RoHS Compliant

Serial ATA Flash Drive

SAFD25M4 Product Specifications

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Version 1.1

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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
- **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
- **Data integrity under power-cycling**
  - No battery required for data storage
- **Temperature ranges**
  - Operation: 0°C to 70°C (32 ~ 158°F)
  - Extended: -40°C to 85°C (-40° ~ 185°F)
  - Storage: -40°C to 100°C (-40° ~ 212°F)
- **Supply voltage**
  - 5.0 V ± 5%
- **Power consumption (typical)***
  - Active mode: 333 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: 50g (approx., non-operating)
  - Vibration: 15g (approx.)
- **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.

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1. Product Description

1.1 Introduction

Apacer's SAFD25M4 is a solid-state disk (SSD) drive that contains a controller, embedded firmware, and flash media along with a male connector. Using NAND flash memory devices, the SAFD drive interfaces with the host allowing data to be seamlessly transferred between the host and the flash devices.

SAFD25M4 drive is designed with a single-chip 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 of up to 100 megabytes per second, which is much faster than any other solid-state or traditional SATA drive currently available on the market.

In addition to buffer management through dynamical allocation, SAFD25M4 adopts the Apacer-specific global wear-leveling scheme to allow uniform use of all storage blocks, ensuring that the lifetime of a flash media can be significantly increased and the disk performance is optimized as well. SAFD25M4 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.

Our customization services include product change notification (PCN), pre-programmed software, customize packaging and labeling, specified testing and safety packing, depending on specific requests.

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.

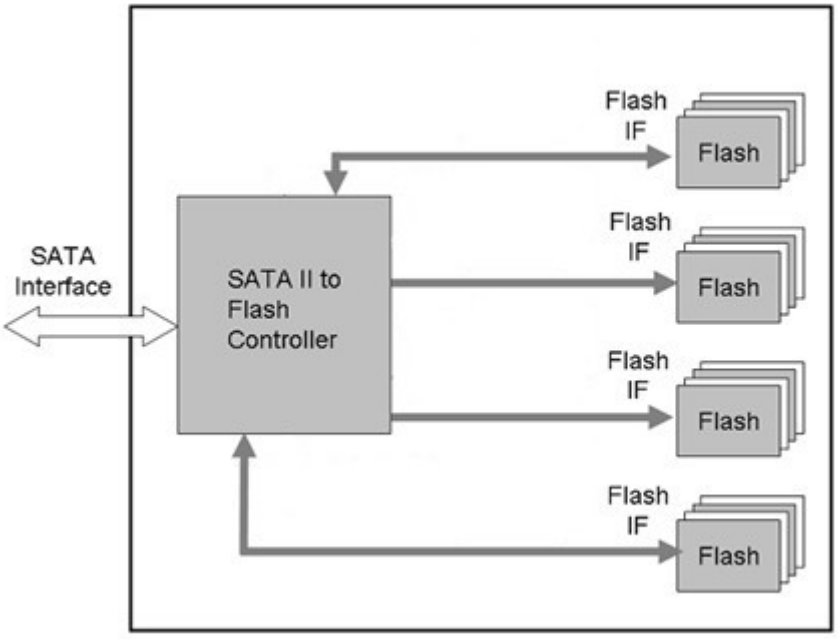

Figure 1-1 Apacer SAFD25M4 block diagram

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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.

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.

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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

