APRO Co., Ltd.

# SLC

## Industrial SATA-III CFast™ Card

### HERMES-G Series

**Document No. :** 100-xxCFA-JGTL

**Version No. :** 02V0

**Date :** April, 2019


ISO 9001 : 2015 CERTIFIED

# Product Features

- **Flash IC**
  - TOSHIBA NAND Flash IC.
  - Single-Level Cell (SLC) management

- **Compatibility**
  - Compliant with SATA Revision 3.0
  - Compliant with CFast™ Specification 2.0
  - SATA 1.5Gbps/3.0Gbps/6.0Gbps data transfer rate.
  - ATA-8 Standard compatible.

- **Additional Capabilities**
  - S.M.A.R.T.*1 (Self-Monitoring, Analysis and Reporting Technology) feature set support.
  - Static wear-leveling algorithm
  - Support bad Block Management

- **Mechanical**
  - 7-pin (data) + 17-pin (power) CFast™ Card connector
  - Dimension: 42.8 mm x 36.4 mm x 3.5 mm.
  - Weight:
    Plastic frame-kit: 10g/0.35 oz.
    Metal frame-kit: 13g/0.46 oz.

- **Power Operating Voltage 3.3V(+/-) 5%**
  - Read Mode: 240.0 mA (max.)
  - Write Mode: 320.0 mA (max.)
  - Idle Mode: 110.0 mA (max.)

- **Performance (Maximum value) *2**
  - Sequential Read: 61.4 MB/sec. (max.)
  - Sequential Write: 27.9 MB/sec. (max.)

- **Capacity**
  - 1GB, 2GB

- **Reliability**
  - **TBW:** Up to 108 TBW at 2GB Capacity. (Test by sequential write)
  - **MTBF:** > 3,000,000 hours
  - **ECC:** Automatic 40 bits per 1024 bytes error correction (ECC) and retry capabilities
  - **Temperature:** (Operating)
    Standard Grade: 0ºC ~ +70ºC
    Industrial. Grade: -40ºC ~ +85ºC
  - **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 SLC SATA III CFast™ Card HERMES-G Series with plastic frame kit**

| Product Picture | Grade | Standard grade (0°C ~ 70°C) | Industrial Grade ( -40°C ~ +85°C ) |
|---|---|---|---|
|  | 1GB | SPCFA001G-JGCTC | WPCFA001G-JGITI |
| | 2GB | SPCFA002G-JGCTC | WPCFA002G-JGITI |
| | | | |
| | | | |
| | | | |

◆ **APRO SLC SATA III CFast™ Card HERMES-G Series with rugged metal frame kit**

| Product Picture | Grade | Standard grade (0°C ~ 70°C) | Industrial Grade ( -40°C ~ +85°C ) |
|---|---|---|---|
|  | 1GB | SRCFA001G-JGCTC | WRCFA001G-JGITI |
| | 2GB | SRCFA002G-JGCTC | WRCFA002G-JGITI |
| | | | |
| | | | |
| | | | |

## 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

**W:** Industrial Grade- operating temp. -40º C ~ +85 º C

**X2** : **The material of case**

**P :** Plastic frame kit

**R** : Rugged Metal frame kit

**X3 X4 X5** : **Product category**

**CFA :** CFast™ card

**X6 X7 X8 X9** : **Capacity**

**001G:** 1GB **002G:** 2GB

**X11** : **Controller**

**J :** HERMES Series

**X12** : **Controller version**

**A, B, C.....**

**X13** : **Controller Grade**

**C :** Commercial grade

**I :** Industrial grade

**X14** : **Flash IC**

**T :** Toshiba SLC-NAND Flash IC

**X15** : **Flash IC grade / Type**

**C :** Commercial grade

**I :** Industrial grade

**X17** : **Reserved for specific requirement**

**C :** Conformal coating (optional)

# Revision History

| Revision | Description | Date |
|---|---|---|
| 1.0 | Initial release | 2014/6/13 |
| 1.1 | Add TBW value for each capacity | 2016/3/8 |
| 2.0 | Add 1GB & 2GB capacities<br>Add HERMES-G Series | 2017/5/18 |
| 2.1 | Updated document form | 2019/05/15 |

