



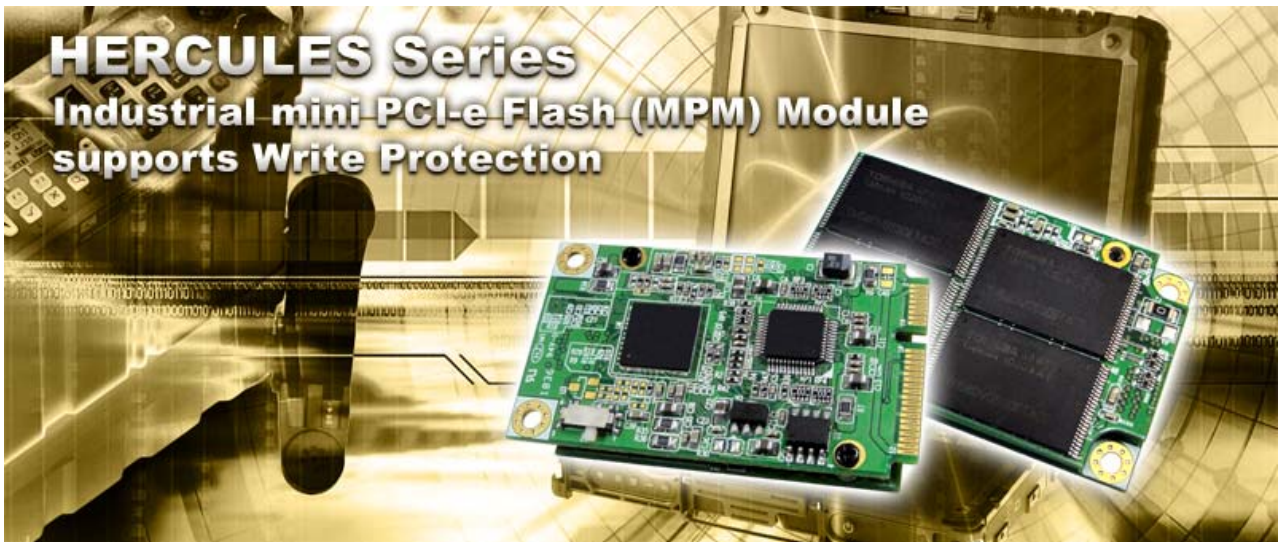
*September 2011*

# **Product Specification**

## **Industrial mini PCI-e Module (MPM)**

### **-HERCULES - I Series-**

**Doc-No: 100-xBMPM-MISL-2V1**



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*Revision History*

<b>Revision</b>	<b>Description</b>	<b>Date</b>
1.0	Initial Release	2011/1/25
2.0	Update Flash IC solution & Available capacity of MPM	2011/6/20
2.1	MPM Compatibility Updated	2011/9/26

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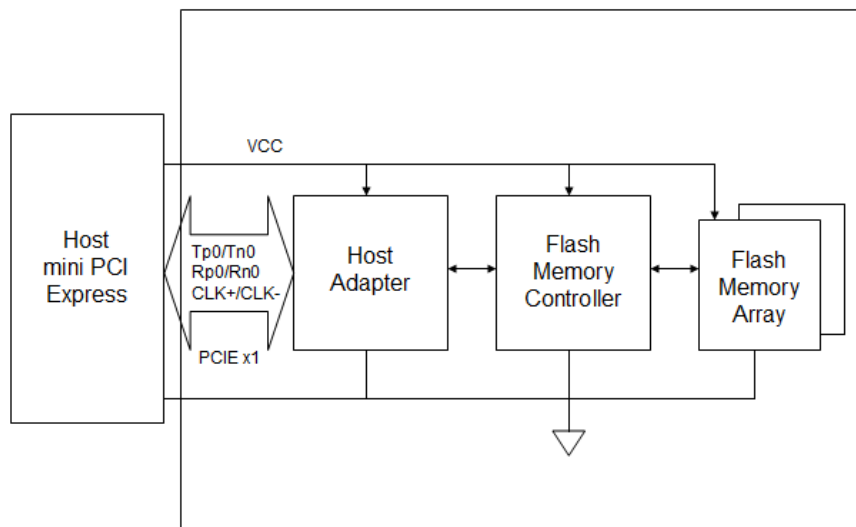
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## 1. Introduction

