MLC

CompactFlash® Card

HERCULES-K Series

Document No. : 100-xxCFC-MKCTMB

Version No. : 02V1

Date : June, 2019

Product Features

■ **Flash IC**

- TOSHIBA 15nm NAND Flash IC.

- Multi-Level Cell (MLC) technology.

■ **Compatibility**

- CF 6.0 standard compatible.

- PC-Card 8.0 (PC-Card ATA) standard compatible.

- PCMCIA specification version 2.1 compatible.

- ATA-8 standard compatible in True-IDE mode.

■ **Additional Capabilities**

- Fast ATA host-to-buffer transfer rates supporting
  PIO mode 4, MDMA mode 4, UDMA mode 6 in
  True-IDE mode

- 4K Mapping units

- S.M.A.R.T.[1] (Self-Monitoring, Analysis and
  Reporting Technology) feature set support.

- TRIM maintenance command support.

- Static, Dynamic, and Global wear leveling algorithm

- Flexible 96-Bit/1KB BCH ECC engine.

- Support bad Block Management

■ **Mechanical**

- Standard 50-pin connector consisting of two rows of
  25 female contacts.

- Dimension: 42.8 mm x 36.4 mm x 3.3 mm.

- Weight:

  Plastic frame-kit: 12g / 0.42 oz.

  Metal frame-kit: 14g / 0.49 oz.

■ **Power: Operating Voltage @ 5V(+/-) 10%**

- Read Mode: 185.4 mA (max.)

- Write Mode: 168.7 mA (max.)

- Idle Mode: 1.2 mA (max.)

■ **Performance (Maximum value) [2]**

- Sequential Read: 103.0sec. (max.)

- Sequential Write: 74.1sec. (max.)

■ **Capacity**

- 4GB, 8GB, 16GB, 32GB, 64GB, 128GB and 256GB

■ **Reliability**

- **TBW:** Up to 75.0 at 256GB Capacity.

  (Client workload by JESD-219A)

- **ECC:** Flexible 96-Bit/1KB BCH ECC engine.

- **Temperature:** (Operating)

  Standard Grade: 0°C ~ +70°C

  Wide Temp. Grade: -40°C ~ +85°C

- **Vibration:** 70 Hz to 2K Hz, 20G, 3 axes.

- **Shock:** 0.5ms, 1500 G, 3 axes

■ **Certifications and Declarations**

- **Certifications**: CE & FCC

- **Declarations**: RoHS & REACH

Remarks:

1. Support official S.M.A.R.T. Utility.

2. Sequential performance is based on CrystalDiskMark
   5.1.2 with file size 1000MB

Order Information

I. *Part Number List*

◆ **APRO MLC CompactFlash® Card HERCULES-K Series with plastic frame kit**

Product Picture	Grade	Standard grade (0℃ ~ 70℃)	Wide Temp Grade (-40℃ ~ +85℃)
	4GB	SPCFC004G-MKCTMB-UF	WPCFC004G-MKCTMB-UFC
	8GB	SPCFC008G-MKCTMB-UF	WPCFC008G-MKCTMB-UFC
	16GB	SPCFC016G-MKCTMB-UF	WPCFC016G-MKCTMB-UFC
	32GB	SPCFC032G-MKCTMB-UF	WPCFC032G-MKCTMB-UFC
	64GB	SPCFC064G-MKCTMB-UF	WPCFC064G-MKCTMB-UFC
	128GB	SPCFC128G-MKCTMB-UF	WPCFC128G-MKCTMB-UFC
	256GB	SPCFC256G-MKCTMB-UF	WPCFC256G-MKCTMB-UFC

◆ **APRO MLC CompactFlash® Card HERCULES-K Series with rugged metal frame kit**

Product Picture	Grade	Standard grade (0℃ ~ 70℃)	Wide Temp Grade (-40℃ ~ +85℃)
	4GB	SRCFC004G-MKCTMB-UF	WRCFC004G-MKCTMB-UFC
	8GB	SRCFC008G-MKCTMB-UF	WRCFC008G-MKCTMB-UFC
	16GB	SRCFC016G-MKCTMB-UF	WRCFC016G-MKCTMB-UFC
	32GB	SRCFC032G-MKCTMB-UF	WRCFC032G-MKCTMB-UFC
	64GB	SRCFC064G-MKCTMB-UF	WRCFC064G-MKCTMB-UFC
	128GB	SRCFC128G-MKCTMB-UF	WRCFC128G-MKCTMB-UFC
	256GB	SRCFC256G-MKCTMB-UF	WRCFC256G-MKCTMB-UFC

