

RoHS Compliant

SATA-Disk Module 4

SDM4 7P/180D Low Profile Specifications

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Version 1.2



Apacer Technology Inc.

4th Fl., 75 Hsin Tai Wu Rd., Sec. 1, Hsichih, New Taipei City, Taiwan 221

Tel: +886-2-2698-2888 Fax: +886-2-2698-2889

www.apacer.com

Features:

- **Standard Serial ATA 2.6 (Gen. 2)**
 - Serial ATA 2.6 (Gen. 2)
 - SATA II, 3.0 Gbps
 - ATA-compatible command set
- **Capacities**
 - 1, 2, 4, 8, 16 GB
- **Performance***
 - Burst read/write: 300 MB/sec
 - Sustained read: up to 43 MB/sec
 - Sustained write: up to 42 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 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**
- **MTBF: >2,000,000**
- **Zero power data retention**
 - No battery required for data storage
- **Temperature ranges**
 - Operation:
 - Standard: 0°C to 70°C
 - Extended: -40 ~ +85°C
 - Storage: -40°C to 100°C
- **Supply voltage**
 - 5.0 V \pm 5%
- **Power consumption (typical)***
 - Active mode: 190 mA@5.0 V
 - Idle mode: 85 mA@5.0 V
- **Connector type**
 - 7-pin signal connector
 - Option : 2-pin additional power connector
- **Form factor**
 - SATA Disk Module
 - Dimension (w/o housing):
 - 30.00x20.00x1.00**, unit: mm
 - Dimension (w/ housing): 32.50x23.30x8.53**, 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.

** Without including the size of SATA connector

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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 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 SDM4 and mainboard.

Apacer's SDM4 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.

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.

2. Functional Block

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.

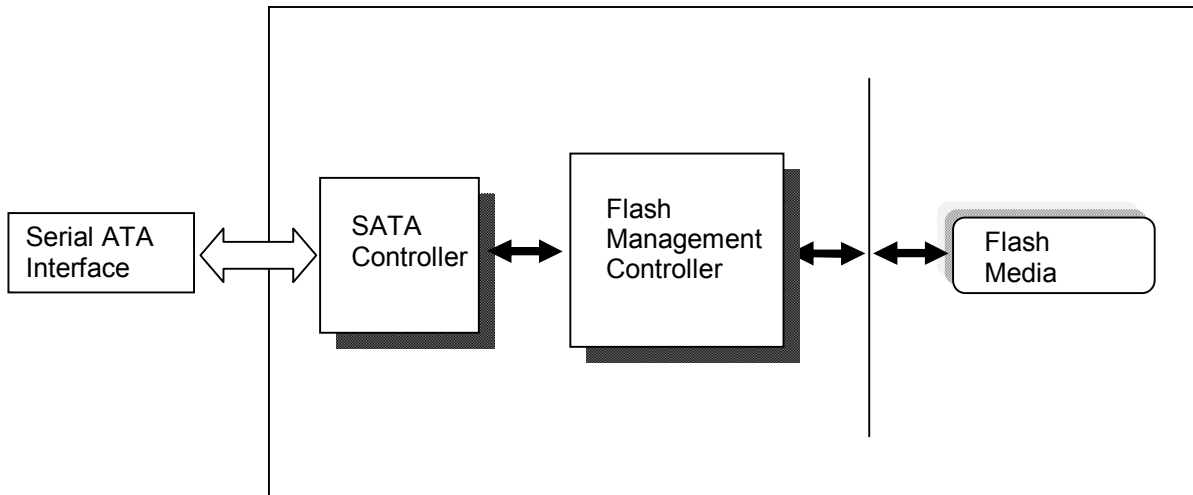
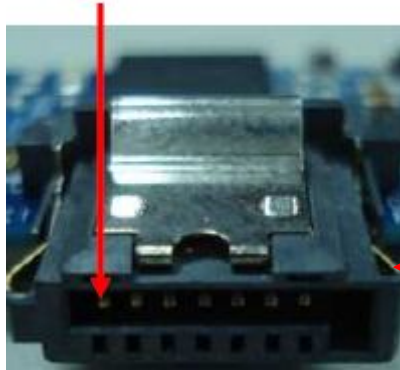


