

RoHS Compliant

CFast 2 HS

CFast 2 HS Product Specifications

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Features:

- **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
- **Connector type**
 - 7 + 17 pin female connector
- **Power consumption (typical)***
 - Supply voltage: 3.3V
 - Active mode: 500 mA
 - Idle mode: 90 mA
- **Performance***
 - Sustained read: Up to 285 MB/sec
 - Sustained write: Up to 260 MB/sec
- **Capacity**
 - 4, 8, 16, 32, 64 GB
- **NAND Flash Type: SLC**
- **MTBF: >2,000,000 hours**
- **Temperature ranges**
 - Operating:
 - Standard: 0°C to 70°C
 - Extended: -40°C to 85°C**
 - Storage: -40°C to 100°C
- **Flash Management**
 - Built-in hardware ECC, enabling up to 40-bit correction per 1K bytes
 - Static/dynamic wear-leveling
 - Flash bad-block management
 - S.M.A.R.T.
 - Power Failure Management
 - ATA Secure Erase
 - TRIM
- **RoHS Compliant**
- **Device Sleep mode (optional)**

*Vary from capacities. The values presented in Power consumption and Performances are typical, and may vary depending on different settings and platforms.

**Available in 8, 16, 32 and 64GB models.

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1. General Description

Apacer CFast 2 HS 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 is compliant with standard CFast specifications. CFast 2 HS consists of SATA-based 7-pin signal segment and 17-pin for power and control purposes. It can offer moderate capacity and decent data transfer performance. For power efficiency, this new flash memory card leverages the technological benefits of SATA Revision 3.1 specifications, including Device Sleep. That will greatly reduce power consumption when the device is not in operating mode. For data integrity, the CFast card is built with ECC engine correcting up to 40-bit. Together with its small form factor nature, Apacer CFast 2 HS is definitely the ideal solution to replace conventional PATA-based CompactFlash for applications in industrial computing systems, mobile computers and video processing instruments.

2. Functional Block

Apacer CFast 2 HS 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.

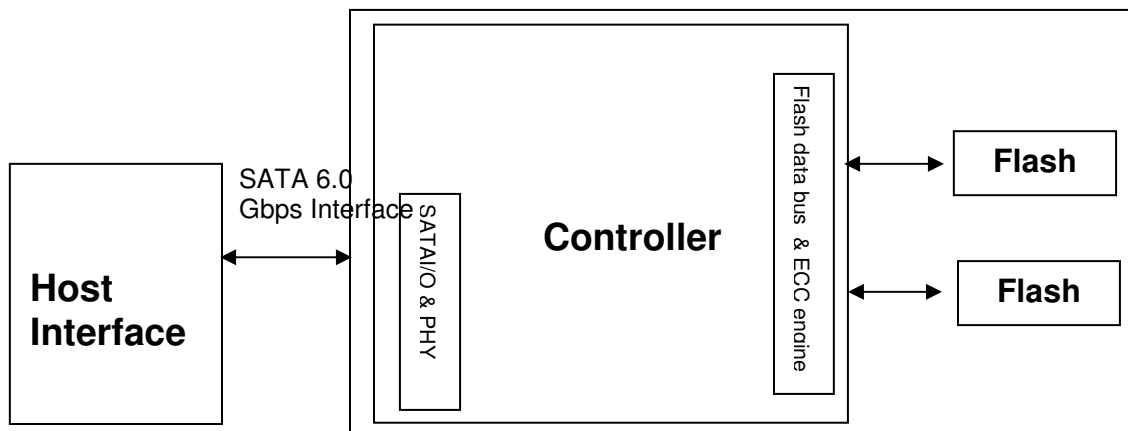


Figure 2-1 Apacer CFast HS block diagram

3. Pin Assignments

Table 3-1 describes CFAST 2 HS 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 |

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| | | | |
|------|-------|------------|--------------------------------------|
| 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 Specification

4.1 Capacity

Table 4-1: Capacity specifications

| Capacity | Total bytes* | Cylinders | Heads | Sectors | Max LBA |
|----------|----------------|-----------|-------|---------|-------------|
| 4 GB | 4,011,614,208 | 7773 | 16 | 63 | 7,835,184 |
| 8 GB | 8,012,390,400 | 15525 | 16 | 63 | 15,649,200 |
| 16 GB | 16,013,942,784 | 16383 | 16 | 63 | 31,277,232 |
| 32 GB | 32,017,047,552 | 16383 | 16 | 63 | 62,533,296 |
| 64 GB | 64,023,257,088 | 16383 | 16 | 63 | 125,045,424 |

*Display of total bytes varies from file systems.**Cylinders, heads or sectors are not applicable for these capacities. Only LBA addressing applies 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 CFAST 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 CFAST 2 HS product family is available as shown in Table 4-2.

