

***Halogen-free & RoHS Recast Compliant***

# **CompactFlash Series 6**

***Specifications for Industrial CompactFlash Card***

**January 30<sup>th</sup>, 2013**

*Version 1.0*



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## Features:

- **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 6
    - PCMCIA UDMA Mode 5
- **Capacities**
  - 16, 32, 64 GB
- **Performance\***
  - Sustained read: Up to 115 MB/sec
  - Sustained write: Up to 80 MB/sec
- **Intelligent ATA/IDE module**
  - Wear-leveling algorithms to substantially increase longevity of flash media
  - Built-in BCH ECC capable of correcting up to 72 bits in 1KB data
  - Supports S.M.A.R.T commands
- **NAND Flash Type: SLC**
- **Power Management**
- **Power Smart Design**
  - Built-in 1.2V Power-On-Reset
  - Built-in 2.7V Voltage detector for power fail protection
- **Temperature ranges**
  - 0°C to 70°C for operation (Standard)
  - -40°C to 85°C (extended temperature)
  - -40°C to 100°C for storage
- **Operating voltage for read and write**
  - 3.3 V
  - 5.0 V
- **Power consumption (typical)\***
  - Active mode: 265 mA
  - Standby mode: 1 mA
- **Connector Type**
  - 50 pins female
- **Physical Dimensions**
  - 36.4mm x 42.8mm x 3.3mm
- **Halogen free**
- **RoHS Recast Compliant**
  - Complies with 2011/65/EU

\*Performance and power consumption may vary depending on capacities, flash configuration or host system settings.

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## Table of Contents

|  |           |
|--|-----------|
| <b>1. GENERAL DESCRIPTION .....</b>          | <b>3</b>  |
| 1.1 PERFORMANCE-OPTIMIZED CONTROLLER .....   | 3         |
| 1.1.1 Power Management .....                 | 3         |
| 1.1.2 RAM .....                              | 3         |
| 1.1.3 Error Correction Code (ECC) .....      | 3         |
| 1.2 INTELLIGENT ENDURANCE DESIGN .....       | 3         |
| 1.2.1 Wear-leveling algorithms .....         | 3         |
| 1.2.2 S.M.A.R.T. Technology .....            | 4         |
| 1.2.3 Flash Block Management .....           | 4         |
| 1.2.4 Power Failure Management .....         | 4         |
| <b>2. FUNCTIONAL BLOCK .....</b>             | <b>5</b>  |
| <b>3. PIN ASSIGNMENTS .....</b>              | <b>6</b>  |
| <b>4. PRODUCT SPECIFICATION .....</b>        | <b>8</b>  |
| 4.1 CAPACITY .....                           | 8         |
| 4.2 PERFORMANCE .....                        | 8         |
| 4.3 ENVIRONMENTAL SPECIFICATIONS .....       | 8         |
| 4.4 CERTIFICATION & COMPLIANCE .....         | 9         |
| <b>5. SOFTWARE INTERFACE .....</b>           | <b>10</b> |
| 5.1 CF-ATA COMMAND SET .....                 | 10        |
| <b>6. OPERATING CONDITIONS .....</b>         | <b>12</b> |
| <b>7. PHYSICAL CHARACTERISTICS .....</b>     | <b>13</b> |
| 7.1 DIMENSION .....                          | 13        |
| <b>8. PRODUCT ORDERING INFORMATION .....</b> | <b>14</b> |
| 8.1 PRODUCT CODE DESIGNATIONS .....          | 14        |

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

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 Performance-Optimized Controller

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The CompactFlash Card Controller translates standard CF signals into flash media data and control signals.

#### 1.1.1 Power Management

The controller unit of this CompactFlash is built with power management design that optimizes power utilization and voltage flow. It enhances the power efficiency of CompactFlash Card Controller by employing advanced circuit regulator technology.

#### 1.1.2 RAM

The controller is implemented with RAM as a data process to optimize data transfer between the host and the flash media.

#### 1.1.3 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.

### 1.2 Intelligent Endurance Design

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#### 1.2.1 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.

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### **1.2.2 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.

