RoHS Compliant

Serial ATA Flash Drive

SAFD 25P Specifications

March 23rd, 2012

Version 1.6

Features:

- **Standard Serial ATA 2.6**
  - Serial ATA 2.6
  - SATA II, 3.0 Gbps
  - ATA-compatible command set

- **Capacities**
  - 32, 64, 128, 256 GB

- **Performance***
  - Burst read/write: 300 MB/sec
  - Sustained read: up to 265 MB/sec
  - Sustained write: up to 230 MB/sec

- **Intelligent endurance design**
  - Built-in hardware ECC, enabling up to 16/24 bit correction per 1024 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

- **MTBF (hours):** >2,000,000

- **Temperature ranges**
  - Operation:
    Standard: 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 $\pm$ 5%

- **Power consumption (typical)***
  - Active mode: 789 mA@5.0 V
  - Idle mode: 196 mA@5.0 V

- **Form factor**
  - 2.5 inch (100 x 69.9 x 9.3, unit: mm)

- **Connector**
  - 7-pin SATA male connector
  - 15-pin SATA power connector

- **IOPS 4K Random (approx.)**
  - 12,000

- **Shock & Vibration**
  - Shock: 1500g (approx.)
  - Vibration: 15g (approx.)

- **Zero power data retention**
  No battery required for data storage

- **RoHS compliant**

*Varies from capacities. The values presented for Performances and Power Consumption are typical and may vary depending on different configurations and platforms.

Rev. 1.6

Table of Contents

Rev. 1.6

1. Product Description

1.1 Introduction

Apacer's Serial ATA Flash Drive (SAFD) 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.

SAFD 25P drive is designed with a single-chip controller, offering capacities of up to 256 gigabytes and providing full support for the SATA II high-speed interface standard. It can operate at sustained access rates higher than 200 megabytes per second, which is much faster than any other traditional SATA-based hard disk drive currently available on the market.

In addition to buffer management through dynamical allocation, SAFD 25P 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 25P 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

SAFD 25P 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.
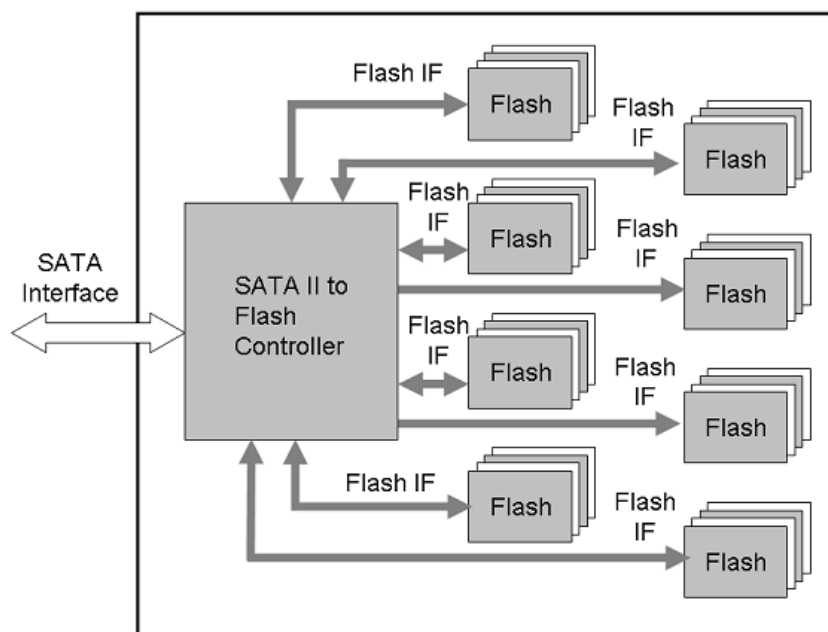

Figure 1-1 Apacer SAFD 25P block diagram

Rev. 1.6

1.3   ATA Mode Support

SAFD 25P 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 SAFD 25P 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**
32 GB	32,017,047,552	16383	16	63	62,533,296
64 GB	64,023,257,088	16383	16	63	125,045,424
128 GB	128,035,676,160	16383	16	63	250,069,680
256 GB	256,060,514,304	16383	16	63	500,118,192

*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 SAFD 25P is shown in Table 1-2.

Table 1-2 Performance specification

Performance \ Capacity	32 GB	64 GB	128 GB	256 GB
Sustained Read 4K/MB (MB/s)	260	265	260	260
Sustained Write (MB/s)	230	230	230	225

Note: Results may differ from various flash configurations.

