

3D NAND Flash

(KIOXIA BiCS5)

M.2 PCIe NVMe Module

HERMES-L Series

(2280 Form-factor)

(Gen-III x 4)



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Product Features

■ Flash IC

- **KIOXIA BiCS FLASH™.*4**
- KIOXIA **BiCS5** 3D-NAND Flash.

■ Compatibility

- NVMe Express™ 1.3 Standard.
- PCI Express® Base Specification Rev 3.0

■ Additional Capabilities

- S.M.A.R.T.*1 (Self-Monitoring, Analysis and Reporting Technology) feature set support.
- Thermal Monitor for SSD's temperature.
- Static and Dynamic wear-leveling algorithm.
- Hardware Low Density Parity Check Code, LDPC support.
- Support **P.I.D.P.** Technology (Power Interrupt Data Protection)
- Hybrid Write Mode with SLC Cache Enable
- AES-256 Bits Encryption Optional, Default disable
- Write Protect Optional, Default enable
- Quick Erase Optional, Default disable

■ Mechanical

- PCI Gen3 x 4 NVMe interface(2280)
- M.2 keying notches in **M** positions.
- **M.2 2280-S2-M** Single-sided placement
- **Dimension: 2280:** 80.0 mm x 22.0 mm
- **Weight: 2280:** 10.00 g / 0.35 oz. (max.)

■ Power

- Operating Voltage 3.3V(+/-) 5%
- Read Mode: 3.7W (RMS.)
- Write Mode: 5.3W (RMS.)
- Idle Mode: 0.9W (RMS.)

■ Performance (Maximum value) ^{2,3}

- Sequential Read: 2,050.0 MB/sec. (max.)
- Sequential Write: 1,950.0 MB/sec. (max.)
- Sustained Seq. Read: 1,100.0 MB/sec. (avg.)
- Sustained Seq. Write: 1,250.0 MB/sec. (avg.)
- 4KB Random Read (QD32): 373.0 K IOPS.
- 4KB Random Write (QD32): 253.0 K IOPS.

■ Capacity

- **2280:** 128GB, 256GB, 512GB, 1TB and 2TB

■ Reliability

- **TBW:** Up to 2,600 TBW at 2TB Capacity.
(Client workload by JESD-219A)
- **ECC:** Designed with hardware LDPC ECC engine with hard-decision and soft-decision decoding.
- **MTBF:** >3,000,000
- **Temperature:** (Operating)
Standard Grade: 0°C ~ +70°C
Wide Temp. Grade: -40°C ~ +85°C
- **Vibration:** 7 Hz~2K Hz/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. Typical I/O performance using IOMeter with a queue depth of 32 (Standard grade)
3. Sequential performance is based on CrystalDiskMark 6.0.2 with file size 1000MB (Standard grade)
4. **BiCS** means Bit Cost Scalable Technology.

BiCS FLASH is a trademark of Toshiba Corporation.

Order Information

I. Part Number List

◆ APRO 3D NAND TLC M.2-2280 Form-factor PCIe NVMe Module HERMES-L Series

Product Picture	Grade	Standard grade (0°C ~ 70°C)	Wide Temp Grade (-40°C ~ +85°C)
	128GB	SBMDP128G-JLCT58M	WBMDP128G-JLCT58MC
	256GB	SBMDP256G-JLCT58M	WBMDP256G-JLCT58MC
	512GB	SBMDP512G-JLCT58M	WBMDP512G-JLCT58MC
	1TB	SBMDP001T-JLCT58M	WBMDP001T-JLCT58MC
	2TB	SBMDP002T-JLCT58M	WBMDP002T-JLCT58MC

II. Part Number Decoder:

X1 X2 X3 X4 X5 X6 X7 X8 X9 — **X11 X12 X13 X14 X15** — **X17 X17 X19 X20**

X1 : Grade

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

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

X2 : The material of case

B : Bare PCBA w/o Casing

X3 X4 X5 : Product category

MDP: M.2 PCIe NVMe Module

X6 X7 X8 X9 : Capacity

128GB: 128GB **001T:** 1TB

256GB: 256GB **002T:** 2TB

512GB: 512GB

X11 : Controller

J : HERMES Series

X12 : Controller version

A, B, C.....

