

RoHS Recast Compliant **SATA-Disk Module 5A**

SDM5A 22P/180D Product Specifications

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Version 1.2



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Features:

- **Standard Serial ATA Interface**
 - Serial ATA Revision 3.1
 - SATA 6.0 Gbps interface
 - ATA-8 command set
 - Backward compatible with SATA 1.5/3.0 Gbps
- **Capacity**
 - 1, 2, 4, 8, 16, 32 GB
- **Performance***
 - Burst read/write: 600 MB/sec
 - Sequential read: Up to 90 MB/sec
 - Sequential write: Up to 75 MB/sec
- **Flash Management**
 - Built-in hardware ECC
 - Global Wear Leveling
 - Flash bad-block management
 - S.M.A.R.T.
 - Power Failure Management
 - ATA Secure Erase
- **NAND Flash Type: SLC**
- **MTBF: >2,000,000 hours**
- **Temperature Range**
 - Operating:
 - Standard: 0°C to 70°C
 - Extended: -40°C to 85°C
 - Storage: -40°C to 100°C
- **Supply Voltage**
 - 5.0 V ± 5%
- **Power Consumption***
 - Active mode: 215 mA
 - Idle mode: 85 mA
- **Connector Type**
 - 7-pin SATA signal connector
 - 15-pin SATA power connector
- **Form Factor**
 - SATA Disk Module: 22-pin/180 degree
- **Shock & Vibration****
 - Shock: 1,500 G
 - Vibration: 15 G
- **RoHS Recast Compliant**
 - Complies with 2011/65/EU Standard

*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.

**Non-operating

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1. General Descriptions

Apacer's SDM5A (SATA Disk Module 5A) is our next generation disk-on-module (DOM) series that offers elevated speed boost and higher error correction capabilities. Built with SATA 6.0 Gb/s interface, SDM5A delivers higher performance in data transfer than its previous SDM selections, reaching up to 90 MB/s in read and 75 MB/s in write.

With its SATA interface compliance and compact size, this high-speed disk module defines an ideal balance of performance, capacities, reliability and cost. SDM5A comes in moderate capacities that are suitable to boot industrial applications and light operating systems for specific operations, while with some extra memory space for data storage. The architectural nature of SATA disk module provides higher resistance to external environmental influences and better flexibility for motherboard space.

Regarding data reliability, SDM5A is built in with powerful ECC engine that can correct up to 40 bits per 1KB data. In addition, the controller unit of this DOM device supports wear-leveling, SMART and power failure management for data integrity. With its trustable reliability, performance and cost effectiveness, Apacer's SDM5A is definitely the ideal storage or cache solution for embedded and industrial computers, servers and thin clients.

2. Functional Block

SDM5A 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

SATA Connectors



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 | 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 | DAS |
| P12 | Ground |
| P13 | Unused (12V) |
| P14 | Unused (12V) |
| P15 | Unused (12V) |



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 specifications of SDM5A are 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 | 1959 | 16 | 63 | 1,974,672 |
| 2 GB | 2,011,226,112 | 3897 | 16 | 63 | 3,928,176 |
| 4 GB | 4,011,614,208 | 7773 | 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 |
| 32 GB | 32,017,047,552 | 16,383 | 16 | 63 | 62,533,296 |

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

**Notes: 1 GB = 1,000,000,000 bytes; 1 sector = 512 bytes.

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 Performance

Performance of SDM5A is listed below in Table 4-2.

Table 4-2 Performance Specifications

| Performance | Capacity | 1 GB | 2 GB | 4 GB | 8 GB | 16 GB | 32 GB |
|---------------------------------|--------------------------------|------|------|------|------|-------|-------|
| | Sequential Read* (MB/s) | | 40 | 55 | 42 | 85 | 90 |
| Sequential Write* (MB/s) | | 15 | 30 | 29 | 55 | 75 | 75 |

Note:

Results may differ from various flash configurations or host system setting.

*Sequential performance is based on CrystalDiskMark 5.2.1 with file size 1,000MB.

4.3 Environmental Specifications

Environmental specifications of SDM5A product are shown in Table 4-3.

Table 4-3 Environmental Specifications

| Item | Specifications |
|-------------------------|--|
| Operating temp. | 0°C to 70°C (Standard); -40°C to 85°C (Extended) |
| Non-operating temp. | -40°C to 100°C |
| Operating vibration | 20~2,000(Hz), 7.69 (Grms), random wave, X, Y, Z axis |
| Non-operating vibration | 10~2,000(Hz), 15(G), sine wave, X, Y, Z axis |
| Operating shock | 50(G), 11(ms), half-sine wave |
| Non-operating shock | 1,500(G), 0.5(ms), half-sine wave |

4.4 Mean Time Between Failures (MTBF)

Mean Time Between Failures (MTBF) is predicted based on reliability data for the individual components in SDM5A. The prediction result for SDM5A is more than 2,000,000 hours.

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

4.5 Certification and Compliance

SDM5A complies with the following standards:

- CE
- FCC
- RoHS Recast
- MIL-STD-810

5. Flash Management

5.1 Error Correction/Detection

SDM5A implements a hardware ECC scheme, based on the BCH algorithm. It can detect and correct up to 40 bits error in 1K bytes.

