

***RoHS Compliant***

***Value Added* **SATA-Disk Module I****

***Specifications for 22P/90D***

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***Version 1.2***



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## Features:

- **Standard Serial ATA Interface**
  - SATA Revision 1.0 compliance
  - SATA 1.5 Gbps interface speed
  - ATA command set
- **Connector type**
  - 7-pin signal connector
  - 15-pin power connector
- **Power consumption (typical)\***
  - Supply voltage: 5V
  - Active mode: 196mA
  - Idle mode: 124mA
- **Performance\***
  - Burst transfer rate: 150 MB/sec
  - Sustained read: Up to 29 MB/sec
  - Sustained write: Up to 13 MB/sec
- **Capacity**
  - 128, 256, 512 MB
  - 1, 2, 4, 8 GB
- **NAND Flash Type: SLC**
- **Temperature ranges**
  - Operation: 0 °C to 70 °C
  - Storage: -40 °C to 100 °C
- **Flash management**
  - Advanced wear-leveling algorithms
  - S.M.A.R.T. technology
  - Built-in hardware ECC
  - Flash block management
  - Power failure management
  - ATA Security Erase
- **Form factor**
  - SATA Disk Module (22-pin/90-degree)
- **Shock & Vibration\*\***
  - Shock: 1,500 G
  - Vibration: 15 G
- **RoHS compliant**

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

\*\*Non-operating

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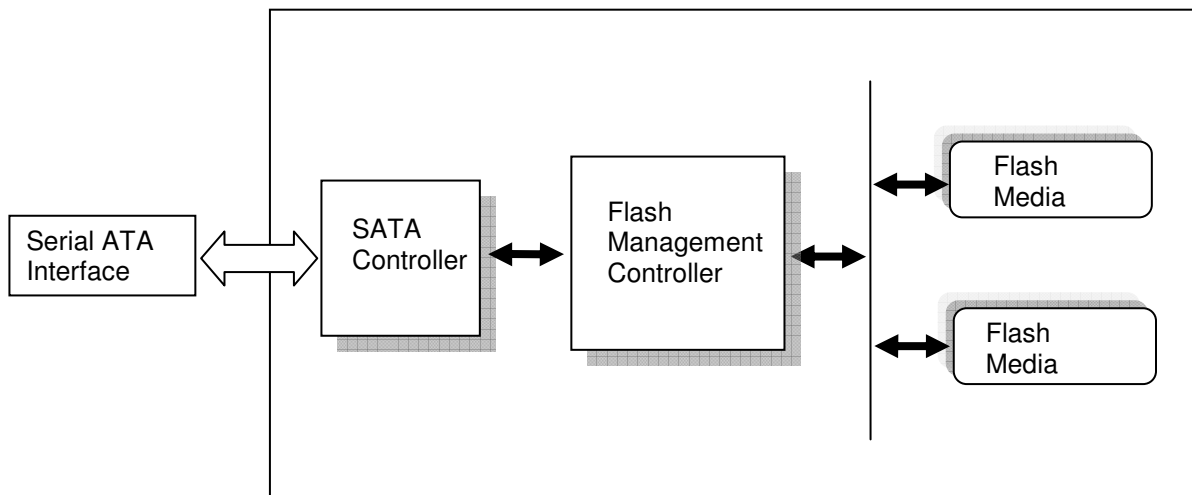
## 1. General Description

Apacer's SATA-Disk Module (SDM) is a high-performance, embedded SSD DOM (Disk-on-module) designed to replace the conventional hard disk drive. SDM SSD can be plugged into a standard SATA connector commonly found in desktops, IT-STB, industrial PC and thin client systems. Moreover, Apacer provides an innovative way for design-in clients with limited spaces on their mainboard.

