APRO Co., Ltd.

MLC

2.5" Rugged Metal

SATA III SSD

HERCULES-TT Series

Support Power interrupts data protection technology

by Tantalum Capacitors.

Document No. : 100-xR2ST-MTCTMB

Version No. : 02V0

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ISO 9001 : 2015 CERTIFIED

Product Features

- **Flash IC**
  - TOSHIBA 15nm NAND Flash IC.
  - Multi-Level Cell (MLC) management

- **Compatibility**
  - Compliant with SATA Revision 3.1
  - SATA 1.5Gb/s; SATA 3Gb/s & SATA 6Gb/s Interface compatible.
  - ATA-8 ACS2 command set

- **Additional Capabilities**
  - S.M.A.R.T. (Self-Monitoring, Analysis and Reporting Technology) feature set support.
  - Native Command Queuing (NCQ) support.
  - TRIM maintenance command support.
  - Support Global wear-leveling algorithm
  - Designed with a DRAM buffer which is support high transfer rate
  - Power interrupts data protection technology by Tantalum Capacitors.
  - Support Bad Block Management

- **Mechanical**
  - Standard 2.5" SATA Flash Disk form-factor (7mm)
  - SATA 7-pin (data) + 15-pin (power connector) SATA Interface
  - Dimension: 100.0mm x 70.0mm x 8.8mm.
  - Weight: 75.00 g / 2.64 oz.

- **Power Operating Voltage 5V(+/-) 5%**
  - Read Mode: 320.0 mA. (max.)
  - Write Mode: 820.0 mA. (max.)
  - Idle Mode: 130.0 mA. (max.)

- **Performance (Maximum value) *[2]**
  - Sequential Read: 561.5 MB/sec. (max.)
  - Sequential Write: 444.1 MB/sec. (max.)
  - 4KB Random Read IOPS (QD32): 71.0K
  - 4KB Random Write IOPS (QD32): 73.0K
  - 4KB Random Read access time: 0.13ms
  - 4KB Random Write access time: 0.03ms

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

- **Reliability**
  - **TBW:** Up to 1800 TBW at 1TB Capacity. (Client workload by JESD-219A)
  - **ECC:** Hardware BCH ECC capable of correcting errors up to 66-bit/1KB
  - **Temperature:** (Operating)
    Standard Grade: 0ºC ~ +70ºC
    Wide Temp. Grade: -40ºC ~ +85ºC
  - **Vibration:** 70 Hz to 2000 Hz, 15G, 3 axes.
  - **Shock:** 0.5ms, 1500 G, 3 axes.

- **Certifications and Declarations**
  - **Certifications**: CE & FCC
  - **Declarations**: RoHS & REACH

Remarks:

1. Sequential performance is based on CrystalDiskMark 5.1.2 with file size 1000MB

Order Information

I. Part Number List

◆ **APRO MLC 2.5" Rugged Metal SATA III SSD HERCULES-TT Series**

Product Picture	Grade	Standard grade (0°C ~ 70°C)	Wide Temp Grade (-40°C ~ +85°C)
	32GB	SR2ST032G-MTCTMB	WR2ST032G-MTCTMB-C
	64GB	SR2ST064G-MTCTMB	WR2ST064G-MTCTMB-C
	128GB	SR2ST128G-MTCTMB	WR2ST128G-MTCTMB-C
	256GB	SR2ST256G-MTCTMB	WR2ST256G-MTCTMB-C
	512GB	SR2ST512G-MTCTMB	WR2ST512G-MTCTMB-C
	1TB	SR2ST001T-MTCTMB	WR2ST001T-MTCTMB-C

Notes:

C : *Special conformal coating treated on whole PCBA which may support wide temp. 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 X19 X20

X1 : **Grade**

S: Standard Grade – operating temp. 0º C ~ 70 º C

W: Wide Temp Grade- operating temp. -40º C ~ +85 º C

X2 : **The material of case**

R : Rugged Metal

X3 X4 X5 : **Product category**

2ST :

2.5” SATA SSD w/DRAM cache & Tantalum Capacitors

X6 X7 X8 X9 : **Capacity**

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

X11 : **Controller**

M : HERCULES Series

X12 : **Controller version**

A, B, C.....

