Enterprise PCIe 5.0 U.2 SSD
Specification
X200 Series

V1.2

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REVISION HISTORY

Revision	Draft Date	History	Author
0.1	Feb 29th ,2024	Preliminary Version, 1st release	Derek
0.2	Mar 21st ,2024	Update performance, power consumption, performance and power sop, physical Dimension, airflow profile	Derek
0.3	Apr 26th ,2024	Fix typo found in chapter 6 and chapter 1.7.2	Derek
0.4	May 8th ,2024	Fix typo found in product overview	Derek
0.5	June 4th, 2024	Update pulse duration, frequency and amplitutde for shock and vibration, update chapter 5 interface PIN no. E12 name to "Ground"	Derek
0.6	Jun 25th ,2024	Update performance, power consumption and drive weight	Derek
0.7	Jun 27th ,2024	Correct weight for U.2 3.2TB & 3.84TB	Derek
0.8	Jul 4th, 2024	Updated numbers for performance, latency, QoS, consistency in chapter 2. And update power consumption and in rush current for chapter 4	Derek
0.9	Jul 8th ,2024	Modify number for performance, latency and QoS	Derek
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0.B	Jul 30th, 2024	1.Modify secion 2.2, 32TB performance number	Derek

		2.Modify secion 2.3 latency, 16TB & 32TB number 3.Modify secion 2.4 IOPs consistency 4.Modify section 2.5 QoS and remove footnote 5.Fix section 3.2, TBW 32TB flash configuration	
0.C	August 8th, 2024	Update U.2 32TB performance, IOPs consistency. Update X200 power consumption	Derek
0.D	August 14th, 2024	Updated performance	Derek
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0.F	Sept 27th,2024	1.Remove "estimation" from power consumption measurement. 2.Remove 99.99% QoS from Overview because 99.99% fluctulated a lot with different platforms	Derek
1.1	Dec 2th ,2024	1.Update power consumption measurement. 2.Update Performance	Woody
1.2	Mar 19th ,2024	Update Performance	Woody

This specification is based on current mass production firmware version of X200-series and is subject to change without notice. Any deviation on following firmware revisions will not be updated unless the deviation is more than 5%.

PRODUCT OVERVIEW

- Capacities
  - OP=7%: 1920, 3840, 7680, 15360, 30720 GB
  - OP=28%: 1600, 3200, 6400, 12800, 25600 GB
- Form Factor
  - U.2 15mm
- PCIe Interface
  - PCIe Gen5x4
  - Single Port x4 lanes/Dual port 2x2 lanes
  - PCIe AER (Advanced Error Reporting)
- Performance
  - Maximum Sequential Read/Write
  - Maximum Random Read/Write
  - Latency (Sustained workload)
  - IOPS Consistency
  - QoS (Quality of Service,99%)[1]
- Power Consumption[2]
  - Typical Power Consumption: 25W
  - Inrush Current: 2.5A
  - Idle Power: <5W
- Endurance / Reliability

DWPD[3]

  - 1DWPD
    - 1920, 3840, 7680, 15360, 30720 GB
  - 3DWPD
    - 1600, 3200, 6400, 12800, 25600 GB

TBW[3]

  - 1600GB SSD – 8760 TB
  - 1920GB SSD – 3504 TB
  - 3200GB SSD – 17520 TB
  - 3840GB SSD – 7008 TB
  - 6400GB SSD –35040 TB
  - 7680GB SSD – 14016 TB
  - 12800GB SSD – 70080 TB
  - 15360GB SSD – 28032 TB
  - 25600GB SSD – 140160 TB
  - 30720GB SSD – 56064 TB

LBAF: 512 / 512+ 8 / 4K / 4K + 8 / 4K + 64 Bytes

- MTBF 2.5 million hours
- UBER < 1 sector per 10^{18} bits read
- Environmental Specification
  - Operation: 0°C ~ 70°C with specified airflow
  - Storage: -40°C ~ 85°C
- RoHS compliant
- Enterprise Features Support List:
  - Namespace
  - Single/Dual Port
  - Reservation
  - Metadata Protection
  - Thermal throttling
  - Power Loss Protection

Hardware AES-XTS 256-bit Encryption

Support SMBus

Support NVMe-MI (Management Interface)

Data Retention – 3 months

- Physical Dimension:
  - U.2 15mm 100(L)x70(W)x15(H) mm[3]
- Compliance
  - PCIe Express Base 5.0
  - NVMe Express 2.0

- NVMe Express Management Interface Rev 1.2
- PCIe Express SFF-8639 Module Specification Revision 4.0, Version1.0

NOTES:

1. Please see “Quality of Service (QoS=99% , 99.99%)” Chapter 2.5 for details.
2. Please see “Power Consumption” Chapter 4.2 for details.