# Contents

## 1. Introduction

APRO SLC CFast™ Card HERMES-G Series compliant to the CFast™ Specification 2.0 issued by CompactFlash Association (CFA), it breakthroughs the speed performance under traditional ATA-8 specification. Integrating the CompactFlash card form factor and Serial ATA (SATA I/ II/ III) interface, the transfer speed is much higher than traditional CF Card while it keeps small form factor and rigid case as CF Card. The HERMES-G Series CFast™ Card also supports Metal Frame Kit as an optional product which may endure various harsh operating environments. The main used Flash memory is SLC-NAND Type Flash memory chips from 1GB and 2GB.

APRO SLC CFast™ Card HERMES-G Series features with great portability and resistance against vibration. The sequential read speed is 61.4 MB/sec and sequential write speed is 27.9 MB/sec. Furthermore, APRO also provide 1.8" SATA to CFast™ card Adapter (P/N: **AD-CA128SATA200AR** ) to increase the application flexibility.

APRO's SLC CFast™ Card supports optional standard grade operating temperature 0°C ~ 70°C and Industrial grade -40°C ~ +85°C.

APRO SLC CFast™ Card HERMES-G Series is suitable to handheld device embedded system, inventory recorder and particularly for serious environment monitor recorder system. Also, through APRO 1.8" SATA to CFast™ card Adapter, APRO SLC CFast™ Card HERMES-G Series can be booting SSD to varieties of IPC motherboards and PC structure system.
Figure 1 shows a block diagram of the used high tech CFast™ Card controller.

