

# MLC

## Mini SATA III Module

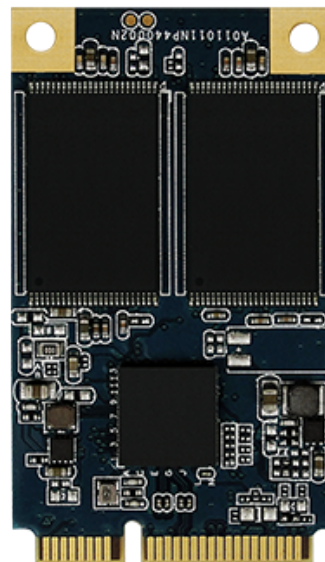
**PHANES-K Series**

**(JEDEC MO-300A)**

**Document No. :** 100-xBMSM-PKCTM

**Version No. :** 02V0

**Date :** May, 2019



ISO 9001 : 2015 CERTIFIED



### Product Features

#### ■ Flash IC

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

#### ■ Compatibility

- SATA Revision 3.2
- SATA 1.5Gb/s; SATA 3Gb/s & SATA 6Gb/s data transfer rate.
- ATA-8 ACS4 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.
- Both Static & Dynamic wear-leveling algorithm
- Hardware Low Density Parity Check Code, LDPC support.

#### ■ Mechanical

- JEDEC MO-300A full size Solid State Drive
- 52 pos. Edge Connector, PCI Express (PCIe) mini
- Dimension: 50.8 mm x 29.85 mm.
- Weight: 8.00 g / 0.28 oz.

#### ■ Power Operating Voltage +3.3V±5%

- Read Mode: 1,650.0 mW (max.)
- Write Mode: 2,690.0 mW (max.)
- Idle Mode: 285.0 mW (max.)

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

- Sequential Read: 550.0 MB/sec. (max.)
- Sequential Write: 490.0 MB/sec. (max.)

#### ■ Capacity

- 16GB, 32GB, 64GB, 128GB, 256GB, 512GB and 1TB

#### ■ Reliability

- **TBW:** Up to 1,080 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: 0°C ~ +70°C  
Wide Temp. Grade: -40°C ~ +85°C
- **Vibration:** 80 Hz to 2000 Hz, 20G, 3 axes.
- **Shock:** 0.5ms, 1500 G, 3 axes

#### ■ Certifications and Declarations

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

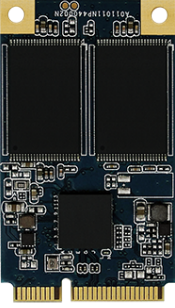
#### Remarks:

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 MLC Mini SATA III Module (mSATA) PHANES-K Series

Product Picture	Grade	Standard grade (0°C ~ 70°C)	Wide Temp Grade (-40°C ~ +85°C)
	16GB	SBMSM016G-PKCTM-(W/T/WT)	WBMSM016G-PKCTM-(W/T/WT)C
	32GB	SBMSM032G-PKCTM-(W/T/WT)	WBMSM032G-PKCTM-(W/T/WT)C
	64GB	SBMSM064G-PKCTM-(W/T/WT)	WBMSM064G-PKCTM-(W/T/WT)C
	128GB	SBMSM128G-PKCTM-(W/T/WT)	WBMSM128G-PKCTM-(W/T/WT)C
	256GB	SBMSM256G-PKCTM-(W/T/WT)	WBMSM256G-PKCTM-(W/T/WT)C
	512GB	SBMSM512G-PKCTM-(W/T/WT)	WBMSM512G-PKCTM-(W/T/WT)C
	1TB	SBMSM001T-PKCTM-(W/T/WT)	WBMSM001T-PKCTM-(W/T/WT)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** — **X17 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

**B** : Bare PCBA w/o Casing

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

**MSM** : mini SATA III Module

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

<b>016G:</b>	16GB	<b>128G:</b>	128GB
<b>032G:</b>	32GB	<b>256G:</b>	256GB
<b>064G:</b>	64GB	<b>512G:</b>	512GB
		<b>001T:</b>	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

