APRO Co., Ltd.

3D NAND Flash

(TOSHIBA **BiCS FLASH™**)

2.5" Rugged Metal SATA III SSD

PHANES-K Series

(7mm Thickness)

Document No. : 100-xR7SF-PKCT3

Version No. : 02V1

Date : October, 2019

ISO 9001 : 2015 CERTIFIED

Product Features

- **Flash IC**
  - TOSHIBA **BiCS FLASH™.**[*3]
  - 3D NAND Flash

- **Compatibility**
  - Compliant with SATA Revision 3.2
  - SATA 1.5Gb/s; SATA 3Gb/s & SATA 6Gb/s
  - Interface compatible.
  - 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**
  - Standard 2.5" SATA Flash Disk form-factor (7mm)
  - SATA 7-pin (data) + 15-pin (power connector) SATA Interface
  - Dimension: 100.0 mm x 69.9 mm x 7.0 mm.
  - Weight: 50.0 g / 1.76 oz.

- **Power Operating Voltage 5V(+/-) 5%**
  - Read Mode: 1,575.0 mW (max.)
  - Write Mode: 1,680.0 mW (max.)
  - Idle Mode: 320.0 mW (max.)

- **Performance (Maximum value) *[2]**
  - Sequential Read: 550.0 MB/sec. (max.)
  - Sequential Write: 500.0 MB/sec. (max.)

- **Capacity**
  - 32GB, 64GB, 128GB, 256GB, 512GB and 1TB

- **Reliability**
  - **TBW:** Up to 835 TBW at 1TB Capacity. (Client workload by JESD-219A)
  - **ECC:** Designed with hardware LDPC ECC engine with hard-decision and soft-decision decoding.
  - **Temperature:** (Operating)
    Standard Grade: 0ºC ~ +70ºC
    Wide Temp. Grade: -40ºC ~ +85ºC
  - **Vibration:** 80Hz~2000Hz/20G.
  - **Shock:** 0.5ms, 1,500G, 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 Toshiba Corporation.

Order Information

I. Part Number List

◆ **APRO Rugged Metal 2.5" SATA III SSD (3D NAND FLASH) PHANES-K Series**

Product Picture	Grade	Standard grade (0°C ~ 70°C)	Wide Temp. Grade (-40°C ~ +85°C)
	32GB	SR7SF032G-PKCT3	WR7SF032G-PKCT3-C
	64GB	SR7SF064G-PKCT3	WR7SF064G-PKCT3-C
	128GB	SR7SF128G-PKCT3	WR7SF128G-PKCT3-C
	256GB	SR7SF256G-PKCT3	WR7SF256G-PKCT3-C
	512GB	SR7SF512G-PKCT3	WR7SF512G-PKCT3-C
	1TB	SR7SF001T-PKCT3	WR7SF001T-PKCT3-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 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**

R : Rugged Metal

X3 X4 X5 : **Product category**

7SF : 2.5" SATA III SSD w/7mm thickness

X6 X7 X8 X9 : **Capacity**

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

X11 : **Controller**

P : PHANES 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**

3 : BiCS 3D-NAND Flash IC.

X17 X18 X19 X20 : **Reserved for specific requirement**

C : Conformal coating (optional)

Revision History

Revision	Description	Date
1.0	Initial release.	2018/11/26
2.0	Updated document form	2019/05/22
2.1	Add 4KB Random Read/Write IOPS (QD32)	2019/10/21

Contents

1. Introduction

APRO Rugged Metal 2.5" SATA III SSD (3D NAND FLASH) PHANES-K Series provides high capacity flash memory Solid State Drive (SSD) that electrically complies with SATA Revision 3.2. APRO Rugged Metal 2.5" SATA III SSD (3D NAND FLASH) PHANES-K 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 are 32GB, 64GB, 128GB, 256GB, 512GB and 1TB.

The operating temperature grade is optional for standard grade 0°C ~ 70°C and Wide Temp. Grade -40°C ~ +85°C. The data transfer performance by sequential read is up to 550.0 MB/sec, and sequential write is up to 500.0 MB/sec.

APRO Rugged Metal 2.5" SATA III SSD (3D NAND FLASH) PHANES-K Series can be high speed booting SSD to varieties of IPC motherboards and PC structure system, and it is also suitable to handheld device embedded system, inventory recorder and particularly for serious environment monitor recorder system

APRO Rugged Metal 2.5" SATA III SSD (3D NAND FLASH) PHANES-K Series provides a high level interface to the host computer. This interface allows a host computer to issue commands to the APRO Rugged Metal 2.5" SATA III SSD (3D NAND FLASH) 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 Rugged Metal 2.5" SATA III SSD (3D NAND FLASH) 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.

