

***RoHS Compliant***

# **Serial ATA Flash Drive**

***SFD25A Product Specifications***

**October 7<sup>th</sup>, 2014**

***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](http://www.apacer.com)

## Features:

- **Compliance with SATA Revision 3.1**
  - Serial ATA Revision 3.1
  - SATA 6.0 Gbps interface
  - Backward compatible with SATA 1.5 and 3.0 Gbps interfaces
  - ATA-8 command set
- **Capacities**
  - 8, 16, 32, 64, 128 GB
- **Performance\***
  - Interface burst read/write: 600 MB/sec
  - Standard speed:
    - Sustained read: up to 160 MB/sec
    - Sustained write: up to 150 MB/sec
  - High speed:
    - Sustained read: up to 530 MB/sec
    - Sustained write: up to 445 MB/sec
    - Random read (4K): up to 82,000 IOPS
    - Random write (4K): up to 76,000 IOPS
- **Flash Management**
  - Built-in hardware ECC, enabling up to 40 bit correction per 1K bytes
  - Static/dynamic wear leveling
  - Flash bad-block management
  - S.M.A.R.T.
  - Power Failure Management
  - ATA Secure Erase
  - TRIM
- **NAND Flash Type:** SLC
- **Temperature ranges**
  - Operating:
    - Standard: 0 °C to 70 °C
    - Extended: -40 °C to 85 °C
  - Storage: -40 °C to 100 °C
- **Supply voltage**
  - 5.0 V  $\pm$  5%
- **Power consumption (typical)\***
  - Standard:
    - Active mode: 275 mA
    - Idle mode: 105 mA
  - High speed:
    - Active mode: 470 mA
    - Idle mode: 95 mA
- **Form factor**
  - 2.5"
  - Dimensions with 7mm enclosure: 100.00 x 69.85 x 6.90, unit: mm
  - Dimensions with 9.5mm enclosure: 100.00 x 69.84 x 9.30, unit: mm
- **Connector**
  - 7-pin SATA signal connector
  - 15-pin SATA power connector
- **Shock & Vibration\*\***
  - Shock: 1500 G
  - Vibration: 15 G
- **SATA power management modes**
- **Device Sleep mode (optional)**
- **RoHS compliant**

\*The values addressed here are typical and may vary depending on settings and platforms.

\*\*Non-operating

---

## Table of Contents

<b>1. Product Description .....</b>	<b>3</b>
1.1 Introduction .....	3
1.2 Capacity Specification .....	3
1.3 Performance.....	3
1.4 Pin Assignments.....	4
<b>2. Software Interface .....</b>	<b>6</b>
2.1 Command Set .....	6
2.2 S.M.A.R.T.....	6
<b>3. Flash Management .....</b>	<b>8</b>
3.1 Error Correction/Detection.....	8
3.2 Bad Block Management .....	8
3.3 Wear Leveling .....	8
3.4 Power Failure Management.....	8
3.5 ATA Secure Erase.....	8
3.6 TRIM .....	9
3.7 SATA Power Management .....	9
<b>4. Reliability Specifications .....</b>	<b>10</b>
4.1 Environmental .....	10
4.2 Mean Time Between Failures (MTBF).....	10
4.3 Certification and Compliance .....	10
<b>5. Electrical Characteristics .....</b>	<b>11</b>
5.1 Operating Voltage .....	11
5.2 Power Consumption .....	11
<b>6. Mechanical Specifications .....</b>	<b>12</b>
6.1 7mm Type Dimensions .....	12
6.2 9.5mm Type Dimensions .....	13
<b>7. Product Ordering Information .....</b>	<b>14</b>
7.1 Product Code Designation.....	14
7.2 Valid Combination.....	15

# 1. Product Description

## 1.1 Introduction

Apacer's SFD25A 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 Specification

**Table 1-1** Capacity specification

Capacity	Total Bytes*	Cylinders	Heads	Sectors	Max LBA*
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
128 GB	128,035,676,160	16,383	16	63	250,069,680

\*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.