Figure 2-1: Functional block diagram

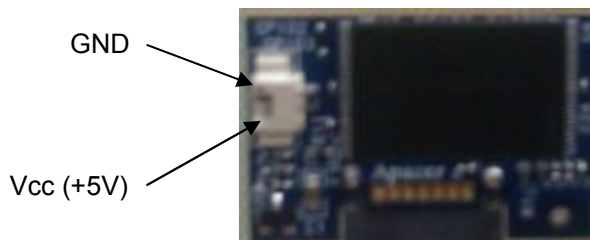
3. Pin Assignments

Signal Pin 1

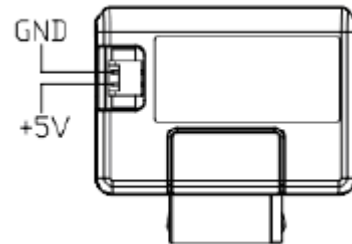


Power Pin1

Power cable type w/o Housing



Power cable type w/ Housing



Signal Segment

Pin	Type	Signal 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 Segment

Pin	Signal Description
P1	Vcc (+5V)
P2	GND

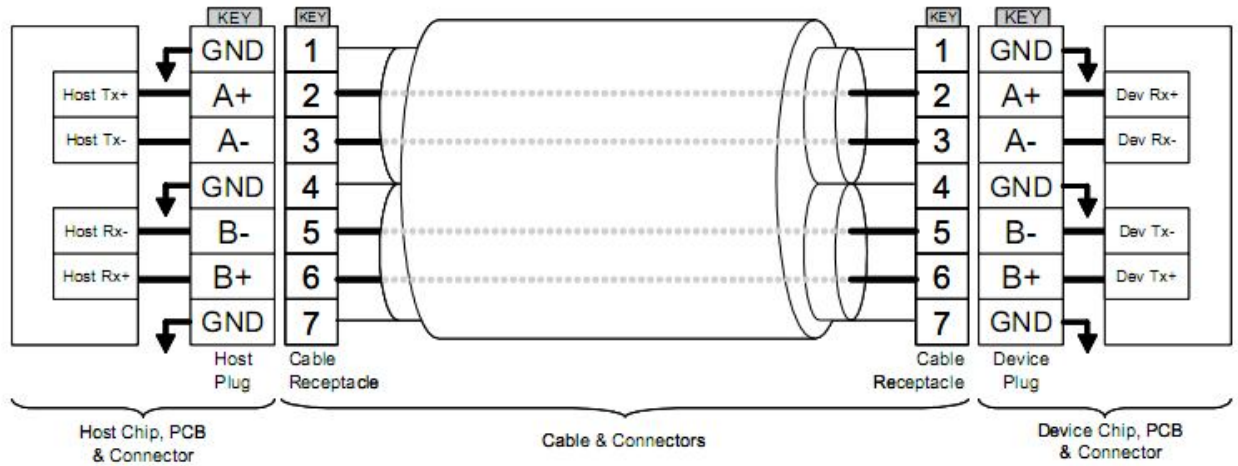


Figure 3-1: SATA Cable/Connector Connection Diagram

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 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
1 GB	1,011,032,064	1,959	16	63	1,974,672
2 GB	2,011,226,112	3,897	16	63	3,928,176
4 GB	4,011,614,208	7,773	16	63	7,835,184
8 GB	8,012,390,400	15,525	16	63	15,649,200
16 GB	16,013,942,784	16,383	16	63	31,277,232

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

**Cylinders, heads or sectors are not applicable for these capacities. Only LBA addressing applies.

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 (Typical)

Capacity	1 GB	2 GB	4 GB	8 GB	16 GB
Performance					
Sustained read (MB/s)	38	43	43	43	43
Sustained write (MB/s)	12	24	24	41	42

Note: Results may differ from various flash configurations.

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 temp.	0~70°C (standard); -40 ~ +85°C (extended)
non-operating temp.	-40~100(°C)
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.)