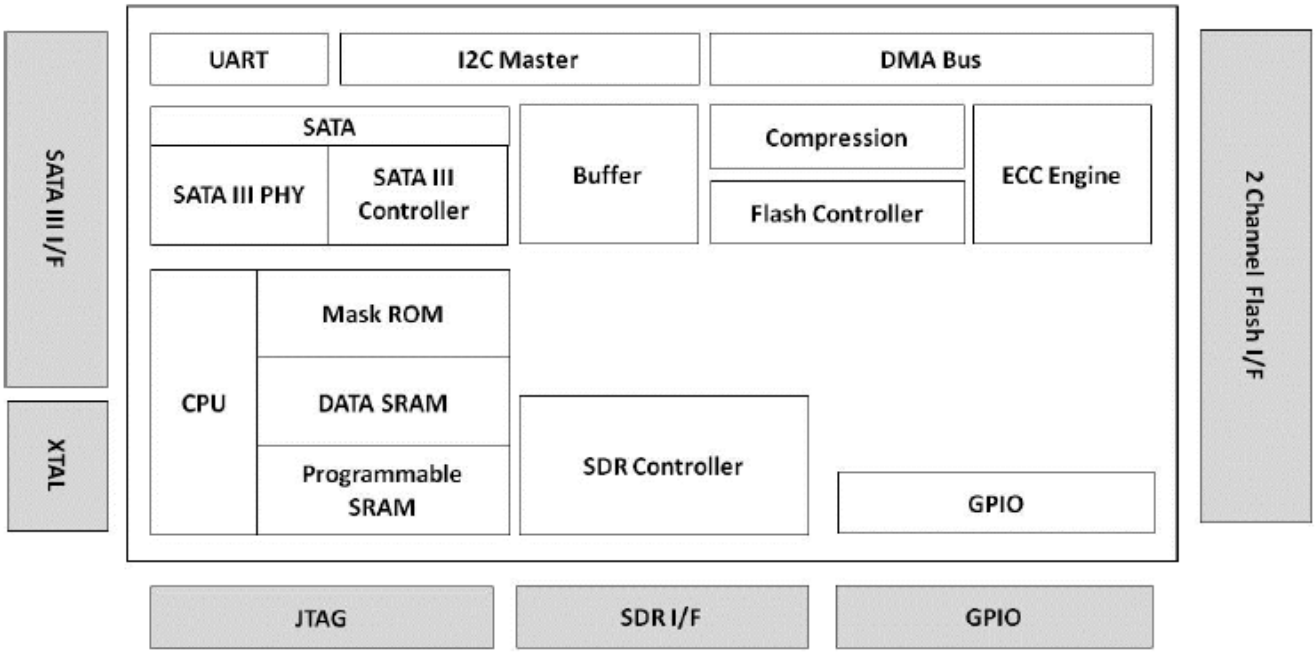

Figure 1: APRO Rugged Metal 2.5" SATA III SSD (3D NAND FLASH) PHANES-K Series block diagram

1.1. *Scope*

This document describes features, specifications and installation guide of APRO Rugged Metal 2.5" SATA III SSD (3D NAND FLASH) 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 Rugged Metal 2.5" SATA III SSD (3D NAND FLASH) 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 Rugged Metal 2.5" SATA III SSD (3D NAND FLASH) 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. *Error Correcting Coding (ECC)*

APRO Rugged Metal 2.5" SATA III SSD (3D NAND FLASH) PHANES-K Series provides a high level interface to the host computer. This interface allows a host computer to issue commands to the APRO Rugged Metal 2.5" SATA III SSD (3D NAND FLASH) 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 Rugged Metal 2.5" SATA III SSD (3D NAND FLASH) 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.

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.

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 Rugged Metal 2.5" SATA III SSD (3D NAND FLASH) PHANES-K Series		Standard Grade	Wide Temp. Grade
		SR7SFxxxG-PKCT3	WR7SFxxxG-PKCT3-C
Temperature	Operating:	0ºC ~ +70ºC	-40ºC ~ +85ºC
	Non-operating:	-20ºC ~ +80ºC	-50ºC ~ +95ºC
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 Rugged Metal 2.5" SATA III SSD (3D NAND FLASH) PHANES-K Series		
DC Input Voltage (VCC)		5V±5%
Maximum average value	Reading Mode :	1,575.0 mW (max.)
	Writing Mode :	1,680.0 mW (max.)
	Idle Mode :	320.0 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	32GB	64GB	128GB	256GB	512GB	1TB
	Sequential Read (MB/s)	300.0	550.0	550.0	550.0	550.0	550.0
	Sequential Write (MB/s)	125.0	255.0	450.0	490.0	490.0	500.0
	4KB Random Read IOPS (QD32)	18.8K	35.0K	65.2K	79.2K	77.1K	77.2K
	4KB Random Write IOPS (QD32)	29.8K	61.2K	82.4K	84.5K	85.3K	88.4K