ORDERING INFORMATION

Single-port SSD

Form Factor	Capacity	DWPD	Interface	Part Number
U.2	1600	3	Single Port	SC-XP208E-1600G
U.2	1920	1	Single Port	SC-XP208P-1920G
U.2	3200	3	Single Port	SC-XP208E-3200G
U.2	3840	1	Single Port	SC-XP208P-3840G
U.2	6400	3	Single Port	SC-XP208E-6400G
U.2	7680	1	Single Port	SC-XP208P-7680G
U.2	12800	3	Single Port	SC-XP208E-12800G
U.2	15360	1	Single Port	SC-XP208P-15360G
U.2	25600	3	Single Port	SC-XP208E-25600G
U.2	30720	1	Single Port	SC-XP208P-30720G

Dual-port SSD

Form Factor	Capacity	DWPD	Interface	Part Number
U.2	1600	3	Dual Port	SC-XX208E-1600G
U.2	1920	1	Dual Port	SC-XX208P-1920G
U.2	3200	3	Dual Port	SC-XX208E-3200G
U.2	3840	1	Dual Port	SC-XX208P-3840G
U.2	6400	3	Dual Port	SC-XX208E-6400G
U.2	7680	1	Dual Port	SC-XX208P-7680G
U.2	12800	3	Dual Port	SC-XX208E-12800G
U.2	15360	1	Dual Port	SC-XX208P-15360G
U.2	25600	3	Dual Port	SC-XX208E-25600G
U.2	30720	1	Dual Port	SC-XX208P-30720G

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1. INTRODUCTION

1.1. General Description

Phison's U.2 15mm Solid State Disk (SSD) delivers all the advantages of flash disk technology with PCIe Gen5 x4 interface, including being fully compliant with standard U.2 form factor, providing low power consumption compared to traditional hard drive and hot-swapping when removing/replacing/upgrading flash disks. X200 series U.2 offers a wide range of capacities up to 32TB and its performance can reach up to 14000 MB/s (for sequential read) and 14000 MB/s (for sequential write) based on TLC NAND flash with the DDR4. Moreover, the power consumption of X200 U.2 15mm SSD is much lower than traditional hard drives, making it the best embedded solution for new platforms.

1.2. Thermal Throttling

The purpose of thermal throttling is to prevent any components in a SSD from over-heating during read and write operations. X200 is designed with multiple on-board thermal sensors and with their accuracy, firmware can apply different levels of throttling to achieve the purpose of protection efficiently and proactively via SMART reading.

Table 1-1 Thermal Throttling Mechanism

Item	Description
Stage 1 No TMT	To monitor temp every 1 sec, until flash temperature over 77°C.
Stage 2 TMT1	While flash temp reach TMT1 (flash 77°C), it would trigger TMT to decrease Performance lightly.
Stage 3 TMT2	While flash temp reach TMT2 (flash 81°C), it would trigger TMT to decrease Performance heavily.
Stage 4 TT Stable	To Keep TT stable within flash temp 77~83°C. Would monitor temperature every second
TMT Protect	While flash temp reach 84°C Force 1 ACTIVE DIE PER CH(~500MB)
TMT Fatal	Perform thermal shutdown process when flash temperature ≥ 85°C or controller temperature ≥ 115°C
Exit TT	While temperature <=75°C, Device exit TT(Full speed)。