Apacer's SDM SSD has a built-in microcontroller with file management firmware that communicates with SATA standard interface. 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. SDM Series is designed to work at 5 volts and uses a standard SATA driver that complies with major operating systems such as the Windows series. Featuring technologies as Advanced Wear-leveling algorithms, S.M.A.R.T, flash block management, power failure management, and ATA Secure Erase, Apacer assures users of a versatile device on data storage.

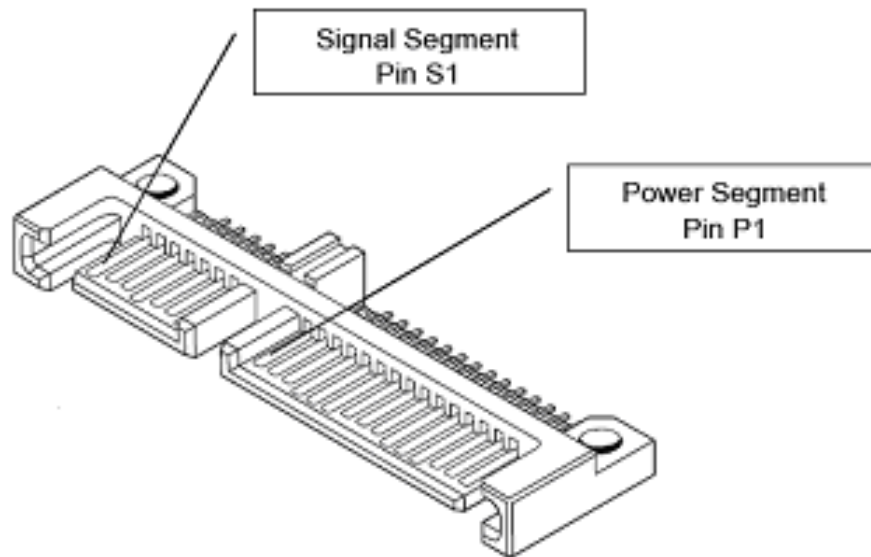
## 2. Functional Block

The SATA-Disk Module (SDM) 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

### 3. Pin Assignments



**Table 3-1:** Signal segment

Pin	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	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)

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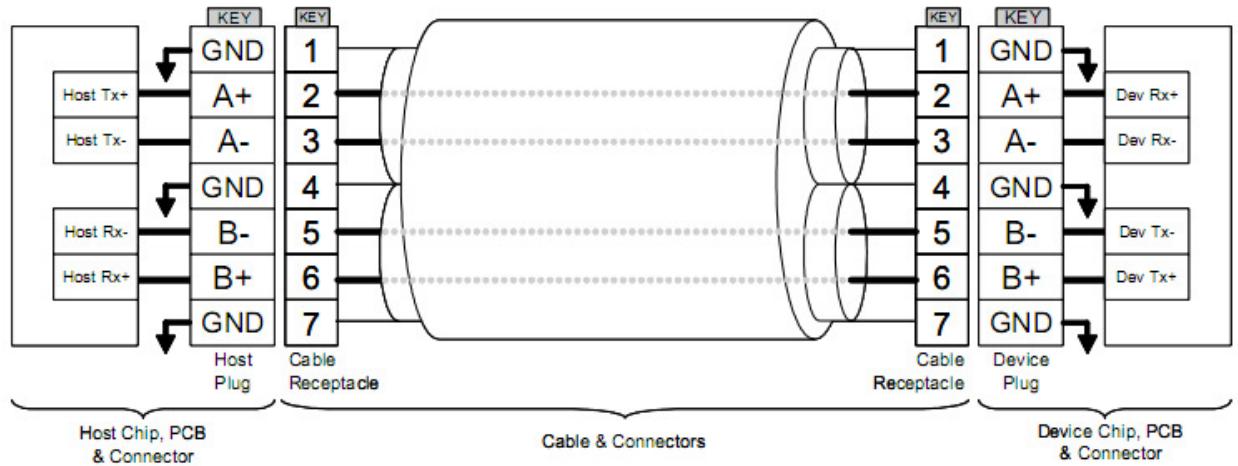


Figure 3-1 SATA Cable/Connector Connection Diagram

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.

