

## Halogen-free & RoHS Recast Compliant

### CompactFlash Series 6A

#### Industrial CF Product Specifications



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Version 2.2



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## Specifications Overview:

- **CompactFlash Association Specification Revision 6.0 Standard Interface**
  - ATA command set compatible
  - ATA transfer mode supports: PIO Mode 6 , Multiword DMA Mode 4 , Ultra DMA Mode 7 , PCMCIA UDMA Mode 7
- **Capacity**
  - 256, 512 MB
  - 1, 2, 4, 8, 16, 32 GB
- **Performance\***
  - Sequential read: Up to 60 MB/sec
  - Sequential write: Up to 65 MB/sec
  - Random read (4K): Up to 2,000 IOPS
  - Random write (4K): Up to 188 IOPS
- **Flash Management**
  - Global Wear Leveling
  - Built-in BCH ECC capable of correcting up to 72 bits in 1KB data
  - Supports S.M.A.R.T commands
  - Flash Block Management
  - Power Failure Management
- **NAND Flash Type: SLC**
- **MTBF: >2,000,000 hours**
- **Endurance (in Terabytes Written: TBW)**
  - 256 MB: 14 TBW
  - 512 MB: 28 TBW
  - 1GB: 56 TBW
  - 2 GB: 113 TBW
  - 4 GB: 224 TBW
  - 8 GB: 461 TBW
  - 16 GB: 885 TBW
  - 32 GB: 1,786 TBW
- **Temperature Range**
  - Operating:
    - Standard: 0°C to 70°C
    - Wide: -40°C to 85°C
  - Storage: -40°C to 100°C
- **Supply Voltage**
  - 3.3V
  - 5.0V
- **Power Consumption\***

Operating Voltage: 3.3V

  - Active mode: 165 mA
  - Standby mode: 10 mA

Operating Voltage: 5.0V

  - Active mode: 230 mA
  - Standby mode: 10 mA
- **Connector Type**
  - 50 pins female
- **Form Factor**
  - 36.4mm x 42.8mm x 3.3mm
- **Write Protect by Hardware Switch**
- **Halogen Free**
- **RoHS Recast Compliant**
  - Complies with 2011/65/EU Standard

\*Varies from capacities. The values for performances and power consumptions presented are typical and may vary depending on flash configurations or platform settings.

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# 1. General Descriptions

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 6.0, supporting transfer modes up to Programmed Input Output (PIO) Mode 6, Multi-word Direct Memory Access (DMA) Mode 4, Ultra DMA Mode 7, and PCMCIA Ultra DMA Mode 7.

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.

## 1.1 Intelligent Endurance Design

### 1.1.1 Error Correction Code (ECC)

The CompactFlash card is programmed with BCH Error Detection Code (EDC) and Error Correction Code (ECC) algorithms capable of correcting up to 72 random bits in 1KB bytes data.

High performance is achieved through hardware-based error detection and correction.

### 1.1.2 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 blocks so that the wearing-down of all blocks can be almost evenly distributed. This will increase the lifespan of SSDs.

### 1.1.3 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.

SMART attribute ID list

| ID (Hex)   | Attribute Name          |
|------------|-------------------------|
| 12 (0x0C)  | Power cycle count       |
| 160 (0xA0) | Initial bad block count |
| 161 (0xA1) | Bad block count         |
| 162 (0xA2) | Spare block count       |
| 163 (0xA3) | Max. erase count        |
| 165 (0xA5) | Avg. erase count        |

## 1.1.4 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.

## 1.1.5 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.

## 2. Functional Block

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.

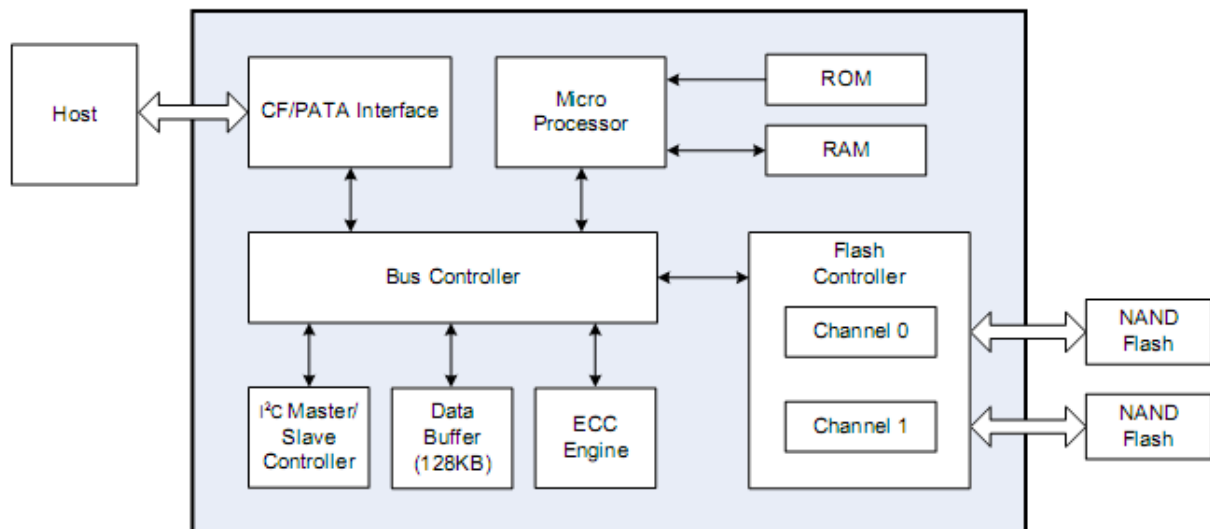


Figure 2-1 Functional Block Diagram

# 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

| 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 <sup>1</sup>   | I            |
| 9       | #OE              | I            | #OE           | I            | #ATA SEL           | I            |
| 10      | A9               | I            | A9            | I            | A9 <sup>1</sup>    | I            |
| 11      | A8               | I            | A8            | I            | A8 <sup>1</sup>    | I            |
| 12      | A7               | I            | A7            | I            | A7 <sup>1</sup>    | I            |
| 13      | VCC              | -            | VCC           | -            | VCC                | -            |
| 14      | A6               | I            | A6            | I            | A6 <sup>1</sup>    | I            |
| 15      | A5               | I            | A5            | I            | A5 <sup>1</sup>    | I            |
| 16      | A4               | I            | A4            | I            | A4 <sup>1</sup>    | I            |
| 17      | A3               | I            | A3            | I            | A3 <sup>1</sup>    | 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            |
| 42      | #WAIT            | O            | #WAIT         | O            | IORDY              | O            |
| 43      | #INPACK          | O            | #INPACK       | O            | DMARQ <sup>2</sup> | O            |
| 44      | #REG             | I            | #REG          | I            | DMACK <sup>2</sup> | I            |
| 45      | BVD2             | O            | #SPKR         | O            | #DASP              | I/O          |
| 46      | BVD1             | O            | #STSCHG       | O            | #PDIAG             | I/O          |

| 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 |
| 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 Specifications

### 4.1 Capacity

Capacity specifications of the Compact Flash Card series (CFC) 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    |
|----------|----------------|-----------|-------|---------|------------|
| 256 MB   | 256,901,120    | 980       | 16    | 32      | 501,760    |
| 512 MB   | 512,483,328    | 993       | 16    | 63      | 1,000,944  |
| 1 GB     | 1,024,966,656  | 1,986     | 16    | 63      | 2,001,888  |
| 2 GB     | 2,048,901,120  | 3,970     | 16    | 63      | 4,001,760  |
| 4 GB     | 4,110,188,544  | 7,964     | 16    | 63      | 8,027,712  |
| 8 GB     | 8,195,604,480  | 15,880    | 16    | 63      | 16,007,040 |
| 16 GB    | 16,391,340,032 | 16,383    | 16    | 63      | 32,014,336 |
| 32 GB    | 32,019,316,736 | 16,383    | 16    | 63      | 62,537,728 |

Note:

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

Performance of the CF cards is listed in Table 4-2.

**Table 4-2** Performance Specifications

| Capacity                 | 256 MB | 512 MB | 1 GB  | 2 GB  | 4 GB  | 8 GB  | 16 GB | 32 GB |
|--------------------------|--------|--------|-------|-------|-------|-------|-------|-------|
| Performance              |        |        |       |       |       |       |       |       |
| Sequential Read* (MB/s)  | 24     | 32     | 32    | 60    | 60    | 60    | 60    | 60    |
| Sequential Write* (MB/s) | 11     | 20     | 21    | 42    | 50    | 60    | 65    | 65    |
| Random Read IOPS** (4K)  | 2,000  | 2,000  | 2,000 | 3,000 | 2,000 | 2,000 | 2,000 | 2,000 |
| Random Write IOPS** (4K) | 32     | 36     | 49    | 49    | 50    | 31    | 67    | 188   |

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 the Compact Flash Card series (CFC) 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/sine (compliant with MIL-STD-810G) |
| Operating shock         | 50G, 11ms, half-sine wave                                  |
| Non-operating shock     | 1,500G, 0.5ms, half-sine wave                              |

## 4.4 Mean Time Between Failures (MTBF)

MTBF, an acronym for Mean Time Between Failures, is a measure of a device's reliability. Its value represents the average time between a repair and the next failure. The measure is typically in units of hours. The higher the MTBF value, the higher the reliability of the device. The predicted result of this CompactFlash Card is higher than 2,000,000 hours.

