

RoHS Compliant

CFast 2.0

SM230-CFast 2.0 Product Specifications



July 17, 2018

Version 1.0



Apacer Technology Inc.

1F, No.32, Zhongcheng Rd., Tucheng Dist., New Taipei City, Taiwan, R.O.C

Tel: +886-2-2267-8000 Fax: +886-2-2267-2261

www.apacer.com

Specifications Overview:

- **Standard Serial ATA Interface**
 - SATA Revision 3.1 compliance
 - SATA 6.0 Gbps interface speed
 - Backward compatible with SATA 1.5 and 3.0 Gbps interfaces
 - ATA-compatible command set
- **Capacity**
 - 8, 16, 32, 64, 128, 256 GB
- **Performance***
 - Burst read/write: 600 MB/sec

Standard:

 - Sequential read: Up to 560 MB/sec
 - Sequential write: Up to 465 MB/sec
 - Random read (4K): Up to 38,000 IOPS
 - Random write (4K): Up to 41,000 IOPS

AES & Opal Implemented:

 - Sequential read: Up to 560 MB/sec
 - Sequential write: Up to 450 MB/sec
 - Random read (4K): Up to 37,000 IOPS
 - Random write (4K): Up to 41,000 IOPS
- **Flash Management**
 - Built-in hardware ECC
 - Global Wear Leveling
 - Flash bad-block management
 - Flash Translation Layer: Page Mapping
 - S.M.A.R.T.
 - Power Failure Management
 - Device Sleep
 - ATA Secure Erase
 - TRIM
- **NAND Flash Type:** MLC
- **MTBF:** >1,000,000 hours
- **Temperature Range**
 - Operating:
 - Standard: 0°C to 70°C
 - Extended: -40°C to 85°C
 - Storage: -40°C to 100°C
- **Power Consumption***
 - Supply voltage: 3.3V
 - Active mode: 645 mA
 - Idle mode: 135 mA
- **Connector Type**
 - 7 + 17 pin female connector
- **Hardware Write-Protection Switch Support (optional)**
- **Security (optional)**
 - Trusted Computing Group (TCG) Opal 2.0
 - AES 256-bit hardware encryption
- **Reliability**
 - Thermal Sensor
 - Thermal Management Technique (optional)
- **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.

Table of Contents

| | |
|---|-----------|
| 1. General Descriptions | 3 |
| 2. Functional Block | 3 |
| 3. Pin Assignments..... | 4 |
| 4. Product Specifications..... | 6 |
| 4.1 Capacity..... | 6 |
| 4.2 Performance | 6 |
| 4.3 Environmental Specifications | 7 |
| 4.4 Mean Time Between Failures (MTBF) | 7 |
| 4.5 Certification and Compliance | 7 |
| 5. Flash Management..... | 8 |
| 5.1 Error Correction/Detection..... | 8 |
| 5.2 Bad Block Management | 8 |
| 5.3 Global Wear Leveling | 8 |
| 5.4 Flash Translation Layer – Page Mapping..... | 8 |
| 5.5 ATA Secure Erase..... | 8 |
| 5.6 Power Failure Management | 9 |
| 5.7 TRIM..... | 9 |
| 5.8 DEVSLP (DevSleep or DEVSLP) Mode..... | 9 |
| 5.9 SATA Power Management..... | 10 |
| 6. Security & Reliability Features | 11 |
| 6.1 TCG Opal (optional) | 11 |
| 6.2 Advanced Encryption Standard (optional)..... | 11 |
| 6.3 Thermal Sensor..... | 11 |
| 6.4 Thermal Management Technique (optional) | 11 |
| 7. Software Interface | 12 |
| 7.1 Command Set..... | 12 |
| 7.2 S.M.A.R.T. | 12 |
| 8. Electrical Specifications | 14 |
| 8.1 Operating Voltage..... | 14 |
| 8.2 Power Consumption | 14 |
| 9. Physical Characteristics..... | 15 |
| 9.1 Dimensions..... | 15 |
| 9.2 Write Protect Switch (optional) | 16 |
| 10. Product Ordering Information..... | 17 |
| 10.1 Product Code Designations..... | 17 |
| 10.2 Valid Combinations..... | 18 |

1. General Descriptions

Apacer SM230-CFast 2.0 is the latest enhancement of conventional CFast form factor that delivers various technological advantages. This new flash memory card comes with SATA 6.0 Gbps interface for higher performance and consists of SATA-based 7-pin signal segment and 17-pin for power and control purposes. Designed without DRAM on the internal controlling unit, SM230-CFast ensures data integrity by preventing data loss during a sudden power outage.

For data efficiency, SM230-CFast 2.0 delivers data transfer rates up to 560 MB/s in sequential access and 38,000 IOPS in 4KB random access. In addition, Apacer CFast cards come with S.M.A.R.T. for lifetime monitoring and customization support if write protection is required. Apacer SM230-CFast 2.0 guarantees reliability of applications in harsh environments by implementing intelligent Flash Management algorithms and Error Correction.