Notes:

C: *Special conformal coating treated on whole PCBA which may support industrial grade operating temperature -40℃ ~ +85℃*

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II. Part Number Decoder:

X1 X2 X3 X4 X5 X6 X7 X8 X9─X11 X12 X13 X14 X15 X16─X18 X19 X20

X1 : **Grade**

S: Standard Grade – operating temp. 0° C ~ 70 ° C

W: Wide Temp Grade- operating temp. -40° C ~ +85 ° C

X2 : **The material of case**

P : Plastic frame kit

R : Rugged Metal frame kit

X3 X4 X5 : **Product category**

CFC : CompactFlash® Card

X6 X7 X8 X9 : **Capacity**

004G:	4GB	**064G:**	64GB
008G:	8GB	**128G:**	128GB
016G:	16GB	**256G:**	256GB
032G:	32GB		

X11 : **Controller**

M : HERCULES Series

X12 : **Controller version**

A, B, C.....

X13 : **Controller Grade**

C : Commercial grade

X14 : **Flash IC**

T : Toshiba NAND Flash IC

X15 : **Flash IC grade / Type**

M : MLC-NAND flash IC

X16 : MLC Technology

B : Toshiba 15nm MLC

X18 X19 : **Data transfer rate and disk type**

PF : PIO-4 mode / fixed disk type

PR : PIO-4 mode / removable disk type

UF : Defaulted as UDMA-6 mode / fixed disk type

UR : UDMA-6 mode / removable disk type

AA : PIO/UDMA & fixed/removable disk type auto-detected

X20 : **Reserved for specific requirement**

C : Conformal coating (optional)

Revision History

Revision	Description	Date
1.0	Preliminary Release	2016/4/12
1.1	Add. 256GB Capacity	2017/10/25
1.2	Updated Version	2018/11/28
2.0	Updated power consumption & performance	2019/04/24
2.1	Updated document form	2019/06/10

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1. Introduction

APRO MLC CompactFlash® (CF) Card HERCULES-K Series designed to follow ATAPI-7 standard. The main used Flash memories are MLC-NAND type flash memory chips. The available Card capacities are 4GB, 8GB, 16GB, 32GB, 64GB, 128GB and 256GB. The operating temperature grade is optional for commercial level 0°C ~ 70°C and wide temperature level -40°C ~ +85°C. The APRO MLC CompactFlash® (CF) Cards are designed electrically complies with the conventional IDE hard Card and support True IDE Mode. The data transfer modes supports PIO- 0~4, MWDMA- 0~4 or UDMA- 0~6. The fastest reading speed is up to 103.0 MB/sec and writing speed is up to 74.1 MB/sec,

The APRO MLC CF products provide a high level interface to the host computer. This interface allows a host computer to issue commands to the CompactFlash® (CF) Card to read or write blocks of memory. Each sector is protected by a powerful 72 bits per 1024 bytes block Error Correcting Code (ECC). APRO MLC CompactFlash® (CF) Card's HERCULES-K Series intelligent controller manages interface protocols, data storage and retrieval as well as ECC, defect handling and diagnostics, power management and clock control.

