RoHS Compliant

SATA-Disk Module 4

SDM4 22P/180D Product Specifications

December 1st, 2011

Version 1.0

Features:

- **Standard Serial ATA 2.6 (Gen. 2)**
  - Serial ATA 2.6 (Gen. 2)
  - SATA II, 3.0 Gbps
  - ATA-compatible command set

- **Capacities**
  - 2, 4, 8, 16, 32, 64 GB

- **Performance***
  - Burst read/write: 300 MB/sec
  - Sustained read: up to 165 MB/sec
  - Sustained write: up to 150 MB/sec

- **Intelligent endurance design**
  - Built-in hardware ECC, enabling up to 16/24 bit correction per 1K bytes
  - Static wear-leveling scheme together with dynamical block allocation to significantly increase the lifespan 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: 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**
  - 5.0 V $\pm$ 5%

- **Power consumption (typical)***
  - Active mode: 333 mA@5.0 V
  - Idle mode: 95 mA@5.0 V

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

- **Form factor**
  - SATA Disk Module
  - Dimension: 45.80x32.80x1.00**, unit: mm

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

- **RoHS compliant**

*Varies from capacities. The values for performances and power consumptions presented are typical and may vary depending on flash configurations or platform settings. The term idle refers to the standby state of the device.
**Excluding the thickness/height of chips and connector, only the thickness of the module is accounted.

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1. General Description

Apacer's SATA-Disk Module 4 (SDM4) 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 connectors 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 SDM4 and mainboard.

Apacer's SDM4-M has a built-in microcontroller with file management firmware that communicates with SATA standard interface. This means SDM4 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.

SDM4 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 Management, ATA Secure Erase, and TRIM, Apacer assures users of a versatile device on data storage.

This SDM4 SSD is designed to be rugged for industrial applications where harsh, demanding environments are often encountered, and has gone through environmental testings such as shock, wide temperature range and ESD. Our SSDs meet international standards and we specialized in customization services in both hardware and systems.

Our customization services include:

- Product change notification (PCN)[1]
- Pre-installed software, custom software imaging and ID strings[2]
- Customize packaging and labeling[2]
- Specified testing[2]
- Safety packaging, such as ESD protection pad, honeycomb-cut packing in sponge, or other types of protection.
- Field Application Engineers in our overseas branches for technical support

[1]Usually notified by our sales representatives or product managers, instead of on packages.
[2]Depending on specified requests

1.1 Performance-Optimized Controller

The heart of SDM4 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 SDM4. 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 Diagram

SDM4 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.
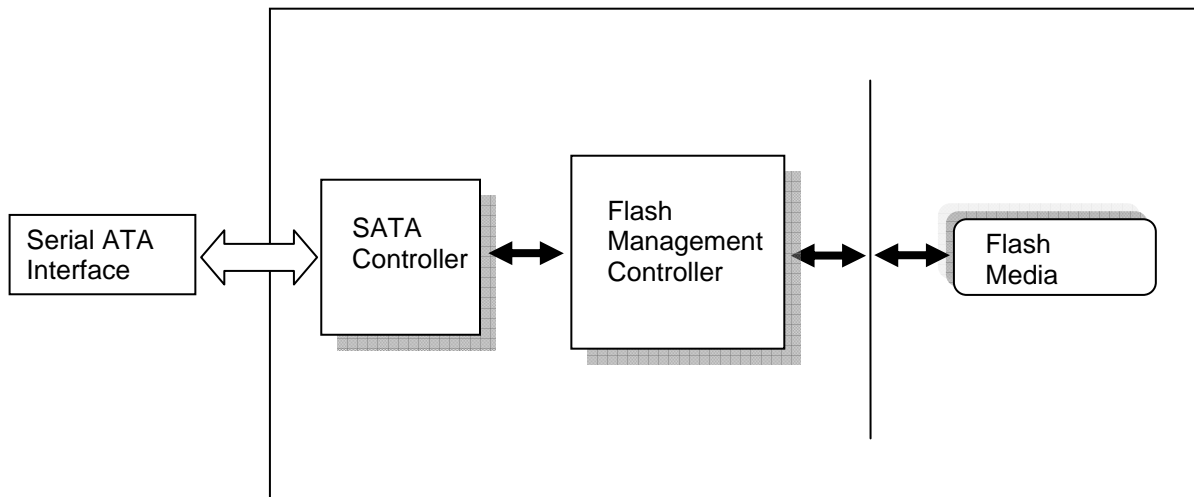
Figure 2-1: Functional block diagram