2. Functional Block

Apacer SM230-CFast 2.0 includes a single-chip SATA 6.0 Gbps and the flash media. The controller integrates the flash management unit to support multi-channel, multi-bank flash arrays. Figure 2-1 shows the functional block diagram.

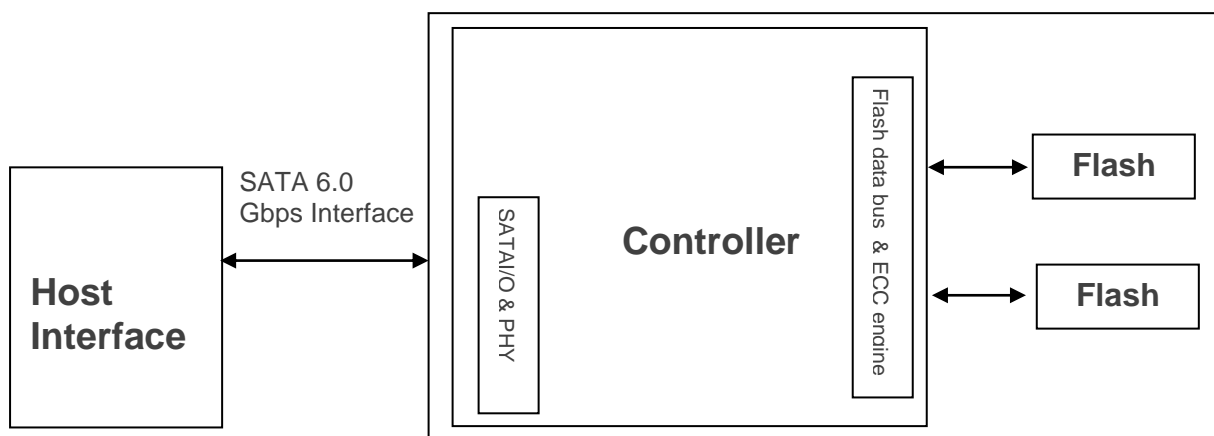


Figure 2-1 Functional Block Diagram

3. Pin Assignments

Table 3-1 describes SM230-CFast 2.0 signal segment, and Table 3-2, its power segment.



Figure 3-1 Pin Assignment

Table 3-1 Signal Segment

| Pin | Definition | Description |
|-----|------------|---------------------------------|
| S1 | GND | Ground |
| S2 | A+ | SATA Differential Signal Pair A |
| S3 | A- | |
| S4 | GND | Ground |
| S5 | B- | SATA Differential Signal Pair B |
| S6 | B+ | |
| S7 | GND | Ground |

Table 3-2 Power Segment

| Pin | Definition | Type | Description |
|------|------------|-------------------|--------------------------------------|
| PC1 | CDI | Input | Card Detect In |
| PC2 | PGND | Device GND | Device GND |
| PC3 | DEVSLP* | DEVSLP card input | DEVSLP enable |
| PC4 | | | Reserved |
| PC5 | | | Reserved |
| PC6 | | | Reserved |
| PC7 | PGND | Device GND | Device GND |
| PC8 | LED1 | LED Output | Power indicator |
| PC9 | LED2 | LED Output | Access indicator |
| PC10 | | | Reserved |
| PC11 | | | Write Protect** |
| PC12 | IFDet | GND | Card output, connect to PGND on card |
| PC13 | PWR | 3.3V | Device power (3.3V) |
| PC14 | PWR | 3.3V | Device power (3.3V) |
| PC15 | PGND | Device GND | Device GND |
| PC16 | PGND | Device GND | Device GND |
| PC17 | CDO | Output | Card Detect Out |

*Optional

**Enabled by adjusting the pin "PC11" from high to low active (from 1Mohm to 100Kohm)

Notes about Write Protect:

Apacer implements the Virtual Write scheme that allows write commands to go through the flash controller and data is temporarily stored, but no data has been actually written into the flash. Once the host resets or restarts the system, all the temporarily stored data will disappear and nowhere to be found in the drive. Since the Virtual Write scheme runs at device level, it requires no software or driver installation and is independent from the host OS.

