Product Specification

APRO aSLC MINI SATA III FLASH MODULE

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Revision History

Revision	Description	Date
1.0	Initial release	2016/3/16
1.1	Add. 512GB Capacity	2016/6/23

CONTENTS

1. Introduction

APRO aSLC mini SATA III Flash Module – PHANES-HR Series provides high capacity flash memory Solid State Drive (SSD) that electrically complies with Serial ATA 3.0 (SATA) standard and is fully compliant with the standard mSATA form factor, known as JEDEC MO-300 standard. APRO aSLC mini SATA III Flash Module – PHANES-HR Series support SATA Gen-III (6.0 GB/s) with high performance. The available disk capacities are 32GB, 64GB, 128GB, 256GB and 512GB.

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 MB/sec, and sequential write is up to 510 MB/sec. which is based on Toshiba's 15nm Toggle MLC flash (with 256MB/512MB/1GB DDR3 cache enabled.

APRO aSLC mini SATA III Flash Module – PHANES-HR Series do not need additional driver; the disk can be configured as a boot device or data storage device. It prevents data loss caused by sudden power failure based on enhanced power cycling technology and more capacitors.

S.M.A.R.T. utility will be provided and users will be not only monitor the operation status of SSD, but also visualize Wear-Leveling status with graphics.

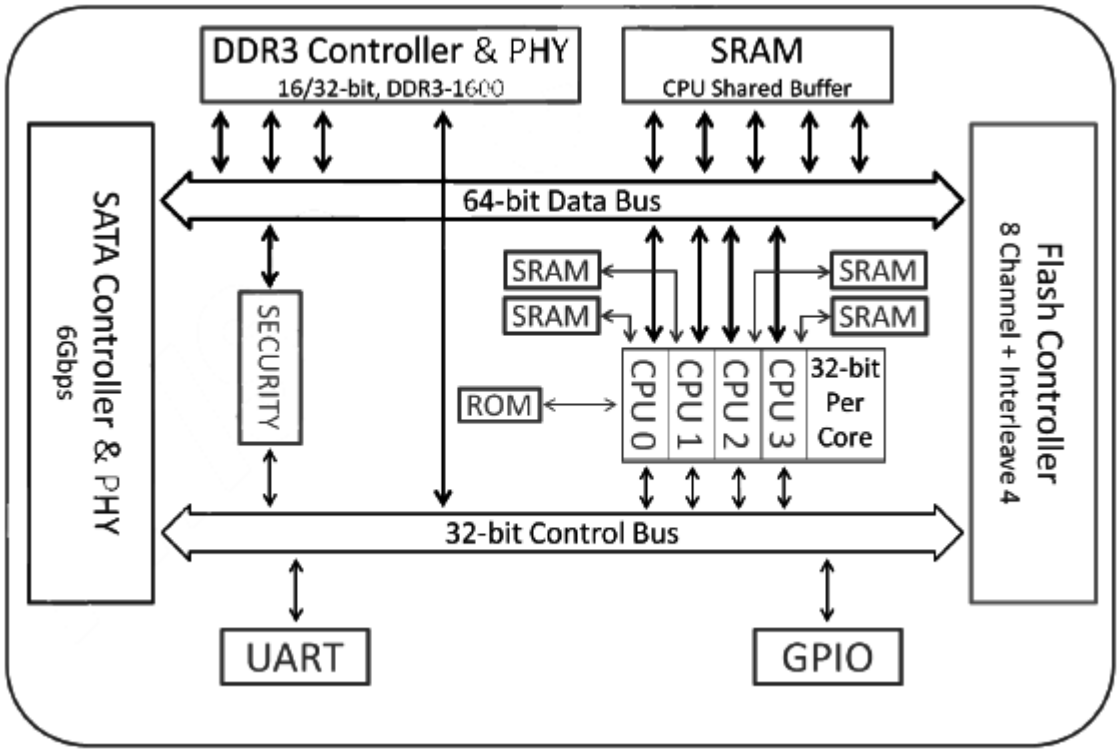

Figure 1: APRO aSLC mini SATA III Flash Module – PHANES-HR Series controller block diagram

1.1. *Scope*

This document describes features, specifications and installation guide of APRO aSLC mini SATA III Flash Module – PHANES-HR Series. In the appendix, there provides order information, warranty policy, RMA/DOA procedure for the most convenient reference.

