APRO Co., Ltd.

3D NAND Flash

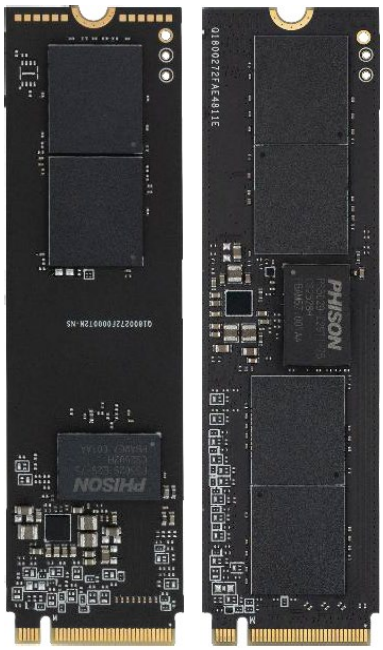
(KIOXIA BiCS8 3D NAND) / (3D aSLC Mode)

M.2 PCIe NVMe SSD

PHANES-PC Series

(2280 Form-factor)

(Gen-4 x 4)



Document No. : 100-xBMDP-PPCT88M

Version No. : 01V0

Date : July 2026

ISO 9001 : 2015 CERTIFIED

Product Features

- **Flash IC**
- KIOXIA BiCS8 3D-NAND Flash IC.
- KIOXIA **BiCS FLASH™ *3**
- KIOXIA BiCS8 3D-NAND Flash w/aSLC Technology.

- **Compatibility**
- PCIe Gen4x4
- NVMe 2.0
- PCI Express Base 4.0

- **Additional Capabilities**
- S.M.A.R.T.***1** (Self-Monitoring, Analysis and Reporting Technology) feature set support.
- Thermal Monitor for SSD's temperature.
- Hardware Low Density Parity Check Code, LDPC support.
- RAID ECC
- HMB (Host Memory Buffer)
- ETEDPP (End to End Data Path Protection)
- Read Only Mode (End of Life)
- Support of **TCG OPAL** (Optional)***4**

- **Mechanical**
- PCI Gen4 x 4 NVMe interface(2280)
- M.2 keying notches in **M** positions.
- **Dimension: M.2 2280-S2-M-H1:** (8.0g)
  Double Side: 80.0 mm x 22.0 mm x 2.15mm

- **Power Management: OP. Voltage 3.3V(+/-) 5%**
- Active mode (Max.): < 4.1W
- Idle mode: < 1.3W

■ **Performance (Maximum value) *2, 3**

- **2280:** (w/SLC Cache)
- Sequential Read: 7,600.0 MB/sec.
- Sequential Write: 6,600.0 MB/sec.
- Ran. 4K Read up to 1,000K IOPS
- Ran. 4K Write up to 1,300K IOPS

■ **Capacity: (2280-D2-M-H2)**

3D NAND : 256GB, 512GB, 1TB, 2TB, 4TB

3D aSLC : 80GB, 1600GB, 320GB, 640GB, 1.2T

■ **Reliability**

- **TBW:** (Client workload by JESD-219A)
- **3D NAND:** Up to 4,706 TB
- **3D aSLC:** Up to 82,616 TB
- **MTBF: >** 4,000,000 hours.
- **UBER:** < 1 sector per 10^{16} bits read.
- **ECC:** Designed with hardware LDPC ECC engine
- **Temperature:**
  Standard grade: 0ºC ~ +70ºC
  Industrial grade: -40ºC ~ +85ºC
- **Vibration:** 80Hz~2000Hz/20G.
- **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. IOMeter, 1GB range, 4K data size, QD=128, 16 worker, 4k aligned
3. CrystalDiskMark 7.0.0, 1GB range, QD=16, Thread=1
4. **TCG OPAL: Optional (Different F/W);** requires third-party software management from customer's system.

Order Information

I. Part Number List

◆ **APRO 3D NAND TLC M.2-2280 Form-factor PCIe NVMe SSD PHANES-PC Series**

Product Picture	Grade	Standard grade (0ºC ~ 70ºC)	Ind. Grade (-40ºC ~ +85ºC)
	256GB	SBMDP256G-PPCT88M	WBMDP256G-PPCT88M
	512GB	SBMDP512G-PPCT88M	WBMDP512G-PPCT88M
	1TB	SBMDP001T-PPCT88M	WBMDP001T-PPCT88M
	2TB	SBMDP002T-PPCT88M	WBMDP002T-PPCT88M
	4TB	SBMDP004T-PPCT88M	WBMDP004T-PPCT88M

◆ **APRO 3D NAND TLC w/aSLC mode M.2-2280 Form-factor PCIe NVMe SSD PHANES-PC Series**

Product Picture	Grade	Standard grade (0ºC ~ 70ºC)	Industrial Grade (-40ºC ~ +85ºC)
	80GB	SBMDP080G-PPCT88MAS	WBMDP080G-PPCT88MAS
	160GB	SBMDP160G-PPCT88MAS	WBMDP160G-PPCT88MAS
	320GB	SBMDP320G-PPCT88MAS	WBMDP320G-PPCT88MAS
	640GB	SBMDP640G-PPCT88MAS	WBMDP640G-PPCT88MAS
	1.2TB	SBMDP1.2T-PPCT88MAS	WBMDP1.2T-PPCT88MAS

II. Part Number Decoder:

X1 X2 X3 X4 X5 X6 X7 X8 X9—X11 X12 X13 X14 X15 X16 X17 X18 X19

X1 : **Grade**

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

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

X2 : **The material of case**

B : Bare PCBA w/o Casing

X3 X4 X5 : **Product category**

MDP: M.2 PCIe NVMe SSD

X6 X7 X8 X9 : **Capacity**

256G	480GB	**80G**	80GB
512G:	960GB	**160G**	160GB
1T:	1TB	**320G**	320GB
2T:	2TB	**640G**	640GB
4T:	4TB	**1.2T**	1.2TB

X11 : **Controller**

P : PHANES Series

X12 : **Controller Protocol**

P : A, S, P…..

