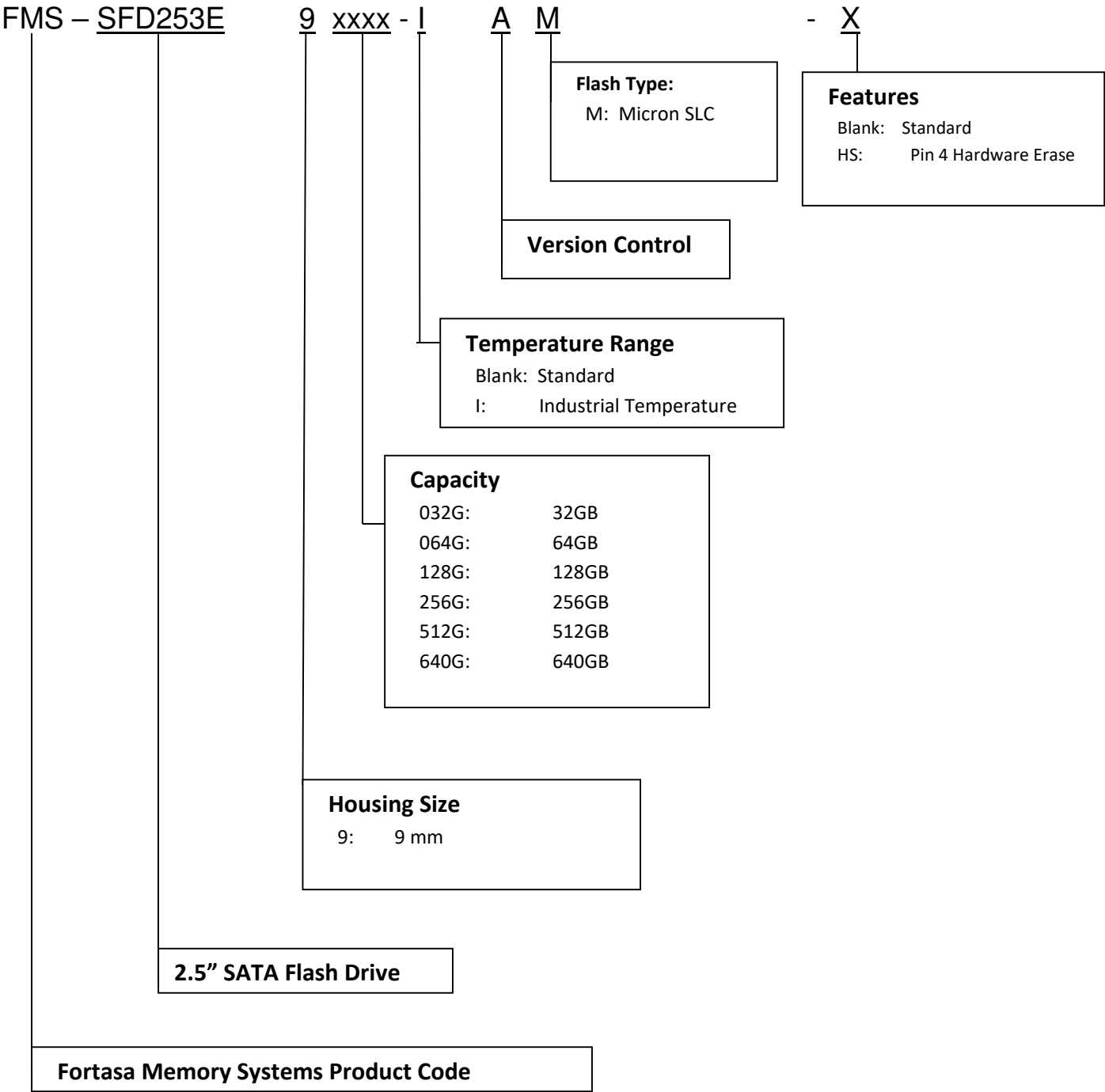
Table 7-1 SSD dimensions

Dimension	Millimeters (mm)
Height	9.4 ± 0.20
Width	70.0 ± 0.20
Length	100.0 ± 0.20



8. Product Ordering Information

8.1 Product Code Designations



SATA Flash Drive – 2.5”

FMS-SFD253E9xxx-XAMx



8.2 Valid Combinations

8.2.1 9mm Housing

Standard Configuration

Capacity	Standard Temperature Model Numbers	Industrial Temperature Model Numbers
32GB	FMS-SFD253E9032G-AM	FMS-SFD253E9032G-IAM
64GB	FMS-SFD253E9064G-AM	FMS-SFD253E9064G-IAM
128GB	FMS-SFD253E9128G-AM	FMS-SFD253E9128G-IAM
256GB	FMS-SFD253E9256G-AM	FMS-SFD253E9256G-IAM
512GB	FMS-SFD253E9512G-AM	FMS-SFD253E9512G-IAM
640GB	FMS-SFD253E9640G-AM	FMS-SFD253E9640G-IAM

Pin 4 - HW Data Erase Enabled

Capacity	Standard Temperature Model Numbers	Industrial Temperature Model Numbers
32GB	FMS-SFD253E9032G-AMHS	FMS-SFD253E9032G-IAMHS
64GB	FMS-SFD253E9064G-AMHS	FMS-SFD253E9064G-IAMHS
128GB	FMS-SFD253E9128G-AMHS	FMS-SFD253E9128G-IAMHS
256GB	FMS-SFD253E9256G-AMHS	FMS-SFD253E9256G-IAMHS
512GB	FMS-SFD253E9512G-AMHS	FMS-SFD253E9512G-IAMHS
640GB	FMS-SFD253E9640G-AMHS	FMS-SFD253E9640G-IAMHS

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	7/15/2021	Initial Release	
2.0	12/19/2023	Added Pin 4 based HW Erase	

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