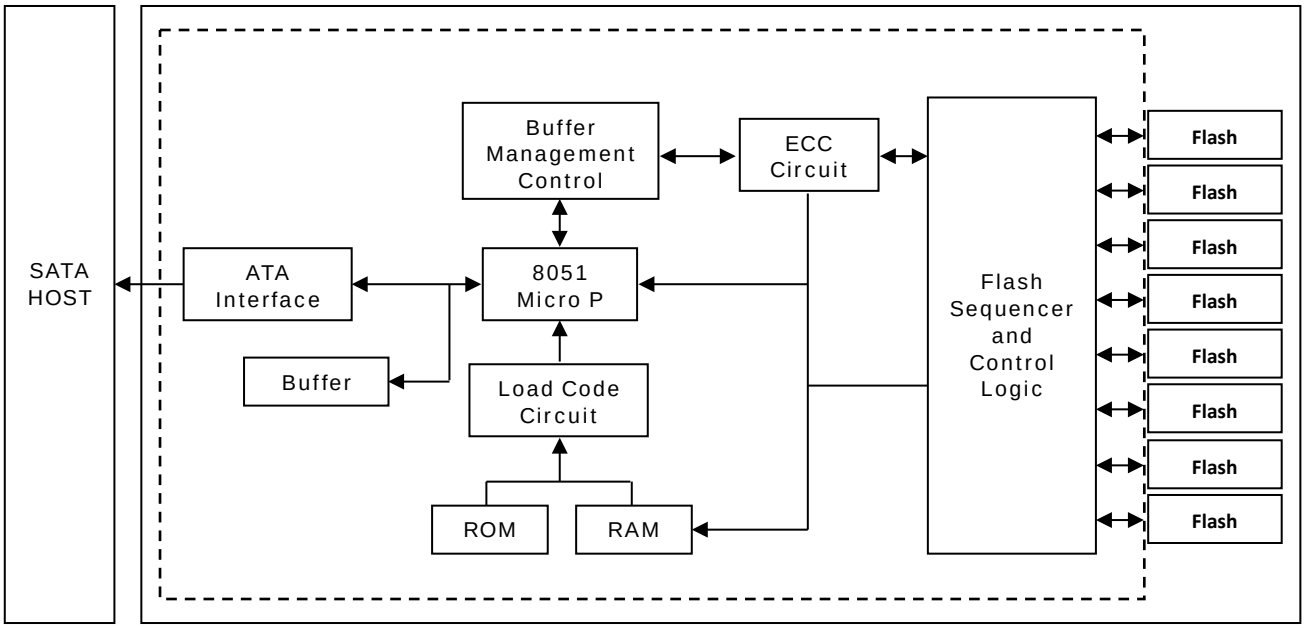


***Figure 1: APRO SLC SATA III CFast™ Card HERMES-G Series block diagram***

## 1.1. *Scope*

This document describes features, specifications and installation guide of APRO SLC SATA III CFast™ Card HERMES-G Series. In the appendix, there provides order information, warranty policy, RMA/DOA procedure for the most convenient reference.

## 1.2. *Flash Management Technology – Static Wear Leveling*

Flash memory can be programed and erased within a limited number of times, and the limited of the P/E cycle is defined by the flash array vendor. The P/E cycle limited applies to each individual erase block in the flash device.

In order to gain the best management for flash memory, APRO SATA III SLC CFast™ Card HERMES-G Series supports Static 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.

A static 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 static data, it moves that data to a more heavily used location before it moves the newly written data. The static wear leveling maximizes effective endurance Flash array compared to no wear leveling or dynamic wear leveling.

## 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 SLC CFast™ Card HERMES-G 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. *Mean Time Between Failure (MTBF)*

### *1.4.1. Definition*

MTBF (Mean time between failures) is defined as failure or maintenance required for the average time including failure detection and maintenance for the device. For a simple and maintainable unit, MTBF = MTTF + MTTR.

**MTTF (mean time to failure)** is defined as the expectation of random variables for time to failure.

**MTTR（mean time to restoration）** is the expectation of random variables of time required for restoration which includes the time required for confirmation that a failure occurred, as well as the time required for maintenance.

### *1.4.2. Obtaining MTBF*

There are two methods for obtaining MTBF:

**A. MTBF software estimation method:** by calculating all the MTBF data of all the components included in the bill of material, and the data of the completed products including actual parameters of voltage and electrical current using analysis software, the MTBF of the completed product is estimated.

**B. MTBF sample test method:** by determining a certain number of samples and a fixed time for testing, using a Arrhenius Model and Coffin-Manson Model to obtain parameters, and then using the formula with the parameters, the longevity and in so the reliability is proved.

Arrhenius Model: **Af = e{ (1/k × Ea ( 1/273+Tmax – 1/273+Ttest)}**

Coffin-Manson Model: **Af = ( ΔTtest/ΔTuse)m**

- **APRO uses the A method to Estimate MTBF**

MTBF is actually obtained by calculation which is just an estimation of future occurrences. The main reason to use the first method is that the data contains the analysis by all the parameters of components and actual parameters of voltage and electrical current of finished products, which is considered adequate and objective.

- **Interpretation of MTBF Analysis**

APRO estimates MTBF using a prediction methodology based on reliability data for the individual components in APRO products. The predicted MTBF based on Parts stress analysis Method of Telcordia Special Report SR-332, for components failure rates. Component data comes from several sources: device life tests, failure analysis of earlier equipment, device physics, and field returns.

The Telcordia model is based on the Telcordia document, Reliability Prediction Procedure for Electronic Equipment, Technical Reference SR-332. This standard basically modified the component models in MIL-HDBK-217 to better reflect the failure rates that AT&T Bell Lab equipment was experiencing in the field and was originally developed by AT&T Bell Lab as the Bellcore model.