Note:

- *The performance was measured using CrystalDiskMarkv5.0; 1GB data size test with SATA 6Gbps host.*
- *Samples were built using Toshiba 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
ECC Technology		Hardware design LDPC (Low Density Parity Check)
Erase counts		TOSHIBA **BiCS FLASH™** 3D NAND Flash: 3K P/E Cycles
TBW (Tera Bytes Written)		
Capacity	32GB	17.0
	64GB	42.0
	128GB	75.0
	256GB	180.0
	512GB	425.0
	1TB	835.0

Note:

- *Client workload by JESD-219A.*
- *Samples were built using Toshiba BiCS 3D-NAND FLASH*
- *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 Rugged Metal 2.5" SATA III SSD (3D NAND FLASH) PHANES-K Series physical specifications and dimensions.

Table 5: Physical Specifications of 2.5" SATA III SSD-PHANES-K Series

Length:	100.0 mm
Width:	69.90 mm
Thickness:	7.0 mm
Weight:	50.0 g / 1.76 oz.

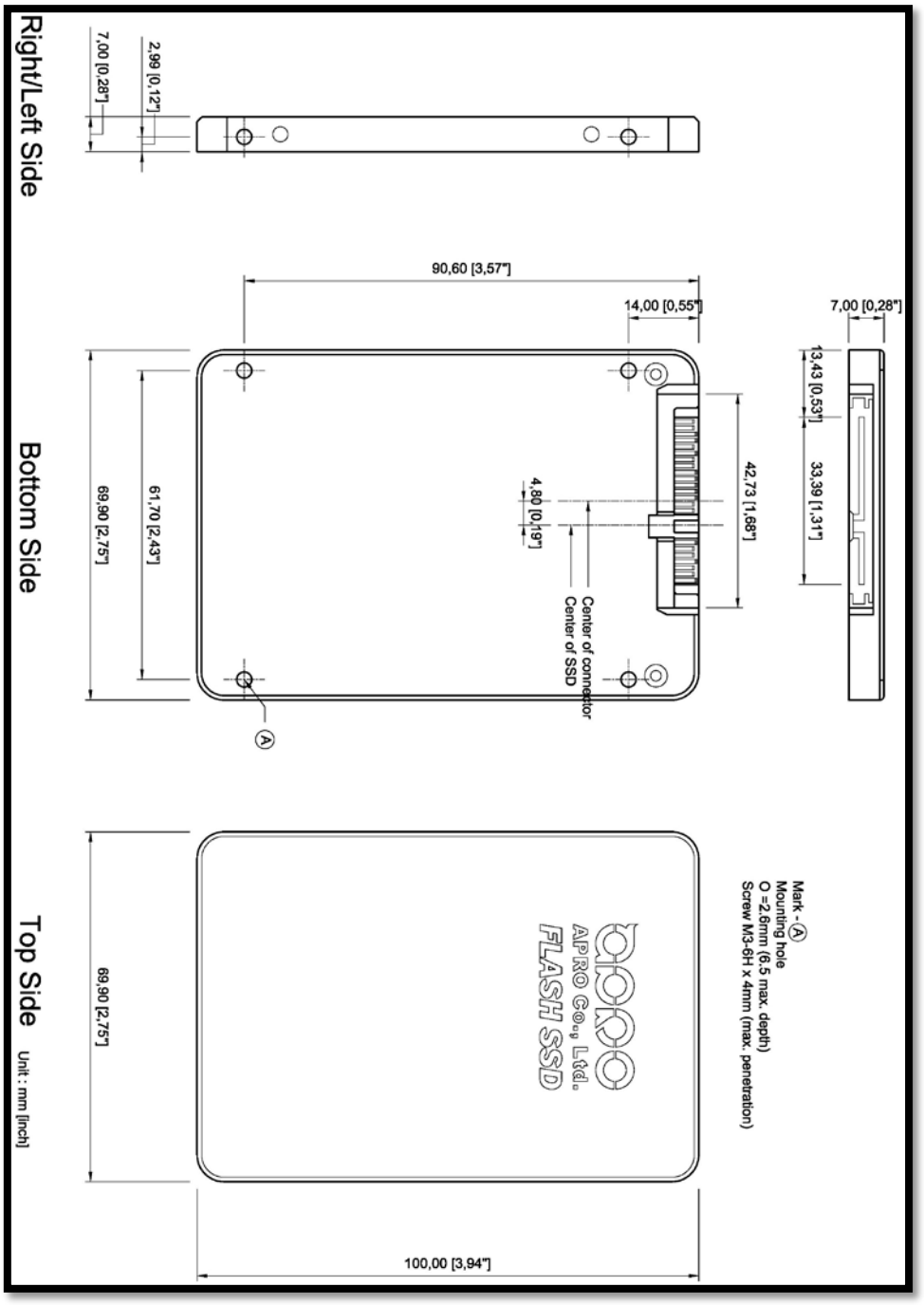

Figure 2: APRO Rugged Metal 2.5" SATA III SSD (3D NAND FLASH) PHANES-K Series Dimension