X13 : **Controller Grade**

C : Commercial grade

X14 : **Flash IC**

T : Toshiba MLC-NAND Flash IC

X15 : **Flash IC grade / Type**

M : MLC -NAND Flash IC

X16 : **MLC Technology**

B : Toshiba 15nm MLC

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

C : Conformal-coating (optional)

Revision History

Revision	Description	Date
1.0	Initial release	2017/05/19
1.1	Updated Version	2018/11/28
2.0	Updated Document Format	2019/06/06

Contents

1. Introduction

APRO MLC 2.5" Rugged Metal SATA III SSD HERCULES-TT Series provides high capacity flash memory Solid State Drive (SSD) that electrically complies with Serial ATA 3.1 (SATA) standard. APRO MLC 2.5" Rugged Metal SATA III SSD HERCULES-TT Series support SATA 1.5Gb/s; SATA 3Gb/s & SATA 6Gb/s data transfer rate with high performance, and designed with a DRAM which is support the data buffer for SSD; Also, the HERCULES-TT Series SSD applied with several tantalum capacitors to provide power buffering after host power interruption for data protection. 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 supports -40°C ~ +85°C. The data transfer performance by sequential read is up to 561.5 MB/sec, and sequential write is up to 444.1 MB/sec.

APRO MLC 2.5" Rugged Metal SATA III SSD HERCULES-TT Series built-in DRAM, provide a high level interface to the host computer. This interface allows a host computer to issue commands to the 2.5" SATA III SSD to read or write blocks of memory. Hardware BCH ECC capable of correcting errors up to 66-bit/1KB (ECC). APRO MLC 2.5" Rugged Metal SATA III SSD HERCULES-TT 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 shows a block diagram of the APRO MLC 2.5" Rugged Metal SATA III SSD HERCULES-TT Series.

