RoHS Compliant

PCIe Flash Drive Series

Datasheet for PCI Express Based 2.5” SSD family

September 28, 2020

Revision 1.0

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

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

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Features:

- **PCIe Interface**
  - – Compliant with NVMe 1.3
  - – Compatible with PCIe Gen 3 x 4 interface
  - – PCI Express Base 3.1
- **Temperature ranges**
  - – Operation:
    - Standard Temperature: 0°C to 70°C
    - Industrial Temperature: -40°C to 85°C
  - – Storage: -40°C to 100°C
- **Capacity**
  - 960GB, 1920GB, 3240GB
- **NAND flash type: BiCS3 3D TLC**
- **Performance**
  - – Interface burst read/write: 4 GB/sec
  - – Sustained Performance
    - –Read: up to 3340 MB/sec
    - –Write: up to 1175MB/sec
    - –Random read 4K: up to 574,000 IOPS
    - –Random write 4K: up to 266,000 IOPS
- **Connector Type**
  - – 2.5” (SFF-8639)
- **Form factor**
  - – 2.5 inch (100.00 x 69.85 x 7.00, unit: mm)
  - – Net Weight: 71.5 ± 5% grams
- **Intelligent endurance design**
  - – Built-in hardware LDPC (Low Density Parity Check) ECC
  - – 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*
- **Thermal Sensor**
- **Endurance in Drive Writes Per Day (DWPD)**
  - – 960 GB: 1665 TBW
  - – 1920 GB: 3115 TBW
  - – 3240 GB: 6230 TBW
- **Security**
  - – AES 256-bit hardware encryption
- **Low power consumption (typical)**
  - – Supply voltage: 12V ± 5%V
  - – Active mode: 705 mA
  - – Idle mode: 180 mA

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1 Product Description

1.1 General Description

Fortasa’s PCI Express 2.5” SSD family is a high-performance, PCI Express interface, solid state drive (SSD) designed to offer a fastest throughput storage solution on a fast PC bus.

The PCIe 2.5” drive offers capacities of up to 4 terabyte, providing full compliance with the latest PCIe Gen3 x4 interface specifications. It can operate at sustained access rates of up to 2800 megabytes per second, which is much faster than other solid-state or traditional HDD drives currently available on the market. **Manufactured using Industrial Temperature rated BiCS3 3D TLC NAND-flash, this SSD can work in highly demanding environment and withstand standard range of operating temperature from -40°C to +85°C.**

PCIe 2.5” SSD products offer 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 PCIe 2.5” SSD also offers Self-Monitoring Analysis and Reporting Technology (S.M.A.R.T.) feature 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 PCIe 2.5” Flash Drive product are shown in Table 1-1. The table lists the specific capacity and useable number of sectors for each product capacity.

Table 1-1: Capacity specifications

Capacity	Total Bytes*	Total LBA**
960GB	960,197,124,096	1,875,385,008
1920GB	1,920,383,410,176	3,750,748,848
3840GB	3,840,755,982,336	7,501,476,528

*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 Flash Drive capacity or custom CHS requirement.

1.3 Performance Specification

Performances of the PCIe 2.5” Flash Drive are listed in Tables 1-2.

