RoHS Recast Compliant

Serial ATA Flash Drive

SAFD 25P Specifications

May 13th, 2013

Version 2.0

Features:

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

- **Capacities**
  - 8, 16, 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 hours

- **Temperature ranges**
  - Operation:
    Standard: 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: 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

- **Shock & Vibration**
  - Shock: 1500 G (non-operating)
  - Vibration: 15 G (non-operating)

- **Endurance****
  - 8 GB: 535 TBW
  - 16 GB: 1070 TBW
  - 32 GB: 2140 TBW
  - 64 GB: 4280 TBW
  - 128 GB: 8565 TBW
  - 256 GB: 17130 TBW

- **RoHS Recast compliant (2011/65/EU standard)**

*Varies from capacities. The values presented for Performances and Power Consumption are typical and may vary depending on different configurations and platforms.
**Endurance of our SSD devices are estimated in TBW (Terabytes Written) and measured under constant PC transfer rate.

Rev. 2.0

Table of Contents

Rev. 2.0

1. Product Description

1.1 Introduction

Apacer's Serial ATA Flash Drive (SAFD) is a standard 2.5-inch solid-state drive (SSD) designed for embedded applications in demanding environments. SAFD 25P drive is designed with a single-chip controller providing full support for the SATA II high-speed interface standard. It can operate at sustained access rates up to 260 megabytes per second.

In addition, 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.
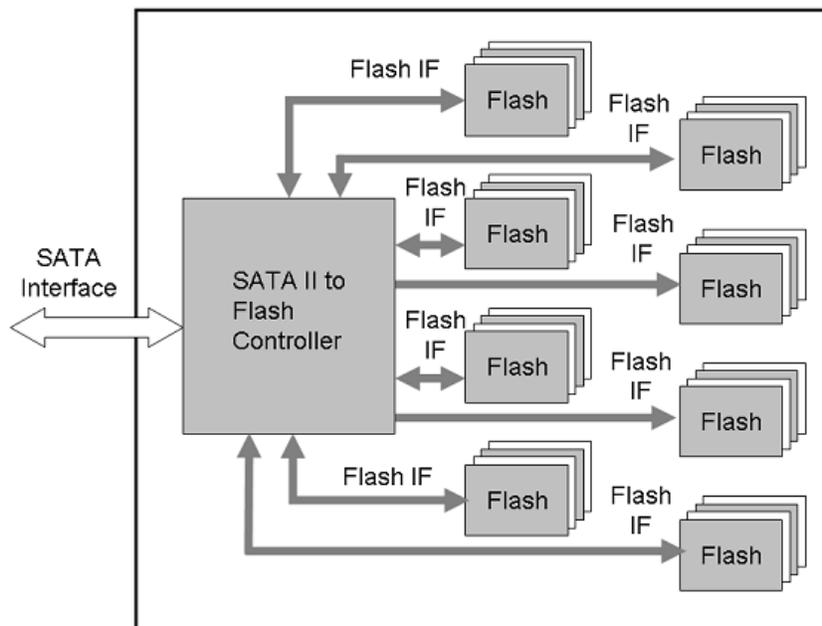

Figure 1-1 Apacer SAFD 25P block diagram

Rev. 2.0

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-4

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**
8 GB	7,012,196,352	13,587	16	63	13,695,696
16 GB	16,013,942,784	16383	16	63	31,277,232
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.
 ***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.

1.5 Performance

Performance of SAFD 25P is shown in Table 1-2.

Table 1-2 Performance specifications

Performance \ Capacity	8 GB	16 GB	32 GB	64 GB	128 GB	256 GB
Sustained Read MB (MB/s)	220	250	260	265	260	260
Sustained Write (MB/s)	120	190	230	230	230	225

Note:
Results may differ from various flash configurations or host system configurations..
The performance was measured by CrystalDiskMark under Windows operating system.

