

RoHS Compliant

CompactFlash Series 5

Specifications for Industrial CompactFlash Card

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Version 1.3



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Features:

- **CompactFlash Association Specification Revision 4.1 Standard Interface**
 - 512 bytes per sector
 - ATA command set compatible
 - ATA transfer mode supports:
 - PIO Mode 6
 - Multiword DMA Mode 4
 - Ultra DMA Mode 5
 - PCMCIA UDMA Mode 5
- **Capacities**
 - 4, 8, 16, 32, 64 GB
- **Performance**
 - Sustained read: Up to 50 MB/sec
 - Sustained write: Up to 18 MB/sec
- **Flash Management**
 - Wear-leveling algorithms to substantially increase longevity of flash media
 - Built-in BCH ECC capable of correcting up to 24 bits in 1,024 byte data
 - Supports S.M.A.R.T commands
- **NAND Flash Type: MLC (commercial/Industrial grade)**
- **Power Smart Design**
- **Temperature Ranges**
 - Standard: 0°C to 70°C
 - Extended: -40°C to 85°C
 - Storage: -40°C to 100°C
- **Operating Voltage for Read and Write**
 - 3.3 V
 - 5.0 V
- **Power Consumption (typical)****
 - Active mode: 165 mA
 - Standby mode: 2 mA
- **Connector Type**
 - 50 pins female
- **Physical Dimensions**
 - 36.4mm x 42.8mm x 3.3mm
- **RoHS Compliant**

*Performance and power consumption may vary depending on capacities and the platforms.

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1. General Description

Apacer's value-added Industrial CompactFlash Card offers high performance, high reliability and power-efficient storage. Regarding standard compliance, this CompactFlash Card complies with CompactFlash specification revision 4.1, supporting transfer modes up to Programmed Input Output (PIO) Mode 6, Multi-word Direct Memory Access (DMA) Mode 4, Ultra DMA Mode 5, and PCMCIA Ultra DMA Mode 5.

For power efficiency, this industrial CompactFlash card supports some power smart design mechanisms such as Power-On-Reset, voltage regulator for output voltage adjustments and power failure protection, as well as the automatic sleep and wake-up feature..

In terms of data integrity and accuracy, the CompactFlash card is built with on-chip hardware 13/24 bit BCH ECC engine that can correct up to 24-bit errors per 1,024 byte data. The 13-bit is used for 2KB page size with 16 bytes spare region per 512 byte data, while the 24-bit ECC is used for flash with 218 or more bytes, accompanied with 4KB data. The controller of this CompactFlash card is designed to transfer the host data through fast DMA engine and utilize the internal memory buffer in a sufficient way, which greatly minimizes the internal microprocessor's loading and improves performance efficiency.

Apacer's value-added CFC provides complete PCMCIA - ATA functionality and compatibility. Apacer's CompactFlash technology is designed for applications in Point of Sale (POS) terminals, telecom, IP-STB, medical instruments, surveillance systems, industrial PCs and handheld applications such as the new generation of Digital Single Lens Reflex (DSLR) cameras.

2. Functional Block Diagram

The CompactFlash Card (CFC) includes a controller and flash media, as well as the CompactFlash standard interface. Figure 2-1 shows the functional block diagram.