#### **X17 X18** : Reserved for specific requirement

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

**W** : Write Protection Switch (optional)

**T** : Thermal Sensor (optional)

**WT** : Write Protection Switch + Thermal Sensor (optional)

**C** : Conformal coating (optional)

### Revision History

Revision	Description	Date
1.0	Initial release.	2018/08/30
1.1	Updated Version	2018/11/28
2.0	Updated document form	2019/05/30

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### 1. Introduction

APRO MLC Mini SATA III Module (mSATA) PHANES-K Series provides high capacity flash memory Solid State Drive (SSD) that electrically complies with SATA Revision 3.2 standard. APRO MLC Mini SATA III Module (mSATA) PHANES-K Series support SATA 1.5Gb/s; SATA 3Gb/s & SATA 6Gb/s data transfer rate with high performance. It is designed with mSATA form factor by JEDEC MO-300A standard, and the available disk capacities are 16GB, 32GB, 64GB, 128GB, 256GB, 512GB and 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.

APRO MLC Mini SATA III Module (mSATA) PHANES-K Series provide the ultra-high random speed for heavy-loading embedded or server operations with space constraints for host computing systems; the performance of sequential read is up to 550.0 MB/sec. (max.), and sequential write is up to 490.0 MB/sec. (max.).

APRO MLC Mini SATA III Module (mSATA) PHANES-K Series provides a high level interface to the host computer. This interface allows a host computer to issue commands to the APRO MLC Mini SATA III Module (mSATA) 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 MLC Mini SATA III Module (mSATA) 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.

