APRO Co., Ltd.

3D NAND Flash

(KIOXIA BiCS3 / BiCS5)

SATA III CFast™ Card

HERMES-M Series

Document No. : 100-xPCFA-JMCTx

Version No. : 01V2

Date : February, 2023

ISO 9001 : 2015 CERTIFIED



Product Features

- **Flash IC**
  - KIOXIA **BiCS FLASH™.**[*3]
  - **BiCS3** 3D TLC NAND Flash
  - **BiCS5** 3D TLC NAND Flash

- **Compatibility**
  - Compliant with SATA Revision 3.2
  - Compliant with CFast™ Specification 2.0
  - SATA 1.5Gb/s; SATA 3Gb/s & SATA 6Gb/s
  - Interface compatible.

- **Additional Capabilities**
  - **S.M.A.R.T.**[*1] (Self-Monitoring, Analysis and Reporting Technology) feature set support.
  - Native Command Queuing (**NCQ**) support.
  - **TRIM** maintenance command support.
  - Both **Static & Dynamic** wear-leveling algorithm
  - Hardware Low Density Parity Check Code, **LDPC** support.
  - Support bad Block Management

- **Mechanical**
  - 7-pin (data) + 17-pin (power) SATA III Cfast™ Card connector
  - Dimension: 42.8 mm x 36.4 mm x 3.5 mm.
  - Weight: Plastic frame-kit: 10g / 0.35 oz.

- **Power Operating Voltage 3.3V(+/-) 5%**
  - Read Mode: 1.41 W (max.)
  - Write Mode: 1.71 W (max.)
  - Idle Mode: 0.71 W (max.)

- **Capacity**
  - **BiCS3:** 32GB, 64GB, 128GB,256GB and 512GB
  - **BiCS5:** 128GB, 256GB, 512GB and 1TB.

- **Performance (Maximum value) *[2]**
  - **BiCS3**

    Seq. Read/Write: 560/330 (MB/sec.)(max.)
  - **BiCS5**

    Seq. Read/Write: 550/490 (MB/sec.)(max.)

- **Reliability**
  - **TBW:** Up to 600.0 TBW at 512GB Capacity. (Client workload by JESD-219A)
  - **MTBF:** > 3,000,000 hours
  - **ECC:** Designed with hardware LDPC ECC engine with hard-decision and soft-decision decoding.
  - **Temperature:**
  - **BiCS3:**

    Standard Grade(Operating): 0ºC ~ +70ºC

    Wide Temp. Grade(Operating): -40ºC ~ +85ºC

    Storage Temperature: -55ºC ~ +95ºC
  - **BiCS5:**

    Standard Grade: 0ºC ~ +70ºC

    Wide Temp. Grade(Operating): -40ºC ~ +85ºC

    Storage Temperature: -40ºC ~ +85ºC
  - **Vibration:** 80 Hz to 2000 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
3. **BiCS** means Bit Cost Scalable Technology.

   BiCS FLASH is a trademark of KIOXIA Corporation.

Order Information

I. Part Number List

◆ **APRO SATA III Cfast™ Card (BiCS3 TLC NAND FLASH) HERMES-M Series**

Product Picture	Grade	Standard grade (0ºC ~ 70ºC)	Wide Temp. Grade (-40ºC ~ +85ºC)
	32GB	SPCFA032G-JMCT3	WPCFA032G-JMCT3-C
	64GB	SPCFA064G-JMCT3	WPCFA064G-JMCT3-C
	128GB	SPCFA128G-JMCT3	WPCFA128G-JMCT3-C
	256GB	SPCFA256G-JMCT3	WPCFA256G-JMCT3-C
	512GB	SPCFA512G-JMCT3	WPCFA512G-JMCT3-C

◆ **APRO SATA III Cfast™ Card (BiCS5 TLC NAND FLASH) HERMES-M Series**

Product Picture	Grade	Standard grade (0ºC ~ 70ºC)	Wide Temp Grade (-40ºC ~ +85ºC)
	128GB	SPCFA128G-JMCT5	WPCFA128G-JMCT5-C
	256GB	SPCFA256G-JMCT5	WPCFA256G-JMCT5-C
	512GB	SPCFA512G-JMCT5	WPCFA512G-JMCT5-C
	1TB	SPCFA001T-JMCT5	WPCFA001T-JMCT5-C

Notes:

C : *Special conformal coating treated on whole PCBA (Optional)*

II. Part Number Decoder:

X1 X2 X3 X4 X5 X6 X7 X8 X9—X11 X12 X13 X14 X15 – X17

X1 : **Grade**

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

X2 : **The material of case**

P : Plastic frame kit

X3 X4 X5 : **Product category**

CFA : Cfast™ Card

X6 X7 X8 X9 : **Capacity**

032G:	32GB	**256G:**	256GB
064G:	64GB	**512G:**	512GB
128G:	128GB	**001T**	1TB

X11 : **Controller**

J : HERMES Series

X12 : **Controller version**

A, B, C…..