1.2. *System Features*

- aSLC-NAND type flash technology
- Standard mSATA form-factor, compliant with JEDEC MO-300A
- Mini PCI-e connector with 52 pins SATA pin out
- SATA 1.0a, SATA 2.6 and SATA 3.0 specification compliance
- S.M.A.R.T. (Self-Monitoring, Analysis and Reporting Technology) function supported.
- TRIM Commands supported.
- aSLC Flash SSD standard grade capacity from 32GB up to 512GB
- Sequential read performance up to 550 MB/sec
- Sequential write performance up to 510 MB/sec
- Automatic 120 bits per 2K bytes error correction (ECC) and retry capabilities
- +3.3 V ±5% operation
- Shock : 0.5ms, 1500 G, 3 axes
- Vibration : 80 Hz to 2K Hz, 20G, 3 axes
- Very high performance, very low power consumption
- Low weight, Noiseless
- Standard grade supports operating temperature 0°C to +70°C, and Industrial Grade, -40°C to +85°C with special conformal coating treatment on PCBA

1.3. *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.

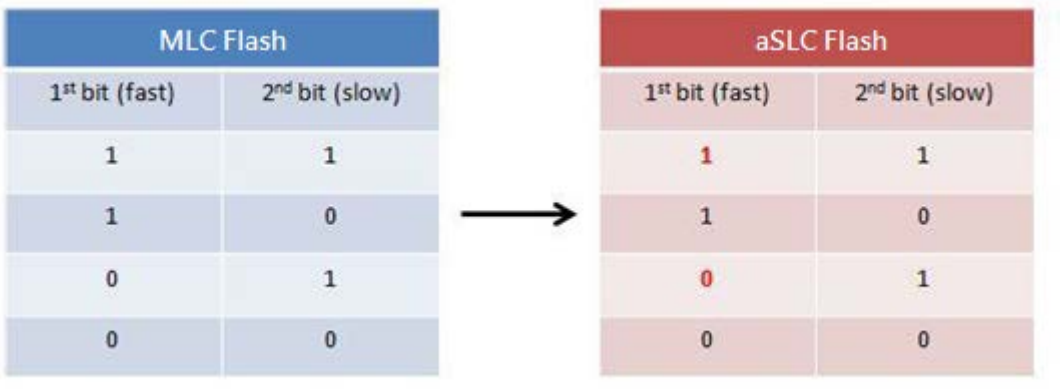

Figure 2: The concept of APRO aSLC Rugged Metal 2.5" SATA III SSD – PHANES-HR Series

1.4. *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 mini SATA III Flash Module – 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.

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 mini SATA III Flash Module PHANES-HR Series		Standard Grade SBMSRxxxG-PHCTMBAS	Wide Temp Grade WBMSRxxxG-PHCTMBAS-C
Temperature	Operating: Non-operating:	0ºC ~ +70ºC -20ºC ~ +80ºC	-40ºC ~ +85ºC -50ºC ~ +95ºC
Humidity	Operating & Non-operating:	10% ~ 95% non-condensing	
Vibration	Operating & Non-operating:	80Hz~2000Hz/20G, 3 axes	
Shock	Operating & Non-operating:	0.5ms, 1500 G, 3 axes	

2.2. *System Power Requirements*

Table 2: Power Requirement

APRO aSLC mini SATA III Flash Module PHANES-HR Series		
DC Input Voltage		3.3V±5%
+3.3V Current (Maximum average value)	Reading Mode :	2,010mW (max.)
	Writing Mode :	2,300mW (max.)
	Idle Mode :	400mW (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		0.2 ms (estimated)				
Maximum Performance	**Capacity**	**32GB**	**64GB**	**128GB**	**256GB**	**512GB**
	Sequential Read (MB/s)	550	550	550	550	550
	Sequential Write(MB/s)	300	490	500	510	510
	4KB Random Read IOPS (QD32)	72K	72K	72K	72K	72K
	4KB Random Write IOPS (QD32)	75K	90K	90K	90K	90K