X13 : Controller Grade

C : Commercial grade

X14 : Flash IC

T : Toshiba NAND Flash IC

X15 : Flash IC grade / Type

5 : BiCS5 3D-NAND Flash IC.

X16 X17 X18 : Form-Factor

8: 2280 Type

M: with the notches in M positions

X20 : Reserved for specific requirement

C : Conformal coating (Optional)

Revision History

Revision	Description	Date
1.0	Initial release.	2022/12/02

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1. Introduction

APRO 3D NAND TLC PCIe NVMe Module HERMES-L Series provides high capacity flash memory Solid State Drive (SSD) that electrically complies with NVMe Express™ 1.3 Standard and support PCI Gen3 x 4 NVMe interface with high performance.

The HERMES-L Series M.2 2280 SSD available disk capacities are 128GB, 256GB, 512GB, 1TB and 2TB. Standard temperature range is from 0°C to +70°C with an optional wide temperature range from -40°C to +85°C. APRO 3D NAND TLC M.2 PCIe NVMe Module HERMES-L Series comes with M positions, supports PCIe Gen III x 4 and it is compliant with NVMe 1.3 providing excellent top and also sustained performance.

APRO's HERMES-L Series 3D NAND TLC M.2 PCIe NVMe 2280 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 data transfer performance of 4K random read is 373,000 IOPS and the 4K random write is up to 353,000 IOPS; the sequential read is up to 2,050 MB/sec, and the sequential write is up to 1,950 MB/sec. test by a 2TB capacity 2280 M.2 SSD.

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 HERMES-L Series 3D NAND TLC PCIe NVMe Module. 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.

