ABACUS PERIPHERALS PVT LTD

ABNE19-E19T M.2 2280 S2 KIOXIA BiCS5 Specification (ABSNE19256GB/ ABSNE19512GB/ABSNE191TB)

Version 1.1

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Abacus Peripherals Pvt Ltd

29,Apurva Indistrial Estate,Makwana Road,Marol,Andheri (E) Mumbai-400059
Tel: +91-22-40914600 Fax: +91-22-40914646

E-mail : daman@abacusperipherals.com

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REVISION HISTORY

Revision	Draft Date	History	Author
1.0	2022/05/09	Preliminary	
1.1	2022/05/25	Add capacity 1TB	

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PRODUCT OVERVIEW

- Capacities
  - 256GB, 512GB, 1024GB, 2048GB
- Form Factor
  - M.2 2280-S2-M
- PCIe Interface
  - PCIe Gen 4 x 4
- Compliance
  - NVMe 1.4
  - PCI Express Base 4.0
- Flash Interface
  - Transfer rate up to 1200MT/s
  - Up to 4pcs of BGA132/BGA152 flash
- Performance[1]
  - Read: 512GB up to 3600 MB/s
  - Write: 512GB up to 2450 MB/s
- Reliability
  - Mean Time Between Failure (MTBF) 1,500,000 hours
  - Uncorrectable Bit Error Rate (UBER) < 1 sector per 10^{16} bits read
- Advanced Flash Management
  - Dynamic Wear Leveling
  - Bad Block Management
  - TRIM
  - SMART
  - Over-Provision
  - Firmware Update
- Power Management
  - PS0/PS1/PS2/PS3/PS4
  - Support APST
  - Support ASPM
  - Support L1.2
- Power Consumption[2]
  - L1.2 < 2.5 mW
- Temperature Range[3]
  - Operation: 0°C ~ 70°C
  - Storage: -40°C ~ 85°C
- RoHS-Compliant
- Features Support List:
  - End to end data path protection
  - Thermal throttling
  - SmartRefresh™
  - Drive log
  - Telemetry
  - Support HMB (Host Memory Buffer)
  - Support of TCG Pyrite

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NOTES:
1. Refer to Chapter 2 for more details
2. Refer to Chapter 4, Section for more details.
3. The operation temperature means the case temperature, in which can be decided via the S.M.A.R.T.

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PERFORMANCE

BiCS5 512Gb mono die

Encrypted

Capacity	Flash Structure (BGA Package)	workload	Performance[1]			
			CrystalDiskMark[A]		CrystalDiskMark[B]	
			Read (MB/s)	Write (MB/s)	Read (MB/s)	Write (MB/s)
256GB	128GB x 2, 4CE	Seq Q8T1	3200	1300	3200	1300
		4K Q32T16	900	500	900	550
512GB	6GB x 2, 8CE	Seq Q8T1	3600	2450	3600	2450
		4K Q32T16				
1TB	512GB x 2, 8CE	Seq Q8T1	3600	2800	3600	2800
		4K Q32T16	2200	800	2200	1100

Capacity	Flash Structure (BGA Package)	Performance[1]	
		ASSD[C]	
		Read (MB/s)	Write (MB/s)
256GB	128GB x 2, 4CE	2750	1200
512GB	256GB x 2, 8CE	3100	2200
1TB	512GB x 2, 8CE	3100	2550

Capacity	Flash Structure (BGA Package)	workload	Performance[1]	
			IOMeter[D]	
			Read	Write
256GB	128GB x 2, 4CE	Seq 128K (MB/s)	3050	1320
		4K QD32 (IOPS)	210K	300K
512GB	256GB x 2, 8CE	Seq 128K (MB/s)	3400	2400
		4K QD32 (IOPS)	420K	420K
1TB	512GB x 2, 8CE	Seq 128K (MB/s)	3500	2800
		4K QD32 (IOPS)	500K	450K

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Capacity	Flash Structure (BGA Package)	Performance[1]		
		workload	ATTO	
			Read (MB/s)	Write (MB/s)
256GB	128GB x 2, 4CE	128K	3100	2400
		256K	3100	3900
		512K	3100	3900
		1M	3100	3900
		2M	3100	3900
		4M	3100	3900
		8M	3100	3900
512GB	256GB x 2, 8CE	128K	3100	4000
		256K	3100	4000
		512K	3100	4000
		1M	3100	4000
		2M	3100	4000
		4M	3100	4000
		8M	3100	4000
1TB	512GB x 2, 8CE	128K	3000	3700
		256K	3000	3700
		512K	3000	3700
		1M	3000	3700
		2M	3000	3700
		4M	3000	3700
		8M	3000	3700

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Non-encrypted

Capacity	Flash Structure (BGA Package)	Performance[1]				
		workload	CrystalDiskMark[A]		CrystalDiskMark[B]	
			Read (MB/s)	Write (MB/s)	Read (MB/s)	Write (MB/s)
256GB	128GB x 2, 4CE	Seq Q8T1	3200	1300	3200	1300
		4K Q32T16	700	500	700	420
512GB	256GB x 2, 8CE	Seq Q8T1	3600	2400	3600	2400
		4K Q32T16	700	500	700	500
1TB	512GB x 2, 8CE	Seq Q8T1	3600	2800	3600	2800
		4K Q32T16	2200	800	2200	1100

Capacity	Flash Structure (BGA Package)	Performance[1]	
		ASSD[C]	
		Read (MB/s)	Write (MB/s)
256GB	128GB x 2, 4CE	2550	1200
512GB	256GB x 2, 8CE	2850	1200
1TB	512GB x 2, 8CE	3100	2550

Capacity	Flash Structure (BGA Package)	Performance[1]		
		workload	IOMeter[D]	
			Read	Write
256GB	128GB x 2, 4CE	Seq 128K (MB/s)	2400	1250
		4K QD32 (IOPS)	210K	100K
512GB	256GB x 2, 8CE	Seq 128K (MB/s)	2400	2400
		4K QD32 (IOPS)	240K	120K
1TB	512GB x 2, 8CE	Seq 128K (MB/s)	3500	2800
		4K QD32 (IOPS)	500K	450K

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Capacity	Flash Structure (BGA Package)	workload	Performance[1]	
			ATTO	
			Read (MB/s)	Write (MB/s)
256GB	128GB x 2, 4CE	128K	1400	1200
		256K	1900	1200
		512K	2500	1200
		1M	2500	1200
		2M	2500	1200
		4M	2500	1200
		8M	2500	1200
512GB	256GB x 2, 8CE	128K	1700	2200
		256K	2200	2200
		512K	3000	2200
		1M	3000	2200
		2M	3000	2200
		4M	3000	2200
		8M	3000	2200
1TB	512GB x 2 ,8CE	128K	3000	3700
		256K	3000	3700
		512K	3000	3700
		1M	3000	3700
		2M	3000	3700
		4M	3000	3700
		8M	3000	3700