APRO Industrial mini PCI-e Flash (MPM) Module is a Solid State Disk on Module which works for mini PCI Express host interface. This product is compliant with PCI Express Mini Card Electromechanical Rev 1.2 Specification; with PCI Express x1 lane bandwidth for high speed data transfer. Compare with conventional compact form factor flash memory drive, APRO mini PCI-e Flash Module adopts 4-channel flash technology to access data to and from flash memory chips simultaneously to perform a very high speed of data transfer rate. Since Data Program/Erase always damage flash memory cells, APRO mini PCI-e Module levels the unavoidable wear of flash memory with Global Wear Leveling to reach a longer drive lifespan. With hardware error collection, APRO mini PCI-e Module can collect 8 or 15 random bits for each 512 byte data sector depends on the spare area of flash memory.

The available disk capacities are 8GB, 16GB and 32GB SLC Flash memory. The operating temperature grade is optional for commercial level 0°C ~ 70°C and wide temperature level -40°C ~ +85°C. The data transfer performance by sustained read is up to 95.9 MB/sec, and sustained write is up to 93.0 MB/sec.

Figure 1 shows a block diagram of the used high tech Industrial mini PCI-e Flash (MPM) Module controller.



**Figure 1: Industrial mini PCI-e Flash Module - HERCULES - I Series controller block diagram**

## 1.1. *Scope*

This document describes the features and specifications and installation guide of APRO's Industrial mini PCI-e Flash (MPM) Module – HERCULES - I Series. In the appendix, there provides order information, warranty policy, and RMA procedure for the most convenient reference.

## 1.2. *System Features*

- SLC-NAND type flash technology
- Compliant with PCI Express Mini Card Electromechanical Rev 1.2 Specification
- Compact form factor for highly integrated system
- Support standard ATA command
- Supports high speed PCI Express host bus to 2.5Gbps
- Bootable for system installation (**BIOS PCI-Express Bootable support needed**)
- Global wear-leveling algorithms
- Support write protect function by switch
- Large memory capacity for heavy data access and storage
- Standard grade capacity from 8GB up to 32GB
- Industrial grade capacity from 8GB up to 32GB
- Performance up to 95.9 MB/sec
- Automatic 8 bits or 15 bits Error Correcting Code (ECC) error correction and retry capabilities
- +3.3V  $\pm$  5% operation
- MTBF > 2,000,000 hours
- Vibration : 6.95 Grms 30 minutes per axis, 1 time in each axis / MIL-STD 810G
- Shock : 1500 G, Pulse width: 0.5msec, 18 times (6 directions) / MIL-STD 810G
- Altitude: 70,000 feet
- Working well in critical environment
- Very high performance, very low power consumption
- Low weight, Noiseless

## 1.3. *Flash Management Technology - Global Wear Leveling*

Wear Leveling is an intrinsic part of the Erase Pooling functionality of APRO industrial mini PCI-e Flash Module using NAND type SLC flash memory. The WEAR LEVELING command is supported to ensure the best of flash memory endurance capability. The HERCULES - I Series industrial mini PCI-e Flash Module supports global wear-leveling algorithms.

## 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

#### 2.1.1. Temperature

**Table 1: Environmental Specification**

APRO Industrial mini PCI-e Flash (MPM) Module supports Write Protect Function HERCULES - I Series		Standard Grade	Industrial Grade
		SBMPM0xxG-MICTC	WBMPM0xxG-MIITI
Temperature	Operating:	0°C ~ 70°C	-40°C ~ +85°C
	Non-operating:	-20°C ~ +80°C	-50°C ~ +95°C

#### 2.1.2. Humidity

- Operating Humidity (30 °C Max. Wet Bulb Temp): 10% to 95%
- Non-Operating Humidity (30 °C Max. Wet Bulb Temp): 10% to 95% (with no condensation relative humidity)

#### 2.1.3. Shock (Operation)

- G Level: 1500 G
- Pulse width: 0.5msec
- Total: 18 times (6 directions)

#### 2.1.4. Vibration (Operation)

- G Level: 6.95 Grms
- Frequency Range: 10 ~ 2000Hz
- Wo=0.031g<sup>2</sup>/Hz
- Duration Time: 30 minutes per axis, 1 time in each axis
- Total: 3 times