Rev. 1.6

1.6　Pin Assignments

Table 1-3 describes SAFD 25P signal segment, and Table1-4, its power segment.
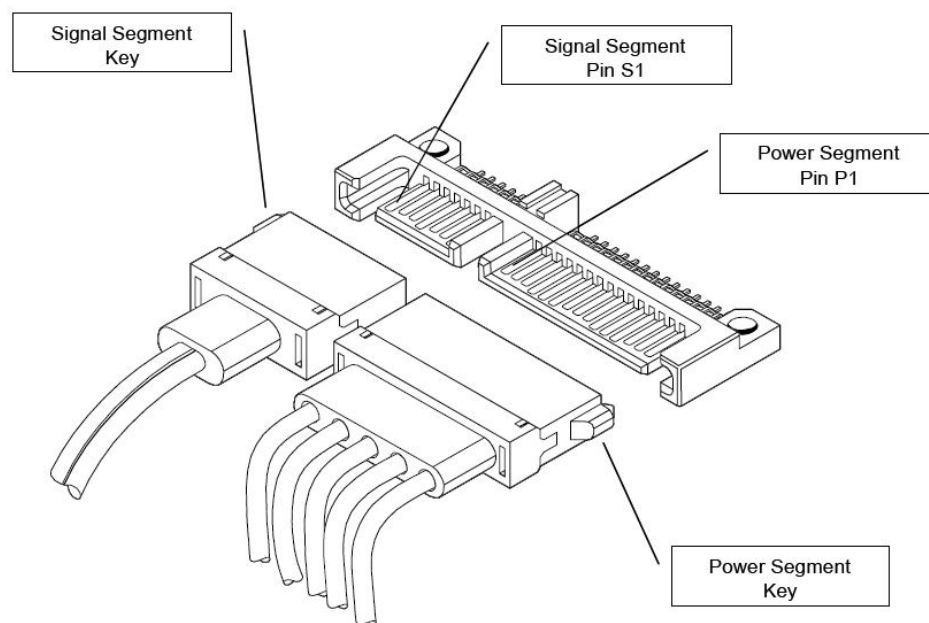
Figure 1-2 Pin Assignments

Table 1-4: Signal segment

Name	Type	Description
S1	GND	
S2	RxP	Serial Data Receiver
S3	RxN	
S4	GND	
S5	TxN	Serial Data Transmitter
S6	TxP	
S7	GND	

Table 1-5: Power segment

Pin	Signal/Description
P1	Not used (3.3V)
P2	Not used (3.3V)
P3	Not used (3.3V)
P4	Ground
P5	Ground
P6	Ground
P7	5V Pre-Charge
P8	5V
P9	5V
P10	Ground
P11	Ground
P12	Ground
P13	Not used (12V Pre-Charge)
P14	Not used (12V)
P15	Not used (12V)

5

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 while 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.
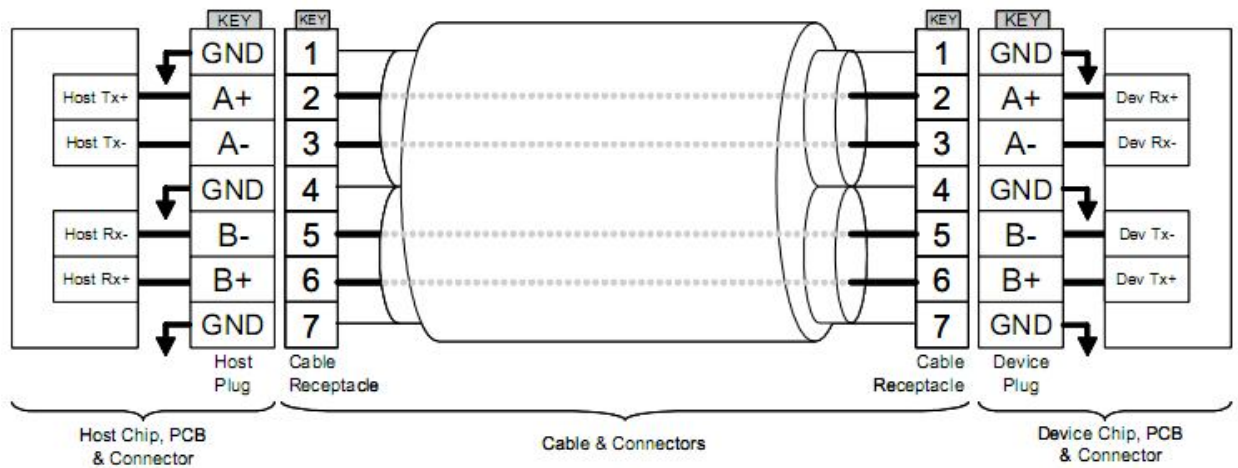
Rev. 1.6