## 1.3 Performance

**Table 1-2** Performance (Standard)

Capacity Performance	8 GB	16 GB	32 GB	64 GB	128 GB
<b>Sustained Read (MB/s)</b>	155	155	160	160	160
<b>Sustained Write (MB/s)</b>	110	145	145	150	150

**Table 1-3** Performance (High-speed)

Capacity Performance	32 GB	64 GB	128 GB
<b>Sustained Read (MB/s)</b>	530	530	530
<b>Sustained Write (MB/s)</b>	270	440	445
<b>Random Read IOPS (4K)</b>	81,000	82,000	82,000
<b>Random Write IOPS (4K)</b>	62,000	73,000	76,000

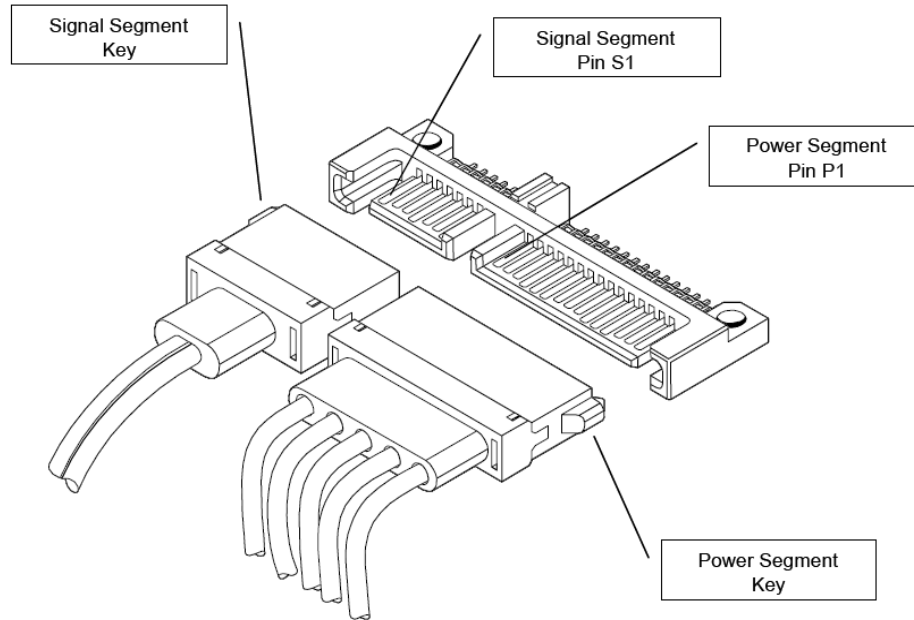
Note: Performance varies from flash configurations or host system settings.

IOPS: measured on 8GB span (16777216 sectors Disk Size), 32 Outstanding I/Os (QD=32), Full Random Data pattern, 4KB Align I/Os and test durations 15minutes.

## 1.4 Pin Assignments

Table 1-4 describes the SFD signal segment, and Table 1-5, power segment.

**Figure 1-1** SATA Connectors



**Table 1-4:** Signal segment

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

**Table 1-5:** Power segment

Pin	Signal/Description
P1	Unused (3.3V)
P2	Unused (3.3V)
P3	Unused or 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)