## 2.2. System Power Requirements

**Table 2: Power Requirement**

Capacity	Power Consumption (Max.)		
	IDLE	Reading	Writing
SLC Flash – 8GB	115mA (0.575 W)	349mA (1.745 W)	345mA (1.725 W)
SLC Flash – 16GB	117mA (0.585 W)	353mA (1.765 W)	353mA (1.765 W)
SLC Flash – 32GB	117mA (0.585 W)	346mA (1.730 W)	354mA (1.770 W)

## 2.3. System Performance

**Table 3: System Performances**

Flash IC		TOSHIBA SLC Flash IC		
Data Transfer Mode supporting		Serial ATA Gen-II (3.0Gb/s = 380MB/s)		
Maximum Performance	Capacity	8GB	16GB	32GB
	Sequential Read (MB/s)	94.8	95.9	93.25
	Sequential Write (MB/s)	71.7	75	72.22
Maximum QD 32	4K Random Read (MB/s)	14.25	14.25	14.92
	4K Random Write (MB/s)	1.92	1.92	2.07
Random Access Time		0.3	0.3	0.3
The number of Flash IC		8	8	8

## 2.4. System Reliability

**Table 4: System Reliability**

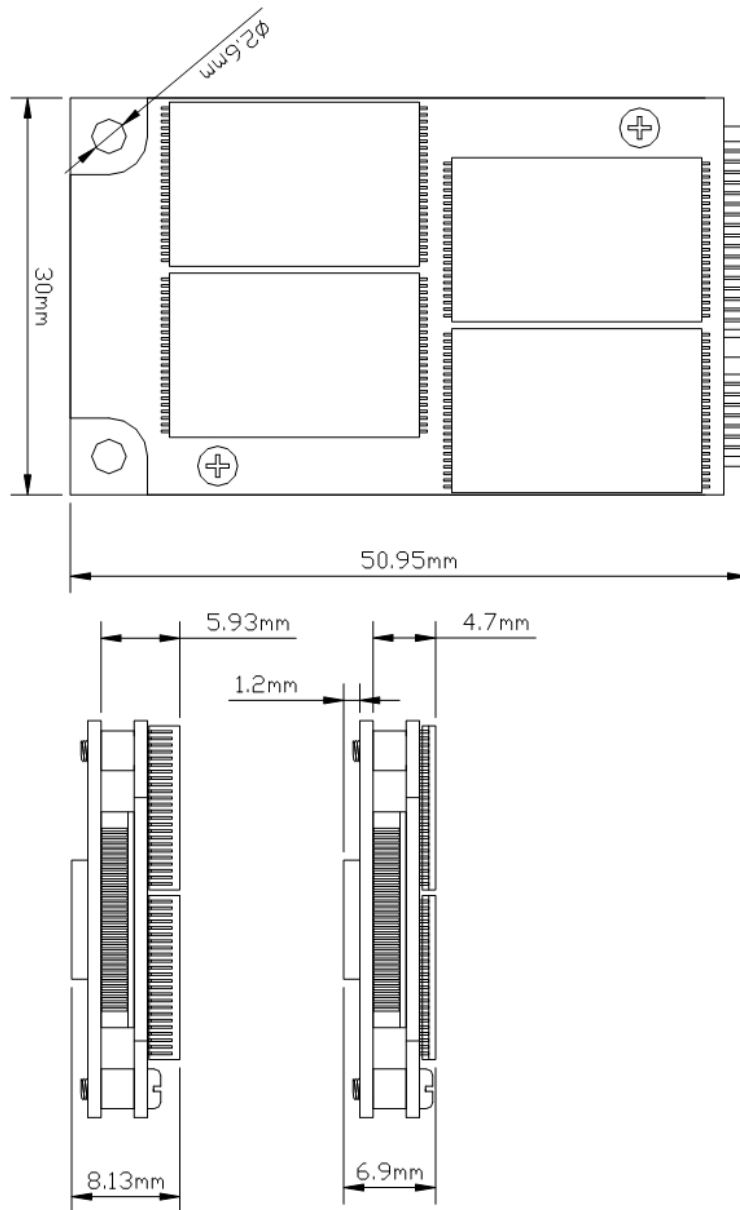
MTBF	>2,000,000 hours
Wear-leveling Algorithms	Global Wear Leveling
Bad Blocks Management	Supportive
ECC Technology	8 bits or 15 bits Error Connection Code
Power Cycling	3000 loops
Endurance	Greater than 2,000,000 cycles Logically contributed by Wear-leveling and advanced bad sector management
Data Retention	10 years

## 2.5. Physical Specifications

Refer to Table 5 and see Figure 2 for Industrial mini PCI-e Flash (MPM) Module - HERCULES - I Series physical specifications and dimensions.

