

**RoHS Compliant**

**CFast 2.0**

SM220-CFast 2.0 Product Specifications



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**Version 2.8**



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## Specifications Overview:

- **Standard Serial ATA Interface**
  - SATA Revision 3.1 compliance
  - SATA 6 Gb/s interface speed
  - Backward compatible with SATA 1.5 and 3 Gb/s interfaces
  - ATA-compatible command set
- **Capacity**
  - 8, 16, 32, 64, 128, 256 GB
- **Performance\***
  - Sequential read: Up to 550 MB/sec
  - Sequential write: Up to 355 MB/sec
  - Random read (4K): Up to 76,000 IOPS
  - Random write (4K): Up to 43,000 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 (optional)
  - ATA Secure Erase
  - TRIM
- **Endurance (in Terabytes Written: TBW)**
  - 8 GB: 13 TBW
  - 16 GB: 29 TBW
  - 32 GB: 66 TBW
  - 64 GB: 136 TBW
  - 128 GB: 297 TBW
  - 256 GB: 309 TBW
- **Temperature Range**
  - Operating:
    - Standard: 0°C to 70°C
    - Wide: -40°C to 85°C
  - Storage: -40°C to 100°C
- **Power Consumption\***
  - Supply voltage: 3.3V
  - Active mode: 705 mA
  - Idle mode: 85 mA
- **Connector Type**
  - 7 + 17 pin female connector
- **NAND Flash Type: MLC**
- **MTBF: >1,000,000 hours**
- **Shock & Vibration\*\***
  - Shock: 1,500 G
  - Vibration: 15 G
- **Write Protect Switch (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.

\*\*Non-operating

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## 1. General Descriptions

Apacer SM220-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 Gb/s interface for higher performance and consists of SATA-based 7-pin signal segment and 17-pin for power and control purposes. For data efficiency, the internal controlling unit of the SM220-CFast 2.0 is engineered with DRAM for enhanced random performance which achieves data transfer rates up to 550 MB/s in sequential access and 76,000 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 SM220-CFast 2.0 guarantees reliability of applications in harsh environments by implementing intelligent Flash Management algorithms and Error Correction.

## 2. Functional Block

Apacer SM220-CFast 2.0 includes a single-chip SATA 6 Gb/s 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.

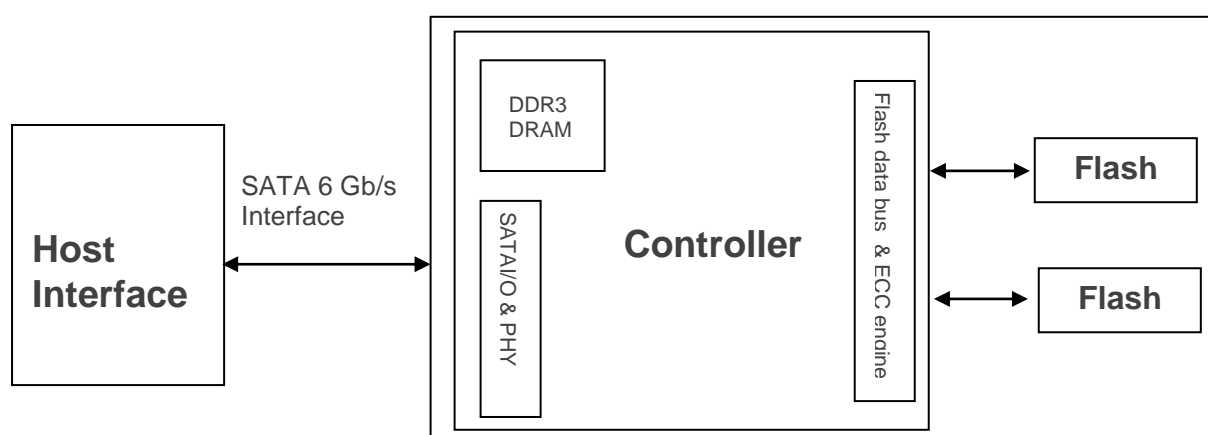
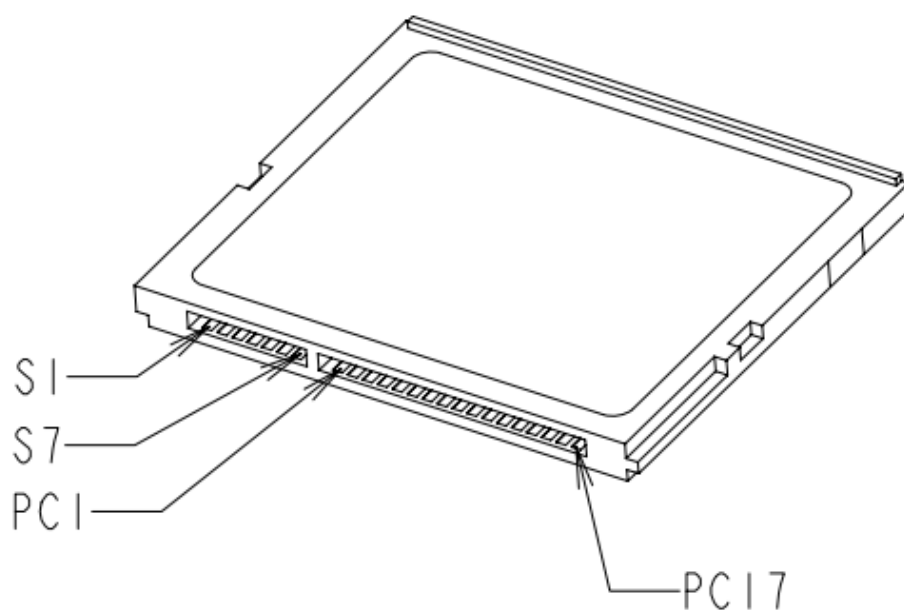


