Halogen Free

Value Added SATA-Disk Module Ⅰ

Specification for 22P/180D

March 1, 2011

Version 1.1

Apacer

Access the best

Features:

- **Standard Serial ATA 1.0 (Gen. 1)**
  - ATA command set compatible
  - SATA Ⅰ | 1.5 Gbps
  - ATA operating mode supports up to:
    PIO Mode-4
    Multiword DMA Mode-2
    Ultra DMA Mode-4

- **Connector type**
  - 7-pin signal connector
  - 15-pin power connector

- **Low power consumption (typical)***
  - Supply voltage: 5V
  - Active mode: 196mA
  - Idle mode: 124mA

- **Performance***
  - Burst transfer rate: 150 MB/sec
  - Sustained read: Up to 35 MB/sec
  - Sustained write:
    Standard: Up to 10 MB/sec
    High Speed: Up to 10 MB/sec

- **Capacity**
  - Standard:
    128, 256, 512 MB
    1, 2, 8 GB
  - High Speed:
    256, 512 MB
    1, 2, 4 GB

- **NAND Flash Type: SLC**

- **Temperature ranges**
  - Operation: 0℃ to 70℃
  - Storage: -40℃ to 100℃

- **Flash management**
  - Intelligent endurance design
    Advanced wear-leveling algorithms
    S.M.A.R.T.
    Built-in hardware ECC
    Enhanced data integrity
  - Intelligent power failure recovery
  - Enhanced security level
    ATA Secure Erase

- **Halogen Free**

*Varies from capacities.

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1. General Description

Apacer's SATA-Disk Module (SDM) 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 SDM and mainboard.

Apacer's SDM SSD has a built-in microcontroller with file management firmware that communicates with SATA standard interface. This means SDM SSD 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.

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

1.1 Performance-Optimized Controller

The heart of an SATA-Disk Module 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 the SATA-Disk Module. 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.

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.
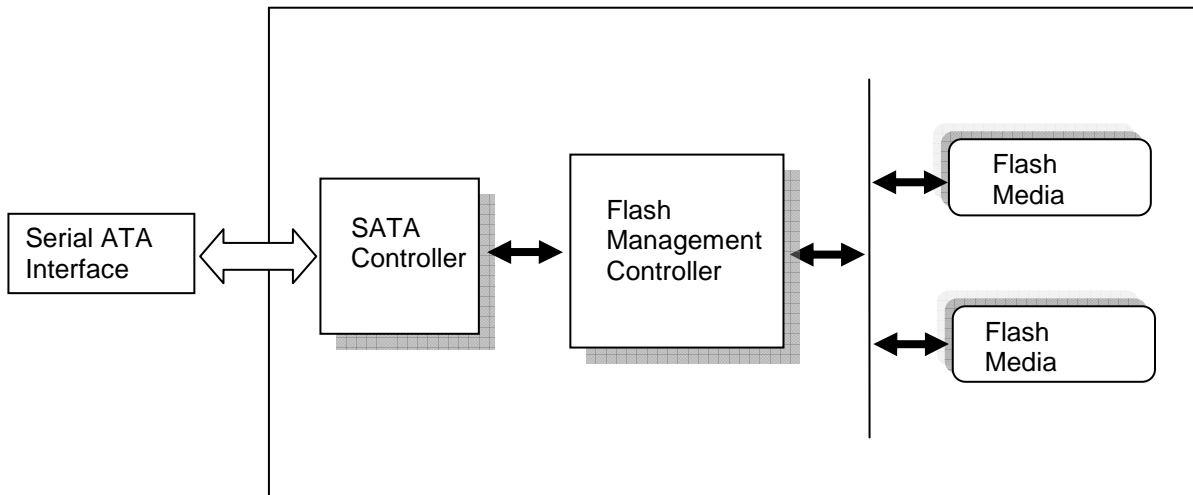
Figure 2-1: Functional block diagram

