RoHS Compliant

Serial ATA Flash Drive

SAFD25M4 Product Specifications

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Version 1.2

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Features:

- **Standard Serial ATA 2.6 (Gen. 2)**
  - Serial ATA 2.6 (Gen. 2)
  - SATA Ⅱ, 3.0 Gbps
  - ATA-compatible command set
  - ATA modes support
- **Capacities**
  - 4, 8, 16, 32, 64 GB
- **Performance***
  - Burst read/write: 300 MB/sec
  - Sustained read: up to 165 MB/sec
  - Sustained write: up to 150 MB/sec
- **Intelligent endurance design**
  - Built-in hardware ECC, enabling up to 16/24 bit correction per 1K bytes
  - Static 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
  - S.M.A.R.T.
  - Power Failure Management
  - ATA Secure Erase
  - TRIM
- **NAND Flash Type:** SLC
- **Endurance**
  - 4GB: 320 TBW
  - 8GB: 640 TBW
  - 16GB: 1,280 TBW
  - 32GB: 2,560 TBW
  - 64GB: 5,130 TBW
- **Temperature ranges**
  - Operation: 0℃ to 70℃ (32 ~ 158℉)
  - Extended: -40℃ to 85℃ (-40° ~ 185℉)
  - Storage: -40℃ to 100℃ (-40° ~ 212℉)
- **Supply voltage**
  - 5.0 V ± 5%
- **Power consumption (typical)***
  - Active mode: 335 mA
  - Idle mode: 95 mA
- **Form factor**
  - 2.5 inch" (70.00 x 48.66 x 9.25**, unit: mm)
- **Connector**
  - 7-pin SATA signal connector
  - 15-pin SATA power connector
- **Shock & Vibration*****
  - Shock: 1500 G
  - Vibration: 15 G
- **RoHS compliant**

*Varies from capacities. The values addressed for Performance and Power consumptions are typical and may vary depending on settings and platforms.
**Including the width of the side brackets. Please "Physical Characteristics" for details.
***Non-operating
Notes about TBW: TBW is the abbreviation of Terabytes Written and it serves as an endurance indicator, though results may change due to external factors in real world applications.

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Table of Contents

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1. Product Description

1.1 Introduction

Apacer's Serial ATA Flash Drive (SAFD) is a non-volatile SATA solid-state drive (SSD) that serves as the ideal boot drive or mass storage device. Compliant with SATA II standard, the drive conforms to most mainstream host system platforms with SATA-compliant interfaces, making it the primary storage solution for replacing traditional hard disk drive.

SAFD 25M4 drive is designed with a powerful controller, offering capacities of up to 64 gigabytes and providing full support for the SATA II high-speed interface standard. It can operate at sustained access rates up to 165 megabytes per second, while power consumption remains at minimal level. Regarding data integrity and memory efficiency, the controller unit of the device handles wear leveling, ECC, bad block management and power management in urgent situations.

In addition to buffer management through dynamical allocation, SAFD 25M4 adopts the global wear-leveling scheme to allow uniform use of all storage blocks, ensuring that the lifespan of a flash media can be significantly increased and the disk performance is optimized as well. SAFD 25M4 provides the S.M.A.R.T. feature that follows the SATA Rev. 2.6, ATA/ATAPI-7 specifications and uses the standard SMART command B0h to read data from the drive. This feature protects the user from unscheduled downtime by monitoring and storing critical drive performance.

1.2 Functional Block Diagram

SAFD25M4 drive includes a single-chip SATA Ⅱ Controller and the flash media, as well as the SATA standard interface. The controller integrates the flash management unit with the controller itself to support multi-channel, multi-bank flash arrays. Figure 1-1 shows the functional block diagram.