Figure 2-1 Functional Block Diagram

## 3. Pin Assignments

Table 3-1 describes SM220-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<br>Signal Pair A |
| S3  | A-         |                                    |
| S4  | GND        | Ground                             |
| S5  | B-         | SATA Differential<br>Signal Pair B |
| S6  | B+         |                                    |
| S7  | GND        | Ground                             |

**Table 3-2 Power Segment**

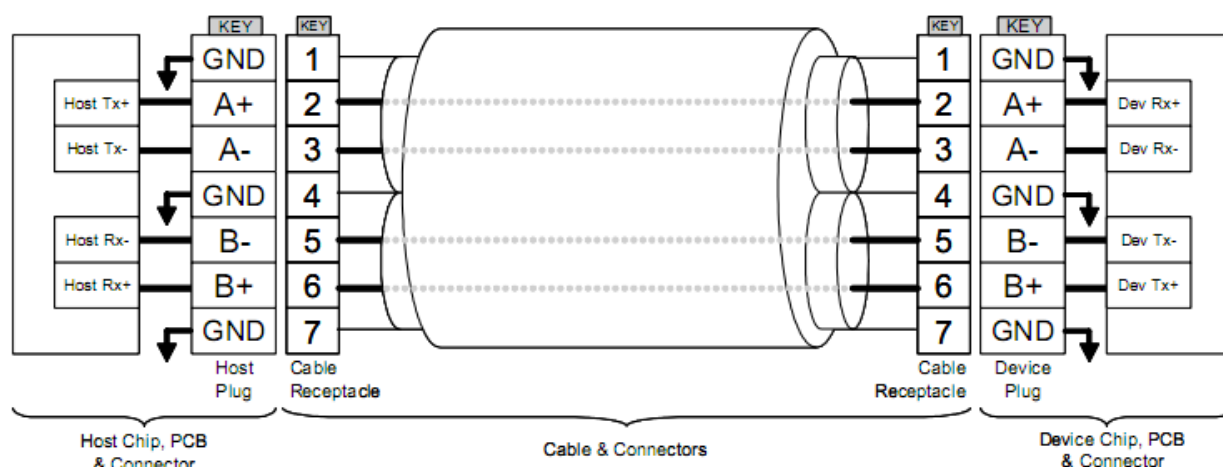
| Pin  | Definition | Type              | Description                          |
|------|------------|-------------------|--------------------------------------|
| PC1  | CDI        | Input             | Card Detect In                       |
| PC2  | PGND       | Device GND        | Device GND                           |
| 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

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 SM220-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 SM220-CFast 2.0 is listed below in Table 4-2.

**Table 4-2** Performance Specifications

| Capacity                 | 8 GB   | 16 GB  | 32 GB  | 64 GB  | 128 GB | 256 GB*** |
|--------------------------|--------|--------|--------|--------|--------|-----------|
| Performance              |        |        |        |        |        |           |
| Sequential Read* (MB/s)  | 120    | 220    | 395    | 435    | 535    | 550       |
| Sequential Write* (MB/s) | 26     | 50     | 100    | 90     | 180    | 355       |
| Random Read IOPS** (4K)  | 15,000 | 26,000 | 48,000 | 45,000 | 76,000 | 55,000    |
| Random Write IOPS** (4K) | 3,000  | 10,000 | 24,000 | 22,000 | 43,000 | 28,000    |

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.