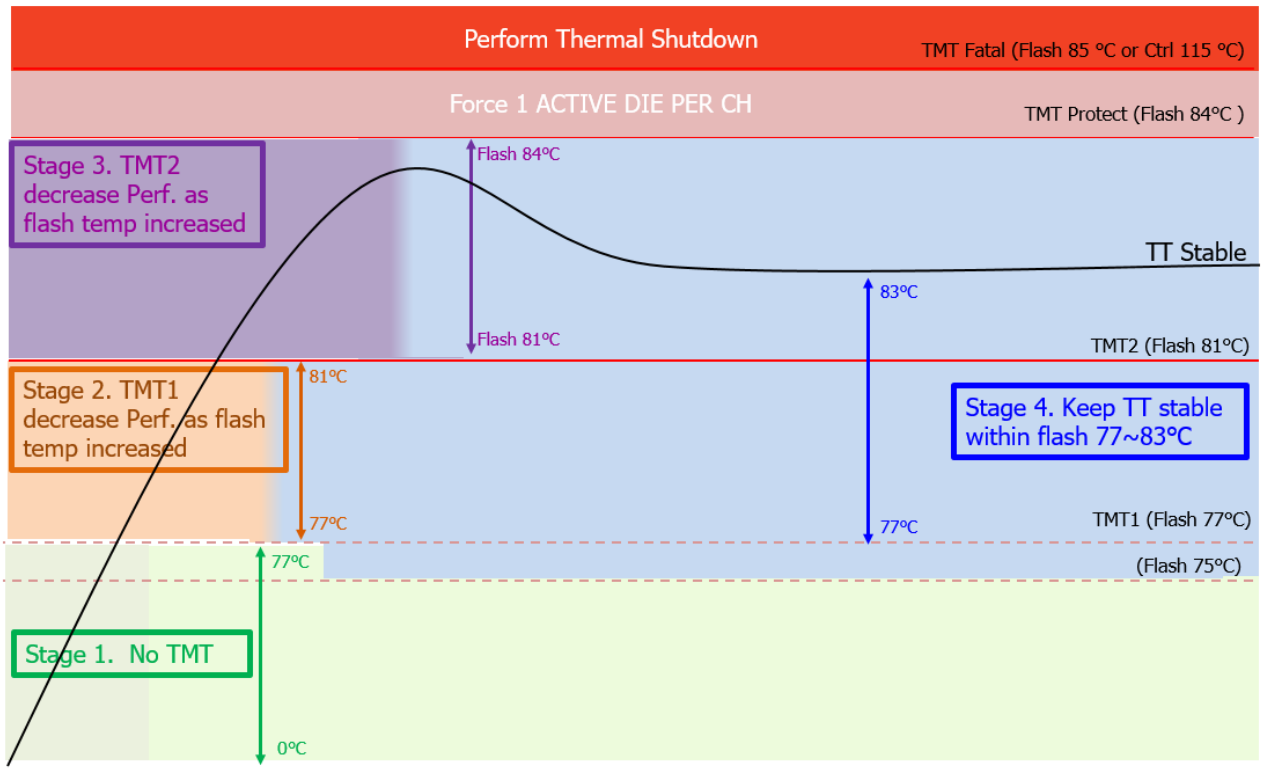

Figure 1-1Thermal Throttling Mechanism

Note:

1. The temperature for TMT is based on T_{case}.(T_{case}: temperate value of on SSD thermal sensor)
2. TMT levels maybe varying by different workloads.

1.3. SSD Security Type

IEEE 1667 is supported but needs to be activated by vendor tool when needed, this is to prevent unintended eDrive implementation and the following necessity of Reverting by PSID before being able to re-install Operation System. Table 1-3 illustrates the types of sanitize operation supported.

Table 1-2 Drive Security Type

Drive Security Type	AES-256 Encryption	Sanitize Operation			TCG Commands	IEEE 1667
		Overwrite	Block Erase	Crypto Erase	PSID Revert Process	Windows eDrive
SED (TCG Opal)	Yes	No	Yes	Yes	Yes	Yes
ISE	Yes	No	Yes	Yes	No	No
Non-SED	No	No	No	No	No	No

2. PRODUCT SPECIFICATIONS

2.1. Electrical/Physical Interface

- PCI Express® Base Specification Ver. 5.0
- NVM Express™ Base Specification Rev. 2.0
- PCIe Gen 5 x 4 lanes & backward compatible to PCIe Gen 4, Gen 3, Gen 2 and Gen 1 Device Capacity
- PCIe Express SFF-8639 Module Specification Revision 5.0, Version0.7
- 256 IO queues supported (1 admin queue and 8 IO queue). Each IO queue support 8K entries

Table 2-1 X200P User Capacity and Addressable Sectors

Model Name	DWPD = 1	User Addressable Sectors	Bytes per Sector
X200P	1920GB	3,750,748,848	512 Byte
	3840GB	7,501,476,528	
	7680GB	15,002,931,888	
	15360GB	30,001,856,512	
	30720GB	60,001,615,872	

Table 2-2 X200E User Capacity and Addressable Sectors

Model Name	DWPD = 3	User Addressable Sectors	Bytes per Sector
X200E	1600GB	3,125,627,568	512 Byte
	3200GB	6,251,233,968	
	6400GB	12,502,446,768	
	12800GB	25,000,148,992	
	25600GB	50,000,297,984	

NOTES:

3. 1 Gigabyte (GB) is equal to 1,000,000,000 bytes; 1 sector is equal to 512 bytes.
4. The total actual usable capacity of the SSD may be less than the total physical capacity because internal NAND management, SSD format, SSD partition, operating system and so on.
5. The count of User Addressable Sectors is calculated by the formula of IDEMA.