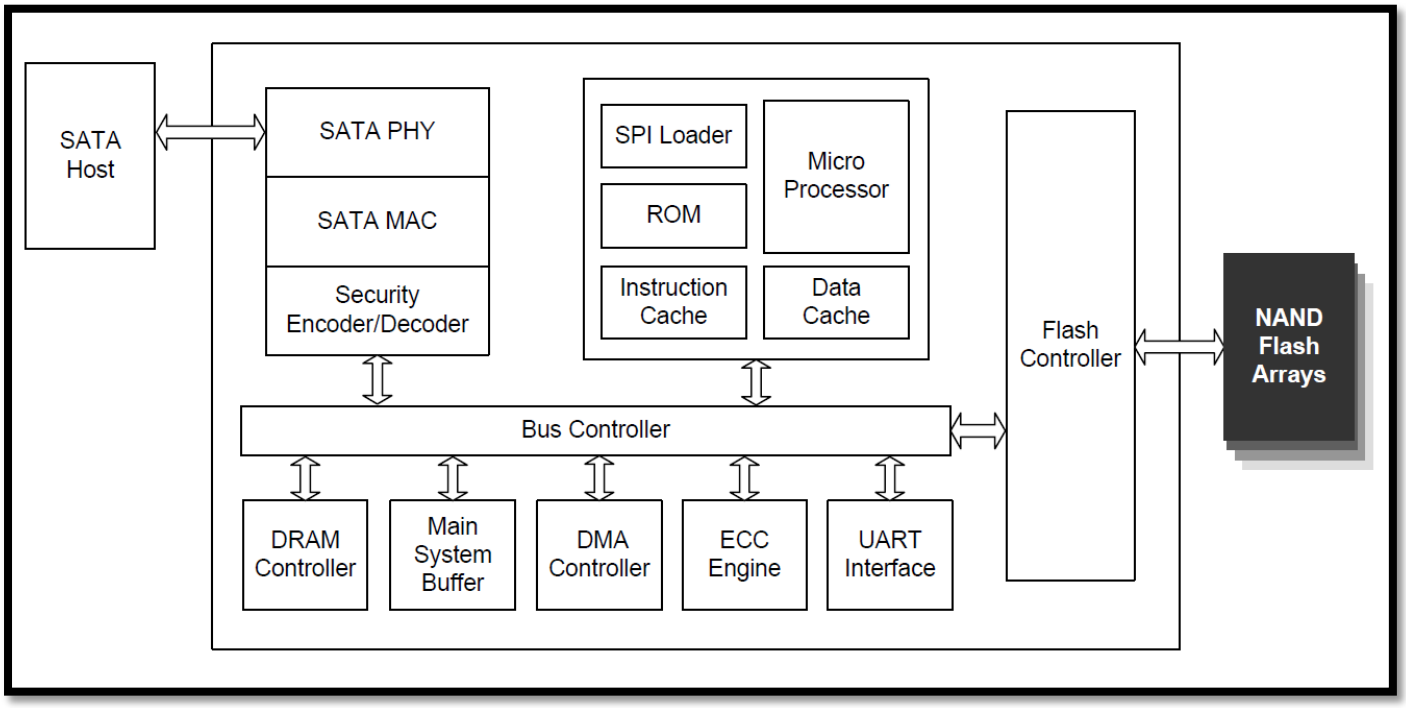

Figure 1: APRO MLC 2.5" Rugged Metal SATA III SSD HERCULES-TT Series block diagram

1.1. *Scope*

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

1.2. *Flash Management Technology – Global Wear Leveling*

In order to gain the best management for flash memory, APRO MLC 2.5" Rugged Metal SATA III SSD HERCULES-TT Series applies Global 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. The objective of global wear leveling is to prevent any frequently updated data from staying at the static area so that wear leveling could be evenly applied to all blocks. Static areas contain any data that does not change, and are ignored by dynamic wear leveling. Such static data may include operating system files, table look-ups, executable files, and etc. Global wear leveling frequently replaces blocks in this area with block in the hot area, and thus each block in all areas has the same probability to be used.

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 data, it moves that data to a more heavily used location before it moves the newly written data. Wear leveling maximizes effective endurance Flash array compared to no wear leveling products.

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 2.5" Rugged Metal SATA III SSD HERCULES-TT 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. *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.

- 32GB to 256GB Supports 4GBits DRAM Cache
- 512GB & 1TB Supports 8GBits DRAM Cache.

1.5. *Power interrupts data protection Technology*

In the event of an unstable power supply, SSD loses power before it can finish programming process from host to flash, this may cause data being written to the incorrect block and further leads to data corruption.

Power interrupt data protection technology is applied with several tantalum capacitors to provide power buffering after host power interruption. The Data Protection Technology provides enough time for the SSD controller can write all DRAM buffer data to flash, all data will be protected and without data loss.

The ability of Power interrupt data protection technology is able to write 1.28MB of data within 60ms.
This ensures all data in the DRAM buffer can be successfully written into flash.

Traditionally, super capacitors were applied in most SSD products, the advantages of tantalum capacitors over super capacitors are:

- **Tantalum capacitors are electrolyte free.**
  It is able to maintain its designed capacitance for several years when used within design limits.
- **Wide operating temperature range.**
  Tantalum capacitors can operate from temperature range of -55C to +125C, which is very suitable for industrial and military usage.
- **Tantalum capacitors have an ultimate high volumetric efficiency (CV/cc).**
  For example, a 50-microfarad tantalum capacitor can be equal and to properly replace a 500-microfarad aluminum capacitor.