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POWER CONSUMPTION

BiCS5 512Gb mono die

Capacity	Flash Configuration (BGA Package)	Power Consumption[3]			
		Read (mW)	Write (mW)	PS3 (mW)	PS4 (mW)
256GB	128GB x 2, 4CE	4250	3000	45	2.5
512GB	256GB x 2, 8CE	4700	4100	45	2.5
1TB	512GB x 2, 8CE	4900	4500	45	2.5

NOTES:

4. Performance is measured with the following conditions
   - A. CrystalDiskMark 8.0.1 x64, 1GB range
   - B. CrystalDiskMark 8.0.1 x64, 16GB range
   - C. ASSD 2.0.7316.34247, Seq
   - D. IOMeter 1.1.0, 1GB range, 4K data size, QD=32T8
   - E. ATTO, transfer Size from 128K to 8M
   - F. Platform: Baffin(HP Spectre x360 15-ebxxxx)gen4 support SKU
   - G. OS Version : Win10 (64bit), version 1809
5. Power consumption is measured during the sequential read and write operations performed by IO Meter (1GB range, 128K data size, QD=128T1).
   - A. PS3 and PS4 are specific in L1.2.

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1. INTRODUCTION

1.1. General Description

Abacus ABSNE19-E19T M.2 2280 with no external DDR solution delivers all the advantages of flash disk technology with PCIe Gen4 x4 interface and is fully compliant with the standard Next Generation Form Factor (NGFF) called M.2 Card Format. ABSNE19-E19T M.2 2280 offers a wide range of capacities up to 2048GB and the 512GB performance is 3600 MB/s[1] (for read) and 2450 MB/s[1] (for write) based on BiCS5 512Gb mono-die TLC NAND flash.

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NOTES:
1. Achieved by 256GB SSD at FOB (fresh-out-of-box) state on CrystalDiskMark x64, 1GB range.

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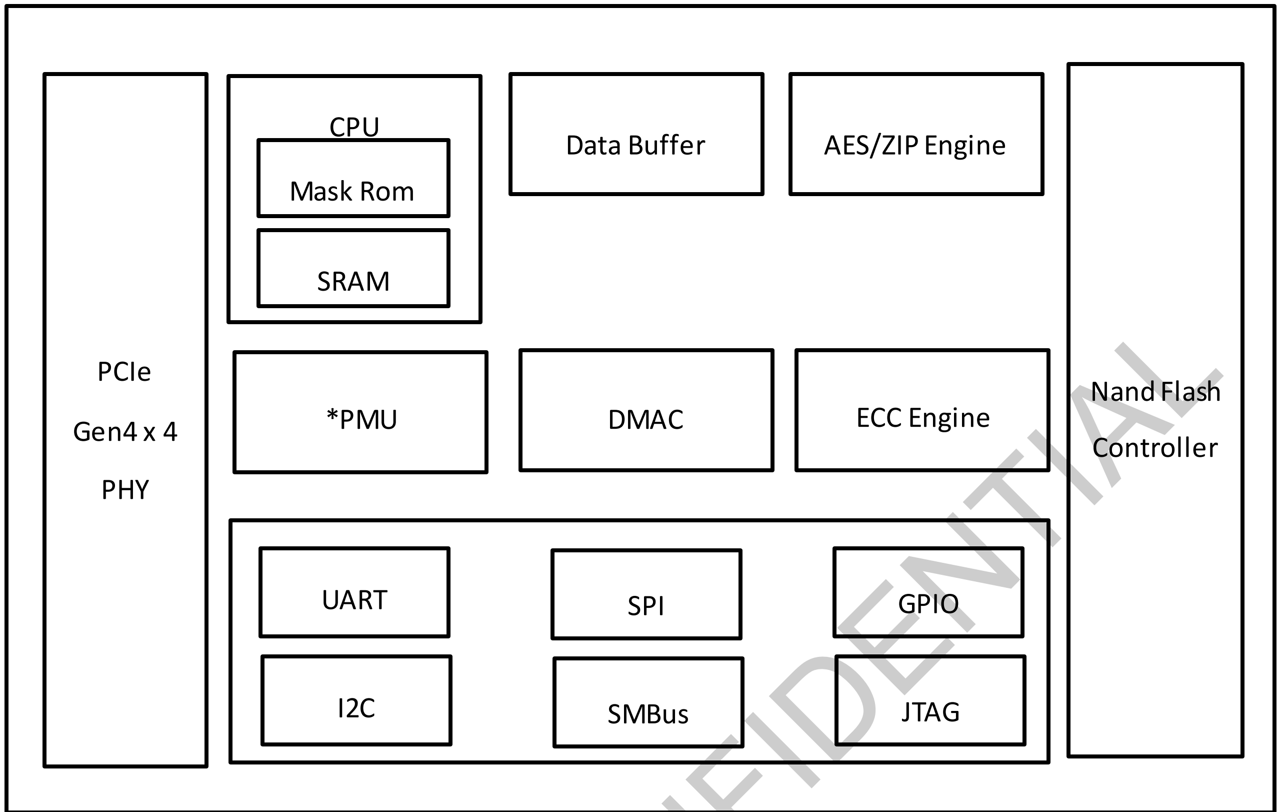
1.2. Controller Block Diagram



*PMU = Power Management Unit

Figure 1-1 ABSNE19-E19T Controller Block Diagram

1.3. Product Block Diagram

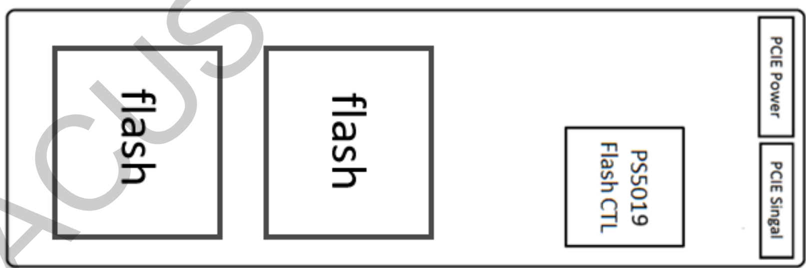


Figure 1-2 ABSNE19-E19T M.2 2280 Product Block Diagram

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1.4. Flash Management

1.4.1. Error Correction Code (ECC)

Flash memory cells will deteriorate with use, which might generate random bit errors in the stored data. Thus, ABSNE19-E19T PCIe SSD applies the LDPC (Low Density Parity Check) of ECC algorithm, which can detect and correct errors occur during read process, ensure data been read correctly, as well as protect data from corruption.