This model supports different failure rate calculation methods in order to support the taking into account of stress, burn-in, laboratory, or field data. A Parts Count or Parts Stress analysis is included in Telcordia performance. Relex supports Telcordia Issues 1 and 2 and also Bellcore Issues 4, 5, and 6.Telcordia Issue 2, released in September 2006, are supported by Relex and Telcordia Issue 1, released in May 2001, is replaced with Relex. Refer to Telcordia Issue 2 Fields for information about the fields in Relex Reliability Studio specific to Telcordia Issue 2.

➢ **Purpose of the analyses**

The purpose of these analyses is to obtain early estimation of device reliability during engineering and customer validation stages. The prediction results will expose the reliability of whole assembly, viewed as a set of serially connected electronic components. Rating of the assembly electronic components will show the ratio between actual critical elements parameters and their specification limits. The purpose of component rating is to improve a product's inherent design reliability, increase its number of operating times, and to reduce warranty costs and to achieve a more robust design.

## *1.4.3. Definitions*

| Term | Definition |
|---|---|
| Failure | The event, or inoperable state, in which any item or part of an item does not, or would not, perform as previously specified. |
| Failure rate | The total number of failures within an item population, divided by the total number of life units expended by that population, during a particular measurement interval under stated condition. |
| FIT | Failures In Time: the number of failures in 1 billion hours. |
| PPM | Part per million: the number of failures in 1 million hours. |
| Mean Time Between Failures (MTBF) | A basic measure of reliability for repairable items: The mean number of life units during which all parts of the item perform within their specified limits, during a particular measurement interval under stated conditions.. |
| GB | Ground, Fixed, Controlled: Nearly zero environmental stress with optimum engineering operation and maintenance. Typical applications are central office, environmentally controlled vaults, environmentally controlled remote shelters, and environmentally controlled customer premise area. |
| GF | Ground, Fixed, Uncontrolled: Some environmental stress with limited maintenance. Typical applications are manholes, poles, remote terminals, and customer premise areas subject to shock, vibration, temperature, or atmospheric variations. |

➢ **Software & Database**

Analysis Software & Analysis Method

Software Name : Relex Reliability Studio 2008

Software Version : Relex Studio 2008

➢ **Analysis Method**

The prediction method used was Telcordia SR-332, Issue 2,

Parts Count

Failure rate ($\boldsymbol{\lambda}$) = $10^9$ hours (FITs)

MTBF=1/$\boldsymbol{\lambda}$

$\boldsymbol{\lambda}_{SSi} = \boldsymbol{\lambda}_{Gi}\ \mathbf{TT}_{Qi}\mathbf{TT}_{Si}\mathbf{TT}_{Ti}$

Where $\boldsymbol{\lambda}_{Gi}$ : Generic steady-state failure rate for device i

$\mathbf{TT}_{Qi}$ : Quality factor for device i

$\mathbf{TT}_{Si}$ : Stress factor for device i

**$TT_{Ti}$** : Temperature factor for device i

- **Calculation Parameter**

  Operation Temperature：25℃

  Environment：Ground Benign, Controlled

  Operation Stress：50% (Voltage, Current, Power)

  Method：Method I, Case 3

Products are advertised with MTBF up to 1 million hours in the market. Take one million hours as an example, the product's estimated life is 114 years. However, the current rapid progress of technology, advancement of flash storage device's manufacturing process research and development, and the supply period of former flash IC manufacturing processes are crucial to the actual life expectancy of flash products. In short, the MTBF of flash storage is for reference only. Good customer service and technical support provided by manufacturers is the most significant issue regarding to the life-span of products.

**Remark:**

All the details of testing and data are for reference only and do not imply any products performance as a result. MTBF is only an estimated date and is depends on both hardware and software. User shall not assume that all the products have the same MTBF as APRO estimates.