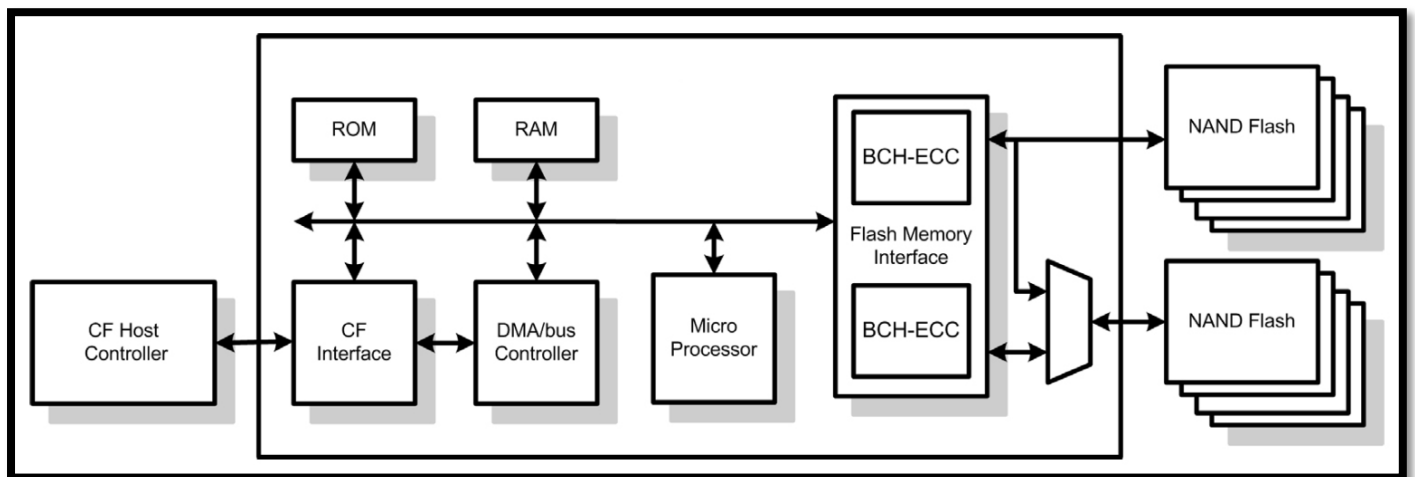Figure 1 shows a block diagram of the APRO MLC CompactFlash® (CF) Card HERCULES-K Series.

Figure 1: APRO MLC CompactFlash® Card HERCULES-K Series block diagram

1.1. *Scope*

This document describes the features and specifications and installation guide of APRO MLC CompactFlash® (CF) Card HERCULES-K Series. In the appendix, there provides order information, warranty policy, RMA/DOA procedure for the most convenient reference.

1.2. *Flash Management Technology – Global Wear leveling*

In order to gain the best management for flash memory, APRO MLC CompactFlash® (CF) Card HERCULES-K Series applies Global Wear-leveling technology to manage the Flash system. The life of flash memory is limited; the management is to increase the life of the flash product. The objective of global wear leveling is to prevent any frequently updated data from staying at the static area so that wear leveling could be evenly applied to all blocks. Static areas contain any data that does not change, and are ignored by dynamic wear leveling. Such static data may include operating system files, table look-ups, executable files, and etc. Global wear leveling frequently replaces blocks in this area with block in the hot area, and thus each block in all areas has the same probability to be used.

Wear-leveling algorithm evenly distributes data over an entire Flash cell array and searches for the least used physical blocks. The identified low cycled sectors are used to write the data to those locations. If blocks are empty, the write occurs normally. If blocks contain data, it moves that data to a more heavily used location before it moves the newly written data. Wear leveling maximizes effective endurance Flash array compared to no wear leveling products.

1.3. *Bad Block Management*

➢ **Early Bad Block**

The fault block generated during the manufacturing process of NAND Flash is called Early Bad Block.

➢ **Later Bad Block**

In the process of use, as the number of operations of writing and erasing increases, a fault block is gradually generated, which is called a Latter Bad Block.

Bad block management is a management mechanism for a bad block to be detected by the control IC and mark bad blocks in the NAND Flash and improve the reliability of data access. The bad block management mechanism of the control IC will establish a **Bad Block Table** when the NAND Flash is started for the first time, and will also record the errors found in the process of use in the bad block table, and data is ported to new valid blocks to avoid data loss.

In order to detect the initial bad blocks to handle run time bad blocks, APRO MLC CompactFlash® Card HERCULES-K Series provides the **Bad Block Management** scheme. It remaps a bad block to one of the reserved blocks so that the data contained in one bad block is not lost and new data writes on a bad block is avoided.

2. Product Specifications

For all the following specifications, values are defined at ambient temperature and nominal supply voltage unless otherwise stated.

