

RoHS Compliant

CompactFlash Series 5

Specifications for Industrial CompactFlash Card

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Version 1.4



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Specifications Overview:

- **CompactFlash Association Specification Revision 4.1 Standard Interface**
 - 512 bytes per sector
 - ATA command set compatible
 - ATA transfer mode supports:
 - PIO Mode 6
 - Multiword DMA Mode 4
 - Ultra DMA Mode 5
 - PCMCIA UDMA Mode 5
- **Capacity**
 - 4, 8, 16, 32, 64 GB
- **Performance***
 - Sequential read: Up to 50 MB/sec
 - Sequential write: Up to 18 MB/sec
- **Flash Management**
 - Built-in hardware ECC
 - Global Wear Leveling
 - S.M.A.R.T.
- **NAND Flash Type: MLC**
- **Temperature Range**
 - Operating:
 - Standard: 0°C to 70°C
 - Extended: -40°C to 85°C
 - Storage: -40°C to 100°C
- **Supply Voltage**
 - 3.3 V
 - 5.0 V
- **Power Consumption***
 - Active mode: 165 mA
 - Idle mode: 2 mA
- **Connector Type**
 - 50 pins female
- **Physical Dimensions**
 - 36.4mm x 42.8mm x 3.3mm
- **Power Smart Design**
- **RoHS Compliant**

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

Table of Contents

1. General Descriptions	3
2. Functional Block	3
3. Pin Assignments.....	4
4. Product Specifications.....	6
4.1 Capacity.....	6
4.2 Performance	6
4.3 Environmental Specifications	6
5. Software Interface	7
5.1 CF-ATA Command Set.....	7
6. Flash Management	9
6.1 Intelligent Endurance Design	9
6.1.1 <i>Global Wear Leveling</i>	9
6.1.2 <i>S.M.A.R.T.</i>	9
6.1.3 <i>Built-in Hardware ECC</i>	9
6.2 Intelligent Power Failure Recovery.....	9
7. Electrical Specifications	10
7.1 Operating Voltage.....	10
7.2 Power Consumption	10
8. Physical Characteristics.....	11
9. Product Ordering Information	12
9.1 Product Code Designations.....	12
9.2 Valid Combinations.....	13

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 4.1, supporting transfer modes up to Programmed Input Output (PIO) Mode 6, Multi-word Direct Memory Access (DMA) Mode 4, Ultra DMA Mode 5, and PCMCIA Ultra DMA Mode 5.

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

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

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

2. Functional Block

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.