X13 : **Controller Grade**

C : Commercial grade (Sorting for Wide Temp. Grade)

X14 : **Flash IC**

T : KIOXIA NAND Flash IC

X15 : **Flash IC grade / Type**

3 : KIOXIA BiCS3 TLC NAND FLASH IC.

5 : KIOXIA BiCS5 TLC NAND FLASH IC.

X17 : **Reserved for specific requirement**

C : Conformal coating (optional)

Revision History

Revision	Description	Date
1.0	Initial release.	2022/03/28
1.1	Add. BiCS5 1TB Capacity	2022/12/01
1.2	Add. BiCS5 wide temperature capacities 128GB to 1TB	2023/02/23

Contents

Product Features ..... - 2 -
Order Information ..... - 3 -
I. Part Number List ..... - 3 -
II. Part Number Decoder: ..... - 3 -
Revision History ..... - 4 -
Contents ..... - 5 -
1. Introduction ..... - 6 -
1.1. *Scope* ..... - 7 -
1.2. *Flash Management Technology – Static & Dynamic Wear Leveling* ..... - 7 -
1.3. *Bad Block Management* ..... - 7 -
1.4. *Error Correcting Coding (ECC)* ..... - 7 -
1.5. *3D-NAND Flash* ..... - 7 -
2. Product Specifications ..... - 8 -
2.1. *System Environmental Specifications* ..... - 8 -
2.2. *System Power Requirements* ..... - 8 -
2.3. *System Performance* ..... - 9 -
2.4. *System Reliability* ..... - 9 -
2.5. *Physical Specifications* ..... - 10 -
2.6. *Conformal coating* ..... - 11 -
3. Interface Description ..... - 11 -
3.1. SATA III CFast™ Card interface ..... - 11 -
3.2. Pin Assignments ..... - 12 -
Appendix A: Limited Warranty ..... - 13 -

1. Introduction

APRO SATA III CFast™ Card (BiCS3 / BiCS5 3D TLC NAND FLASH) HERMES-M Series provides high capacity flash memory Solid State Drive (SSD) that electrically complies with SATA Revision 3.2. APRO SATA III CFast™ Card (BiCS3 / BiCS5 3D TLC NAND FLASH) HERMES-M Series support SATA 1.5Gb/s; SATA 3Gb/s & SATA 6Gb/s data transfer rate with high performance. The main used flash memories are BiCS 3D NAND FLASH memory chips. The available disk capacities for BiCS3 are 32GB, 64GB, 128GB, 256GB and 512GB; For BiCS5 are 128GB, 256GB, 512GB and 1TB.

APRO SATA III CFast™ Card (BiCS3 TLC NAND FLASH) HERMES-M Series supports the operating temperature for standard grade is 0°C ~ 70°C; and for wide temperature grade is -40°C ~ 85°C.
APRO SATA III CFast™ Card (BiCS5 TLC NAND FLASH) HERMES-M Series supports the operating temperature for standard grade is 0°C ~ 70°C; ; and for wide temperature grade is -40°C ~ 85°C.
The data transfer performance by sequential read is up to 550.0 MB/sec (max), and sequential write is up to 490.0 MB/sec (max).

APRO SATA III CFast™ Card (BiCS3 / BiCS5 3D TLC NAND FLASH) HERMES-M Series is suitable to handheld device embedded system, inventory recorder and particularly for serious environment monitor recorder system. Furthermore, APRO also provide 1.8" SATA to CFast™ card Adapter (P/N: **AD-CA128SATA200AR**) to increase the application flexibility.
APRO SATA III CFast™ Card (BiCS3 / BiCS5 3D TLC NAND FLASH) HERMES-M Series provide a high level interface to the host computer. This interface allows a host computer to issue commands to the APRO SATA III CFast™ Card (BiCS3 / BiCS5 3D TLC NAND FLASH) HERMES-M Series to read or write blocks of memory. A powerful hardware design is architecture multiplied LDPC (Low Density Parity Check) for Error Correcting Coding (ECC). APRO SATA III CFast™ Card (BiCS3 / BiCS5 3D TLC NAND FLASH) HERMES-M Series intelligent controller manages interface protocols, data storage and retrieval as well as ECC, bad block management and diagnostics, power management and clock control.