\*P3 can be configured as Device Sleep trigger by option

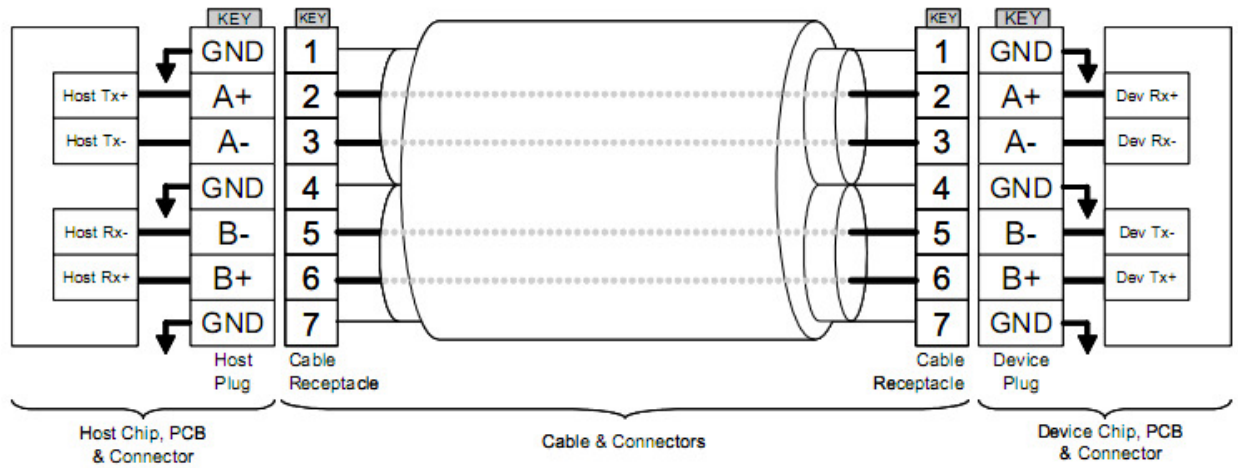


Figure 1-3 SATA Cable/Connector Connection Diagram

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.

## 2. Software Interface

### 2.1 Command Set

Table 2-1 summarizes the ATA commands supported by SFD25A.

**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	Read Sector(s)	Cah	Write DMA
40 or	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	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.

# Serial ATA Flash Drive

## APS25AXXxxxx-XTX



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 (Hex)	Attribute Name
9 (0x09)	Power-on hours
12 (0x0C)	Power cycle count
163 (0xA3)	Max. erase count
164 (0xA4)	Avg. erase count
166 (0xA6)	Total later bad block count
167 (0xA7)	SSD Protect Mode (vendor specific)
168 (0xA8)	SATA PHY Error Count
175 (0xAF)	Bad Cluster Table Count
192 (0xC0)	Unexpected Power Loss Count
194 (0xC2)	Temperature
241 (0xF1)	Total sectors of write



---

## 3. Flash Management

### 3.1 Error Correction/Detection

---

SFD25A implements a hardware ECC scheme, based on the BCH algorithm. It can detect and correct up to 40 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 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.

---

## 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  $\mu$ 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:

1. The behaviors of power management features would depend on host/device settings.
2. Device Sleep mode is optional, depending on product ordering selections.

---

## 4. Reliability Specifications

### 4.1 Environmental

---

SFD25A environmental specifications follow MIL-STD-810F, as indicated in the following table.

**Table 4-1** SFD25A environmental specifications

Environment	Specification
Temperature	0°C to 70°C (Operating) / -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

### 4.2 Mean Time Between Failures (MTBF)

---

Mean Time Between Failures (MTBF) is predicted based on reliability data for the individual components in SFD drive. The prediction result for the SFD25A 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

---

SFD25A complies with the following standards:

- CE
- FCC
- RoHS
- MIL-STD-810F

## 5. Electrical Characteristics

### 5.1 Operating Voltage

Table 5-1 lists the supply voltage for SFD25A.

**Table 5-1** SFD25A operating voltage

Parameter	Conditions
Supply voltage	5V $\pm$ 5% ( 4.75-5.25 V)

### 5.2 Power Consumption

**Table 5-2** Power consumption (Standard)

Mode \ Capacity	8 GB	16 GB	32 GB	64 GB	128 GB
Active (mA)	220	275	275	275	275
Idle (mA)	100	100	100	100	105

