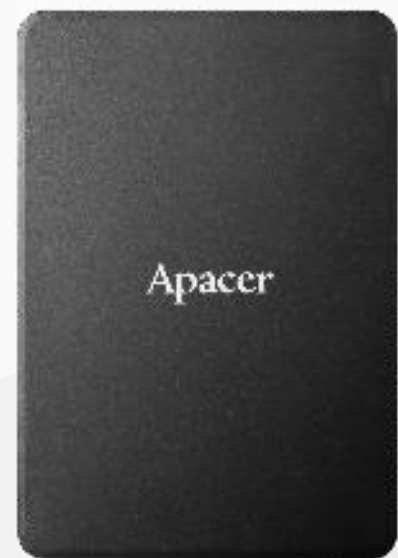


RoHS Compliant
Serial ATA Flash Drive
SM230-25 Product Specifications



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Version 1.3



Apacer Technology Inc.

1F, No.32, Zhongcheng Rd., Tucheng Dist., New Taipei City, Taiwan, R.O.C

Tel: +886-2-2267-8000 Fax: +886-2-2267-2261

www.apacer.com

Features:

- **Compliance with SATA Revision 3.1**
 - SATA 6.0 Gbps interface
 - Backward compatible with SATA 1.5 and 3.0 Gbps interfaces
 - ATA-8 command set
- **Capacity**
 - 32, 64, 128, 256, 512 GB
 - 1 TB
- **Performance***
 - Burst read/write: 600 MB/sec

Standard:

 - Sequential read: Up to 440 MB/sec
 - Sequential write: Up to 495 MB/sec
 - Seq. read QD32: Up to 530 MB/sec
 - Seq. write QD32: Up to 520 MB/sec
 - Random read (4K): Up to 41,000 IOPS
 - Random write (4K): Up to 65,000 IOPS

AES & Opal Implemented:

 - Sequential read: Up to 475 MB/sec
 - Sequential write: Up to 485 MB/sec
 - Seq. read QD32: Up to 560 MB/sec
 - Seq. write QD32: Up to 510 MB/sec
 - Random read (4K): Up to 35,000 IOPS
 - Random write (4K): Up to 59,000 IOPS

AES Implemented:

 - Sequential read: Up to 435 MB/sec
 - Sequential write: Up to 490 MB/sec
 - Seq. read QD32: Up to 560 MB/sec
 - Seq. write QD32: Up to 510 MB/sec
 - Random read (4K): Up to 41,000 IOPS
 - Random write (4K): Up to 60,000 IOPS
- **Flash Management**
 - Built-in hardware ECC
 - Global Wear Leveling
 - Flash bad-block management
 - S.M.A.R.T.
 - Power Failure Management
 - ATA Secure Erase
 - TRIM
- **Temperature Range**
 - Operating:
 - Standard: 0°C to 70°C
 - Extended: -40°C to 85°C
 - Storage: -40°C to 100°C
- **Supply Voltage**
 - 5.0 V ± 5%
- **Power Consumption***
 - Active mode: 590 mA
 - Idle mode: 100 mA
- **Connector Type**
 - 7-pin SATA signal connector
 - 15-pin SATA power connector
- **Form Factor**
 - 2.5"
 - Dimensions: 100.00 x 69.85 x 6.90, unit: mm
- **Shock & Vibration****
 - Shock: 1,500 G
 - Vibration: 15 G
- **NAND Flash Type: MLC**
- **MTBF: >1,200,000 hours**
- **Security Function (optional)**
 - Trusted Computing Group (TCG) Opal 2.0
 - AES 256-bit hardware encryption
- **Endurance (in Terabytes Written: TBW)**
 - 32 GB: **TBD** TBW
 - 64 GB: **TBD** TBW
 - 128 GB: **TBD** TBW
 - 256 GB: **TBD** TBW
 - 512 GB: 1,054 TBW
 - 1 TB: 2,075 TBW
- **SATA Power Management Modes**
- **Device Sleep Mode**
- **Thermal Sensor**
- **RoHS Compliant**

*Varies from capacities. The values for performances and power consumptions presented are typical and may vary depending on flash configurations or platform settings. The term idle refers to the standby state of the device.

