*RoHS Compliant*

# SATA-Disk Module II

*Specification for 7P/180D Low Profile*

**January 18, 2011**

*Version 1.2*

**Apacer**
*Access the best*

# 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 27 MB/sec
  - Sustained write: up to 23 MB/sec

- **Intelligent endurance design**
  - Built-in hardware BCH ECC, correcting 8-bit or 15-bit error per 512-byte data sector
  - 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.

- **NAND Flash Type:** SLC

*Based on 2 GB model

- **Data integrity under power-cycling**
  - No battery required for data storage

- **Temperature**
  - 0°C to 70°C for operating
  - -40°C to 100°C for storage

- **Supply voltage**
  - 3.3 V /5 V

- **Low power consumption**
  - Active mode: 230 mA* /165 mA (3.3 V /5 V)
  - Idle mode: 165 mA* /112 mA (3.3 V /5 V)

- **Connector**
  - 7-pin SATA female connector
  - 2-pin SATA power connector

- **RoHS compliant**

# Table of Contents

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# 1. Product Description

## 1.1 Introduction

Apacer's SATA Disk Module (SDM) 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 SDM drive interfaces with the host allowing data to be seamlessly transferred between the host and the flash devices.

The SDM drive is designed with a single-chip controller, offering capacities of up to four gigabytes and providing full support for the SATA II high-speed interface standard. It can operate at sustained access rates of up to thirty five megabytes per second, which is much faster than any other competitor in the market.

In addition to buffer management through dynamical allocation, the SDM adopts the static 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. The SDM provides the S.M.A.R.T. feature complies to 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

The SDM 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.
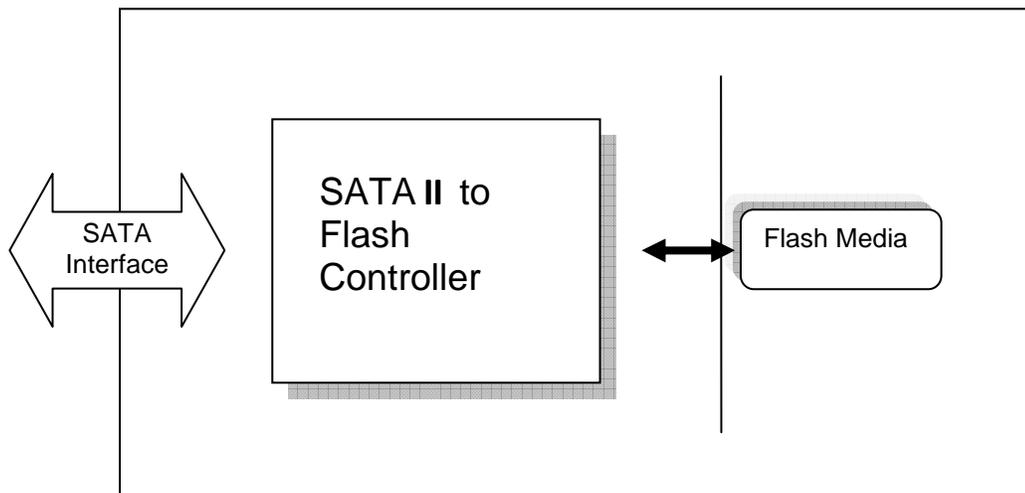


**Figure 1-1** Apacer SDM block diagram

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## 1.3　ATA Mode Support

The SDM 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 the SDM 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 specifications

| Capacity | Total Bytes | Cylinders | Heads | Sectors | Max LBA |
|---|---|---|---|---|---|
| 512 MB | 487,710,720 | 945 | 16 | 63 | 952,560 |
| 1 GB | 992,968,704 | 1,924 | 16 | 63 | 1,939,392 |
| 2 GB | 2,002,452,480 | 3,880 | 16 | 63 | 3,911,040 |
| 4 GB | 4,021,936,128 | 7,793 | 16 | 63 | 7,855,344 |

## 1.5　Performance

Performance of the SDM is shown in Table 1-2

**Table 1-2:** Performance

| Performance　　　　　　Capacity | 512 MB | 1 GB | 2 GB | 4 GB |
|---|---|---|---|---|
| Sustained read (MB/s) | 22 | 27 | 27 | 27 |
| Sustained write (MB/s) | 8 | 12 | 22 | 23 |

Note: Performances vary from flash configurations.

