

RoHS Compliant

Industrial CompactFlash Series 5 - WP

August 7, 2013

Revision 1.2

***This Specification Describes the Features and Capabilities of
the Industrial CompactFlash Cards***

***Please Contact Fortasa Sales for any Custom Features
Required For Your Specific Application***



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CompactFlash Card CF5 - WP

FMS-CFxxxxKXXS-XXXXXA



- **CompactFlash Association Specification 4.1 Compliant**

- ATA command set compatible
 - ATA mode support for up to:
 - PIO Mode-6
 - Multiword DMA Mode-4
 - Ultra DMA Mode-5

- **Connector Type**

- 50 pins female

- **Low power consumption (typical)**

- Supply voltage: 3.3V & 5V
- Active mode: 175 mA
- Sleep mode: 3 mA

- **Capacity**

128, 256, 512 MB
1, 2, 4, 8, 16, 32, 64 GB

- **Performance**

- Sustained read: Up to 55 MB/sec
- Sustained write: Up to 42 MB/sec

- **NAND flash type: SLC**

- **Superior Reliability Through Built-in Hardware ECC**

- Corrects up to 24 single-bit errors per 1,024-byte sector

- **Hardware Write Protect**

- Write Protect activated through hardware switch

- **Temperature ranges**

- Operation:
 - Standard Temperature: 0°C to 70°C
 - Industrial Temperature: -40°C to 85°C
- Storage: -40°C to 100°C

- **Flash management**

- Intelligent endurance design
 - Advanced wear-leveling algorithms*
 - S.M.A.R.T. Technology*
 - Enhanced Data Integrity*
- Intelligent power failure recovery

- **RoHS Compliant**

- **Endurance in Terrabytes Written (TBW)**

- 256 MB: 6.8 TBW
- 512 MB: 14.0 TBW
- 1 GB: 27.4 TBW
- 2 GB: 45.5 TBW
- 4 GB: 54.7 TBW
- 8 GB: 80.6 TBW
- 16 GB: 129.8 TBW
- 32 GB: 223.0 TBW
- 64 GB: 429.3 TBW

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1. General Description

Fortasa's Industrial CompactFlash Card 5 (CFC5) offers the highest reliability and performance storage solution critical to most demanding OEM customers.

Fortasa's CFC5 provides complete PCMCIA - ATA functionality and compatibility. CFC5 complies with CompactFlash specification revision 4.1, supporting transfer modes up to Programmed Input Output (PIO) Mode 6, Multiword Direct Memory Access (DMA) Mode 4, Ultra DMA Mode 5, and PCMCIA Ultra DMA Mode 5.

Fortasa's CompactFlash technology is designed for use in Point of Sale (POS) terminals, telecom, IP-STB, medical instruments, surveillance systems, industrial PCs and handheld applications. Featuring advanced technologies such as Advanced Wear-leveling algorithms, S.M.A.R.T, Enhanced Data Integrity, Built-in Hardware ECC, and Intelligent Power Failure Recovery, Fortasa's CompactFlash Card offers the most cost effective solution for most critical applications.

Offered in standard and industrial temperature range, Fortasa's CompactFlash card 5 product is the most cost effective and trustworthy solution in the OEM memory system.

2. Functional Block

The CompactFlash Card (CFC5) includes a controller and flash media, as well as the CompactFlash standard interface. Figure 2-1 shows the functional block diagram.