**Non-operating

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1. Product Description

1.1 Introduction

Apacer's SM230-25 is a well-balanced solid-state disk (SSD) drive with standard form factor and great performance. Designed in SATA 6.0 Gbps interface, the SSD is able to deliver exceptional read/write speed, making it the ideal companion for heavy-loading industrial or server operations.

In regard of reliability, the drive comes with various implementations including powerful hardware ECC engine, power saving modes, wear leveling, flash block management, S.M.A.R.T., TRIM, and power failure management.

1.2 Capacity

Capacity specifications of SM230-25 are available as shown in Table 1-1. It lists the specific capacity and the default numbers of heads, sectors and cylinders for each product line.

Table 1-1 Capacity Specifications

Capacity	Total bytes*	Cylinders	Heads	Sectors	Max LBA
32 GB	32,017,047,552	16,383	16	63	62,533,296
64 GB	64,023,257,088	16,383	16	63	125,045,424
128 GB	128,035,676,160	16,383	16	63	250,069,680
256 GB	256,060,514,304	16,383	16	63	500,118,192
512 GB	512,110,190,592	16,383	16	63	1,000,215,216
1 TB	1,024,209,543,168	16,383	16	63	2,000,409,264

*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.

1.3 Performance

Performance of SM230-25 is listed below in Table 1-2, 1-3 and 1-4.

Table 1-2 Performance Specifications (Standard)

Capacity	512 GB	1 TB
Performance		
Sequential Read* (MB/s)	440	435
Sequential Write* (MB/s)	495	495
Seq. Read QD32* (MB/s)	530	510
Seq. Write QD32* (MB/s)	520	520
Random Read IOPS** (4K)	41,000	41,000
Random Write IOPS** (4K)	65,000	63,000

Table 1-3 Performance Specifications (AES and Opal implemented)

Capacity	32 GB	64 GB	128 GB	256 GB	512 GB
Performance					
Sequential Read* (MB/s)	475	470	450	450	425
Sequential Write* (MB/s)	150	260	475	475	485
Seq. Read QD32* (MB/s)	560	560	560	560	560
Seq. Write QD32* (MB/s)	270	460	500	500	510
Random Read IOPS** (4K)	23,000	33,000	34,000	35,000	34,000
Random Write IOPS** (4K)	15,000	29,000	53,000	54,000	59,000

Table 1-4 Performance Specifications (AES implemented)

Capacity	1 TB
Performance	
Sequential Read* (MB/s)	435
Sequential Write* (MB/s)	490
Seq. Read QD32* (MB/s)	560
Seq. Write QD32* (MB/s)	510
Random Read IOPS** (4K)	41,000
Random Write IOPS** (4K)	60,000

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.

1.4 Pin Assignments

Table 1-5 describes the SFD signal segment, and Table 1-6, power segment.