Note:

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

2.4. *System Reliability*

Table 4: System Reliability

Wear-leveling Algorithms	Dynamic and Static Wear-leveling	
Bad Blocks Management	Supportive	
ECC Technology	120 bits per 2K bytes	
Endurance	TBW (Tera Bytes Written) ; Based on Sequential Write Test.	
Capacity	**TBW(TB)**	**DWPD & Lifespan**
32GB	642	DWPD=18.76 DWPD (Drive Written Per Day) Lifespan = 3 Years
64GB	1,284	
128GB	2,568	
256GB	5,136	
512GB	10,271	

NOTES:

(1). Samples were built using Toshiba 15nm Toggle MLC NAND flash.

(2). TBW may differ according to flash configuration and platform.

(3) 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 physical specifications and dimensions.

Table 5: Physical Specifications

Length:	50.80 mm
Width:	29.80 mm
Thickness:	3.20 mm
Weight:	8.0 g / 0.3 oz

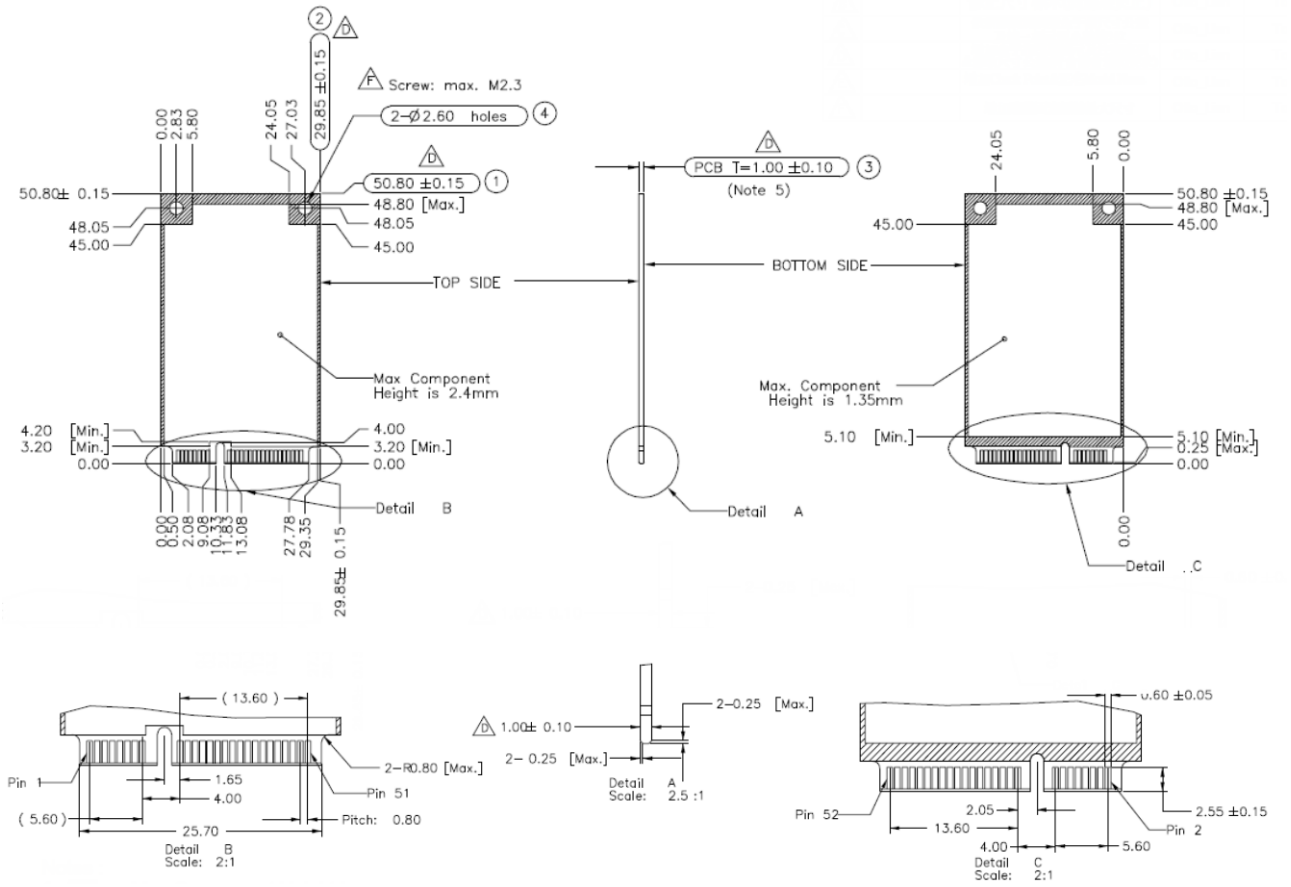

Figure 3: APRO aSLC mini SATA III Flash Module Dimension

2.5.1. 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. *APRO aSLC mini SATA III Flash Module interface*

APRO Mini SATA III Flash Module is equipped with mini PCI-e 52 pins SATA pin out

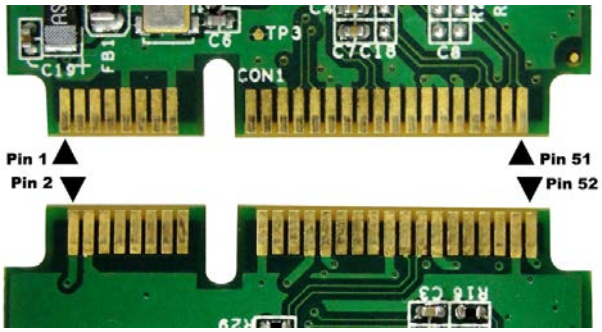

Figure 4: The connectors of mini SATA Flash Module

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

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

3.3. *ATA Commands List*

Individual ATA commands are identified by the value placed in the Feature register.