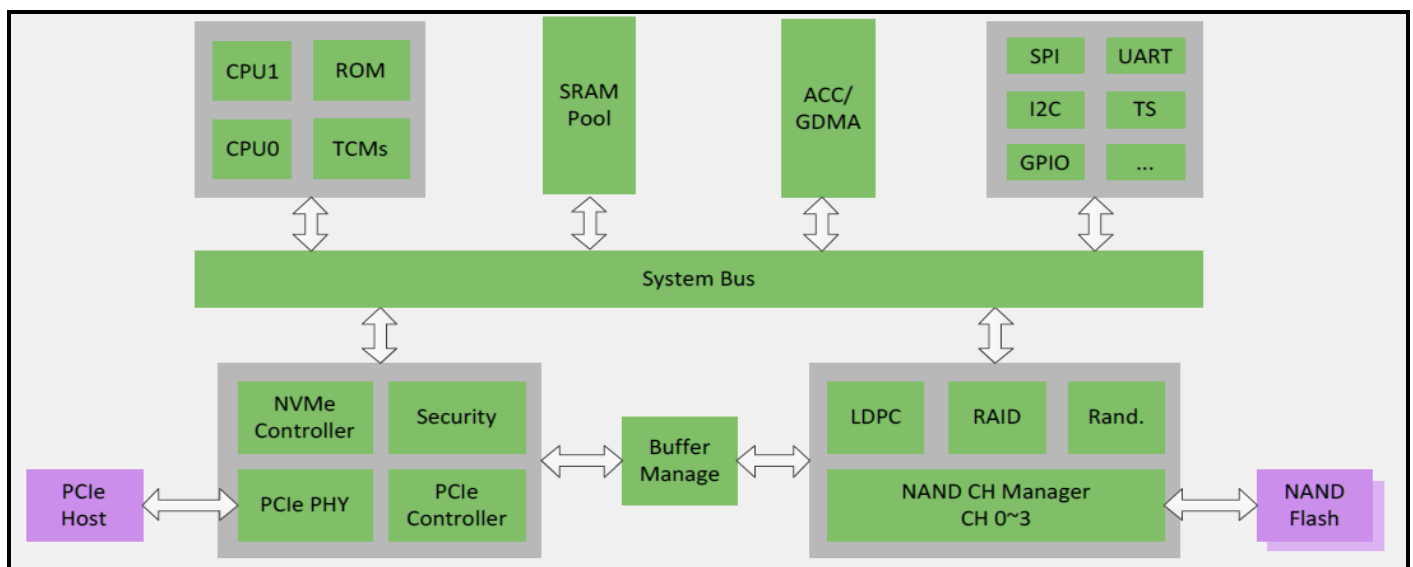


Figure 1: APRO 3D NAND TLC M.2 PCIe NVMe Module HERMES-L Series block diagram

1.1. Scope

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

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 M.2 PCIe NVMe Module HERMES-L Series provides advanced Wear Leveling algorithm, which can efficiently spread out the flash usage through the whole flash media area. Moreover, by implementing both wear-leveling algorithms, the life expectancy of the NAND flash are greatly improved, as dynamic and also static data is shifted, if necessary, in order to guarantee an evenly use of all flash cells.

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 Later 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 M.2 PCIe NVMe Module HERMES-L 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. P.I.D.P. Technology (Power Interrupt Data Protection)

In order to mitigate the damage power interruption can cause to the storage device, APRO's Industrial flash storage has designed a special technology to detect and eliminate the damage that power interruption generates and ensures data integrity. Flash will become write-protected to prevent data from being written into the wrong sector. Built-in voltage detect function alerts the host system of any unstable power supply and prevents the transmission of commands until power levels are once again stabilized.

1.5. Thermal Management

APRO 3D NAND TLC M.2 PCIe NVMe Module HERMES-L Series has built-in thermal sensor which can detect environment temperature of SSD. In the meantime, firmware will monitor the thermal sensor to prevent any failure of overheating. During extreme temperature, firmware will adjust the data transfer behavior to maintain the SSD's reliable operation.

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 Module		Standard Grade	Wide Temp Grade
HERMES-L Series		SBMDPxxxG-JLCT58BM	WBMDPxxxG-JLCT58BMC
Temperature	Operating:	0°C ~ +70°C	-40°C ~ +85°C
	Non-operating:	-20°C ~ +80°C	-50°C ~ +95°C
Humidity	Operating & Non-operating:	10% ~ 95% non-condensing	
	Frequency/Acceleration:	7 Hz to 2K Hz, 20G, 3 axes (IEC 68-2-6)	
Shock	Operating & Non-operating:	0.5ms, 1500 G, 3 axes (IEC 68-2-27)	
Electrostatic Discharge (ESD)	Temperature:	24°C	
	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 HERMES-L Series						
DC Input Voltage 3.3V±5% (VCC)		128GB	256GB	512GB	1TB	2TB
Maximum average value	Reading Mode :	2.3W (RMS.)	3.1W (RMS.)	3.4W (RMS.)	3.6W (RMS.)	3.7W (RMS.)
	Writing Mode :	1.8W (RMS.)	2.1W (RMS.)	2.6W (RMS.)	3.7W (RMS.)	5.3W (RMS.)
	Idle Mode :	0.9W (RMS.)	0.9W (RMS.)	0.9W (RMS.)	0.9W (RMS.)	0.9W (RMS.)
	Power-On Peak	3.1W (RMS.)	4.0W (RMS.)	4.1W (RMS.)	4.4W (RMS.)	6.1W (RMS.)

Note: * Current results may vary depending on system components and power circuit design.

2.3. Capacity and Device Parameters

Capacity	Cylinders	Heads	Sectors	LBA	User Capacity(MB)
128GB	16,383	16	63	234,441,648	114,473
256GB	16,383	16	63	468,862,128	228,937
512GB	16,383	16	63	937,703,088	457,863
1TB	16,383	16	63	1,875,385,008	915,715
2TB	16,383	16	63	3,750,748,848	1,831,420

2.4. System Performance

Table 3: System Performances

Data Transfer Mode supporting		PCI Gen3 x 4 NVMe interface				
Maximum Performance	Form-factor	2280				
	Capacity	128GB	256GB	512GB	1TB	2TB
	Sequential Read (MB/s)	780	1,600	2,050	2,050	2,050
	Sequential Write (MB/s)	560	1,100	1,800	1,900	1,950
	Sustained Seq. Read (MB/s) (avg.)	490	490	990	1,150	1,100
	Sustained Seq. Write (MB/s)(avg.)	100	210	400	740	1,250
	4KB Random Read IOPS (QD32)	48,000	99,000	189,000	327,000	373,000
	4KB Random Write IOPS (QD32)	25,000	214,000	328,000	352,000	353,000