Figure 1-1 SATA Connectors

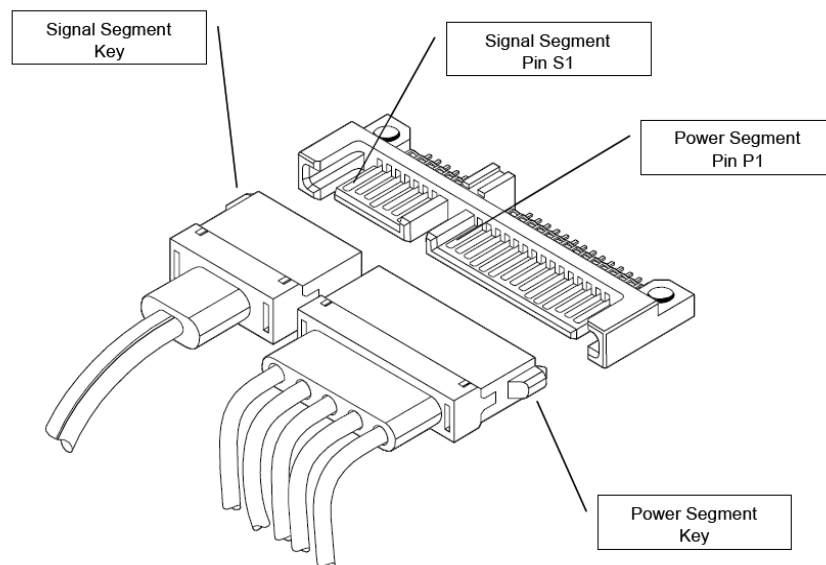


Table 1-5 Signal Segment

Pin	Type	Description
S1	GND	
S2	RxP	+ Differential Receive Signal
S3	RxN	- Differential Receive Signal
S4	GND	
S5	TxN	- Differential Transmit Signal
S6	TxP	+ Differential Transmit Signal
S7	GND	

Table 1-6 Power Segment

Pin	Signal/Description
P1	Unused (3.3V)
P2	Unused (3.3V)
P3	Device Sleep
P4	Ground
P5	Ground
P6	Ground
P7	5V
P8	5V
P9	5V
P10	Ground
P11	DAS
P12	Ground
P13	Unused (12V)
P14	Unused (12V)
P15	Unused (12V)



Figure 1-2 SATA Cable/Connector Connection Diagram

The connector on the left represents the Host with TX/RX differential pairs connected to a cable. The connector on the right shows the Device with TX/RX differential pairs also connected to the cable. Notice also the ground path connecting the shielding of the cable to the Cable Receptacle.

2. Software Interface

2.1 Command Set

Table 2-1 summarizes the ATA commands supported by SM230-25.

Table 2-1 Command Set

Code	Command	Code	Command
E5h	Check Power Mode	F6h	Security Disable Password
90h	Execute Diagnostics	F3h	Security Erase Prepare
E7h	Flush Cache	F4h	Security Erase Unit
ECh	Identify Device	F5h	Security Freeze Lock
E3h	Idle	F1h	Security Set Password
E1h	Idle Immediate	F2h	Security Unlock
91h	Initialize Device Parameters	7Xh	Seek
C8h	Read DMA	EFh	Set Features
25h	Read DMA EXT	C6h	Set Multiple Mode
60h	Read FPDMA Queued	E6h	Sleep
47h	Read Log DMA EXT	B0h	S.M.A.R.T.
2Fh	Read Log EXT	E2h	Standby
C4h	Read Multiple	E0h	Standby Immediate
20 or 21h	Read Sector(s)	CAh	Write DMA
40 or 41h	Read Verify Sector(s)	35h	Write DMA EXT
10h	Recalibrate	61h	Write FPDMA Queued
57h	Write Log DMA EXT	3Fh	Write Log EXT
C5h	Write Multiple	30h or 31h	Write Sector(s)

2.2 S.M.A.R.T.

S.M.A.R.T. is an abbreviation for Self-Monitoring, Analysis and Reporting Technology, a self-monitoring system that provides indicators of drive health as well as potential disk problems. It serves as a warning for users from unscheduled downtime by monitoring and displaying critical drive information. Ideally, this should allow taking proactive actions to prevent drive failure and make use of S.M.A.R.T. information for future product development reference.

Apacer devices use the standard SMART command B0h to read data out from the drive to activate our S.M.A.R.T. feature that complies with the ATA/ATAPI specifications. S.M.A.R.T. Attribute IDs shall include initial bad block count, total later bad block count, maximum erase count, average erase count, power on hours and power cycle. When the S.M.A.R.T. Utility running on the host, it analyzes and reports the disk status to the host before the device reaches in critical condition.

Note: Attribute IDs may vary from product models due to various solution design and supporting capabilities.

Apacer memory products come with S.M.A.R.T. commands and subcommands for users to obtain information of drive status and to predict potential drive failures. Users can take advantage of the following commands/subcommands to monitor the health of the drive.