X13 : **Controller CTL Model Name**

C : A, B, C….

X14 : **Flash IC**

T : KIOXIA NAND Flash IC

15 : **Flash IC grade / Type**

8 : KIOXIA BiCS8 3D-NAND Flash IC

X16 X17: **Form-Factor**

8: 2280 Type

M: with the notches in M positions

X18 X19: **Others**

AS: aSLC mode

TG: TCG Opal 2.0

Revision History

Revision	Description	Date
1.0	Initial release.	2026/07/26

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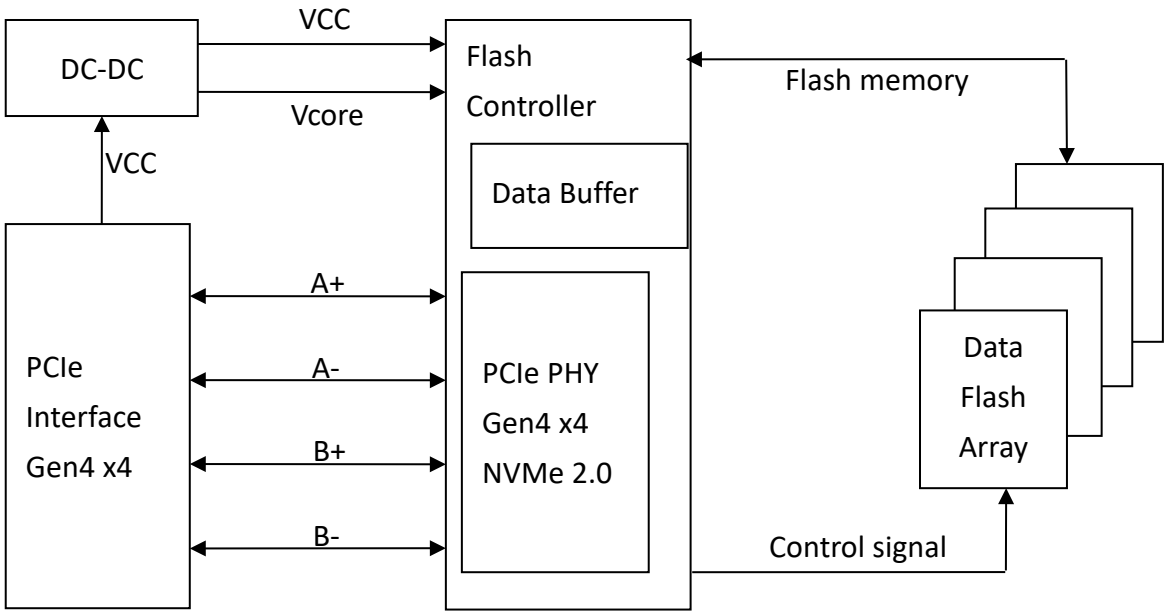
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1. Introduction

APRO 3D NAND TLC PCIe NVMe SSD PHANES-PC Series provides high-capacity flash memory Solid State Drive (SSD) that electrically complies with NVM Express™ 2.0 Standard and support PCI Gen4 x 4 NVMe interface with high performance. The PHANES-PC Series M.2 2280 SSD available disk capacities are 256GB, 512GB, 1TB, 2TB, 4TB for **Kioxia BiCS8 3D NAND** solution, the capacities from 80GB, 1600GB, 320GB, 640GB, 1.2T are the **Kioxia BiCS8 aSLC mode solution**. The operating temperature range is 0°C ~ +70°C and -40°C ~ +85°C.

APRO 3D NAND TLC M.2 PCIe NVMe SSD PHANES-PC Series comes with M positions and supports up to 4 PCI Express lanes. APRO's PHANES-PC Series 3D NAND TLC M.2 PCIe NVMe SSD provides the ultra-high random speed but in low power consumption. It is the most favorable solution for heavy-loading embedded systems or server computing with space limitation.
The powerful controller provides LDPC (Low Density Parity Check) to detect eventual errors while writing and increases the reliability in comparison to a standard ECC mechanism.

APRO's sophisticated S.M.A.R.T. tool is available for customers' request. It is able to monitor the health status of the PHANES-PC Series 3D NAND TLC PCIe NVMe SSD. The optional product with "Thermal Sensor" function, the user may detect its operating temperature by the S.M.A.R.T. tool whenever the SSD is operating. Currently, the S.M.A.R.T. tool is only for Windows OS based systems.



NOTES:

1.PMU: Power Management Unit

2.SEC: Single Bit Error Correct

Figure 1: APRO 3D NAND TLC M.2 PCIe NVMe SSD PHANES-PC Series Controller block diagram

1.1. *Scope*

This document describes features, specifications and installation guide of APRO 3D NAND TLC M.2 PCIe NVMe SSD PHANES-PC Series. In the appendix, there provides order information, warranty policy, RMA/DOA procedure for the most convenient reference.

1.2. *3D-NAND Flash*

3D NAND is a vertical implementation of the NAND flash cell memory array. The memory cell transistors forming the NAND string are connected in a series vertically and the memory transistors are changed from the floating-gate type to a trapped charge type. In floating-gate technology, die density is increased by shrinking peripheral circuits and active circuits.

With 3D, holding the X/Y dimension of the die constant, die density is increased through multiple layers of the active circuits on the Z axis. Higher-density 3D NAND die enables applications needing high-density NAND chip solutions.