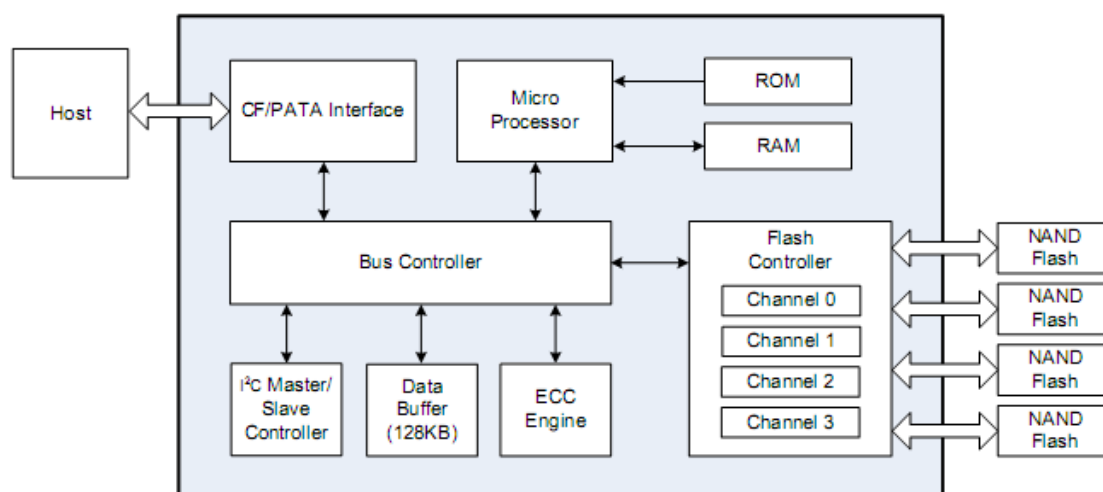


Figure 2-1 Functional Block Diagram

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 ¹	I
9	#OE	I	#OE	I	#ATA SEL	I
10	A9	I	A9	I	A9 ¹	I
11	A8	I	A8	I	A8 ¹	I
12	A7	I	A7	I	A7 ¹	I
13	VCC	-	VCC	-	VCC	-
14	A6	I	A6	I	A6 ¹	I
15	A5	I	A5	I	A5 ¹	I
16	A4	I	A4	I	A4 ¹	I
17	A3	I	A3	I	A3 ¹	I
18	A2	I	A2	I	A2	I
19	A1	I	A1	I	A1	I
20	A0	I	A0	I	A0	I
21	D0	I/O	D0	I/O	D0	I/O
22	D1	I/O	D1	I/O	D1	I/O
23	D2	I/O	D2	I/O	D2	I/O
24	WP	O	#IOIS16	O	#IOCS16	O
25	#CD2	O	#CD2	O	#CD2	O
26	#CD1	O	#CD1	O	#CD1	O
27	D11	I/O	D11	I/O	D11	I/O
28	D12	I/O	D12	I/O	D12	I/O
29	D13	I/O	D13	I/O	D13	I/O
30	D14	I/O	D14	I/O	D14	I/O
31	D15	I/O	D15	I/O	D15	I/O
32	#CE2	I	#CE2	I	#CS1	I
33	#VS1	O	#VS1	O	#VS1	O
34	#IORD	I	#IORD	I	#IORD	I
35	#IOWR	I	#IOWR	I	#IOWR	I
36	#WE	I	#WE	I	#WE	I
37	RDY/-BSY	O	#IREQ	O	INTRQ	O
38	VCC	-	VCC	-	VCC	-
39	#CSEL	I	#CSEL	I	#CSEL	I
40	#VS2	O	#VS2	O	#VS2	O
41	RESET	I	RESET	I	#RESET	I
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

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.

Table 4-1 Capacity Specifications

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

*Display of total bytes varies from file systems, which means not all of the bytes can be used for storage.

**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 CompactFlash cards are listed in Table 4-2.

Table 4-2 Performance Specifications

Capacity	4 GB	4 GB	8 GB	16 GB	32 GB	64 GB
Performance	(Dual Channel)	(Single Channel)				
Sequential Read* (MB/s)	49	17	50	50	50	50
Sequential Write* (MB/s)	13	4	14	14	18	18

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.

4.3 Environmental Specifications

Environmental specifications of the CompactFlash cards are shown in Table 4-3.

Table 4-3 Environmental Specifications

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

5. Software Interface

5.1 CF-ATA Command Set

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

Table 5-1 CFC-ATA Command Set

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

Command	Code	FR ¹	SC ²	SN ³	CY ⁴	DH ⁵	LBA ⁶
Write-Verify	3CH	—	Y	Y	Y	Y	Y

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

6. Flash Management

6.1 Intelligent Endurance Design

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

6.1.2 S.M.A.R.T.

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

6.1.3 Built-in Hardware ECC

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

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

6.2 Intelligent Power Failure Recovery

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

7. Electrical Specifications

7.1 Operating Voltage

Table 7-1 lists the supply voltage for the CompactFlash cards.

Table 7-1 Operating Range

Item	Range
Supply Voltage	3.3V $\pm$ 5% (3.135-3.465V)
Supply Voltage	5V $\pm$ 5% (4.75-5.25V)

7.2 Power Consumption

Table 7-2 lists the power consumption for the CompactFlash cards.

Table 7-2 Power Consumption

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

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.