Rev. 2.0

1.6 Pin Assignments

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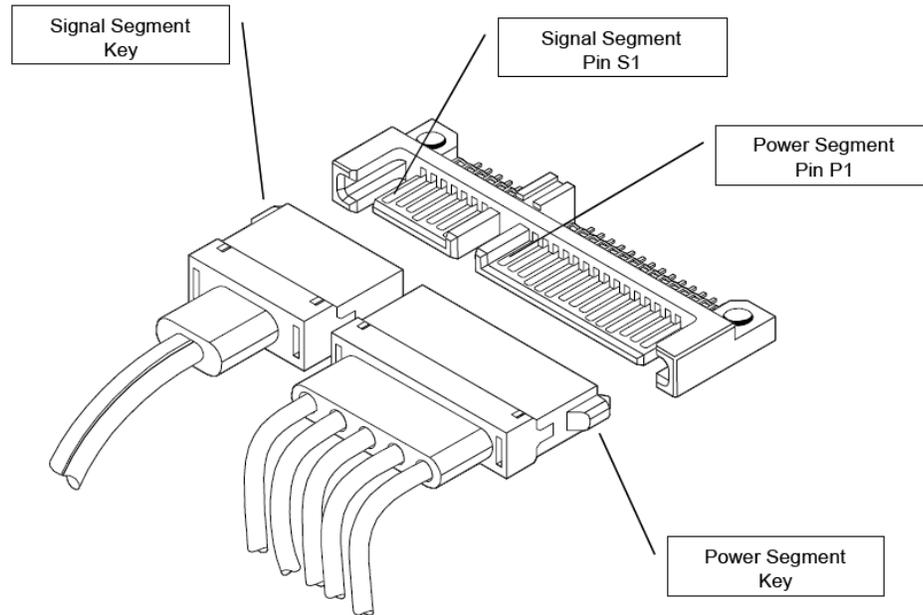
Figure 1-2 Pin Assignments

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
P8	5V
P9	5V
P10	Ground
P11	Reserved
P12	Ground
P13	Not used (12V)
P14	Not used (12V)
P15	Not used (12V)
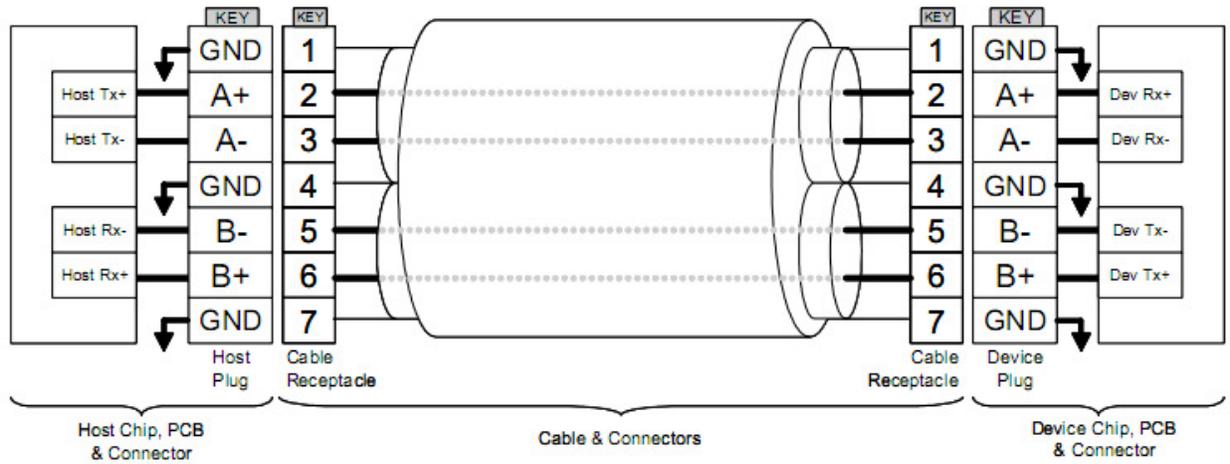
Figure 1-3 SATA Cable / Connector Connection Diagram

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. 2.0

2. Software Interface

2.1 Command Set

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

Table 2-1: Command set

Command	Code
Check-Power-Mode	E5H
Execute-Drive-Diagnostic	90H
Flush-Cache	E7H
Identify-Drive	ECH
Idle	E3H
Idle-Immediate	E1H
Initialize-Drive-Parameters	91H
Read-DMA	C8H or C9H
Read-Multiple	C4H
Read-Sector(s)	20H or 21H
Read-Verify-Sector(s)	40H or 41H
Recalibrate	10H
Security-Disable-Password	F6H
Security-Erase-Prepare	F3H
Security-Erase-Unit	F4H
Security-Freeze-Lock	F5H
Security-Set-Password	F1H
Security-Unlock	F2H
Seek	7XH
Set-Features	EFH
Set-Multiple-Mode	C6H
Sleep	E6H
SMART	B0H
Standby	E2H
Standby-Immediate	E0H
Write-DMA	CAH
Write-Multiple	C5H
Write-Sector(s)	30H

Rev. 2.0

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.