2.2. Performance

2.2.1. Sequential Read/Write Performance and 4K Sustained Random Read/ Write Performance

Table 2-3 High Performance Sequential Read/ Write Performance

Capacity	Model Name	Flash Type	Maximum Performance[1]	
			Sequential 128KB (QD=32, Jobs=1)	
			Read (MB/s)	Write (MB/s)
1600GB	X200E	3D TLC	14,800	4,300
1920GB	X200P	3D TLC	14,800	4,300
3200GB	X200E	3D TLC	14,800	8,600
3840GB	X200P	3D TLC	14,800	8,600
6400GB	X200E	3D TLC	14,800	8,700
7680GB	X200P	3D TLC	14,800	8,700
12800GB	X200E	3D TLC	14,800	8,500
15360GB	X200P	3D TLC	14,800	8,500
25600 GB	X200E	3D TLC	14,800	7,400
30720 GB	X200P	3D TLC	14,800	7,400

Table 2-4 High Performance Random Read/ Write Performance

Capacity	Model Name	Flash Type	Maximum Performance[1]	
			4K Random (QD=128 , Jobs=8)	
			Read (IOPS)	Write (IOPS)
1600GB	X200E	3D TLC	2,400,000	390,000
1920GB	X200P	3D TLC	2,400,000	140,000
3200GB	X200E	3D TLC	3,300,000	790,000
3840GB	X200P	3D TLC	3,300,000	320,000
6400GB	X200E	3D TLC	3,200,000	880,000
7680GB	X200P	3D TLC	3,200,000	390,000
12800GB	X200E	3D TLC	2,800,000	900,000
15360GB	X200P	3D TLC	2,800,000	420,000
25600 GB	X200E	3D TLC	2,300,000	615,000
30720 GB	X200P	3D TLC	2,300,000	265,000

NOTES:

6. Performance was estimated based on TLC NAND flash.

7. Performance may differ according to flash configuration and platform.
8. The tables are for reference only. Any criteria for accepting goods shall be further discussed based on different flash configurations.

2.3. Latency

2.3.1. *Latency*

Table 2-5 High Performance 4KB Sustained Random Read/Write Latency

Capacity	Model	4K Sustained Random (QD=1, Jobs=1)		4K Random (QD=8, Jobs=4)	
		Read	Write	Read	Write
		µs	µs	µs	µs
1600 GB	X200E	60	9	70	100
1920 GB	X200P	60	9	70	250
3200 GB	X200E	60	9	70	50
3840 GB	X200P	60	9	70	110
6400 GB	X200E	60	9	70	50
7680 GB	X200P	60	9	70	100
12800 GB	X200E	60	9	70	50
15360 GB	X200P	60	9	70	100
25600 GB	X200E	65	9	70	60
30720 GB	X200P	65	10	70	130

NOTES:

9. Performance was estimated based on TLC NAND flash.
10. Performance may differ according to flash configuration and platform.
11. The tables are for reference only. Any criteria for accepting goods shall be further discussed based on different flash configurations.

2.4. IOPS Consistency

2.4.1. *IOPS Consistency*

Table 2-6 High Performance 4KB Sustained Random Read/Write IOPS Consistency

Capacity	Model	4K Sustained Random (QD=1, Jobs =1)		4K Sustained Random (QD=8, Jobs=4)	
		Read	Write	Read	Write
		%	%	%	%
1600 GB	X200E	95	95	95	90
1920 GB	X200P	95	95	95	95
3200 GB	X200E	95	95	95	90
3840 GB	X200P	95	95	95	95
6400 GB	X200E	95	95	95	90
7680 GB	X200P	95	95	95	95
12800 GB	X200E	95	95	95	90
15360 GB	X200P	95	95	95	95
25600 GB	X200E	95	95	95	90
30720 GB	X200P	95	95	95	95

NOTES:

12. Consistency Definition: (IOPS in the 99.9% 1-second interval) / (average IOPS during the test)
13. Performance was estimated based on TLC NAND flash.
14. Performance may differ according to flash configuration and platform.
15. The tables are for reference only. Any criteria for accepting goods shall be further discussed based on different flash configurations.
16. Numbers with * are an estimation, actual results will be provided later

2.5. Quality of Service (QoS=99%, 99.99%)

High Performance: 4KB Sustained Random Read/Write Quality of Service (QoS=99% , QoS=99.99%)

Table 2-7 QoS = 99%

Capacity	Model	(QD=1, Jobs =1)		(QD=8, Jobs =4)	
		Read (4KB)	Write (4KB)	Read (4KB)	Write (4KB)
		µs	µs	µs	µs
1600 GB	X200E	70	10	140	120
1920 GB	X200P	70	10	140	250
3200 GB	X200E	70	10	130	120
3840 GB	X200P	70	10	130	150
6400 GB	X200E	70	10	120	120
7680 GB	X200P	70	10	120	120
12800 GB	X200E	70	10	120	120
15360 GB	X200P	70	10	120	120
25600 GB	X200E	70	10	120	120
30720 GB	X200P	70	10	120	150