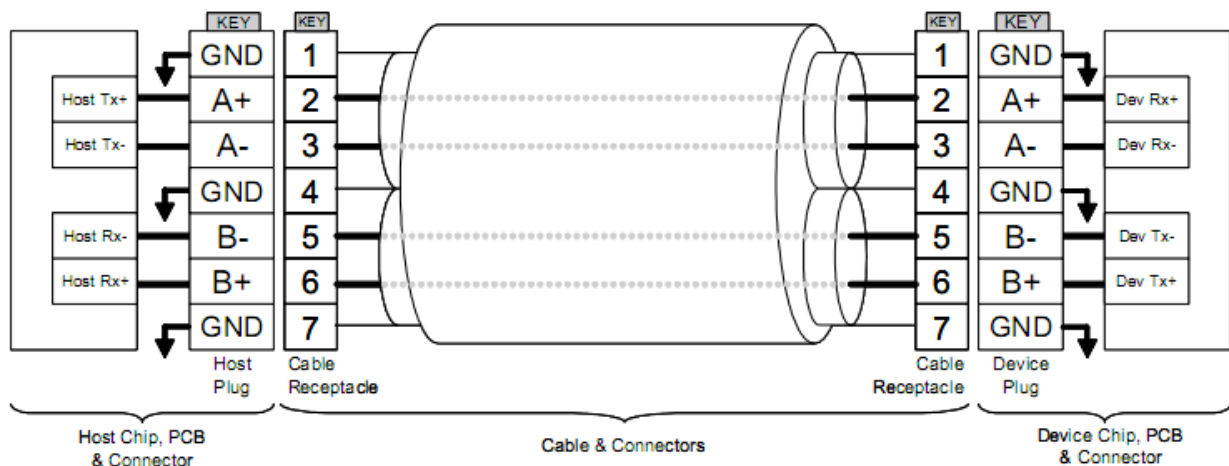


Figure 3-2 SATA Cable / Connector Connection Diagram

The connector on the left represents the Host with TX/RX differential pairs connected to a cable while 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 the SM230-CFast 2.0 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 |
|----------|-----------------|-----------|-------|---------|-------------|
| 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 |
| 64 GB | 64,023,257,088 | 16,383 | 16 | 63 | 125,045,424 |
| 128 GB | 128,035,676,160 | 16,383 | 16 | 63 | 250,069,680 |
| 256 GB | 256,060,514,304 | 16,383 | 16 | 63 | 500,118,192 |

*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 SM230-CFast 2.0 product family is available as shown in Table 4-2 and 4-3.

Table 4-2 Performance Specifications (Standard)

| Capacity | 8 GB | 16 GB | 32 GB | 64 GB | 128 GB | 256 GB |
|---------------------------------|-------|--------|--------|--------|--------|--------|
| Performance | | | | | | |
| Sequential Read* (MB/s) | 135 | 280 | 560 | 560 | 560 | 555 |
| Sequential Write* (MB/s) | 60 | 125 | 270 | 235 | 450 | 465 |
| Random Read IOPS** (4K) | 8,000 | 14,000 | 24,000 | 23,000 | 38,000 | 38,000 |
| Random Write IOPS** (4K) | 3,000 | 7,000 | 16,000 | 18,000 | 38,000 | 41,000 |

Table 4-3 Performance Specifications (AES & Opal Implemented)

| Capacity | 8 GB | 16 GB | 32 GB | 64 GB | 128 GB | 256 GB |
|---------------------------------|-------|--------|--------|--------|--------|--------|
| Performance | | | | | | |
| Sequential Read* (MB/s) | 135 | 280 | 560 | 560 | 560 | 560 |
| Sequential Write* (MB/s) | 65 | 130 | 265 | 450 | 230 | 430 |
| Random Read IOPS** (4K) | 7,000 | 13,000 | 23,000 | 37,000 | 23,000 | 37,000 |
| Random Write IOPS** (4K) | 3,000 | 7,000 | 16,000 | 38,000 | 18,000 | 41,000 |

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.

**Random performance measured using IOMeter with Queue Depth 32.

4.3 Environmental Specifications

Environmental specifications of SM230-CFast 2.0 are shown in Table 4-4.

Table 4-4 Environmental Specifications

| Environment | Specifications |
|-------------|---|
| Temperature | 0°C to 70°C (Standard); -40°C to 85°C (Extended) |
| | -40°C to 100°C (Non-operating) |
| Vibration | Non-operating: Sine wave, 15(G), 10~2000(Hz), Operating: Random, 7.69(GRMS), 20~2000(Hz) |
| Shock | Non-operating: Acceleration, 1,500 G, 0.5 ms Operating: Peak acceleration, 50 G, 11 ms |

Note: This Environmental Specification table indicates the conditions for testing the device. Real world usages may affect the results.

4.4 Mean Time Between Failures (MTBF)

Mean Time Between Failures (MTBF) is predicted based on reliability data for the individual components in SM230-CFast 2.0. Serving as statistical reference, the prediction result for SM230-CFast is more than 1,000,000 hours.

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

4.5 Certification and Compliance

SM230-CFast 2.0 complies with the following standards:

- CE
- FCC
- RoHS
- MIL-STD-810G

5. Flash Management

5.1 Error Correction/Detection

SM230-CFast 2.0 implements a hardware ECC scheme, based on the BCH algorithm. It can detect and correct up to 76 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, page 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 Flash Translation Layer – Page Mapping

Page mapping is an advanced flash management technology whose essence lies in the ability to gather data, distribute the data into flash pages automatically, and then schedule the data to be evenly written. Page-level mapping uses one page as the unit of mapping. The most important characteristic is that each logical page can be mapped to any physical page on the flash memory device. This mapping algorithm allows different sizes of data to be written to a block as if the data is written to a data pool and it does not need to take extra operations to process a write command. Thus, page mapping is adopted to increase random access speed and improve SSD lifespan, reduce block erase frequency, and achieve optimized performance and lifespan.