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3. Pin Assignments

SATA Connectors

Signal Segment Key

Signal Segment Pin S1

Power Segment Pin P1
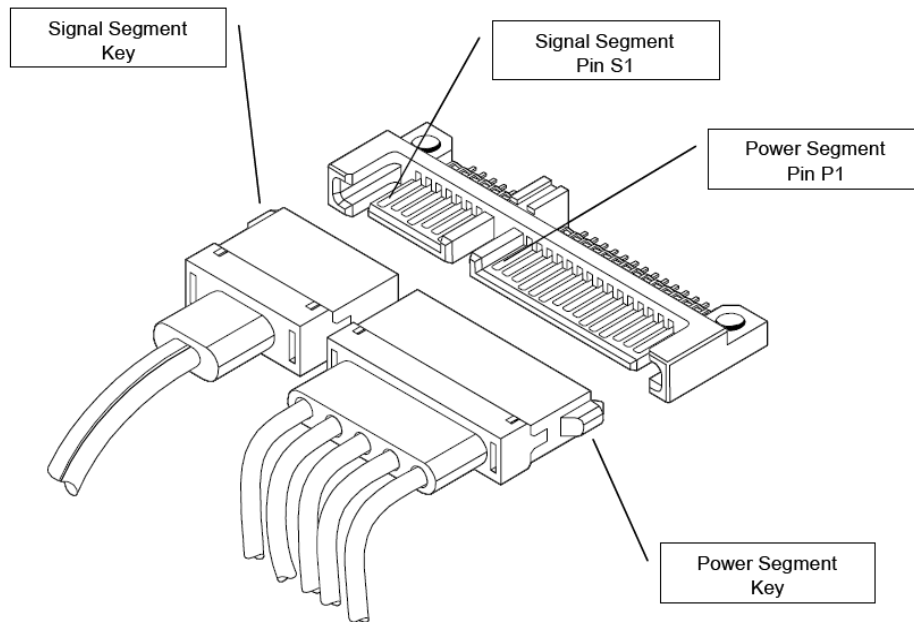
Power Segment Key

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	Unused (3.3V)
P2	Unused (3.3V)
P3	Unused (3.3V)
P4	Ground
P5	Ground
P6	Ground
P7	5V
P8	5V
P9	5V
P10	Ground
P11	Reserved/Ground
P12	Ground
P13	Unused (12V)
P14	Unused (12V)
P15	Unused (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. Capacity Specification

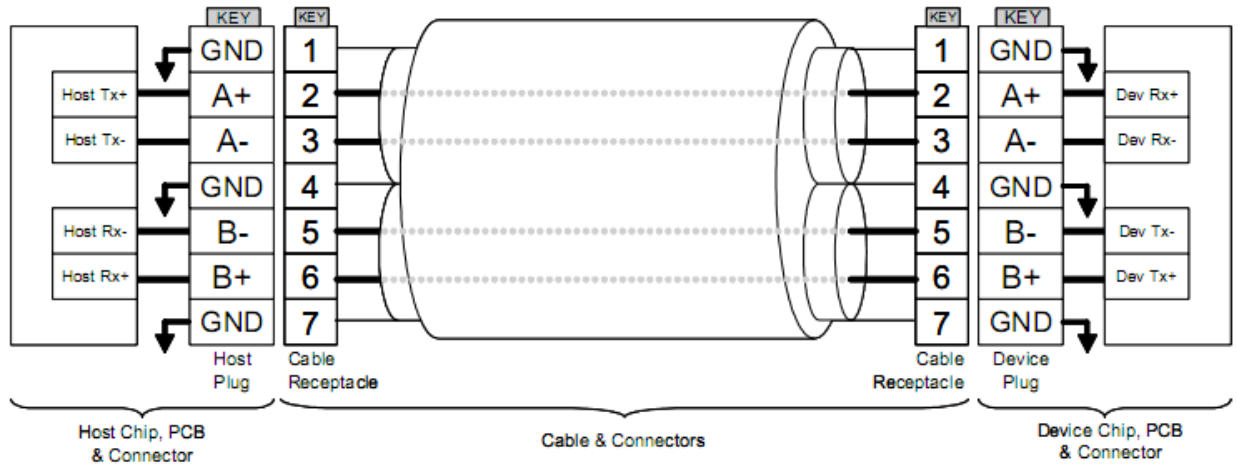Capacity specification of SDM4 is available as shown in Table 4-1. It lists the specific capacity and the default numbers of heads, sectors and cylinders for each product line.

