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Compact Flash III series
AP-CFxxxxE3NR-XXXXXXQ

RoHS Compliant

Compact Flash Series III

Industrial CF Specifications

August 11th, 2013

Version 1.1



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Compact Flash III series

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Features:

- **Compact Flash Association Specification Revision 3.0 Standard Interface**
 - ATA command set compatible
 - ATA mode support for up to:
 - PIO Mode-6
 - Multiword DMA Mode-4
 - Ultra DMA Mode-4
- **Connector Type**
 - 50 pins female
- **Power consumption (typical)***
 - Supply voltage: 3.3V & 5V
 - Active mode: 80 mA/95 mA (3.3V/5.0V)
 - Sleep mode: 700 μ A/900 μ A (3.3V/5.0V)
- **Performance***
 - Sustained read: up to 29 MB/sec
 - Sustained write: up to 15 MB/sec
- **Capacity**
 - 128, 256, 512 MB
 - 1, 2, 4, 8, 16 GB
- **NAND Flash Type: SLC**
- **Shock & Vibration****
 - Shock: 1,500 G
 - Vibration: 15 G
- **Temperature ranges**
 - Operating:
 - Standard: 0°C to 70°C
 - Extended: -40°C to 85°C
 - Storage: -40°C to 100°C
- **Flash management**
 - Advanced wear-leveling algorithms
 - S.M.A.R.T. technology
 - Built-in hardware ECC
 - Flash block management
 - Power failure management
- **Endurance (TBW: Terabytes Written)**
 - 128 MB: 3.3 TBW
 - 256 MB: 6.7 TBW
 - 512 MB: 12.9 TBW
 - 1 GB: 25.6 TBW
 - 2 GB: 38.4 TBW
 - 4 GB: 51.9 TBW
 - 8 GB: 69.8 TBW
 - 16 GB: 115.0 TBW
- **Physical Dimensions**
 - 36.4mm x 42.8mm x 3.3mm
- **RoHS compliant**

*Varies from capacities. The values addressed for Performance and Power consumptions are typical and may vary depending on settings and platforms.