\*\*\*256GB adopts 8K mapping algorithm.



## 4.3 Environmental Specifications

Environmental specifications of SM220-CFast 2.0 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 (Wide)               |
| Non-operating temp.     | -40°C to 100°C   |
| Operating vibration     | 7.69 GRMS, 20~2000 Hz/random (compliant with MIL-STD-810G) |
| Non-operating vibration | 4.02 GRMS, 15~2000 Hz/random (compliant with MIL-STD-810G) |
| Operating shock         | 50G, 11ms  |
| Non-operating shock     | 1500G, 0.5ms (compliant with MIL-STD-883K)                 |

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 SM220-CFast 2.0. The prediction result for SM220-CFast 2.0 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

SM220-CFast 2.0 complies with the following standards:

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

## 4.6 Endurance

The endurance of a storage device is predicted by TeraBytes Written based on several factors related to usage, such as the amount of data written into the drive, block management conditions, and daily workload for the drive. Thus, key factors, such as Write Amplifications and the number of P/E cycles, can influence the lifespan of the drive.

**Table 4-4** Endurance Specifications

| Capacity | TeraBytes Written |
|----------|-------------------|
| 8 GB     | 13                |
| 16 GB    | 29                |
| 32 GB    | 66                |
| 64 GB    | 136               |
| 128 GB   | 297               |
| 256 GB   | 309               |

Note:

- The measurement assumes the data written to the SSD for test is under a typical and constant rate.
- The measurement follows the standard metric: 1 TB (Terabyte) = 1,024 GB.
- This estimation complies with JEDEC JESD-219, enterprise endurance workload of random data with payload size distribution.

## 5. Flash Management

### 5.1 Error Correction/Detection

SM220-CFast 2.0 implements a hardware ECC scheme, based on the BCH algorithm. It can detect and correct up to 72 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 power supply becomes unstable. Power disruption may occur when users are storing data into the SSD, leading to instability in the drive. However, with Power Failure Management, a firmware protection mechanism will be activated to scan pages and blocks once power is resumed. Valid data will be transferred to new blocks for merging and the mapping table will be rebuilt. Therefore, data reliability can be reinforced, preventing damage to data stored in the NAND Flash.

## 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 SATA Power Management

By complying with SATA 6 Gb/s specifications, the SSD supports the following SATA power saving modes:

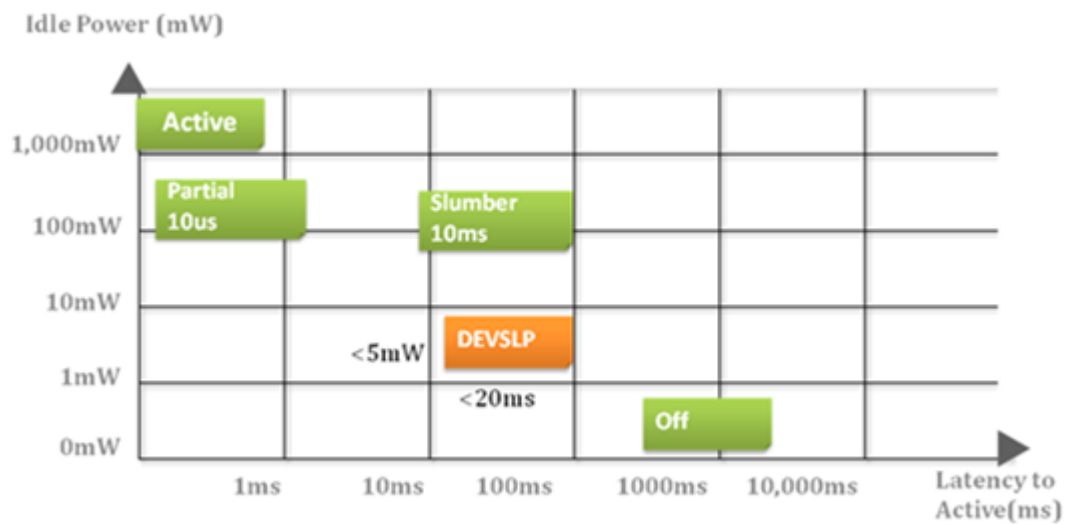
- ACTIVE: PHY ready, full power, Tx & Rx operational
- PARTIAL: Reduces power, resumes in under 10  $\mu$ s (microseconds)
- SLUMBER: Reduces power, resumes in under 10 ms (milliseconds)
- HIPM: Host-Initiated Power Management
- DIPM: Device-Initiated Power Management
- AUTO-SLUMBER: Automatic transition from partial to slumber.
- Device Sleep (DevSleep or DEVSLP): PHY powered down; power consumption  $\leq$  5 mW; host assertion time  $\leq$  10 ms; exit timeout from this state  $\leq$  20 ms (unless specified otherwise in SATA Identify Device Log).