Note:

- Performance results are measured in Room Temperature with Out-of-Box devices and may vary depending on overall system setup. In addition, HERMES-L series adopt hybrid mode which enables SLC Cache up to 3% of total user capacity followed by TLC direct write to strike balance between burst performance and steady overall stability.
- Performance results are based on CrystalDiskMark 6.0.2 with file size 1000MB. Unit of 4KB items is I.O.P.S.
- Performance results are based on AIDA 64 v5.98 with block size 1MB of Linear Read & Write Test Item.

2.5. System Reliability

Table 4: 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		NAND 3D NAND TLC Flash Cell Level : 3K P/E Cycles	
TBW (Tera Bytes Written)		Sequential workload	Client workload
Capacity	128GB	340.0	93.0
	256GB	680.0	206.0
	512GB	1,363.0	471.0
	1TB	2,727.0	1,086.0
	2TB	5,454.0	2,600.0

Note:

- Sequential: Mainly sequential write are estimated by PassMark Burnin Test v8.1 pro.
- Client: Follow JESD218 Test method and JESD219A Workload, tested by ULINK. (The capacity lower than 64GB client workload is not specified in JEDEC219A, the values are estimated.)
- Based on out-of-box performance.

2.8. Heat Sink copper layer

APRO 3D NAND TLC M.2 PCIe NVMe Module HERMES-L Series industrial temperature models come with a Heat Sink copper layer installed on top of M.2 PCIe NVMe SSD with dimension of 68x20x0.25 mm. This design will increase M.2 PCIe NVMe SSD height to 1.95mm max due to the thermal pad and copper layer itself.