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

3. *Interface Description*

3.1. *Rugged Metal 2.5" SATA III SSD interface*

APRO Rugged Metal 2.5" SATA III SSD (3D NAND FLASH) PHANES-K Series is equipped with 7 pins in the signal segment and 15 pins in the power segment.

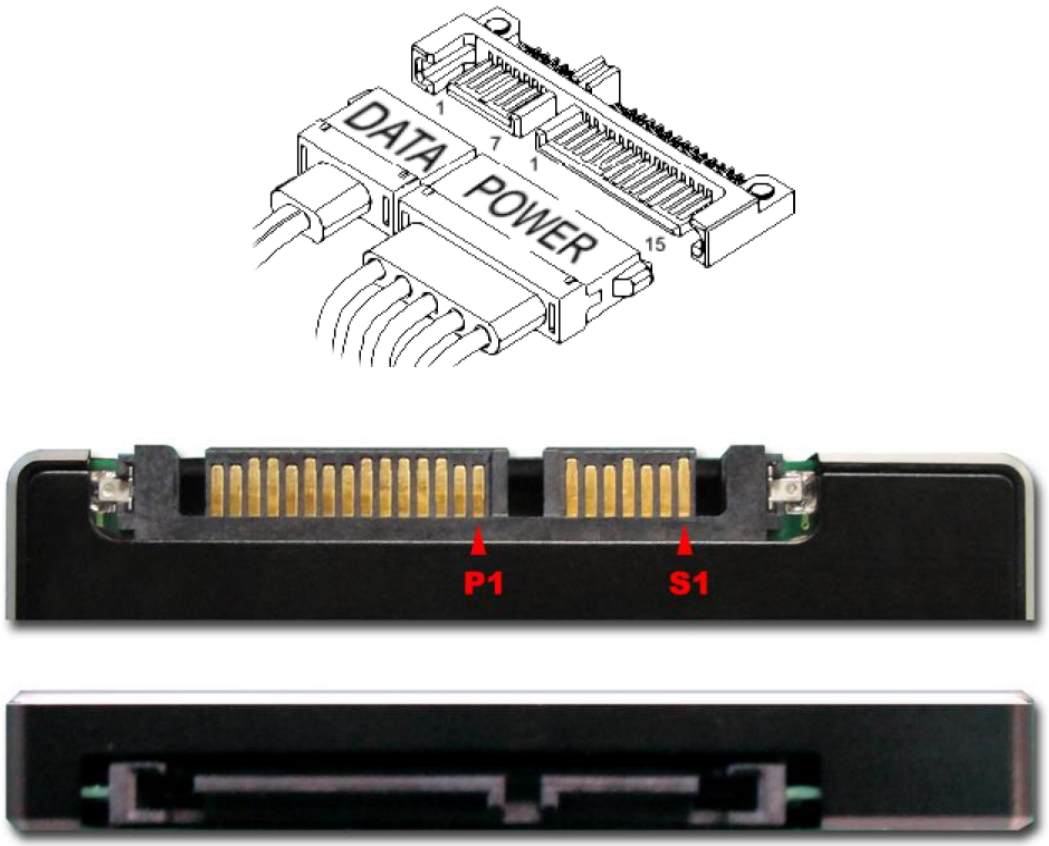

Figure 3: The connectors of Signal Segment and Power Segment

3.2. Pin Assignments

There are total of 7 pins in the signal segment and 15 pins in the power segment.

The pin assignments are listed in below table 6.

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

Key and Spacing separate signal and power segments		
P1	NC	NA
P2	NC	NA
P3	DEVSLP	NA
P4	GND	NA
P5	GND	NA
P6	GND	NA
P7	V5	5V Power, Pre-Charge
P8	V5	5V Power
P9	V5	5V Power
P10	GND	NA
P11	Reversed	
P12	GND	NA
P13	NC	NA
P14	NC	NA
P15	NC	NA

Table 6 - Pin Assignments

Appendix A: Limited Warranty

APRO warrants your Rugged Metal 2.5" SATA III SSD (3D NAND FLASH) 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:

- **3D NAND FLASH (Standard grade / Wide Temp. Grade) 2 years / Within 3K Erasing Counts**

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