2.1. System Environmental Specifications

Table 1: Environmental Specification

APRO MLC CompactFlash® Card HERCULES-K Series		Standard Grade	Wide Temp. Grade
		SxCFCxxxG-MKCTMB-UF	WxCFCxxxG-MKCTMB-UFC
Temperature	Operating:	0°C ~ +70°C	-40°C ~ +85°C
	Non-operating:	-20°C ~ +80°C	-50°C ~ +95°C
Humidity	Operating & Non-operating:	10% ~ 95% non-condensing	
Vibration	Operating & Non-operating:	70 Hz to 2 KHz, 20G, 3 axes	
Shock	Operating & Non-operating:	Duration: 0.5ms, 1500G, 3 axes	

2.2. System Power Requirements

Table 2: Power Requirement

APRO MLC CompactFlash® Card HERCULES-K Series	
DC Input Voltage (VCC) +5V ± 10% or +3.3V ± 10%	Operating @ +5V ± 10%
Reading Mode :	185.4 mA (max.)
Writing Mode :	168.7 mA (max.)
Idle Mode :	1.2 mA (max.)

2.3. System Performance

Table 3: System Performances

Data Transfer Mode	PIO 0~4, MWDMA 0~4, UDMA 0~6 supported						
Access Time	0.5 ms (256GB)						
Capacity	4GB	8GB	16GB	32GB	64GB	128GB	256GB
Sequential Read (MB/s)	80.1	79.7	82.9	103.8	102.0	103.1	103.0
Sequential Write(MB/s)	27.5	27.8	25.8	44.6	78.8	84.5	74.1

Note: The performance was measured using CrystalDiskMark by file size 1000MB (QD32).

➢ *All values quoted are typically at 25℃ and nominal supply voltage.*

➢ *Testing of the MLC CompactFlash® Card maximum performance was performed under the following platform:*

  - Computer with AMD processor

  - Windows 7 Professional operating system

2.4. System Reliability

Table 4: System Reliability

Wear-leveling Algorithms	Global wear-leveling algorithms
Bad Blocks Management	Supported
ECC Technology	72-bits per 1024 bytes block
Erase counts	NAND MLC Flash Cell Level : 3K P/E Cycles
Capacity	TBW(TB)
4GB	1.17
8GB	2.34
16GB	4.68
32GB	9.37
64GB	18.75
128GB	37.5
256GB	75.0

Note:

➢ *Samples were built using Toshiba 15nm Toggle MLC NAND flash.*

➢ *Client workload by JESD-219A.*

➢ *The endurance of SSD could be estimated based on user behavior, NAND endurance cycles, and write amplification factor.*

  It is not guaranteed by flash vendor.

2.5. *Physical Specifications*

Refer to Table 5 and see Figure 3 for APRO MLC CompactFlash® Card HERCULES-K Series physical specifications and dimensions.

Table 5: Physical Specifications of APRO MLC CompactFlash® Card-HERCULES-K Series

