MLC

2.5″ Rugged Metal SATA III SSD

PHANES-HR Series

Supports DRAM Cache

(7mm Thickness)

Document No. : 100-xR7SR-PHCTMB

Version No. : 02V0

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ISO 9001 : 2015 CERTIFIED

Product Features

■ **Flash IC**

- TOSHIBA 15nm NAND Flash IC.

- Multi-Level Cell (MLC) technology.

■ **Compatibility**

- SATA Revision 3.2

- SATA 1.5Gb/s; SATA 3Gb/s & SATA 6Gb/s data transfer rate.

- ATA-8 ACS2 command set

■ **Additional Capabilities**

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

- Thermal Monitor for SSD's temperature.

- Native Command Queuing (NCQ) support.

- TRIM maintenance command support.

- Static and Dynamic Wear Leveling

- Power Loss Protection

- Over-Provision

- Bad Block Management

- Support expanded register for SATA protocol 48 bits addressing mode

■ **Mechanical**

- Standard 2.5″ SATA Flash Disk form-factor

- SATA 7-pin (data) + 15-pin (power connector) SATA Interface

- Dimension: 100.0 mm x 69.9 mm x 7.0 mm

- Weight: 65.0 g / 2.29 oz.

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

- Read Mode: 3,150.0 mW (max.)

- Write Mode: 5,500.0 mW (max.)

- Idle Mode: 190.0 mW (max.)

■ **Performance (Maximum value) [2]**

- Sequential Read: 565.0 MB/sec. (max.)

- Sequential Write: 501.0 MB/sec. (max.)

- 4KB Random Read IOPS (QD32): 76K (max.)

- 4KB Random Write IOPS (QD32): 80K (max.)

- 4KB Random Read access time: 0.12ms

- 4KB Random Write access time: 0.04ms

■ **Capacity**

- 64GB, 128GB, 256GB, 512GB, 1TB and 2TB.

■ **Reliability**

- **TBW:** Up to 4,144 TBW by 2TB Capacity. (Sequential Write)

- **ECC Scheme:** Automatic 120 bits per 2K bytes error correction (ECC) and retry capabilities

- **Temperature:** (Operating)
  Standard Grade: 0°C ~ +70°C
  Wide Temp. Grade: -40°C ~ +85°C

- **Vibration:** 80 Hz to 2000 Hz, 20G, 3 axes.

- **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. Typical I/O performance numbers as measured fresh-out-of-the-box (FOB) using Iometer with a queue depth of 32

Order Information

I. Part Number List

◆ APRO MLC Rugged Metal 2.5″ SATA III SSD PHANES-HR Series

Product Picture	Grade	Standard grade (0°C ~ 70°C)	Wide Temp Grade (-40°C ~ +85°C)
	64GB	SR7SR064G-PHCTMB	WR7SR064G-PHCTMBC
	128GB	SR7SR128G-PHCTMB	WR7SR128G-PHCTMBC
	256GB	SR7SR256G-PHCTMB	WR7SR256G-PHCTMBC
	512GB	SR7SR512G-PHCTMB	WR7SR512G-PHCTMBC
	1TB	SR7SR001T-PHCTMB	WR7SR001T-PHCTMBC
	2TB	SR7SR002T-PHCTMB	WR7SR002T-PHCTMBC

Notes:

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

II. Part Number Decoder:

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

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**

7SR : 2.5″ SATA SSD with DRAM Cache

X6 X7 X8 X9 : **Capacity**

064G:	64GB	**512G**	512GB
128GB:	128GB	**001T**	1TB
256G:	256GB	**002T**	2TB

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**

M : MLC-NAND Flash IC

X16 :**Flash IC**

B : Toshiba 15nm MLC

X18 : **Reserved for specific requirement**

C : Conformal-coating (optional)

Revision History

Revision	Description	Date
1.0	Initial release	2016/04/20
1.1	Add. 2TB Power consumption	2017/07/18
1.2	Updated Version	2018/11/28
1.3	Updated power consumption & performance	2019/04/24
2.0	Updated document form	2019/05/28

Contents

APRO
Product Specifications

1. Introduction

APRO MLC Rugged Metal 2.5″ SATA III SSD PHANES-HR Series provides high capacity flash memory Solid State Drive (SSD) that electrically complies with SATA Revision 3.2. APRO MLC Rugged Metal 2.5″ SATA III SSD PHANES-HR Series support SATA 1.5Gb/s; SATA 3Gb/s & SATA 6Gb/s data transfer rate with high performance. The available disk capacities are 64GB, 128GB, 256GB, 512GB, 1TB and 2TB..

