

*RoHS Compliant*

# **SATA-Disk Module 3**

*Specification for 7P/270D*

**July 18, 2011**

*Version 1.1*



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

## SATA-Disk Module 3

### AP-SDMxxxx8AANS-XXTX

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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**
  - 512 MB, 1, 2, 4 GB
- **Performance\***
  - Burst read/write: 300 MB/sec
  - Sustained read: up to 30 MB/sec
  - Sustained write: up to 10 MB/sec
- **Intelligent endurance design**
  - Built-in hardware ECC, enabling up to 14/28 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**
- **Zero power data retention**
  - No battery required for data storage
- **Temperature ranges**
  - Operation:
    - Standard: 0°C to 70°C
    - Extended Temperature: -40°C to 85°C
  - Storage: -40°C to 100°C
- **Supply voltage**
  - 5.0 V  $\pm$  5%
- **Low power consumption\***
  - Active mode: 205 mA@5.0 V
  - Idle mode: 95 mA@5.0 V
- **Connector type**
  - 7-pin signal connector
  - 2-pin power connector
- **RoHS compliant**

\*Varies from capacities.

\*Based on 512MB capacity.

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# **SATA-Disk Module 3**

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## **1. General Description**

Apacer's SATA-Disk Module 3 (SDM3) is a high-performance, embedded SSD designed to replace the conventional SATA hard disk drive. SDM SSD can be plugged into a standard Serial ATA 7-pin connector commonly found in desktops, IT-STB, industrial PC and thin client systems. Moreover, Apacer provides an innovative way for design-in customers to strengthen the vibration-resistance between SDM3 and mainboard.

Apacer's SDM3 has a built-in microcontroller with file management firmware that communicates with SATA standard interface. This means SDM3 does not require additional or proprietary host software such as Flash File System (FFS) and Memory Technology Driver (MTD). This product is well suited for embedded flash storage applications offering new and expanded functionalities as well as more cost-effective designs, better performance and increased reliability.

SDM3 Series is designed to work at 5 Volts and uses a standard SATA driver that complies with major operating systems such as Microsoft's Windows series.

Featuring technologies as Apacer-specific Wear-leveling algorithms, S.M.A.R.T, Enhanced Data Integrity, Intelligent Power Failure Recovery, ATA Secure Erase, and TRIM, Apacer assures users of a versatile device on data storage.

### **1.1 Performance-Optimized Controller**

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The heart of SDM3 is the Flash controller, which translates standard SATA signals into the data and controls of the flash media. The SATA and Flash Management controller are specifically designed to attain high data throughput from the host to the flash.

#### **1.1.1 Power Management Unit (PMU)**

The power management unit (PMU) controls the power consumption of SDM3. It can dramatically extend product battery life by leaving the idle part of the circuitry into sleep mode. The PMU has zero wake-up latency.

#### **1.1.2 SRAM Buffer**

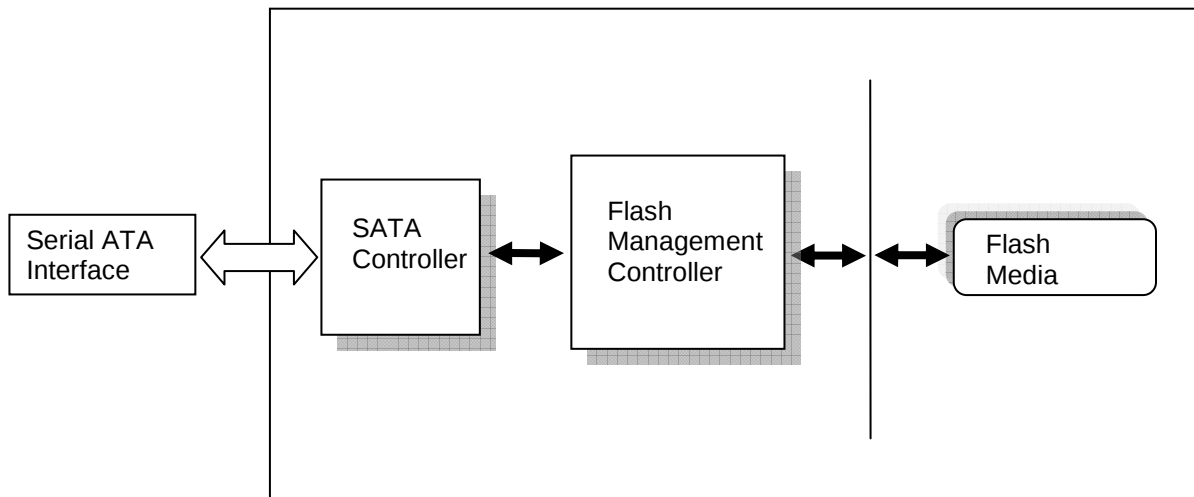
The Flash Controller performs as a SRAM buffer to optimize the host's data transfer to and from the flash media.