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## 1.6 Pin Assignments

Power Pin 1
(Power Cable Type)

Power Pin 1
(Power Cable-less Type)

Signal Pin 1

7P/180D w/o Housing
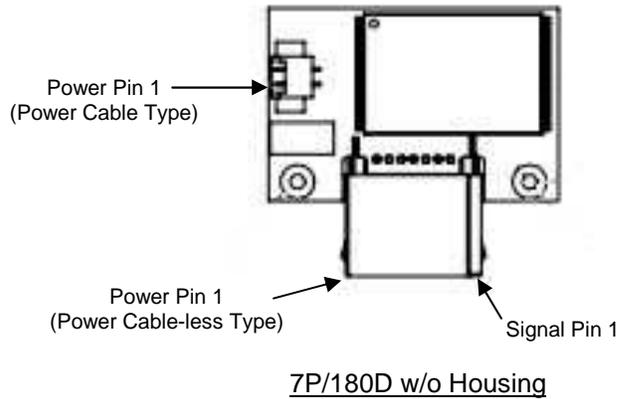
**Table 1-3:** Signal segment

| 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 | |

Power Pin 1
(Power Cable Type)

Power Pin 1
(Power Cable-less Type)

Signal Pin 1

7P/180D w/ Housing
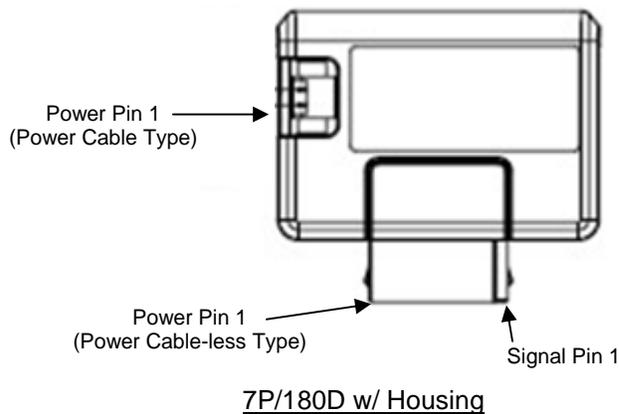
**Table 1-4:** Power segment

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

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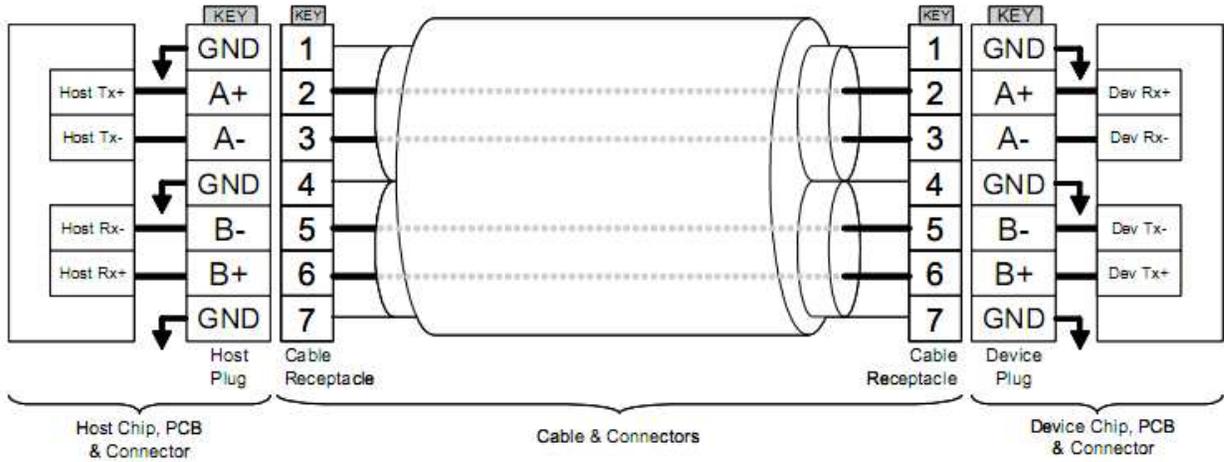
**Figure 1-2** SATA Cable/Connector Connection Diagram

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.

