SLC

Industrial SATA III CFast™ Card

PHANES-K Series

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ISO 9001 : 2015 CERTIFIED

Product Features

- ■ **Flash IC**

  - TOSHIBA NAND Flash IC.

  - Single-Level Cell (SLC) management

- ■ **Compatibility**

  - Compliant with SATA Revision 3.2

  - Compliant with CFast™ Specification 2.0

  - SATA 1.5Gbps/3.0Gbps/6.0Gbps data transfer rate.

  - ATA-8 ACS4 command set

- ■ **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

  - Support DIPM/HIPM Mode for power saving

- ■ **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: 1,650.0 mW (max.)

  - Write Mode: 1,700.0 mW (max.)

  - Idle Mode: 325.0 mW (max.)

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

  - Sequential Read: 510.0 MB/sec. (max.)

  - Sequential Write: 305.0 MB/sec. (max.)

- ■ **Capacity**

  - 8GB, 16GB and 32GB

- ■ **Reliability**

  - **TBW:** Up to 325 TBW at 32GB Capacity. (Client workload by 219A)

  - **MTBF:** > 3,000,000 hours.

  - **ECC:** Designed with hardware LDPC ECC engine with hard-decision and soft-decision decoding.

  - **Temperature:** (Operating)

    Standard Grade: 0°C ~ +70°C

    Industrial Grade: -40°C ~ +85°C

  - **Vibration:** 80 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 Industrial SATA III CFast^{TM} Card PHANES-K Series with plastic frame kit**

Product Picture	*Grade*	*Standard grade (0°C ~ 70°C)*	*Industrial Grade (-40°C ~ +85°C)*
	8GB	SPCFA008G-PKCTC-(T)	WPCFA008G-PKITI-(T)
	16GB	SPCFA016G-PKCTC-(T)	WPCFA016G-PKITI-(T)
	32GB	SPCFA032G-PKCTC-(T)	WPCFA032G-PKITI-(T)

◆ **APRO SLC Industrial SATA III CFast^{TM} Card PHANES-K Series with rugged metal frame kit**

Product Picture	*Grade*	*Standard grade (0°C ~ 70°C)*	*Industrial Grade (-40°C ~ +85°C)*
	8GB	SRCFA008G-PKCTC-(T)	WRCFA008G-PKITI-(T)
	16GB	SRCFA016G-PKCTC-(T)	WRCFA016G-PKITI-(T)
	32GB	SRCFA032G-PKCTC-(T)	WRCFA032G-PKITI-(T)

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. 0° C ~ 70 ° C

W: Industrial 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**

CFA : CFast^{TM} Card

X6 X7 X8 X9 : **Capacity**

008G:	8GB	**032G:**	32GB
016G:	16GB		

X11 : **Controller**

P : PHANES 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**

Blank : Standard product w/o thermal sensor and conformal-coating

T : Thermal Sensor(optional)

C : Conformal-coating(optional)

Revision History

Revision	Description	Date
1.0	Initial release.	2018/11/23
1.1	Updated Version	2018/11/28
2.0	Updated document form	2019/05/24

Contents

1. Introduction

APRO SLC industrial SATA III CFast™ Card PHANES-K 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 support SATA 1.5Gb/s; SATA 3Gb/s & SATA 6Gb/s data transfer rate with high performance, the transfer speed is much higher than traditional CF Card while it keeps small form factor and rigid case as CF Card. The APRO SLC industrial SATA III CFast™ Card PHANES-K Series 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 for 8GB, 16GB and 32GB capacities.

APRO SLC industrial SATA III CFast™ Card PHANES-K Series features with great portability and resistance against vibration. The sequential read speed is 540.0 MB/sec and sequential write speed is 305.0 MB/sec for Single Level Cell (SLC) solution. Furthermore, APRO also provide 1.8″ SATA to CFast™ card Adapter (**P/N: AD-CA128SATA200AR**) to increase the application flexibility.

APRO SLC industrial SATA III CFast™ Card PHANES-K Series supports optional standard grade operating temperature 0°C ~ 70°C and industrial grade operating temperature -40°C ~ +85°C.