Table 2-8 QoS=99.99%

Capacity	Model	(QD=1, Jobs =1)		(QD=8, Jobs =4)	
		Read (4KB)	Write (4KB)	Read (4KB)	Write (4KB)
		µs	µs	µs	µs
1600 GB	X200E	75	13	240	500
1920 GB	X200P	75	13	240	500
3200 GB	X200E	75	13	200	500
3840 GB	X200P	75	13	200	500
6400 GB	X200E	75	13	180	500
7680 GB	X200P	75	13	180	500
12800 GB	X200E	75	13	160	500
15360 GB	X200P	75	13	160	500
25600 GB	X200E	75	13	160	500
30720 GB	X200P	75	13	160	500

2.6. Reliability

2.6.1. TBW(Terabytes Written)

Table 2-9 TBW

Capacity	Model Name	Flash Structure	Flash Type	TBW	DWPD
1600GB	X200E	256GB x 8	3D TLC	8760	3
1920GB	X200P	256GB x 8	3D TLC	3504	1
3200GB	X200E	256GB x 16	3D TLC	17520	3
3840GB	X200P	256GB x 16	3D TLC	7008	1
6400GB	X200E	512GB x 16	3D TLC	35040	3
7680GB	X200P	512GB x 16	3D TLC	14016	1
12800GB	X200E	512GB x 32	3D TLC	70080	3
15360GB	X200P	512GB x 32	3D TLC	28032	1
25600GB	X200E	1024GB x 32	3D TLC	140160	3
30720GB	X200P	1024GB x 32	3D TLC	56064	1

2.6.2. UBER

Table 2-10 UBER

Capacity	Flash Type	UBER
1600GB	3D NAND	< 1 sector per 10^{18} bits read
1920GB		
3200GB		
3840GB		
6400GB		
7680GB		
15360GB		
12800GB		
25600GB		
30720GB		

NOTE:

17. UBER (Uncorrectable Bit Error Rates) means the uncorrectable error per bits read.

2.6.3. MTBF

Mean Time Between Failures(MTBF) is demonstrated through a 2,000-hour Reliability Demonstration Test.

Table 2-11 MTBF

Description	Value
Mean Time Between Failures	2.5 million hours

2.7. Weight

Table 2-12 U.2 Weight

Capacity	Flash Configuration	Flash Type	Weight (g)
1600GB	256GB x 8	32CE, 512Gb, QDP	188
1920GB	256GB x 8	32CE, 512Gb, QDP	188
3200GB	256GB x 16	64CE, 512Gb QDP	199
3840GB	256GB x 16	64CE, 512Gb QDP	199
6400GB	512GB x 16	64CE, 512Gb ODP	201
7680GB	512GB x 16	64CE, 512Gb ODP	201
12800GB	512GB x 32	128CE, 512Gb ODP	168
15360GB	512GB x 32	128CE, 512Gb ODP	168
25600GB	1024GB x 32	128CE, 512Gb HDP	169
30720GB	1024GB x 32	128CE, 512Gb HDP	169

3. ENVIRONMENTAL SPECIFICATIONS

3.1. Environmental Conditions

3.1.1. *Temperature and Humidity*

Table 3-1 Temperature and Humidity Specification

Temperature	Operating	0°C to 70°C
	Non-operating	-40°C to 85°C
Relative Humidity	Operating	5% to 95%
	Non-operating	5% to 95%

3.1.2. *Shock*

Table 3-2 Shock

Shock	Operating	500G, 2ms
		1000G, 0.5ms
	Non-operating	500G, 2ms
		1000G, 0.5ms

3.1.3. *Vibration*

Table 3-3 Vibration

Vibration	Operating	7 to 800 Hz	2.17 Grms
	Non-operating	10 - 2000 Hz	16.3 Grms
		2 -5 - 500 Hz	0.4G/3G

3.1.4. *Altitude*

Table 3-4 Altitude

Altitude	Operating Type	Value
	Operating	0 to 18,000 feet
	Non-operating	0 to 40,000 feet

3.2. Electrostatic Discharge (ESD)

Table 3-5 Electrostatic Discharge (ESD)

Specification	+/- 4KV
EN55035, CISPR 35 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.

3.3. EMI Compliance

Table 3-6 EMI Compliance

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

NOTES:

18. Test condition and criteria is referred to IPC-9701.

19. The cumulative number of failures can't exceed 20 pcs after testing.
20. This test item will be executed when required.