Figure 1 shows a block diagram of the APRO SATA III CFast™ Card (BiCS3 / BiCS5 3D TLC NAND FLASH) HERMES-M Series.

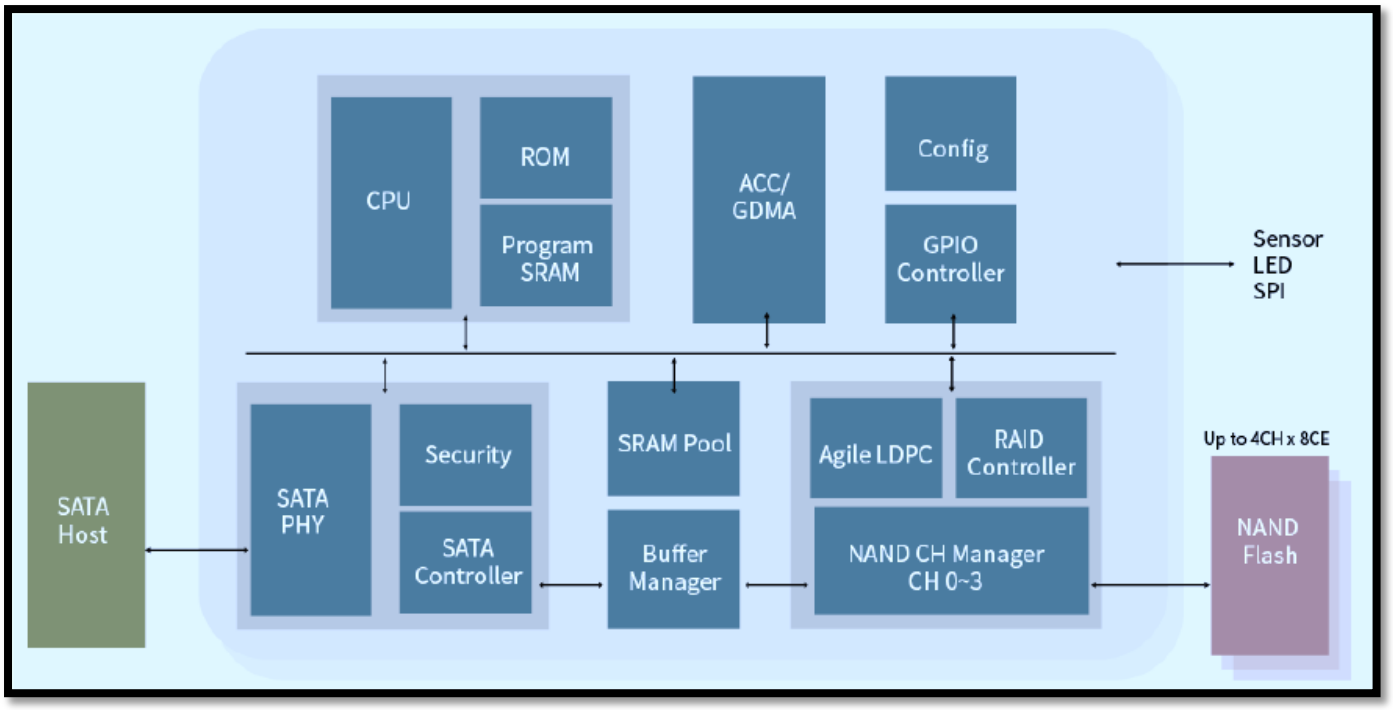


Figure 1: APRO SATA III CFastTM Card (BiCS3 / BiCS5 3D TLC NAND FLASH) HERMES-M Series block diagram

1.1. *Scope*

This document describes features, specifications and installation guide of APRO SATA III CFast™ Card (BiCS3 / BiCS5 3D TLC NAND FLASH) HERMES-M Series. In the appendix, there provides order information, warranty policy, RMA/DOA procedure for the most convenient reference.