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# 2. Software Interface

## 2.1 Command Set

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

**Table 2-1** Command set

| Command Name | Code (Hex) | FR[1] | SC[2] | SN[3] | CY[4] | DH[5] | LBA[6] |
|---|---|---|---|---|---|---|---|
| Check-Power-Mode | E5h | - | - | - | - | D[8] | - |
| Flush-Cache | E7h | - | - | - | - | D | - |
| Identify-Drive | ECh | - | - | - | - | D | - |
| Idle | E3h | - | Y[7] | - | - | D | - |
| Idle-Immediate | E1h | - | - | - | - | D | - |
| Initialize-Drive-Parameters | 91h | - | Y | - | - | Y | - |
| Recalibrate | 10h | - | - | - | - | D | - |
| Read-DMA | C8h | - | Y | Y | Y | Y | Y |
| Read-Multiple | C4h | - | Y | Y | Y | Y | Y |
| Read-Sector(s) | 20h | - | Y | Y | Y | Y | Y |
| Read-Verify-Sector(s) | 40h | - | Y | Y | Y | Y | Y |
| SMART | B0h | - | Y | Y | Y | D | Y |
| Set-Features | EFh | Y | - | - | - | D | - |
| Set-Multiple-Mode | C6h | - | Y | - | - | D | - |
| Sleep | E6h | - | - | - | - | 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 High/Low registers
5. DH - Drive/Head Number register
6. LBA - Logical Block Address mode supported
7. Y - The register contains a valid parameter for this command.
8. For the Drive/Head register:
   - Y means both the SDM and Head parameters are used;
   - D means only the SDM parameter is valid, and not for the Head parameter.

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# 3. Flash Management

## 3.1 Error Correction/Detection

The SDM implements a hardware ECC scheme, based on the BCH algorithm. It can detect and correct up to 8 bits or 15 bits error in 512 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. The SDM'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 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.

## 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.

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## 3.5    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 SDM 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 3 vendor-specified SMART Attribute IDs (E5h, EAh-EBh, and E8h) in the SDM. 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 the SDM is in critical condition.

# 4. Environmental Specifications

## 4.1 Environments

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

**Table 4-1** SDM environmental specifications (plan)

| Environment | Specification |
|---|---|
| Temperature | 0°C to 70°C (Operating) |
| | -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 | Acceleration: 1,500 G, 0.5 ms<br>Peak acceleration: 50 G, 11 ms |

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# 5. 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 5-1:** Operating voltage

| Ambient Temperature | 3.3V | 5V |
|---|---|---|
| 0℃ to 70℃ | 3.135-3.465V | 4.75-5.25V |

**Table 5-2:** Absolute maximum power pin stress ratings

| Parameter | Symbol | Conditions |
|---|---|---|
| Input Power | $V_{DD}$ | -0.3V min. to 6.5V max. |
| Voltage on any pin except $V_{DD}$ with respect to GND | V | -0.5V min. to VDD + 0.5V max. |

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# 6. Physical Characteristics