1.4.2. Wear Leveling

NAND flash devices can only undergo a limited number of program/erase cycles, when flash media is not used evenly, some blocks get updated more frequently than others and the lifetime of 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.

Abacus 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.

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1.4.3. Bad Block Management

Bad blocks are blocks that do not function properly or contain more invalid bits causing stored data unstable, and their reliability is not guaranteed. Blocks that are identified and marked as bad by the manufacturer are referred to as “Early Bad Blocks”. Bad blocks that are developed during the lifespan of the flash are named “Later Bad Blocks”. Abacus implements an efficient bad block management algorithm to detect the factory-produced bad blocks and manages bad blocks that appear with use. This practice prevents data being stored into bad blocks and further improves the data reliability.

1.4.4. TRIM

TRIM is a feature which helps improve the read/write performance and speed of solid state drives (SSD). Unlike hard disk drives (HDD), SSDs are not able to overwrite existing data, so the available space gradually becomes smaller with each use. With the TRIM command, the operating system can inform the SSD so that blocks of data that are no longer in use can be removed permanently. Thus, the SSD will perform the erase action, which prevents unused data from occupying blocks at all time.

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1.4.5. SMART

SMART, an acronym for Self-Monitoring, Analysis and Reporting Technology, is an open standard that allows a solid state drive to automatically detect its health and report potential failures. When a failure is recorded by SMART, users can choose to replace the drive to prevent unexpected outage or data loss. Moreover, SMART can inform users impending failures while there is still time to perform proactive actions, such as save data to another device.

1.4.6. Over-Provision

Over Provisioning refers to the preserving additional area beyond user capacity in a SSD, which is not visible to users and cannot be used by them. However, it allows a SSD controller to utilize additional space for better performance and WAF. With Over Provisioning, the performance and IOPS (Input/Output Operations per Second) are improved by providing the controller additional space to manage P/E cycles, which enhances the reliability and endurance as well. Moreover, the write amplification of the SSD becomes lower when the controller writes data to the flash.

1.4.7. Firmware Upgrade

Firmware can be considered as a set of instructions on how the device communicates with the host. Firmware will be upgradable when new features are added, compatibility issues are fixed, or read/write performance gets improved.

1.4.8. Thermal Throttling

The purpose of thermal throttling is to prevent any components in a SSD from over-heating during read and write operations. ABSNE19-E19T 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 SMART reading.

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1.5. Advanced Device Security Features

1.5.1. Secure Erase

Secure Erase is a standard NVMe format command and will write all "0xFF" to fully wipe all the data on hard drives and SSDs. When this command is issued, SSD controller will erase its storage blocks and return to its factory default settings.

1.5.2. Crypto Erase

Crypto Erase is a feature that erases all data of an OPAL-activated SSD or a "SED" (Security-Enabled Disk) drive by resetting the cryptographic key of the disk. Since the key is modified, the previously encrypted data will become useless, achieving the purpose of data security.

1.5.3. Physical Presence SID (PSID)

Physical Presence SID (PSID) is defined by TCG OPAL as a 32-character string and the purpose is to revert SSD back to its manufacturing setting when the drive is still OPAL-activated. PSID code can be printed on a SSD label when an OPAL-activated SSD supports PSID revert feature.

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1.6. SSD Lifetime Management

1.6.1. Terabytes Written (TBW)

TBW (Terabytes Written) is a measurement of SSDs' expected lifespan, which represents the amount of data written to the device. To calculate the TBW of a SSD, the following equation is applied:

TBW = [(*NAND Endurance*) x (*SSD Capacity*)] / [*WAF*]

NAND Endurance: NAND endurance refers to the P/E (Program/Erase) cycle of a NAND flash.

SSD Capacity: The SSD capacity is the specific capacity in total of a SSD.

WAF: Write Amplification Factor (WAF) is a numerical value representing the ratio between the amount of data that a SSD controller needs to write and the amount of data that the host's flash controller writes. A better WAF, which is near 1, guarantees better endurance and lower frequency of data written to flash memory.

TBW in this document is based on JEDEC 218/219 workload.

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1.6.2. Media Wear Indicator

Actual life indicator reported by SMART Attribute byte index [5], Percentage Used, recommends User to replace drive when reaching to 100%.

1.6.3. Read Only Mode (End of Life)

When drive is aged by cumulated program/erase cycles, media worn-out may cause increasing numbers of later bad block. When the number of usable good blocks falls outside a defined usable range, the drive will notify Host through AER event and Critical Warning to enter Read Only Mode to prevent further data corruption. User should start to replace the drive with another one immediately.

1.7. Adaptive Approach to Performance Tuning

1.7.1. Throughput

Based on the available space of the disk, ABSNE19-E19T will regulate the read/write speed and manage the performance of throughput. When there still remains a lot of space, the firmware will continuously perform read/write action. There is still no need to implement garbage collection to allocate and release memory, which will accelerate the read/write processing to improve the performance. Contrarily, when the space is going to be used up, ABSNE19-E19T will slow down the read/write processing, and implement garbage collection to release memory. Hence, read/write performance will become slower.

1.7.2. SLC Caching

ABSNE19-E19T's firmware design currently adopts dynamic caching to deliver better performance for better endurance and consumer user experience.

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2. PRODUCT SPECIFICATIONS

- Capacity
  - 256GB, 512GB, 1024GB, 2048GB
  - Support 32-bit addressing mode
- Electrical/Physical Interface
  - PCIe Interface
  - Compliant with NVMe 1.4
  - PCIe Express Base Ver 4.0
  - PCIe Gen 4 x 4 lane & backward compatible to PCIe Gen 3, PCIe Gen 2 and Gen 1
  - Support up to QD 128 with queue depth of up to 64K
  - Support power management
- Supported NAND Flash
  - Support up to 16 Flash Chip Enables (CE) within a single design
  - Support up to 4pcs of BGA132/152 flash
  - Support 8-bit I/O NAND Flash
  - Support Toggle 4.0 interface
    - KIOXIA BiCS5 512Gb mono-die
    - KIOXIA BiCS5 1024Gb mono-die
- ECC Scheme
  - ABSNE19-E19T PCIe SSD applies LDPC of ECC algorithm.
- Sector Size Support
  - 512B
  - 4KB
- UART/ GPIO
- Support SMART and TRIM commands
- LBA Range
  - IDEMA standard

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■ Performance

BiCS5 512Gb mono die

Encrypted

Table 2-1 Performance of ABSNE19-E19T+ BiCS5 512Gb mono-die

Capacity	Flash Structure (BGA Package)	workload	Performance[1]			
			CrystalDiskMark[A]		CrystalDiskMark[B]	
			Read (MB/s)	Write (MB/s)	Read (MB/s)	Write (MB/s)
256GB	128GB x 2, 4CE	Seq Q8T1	3200	1300	3200	1300
		4K Q32T16	900	500	900	550
512GB	256GB x 2, 8CE	Seq Q8T1	3600	2450	3600	2450
		4K Q32T16	1700	750	1700	800
1TB	512GB x 2, 8CE	Seq Q8T1	3600	2800	3600	2800
		4K Q32T16	2200	800	2200	1100