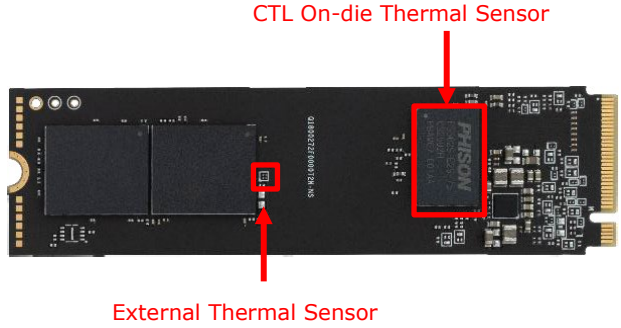
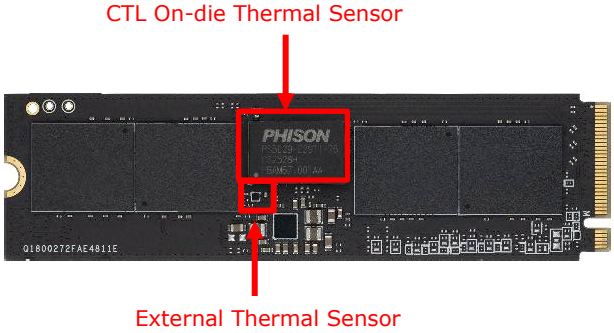
1.3. *Error Correcting Coding (ECC)*

APRO 3D NAND TLC M.2 PCIe NVMe SSD PHANES-PC Series provides a high level interface to the host computer. This interface allows a host computer to issue commands to the APRO 3D NAND TLC M.2 PCIe NVMe SSD PHANES-PC 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 3D NAND TLC M.2 PCIe NVMe SSD PHANES-PC Series intelligent controller manages interface protocols, data storage and retrieval as well as ECC, bad block management and diagnostics, power management and clock control.

1.4. *Thermal Throttling*

The purpose of thermal throttling is to prevent any components in an SSD from over-heating during read and write operations. The controller is designed with an on-die thermal sensor and with its accuracy, firmware can apply different levels of throttling to achieve the purpose of protection efficiently and proactively via S.M.A.R.T. reading.

- Purpose of Thermal Throttling:
  - In order to keep the optimal performance in the safe range of the temperature.
- Thermal sensors:
  - There is controller on-die sensor & external thermal sensor to detect SSD temperature. (The thermal sensor is shown below. The picture is for reference only).
  - Controller on-die sensor detects controller temperature itself, while external thermal sensor helps to detect NAND temperature.
  - S.M.A.R.T. value shows the NAND temperature as Thermal Throttling triggered point.

Type1: 2x NAND PCBA (Top Side)	Type2: 4x NAND PCBA (Top Side)
	

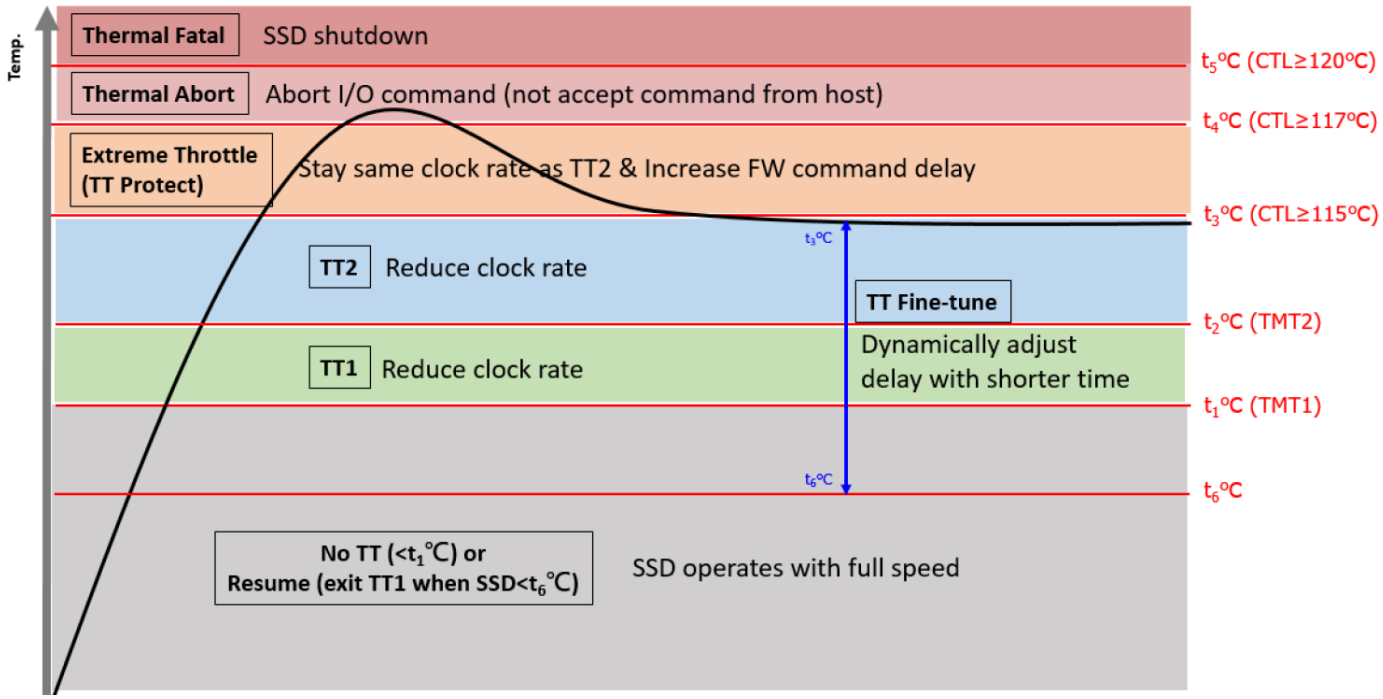


Figure 2-1 Thermal Throttling Schematic

	Stage	Status	Operation temp.
t_1/t_6	No TT/Resume	SSD operates with full speed	<82°C / <74°C
t_1	TT1	Reduce clock rate and increase firmware command delay	82°C
t_2	TT2	Keep same clock rate as TT1, but increase more firmware command delay	85°C
t_3~t_6	TT Fine-tune	Dynamically adjust delay with shorter time	74°C ~ 95°C
t_3	Extreme Throttle (TT Protect)	Reduce more clock rate and increase firmware command delay	95°C (or CTL ≥ 115°C)
t_4	Thermal Abort	Abort I/O command (not accept I/O command from host)	98°C (or CTL ≥ 117°C)
t_5	Thermal Fatal	SSD shutdown	100°C (or CTL ≥ 120°C)

Notes:

1. Operation temp. in Thermal Throttling Temperature Setting table means NAND temperature, which can be read by S.M.A.R.T.