2. Software Interface

2.1 Command Set

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

Table 2-1: Command set (1 of 2)

Command	Code	FR[1]	SC[2]	SN[3]	CY[4]	DH[5]	LBA[6]
Check-Power-Mode	E5H	-	-	-	-	D[8]	-
Execute-Drive-Diagnostic	90H	-	-	-	-	D	-
Flush-Cache	E7H	-	-	-	-	D	-
Identify-Drive	ECH	-	-	-	-	D	-
Idle	E3H	-	Y	-	-	D	-
Idle-Immediate	E1H	-	-	-	-	D	-
Initialize-Drive-Parameters	91H	-	Y	-	-	Y	-
Read-DMA	C8H or C9H	-	Y	Y	Y	Y	Y
Read-Multiple	C4H	-	Y	Y	Y	Y	Y
Read-Sector(s)	20H or 21H	-	Y	Y	Y	Y	Y
Read-Verify-Sector(s)	40H or 41H	-	Y	Y	Y	Y	Y
Recalibrate	10H	-	-	-	-	D	-
Security-Disable-Password	F6H	-	-	-	-	D	-
Security-Erase-Prepare	F3H	-	-	-	-	D	-
Security-Erase-Unit	F4H	-	-	-	-	D	-
Security-Freeze-Lock	F5H	-	-	-	-	D	-
Security-Set-Password	F1H	-	-	-	-	D	-
Security-Unlock	F2H	-	-	-	-	D	-
Seek	7XH	-	-		Y	Y	
Set-Features	EFH	Y[7]	-	-	-	D	-

Table 2-1: Command set (2 of 2)

Command	Code	FR[1]	SC[2]	SN[3]	CY[4]	DH[5]	LBA[6]
Set-Multiple-Mode	C6H	-	Y	-	-	D	-
Sleep	E6H	-	-	-	-	D	-
SMART	B0H	Y	Y	Y	Y	D	
Standby	E2H	-	-	-	-	D	-
Standby-Immediate	E0H	-	-	-	-	D	-
Write-DMA	CAH	-	Y	Y	Y	Y	Y
Write-Multiple	C5H	-	Y	Y	Y	Y	Y
Write-Sector(s)	30H	-	Y	Y	Y	Y	Y

1. FR - Features register
2. SC - Sector Count register
3. SN - Sector Number register
4. CY - Cylinder registers
5. DH - Drive/Head register
6. LBA - Logical Block Address mode supported (see command descriptions for use)
7. Y - The register contains a valid parameter for this command.
8. For the Drive/Head register:
   Y means both the SAFD and Head parameters are used
   D means only the SAFD parameter is valid and not the Head parameter

2.2   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, Apacer SMART defines vendor-specified SMART Attribute IDs (A0 ~ A5, and 0C). They represent Initial bad block count, Bad block count, Spare block count, Maximum erase count, Average erase count and Power cycle. When the Apacer SMART Utility running on the host, it analyzes and reports the disk status to the host before the device reaches in critical condition.

3. Flash Management

3.1 Error Correction/Detection

SAFD 25P implements hardware ECC scheme based on the BCH algorithm which can detect and correct up to 16 bits or 24 bits error in 1024 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. SAFD 25P'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 global wear leveling. 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.

3.6   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.

4. Environmental Specifications

4.1 Environments

SAFD 25P environmental specifications follow the US Military Standard MIL-STD-810F, as shown in Table 4-1.

Table 4-1 SAFD 25P environmental specifications

Environment	Specification
Temperature	0°C to 70°C (Operating – Standard); -40°C to 85°C (Operating – ET*)
	-40°C to 100°C (Non-operating)
Humidity	5% to 95% RH (Non-condensing)
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

*Extended Temperature

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 MTBFs are given in databases and often these values are not really accurate, the prediction result for SAFD 25P 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

SAFD 25P drive complies with the following standards:

- CE – EN55022/55024
- FCC 47CFR Part15 Class B
- RoHS
- MIL-STD-810F
- SATA II (SATA Rev. 2.5)
- Up to ATA/ATAPI-7 (including S.M.A.R.T.)

Rev. 1.6

5. Electrical Characteristics

5.1 Operating Voltage

Table 5-1 lists the supply voltage for SAFD 25P.

Table 5-1 SAFD 25P operating voltage

Parameter	Conditions
Supply voltage	5.0 V ±10% (4.5-5.5 V)

5.2 Power Consumption

Table 5-2 lists SAFD 25P power consumption.

