

3D NAND TLC Flash

(KIOXIA BiCS FLASH™)

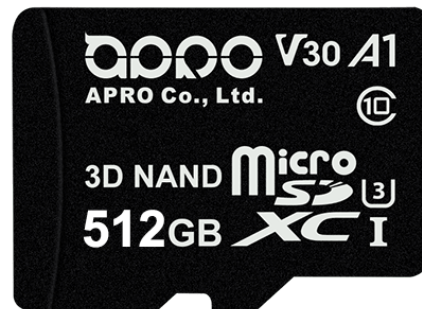
MicroSD Card 6.10

PHANES-T Series

Document No. : 100-xPMSD-PTCT5

Version No. : 01V3

Date : July, 2024



ISO 9001 : 2015 CERTIFIED



Product Features

■ Flash IC

- KIOXIA BiCS5 3D-NAND Flash IC.
- KIOXIA **BiCS FLASH™** *3

■ Compatibility

- The Command List supports
Part 1 Physical Layer Specification Ver6.10 Final Specifications.
- Card Capacity of Non-secure Area, Secure Area Supports
Part 3 Security Specification Ver7.00 Final Specifications.
- Support **File System Specification Ver3.00**

■ Additional Capabilities

- S.M.A.R.T.*1 feature set support.
- Bus Speed supports UHS-1
- Video Speed Class supports up to V30.
- Speed Class supports: Class 10/A2/UHS-1, U3
- Supports **SD mode** and **SPI mode**
- Compliant with Part 1 Physical Layer Specification ver. 6.10, CPRM is Optional in the microSDXC.
- Supports Auto-Read Refresh
- Support bad Block Management
- Supports **LVS initialization** flow
- Support both Static and Dynamic Wear Leveling

■ Mechanical

- 8 exposed contact pins on one side.
- Dimension: 15.0mm x 11.0mm x 1.0mm.
- Weight: 0.3 g / 0.01 oz.

■ Power Operating Voltage 2.7V to 3.6V

- Read Mode: 400 mA (max.)
- Write Mode: 400 mA (max.)
- Standby Mode: 1 mA (max.)

■ Performance (Maximum value) *2

microSD Card 3D NAND TLC performance

- Sequential Read: 101.0 MB/sec. (max.)
- Sequential Write: 93.0 MB/sec. (max.)

■ Capacity

microSD Card 3D NAND TLC

64GB, 128GB, 256GB and 512GB

■ Reliability

- **ECC:** Designed with ECC Algorithm. (Error Correcting Code)
- **TBW:** Up to 1,462 TBW at 512GB Capacity. (Sequential Write)
- **MTBF:** > 3,000,000 hours
- **Temperature:**
Operation temp. range: -25°C ~ +85°C
Storage temp. range: -40°C ~ +85°C
- **Vibration:** 80Hz~2000Hz/20G.
- **Shock:** 0.5ms, 1500 G, 3 axes.
- **Erase counts:** 3K

■ 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
3. **BiCS** means Bit Cost Scalable Technology.
BiCSFLASH is a trademark of KIOXIA Corporation.

Order Information

I. Part Number List

◆ APRO 3D NAND TLC Micro Secure Digital Memory Card Version 6.10 PHANES-T Series

Product Picture	Grade	Std. Temp. Grade (-25 °C ~ +85°C)
	64GB	SPMSD064G-PTCT5
	128GB	SPMSD128G-PTCT5
	256GB	SPMSD256G-PTCT5
	512GB	SPMSD512G-PTCT5

II. Part Number Decoder:

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

X1 : Grade

S: Standard Grade – operating temp. -25° C ~ 85 ° C

X12 : Controller version

A, B, C.....