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		Attribute Name
5	5	Re-Assigned Sector Count
9	9	Power-On Hours
12	C	Power Cycle Count
175	AF	Program Fail Count
		(Worst case component)
176	B0	Erase Fail Count
		(Worst case component)
177	B1	Wear Leveling Count
178	B2	Used Reserved Block Count (Worst case component)
179	B3	Used Reserved Block Count (SSD total)
180	B4	Unused Reserved Block Count
		(SSD total)
181	B5	Program Fail Count
		(SSD total)
182	B6	Erase Fail Count
		(SSD total)
187	B8	Uncorrectable Error Count
194	C2	Temperature
195	C3	ECC Rate

ID		Attribute Name
199	C7	CRC Error Count
238	Ee	Percentage P.E. Cycle Remaining
239	Ef	Normalized Wear Cycle
241	F1	Total LBA Written
242	F2	Total LBA Read

3. Flash Management

3.1 Error Correction/Detection

SM230-25 implements a hardware ECC scheme, based on the BCH algorithm. It can detect and correct up to 72 bits error in 1K bytes.

3.2 Bad Block Management

Current production technology is unable to guarantee total reliability of NAND flash memory array. When a flash memory device leaves factory, it comes with a minimal number of initial bad blocks during production or out-of-factory as there is no currently known technology that produce flash chips free of bad blocks. In addition, bad blocks may develop during program/erase cycles. When host performs program/erase command on a block, bad block may appear in Status Register. Since bad blocks are inevitable, the solution is to keep them in control. Apacer flash devices are programmed with ECC, block mapping technique and S.M.A.R.T to reduce invalidity or error. Once bad blocks are detected, data in those blocks will be transferred to free blocks and error will be corrected by designated algorithms.

3.3 Global Wear Leveling

Flash memory devices differ from Hard Disk Drives (HDDs) in terms of how blocks are utilized. For HDDs, when a change is made to stored data, like erase or update, the controller mechanism on HDDs will perform overwrites on blocks. Unlike HDDs, flash blocks cannot be overwritten and each P/E cycle wears down the lifespan of blocks gradually. Repeatedly program/erase cycles performed on the same memory cells will eventually cause some blocks to age faster than others. This would bring flash storages to their end of service term sooner. Global wear leveling is an important mechanism that levels out the wearing of all blocks so that the wearing-down of all blocks can be almost evenly distributed. This will increase the lifespan of SSDs.

3.4 ATA Secure Erase

ATA Secure Erase is an ATA disk purging command currently embedded in most of the storage drives. Defined in ATA specifications, (ATA) Secure Erase is part of Security Feature Set that allows storage drives to erase all user data areas. The erase process usually runs on the firmware level as most of the ATA-based storage media currently in the market are built-in with this command. ATA Secure Erase can securely wipe out the user data in the drive and protects it from malicious attack.

3.5 Power Failure Management

Power Failure Management plays a crucial role when experiencing unstable power supply. Power disruption may occur when users are storing data into the SSD. In this urgent situation, the controller would run multiple write-to-flash cycles to store the metadata for later block rebuilding. This urgent operation requires about several milliseconds to get it done. At the next power up, the firmware will perform a status tracking to retrieve the mapping table and resume previously programmed NAND blocks to check if there is any incompleteness of transmission.

3.6 TRIM

TRIM is a SATA command that helps improve the read/write performance and efficiency of solid-state drives (SSD). The command enables the host operating system to inform SSD controller which blocks contain invalid data, mostly because of the erase commands from host. The invalid will be discarded permanently and the SSD will retain more space for itself.

3.7 SATA Power Management

By complying with SATA 6.0 Gb/s specifications, the SSD 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.
- Device Sleep (DevSleep or DEVSLP): PHY powered down; power consumption \leq 5 mW; host assertion time \leq 10 ms; exit timeout from this state \leq 20 ms (unless specified otherwise in SATA Identify Device Log).