Capacity	Flash Structure (BGA Package)	Performance[1]	
		ASSD[C]	
		Read (MB/s)	Write (MB/s)
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Capacity	Flash Structure (BGA Package)	workload	Performance[1]	
			IOMeter[D]	
			Read	Write
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		4K QD32 (IOPS)	210K	300K
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		workload	ATTO	
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		512K	3100	3900
		1M	3100	3900
		2M	3100	3900
		4M	3100	3900
		8M	3100	3900
512GB	256GB x 2, 8CE	128K	3100	4000
		256K	3100	4000
		512K	3100	4000
		1M	3100	4000
		2M	3100	4000
		4M	3100	4000
		8M	3100	4000
1TB	512GB x 2, 8CE	128K	3000	3700
		256K	3000	3700
		512K	3000	3700
		1M	3000	3700
		2M	3000	3700
		4M	3000	3700
		8M	3000	3700

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Non-encrypted

Capacity	Flash Structure (BGA Package)	workload	Performance[1]			
			CrystalDiskMark[A]		CrystalDiskMark[B]	
			Read (MB/s)	Write (MB/s)	Read (MB/s)	Write (MB/s)
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Capacity	Flash Structure (BGA Package)	Performance[1]	
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512GB	256GB x 2, 8CE	Seq 128K (MB/s)	2400	2400
		4K QD32 (IOPS)	240K	120K
1TB	512GB x 2, 8CE	Seq 128K (MB/s)	3500	2800
		4K QD32 (IOPS)	500K	450K

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Capacity	Flash Structure (BGA Package)	Performance[1]		
		workload	ATTO	
			Read (MB/s)	Write (MB/s)
256GB	128GB x 2, 4CE	128K	1400	1200
		256K	1900	1200
		512K	2500	1200
		1M	2500	1200
		2M	2500	1200
		4M	2500	1200
		8M	2500	1200
512GB	256GB x 2, 8CE	128K	1700	2200
		256K	2200	2200
		512K	3000	2200
		1M	3000	2200
		2M	3000	2200
		4M	3000	2200
		8M	3000	2200
1TB	512GB x 2, 8CE	128K	3000	3700
		256K	3000	3700
		512K	3000	3700
		1M	3000	3700
		2M	3000	3700
		4M	3000	3700
		8M	3000	3700

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NOTES:

1. Performance is measured with the following conditions
   - A. CrystalDiskMark 8.0.1 x64, 1GB range
   - B. CrystalDiskMark 8.0.1 x64, 16GB range
   - C. ASSD 2.0.7316.34247, Seq

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D. IOMeter 1.1.0, 1GB range, 4K data size, QD=32T8

E. ATTO, transfer Size from 128K to 8M

F. Platform: Baffin(HP Spectre x360 15-ebxxxx)gen4 support SKU

G. OS Version : Win10 (64bit), version 1809

- **TBW (Terabytes Written)**

BiCS5 512Gb mono die

Capacity	TBW
256 GB	>200 TB
512 GB	>300 TB
1TB	>600 TB

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3. ENVIRONMENTAL SPECIFICATIONS

3.1. Environmental Conditions

3.1.1. Temperature and Humidity

Table 3-1 High Temperature

	Temperature	Humidity
Operation	70°C	0% RH
Storage	85°C	0% RH

Table 3-2 Low Temperature

	Temperature	Humidity
Operation	0°C	0% RH
Storage	-40°C	0% RH

Table 3-3 High Humidity

	Temperature	Humidity
Operation	40°C	90% RH
Storage	40°C	93% RH

Table 3-4 Temperature Cycling

	Temperature
Operation	0°C
	70°C[1]
Storage	-40°C
	85°C

Notes:

1. The operation temperature is measured by the case temperature, in which can be decided via the S.M.A.R.T. Airflow is suggested and it will allow device to be operated at appropriate temperature for each component during heavy workloads environment.

3.1.2. Shock

Table 3-5 Shock

	Acceleration Force
Non-operational	1500G

3.1.3. Vibration

Table 3-6 Vibration

	Condition	
	Frequency/Displacement	Frequency/Acceleration
Non-operational	20Hz~80Hz/1.52mm	80Hz~2000Hz/20G

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3.1.4. Drop

Table 3-7 Drop

	Height of Drop	Number of Drop
Non-operational	80cm free fall	6 face of each unit

3.1.5. Bending

Table 3-8 Bending

	Force	Action
Non-operational	≥ 20N	Hold 1min/5times

3.1.6. Torque

Table 3-9 Torque

	Force	Action
Non-operational	0.5N-m or ±2.5 deg	Hold 1min/5times

3.1.7. Durability

Table 3-10 Durability

	Condition
operational	1000 mating cycles

3.1.8. Electrostatic Discharge (ESD)

Table 3-11 ESD

Specification	+/- 4KV
EN 55024, CISPR 24 EN 61000-4-2 and IEC 61000-4-2	Device functions are affected, but EUT will be back to its normal or operational state automatically.

3.1.9. EMI Compliance

Table 3-12 EMI

Specification
EN 55032, CISPR 32(CE) AS/NZS CISPR 32(CE) ANSI C63.4 (FCC) VCCI-CISPR 32 (VCCI) CNS 13438 (BSMI)

3.2. 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 1,500,000 hours. The higher the MTBF value, the higher the reliability of the device.

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Our MTBF result is based on Telcorida methodology. Please note that a lower MTBF should be expected for higher capacity drives, and we apply the lowest MTBF for all capacities.

3.3. Certification & Compliance

Table 3-13 Certification & Compliance

Specification
RoHS WHQL PCI Express Base 4.0 UNH-IOL NVM Express Logo

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4. ELECTRICAL SPECIFICATIONS

4.1. Supply Voltage

Table 4-1 Supply Voltage

Parameter	Rating
Operating Voltage	Min = 3.14V Max = 3.47 V
Rise Time (Max/Min)	100 ms / 0.1 ms
Fall Time (Max/Min)	5 s / 1 ms
Min. Off Time[1]	5 s

NOTE:

1. Minimum time between power removed from SSD (Vcc < 100 mV) and power re-applied to the drive.

4.2. Power Consumption

Table 4-2 Power Consumption in mW

Capacity	Flash Structure	CE#	Read (Max)	Write (Max)	Read (Avg.)	Write (Avg.)
256GB	128GB x 2	4	4250	3000	4100	2950
512GB	256GB x 2	8	4700	4100	4600	3800
1TB	512GB x 2	8	4900	4500	45	2.5

NOTES:

1. Based on HPE36Pxx-series under ambient temperature.
2. The average value of power consumption is achieved based on 100% conversion efficiency.
3. The measured power voltage is 3.3V.
4. The temperature of a storage device in PS1 should remain constant or should slightly decrease for all workloads so the actual power in PS1 should be lower than PS0.
5. The temperature of a storage device in PS2 should decrease sharply for all workloads so the actual power in PS2 should be lower than PS1.