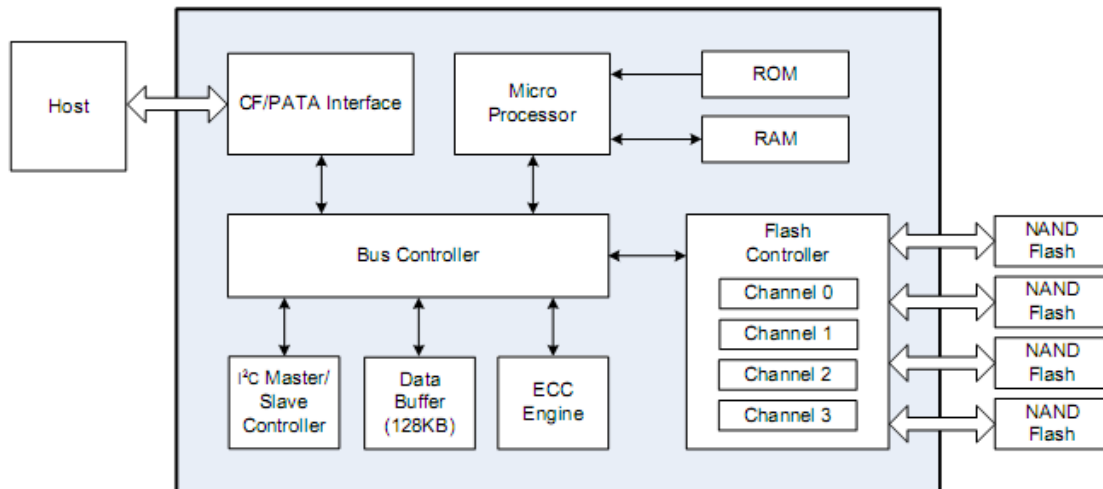


Figure 2-1: Functional block diagram

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 (1 of 2)

| Pin No. | Memory card mode | | I/O card mode | | True IDE mode | |
|---------|------------------|--------------|---------------|--------------|------------------|--------------|
| | Signal name | Pin I/O type | Signal name | Pin I/O type | Signal name | Pin I/O type |
| 1 | GND | - | GND | - | GND | - |
| 2 | D3 | I/O | D3 | I/O | D3 | I/O |
| 3 | D4 | I/O | D4 | I/O | D4 | I/O |
| 4 | D5 | I/O | D5 | I/O | D5 | I/O |
| 5 | D6 | I/O | D6 | I/O | D6 | I/O |
| 6 | D7 | I/O | D7 | I/O | D7 | I/O |
| 7 | #CE1 | I | #CE1 | I | #CS0 | I |
| 8 | A10 | I | A10 | I | A10 ¹ | I |
| 9 | #OE | I | #OE | I | #ATA SEL | I |
| 10 | A9 | I | A9 | I | A9 ¹ | I |
| 11 | A8 | I | A8 | I | A8 ¹ | I |
| 12 | A7 | I | A7 | I | A7 ¹ | I |
| 13 | VCC | - | VCC | - | VCC | - |
| 14 | A6 | I | A6 | I | A6 ¹ | I |
| 15 | A5 | I | A5 | I | A5 ¹ | I |
| 16 | A4 | I | A4 | I | A4 ¹ | I |
| 17 | A3 | I | A3 | I | A3 ¹ | I |
| 18 | A2 | I | A2 | I | A2 | I |
| 19 | A1 | I | A1 | I | A1 | I |
| 20 | A0 | I | A0 | I | A0 | I |
| 21 | D0 | I/O | D0 | I/O | D0 | I/O |
| 22 | D1 | I/O | D1 | I/O | D1 | I/O |
| 23 | D2 | I/O | D2 | I/O | D2 | I/O |
| 24 | WP | O | #IOIS16 | O | #IOCS16 | O |
| 25 | #CD2 | O | #CD2 | O | #CD2 | O |
| 26 | #CD1 | O | #CD1 | O | #CD1 | O |
| 27 | D11 | I/O | D11 | I/O | D11 | I/O |
| 28 | D12 | I/O | D12 | I/O | D12 | I/O |
| 29 | D13 | I/O | D13 | I/O | D13 | I/O |
| 30 | D14 | I/O | D14 | I/O | D14 | I/O |
| 31 | D15 | I/O | D15 | I/O | D15 | I/O |
| 32 | #CE2 | I | #CE2 | I | #CS1 | I |
| 33 | #VS1 | O | #VS1 | O | #VS1 | O |
| 34 | #IORD | I | #IORD | I | #IORD | I |
| 35 | #IOWR | I | #IOWR | I | #IOWR | I |
| 36 | #WE | I | #WE | I | #WE | I |
| 37 | RDY/-BSY | O | #IREQ | O | INTRQ | O |
| 38 | VCC | - | VCC | - | VCC | - |
| 39 | #CSEL | I | #CSEL | I | #CSEL | I |
| 40 | #VS2 | O | #VS2 | O | #VS2 | O |
| 41 | RESET | I | RESET | I | #RESET | I |