Table 5-2 SAFD 25P power consumption (typical)

Capacity / Performance	32 GB	64 GB	128 GB	256 GB
Active Mode (mA)	718	789	620	691
Idle Mode (mA)	190	190	193	196

Note: power consumption may vary depending on flash configurations or platforms.

5.3 Electrostatic Discharge

Table 5-3 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

13

	25	-4kV	B	A
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

Table 5-4 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.

Rev. 1.6

6. Physical Characteristics

6.1 Metal Housing

Figure 6-1 illustrates the overall dimensions of SAFD 25P w/Metal Housing, as listed in Table 6-1.

Table 6-1 SAFD 25P w/Metal Housing dimensions

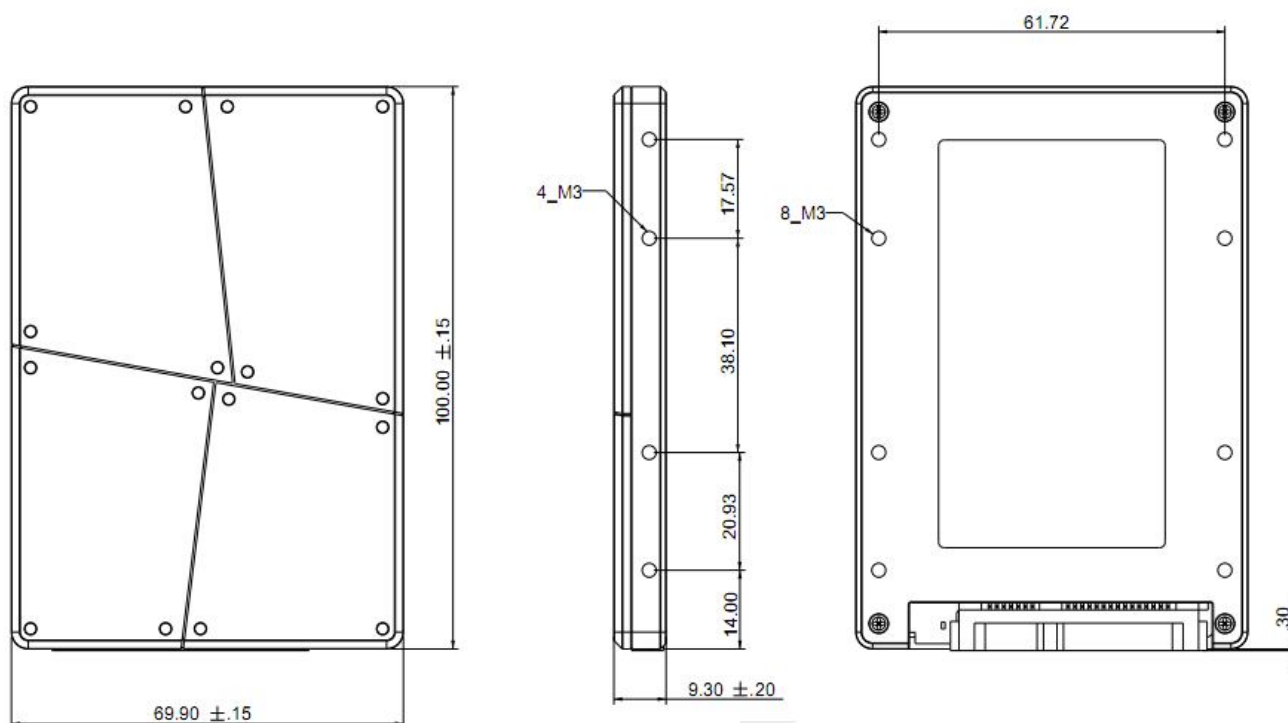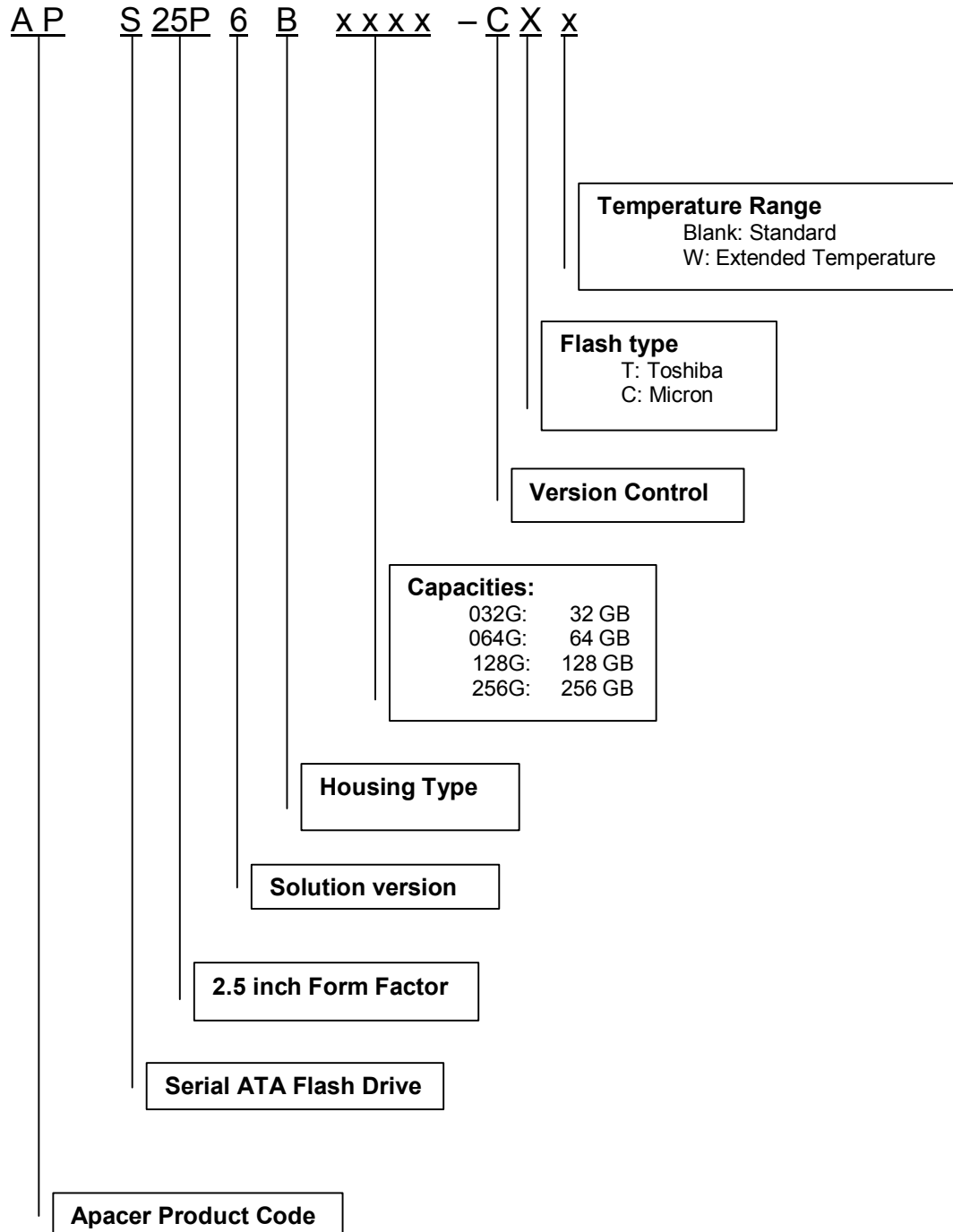| Dimension	Millimeters (㎜)
Height	9.30 ± 0.20
Width	69.90 ± 0.15
Length	100.00 ± 0.15