1.2. *Flash Management Technology – Static & Dynamic Wear Leveling*

NAND flash devices can only undergo a limited number of program/erase cycles, and in most cases, the flash media are not used evenly. If some areas get updated more frequently than others, the lifetime of the device would be reduced significantly. Thus, Wear Leveling is applied to extend the lifespan of NAND Flash by evenly distributing write and erase cycles across the media.

APRO SATA III CFast™ Card (BiCS3 / BiCS5 3D TLC NAND FLASH) HERMES-M Series provides advanced Wear Leveling algorithm, which can efficiently spread out the flash usage through the whole flash media area. Moreover, by implementing both dynamic and static Wear Leveling algorithms, the life expectancy of the NAND flash is greatly improved.

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 SATA III CFast™ Card (BiCS3 / BiCS5 3D TLC NAND FLASH) HERMES-M 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.

1.4. *Error Correcting Coding (ECC)*

APRO SATA III CFast™ Card (BiCS3 / BiCS5 3D TLC NAND FLASH) HERMES-M Series provides a high level interface to the host computer. This interface allows a host computer to issue commands to the APRO SATA III CFast™ Card (BiCS3 / BiCS5 3D TLC NAND FLASH) HERMES-M Series to read or write blocks of memory. A powerful hardware design is architecture multiplied LDPC (Low Density Parity Check) for Error Correcting Coding (ECC). APRO SATA III CFast™ Card (BiCS3 / BiCS5 3D TLC NAND FLASH) HERMES-M Series intelligent controller manages interface protocols, data storage and retrieval as well as ECC, bad block management and diagnostics, power management and clock control.

1.5. *3D-NAND Flash*

3D NAND is a vertical implementation of the NAND flash cell memory array. The memory cell transistors forming the NAND string are connected in a series vertically and the memory transistors are changed from the floating-gate type to a trapped charge type.

In floating-gate technology, die density is increased by shrinking peripheral circuits and active circuits.

With 3D, holding the X/Y dimension of the die constant, die density is increased through multiple layers of the active circuits on the Z axis. Higher-density 3D NAND die enables applications needing high-density NAND chip solutions.

BiCS3 3D TLC NAND Flash is 64-layer vertically stacked architecture; and **BiCS5** 3D TLC NAND Flash is 112-layer vertically stacked architecture.

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 SATA III CFast™ Card HERMES-M Series (BiCS3 / BiCS5 3D TLC NAND FLASH)		
Temperature	**Operating:**	0ºC ~ +70ºC / -40ºC ~ +85ºC
	Non-operating:	**BiCS3** -55ºC ~ +95ºC / **BiCS5** -40ºC ~ +85ºC
Humidity	**Operating & Non-operating:**	10% ~ 95% non-condensing
Vibration	**Frequency/Acceleration:**	80 Hz to 2000 Hz, 20G, 3 axes
Shock	**Operating & Non-operating:**	0.5ms, 1500 G, 3 axes
Electrostatic Discharge (ESD)	**Temperature:**	24ºC
	Relative Humidity:	49% (RH)
	+/-4KV:	Device functions are affected, but EUT will be back to its normal or operational state automatically.

2.2. *System Power Requirements*

Table 2: Power Requirement

APRO SATA III CFast™ Card (BiCS3 / BiCS5 3D TLC NAND FLASH) HERMES-M Series		
DC Input Voltage (VCC)		3.3V±5%
Maximum average value	**Reading Mode :**	1.41 W (max.)
	Writing Mode :	1.71 W (max.)
	Idle Mode :	0.71 W (max.)

2.3. System Performance

Table 3: System Performances

APRO SATA III CFast™ Card HERMES-M Series (BiCS3 3D TLC NAND FLASH)						
Data Transfer Mode supporting		Serial ATA Gen-III (6.0Gb/s = 768MB/s)				
Maximum Performance	**Capacity**	**32GB**	**64GB**	**128GB**	**256GB**	**512GB**
	Sequential Read (MB/s)	170.0	350.0	550.0	560.0	560.0
	Sequential Write (MB/s)	35.0	70.0	150.0	290.0	330.0
	4KB Random Read (Q32T1)	11,000	22,000	44,000	77,000	83,000
	4KB Random Write (Q32T1)	8,000	18,000	36,000	67,000	74,000