## 4. Product Specifications

### 4.1 Capacity

Capacity specification of the SATA-Disk Module (SDM) product family is available as shown in Table 4-1.

**Table 4-1:** Capacity specifications

Capacity	Total bytes*	Cylinders	Heads	Sectors	Max LBA
128 MB	128,057,344	977	8	32	250,112
256 MB	256,901,120	980	16	32	501,760
512 MB	512,483,328	993	16	63	1,000,944
1 GB	1,024,966,656	1,986	16	63	2,001,888
2 GB	2,048,385,024	3,969	16	63	4,000,752
4 GB	4,096,253,952	7,937	16	63	8,000,496
8 GB	8,001,552,384	15,504	16	63	15,628,032

\*Display of total bytes varies from file systems. 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.

### 4.2 ATA Mode Support

The SATA Disk Module 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-4

### 4.3 Performance

Performances of SATA-Disk Modules are listed below in table 4-2.

**Table 4-2:** Performance

Capacity	128 MB	256 MB	512 MB	1 GB	2 GB	4 GB	8 GB
<b>Performance</b>							
<b>Sustained read (MB/s)</b>	17	28	29	21	20	21	20
<b>Sustained write (MB/s)</b>	5	8	9	12	11	13	11

Note: Performances vary from host system configurations.

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## 4.4 Environmental Specifications

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Environmental specification of the SATA-Disk Module (SDM) product family follows the MIL-STD-810F standards as shown in Table 4-3.

**Table 4-3:** Environmental specifications

Environment		Specification
Temperature	Operation	0 °C to 70 °C
	Storage	-40 °C to 100 °C
Vibration (Non-Operating)		Sine wave: 10~2000Hz, 15G (X, Y, Z axes)
Shock (Non-Operating)		Half sine wave, 1500 G, 0.5 ms (X, Y, Z ; All 6 axes)

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## **5. Flash Management**

### **5.1. Advanced wear-leveling algorithms**

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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.

### **5.2 S.M.A.R.T. technology**

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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 SMART feature adopts the standard SMART command B0h to read data from the drive. When the Apacer SMART Utility running on the host, it analyzes and reports the disk status to the host before the device is in critical condition.

### **5.3 Built-in hardware ECC**

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The SATA-Disk Module uses BCH Error Detection Code (EDC) and Error Correction Code (ECC) algorithms which correct up to eight random single-bit errors for each 512-byte block of data. High performance is fulfilled through hardware-based error detection and correction.

### **5.4 Flash block management**

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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.

### **5.5 Power Failure Management**

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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

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perform a status tracking to retrieve the mapping table and resume previously programmed NAND blocks to check if there is any incompleteness of transmission.

## **5.6 ATA Security Erase**

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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.

## 6. Software Interface

### 6.1 Command Set

This section defines the software requirements and the format of the commands the host sends to the SATA-Disk Module (SDM). Commands are issued to the SDM 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 (1 of 2)

Command	Code
Check-Power-Mode	E5H or 98H
Execute-Drive-Diagnostic	90H
Erase Sector(s)	C0H
Flush-Cache	E7H
Format Track	50H
Identify-Drive	ECH
Idle	E3H or 97H
Idle-Immediate	E1H or 95H
Initialize-Drive-Parameters	91H
NOP	00H
Read-Buffer	E4H
Read-DMA	C8H or C9H
Read-Multiple	C4H
Read-Sector(s)	20H or 21H
Read-Verify-Sector(s)	40H or 41H
Recalibrate	1XH
Request-Sense	03H
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

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**Table 6-1:** Command set (2 of 2)