5.5 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.

5.6 Power Failure Management

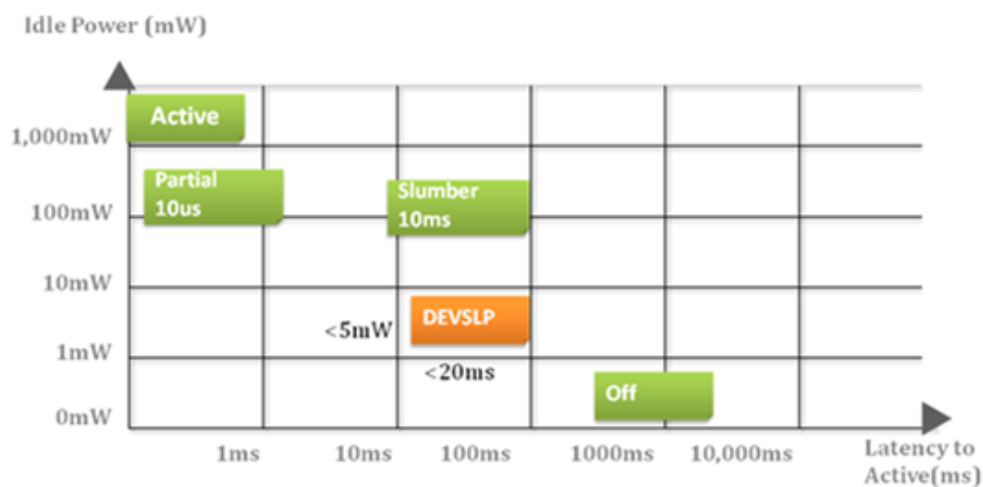
Power Failure Management plays a crucial role when experiencing unstable power supply. Power disruption may occur when users are storing data into the SSD. In this urgent situation, the controller would run multiple write-to-flash cycles to store the metadata for later block rebuilding. This urgent operation 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.

5.7 TRIM

TRIM is a SATA command that helps improve the read/write performance and efficiency of solid-state drives (SSD). The command enables the host operating system to inform SSD controller which blocks contain invalid data, mostly because of the erase commands from host. The invalid will be discarded permanently and the SSD will retain more space for itself.

5.8 DEVSLP (DevSleep or DEVSLP) Mode

Device Sleep is a feature that allows SATA devices to enter a low power mode by designating pin 38 as DEVSLP signal with an aim to reducing power consumption.



| Parameter | Description & Conditions | Min | Max |
|---------------|---|--------|-------------|
| V_{DIn} | Tolerated input voltage. | -0.5 V | 3.6 V |
| $V_{HAssert}$ | Voltage presented to host if signal not driven low. Value specified for all allowable $I_{HAssert}$. | - | 2.4 V |
| $I_{HNegate}$ | Device current delivered to host if host driving signal low. Value specified at $V_{HNegate}$ voltage of 0 V. | - | 100 μ A |

5.9 SATA Power Management

By complying with SATA 6.0 Gb/s specifications, the SSD supports the following SATA power saving modes:

- ACTIVE: PHY ready, full power, Tx & Rx operational
- PARTIAL: Reduces power, resumes in under 10 μ s (microseconds)
- SLUMBER: Reduces power, resumes in under 10 ms (milliseconds)
- HIPM: Host-Initiated Power Management
- DIPM: Device-Initiated Power Management
- AUTO-SLUMBER: Automatic transition from partial to slumber.

Note: The behaviors of power management features would depend on host/device settings.

6. Security & Reliability Features

6.1 TCG Opal (optional)

Developed by the Trusted Computing Group (TCG), an organization whose members work together to formulate industry standards, Opal is a set of security specifications used for applying hardware-based encryption to storage devices.

Hardware encryption has many advantages. First of all, it transfers the computational load of the encryption process to dedicated processors, reducing the stress on the host system's CPU. In addition, storage devices complying with Opal specifications are self-encryption devices. Opal specifications also feature boot authentication. When the drive is being accessed, the shadow MBR will request the drive password at boot. The drive will only unlock and decrypt if the correct password is supplied. The other feature is LBA-specific permissions. Users are assigned different permissions for LBA ranges created by the device administrator. Each LBA range is password-protected and can only be accessed by users with the correct key to perform permitted actions (read/write/erase).

6.2 Advanced Encryption Standard (optional)

Advanced Encryption Standard (AES) is a specification for the encryption of electronic data. AES has been adopted by the U.S. government since 2001 to protect classified information and is now widely implemented in embedded computing applications. The AES algorithm used in software and hardware is symmetric so that encrypting/decrypting requires the same encryption key. Without the key, the encrypted data is inaccessible to ensure information security.

Notably in flash memory applications, AES 256-bit hardware encryption is the mainstream to protect sensitive or confidential data. The hardware encryption provides better performance, reliability, and security than software encryption. It uses a dedicated processor, which is built inside the controller, to process the encryption and decryption. This enormously shortens the processing time and makes it efficient.