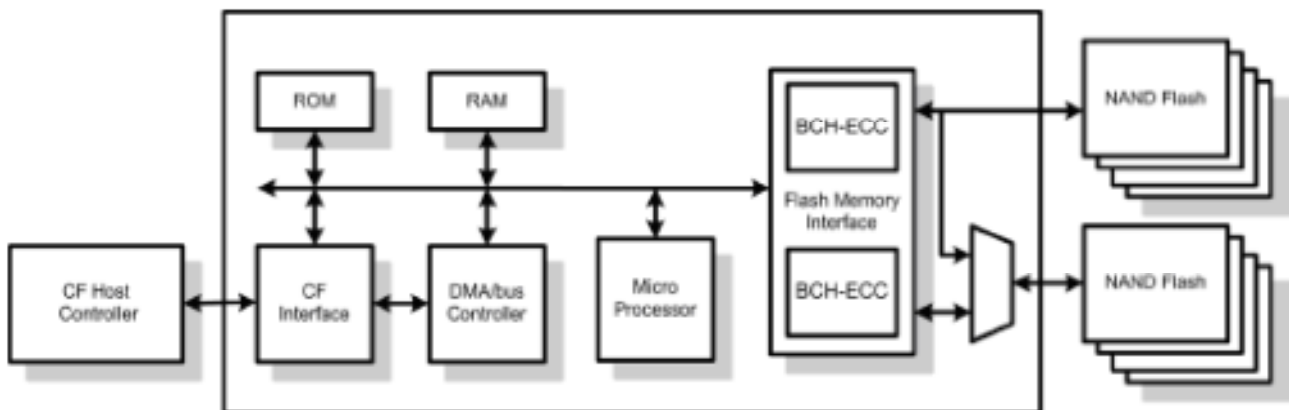


Figure 2-1: Functional Block Diagram

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 [†]	I
9	#OE	I	#OE	I	#ATA SEL	I
10	A9	I	A9	I	A9 [†]	I
11	A8	I	A8	I	A8 [†]	I
12	A7	I	A7	I	A7 [†]	I
13	VCC	-	VCC	-	VCC	-
14	A6	I	A6	I	A6 [†]	I
15	A5	I	A5	I	A5 [†]	I
16	A4	I	A4	I	A4 [†]	I
17	A3	I	A3	I	A3 [†]	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	#IOIS1e	O	#IOCS1e	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

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	!ORDY	O
43	#INPACK	O	#INPACK	O	DMARQ ²	O
44	#REG	I	#REG	I	DMACK ²	I
45	BVD2	O	#SPKR	O	#DASP	I/O
46	BVD1	O	#STSCHG	O	#PDIAG	I/O
47	D8	I/O	D8	I/O	D8	I/O
48	D9	I/O	D9	I/O	D9	I/O
49	D10	I/O	D10	I/O	D10	I/O
50	GND	-	GND	-	GND	-

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

4. Capacity Specification

Standard capacity specification of the CompactFlash Card products are shown in Table 4-1. The table lists the specific capacity and the default numbers of heads, sectors and cylinders (CHS) for each product line.

Table 4-1: Capacity specifications

Capacity	Total Bytes ^{1,2}	Cylinders	Heads	Sectors	Max LBA
128MB	128,450,560	980	8	32	250,880
256MB	256,901,120	980	16	32	501,760
512MB	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	16,391,340,032	16383 ³	16	63	32,014,336
32GB	32,019,316,736	16383 ³	16	63	62,537,728
64GB	64,030,244,864	16383 ³	16	63	125,059,072

1. Total bytes includes reserved system blocks.
2. Total bytes displayed varies depending on the operating system.
3. 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.

Please contact Fortasa Memory System Sales for any non-listed CompactFlash Card capacity or custom CHS requirement.

4.1 Performance Specification

Performance of the CompactFlash Card are listed in Table 4-2.

Table 4-2: Performance specifications

Performance \ Capacity	Capacity									
	128MB	256MB	512MB	1GB	2GB	4GB	8GB	16GB	32GB	64GB
Sustained read (MB/s)	21	24	47	45	55	55	55	48	57	50
Sustained write (MB/s)	6	6	22	19	25	35	42	38	27	26

4.2 Environmental Specifications

Environmental specification of the CompactFlash Card series follows the MIL-STD-810F standard as shown in Table 4-3.

Table 4-3: Environmental specifications

Environment		Specification
Temperature	Operation	0°C to 70°C (standard) / -40°C to 85°C (industrial)
	Storage	-40°C to 100°C
Vibration		Sine wave: 10~2000Hz, 15G (X, Y, Z axes)
Shock		Half sine wave, Peak acceleration 50 G, 11 ms (X, Y, Z ; All 6 axes)
Humidity		5% to 95% RH (Non-condensing)

4.3 Endurance

The endurance of a storage device is predicted by a JEDEC approved test methodology. The data, reported in TeraBytes Written, is based on several factors related to device architecture and product usage, such as the amount of data written into the drive, block management conditions, and daily workload for the drive. Please contact Sales to learn more about the TBW analysis and calculations.