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Table 3-1: Pin assignments (2 of 2)

| Pin No. | Memory card mode | | I/O card mode | | True IDE mode | |
|---------|------------------|--------------|---------------|--------------|--------------------|--------------|
| | Signal name | Pin I/O type | Signal name | Pin I/O type | Signal name | Pin I/O type |
| 42 | #WAIT | O | #WAIT | O | IORDY | O |
| 43 | #INPACK | O | #INPACK | O | DMARQ ² | O |
| 44 | #REG | I | #REG | I | DMACK ² | I |
| 45 | BVD2 | O | #SPKR | O | #DASP | I/O |
| 46 | BVD1 | O | #STSCHG | O | #PDIAG | I/O |
| 47 | D8 | I/O | D8 | I/O | D8 | I/O |
| 48 | D9 | I/O | D9 | I/O | D9 | I/O |
| 49 | D10 | I/O | D10 | I/O | D10 | I/O |
| 50 | GND | - | GND | - | GND | - |

1. The signal should be grounded by the host.
2. Connection required when UDMA is in use.

4. Product Specification

4.1 Capacity

Capacity specifications of the Compact Flash Card series (CFC) is available as shown in Table 4-1.

Table 4-1: Capacity specifications

| Capacity | Total bytes ¹ | Cylinders | Heads | Sectors | Max LBA |
|----------|--------------------------|---------------------|-------|---------|-------------|
| 4GB | 4,110,188,544 | 7,964 | 16 | 63 | 8,027,712 |
| 8GB | 8,195,604,480 | 15,880 | 16 | 63 | 16,007,040 |
| 16GB | 16,391,340,032 | 16,383 ² | 16 | 63 | 32,014,336 |
| 32GB | 32,019,316,736 | 16,383 | 16 | 63 | 62,537,728 |
| 64GB | 64,030,244,864 | 16,383 | 16 | 63 | 125,059,072 |

¹Cylinders, heads or sectors are not applicable for these capacities. Only LBA addressing applies

²Notes: 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 CompactFlash cards are listed in Table 4-2.

Table 4-2: Performance specifications

| Capacity \ Performance | 4 GB (Dual Channel) | 4 GB (Single Channel) | 8 GB | 16 GB | 32 GB | 64 GB |
|------------------------|------------------------|--------------------------|------|-------|-------|-------|
| Sustained read (MB/s) | 49 | 17 | 50 | 50 | 50 | 50 |
| Sustained write (MB/s) | 13 | 4 | 14 | 14 | 18 | 18 |

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

4.3 Environmental Specifications

Environmental specification follows the MIL-STD-810F standards is available as shown in Table 4-3.

Table 4-3: Environmental specifications

| Environment | | Specification |
|---------------------------|-----------|--|
| Temperature | Operation | 0°C to 70°C / -40°C to 85°C |
| | Storage | -40°C to 100°C |
| Vibration (Non-Operation) | | Sine wave: 10~2000Hz, 15G (X, Y, Z axes) |
| Shock (Non-Operation) | | Half sine wave, acceleration 1500 G, 0.5 ms (X, Y, Z ; All 6 axes) |

5. Software Interface

5.1 CF-ATA Command Set

Table 5-1 summarizes the CF-ATA command set with the paragraphs that follow describing the individual commands and the task file for each.

Table 5-1: CFC-ATA command set

| Command | Code | FR ¹ | SC ² | SN ³ | CY ⁴ | DH ⁵ | LBA ⁶ |
|-----------------------------|------------|-----------------|-----------------|-----------------|-----------------|-----------------|------------------|
| Check-Power-Mode | E5H or 98H | — | — | — | — | D ⁸ | — |
| Execute-Drive-Diagnostic | 90H | — | — | — | — | D | — |
| Erase-Sector(s) | C0H | — | Y ⁷ | Y | Y | Y ⁸ | Y |
| Flush-Cache | E7H | — | — | — | — | D | — |
| Format-Track | 50H | — | Y | — | Y | Y | Y |
| Identify-Drive | ECH | — | — | — | — | D | — |
| Idle | E3H or 97H | — | Y | — | — | D | — |
| Idle-Immediate | E1H or 95H | — | — | — | — | D | — |
| Initialize-Drive-Parameters | 91H | — | Y | — | — | Y | — |
| NOP | 00H | — | — | — | — | D | — |
| Read-Buffer | E4H | — | — | — | — | D | — |
| Read-Multiple | C4H | — | Y | Y | Y | Y | Y |
| Read-Sector(s) | 20H or 21H | — | Y | Y | Y | Y | Y |
| Read-Verify-Sector(s) | 40H or 41H | — | Y | Y | Y | Y | Y |
| Recalibrate | 1XH | — | — | — | — | D | — |
| Request-Sense | 03H | — | — | — | — | D | — |
| Seek | 7XH | — | — | Y | Y | Y | Y |
| Set-Features | EFH | Y | — | — | — | D | — |
| Set-Multiple-mode | C6H | - | Y | - | - | D | - |