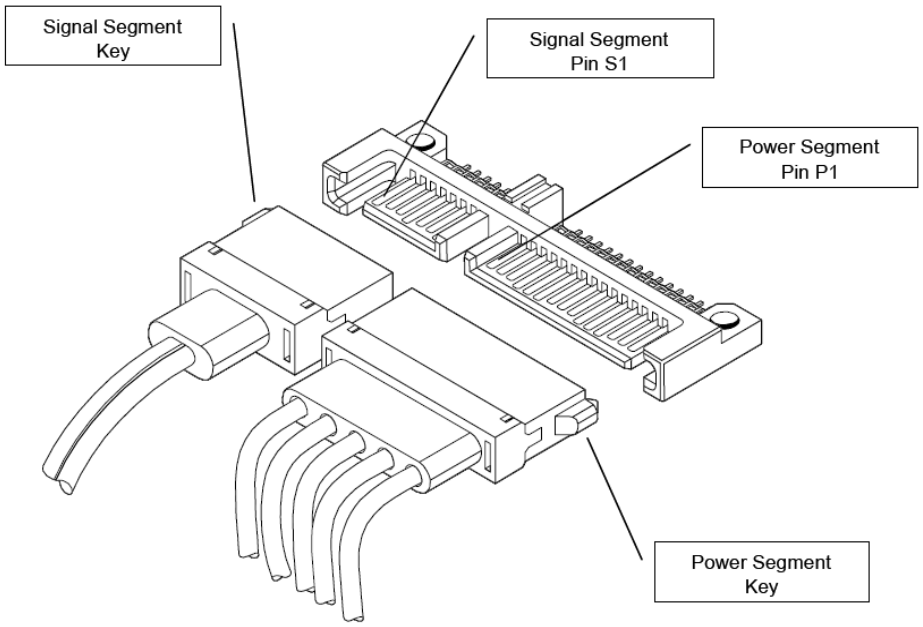

Table 1-3: Signal segment

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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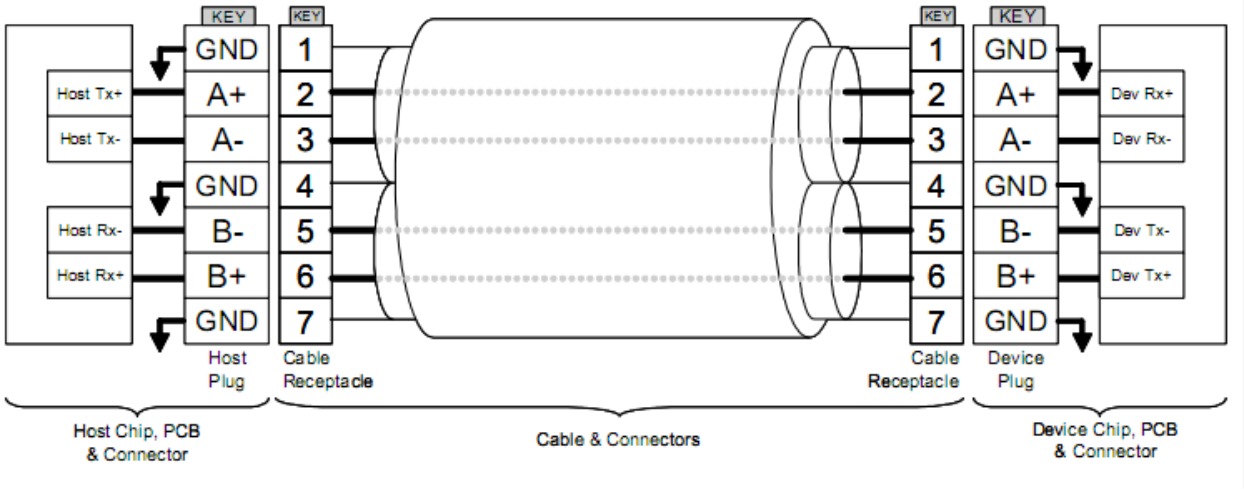

Figure 1-3 SATA Cable/Connector Connection Diagram

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

Although bad blocks on the flash media are already identified by the flash manufacturer, they can also be accumulated over time during operation. SAFD25M4's controller maintains a table that lists those normal blocks with disk data, the free blocks for wear leveling, and bad blocks with errors. When a normal block is detected broken, it is replaced with a free block and listed as a bad block. When a free block is detected broken, it is then removed from the free block list and marked as a bad block.

During device operation, this ensures that newly accumulated bad blocks are transparent to the host. The device will stop file write service once there are only two free blocks left such that the read function is still available for copying the files from the disk into another.

3.3 Wear Leveling

The NAND flash devices are limited by a certain number of write cycles. When using a FAT-based file system, frequent FAT table updates are required. If some area on the flash wears out faster than others, it would significantly reduce the lifetime of the whole SSD, even if the erase counts of others are far from the write cycle limit. Thus, if the write cycles can be distributed evenly across the media, the lifetime of the media can be prolonged significantly. This scheme is called wear leveling.

Apacer's wear-leveling scheme is achieved both via buffer management and Apacer-specific wear leveling mechanism. They both ensure that the lifetime of the flash media can be increased, and the disk access performance is optimized as well.

3.4 Power Failure Management

The Low Power Detection on the controller initiates crucial data saving before the power supplied to the device is too low. This feature prevents the device from crash and ensures data integrity during an unexpected power-off.

3.5 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. Once executed, neither data nor the erase counter on the device would be recoverable, which blurs the accuracy of device lifespan. The process to erase will not be stopped until finished while encountering power failure, and will be continued when power is back on.

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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 SAFD25M4 uses the standard SMART command B0h to read data from the drive for SMART feature as the SATA Rev.2.6 ATA/ATAPI-7 specifications. Based on the SFF-8035i Rev. 2.0 specifications, Apacer SMART defines vendor-specified SMART Attribute IDs (A0h, A1h, A2h, A3h, A4h-A5h) in SAFD25M4. They represent initial back block count, bad block count, spare block count, maximum erase count, and average erase counts respectively. When the Apacer SMART Utility running on the host, it analyzes and reports the disk status to the host before SAFD25M4 is 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 gets used again, the SSD has to keep 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 support 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, as shown in below table.