**Table 5: Physical Specifications**

<b>Length:</b>	50.95 mm / 2.006 in
<b>Width:</b>	30.00 mm / 1.181 in
<b>Thickness:</b>	6.90 mm / 0.272 in (16GB, 32GB)
<b>Weight:</b>	19.0 g ± 2 g / 0.67 oz



**Figure 2: mini PCI-e Flash (MPM) Module 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.

## 2.7. Capacity Specifications

APRO Industrial mini PCI-e Flash (MPM) Module has built-in TOSHIBA SLC -NAND Type Flash memory chips. The Table 6 shows the quantities of applied TOSHIBA Flash memory chips for each card.

**Table 6: Card Configuration vs. TOSHIBA NAND SLC Flash IC**

Card capacity	TOSHIBA SLC flash memory * Q'TY
8GB	8Gb Toshiba SLC Flash IC or equal * 8
16GB	16Gb Toshiba SLC Flash IC or equal * 8
32GB	32Gb Toshiba SLC Flash IC or equal * 8

The table 7 shows the specific capacity for the various models and the default number of heads, sectors/track and cylinders.

**Table 7: Device Parameters**

Unformatted Capacity	Default Cylinder	Default Head	Default Sector	LBA
8GB	15,343	16	63	15,465,744
16GB	16,383	15	63	61,865,984
32GB	16,383	15	63	126,353,408

### 3. Interface Description

#### 3.1. Industrial mini PCI-e Flash (MPM) Module interface

APRO Industrial mini PCI-e Flash (MPM) Module comes with 52 pins mini PCI Express host slot.

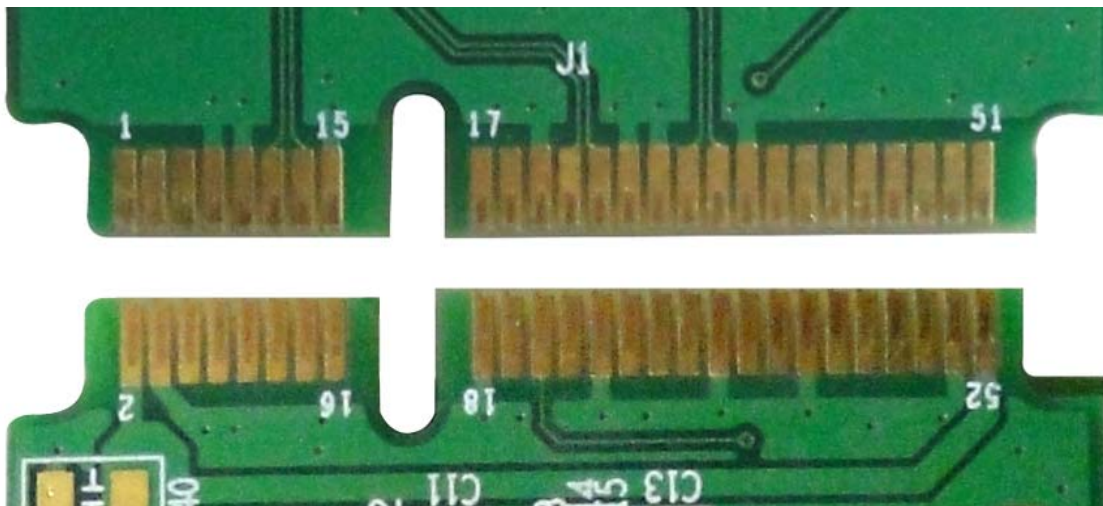


Figure 3 :The top bottom view of mini PCI-e Module Interface

#### 3.2. Pin Assignments

The pin assignments are listed in below table 8.