APRO SLC industrial SATA III CFast™ Card PHANES-K Series provides a high level interface to the host computer. This interface allows a host computer to issue commands to the APRO SLC industrial SATA III CFast™ Card PHANES-K 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 SLC industrial SATA III CFast™ Card PHANES-K Series intelligent controller manages interface protocols, data storage and retrieval as well as ECC, bad block management and diagnostics, power management and clock control.
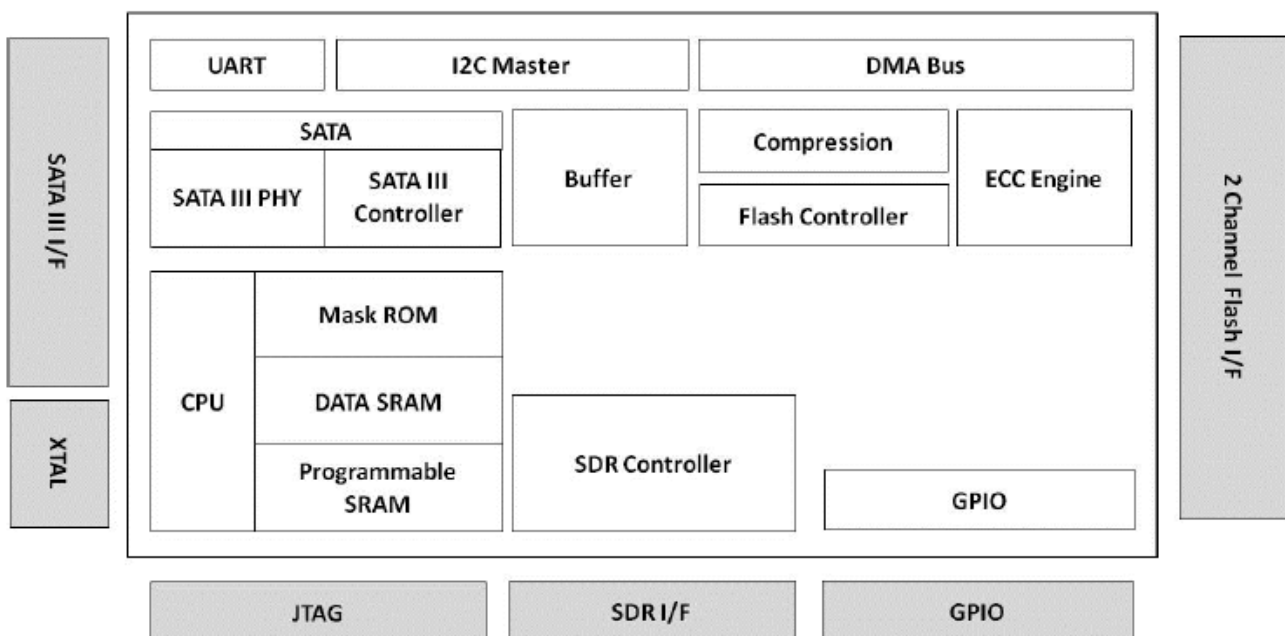

Figure 1: APRO SLC industrial SATA III CFastTM Card PHANES-K Series block diagram

1.1. *Scope*

This document describes features, specifications and installation guide of APRO SLC industrial SATA III CFast™ Card PHANES-K 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 SLC industrial SATA III CFast™ Card PHANES-K 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 SLC industrial SATA III CFast™ Card PHANES-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.

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: $\mathbf{Af = e\{ (1/k \times Ea (1/273+Tmax - 1/273+Ttest)\}}$

Coffin-Manson Model: $\mathbf{Af = (\Delta Ttest/\Delta Tuse)m}$

➢   **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 (λ) = 10^9 hours (FITs)

MTBF=1/λ

$\lambda_{SSi} = \lambda_{Gi} TT_{Qi}TT_{Si}TT_{Ti}$

Where λ_{Gi} : Generic steady-state failure rate for device i

TT_{Qi} : Quality factor for device i

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 PHANES-K Series		Standard Grade SxCFAxxxG-PKCTC	Industrial Grade WxCFAxxxG-PKITI
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	Frequency/Acceleration:	80 Hz to 2000 Hz, 20G, 3 axes	
Shock	Operating & Non-operating:	0.5ms, 1500 G, 3 axes	
Electrostatic Discharge (ESD)	Temperature:	24°C	
	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 PHANES-K Series		
DC Input Voltage (VCC)		3.3V±5%
Maximum average value	Reading Mode :	1,650.0 mW (max.)
	Writing Mode :	1,700.0 mW (max.)
	Idle Mode :	325.0 mW (max.)

2.3. System Performance

Table 3: System Performances

Data Transfer Mode supporting		Serial ATA Gen-III (6.0Gb/s = 768MB/s)		
Maximum Performance	Capacity	8GB	16GB	32GB
	Sequential Read (MB/s)	320.0	540.0	510.0
	Sequential Write (MB/s)	70.0	155.0	305.0

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

2.4. System Reliability

Table 4: System Reliability

Wear-leveling Algorithms	Static and Dynamic wear-leveling algorithms		
Bad Block Management	Supportive		
ECC Technology	Hardware design LDPC (Low Density Parity Check)		
Erase counts	NAND SLC Flash Cell Level : 60K P/E Cycles		
TBW (Tera Bytes Written)			
Capacity	8GB	74.0	
	16GB	153.0	
	32GB	325.0	

Note:

➤ *Samples were built using Toshiba SLC NAND flash.*

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 2 for APRO SLC industrial SATA III CFast™ Card PHANES-K Series physical specifications and dimensions.