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3. Pin Assignments
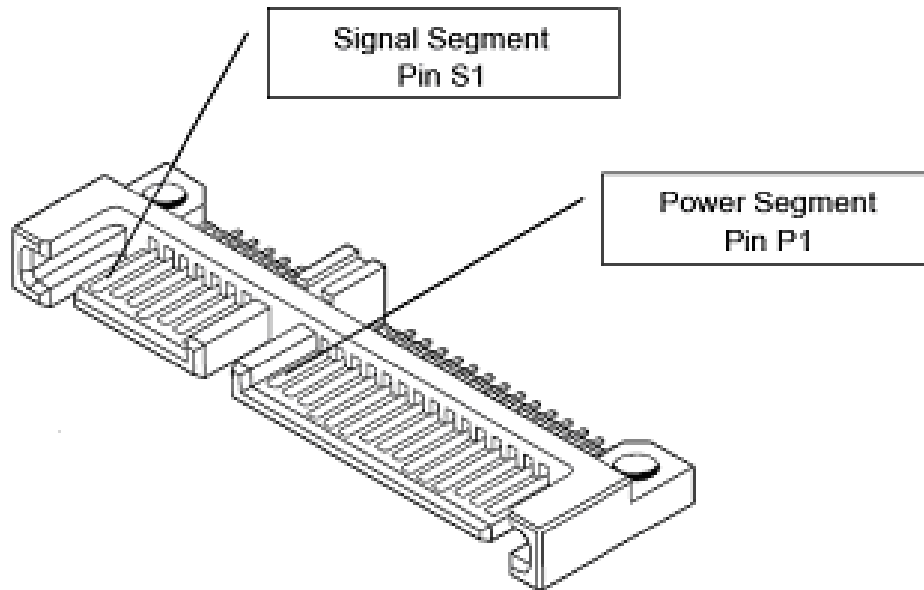
Table 3-1: Signal segment

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	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	Ground
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.

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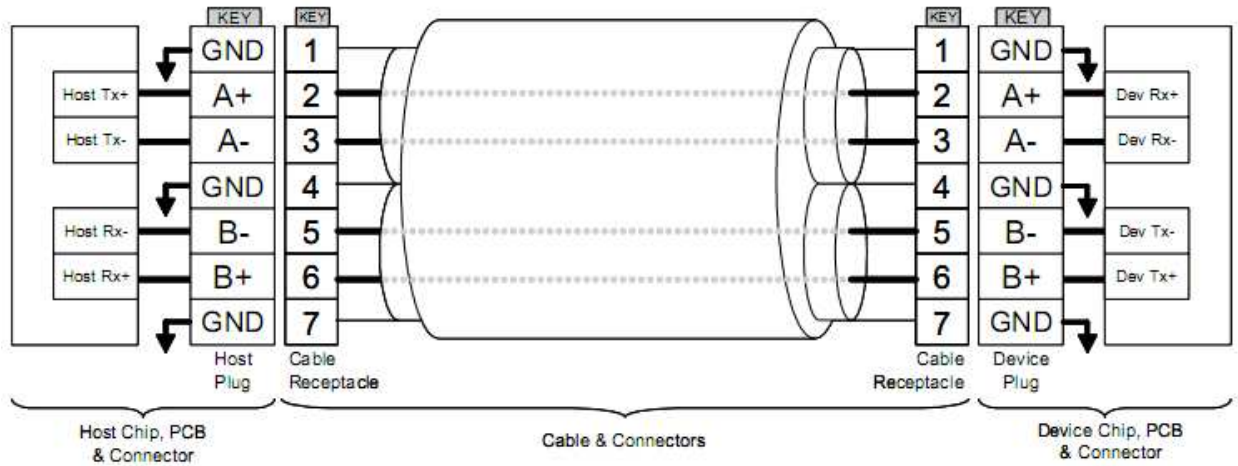# 4. Capacity Specification

Capacity specification of the SATA-Disk Module (SDM) 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
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.

4.1 Performance Specification

4.1.1 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

4.1.2 Performance

Performances of both standard and high speed SATA-Disk Modules are listed below in table 4-2 and table 4-3 respectively.

Table 4-2: Standard Performance

Performance \ Capacity	128 MB / 256 MB / 512 MB / 1 GB	2 GB	8 GB
Sustained read (MB/s)	15	20	20
Sustained write (MB/s)	5	5	10

Table 4-3: High Speed Performance

Performance \ Capacity	256 MB / 512 MB 1 GB / 2 GB	4 GB
Sustained read (MB/s)	25	35
Sustained write (MB/s)	7	10

Note: Performances vary from different configurations.