Rev. 2.0

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 Flash 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 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. 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 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.

Note: The controller unit of this product model is designed with a DRAM as a write cache for improved performance and data efficiency. Though unlikely to happen in most cases, the data cached in the volatile DRAM might be potentially affected if a sudden power loss takes place before the cached data is flushed into non-volatile NAND flash memory.

3.5 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.

Rev. 2.0

3.6   TRIM

TRIM, though in capital letters usually, is a memory computation command rather than an abbreviation. It is mainly a SATA command that enables the operating system to inform the SSD (Solid State Drive) which blocks of previously stored data are no longer valid, due to erases by the host or operating system, such as file deletions or disk formatting. Once notified, SSD will begin the discard of the invalid LBAs and retain more space for itself, in fact, the discarded is no longer recoverable.

When an LBA is replaced by the operating system, as with overwrite of a file, the SSD is informed that the originally occupied LBA is determined as no longer in use or invalid. The SSD will not save those blocks in garbage collected sectors. Noticeably, a file deletion command by host or operating system never actually erases the actual content, rather, just the file is marked as deleted. This issue is even specifically noticeable for flash based memory devices, such as SSDs. In fact, an SSD will keep garbage collecting the invalid, previously occupied LBAs, if it is not informed that these LBAs can be erased. Thus, the SSD would experience a significant performance downfall.

Rev. 2.0

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℃ to 70℃ (Operating – Standard); -40℃ to 85℃ (Operating – ET*)
	-40℃ to 100℃ (Non-operating)
Vibration**	Sine wave Frequency: 10-2000 Hz Acceleration : 15 G Direction : X, Y, Z axis
Shock**	Half sine wave Acceleration: 1,500 G Direction : ±X, ±Y, ±Z axis

*Extended Temperature
**Non-operating

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 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
- FCC
- RoHS Recast
- MIL-STD-810F

4.4 Endurance

Terabytes Written (TBW) is an endurance rating system that indicates the maximum number of terabytes written by the host to the drive. NAND flash has a limit on how many P/E cycles it can withstand before its data retention becomes unreliable. Thus, key factors, such as wear leveling, flash configurations, Write Amplifications and the number of P/E cycles, can influence the lifespan of the drive.

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

Capacity	TBW (TB)
8 GB	535
16 GB	1070
32 GB	2140
64 GB	4280
128 GB	8565
256 GB	17130

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.

Rev. 2.0

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 ±5% (4.75-5.25 V)

5.2 Power Consumption

Table 5-2 lists SAFD 25P power consumption.

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

Performance \ Capacity	8 GB	16 GB	32 GB	64 GB	128 GB	256 GB
Active Mode (mA)	400	555	718	789	620	691
Idle Mode (mA)	230	255	190	190	193	196