Table 1-2: Performance specifications

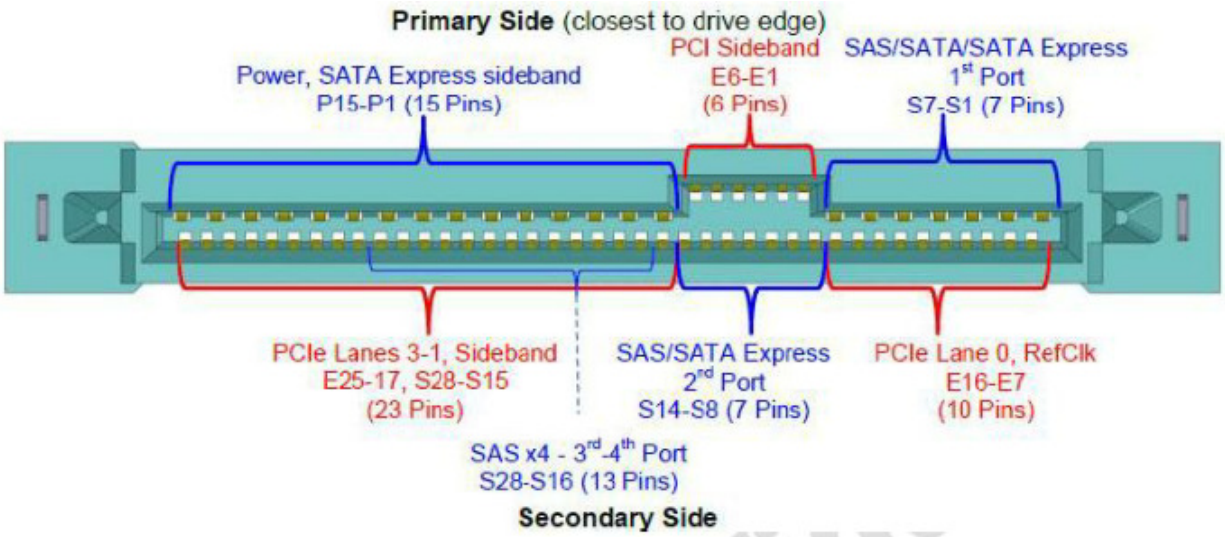
Performance \ Capacity	960GB	1920GB	3840GB
Sustained read (MB/s)	3340	3225	2920
Sustained write (MB/s)	1165	1175	1120
Random Read IOPS (4K)	396,000	574,000	455,000
Random Write IOPS (4K)	266,000	264,000	250,000

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 128.

1.4 Pin Assignments

Pin assignment of the PCIe 2.5” is shown in Figure 1-2 and described in Table 1-3.

Figure 1-2: PCIe 2.5” pin assignment



Pin Number	Name	Type	Description
P1	WAKE#	Input	Signal for Link reactivation
P2	-	-	Outside scope of this specification
P3	CLKREQ#	Bi-Dir	Clock request
P4	IfDet#	Input	Interface Type Detect
P5	Ground	Ground	Ground
P6	Ground	Ground	Ground
P7	-	-	Outside scope of this specification
P8	-	-	Outside scope of this specification
P9	-	-	Outside scope of this specification
P10	PRSNT#	Input	Presence detect
P11	Activity	Input	-
P12	Ground	Ground	Ground

Pin Number	Name	Type	Description
P13	+12V Precharge	Power	+12V Precharge power for SFF-8639 module
P14	+12V	Power	+12V power for SFF-8639 module
P15	+12V	Power	+12V power for SFF-8639 module
S1	Ground	Ground	Ground
S2	-	-	Outside scope of this specification
S3	-	-	Outside scope of this specification
S4	Ground	Ground	Ground
S5	-	-	Outside scope of this specification
S6	-	-	Outside scope of this specification
S7	Ground	Ground	Ground
S8	Ground	Ground	Ground
S9	-	-	Outside scope of this specification
S10	-	-	Outside scope of this specification
S11	Ground	Ground	Ground
S12	-	-	Outside scope of this specification
S13	-	-	Outside scope of this specification
S14	Ground	Ground	Ground
S15	Reserved	-	Reserved
S16	Ground	Ground	Ground
S17	PETp1	Diff-Pair	Transmitter differential pair, Lane 1
S18	PETn1	Diff-Pair	Transmitter differential pair, Lane 1
S19	Ground	Ground	Ground
S20	PERn1	Diff-Pair	Receiver differential pair, Lane 1

Pin Number	Name	Type	Description
S21	PERp1	Diff-Pair	Receiver differential pair, Lane 1
S22	Ground	Ground	Ground
S23	PETp2	Diff-Pair	Transmitter differential pair, Lane 2
S24	PETn2	Diff-Pair	Transmitter differential pair, Lane 2
S25	Ground	Ground	Ground
S26	PERn2	Diff-Pair	Receiver differential pair, Lane 2
S27	PERp2	Diff-Pair	Receiver differential pair, Lane 2
S28	Ground	Ground	Ground
E1	REFCLKB+	Diff-Pair	Reference clock (differential pair) for second X2 port
E2	REFCLKB-	Diff-Pair	Reference clock (differential pair) for second X2 port
E3	+3.3 Vaux	Power	3.3 V auxiliary power
E4	PERSTB#	Output	Fundamental reset for second X2 port
E5	PERST#	Output	Fundamental reset (if dual-port enabled, first X2 port)
E6	Reserved	-	Reserved
E7	REFCLK+	Diff-Pair	Reference clock (if dual-port enabled, first X2 port)
E8	REFCLK-	Diff-Pair	Reference clock (if dual-port enabled, first X2 port)
E9	Ground	Ground	Ground
E10	PETp0	Diff-Pair	Transmitter differential pair, Lane 0
E11	PETn0	Diff-Pair	Transmitter differential pair, Lane 0
E12	Ground	Ground	Ground
E13	PERn0	Diff-Pair	Receiver differential pair, Lane 0