## 4.5 Certification and Compliance

The CompactFlash card complies with the following global standards:

- CE
- FCC
- Halogen-free
- EMC
- RoHS Recast (2011/65/EU)

## 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 |
|----------|-------------------|
| 256 MB   | 14                |
| 512 MB   | 28                |
| 1 GB     | 56                |
| 2 GB     | 113               |
| 4 GB     | 224               |
| 8 GB     | 461               |
| 16 GB    | 885               |
| 32 GB    | 1,786             |

Note:

- This estimation complies with JEDEC JESD-219, enterprise endurance workload of sequential data with payload size distribution.
- Flash vendor guaranteed SLC P/E cycle: Toshiba – 60k
- WAF/WLE may vary from capacity, flash configurations and writing behavior on each platform.
- 1 Terabyte = 1,000 GB

## 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 Set                  | Command                                    | Code       | Protocol          |
|------------------------------|--------------------------------------------|------------|-------------------|
| CFA Feature Set              | Request Sense                              | 03h        | Non-data          |
|                              | Write Sectors Without Erase                | 38h        | PIO data-out      |
|                              | Erase Sectors                              | C0h        | Non-data          |
|                              | Write Multiple Without Erase               | CDh        | PIO data-out      |
|                              | Translate Sector                           | 87h        | PIO data-in       |
|                              | Set Features Enable/Disable 8-bit Transfer | EFh        | Non-data          |
| General Feature Set          | Execute Drive Diagnostic                   | 90h        | Device diagnostic |
|                              | Flush Cache                                | E7h        | Non-data          |
|                              | Identify Device                            | ECh        | PIO data-in       |
|                              | Read DMA                                   | C8h        | DMA               |
|                              | Read Multiple                              | C4h        | PIO data-in       |
|                              | Read Sector(s)                             | 20h or 21h | PIO data-in       |
|                              | Read Verify Sector(s)                      | 40h or 41h | Non-data          |
|                              | Set Feature                                | EFh        | Non-data          |
|                              | Set Multiple Mode                          | C6h        | Non-data          |
|                              | Write DMA                                  | CAh        | DMA               |
|                              | Write Multiple                             | C5h        | PIO data-out      |
|                              | Write Sector(s)                            | 30h or 31h | PIO data-out      |
|                              | NOP                                        | 00h        | Non-data          |
|                              | Read Buffer                                | E4h        | PIO data-in       |
|                              | Write Buffer                               | E8h        | PIO data-out      |
|                              | Set Feature                                | EFh        | Non-data          |
| Power Management Feature Set | Check Power Mode                           | E5h or 98h | Non-data          |
|                              | Idle                                       | E3h or 97h | Non-data          |
|                              | Idle Immediate                             | E1h or 95h | Non-data          |
|                              | Sleep                                      | E6h or 99h | Non-data          |
|                              | Standby                                    | E2h or 96h | Non-data          |
|                              | Standby Immediate                          | E0h or 94h | Non-data          |

| Command Set                     | Command                          | Code | Protocol     |
|---------------------------------|----------------------------------|------|--------------|
| Security Mode Feature Set       | Security Set Password            | F1h  | PIO data-out |
|                                 | Security Unlock                  | F2h  | PIO data-out |
|                                 | Security Erase Prepare           | F3h  | Non-data     |
|                                 | Security Erase Unit              | F4h  | PIO data-out |
|                                 | Security Freeze Lock             | F5h  | Non-data     |
|                                 | Security Disable Password        | F6h  | PIO data-out |
| SMART Feature Set               | SMART Disable Operations         | B0h  | Non-data     |
|                                 | SMART Enable/Disable Autosave    | B0h  | Non-data     |
|                                 | SMART Enable Operations          | B0h  | Non-data     |
|                                 | SMART Return Status              | B0h  | Non-data     |
|                                 | SMART Execute Off-line Immediate | B0h  | Non-data     |
|                                 | SMART Read Data                  | B0h  | PIO data-in  |
| Host Protected Area Feature Set | Read Native Max Address          | F8h  | Non-data     |
|                                 | Set Max Address                  | F9h  | Non-data     |
|                                 | Set Max Set Password             | F9h  | PIO data-out |
|                                 | Set Max Lock                     | F9h  | Non-data     |
|                                 | Set Max Freeze Lock              | F9h  | Non-data     |
|                                 | Set Max Unlock                   | F9h  | PIO data-out |
| Others                          | Format Track                     | 50h  | PIO data-out |
|                                 | Initialize Drive Parameters      | 91h  | Non-data     |
|                                 | Recalibrate                      | 1Xh  | Non-data     |
|                                 | Seek                             | 7Xh  | Non-data     |
|                                 | Wear Level                       | F5h  | Non-data     |
|                                 | Write Verify                     | 3Ch  | PIO data-out |
| 48-bit Address Feature Set      | Read Sector Ext                  | 24h  | PIO data-in  |
|                                 | Read DMA Ext                     | 25h  | DMA          |
|                                 | Read Multiple Ext                | 29h  | PIO data-in  |
|                                 | Write Sector Ext                 | 34h  | PIO data-out |
|                                 | Write DMA Ext                    | 35h  | DMA          |
|                                 | Read Verify Sector Ext           | 42h  | Non-data     |
|                                 | Write Multiple FUA Ext           | CEh  | PIO data-out |
|                                 | Flush Cache Ext                  | EAh  | Non-data     |

## 6. Electrical Specifications

### 6.1 Operating Voltage

Table 6-1 lists the supply voltage for the CompactFlash card.

**Table 6-1** Operating Range

| Item                   | Range            |
|------------------------|------------------|
| Supply voltage at 3.3V | 3.135 to 3.465 V |
| Supply voltage at 5V   | 4.75 to 5.25 V   |

### 6.2 Power Consumption

Table 6-2 and 6-3 list the power consumption for the CompactFlash card.

**Table 6-2** Power Consumption @3.3V

| Capacity<br>Mode | 256 MB | 512 MB | 1 GB | 2GB | 4 GB | 8 GB | 16 GB | 32 GB |
|------------------|--------|--------|------|-----|------|------|-------|-------|
| Active (mA)      | 100    | 105    | 110  | 130 | 150  | 150  | 145   | 165   |
| Standby (mA)     | 10     | 10     | 10   | 10  | 10   | 10   | 10    | 10    |

**Table 6-3** Power Consumption @5V

| Capacity<br>Mode | 256 MB | 512 MB | 1 GB | 2GB | 4 GB | 8 GB | 16 GB | 32 GB |
|------------------|--------|--------|------|-----|------|------|-------|-------|
| Active (mA)      | 110    | 120    | 120  | 175 | 175  | 200  | 215   | 230   |
| Standby (mA)     | 10     | 10     | 10   | 10  | 10   | 10   | 10    | 10    |

Note:

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

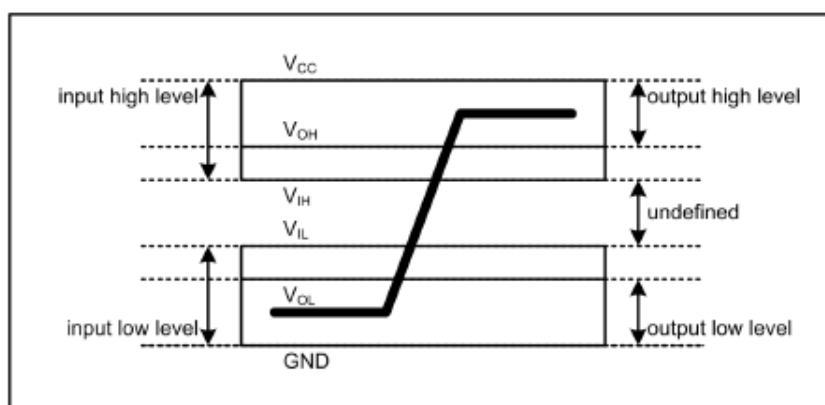
\*\*Active power is an average power measurement performed using CrystalDiskMark with 128KB sequential read/write transfers.

## 6.3 AC/DC Characteristics

The following section provides general AC/DC characteristics of this CompactFlash card.

### 6.3.1 General DC Characteristics

Definitions of  $V_{IH}$ ,  $V_{CC}$ ,  $V_{OH}$ ,  $V_{OL}$



#### • DC characteristics for host interface ( $V_{CC} = 3.3V/5V$ )

| Parameter                 | Symbol   | Minimum | Maximum | Unit | Remark              |
|---------------------------|----------|---------|---------|------|---------------------|
| Supply Voltage 5V         | $V_{CC}$ | 4.5     | 5.5     | V    |                     |
| Supply voltage 3.3V       | $V_{CC}$ | 2.97    | 3.63    | V    |                     |
| High Level Output Voltage | $V_{OH}$ | 2.5     |         | V    |                     |
| Low Level Output Voltage  | $V_{OL}$ |         | 0.4     | V    |                     |
| High Level Input Voltage  | $V_{IH}$ | 2.4     |         | V    | Non-Schmitt trigger |
|                           |          | 2.05    |         | V    | Schmitt trigger     |
| Low Level Input Voltage   | $V_{IL}$ |         | 0.6     | V    | Non-Schmitt trigger |
|                           |          |         | 1.25    | V    | Schmitt trigger     |
| Pull-up Resistance        | $R_{PU}$ | 52.7    | 141     | kOhm |                     |
| Pull-down Resistance      | $R_{PD}$ | 47.5    | 172     | kOhm |                     |