1.5. *TCG Opal 2.0 (Optional)*

- AES 256-bitHardware Self Encryption
- Deploy Storage Device & Take Ownership: The Storage Device is integrated into its target system and ownership transferred by setting or changing the Storage Device's owner credential.
- Activate or Enroll Storage Device: LBA ranges are configured and data encryption and access control credentials (re)generated and/or set on the Storage Device. Access control is configured for LBA range unlocking.
- Lock & Unlock Storage Device: unlocking of one or more LBA ranges by the host and locking of those ranges under host control via either an explicit lock or implicit lock triggered by a reset event. MBR shadowing provides a mechanism to boot into a secure pre-boot authentication environment to handle device unlocking.
- Repurpose & End-of-Life: erasure of data within one or more.

1.6. *UBER*

Table 1: UBER Calculation.

Capacity	UBER
256GB	< 1 sector per 10^{16} bits read
512GB	
1TB	
2TB	
4TB	
80GB	
160GB	
320GB	
640GB	
1.2TB	

Notes:

- *UBER (Uncorrectable Bit Error Rates) means the uncorrectable error per bits read.*
- *UBER = FER (fail rate)/ Data Size (user data bit)*
- *FER = uncorrectable ECC frame number / total ECC frame number*
- *LDPC for Kioxia TLC ECC capability > 120bit/KB*

1.7. *MTBF*

MTBF, Mean Time Between Failures, is a measure of reliability of a device. Its value represents the average time between a repair and the next failure. The unit of MTBF is in hours. The higher the MTBF value, the higher the reliability of the device.

Our MTBF result is based on simulation software (Relex7.3). Please note that a lower MTBF should be expected for higher capacity drives, and we apply the lowest MTBF for all capacities.

Table 2: MTBF Calculation.

Capacity	MTBF
256GB	> 4.0 million hours
512GB	
1TB	
2TB	
4TB	
80GB	
160GB	
320GB	
640GB	
1.2TB	

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 M.2 PCIe NVMe SSD PHANES-PC Series		Standard Temp.	Wide Temp.
Temperature	**Operating:**	0ºC ~ +70ºC	-40ºC ~ +85ºC
	Non-operating:	-40ºC ~ +85ºC	-40ºC ~ +85ºC
Humidity	**Operating & Non-operating:**	10% ~ 95% non-condensing	
	Frequency/Acceleration:	80Hz~2000Hz/20G.	
Shock	**Operating & Non-operating:**	0.5ms, 1500 G, 3 axes	
Electrostatic Discharge (ESD)	**Temperature:**	24ºC	
	Relative Humidity:	51%	
	+/-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 3D NAND TLC M.2-2280 Form-factor PCIe NVMe PHANES-PC Series				
Power Consumption		Read (mW)	Writing (mW)	Idle (mW)
3D TLC w/aSLC Capacity	***256GB***	3,210	2,670	1,200
	512GB	3,900	3,460	1,200
	1TB	3,920	3,770	1,200
	2TB	3,930	3,780	1,200
	4TB	4,025	3,865	1,300
3D TLC Capacity	***80GB***	3,210	2,670	1,200
	160GB	3,900	3,460	1,200
	320GB	3,920	3,770	1,200
	640GB	3,930	3,780	1,200
	1.2TB	4,025	3,865	1,300

Note:

1. Use CrystalDiskMark 8.0.4 with the setting of 1GB. Sequentially read and write the disk for 5 times,
2. and measure power consumption during sequential Read [1/5]~[5/5] or sequential Write [1/5]~[5/5].
3. The measured power voltage is 3.3V.
4. Idle power consumption is measured at idle state with no write/read operation.
5. It will not enter LPM (Low Power Mode) to avoid complex compatibility issues.

6. Power consumption may differ according to flash configuration, use condition, environment and platform.
7. Measurement environment: Room temperature: 20~25℃, humidity: 40~60%RH, DC+3.3V condition.

2.3. *Device Capacity*

Table 3: User Capacity and Addressable Sectors

Capacity	512Bytes/Sector	4KBytes/Sector
	Number of Total LBA	Number of Total LBA
256GB	500,118,192	62,514,774
512GB	1,000,215,216	125,026,902
1TB	2,000,409,264	250,051,158
2TB	4,000,797,360	500,099,670
4TB	8,001,573,552	1,000,196,694
80GB	156,301,488	19,537,686
160GB	312,581,808	39,072,726
320GB	625,142,448	78,142,806
640GB	1,250,263,728	156,282,966
1,280GB	2,500,506,288	312,563,286

Notes

1. 1 Gigabyte (GB) is equal to 1,000,000,000 Bytes; 1 sector is equal to 512 Bytes or 4K Bytes.
2. The calculation is following IDEMA Standard.
3. The total actual user data size of the SSD may be less than device capacity due to SSD format, SSD partition, operating system.
4. EX: OS shows 476.94GB (NTFS) with 512GB SSD.