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4.2 Environmental Specifications

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

Table 4-4: Environmental specifications

Environment		Specification
Temperature	Operation	0℃ to 70℃
	Storage	-40℃ to 100℃
Humidity		5% to 95% RH (Non-condensing)
Vibration (Non-Operation)		Sine wave: 10~2000Hz, 15G (X, Y, Z axes)
Shock (Non-Operation)		Half sine wave, Peak acceleration 50 G, 11 ms (X, Y, Z ; All 6 axes)

5. Flash Management

5.1 Intelligent Endurance Design

5.1.1 Advanced wear-leveling algorithms

The NAND flash devices are limited by a certain number of write cycles. When using a file system, frequent file table updates is mandatory. If some area on the flash wears out faster than others, it would significantly reduce the lifetime of the whole device, 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. The scheme is achieved both via buffer management and Apacer-specific advanced wear leveling to ensure that the lifetime of the flash media can be increased, and the disk access performance is optimized as well.

5.1.2 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 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.

5.1.2 Built-in hardware ECC

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.

5.1.3 Enhanced data Integrity

The properties of NAND flash memory make it ideal for applications that require high integrity while operating in challenging environments. The integrity of data to NAND flash memory is generally maintained through ECC algorithms and bad block management. Flash controllers can support up to 8 bits ECC capability for accuracy of data transactions, and bad block management is a preventive mechanism from loss of data by retiring unusable media blocks and relocating the data to the other blocks, along with the integration of advanced wear leveling algorithms, so that the lifespan of device can be expanded.

5.2 Intelligent Power Failure Recovery

The Low Power Detection on the controller initiates cached data saving before the power supply to the device is too low. This feature prevents the device from crash and ensures data integrity during an unexpected blackout. Once power was failure before cached data writing back into flash, data in the cache will lost. The next time the power is on, the controller will check these fragmented data segment, and, if necessary, replace them with old data kept in flash until programmed successfully.

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5.3 Enhanced Security Level

5.3.1 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.

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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 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	FR[1]	SC[2]	SN[3]	CY[4]	DH[5]	LBA[6]
Check-Power-Mode	E5H or 98H	-	-	-	-	D[8]	-
Execute-Drive-Diagnostic	90H	-	-	-	-	D	-
Erase Sector(s)	C0H	-	Y	Y	Y	Y	Y
Flush-Cache	E7H	-	-	-	-	D	-
Format Track	50H	-	Y[7]	-	Y	Y[8]	Y
Identify-Drive	ECH	-	-	-	-	D	-
Idle	E3H or 97H	-	Y	-	-	D	-
Idle-Immediate	E1H or 95H	-	-	-	-	D	-
Initialize-Drive-Parameters	91H	-	Y	-	-	Y	-
NOP	00H	-	-	-	-	D	-
Read-Buffer	E4H	-	-	-	-	D	-
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	1XH	-	-	-	-	D	-
Request-Sense	03H	-	-	-	-	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	Y	Y
Set-Features	EFH	Y[7]	-	-	-	D	-

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

Command	Code	FR[1]	SC[2]	SN[3]	CY[4]	DH[5]	LBA[6]
SMART	B0H	Y	Y	Y	Y	D	
Set-Multiple-Mode	C6H	-	Y	-	-	D	-
Set-Sleep-Mode	E6H or 99H	-	-	-	-	D	-
Standby	E2H or 96H	-	-	-	-	D	-
Standby-Immediate	E0H or 94H	-	-	-	-	D	-
Translate-Sector	87H	-	Y	Y	Y	Y	Y
Write-Buffer	E8H	-	-	-	-	D	-
Write-DMA	CAH or CBH	-	Y	Y	Y	Y	Y
Write-Multiple	C5H	-	Y	Y	Y	Y	Y
Write-Multiple-Without-Erase	CDH	-	Y	Y	Y	Y	Y
Write-Sector(s)	30H or 31H	-	Y	Y	Y	Y	Y
Write-Sector-Without-Erase	38H	-	Y	Y	Y	Y	Y
Write-Verify	3CH	-	Y	Y	Y	Y	Y

1. FR - Features register
2. SC - Sector Count register
3. SN - Sector Number register
4. CY - Cylinder registers
5. 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 SDM and Head parameters are used
　D means only the SDM parameter is valid and not the Head parameter

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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