Pin Number	Name	Type	Description
E14	PERp0	Diff-Pair	Receiver differential pair, Lane 0
E15	Ground	Ground	Ground
E16	Reserved	-	Reserved
E17	PETp3	Diff-Pair	Transmitter differential pair, Lane 3
E18	PETn3	Diff-Pair	Transmitter differential pair, Lane 3
E19	Ground	Ground	Ground
E20	PERn3	Diff-Pair	Receiver differential pair, Lane 3
E21	PERp3	Diff-Pair	Receiver differential pair, Lane 3
E22	Ground	Ground	Ground
E23	SMCLK	Bi-Dir	SMBus (System Management Bus) clock
E24	SMDAT	Bi-Dir	SMBus (System Management Bus) data
E25			

Table 1-3: Pin Assignment Description

2. Software Interface

2.1 Command Set

Table 2-1 summarizes the PCIe 2.5” command set.

Table 2-1 Admin Commands

Opcode	Command Description
00h	Delete I/O Submission Queue
01h	Create I/O Submission Queue
02h	Get Log Page
04h	Delete I/O Completion Queue
05h	Create I/O Completion Queue
06h	Identify
08h	Abort
09h	Set Features
0Ah	Get Features
0Ch	Asynchronous Event Request
10h	Firmware Activate
11h	Firmware Image Download
14h	Device Self Test

Table 2-2 Admin Commands – NVM Command Set Specific

Opcode	Command Description
80h	Format NVM
81h	Security Send
82h	Security Receive

Table 2-3 NVM Commands

Opcode	Command Description
00h	Flush
01h	Write
02h	Read
05h	Compare
08h	Write Zeroes
09h	Dataset Management

3. Flash Management

3.1 Error Correction/Detection

The PCIe 2.5” implements a hardware LDPC (Low Density Parity Check) ECC algorithm.

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 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 PCIe 2.5” Flash Drive products offer advanced data wear leveling which distributes Flash writes evenly across the 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 Flash Drive due to system power glitches.

3.4 ATA Secure Erase

Accomplished by the Secure Erase (SE) command, which is part of the 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. Execution of this command amounts to electronic data shredding and causes the SSD to internally completely erase all possible user data. Aside from user data, all data erase counters and other internal controller information stored on the Flash media will be also permanently deleted. 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.

SMART Attributes (Log Identifier 02h)

Bytes Index	Bytes	Description
[0]	1	Critical Warning
[2:1]	2	Composite Temperature
[3]	1	Available Spare
[4]	1	Available Spare Threshold
[5]	1	Percentage Used
[31:6]	26	Reserved
[47:32]	16	Data Units Read
[63:48]	16	Data Units Written
[79:64]	16	Host Read Commands
[95:80]	16	Host Write Commands
[111:96]	16	Controller Busy Time
[127:112]	16	Power Cycles
[143:128]	16	Power On Hours
[159:144]	16	Unsafe Shutdowns
[175:160]	16	Media and Data Integrity Errors
[191:176]	16	Number of Error Information Log Entries
[195:192]	4	Warning Composite Temperature Time
[199:196]	4	Critical Composite Temperature Time
[201:200]	2	Temperature Sensor 1 (Current Temperature)
[203:202]	2	Temperature Sensor 2 (N/A)
[205:204]	2	Temperature Sensor 3 (N/A)
[207:206]	2	Temperature Sensor 4 (N/A)
[209:208]	2	Temperature Sensor 5 (N/A)
[211:210]	2	Temperature Sensor 6 (N/A)
[213:212]	2	Temperature Sensor 7 (N/A)
[215:214]	2	Temperature Sensor 8 (N/A)
[511:216]	296	Reserved

SMART Attributes (Log Identifier C0h)