Table 8: Pin Assignments

Mechanical Key			
Pin #	Name	Type	Description
1	WAKE#	NU	<b>Not used</b> - This pin is not used.
2	3.3V	P	<b>Power</b> - DC power supply.
3	Reserved	-	<b>Reserved</b> - DC power supply.
4	GND	P	<b>Power</b> - DC power supply.
5	Reserved	-	<b>Reserved</b> - DC power supply.
6	1.5V	P	<b>Power</b> - DC power supply.
7	CLKREQ#	O	<b>Output</b> - Standard active output driver.
8	Reserved	-	<b>Reserved</b> - DC power supply.
9	GND	P	<b>Power</b> - DC power supply.
10	Reserved	-	<b>Reserved</b> - DC power supply.
11	REFCLK-	A <sub>DIFF</sub>	<b>Analog differential</b> - Signal pair for the twisted-pair interface.

12	Reserved	-	<b>Reserved</b> - DC power supply.
13	REFCLK+	A <sub>DIFF</sub>	<b>Analog differential</b> - Signal pair for the twisted-pair interface.
14	Reserved	-	<b>Reserved</b> - DC power supply.
15	GND	P	<b>Power</b> - DC power supply.
16	Reserved	-	<b>Reserved</b> - DC power supply.
17	Reserved	-	<b>Reserved</b> - DC power supply.
18	GND	P	<b>Power</b> - DC power supply.
19	Reserved	-	<b>Reserved</b> - DC power supply.
20	Reserved	-	<b>Reserved</b> - DC power supply.
21	GND	P	<b>Power</b> - DC power supply.
22	PERST#	I	<b>Input</b> - Standard input-only signal.
23	PERn0	A <sub>DIFF</sub>	<b>Analog differential</b> - Signal pair for the twisted-pair interface.
24	+3.3Vaux	P	<b>Power</b> - DC power supply.
25	PERp0	A <sub>DIFF</sub>	<b>Analog differential</b> - Signal pair for the twisted-pair interface.
26	GND	P	<b>Power</b> - DC power supply.
27	GND	P	<b>Power</b> - DC power supply.
28	1.5V	P	<b>Power</b> - DC power supply.
29	GND	P	<b>Power</b> - DC power supply.
30	SMB_CLK	NU	<b>Not used</b> - This pin is not used.
31	PETn0	A <sub>DIFF</sub>	<b>Analog differential</b> - Signal pair for the twisted-pair interface.
32	SMB_DATA	NU	<b>Not used</b> - This pin is not used.
33	PETp0	A <sub>DIFF</sub>	<b>Analog differential</b> - Signal pair for the twisted-pair interface.
34	GND	P	<b>Power</b> - DC power supply.
35	GND	P	<b>Power</b> - DC power supply.
36	USB_D-	NU	<b>Not used</b> - This pin is not used.
37	Reserved	-	<b>Reserved</b> - DC power supply.
38	USB_D+	NU	<b>Not used</b> - This pin is not used.
39	Reserved	-	<b>Reserved</b> - DC power supply.
40	GND	P	<b>Power</b> - DC power supply.
41	Reserved	-	<b>Reserved</b> - DC power supply.
42	LED_WWAN#	NU	<b>Not used</b> - This pin is not used.
43	Reserved	-	<b>Reserved</b> - DC power supply.
44	LED_WLAN#	NU	<b>Not used</b> - This pin is not used.
45	Reserved	-	<b>Reserved</b> - DC power supply.

46	LED_WPAN#	NU	<b>Not used</b> - This pin is not used.
47	Reserved	-	<b>Reserved</b> - DC power supply.
48	1.5V	P	<b>Power</b> - DC power supply.
49	Reserved	-	<b>Reserved</b> - DC power supply.
50	GND	P	<b>Power</b> - DC power supply.
51	Reserved	-	<b>Reserved</b> - DC power supply.
52	3.3V	P	<b>Power</b> - DC power supply.

*Notes:*

*PETp0 / PETn0 : PCI Express transmitter differential pair*

*PERp0 / PERn0 : PCI Express receiver differential pair*

*REFCLK+ / REFCLK- : PCI Express differential clock*

*PERST# : PCI Express reset*

*CLKREQ# : Clock request to host*

*GND : Ground*

## 4. Functional Description

### 4.1. ATA Commands

The commands supported ATA/ATAPI-7 commands; certain obsolesced commands are also supported. The supported commands are listed in Table 9.