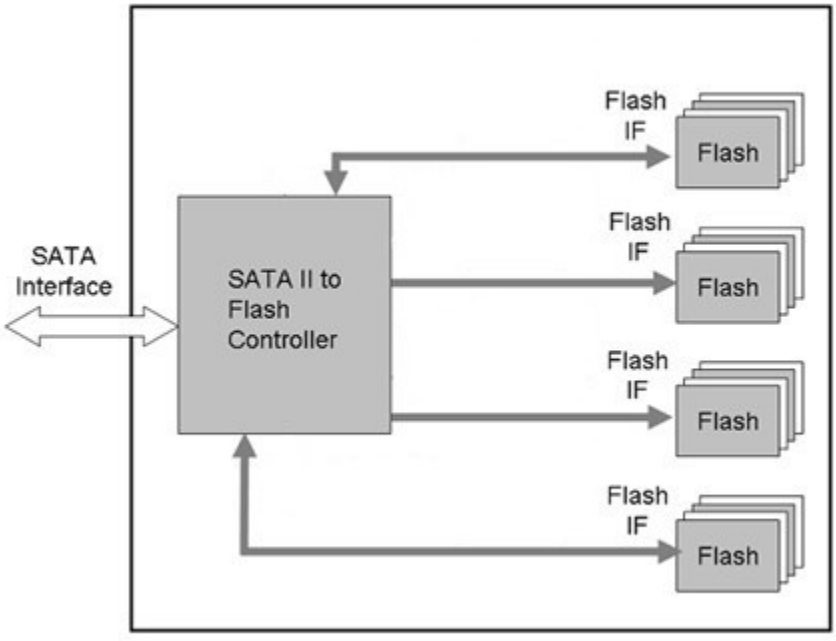

Figure 1-1 Apacer SAFD25M4 block diagram

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1.3 ATA Mode Support

SAFD25M4 provides ATA mode support as follows:

- Up to PIO mode-4
- Up to Multiword DMA mode-2
- Up to UDMA mode-5

1.4 Capacity Specification

Capacity specification of SAFD25M4 product family is available as shown in Table 1-1. It lists the specific capacity, the default numbers of logical cylinders and heads, and the number of logical sectors per track for each product line.

Table 1-1 Capacity specification

Capacity	Total Bytes*	Cylinders	Heads	Sectors	Max LBA*
4 GB	4,011,614,208	7,773	16	63	7,835,184
8 GB	8,012,390,400	15,525	16	63	15,649,200
16 GB	16,013,942,784	16,383	16	63	31,277,232
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

*Display of total bytes varies from file systems.
**Cylinders, heads or sectors are not applicable for these capacities. Only LBA addressing applies.
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.

1.5 Performance

Performance of SAFD25M4 is shown in Table 1-2.

Table 1-2 Performance specification

Capacity / Performance	4 GB	8 GB	16 GB	32 GB	64 GB
Sustained Read (MB/s)	150	160	160	160	165
Sustained Write (MB/s)	50	95	95	145	150

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

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1.6 Pin Assignments

Table 1-3 describes the SAFD signal segment, and Table1-4, power segment.