X2 : The material of case

P : Plastic casing

X13 : Controller Grade

C : Commercial grade

X3 X4 X5 : Product category

MSD : Micro Secure Digital (SD) memory card

X14 : Flash IC

T : KIOXIA NAND Flash IC

X6 X7 X8 X9 : Capacity

064G: 64GB **256G:** 256GB

128G: 128GB **512G:** 512GB

X15 : Flash IC grade / Type

5 : KIOXIA BiCS5 3D-NAND Flash IC

X11 : Controller

P : PHANES Series

Revision History

Revision	Description	Date
1.0	Initial release	2021/11/24
1.1	Add. TBW	2022/04/01
1.2	Add. 512GB Capacity	2023/02/01
1.3	Add. supports LVS initialization flow decryption.	2024/07/09

Contents

Product Features	- 2 -
Order Information	- 3 -
I. Part Number List	- 3 -
II. Part Number Decoder:	- 3 -
Revision History	- 4 -
Contents	- 5 -
1. Introduction	- 6 -
1.1. Scope	- 6 -
1.2. Flash Management Technology – Static & Dynamic Wear Leveling	- 6 -
1.3. Bad Block Management	- 6 -
1.4. Error Correction Code (ECC)	- 7 -
1.5. Auto-Read Refresh	- 7 -
2. Product Specifications	- 7 -
2.1. System Environmental Specifications	- 7 -
2.2. System Power Requirements	- 7 -
2.3. System Performance	- 8 -
2.4. System Reliability	- 8 -
2.5. Tera Bytes Written	- 9 -
2.6. Physical Specifications	- 10 -
3. Interface Description	- 12 -
3.1. Micro Secure Digital Memory Card interface	- 12 -
3.2. Pin Assignments	- 12 -
Appendix A: Limited Warranty	- 13 -

1. Introduction

APRO 3D NAND TLC Micro Secure Digital Memory Card Version 6.10 PHANES-T Series is fully compliant to the specification released by SD Card Association. The Command List supports [Part 1 Physical Layer Specification Ver6.10 Final] definitions. Card Capacity of Non-secure Area, Secure Area Supports [Part 3 Security Specification Ver4.00 Final] Specifications.

The microSD 6.10 card comes with 8-pin interface, designed to operate at a maximum operating frequency of 208MHz. It can alternate communication protocol between the SD mode and SPI mode. It performs data error detection and correction with very low power consumption. Its capacity could reach 512GB with exFAT SDXC.

The main used Flash memory is 3D-NAND Type Flash memory chips which capacities are 64GB, 128GB, 256GB and 512GB.

APRO 3D NAND TLC Micro Secure Digital Memory Card Version 6.10 PHANES-T Series support the standard grade operating temp. -25° C ~ 85 ° C and the storage temp. is -40~+85°C.

1.1. Scope

This document describes the key features and specifications of APRO 3D NAND TLC Micro Secure Digital Memory Card Version 6.10 PHANES-T Series.

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 3D NAND TLC Micro Secure Digital Memory Card Version 6.10 PHANES-T 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 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 3D NAND TLC Micro Secure Digital Memory Card Version 6.10 PHANES-T 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. Error Correction Code (ECC)

Flash memory cells will deteriorate with use, which might generate random bit errors in the stored data. Thus, microSD card applies ECC Algorithm, which can detect and correct errors during Read processes, ensuring data is read correctly, as well as protecting data from corruption.

1.5. Auto-Read Refresh

Auto-Read Refresh is especially applied on devices that read data mostly but rarely write data, such as GPS. When blocks are continuously read, then the device cannot activate wear leveling since it can only be applied while writing data. Thus, errors will accumulate and become uncorrectable. Accordingly, to avoid errors exceed the amount ECC can correct and blocks turn bad, APRO 3D NAND TLC Micro Secure Digital Memory Card Version 6.10 PHANES-T Series firmware will automatically refresh the bit errors when the error number in one block approaches the threshold, ex., 24 bits.