Bytes Index	Bytes	Description
[0-255]	256	Reserved
[256-257]	2	SSD Protect Mode
[258-261]	4	ECC Fail Count
[262-273]	12	Reserved
[274-277]	4	Total Later Black Count
[278-281]	4	Maximum Erase Count
[282-285]	4	Average Erase Count
[286-289]	4	Program Fail Count
[290-293]	4	Erase Fail Count
[294-301]	8	Flash Write Sector
[302-511]	210	Reserved

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 Thermal Sensor

The PCIe 2.5” SSD contains a Thermal Sensor that measures module temperature. The drive temperature can be obtained by polling SMART Command attribute ID 200h. When the device temperature reaches a pre-set temperature threshold, the drive 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 PCIe 2.5” 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		Frequency/Displacement - 20Hz~80Hz/1.52mm Frequency/Acceleration - 80Hz~2000Hz/20G
Shock		Operating / Non-operating: 1500 G, 0.5 ms
Humidity		RH 90% under 40°C

4.2 Mean Time Between Failures (MTBF)

Mean Time Between Failures (MTBF) is predicted based on reliability data for the individual components in the The PCIe 2.5” drive. Based on provided component data, PCIe 2.5” 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 PCIe 2.5” complies with the following standards:

- CE - EN55022
- FCC - CISPR22
- 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 (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 Fortasa Sales to learn more about the DWPD analysis and calculations.

Capacity	Drive Writes Per Day
960GB	2.3
1920GB	2.3
3840GB	3.3

Note:

- This estimation complies with JEDEC 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	5V
Standard	0°C to +70°C	12V ±5%
Industrial	-40°C to +85°C	

5.2 Power Consumption

Tables 5-2 lists the PCIe 2.5” power consumption.

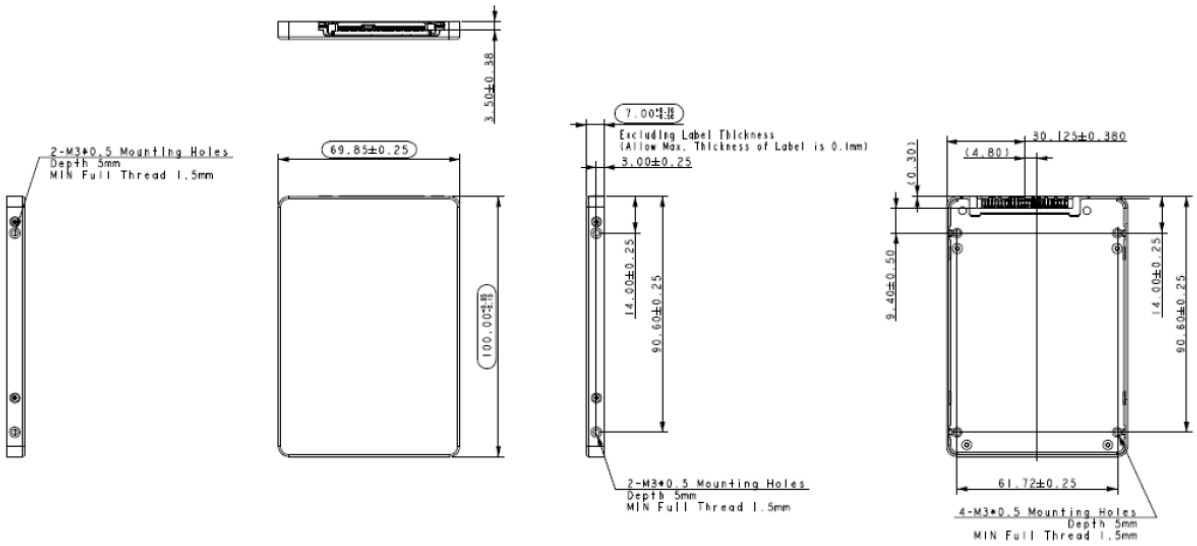
Table 5-2 PCIe 2.5” power consumption (typical)

Capacity / Performance	960GB	1920GB	3840GB
Active Mode (mW)	535	680	705
Idle Mode (mW)	175	175	180