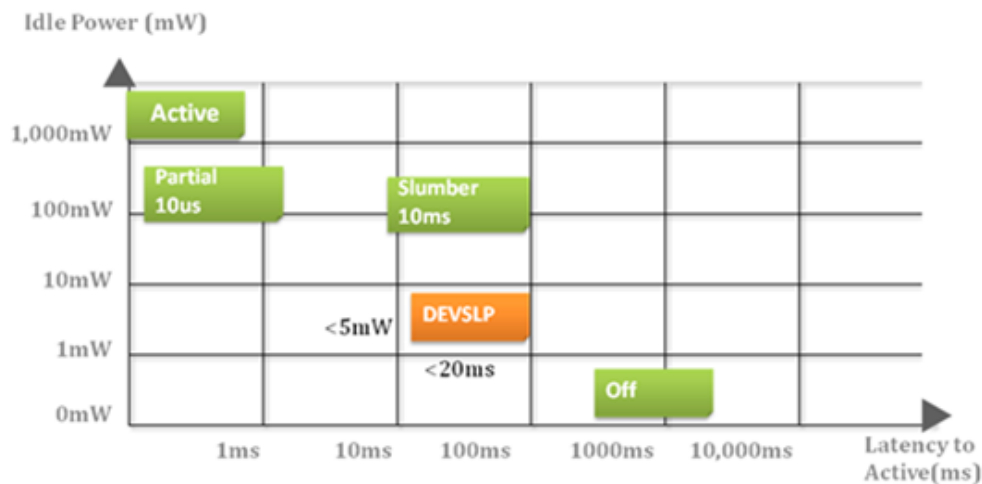
Note: The behaviors of power management features would depend on host/device settings.

3.8 Thermal Sensor

Apacer Thermal Sensor is a digital temperature sensor with serial interface. By using designated pins for transmission, storage device owners are able to read temperature data.

3.9 DEVSLP (DevSleep or DEVSLP) Mode

Device Sleep is a feature that allows SATA devices to enter a low power mode by designating pin 44 as DEVSLP signal with an aim to reducing power consumption.



3.10 Advanced Encryption Standard (optional)

Advanced Encryption Standard (AES) is a specification for the encryption of electronic data. AES has been adopted by the U.S. government since 2001 to protect classified information and is now widely implemented in embedded computing applications. The AES algorithm used in software and hardware is symmetric so that encrypting/decrypting requires the same encryption key. Without the key, the encrypted data is inaccessible to ensure information security.

Notably in flash memory applications, AES 256-bit hardware encryption is the mainstream to protect sensitive or confidential data. The hardware encryption provides better performance, reliability, and security than software encryption. It uses a dedicated processor, which is built inside the controller, to process the encryption and decryption. This enormously shortens the processing time and makes it efficient.

3.11 TCG Opal (optional)

Developed by the Trusted Computing Group (TCG), an organization whose members work together to formulate industry standards, Opal is a set of security specifications used for applying hardware-based encryption to storage devices.

Hardware encryption has many advantages. First of all, it transfers the computational load of the encryption process to dedicated processors, reducing the stress on the host system's CPU. In addition, storage devices complying with Opal specifications are self-encryption devices. Opal specifications also feature boot authentication. When the drive is being accessed, the shadow MBR will request the drive password at boot. The drive will only unlock and decrypt if the correct password is supplied. The other feature is LBA-specific permissions. Users are assigned different permissions for LBA ranges created by the device administrator. Each LBA range is password-protected and can only be accessed by users with the correct key to perform permitted actions (read/write/erase).

4. Reliability Specifications

4.1 Environmental Specifications

Environmental specifications of SM230-25 product are shown in Table 4-1.

Table 4-1 Environmental Specifications

Environment	Specifications
Temperature	0°C to 70°C (Standard); -40°C to 85°C (Extended)
	-40°C to 100°C (Non-operating)
Vibration	Non-operating: Sine wave, 15(G), 10~2000(Hz), Operating: Random, 7.69(GRMS), 20~2000(Hz)
Shock	Non-operating: Acceleration, 1,500 G, 0.5 ms Operating: 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 SM230-25. The prediction result for SM230-25 is more than 1,200,000 hours.

Note: The MTBF is predicated and calculated based on “Telcordia Technologies Special Report, SR-332, Issue 2” method.

4.3 Certification and Compliance

SM230-25 complies with the following standards:

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

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.