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 3D NAND TLC Micro Secure Digital Memory Card Version 6.10 PHANES-T Series		Standard temp. grade
Temperature	Operating:	-25°C ~ +85°C
	Non-operating:	-40°C ~ +85°C
Humidity	Operating & Non-operating:	10% ~ 95% non-condensing
Vibration	Operating & Non-operating:	80Hz~2000Hz/20G.
Shock	Operating & Non-operating:	0.5ms, 1500 G, 3 axes

2.2. System Power Requirements

Table 2: Power Requirement

APRO 3D NAND TLC Micro Secure Digital Memory Card Version 6.10 PHANES-T Series		Standard temp. grade
DC Input Voltage (VCC)		2.7V to 3.6V
Maximum average value	Reading Mode :	< 400 mA
	Writing Mode :	< 400 mA
	Standby Mode :	< 1 mA

2.3. System Performance

Table 3: System Performances

Product Solution	3D NAND TLC Flash			
Speed level	A2, V30, Class10, U3, UHS-1			
Capacity level	microSDXC			
Capacity	64GB	128GB	256GB	512GB
Sequential Read (MB/s)	101.0	101.0	101.0	101.0
Sequential Write (MB/s)	53.0	93.0	93.0	93.0

Note:

- The performance is obtained from TestMetrix Test (@500MB).

2.4. System Reliability

Table 4: System Reliability

Wear-leveling Algorithms	Static and Dynamic wear-leveling algorithms
Bad Blocks Management	Supportive
ECC Technology	Designed with ECC Algorithm
MTBF	> 3,000,000 hours
Endurance	3D NAND TLC Flash : 3K Erase counts
Durability	10,000 inserting cycles
Bending	>10N
Torque	0.1N +/- 2.5 deg.
Drop Test	1.5M free fall
Salt Spray	Concentration: 3% NaCl/35°C
Waterproof	1000mm submerge for 30 minutes, IPx7 compliance
Electrostatic Discharge (ESD)	Contact: +/- 4KV each item 25 times Air: +/- 8KV 10 times
X-Ray Exposure Test	0.1 Gy of medium energy radiation (70 keV to 140keV, cumulative does per year) to both sides of the card.

Note:

- 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. Tera Bytes Written

Table 4: System Reliability

Erase counts	KIOXIA BiCS5 3D-NAND Flash: 3K P/E Cycles
Capacity	TBW(TB)
64GB	182
128GB	365
256GB	731
512GB	1,462

➤ *Workload by Sequential Write.*

The endurance of SSD could be varying based on user behavior, NAND endurance cycles, and write amplification factor. It is not guaranteed by flash vendor.