Capacity	TBW
128MB	0.5
256MB	1.1
512MB	2.3
1GB	4.5
2GB	9.1
4GB	18.2
8GB	36.5
16GB	73.0
32GB	146.0
64GB	292.1

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

The most critical attribute of a Fortasa CompactFlash Card is its inherent high level of reliability. This characteristic is achieved through unique technical features of Flash Controller and specific component selection that offer higher degree of reliability compared to the consumer grade components.

5.1 Intelligent Flash Controller Features

5.1.1 Advanced wear-leveling algorithms

All NAND flash devices are limited by a finite number of write cycles. Under a standard file system, frequent file table updates are mandatory. As a painful side effect of OS file overhead, some areas of flash address space wear out faster than others. As these certain sections get a substantially higher write occurrence the whole CompactFlash card can wear out very quickly. This uneven wear would significantly reduce the lifetime of the whole device, even if majority of the Flash sectors are far from the write cycle limit. Fortasa's CompactFlash Card products offer advanced data wear leveling which distributes Flash writes evenly across the card memory space. By utilizing this advanced wear leveling feature, the lifetime of the media can be significantly extended.

5.1.2 S.M.A.R.T. technology

S.M.A.R.T. is an acronym for Self-Monitoring, Analysis and Reporting Technology, an open standard allowing disk drives to automatically monitor their own health and report potential problems. It protects the user from unscheduled downtime by monitoring and storing critical drive performance and calibration parameters. Ideally, this should allow taking proactive actions to prevent impending drive failure. Fortasa SMART feature adopts the conventional SMART command B0h to read data from the drive. By having the Fortasa SMART Utility running on the host, the system can monitor and analyze the CompactFlash card status and determine the end of useful life for a graceful and scheduled maintenance and replacement.

5.1.3 Built-in hardware ECC

The Fortasa Flash Controller uses superior BCH Error Detection Code (EDC) and Error Correction Code (ECC) algorithm which can correct up to 24-bit errors per 1,024 byte data. This built-in hardware ECC performs parity generation and error detection/correction for data integrity.

5.1.4 Enhanced data integrity

The properties of NAND flash memory make it ideal for applications that require high integrity while operating in challenging environments. The integrity of data to NAND flash memory is generally maintained through ECC algorithms and bad block management. Flash controllers can support up to 8 bits ECC capability for accuracy of data transactions, and bad block management is a preventive mechanism from loss of data by retiring unusable media blocks and relocating the data to the other blocks, along with the integration of advanced wear leveling algorithms, so that the lifespan of device can be expanded.

5.2 Intelligent Power Failure Recovery

The Low Power Detection on the Flash controller initiates cached data saving before the power supply to the device drops too low for operation. This feature prevents the device from system crash and ensures data integrity during an unexpected brownout. This feature makes sure that there are no catastrophic failures of the CompactFlash card due to system power glitches.