Note:

1. The behaviors of power management features would depend on host/device settings.
2. Device Sleep mode is optional depending on product ordering selections.

## 5.9 DEVSLP (DevSleep or DEVSLP) Mode

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



## 6. Software Interface

### 6.1 Command Set

Table 6-1 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)           |

### 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  | SMART READ LOG                    |
| D6h  | SMART WRITE LOG                   |
| 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               |
| 171 (0xAB) | Program Fail Count                 |
| 172 (0xAC) | Erase Fail Count                   |
| 175 (0xAF) | Bad Cluster Table Count            |
| 192 (0xC0) | Unexpected Power Loss Count        |
| 194 (0xC2) | Temperature                        |
| 231 (0xE7) | Lifetime Left                      |
| 241 (0xF1) | Total Sectors of Write             |

## 7. Electrical Specifications

### 7.1 Operating Voltage

Table 7-1 lists the supply voltage for SM220-CFast 2.0.

**Table 7-1** Operating Range

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

### 7.2 Power Consumption

Table 7-2 lists the power consumption for SM220-CFast 2.0.

**Table 7-2** Power Consumption

| Capacity<br>Mode | 8 GB | 16 GB | 32 GB | 64 GB | 128 GB | 256 GB |
|------------------|------|-------|-------|-------|--------|--------|
| Active (mA)      | 195  | 230   | 300   | 320   | 435    | 705    |
| Idle (mA)        | 85   | 85    | 85    | 80    | 85     | 85     |

Note:

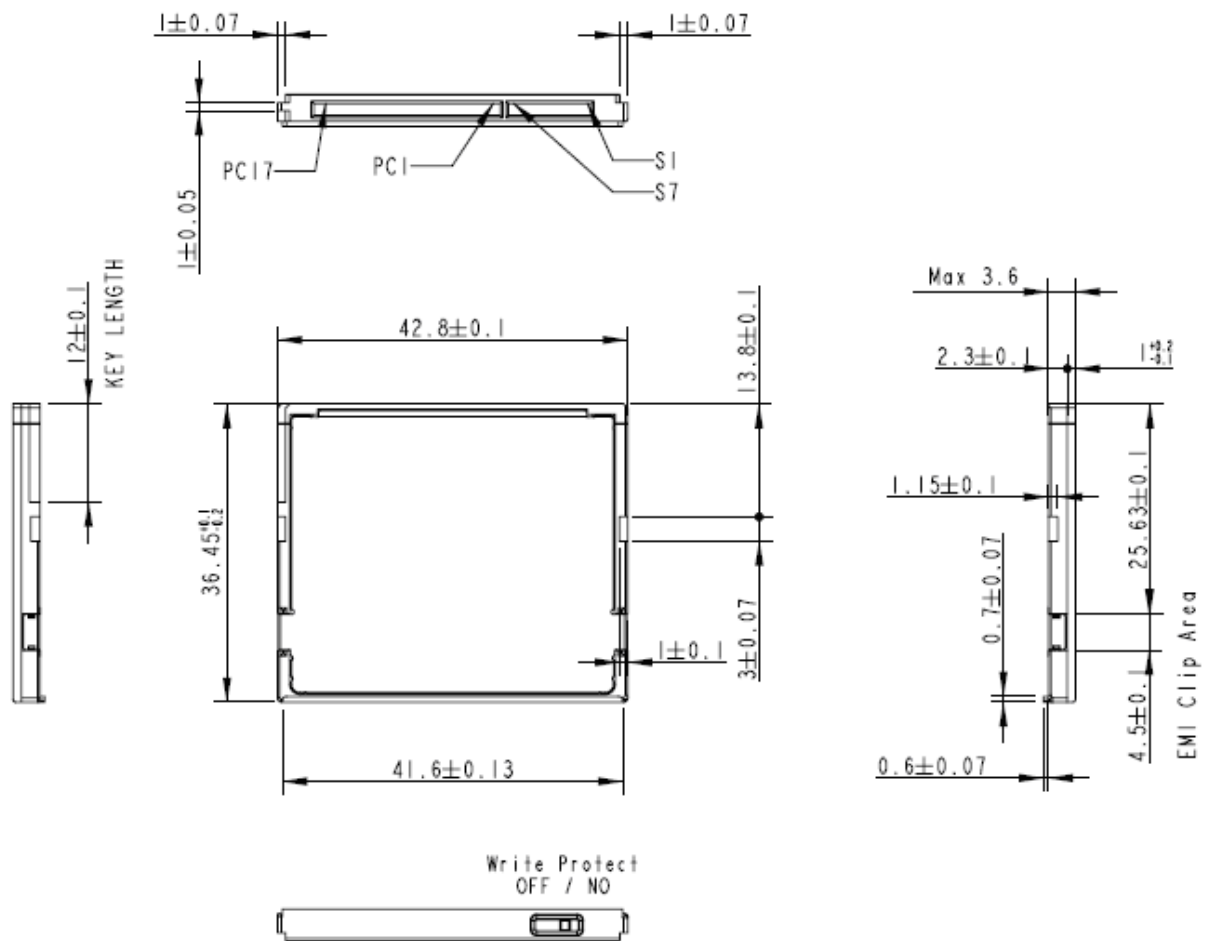
\*All values are typical and may vary depending on flash configurations or host system settings.

