APRO Co., Ltd.

3D NAND TLC Flash

(KIOXIA BiCS FLASHTM)

SDXC Card 6.10

PHANES-T Series

Document No. : 100-xPSDX-PTCT5

Version No. : 01V0

Date : December, 2021

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** (Self-Monitoring, Analysis and Reporting Technology) 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 SDXC.
  - Supports Auto-Read Refresh
  - Support bad Block Management
  - Support both Static and Dynamic Wear Leveling

- **Mechanical**
  - 9 exposed contact pins on one side.
  - Dimension: 32.0mm x 24.0mm x 2.1mm.
  - Weight: 2.5 g / 0.09 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**

  SDXC Card 3D NAND TLC performance
  - Sequential Read: 101.0 MB/sec. (max.)
  - Sequential Write: 93.0 MB/sec. (max.)

- **Capacity**
  - **SDXC Card 3D NAND TLC**

    64GB, 128GB and 256GB

- **Reliability**
  - **ECC:** Designed with ECC Algorithm. (Error Correcting Code)
  - **MTBF:** > 3,000,000 hours
  - **Temperature:**

    Operation temp. range: -25ºC ~ +85ºC

    Storage temp. range: -40ºC ~ +85ºC
  - **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 SDXC Card Version 6.10 PHANES-T Series**

Product Picture	Grade	Std. Temp. Grade (-25 ºC ~ +85ºC)
	64GB	SPSDX064G-PTCT5
	128GB	SPSDX128G-PTCT5
	256GB	SPSDX256G-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. -25º C ~ 85 º C

X2 : **The material of case**

P : Plastic casing

X3 X4 X5 : **Product category**

SDX : Secure Digital eXtended Capacity card

X6 X7 X8 X9 : **Capacity**

064G:	64GB	**256G:**	256GB
128G:	128GB		

X11 : **Controller**

P : PHANES Series

X12 : **Controller version**

A, B, C.....

X13 : **Controller Grade**

C : Commercial grade

X14 : **Flash IC**

T : KIOXIA NAND Flash IC

X15 : **Flash IC grade / Type**

5 : KIOXIA BiCS5 3D-NAND Flash IC

Revision History

Revision	Description	Date
1.0	Initial release	2021/12/01
1.1	Add. TBW	2022/04/01

Contents

1. Introduction

APRO 3D NAND TLC SDXC 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 Ver7.00 Final] Specifications.

The SD card comes with a 9-pin interface, designed to operate at a maximum 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 256GB with exFAT SDXC.

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

APRO 3D NAND TLC SDXC Card Version 6.10 PHANES-T Series support the standard grade operating temp. -25º C ~ 85 º 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 SDXC 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 SDXC 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 SDXC 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, SDXC 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 SDXC 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 SDXC Card Version 6.10 PHANES-T Series		Standard temp. grade
Temperature	**Operating:**	-25ºC ~ +85ºC
	Non-operating:	-40ºC ~ +85ºC
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 SDXC 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	SDXC		
Capacity	64GB	128GB	256GB
Sequential Read (MB/s)	101.0	101.0	101.0
Sequential Write (MB/s)	53.0	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℃
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