Figure 1-2 SATA Connectors

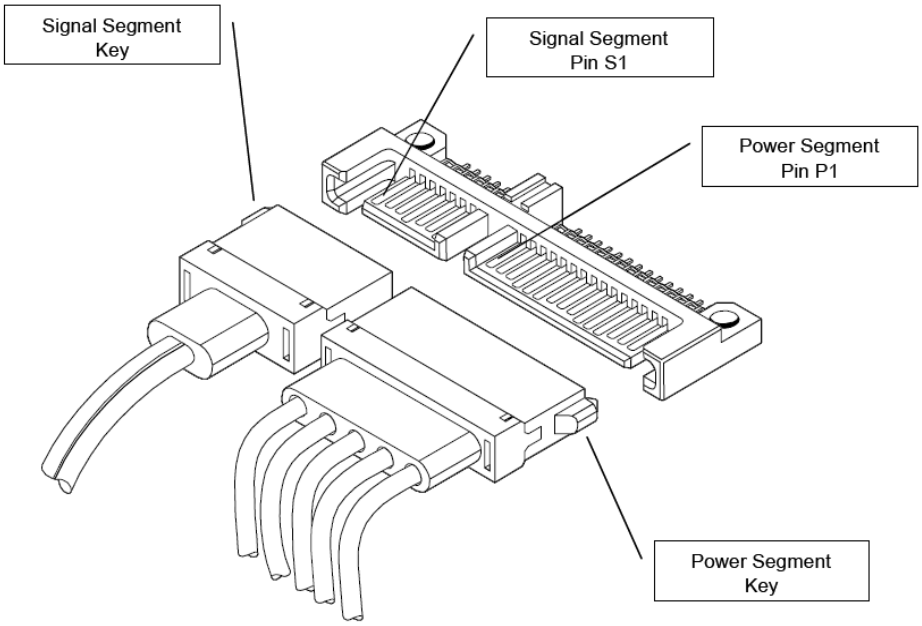

Table 1-3: Signal segment

Name	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 1-4: Power segment

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

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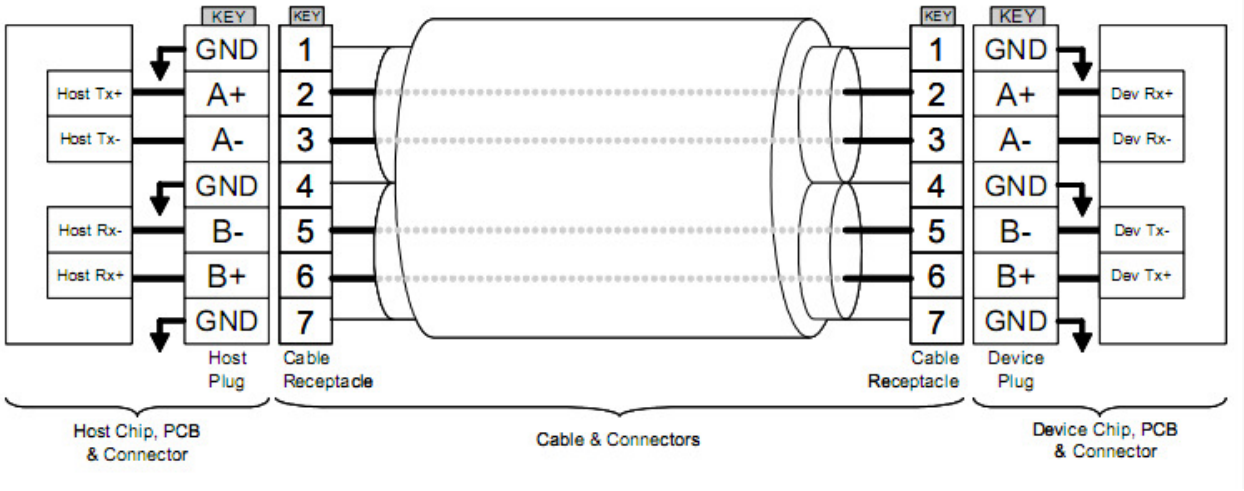

Figure 1-3 SATA Cable/Connector Connection Diagram

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.

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2. Software Interface

2.1 Command Set

Table 2-1 summarizes the ATA commands supported by SAFD25M4.

Table 2-1: Command set

Code	Command	Code	Command
E5h	Check Power Mode	F3h	Security Erase Prepare
06h	Data Set Management	F4h	Security Erase Unit
90h	Execute Device Diagnostic	F5h	Security Freeze Lock
E7h	Flush Cache	F1h	Security Set Password
EAh	Flush Cache EXT	F2h	Security Unlock
Ech	Identify Device	70h	Seek
E3h	Idle	Efh	Set Features
E1h	Idle Immediate	C6h	Set Multiple Mode
91h	Initialize Device Parameters	E6h	Sleep
C8h	Read DMA	B0h	SMART
25h	Read DMA EXT	E2h	Standby
C4h	Read Multiple	E0h	Standby Immediate
29h	Read Multiple EXT	Cah	Write DMA
20h	Read Sector	35h	Write DMA EXT
24h	Read Sector EXT	C5h	Write Multiple
40h	Read Verify Sectors	39h	Write Multiple EXT
42h	Read Verify Sectors EXT	30h	Write Sector
10h	Recalibrate	34h	Write Sector EXT
F6h	Security Disable Password		

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3. Flash Management

3.1 Error Correction/Detection

SAFD25M4 implements a hardware ECC scheme, based on the BCH algorithm. It can detect and correct up to 16 bits or 24 bits error in 1K bytes.