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

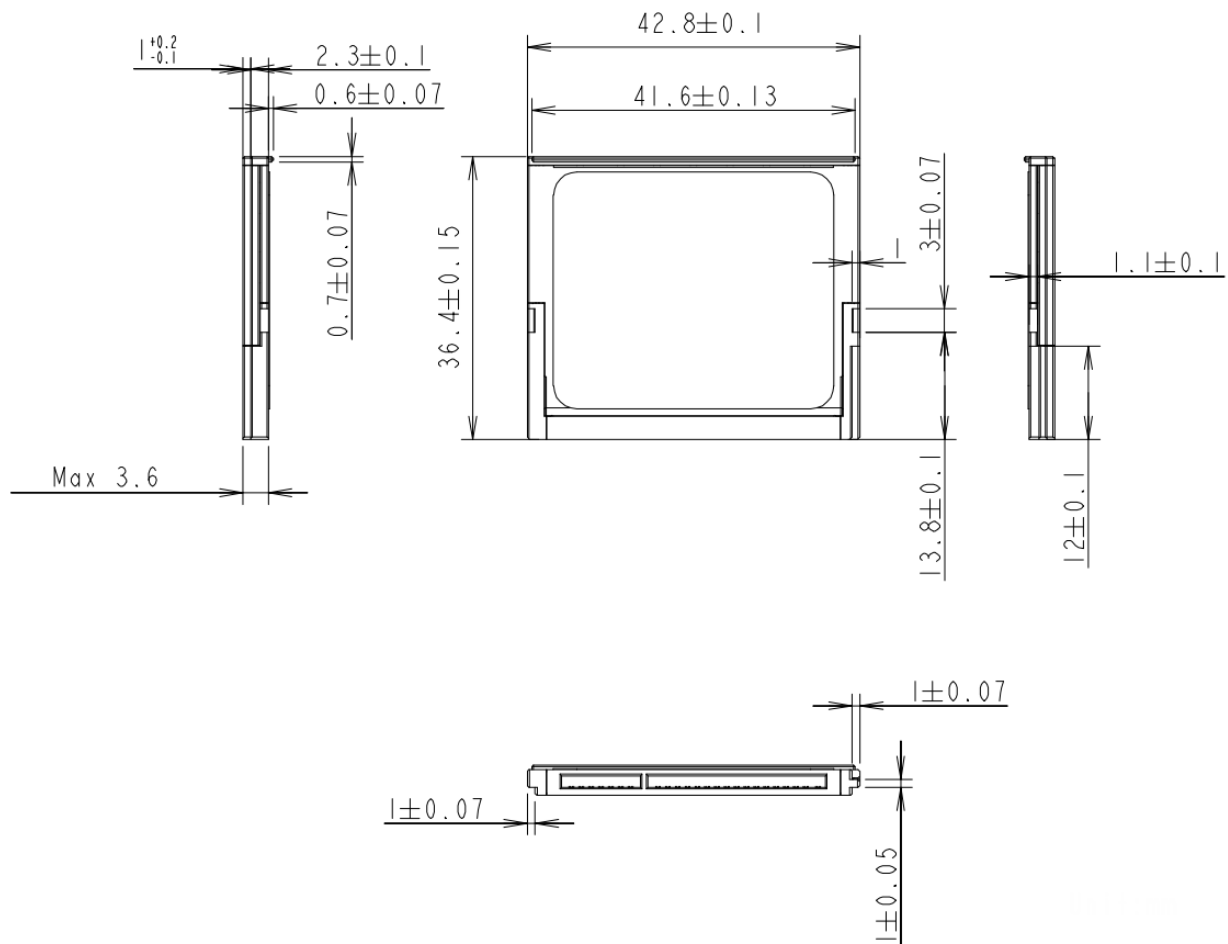


## 8. Physical Characteristics

### 8.1 With Write Protect Switch