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## 2. Functional Block

SDM3 includes the SATA and Flash Management controllers, and flash media, as well as the SATA standard interface. Figure 2-1 shows the functional block diagram.

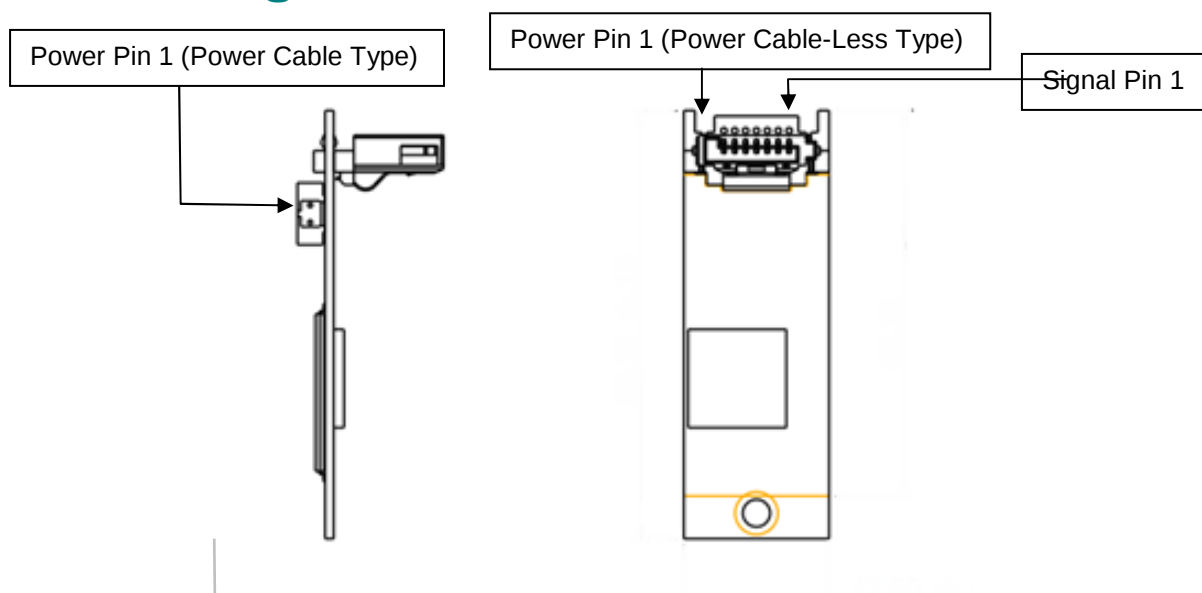


**Figure 2-1:** Functional block diagram

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### 3. Pin Assignments



**Table 3-1:** 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 3-2:** Power segment

| Pin | Signal/Description |
|-----|--------------------|
| P1  | VCC (5V)           |
| P2  | GND                |

The diagram illustrates the internal wiring of a USB cable. On the left, the Host side features a Host Plug with pins 1 through 7. Pins 1, 4, and 7 are Ground (GND). Pins 2 and 3 are Data+ (A+) and Data- (A-) respectively. Pins 5 and 6 are Data- (B-) and Data+ (B+) respectively. The Host Plug is connected to the Host Chip, PCB & Connector. On the right, the Device side features a Device Plug with pins 1 through 7. Pins 1, 4, and 7 are Ground (GND). Pins 2 and 3 are Data+ (A+) and Data- (A-) respectively. Pins 5 and 6 are Data- (B-) and Data+ (B+) respectively. The Device Plug is connected to the Device Chip, PCB & Connector. The Cable & Connectors section shows the internal wiring connecting the Host Plug to the Device Plug.

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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## 4. Capacity Specification

Capacity specification of SDM3 product family is available as shown in Table 4-1. It lists the specific capacity and the default numbers of heads, sectors and cylinders for each product line.