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.

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 devices use the standard SMART command B0h to read data out from the drive to activate our SMART feature that complies with the ATA/ATAPI-7 specifications. Based on the SFF-8035i Rev. 2.0 specifications, Apacer SMART defines vendor-specified SMART Attribute IDs (A0 ~ A5, and 0C). They represent Initial bad block count, Bad block count, Spare block count, Maximum erase count, Average erase count and Power cycle. When the Apacer SMART Utility running on the host, it analyzes and reports the disk status to the host before the device reaches 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.

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		

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 V _{DD} + 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 (typical)

Modes \ Capacity	1 GB	2 GB	4 GB	8 GB	16 GB
	Active (mA)	160	160	200	185
Idle (mA)	71	71	71	85	85

Note: Results may differ from various flash configurations or platforms.

7.1 Electrostatic Discharge

Electrostatic discharge

Item	Amount of Discharge	Voltage
Air Discharge	10	+8kV

SATA-Disk Module 4
APSDMxxxxX5AN-AXXX

	10	-8kV
Contact Discharge	25	+4kV
	25	-4kV
Indirect Discharge (HCP)	25	+4kV
	25	-4kV
Indirect Discharge (VCP Front)	25	+4kV
	25	-4kV
Indirect Discharge (VCP Left)	25	+4kV
	25	-4kV
Indirect Discharge (VCP Back)	25	+4kV
	25	-4kV
Indirect Discharge (VCP Right)	25	+4kV
	25	-4kV

7.2 Electrical Fast Transient/Burst

Electrical Fast Transient/Burst

Inject Line	Polarity	Voltage kV	Inject Time (Second)	Inject Method
L-N-PE	±	1kV	60	Direct

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.

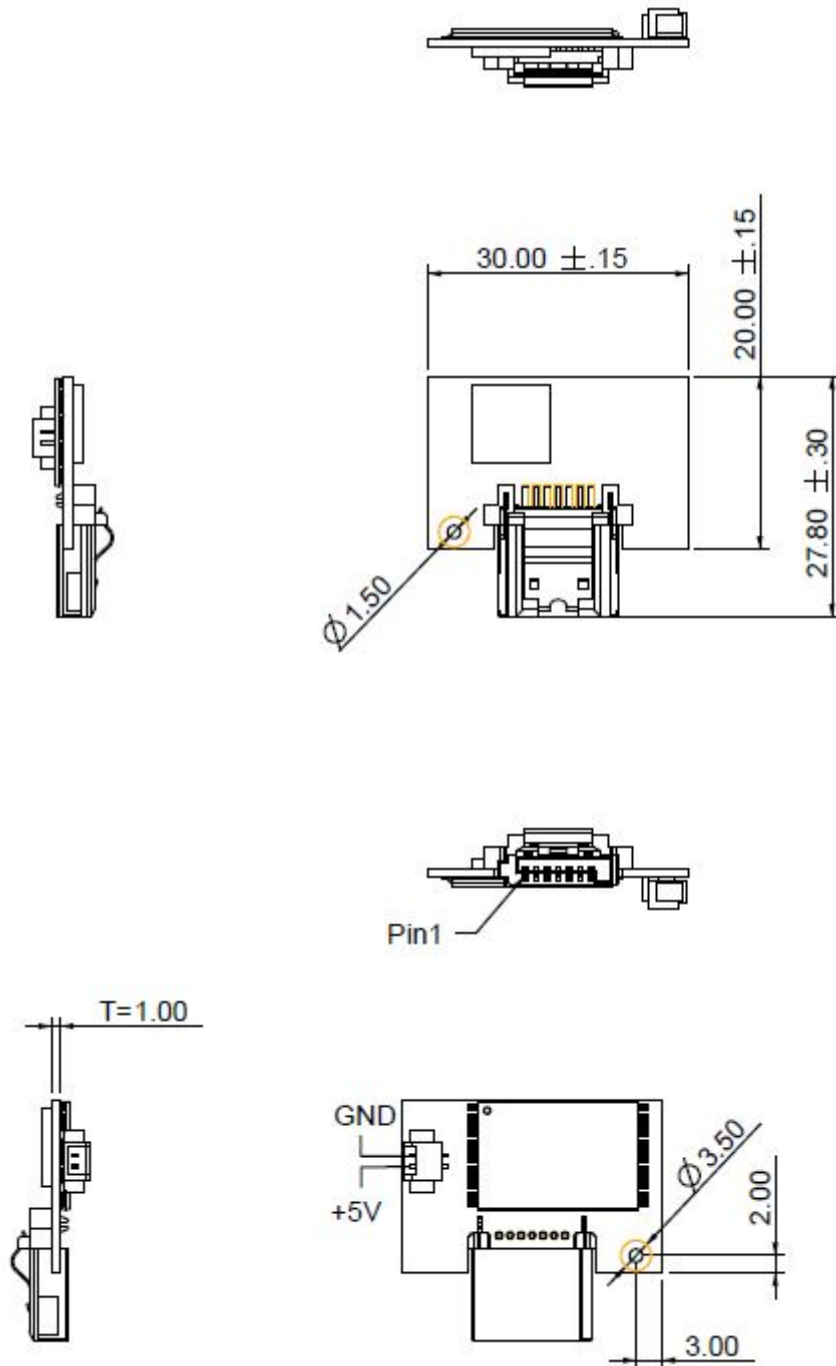
The Contact discharges were applied at least total 200 discharges at a minimum of four test points.

