# RoHS Compliant Serial ATA Flash Drive

Specifications for SAFD 18P-M

November 30<sup>th</sup>, 2011

Version 1.3



Apacer Technology Inc. 4<sup>th</sup> Fl., 75 Hsin Tai Wu Rd., Sec.1, Hsichih, New Taipei City, Taiwan 221 Tel: +886-2-2698-2888 Fax: +886-2-2698-2889 www.apacer.com



### **Features**:

- Standard Serial ATA 2.6
  - Serial ATA 2.6
  - SATA II, 3.0 Gbps
  - ATA-compatible command set
- Capacities
  - 16, 32, 64, 128, 256 GB

#### • Performance\*

- Burst read/write: 300 MB/sec
- Sustained read: up to 250 MB/sec
- Sustained write: up to 165 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
- NAND Flash Type: MLC

- Zero power data retention
   No battery required for data storage
- Temperature ranges – Operation: Standard: 0°C to 70°C (32 ~ 158°F) Extended: -40 ~ +85°C (-40° ~ 185°F)\*\*
  - Storage: -40°C to 100°C (-40° ~ 212°F)
- Supply voltage
- Cache on board: 64 MB
- Power consumption (Typical)\*
  - Active mode(Max): 819 mA
    - Idle mode: 194 mA
- Form factor
  - 1.8 inch SATA Flash Drive (78.5 x 54 x 5, unit: mm)
- Connector
  - 7-pin SATA male connector
  - 9-pin SATA power connector

#### Shock & Vibration

- Shock: 50g (approx.)
- Vibration: 15g (approx.)

#### RoHS compliant

\*Varies from capacities. The values addressed in the Performance and Power consumption are typical and may vary depending on settings and platforms.

\*\*Only available in 32, 64, 128GB capacities. Please see "Product Ordering Information" for further details.



## **Table of Contents**

| 1. | Pro  | duct Description3                   |
|----|------|-------------------------------------|
|    | 1.1  | Introduction                        |
|    | 1.2  | Functional Block Diagram            |
|    | 1.3  | ATA Mode Support4                   |
|    | 1.4  | Capacity Specification4             |
|    | 1.5  | Performance4                        |
|    | 1.6  | Pin Assignments                     |
| 2. | Sof  | tware Interface7                    |
|    | 2.1  | Command Set7                        |
|    | 2.2  | S.M.A.R.T                           |
| 3. | Flas | sh Management10                     |
|    | 3.1  | Error Correction/Detection          |
|    | 3.2  | Bad Block Management                |
|    | 3.3  | Wear Leveling                       |
|    | 3.4  | Power Failure Management10          |
|    | 3.5  | ATA Secure Erase10                  |
| 4. | EN\  | /IRONMENTAL SPECIFICATIONS          |
|    | 4.1  | Environments11                      |
|    | 4.2  | Mean Time Between Failures (MTBF)11 |
|    | 4.3  | Certification and Compliance11      |
| 5. | Ele  | ctrical Characteristics12           |
|    | 5.1  | Operating Voltage                   |
|    | 5.2  | Power Consumption                   |
|    | 5.3  | Electrostatic Discharge             |
|    | 5.4  | Electrical Fast Transient/Burst     |
| 6. | Phy  | vsical Characteristics14            |
| 7. | Pro  | duct Ordering Information16         |
|    | 7.1  | Product Code Designations           |
|    | 7.2  | Valid Combinations                  |



## **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. Though built with MLC, this SSD can work in highly demanding environment as it can withstand ambient temperature from -40°C to +85°C (for certain capacities only).

SAFD 18P-M drive is designed with a single-chip controller, offering capacities of up to 128 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, SAFD 18P-M adopts 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. SAFD 18P-M provides the S.M.A.R.T. feature that follows the SATA Rev. 2.6 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 18P-M 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.