## 6.1    Power Cable-less Type

**6.1.1 W/O Housing**    (Refer to SDM Power Cable-less Design Guide)
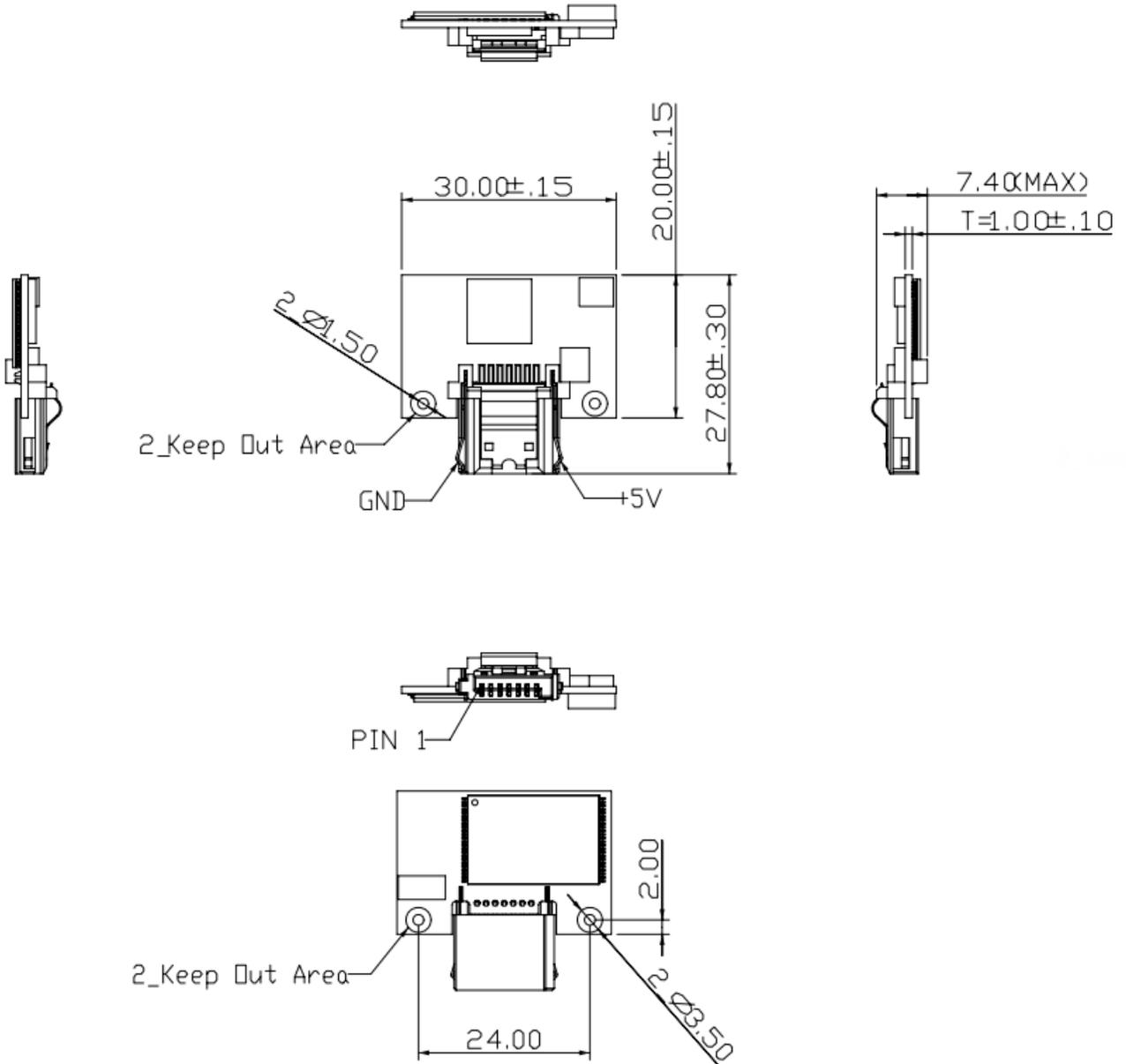


Unit: ㎜
Tolerance: ± 0.25

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### 6.1.2 W/Housing   (Refer to SDM Power Cable-less Design Guide)