Table 4-3 Power State Power Consumption in mW

Capacity	Flash Configuration	CE#	Active			PS3	PS4
			PS0	PS1	PS2		
256GB	BGA132, KIOXIA BiCS5, 1024Gb DDP	4	4250	2200	1600	45	2.5
512GB	BGA132, KIOXIA BiCS5, 2048Gb QDP	8	4700	2400	1700	45	2.5
1TB	BGA132, KIOXIA BiCS5, 4096Gb HDP	8	4900	2600	1800	45	2.5

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NOTES:

1. Based on HPE36Pxx-series under ambient temperature.
2. The average value of power consumption is achieved based on 100% conversion efficiency.
3. The measured power voltage is 3.3V.
4. PS3 and PS4 are specific in L1.2.

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5. INTERFACE

5.1. Pin Assignment and Descriptions

Table 5-1 defines the signal assignment of the internal NGFF connector for SSD usage, described in the PCI Express M.2 Specification version 1.0 of the PCI-SIG.

Table 5-1 Pin Assignment and Description of ABSNE19-E19T M.2 2280

Pin No.	PCIe Pin	Description
1	GND	CONFIG_3 = GND
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	TBD	TBD
9	GND	Ground
10	LED1#	Open drain, active low signal. These signals are used to allow the add-in card to provide status indicators via LED devices that will be provided by the system.
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	N/C	No connect
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	No connect
27	GND	Ground
28	N/C	No connect
29	PETn1	PCIe TX Differential signal defined by the PCI Express M.2 spec
30	TBD	TBD
31	PETp1	PCIe TX Differential signal defined by the PCI Express M.2 spec
32	N/C	No connect
33	GND	Ground
34	N/C	No connect
35	PERn1	PCIe RX Differential signal defined by the PCI Express M.2 spec

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Pin No.	PCIe Pin	Description
36	N/C	No connect
37	PERp1	PCIe RX Differential signal defined by the PCI Express M.2 spec
38	N/C	No connect
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	PEWAKE#(I/O)(0/3.3V)	PCIe PME Wake. Open Drain with pull up on platform; Active Low.
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	No connect
68	SUSCLK(32KHz) (I)(0/3.3V)	32.768 kHz clock supply input that is provided by the platform chipset to reduce power and cost for the module.
69	NC	CONFIG_1 = No connect
70	3.3V	3.3V source
71	GND	Ground
72	3.3V	3.3V source
73	GND	Ground

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Pin No.	PCIe Pin	Description
74	3.3V	3.3V source
75	GND	CONFIG_2 = Ground

6. SUPPORTED COMMANDS

6.1. NVMe Command List.

Table 6-1 Admin Commands

Opcode	Command Description
00h	Delete I/O Submission Queue
01h	Create I/O Submission Queue
02h	Get Log Page
04h	Delete I/O Completion Queue
05h	Create I/O Completion Queue
06h	Identify
08h	Abort
09h	Set Features
0Ah	Get Features
0Ch	Asynchronous Event Request
10h	Firmware Activate
11h	Firmware Image Download
14h	Device Self-test

Table 6-2 Admin Commands – NVM Command Set Specific

Opcode	Command Description
80h	Format NVM
81h	Security Send
82h	Security Receive
84h	Sanitize

Table 6-3 NVM Commands

Opcode	Command Description
00h	Flush
01h	Write
02h	Read
04h	Write Uncorrectable
08h	Write Zeroes
09h	Dataset Management
0Ch	Verify

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6.2. Identify Device Data

The following table details the sector data returned by the IDENTIFY DEVICE command.

Table 6-4 Identify Controller Data Structure

Bytes	O/M	Description	Default Value
01:00	M	PCI Vendor ID (VID)	0x1987
03:02	M	PCI Subsystem Vendor ID (SSVID)	0x1987
23:04	M	Serial Number (SN)	SN
63:24	M	Model Number (MN)	Model Number
71:64	M	Firmware Revision (FR)	FW Name
72	M	Recommended Arbitration Burst (RAB)	0x4
75:73	M	IEEE OUI Identifier (IEEE)	Assigned by IEEE/RAC
76	O	Controller Multi-Path I/O and Namespace Sharing Capabilities (CMIC)	0x0
77	M	Maximum Data Transfer Size (MDTS)	0x6
79:78	M	Controller ID (CNTLID)	0x0
83:80	M	Version (VER)	0x10400
87:84	M	RTD3 Resume Latency (RTD3R)	0x7A120
91:88	M	RTD3 Entry Latency (RTD3E)	0x1E
95:92	M	Optional Asynchronous Events Supported (OAES)	0x0
99:96	M	Controller Attributes (CTRATT)	0x2
101:100	O	Read Recovery Levels Supported (RRLS)	0x0
110:102	-	Reserved	0x00
111	M	Controller Type (CNTRLTYPE)	0x1
127:112	O	FRU Globally Unique Identifier (FGUID)	0x00
129:128	O	Command Retry Delay Time 1 (CRDT1)	0x0
131:130	O	Command Retry Delay Time 2 (CRDT2)	0x0
133:132	O	Command Retry Delay Time 3 (CRDT3)	0x0
239:134	-	Reserved	0x00
255:240	-	Refer to the NVMe Management Interface Specification for definition	0x00
257:256	M	Optional Admin Command	0x17

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		Support (OACS)	
258	M	Abort Command Limit (ACL)	0x3
259	M	Asynchronous Event Request Limit (AERL)	0x3
260	M	Firmware Updates (FRMW)	0x12
261	M	Log Page Attributes (LPA)	0x1E
262	M	Error Log Page Entries (ELPE)	0x3E
263	M	Number of Power States Support (NPSS)	0x4
264	M	Admin Vendor Specific Command Configuration (AVSCC)	0x1
265	O	Autonomous Power State Transition Attributes (APSTA)	0x1
267:266	M	Warning Composite Temperature Threshold (WCTEMP)	0x164
269:268	M	Critical Composite Temperature Threshold (CCTEMP)	0x166
271:270	O	Maximum Time for Firmware Activation (MTFA)	0x64
275:272	O	Host Memory Buffer Preferred Size (HMPRE)	0x4000
279:276	O	Host Memory Buffer Minimum Size (HMMIN)	0x4000
295:280	O	Total NVM Capacity (TNVMCAP)	0x00
311:296	O	Unallocated NVM Capacity (UNVMCAP)	0x00
315:312	O	Replay Protected Memory Block Support (RPMBS)	0x0
317:316	O	Extended Device Self-test Time (EDSTT)	0x1E
318	O	Device Self-test Options (DSTO)	0x0
319	M	Firmware Update Granularity (FWUG)	0x4
321:320	M	Keep Alive Support (KAS)	0x0
323:322	O	Host Controlled Thermal Management Attributes (HCTMA)	0x1
325:324	O	Minimum Thermal Management Temperature (MNTMT)	0x111