The operating temperature grade is optional for Standard grade 0°C ~ 70°C and wide temp grade with conformal coating supports -40°C ~ +85°C. The data transfer performance by sequential read is up to 550.0 MB/sec, and sequential write is up to 530.0 MB/sec. which is based on Toshiba's 15nm Toggle MLC flash (with 256MB/512MB/1024/2048 MB dram cache enabled.)

APRO MLC Rugged Metal 2.5″ SATA III SSD PHANES-HR Series products provide a high level interface to the host computer. This interface allows a host computer to issue commands to the APRO MLC Rugged Metal 2.5″ SATA III SSD PHANES-HR Series to read or write blocks of memory. Each sector is protected by a powerful 120 bits per 2K bytes error correction (ECC). APRO MLC Rugged Metal 2.5″ SATA III SSD PHANES-HR Series intelligent controller manages interface protocols, data storage and retrieval as well as ECC, defect handling and diagnostics, power management and clock control.
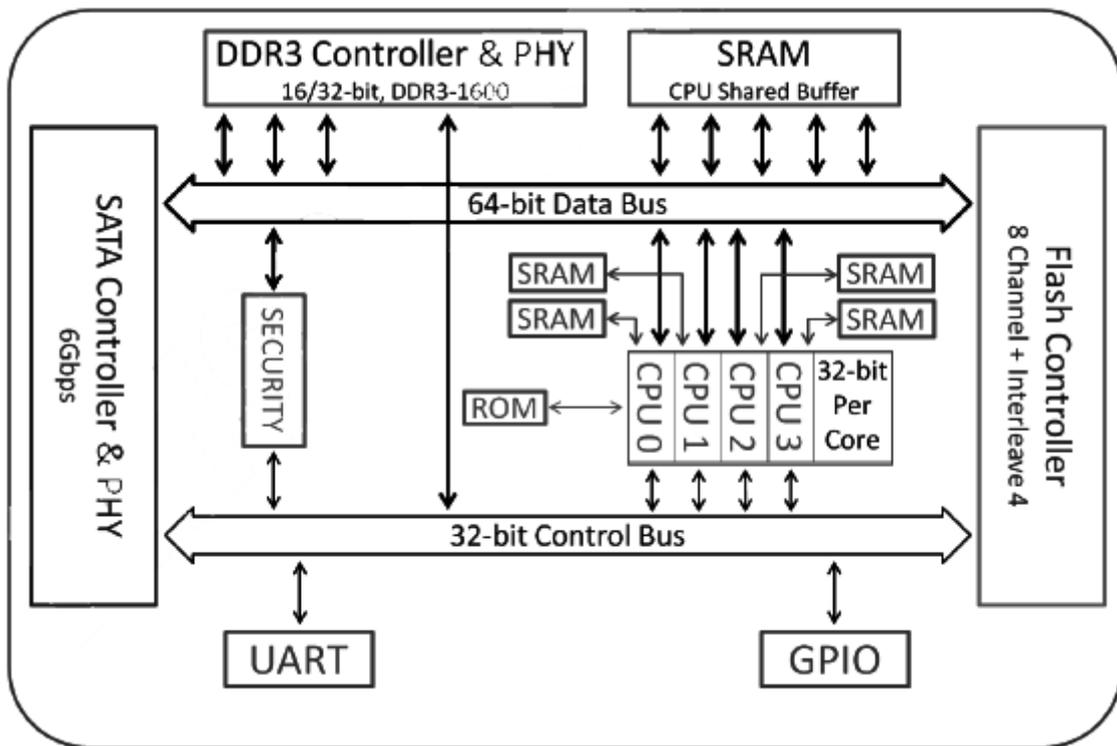

Figure 1: APRO MLC Rugged Metal 2.5″ SATA III SSD PHANES-HR Series block diagram

1.1. *Scope*

This document describes features, specifications and installation guide of APRO MLC Rugged Metal 2.5″ SATA III SSD PHANES-HR Series. In the appendix, there provides order information, warranty policy, RMA/DOA procedure for the most convenient reference.