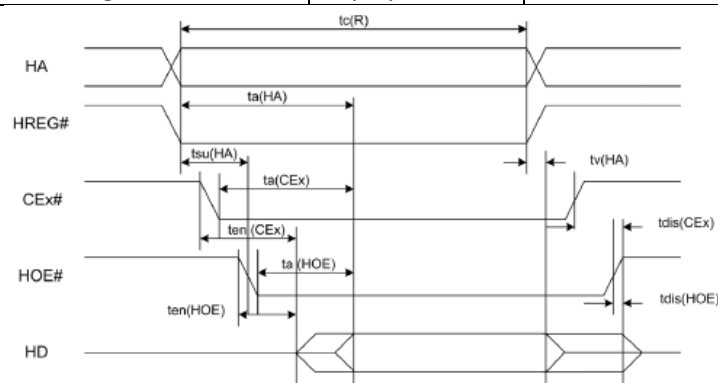
#### • General DC characteristics

| Parameter                 | Symbol   | Minimum | Maximum | Unit | Remark              |
|---------------------------|----------|---------|---------|------|---------------------|
| Supply Voltage            | $V_{CC}$ | 2.7     | 3.6     | V    |                     |
| High Level Output Voltage | $V_{OH}$ | 2.4     |         | V    |                     |
| Low Level Output Voltage  | $V_{OL}$ |         | 0.4     | V    |                     |
| High Level Input Voltage  | $V_{IH}$ | 2.0     |         | V    | Non-Schmitt trigger |
|                           |          | 1.4     | 2.0     | V    | Schmitt trigger     |
| Low Level Input Voltage   | $V_{IL}$ |         | 0.8     | V    | Non-Schmitt trigger |
|                           |          |         | 1.2     | V    | Schmitt trigger     |
| Pull-up Resistance        | $R_{PU}$ | 40      |         | kOhm |                     |
| Pull-down Resistance      | $R_{PD}$ | 40      |         | kOhm |                     |

## 6.3.2 General AC Characteristics

### • Attribute Memory Read Timing

| Item                           | Symbol     | Min. (ns) | Max. (ns) |
|--------------------------------|------------|-----------|-----------|
| Read Cycle Time                | tc (R)     | 300       |           |
| Address Access Time            | ta (HA)    |           | 300       |
| Card Enable Access Time        | ta (CE#)   |           | 300       |
| Output Enable Access Time      | ta (HOE)   |           | 150       |
| Output Disable Time from CEx#  | tdis (CE#) |           | 100       |
| Output Disable Time from HOE#  | tdis (HOE) |           | 100       |
| Address Setup Time             | tsu (HA)   | 30        |           |
| Output Enable Time from CEx#   | ten (CE#)  | 5         |           |
| Output Enable Time from HOE#   | ten (HOE)  | 5         |           |
| Data Valid from Address Change | tv (HA)    | 0         |           |

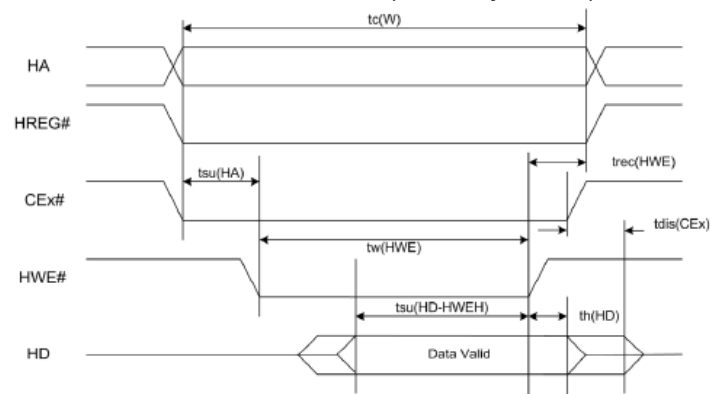


Notes: all time intervals are in nanoseconds. HD refers to the data provided by the CompactFlash card to the system. The CEx# signal or both of the HOE# and the HWE# signal are de-asserted between consecutive cycle operations.

### • Attribute Memory Write Timing

| Item                     | Symbol        | Min. (ns) | Max. (ns) |
|--------------------------|---------------|-----------|-----------|
| Write Cycle Time         | tc (W)        | 250       |           |
| Write Pulse Width        | tw (HWE)      | 150       |           |
| Address setup Time       | tsu (HA)      | 30        |           |
| Write Recovery Time      | trec (HWE)    | 30        |           |
| Data Setup Time for HWE# | tsu (HD-HWEH) | 80        |           |
| Data Hold Time           | th (HD)       | 30        |           |

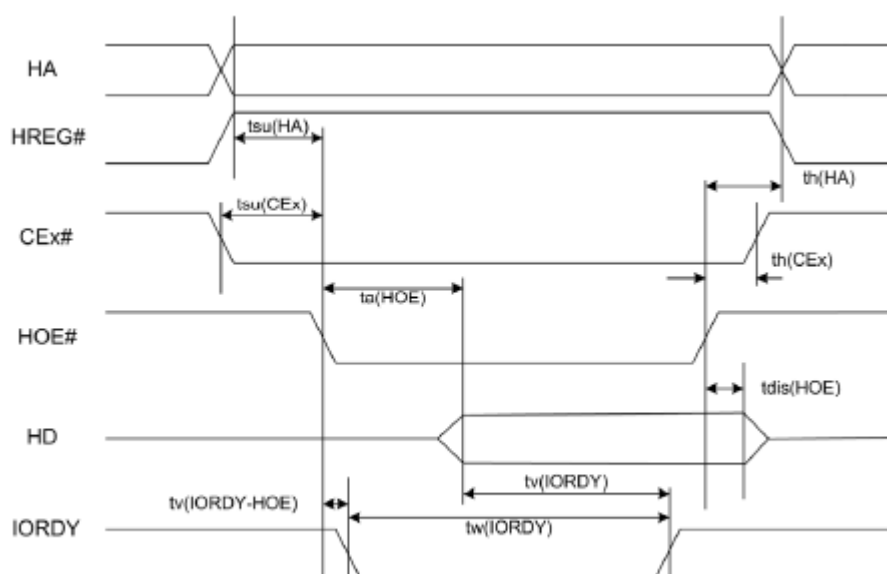
Notes: all time intervals are in nanoseconds. HD refers to the data provided by the CompactFlash card to the system.



## • Common Memory Read Timing

| Cycle Time Mode               |                | 250 ns |      | 120 ns |      | 100 ns |      | 80 ns |      |
|-------------------------------|----------------|--------|------|--------|------|--------|------|-------|------|
| Item                          | Symbol         | Min.   | Max. | Min.   | Max. | Min.   | Max. | Min.  | Max. |
| Output Enable Access Time     | ta (HOE)       |        | 125  |        | 60   |        | 50   |       | 45   |
| Output Disable Time from HOE# | tdis (HOE)     |        | 100  |        | 60   |        | 50   |       | 45   |
| Address Setup Time            | tsu (HA)       | 30     |      | 15     |      | 10     |      | 10    |      |
| Address Hold Time             | th (HA)        | 20     |      | 15     |      | 15     |      | 10    |      |
| CE# Setup before HOE#         | tsu (CE#)      | 5      |      | 5      |      | 5      |      | 5     |      |
| CE# Hold following HOE#       | th (CE#)       | 20     |      | 15     |      | 15     |      | 10    |      |
| Wait Delay falling from HOE#  | tv (IORDY-HOE) |        | 35   |        | 35   |        | 35   |       | Na   |
| Data Setup for Wait Release   | tv (IORDY)     |        | 0    |        | 0    |        | 0    |       | Na   |
| Wait Width Time               | tw (IORDY)     |        | 350  |        | 350  |        | 350  |       | Na   |

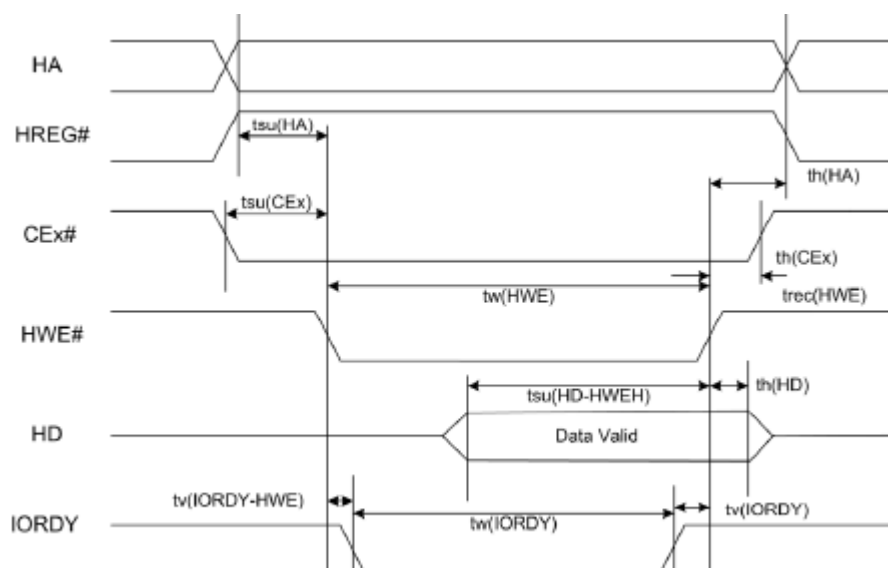
Note: IORDY is not supported in this 80 ns mode. The maximum load on IORDY is 1 LSTTL with a 50 pF (40 pF below 120 nsec cycle time) total load. All time intervals are in nanoseconds. HD refers to the data provided by the CompactFlash card to the system. The IORDY signal can be ignored when the HOE# cycle-to-cycle time is greater than the Wait Width Time. The Max Wait Width Time can be determined from the Card Information Structure (CIS). Although adhering to the PCM-CIA specification, the Wait Width Time is intentionally designed to be lower in this specification.