Ambient Temperature	5V
0℃ to +70℃	4.5-5.5V

Table 7-2: Absolute maximum power pin stress ratings

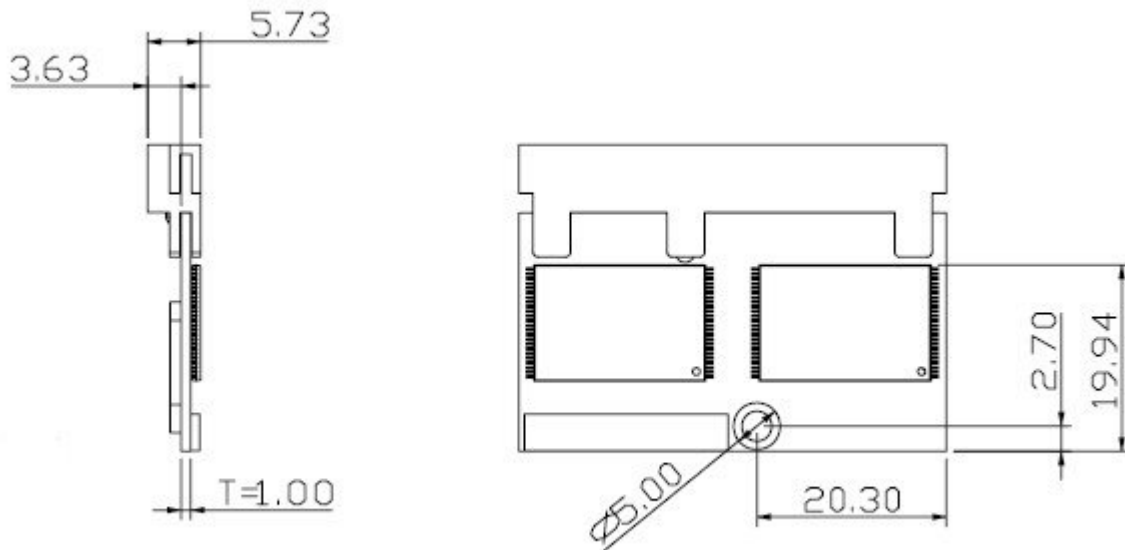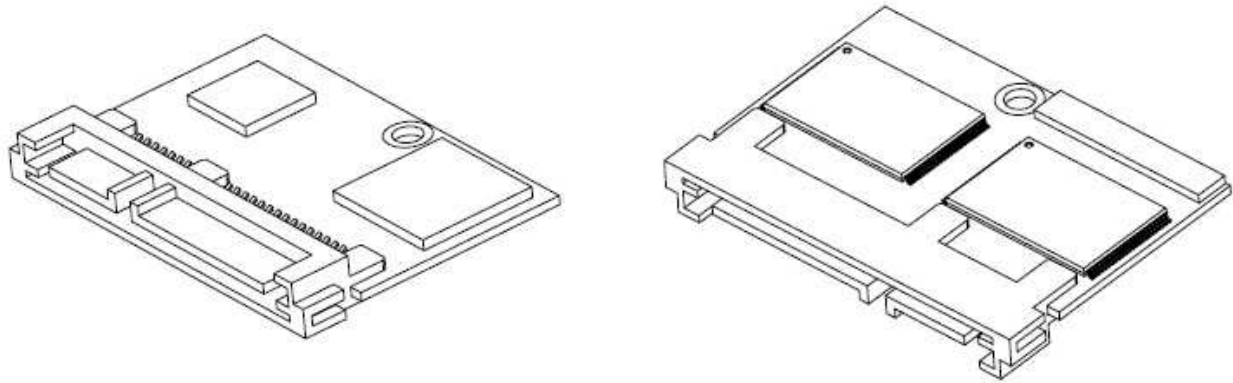| Parameter	Symbol	Conditions
Input Power	V_{DD}	-0.3V min. to 6.5V max.
Voltage on any pin except V_{DD} with respect to GND	V	-0.5V min. to VDD + 0.5V max.