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 2.5" Rugged Metal SATA III SSD HERCULES-TT Series		Standard Grade	Wide Temp Grade
		SR2STxxxG-MTCTMB	WR2STxxxG-MTCTMB-C
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 2000 Hz, 15G, 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 MLC 2.5" Rugged Metal SATA III SSD HERCULES-TT Series		
DC Input Voltage (VCC)		5V±5%
Maximum average value	Reading Mode :	320.0 mA. (max.)
	Writing Mode :	820.0 mA. (max.)
	Idle Mode :	130.0 mA. (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:	0.13 ms.					
	Write:	0.03 ms.					
Maximum Performance	Capacity	32GB	64GB	128GB	256GB	512GB	1TB
	Sequential Read (MB/s)	555.5	551.3	560.3	561.9	561.7	561.5
	Sequential Write(MB/s)	101.8	89.9	177.2	358.4	442.4	444.1
	4KB Random Read IOPS (QD32)	52.9K	50.0K	70.6K	72.1K	71.0K	71.8K
	4KB Random Write IOPS (QD32)	25.1K	22.1K	43.8K	79.4K	73.0K	73.4K

Note:

1. The performance was measured using CrystalDiskMarkv5.0x64 with SATA 6Gbps host.

2. Samples were built using Toshiba 15nm MLC

3. Performance may differ according to flash configuration and platform.

2.4. System Reliability

Table 4: System Reliability

Wear-leveling Algorithms		Global wear-leveling algorithms
Bad Block Management		Supportive
ECC Technology		Hardware BCH ECC capable of correcting errors up to 66-bit/1KB (ECC).
Erase counts		NAND MLC Flash Cell Level：3K P/E Cycles
TBW (Tera Bytes Written)		
Capacity	**32GB**	55.0
	64GB	110.0
	128GB	230.0
	256GB	450.0
	512GB	900.0
	1TB	1,800.0

Note:

- *Samples were built using Toshiba 15nm Toggle MLC NAND flash.*
- *The test followed JEDEC219A client endurance workload.*
- *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 MLC 2.5” Rugged Metal SATA III SSD HERCULES-TT Series physical specifications and dimensions.

Table 5: Physical Specifications of APRO MLC 2.5” Rugged Metal SATA III SSD HERCULES-TT Series

Length:	100.0 mm
Width:	70.0 mm
Thickness:	8.80 mm
Weight:	75.00 g / 2.64 oz.