2.4. *System Performance*

Table 4: System Performances

Interface		PCI Gen4 x 4 NVMe			
Grade		Standard Grade *(0°C ~ 70°C)* (With SLC cache)			
Utility		Burst Seq. R/W Performance		Sustained Sequential Performance	
Performance		Read (MB/s)	Write (MB/s)	Read (MB/s)	Write (MB/s)
3D TLC Capacity	256GB	5,000	3,100	3,000	260
	512GB	7,200	5,600	4,900	470
	1TB	7,200	6,300	5,100	900
	2TB	7,300	6,600	6,100	1,600
	4TB	7,200	6,600	5,700	1,700

Utility		Burst Random R/W IOPS Performance		Sustained Random R/W IOPS Performance	
Performance		Read (MB/s)	Write (MB/s)	Read (MB/s)	Write (MB/s)
3D TLC Capacity	256GB	350K	700K	110K	5K
	512GB	690K	1,200K	160K	8K
	1TB	1,000K	1,300K	200K	9K
	2TB	1,000K	1,300K	200K	12K
	4TB	1,000K	1,300K	190K	11K

Interface		PCI Gen4 x 4 NVMe			
Grade		Wide Temp. Grade *(-40°C ~ +85°C)* (With SLC cache)			
Utility		Burst Seq. R/W Performance		Sustained Sequential Performance	
Performance		Read (MB/s)	Write (MB/s)	Read (MB/s)	Write (MB/s)
3D TLC Capacity	256GB	4,500	3,100	3,000	260
	512GB	7,200	5,600	4,900	470
	1TB	7,200	6,300	5,100	900
	2TB	7,300	6,600	6,100	1,600
	4TB	7,200	6,600	5,700	1,700

Utility		Burst Random R/W IOPS Performance		Sustained Random R/W IOPS Performance	
Performance		Read (MB/s)	Write (MB/s)	Read (MB/s)	Write (MB/s)
3D TLC Capacity	256GB	350K	700K	110K	5K
	512GB	680K	1,200K	160K	8K
	1TB	1,000K	1,300K	200K	9K
	2TB	1,000K	1,300K	200K	12K
	4TB	1,000K	1,300K	190K	10K

Interface		PCI Gen4 x 4 NVMe			
Grade		Standard Grade *(0°C ~ 70°C)* (With SLC cache)			
Utility		Burst Seq. R/W Performance		Sustained Sequential Performance	
Performance		Read (MB/s)	Write (MB/s)	Read (MB/s)	Write (MB/s)
3D TLC w/aSLC Capacity	*80GB*	5,000	3,100	4,800	3,100
	160GB	7,200	5,600	5,250	5,550
	320GB	7,200	6,300	5,300	6,300
	640GB	7,300	6,600	6,250	6,550
	1.2TB	7,200	6,600	5,350	6,300

Utility		Burst Random R/W IOPS Performance		Sustained Random R/W IOPS Performance	
Performance		Read (MB/s)	Write (MB/s)	Read (MB/s)	Write (MB/s)
3D TLC w/aSLC Capacity	80GB	350K	700K	228K	24K
	160GB	690K	1,200K	304K	31K
	320GB	1,000K	1,300K	379K	24K
	640GB	1,000K	1,300K	359K	27K
	1.2TB	1,000K	1,300K	345K	23K

Interface		PCI Gen4 x 4 NVMe			
Grade		Wide Temp. Grade *(-40°C ~ +85°C)* (With SLC cache)			
Utility		Burst Seq. R/W Performance		Sustained Sequential Performance	
Performance		Read (MB/s)	Write (MB/s)	Read (MB/s)	Write (MB/s)
3D TLC w/aSLC Capacity	80GB	5,000	3,100	4,800	3,100
	160GB	7,200	5,600	5,250	5,550
	320GB	7,200	6,300	5,300	6,300
	640GB	7,300	6,600	6,250	6,550
	1.2TB	7,200	6,600	5,350	6,300

Utility		Burst Random R/W IOPS Performance		Sustained Random R/W IOPS Performance	
Performance		Read (MB/s)	Write (MB/s)	Read (MB/s)	Write (MB/s)
3D TLC w/aSLC Capacity	80GB	350K	700K	228K	24K
	160GB	690K	1,200K	304K	31K
	320GB	1,000K	1,300K	379K	24K
	640GB	1,000K	1,300K	359K	27K
	1.2TB	1,000K	1,300K	345K	23K

Note:

1. Performance may differ according to flash configuration, use condition, environment and platform.
2. Performance specification is under that Thermal Throttling has not worked yet.
3. Performance is measured with the follow conditions
   (a.) IOmeter v1.1.0 with QD32T16, 1GB range for 4KB Burst random.
   (b.) Fio on Linux v5.10.32-ryder-20211006 with QD32T8, and SSD is fully written for 4KB Sustained random.
   (c.) OS: Win11 64bit for Burst random.
   (d.) OS: Ubuntu 20.04.2 LTS for Sustained random.
   (e.) AMD Ryzen 7 7700X 8-Core Processor
4. Measurement environment: Room temperature: 20~25℃, humidity: 40~60%RH, DC+3.3V condition.