6.3 Thermal Sensor

Apacer Thermal Sensor is a digital temperature sensor with serial interface. By using a designated pin for transmission, storage device owners are able to read temperature data.

6.4 Thermal Management Technique (optional)

Thermal management technique can monitor the temperature of the SSD equipped with a built-in thermal sensor via S.M.A.R.T. commands. This method can ensure the temperature of the device stays within temperature limits by drive throttling, i.e. reducing the speed of the drive when the device temperature reaches the threshold level, so as to prevent overheating, guarantee data reliability, and prolong product lifespan. When the temperature exceeds the maximum threshold level, thermal throttling will be triggered to reduce performance step by step to prevent hardware components from being damaged. Performance is only permitted to drop to the extent necessary for recovering a stable temperature to cool down the device's temperature. Once the temperature decreases to the minimum threshold value, transfer speeds will rise back to its optimum performance level.

7. Software Interface

7.1 Command Set

Table 7-1 Command Set

| Code | Command | Code | Command |
|-----------|------------------------------|------------|---------------------------|
| E5h | Check Power Mode | F6h | Security Disable Password |
| 90h | Execute Diagnostics | F3h | Security Erase Prepare |
| E7h | Flush Cache | F4h | Security Erase Unit |
| ECh | Identify Device | F5h | Security Freeze Lock |
| E3h | Idle | F1h | Security Set Password |
| E1h | Idle Immediate | F2h | Security Unlock |
| 91h | Initialize Device Parameters | 7Xh | Seek |
| C8h | Read DMA | EFh | Set Features |
| 25h | Read DMA EXT | C6h | Set Multiple Mode |
| 60h | Read FPDMA Queued | E6h | Sleep |
| 47h | Read Log DMA EXT | B0h | S.M.A.R.T. |
| 2Fh | Read Log EXT | E2h | Standby |
| C4h | Read Multiple | E0h | Standby Immediate |
| 20 or 21h | Read Sector(s) | CAh | Write DMA |
| 40 or 41h | Read Verify Sector(s) | 35h | Write DMA EXT |
| 10h | Recalibrate | 61h | Write FPDMA Queued |
| 57h | Write Log DMA EXT | 3Fh | Write Log EXT |
| C5h | Write Multiple | 30h or 31h | Write Sector(s) |

7.2 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 |

8. Electrical Specifications

8.1 Operating Voltage

Table 8-1 lists the supply voltage for SM230-CFast 2.0.

Table 8-1 Operating Range

| Parameter | Symbol | Min | Type | Max | Units |
|--------------|--------|-------|------|-------|-------|
| Power Supply | Vcc | 3.135 | 3.3 | 3.465 | V |

8.2 Power Consumption

Table 8-2 lists the power consumption for SM230-CFast 2.0.

Table 8-2 Power Consumption

| Mode \ Capacity | Capacity | | | | | |
|-----------------|----------|-------|-------|-------|--------|--------|
| | 8 GB | 16 GB | 32 GB | 64 GB | 128 GB | 256 GB |
| Active (mA) | 645 | 645 | 645 | 645 | 645 | 645 |
| Idle (mA) | 120 | 115 | 110 | 110 | 105 | 135 |

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.