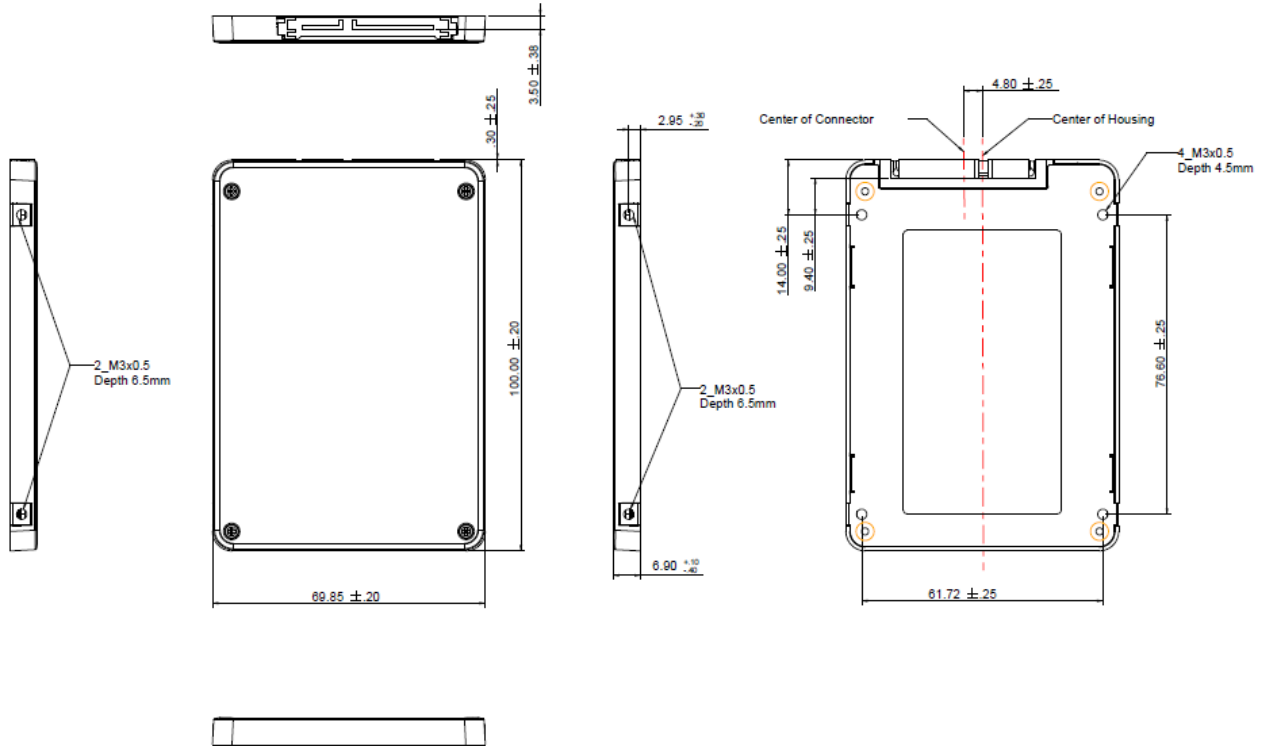
**Table 5-2** Power consumption (High-speed)

Mode \ Capacity	32 GB	64 GB	128 GB
Active (mA)	320	460	470
Idle (mA)	95	95	95

Note: Power consumptions may vary depending on settings and platforms.