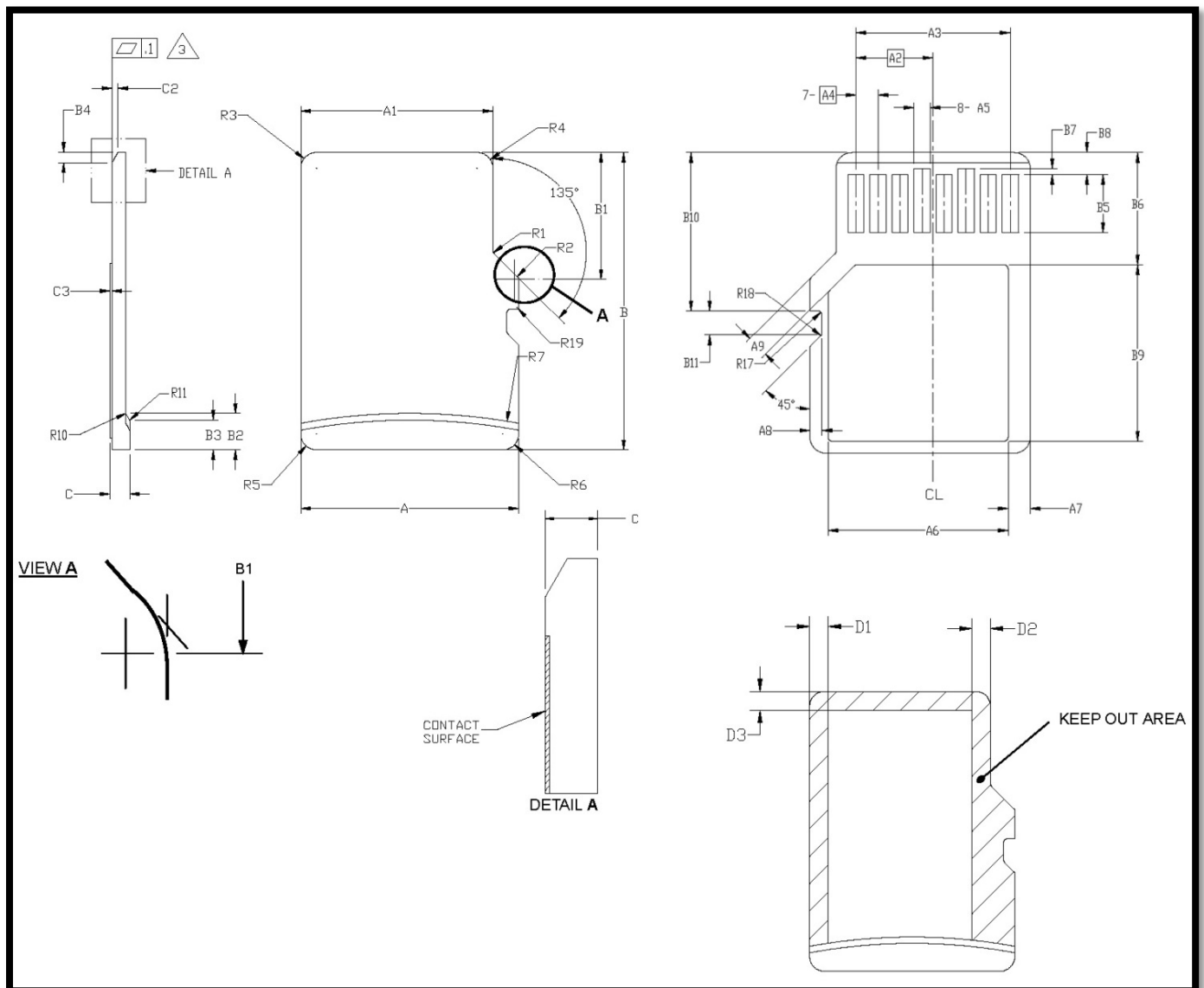
2.6. Physical Specifications

Refer to Table 5 and see Figure 1 for APRO 3D NAND TLC Micro Secure Digital Memory Card Version 6.10 PHANES-T Series physical specifications and dimensions.

Table 5: Physical Specifications of APRO 3D NAND TLC Micro Secure Digital Memory Card PHANES-T Series

Length:	15.00 mm
Width:	11.00 mm
Thickness:	1.0 mm
Weight:	0.3 g / 0.01 oz

Figure 2: APRO 3D NAND TLC Micro Secure Digital Memory Card Version 6.10 PHANES-T Series Dimension




SYMBOL	COMMON DIMENSIONS			NOTE
	MIN	NOM	MAX	
A	10.90	11.00	11.10	
A1	9.60	9.70	9.80	
A2	-	3.85	-	BASIC
A3	7.60	7.70	7.80	
A4	-	1.10	-	BASIC
A5	0.75	0.80	0.85	
A6	-	-	8.50	
A7	0.90	-	-	
A8	0.60	0.70	0.80	
A9	0.80	-	-	
B	14.90	15.00	15.10	
B1	6.30	6.40	6.50	
B2	1.64	1.84	2.04	
B3	1.30	1.50	1.70	
B4	0.42	0.52	0.62	
B5	2.80	2.90	3.00	
B6	5.50	-	-	
B7	0.20	0.30	0.40	
B8	1.00	1.10	1.20	
B9	-	-	9.00	
B10	7.80	7.90	8.00	
B11	1.10	1.20	1.30	
C	0.90	1.00	1.10	
C1	0.60	0.70	0.80	
C2	0.20	0.30	0.40	
C3	0.00	-	0.15	
D1	1.00	-	-	
D2	1.00	-	-	
D3	1.00	-	-	
R1	0.20	0.40	0.60	
R2	0.20	0.40	0.60	
R3	0.70	0.80	0.90	
R4	0.70	0.80	0.90	
R5	0.70	0.80	0.90	
R6	0.70	0.80	0.90	
R7	29.50	30.00	30.50	
R10	-	0.20	-	
R11	-	0.20	-	
R17	0.10	0.20	0.30	
R18	0.20	0.40	0.60	
R19	0.05	-	0.20	

Notes:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994.