1.2. *Flash Management Technology - Static and 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 MLC Rugged Metal 2.5″ SATA III SSD PHANES-HR 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 MLC Rugged Metal 2.5″ SATA III SSD PHANES-HR 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. *Power Loss Protection: Flushing Mechanism*

Power Loss Protection is a mechanism to prevent data loss during unexpected power failure. DRAM is a volatile memory and frequently used as temporary cache or buffer between the controller and the NAND flash to improve the SSD performance. However, one major concern of the DRAM is that it is not able to keep data during power failure. Accordingly, APRO's MLC SSD applies the Guaranteed Flush technology, which requests the controller to transfer data to the cache. Only when the data is fully committed to the NAND flash will the controller send acknowledgement (ACK) to the host.

Such implementation can prevent false-positive performance and the risk of power cycling issues.

Additionally, it is critical for a controller to shorten the time the in-flight data stays in the cache. Thus, APRO MLC Rugged Metal 2.5″ SATA III SSD PHANES-HR Series applies an algorithm to reduce the amount of data resides in the cache to provide a better performance. This SmartCacheFlush technology allows incoming data to only have a "pit stop" in the cache and then move to the NAND flash at once. If the flash is jammed due to particular file sizes (such as random 4KB data), the cache will be treated as an "organizer", consolidating incoming data into groups before written into the flash to improve write amplification.

1.5. *DRAM Buffer*

SSDs designed with a DRAM buffer which is support high transfer rate as a data buffer for the SSD; SSD with DRAM buffer is able

to deliver excellent random data transfer speed.

➤ 64GB to 256GB Supports 4GBits DRAM Cache

➤ 512GB & 1TB Supports 8GBits DRAM Cache.

➤ 2TB Supports 16GBits DRAM Cache.

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 Rugged Metal 2.5" SATA III SSD PHANES-HR Series		Standard Grade SR7SRxxxG-PHCTMB	Wide Temp Grade WR7SRxxxG-PHCTMB/C
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 MLC Rugged Metal 2.5" SATA III SSD PHANES-HR Series		
DC Input Voltage (VCC)		5V±5%
Maximum average value	**Reading Mode :**	3,150.0 mW (max.)
	Writing Mode :	5,500.0 mW (max.)
	Idle Mode :	190.0 mW (max.)

2.3. System Performance

Table 3: System Performances

Data Transfer Mode supporting		Serial ATA Gen-III (6.0Gb/s = 768MB/s)					
4KB Random access time	Read:	0.12 ms.					
	Write:	0.04 ms.					
Maximum Performance	Capacity	**64GB**	**128GB**	**256GB**	**512GB**	**1TB**	**2TB**
	Sequential Read (MB/s)	542.0	563.0	563.0	563.0	561.0	565.0
	Sequential Write(MB/s)	101.0	203.0	402.0	529.0	523.0	501.0
	4KB Random Read IOPS (QD32)	51.0K	92.0K	93.0K	92.0K	91.0K	76.0K
	4KB Random Write IOPS (QD32)	24.0K	50.0K	73.0K	71.0K	74.0K	80.0K

Note: The performance was measured using CrystalDiskMark with SATA 6Gbps host.

2.4. System Reliability

Table 4: System Reliability

| Wear-leveling Algorithms		Static and Dynamic wear-leveling algorithms
Bad Blocks Management		Supportive
ECC Technology		120 bits per 2K bytes
Erase counts		NAND MLC Flash Cell Level : 3K P/E Cycles
TBW (Tera Bytes Written)		
Capacity	64GB	128.0
	128GB	257.0
	256GB	514.0
	512GB	1,028.0
	1TB	2,057.0
	2TB	4,114.0

Note:

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

➤ *Test by sequential Write.*

➤ *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 Rugged Metal 2.5″ SATA III SSD PHANES-HR Series physical specifications and

dimensions.