Table 4-1: Capacity specifications

Capacity	Total bytes*	Cylinders	Heads	Sectors	Max LBA
2 GB	2,002,452,480	3,880	16	63	3,911,040
4 GB	3,011,420,160	5835	16	63	5,881,680
8 GB	7,012,196,352	15334	16	63	13,695,696
16 GB	16,013,942,784	16,383	16	63	31,277,232
32 GB	32,017,047,552	16,383	16	63	62,533,296
64 GB	63,351,106,560	16,383	16	63	123,732,736

*Display of total bytes varies from file systems, which means not all of the bytes can be used for storage.

4.1 Performance Specification

4.1.1 ATA Mode Support

SDM4 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 SDM4 are listed below in table 4-2.

Table 4-2: Performance (Standard)

Performance \ Capacity	2 GB	4 GB	8 GB	16 GB	32 GB
Sustained read (MB/s)	75	80	80	85	85
Sustained write (MB/s)	26	50	50	80	80

Performance (High-speed)

Performance \ Capacity	4 GB	8 GB	16 GB	32 GB	64 GB
Sustained read (MB/s)	150	160	160	160	165
Sustained write (MB/s)	50	100	95	145	150

Note: Results may differ from various flash configurations.

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4.2 Environmental Specifications

Environmental specification of SDM4 product family which follows the MIL-STD-202 and MIL-STD-810 standards is available as shown in Table 4-3.

Table 4-3 SDM4 environmental specifications

Item	Specification
operating temperature	0~70(℃)
Extended temperature	-40 ~ +85(℃)
non-operating temp.	-40~100(℃)
humidity	10~95% R.H, non-condensing
operating vibration	10~2000(Hz), 15(G), sine wave, 1(hr)/per axis
non-operating vibration	20~2000(Hz), 7.7(Grms), random wave, 1(hr)/per axis
operating shock	50(G), 11(ms), half-sine wave
non-operating shock	1500(G), 0.5(ms), half-sine wave

4.3 Mean Time Between Failures (MTBF)

Mean Time Between Failures (MTBF) is predicted based on reliability data for the individual components in SDM4. Although many component MTBFs are given in databases and often these values are not really accurate, the prediction result for SDM4 is more than 2,000,000 hours.

Notes about the MTBF:

The MTBF is predicated and calculated based on "Telcordia Technologies Special Report, SR-332, Issue 2" method.

4.4 Certification and Compliance

SDM4 complies with the following standards:

- CE – EN55022/55024
- FCC 47CFR Part15 Class B
- RoHS
- MIL-STD-202 and MIL-STD-810
- SATA II (SATA Rev. 2.6)
- Up to ATA/ATAPI-7 (including S.M.A.R.T.)

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5. Flash Management

5.1 Error Correction/Detection

SDM4 implements a hardware ECC scheme, based on the BCH algorithm. It can detect and correct up to 16 bits or 24 bits error in 1K bytes.

5.2 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. SDM4'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

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

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

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.

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 SDM4 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 SDM4. 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 SDM4 is in critical condition.

5.7 TRIM

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 SDM4. Commands are issued to SDM4 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		

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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	4.75-5.25V
Extended Temperature	-40°C to 85°C	

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.

Table 7-4: Power consumption – Standard (typical)

Mode \ Capacity	2 GB	4 GB	8 GB	16 GB	32 GB
Active (mA)	187	224	233	220	230
Stand By (mA)	71	72	72	75	75

Power consumption – High speed (typical)

Mode \ Capacity	4 GB	8 GB	16 GB	32 GB	64 GB
Active (mA)	255	333	324	280	300
Stand By (mA)	85	95	95	77	80

Note: Power consumptions may vary depending on flash configurations and platforms

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7.1   Electrostatic Discharge