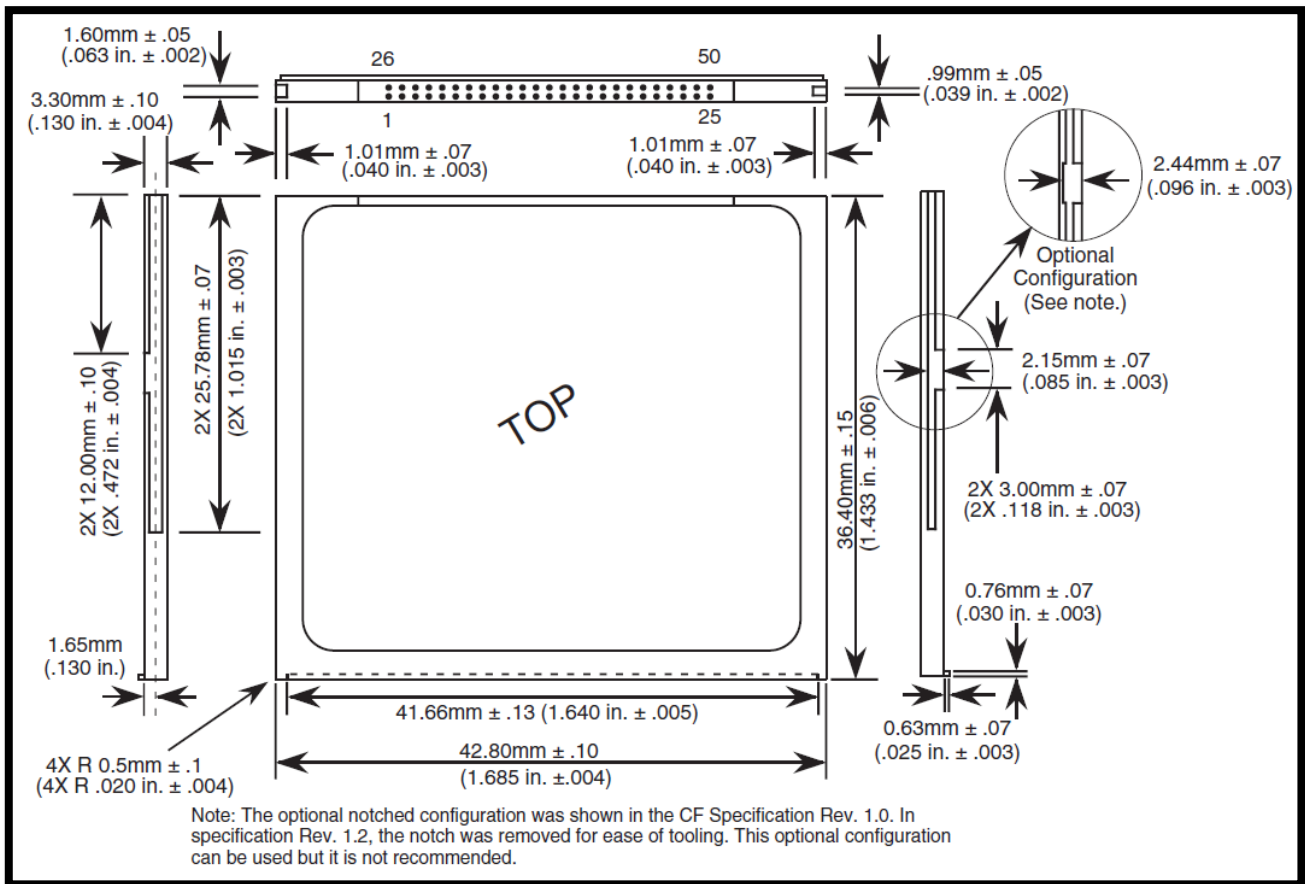|	
Length:	36.40 ± 0.15 mm
Width:	42.80 ± 0.10 mm
Thickness:	3.3 mm ± 0.10 mm
Weight:	**Plastic frame-kit:** 12g / 0.42 oz. **Metal frame-kit:** 14g / 0.49 oz.

Figure 3: APRO MLC CompactFlash® Card Dimension

2.6. *Conformal coating*

Conformal coating is a protective, dielectric coating designed to conform to the surface of an assembled printed circuit board. Commonly used conformal coatings include silicone, acrylic, urethane and epoxy. APRO applies only silicone on APRO storages products upon requested especially by customers. The type of silicone coating features good thermal shock resistance due to flexibility. It is also easy to apply and repair.

Conformal coating offers protection of circuitry from moisture, fungus, dust and corrosion caused by extreme environments. It also prevents damage from those Flash storages handling during construction, installation and use, and reduces mechanical stress on components and protects from thermal shock. The greatest advantage of conformal coating is to allow greater component density due to increased dielectric strength between conductors.

APRO use MIL-I-46058C silicon conformal coating

2.7. *Device Parameter*

The table 6 shows the specific capacity for the various models and the default number of heads, sectors/track and cylinders.

Table 6: Device Parameter of APRO MLC CompactFlash® Card-HERCULES-K Series

Unformatted Capacity	Cylinder	Head	Sector	LBA Total Sectors
4GB	7,785	16	63	7,847,280
8GB	15,538	16	63	15,662,304
16GB	31,045	16	63	31,293,360
32GB	62,041	16	63	62,537,328
64GB	16,383	16	63	125,059,072
128GB	16,383	16	63	250,085,376
256GB	16,383	16	63	500,170,752