## 6. Mechanical Specifications

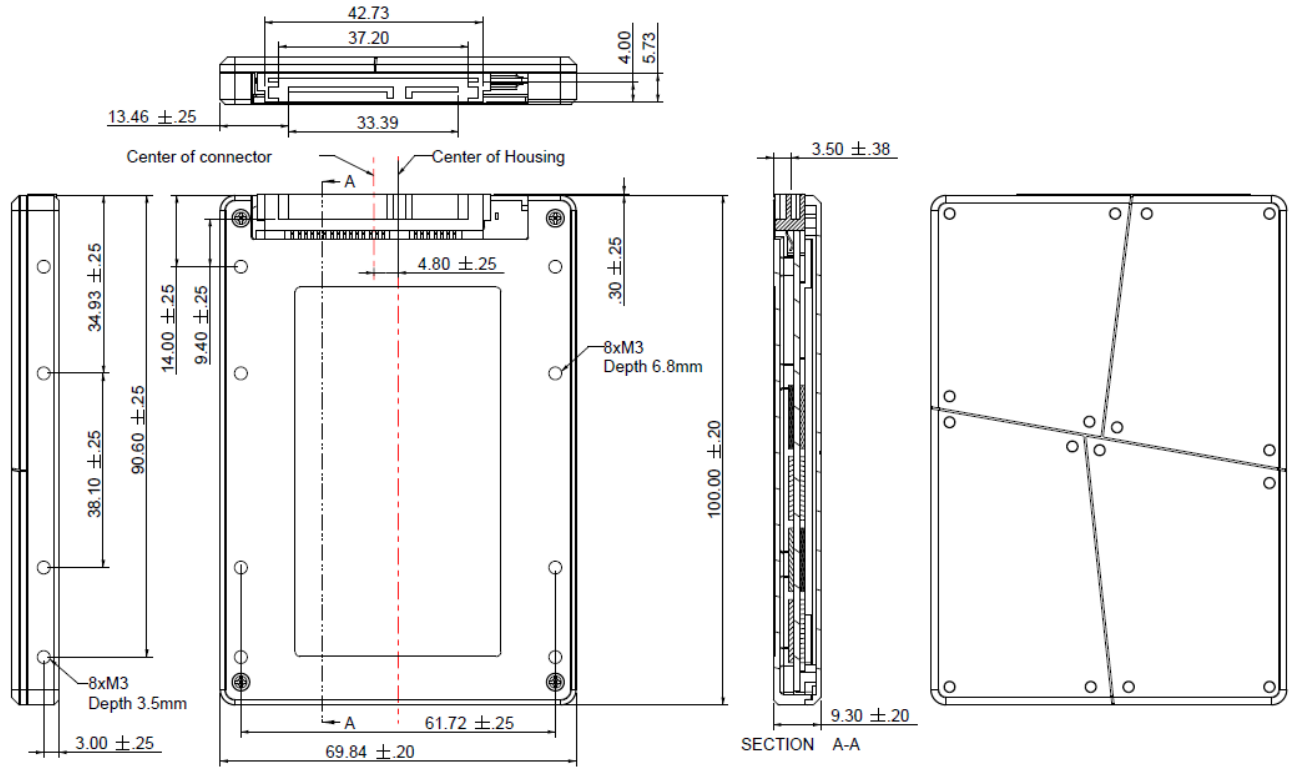
### 6.1 7mm Type Dimensions



Unit: mm  
Tolerance:  $\pm 0.2$

Figure 6-1 SFD25A with 7mm Housing physical dimensions

## 6.2 9.5mm Type Dimensions

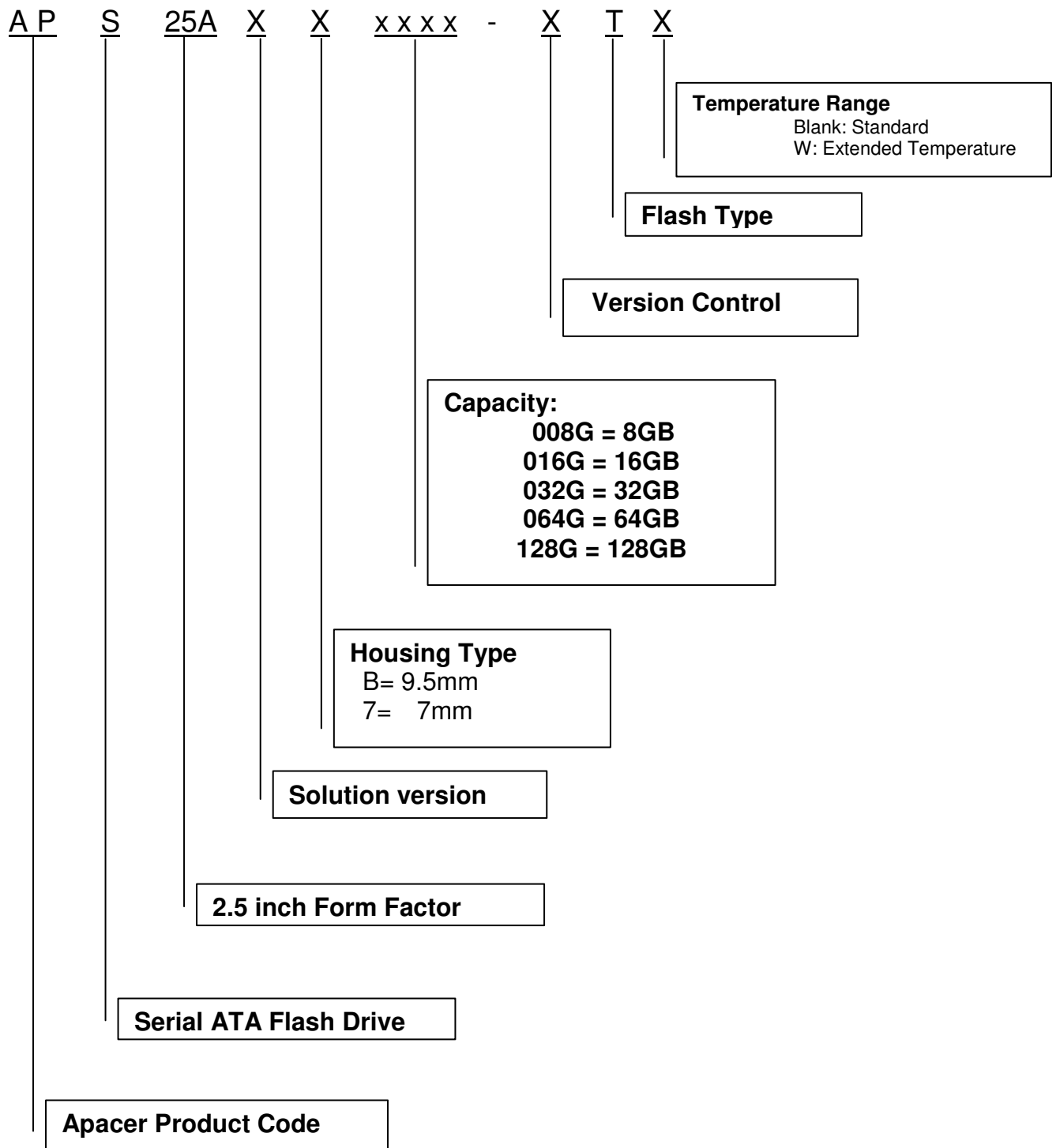


Unit: mm  
 Tolerance:  $\pm 0.2$

Figure 6-2 SFD25A with 9.5mm Housing physical dimensions

## 7. Product Ordering Information

### 7.1 Product Code Designation



## 7.2 Valid Combination

### A. Standard Speed

#### 7.2.1 9.5mm Metal Housing / Operating Temperature (0°C ~ 70°C)

Capacity	NO DEVSLP	DEVSLP
8 GB	APS25ABB008G-AT	APS25ABB008G-BT
16GB	APS25ABB016G-AT	APS25ABB016G-BT
32GB	APS25ABB032G-AT	APS25ABB032G-BT
64GB	APS25ABB064G-AT	APS25ABB064G-BT
128GB	APS25ABB128G-AT	APS25ABB128G-BT