4. ELECTRICAL SPECIFICATIONS

4.1. Supply Voltage

Table 4-1 Supply Voltage

12v operating voltage	12V +/- 10%
12v noise level	240mVp-p, 0-20MHz
12v min off time	500ms
3.3v aux	+5%/- 10%

NOTE:

21. 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

Model Name	Capacity	Active Read(W) (Average RMS)	Active Write(W) (Average RMS)	Idle (W)
X200	1600GB	16	16	5
	192	16	16	5

0GB			
3200GB	18	22	5
3840GB	17	22	5
6400GB	20	23	5
7680GB	20	23	5
12800GB	21	24	5
15360GB	22	24	5
25600GB	23	25	5
30720	23	25	5

	GB			

NOTES:

22. Power consumption is measured in average RMS on full speed mode.

4.3. Inrush Current

Table 4-3 Inrush Current

Inrush current	1600GB /1920GB	3200GB /3840GB	6400GB /7680GB	12800GB /15360GB	25600GB /30720GB
12v	2.5A				3A

5. PHYSICAL DIMENSION

Figure 5-1 shows the case mechanical information of Phison X200 Series SSD in the U.2 15mm form factor. All dimensions are in millimeters.

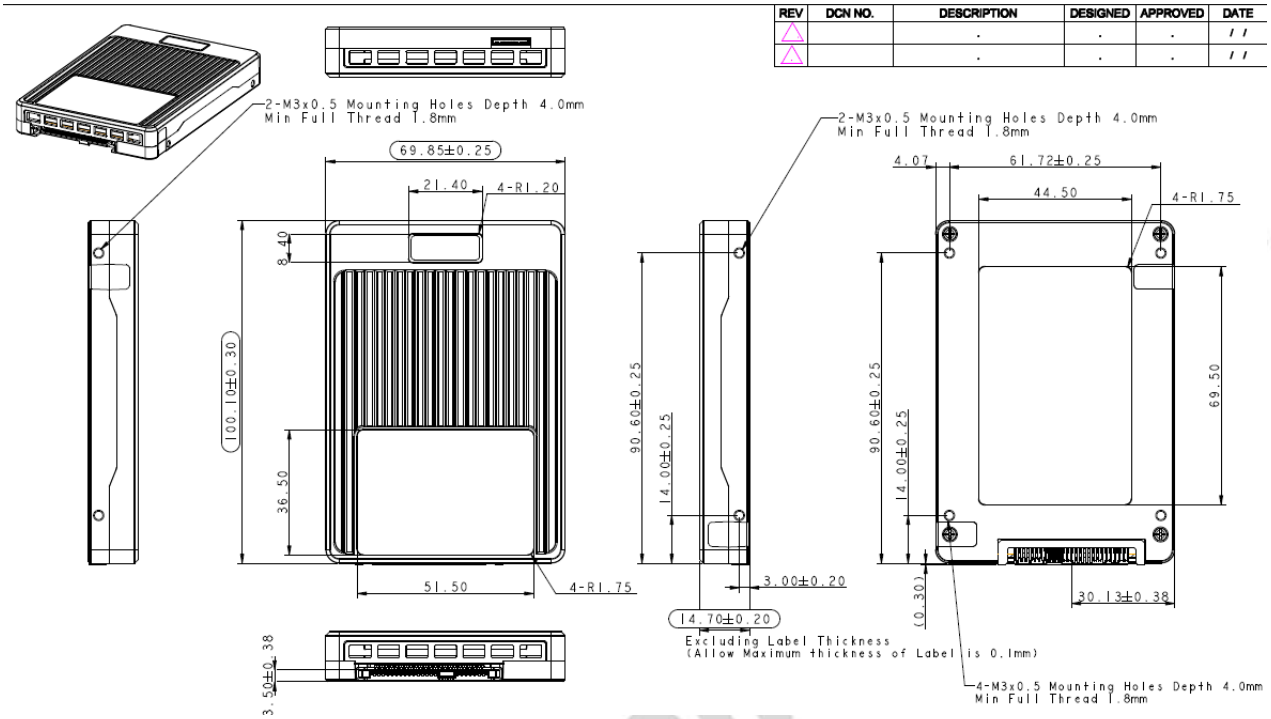

Figure 5-1 U.2 / U.2 2.5-inch 15mm Mechanical information

6. INTERFACE

6.1. PCIe U.2 and U.2 Pin Assignment and Descriptions

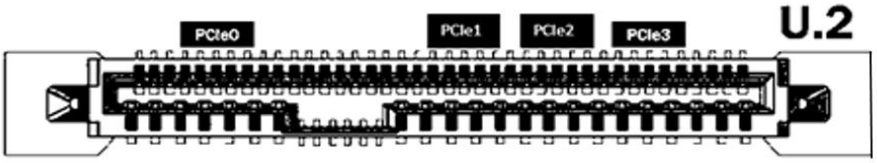

Figure 6-1 X200 U.2 PCIe SSD Pin Assignment

Table 6-1 Pin Assignment and Descriptions

Pin No.	Name	Description
P1	WAKE#	Reserved
P2	Reserved	Reserved
P3	PWRDIS	Power disable
P4	IfDet#	Interface Type Detect
P5	Ground	Ground
P6	Ground	Ground
P7	+5V	NC
P8	+5V	NC
P9	+5V	NC
P10	PRSNT#	Presence detect
P11	Activity#	Activity indicator
P12	Ground	Ground
P13	+12V Precharge	+12V Precharge power
P14	+12V	+12V for SFF-8639 power
P15	+12V	+12V for SFF-8639 power
SG1	Ground	Ground
SG2	Ground	Ground
S1	Ground	Ground
S2	NC	NC
S3	NC	NC
S4	Ground	Ground
S5	NC	NC
S6	NC	NC
S7	Ground	Ground
S8	Ground	Ground
S9	NC	NC
S10	NC	NC
S11	Ground	Ground
S12	NC	NC
S13	NC	NC
S14	Ground	Ground
S15	HPT0	Host port type-0
S16	Ground	Ground
S17	U.2 TX p1	Transmitter differential pair, U.2 Lane 1
S18	U.2 TX n1	Transmitter differential pair, U.2 Lane 1
S19	Ground	Ground
S20	U.2 RX n1	Receiver differential pair, U.2 Lane 1
S21	U.2 RX p1	Receiver differential pair, U.2 Lane 1

Pin No.	Name	Description
S22	Ground	Ground
S23	U.2 TX p2	Transmitter differential pair, or U.2 Lane 2