3.2 Bad Block Management

Contemporary process technology is unable to guarantee total reliability of NAND flash memory array. When a flash memory device leaves factory, it comes with a highly minimal number of initial bad block during production or out-of-factory as there is no currently known technology that produce flash chips free of bad blocks. On the other hand, 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 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. On the other hand, NAND flash storage adopts flash as their primary media. 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 earlier. Wear leveling is an important mechanism that level out the wearing of blocks so that the wearing-down of blocks can be almost evenly distributed. This will increase the lifespan of SSDs. Commonly used wear leveling types are Static and Dynamic.

3.4 Power Failure Management

Power Failure Management ensures data transmission when experiencing unstable power supply. When power disruption takes places, NAND Flash will have to cache multiple write-to-flash cycles to securely store data. This urgent operation requires about several milliseconds to get it done. When the supplied voltage is below a certain percentage of the required, the flash controller will be signaled by a detector IC component with low power detection signal and then the firmware will communicate the controller to flush all the data into the cache of Flash storage area. This can prevent incomplete data transmission. The crucial part lies in the strength of the capacitor of the SSD. The capacitor must be able to hold up some milliseconds of remaining time before the power is totally out, for the urgent write-back-into-flash operations to complete.

3.5 ATA Secure Erase

Accomplished by the Secure Erase (SE) command, which is 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 an 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. Once executed, neither data nor the erase counter on the device would be recoverable, which blurs the accuracy of

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device lifespan. The process to erase will not be stopped until finished even if power failure is encountered, and will be continued when power resumes.

3.6 S.M.A.R.T.

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.

Apacer devices use the standard SMART command B0h to read data out from the drive to activate our SMART feature that complies with the ATA/ATAPI-7 specifications. Based on the SFF-8035i Rev. 2.0 specifications, SMART Attribute IDs shall include Initial bad block count, Bad block count, Spare block count, Maximum erase count, Average erase count and Power cycle. When the SMART Utility running on the host, it analyzes and reports the disk status to the host before the device reaches in critical condition.

3.7 TRIM

Made of millions of NAND flash cells, SSD can be written into groups called pages in 4K size generally, but can only be erased in larger groups called blocks of 128 pages or 512KB. These stipulations are partially the source of many performance issues. Until an address is used again, the SSD keeps track of every last bit of data that's written on it. The ATA-TRIM instruction tilts the balance in favor of the SSD. TRIM addresses a major part of the performance degradation issue over time that plagues all SSDs. A TRIM enabled drive running an OS with TRIM supported will stay closer to its peak performance over time.

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4. Environmental Specifications

4.1 Environments

SAFD25M4 environmental specifications follow the US Military Standard MIL-STD-810F

Table 4-1 SAFD25M4 environmental specifications

Environment	Specification
Temperature	0℃ to 70℃ (Operating – Standard), -40℃ to 85℃ (operating-extended)
	-40℃ to 100℃ (Non-operating)
Vibration	Non-operating: Sine wave, 10~2000(Hz), 15(G), X, Y, Z axis
	Operating: Random, 20~2000(Hz), 7.69 G rms, X, Y, Z axis
Shock	Non-operating: Half sine wave 1500 (G), ±X, ±Y, ±Z axis
	Operating: Half sine wave, 50 G, ±X, ±Y, ±Z axis

4.2 Mean Time Between Failures (MTBF)

Mean Time Between Failures (MTBF) is predicted based on reliability data for the individual components in SAFD drive. The prediction result for the SAFD25M4 is more than 2,000,000 hours.

Notes about MTBF:

The prediction is based on Bellcore analysis method by assuming device failure rate can be generated by the sum of failure rates in each component.

4.3 Certification and Compliance

SAFD25M4 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. These factors can estimate the lifespan of the drive, by averaging the amount of data written into the SSD in a daily basis. The endurance of our devices is estimated by the following:

The lifetime and TBW of the device are listed in the following table.