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 Dimensions



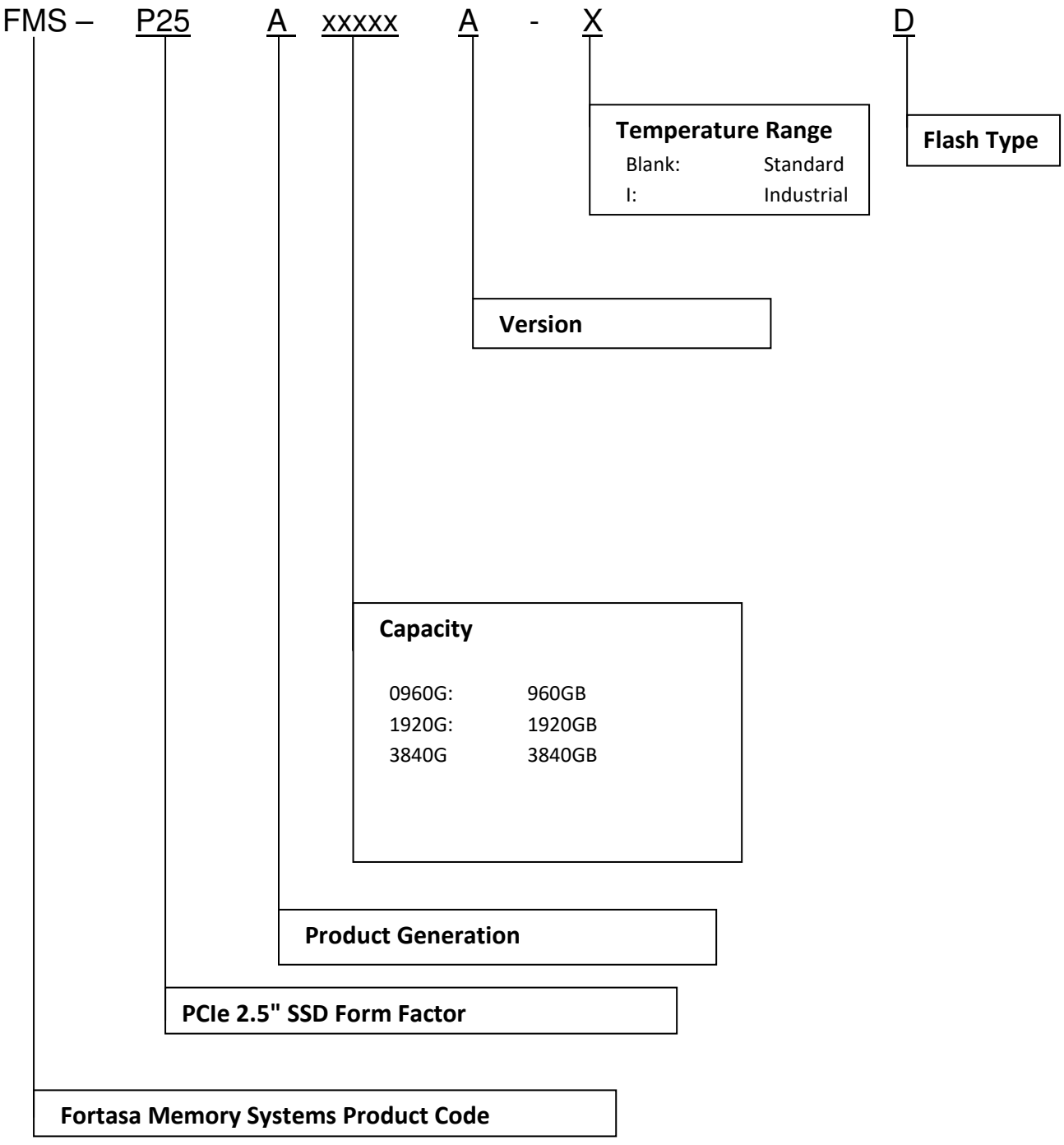
6.2 Net Weight

Table 6-1: Net Weight

Capacity	Net Weight (g ±5%)
960GB	61.3
1,920GB	70.1
3,840GB	71.5

7. Product Ordering Information

7.1 Product Code Designations



7.2 Valid Combinations

Capacity	Standard Temperature	Industrial Temperature
960GB	FMS-P25A0960GA-TD	FMS-P25A0960GA-ITD
1920GB	FMS-P25A1920GA-TD	FMS-P25A1920GA-ITD
3840GB	FMS-P25A3840GA-TD	FMS-P25A3840GA-ITD

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	9/28/2020	Initial Release	