Electrostatic discharge

Item	Amount of Discharge	Voltage	Required Criteria	Complied To Criteria (A,B,C)
Air Discharge	10	+8kV	B	A
	10	-8kV	B	A
Contact Discharge	25	+4kV	B	A
	25	-4kV	B	A
Indirect Discharge (HCP)	25	+4kV	B	A
	25	-4kV	B	A
Indirect Discharge (VCP Front)	25	+4kV	B	A
	25	-4kV	B	A
Indirect Discharge (VCP Left)	25	+4kV	B	A
	25	-4kV	B	A
Indirect Discharge (VCP Back)	25	+4kV	B	A
	25	-4kV	B	A
Indirect Discharge (VCP Right)	25	+4kV	B	A
	25	-4kV	B	A

7.2   Electrical Fast Transient/Burst

Electrical Fast Transient/Burst

Inject Line	Polarity	Voltage kV	Inject Time (Second)	Inject Method	Required Criteria	Complied to Criteria
L-N-PE	±	1kV	60	Direct	B	A

Notes about 7.1 Electrostatic Discharge & 7.2 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.

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Meet criteria A: Operate as intended during and after the test
Meet criteria B: Operate as intended after the test
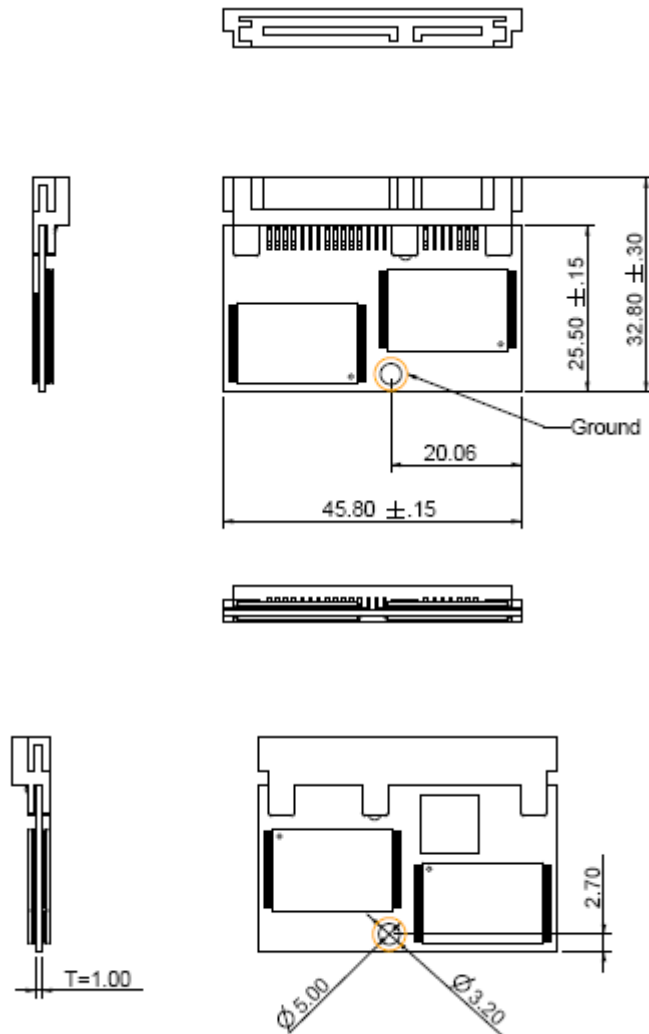Meet criteria C: Loss/Error of function