# Common Memory Write Timing

| Cycle Time Mode              |                | 250 ns |      | 120 ns |      | 100 ns |      | 80 ns |      |
|------------------------------|----------------|--------|------|--------|------|--------|------|-------|------|
| Item                         | Symbol         | Min.   | Max. | Min.   | Max. | Min.   | Max. | Min.  | Max. |
| Data Setup before HWE#       | tsu (HD-HWEH)  | 80     |      | 50     |      | 40     |      | 30    |      |
| Data Hold following HWE#     | th (HD)        | 30     |      | 15     |      | 10     |      | 10    |      |
| HWE# Pulse Width             | tw (HWE)       | 150    |      | 70     |      | 60     |      | 55    |      |
| Address Setup Time           | tsu (HA)       | 30     |      | 15     |      | 10     |      | 10    |      |
| CE# Setup before HWE#        | tsu (CE#)      | 5      |      | 5      |      | 5      |      | 5     |      |
| Write Recovery Time          | trec (HWE)     | 30     |      | 15     |      | 15     |      | 15    |      |
| Address Hold Time            | th (HA)        | 20     |      | 15     |      | 15     |      | 15    |      |
| CE# Hold following HWE#      | th (CE#)       | 20     |      | 15     |      | 15     |      | 10    |      |
| Wait Delay falling from HWE# | tv (IORDY-HWE) |        | 35   |        | 35   |        | 35   |       | Na   |
| HWE# High from Wait Release  | tv (IORDY)     | 0      |      | 0      |      | 0      |      | Na    |      |
| Wait Width Time              | tw (IORDY)     |        | 350  |        | 350  |        | 350  |       | Na   |

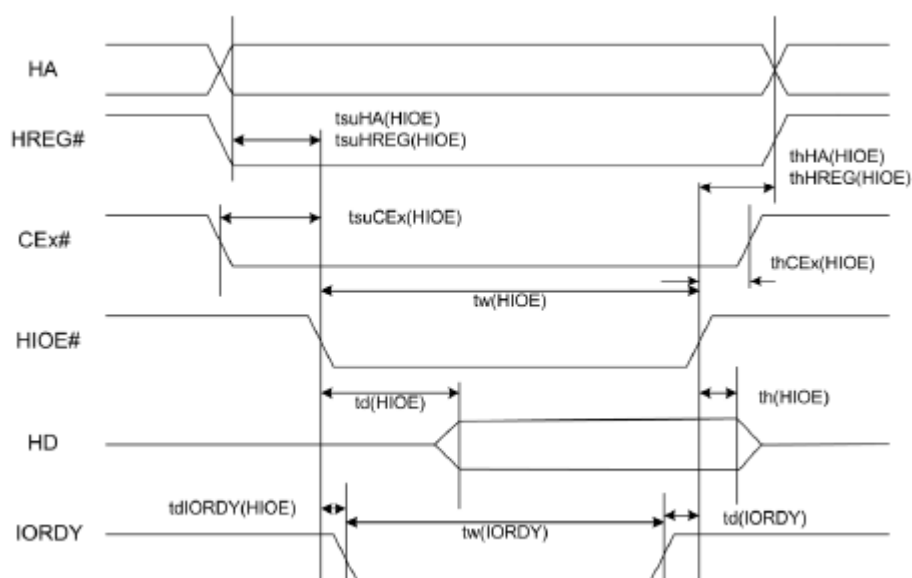
Note: IORDY is not supported in this 80 ns mode. The maximum load on IORDY is 1 LSTTL with a 50 pF (40 pF below 120 nsec cycle time) total load. All time intervals are in nanoseconds. HD refers to the data provided by the CompactFlash card to the system. The IORDY signal can be ignored when the HWE# cycle-to-cycle time is greater than the Wait Width Time. The Max Wait Width Time can be determined from the Card Information Structure (CIS). Although adhering to the PCM-CIA specification, the Wait Width Time is intentionally designed to be lower in this specification.



# I/O Read Timing

| Cycle Time Mode               |                | 250 ns |      | 120 ns |      | 100 ns |      | 80 ns |      |
|-------------------------------|----------------|--------|------|--------|------|--------|------|-------|------|
| Item                          | Symbol         | Min.   | Max. | Min.   | Max. | Min.   | Max. | Min.  | Max. |
| Data Delay after HIOE#        | td (HIOE)      |        | 100  |        | 50   |        | 50   |       | 45   |
| Data Hold following HIOE#     | th (HIOE)      | 0      |      | 5      |      | 5      |      | 5     |      |
| HIOE# Width Time              | tw (HIOE)      | 165    |      | 70     |      | 65     |      | 55    |      |
| Address Setup before HIOE#    | tsuHA (HIOE)   | 70     |      | 25     |      | 25     |      | 15    |      |
| Address Hold following HIOE#  | thHA (HIOE)    | 20     |      | 10     |      | 10     |      | 10    |      |
| CE# Setup before HIOE#        | tsuCE# (HIOE)  | 5      |      | 5      |      | 5      |      | 5     |      |
| CE# Hold following HIOE#      | thCE# (HIOE)   | 20     |      | 10     |      | 10     |      | 10    |      |
| HREG# Setup before HIOE#      | tsuHREG (HIOE) | 5      |      | 5      |      | 5      |      | 5     |      |
| HREG# Hold following HIOE#    | thHREG (HIOE)  | 0      |      | 0      |      | 0      |      | 0     |      |
| Wait Delay falling from HIOE# | tdIORDY (HIOE) |        | 35   |        | 35   |        | 35   |       | Na   |
| Data Delay from Wait Rising   | td (IORDY)     |        | 0    |        | 0    |        | 0    |       | na   |
| Wait Width Time               | tw (IORDY)     |        | 350  |        | 350  |        | 350  |       | Na   |

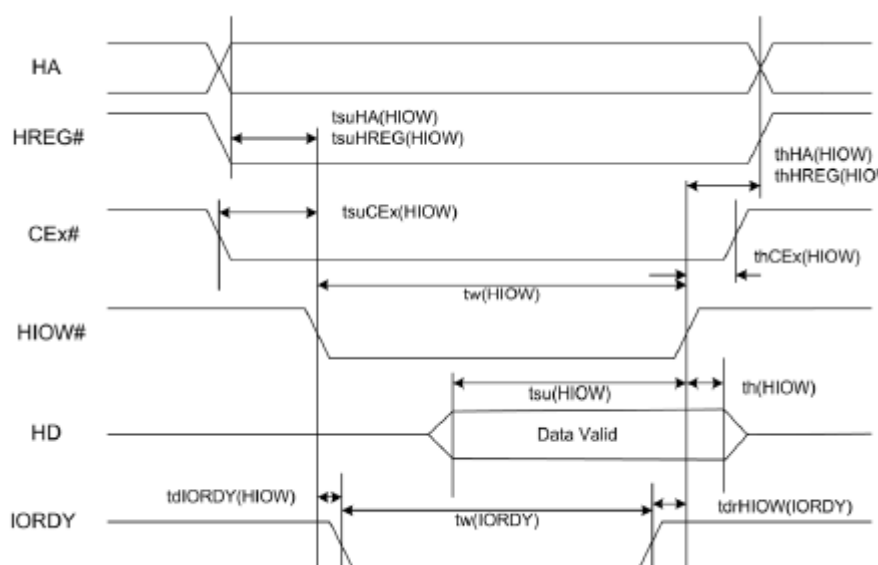
Note: IORDY is not supported in this 80 ns mode. Maximum load on IORDY is 1 LSTTL with a 50 pF (40 pF below 120 nsec cycle time) total load. All time intervals are in nanoseconds. Although minimum time from IORDY high to HIOE# high is 0 nsec, the minimum HIOE# width is still met. HD refers to data provided by the CompactFlash Card to the system. Although following PCMCIA specification, the Wait Width Time is intentionally lower in this specification.



# I/O Write Timing

| Cycle Time Mode                            |                             | 250 ns |      | 120 ns |      | 100 ns |      | 80 ns |      |
|--------------------------------------------|-----------------------------|--------|------|--------|------|--------|------|-------|------|
| Item                                       | Symbol                      | Min.   | Max. | Min.   | Max. | Min.   | Max. | Min.  | Max. |
| Data Setup before H <sub>IOW</sub> #       | tsu (H <sub>IOW</sub> )     | 60     |      | 20     |      | 20     |      | 15    |      |
| Data Hold following H <sub>IOW</sub> #     | th (H <sub>IOW</sub> )      | 30     |      | 10     |      | 5      |      | 5     |      |
| H <sub>IOW</sub> # Width Time              | tw (H <sub>IOW</sub> )      | 165    |      | 70     |      | 65     |      | 65    |      |
| Address Setup before H <sub>IOW</sub> #    | tsuHA (H <sub>IOW</sub> )   | 70     |      | 25     |      | 25     |      | 15    |      |
| Address Hold following H <sub>IOW</sub> #  | thHA (H <sub>IOW</sub> )    | 20     |      | 20     |      | 10     |      | 10    |      |
| CEx# Setup before H <sub>IOW</sub> #       | tsuCEX (H <sub>IOW</sub> )  | 5      |      | 5      |      | 5      |      | 5     |      |
| CEx# Hold following H <sub>IOW</sub> #     | thCEX (H <sub>IOW</sub> )   | 20     |      | 20     |      | 10     |      | 10    |      |
| HREG# Setup before H <sub>IOW</sub> #      | tsuHREG (H <sub>IOW</sub> ) | 5      |      | 5      |      | 5      |      | 5     |      |
| HREG# Hold following H <sub>IOW</sub> #    | thHREG (H <sub>IOW</sub> )  | 0      |      | 0      |      | 0      |      | 0     |      |
| Wait Delay falling from H <sub>IOW</sub> # | tdIORDY (H <sub>IOW</sub> ) |        | 35   |        | 35   |        | 35   |       | na   |
| H <sub>IOW</sub> # high from Wait High     | tdH <sub>IOW</sub> (IORDY)  | 0      |      | 0      |      | 0      |      | na    |      |
| Wait Width Time                            | tw (IORDY)                  |        | 350  |        | 350  |        | 350  |       | na   |

Note: IORDY is not supported in this 80 ns mode. The maximum load on IORDY is 1 LSTTL with a 50 pF (40 pF below 120 nsec cycle time) total load. All time intervals are in nanoseconds. Although minimum time from IORDY high to H<sub>IOW</sub># high is 0 nsec, the minimum H<sub>IOW</sub># width is still met. HD refers to data provided by the CompactFlash Card to the system.