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

Command	Code	FR ¹	SC ²	SN ³	CY ⁴	DH ⁵	LBA ⁶
Check-Power-Mode	E5H or 98H	-	-	-	-	D8	-
Execute-Drive-Diagnostic	90H	-	-	-	-	D	-
Erase-Sector(s)	C0H	-	Y	Y	Y	Y	Y
Flush-Cache	E7H	-	-	-	-	D	-
Format-Track	50H	-	Y ⁷	-	Y	Y ⁸	Y
Identify-Drive	ECH	-	-	-	-	D	-
Idle	E3H or 97H	-	Y	-	-	D	-
Idle-Immediate	E1H or 95H	-	-	-	-	D	-
Initialize-Drive-Parameters	91H	-	Y	-	-	Y	-
NOP	00H	-	-	-	-	D	-
Read-Buffer	E4H	-	-	-	-	D	-
Read DMA	C8H or C9H	-	Y	Y	Y	Y	Y
Read-Long-Sector	22H or 23H	-	-	Y	Y	Y	Y
Read-Multiple	C4H	-	Y	Y	Y	Y	Y
Read-Sector(s)	20H or 21H	-	Y	Y	Y	Y	Y
Read-Verify-Sector(s)	40H or 41H	-	Y	Y	Y	Y	Y
Recalibrate	1XH	-	-	-	-	D	-
Request-Sense	03H	-	-	-	-	D	-
Seek	7XH	-	-	Y	Y	Y	Y
Set-Features	EFH	Y	-	-	-	D	-
SMART	B0H	Y	Y	Y	Y	D	-
Set-Multiple-Mode	C6H	-	Y	-	-	D	-
Set-Sleep-Mode	E6H or 99H	-	-	-	-	D	-
Stand-By	E2H or 96H	-	-	-	-	D	-
Stand-By-Immediate	E0H or 94H	-	-	-	-	D	-
Translate Sector	87H	-	Y	Y	Y	Y	Y
Write-Buffer	E8H	-	-	-	-	D	-
Write DMA	CAH or CBH	-	Y	Y	Y	Y	Y
Write-Long-Sector	32H or 33H	-	-	Y	Y	Y	Y
Write-Multiple	C5H	-	Y	Y	Y	Y	Y
Write-Multiple-Without-Erase	CDH	-	Y	Y	Y	Y	Y
Write-Sector(s)	30H or 31H	-	Y	Y	Y	Y	Y
Write-Sector(s)-Without-Erase	38H	-	Y	Y	Y	Y	Y
Write-Verify	3CH	-	Y	Y	Y	Y	Y

1. FR - Features register

2. SC - Sector Count register

3. SN - Sector Number register

4. CY - Cylinder registers

5. DH - Drive/Head register

6. LBA - Logical Block Address mode supported

7. Y - The register contains a valid parameter for this command

8. For the Drive/Head register:

Y means both the CFC and Head parameters are used

D means only the CFC parameter is valid and not the Head parameter

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

Range	Ambient Temperature	3.3V	5V
Commercial	0°C to +70°C	3.135-3.465V	4.75-5.25V
Industrial	-40°C to +85°C		

Table 7-2: Absolute maximum power pin stress ratings

Parameter	Symbol	Conditions
Input Power	V_{DD}	-0.3V min to 6.5V max -0.3V min to 4.0V max
Voltage on any flash media interface pin 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
TPU-READY ¹	Host Power-up/Reset to Ready Operation	200	1000	ms
TPU-WRITE ¹	Host Power-up/Reset 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.

8. Physical Characteristics

8.1 Dimensions

TABLE 8-1: Type I CFC physical specification

Length:	36.40 +/- 0.15mm (1.433 +/- 0.06 in.)
Width:	42.80 +/- 0.10mm (1.685 +/- 0.04 in.)
Thickness (Including Label Area):	3.30mm +/- 0.10mm (0.130 +/- 0.04 in.)