8. Physical Characteristics

8.1 Power Cable Type

7-pin/180 Degree Low Profile Module

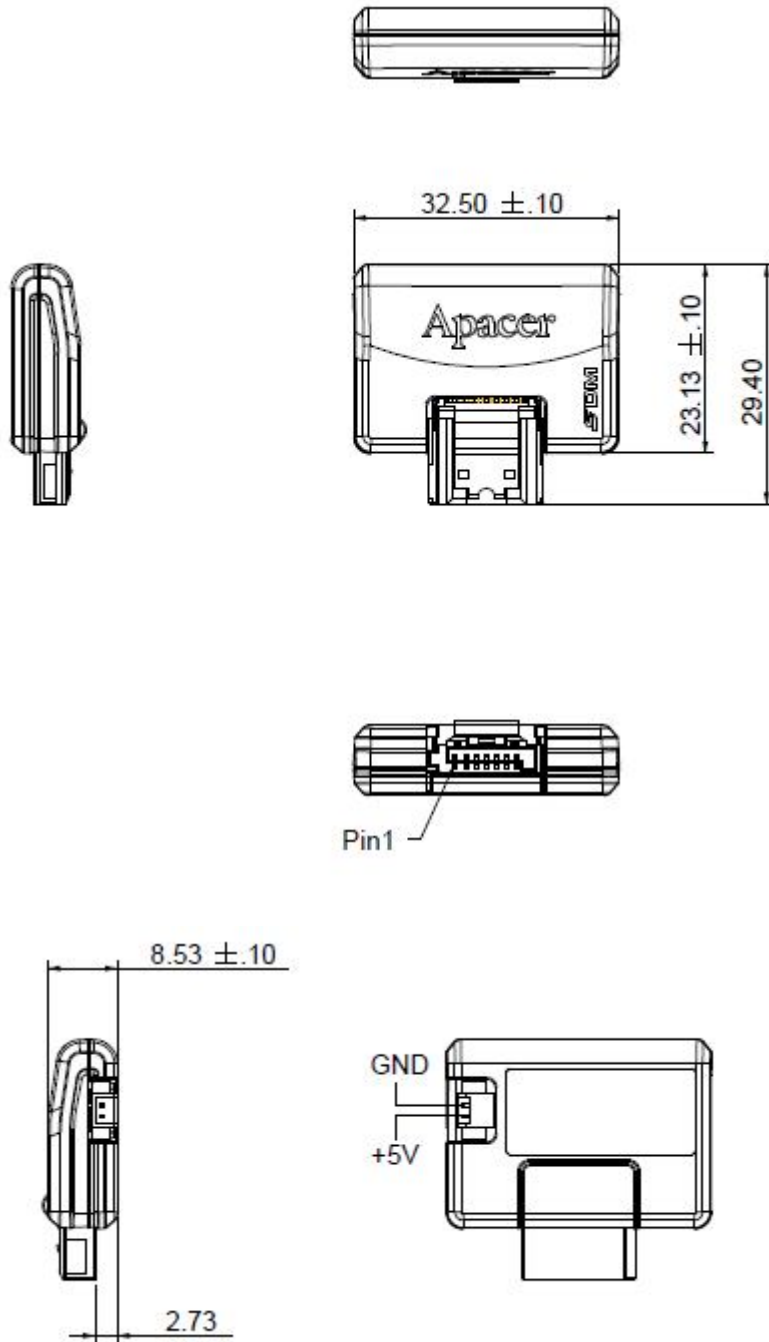
8.1.1 W/o Housing



Unit: mm
Tolerance: ± 0.25

SATA-Disk Module 4 APSDMxxxxX5AN-AXXX

8.1.2 W/ Housing

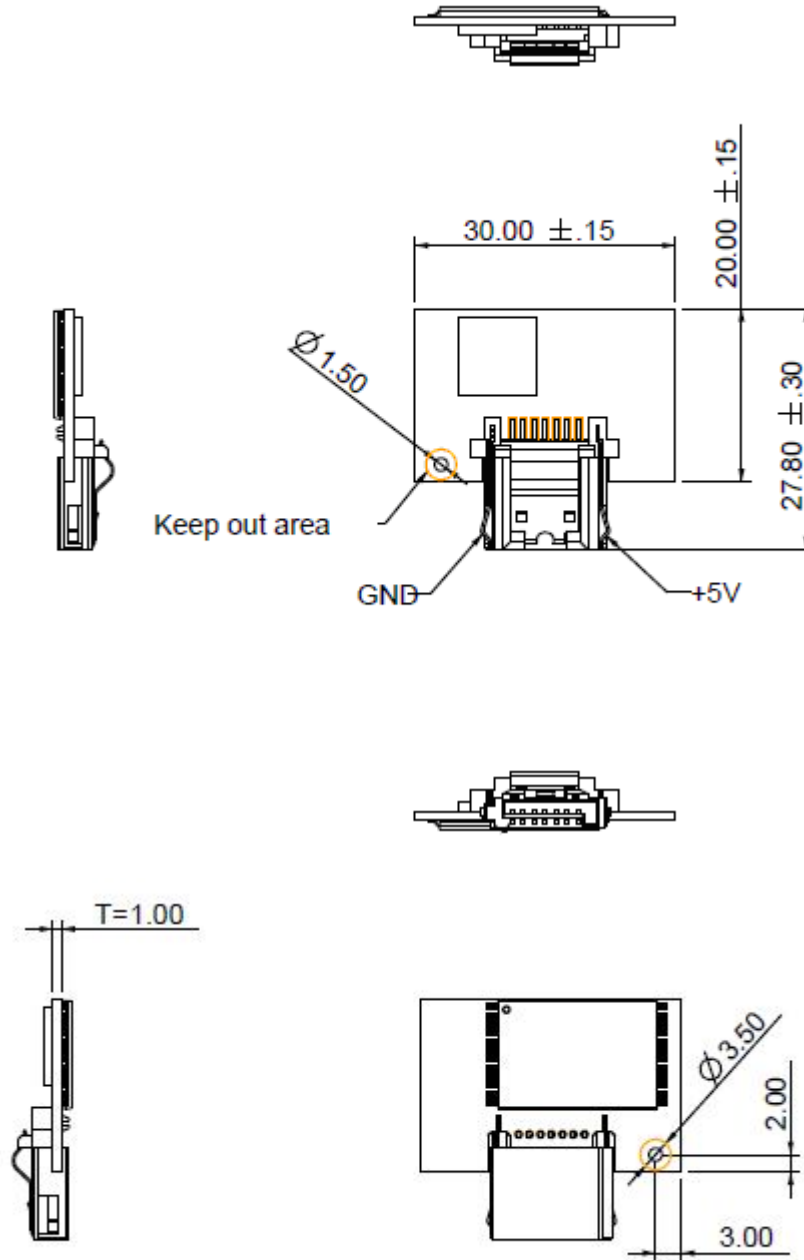


Unit: mm
Tolerance: ± 0.25

8.2 Power Cable-less Type

7-pin/180 Degree Low Profile Module

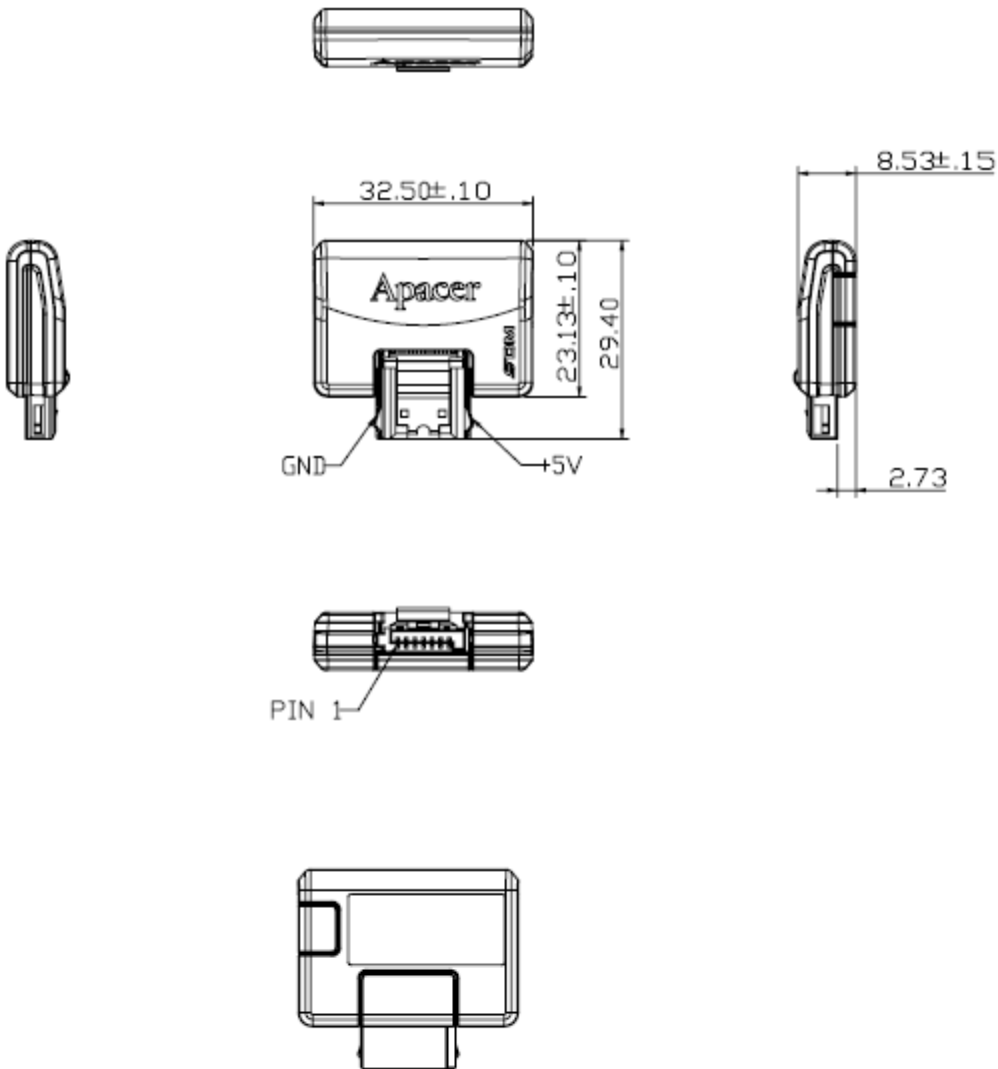
8.2.1 W/o Housing



Unit: mm
Tolerance: ± 0.25

SATA-Disk Module 4 APSDMxxxxX5AN-AXXX

8.2.2 W/ Housing

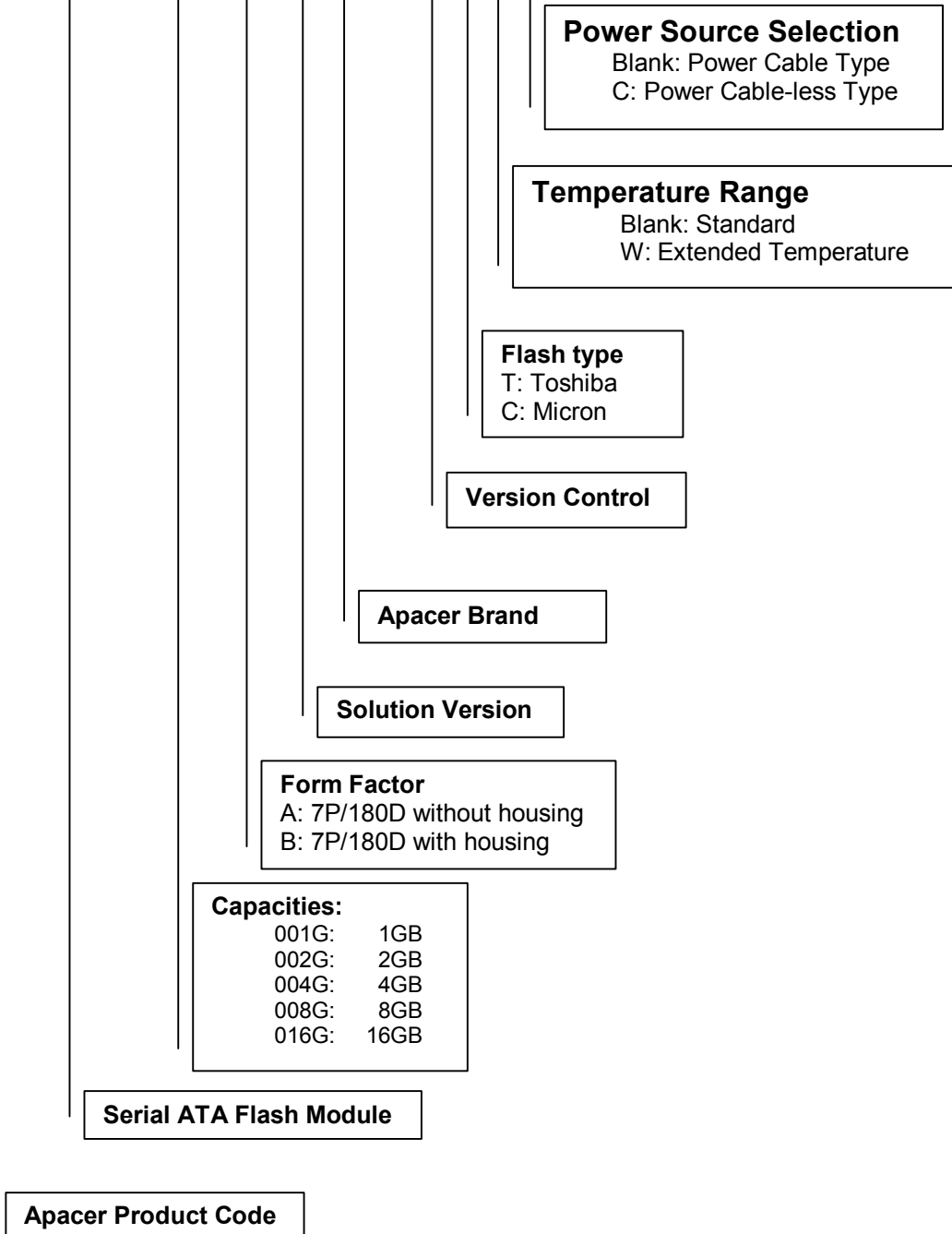


Unit: mm
Tolerance: ± 0.25

9. Product Ordering Information

9.1 Product Code Designations

