

# aSLC

## **2.5" Rugged Metal SATA III SSD**

### **PHANES-HR Series**

**Supports DRAM Cache**

**(7mm Thickness)**



**Document No. :** 100-xR7SR-PHCTMBAS

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ISO 9001 : 2015 CERTIFIED



### Product Features

#### ■ Flash IC

- TOSHIBA 15nm NAND Flash IC.
- Multi-Level Cell (MLC) management by enhance endurance technology (aSLC)

#### ■ 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. \*<sup>1</sup> (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: 100.0mm x 69.9mm x 7.0mm.
- Weight: 65.0 g / 2.29 oz.

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

- Read Mode: 2,520 mW (max.)
- Write Mode: 3,240 mW (max.)
- Idle Mode: 225 mW (max.)

#### ■ Performance (Maximum value) <sup>2, 3, 4</sup>

- Sequential Read: 564.0 MB/sec. (max.)
- Sequential Write: 540.0 MB/sec. (max.)
- 4KB Random Read IOPS (QD32): 95K
- 4KB Random Write IOPS (QD32): 86K
- 4KB Random Read latency time: 0.17ms
- 4KB Random Read latency time: 0.19ms

#### ■ Capacity

- 32GB, 64GB, 128GB, 256GB, 512GB, 1TB

#### ■ Reliability

- **TBW:** Up to 20,547 TBW by 1TB Capacity. (Sequential Write)
- **ECC Scheme:** up to 120 bits error in 2K Byte data
- **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
3. 4KB transfers used for READ/WRITE latency values
4. Performance values vary by capacity

### Order Information

#### I. Part Number List

##### ◆ APRO aSLC 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 )
	32GB	SR7SR032G-PHCTMBAS	WR7SR032G-PHCTMBASC
	64GB	SR7SR064G-PHCTMBAS	WR7SR064G-PHCTMBASC
	128GB	SR7SR128G-PHCTMBAS	WR7SR128G-PHCTMBASC
	256GB	SR7SR256G-PHCTMBAS	WR7SR256G-PHCTMBASC
	512GB	SR7SR512G-PHCTMBAS	WR7SR512G-PHCTMBASC
	1TB	SR7SR001T-PHCTMBAS	WR7SR001T-PHCTMBASC

#### 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 X17 X18 X19**

#### **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 Meta

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

**7SR** : 2.5" SATA SSD with DRAM Cache

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

**032G:** 32GB      **256G:** 256GB

**064G:** 64GB      **512G** 512GB

**128GB:** 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

**M** : MLC-NAND Flash IC

#### **X16** : Flash IC

**B** : Toshiba 15nm MLC

#### **X17 X18** : aSLC Technology

**AS** : aSLC Technology extends MLC product's lifespan

#### **X19** : Reserved for specific requirement

**C** : Conformal-coating (optional)

### Revision History

Revision	Description	Date
1.0	Initial release.	2016/04/29
1.1	Document format upgrade.	2017/03/22
1.2	Updated Version	2018/11/28
2.0	Updated power consumption & performance	2019/04/01
2.1	Updated document form	2019/05/22

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### 1. Introduction

APRO aSLC 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 aSLC 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 32GB, 64GB, 128GB, 256GB, 512GB, 1TB

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 564.0 MB/sec, and sequential write is up to 540.0 MB/sec.

APRO aSLC 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 aSLC 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 aSLC 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.