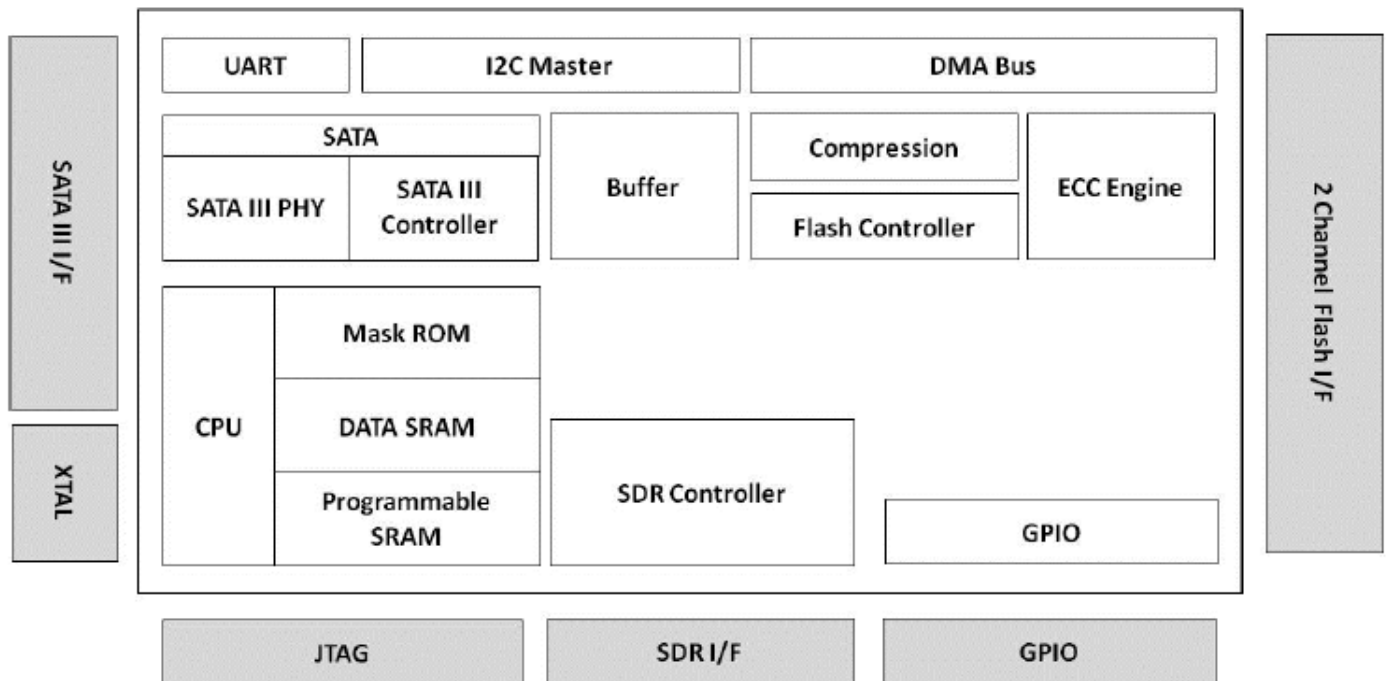


Figure 1: APRO MLC Mini SATA III Module (mSATA) PHANES-K Series block diagram

### 1.1. *Scope*

This document describes features, specifications and installation guide of APRO MLC Mini SATA III Module (mSATA) 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 MLC Mini SATA III Module (mSATA) 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 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 MLC Mini SATA III Module (mSATA) 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.

## 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 Mini SATA III Module (mSATA)		Standard Grade	Wide Temp Grade
PHANES-K Series		SBMSMxxxG-PKCTM	WBMSMxxxG-PKCTMC
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 Mini SATA III Module (mSATA) PHANES-K Series		
DC Input Voltage (VCC)		+3.3V±5%
Maximum average value	Reading Mode :	1,650.0 mW (max.)
	Writing Mode :	2,690.0 mW (max.)
	Idle Mode :	285.0 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	16GB	32GB	64GB	128GB	256GB	512GB	1TB
	Sequential Read (MB/s)	320.0	550.0	550.0	550.0	550.0	550.0	530.0
	Sequential Write (MB/s)	85.0	160.0	310.0	465.0	490.0	490.0	435.0

Note:

- The performance was measured using CrystalDiskMark v5.0x64 with SATA 6Gbps host.
- Samples were built using Toshiba 15nm Toggle MLC NAND.
- Performance may differ according to flash configuration, SDR configuration, and platform.
- The table above is for reference only. The criteria for MP (mass production) and for accepting goods shall be discussed based on different flash configuration.



### 2.4. System Reliability

**Table 4: System Reliability**

<b>Wear-leveling Algorithms</b>	Static and Dynamic wear-leveling algorithms	
<b>Bad Block Management</b>	Supportive	
<b>ECC Technology</b>	Hardware design LDPC (Low Density Parity Check)	
<b>Erase counts</b>	NAND MLC Flash Cell Level : 3K P/E Cycles	
<b>TBW (Tera Bytes Written)</b>		
<b>Capacity</b>	<b>16GB</b>	6.0
	<b>32GB</b>	13.0
	<b>64GB</b>	30.0
	<b>128GB</b>	87.0
	<b>256GB</b>	198.0
	<b>512GB</b>	540.0
	<b>1TB</b>	1,080.0

Note:

- Client workload by JESD-219A
- Samples were built using Toshiba 15nm Toggle MLC 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 MLC Mini SATA III Module (mSATA) PHANES-K Series physical specifications and dimensions.

**Table 5: Physical Specifications of APRO MLC Mini SATA III Module (mSATA) PHANES-K Series**

<b>Length:</b>	50.8 mm
<b>Width:</b>	29.85 mm
<b>Weight:</b>	8.0 g / 0.28 oz.