● True IDE PIO Mode Read/Write Timing

| Item                                                                    | Symbol | Mode 0 | Mode 1 | Mode 2 | Mode 3 | Mode 4 | Mode 5 | Mode 6 |
|-------------------------------------------------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|
| Cycle Time (Min.)                                                       | t0     | 600    | 383    | 240    | 180    | 120    | 100    | 80     |
| Address Valid to HIOE# / HIOW# Setup (Min.)                             | t1     | 70     | 50     | 30     | 30     | 25     | 15     | 10     |
| HIOE# / HIOW# (Min.)                                                    | t2     | 165    | 125    | 100    | 80     | 70     | 65     | 55     |
| HIOE# / HIOW# (Min.) Register (8-bit)                                   | t2     | 290    | 290    | 290    | 80     | 70     | 65     | 55     |
| HIOE# / HIOW# Recovery Time (Min.)                                      | t2i    | -      | -      | -      | 70     | 25     | 25     | 20     |
| HIOW# Data Setup (Min.)                                                 | t3     | 60     | 45     | 30     | 30     | 20     | 20     | 15     |
| HIOW# Data Hold (Min.)                                                  | t4     | 30     | 20     | 15     | 10     | 10     | 5      | 5      |
| HIOE# Data Setup (Min.)                                                 | t5     | 50     | 35     | 20     | 20     | 20     | 15     | 10     |
| HIOE# Data Hold (Min.)                                                  | t6     | 5      | 5      | 5      | 5      | 5      | 5      | 5      |
| HIOE# Data Tristate (Max.)                                              | t6Z    | 30     | 30     | 30     | 30     | 30     | 20     | 20     |
| Address Valid to IOCS16# Assertion (Max.)                               | t7     | 90     | 50     | 40     | n/a    | n/a    | n/a    | n/a    |
| Address Valid to IOCS16# released (Max.)                                | t8     | 60     | 45     | 30     | n/a    | n/a    | n/a    | n/a    |
| HIOE# / HIOW# to Address Valid Hold                                     | t9     | 20     | 15     | 10     | 10     | 10     | 10     | 10     |
| Read Data Valid to IORDY Active (Min.), if IORDY initially low after tA | tRD    | 0      | 0      | 0      | 0      | 0      | 0      | 0      |
| IORDY Setup Time                                                        | tA     | 35     | 35     | 35     | 35     | 35     | Na     | Na     |
| IORDY Pulse Width (Max.)                                                | tB     | 1250   | 1250   | 1250   | 1250   | 1250   | Na     | Na     |
| IORDY Assertion to Release (Max.)                                       | tC     | 5      | 5      | 5      | 5      | 5      | Na     | Na     |

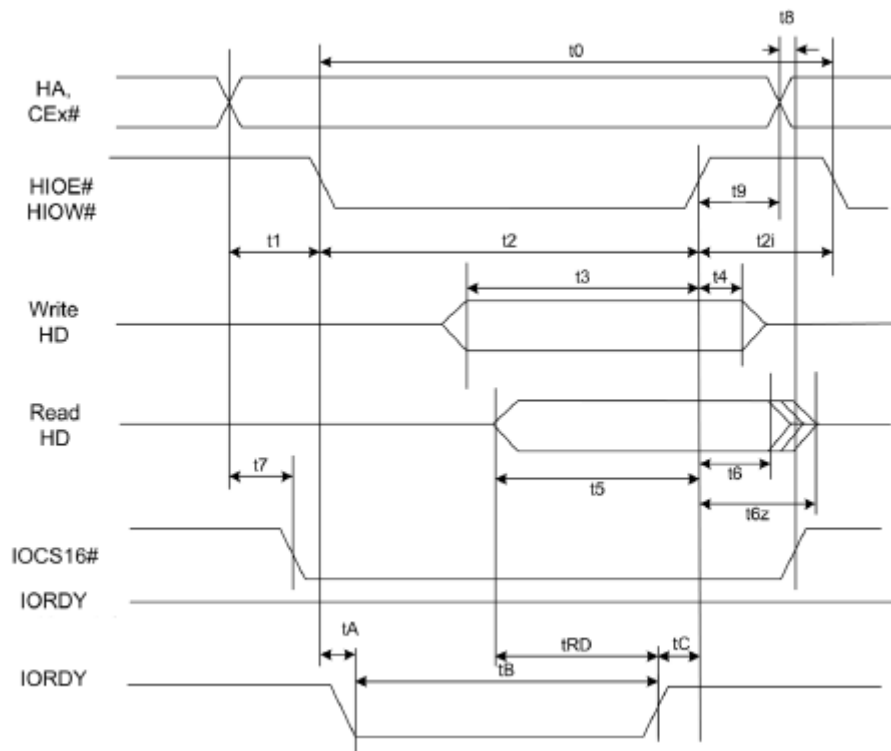
\*All timing intervals are measured in nanoseconds. The maximum load on IOCS16# is 1 LSTTL with a 50 pF (40 pF below 120 nsec cycle time) total load. All time intervals are in nanoseconds. Although minimum time from IORDY high to HIOE# high is 0 nsec, the minimum HIOE# width is still met.

Where t0 denotes the minimum total cycle time; t2 represents the minimum command active time; t2i is the minimum command recovery time or command inactive time. Actual cycle time equals to the sum of actual command active time and actual command inactive time. The three timing requirements for t0, t2, and t2i are met. The minimum total cycle time requirement is greater than the sum of t2 and t2i, implying that a host implementation can extend either or both t2 or t2i to ensure that t0 is equal to or greater than the value reported in the device identity data. A CompactFlash card implementation supports any legal host implementation.

The delay originates from HIOW# or HIOE# activation until the state of IORDY is first sampled. If IORDY is inactive, the host waits until IORDY is active before the PIO cycle is completed. When the CompactFlash Card is not driving IORDY, which is negated at tA after HIOE# or HIOW# activation, then t5 is met and tRD is inapplicable. When the CompactFlash Card is driving IORDY, which is negated at the time tA after HIOE# or HIOW# activation, then tRD is met and t5 is inapplicable.

Both t7 and t8 apply to modes 0, 1, and 2 only. For other modes, the signal is invalid.

IORDY is not supported in this mode.



Device address comprises CE1#, CE2#, and HA[2:0]

Data comprises HD[15:0] (16-bit) or HD[7:0] (8-bit)

IOCS16# is shown for PIO modes 0, 1, and 2. For other modes, the signal is ignored.

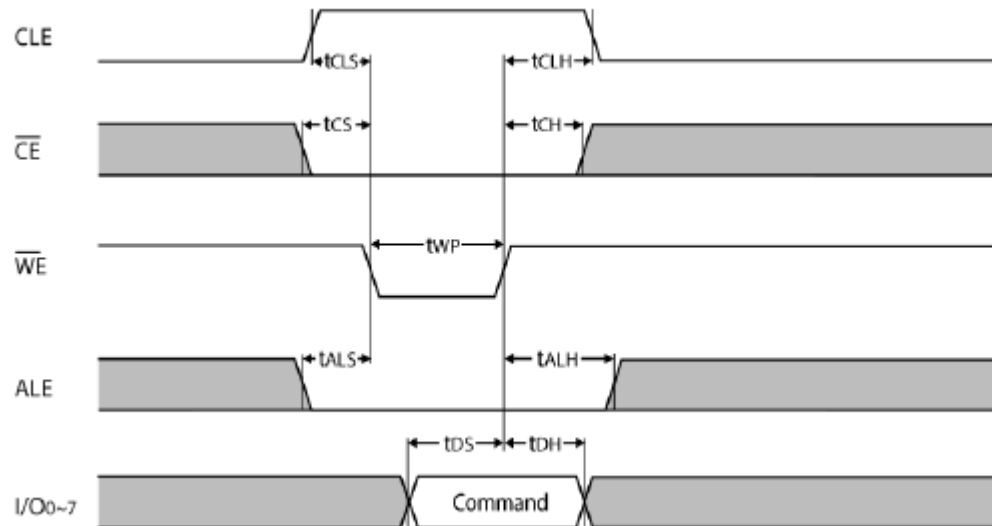
The negation of IORDY by the device is used to lengthen the PIO cycle. Whether the cycle is to be extended is determined by the host after  $t_A$  from the assertion of HIOE# or HIOW#. The assertion and negation of IORDY is described in the following cases. First, the device never negates IORDY, so no wait is generated. Secondly, device drives IORDY low before  $t_A$ . Thus, wait is generated. The cycle is completed after IORDY is re-asserted. For cycles in which a wait is generated and HIOE# is asserted, the device places read data on D15-D00 for  $t_{RD}$  before IORDY is asserted.