2.5. *System Reliability*

Table 5: System Reliability

Wear-leveling Algorithms		Static and Dynamic wear-leveling algorithms	
Bad Block Management		Supportive	
ECC Technology		Hardware design LDPC (Low Density Parity Check)	
Erase counts		BiSC8 3D NAND TLC Flash Cell Level : 3K P/E Cycles BiSC8 3D NAND TLC w/aSLC mode Flash Cell Level : 100K P/E Cycles	
TBW (Tera Bytes Written)		**TBW**	**DWPD**
3D TLC Capacity	**256GB**	212	0.75
	512GB	524	0.93
	1TB	1,288	1.14
	2TB	2,690	1.19
	4TB	4,706	1.05
3D TLC w/aSLC Capacity	***80GB***	4,895	55.87
	160GB	10,077	57.51
	320GB	20,258	57.81
	640GB	40,895	58.35
	1.2TB	82,616	58.94

Note:

1. TBW is measured by JEDEC Client 219A workload.
   (a) TLC: Calculated with PE count = 3,000.
   (b) pSLC: Calculated with PE count = 100,000.
2. TBW may differ according to flash configuration and platform configuration.
3. DWPD is calculated based on 3-year lifetime.
4. DWPD = TBW / (365 x 3years x User capacity)
5. The SSD supports trim function. If Operation System does not support trim command, performance and TBW will be affected. (Like certain Windows OS, Linux kernel version before 2.6.33, other OS please refer to respective user manual)
6. The endurance of SSD could be estimated based on user behavior, NAND endurance cycles, and write amplification factor.

2.6. *Physical Specifications*

Refer to Table 5 and see Figure 2 for 3D NAND TLC M.2-2280 Form-factor PCIe NVMe SSD PHANES-PC Series physical specifications and dimensions.

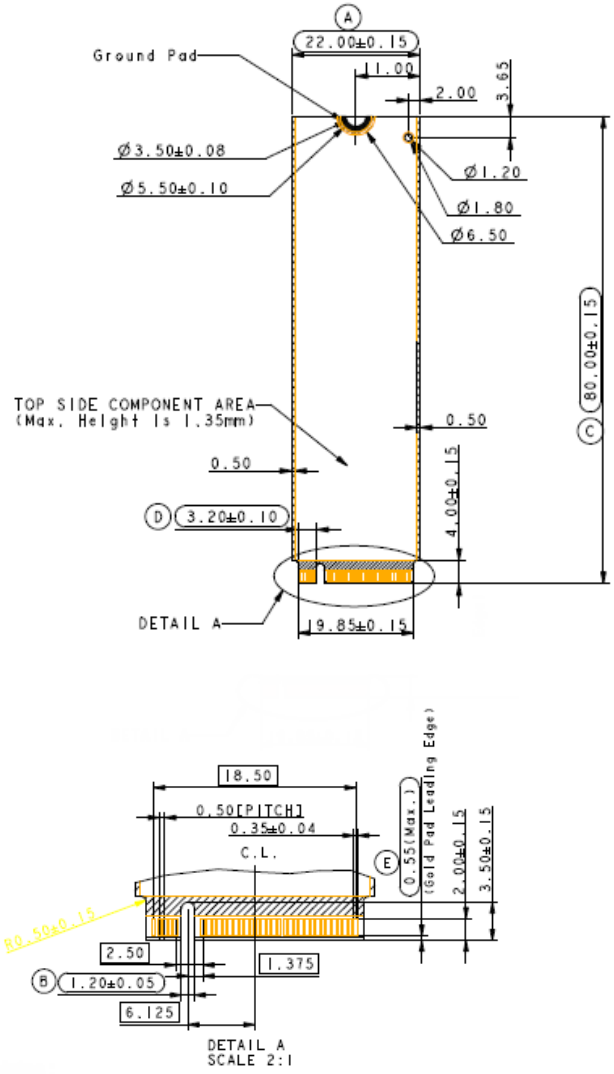
Table 6: Physical Specifications

Form-factor	M.2 2280-S2-M-H1 / 80.00mm (L) x 22mm (W) x 2.15mm (H)
Length:	80.0 mm
Width:	22.0 mm
Thickness	2.15 mm
Weight:	10.0 g

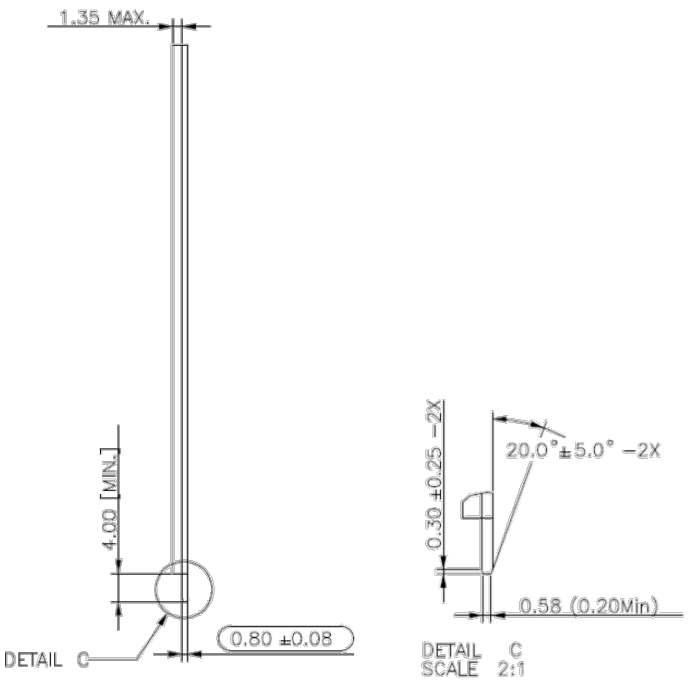
Figure 2: APRO 3D NAND TLC M.2-S2-2280 Form-factor

M.2 2280-M-H1, 80.00mm (L) x 22mm (W) x 2.15mm (H)