<b>Command</b>	<b>Code</b>
SMART	B0H
Set-Multiple-Mode	C6H
Set-Sleep-Mode	E6H or 99H
Standby	E2H or 96H
Standby-Immediate	E0H or 94H
Translate-Sector	87H
Write-Buffer	E8H
Write-DMA	CAH or CBH
Write-Multiple	C5H
Write-Multiple-Without-Erase	CDH
Write-Sector(s)	30H or 31H
Write-Sector-Without-Erase	38H
Write-Verify	3CH

## 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

<b>Ambient Temperature</b>	0°C to +70°C
<b>Supply voltage</b>	4.75-5.25V

**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.

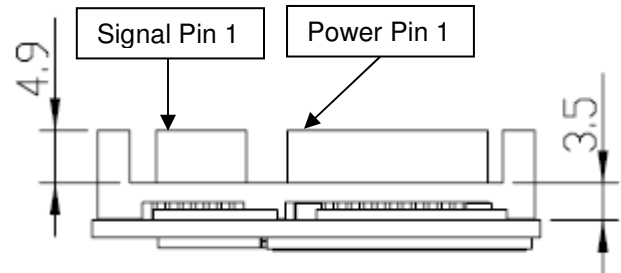
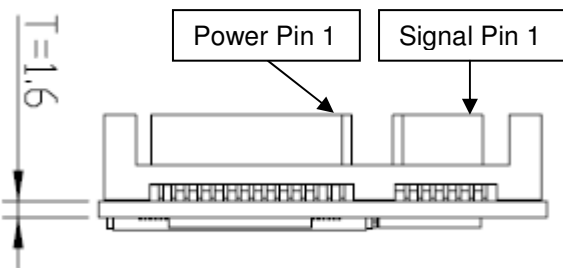
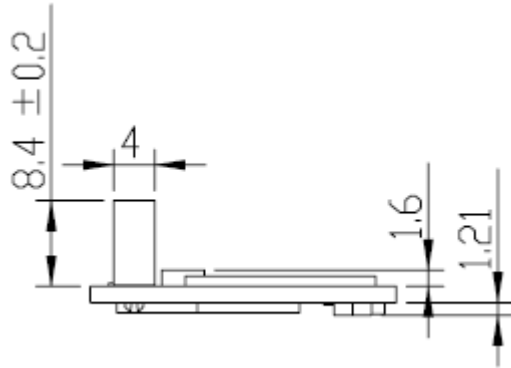
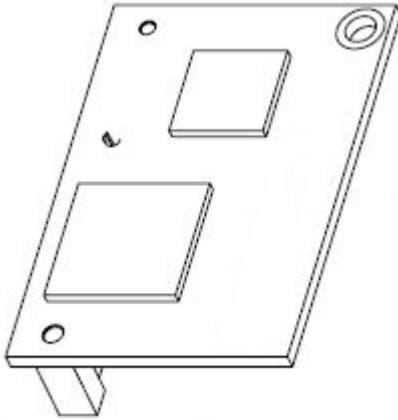
**Table 7-3:** Recommended system power-up timing

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.