APRO SATA III CFast™ Card HERMES-M Series (BiCS5 3D TLC NAND FLASH)					
Data Transfer Mode supporting		Serial ATA Gen-III (6.0Gb/s = 768MB/s)			
Maximum Performance	**Capacity**	**128GB**	**256GB**	**512GB**	**1TB**
	Sequential Read (MB/s)	430.0	550.0	550.0	550.0
	Sequential Write (MB/s)	290.0	480.0	490.0	490.0
	4KB Random Read (Q32T1)	40,000	70,000	72,000	73,000
	4KB Random Write (Q32T1)	27,000	48,000	59,000	59,000

Note:

- *The performance was measured using CrystalDiskMarkv5.0; 1GB data size test with SATA 6Gbps host.*
- *Samples were built using KIOXIA BiCS 3D-NAND FLASH*
- *Performance may differ according to flash configuration and platform.*

2.4. System Reliability

Table 4: System Reliability

Wear-leveling Algorithms		Static and Dynamic wear-leveling algorithms
Bad Block Management		Supportive
MTBF		> 3,000,000 hours
ECC Technology		Hardware design LDPC (Low Density Parity Check)
Erase counts		KIOXIA **BiCS FLASH™** 3D NAND Flash: 3K P/E Cycles
TBW (Tera Bytes Written) / Unit: TB.		
Capacity	**32GB**	38
	64GB	75
	128GB	150
	256GB	300
	512GB	600
	1TB	1,200

Note:

- *Client: Follow JESD218 Test method and JESD219A Workload, tested by ULINK. (The capacity lower than 64GB client workload is not specified in JEDEC219A, the values are estimated.)*
- *Samples were built using KIOXIA BiCS 3D-NAND FLASH*

2.5. *Physical Specifications*

Refer to Table 5 and see Figure 2 for APRO SATA III CFast™ Card (BiCS3 / BiCS5 3D TLC NAND FLASH) HERMES-M Series physical specifications and dimensions.

Table 5: Physical Specifications of APRO SATA III CFast™ Card (BiCS3 / BiCS5 3D TLC NAND FLASH) HERMES-M Series

Length:	42.8 mm
Width:	36.4 mm
Thickness:	3.5 mm
Weight:	10g (0.35 oz.)