3. Interface Description

4.1. M.2 PCIe NVMe Module HERMES-L Series interface

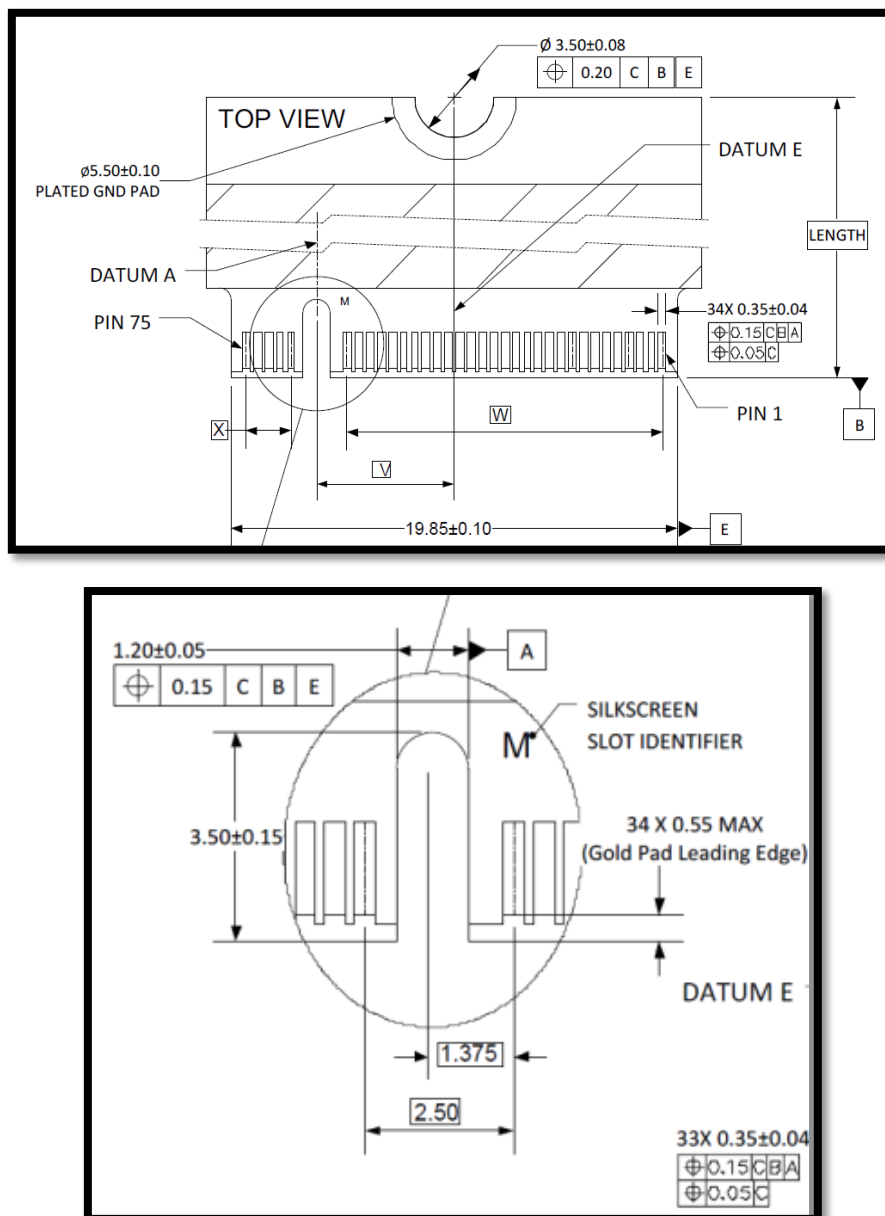


Figure 3: The connectors of Signal Segment and Power Segment

4.2. Pin Assignments

APRO 3D NAND TLC M.2 PCIe NVMe Module HERMES-L Series operates with standard SATA pin-out.

Table 6 - Pin Assignments

Signal Name	Pin Number		Signal Name
		75	GND
3.3V	74	73	GND
3.3V	72	71	GND
3.3V	70	69	NC
NC	68	67	NC
Notch	66	65	Notch
Notch	64	63	Notch
Notch	62	61	Notch
Notch	60	59	Notch
NC (Reversed)	58		
NC (Reversed)	56	57	GND
NC	54	55	REFCLKp
CLKREQ# (I/O)(0/3.3V)	52	53	REFCLKn
PERST# (I)(0/3.3V)	50	51	GND
NC	48	49	PERp0
NC	46	47	PERn0
NC	44	45	GND
NC. (SMB_DATA)	42	43	PETp0
NC. (SMB_CLK)	40	41	PETn0
NC	38	39	GND
NC	36	37	PERp1
NC	34	35	PERn1
NC	32	33	GND
NC	30	31	PETp1
NC (reserved for ROM code)	28	29	PETn1
NC	26	27	GND
NC	24	25	PERp2
NC	22	23	PERn2
NC	20	21	GND
3.3V	18	19	PETp2
3.3V	16	17	PETn2
3.3V	14	15	GND
3.3V	12	13	PERp3
LED1# (O) (OD)	10	11	PERn3
NC	8	9	GND
NC	6	7	PETp3
3.3V	4	5	PETn3
3.3V	2	3	GND
		1	GND

4.3. Electrical connectors of M.2

APRO 3D NAND TLC M.2 PCIe NVMe Module HERMES-L Series interconnection is based on a 75 positions Edge Card connector. The 75 positions connector is intended to be keyed so as to distinguish between families of host interfaces and the various Sockets used in general Platforms.

APRO 3D NAND TLC M.2 PCIe NVMe Module HERMES-L Series is compliant with M.2 Socket 2 M Key.

4.4. Driver

APRO 3D NAND TLC M.2 PCIe NVMe Module HERMES-L Series is compliant with NVMe Express™ 1.3 Standard.

The application's O.S. and BIOS should include NVMe driver to compatible with NVMe storage device. Most of O.S. includes NVMe in-box driver now.

O.S. Driver: Please visit the website <http://nvmeexpress.org/resources/drivers> for more information about the driver for each O.S

BIOS Driver: NVMe driver for BIOS support, please contact with motherboard manufacturers.

Appendix A: Limited Warranty

APRO warrants your 3D NAND TLC M.2-2242 & 2280 Form-factor PCIe NVMe Module HERMES-L 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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