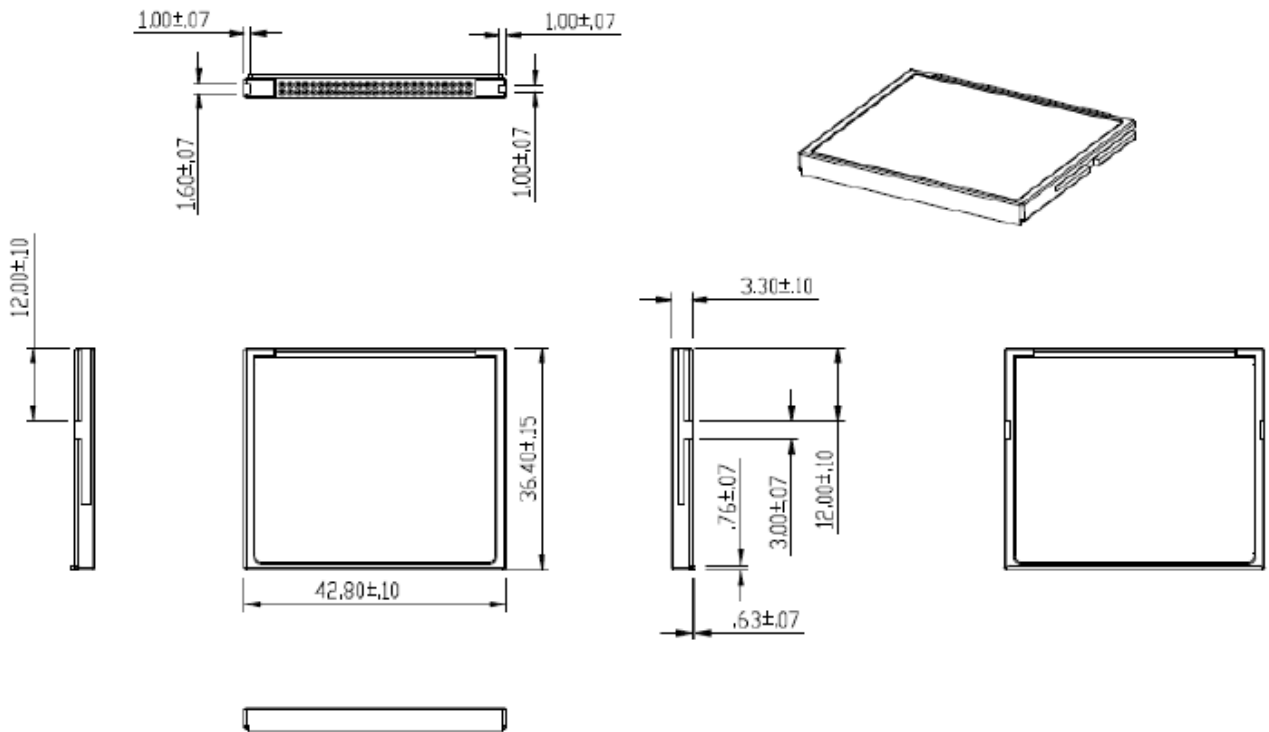
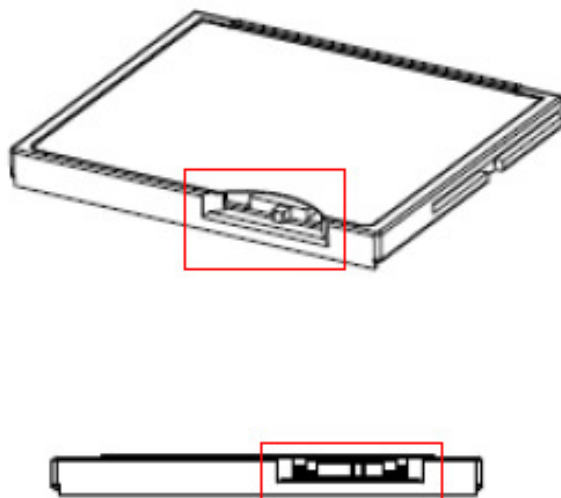


FIGURE 8-1: Physical dimension

8.2 Write Protect Hardware Switch

This Industrial CompactFlash card device incorporates a hardware write protect function enabled by a mechanical switch. Users can activate/deactivate the write protection option with the proper switch setting. Please refer to the illustration below the Write Protect switch position.