**Non-operating

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1. General Description

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

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

2. Functional Block

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

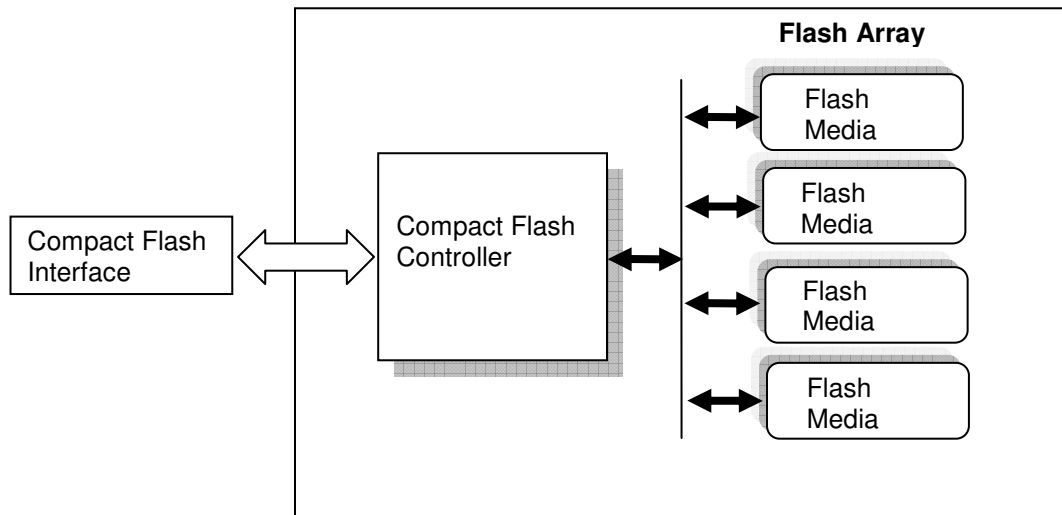


Figure 2-1: Functional block diagram

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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	#CE1	I
8	A10	I	A10	I	A10 ¹	I
9	#OE	I	#OE	I	#OE	I
10	A9	I	A9	I	A9 ¹	I
11	A8	I	A8	I	A8 ¹	I
12	A7	I	A7	I	A7 ¹	I
13	VCC	-	VCC	-	VCC	-
14	A6	I	A6	I	A6 ¹	I
15	A5	I	A5	I	A5 ¹	I
16	A4	I	A4	I	A4 ¹	I
17	A3	I	A3	I	A3 ¹	I
18	A2	I	A2	I	A2	I
19	A1	I	A1	I	A1	I
20	A0	I	A0	I	A0	I
21	D0	I/O	D0	I/O	D0	I/O
22	D1	I/O	D1	I/O	D1	I/O
23	D2	I/O	D2	I/O	D2	I/O
24	WP	O	#IOCS16	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	#CE2	I
33	#VS1	O	#VS1	O	#VS1	O
34	#IORD	I	#IORD	I	#IORD	I
35	#IOWR	I	#IOWR	I	#IOWR	I
36	#WE	I	#WE	I	#WE	I
37	RDY/-BSY	O	-IREQ	O	INTRQ	O
38	VCC	-	VCC	-	VCC	-
39	#CSEL	I	#CSEL	I	#CSEL	I
40	#VS2	O	#VS2	O	#VS2	O
41	RESET	I	RESET	I	RESET	I

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

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

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

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4. Product Specifications

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 ^{1,2}	Cylinders	Heads	Sectors	Max LBA
128 MB	128,450,560	980	8	32	250,880
256 MB	256,901,120	980	16	32	501,760
512 MB	512,483,328	993	16	63	1,000,944
1GB	1,024,966,656	1,986	16	63	2,001,888
2GB	2,048,901,120	3,970	16	63	4,001,760
4GB	4,110,188,544	7,964	16	63	8,027,712
8GB	8,195,604,480	15,880	16	63	16,007,040
16GB	16,391,208,960	16,383 ³	16	63	32,014,080

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 Specification

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

Table 4-2: Performance specifications

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

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

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4.3 Environmental Specifications

Environmental specification of the Compact Flash Card series (CFC) follows the MIL-STD-810F standards 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
Vibration (Non-Operation)		Sine wave : 10~2000Hz, 15G (X, Y, Z axes)
Shock (Non-Operation)		Half sine wave 1,500G (X, Y, Z ; All 6 axes)

4.5 Endurance

The endurance of a storage device is predicted by TeraBytes Written based on several factors related to usage, such as the amount of data written into the drive, block management conditions, and daily workload for the drive. Thus, key factors, such as Write Amplifications and the number of P/E cycles, can influence the lifespan of the drive.

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

Notes:

- The measurement assumes the data written to the SSD for test is under a typical and constant rate.
- The measurement follows the standard metric: 1 TB (Terabyte) = 1000 GB.

5. Flash Management

5.1. Advanced wear-leveling algorithms

Flash memory devices differ from Hard Disk Drives (HDDs) in terms of how blocks are utilized. For HDDs, when a change is made to stored data, like erase or update, the controller mechanism on HDDs will perform overwrites on blocks. Unlike HDDs, flash blocks cannot be overwritten and each P/E cycle wears down the lifespan of blocks gradually. Repeatedly program/erase cycles performed on the same memory cells will eventually cause some blocks to age faster than others. This would bring flash storages to their end of service term sooner. Wear leveling is an important mechanism that level out the wearing of blocks so that the wearing-down of blocks can be almost evenly distributed. This will increase the lifespan of SSDs. Commonly used wear leveling types are Static and Dynamic.

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

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

5.3 Built-in hardware ECC

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

5.4 Flash block management

Current production technology is unable to guarantee total reliability of NAND flash memory array. When a flash memory device leaves factory, it comes with a minimal number of initial bad blocks during production or out-of-factory as there is no currently known technology that produce flash chips free of bad blocks. In addition, bad blocks may develop during program/erase cycles. When host performs program/erase command on a block, bad block may appear in Status Register. Since bad blocks are inevitable, the solution is to keep them in control. Apacer flash devices are programmed with ECC, block mapping technique and S.M.A.R.T to reduce invalidity or error. Once bad blocks are detected, data in those blocks will be transferred to free blocks and error will be corrected by designated algorithms.