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.
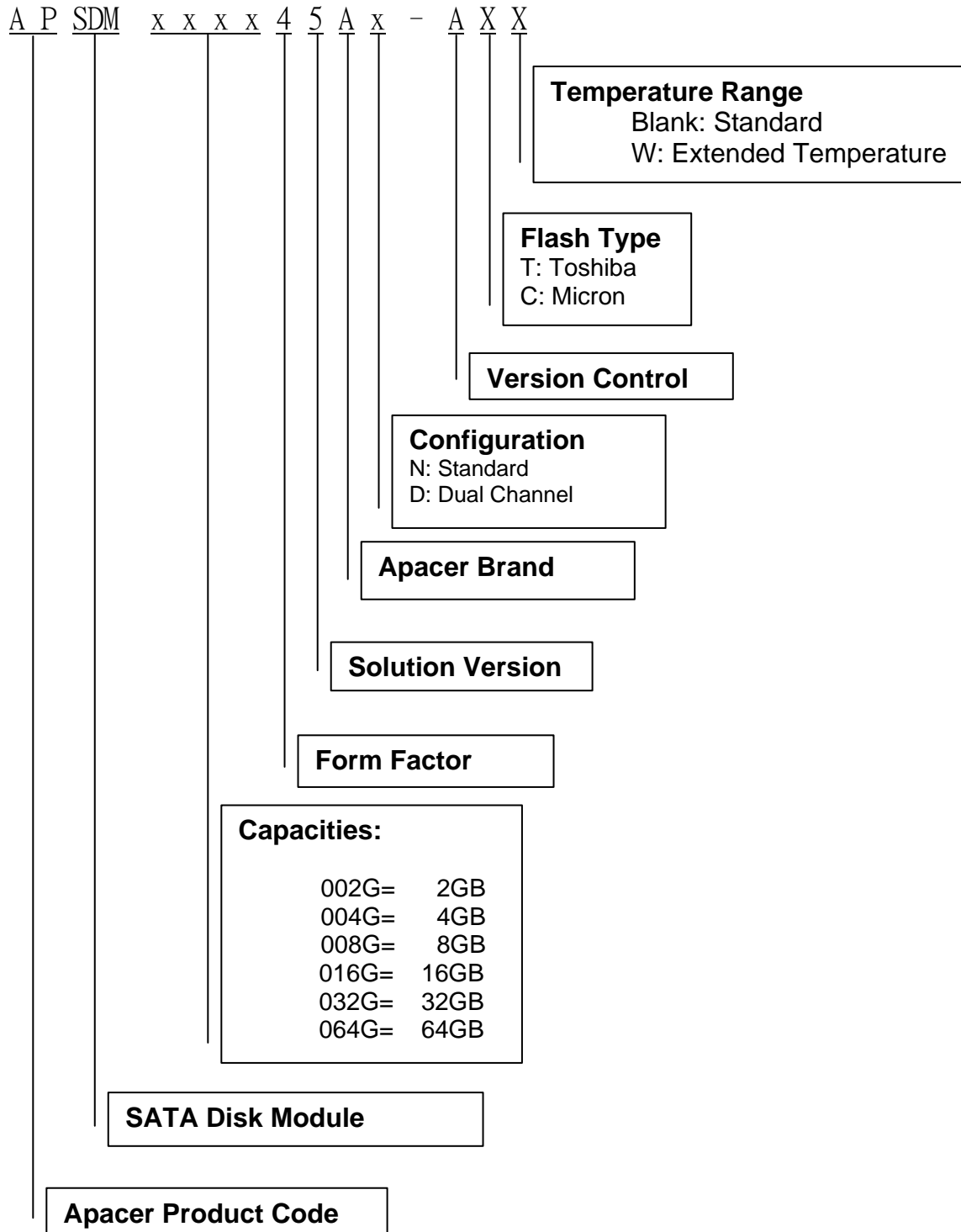
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8. Physical Characteristics

8.1 Dimensions

Unit: ㎜
Tolerance: ± 0.25

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9. Product Ordering Information

9.1 Product Code Designations

A P SDM x x x x 4 5 A x – A X X

Temperature Range
    Blank: Standard
    W: Extended Temperature

Flash Type
T: Toshiba
C: Micron

Version Control

Configuration
N: Standard
D: Dual Channel

Apacer Brand

Solution Version

Form Factor

Capacities:

002G=   2GB
004G=   4GB
008G=   8GB
016G=   16GB
032G=   32GB
064G=   64GB

SATA Disk Module

Apacer Product Code

9.2 Valid Combinations

9.2.1 SDM4 22P/180D Standard type

Capacity	Standard	Extended Temperature
2GB	APSDM002G45AN-AT	APSDM002G45AN-ATW
4GB	APSDM004G45AN-AT	APSDM004G45AN-ATW
8GB	APSDM008G45AN-AT	APSDM008G45AN-ATW
16GB	APSDM016G45AN-AC	APSDM016G45AN-ACW
32GB	APSDM032G45AN-AC	APSDM032G45AN-ACW

9.2.2 SDM4 22P/180D High Speed type

Capacity	Standard	Extended Temperature
4GB	APSDM004G45AD-AT	APSDM004G45AD-ATW
8GB	APSDM008G45AD-AT	APSDM008G45AD-ATW
16GB	APSDM016G45AD-AT	APSDM016G45AD-ATW
32GB	APSDM032G45AD-AC	APSDM032G45AD-ACW
64GB	APSDM064G45AD-AC	APSDM064G45AD-ACW

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	Date	Description	Remark
0.1	11/22/2011	Preliminary release	
1.0	12/01/2011	Official release	

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