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| | | | | | | | |
|-------------------------------|------------|---|----------------|---|---|---|---|
| Set-Sleep-Mode | E6H or 99H | – | – | – | – | D | – |
| Standby | E2H or 96H | – | – | – | – | D | – |
| Standby-Immediate | E0H or 94H | – | – | – | – | D | – |
| Translate-Sector | 87H | – | Y | Y | Y | Y | Y |
| Write-Buffer | E8H | – | – | – | – | D | – |
| Write-Multiple | C5H | – | Y ⁷ | Y | Y | Y | Y |
| Write-Multiple-Without-Erase | CDH | – | Y | Y | Y | Y | Y |
| Write-Sector(s) | 30H or 31H | – | Y | Y | Y | Y | Y |
| Write-Sector(s)-Without-Erase | 38H | – | Y | Y | Y | Y | Y |
| Write-Verify | 3CH | – | Y | Y | Y | Y | Y |

1. FR - Features register
2. SC - Sector Count register
3. SN - Sector Number register
4. CY - Cylinder registers
5. DH - Drive/Head register
6. LBA - Logical Block Address mode supported
7. Y - The register contains a valid parameter for this command
8. For the Drive/Head register:
 Y means both the CompactFlash card and head parameters are used;
 D means only the CompactFlash card parameter is valid and not the head parameter

6. Flash Management

6.1 Intelligent Endurance Design

6.1.1 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. On the other hand, NAND flash storage adopts flash as their primary media. 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 earlier. 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.

6.1.2 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.

6.1.3 Built-in Hardware ECC

The ECC bit encoding takes places when host/OS writes data to the SSD. This step is simpler and quick. On the other hand, the ECC bit decoding is processed when host/OS reads data from the SSD. In this step, the ECC codes will be in progress for detecting, comparing and detecting potential error. Thus, the power of the ECC lies mostly in the read data side.

This ATA CompactFlash card employs BCH Error Correction Code (ECC) algorithms. This on-chip hardware BCH-ECC engines is 13/24 bit programmed that can correct up to 24-bit errors per 1,024 byte data. This built-in hardware ECC performs parity generation and error detection/correction for data integrity.

6.2 Intelligent Power Failure Recovery

Power Failure Management ensures data transmission when experiencing unstable power supply. When power disruption takes places, NAND Flash will have to cache multiple write-to-flash cycles to securely store data. This urgent operation requires about several milliseconds to get it done. When the supplied voltage is below a certain percentage of the required, the flash controller will be signaled by a detector IC component with low power detection signal and then the firmware will communicate the controller to flush all the data into the cache of Flash storage area. This can prevent incomplete data transmission. The crucial part lies in the strength of the capacitor of the SSD. The capacitor must be able to hold up some milliseconds of remaining time before the power is totally out, for the urgent write-back-into-flash operations to complete.

7. Electrical Specification

Table 7-1: Operating range

| Range | Ambient Temperature | 3.3V | 5V |
|----------------------|---------------------|--------------|------------|
| Standard Temperature | 0°C to 70°C | 3.135-3.465V | 4.75-5.25V |
| Extended Temperature | -40°C to +85°C | | |
| Storage Temperature | -40°C to +100°C | | |

Table 7-2: Power consumption (at 5V, typical)

| Modes \ Capacity | 4 GB | 4 GB | 8 GB | 16 GB | 32 GB | 64 GB |
|--------------------|----------------|------------------|------|-------|-------|-------|
| | (Dual Channel) | (Single Channel) | | | | |
| Active (mA) | 150 | 150 | 155 | 165 | 165 | 170 |
| Idle (mA) | 5 | 5 | 5 | 5 | 5 | 5 |

Notes: results may vary depending on flash configurations or platforms.