8. Physical Characteristics

Table 8-1 Type I CFC Physical Specification

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

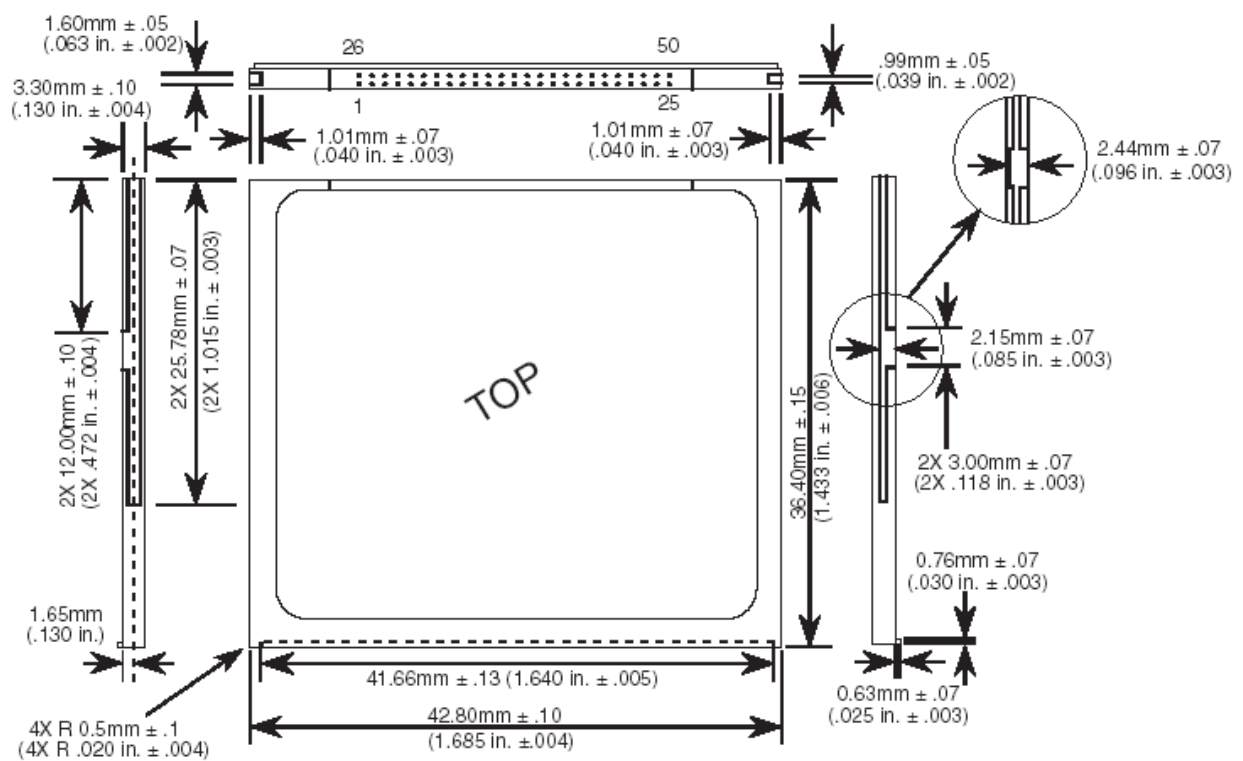


Figure 8-1 Physical Dimension

Unit: mm

9. Product Ordering Information

9.1 Product Code Designations

AP – CF xxxG L 9 X S – XXXXXX

Specification

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

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Configuration

E: Single Channel
 F: Dual Channel

CTL Type

CFC Type

Capacity

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

Model Name

Apacer Product Code

9.2 Valid Combinations

A. Standard Temperature

9.2.1 Non-Removable

Capacity	Part Number
4GB	AP-CF004GL9FS-NR
4GB	AP-CF004GL9ES-NR
8GB	AP-CF008GL9FS-NR
16GB	AP-CF016GL9FS-NR
32GB	AP-CF032GL9FS-NR
64GB	AP-CF064GL9FS-NR

9.2.2 Removable

Capacity	Part Number
4GB	AP-CF004GL9FS-RM
4GB	AP-CF004GL9ES-RM
8GB	AP-CF008GL9FS-RM
16GB	AP-CF016GL9FS-RM
32GB	AP-CF032GL9FS-RM
64GB	AP-CF064GL9FS-RM

9.2.3 Non-DMA + Removable

Capacity	Part Number
4GB	AP-CF004GL9FS-NDRM
4GB	AP-CF004GL9ES-NDRM
8GB	AP-CF008GL9FS-NDRM
16GB	AP-CF016GL9FS-NDRM
32GB	AP-CF032GL9FS-NDRM
64GB	AP-CF064GL9FS-NDRM

9.2.4 Non-DMA + Non-Removable

Capacity	Part Number
4GB	AP-CF004GL9FS-NDNR
4GB	AP-CF004GL9ES-NDNR
8GB	AP-CF008GL9FS-NDNR
16GB	AP-CF016GL9FS-NDNR
32GB	AP-CF032GL9FS-NDNR
64GB	AP-CF064GL9FS-NDNR

B. Extended Temperature

9.2.5 Non-Removable

Capacity	Part Number
4GB	AP-CF004GL9ES-ETNR
8GB	AP-CF008GL9FS-ETNR
16GB	AP-CF016GL9FS-ETNR
32GB	AP-CF032GL9FS-ETNR

9.2.6 Removable

Capacity	Part Number
4GB	AP-CF004GL9ES-ETRM
8GB	AP-CF008GL9FS-ETRM
16GB	AP-CF016GL9FS-ETRM
32GB	AP-CF032GL9FS-ETRM

9.2.7 Non-DMA + Removable

Capacity	Part Number
4GB	AP-CF004GL9ES-ETNDRM
8GB	AP-CF008GL9FS-ETNDRM
16GB	AP-CF016GL9FS-ETNDRM
32GB	AP-CF032GL9FS-ETNDRM

9.2.7 Non-DMA + Non-Removable

Capacity	Part Number
4GB	AP-CF004GL9ES-ETNDNR
8GB	AP-CF008GL9FS-ETNDNR
16GB	AP-CF016GL9FS-ETNDNR
32GB	AP-CF032GL9FS-ETNDNR

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	3/13/2012
1.0	Official release	4/12/2012
1.1	- Updated Product Ordering Information (with the addition of standard operating temperature models) - Added 64GB capacity	7/23/2012
1.2	- Added standard operating temperature specifications - Updated Product Ordering Information due to the addition of standard temperature specifications - Added 4GB capacity model	9/20/2012
1.3	Added 4GB models of single channel.	10/01/2015
1.4	Changed Wear-Leveling Algorithms to Global Wear Leveling at Flash Management on Specifications Overview page and 6.1 Flash Management	6/4/2018

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