A P SDM x x x x X 5 AN - A X X X



7.2 Valid Combinations

7P/180D LP without hosing: Power Cable Type

Capacity	Standard	Extended Temperature
1GB	APSDM001GA5AN-AT	APSDM001GA5AN-ATW
2GB	APSDM002GA5AN-AT	APSDM002GA5AN-ATW
4GB	APSDM004GA5AN-AT	APSDM004GA5AN-ATW
8GB	APSDM008GA5AN-AC	APSDM008GA5AN-ACW
16GB	APSDM016GA5AN-AC	APSDM016GA5AN-ACW

7P/180D LP with hosing: Power Cable Type

Capacity	Standard	Extended Temperature
1GB	APSDM001GB5AN-AT	APSDM001GB5AN-ATW
2GB	APSDM002GB5AN-AT	APSDM002GB5AN-ATW
4GB	APSDM004GB5AN-AT	APSDM004GB5AN-ATW
8GB	APSDM008GB5AN-AC	APSDM008GB5AN-ACW
16GB	APSDM016GB5AN-AC	APSDM016GB5AN-ACW

7P/180D LP without hosing: Power Cable-less Type

Capacity	Standard	Extended Temperature
1GB	APSDM001GA5AN-ATC	APSDM001GA5AN-ATWC
2GB	APSDM002GA5AN-ATC	APSDM002GA5AN-ATWC
4GB	APSDM004GA5AN-ATC	APSDM004GA5AN-ATWC
8GB	APSDM008GA5AN-ACC	APSDM008GA5AN-ACWC
16GB	APSDM016GA5AN-ACC	APSDM016GA5AN-ACWC

7P/180D LP with hosing: Power Cable-less Type

Capacity	Standard	Extended Temperature
1GB	APSDM001GB5AN-ATC	APSDM001GB5AN-ATWC
2GB	APSDM002GB5AN-ATC	APSDM002GB5AN-ATWC
4GB	APSDM004GB5AN-ATC	APSDM004GB5AN-ATWC
8GB	APSDM008GB5AN-ACC	APSDM008GB5AN-ACWC
16GB	APSDM016GB5AN-ACC	APSDM016GB5AN-ACWC

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