8. Physical Characteristics

8.1 Dimensions

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.) |

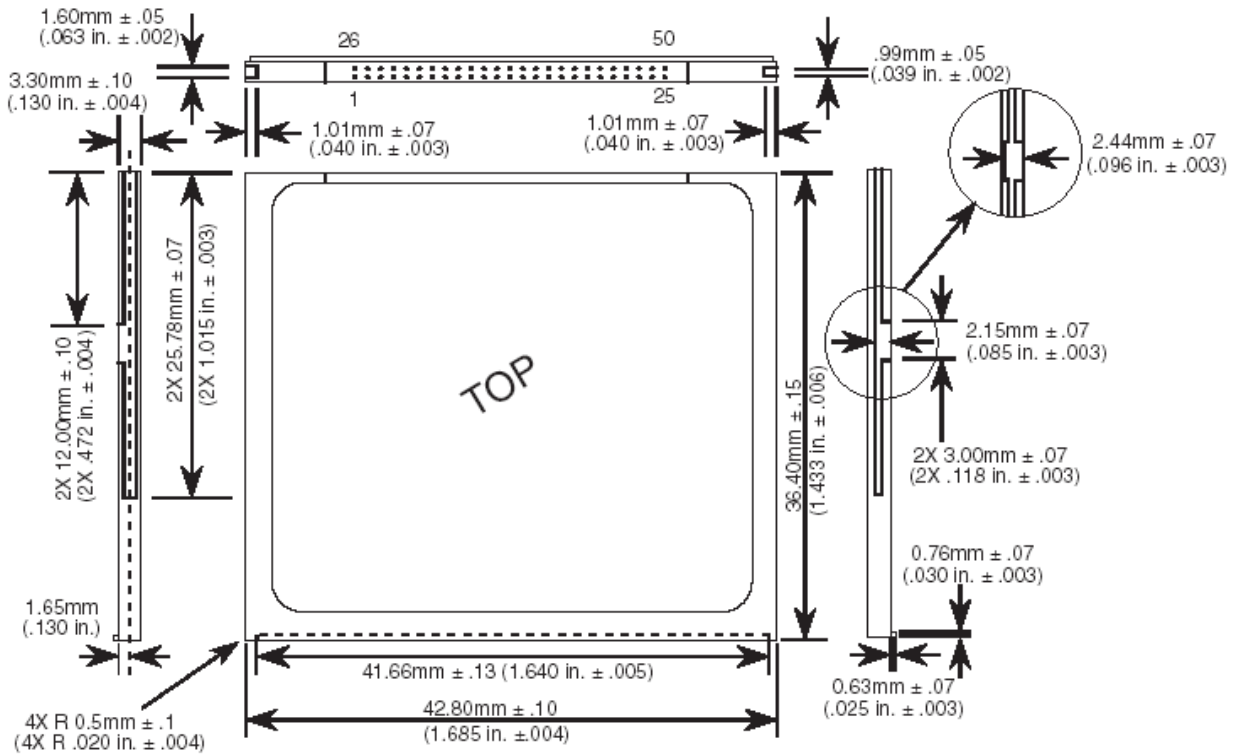


FIGURE 8-1: Physical dimension

Unit: mm

9. Product Ordering Information

9.1 Product Code Designations

A P - C F x x x x L 9 X S - X X X X X X

Specification

RM: Removable
NR: Non-Removable
NDRM: Non-DMA + Removable
NDNR: Non-DMA + Non-Removable
ETRM: Ext. Temp. + Removable
ETNR: Ext. Temp. + Non-Removable
ETNDRM: Ext. Temp + Non-DMA + Removable
ETNDNR: Ext. Temp + Non-DMA + Non-Removable

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Configuration

E : Single Channel
F : Dual Channel

CTL Type

CFC Type

Capacities:

004G = 4GB
008G = 8GB
016G = 16GB
032G = 32GB
064G = 64GB

Model Name

Apacer Product Code

9.2 Valid Combinations

9.2.1 Standard Temperature

9.2.1.1 Non-Removable

| Capacity | AP/N |
|-----------------|------------------|
| 4GB | AP-CF004GL9FS-NR |
| 4GB | AP-CF004GL9ES-NR |
| 8GB | AP-CF008GL9FS-NR |
| 16GB | AP-CF016GL9FS-NR |
| 32GB | AP-CF032GL9FS-NR |
| 64GB | AP-CF064GL9FS-NR |

9.2.1.2 Removable

| Capacity | AP/N |
|-----------------|------------------|
| 4GB | AP-CF004GL9FS-RM |
| 4GB | AP-CF004GL9ES-RM |
| 8GB | AP-CF008GL9FS-RM |
| 16GB | AP-CF016GL9FS-RM |
| 32GB | AP-CF032GL9FS-RM |
| 64GB | AP-CF064GL9FS-RM |

9.2.1.3 Non-DMA + Removable

| Capacity | AP/N |
|-----------------|--------------------|
| 4GB | AP-CF004GL9FS-NDRM |
| 4GB | AP-CF004GL9ES-NDRM |
| 8GB | AP-CF008GL9FS-NDRM |
| 16GB | AP-CF016GL9FS-NDRM |
| 32GB | AP-CF032GL9FS-NDRM |
| 64GB | AP-CF064GL9FS-NDRM |

9.2.1.4 Non-DMA + Non-Removable

| Capacity | AP/N |
|-----------------|--------------------|
| 4GB | AP-CF004GL9FS-NDNR |
| 4GB | AP-CF004GL9ES-NDNR |
| 8GB | AP-CF008GL9FS-NDNR |
| 16GB | AP-CF016GL9FS-NDNR |
| 32GB | AP-CF032GL9FS-NDNR |
| 64GB | AP-CF064GL9FS-NDNR |

Note: please consult with Apacer sales representative for availability.

9.2.2 Extended Temperature

9.2.2.1 Ext. Temp. + Non-Removable

| Capacity | AP/N |
|-----------------|--------------------|
| 4GB | AP-CF004GL9ES-ETNR |
| 8GB | AP-CF008GL9FS-ETNR |
| 16GB | AP-CF016GL9FS-ETNR |
| 32GB | AP-CF032GL9FS-ETNR |

9.2.2.2 Ext. Temp. + Removable

| Capacity | AP/N |
|-----------------|--------------------|
| 4GB | AP-CF004GL9ES-ETRM |
| 8GB | AP-CF008GL9FS-ETRM |
| 16GB | AP-CF016GL9FS-ETRM |
| 32GB | AP-CF032GL9FS-ETRM |

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9.2.2.3 Non-DMA + Removable

| Capacity | AP/N |
|-----------------|----------------------|
| 4GB | AP-CF004GL9ES-ETNDRM |
| 8GB | AP-CF008GL9FS-ETNDRM |
| 16GB | AP-CF016GL9FS-ETNDRM |
| 32GB | AP-CF032GL9FS-ETNDRM |

9.2.2.4 Non-DMA + Non-Removable

| Capacity | AP/N |
|-----------------|----------------------|
| 4GB | AP-CF004GL9ES-ETNDNR |
| 8GB | AP-CF008GL9FS-ETNDNR |
| 16GB | AP-CF016GL9FS-ETNDNR |
| 32GB | AP-CF032GL9FS-ETNDNR |

Note: please consult with Apacer sales representative for availability.

Revision History

| Revision | Date | Description | Remark |
|----------|------------|--|--------|
| 0.1 | 03/13/2012 | Preliminary | |
| 1.0 | 04/12/2012 | Official release | |
| 1.1 | 07/23/2012 | Updated Product Ordering Information (with the addition of standard operating temperature models) Added 64GB capacity | |
| 1.2 | 09/20/2012 | Added standard operating temperature specifications Updated Product Ordering Information due to the addition of standard temperature specifications Added 4GB capacity model | |
| 1.3 | 10/01/2015 | Added 4GB models of single channel. | |

Global Presence

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