Table 5: Physical Specifications of APRO SLC industrial SATA III CFastTM Card PHANES-K Series

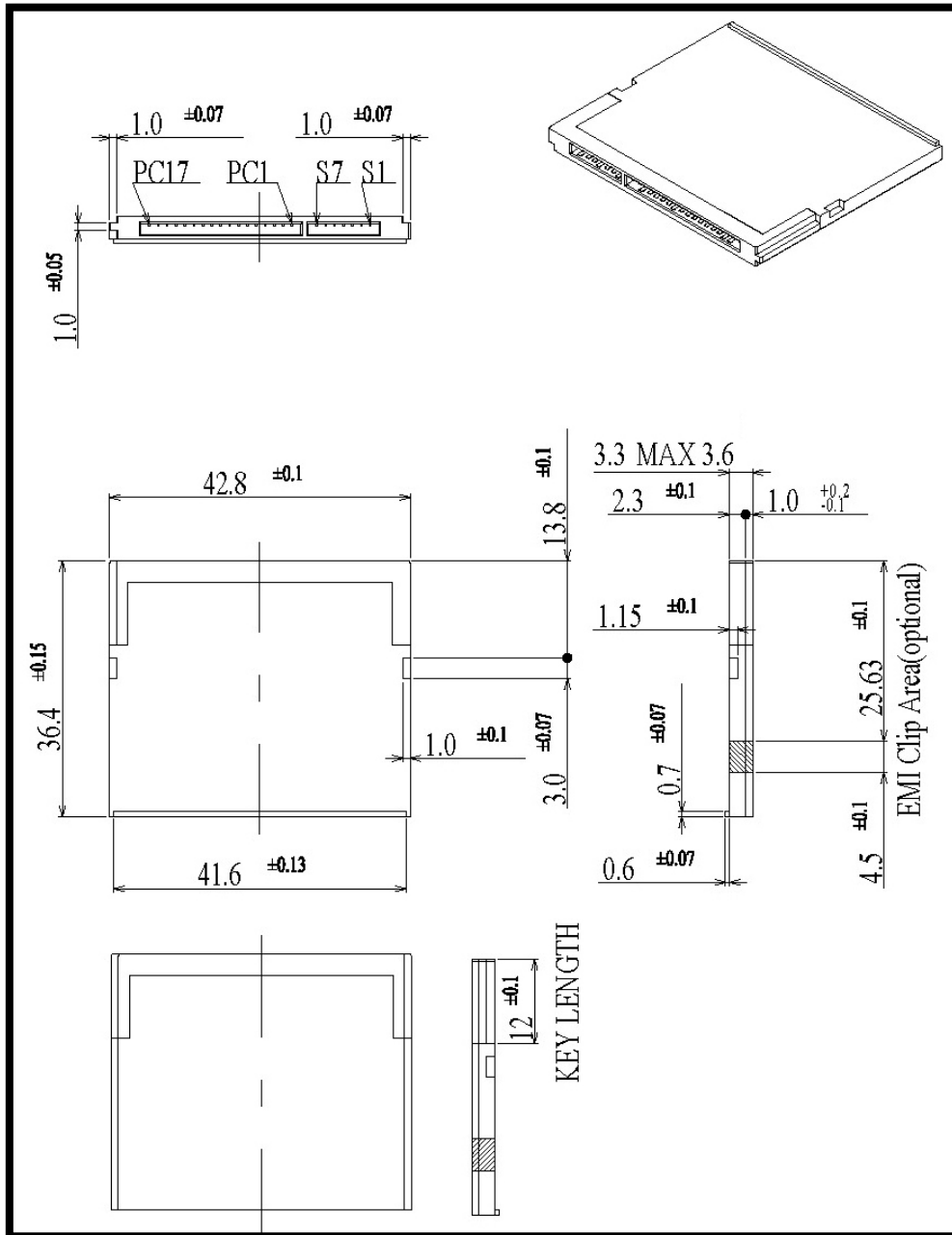| Length:	36.4 mm
Width:	42.8 mm
Thickness:	3.5 mm
Weight:	**Plastic frame-kit:** 10g /0.35 oz. **Metal frame-kit:** 13g /0.46 oz.

Figure 2: APRO SLC industrial SATA III CFastTM Card PHANES-K 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

2. Interface Description

3.1. SLC SATA III CFast^{TM} Card interface

APRO SLC industrial SATA III CFast^{TM} Card PHANES-K 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 industrial SATA III CFast™ Card PHANES-K 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	GND	NA
S2	A+	Differential Signal Pair A
S3	A-	
S4	GND	NA
S5	B-	Differential Signal Pair B
S6	B+	
S7	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 industrial SATA III CFast^{TM} Card PHANES-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:

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

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