Table 4-1 SAFD25M4 environmental specifications

Environment	Specification
Temperature	0°C to 70°C (Operating – Standard), -40°C to 85°C (operating-extended)
	-40°C to 100°C (Non-operating)
Humidity	5% to 95% RH (Non-condensing)
Vibration	Sine wave: 10~2000(Hz), 15(G) Random: 20~2000(Hz), 7.7(Grms)
Shock	operating: 50(G), 11(ms) non-operating: 1500(G), 0.5(ms)

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. Although many component of MTBF are given in databases and often these values are not really accurate, the prediction result for the SAFD25M4 is 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

SAFD25M4 complies with the following standards:

- CE – EN55022/55024
- FCC 47CFR Part15 Class B
- RoHS
- MIL-STD-810F
- SATA II (SATA Rev. 2.6)
- Up to ATA/ATAPI-7 (including S.M.A.R.T.)

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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	333	333	280	300
Stand By (mA)	85	95	95	77	80

Note: Power consumptions may vary depending on settings and platforms

5.3 Electrostatic Discharge

Electrostatic discharge

Item	Amount of Discharge	Voltage	Required Criteria	Complied To Criteria (A,B,C)
Air Discharge	10	+8kV	B	A
	10	-8kV	B	A
Contact Discharge	25	+4kV	B	A
	25	-4kV	B	A
Indirect Discharge (HCP)	25	+4kV	B	A
	25	-4kV	B	A
Indirect Discharge (VCP Front)	25	+4kV	B	A
	25	-4kV	B	A
Indirect Discharge (VCP Left)	25	+4kV	B	A
	25	-4kV	B	A

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Indirect Discharge (VCP Back)	25	+4kV	B	A
	25	-4kV	B	A
Indirect Discharge (VCP Right)	25	+4kV	B	A
	25	-4kV	B	A

5.4 Electrical Fast Transient/Burst

Electrical Fast Transient/Burst

Inject Line	Polarity	Voltage kV	Inject Time (Second)	Inject Method	Required Criteria	Complied to Criteria
L-N-PE	±	1kV	60	Direct	B	A

Notes about 5.3 Electrostatic Discharge & 5.4 Electrical Fast Transient/Burst

The tests performed are from lowest level up to the highest level as required by standard, but only highest level is shown on the report.

Meet criteria A: Operate as intended during and after the test
Meet criteria B: Operate as intended after the test
Meet criteria C: Loss/Error of function

Additional Information:
EUT stopped operation and could / could not be reset by operator at kV.
No false alarms or other malfunctions were observed during or after the test.

The Contact discharges were applied at least total 200 discharges at a minimum of four test points.

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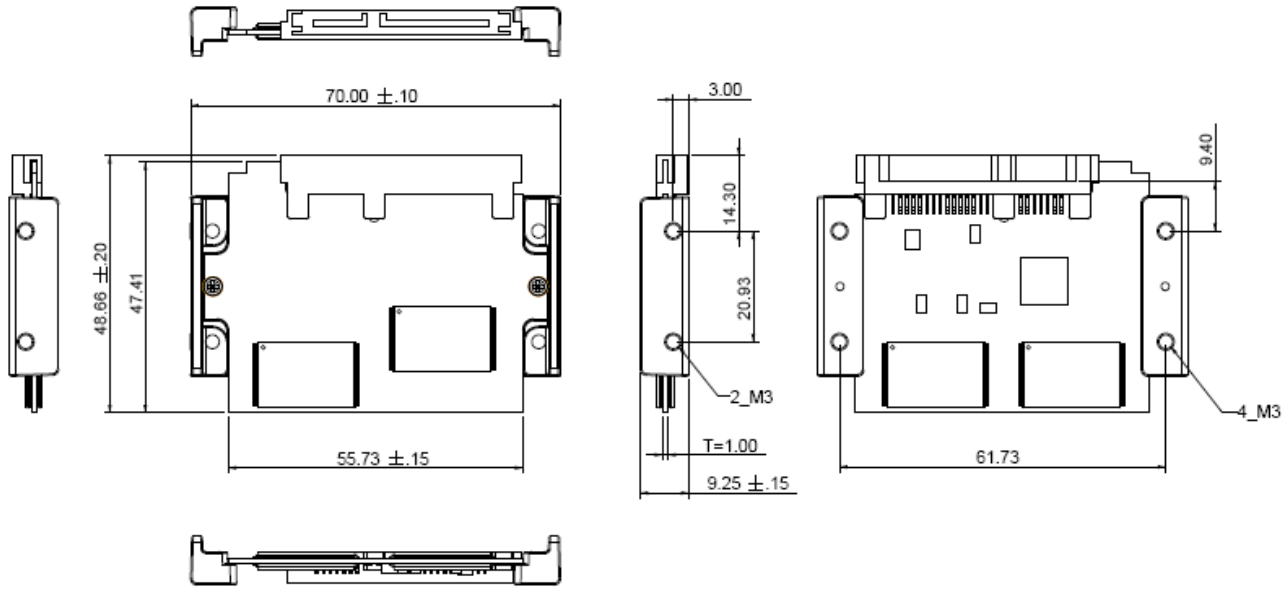
6. Physical Characteristics