9. Physical Characteristics

9.1 Dimensions

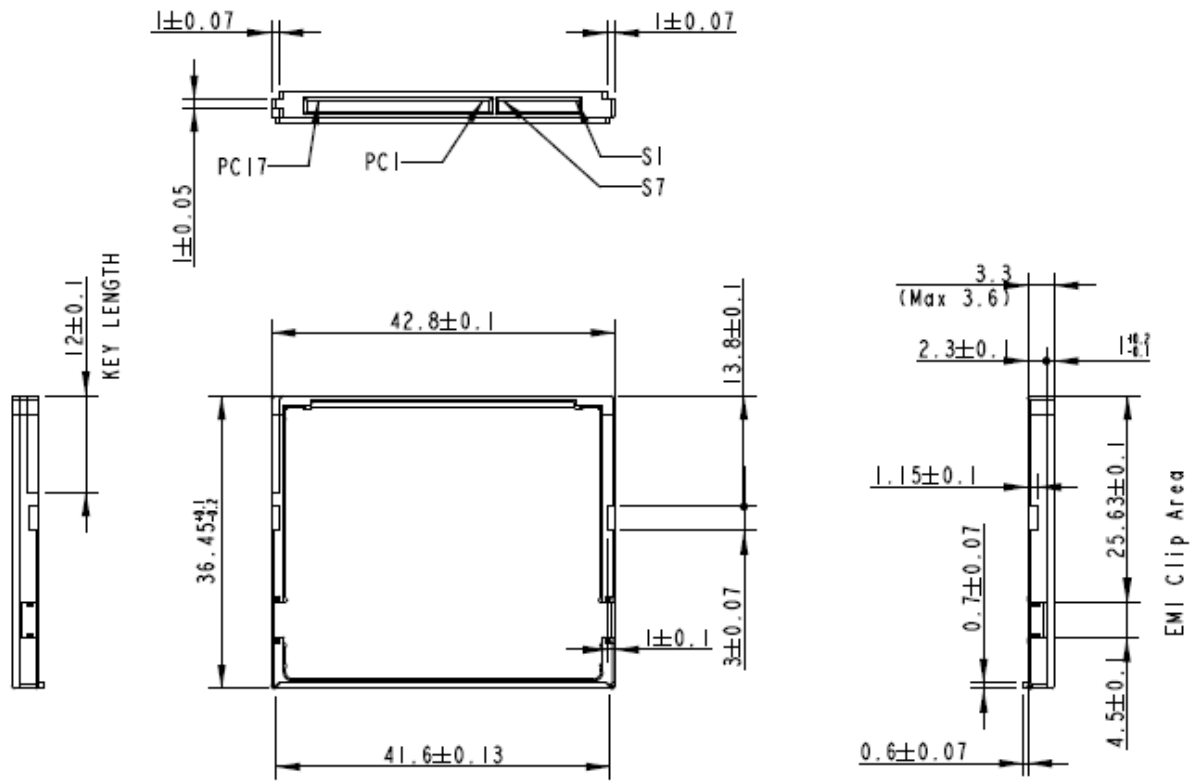
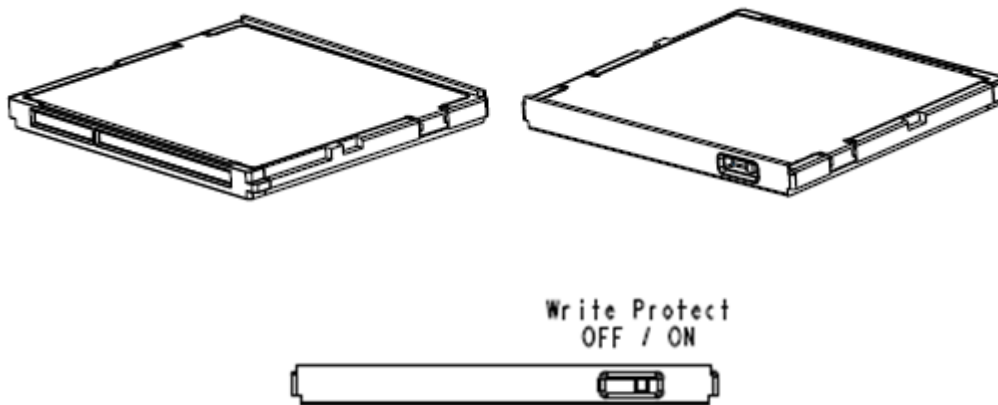


Figure 8-1 Physical Dimensions

Unit: mm

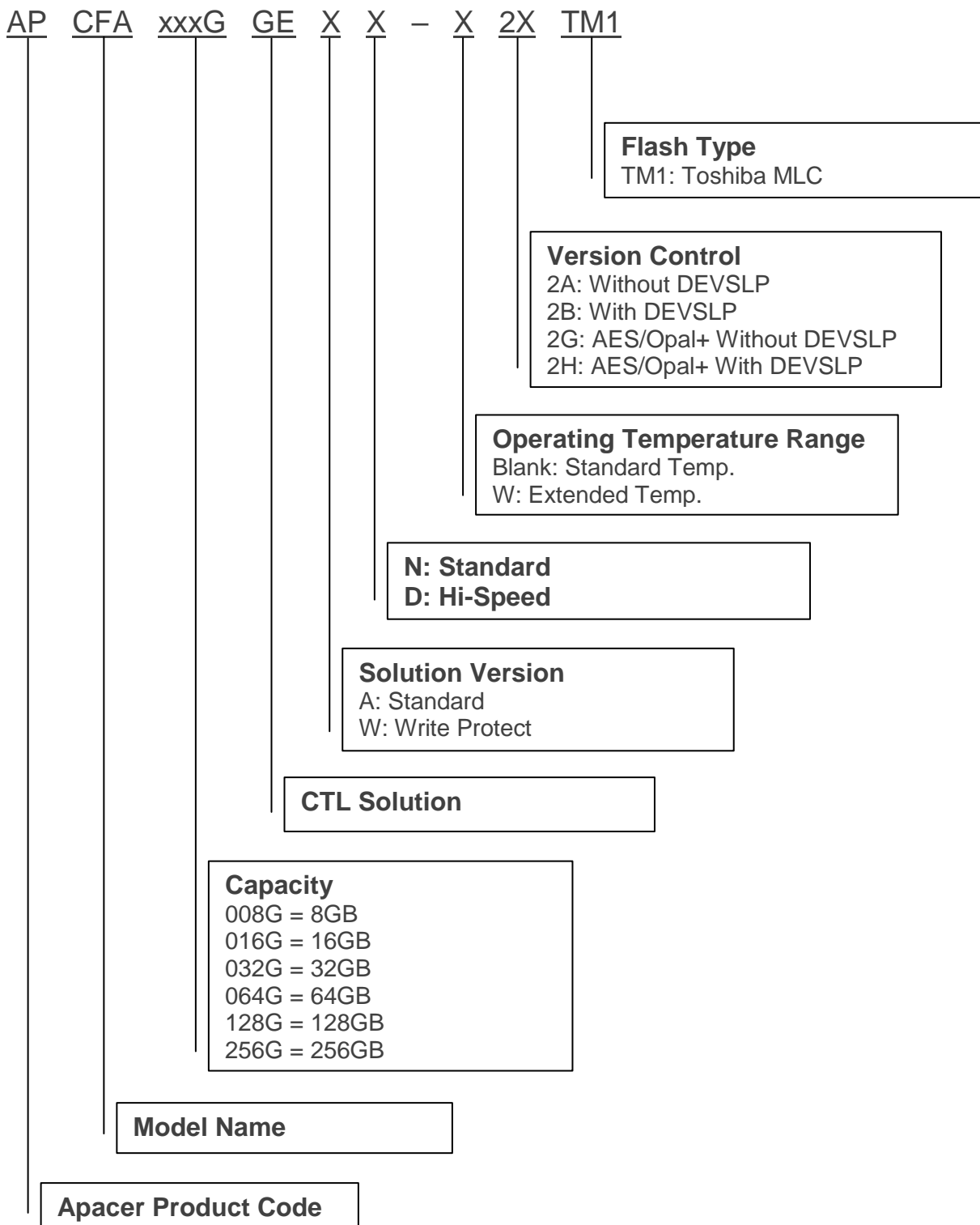
9.2 Write Protect Switch (optional)