Table 4-2 Endurance Specifications

Capacity	TeraBytes Written
32 GB	TBD
64 GB	TBD
128 GB	TBD
256 GB	TBD
512 GB	1,054
1 TB	2,075

Note:

- 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) = 1,000 GB.
- The estimated values are based on JEDEC Enterprise endurance workload comprised of random data with the payload size distribution with sequential write behavior.

5. Electrical Specifications

5.1 Operating Voltage

Table 5-1 lists the supply voltage for SM230-25.

Table 5-1 Operating Range

Item	Range
Supply Voltage	5V \pm 5% (4.75-5.25V)

5.2 Power Consumption

Table 5-2 lists the power consumption for SM230-25.

Table 5-2 Power Consumption

Mode \ Capacity	Capacity					
	32 GB	64 GB	128 GB	256 GB	512 GB	1 TB
Active (mA)	365	380	545	590	470	490
Idle (mA)	100	95	95	95	95	80

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

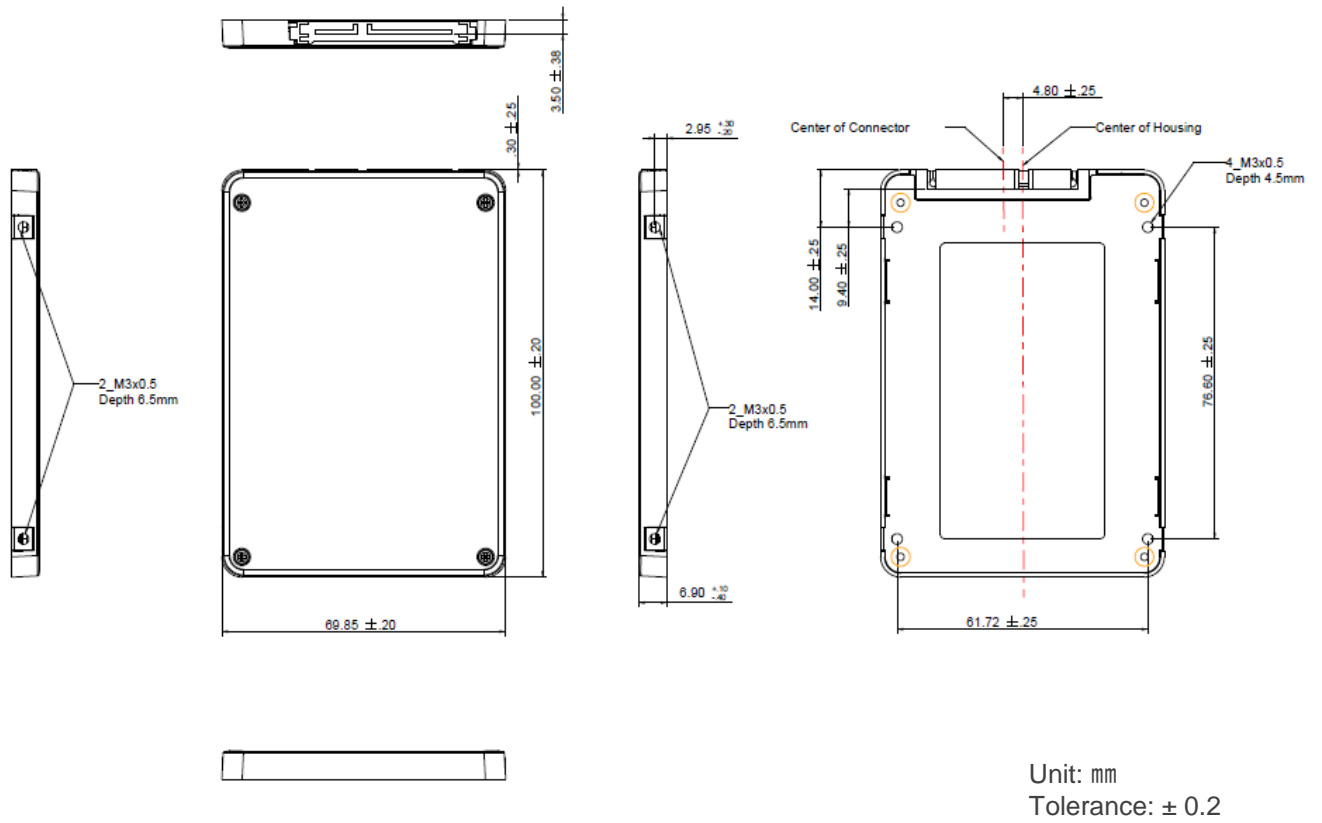
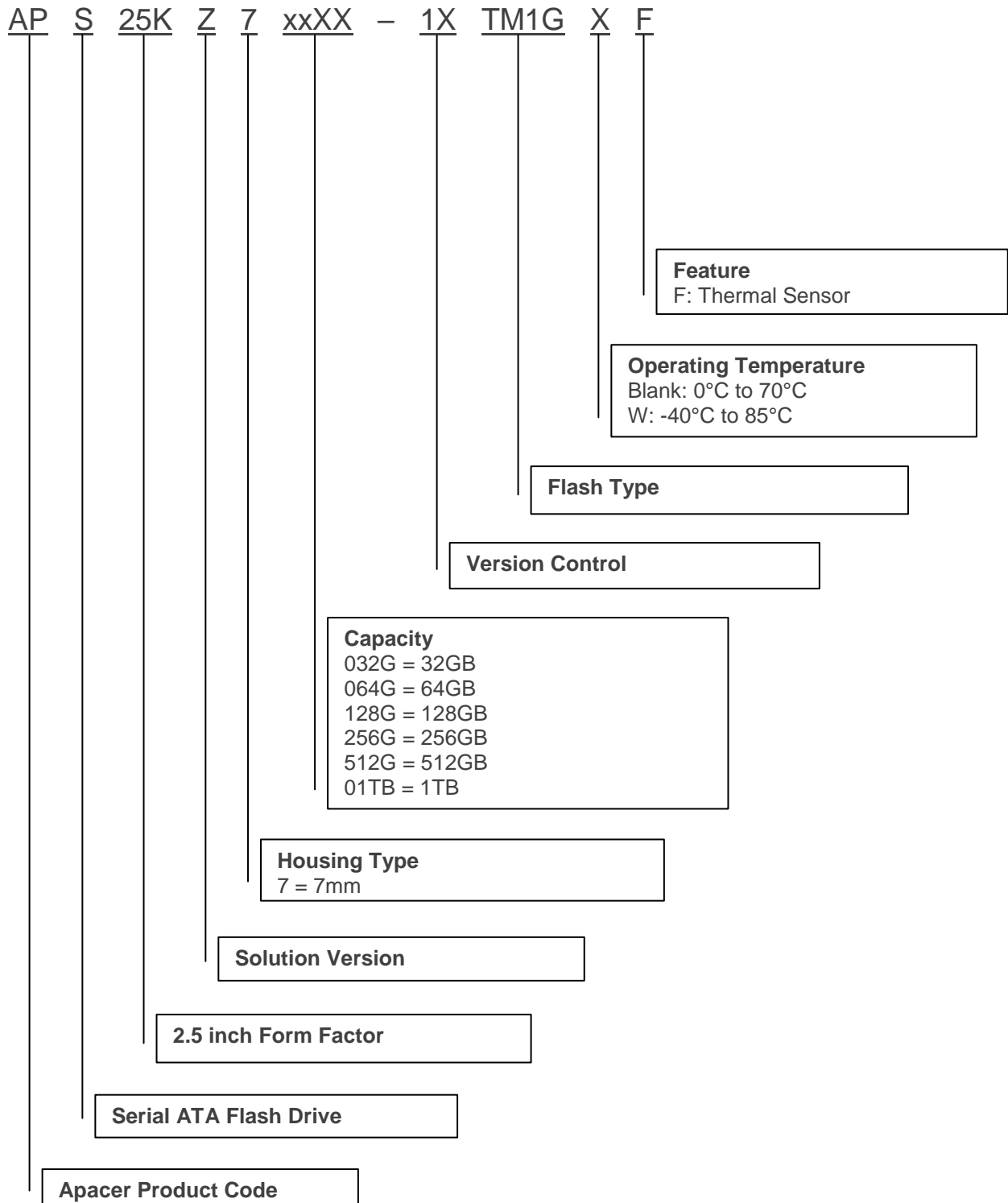