6.1 Dimensions



Unit: mm

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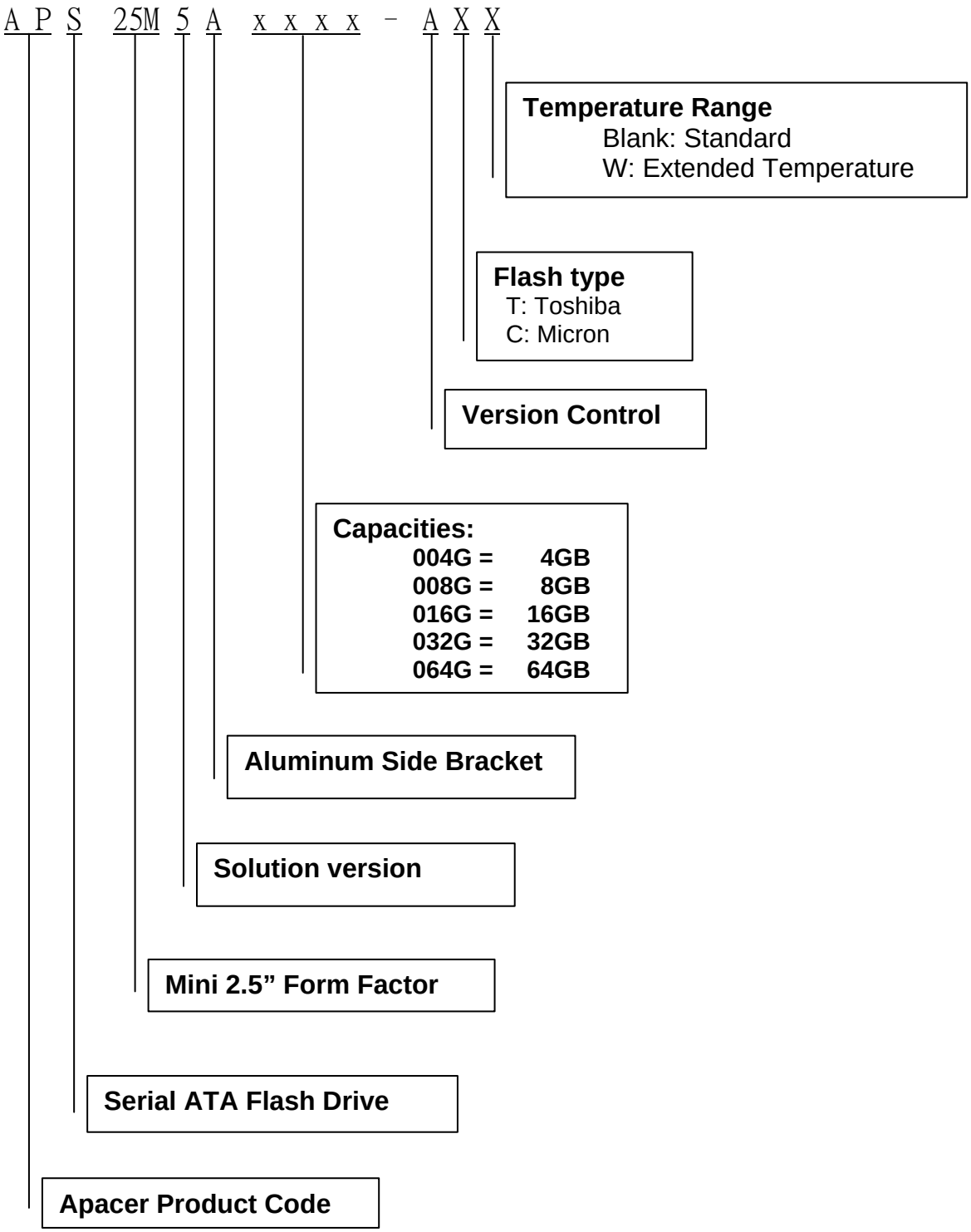
7. Product Ordering Information

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: 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.

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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

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