Top View



Side View



Bottom View

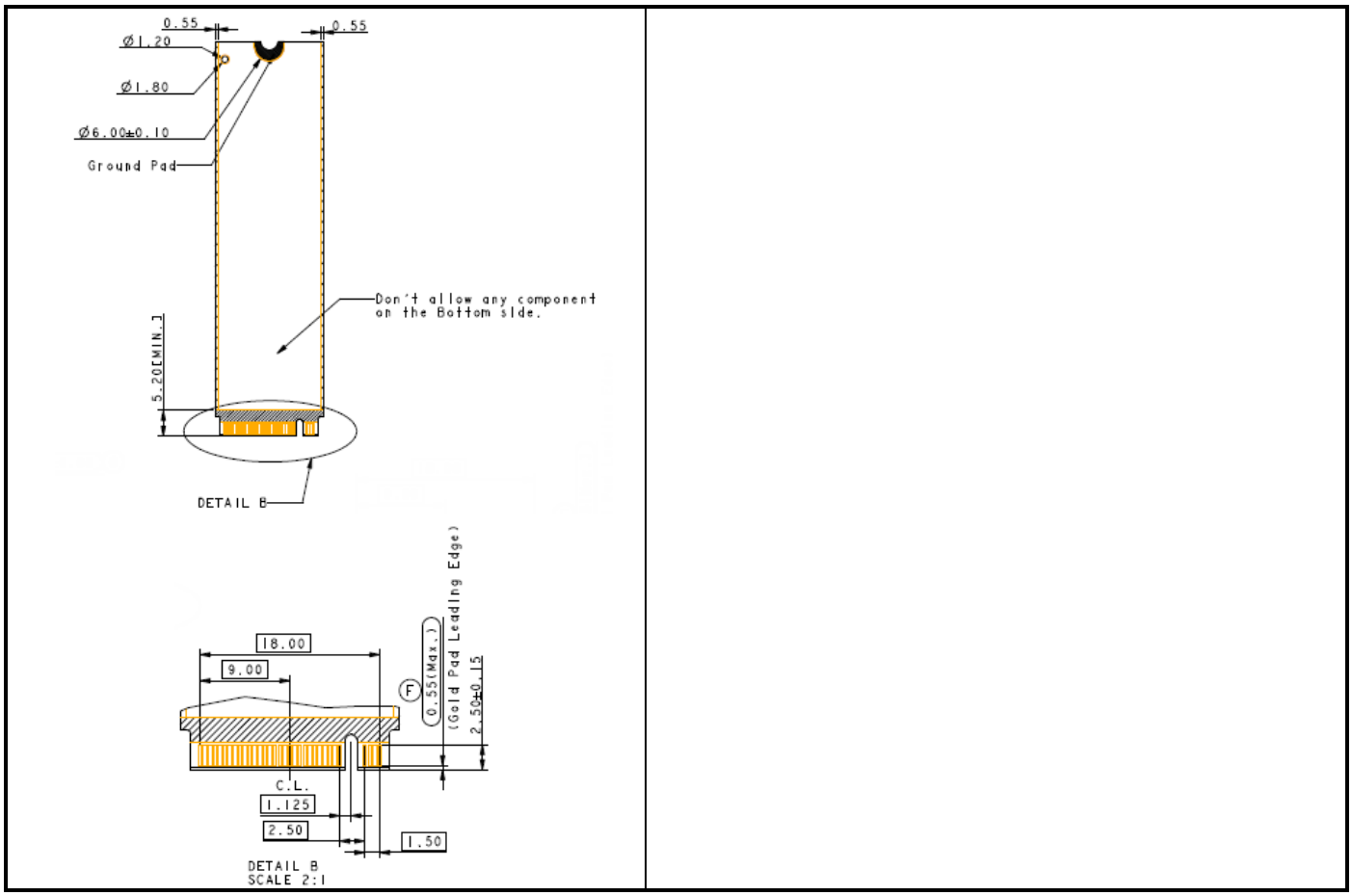


Figure 3: APRO 3D NAND TLC M.2-D2-2280 Form-factor

3. Interface Description

3.1. M Key M.2 SSD Assembly Precautions

M Key M.2 SSD is only compatible to M Key socket. As shown in Use Case 2, misuse may cause severe damages to SSD including burn-out.

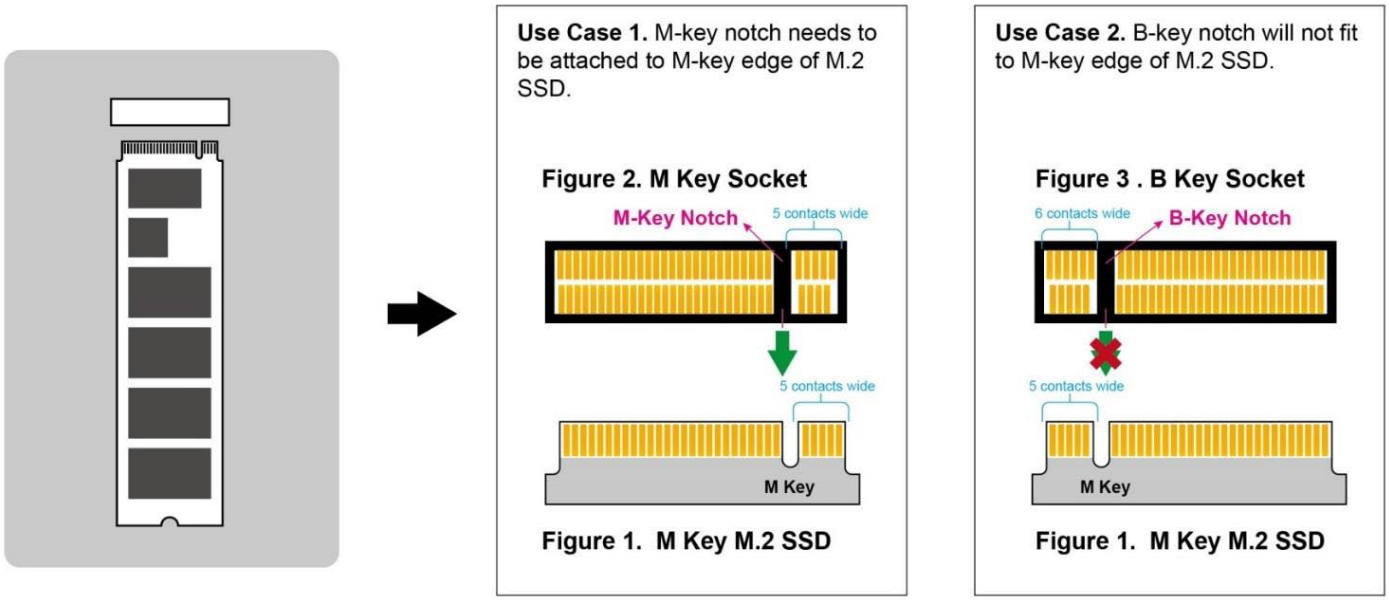


Figure 4: M Key M.2 Assembly Precautions

4.1. Pin Assignments

Pin Assignment and Description of APRO 3D NAND TLC M.2 PCIe NVMe SSD PHANES-PC Series

