

RoHS Compliant

ATA CF

Specifications

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Version 1.6



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Features:

- **Standard ATA/IDE bus interface bus interface**
 - ATA command set compatible
 - ATA mode support for up to:
 - PIO Mode-4
 - Multiword DMA Mode-2
 - Ultra DMA Mode-4
- **Connector Type**
 - 50 pins female
- **Power consumption (typical)****
 - Supply voltage: 3.3V & 5V
 - Active mode: 80 mA/95 mA (3.3V/5.0V)
 - Sleep mode: 500 μ A/600 μ A (3.3V/5.0V)
- **Performance****
 - Sustained read: up to 29 MB/sec
 - Sustained write: up to 15 MB/sec
- **Capacity**
 - 128, 256, 512 MB
 - 1, 2, 4, 8, 16 GB
- **NAND Flash Type: SLC**
- **Physical Dimensions**
 - 36.4mm x 42.8mm x 3.3mm
- **Temperature ranges**
 - Operation:
 - Standard: 0°C to 70°C
 - Extended: -40°C to 85°C
 - Storage: -40°C to 100°C
- **Flash management**
 - Advanced wear-leveling algorithms
 - S.M.A.R.T. technology
 - Built-in hardware ECC
 - Flash block management
 - Power failure management
- **Endurance (TBW: Terabytes Written)**
 - 128 MB: 3.3 TBW
 - 256 MB: 6.7 TBW
 - 512 MB: 12.9 TBW
 - 1 GB: 25.6 TBW
 - 2 GB: 38.4 TBW
 - 4 GB: 51.9 TBW
 - 8 GB: 69.8 TBW
 - 16 GB: 115.0 TBW
- **RoHS compliant**
- **Shock & Vibration****
 - Shock: 1500G
 - Vibration: 15G
- **MTBF > 2,000,000 hours**

*The values addressed here for performance and power consumption are typical and may vary depending on configurations and platforms.

**Non-operating

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1. General Description

Apacer's ATA CF offers reliable and high performance storage compatible with CF Type I and Type II devices. Unlike the ordinary cards, Apacer ATA CF provides solid compatibilities for use in Point of Sale (POS) terminals, telecom, IP-STB, medical instruments, surveillance systems, industrial PCs and handheld applications.

With featuring technologies as wear leveling, S.M.A.R.T, built-in hardware ECC, flash block management, and power failure management, the ATA CF is the ideal embedded storage for mission oriented applications.

2. Functional Block

The ATA CF includes a controller and flash media, as well as the ATA CF standard interface. Figure 2-1 shows the functional block diagram.



Figure 2-1: Functional block diagram

3. Pin Assignments

Table 3-1 lists the pin assignments with respective signal names for the 50-pin configuration. A “#” suffix indicates the active low signal. The pin type can be input, output or input/output.

Table 3-1: Pin assignments

| Pin No. | True IDE mode | | Pin No. | True IDE mode | |
|---------|---------------|--------------|---------|---------------|--------------|
| | Signal name | Pin I/O type | | Signal name | Pin I/O type |
| 1 | GND | - | 26 | #CD1 | O |
| 2 | D3 | I/O | 27 | D11 | I/O |
| 3 | D4 | I/O | 28 | D12 | I/O |
| 4 | D5 | I/O | 29 | D13 | I/O |
| 5 | D6 | I/O | 30 | D14 | I/O |
| 6 | D7 | I/O | 31 | D15 | I/O |
| 7 | #CE1 | I | 32 | #CE2 | I |
| 8 | GND | - | 33 | #VS1 | O |
| 9 | GND | - | 34 | #IORD | I |
| 10 | GND | - | 35 | #IOWR | I |
| 11 | GND | - | 36 | VCC | - |
| 12 | GND | - | 37 | INTRQ | O |
| 13 | VCC | - | 38 | VCC | - |
| 14 | GND | - | 39 | #CSEL | I |
| 15 | GND | - | 40 | #WP_PD* | I |
| 16 | GND | - | 41 | RESET | I |
| 17 | GND | - | 42 | IORDY | O |
| 18 | A2 | I | 43 | DMARQ** | O |
| 19 | A1 | I | 44 | DMACK** | I |
| 20 | A0 | I | 45 | #DASP | I/O |
| 21 | D0 | I/O | 46 | #PDIAG | I/O |
| 22 | D1 | I/O | 47 | D8 | I/O |
| 23 | D2 | I/O | 48 | D9 | I/O |
| 24 | #IOCS16 | O | 49 | D10 | I/O |
| 25 | #CD2 | O | 50 | GND | - |