Figure 6-1 Physical Dimensions

7. Product Ordering Information

7.1 Product Code Designations



7.2 Valid Combinations

7.2.1 Standard

Capacity	Standard Temperature	Extended Temperature
512GB	APS25KZ7512G-1BTM1GF	APS25KZ7512G-1BTM1GWF
1TB	APS25KZ701TB-1BTM1GF	APS25KZ701TB-1BTM1GWF

7.2.2 AES/Opal Function

Capacity	Standard Temperature	Extended Temperature
32GB	APS25KZ7032G-1HTM1GF	APS25KZ7032G-1HTM1GWF
64GB	APS25KZ7064G-1HTM1GF	APS25KZ7064G-1HTM1GWF
128GB	APS25KZ7128G-1HTM1GF	APS25KZ7128G-1HTM1GWF
256GB	APS25KZ7256G-1HTM1GF	APS25KZ7256G-1HTM1GWF
512GB	APS25KZ7512G-1HTM1GF	APS25KZ7512G-1HTM1GWF

7.2.3 AES Function

Capacity	Standard Temperature	Extended Temperature
1TB	APS25KZ701TB-1VTM1GF	APS25KZ701TB-1VTM1GWF

Note: Valid combinations are those products in mass production or will be in mass production. Consult your Apacer sales representative to confirm availability of valid combinations and to determine availability of new combinations.

Revision History

Revision	Description	Date
1.0	Official release	8/18/2017
1.1	<ul style="list-style-type: none">- Removed DRAM cache support from Features page- Removed the note about DRAM cache from 3.5 Power Failure Management	2/22/2018
1.2	<ul style="list-style-type: none">- Added 32-256GB support- Added Security Function to Features page- Added Table 1-3 and 1-4 to 1.3 Performance- Added 3.10 Advanced Encryption Standard- Added 3.11 TCG Opal- Updated 7. Product Ordering Information	3/7/2018
1.3	Added “optional” to Security Function on Features page, 3.10 Advanced Encryption Standard and 3.11 TCG Opal	3/9/2018

Global Presence

Taiwan (Headquarters)

Apacer Technology Inc.

1F., No.32, Zhongcheng Rd., Tucheng Dist.,
New Taipei City 236, Taiwan R.O.C.
Tel: 886-2-2267-8000
Fax: 886-2-2267-2261
amtsales@apacer.com

U.S.A.

Apacer Memory America, Inc.

46732 Lakeview Blvd., Fremont, CA 94538
Tel: 1-408-518-8699
Fax: 1-510-249-9551
sa@apacerus.com

Japan

Apacer Technology Corp.

6F, Daiyontamachi Bldg., 2-17-12, Shibaura, Minato-Ku,
Tokyo, 108-0023, Japan
Tel: 81-3-5419-2668
Fax: 81-3-5419-0018
jpservices@apacer.com

Europe

Apacer Technology B.V.

Science Park Eindhoven 5051 5692 EB Son,
The Netherlands
Tel: 31-40-267-0000
Fax: 31-40-290-0686
sales@apacer.nl

China

Apacer Electronic (Shanghai) Co., Ltd

Room D, 22/FL, No.2, Lane 600, JieyunPlaza,
Tianshan RD, Shanghai, 200051, China
Tel: 86-21-6228-9939
Fax: 86-21-6228-9936
sales@apacer.com.cn

India

Apacer Technologies Pvt Ltd,

Unit No.201, "Brigade Corner", 7th Block
Jayanagar,
Yediyur Circle, Bangalore – 560082, India
Tel: 91-80-4152-9061
Fax: 91-80-4170-0215
sales_india@apacer.com