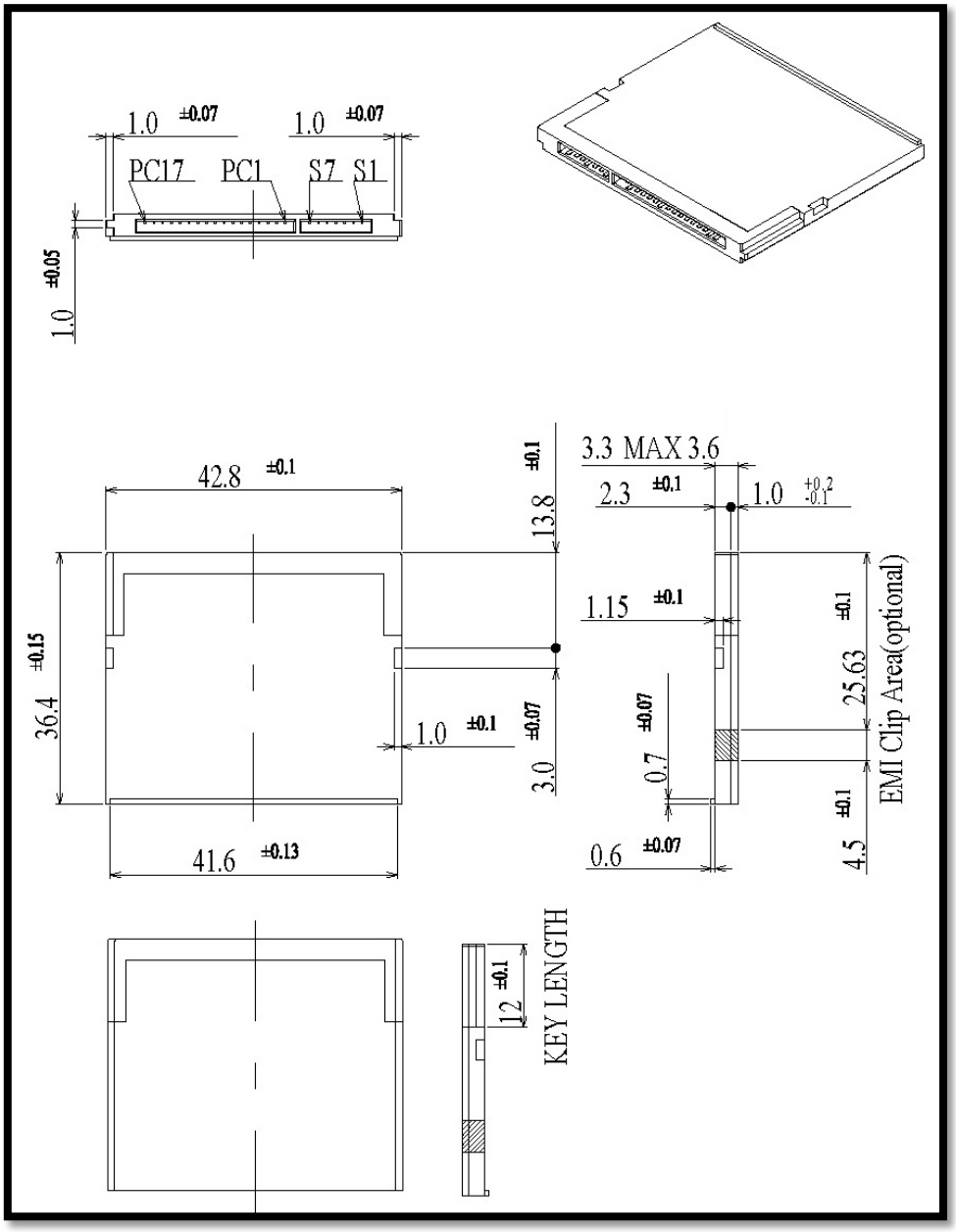


Figure 2: APRO SATA III CFastTM Card (BiCS3 / BiCS5 3D TLC NAND FLASH) HERMES-M Series Dimension

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

3. Interface Description

3.1. SATA III CFast™ Card interface

APRO SATA III CFast™ Card (BiCS3 / BiCS5 3D TLC NAND FLASH) HERMES-M Series is equipped with 7 pins in the signal segment and 17 pins in the power segment.



Figure 3: The connectors of Signal Segment and Power Segment

3.2. Pin Assignments

APRO SATA III CFast™ Card (BiCS3 / BiCS5 3D TLC NAND FLASH) HERMES-M Series operates with standard SATA pin-out.

The pin assignments are listed in below table 6.

Key and Spacing separate signal and power segments		
Name	**Type**	**Description**
S1	SGND	Ground for signal integrity
S2	A+	Differential Signal Pair A
S3	A-	
S4	SGND	Ground for signal integrity
S5	B-	Differential Signal Pair B
S6	B+	
S7	SGND	Ground for signal integrity

P1	CDI	Card Detect In
P2	PGND	Device Ground
P3	DEVSLP	Device Sleep
P4	NA	Reserved
P5	NA	Reserved
P6	NA	Reserved
P7	PGND	Device Ground
P8	NA	Reserved
P9	LED2	HDDA LED (LED are lighted when P9 low active)
P10	NA	Reserved
P11	NA	Reserved
P12	IFDET	GND
P13	PWR	Device Power 3.3V
P14	PWR	Device Power 3.3V
P15	PGND	Device Ground
P16	PGND	Device Ground
P17	CDO	Card Detect Out

Table 6 - Pin Assignments

Appendix A: Limited Warranty

APRO warrants your SATA III CFast™ Card (BiCS3 / BiCS5 3D TLC NAND FLASH) HERMES-M 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:

- **3D NAND FLASH 2 years / Within 3K Erasing Counts**

This document is for information use only and is **subject to change without prior notice**. APRO Co., Ltd. assumes no responsibility for any errors that may appear in this document, nor for incidental or consequential damages resulting from the furnishing, performance or use of this material. No part of this document may be reproduced, transmitted, transcribed, stored in a retrievable manner or translated into any language or computer language, in any form or by any means, electronic, mechanical, magnetic, optical, chemical, manual or otherwise, without the prior written consent of an officer of APRO Co., Ltd.

All parts of the APRO documentation are protected by copyright law and all rights are reserved.

APRO and the APRO logo are registered trademarks of APRO Co., Ltd.

Product names mentioned herein are for identification purposes only and may be trademarks and/or registered trademarks of their respective companies.

© 2022 APRO Corporation. All rights reserved