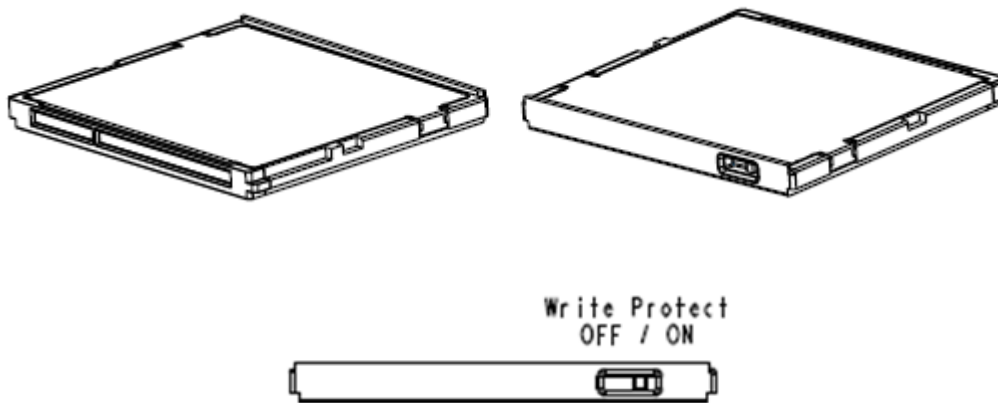
## 8.2 Without Write Protect Switch



Unit: mm

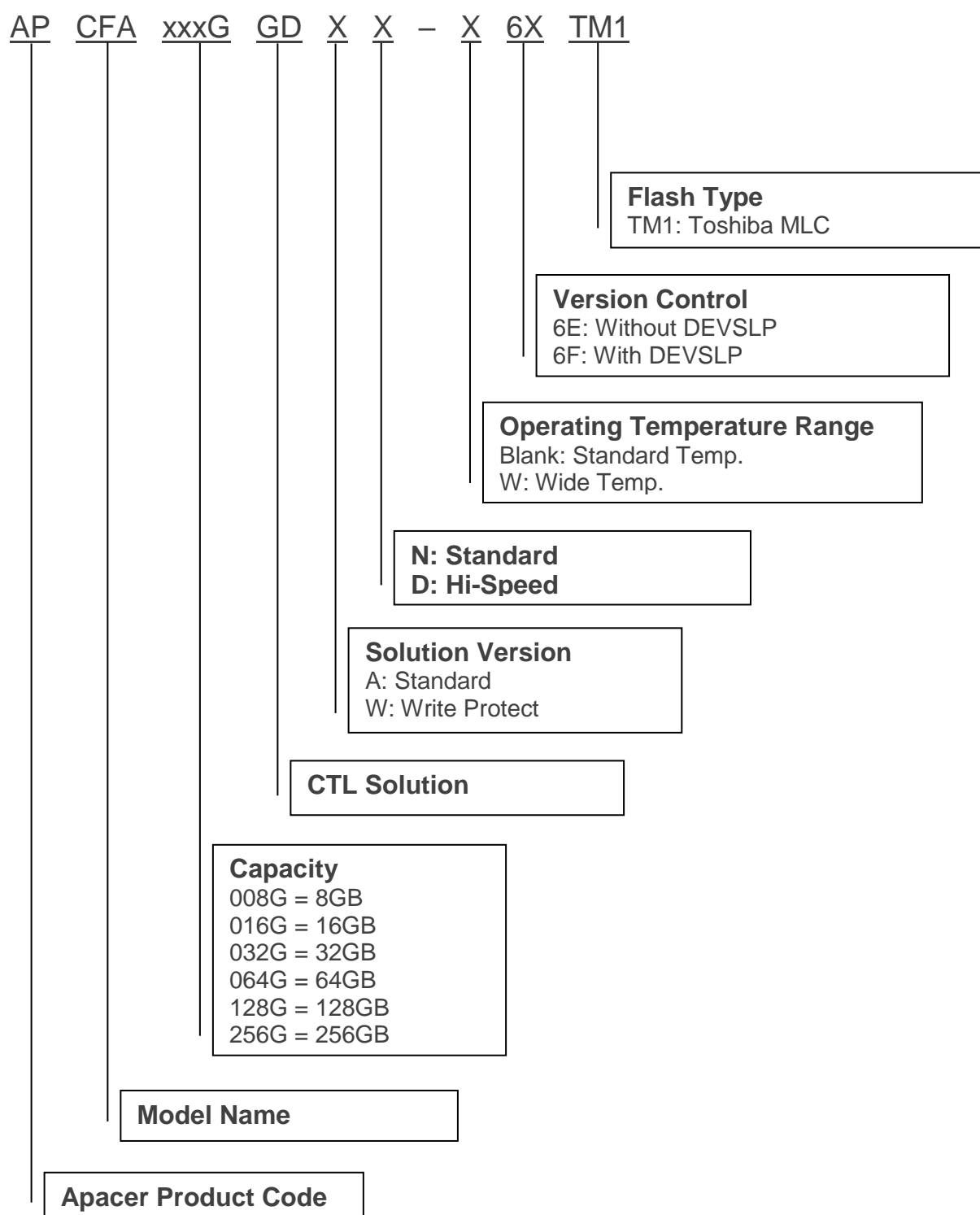
### 8.3 Write Protect Switch (optional)