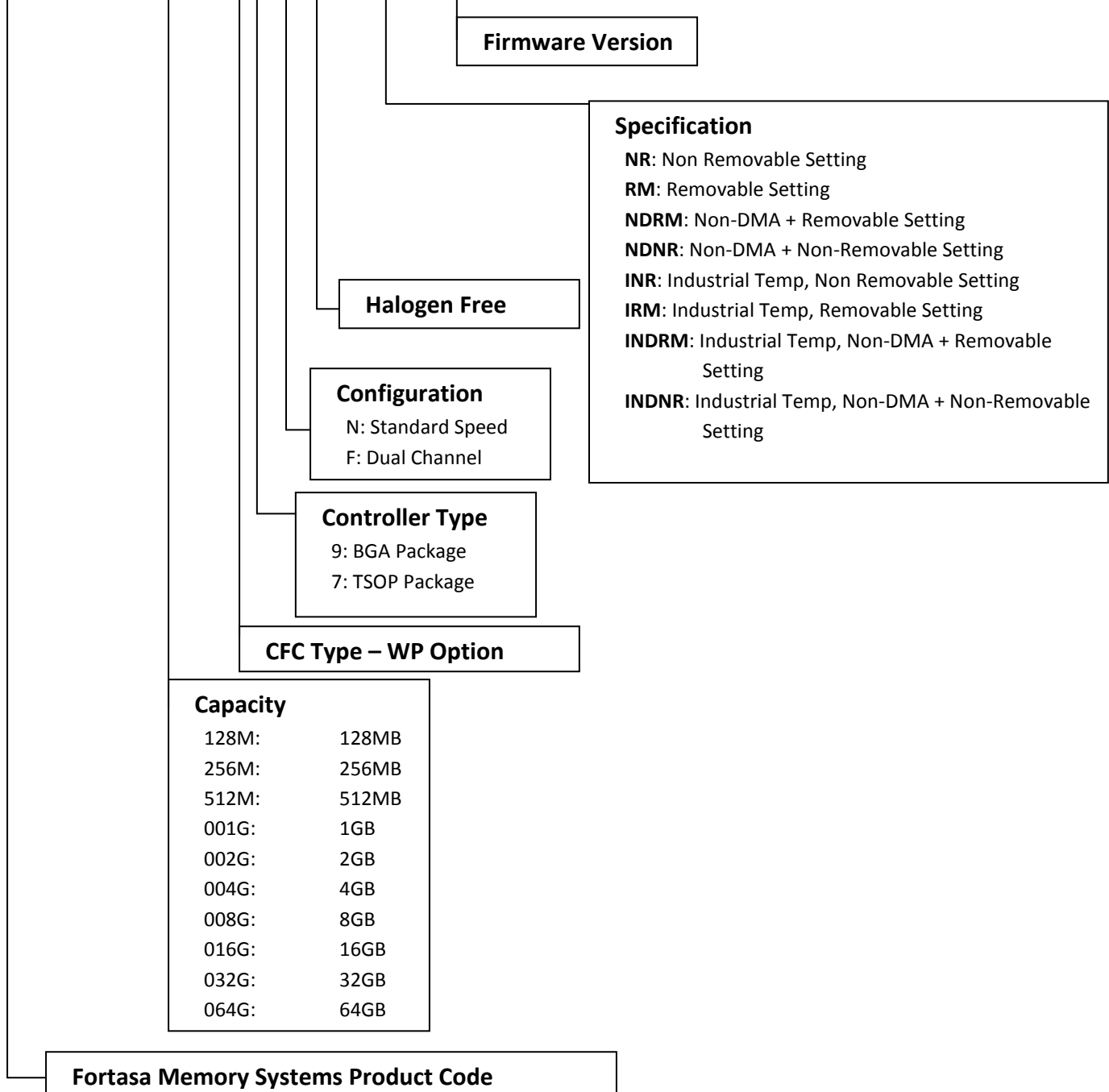
Description of Fortasa Write Protect:

Fortasa CompactFlash card firmware implements a Virtual Write scheme that allows the write commands to be accepted by the flash controller without posting any error messages. The OS continues to function uninterrupted but since the write process is virtual, no physical data has been actually written into the flash. Since the Virtual Write scheme runs at device level, it requires no software or driver installation and is fully transparent to the host OS.

9. Product Ordering Information

9.1 Product Code Designations

FMS – C F x x x x K7 X S – XXXXA



9.2 Valid Combinations

9.2.1 Standard Temperature

9.2.1.1 Non-Removable Configuration

Capacity	Model Number
128M	FMS-CF128MK9NS-NRA
256M	FMS-CF256MK9NS-NRA
512M	FMS-CF512MK9NS-NRA
1GB	FMS-CF001GK9NS-NRA
2GB	FMS-CF002GK9NS-NRA
4GB	FMS-CF004GK9NS-NRA
8GB	FMS-CF008GK9NS-NRA
16GB	FMS-CF016GK9FS-NR
32GB	FMS-CF032GK9FS-NR
64GB	FMS-CF064GK7FS-NR

9.2.1.2 Removable Configuration

Capacity	Model Number
128M	FMS-CF128MK9NS-RMA
256M	FMS-CF256MK9NS-RMA
512M	FMS-CF512MK9NS-RMA
1GB	FMS-CF001GK9NS-RMA
2GB	FMS-CF002GK9NS-RMA
4GB	FMS-CF004GK9NS-RMA
8GB	FMS-CF008GK9NS-RMA
16GB	FMS-CF016GK9FS-RM
32GB	FMS-CF032GK9FS-RM
64GB	FMS-CF064GK7FS-RM