● Flash Interface AC Characteristics

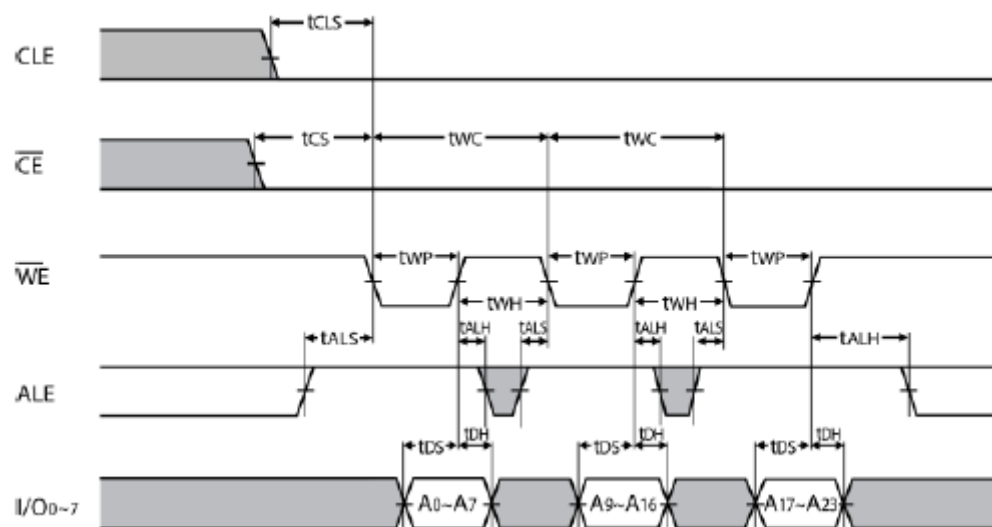
| Parameter         | Symbol | Timing                   |                         | Unit |
|-------------------|--------|--------------------------|-------------------------|------|
|                   |        | Disable Flash CMD Extend | Enable Flash CMD Extend |      |
| CLE Setup time    | tCLS   | 2                        | 4                       | tCK  |
| CLE hold time     | tCLH   | 1                        | 2                       | tCK  |
| ALE setup time    | tALS   | 2                        | 4                       | tCK  |
| ALE hold time     | tALH   | 1                        | 2                       | tCK  |
| WE pulse width    | tWP    | 1                        | 2                       | tCK  |
| Data setup time   | tDS    | 1                        | 3                       | tCK  |
| Data hold time    | tDH    | 1                        | 1                       | tCK  |
| Write cycle time  | tWC    | 2                        | 4                       | tCK  |
| WE high hold time | tWH    | 1                        | 2                       | tCK  |
| WE Low hold time  | tWP    | 1                        | 2                       | tCK  |

| Parameter         | Symbol | Timing | Unit |
|-------------------|--------|--------|------|
| WE Pulse Width    | tWP    | 0.5    | tCK  |
| Data setup time   | tDS    | 0.75   | tCK  |
| Data hold time    | tDH    | 0.25   | tCK  |
| Write cycle time  | tWC    | 1      | tCK  |
| WE high hold time | tWH    | 0.5    | tCK  |
| WE pulse width    | tWP    | 0.5    | tCK  |
| Read cycle time   | tRC    | 1      | tCK  |
| RE Pulse Width    | tRP    | 0.5    | tCK  |
| RE High Hold Time | tREH   | 0.5    | tCK  |