Figure 6-1 SAFD 25P w/Metal Housing physical dimensions

7. Product Ordering Information

7.1 Product Code Designations

A P   S 25P 6 B   x x x x   − C X x

Temperature Range
    Blank: Standard
    W: Extended Temperature

Flash type
    T: Toshiba
    C: Micron

Version Control

Capacities:
    032G: 32 GB
    064G: 64 GB
    128G: 128 GB
    256G: 256 GB

Housing Type

Solution version

2.5 inch Form Factor

Serial ATA Flash Drive

Apacer Product Code

7.2   Valid Combinations

Capacity	Standard	Extended Temperature
32GB	APS25P6B032G-CT	APS25P6B032G-CTW
64 GB	APS25P6B064G-CT	APS25P6B064G-CTW
128 GB	APS25P6B128G-CC	APS25P6B128G-CCW
256 GB	APS25P6B256G-CC	APS25P6B256G-CCW

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	Formal release	02/21/2011
1.1	Updated Physical Characteristics and Product Ordering Information	03/17/2011
1.2	Updated Product Ordering Information	05/13/2011
1.3	Revised Product Ordering Information	05/17/2011
1.4	Higher capacities added -- added 128GB & 256GB	10/14/2011
1.5	Updated Performance and Power Consumptions due to changes in flash configurations Updated Product Ordering Information	11/30/2011
1.6	Revised S.M.A.R.T information	03/23/2012

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Rev. 1.6