#### 7.2.2 9.5mm Metal Housing / Operating Temperature (-40°C ~ 85°C)

Capacity	NO DEVSLP	DEVSLP
8 GB	APS25ABB008G-ATW	APS25ABB008G-BTW
16GB	APS25ABB016G-ATW	APS25ABB016G-BTW
32GB	APS25ABB032G-ATW	APS25ABB032G-BTW
64GB	APS25ABB064G-ATW	APS25ABB064G-BTW
128GB	APS25ABB128G-ATW	APS25ABB128G-BTW

#### 7.2.3 7mm Housing / Operating Temperature (0°C ~ 70°C)

Capacity	NO DEVSLP	DEVSLP
8 GB	APS25AB7008G-AT	APS25AB7008G-BT
16GB	APS25AB7016G-AT	APS25AB7016G-BT
32GB	APS25AB7032G-AT	APS25AB7032G-BT
64GB	APS25AB7064G-AT	APS25AB7064G-BT
128GB	APS25AB7128G-AT	APS25AB7128G-BT

#### 7.2.4 7mm Housing / Operating Temperature (-40°C ~ 85°C)

Capacity	NO DEVSLP	DEVSLP
8 GB	APS25AB7008G-ATW	APS25AB7008G-BTW
16GB	APS25AB7016G-ATW	APS25AB7016G-BTW
32GB	APS25AB7032G-ATW	APS25AB7032G-BTW
64GB	APS25AB7064G-ATW	APS25AB7064G-BTW
128GB	APS25AB7128G-ATW	APS25AB7128G-BTW