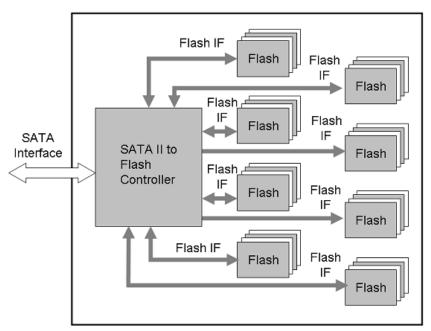


Figure 1-1 Apacer SAFD 18P-M block diagram



### **1.3 ATA Mode Support**

SAFD 18P-M 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 specifications of SAFD 18P-M product family are 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.

| Capacity | Total Bytes     | Cylinders | Heads | Sectors | Max LBA*    |
|----------|-----------------|-----------|-------|---------|-------------|
| 16 GB    | 16,013,942,784  | 16383     | 16    | 63      | 31,277,232  |
| 32 GB    | 32,017,047,752  | 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 |
| 256 GB   | 253,437,379,584 | 16,383    | 16    | 63      | 494,994,882 |

\*Cylinders, heads or sectors are not applicable for these capacities. Only LBA addressing applies.

### 1.5 Performance

Performances of SAFD 18P-M is shown in Table 1-2.

 Table 1-2 Performance specification

| Capacity<br>Performance   | 16 GB | 32 GB | 64 GB | 128 GB | 256 GB |
|---------------------------|-------|-------|-------|--------|--------|
| Sustained Read<br>(MB/s)  | 200   | 200   | 250   | 250    | 250    |
| Sustained Write<br>(MB/s) | 50    | 50    | 80    | 155    | 165    |

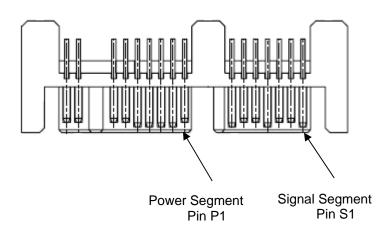
Note: Performances vary from flash configurations.



### 1.6 Pin Assignments

Table 1-3 describes SAFD 18P-M signal segment, and Table1-4, its power segment.

#### Figure 1-2 Micro-SATA Connectors



| Table 1-3 Signal segment | Table | 1-3 | Signal | segment |
|--------------------------|-------|-----|--------|---------|
|--------------------------|-------|-----|--------|---------|

| Name | Туре | Description                    |
|------|------|--------------------------------|
| S1   | GND  |                                |
| S2   | RxP  | + Differential Receive Signal  |
| S3   | RxN  | - Differential Receive Signal  |
| S4   | GND  |                                |
| S5   | TxN  | - Differential Transmit Signal |
| S6   | ТхР  | + Differential Transmit Signal |
| S7   | GND  |                                |

Table 1-4 Power segment

| Pin | Туре     | Signal/Description |
|-----|----------|--------------------|
| P1  | V33      | 3.3 V Power        |
| P2  | V33      | 3.3 V Power        |
| P3  | GND      |                    |
| P4  | GND      |                    |
| P5  | V5       | 5 V Power          |
| P6  | V5       | 5 V Power          |
| P7  | GND      | Ground/Reserved    |
| P8  | Optional | NC                 |
| P9  | Optional | NC                 |



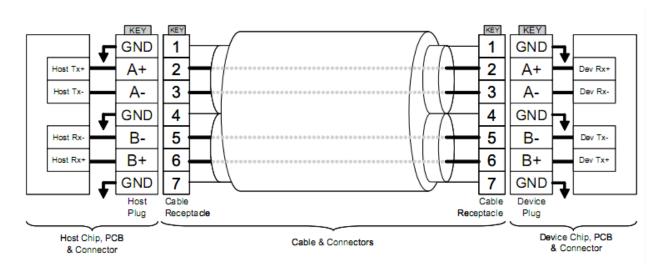


Figure 1-3 SATA Cable/Connector Connection Diagram

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 SAFD 18P-M.

| Command                     | Code       | FR <sup>1</sup> | SC <sup>2</sup> | SN <sup>3</sup> | CY⁴ | DH⁵            | LBA <sup>6</sup> |
|-----------------------------|------------|-----------------|-----------------|-----------------|-----|----------------|------------------|
| Check-Power-Mode E5H        |            | -               | -               | -               | -   | D <sup>8</sup> | -                |
| 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 <sup>7</sup>  | -               | -               | -   | D              | -                |

Table 2-1 Command set (1 of 2)