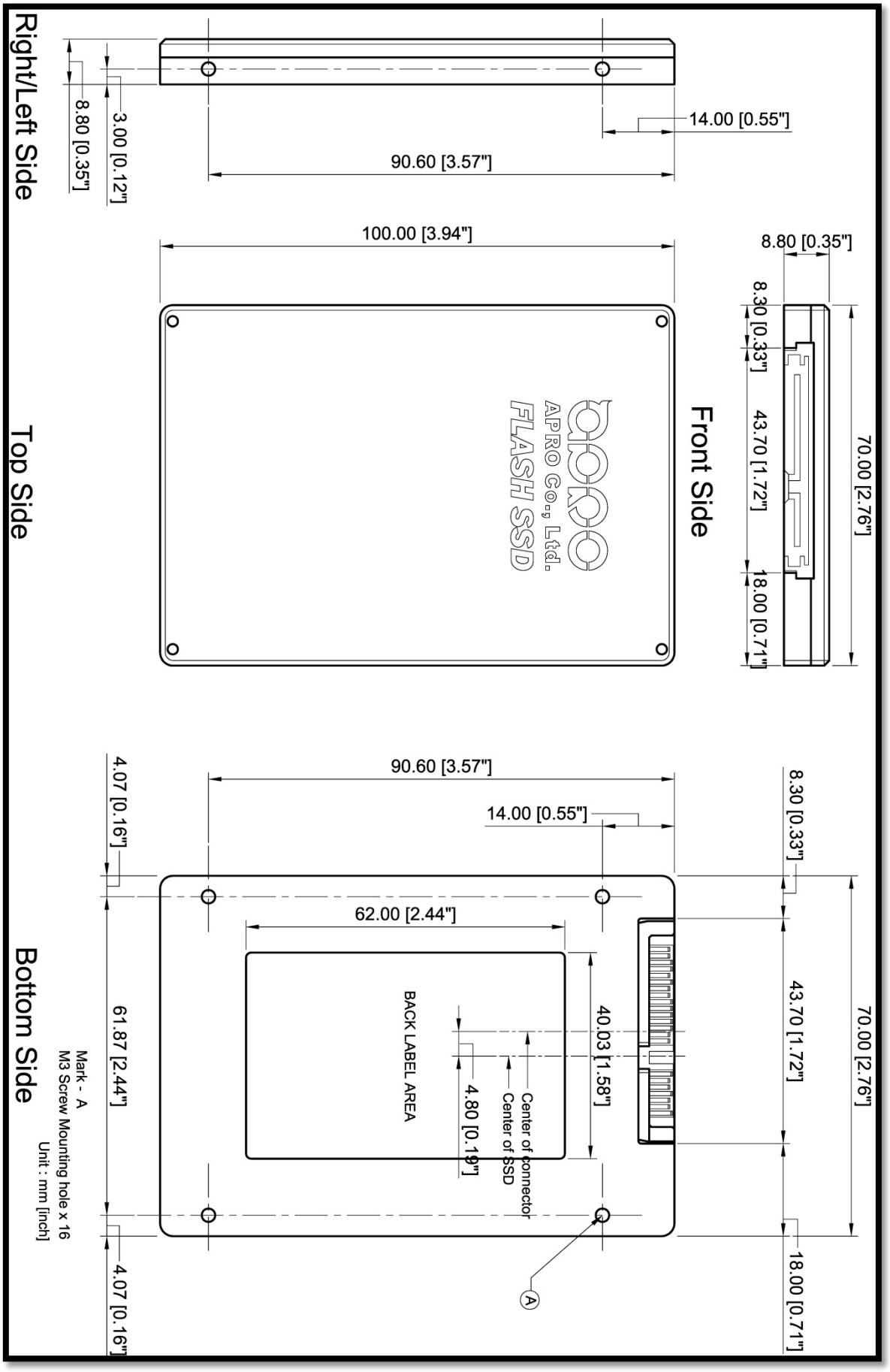

Figure 2: APRO MLC 2.5" Rugged Metal SATA III SSD HERCULES-TT Series Dimension

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. APRO MLC 2.5" SATA-III SSD interface

APRO 2.5" SATA-III SSD is equipped with 7 pins in the signal segment and 15 pins in the power segment.

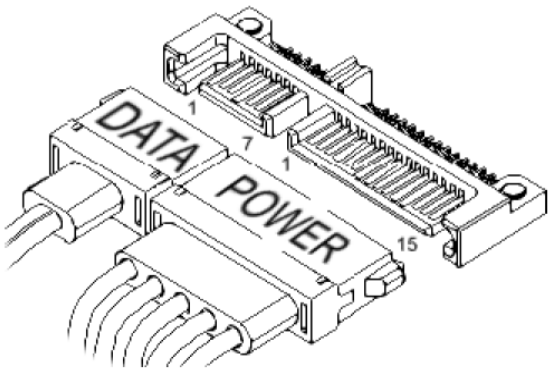

Figure 3: The connectors of Signal Segment and Power Segment

3.2. Pin Assignments

APRO MLC 2.5" Rugged Metal SATA III SSD HERCULES-TT Series operates with standard SATA pin-out.

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	NC	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	DAS/DSS	Device Activity Signal / Disable Staggered Spin up
P12	GND	NA
P13	NC	NA
P14	NC	NA
P15	NC	NA

Table 6 - Pin Assignments

Appendix A: Limited Warranty

APRO warrants you MLC 2.5" Rugged Metal SATA III SSD HERCULES-TT 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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