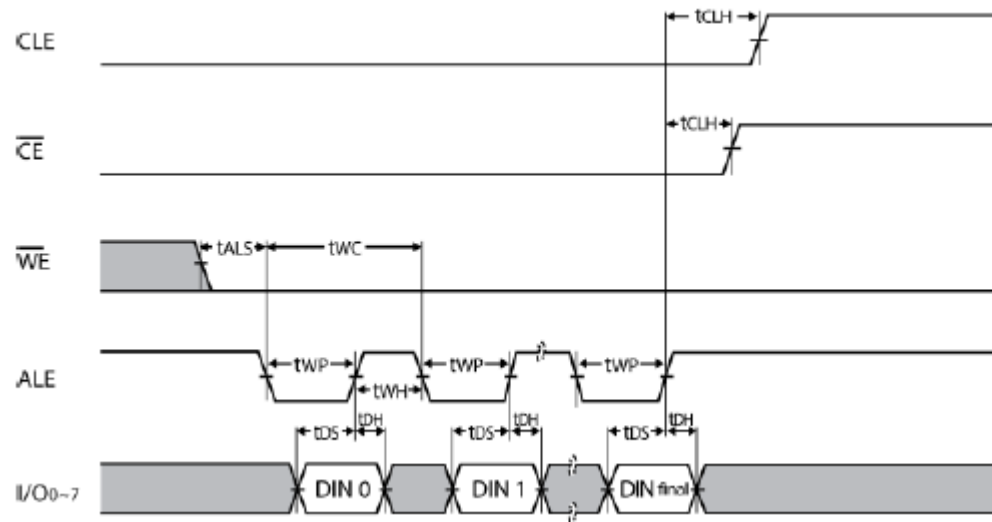
- Command Latch Cycle



- Address Latch Cycle



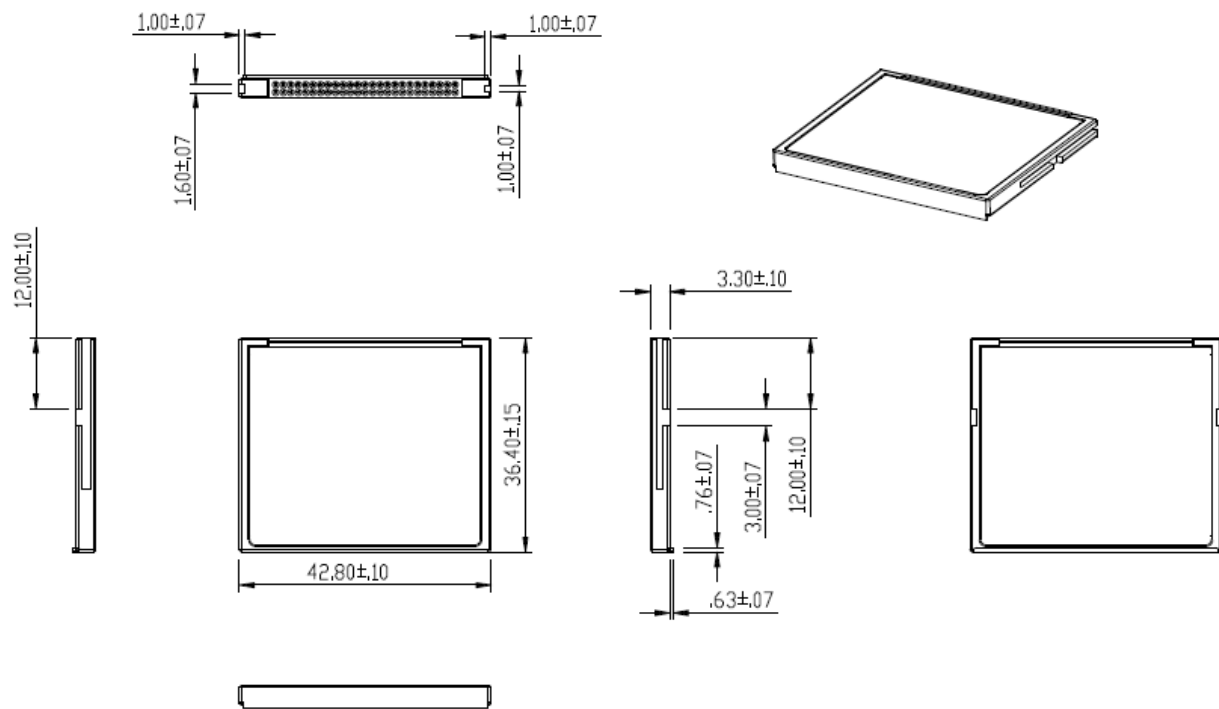
- Input Data Latch Cycle



## 7. Physical Characteristics

## 7.1 Dimensions

### 7.1.1 Without Write Protect Switch



### Figure 7-1 Physical Dimensions

Unit: mm

## 7.1.2 With Write Protect Switch

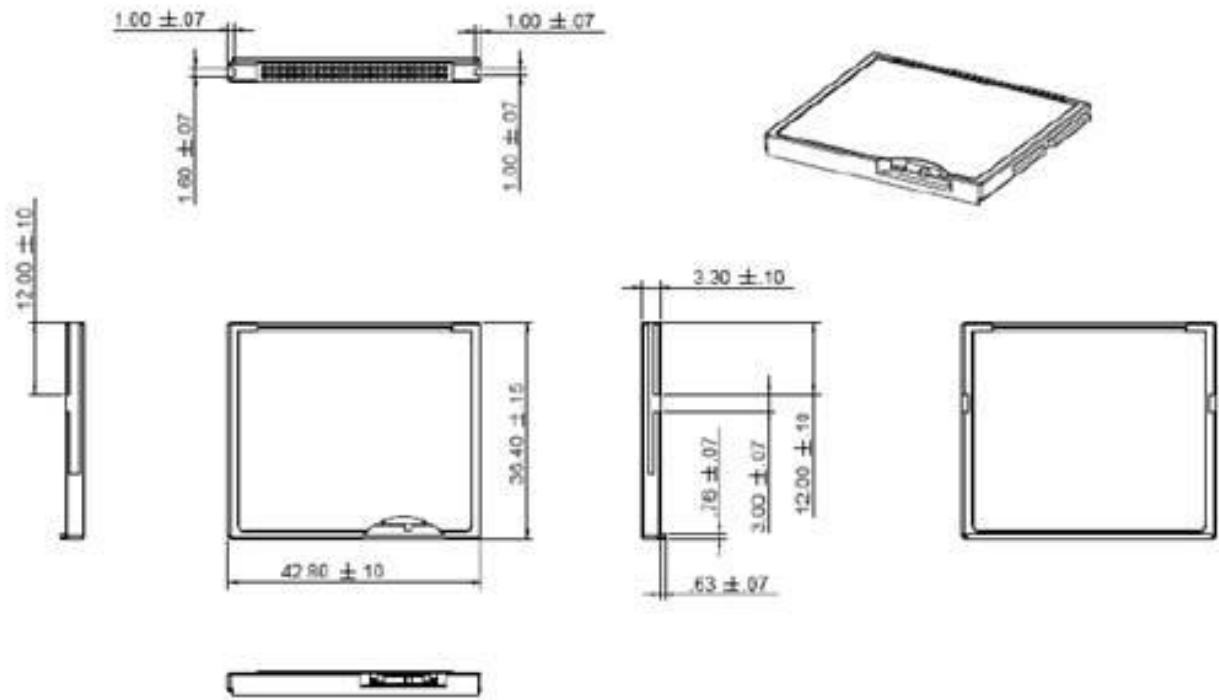
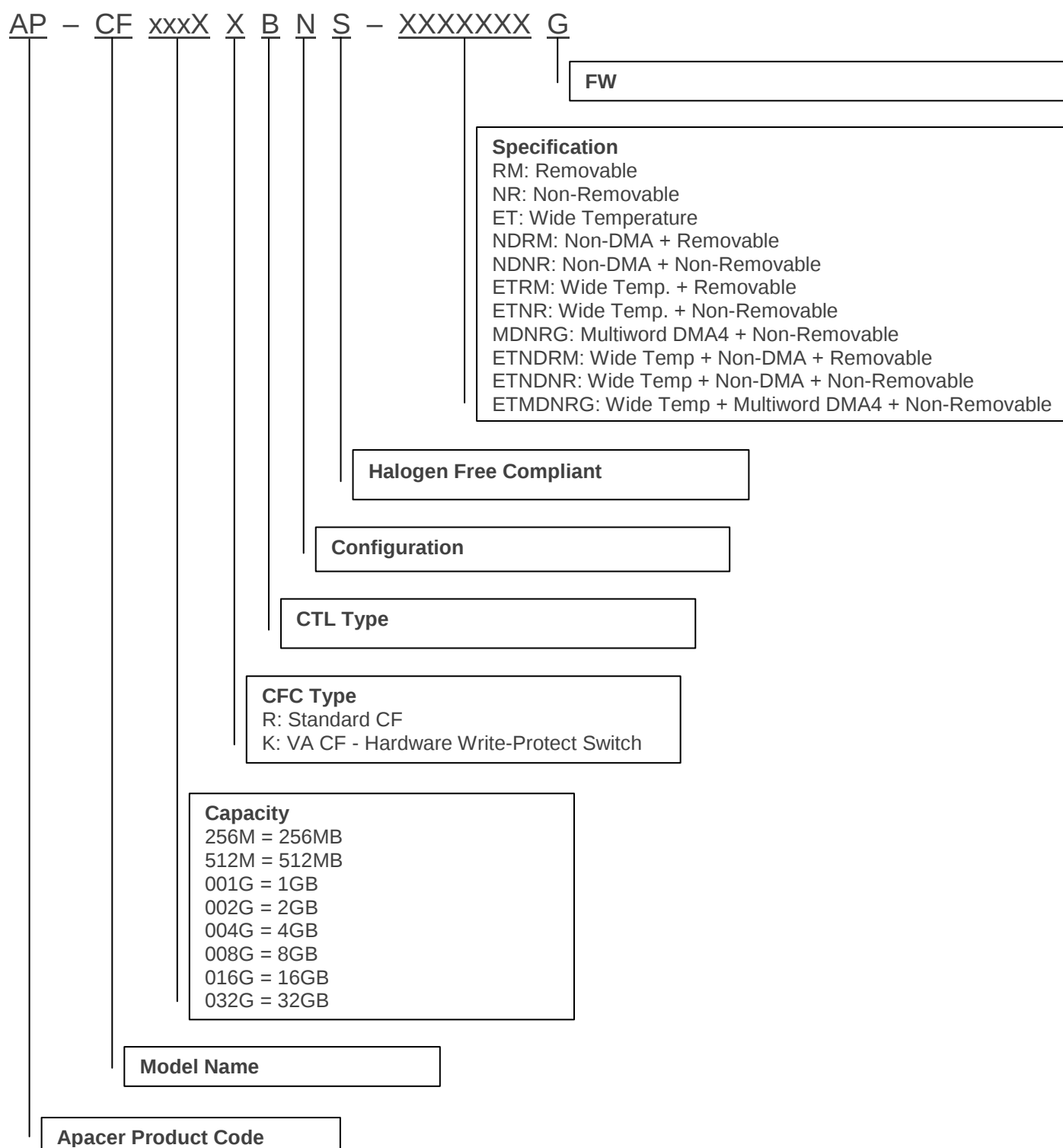


Figure 7-2 Physical Dimensions

Unit: mm

## 8. Product Ordering Information

### 8.1 Product Code Designations



## 8.2 Valid Combinations

### A. Standard CF - Standard Temperature

#### 8.2.1 Non-Removable

| Capacity | Part Number       |
|----------|-------------------|
| 256MB    | AP-CF256MRBNS-NRG |
| 512MB    | AP-CF512MRBNS-NRG |
| 1GB      | AP-CF001GRBNS-NRG |
| 2GB      | AP-CF002GRBNS-NRG |
| 4GB      | AP-CF004GRBNS-NRG |
| 8GB      | AP-CF008GRBNS-NRG |
| 16GB     | AP-CF016GRBNS-NRG |
| 32GB     | AP-CF032GRBNS-NRG |

#### 8.2.2 Removable

| Capacity | Part Number       |
|----------|-------------------|
| 256MB    | AP-CF256MRBNS-RMG |
| 512MB    | AP-CF512MRBNS-RMG |
| 1GB      | AP-CF001GRBNS-RMG |
| 2GB      | AP-CF002RBNS-RMG  |
| 4GB      | AP-CF004GRBNS-RMG |
| 8GB      | AP-CF008GRBNS-RMG |
| 16GB     | AP-CF016GRBNS-RMG |
| 32GB     | AP-CF032GRBNS-RMG |

#### 8.2.3 Non-DMA + Non-Removable

| Capacity | Part Number         |
|----------|---------------------|
| 256MB    | AP-CF256MRBNS-NDNRG |
| 512MB    | AP-CF512MRBNS-NDNRG |
| 1GB      | AP-CF001GRBNS-NDNRG |
| 2GB      | AP-CF002GRBNS-NDNRG |
| 4GB      | AP-CF004GRBNS-NDNRG |
| 8GB      | AP-CF008GRBNS-NDNRG |
| 16GB     | AP-CF016GRBNS-NDNRG |
| 32GB     | AP-CF032GRBNS-NDNRG |

#### 8.2.4 Non-DMA + Removable

| Capacity | Part Number         |
|----------|---------------------|
| 256MB    | AP-CF256MRBNS-NDRMG |
| 512MB    | AP-CF512MRBNS-NDRMG |
| 1GB      | AP-CF001GRBNS-NDRMG |
| 2GB      | AP-CF002GRBNS-NDRMG |
| 4GB      | AP-CF004GRBNS-NDRMG |
| 8GB      | AP-CF008GRBNS-NDRMG |
| 16GB     | AP-CF016GRBNS-NDRMG |
| 32GB     | AP-CF032GRBNS-NDRMG |

#### 8.2.5 Multiword DMA4+ Non-Removable

| Capacity | Part Number         |
|----------|---------------------|
| 256MB    | AP-CF256MRBNS-MDNRG |
| 512MB    | AP-CF512MRBNS-MDNRG |
| 1GB      | AP-CF001GRBNS-MDNRG |
| 2GB      | AP-CF002GRBNS-MDNRG |
| 4GB      | AP-CF004GRBNS-MDNRG |
| 8GB      | AP-CF008GRBNS-MDNRG |
| 16GB     | AP-CF016GRBNS-MDNRG |
| 32GB     | AP-CF032GRBNS-MDNRG |

### B. Standard CF - Wide Temperature

#### 8.2.6 Non-Removable

| Capacity | Part Number         |
|----------|---------------------|
| 256MB    | AP-CF256MRBNS-ETNRG |
| 512MB    | AP-CF512MRBNS-ETNRG |
| 1GB      | AP-CF001GRBNS-ETNRG |
| 2GB      | AP-CF002GRBNS-ETNRG |
| 4GB      | AP-CF004GRBNS-ETNRG |
| 8GB      | AP-CF008GRBNS-ETNRG |
| 16GB     | AP-CF016GRBNS-ETNRG |
| 32GB     | AP-CF032GRBNS-ETNRG |

### 8.2.7 Removable

| Capacity | Part Number         |
|----------|---------------------|
| 256MB    | AP-CF256MRBNS-ETRMG |
| 512MB    | AP-CF512MRBNS-ETRMG |
| 1GB      | AP-CF001GRBNS-ETRMG |
| 2GB      | AP-CF002GRBNS-ETRMG |
| 4GB      | AP-CF004GRBNS-ETRMG |
| 8GB      | AP-CF008GRBNS-ETRMG |
| 16GB     | AP-CF016GRBNS-ETRMG |
| 32GB     | AP-CF032GRBNS-ETRMG |

### 8.2.8 Non-DMA + Non-Removable

| Capacity | Part Number           |
|----------|-----------------------|
| 256MB    | AP-CF256MRBNS-ETNDNRG |
| 512MB    | AP-CF512MRBNS-ETNDNRG |
| 1GB      | AP-CF001GRBNS-ETNDNRG |
| 2GB      | AP-CF002GRBNS-ETNDNRG |
| 4GB      | AP-CF004GRBNS-ETNDNRG |
| 8GB      | AP-CF008GRBNS-ETNDNRG |
| 16GB     | AP-CF016GRBNS-ETNDNRG |
| 32GB     | AP-CF032GRBNS-ETNDNRG |

### 8.2.9 Non-DMA + Removable

| Capacity | Part Number           |
|----------|-----------------------|
| 256MB    | AP-CF256MRBNS-ETNDRMG |
| 512MB    | AP-CF512MRBNS-ETNDRMG |
| 1GB      | AP-CF001GRBNS-ETNDRMG |
| 2GB      | AP-CF002GRBNS-ETNDRMG |
| 4GB      | AP-CF004GRBNS-ETNDRMG |
| 8GB      | AP-CF008GRBNS-ETNDRMG |
| 16GB     | AP-CF016GRBNS-ETNDRMG |
| 32GB     | AP-CF032GRBNS-ETNDRMG |