### **1.2.3 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.

### **1.2.4 Power Failure Management**

Power Failure Management plays a crucial role when experiencing unstable power supply. Power disruption may occur when users are storing data into the SSD. In this urgent situation, the controller would run multiple write-to-flash cycles to store the metadata for later block rebuilding. This urgent operation requires about several milliseconds to get it done. At the next power up, the firmware will perform a status tracking to retrieve the mapping table and resume previously programmed NAND blocks to check if there is any incompleteness of transmission.

## 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 (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 <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            |

# Compact Flash 6 series

## AP-CFxxxxRAXS-XXXXXX



**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 <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          |
| 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 specification of the Compact Flash Card series (CFC) 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 <sup>1</sup> | Cylinders | Heads | Sectors | Max LBA     |
|----------|--------------------------|-----------|-------|---------|-------------|
| 16GB     | 16,391,340,032           | 16,383    | 16    | 63      | 32,014,336  |
| 32GB     | 32,019,316,736           | 16,383    | 16    | 63      | 62,537,728  |
| 64 GB    | 64,030,244,864           | 16,383    | 16    | 63      | 125,059,072 |

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                      | 16 GB | 32 GB | 64 GB |
|-------------------------------|-------|-------|-------|
| <b>Performance</b>            |       |       |       |
| <b>Sustained read (MB/s)</b>  | 110   | 110   | 115   |
| <b>Sustained write (MB/s)</b> | 65    | 75    | 80    |

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

### 4.3 Environmental Specifications

Environmental specification of the Compact Flash Card series (CFC) which 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 (Extended Temperature) |
|                           | Storage -40°C to 100°C                                      |
| Humidity                  | 5% to 95% RH (Non-condensing)                               |
| Vibration (Non-Operating) | Sine wave : 10~2000Hz, 15G (X, Y, Z axes)                   |
| Shock (Non-Operating)     | Half sine wave 1,500G (X, Y, Z ; All 6 axes)                |

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## 4.4 Certification & Compliance

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The CompactFlash card complies with the following global standards:

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

## 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          |

# Compact Flash 6 series

## AP-CFxxxxRAXS-XXXXXX



|                                 |                                  |     |              |
|---------------------------------|----------------------------------|-----|--------------|
| 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. Operating Conditions

Table 6-1: Operating range

| Parameters             | Range           |
|------------------------|-----------------|
| Ambient temperature    | 0°C to 70°C     |
| Extended temperature   | -40°C to 85°C   |
| Supply voltage at 3.3V | 3.135 ~ 3.465 V |
| Supply voltage at 5V   | 4.75 ~ 5.25 V   |

Table 6-2: Power consumption (typical)

| Mode \ Capacity | 16 GB | 32 GB | 64 GB |
|-----------------|-------|-------|-------|
| Active (mA)     | 245   | 250   | 265   |
| Stand By (mA)   | 1     | 1     | 1     |

Note: Power consumptions may vary depending on settings and platforms

## 7. Physical Characteristics

### 7.1 Dimension



FIGURE 7-1: Physical dimension

Unit: mm

## 8. Product Ordering Information

### 8.1 Product Code Designations

**A P - C F x x x x R A X S - X X X X X X**

**Specification**

RM: Removable  
 NR: Non-Removable  
 ET: Extended Temperature  
 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

**Halogen Free Compliant**

**Configuration**

E : Single Channel  
 F : Dual Channel

**CTL Type**

**CFC Type**

**Capacities:**

|      |      |
|------|------|
| 016G | 16GB |
| 032G | 32GB |
| 064G | 64GB |

**Model Name**

**Apacer Product Code**

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## 8.2 Valid Combinations

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### 8.2.1 Standard Temperature

#### 8.2.1.1 Non-Removable

| <i>Capacity</i> | <i>AP/N</i>      |
|-----------------|------------------|
| 16GB            | AP-CF016GRAFS-NR |
| 32GB            | AP-CF032GRAFS-NR |
| 64GB            | AP-CF064GRAFS-NR |

#### 8.2.1.2 Removable

| <i>Capacity</i> | <i>AP/N</i>      |
|-----------------|------------------|
| 16GB            | AP-CF016GRAFS-RM |
| 32GB            | AP-CF032GRAFS-RM |
| 64GB            | AP-CF064GRAFS-RM |