# 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 SLC SATA III CFast™ Card HERMES-G Series | | Standard Grade SxCFAxxxG-JGCTC | Industrial Grade WxCFAxxxG-JGITI |
|---|---|---|---|
| Temperature | Operating: | 0ºC ~ +70ºC | -40ºC ~ +85ºC |
| | Non-operating: | -20ºC ~ +80ºC | -50ºC ~ +95ºC |
| Humidity | Operating & Non-operating: | 10% ~ 95% non-condensing | |
| Vibration | Frequency / Acceleration: | 70 Hz to 2K 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 SLC SATA III CFast™ Card HERMES-G Series | | |
|---|---|---|
| DC Input Voltage (VCC) | | 3.3V±5% |
| Maximum average value | Reading Mode : | 240.0 mA (max.) |
| | Writing Mode : | 320.0 mA (max.) |
| | Idle Mode : | 110.0 mA (max.) |

## 2.3. System Performance

***Table 3: System Performances***

| Data Transfer Mode supporting | | Serial ATA Gen-III (6.0Gb/s = 768MB/s) | |
|---|---|---|---|
| Average Access Time | | 0.1 ms (estimated) | |
| Maximum Performance | Capacity | 1GB | 2GB |
| | Sequential Read (MB/s) | 30.0 | 61.4 |
| | Sequential Write(MB/s) | 14.0 | 27.9 |

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

## 2.4. System Reliability

***Table 4: System Reliability***

| | |
|---|---|
| **Wear-leveling Algorithms** | Static wear-leveling algorithms |
| **Bad Blocks Management** | Supportive |
| **ECC Technology** | 40 bits per 1024 bytes |
| **Thermal Sensor** | Supportive |
| **Erase counts** | NAND SLC Flash Cell Level：60K P/E Cycles |
| **Capacity** | **TBW(TB)** |
| **1GB** | 54 |
| **2GB** | 108 |

*Note:*

- *Test by sequential write.*
- *The endurance of SSD could be varying 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 2 for APRO SLC SATA III CFast™ Card HERMES-G Series physical specifications and dimensions.

***Table 5: Physical Specifications of APRO SLC SATA III CFast™ Card-HERMES-G Series***

| | |
|---|---|
| **Length:** | 36.4 mm |
| **Width:** | 42.8 mm |
| **Thickness:** | 3.5 mm |
| **Weight:** | Plastic frame-kit: 10g / 0.35 oz.<br>Metal frame-kit: 13g / 0.46 oz. |