*Write-Protect enabled when pin 40 assigned to GND.

**Connection required when UDMA is in use.

4. Product Specifications

4.1 Capacity

Capacity specification of the ATA CF series is available as shown in Table 4-1. It lists the specific capacity and the default numbers of heads, sectors and cylinders for each product line.

Table 4-1: Capacity specifications

| Capacity | Total bytes | Cylinders | Heads | Sectors | Max LBA |
|----------|----------------|-----------|-------|---------|------------|
| 128 MB | 128,057,344 | 977 | 8 | 32 | 250,112 |
| 256 MB | 256,901,120 | 980 | 16 | 32 | 501,760 |
| 512 MB | 512,483,328 | 993 | 16 | 63 | 1,000,944 |
| 1GB | 1,024,966,656 | 1986 | 16 | 63 | 2,001,888 |
| 2GB | 2,048,385,024 | 3969 | 16 | 63 | 4,000,752 |
| 4GB | 4,096,253,952 | 7937 | 16 | 63 | 8,000,496 |
| 8GB | 8,001,552,384 | 15504 | 16 | 63 | 15,628,032 |
| 16GB | 16,001,040,384 | 16383* | 16 | 63 | 31,252,032 |

Notes:

Display of total bytes varies from operating systems.

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

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

Performances of the CF cards are listed in Table 4-2

Table 4-2: Performance specifications

| Capacity | 128 MB | 256 MB | 512 MB | 1 GB | 2 GB | 4 GB | 8 GB | 16 GB |
|-------------------------------|--------|--------|--------|------|------|------|------|-------|
| Sustained read (MB/s) | 17 | 29 | 19 | 21 | 20 | 21 | 21 | 20 |
| Sustained write (MB/s) | 4 | 8 | 7 | 12 | 11 | 11 | 13 | 15 |

Notes: performance may vary depending on flash configurations or host system settings.

4.3 Environmental

Environmental specification of the ATA CF follows the MIL-STD-810F standards as shown in Table 4-4.

Table 4-3: Environmental specifications

| Environment | | Specification |
|---------------------------|-----------|---|
| Temperature | Operation | 0°C to 70°C; -40°C to 85°C (Extended Temperature) |
| | Storage | -40°C to 100°C |
| Vibration (Non-Operation) | | Sine wave : 10~2000Hz, 15G (X, Y, Z axes) |
| Shock (Non-Operation) | | Half sine wave 1,500G (X, Y, Z ; All 6 axes) |

4.4 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.

| Capacity | TeraBytes Written |
|----------|-------------------|
| 128 MB | 3.3 |
| 256 MB | 6.7 |
| 512 MB | 12.9 |
| 1 GB | 25.6 |
| 2 GB | 38.4 |
| 4 GB | 51.9 |
| 8 GB | 69.8 |
| 16 GB | 115.0 |

Notes:

- 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) = 1000 GB.

4.5 Mean Time Between Failures (MTBF)

Mean Time Between Failures (MTBF) is predicted based on reliability data for the individual components in our drive device. Although many component of MTBF are given in databases and often these values are not really accurate, the prediction result for this unit more than 2,000,000 hours for its SLC flash configuration

Notes about the MTBF:

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

5. Flash Management

5.1. Advanced wear-leveling algorithms

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.