Capacity	TeraBytes Written
4 GB	320
8 GB	640

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16 GB	1,280
32 GB	2,560
64 GB	5,130

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.

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5. Electrical Characteristics

5.1 Operating Voltage

Table 5-1 lists the supply voltage for SAFD25M4.

Table 5-1 SAFD25M4 operating voltage

Parameter	Conditions
Supply voltage	5V ±5% (4.75-5.25 V)

5.2 Power Consumption

Table 5-2 Power consumption (typical)

Mode \ Capacity	4 GB	8 GB	16 GB	32 GB	64 GB
Active (mA)	255	335	335	335	335
Stand By (mA)	85	95	95	95	95

Note: Power consumptions may vary depending on settings and platforms

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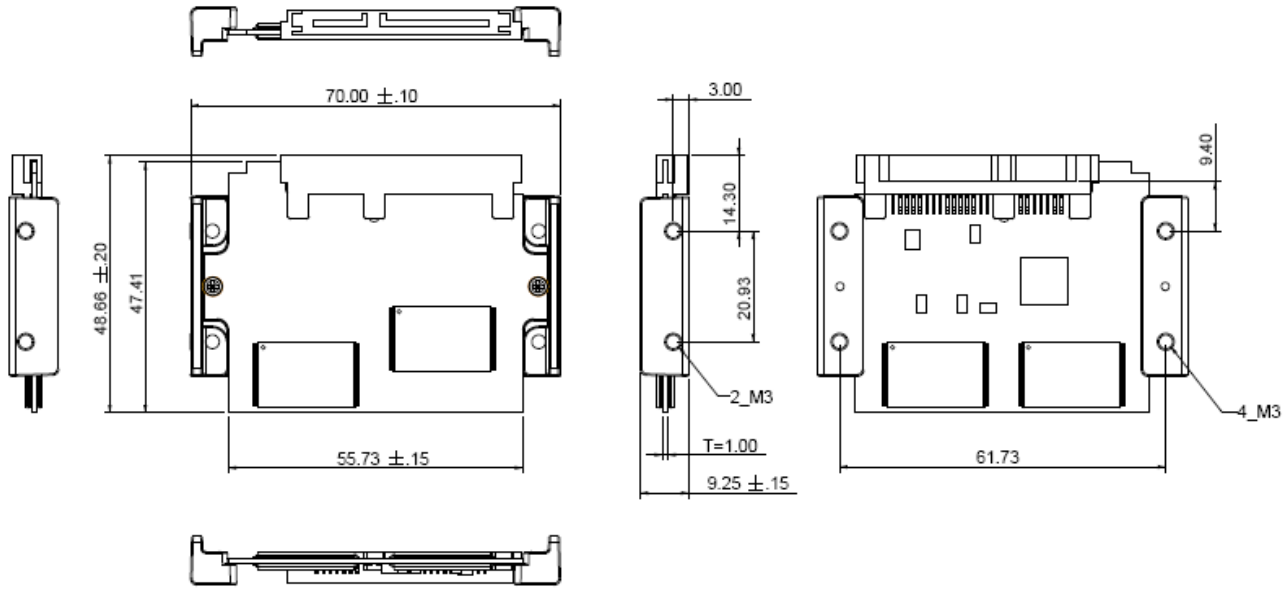
6. Physical Characteristics