Table 5: Physical Specifications of APRO MLC Rugged Metal 2.5″ SATA III SSD PHANES-HR Series

Length:	100.0 mm
Width:	69.90 mm
Thickness:	7.0 mm
Weight:	65.0 g / 2.29 oz.
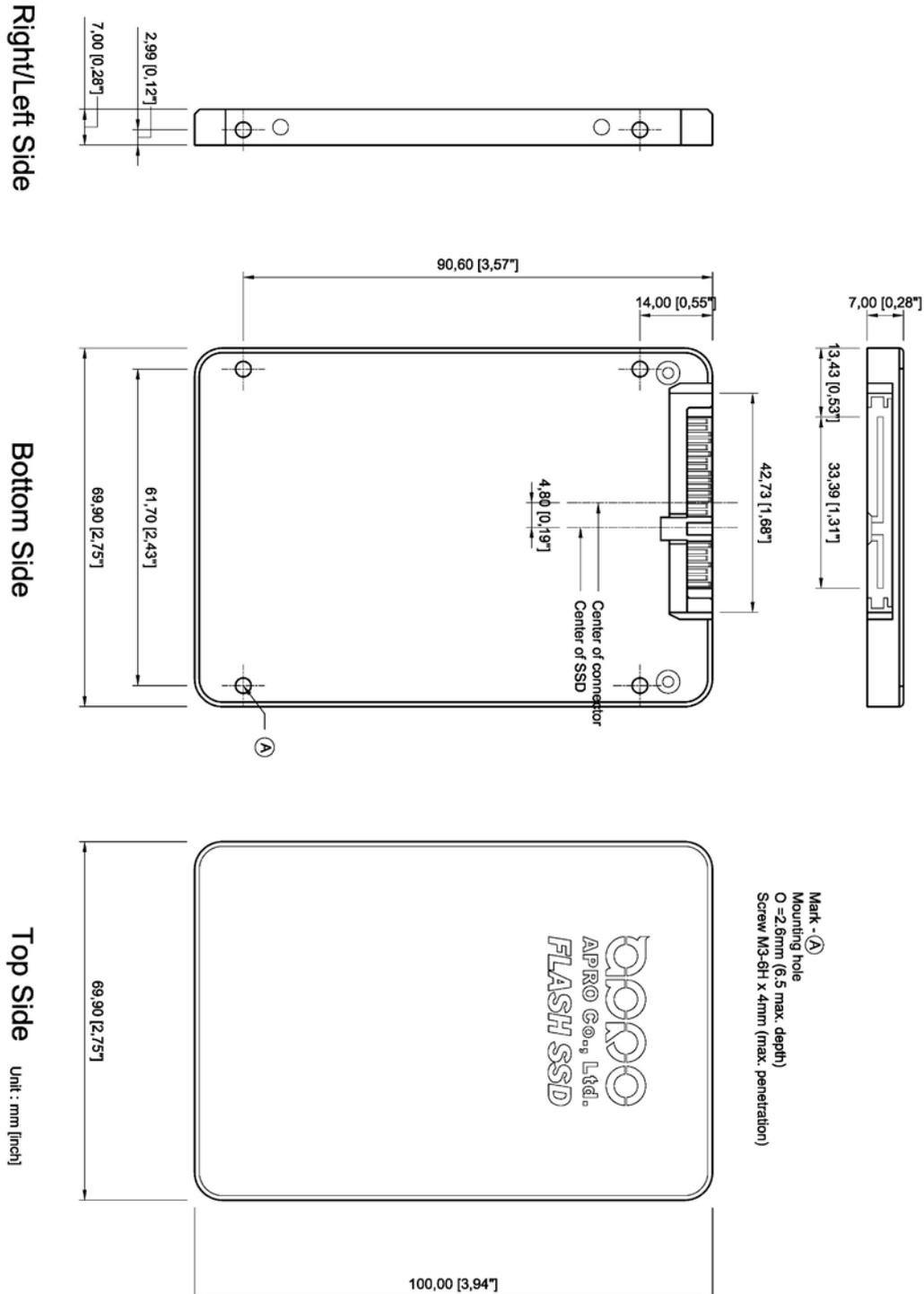
Figure 3: APRO MLC Rugged Metal 2.5″ SATA III SSD PHANES-HR Series Dimension