Table 7: ATA Commands

Op-Code	Command Description	Op-Code		Command Description
00h	NOP	60h		Read FPDMA Queued
06h	Data Set Management	61h		Write FPDMA Queued
10h	Recalibrate	70h		Seek
20h	Read Sectors	90h		Execute Device Diagnostic
21h	Read Sectors without Retry	91h		Initialize Device Parameters
24h	Read Sectors EXT	92h		Download Microcode
25h	Read DMA EXT	93h		Download Microcode DMA
27h	Read Native Max Address EXT	B0h		SMART
29h	Read Multiple EXT	B0h	D0h	SMART READ DATA
2Fh	Read Log EXT	B0h	D1h	SMART READ DATA ATTRIBUTE THRESHOLD
30h	Write Sectors	B0h	D2h	SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE
31h	Write Sectors without Retry	B0h	D3h	SMART SAVE ATTRIBUTE VALUES
34h	Write Sectors EXT	B0h	D4h	SMART EXECUTE OFF-LINE IMMEDIATE
35h	Write DMA EXT	B0h	D5h	SMART READ LOG
37h	Set Native Max Address EXT	B0h	D6h	SMART WRITE LOG
39h	Write Multiple EXT	B0h	D8h	SMART ENABLE OPERATIONS
3Dh	Write DMA FUA EXT	B0h	D9h	SMART DISABLE OPERATIONS
3Fh	Write Long EXT	B0h	DAh	SMART RETURN STATUS
40h	Read Verify Sectors	B0h	DBh	SMART ENABLE/DISABLE AUTOMATIC OFF-LINE
41h	Read Verify Sectors without Retry	B1h		DEVICE CONFIGURATION OVERLAY
42h	Read Verify Sectors EXT	B1h	C0h	DEVICE CONFIGURATION RESTORE
45h	Write Uncorrectable EXT	B1h	C1h	DEVICE CONFIGURATION FREEZE LOCK
47h	Read Log DMA EXT	B1h	C2h	DEVICE CONFIGURATION IDENTIFY
57h	Write Log DMA EXT	B1h	C3h	DEVICE CONFIGURATION SET