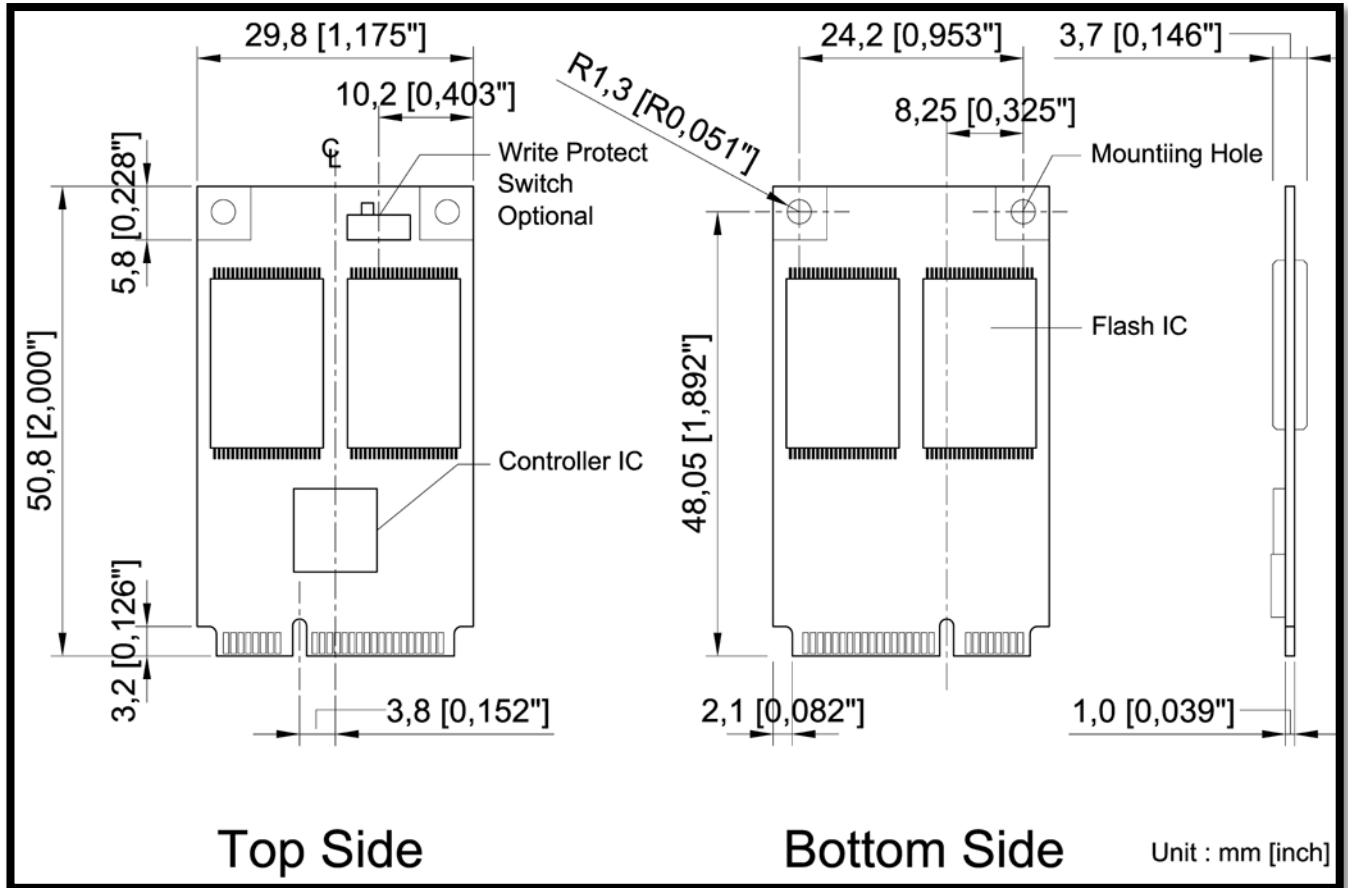


Figure 2: APRO Mini SATA III Module (JEDEC MO-300A) Dimension

## 2.6. Conformal coating

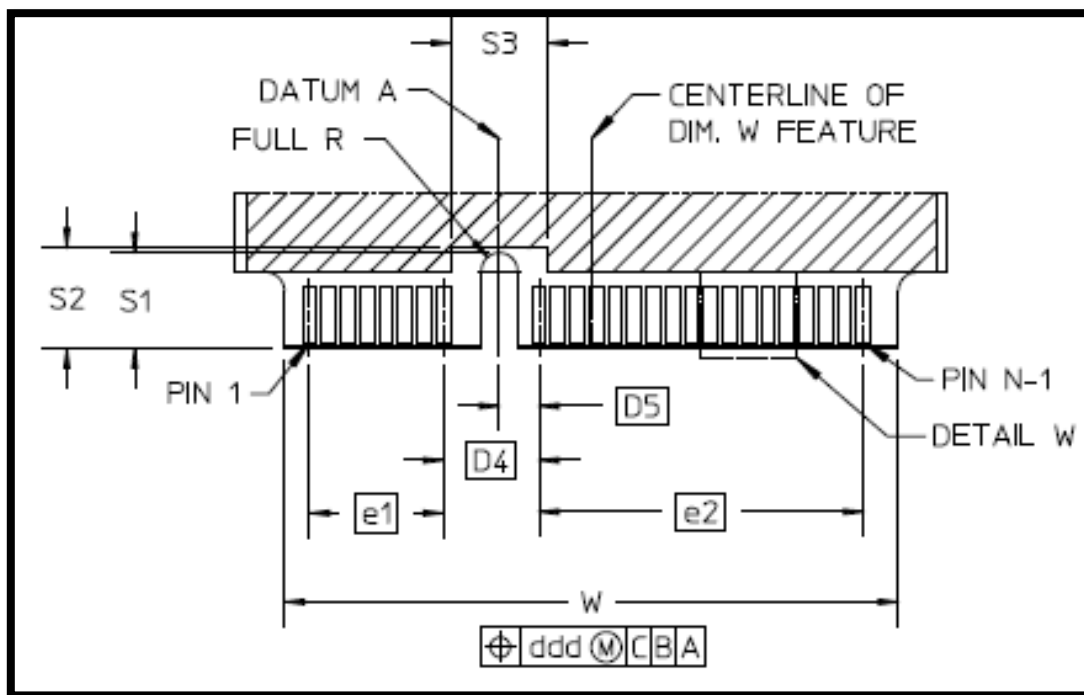
Conformal coating is a protective, dielectric coating designed to conform to the surface of an assembled printed circuit board. Commonly used conformal coatings include silicone, acrylic, urethane and epoxy. APRO applies only silicone on APRO storage products upon requested especially by customers. The 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 use MIL-I-46058C silicon conformal coating

## 3. Interface Description

### 3.1. Mini SATA III Module interface



*Figure 3: The connectors of Signal Segment and Power Segment*

### 3.2. Pin Assignments

APRO MLC Mini SATA III Module (mSATA) PHANES-K Series operates with standard SATA pin-out. The pin assignments are listed in below table 6.

Table 6 - Pin Assignments

Signal Name	Pin #	Pin #	Signal Name
NC	1	2	+ 3.3V
NC	3	4	DGND
NC	5	6	NC
NC	7	8	NC
DGND	9	10	NC
NC	11	12	NC
NC	13	14	NC
DGND	15	16	NC
NC	17	18	DGND
NC	19	20	NC
SATA GND	21	22	NC
TX+	23	24	+ 3.3V
TX-	25	26	SATA GND
SATA GND	27	28	NC
SATA GND	29	30	NC
RX-	31	32	NC
RX+	33	34	DGND
SATA GND	35	36	NC
SATA GND	37	38	NC
+ 3.3V	39	40	DGND
+ 3.3V	41	42	NC
NC	43	44	DEVSLP
NC	45	46	NC
NC	47	48	NC
DAS	49	50	DGND
GND	51	52	+ 3.3V

### **Appendix A: Limited Warranty**

APRO warrants your MLC mini SATA III Module 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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