32.50±.10

23.13±.10

29.40

8.53±.15

2.73

GND

+5V

PIN 1

Unit: ㎜
Tolerance: ± 0.25

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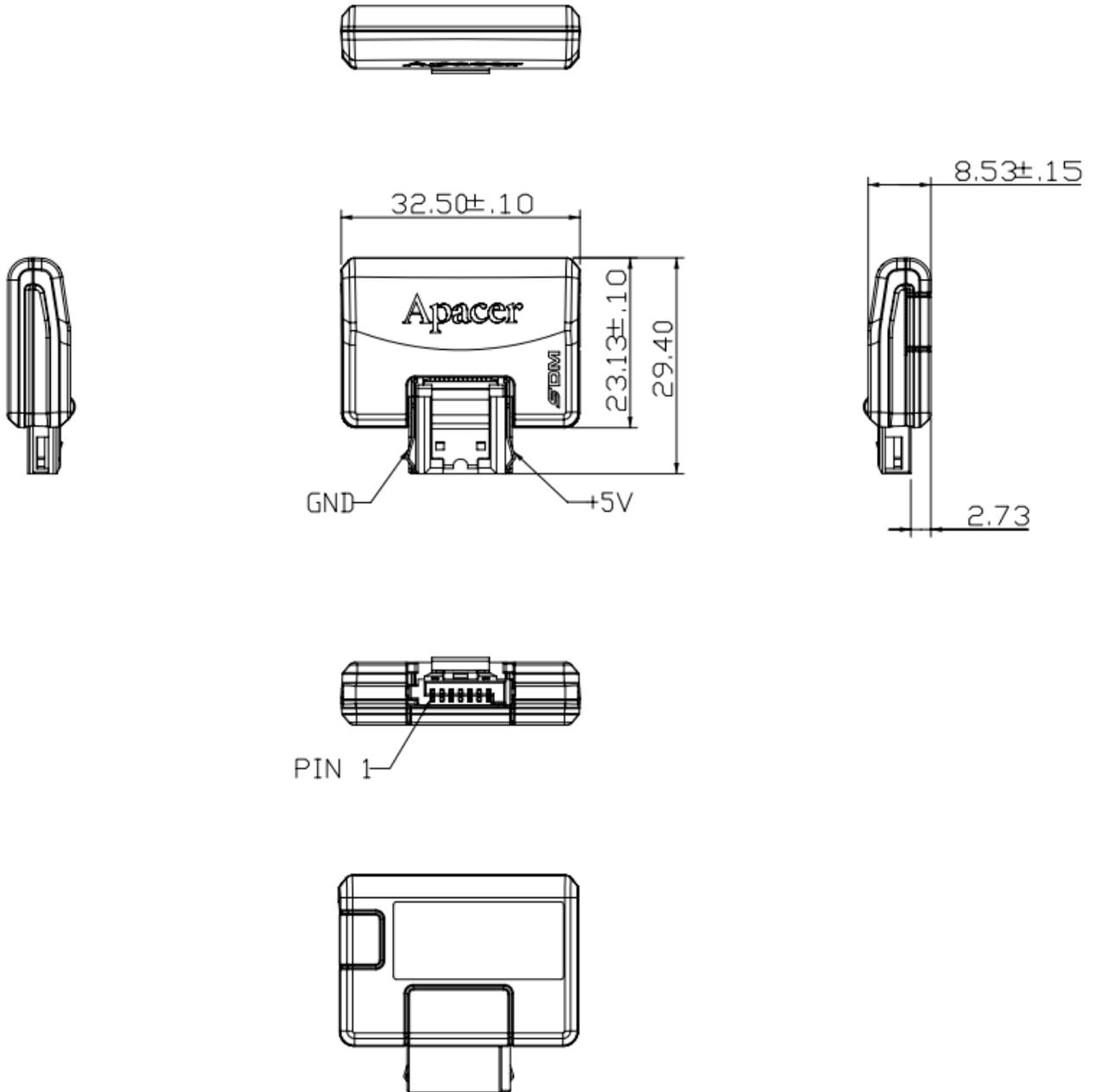
## 6.2 Power Cable Type