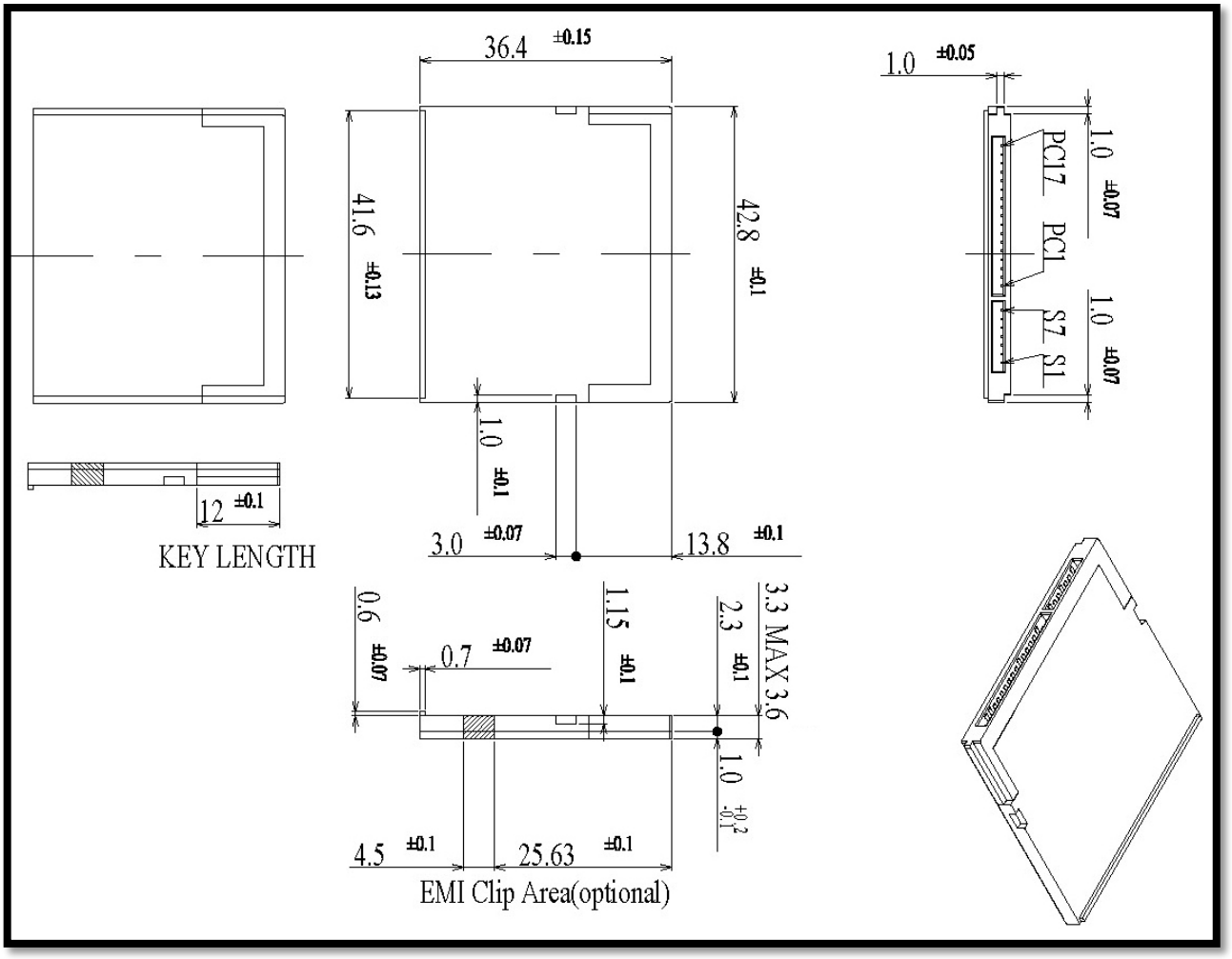


***Figure 2: APRO SLC SATA III CFast™ Card Dimension***

## 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. Interface Description

## 3.1. SLC SATA III CFast™ Card interface

APRO SLC SATA III CFast™ Card HERMES-G Series is equipped with 7 pins in the signal segment and 17 pins in the power segment.

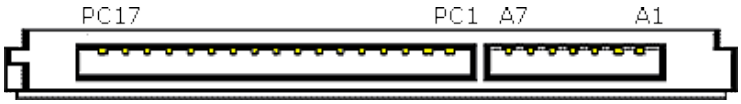


***Figure 3: The connectors of Signal Segment and Power Segment***

## 3.2. Pin Assignments

APRO SLC SATA III CFast™ Card HERMES-G 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** |
| **A1** | GND | NA |
| **A2** | A+ | Differential Signal Pair A |
| **A3** | A- | |
| **A4** | GND | NA |
| **A5** | B- | Differential Signal Pair B |
| **A6** | B+ | |
| **A7** | GND | NA |

| | | |
|---|---|---|
| **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** | LED1 | LED Output |
| **P9** | LED2 | LED Output |
| **P10** | NA | Reserved |
| **P11** | NA | Reserved |
| **P12** | IFDET | NA |
| **P13** | PWR | Device Power |
| **P14** | PWR | Device Power |
| **P15** | PGND | Device Ground |
| **P16** | PGND | Device Ground |
| **P17** | CDO | Card Detect Out |

***Table 6 - Pin Assignments***

## Appendix A: Limited Warranty

APRO warrants your SLC SATA III CFast™ Card HERMES-G 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:***

- **SLC STD. Grade 3 years / Within 60K Erasing Counts**
- **SLC IND. Grade 5 years / Within 60K Erasing Counts**

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