#### 8.2.1.3 Non-DMA + Removable

| <i>Capacity</i> | <i>AP/N</i>        |
|-----------------|--------------------|
| 16GB            | AP-CF016GRAFS-NDRM |
| 32GB            | AP-CF032GRAFS-NDRM |
| 64GB            | AP-CF064GRAFS-NDRM |

#### 8.2.1.4 Non-DMA + Non-Removable

| <i>Capacity</i> | <i>AP/N</i>        |
|-----------------|--------------------|
| 16GB            | AP-CF016GRAFS-NDNR |
| 32GB            | AP-CF032GRAFS-NDNR |
| 64GB            | AP-CF064GRAFS-NDNR |



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## 8.2.2 Extended Temperature

### 8.2.2.1 Ext. Temp. + Non-Removable

| <b>Capacity</b> | <b>AP/N</b>        |
|-----------------|--------------------|
| 16GB            | AP-CF016GRAFS-ETNR |
| 32GB            | AP-CF032GRAFS-ETNR |
| 64GB            | AP-CF064GRAFS-ETNR |

### 8.2.2.2 Ext. Temp. + Removable

| <b>Capacity</b> | <b>AP/N</b>        |
|-----------------|--------------------|
| 16GB            | AP-CF016GRAFS-ETRM |
| 32GB            | AP-CF032GRAFS-ETRM |
| 64GB            | AP-CF064GRAFS-ETRM |

### 8.2.2.3 Non-DMA + Removable

| <b>Capacity</b> | <b>AP/N</b>          |
|-----------------|----------------------|
| 16GB            | AP-CF016GRAFS-ETNDRM |
| 32GB            | AP-CF032GRAFS-ETNDRM |
| 64GB            | AP-CF064GRAFS-ETNDRM |

### 8.2.2.4 Non-DMA + Non-Removable

| <b>Capacity</b> | <b>AP/N</b>          |
|-----------------|----------------------|
| 16GB            | AP-CF016GRAFS-ETNDNR |
| 32GB            | AP-CF032GRAFS-ETNDNR |
| 64GB            | AP-CF064GRAFS-ETNDNR |

**Note:** Please consult with Apacer sales representatives for availabilities.

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## Revision History

| Revision | Date       | Description      | Remark |
|----------|------------|------------------|--------|
| 1.0      | 01/30/2013 | Official release |        |

Компания «Океан Электроники» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Поставка оригинальных импортных электронных компонентов напрямую с производств Америки, Европы и Азии, а так же с крупнейших складов мира;
- Широкая линейка поставок активных и пассивных импортных электронных компонентов (более 30 млн. наименований);
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Помощь Конструкторского Отдела и консультации квалифицированных инженеров;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Поставка электронных компонентов под контролем ВП;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- При необходимости вся продукция военного и аэрокосмического назначения проходит испытания и сертификацию в лаборатории (по согласованию с заказчиком);
- Поставка специализированных компонентов военного и аэрокосмического уровня качества (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Actel, Aeroflex, Peregrine, VPT, Syfer, Eurofarad, Texas Instruments, MS Kennedy, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Компания «Океан Электроники» является официальным дистрибьютором и эксклюзивным представителем в России одного из крупнейших производителей разъемов военного и аэрокосмического назначения «JONHON», а так же официальным дистрибьютором и эксклюзивным представителем в России производителя высокотехнологичных и надежных решений для передачи СВЧ сигналов «FORSTAR».



## JONHON

«JONHON» (основан в 1970 г.)

Разъемы специального, военного и аэрокосмического назначения:

(Применяются в военной, авиационной, аэрокосмической, морской, железнодорожной, горно- и нефтедобывающей отраслях промышленности)

«FORSTAR» (основан в 1998 г.)

ВЧ соединители, коаксиальные кабели,  
кабельные сборки и микроволновые компоненты:

(Применяются в телекоммуникациях гражданского и специального назначения, в средствах связи, РЛС, а так же военной, авиационной и аэрокосмической отраслях промышленности).



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