S24	U.2 TX n2	Transmitter differential pair, or U.2 Lane 2
S25	Ground	Ground
S26	U.2 RX n2	Receiver differential pair, U.2 Lane 2
S27	U.2 RX p2	Receiver differential pair, U.2 Lane 2
S28	Ground	Ground
E1	REFCLKB+	Reference clock (differential pair) for second X2 port
E2	REFCLKB-	Reference clock (differential pair) for second X2 port
E3	+3.3 Vaux	3.3 V auxiliary power
E4	CLKREQ#/PERSTB#	Clock request/Fundamental reset for second x2 port
E5	PERST#	Fundamental reset (if Single Port mode enabled, first x2 port)
E6	IFDet2#	Interface Type Detect
E7	REFCLK+	Reference clock (if dual-port enabled, first X2 port)
E8	REFCLK-	Reference clock (if dual-port enabled, first X2 port)
E9	Ground	Ground
E10	U.2 TX p0	Transmitter differential pair, U.2 Lane 0
E11	U.2 TX n0	Transmitter differential pair, U.2 Lane 0
E12	Ground	Ground
E13	U.2 RX n0	Receiver differential pair, U.2 Lane 0
E14	U.2 RX p0	Receiver differential pair, U.2 Lane 0
E15	Ground	Ground
E16	HPT1	Host port type
E17	U.2 TX p3	Transmitter differential pair, U.2 Lane 3
E18	U.2 TX n3	Transmitter differential pair, U.2 Lane 3
E19	Ground	Ground
E20	U.2 RX n3	Receiver differential pair, U.2 Lane 3
E21	U.2 RX p3	Receiver differential pair, U.2 Lane 3
E22	Ground	Ground
E23	SMCLK	SMBus (System Management Bus) clock
E24	SMDAT	SMBus (System Management Bus) data
E25	DualPortEn#	Dual-port Enable

7. SUPPORTED COMMANDS

7.1. NVMe Command List

Table 7-1 Admin Command List

Identifier	O/M	Supported	Command Description
00h	M	Y	Delete I/O Submission Queue
01h	M	Y	Create I/O Submission Queue
02h	M	Y	Get Log Page
04h	M	Y	Delete I/O Completion Queue
05h	M	Y	Create I/O Completion Queue
06h	M	Y	Identify
08h	M	Y	Abort
09h	M	Y	Set Feature
0Ah	M	Y	Get Feature
0Ch	M	Y	Asynchronous Event Request
0Dh	O	Y	Namespace Management
10h	O	Y	Firmware Commit
11h	O	Y	Firmware Image Download
14h	O	Y	Device Self-test
15h	O	Y	Namespace Attachment
18h	O	-	Keep Alive
19h	O	-	Directive Send
1Ah	O	-	Directive Receive
1Ch	O	-	Virtualization Management
1Dh	O	Y	NVMe-MI Send
1Eh	O	Y	NVMe-MI Receive
7Ch	O	-	Doorbell Buffer Config
80h	O	Y	Format NVM
81h	O	Y	Security Send
82h	O	Y	Security Receive
84h	O	Y	Sanitize
86h	O	-	Get LBA Status