5.2 S.M.A.R.T. technology

S.M.A.R.T. is an acronym for Self-Monitoring, Analysis and Reporting Technology, an open standard allowing disk drives to automatically monitor their own health and report potential problems. It protects the user from unscheduled downtime by monitoring and storing critical drive performance and calibration parameters. Ideally, this should allow taking proactive actions to prevent impending drive failure. Apacer SMART feature adopts the standard SMART command B0h to read data from the drive. When the Apacer SMART Utility running on the host, it analyzes and reports the disk status to the host before the device is in critical condition.

5.3 Built-in hardware ECC

The ATA-Disk Module uses BCH Error Detection Code (EDC) and Error Correction Code (ECC) algorithms which correct up to eight random single-bit errors for each 512-byte block of data. High performance is fulfilled through hardware-based error detection and correction.

5.4 Flash 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.

5.5 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

Table 6-1 summarizes the command set with the paragraphs that follow describing the individual commands and the task file for each.

Table 6-1: Command set (1 of 2)

| Command | Code |
|-----------------------------|------------|
| Check-Power-Mode | E5H or 98H |
| Execute-Drive-Diagnostic | 90H |
| Erase Sector(s) | C0H |
| Flush-Cache | E7H |
| Format Track | 50H |
| Identify-Drive | ECH |
| Idle | E3H or 97H |
| Idle-Immediate | E1H or 95H |
| Initialize-Drive-Parameters | 91H |
| NOP | 00H |
| Read-Buffer | E4H |
| Read-DMA | C8H or C9H |
| Read-Multiple | C4H |
| Read-Sector(s) | 20H or 21H |
| Read-Verify-Sector(s) | 40H or 41H |
| Recalibrate | 1XH |
| Request-Sense | 03H |
| Security-Disable-Password | F6H |
| Security-Erase-Prepare | F3H |
| Security-Erase-Unit | F4H |
| Security-Freeze-Lock | F5H |
| Security-Set-Password | F1H |
| Security-Unlock | F2H |
| Seek | 7XH |
| Set-Features | EFH |

Table 6-1: Command set (2 of 2)

| Command | Code |
|------------------------------|-------------|
| SMART | B0H |
| Set-Multiple-Mode | C6H |
| Set-Sleep-Mode | E6H or 99H |
| Standby | E2H or 96H |
| Standby-Immediate | E0H or 94H |
| Translate-Sector | 87H |
| Write-Buffer | E8H |
| Write-DMA | CAH or CBH |
| Write-Multiple | C5H |
| Write-Multiple-Without-Erase | CDH |
| Write-Sector(s) | 30H or 31H |
| Write-Sector-Without-Erase | 38H |
| Write-Verify | 3CH |

7. Electrical Specification

Caution: Absolute Maximum Stress Ratings – Applied conditions greater than those listed under “Absolute Maximum Stress Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these conditions or conditions greater than those defined in the operational sections of this data sheet is not implied. Exposure to absolute maximum stress rating conditions may affect device reliability.

Table 7-1: Operating range

| | |
|------------------------------|--------------------------|
| Operating Temperature | 0°C to +70°C |
| | -40°C to +85°C |
| Supply voltage | 5V ± 5% (4.75-5.25V) |
| | 3.3V ± 5% (3.135-3.465V) |

Table 7-2: Absolute maximum power pin stress ratings

| Parameter | Symbol | Conditions |
|--|----------|------------------------------------|
| Input Power | V_{DD} | -0.3V min. to 6.5V max. |
| Voltage on any pin except V_{DD} with respect to GND | V | -0.5V min. to $V_{DD} + 0.5V$ max. |

Table 7-3: Recommended system power-up timing

| Symbol | Parameter | Typical | Maximum | Units |
|------------------|-----------------------------|---------|---------|-------|
| $T_{PU-READY}^*$ | Power-up to Ready Operation | 200 | 1000 | ms |
| $T_{PU-WRITE}^*$ | Power-up to Write Operation | 200 | 1000 | ms |

*This parameter is measured only for initial qualification and after a design or process change that could affect this parameter.