Table 7-3: Recommended system power-up timing

Symbol	Parameter	Typical	Maximum	Units
$T_{PU-READY}$[1]	Power-up to Ready Operation	200	1000	ms
$T_{PU-WRITE}$[1]	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.
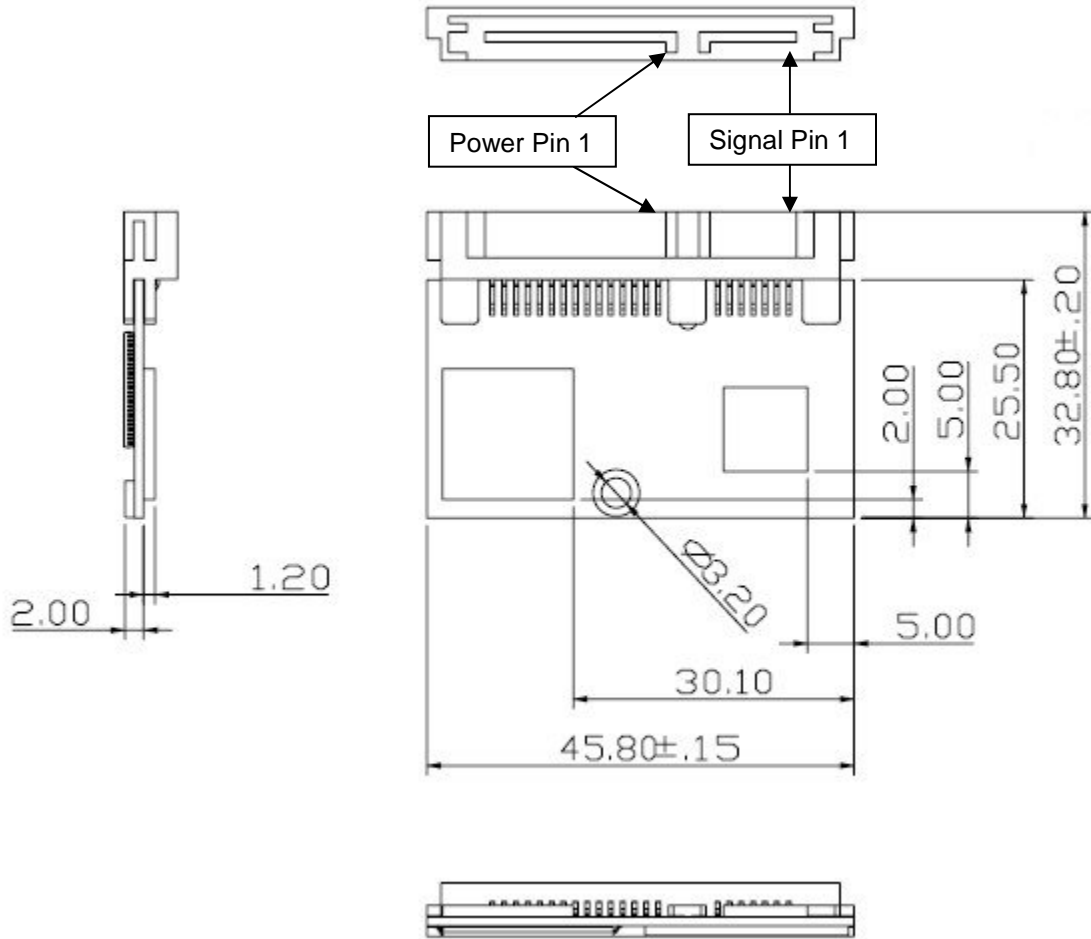
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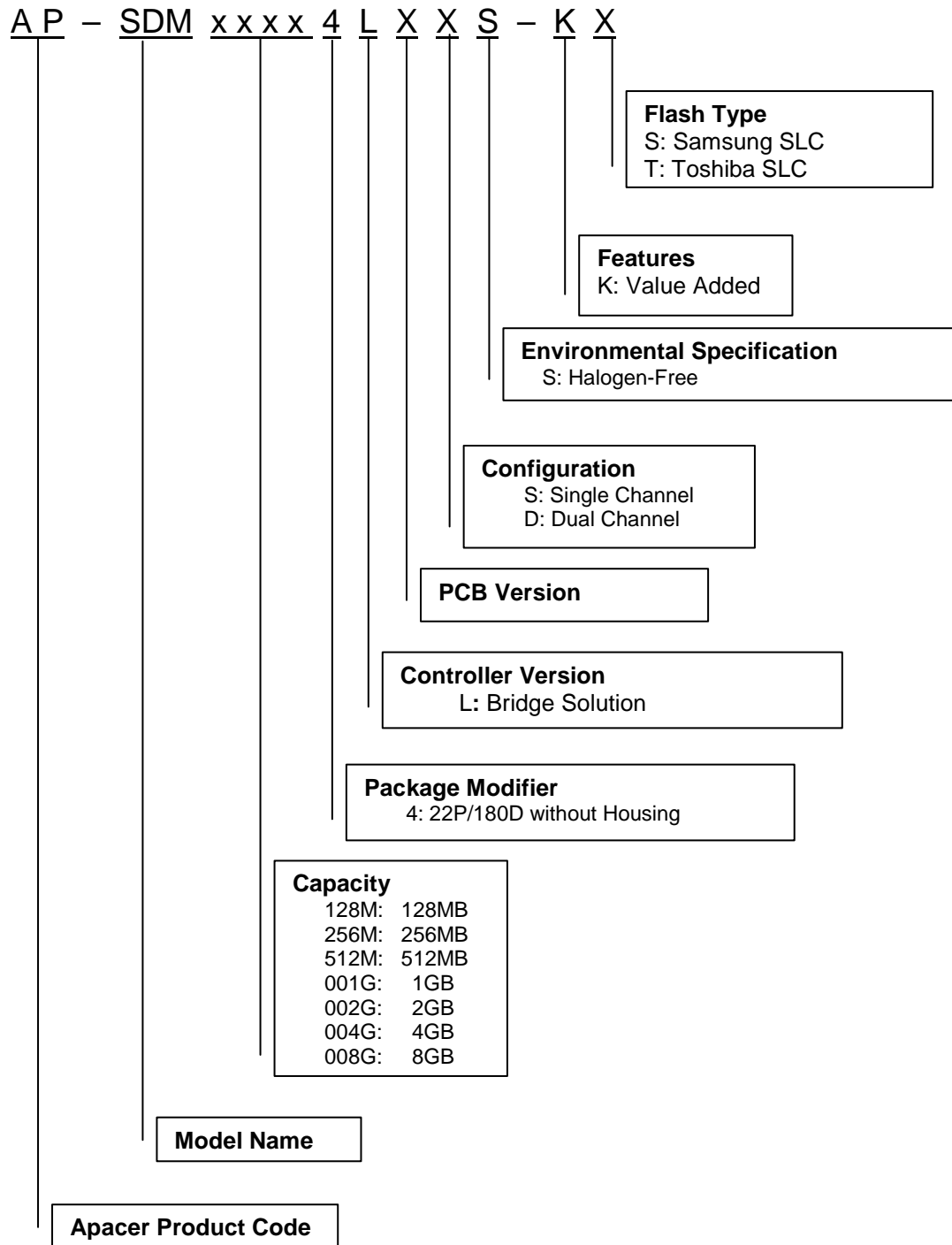# 8. Physical Characteristics