**Table 9: Device ATA Commands Supported**

CHECK POWER MODE	E5h
EXECUTE DIAGNOSTICS	90h
FLUSH CACHE	E7h
FLUSH CACHE EXT	EAh
IDENTIFY DEVICE	ECh
IDLE	E3h
IDLE IMMEDIATE	E1h
INITIALIZE DEVICE PARAMETERS	91h
READ BUFFER	E4H
READ DMA	C8h or C9h
READ DMA EXT	25h
READ FPDMA QUEUED	60h
READ LOG EXT	2Fh
READ MULTIPLE	C4h
READ MULTIPLE EXT	29h
READ SECTOR(S)	20h or 21h
READ SECTOR(S) EXT	24h
READ VERIFY SECTOR(S)	40h or 41h
READ VERIFY SECTOR(S) EXT	42h
RECALIBRATE	10h
SET FEATURES	EFh
SECURITY DISABLE PASSWORD	F6h
SECURITY ERASE PREPARE	F3h
SECURITY ERASE UNIT	F4h
SECURITY FREEZE LOCK	F5h
SECURITY SET PASSWORD	F1h
SECURITY UNLOCK	F2h
SEEK	7xh

SET FEATURES	EFh
SET MULTIPLE MODE	C6h
SLEEP	E6h
SMART	B0h
STANDBY	E2h
STANDBY IMMEDIATE	E0h
SANITIZE (including fast secure erase)	80h
WRITE BUFFER	E8h
WRITE DMA	CAh or CBh
WRITE DMA EXT	35h
WRITE DMA FUA EXT	3Dh
WRITE FPDMA QUEUED	61h
WRITE MULTIPLE	C5h
WRITE MULTIPLE EXT	39h
WRITE MULTIPLE FUA EXT	CEh
WRITE SECTOR(S)	30h or 31h
WRITE SECTOR(S) EXT	34h

Notes:

*O = Valid, - = Don't care*

*SC = Sector Count Register*

*SN = Sector Number Register*

*CY = Cylinder Low/High Register*

*DR = DEVICE SELECT Bit (DEVICE/HEAD Register Bit 4)*


*HD = HEAD SELECT Bit (DEVICE/HEAD Register Bit 3-0)*

*FT = Features Register*

## Appendix A. Ordering Information

### 1. Part Number List:

◆ Industrial mini PCI-e flash module supports write protection – HERCULES - I Series

Product Picture	Grade	Standard grade ( 0°C ~ 70°C )	Industrial Grade ( -40°C ~ +85°C )
	8GB	SBMPM008G-MICTC	WBMPM008G-MIITI
	16GB	SBMPM016G-MICTC	WBMPM016G-MIITI
	32GB	SBMPM032G-MICTC	WBMPM032G-MIITI

### 2. Part Number Decoder:

**X1 X2 X3 X4 X5 X6 X7 X8 X9** — **X11 X12 X13 X14 X15** / **C**

**X1** : Grade

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

W: Industrial Grade – operating temp. -40° C ~ +85 ° C

**X2** : The material of case

B : Bare (without casing)

**X3 X4 X5** : Product category

MPM : mini PCI-e flash module (MPM)

**X6 X7 X8 X9** : Capacity

008G: 08GB

016G: 16GB

032G: 32GB

**X11** : Controller

M : SMI (HERCULES Series)

**X12** : Controller version

A,B,C.....I

**X13** : Controller Grade

C : Commercial grade

I : Industrial grade

**X14** : Flash IC

T : Toshiba SLC-NAND Flash IC

**X15** : Flash IC grade / Type

C : Commercial grade

I : Industrial grade

**C** : Reserved for specific requirement

C : Conformal-coating

## ***Appendix B. Limited Warranty***

APRO warrants your Industrial mini-PCI-e Flash (MPM) 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:***

- **SBMPM0xxG-MICTC**                      **3 years**
- **WBMPM0xxG-MIIT1**                      **5 years**



***The warranty period is able to extend. Please contact APRO and/or Your APRO distributors for more information.***