Table 4-2: Performance table

| Capacity \ Performance | 4 GB | 8 GB | 16 GB | 32 GB | 64 GB |
|------------------------|------|------|-------|-------|-------|
| Sustained Read (MB/s) | 220 | 220 | 285 | 285 | 285 |
| Sustained Write (MB/s) | 60 | 65 | 135 | 260 | 260 |

Note: Performances results are measured by CrystalDiskMark under Windows 7 and may vary from host system configurations.

4.3 Environmental Specifications

Environmental specification of the CFAST 2 HS follows the military standards, shown in Table 4-3.

Table 4-3 Environmental specification

| Environment | Specification |
|-------------|---|
| Temperature | 0°C to 70°C (Operating) / -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.

*Available in 8, 16, 32, and 64GB models

4.4 Mean Time Between Failures (MTBF)

Mean Time Between Failures (MTBF) is predicted based on reliability data for the individual components in CFast 2 HS. Serving as statistical reference, the prediction result for CFast 2 HS 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.

4.5 Certification and Compliance

CFast 2 HS complies with the following standards

- CE
- FCC
- RoHS
- MIL-STD

5. Flash Management

5.1 Error Correction/Detection

Apacer 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 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. Wear leveling is an important mechanism that level out the wearing of blocks so that the wearing-down of blocks can be almost evenly distributed. This will increase the lifespan of SSDs. Commonly used wear leveling types are Static and Dynamic.

5.4 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.

5.5 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 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.

5.7 SATA Power Management Modes

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.
- 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.

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.

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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 Specification

7.1 Operating Voltage

Table 7-1 lists operating voltage of CFast 2 HS.

Table 7-1: Operating voltage

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

7.2 Power Consumption

Table 7-2 Power consumption (typical)

| Mode \ Capacity | 4 GB | 8 GB | 16 GB | 32 GB | 64 GB |
|--------------------|------|------|-------|-------|-------|
| Active (mA) | 265 | 230 | 275 | 390 | 500 |
| Idle (mA) | 90 | 90 | 90 | 90 | 90 |

Note: Power consumption may vary from flash configurations and/or platform settings.

8. Mechanical Specifications

8.1 Dimensions



Unit: mm

FIGURE 8-1: Physical dimension

9. Product Ordering Information

9.1 Product Code Designations



9.2 Valid Combinations

9.2.1 Standard Temperature

7.2.1.1 (STD)

| Capacity | AP/N |
|-----------------|------------------|
| 4GB | APCFA004GACAD-AT |
| 8GB | APCFA008GACAD-AT |
| 16GB | APCFA016GACAD-AT |
| 32GB | APCFA032GACAD-AT |
| 64GB | APCFA064GACAD-AT |

7.2.1.2(DEVSLP)

| Capacity | AP/N |
|-----------------|------------------|
| 4GB | APCFA004GACAD-BT |
| 8GB | APCFA008GACAD-BT |
| 16GB | APCFA016GACAD-BT |
| 32GB | APCFA032GACAD-BT |
| 64GB | APCFA064GACAD-BT |

9.2.2 Extended Temperature

7.2.1.1 (STD)

| Capacity | AP/N |
|-----------------|-------------------|
| 8GB | APCFA008GACAD-WAT |
| 16GB | APCFA016GACAD-WAT |
| 32GB | APCFA032GACAD-WAT |
| 64GB | APCFA064GACAD-WAT |

7.2.1.2(DEVSLP)

| Capacity | AP/N |
|-----------------|-------------------|
| 8GB | APCFA008GACAD-WBT |
| 16GB | APCFA016GACAD-WBT |
| 32GB | APCFA032GACAD-WBT |
| 64GB | APCFA064GACAD-WBT |

Note: Please consult with Apacer sales representatives for availabilities.

Revision History

| Revision | Date | Description | Remark |
|----------|------------|--|--------|
| 0.1 | 11/19/2013 | Preliminary | |
| 1.0 | 11/26/2013 | Official release | |
| 1.1 | 12/19/2013 | Added Endurance (TBW) section | |
| 1.2 | 01/21/2014 | Removed 64GB from the Product Ordering Information due to consideration about availability | |
| 1.3 | 02/13/2014 | Updated power consumption due to firmware revision | |
| 1.4 | 04/16/2014 | Added 64GB information | |
| 1.5 | 05/22/2014 | Revised mechanical drawing | |
| 1.6 | 06/26/2014 | Removed 4GB from extended temperature specifications | |

Global Presence

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