**Table 4-1:** Capacity specifications

| Capacity | Total bytes*  | Cylinders | Heads | Sectors | Max LBA   |
|----------|---------------|-----------|-------|---------|-----------|
| 512 MB   | 494,936,064   | 959       | 16    | 63      | 966,672   |
| 1 GB     | 988,839,936   | 1916      | 16    | 63      | 1,931,328 |
| 2 GB     | 1,982,324,736 | 3841      | 16    | 63      | 3,871,728 |
| 4 GB     | 3,952,263,168 | 7658      | 16    | 63      | 7,719,264 |

\*Display of total bytes varies from file systems.

### 4.1 Performance Specification

#### 4.1.1 ATA Mode Support

SDM3 supports the following ATA operating modes:

- Supports up to PIO Mode-4
- Supports up to Multi-word DMA Mode-2
- Supports up to Ultra DMA Mode-5

#### 4.1.2 Performance

Performances of SDM3 are listed below in table 4-2.

**Table 4-2:** Performance

| Capacity               | 512 MB | 1 GB | 2 GB | 4 GB |
|------------------------|--------|------|------|------|
| Performance            |        |      |      |      |
| Sustained read (MB/s)  | 25     | 30   | 30   | 30   |
| Sustained write (MB/s) | 5      | 10   | 10   | 10   |

Note: Results may differ from various flash configurations.

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### 4.2 Environmental Specifications

Environmental specification of SDM3 product family which follows the MIL-STD-810F standards is available as shown in Table 4-3.

**Table 4-3** SDM3 environmental specifications

| Item                    | Specification                                     |
|-------------------------|---------------------------------------------------|
| operating temp.         | 0~70(°C) <sup>*1</sup> ; -40~85(°C) <sup>*2</sup> |
| non-operating temp.     | -40~100(°C)                                       |
| humidity                | 10~95% R.H, 30(°C) max. wet bulb temp., operating |
| operating vibration     | 10~2000(Hz), 15(G), sine wave                     |
| non-operating vibration | 20~2000(Hz), 7.7(Grms), random wave               |
| operating shock         | 50(G), 11(ms), half-sine wave                     |
| non-operating shock     | 1500(G), 0.5(ms), half-sine wave                  |

\*1 : commercial grade

\*2 : industrial grade

### 4.3 Mean Time Between Failures (MTBF)

Mean Time Between Failures (MTBF) is predicted based on reliability data for the individual components in SDM3. Although many component MTBFs are given in databases and often these values are not really accurate, the prediction result for SDM3 is more than 2,000,000 hours.

### 4.4 Certification and Compliance

SDM3 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. Flash Management**

### **5.1 Error Correction/Detection**

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SDM3 implements a hardware ECC scheme, based on the BCH algorithm. It can detect and correct up to 14 bits or 28 bits error in 1K bytes.

### **5.2 Bad Block Management**

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Although bad blocks on the flash media are already identified by the flash manufacturer, they can also be accumulated over time during operation. SDM3'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.

### **5.3 Wear Leveling**

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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 static wear leveling. They both ensure that the lifetime of the flash media can be increased, and the disk access performance is optimized as well.

### **5.4 Power Failure Management**

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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.

### **5.5 ATA Secure Erase**

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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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#### **5.6 S.M.A.R.T.**

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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 SDM3 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 SDM3. 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 SDM3 is in critical condition.

#### **5.7 Trim**

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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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## 6. Software Interface

### 6.1 Command Set

This section defines the software requirements and the format of the commands the host sends to SDM3. Commands are issued to SDM3 by loading the required registers in the command block with the supplied parameters, and then writing the command code to the Command register.

**Table 6-1:** 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    |      |                        |

# SATA-Disk Module 3

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## 7. Electrical Specification

**Caution: Absolute Maximum Stress Ratings** – Applied conditions greater than those listed under “Absolute Maximum Stress Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these conditions or conditions greater than those defined in the operational sections of this data sheet is not implied. Exposure to absolute maximum stress rating conditions may affect device reliability.