8. Physical Characteristics

8.1 Dimension

TABLE 8-1: Type I CFC physical specification

| | |
|--|--------------------------------------|
| Length: | 36.40 +/- 0.15mm (1.433+/- 0.06 in.) |
| Width: | 42.80 +/- 0.10mm (1.685+/- 0.04 in.) |
| Thickness (Including Label Area): | 3.3mm+/-0.10mm (0.130+/-0.04in.) |



FIGURE 8-1: Physical dimension

9. Product Ordering Information

9.1 Product Code Designations

AP - CFxxxxH4XR - XXXXXX Q



9.2 Valid Combinations

Standard Temperature

Non-Removable

| Capacity | Model Number |
|----------|-------------------|
| 128MB | AP-CF128MH4NR-NRQ |
| 256MB | AP-CF256MH4NR-NRQ |
| 512MB | AP-CF512MH4NR-NRQ |
| 1GB | AP-CF001GH4NR-NRQ |
| 2GB | AP-CF002GH4NR-NRQ |
| 4GB | AP-CF004GH4NR-NRQ |
| 8GB | AP-CF008GH4NR-NRQ |
| 16GB | AP-CF016GH4NR-NRQ |

Non-DMA & Non-Removable

| Capacity | Model Number |
|----------|---------------------|
| 128MB | AP-CF128MH4NR-NDNRQ |
| 256MB | AP-CF256MH4NR-NDNRQ |
| 512MB | AP-CF512MH4NR-NDNRQ |
| 1GB | AP-CF001GH4NR-NDNRQ |
| 2GB | AP-CF002GH4NR-NDNRQ |
| 4GB | AP-CF004GH4NR-NDNRQ |
| 8GB | AP-CF008GH4NR-NDNRQ |
| 16GB | AP-CF016GH4NR-NDNRQ |

Extended Temperature

Non-Removable

| Capacity | Model Number |
|----------|---------------------|
| 128MB | AP-CF128MH4NR-ETNRQ |
| 256MB | AP-CF256MH4NR-ETNRQ |
| 512MB | AP-CF512MH4NR-ETNRQ |
| 1GB | AP-CF001GH4NR-ETNRQ |
| 2GB | AP-CF002GH4NR-ETNRQ |
| 4GB | AP-CF004GH4NR-ETNRQ |
| 8GB | AP-CF008GH4NR-ETNRQ |
| 16GB | AP-CF016GH4NR-ETNRQ |

Non-DMA & Non-Removable

| Capacity | Model Number |
|----------|-----------------------|
| 128MB | AP-CF128MH4NR-ETNDNRQ |
| 256MB | AP-CF256MH4NR-ETNDNRQ |
| 512MB | AP-CF512MH4NR-ETNDNRQ |
| 1GB | AP-CF001GH4NR-ETNDNRQ |
| 2GB | AP-CF002GH4NR-ETNDNRQ |
| 4GB | AP-CF004GH4NR-ETNDNRQ |
| 8GB | AP-CF008GH4NR-ETNDNRQ |
| 16GB | AP-CF016GH4NR-ETNDNRQ |

Revision History

| Revision | Date | Description | Remark |
|----------|------------|---|--------|
| 0.1 | 02/16/2009 | Preliminary | |
| 0.2 | 02/18/2009 | Updated pin assignments | |
| 1.0 | 02/23/2009 | Official release | |
| 1.1 | 03/06/2009 | Product name changed | |
| 1.2 | 04/01/2009 | Updated feature and valid combination wording | |
| 1.3 | 01/06/2010 | Corrected valid combinations | |
| 1.4 | 03/22/2011 | Updated Performance Specification & Product Ordering Information | |
| 1.5 | 03/22/2012 | Updated performance information | |
| 1.6 | 08/27/2013 | Updated performance information due to change in flash configurations | |

Global Presence

| | |
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