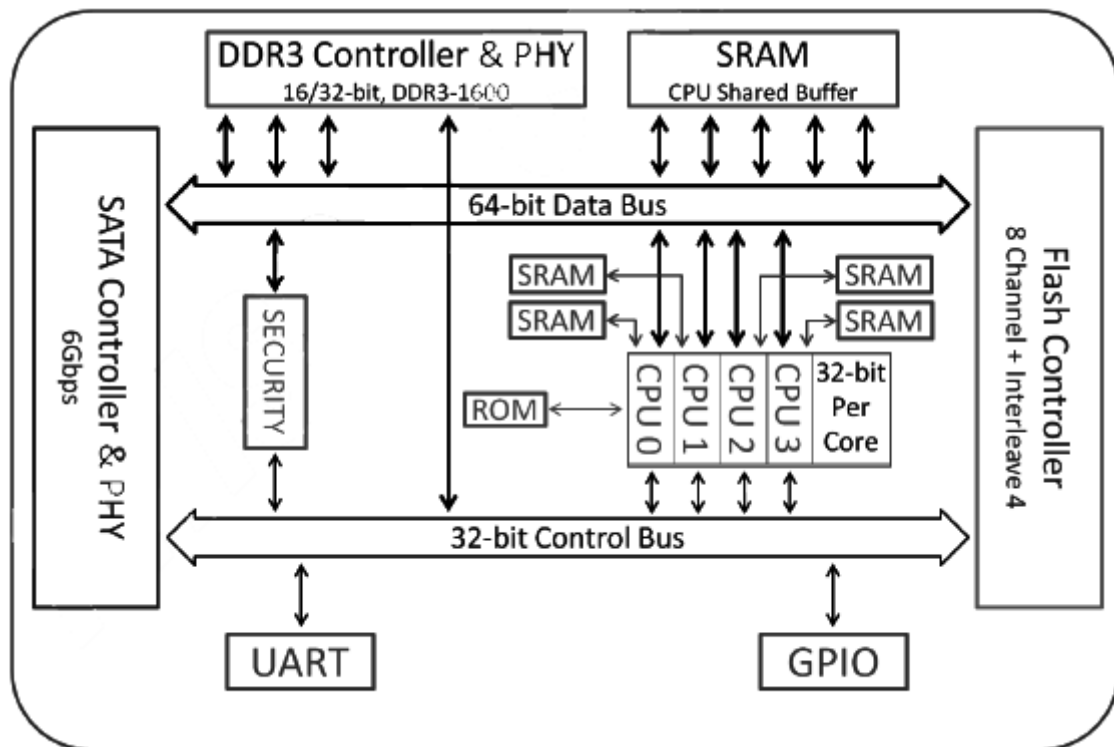


Figure 1: APRO aSLC Rugged Metal 2.5" SATA III SSD PHANES-HR Series block diagram

### 1.1. *Scope*

This document describes features, specifications and installation guide of APRO aSLC 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 - Dynamic and Static 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 aSLC 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**

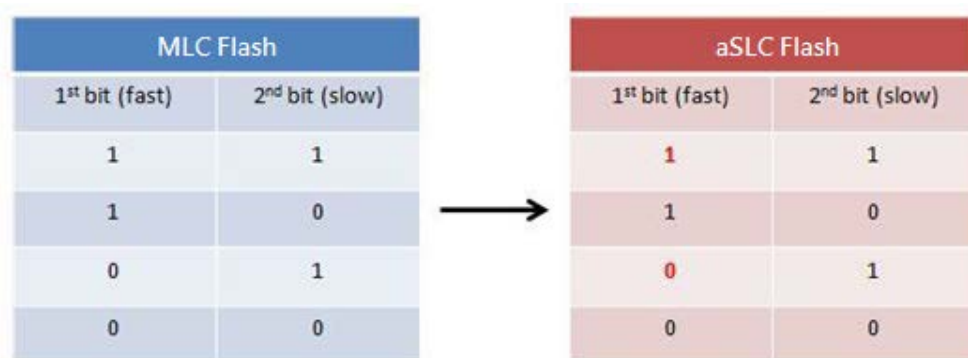
In the process of use, as the number of operations of writing and erasing increases, a fault block is gradually generated, which is called a Later Bad Block.

**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 aSLC 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. aSLC Technology

The aSLC can be considered as an extended version of the MLC. While MLC contains both fast and slow pages, aSLC only utilizes fast pages for programming. The concept of aSLC is demonstrated in the **Figure 2** below. The first and second bits of a memory cell represent a fast and slow page respectively, as shown in the left table. Since only fast pages are programmed when applying aSLC, the bits highlighted in red are used, as shown in the right table. As a result, aSLC provides better performance and endurance than MLC does. Moreover, the aSLC performs similarly to the SLC, yet more cost effective.



**Figure 2: The concept of APRO aSLC Rugged Metal 2.5" SATA III SSD PHANES-HR Series**

### 1.5. 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 aSLC 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 aSLC 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.