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.



## 9. Product Ordering Information

### 9.1 Product Code Designations



## 9.2 Valid Combinations

### 9.2.1 Without DEVSLP

| Capacity | Standard Temperature | Wide Temperature     |
|----------|----------------------|----------------------|
| 8GB      | APCFA008GGDAN-6ETM1  | APCFA008GGDAN-W6ETM1 |
| 16GB     | APCFA016GGDAN-6ETM1  | APCFA016GGDAN-W6ETM1 |
| 32GB     | APCFA032GGDAD-6ETM1  | APCFA032GGDAD-W6ETM1 |
| 64GB     | APCFA064GGDAD-6ETM1  | APCFA064GGDAD-W6ETM1 |
| 128GB    | APCFA128GGDAD-6ETM1  | APCFA128GGDAD-W6ETM1 |
| 256GB    | APCFA256GGDAD-6ETM1  | APCFA256GGDAD-W6ETM1 |

### 9.2.2 With DEVSLP

| Capacity | Standard Temperature | Wide Temperature     |
|----------|----------------------|----------------------|
| 8GB      | APCFA008GGDAN-6FTM1  | APCFA008GGDAN-W6FTM1 |
| 16GB     | APCFA016GGDAN-6FTM1  | APCFA016GGDAN-W6FTM1 |
| 32GB     | APCFA032GGDAD-6FTM1  | APCFA032GGDAD-W6FTM1 |
| 64GB     | APCFA064GGDAD-6FTM1  | APCFA064GGDAD-W6FTM1 |
| 128GB    | APCFA128GGDAD-6FTM1  | APCFA128GGDAD-W6FTM1 |
| 256GB    | APCFA256GGDAD-6FTM1  | APCFA256GGDAD-W6FTM1 |

### 9.2.3 Without DEVSLP+ Write Protect

| Capacity | Standard Temperature | Wide Temperature     |
|----------|----------------------|----------------------|
| 8GB      | APCFA008GGDWN-6ETM1  | APCFA008GGDWN-W6ETM1 |
| 16GB     | APCFA016GGDWN-6ETM1  | APCFA016GGDWN-W6ETM1 |
| 32GB     | APCFA032GGDWD-6ETM1  | APCFA032GGDWD-W6ETM1 |
| 64GB     | APCFA064GGDWD-6ETM1  | APCFA064GGDWD-W6ETM1 |
| 128GB    | APCFA128GGDWD-6ETM1  | APCFA128GGDWD-W6ETM1 |
| 256GB    | APCFA256GGDWD-6ETM1  | APCFA256GGDWD-W6ETM1 |