3. *Interface Description*

3.1. *CF Card interface (CompactFlash® Type I)*

APRO MLC CompactFlash® Card HERCULES-K Series equipped Standard 50-pin connector consisting of two rows of 25 female contacts.
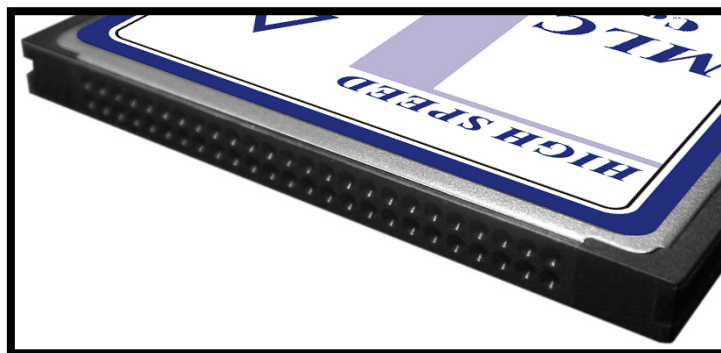

Figure 3: 50-pin CompactFlash® Type I Connector

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Product Specifications

3.2. Pin Assignments

Signals whose source is the host is designated as inputs while signals that the CompactFlash® (CF) Card sources are outputs. The pin assignments are listed in below table 7. The signal/pin assignments are listed in below Table 7. Low active signals have a "-" prefix. Pin types are Input, Output or Input/Output.

Table 7 - Pin Assignments of APRO MLC CompactFlash® Card-HERCULES-K Series

PC Card Memory Mode				PC Card I/O Mode				True IDE Mode[4]			
Pin No.	Signal Name	Pin Type	In, Out Type	Pin No.	Signal Name	Pin Type	In, Out Type	Pin No.	Signal Name	Pin Type	In, Out Type
1	GND		Ground	1	GND		Ground	1	GND		Ground
2	D03	I/O	11Z,OZ3	2	D03	I/O	11Z,OZ3	2	D03	I/O	11Z,OZ3
3	D04	I/O	11Z,OZ3	3	D04	I/O	11Z,OZ3	3	D04	I/O	11Z,OZ3
4	D05	I/O	11Z,OZ3	4	D05	I/O	11Z,OZ3	4	D05	I/O	11Z,OZ3
5	D06	I/O	11Z,OZ3	5	D06	I/O	11Z,OZ3	5	D06	I/O	11Z,OZ3
6	D07	I/O	11Z,OZ3	6	D07	I/O	11Z,OZ3	6	D07	I/O	11Z,OZ3
7	-CE1	I	13U	7	-CE1	I	13U	7	-CS0	I	13Z
8	A10	I	11Z	8	A10	I	11Z	8	A10[2]	I	11Z
9	-OE	I	13U	9	-OE	I	13U	9	-ATA SEL	I	13U
10	A09	I	11Z	10	A09	I	11Z	10	A09[2]	I	11Z
11	A08	I	11Z	11	A08	I	11Z	11	A08[2]	I	11Z
12	A07	I	11Z	12	A07	I	11Z	12	A07[2]	I	11Z
13	VCC		Power	13	VCC		Power	13	VCC		Power
14	A06	I	11Z	14	A06	I	11Z	14	A06[2]	I	11Z
15	A05	I	11Z	15	A05	I	11Z	15	A05[2]	I	11Z
16	A04	I	11Z	16	A04	I	11Z	16	A04[2]	I	11Z
17	A03	I	11Z	17	A03	I	11Z	17	A03[2]	I	11Z
18	A02	I	11Z	18	A02	I	11Z	18	A02	I	11Z
19	A01	I	11Z	19	A01	I	11Z	19	A01	I	11Z
20	A00	I	11Z	20	A00	I	11Z	20	A00	I	11Z
21	D00	I/O	11Z,OZ3	21	D00	I/O	11Z,OZ3	21	D00	I/O	11Z,OZ3
22	D01	I/O	11Z,OZ3	22	D01	I/O	11Z,OZ3	22	D01	I/O	11Z,OZ3
23	D02	I/O	11Z,OZ3	23	D02	I/O	11Z,OZ3	23	D02	I/O	11Z,OZ3
24	WP	O	OT3	24	-IOIS16	O	OT3	24	-IOCS16	O	ON3
25	-CD2	O	Ground	25	-CD2	O	Ground	25	-CD2	O	Ground
26	-CD1	O	Ground	26	-CD1	O	Ground	26	-CD1	O	Ground
27	D11[1]	I/O	11Z,OZ3	27	D11[1]	I/O	11Z,OZ3	27	D11[1]	I/O	11Z,OZ3
28	D12[1]	I/O	11Z,OZ3	28	D12[1]	I/O	11Z,OZ3	28	D12[1]	I/O	11Z,OZ3
29	D13[1]	I/O	11Z,OZ3	29	D13[1]	I/O	11Z,OZ3	29	D13[1]	I/O	11Z,OZ3