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

| Command           | Code | <b>F</b> R <sup>1</sup> | SC <sup>2</sup> | SN <sup>3</sup> | CY⁴ | DH⁵ | LBA <sup>6</sup> |
|-------------------|------|-------------------------|-----------------|-----------------|-----|-----|------------------|
| Set-Multiple-Mode | С6Н  | -                       | Y               | -               | -   | D   | -                |
| Sleep             | E6H  | -                       | -               | -               | -   | D   | -                |
| SMART             | B0H  | Y                       | Y               | Y               | Y   | D   |                  |
| Standby           | E2H  | -                       | -               | -               | -   | D   | -                |
| Standby-Immediate | E0H  | -                       | -               | -               | -   | D   | -                |
| Write-DMA         | САН  | -                       | 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

SC - Sector Count register
 SN - Sector Number register

4. CY - Cylinder registers5. 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 SAFD 18P-M uses the standard SMART command B0h to read data from the drive for SMART feature as the SATA Rev.2.6 specification. Based on the SFF-8035i Rev. 2.0 specifications, Apacer SMART defines 3 vendor-specified SMART Attribute IDs (E5h, EAh-EBh, and E8h) in SAFD 18P-M. They represent Flash ID, maximum erase count, average erase count, good block count, free-list block count, and firmware version information. When the Apacer SMART Utility running on the host, it analyzes and reports the disk status to the host before SAFD 18P-M is in critical condition.



## 3. Flash Management

### 3.1 Error Correction/Detection

SAFD 18P-M 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 18P-M'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 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.



## 4. ENVIRONMENTAL SPECIFICATIONS

### 4.1 Environments

SAFD 18P-M environmental specifications follow the US Military Standard MIL-STD-810F, as shown in Table 4-1.

| Environment       | Specification   |  |  |
|-------------------|---|--|--|
| Terrerereture     | $0^{\circ}$ C to $70^{\circ}$ C (Operating – Standard), -40 ~ +85^{\circ}C (Operating-extended) |  |  |
| Temperature       | -40°C to 100°C (Non-operating)  |  |  |
| Humidity          | 5% to 95% RH (Non-condensing)   |  |  |
| Vibration         | Sine wave: 5~55~5 Hz (X, Y, Z)<br>Random: 10-2000 Hz, 16.3 G (X, Y, Z)                          |  |  |
| Shock - Operating | Acceleration: 1,500 G, 0.5 ms<br>Peak acceleration: 50 G, 11 ms                                 |  |  |
| Altitude          | 80,000 ft   |  |  |

Table 4-1 SAFD 18P-M environmental specifications

\*Extended Temperature specification is only available in 32, 64, 128GB capacities.

### 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 18P-M is more than 1,000,000 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 18P-M drive 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.)



## 5. Electrical Characteristics

### 5.1 Operating Voltage

Table 5-1 lists the supply voltage for SAFD 18P-M.

| Table 5-1 | SAFD | 18P-M o | perating | voltage |
|-----------|------|---------|----------|---------|
|-----------|------|---------|----------|---------|

| Parameter      | Conditions                                    |
|----------------|---|
| Supply voltage | 3.3V ±5% (3.135-3.465V) / 5V ±5% (4.75-5.25V) |

### 5.2 **Power Consumption**

The following table displays the power consumption information for capacities of SAFD 18P-M.

Table 5-2 SAFD 18P-M power consumption (Typical)

| Capacity<br>Mode    | 16 GB | 32 GB | 64 GB | 128 GB | 256 GB |
|---------------------|-------|-------|-------|--------|--------|
| Active Mode<br>(mA) | 470   | 472   | 540   | 790    | 819    |
| Idle Mode<br>(mA)   | 190   | 194   | 197   | 206    | 206    |

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

### 5.3 Electrostatic Discharge

#### Electrostatic discharge

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



| Indirect                 | 25 | +4kV | В | А |
|--------------------------|----|------|---|---|
| Discharge<br>(VCP Left)  | 25 | -4kV | В | A |
| Indirect                 | 25 | +4kV | В | A |
| Discharge<br>(VCP Back)  | 25 | -4kV | В | А |
| Indirect                 | 25 | +4kV | В | A |
| Discharge<br>(VCP Right) | 25 | -4kV | В | A |