5.2 Bad Block Management

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.

5.3 Global Wear Leveling

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. Global wear leveling is an important mechanism that levels out the wearing of all blocks so that the wearing-down of all blocks can be almost evenly distributed. This will increase the lifespan of SSDs.

5.4 ATA Secure Erase

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.

5.5 Power Failure Management

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

6. Software Interface

6.1 Command Set

This section defines the software requirements and the format of the commands the host sends to SDM5A. Commands are issued to SDM5A 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 | | |

6.2 S.M.A.R.T.

S.M.A.R.T. is an abbreviation for Self-Monitoring, Analysis and Reporting Technology, a self-monitoring system that provides indicators of drive health as well as potential disk problems. It serves as a warning for users from unscheduled downtime by monitoring and displaying critical drive information. Ideally, this should allow taking proactive actions to prevent drive failure and make use of S.M.A.R.T. information for future product development reference.

Apacer devices use the standard SMART command B0h to read data out from the drive to activate our S.M.A.R.T. feature that complies with the ATA/ATAPI specifications. S.M.A.R.T. Attribute IDs shall include initial bad block count, total later bad block count, maximum erase count, average erase count, power on hours and power cycle. When the S.M.A.R.T. Utility running on the host, it analyzes and reports the disk status to the host before the device reaches in critical condition.

Note: Attribute IDs may vary from product models due to various solution design and supporting capabilities.

Apacer memory products come with S.M.A.R.T. commands and subcommands for users to obtain information of drive status and to predict potential drive failures. Users can take advantage of the following commands/subcommands to monitor the health of the drive.

| Code | SMART Subcommand |
|------|-----------------------------------|
| D0h | READ DATA |
| D1h | READ ATTRIBUTE THRESHOLDS |
| D2h | Enable/Disable Attribute Autosave |
| D4h | Execute Off-line Immediate |
| D5h | Read Log (optional) |
| D6h | Write Log (optional) |
| D8h | Enable Operations |
| D9h | Disable operations |
| DAh | Return Status |

General SMART attribute structure

| Byte | Description |
|-------|-------------|
| 0 | ID (Hex) |
| 1 – 2 | Status flag |
| 3 | Value |
| 4 | Worst |
| 5*-11 | Raw Data |

*Byte 5: LSB

SMART attribute ID list

| ID (Hex) | Attribute Name |
|------------|------------------------------------|
| 9 (0x09) | Power-on hours |
| 12 (0x0C) | Power cycle count |
| 163 (0xA3) | Max. erase count |
| 164 (0xA4) | Avg. erase count |
| 166 (0xA6) | Total later bad block count |
| 167 (0xA7) | SSD Protect Mode (vendor specific) |
| 168 (0xA8) | SATA PHY Error Count |
| 175 (0xAF) | Bad Cluster Table Count |
| 192 (0xC0) | Unexpected Power Loss Count |
| 194 (0xC2) | Temperature |
| 241 (0xF1) | Total sectors of write |

7. Electrical Specifications

7.1 Operating Voltage

Table 7-1 lists the supply voltage for SDM5A.

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

| Item | Range |
|----------------|--------------------------|
| Supply Voltage | 5V \pm 5% (4.75-5.25V) |

7.2 Power Consumption

Table 7-2 lists the power consumption for SDM5A.

Table 7-2 Power Consumption

| Mode \ Capacity | Capacity | | | | | |
|--------------------|----------|-----|------|------|-------|-------|
| | 1 GB | 2GB | 4 GB | 8 GB | 16 GB | 32 GB |
| Active (mA) | 140 | 165 | 200 | 170 | 205 | 215 |
| Idle (mA) | 70 | 80 | 85 | 85 | 85 | 80 |

Note:

*All values are typical and may vary depending on flash configurations or host system settings.

**Active power is an average power measurement performed using CrystalDiskMark with 128KB sequential read/write transfers.

8. Physical Characteristics



Unit: mm
Tolerance: ± 0.25

9. Product Ordering Information

9.1 Product Code Designations



9.2 Valid Combinations

| Capacity | Standard Temperature | Extended Temperature |
|----------|----------------------|----------------------|
| 1GB | APSDM001G42AN-PT | APSDM001G42AN-PTW |
| 2GB | APSDM002G42AN-PT | APSDM002G42AN-PTW |
| 4GB | APSDM004G42AN-PT | APSDM004G42AN-PTW |
| 8GB | APSDM008G42AN-PT | APSDM008G42AN-PTW |
| 16GB | APSDM016G42AN-PT | APSDM016G42AN-PTW |
| 32GB | APSDM032G42AN-PT | APSDM032G42AN-PTW |

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 | Description | Date |
|----------|--|-----------|
| 0.1 | Preliminary release | 1/7/2016 |
| 1.0 | Official release – updated performance and power consumption values for 32GB | 3/17/2016 |
| 1.1 | - Updated performance values - Updated product ordering information due to FW update (3A) | 3/24/2017 |
| 1.2 | Updated product ordering information due to FW update (4A) | 1/2/2018 |

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