- 13 -   APRO MLC CompactFlash® Card HERCULES-K Series

PC Card Memory Mode				PC Card I/O Mode				True IDE Mode[4]			
Pin No.	Signal Name	Pin Type	In, Out Type	Pin No.	Signal Name	Pin Type	In, Out Type	Pin No.	Signal Name	Pin Type	In, Out Type
30	D14[1]	I/O	11Z,OZ3	30	D14[1]	I/O	11Z,OZ3	30	D14[1]	I/O	11Z,OZ3
31	D15[1]	I/O	11Z,OZ3	31	D15[1]	I/O	11Z,OZ3	31	D15[1]	I/O	11Z,OZ3
32	-CE2[1]	I	13U	32	-CE2[1]	I	13U	32	-CS1[1]	I	13Z
33	-VS1	O	Ground	33	-VS1	O	Ground	33	-VS1	O	Ground
34	-IORD	I	13U	34	-IORD	I	13U	34	-IORD[7] HSTROBE[8] -HDMARDY[9]	I	13Z
35	-IOWR	I	13U	35	-IOWR	I	13U	35	-IOWR[7] STOP[8,9]	I	13Z
36	-WE	I	13U	36	-WE	I	13U	36	-WE[3]	I	13U
37	READY	O	OT1	37	-IREQ	O	OT1	37	INTRQ	O	OZ1
38	VCC		Power	38	VCC		Power	38	VCC		Power
39	-CSEL[5]	I	12Z	39	-CSEL[5]	I	12Z	39	-CSEL	I	12U
40	-VS2	O	OPEN	40	-VS2	O	OPEN	40	-VS2	O	OPEN
41	RESET	I	12Z	41	RESET	I	12Z	41	-RESET	I	12Z
42	-WAIT	O	OT1	42	-WAIT	O	OT1	42	IORDY[7] -DDMARDY[8] DSTROBE[9]	O	ON1
43	-INPACK	O	OT1	43	-INPACK	O	OT1	43	DMARQ	O	OZ1
44	-REG	I	13U	44	-REG	I	13U	44	-DMACK[6]	I	13U
45	BVD2	O	OT1	45	-SPKR	O	OT1	45	-DASP	I/O	11U,ON1
46	BVD1	O	OT1	46	-STSCHG	O	OT1	46	-PDIAG	I/O	11U,ON1
47	D08[1]	I/O	11Z,OZ3	47	D08[1]	I/O	11Z,OZ3	47	D08[1]	I/O	11Z,OZ3
48	D09[1]	I/O	11Z,OZ3	48	D09[1]	I/O	11Z,OZ3	48	D09[1]	I/O	11Z,OZ3
49	D10[1]	I/O	11Z,OZ3	49	D10[1]	I/O	11Z,OZ3	49	D10[1]	I/O	11Z,OZ3
50	GND		Ground	50	GND		Ground	50	GND		Ground

Appendix A: Limited Warranty

APRO warrants your MLC CompactFlash® Card HERCULES-K Series against defects in material and workmanship for the life of the drive. The warranty is void in the case of misuse, accident, alteration, improper installation, misapplication or the result of unauthorized service or repair. The implied warranties of merchantability and fitness for a particular purpose, and all other warranties, expressed or implied, except as set forth in this warranty, shall not apply to the products delivered. In no event shall APRO be liable for any lost profits, lost savings or other incidental or consequential damages arising out of the use of, or inability to use, this product.

BEFORE RETURNING PRODUCT, A RETURN MATERIAL AUTHORIZATION (RMA) MUST BE OBTAINED FROM APRO.

Product shall be returned to APRO with shipping prepaid. If the product fails to conform based on customers' purchasing orders, APRO will reimburse customers for the transportation charges incurred.

WARRANTY PERIOD:

- **MLC (Standard grade / Wide temp. grade)   2 years / Within 3K Erasing Counts**

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