## 8. Physical Characteristics

### 8.1 Dimension

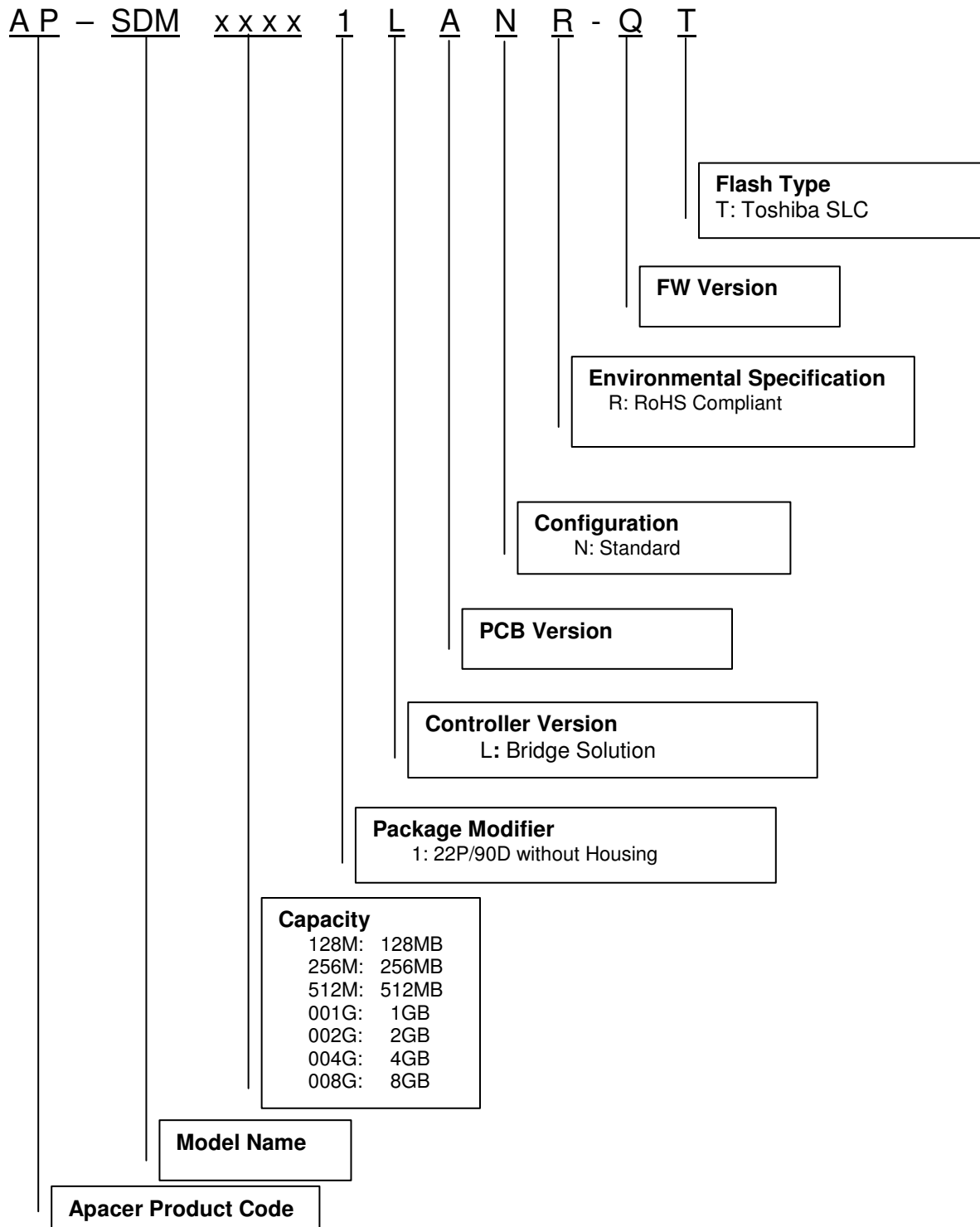


Unit: mm  
Tolerance:  $\pm 0.25$



## 9. Product Ordering Information

### 9.1 Product Code Designations



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**AP-SDMxxxx1LANR-QT**



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## 9.2 Valid Combinations

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<b>Capacity</b>	<b>Standard</b>
128MB	AP-SDM128M1LANR-QT
256MB	AP-SDM256M1LANR-QT
512MB	AP-SDM512M1LANR-QT
1GB	AP-SDM001G1LANR-QT
2GB	AP-SDM002G1LANR-QT
4GB	AP-SDM004G1LANR-QT
8GB	AP-SDM008G1LANR-QT

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## Revision History

Revision	Date	Description	Remark
1.0	02/12/2009	Official release	
1.1	03/01/2011	Updated Product Ordering Information	
1.2	08/01/2013	Updated performance and product ordering information due to change in NAND flash use	

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## Global Presence

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