### 5.4 Electrical Fast Transient/Burst

Electrical Fast Transient/Burst

| Inject<br>Line | Polarity | Voltage<br>kV | Inject<br>Time<br>(Second) | Inject<br>Method | Required<br>Criteria | Complied<br>to<br>Criteria |
|----------------|----------|---------------|----------------------------|------------------|----------------------|----------------------------|
| L-N-PE         | ±        | 1kV           | 60                         | Direct           | В                    | А                          |

#### Notes about Electrostatic Discharge & 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

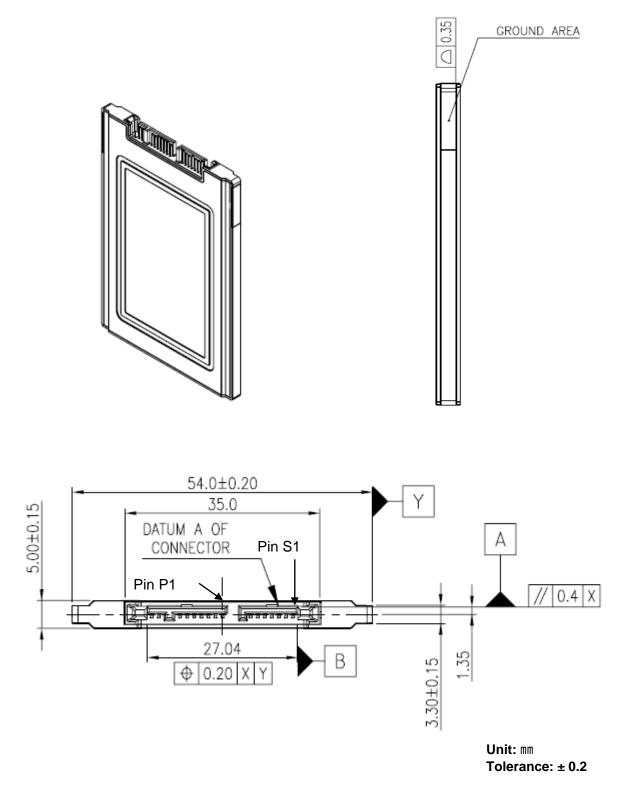
Additional Information:

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.

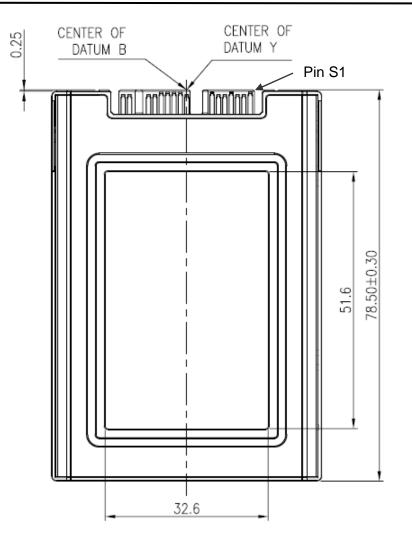
The Contact discharges were applied at least total 200 discharges at a minimum of four test points.