2. DIMENSIONS ARE IN MILLIMETERS.

3.  COPLANARITY IS ADDITIVE TO C1 MAX THICKNESS.

3. Interface Description

3.1. Micro Secure Digital Memory Card interface

APRO 3D NAND TLC Micro Secure Digital Memory Card Version 6.10 PHANES-T Series has 8 exposed contacts on one side.

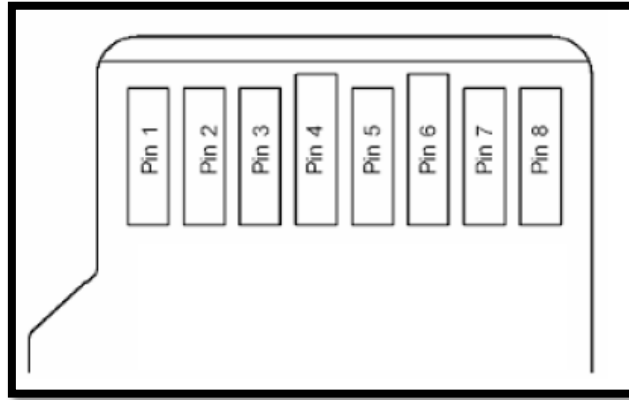


Figure 3: 8 Pins Connector

3.2. Pin Assignments

There are total of 8 pins in the Micro SD Connector. The pin assignments are listed in below table 6.

Table 6 - Pin Assignments

Pin Number	SD Mode			SPI Mode		
	Pin Name	Type ¹	Description	Pin Name	Type	Description
Pin 1	DAT2	I/O/PP	Data Line [bit2]	RSV		
Pin 2	CD / DAT3 ²	I/O/PP ³	Card Detect / Data Line [bit3]	CS	I ³	Chip Select
Pin 3	CMD	PP	Command / Response	DI	I	Data in
Pin 4	V _{DD}	S	Supply voltage	V _{DD}	S	Supply voltage
Pin 5	CLK	I	Clock	SCLK	I	Clock
Pin 6	V _{SS}	S	Supply voltage ground	V _{SS}	S	Supply voltage ground
Pin 7	DAT0	I/O/PP	Data Line [bit0]	DO	O/PP	Data Out
Pin 8	DAT1	I/O/PP	Data Line [bit1]	RSV		

- S: power supply, I:input; O:output using push-pull drivers; PP:I/O using push-pull drivers.
- The extended DAT lines (DAT1-DAT3) are input on power up. They start to operate as DAT lines after SET_BUS_WIDTH command. The Host shall keep its own DAT1-DAT3 lines in input mode, as well, while they are not used. It is defined so, in order to keep compatibility to Multi-Media Cards.
- At power up this line has a 50KOhm pull up enabled in the card. This resistor serves two functions Card detection and Mode Selection. For Mode Selection, the host can drive the line high or let it be pulled high to select SD mode. If the host wants to select SPI mode it should drive the line low. For Card detection, the host detects that the line is pulled high. This pull-up should be disconnected by the user during regular data transfer period, with SET_CLR_CARD_DETECT(ACMD42) command.

Appendix A: Limited Warranty

APRO warrants your 3D NAND TLC Micro Secure Digital Memory Card Version 6.10 PHANES-T 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:

- **3D NAND TLC (Standard grade / Wide temp. grade) 2 years / Within 3K Erasing Counts**

This document is for information use only and is **subject to change without prior notice**. APRO Co., Ltd. assumes no responsibility for any errors that may appear in this document, nor for incidental or consequential damages resulting from the furnishing, performance or use of this material. No part of this document may be reproduced, transmitted, transcribed, stored in a retrievable manner or translated into any language or computer language, in any form or by any means, electronic, mechanical, magnetic, optical, chemical, manual or otherwise, without the prior written consent of an officer of APRO Co., Ltd.

All parts of the APRO documentation are protected by copyright law and all rights are reserved.

APRO and the APRO logo are registered trademarks of APRO Co., Ltd.

Product names mentioned herein are for identification purposes only and may be trademarks and/or registered trademarks of their respective companies.

© 2023 APRO Corporation. All rights reserved