---

## B. High Speed

### 7.2.5 9.5mm Metal Housing / Operating Temperature (0°C ~ 70°C)

Capacity	NO DEVSLP	DEVSLP
32GB	APS25A7B032G-3AT	APS25A7B032G-3BT
64GB	APS25A7B064G-3AT	APS25A7B064G-3BT
128GB	APS25A7B128G-3AT	APS25A7B128G-3BT

### 7.2.6 9.5mm Metal Housing / Operating Temperature (-40°C ~ 85°C)

Capacity	NO DEVSLP	DEVSLP
32GB	APS25A7B032G-3ATW	APS25A7B032G-3BTW
64GB	APS25A7B064G-3ATW	APS25A7B064G-3BTW
128GB	APS25A7B128G-3ATW	APS25A7B128G-3BTW

### 7.2.7 7mm Housing / Operating Temperature (0°C ~ 70°C)

Capacity	NO DEVSLP	DEVSLP
32GB	APS25A77032G-3AT	APS25A77032G-3BT
64GB	APS25A77064G-3AT	APS25A77064G-3BT
128GB	APS25A77128G-3AT	APS25A77128G-3BT

### 7.2.8 7mm Housing / Operating Temperature (-40°C ~ 85°C)

Capacity	NO DEVSLP	DEVSLP
32GB	APS25A77032G-3ATW	APS25A77032G-3BTW
64GB	APS25A77064G-3ATW	APS25A77064G-3BTW
128GB	APS25A77128G-3ATW	APS25A77128G-3BTW

**Note:** Please consult with Apacer sales representatives for availabilities.

---

## Revision History

Revision	Description	Date
1.0	Official release	01/15/2014
1.1	Added 32, 64 and 128GB high speed models	07/10/2014
1.2	Revised Product Ordering Information	08/15/2014
1.3	Revised part numbers of 32GB in high speed models	10/07/2014

---

## 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](mailto: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](mailto: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](mailto: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](mailto: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](mailto: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](mailto:sales_india@apacer.com)

Компания «Океан Электроники» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Поставка оригинальных импортных электронных компонентов напрямую с производств Америки, Европы и Азии, а так же с крупнейших складов мира;
- Широкая линейка поставок активных и пассивных импортных электронных компонентов (более 30 млн. наименований);
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Помощь Конструкторского Отдела и консультации квалифицированных инженеров;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Поставка электронных компонентов под контролем ВП;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- При необходимости вся продукция военного и аэрокосмического назначения проходит испытания и сертификацию в лаборатории (по согласованию с заказчиком);
- Поставка специализированных компонентов военного и аэрокосмического уровня качества (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Actel, Aeroflex, Peregrine, VPT, Syfer, Eurofarad, Texas Instruments, MS Kennedy, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Компания «Океан Электроники» является официальным дистрибьютором и эксклюзивным представителем в России одного из крупнейших производителей разъемов военного и аэрокосмического назначения «JONHON», а так же официальным дистрибьютором и эксклюзивным представителем в России производителя высокотехнологичных и надежных решений для передачи СВЧ сигналов «FORSTAR».



## JONHON

«JONHON» (основан в 1970 г.)

Разъемы специального, военного и аэрокосмического назначения:

(Применяются в военной, авиационной, аэрокосмической, морской, железнодорожной, горно- и нефтедобывающей отраслях промышленности)

«FORSTAR» (основан в 1998 г.)

ВЧ соединители, коаксиальные кабели, кабельные сборки и микроволновые компоненты:

(Применяются в телекоммуникациях гражданского и специального назначения, в средствах связи, РЛС, а так же военной, авиационной и аэрокосмической отраслях промышленности).



Телефон: 8 (812) 309-75-97 (многоканальный)

Факс: 8 (812) 320-03-32

Электронная почта: [ocean@oceanchips.ru](mailto:ocean@oceanchips.ru)

Web: <http://oceanchips.ru/>

Адрес: 198099, г. Санкт-Петербург, ул. Калинина, д. 2, корп. 4, лит. А