6.1 Dimensions



Unit: mm

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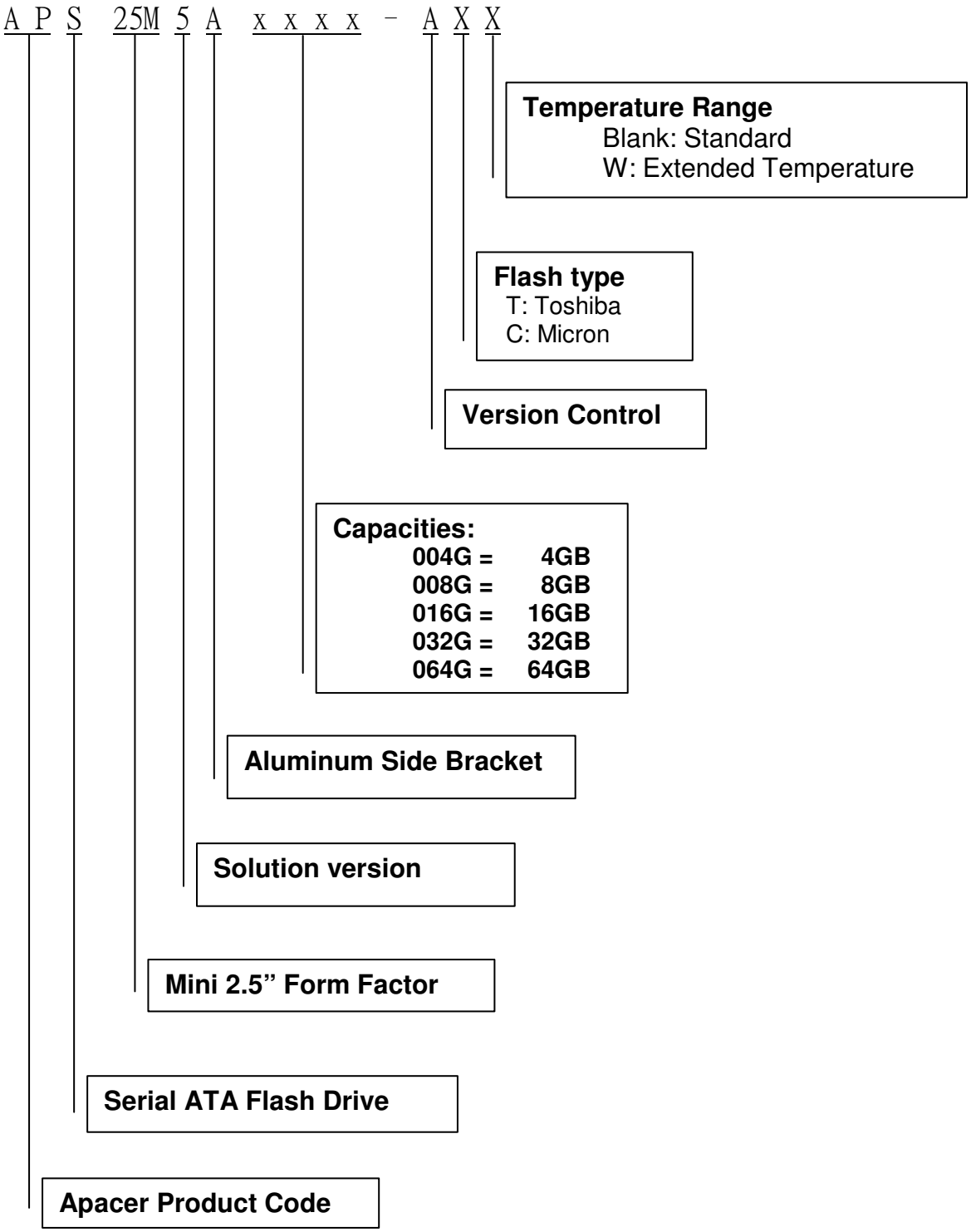
7. Product Ordering Information

7.1 Product Code Designations



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7.2 Valid Combinations

Capacity	Standard	Extended Temperature
4GB	APS25M5A004G-AT	APS25M5A004G-ATW
8GB	APS25M5A008G-AT	APS25M5A008G-ATW
16GB	APS25M5A016G-AT	APS25M5A016G-ATW
32GB	APS25M5A032G-AC	APS25M5A032G-ACW
64GB	APS25M5A064G-AC	APS25M5A064G-ACW

Note: Please consult with Apacer sales representatives for availability.

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Revision History

Revision	Description	Date
0.1	Preliminary Release	11/17/2011
1.0	Official release	12/02/2011
1.1	Revised capacity information	1/20/2012
1.2	Updated S.M.A.R.T. information Added Endurance section	07/13/2012

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