Op-Code		Command Description	Op-Code			Command Description
B1h	C4h	DEVICE CONFIGURATION IDENTIFY DMA	ECh			Identify Device
B1h	C5h	DEVICE CONFIGURATION SET DMA	EFh			Set Features
C4h		Read Multiple	EFh	02h		Enable 8-bit PIO transfer mode
C5h		Write Multiple	EFh	03h		Set transfer mode based on value in Count field
C6h		Set Multiple Mode	EFh	05h		Enable advanced power management
C8h		Read DMA	EFh	10h		Enable use of Serial ATA feature
C9h		Read DMA without Retry	EFh	10h	02h	Enable DMA Setup FIS Auto-Activate optimization
CAh		Write DMA	EFh	10h	03h	Enable Device-initiated interface power state (DIPM) transitions
CBh		Write DMA without Retry	EFh	10h	06h	Enable Software Settings Preservation (SSP)
CEh		Write Multiple FUA EXT	EFh	10h	07h	Enable Device Automatic Partial to Slumber transitions
E0h		Standby Immediate	EFh	10h	09h	Enable Device Sleep
E1h		Idle Immediate	EFh	55h		Disable read look-ahead feature
E2h		Standby	EFh	66h		Disable reverting to power-on defaults
E3h		Idle	EFh	82h		Disable write cache
E4h		Read Buffer	EFh	85h		Disable advanced power management
E5h		Check Power Mode	EFh	90h		Disable use of Serial ATA feature set
E6h		Sleep	EFh	90h	02h	Disable DMA Setup FIS Auto-Activate optimization
E7h		Flush Cache	EFh	90h	03h	Disable Device-initiated interface power state (DIPM) transitions
E8h		Write Buffer	EFh	90h	06h	Disable Software Settings Preservation (SSP)
E9h		Read Buffer DMA	EFh	90h	07h	Disable Device Automatic Partial to Slumber transitions
EAh		Flush Cache EXT	EFh	90h	09h	Disable Device Sleep
EBh		Write Buffer DMA	EFh	AAh		Enable read look-ahead feature

Op-Code		Command Description	Op-Code	Command Description
EFh	CCh	Enable reverting to power-on defaults	F4h	Security Erase Unit
F1h		Security Set Password	F5h	Security Freeze Lock
F2h		Security Unlock	F6h	Security Disable Password
F3h		Security Erase Prepare	F8h	Read Native Max Address

Appendix A: Ordering Information

1. Part Number List

◆ **APRO aSLC mini SATA III Flash Module – PHANES-HR Series**

Product Picture	*Capacity*	*Standard grade (0ºC ~ 70ºC)*	*Wide Temp Grade (-40ºC ~ +85ºC)*
	*32GB*	SBMSR032G-PHCTMBAS	WBMSR032G-PHCTMBAS-C
	64GB	SBMSR064G-PHCTMBAS	WBMSR064G-PHCTMBAS-C
	128GB	SBMSR128G-PHCTMBAS	WBMSR128G-PHCTMBAS-C
	256GB	SBMSR256G-PHCTMBAS	WBMSR256G-PHCTMBAS-C
	512GB	SBMSR512G-PHCTMBAS	WBMSR512G-PHCTMBAS-C

Notes:

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

2. Part Number Decoder:

X1 X2 X3 X4 X5 X6 X7 X8 X9 — X11 X12 X13 X14 X15 X16 X17 X18 — C

X1 : **Grade**

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

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

(Standard grade with conformal coating)

X2 : **The material of case**

B : Bare (without casing)

X3 X4 X5 : **Product category**

MSR : mini SATA Flash Module (mSATA) w/DRAM

X6 X7 X8 X9 : **Capacity**

032G:	32GB	**512G:**	512GB
064G:	64GB		
128G:	128GB		
256G:	256GB		

X11 : **Controller**

P : PHANES Series

X12 : Controller version

A, B, C…..

X13 : **Controller Grade**

C : Standard grade

X14 : **Flash IC**

T : Toshiba Flash IC

X15 : **Flash IC grade / Type**

M : MLC-NAND Flash IC

X16 X17 X18: **Flash IC**

B : 15 nm

AS : aSLC Technology.

C : **Reserved for specific requirement**

C : Conformal-coating

Appendix B: Limited Warranty

APRO warrants your aSLC mini SATA III Flash Module – 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) 3 years / Within 20K Erasing Counts**

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