1.0	02/20/2012	Official release	
1.1	03/12/2012	Updated Product Ordering Information Added housing for the physical design	
1.2	04/06/2012	Updated S.M.A.R.T information Updated Product Ordering Information Updated Mechanical Drawings	

Global Presence

Taiwan (Headquarters)	Apacer Technology Inc. 4 th Fl., 75 Hsin Tai Wu Rd., Sec.1 Hsichih, New Taipei City Taiwan 221 R.O.C. Tel: +886-2-2698-2888 Fax: +886-2-2698-2889 amtsales@apacer.com
U.S.A.	Apacer Memory America, Inc. 386 Fairview Way, Suite102, Milpitas, CA 95035 Tel: 1-408-518-8699 Fax: 1-408-935-9611 sa@apacerus.com
Japan	Apacer Technology Corp. 5F, Matsura Bldg., Shiba, Minato-Ku Tokyo, 105-0014, Japan Tel: 81-3-5419-2668 Fax: 81-3-5419-0018 jpservices@apacer.com
Europe	Apacer Technology B.V. Science Park Eindhoven 5051 5692 EB Son, The Netherlands Tel: 31-40-267-0000 Fax: 31-40-267-0000#6199 sales@apacer.nl
China	Apacer Electronic (Shanghai) Co., Ltd 1301, No.251,Xiaomujiao Road, Shanghai, 200032, China Tel: 86-21-5529-0222 Fax: 86-21-5206-6939 sales@apacer.com.cn
India	Apacer Technologies Pvt Ltd, #1064, 1st Floor, 7th 'A' Main, 3rd Block Koramangala, Bangalore – 560 034 Tel: +91 80 4152 9061/62/63 Fax: +91 80 4170 0215 sales_india@apacer.com

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