9.2.1.2 Non-DMA + Removable Configuration

Capacity	Model Number
128M	FMS-CF128MK9NS-NDRMA
256M	FMS-CF256MK9NS-NDRMA
512M	FMS-CF512MK9NS-NDRMA
1GB	FMS-CF001GK9NS-NDRMA
2GB	FMS-CF002GK9NS-NDRMA
4GB	FMS-CF004GK9NS-NDRMA
8GB	FMS-CF008GK9NS-NDRMA
16GB	FMS-CF016GK9FS-NDRM
32GB	FMS-CF032GK9FS-NDRM
64GB	FMS-CF064GK7FS-NDRM

9.2.1.3 Non-DMA + Non-Removable Configuration

Capacity	Model Number
128M	FMS-CF128MK9NS-NDNRA
256M	FMS-CF256MK9NS-NDNRA
512M	FMS-CF512MK9NS-NDNRA
1GB	FMS-CF001GK9NS-NDNRA
2GB	FMS-CF002GK9NS-NDNRA
4GB	FMS-CF004GK9NS-NDNRA
8GB	FMS-CF008GK9NS-NDNRA
16GB	FMS-CF016GK9FS-NDNR
32GB	FMS-CF032GK9FS-NDNR
64GB	FMS-CF064GK7FS-NDNR

9.2.2 Industrial Temperature

9.2.2.1 Non-Removable Configuration

Capacity	Model Number
128M	FMS-CF128MK9NS-INRA
256M	FMS-CF256MK9NS-INRA
512M	FMS-CF512MK9NS-INRA
1GB	FMS-CF001GK9NS-INRA
2GB	FMS-CF002GK9NS-INRA
4GB	FMS-CF004GK9NS-INRA
8GB	FMS-CF008GK9NS-INRA
16GB	FMS-CF016GK9FS-INR
32GB	FMS-CF032GK9FS-INR
64GB	FMS-CF064GK7FS-INR

9.2.2.2 Removable Configuration

Capacity	Model Number
128M	FMS-CF128MK9NS-IRMA
256M	FMS-CF256MK9NS-IRMA
512M	FMS-CF512MK9NS-IRMA
1GB	FMS-CF001GK9NS-IRMA
2GB	FMS-CF002GK9NS-IRMA
4GB	FMS-CF004GK9NS-IRMA
8GB	FMS-CF008GK9NS-IRMA
16GB	FMS-CF016GK9FS-IRM
32GB	FMS-CF032GK9FS-IRM
64GB	FMS-CF064GK7FS-IRM

9.2.2.2 Non-DMA + Removable Configuration

Capacity	Model Number
128M	FMS-CF128MK9NS-INDRMA
256M	FMS-CF256MK9NS-INDRMA
512M	FMS-CF512MK9NS-INDRMA
1GB	FMS-CF001GK9NS-INDRMA
2GB	FMS-CF002GK9NS-INDRMA
4GB	FMS-CF004GK9NS-INDRMA
8GB	FMS-CF008GK9NS-INDRMA
16GB	FMS-CF016GK9FS-INDRM
32GB	FMS-CF032GK9FS-INDRM
64GB	FMS-CF064GK7FS-INDRM

9.2.2.3 Non-DMA + Non-Removable Configuration

Capacity	Model Number
128M	FMS-CF128MK9NS-INDNRA
256M	FMS-CF256MK9NS-INDNRA
512M	FMS-CF512MK9NS-INDNRA
1GB	FMS-CF001GK9NS-INDNRA
2GB	FMS-CF002GK9NS-INDNRA
4GB	FMS-CF004GK9NS-INDNRA
8GB	FMS-CF008GK9NS-INDNRA
16GB	FMS-CF016GK9FS-INDNR
32GB	FMS-CF032GK9FS-INDNR
64GB	FMS-CF064GK7FS-INDNR

10. Revision History

Revision	Date	Description	Comments
1.0	06/19/2012	Initial Release	
1.1	09/07/2012	Revised Product Ordering Information	
1.2	08/07/2013	Updated performance and product ordering information due to change in NAND flash use Added endurance (TBW) section	