## 9.2.4 With DEVSLP+ Write Protect

| Capacity | Standard Temperature | Wide Temperature     |
|----------|----------------------|----------------------|
| 8GB      | APCFA008GGDWN-6FTM1  | APCFA008GGDWN-W6FTM1 |
| 16GB     | APCFA016GGDWN-6FTM1  | APCFA016GGDWN-W6FTM1 |
| 32GB     | APCFA032GGDWD-6FTM1  | APCFA032GGDWD-W6FTM1 |
| 64GB     | APCFA064GGDWD-6FTM1  | APCFA064GGDWD-W6FTM1 |
| 128GB    | APCFA128GGDWD-6FTM1  | APCFA128GGDWD-W6FTM1 |
| 256GB    | APCFA256GGDWD-6FTM1  | APCFA256GGDWD-W6FTM1 |

**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   | 1/18/2016  |
| 1.1      | <ul style="list-style-type: none"> <li>- Added 8-16GB support</li> <li>- Updated performance and IOPS values</li> <li>- Added 5.4 Page Mapping FTL and 5.9 DEVSLP Mode sections</li> <li>- Updated product ordering information</li> </ul>   | 11/11/2016 |
| 1.2      | Rephrased "FW Version" to "Version Control" for Product Code Designations  | 11/29/2016 |
| 1.3      | Updated 1. General Description   | 1/26/2017  |
| 1.4      | Added product photo to Features page   | 2/2/2017   |
| 1.5      | <ul style="list-style-type: none"> <li>- Added 256GB support</li> <li>- Updated functional block diagram</li> <li>- Removed the note from 5.5 Power Failure Management</li> <li>- Revised the description of 5.4 Flash Translation Layer – Page Mapping</li> <li>- Updated product ordering information</li> </ul> | 3/28/2017  |
| 1.6      | <ul style="list-style-type: none"> <li>- Updated product photos</li> <li>- Updated product ordering information for 8-128GB</li> </ul>   | 4/5/2017   |
| 1.7      | <ul style="list-style-type: none"> <li>- Removed the product photo for standard temperature</li> <li>- Updated performance for 16GB, 64GB, and 128GB</li> </ul>  | 4/5/2017   |
| 1.8      | Updated performance for all capacities   | 6/14/2017  |
| 1.9      | Revised DEVSLP signal from pin 44 to pin 3 at 5.9 DEVSLP (DevSleep or DEVSLP) Mode   | 9/5/2017   |
| 2.0      | Added a note to 4.2 Performance for 256GB  | 12/11/2017 |
| 2.1      | <ul style="list-style-type: none"> <li>- Changed idle power consumption to TBD at 7.2 Power Consumption</li> <li>- Updated 9. Product Ordering information due to FW change</li> </ul>   | 4/2/2018   |
| 0.1      | Changed version number to 0.1  | 4/25/2018  |
| 2.2      | Updated Power Consumption on Specifications Overview page and 7.2 Power Consumption  | 7/9/2018   |
| 2.3      | Updated 9. Product Ordering Information by adding 9.2.3 and 9.2.4 sections   | 7/19/2018  |
| 2.4      | <ul style="list-style-type: none"> <li>- Added Endurance to Specifications Overview</li> <li>- Added 4.6 Endurance</li> </ul>  | 9/6/2018   |

| Revision | Description   | Date       |
|----------|---|------------|
| 2.5      | <ul style="list-style-type: none"> <li>- Renamed extended temperature to wide temperature</li> <li>- Updated Performance and Power Consumption on Specifications Overview page</li> <li>- Updated 4.2 Performance and 7.2 Power Consumption</li> <li>- Updated technology description for 5.6 Power Failure Management</li> <li>- Updated 9. Product Ordering Information due to FW change</li> </ul>   | 12/12/2019 |
| 2.6      | <ul style="list-style-type: none"> <li>- Changed SATA 6.0 Gbps to SATA 6 Gb/s in accordance with SATA naming guidelines</li> <li>- Updated operating/non-operating vibration spec at Table 4-3 Environmental Specifications</li> <li>- Updated MIL compliance from MIL-STD-810F to MIL-STD-810G at 4.5 Certification and Compliance</li> <li>- Capitalized every letter for commands at 6.1 Command Set and SMART subcommand at 6.2 S.M.A.R.T.</li> </ul> | 3/19/2020  |
| 2.7      | <ul style="list-style-type: none"> <li>- Added Write Protect Switch to Specifications Overview page</li> <li>- Added 8.2 Write Protect Switch</li> </ul>  | 4/14/2020  |
| 2.8      | <ul style="list-style-type: none"> <li>- Added the product photo with write protect to the cover page</li> <li>- Updated physical dimensions by including mechanical spec with write protect switch (Section 8.1)</li> </ul>  | 4/15/2020  |



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