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327:326	O	Maximum Thermal Management Temperature (MXTMT)	0x166
331:328	O	Sanitize Capabilities (SANICAP)	0xA0000002
335:332		Host Memory Buffer Minimum Descriptor Entry Size (HMMINDS)	0x400
337:336		Host Memory Maximum Descriptors Entries (HMMAXD)	0x10
339:338		NVM Set Identifier Maximum (NSETIDMAX)	0x0
341:340		Endurance Group Identifier Maximum (ENDGIDMAX)	0x0
342		ANA Transition Time (ANATT)	0x0
343		Asymmetric Namespace Access Capabilities (ANACAP)	0x0
347:344		ANA Group Identifier Maximum (ANAGRPMAX)	0x0
351:348		Number of ANA Group Identifiers (NANAGRPID)	0x0
355:352		Persistent Event Log Size (PELS)	0x60
511:356		Reserved	0x00
NVM Command Set Attributes			
512	M	Submission Queue Entry Size (SQES)	0x66
513	M	Completion Queue Entry Size (CQES)	0x44
515:514	M	Maximum Outstanding Commands (MAXCMD)	0x100
519:516	M	Number of Namespaces (NN)	0x1
521:520	M	Optional NVM Command Support (ONCS)	0x5F
523:522	M	Fused Operation Support (FUSES)	0x0
524	M	Format NVM Attributes (FNA)	0x0
525	M	Volatile Write Cache (VWC)	0x7
527:526	M	Atomic Write Unit Normal (AWUN)	0xFF
529:528	M	Atomic Write Unit Power Fail (AWUPF)	0x0
530	M	NVM Vendor Specific Command Configuration (NVSCC)	0x1
531	M	Reserved	0x0

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533:532	O	Atomic Compare & Write Unit (ACWU)	0x0
535:534	M	Reserved	0x00
539:536	O	SGL Support (SGLS)	0x0
543:540	O	Maximum Number of Allowed Namespaces (MNAN)	0x0
767:544	M	Reserved	0x00
1023:768	M	NVM Subsystem NVMe Qualified Name (SUBNQN)	0x00
1791:1024		Reserved	0x00
2047:1792		Refer to the NVMe over Fabrics specification.	0x00
Power State Descriptors			
2079:2048	M	Power State 0 Descriptor	0x0000000000000000000000000000000000000000000001F4
2111:2080	O	Power State 1 Descriptor	0x0000000000000000010101010000000000000000000000F0
2143:2112	O	Power State 2 Descriptor	0x0000000000000000020202020000000000000000000000BE
2175:2144	O	Power State 3 Descriptor	0x000000000000000003030303000027100000138801 1002BC
2207:2176	O	Power State 4 Descriptor	0x0000000000000000040404040000AFC80000138801100032
...	-	(N/A)	0
3071:3040	O	Power State 31 Descriptor	0
Vendor Specific			
3278:3072	O	Vendor Specific (VS)	0x00
3279	M	Vendor Specific (VS)	0x0
4095:3280	O	Vendor Specific (VS)	0x00

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6.3. SMART Attributes

Table 6-5 SMART Attributes (Log Identifier 02h)

Bytes Index	Bytes	Description
[0]	1	Critical Warning
[2:1]	2	Composite Temperature
[3]	1	Available Spare
[4]	1	Available Spare Threshold
[5]	1	Percentage Used
[31:6]	26	Reserved
[47:32]	16	Data Units Read
[63:48]	16	Data Units Written
[79:64]	16	Host Read Commands
[95:80]	16	Host Write Commands
[111:96]	16	Controller Busy Time
[127:112]	16	Power Cycles
[143:128]	16	Power On Hours

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Bytes Index	Bytes	Description
[159:144]	16	Unsafe Shutdowns
[175:160]	16	Media and Data Integrity Errors
[191:176]	16	Number of Error Information Log Entries
[195:192]	4	Warning Composite Temperature Time
[199:196]	4	Critical Composite Temperature Time
[201:200]	2	Temperature Sensor 1
[203:202]	2	Temperature Sensor 2
[205:204]	2	Temperature Sensor 3
[207:206]	2	Temperature Sensor 4
[209:208]	2	Temperature Sensor 5
[211:210]	2	Temperature Sensor 6
[213:212]	2	Temperature Sensor 7
[215:214]	2	Temperature Sensor 8
[511:216]	296	Reserved