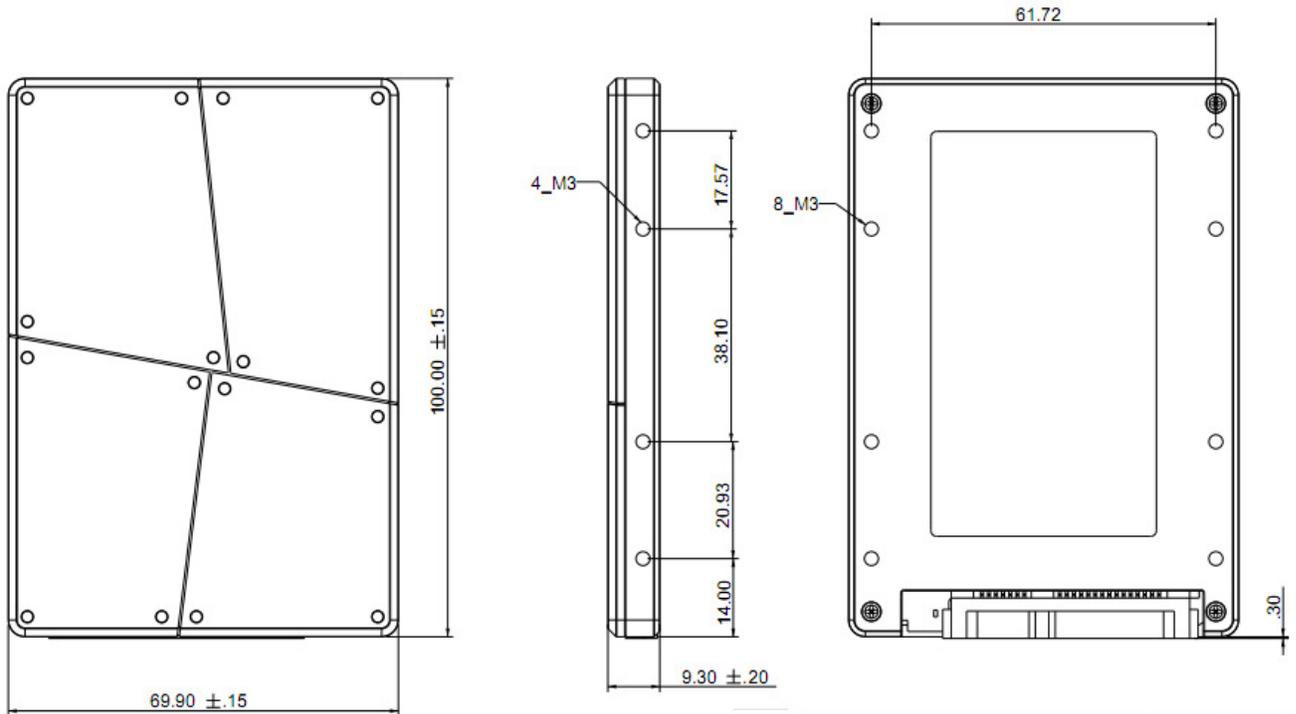Note: power consumption may vary depending on flash configurations or platforms.

Rev. 2.0

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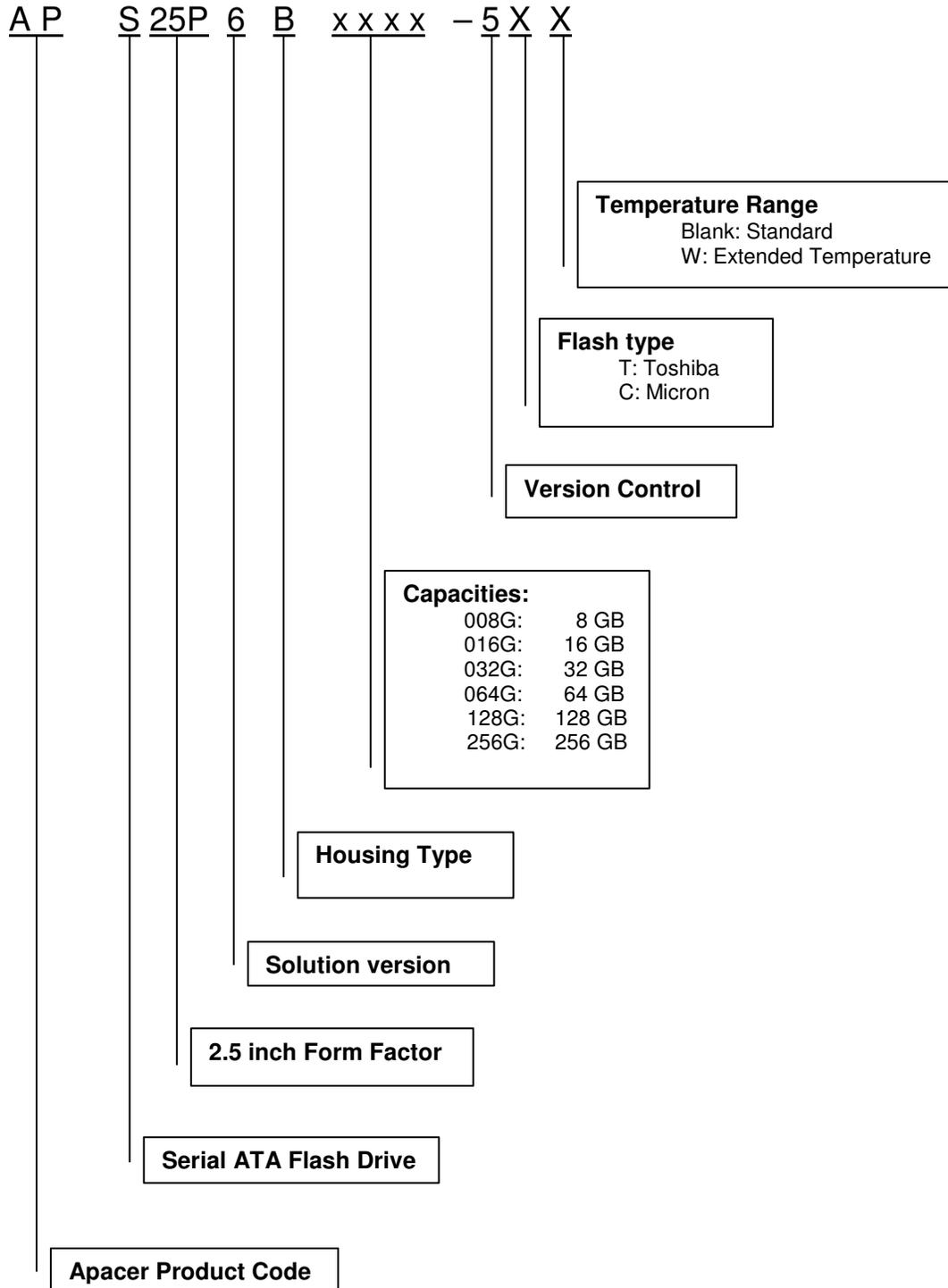
Table 6-1 SAFD 25P w/Metal Housing dimensions