5.5 Power Failure Management

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

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6. Software Interface

6.1 Command Set

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

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

Command	Code
Check-Power-Mode	E5H or 98H
Execute-Drive-Diagnostic	90H
Erase Sector(s)	C0H
Flush-Cache	E7H
Format Track	50H
Identify-Drive	ECH
Idle	E3H or 97H
Idle-Immediate	E1H or 95H
Initialize-Drive-Parameters	91H
NOP	00H
Read-Buffer	E4H
Read-DMA	C8H or C9H
Read-Multiple	C4H
Read-Sector(s)	20H or 21H
Read-Verify-Sector(s)	40H or 41H
Recalibrate	1XH
Request-Sense	03H
Seek	7XH
Set-Features	EFH
SMART	B0H
Set-Multiple-Mode	C6H
Set-Sleep-Mode	E6H or 99H
Standby	E2H or 96H
Standby-Immediate	E0H or 94H
Translate-Sector	87H
Write-Buffer	E8H
Write-DMA	CAH or CBH
Write-Multiple	C5H
Write-Multiple-Without-Erase	CDH

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Write-Sector(s)	30H or 31H
Write-Sector-Without-Erase	38H
Write-Verify	3CH

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7. Electrical Specification

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

Table 7-1: Operating range

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

Table 7-2: Absolute maximum power pin stress ratings

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

Table 7-3: Recommended system power-up timing

Symbol	Parameter	Typical	Maximum	Units
T _{PU-READY} ¹	Power-up to Ready Operation	200	1000	ms
T _{PU-WRITE} ¹	Power-up to Write Operation	200	1000	ms