Apacer implements the Virtual Write scheme that allows write commands to go through the flash controller and data temporarily stored, but no data has been actually written into the flash. Once the system is reset and rebooted, the temporarily stored data will be lost and nowhere to be found in the system. Since the Virtual Write scheme runs at device level, it requires no software or driver installation and is independent from the host OS.



10. Product Ordering Information

10.1 Product Code Designations



10.2 Valid Combinations

A. Standard

10.2.1 Without DEVSLP

| Capacity | Standard Temperature | Extended Temperature |
|----------|----------------------|----------------------|
| 8GB | APCFA008GGEAN-2ATM1 | APCFA008GGEAN-W2ATM1 |
| 16GB | APCFA016GGEAN-2ATM1 | APCFA016GGEAN-W2ATM1 |
| 32GB | APCFA032GGEAD-2ATM1 | APCFA032GGEAD-W2ATM1 |
| 64GB | APCFA064GGEAD-2ATM1 | APCFA064GGEAD-W2ATM1 |
| 128GB | APCFA128GGEAD-2ATM1 | APCFA128GGEAD-W2ATM1 |
| 256GB | APCFA256GGEAD-2ATM1 | APCFA256GGEAD-W2ATM1 |

10.2.2 With DEVSLP

| Capacity | Standard Temperature | Extended Temperature |
|----------|----------------------|----------------------|
| 8GB | APCFA008GGEAN-2BTM1 | APCFA008GGEAN-W2BTM1 |
| 16GB | APCFA016GGEAN-2BTM1 | APCFA016GGEAN-W2BTM1 |
| 32GB | APCFA032GGEAD-2BTM1 | APCFA032GGEAD-W2BTM1 |
| 64GB | APCFA064GGEAD-2BTM1 | APCFA064GGEAD-W2BTM1 |
| 128GB | APCFA128GGEAD-2BTM1 | APCFA128GGEAD-W2BTM1 |
| 256GB | APCFA256GGEAD-2BTM1 | APCFA256GGEAD-W2BTM1 |

10.2.3 Without DEVSLP + Write Protect

| Capacity | Standard Temperature | Extended Temperature |
|----------|----------------------|----------------------|
| 8GB | APCFA008GGEWN-2ATM1 | APCFA008GGEWN-W2ATM1 |
| 16GB | APCFA016GGEWN-2ATM1 | APCFA016GGEWN-W2ATM1 |
| 32GB | APCFA032GGEWD-2ATM1 | APCFA032GGEWD-W2ATM1 |
| 64GB | APCFA064GGEWD-2ATM1 | APCFA064GGEWD-W2ATM1 |
| 128GB | APCFA128GGEWD-2ATM1 | APCFA128GGEWD-W2ATM1 |
| 256GB | APCFA256GGEWD-2ATM1 | APCFA256GGEWD-W2ATM1 |

10.2.4 With DEVSLP + Write Protect

| Capacity | Standard Temperature | Extended Temperature |
|----------|----------------------|----------------------|
| 8GB | APCFA008GGEWN-2BTM1 | APCFA008GGEWN-W2BTM1 |
| 16GB | APCFA016GGEWN-2BTM1 | APCFA016GGEWN-W2BTM1 |
| 32GB | APCFA032GGEWD-2BTM1 | APCFA032GGEWD-W2BTM1 |
| 64GB | APCFA064GGEWD-2BTM1 | APCFA064GGEWD-W2BTM1 |
| 128GB | APCFA128GGEWD-2BTM1 | APCFA128GGEWD-W2BTM1 |
| 256GB | APCFA256GGEWD-2BTM1 | APCFA256GGEWD-W2BTM1 |