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 uses MIL-I-46058C silicon conformal coating

3.   *Interface Description*

3.1. *MLC 2.5″ SATA III SSD interface*

APRO MLC Rugged Metal 2.5″ SATA III SSD PHANES-HR Series is equipped with standard 7 pins + 15 pins Serial ATA connector.
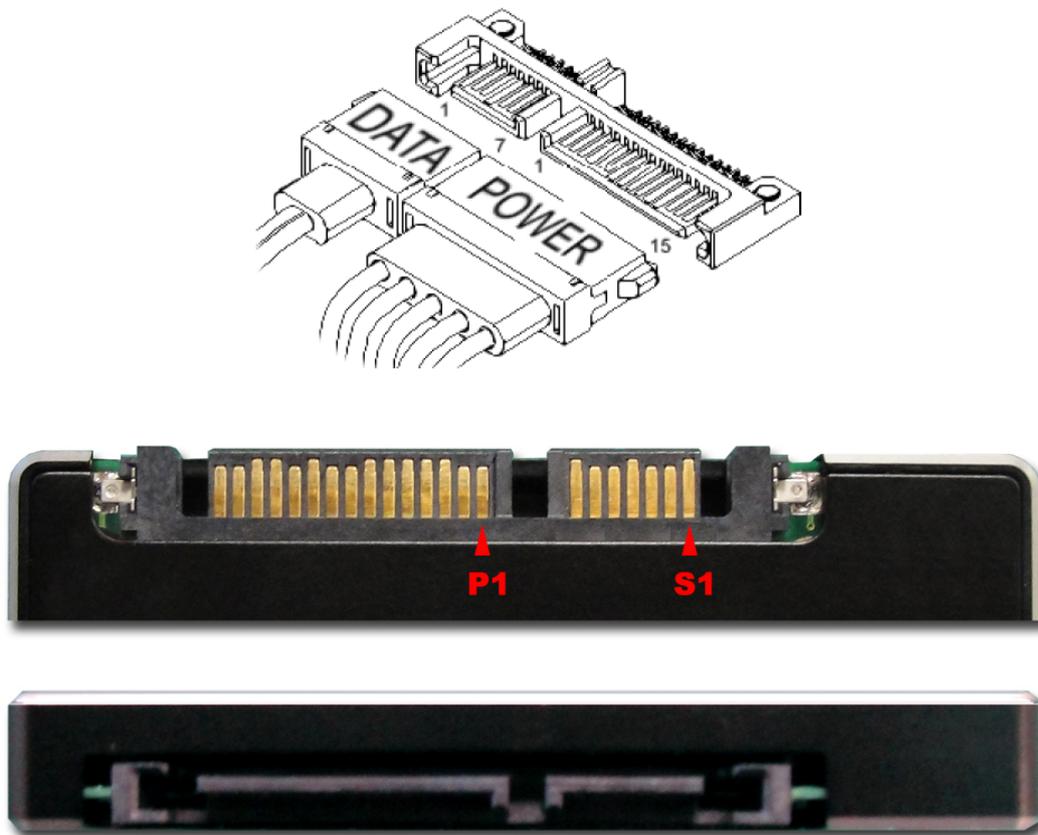

Figure 4: The connectors of APRO MLC Rugged Metal 2.5″ SATA III SSD PHANES-HR Series

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.

Table 6 - Pin Assignments

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	5V	5V Power, Pre-Charge
P8	5V	5V Power
P9	5V	5V Power
P10	GND	NA
P11	Reserved	Device Activity Signal / Disable Staggered Spin up
P12	GND	NA
P13	Not Used (12V pre-charge)	NA
P14	Not Used (12V)	NA
P15	Not Used (12V)	NA

Notes:

➢ *All pins are in a signal row with a 1.27 mm (0.050″ pitch).*

➢ *The commands on the mating sequence in forward table apply to the case of backplane blind mate connector only. In this case, the mating sequences are:*

➢ *(1) The pre-charge power pins and other ground pins.*

➢ *(2) The signal pins and the rest of the power pin*

Appendix A: Limited Warranty

APRO warrants your MLC Rugged Metal 2.5″ SATA III SSD PHANES-HR 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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