**Table 7-1:** Operating range

| Range                | Ambient Temperature | 5V       |
|----------------------|---------------------|----------|
| Standard             | 0°C to +70°C        | 4.5-5.5V |
| Extended Temperature | -40°C to 85°C       |          |

**Table 7-2:** Absolute maximum power pin stress ratings

| Parameter                                                     | Symbol          | Conditions                                |
|---------------------------------------------------------------|-----------------|-------------------------------------------|
| Input Power                                                   | V <sub>DD</sub> | -0.3V min. to 6.5V max.                   |
| Voltage on any pin except V <sub>DD</sub> with respect to GND | V               | -0.5V min. to V <sub>DD</sub> + 0.5V max. |

**Table 7-3:** Recommended system power-up timing

| Symbol                             | Parameter                   | Typical | Maximum | Units |
|------------------------------------|-----------------------------|---------|---------|-------|
| T <sub>PU-READY</sub> <sup>1</sup> | Power-up to Ready Operation | 200     | 1000    | ms    |
| T <sub>PU-WRITE</sub> <sup>1</sup> | Power-up to Write Operation | 200     | 1000    | ms    |

1. This parameter is measured only for initial qualification and after a design or process change that could affect this parameter.

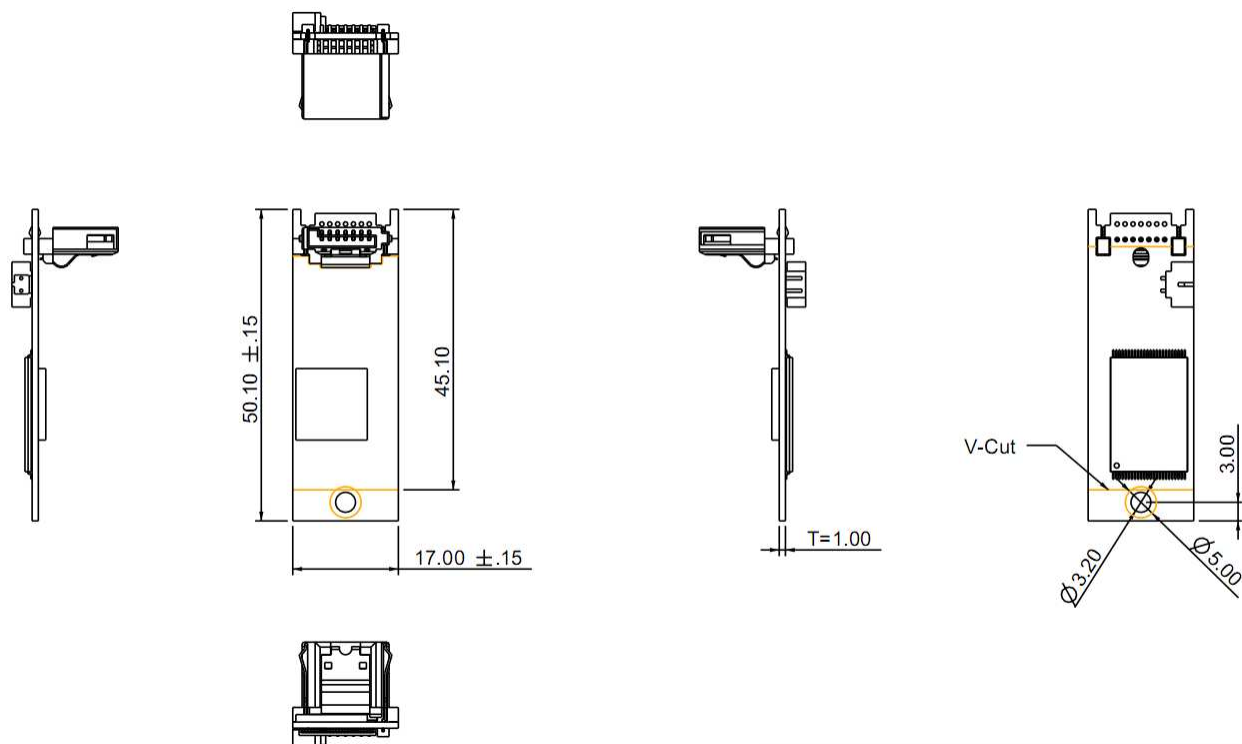
# SATA-Disk Module 3

## AP-SDMxxxx8AANS-XXTX

## 8. Physical Characteristics

### 8.1 Dimension

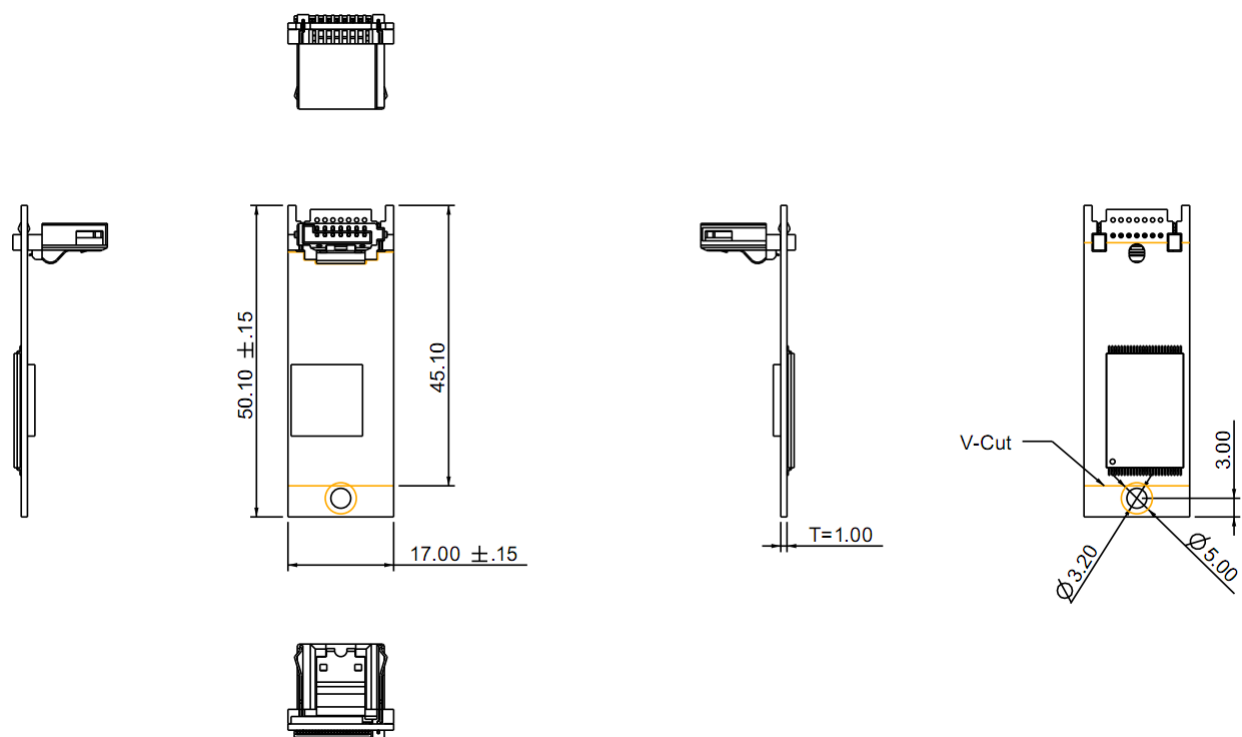
#### 8.1.1 Power Cable Type



Unit: mm  
Tolerance:  $\pm 0.25$

## SATA-Disk Module 3 AP-SDMxxxx8AANS-XXTX

### 8.1.2 Power Cable-Less Type



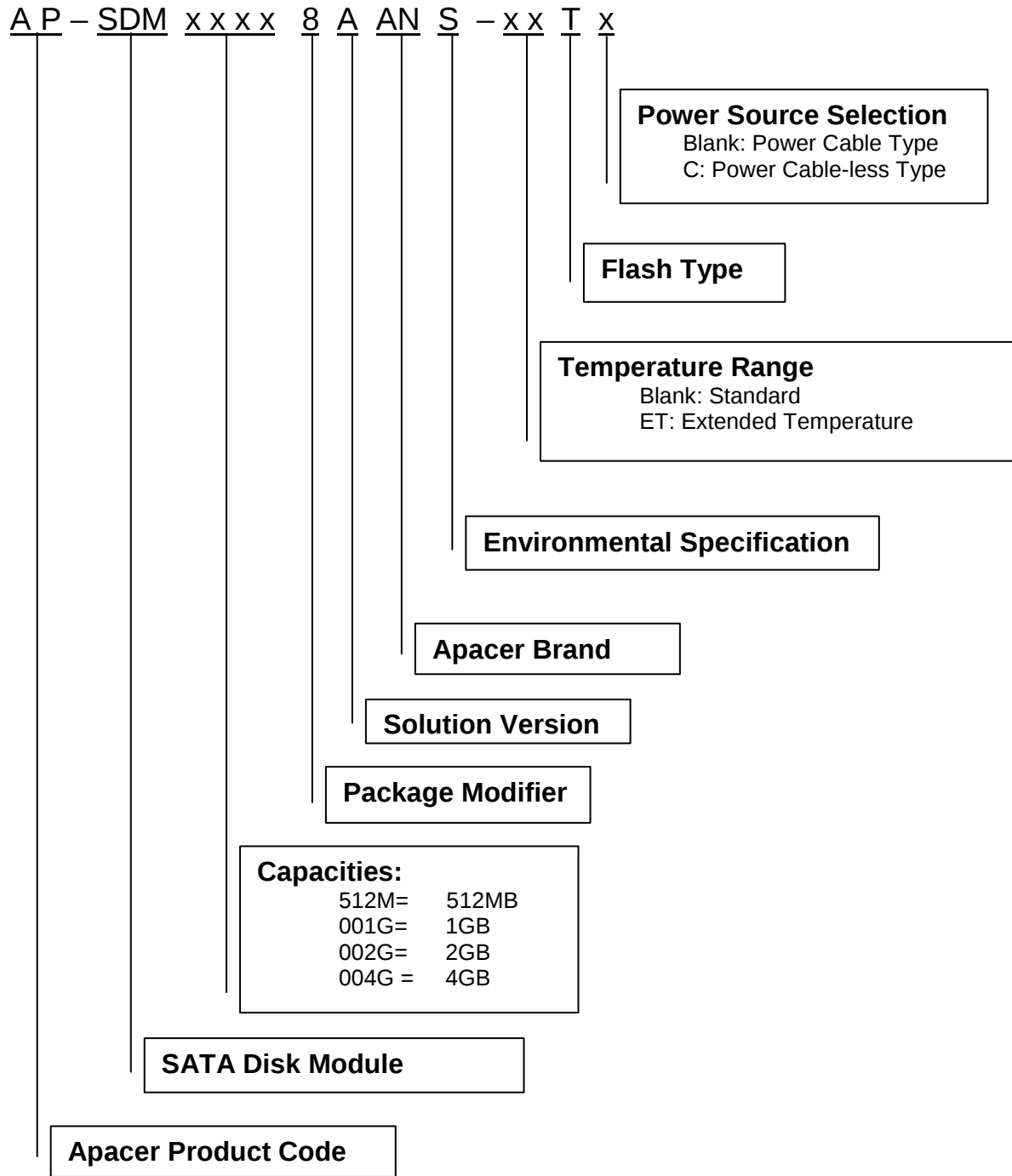
Unit: mm  
Tolerance: ± 0.25

# SATA-Disk Module 3

## AP-SDMxxxx8AANS-XXTX

## 9. Product Ordering Information

### 9.1 Product Code Designations



## SATA-Disk Module 3

### AP-SDMxxxx8AANS-XXTX

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## 9.2 Valid Combinations

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### 7P/270D: Power Cable Type

| Capacity | Standard          | Extended Temperature |
|----------|-------------------|----------------------|
| 512MB    | AP-SDM512M8AANS-T | AP-SDM512M8AANS-ETT  |
| 1GB      | AP-SDM001G8AANS-T | AP-SDM001G8AANS-ETT  |
| 2GB      | AP-SDM002G8AANS-T | AP-SDM002G8AANS-ETT  |
| 4GB      | AP-SDM004G8AANS-T | AP-SDM004G8AANS-ETT  |

### 7P/270D: Power Cable-less Type

| Capacity | Standard           | Extended Temperature |
|----------|--------------------|----------------------|
| 512MB    | AP-SDM512M8AANS-TC | AP-SDM512M8AANS-ETTC |
| 1GB      | AP-SDM001G8AANS-TC | AP-SDM001G8AANS-ETTC |
| 2GB      | AP-SDM002G8AANS-TC | AP-SDM002G8AANS-ETTC |
| 4GB      | AP-SDM004G8AANS-TC | AP-SDM004G8AANS-ETTC |

**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.

**SATA-Disk Module 3**  
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## **Revision History**

| <b>Revision</b> | <b>Date</b> | <b>Description</b>                                                                                                      | <b>Remark</b> |
|-----------------|-------------|-------------------------------------------------------------------------------------------------------------------------|---------------|
| 1.0             | 06/22/2011  | Formal release                                                                                                          |               |
| 1.1             | 07/18/2011  | Updated Power Consumption<br>– Active mode: 209 mA -> 205mA<br>– Idle mode: 200 mA -> 95mA<br>(Based on 512MB capacity) |               |

## SATA-Disk Module 3 AP-SDMxxxx8AANS-XXTX

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### Global Presence

|                              |                                                                                                                                                                                                                                                                  |
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