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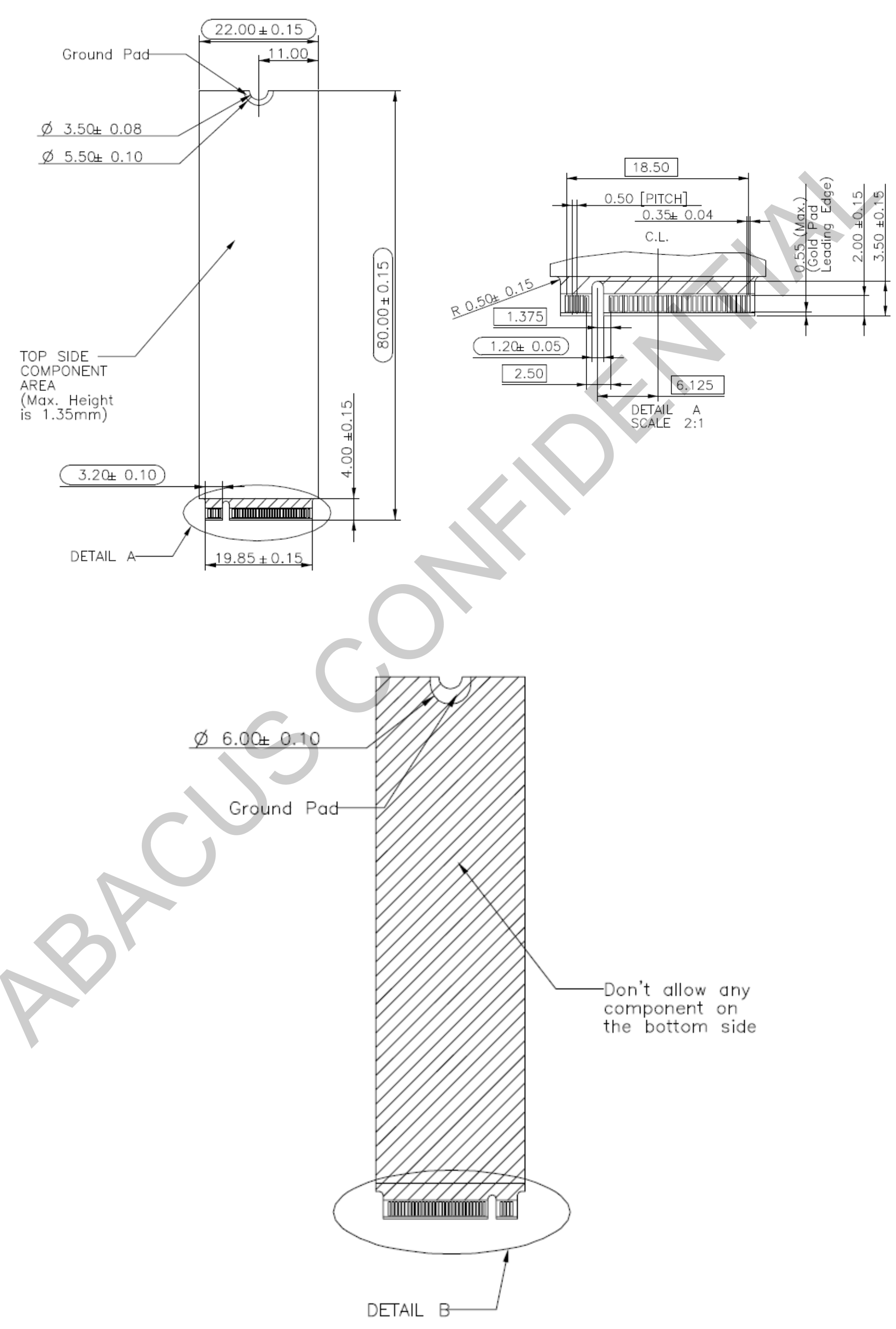
7. PHYSICAL DIMENSION

M.2 2280 S2 : 80.00mm (L) x 22.00mm (W) x 2.15mm (H)



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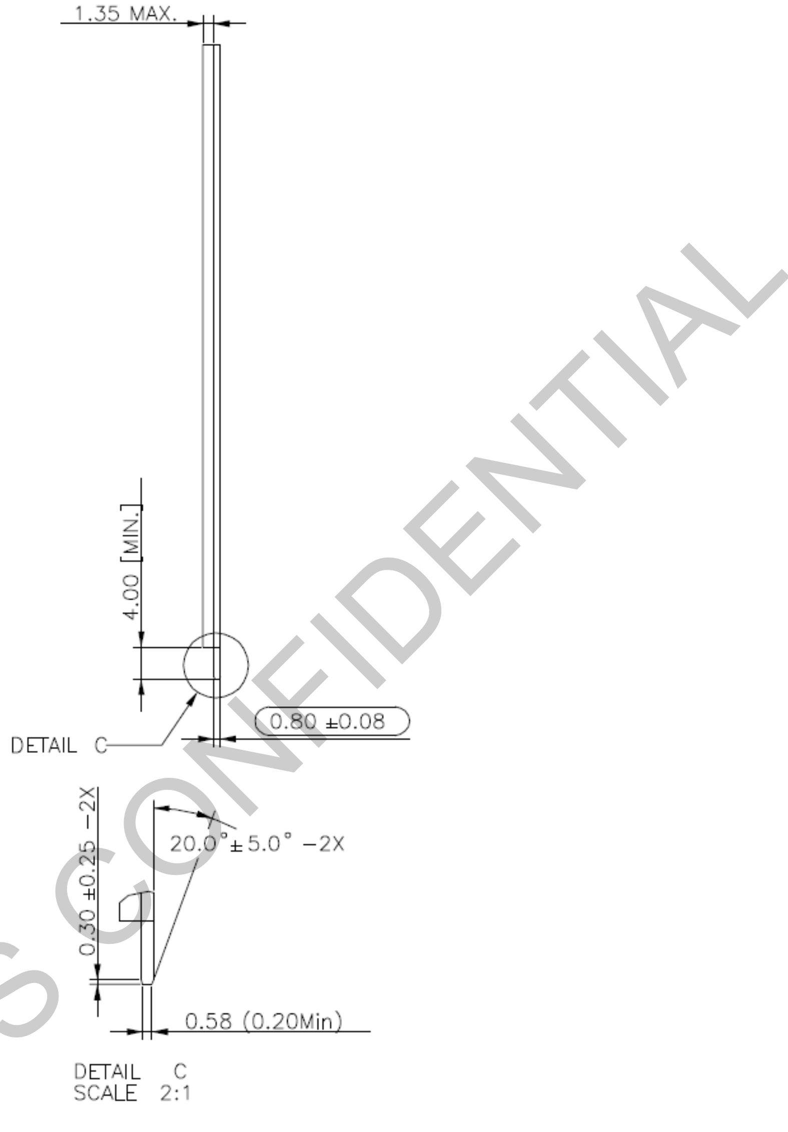
Bottom View



Side View

Notes :
1. = Max Component Height
2. = No Component
3. = No Component / Signal Vias / Signal Copper / Printing
4. General Tolerance ±0.15mm
5. are critical dimensions

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8. APPLICATION NOTES

8.1. Wafer Level Chip Scale Packaging (WLCSP) Handling Precautions

There are a lot of components assembled on a single SSD device. Please handle the drive with care especially when it has any WLCSP (Wafer Level Chip Scale Packaging) components such as PMIC, thermal sensor or load switch. WLCSP is one of the packaging technologies that is widely adopted for making smaller footprints, but any bumps or scratches may damage those ultrasmall parts so gentle handling is strongly recommended.