### 6.2.1 W/O Housing
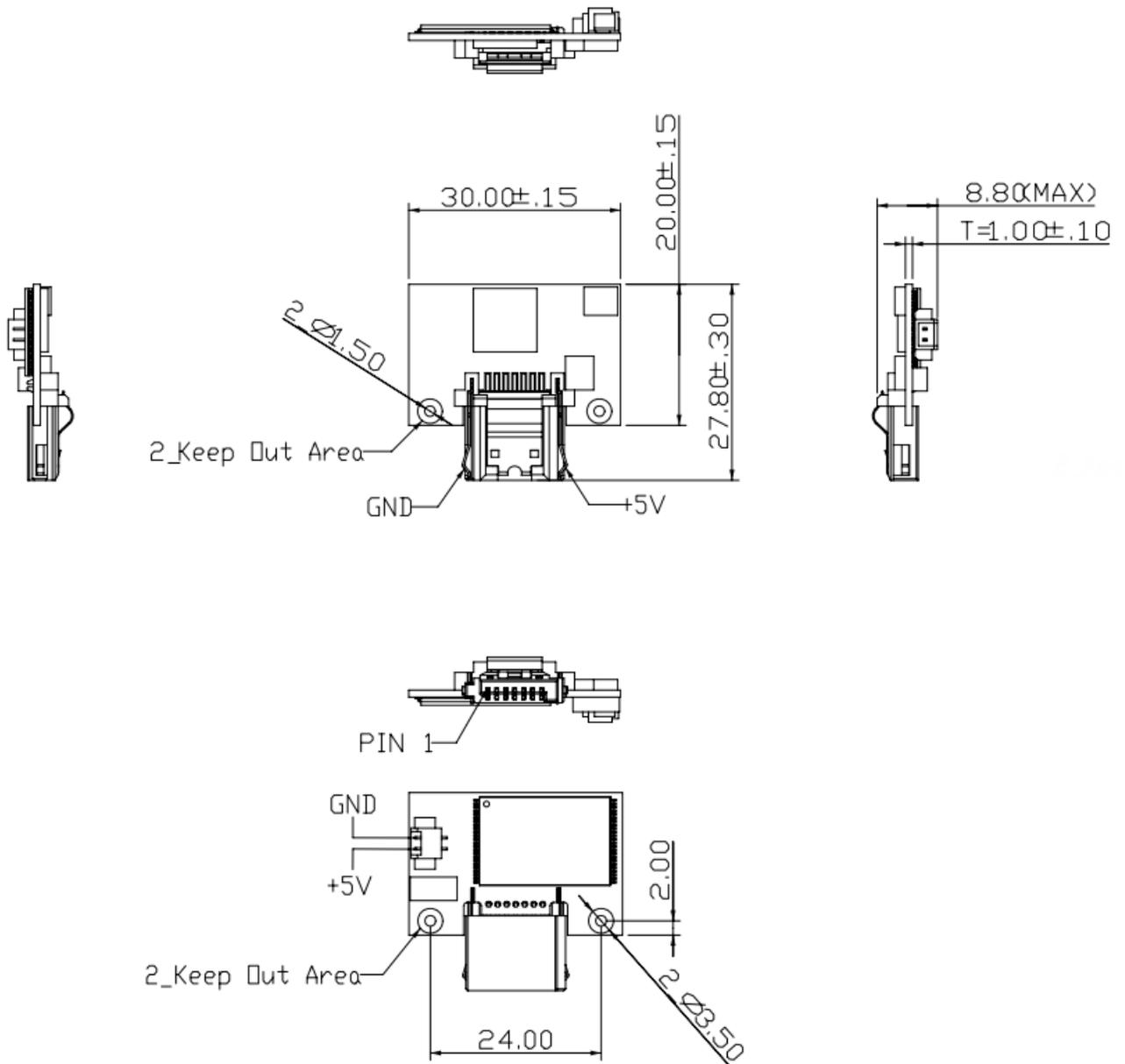
30.00±.15
20.00±.15
27.80±.30
2_Ø1.50
2_Keep Out Area
GND
+5V