## 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 aSLC Rugged Metal 2.5" SATA III SSD		Standard Grade	Wide Temp Grade
PHANES-HR Series		SR7SRxxxG-PHCTMBAS	WR7SRxxxG-PHCTMBAS/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 aSLC Rugged Metal 2.5" SATA III SSD PHANES-HR Series			
DC Input Voltage (VCC)		5V±5%	
+5V Current (Maximum average value)	Reading Mode :	2,520.0 mW (512GB max.)	
	Writing Mode :	3,240.0 mW (512GB max.)	
	Idle Mode :	225.0 mW (512GB 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	32GB	64GB	128GB	256GB	512GB	1TB
	Sequential Read (MB/s)	565.0	563.0	559.0	564.0	559.0	559.0
	Sequential Write(MB/s)	354.0	517.0	526.0	540.0	536.0	536.0
	4KB Random Read IOPS (QD32)	72.0 K	96.0 K	97.0 K	94.0 K	95.0 K	95.0 K
	4KB Random Write IOPS (QD32)	72.0 K	80.0 K	80.0 K	79.0 K	86.0 K	86.0 K

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 w/aSLC Technology : 20K P/E Cycles
TBW (Tera Bytes Written)		
Capacity	32GB	642
	64GB	1,284
	128GB	2,568
	256GB	5,136
	512GB	10,273
	1TB	20,547

Note:

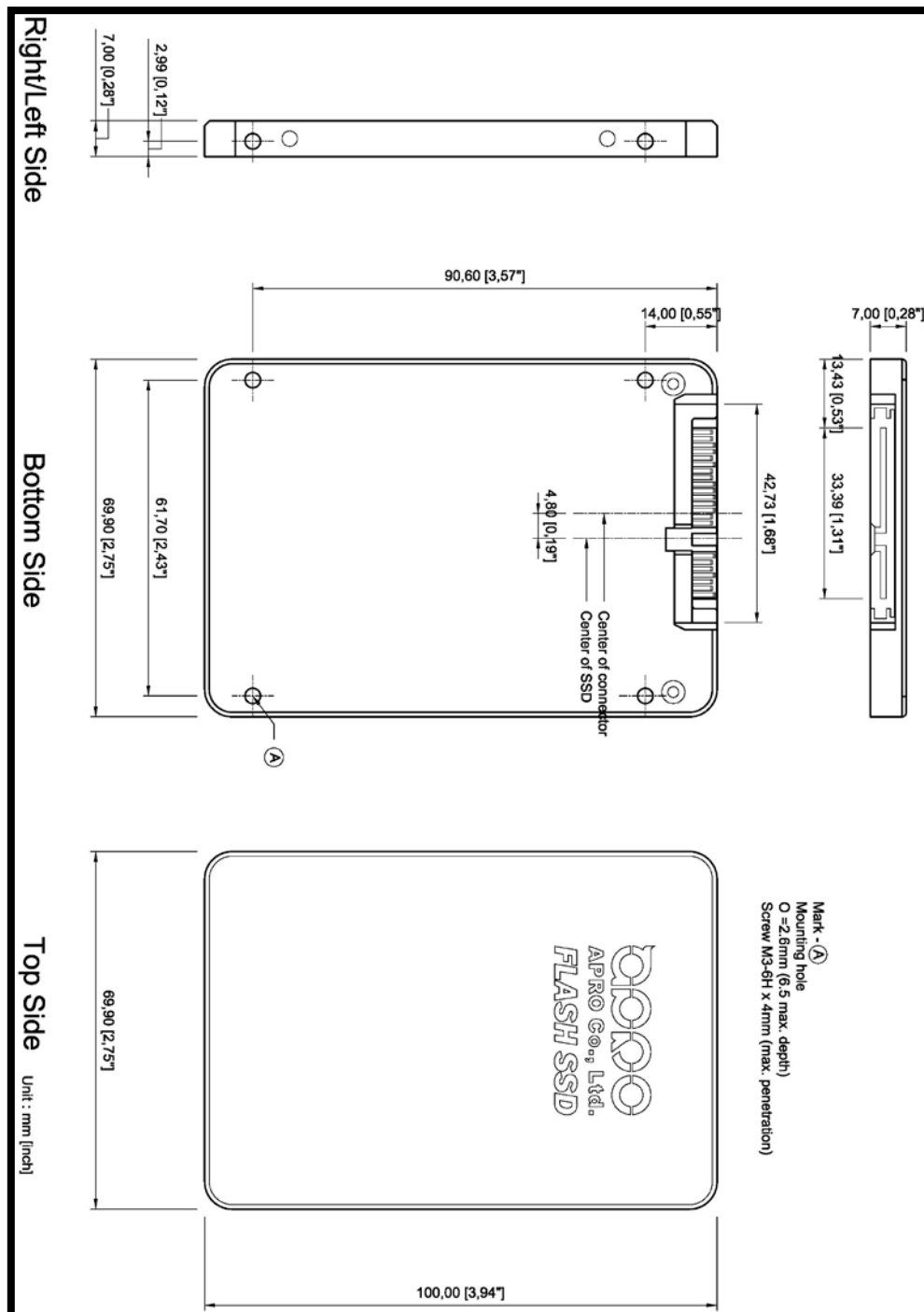
- Samples were built using Toshiba 15nm Toggle MLC by enhance endurance technology (aSLC)
- Test by sequential write.
- The endurance of SSD could be estimated based on user behavior, NAND endurance cycles, and write amplification factor.  
It is not guaranteed by flash vendor.