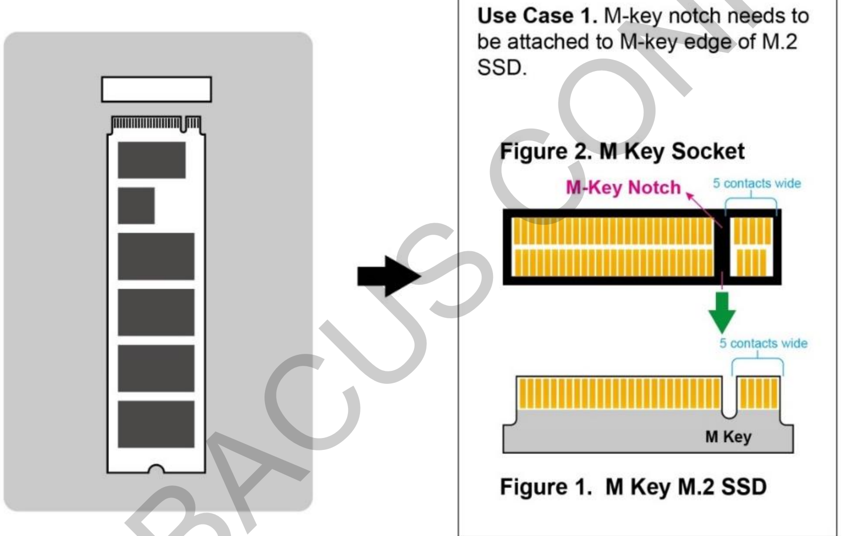
DO NOT DROP SSD

INSTALL SSD WITH CARE

STORE SSD IN A PROPER PACKAGE

8.2. M Key M.2 SSD Assembly Precautions

M Key M.2 SSD (Figure 1) is only compatible to M Key (Figure 2) socket. As shown in Use Case 2, misuse may cause severe damages to SSD including burn-out.



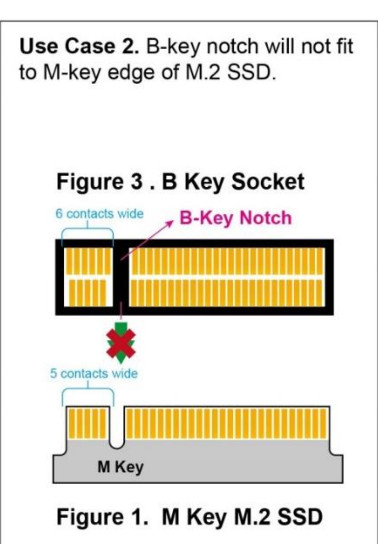


Figure 8-1 M Key M.2 Assembly Precautions

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9. REFERENCES

The following table is to list out the standards that have been adopted for designing the product.

Table 9-1 List of Standards References

Title	Acronym/Source
RoHS	Restriction of Hazardous Substances Directive; for further information, please contact us at daman@abacusperipherals.com
M.2	http://www.pcisig.com
PCI Express Base 3.1	https://www.pcisig.com/specifications/pciexpress/base3/
NVM Express Specification Rev.1.4	http://www.nvmexpress.org/
Solid-State Drive Requirements and Endurance Test Method (JESD219A)	http://www.jedec.org/standards-documents/docs/jesd219a

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10. TERMINOLOGY

The following table is to list out the acronyms that have been applied throughout the document.

Table 10-1 List of Terminology

Term	Definitions
ATTO	Commercial performance benchmark application
DDR	Double data rate (SDRAM)
ASPM	Active States Power Management
APST	Autonomous Power State Transition
LBA	Logical block addressing
MB	Mega-byte
GB	Giga-byte
TB	Tera-byte
MTBF	Mean time between failures
PCIe	PCI Express / Peripheral Component Interconnect Express
S.M.A.R.T.	Self-monitoring, analysis and reporting technology
SSD	Solid state disk

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11. PRODUCT WARRANTY POLICY

In the event the Product does not conform to the specification within Abacus agreed warranty period and such inconformity is solely attributable to Phison's cause, Abacus agrees at its discretion replace or repair the nonconforming Product. Notwithstanding the foregoing, the aforementioned warranty shall exclude the inconformity arising from, in relation to or associated with:

(1) alternation, modification, improper use, misuse or excessive use of the Product;

(2) failure to comply with Phison's instructions;

(3) Phison's compliance with customer (including customer's suppliers, subcontractors or downstream customers) indicated instructions, technologies, designs, specifications, materials, components, parts;

(4) combination of the Product with other materials, compone nts, parts, goods, hardware, firmware or software not developed by Abacus; or

(5) other error or failure not solely attributable to Phison's cause (including without limitation, normal wear or tear, manufacturing or assembly wastage, improper operation, virus, unauthorized maintenance or repair).

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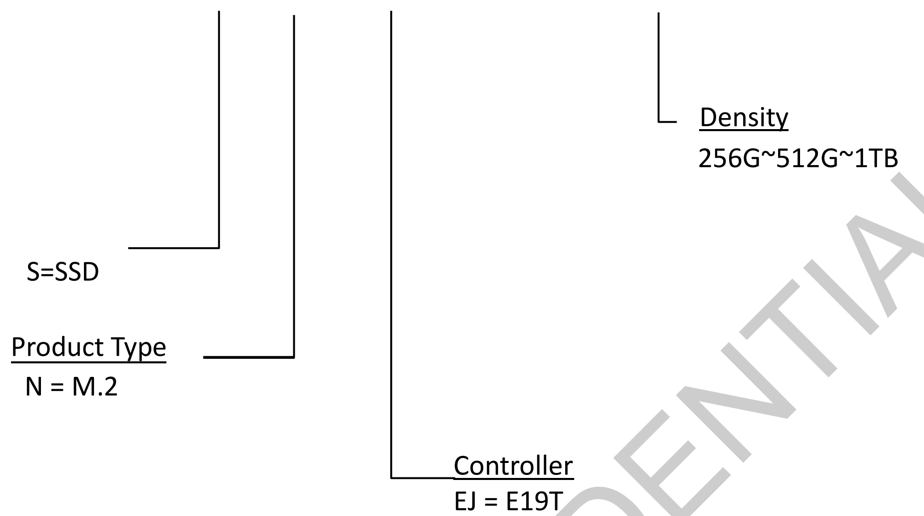
12. PRODUCT ORDERING INFORMATION

12.1. Coding Rule

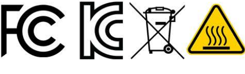


12.2. Valid Combination

256GB	ABNE19256GB
512GB	ABSNE19512GB
1TB	ABSNE191TB

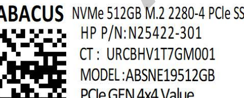
ABACUS NVMe 1TB M.2 2280- 4 PCIe SSD
HP P/N:N25423-301
CT : URCBKV1T7GM001
MODEL : ABSNE191TB
PCIe GEN 4x4 Value
RATED DC+ 3.3.V ⎓ 2.5A
MADE IN INDIA

FW :HPE36P01 HW - A
DC : 2022/05
OUI : 8C1F64984
PS-5019-E19-35
S/N : GM191TB00001



ABACUS NVMe 512GB M.2 2280-4 PCIe SSD
HP P/N:N25422-301
CT : URCBHV1T7GM001
MODEL :ABSNE19512GB
PCIe GEN 4x4 Value
RATED DC+ 3.3.V ⎓ 2.5A
MADE IN INDIA

FW :HPE36P01 HW - A
DC : 2022/05
OUI : 8C1F64984
PS-5019-E19-35
S/N : GM1951200001



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