8.80(MAX)
T=1.00±.10

PIN 1

GND
+5V
2_Keep Out Area
24.00
2.00
2_Ø3.50

Unit: ㎜
Tolerance: ± 0.25

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## 6.2.2 W/Housing
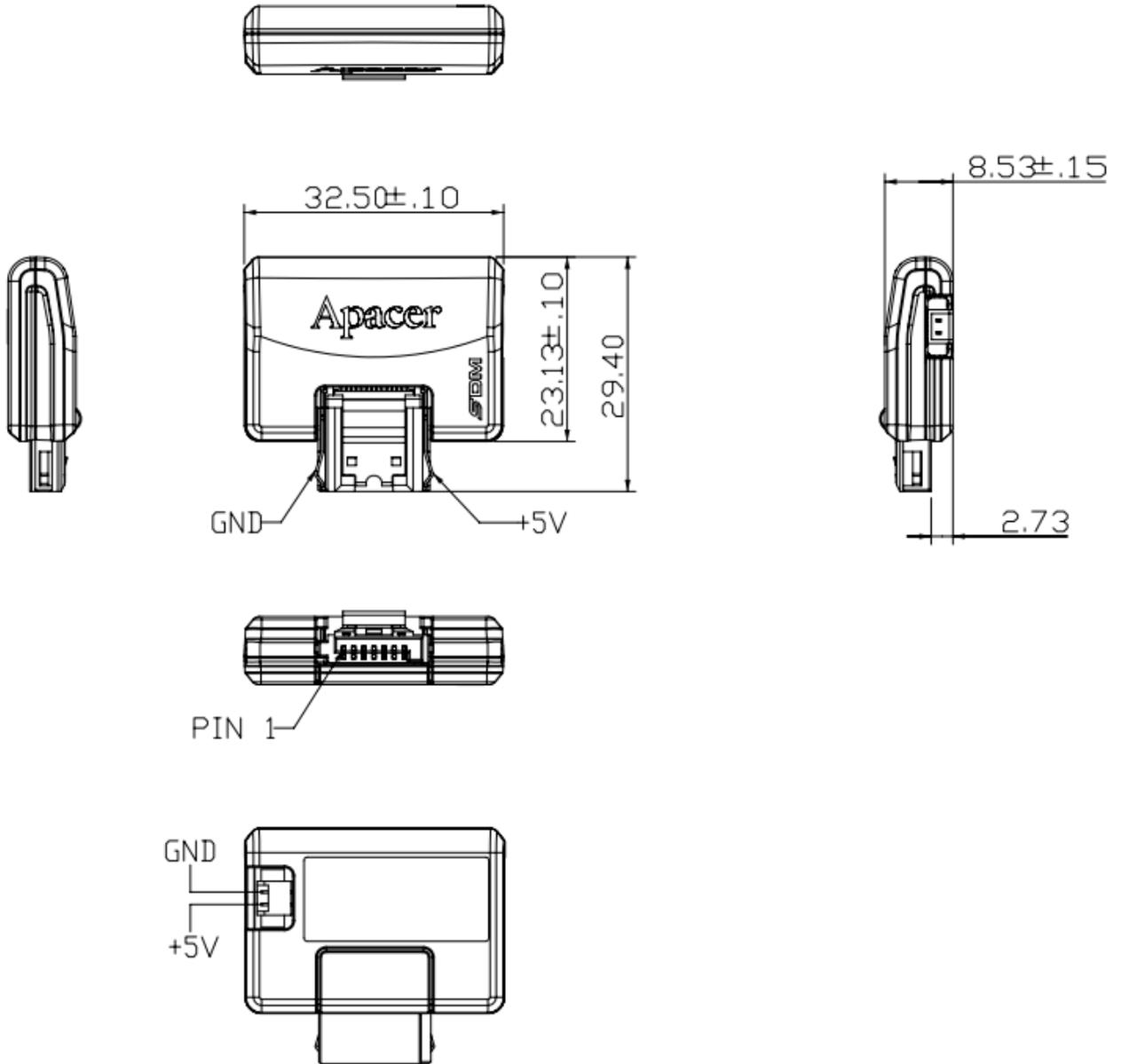