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

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8. Physical Characteristics

8.1 Dimension

TABLE 8-1: Type I CFC physical specification

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



Unit: mm

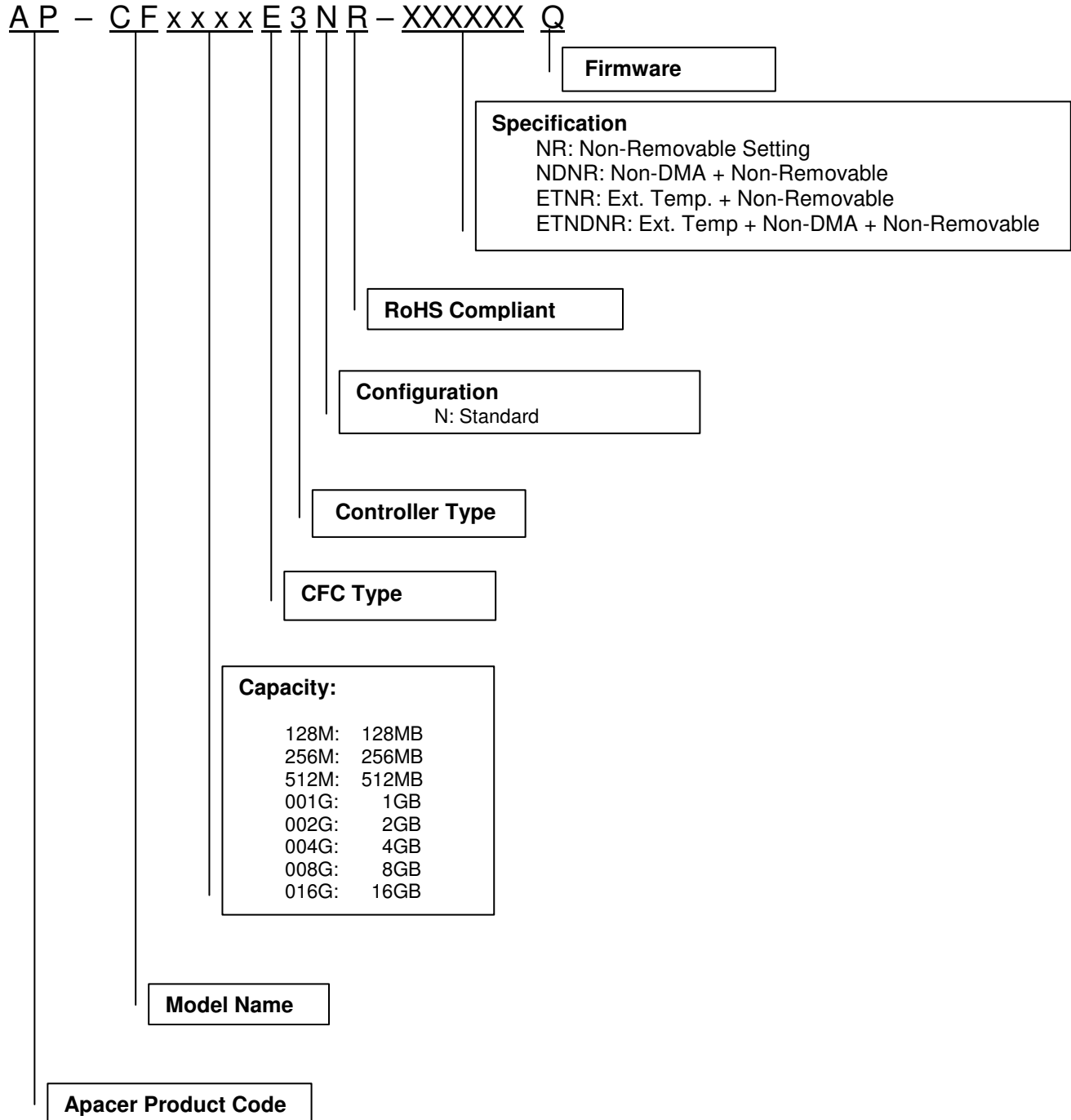
FIGURE 8-1: Physical dimension

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9. Product Ordering Information

9.1 Product Code Designations



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9.2 Valid Combinations

Standard Temperature

Non-Removable

Capacity	Model Number
128MB	AP-CF128ME3NR-NRQ
256MB	AP-CF256ME3NR-NRQ
512MB	AP-CF512ME3NR-NRQ
1GB	AP-CF001GE3NR-NRQ
2GB	AP-CF002GE3NR-NRQ
4GB	AP-CF004GE3NR-NRQ
8GB	AP-CF008GE3NR-NRQ
16GB	AP-CF016GE3NR-NRQ

Non-DMA & Non-Removable

Capacity	Model Number
128MB	AP-CF128ME3NR-NDNRQ
256MB	AP-CF256ME3NR-NDNRQ
512MB	AP-CF512ME3NR-NDNRQ
1GB	AP-CF001GE3NR-NDNRQ
2GB	AP-CF002GE3NR-NDNRQ
4GB	AP-CF004GE3NR-NDNRQ
8GB	AP-CF008GE3NR-NDNRQ
16GB	AP-CF016GE3NR-NDNRQ

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Extended Temperature

Non-Removable

Capacity	Model Number
128MB	AP-CF128ME3NR-ETNRQ
256MB	AP-CF256ME3NR-ETNRQ
512MB	AP-CF512ME3NR-ETNRQ
1GB	AP-CF001GE3NR-ETNRQ
2GB	AP-CF002GE3NR-ETNRQ
4GB	AP-CF004GE3NR-ETNRQ
8GB	AP-CF008GE3NR-ETNRQ
16GB	AP-CF016GE3NR-ETNRQ

Non-DMA & Non-Removable

Capacity	Model Number
128MB	AP-CF128ME3NR-ETNDNRQ
256MB	AP-CF256ME3NR-ETNDNRQ
512MB	AP-CF512ME3NR-ETNDNRQ
1GB	AP-CF001GE3NR-ETNDNRQ
2GB	AP-CF002GE3NR-ETNDNRQ
4GB	AP-CF004GE3NR-ETNDNRQ
8GB	AP-CF008GE3NR-ETNDNRQ
16GB	AP-CF016GE3NR-ETNDNRQ

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Revision History

Revision	Date	Description	Remark
1.0	05/19/2011	Official release	
1.1	08/11/2013	Updated performance and product ordering information due to change in NAND flash use Updated the address of Taiwan headquarter Added endurance TBW section to replace MTBF	

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Global Presence

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