B. AES/Opal Function (optional)

10.2.5 Without DEVSLP

| Capacity | Standard Temperature | Extended Temperature |
|----------|----------------------|----------------------|
| 8GB | APCFA008GGEAN- 2GTM1 | APCFA008GGEAN-W2GTM1 |
| 16GB | APCFA016GGEAN- 2GTM1 | APCFA016GGEAN-W2GTM1 |
| 32GB | APCFA032GGEAD- 2GTM1 | APCFA032GGEAD-W2GTM1 |
| 64GB | APCFA064GGEAD- 2GTM1 | APCFA064GGEAD-W2GTM1 |
| 128GB | APCFA128GGEAD- 2GTM1 | APCFA128GGEAD-W2GTM1 |
| 256GB | APCFA256GGEAD- 2GTM1 | APCFA256GGEAD-W2GTM1 |

10.2.6 With DEVSLP

| Capacity | Standard Temperature | Extended Temperature |
|----------|----------------------|----------------------|
| 8GB | APCFA008GGEAN-2HTM1 | APCFA008GGEAN-W2HTM1 |
| 16GB | APCFA016GGEAN-2HTM1 | APCFA016GGEAN-W2HTM1 |
| 32GB | APCFA032GGEAD-2HTM1 | APCFA032GGEAD-W2HTM1 |
| 64GB | APCFA064GGEAD-2HTM1 | APCFA064GGEAD-W2HTM1 |
| 128GB | APCFA128GGEAD-2HTM1 | APCFA128GGEAD-W2HTM1 |
| 256GB | APCFA256GGEAD-2HTM1 | APCFA256GGEAD-W2HTM1 |

10.2.7 Without DEVSLP + Write Protect

| Capacity | Standard Temperature | Extended Temperature |
|----------|----------------------|----------------------|
| 8GB | APCFA008GGEWN-2GTM1 | APCFA008GGEWN-W2GTM1 |
| 16GB | APCFA016GGEWN-2GTM1 | APCFA016GGEWN-W2GTM1 |
| 32GB | APCFA032GGEWD-2GTM1 | APCFA032GGEWD-W2GTM1 |
| 64GB | APCFA064GGEWD-2GTM1 | APCFA064GGEWD-W2GTM1 |
| 128GB | APCFA128GGEWD-2GTM1 | APCFA128GGEWD-W2GTM1 |
| 256GB | APCFA256GGEWD-2GTM1 | APCFA256GGEWD-W2GTM1 |

10.2.8 With DEVSLP + Write Protect

| Capacity | Standard Temperature | Extended Temperature |
|----------|----------------------|----------------------|
| 8GB | APCFA008GGEWN-2HTM1 | APCFA008GGEWN-W2HTM1 |
| 16GB | APCFA016GGEWN-2HTM1 | APCFA016GGEWN-W2HTM1 |
| 32GB | APCFA032GGEWD-2HTM1 | APCFA032GGEWD-W2HTM1 |
| 64GB | APCFA064GGEWD-2HTM1 | APCFA064GGEWD-W2HTM1 |
| 128GB | APCFA128GGEWD-2HTM1 | APCFA128GGEWD-W2HTM1 |
| 256GB | APCFA256GGEWD-2HTM1 | APCFA256GGEWD-W2HTM1 |

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 |
|----------|------------------|-----------|
| 1.0 | Official release | 7/17/2018 |

Global Presence

Taiwan (Headquarters)

Apacer Technology Inc.

1F., No.32, Zhongcheng Rd., Tucheng Dist.,
New Taipei City 236, Taiwan R.O.C.
Tel: 886-2-2267-8000
Fax: 886-2-2267-2261
amtsales@apacer.com

U.S.A.

Apacer Memory America, Inc.

46732 Lakeview Blvd., Fremont, CA 94538
Tel: 1-408-518-8699
Fax: 1-510-249-9551
sa@apacerus.com

Japan

Apacer Technology Corp.

6F, Daiyontamachi Bldg., 2-17-12, Shibaura, Minato-Ku,
Tokyo, 108-0023, 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: 31-40-290-0686
sales@apacer.nl

China

Apacer Electronic (Shanghai) Co., Ltd

Room D, 22/FL, No.2, Lane 600, JieyunPlaza,
Tianshan RD, Shanghai, 200051, China
Tel: 86-21-6228-9939
Fax: 86-21-6228-9936
sales@apacer.com.cn

India

Apacer Technologies Pvt Ltd,

Unit No.201, "Brigade Corner", 7th Block
Jayanagar,
Yediyur Circle, Bangalore – 560082, India
Tel: 91-80-4152-9061
Fax: 91-80-4170-0215
sales_india@apacer.com