8.1 Dimension

Unit: mm
Tolerance: ± 0.25

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Power Pin 1

Signal Pin 1

2.00

1.20

∅3.20

2.00

5.00

25.50

32.80±.20

5.00

30.10

45.80±.15

Unit: mm
Tolerance: ± 0.25

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9. Product Ordering Information

9.1 Product Code Designations

A P – SDM x x x x 4 L X X S – K X

Flash Type
S: Samsung SLC
T: Toshiba SLC

Features
K: Value Added

Environmental Specification
S: Halogen-Free

Configuration
S: Single Channel
D: Dual Channel

PCB Version

Controller Version
L: Bridge Solution

Package Modifier
4: 22P/180D without Housing

Capacity
128M: 128MB
256M: 256MB
512M: 512MB
001G: 1GB
002G: 2GB
004G: 4GB
008G: 8GB

Model Name

Apacer Product Code

9.2 Valid Combinations

Capacity	Standard	High Speed
128 MB	AP-SDM128M4LASS-KS	N/A
256 MB	AP-SDM256M4LASS-KS	AP-SDM256M4LADS-KS
512 MB	AP-SDM512M4LASS-KS	AP-SDM512M4LADS-KS
1 GB	AP-SDM001G4LASS-KS	AP-SDM001G4LADS-KS
2 GB	AP-SDM002G4LASS-KS	AP-SDM002G4LADS-KS
4 GB	N/A	AP-SDM004G4LADS-KS
8 GB	AP-SDM008G4LASS-KT	N/A

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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	

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