Unit: ㎜
Tolerance: ± 0.25

# 7. Product Ordering Information

## 7.1    Product Code Designations

A P – SDM x x x x x P AN S – H T X

**Power Source Selection**
Blank: From Power Cable
C: From Connector

**Flash Type**

**Version Control**

**Environmental Specification**

**Apacer Brand**

**Solution Version**

**Package Modifier**
A= 7P/180D LP without housing
B= 7P/180D LP with housing

**Capacity:**
512M        512MB
001G:        1 GB
002G        2 GB
004G:        4 GB

**SATA Disk Module**

**Apacer Product Code**

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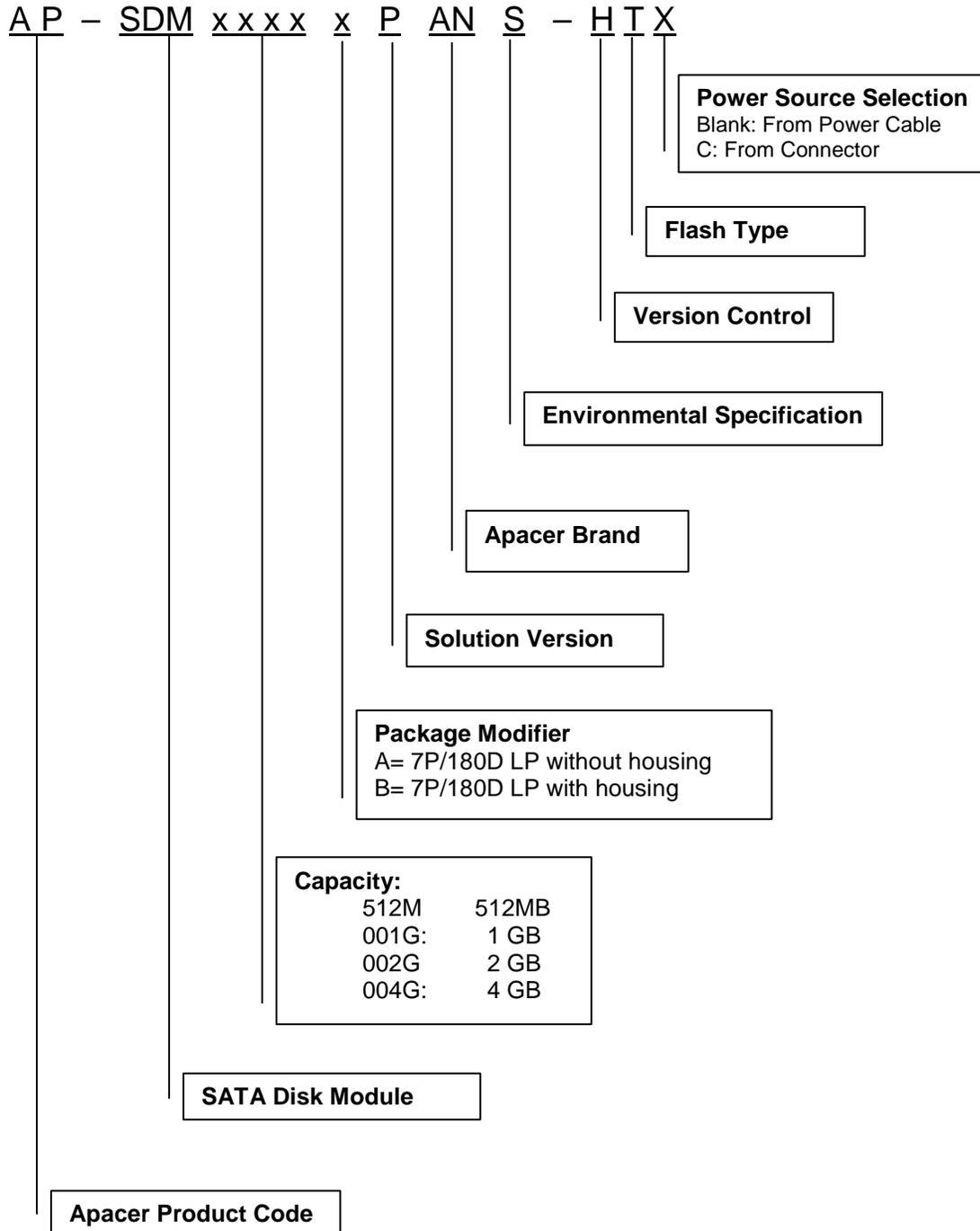
## 7.2 Valid Combinations

**7P/180D Low Profile without housing; Power Source from Cable**

| Capacity | Model Number |
|---|---|
| 512MB | AP-SDM512MAPANS-HT |
| 1GB | AP-SDM001GAPANS-HT |
| 2GB | AP-SDM002GAPANS-HT |
| 4GB | AP-SDM004GAPANS-HT |

**7P/180D Low Profile without housing; Power Source from Connector**

| Capacity | Model Number |
|---|---|
| 512MB | AP-SDM512MAPANS-HTC |
| 1GB | AP-SDM001GAPANS-HTC |
| 2GB | AP-SDM002GAPANS-HTC |
| 4GB | AP-SDM004GAPANS-HTC |

**7P/180D Low Profile with housing; Power Source from Cable**

| Capacity | Model Number |
|---|---|
| 512MB | AP-SDM512MBPANS-HT |
| 1GB | AP-SDM001GBPANS-HT |
| 2GB | AP-SDM002GBPANS-HT |
| 4GB | AP-SDM004GBPANS-HT |

**7P/180D Low Profile with housing; Power Source from Connector**

| Capacity | Model Number |
|---|---|
| 512MB | AP-SDM512MBPANS-HTC |
| 1GB | AP-SDM001GBPANS-HTC |
| 2GB | AP-SDM002GBPANS-HTC |
| 4GB | AP-SDM004GBPANS-HTC |

**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.

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# Revision History

| Revision | Date | Description | Remark |
|---|---|---|---|
| 0.1 | 03/17/2009 | Preliminary | |
| 0.2 | 03/30/2009 | Updated product ordering information | |
| 0.3 | 04/02/2009 | Updated 8GB model details & pin assignments | |
| 0.4 | 04/06/2009 | Updated context | |
| 0.5 | 04/22/2009 | Updated drawings and feature context | |
| 0.6 | 08/11/2009 | Updated feature wording & performance table | |
| 0.7 | 08/18/2009 | Updated wording on physical characteristics | |
| 1.0 | 10/28/2009 | Official release | |
| 1.1 | 11/05/2010 | Added 3.3V support at supply voltage | |
| 1.2 | 01/18/2011 | Updated product ordering information | |

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