## 6. Physical Characteristics





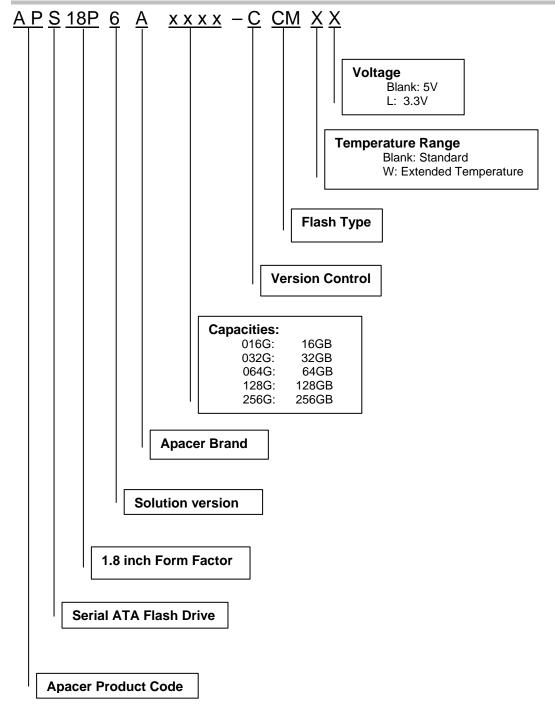


Unit: mm Tolerance: ± 0.2



## 7. Product Ordering Information

### 7.1 Product Code Designations





### 7.2 Valid Combinations

#### SAFD18P (voltage: 5V)

| Capacity | Standard         | Extended Temperature |
|----------|------------------|----------------------|
| 16 GB    | APS18P6A016G-CCM |                      |
| 32 GB    | APS18P6A032G-CCM | APS18P6A032G-CCMW    |
| 64 GB    | APS18P6A064G-CCM | APS18P6A064G-CCMW    |
| 128 GB   | APS18P6A128G-CCM | APS18P6A128G-CCMW    |
| 256 GB   | APS18P6A256G-CCM |                      |

#### SAFD18P (voltage: 3.3V)

| Capacity | Standard          | Extended Temperature |
|----------|-------------------|----------------------|
| 16 GB    | APS18P6A016G-CCML |                      |
| 32 GB    | APS18P6A032G-CCML | APS18P6A032G-CCMWL   |
| 64 GB    | APS18P6A064G-CCML | APS18P6A064G-CCMWL   |
| 128 GB   | APS18P6A128G-CCML | APS18P6A128G-CCMWL   |
| 256 GB   | APS18P6A256G-CCML |                      |

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       |
|----------|---|------------|
| 0.1      | Preliminary release   | 01/19/2010 |
| 1.0      | Official release  | 08/05/2011 |
| 1.1      | Version updates   | 11/07/2011 |
|          | <ul> <li>Corrected power consumption</li> </ul>   |            |
|          | <ul> <li>Added information about electrostatic discharge and<br/>electrical fast transient/burst</li> </ul> |            |
|          | <ul> <li>Added information about shock and vibration on the<br/>Feature page</li> </ul>                     |            |
|          | <ul> <li>Temperatures in Fahrenheit are added on the<br/>Feature page</li> </ul>                            |            |
| 1.2      | Version updates   | 11/11/2011 |
|          | <ul> <li>Updated performance and power consumption</li> </ul>   |            |
|          | <ul> <li>Updated address for our European base</li> </ul>   |            |
|          | ■ Updated POI   |            |
| 1.3      | Version updates   | 11/30/2011 |
|          | Extended operating temperature  |            |



## **Global Presence**

| Taiwan (Headquarters) | Apacer Technology Inc.<br>4 <sup>th</sup> Fl., 75 Hsin Tai Wu Rd., Sec.1<br>Hsichih, New Taipei City<br>Taiwan 221<br>R.O.C.<br>Tel: +886-2-2698-2888<br>Fax: +886-2-2698-2889<br>amtsales@apacer.com |
|-----------------------|---|
| U.S.A.                | Apacer Memory America, Inc.<br>386 Fairview Way, Suite102,<br>Milpitas, CA 95035<br>Tel: 1-408-518-8699<br>Fax: 1-408-935-9611<br><u>sa@apacerus.com</u>  |
| Japan                 | Apacer Technology Corp.<br>5F, Matsura Bldg., Shiba, Minato-Ku<br>Tokyo, 105-0014, Japan<br>Tel: 81-3-5419-2668<br>Fax: 81-3-5419-0018<br>jpservices@apacer.com                                       |
| Europe                | Apacer Technology B.V.<br>Science Park Eindhoven 5051 5692 EB Son,<br>The Netherlands<br>Tel: 31-40-267-0000<br>Fax: 31-40-267-0000#6199<br>sales@apacer.nl   |
| China                 | Apacer Electronic (Shanghai) Co., Ltd<br>1301, No.251,Xiaomuqiao Road, Shanghai,<br>200032, China<br>Tel: 86-21-5529-0222<br>Fax: 86-21-5206-6939<br>sales@apacer.com.cn                              |
| India                 | Apacer Technologies Pvt Ltd,<br>#1064, 1st Floor, 7th 'A' Main,<br>3rd Block Koramangala, Bangalore – 560 034<br>Tel: +91 80 4152 9061/62/63<br>Fax: +91 80 4170 0215<br>sales_india@apacer.com       |