### 8.2.10 Multiword DMA4+ Non-Removable

| Capacity | Part Number           |
|----------|-----------------------|
| 256MB    | AP-CF256MRBNS-ETMDNRG |
| 512MB    | AP-CF512MRBNS-ETMDNRG |
| 1GB      | AP-CF001GRBNS-ETMDNRG |
| 2GB      | AP-CF002GRBNS-ETMDNRG |
| 4GB      | AP-CF004GRBNS-ETMDNRG |
| 8GB      | AP-CF008GRBNS-ETMDNRG |
| 16GB     | AP-CF016GRBNS-ETMDNRG |
| 32GB     | AP-CF032GRBNS-ETMDNRG |

## C. VA CF - Standard Temperature

### 8.2.11 Non- Removable

| Capacity | Part Number       |
|----------|-------------------|
| 256MB    | AP-CF256MKBNS-NRG |
| 512MB    | AP-CF512MKBNS-NRG |
| 1GB      | AP-CF001GKBNS-NRG |
| 2GB      | AP-CF002GKBNS-NRG |
| 4GB      | AP-CF004GKBNS-NRG |
| 8GB      | AP-CF008GKBNS-NRG |
| 16GB     | AP-CF016GKBNS-NRG |
| 32GB     | AP-CF032GKBNS-NRG |

### 8.2.12 Removable

| Capacity | Part Number       |
|----------|-------------------|
| 256MB    | AP-CF256MKBNS-RMG |
| 512MB    | AP-CF512MKBNS-RMG |
| 1GB      | AP-CF001GKBNS-RMG |
| 2GB      | AP-CF002RKBNS-RMG |
| 4GB      | AP-CF004GKBNS-RMG |
| 8GB      | AP-CF008GKBNS-RMG |
| 16GB     | AP-CF016GKBNS-RMG |
| 32GB     | AP-CF032GKBNS-RMG |

### 8.2.13 Non-DMA + Non-Removable

| Capacity | Part Number         |
|----------|---------------------|
| 256MB    | AP-CF256MKBNS-NDNRG |
| 512MB    | AP-CF512MKBNS-NDNRG |
| 1GB      | AP-CF001GKBNS-NDNRG |
| 2GB      | AP-CF002GKBNS-NDNRG |
| 4GB      | AP-CF004GKBNS-NDNRG |
| 8GB      | AP-CF008GKBNS-NDNRG |
| 16GB     | AP-CF016GKBNS-NDNRG |
| 32GB     | AP-CF032GKBNS-NDNRG |

### 8.2.14 Non-DMA + Removable

| Capacity | Part Number         |
|----------|---------------------|
| 256MB    | AP-CF256MKBNS-NDRMG |
| 512MB    | AP-CF512MKBNS-NDRMG |
| 1GB      | AP-CF001GKBNS-NDRMG |
| 2GB      | AP-CF002GKBNS-NDRMG |
| 4GB      | AP-CF004GKBNS-NDRMG |
| 8GB      | AP-CF008GKBNS-NDRMG |
| 16GB     | AP-CF016GKBNS-NDRMG |
| 32GB     | AP-CF032GKBNS-NDRMG |

### 8.2.15 Multiword DMA4+ Non-Removable

| Capacity | Part Number         |
|----------|---------------------|
| 256MB    | AP-CF256MKBNS-MDNRG |
| 512MB    | AP-CF512MKBNS-MDNRG |
| 1GB      | AP-CF001GKBNS-MDNRG |
| 2GB      | AP-CF002GKBNS-MDNRG |
| 4GB      | AP-CF004GKBNS-MDNRG |
| 8GB      | AP-CF008GKBNS-MDNRG |
| 16GB     | AP-CF016GKBNS-MDNRG |
| 32GB     | AP-CF032GKBNS-MDNRG |

## D. VA CF - Wide Temperature

### 8.2.16 Non-Removable

| Capacity | Part Number         |
|----------|---------------------|
| 256MB    | AP-CF256MKBNS-ETNRG |
| 512MB    | AP-CF512MKBNS-ETNRG |
| 1GB      | AP-CF001GKBNS-ETNRG |
| 2GB      | AP-CF002GKBNS-ETNRG |
| 4GB      | AP-CF004GKBNS-ETNRG |
| 8GB      | AP-CF008GKBNS-ETNRG |
| 16GB     | AP-CF016GKBNS-ETNRG |
| 32GB     | AP-CF032GKBNS-ETNRG |

### 8.2.17 Removable

| Capacity | Part Number         |
|----------|---------------------|
| 256MB    | AP-CF256MKBNS-ETRMG |
| 512MB    | AP-CF512MKBNS-ETRMG |
| 1GB      | AP-CF001GKBNS-ETRMG |
| 2GB      | AP-CF002GKBNS-ETRMG |
| 4GB      | AP-CF004GKBNS-ETRMG |
| 8GB      | AP-CF008GKBNS-ETRMG |
| 16GB     | AP-CF016GKBNS-ETRMG |
| 32GB     | AP-CF032GKBNS-ETRMG |

### 8.2.18 Non-DMA + Non-Removable

| Capacity | Part Number           |
|----------|-----------------------|
| 256MB    | AP-CF256MKBNS-ETNDNRG |
| 512MB    | AP-CF512MKBNS-ETNDNRG |
| 1GB      | AP-CF001GKBNS-ETNDNRG |
| 2GB      | AP-CF002GKBNS-ETNDNRG |
| 4GB      | AP-CF004GKBNS-ETNDNRG |
| 8GB      | AP-CF008GKBNS-ETNDNRG |
| 16GB     | AP-CF016GKBNS-ETNDNRG |
| 32GB     | AP-CF032GKBNS-ETNDNRG |

### 8.2.19 Non-DMA + Removable

| Capacity | Part Number           |
|----------|-----------------------|
| 256MB    | AP-CF256MKBNS-ETNDRMG |
| 512MB    | AP-CF512MKBNS-ETNDRMG |
| 1GB      | AP-CF001GKBNS-ETNDRMG |
| 2GB      | AP-CF002GKBNS-ETNDRMG |
| 4GB      | AP-CF004GKBNS-ETNDRMG |
| 8GB      | AP-CF008GKBNS-ETNDRMG |
| 16GB     | AP-CF016GKBNS-ETNDRMG |
| 32GB     | AP-CF032GKBNS-ETNDRMG |

### 8.2.20 Multiword DMA4+ Non-Removable

| Capacity | Part Number           |
|----------|-----------------------|
| 256MB    | AP-CF256MKBNS-ETMDNRG |
| 512MB    | AP-CF512MKBNS-ETMDNRG |
| 1GB      | AP-CF001GKBNS-ETMDNRG |
| 2GB      | AP-CF002GKBNS-ETMDNRG |
| 4GB      | AP-CF004GKBNS-ETMDNRG |
| 8GB      | AP-CF008GKBNS-ETMDNRG |
| 16GB     | AP-CF016GKBNS-ETMDNRG |
| 32GB     | AP-CF032GKBNS-ETMDNRG |

**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       |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 0.1      | Preliminary release                                                                                                                                                                                                                                                                                                                                         | 12/29/2016 |
| 1.0      | <ul style="list-style-type: none"> <li>- Added 256MB support</li> <li>- Updated power consumption @3.3V</li> <li>- Updated product ordering information</li> </ul>                                                                                                                                                                                          | 1/26/2017  |
| 1.1      | Updated CompactFlash Association Specification Revision 6.0 Standard Interface on Features page                                                                                                                                                                                                                                                             | 3/14/2017  |
| 1.2      | <ul style="list-style-type: none"> <li>- Added MTBF on Features page</li> <li>- Changed the description of <math>1.99 \times 10^6</math> hours to 2,000,000 hours at 4.4 Mean Time Between Failures (MTBF)</li> </ul>                                                                                                                                       | 7/21/2017  |
| 1.3      | <ul style="list-style-type: none"> <li>- Added product photos to cover page</li> <li>- Added Power Failure Management to Flash Management on Features page</li> <li>- Added 1.1.5 Power Failure Management</li> </ul>                                                                                                                                       | 9/22/2017  |
| 1.4      | Revised 4.1 Capacity                                                                                                                                                                                                                                                                                                                                        | 3/16/2018  |
| 1.5      | <ul style="list-style-type: none"> <li>- Changed "Features" to "Specifications Overview"</li> <li>- Modified total bytes of 1GB at 4.1 Capacity</li> </ul>                                                                                                                                                                                                  | 5/2/2018   |
| 1.6      | Updated 4.3 Environmental Specifications                                                                                                                                                                                                                                                                                                                    | 5/24/2018  |
| 1.7      | <ul style="list-style-type: none"> <li>- Updated wear-leveling algorithms at Flash Management on Specifications Overview page to Global Wear Leveling</li> <li>- Updated 1.1.2 Wear-Leveling Algorithms to Global Wear Leveling</li> </ul>                                                                                                                  | 9/3/2018   |
| 1.8      | <ul style="list-style-type: none"> <li>- Renamed extended temperature to wide temperature</li> <li>- Added SMART attribute ID list table to 1.1.3 S.M.A.R.T. Technology</li> <li>- Renamed Power Failure Management to DataDefender at Flash Management on Specifications Overview page and 1.1.5 section and updated the technology description</li> </ul> | 2/20/2019  |
| 1.9      | <ul style="list-style-type: none"> <li>- Added Endurance to Specifications Overview page</li> <li>- Added 4.6 Endurance</li> </ul>                                                                                                                                                                                                                          | 2/26/2019  |
| 2.0      | Updated total bytes and max LBA for 2-32GB at 4.1 Capacity                                                                                                                                                                                                                                                                                                  | 3/28/2019  |
| 2.1      | Removed DataDefender support and replaced it with Power Failure Management at Flash Management on Specifications Overview page and 1.1.5 section                                                                                                                                                                                                            | 7/16/2019  |
| 2.2      | Updated 8. Product Ordering Information by adding MDNRG and ETMDNRG to the specification code at 8.1 Product Code Designations                                                                                                                                                                                                                              | 8/22/2019  |

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