Pin No.	PCIe Pin	Description
1	GND	Ground
2	3.3V	3.3V source
3	GND	Ground
4	3.3V	3.3V source
5	PETn3	PCIe TX Differential signal defined by the PCI Express M.2 spec
6	N/C	No connect
7	PETp3	PCIe TX Differential signal defined by the PCI Express M.2 spec
8	PLN# (I)(0/3.3V)	Power Loss Notification
9	GND	Ground
10	LED+1# (O)(OD)(3.3V)	These signals are used to allow the add-in card to provide status indicators via LED devices that will be provided by the system. Open drain, active low signal.
11	PERn3	PCIe RX Differential signal defined by the PCI Express M.2 spec
12	3.3V	3.3V source
13	PERp3	PCIe RX Differential signal defined by the PCI Express M.2 spec
14	3.3V	3.3V source
15	GND	Ground
16	3.3V	3.3V source
17	PETn2	PCIe TX Differential signal defined by the PCI Express M.2 spec
18	3.3V	3.3V source
19	PETp2	PCIe TX Differential signal defined by the PCI Express M.2 spec
20	N/C	No connect
21	GND	Ground
22	VIO 1.8V	I/O source (low current)
23	PERn2	PCIe RX Differential signal defined by the PCI Express M.2 spec
24	N/C	No connect
25	PERp2	PCIe RX Differential signal defined by the PCI Express M.2 spec
26	N/C or GPIO Write Protect	No connect Optional: GPIO Write Protect
27	GND	Ground
28	N/C	No connect
29	PETn1	PCIe TX Differential signal defined by the PCI Express M.2 spec
30	PLA_S3# (O)(0/3.3V)	Power Loss Acknowledge. Open Drain with pull-up on platform.
31	PETp1	PCIe TX Differential signal defined by the PCI Express M.2 spec

32	GND	Ground
33	GND	Ground
34	N/C	No connect
35	PERn1	PCIe RX Differential signal defined by the PCI Express M.2 spec
36	N/C	No connect
37	PERp1	PCIe RX Differential signal defined by the PCI Express M.2 spec
38	GND	Ground
39	GND	Ground
40	SMB_CLK (I/O)(0/1.8V)	SMBus Clock; Open Drain with pull-up on platform.
41	PETn0	PCIe TX Differential signal defined by the PCI Express M.2 spec
42	SMB_DATA (I/O)(0/1.8V)	SMBus Data; Open Drain with pull-up on platform.
43	PETp0	PCIe TX Differential signal defined by the PCI Express M.2 spec
44	ALERT#(O)(0/1.8V)	Alert notification to master. Open Drain with pull-up on platform. Active low.
45	GND	Ground
46	N/C	No connect
47	PERn0	PCIe RX Differential signal defined by the PCI Express M.2 spec
48	N/C	No connect
49	PERp0	PCIe RX Differential signal defined by the PCI Express M.2 spec
50	PERST#(I)(0/3.3V)	PE-Reset is a functional reset to the card as defined by the PCIe Mini CEM specification.
51	GND	Ground
52	CLKREQ#(I/O)(0/3.3V)	Clock Request is a reference clock request signal as defined by the PCIe Mini CEM specification. Also used by L1 PM Sub-states.
53	REFCLKn	PCIe Reference Clock signals (100 MHz) defined by the PCI Express M.2 spec.
54	NC	No connect
55	REFCLKp	PCIe Reference Clock signals (100 MHz) defined by the PCI Express M.2 spec.
56	Reserved for MFG DATA	Manufacturing Data line. Used for SSD manufacturing only. Not used in normal operation. Pins should be left N/C in platform Socket.
57	GND	Ground
58	Reserved for MFG CLOCK	Manufacturing Clock line. Used for SSD manufacturing only. Not used in normal operation. Pins should be left N/C in platform Socket.
59	Module Key M	Module Key

60	Module Key M	
61	Module Key M	
62	Module Key M	
63	Module Key M	
64	Module Key M	
65	Module Key M	
66	Module Key M	
67	N/C or GPIO Eease	No Connect Optional: GPIO Erase
68	N/C	No Connect
69	N/C	No Connect for PCIe.
70	3.3V	3.3V source
71	GND	Ground
72	3.3V	3.3V source
73	VIO_CFG (O)	Sideband IO voltage indication. Signal with a weak pull-up on Platforms that support this function. When the Adapter supports 3.3V on the sideband IO signals, it must be connected to ground on the Adapter, otherwise it must be left unconnected on the Adapter.
74	3.3V	3.3V source
75	GND	CONFIG_2 = Ground

Table 7 - Pin Assignments

Appendix A: Limited Warranty

APRO warrants your 3D NAND TLC M.2-2280 Form-factor PCIe NVMe SSD PHANES-PC 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:

- **BiCS 8 3D NAND TLC (Standard grade / Industrial grade) 2 years / Within 3K Erasing Counts**
- **BiCS 8 3D aSLC (Wide Temp. Grade) 2 years / Within 100K Erasing Counts**

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