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

Rev. 2.0

7. Product Ordering Information

7.1   Product Code Designations

A P   S 25P 6 B   x x x x − 5 X X

Temperature Range
    Blank: Standard
    W: Extended Temperature

Flash type
    T: Toshiba
    C: Micron

Version Control

Capacities:
008G:	8 GB
016G:	16 GB
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

Rev. 2.0

7.2   Valid Combinations

Capacity	Standard	Extended Temperature
8 GB	APS25P6B008G-5T	APS25P6B008G-5TW
16 GB	APS25P6B016G-5T	APS25P6B016G-5TW
32 GB	APS25P6B032G-5T	APS25P6B032G-5TW
64 GB	APS25P6B064G-5T	APS25P6B064G-5TW
128 GB	APS25P6B128G-5C	APS25P6B128G-5CW
256 GB	APS25P6B256G-5C	APS25P6B256G-5CW

Note: Please consult with Apacer sales representatives for availabilities.

Rev. 2.0

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
1.7	Added Endurance section Revised environmental specifications	05/24/2012
1.8	Updated Product Ordering Information due to firmware upgrade	11/09/2012
1.9	8GB and 16GB have been added and become available Environmental specifications updated from RoHS to RoHS Recast	02/01/2013
2.0	Updated Product Ordering Information due to firmware upgrade	05/13/2013

Global Presence

Taiwan (Headquarters)

Apacer Technology Inc.
4th Fl., 75 Hsin Tai Wu Rd., Sec.1
Xizhi, New Taipei City
Taiwan 221
R.O.C.
Tel: +886-2-2698-2888
Fax: +886-2-2698-2889
amtsales@apacer.com

U.S.A.

Apacer Memory America, Inc.
386 Fairview Way, Suite102,
Milpitas, CA 95035
Tel: 1-408-518-8699
Fax: 1-408-935-9611
sa@apacerus.com

Japan

Apacer Technology Corp.
5F, Matsura Bldg., Shiba, Minato-Ku
Tokyo, 105-0014, 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: 31-40-267-0000#6199
sales@apacer.nl

China

Apacer Electronic (Shanghai) Co., Ltd
1301, No.251,Xiaomuqiao Road, Shanghai,
200032, China
Tel: 86-21-5529-0222
Fax: 86-21-5206-6939
sales@apacer.com.cn

India

Apacer Technologies Pvt Ltd,
535, 1st Floor, 8th cross, JP Nagar 3rd Phase,
Bangalore – 560078, India
Tel: 91-80-4152-9061
sales_india@apacer.com