- *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.*

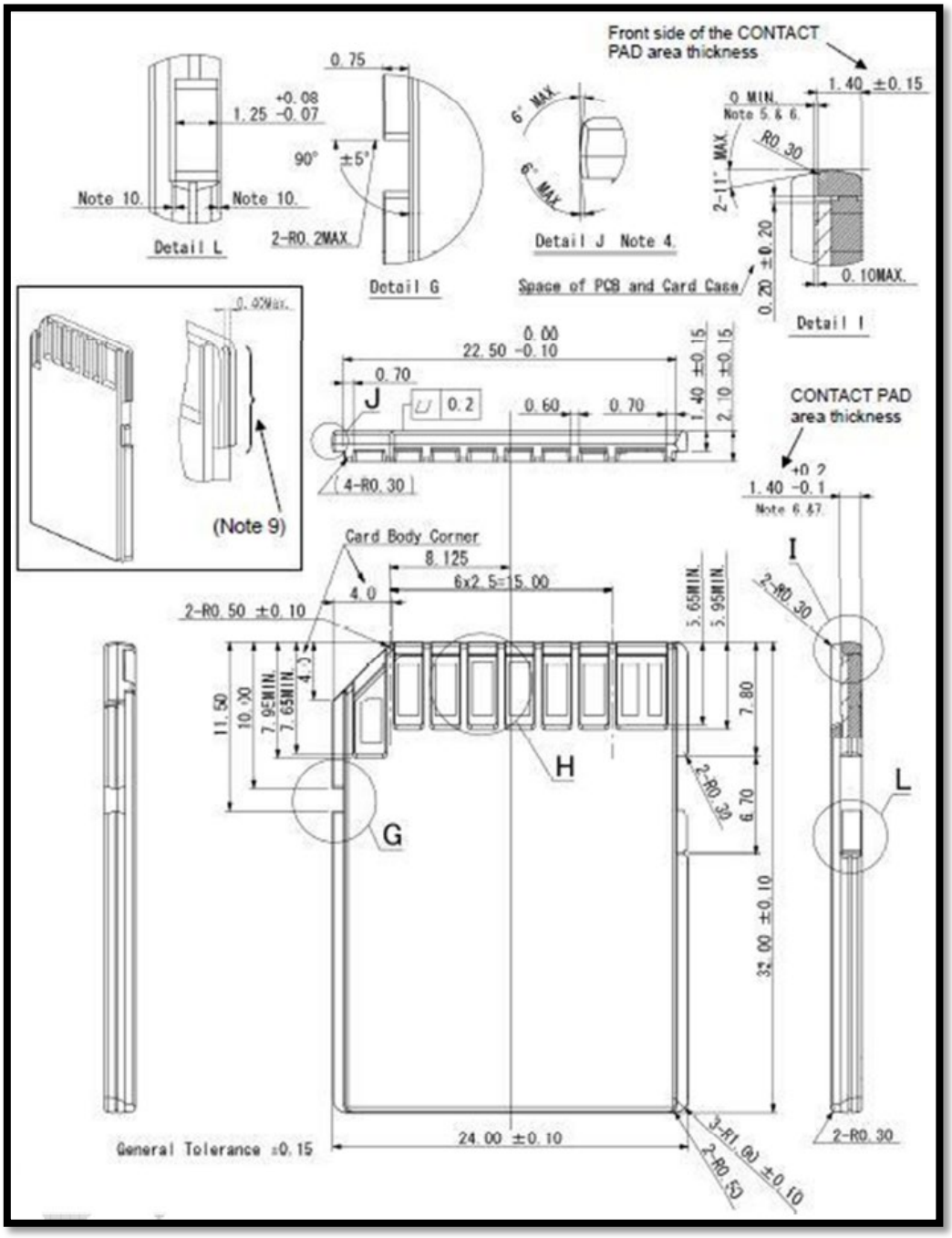
2.6. *Physical Specifications*

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

Table 5: Physical Specifications of APRO 3D NAND TLC SDXC Card PHANES-T Series

Length:	32.00 mm
Width:	24.00 mm
Thickness:	2.1 mm
Weight:	2.5 g / 0.09 oz

Figure 2: APRO 3D NAND TLC SDXC Card Version 6.10 PHANES-T Series Dimension



3. Interface Description

3.1. SDXC Card interface

APRO 3D NAND TLC SDXC Card Version 6.10 PHANES-T Series has 9 exposed contacts on one side.

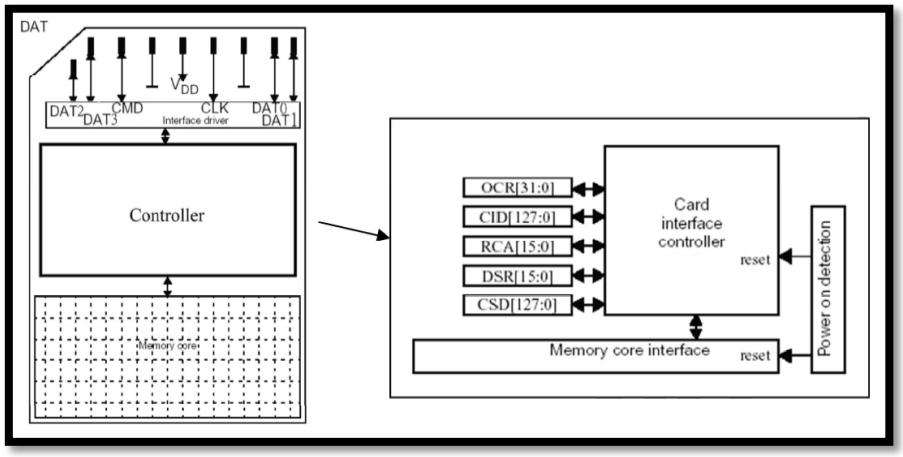


Figure 3: 9 Pins Connector

3.2. Pin Assignments

There are total of 9 pins in the SDXC 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	CD / DAT3[2]	I/O/PP[3]	Card Detect / Data Line [bit3]	CS	I[3]	Chip Select
Pin 2	CMD	PP	Command / Response	DI	I	Data in
Pin 3	V_{SS1}	S	Supply voltage ground	V_{SS}	S	Supply voltage ground
Pin 4	V_{DD}	S	Supply voltage	V_{DD}	S	Supply voltage
Pin 5	CLK	I	Clock	SCLK	I	Clock
Pin 6	V_{SS2}	S	Supply voltage ground	V_{SS2}	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		
Pin 9	DAT2	I/O/PP	Data Line [bit2]	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, withSET_CLR_CARD_DETECT(ACMD42) command.

Appendix A: Limited Warranty

APRO warrants your 3D NAND TLC SDXC 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**

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