### 2.5. Physical Specifications

Refer to Table 5 and see Figure 3 for Rugged Metal 2.5" SATA III aSLC SSD PHANES-HR Series physical specifications and dimensions.

**Table 5: Physical Specifications of APRO aSLC Rugged Metal 2.5" SATA III SSD-PHANES-HR Series**

<b>Length:</b>	100.0 mm
<b>Width:</b>	69.90 mm
<b>Thickness:</b>	7.0 mm
<b>Weight:</b>	65.0 g / 2.29 oz.



**Figure 3: APRO aSLC Rugged Metal 2.5" SATA III SSD 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 storage 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.

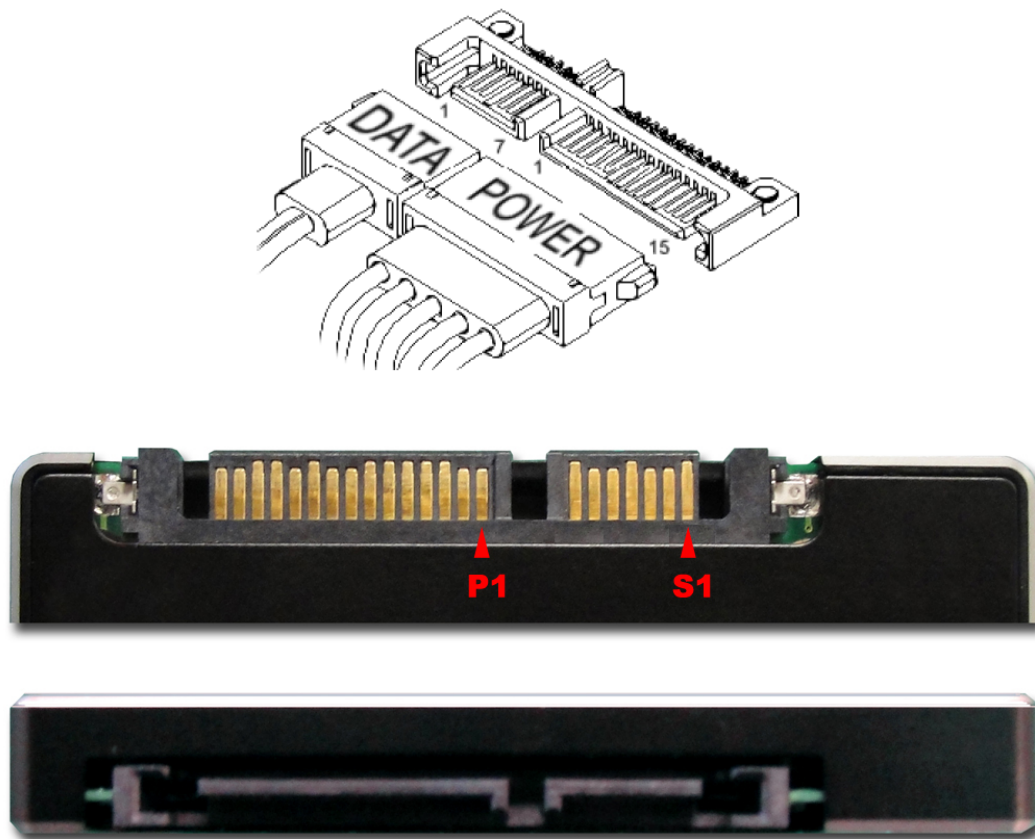
Conformal coating offers protection of circuitry from moisture, fungus, dust and corrosion caused by extreme environments. It also prevents damage from those Flash storages handling during construction, installation and use, and reduces mechanical stress on components and protects from thermal shock. 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. aSLC Rugged Metal 2.5" SATA III SSD interface

APRO aSLC 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 aSLC Rugged Metal 2.5" SATA III SSD**

### 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 aSLC 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:**

- **aSLC ( Standard grade / Wide temp. grade )     2 years / Within 20K Erasing Counts**

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