Table 7-2 I/O Commands

Identifier	O/M	Supported	Command Description
00h	M	Y	Flush
01h	M	Y	Write
02h	M	Y	Read
04h	O	Y	Write Uncorrectable
05h	O	Y	Compare
08h	O	Y	Write Zeroes
09h	O	Y	Dataset Management (Trim only)
0Ch	O	Y	Verify
0Dh	O	Y	Reservation Register
0Eh	O	Y	Reservation Report
11h	O	Y	Reservation Acquire
15h	O	Y	Reservation Release

Table 7-3 Set Feature Commands

Identifier	O/M	Supported	Command Description

00h	-	-	Reserved
01h	M	Y	Arbitration
02h	M	Y	Power Management
03h	O	-	LBA Range Type
04h	M	Y	Temperature Threshold
05h	M	Y	Error Recovery
06h	O	-	Volatile Write Cache
07h	M	Y	Number Of Queues
08h	M	Y	Interrupt Coalescing
09h	M	Y	Interrupt Vector Configuration
0Ah	M	Y	Write Atomicity Normal
0Bh	M	Y	Asynchronous Event Configuration
0Ch	O	-	Autonomous Power State Transition
0Dh	O	-	Host Memory Buffer
0Eh	O	Y	Timestamp
0Fh	O	-	Keep Alive Timer
10h	O	Y	Host Controlled Thermal Management
11h	O	-	Non-Operational Power State Config
12h	O	-	Read Recovery Level Config
13h	O	-	Predictable Latency Mode Config
14h	O	-	Predictable Latency Mode Window
15h	O	-	LBA Status Information Attributes
16h	O	-	Host Behavior Support
17h	O	Y	Sanitize Config
18h	O	Y	Endurance Group Event Configuration
19h - 77h	-	-	Reserved (NVMe Reserved)
78h – 7Dh	-	-	Reserved(NVMe MI Reserved)
7Eh	M	Y	Controller Metadata (NVMe MI)
7Fh	M	Y	Namespace Metadata (NVMe MI)
80h	O	-	Software Progress Marker
81h	O	Y	Host Identifier
82h	O	Y	Reservation Notification Mask
83h	O	Y	Reservation Persistence
84h	O	-	Namespace Write Protection Config
85h - BFh	-	-	Command Set Specific (Reserved)
C0h - FFh	O	-	Vendor Specific

Table 7-4 Get Log Page Commands

Identifier	O/M	Supported	Command Description
00h	O	Y	Supported Log Pages
01h	M	Y	Error Information
02h	M	Y	SMART / Health Information
03h	M	Y	Firmware Slot Information
04h	O	Y	Changed Namespace List
05h	O	Y	Commands Supported and Effects
06h	O	Y	Device Self-test
07h	O	Y	Telemetry Host-Initiated
08h	O	Y	Telemetry Controller-Initiated
09h	O	Y	Endurance Group Information
0Ah	O	-	Predictable Latency Per NVM Set
0Bh	O	-	Predictable Latency Event Aggregate
0Ch	O	-	Asymmetric Namespace Access

Identifier	O/M	Supported	Command Description
0Dh	O	Y	Persistent Event Log
0Eh	O	-	LBA Status Information
0Fh	O	Y	Endurance Group Event Aggregate
10h	O	-	Media Unit Status
11h	O	-	Supported Capacity Configuration List
12h	O	Y	Feature Identifiers Supported and Effects
13h	O	Y	NVMe-MI Commands Supported and Effects
14h	O	Y	Command and Feature Lockdown
15h	O	-	Boot Partition
16h	O	-	Rotational Media Information
17h - 6Fh	-	-	Reserved
70h	O		Discovery
71h - 7Fh	-		Reserved
80h	O	Y	Reservation Notification
81h	O	Y	Sanitize Status
82h - FFh	-	-	Reserved

Table 7-5 NVMe Management Interface Commands

Identifier	O/M	Supported	Command Description
00h	M	Y	Read NVMe-MI Data Structure
01h	M	Y	NVM Subsystem Health Status Poll
02h	M	Y	Controller Health Status Poll
03h	M	Y	Configuration Set
04h	M	Y	Configuration Get
05h	M	Y	VPD Read
06h	M	Y	VPD Write
07h	M	Y	Reset
08h	-	-	SES Receive
09h	-	-	SES Send
0Ah	O	-	Management Endpoint Buffer Read
0Bh	O	-	Management Endpoint Buffer Write
0Ch	O	-	Shutdown
0Ch - BFh	O	-	Reserved
C0h - FFh	O	-	Vendor Specific

NOTES:

23. “Y” means “Support”.
24. “O” means “Option, default No support”.
25. “-” means “No support”.

Table 7-6 SMBus / I2C Elements Supported

SMBus/I2C Element	SMBus/I2C Address(8bit)	
	Hex Format	Binary format
FRU Information Device (for NVMe Storage Device)	A6h	1010_011xb
SMBus/I2C Management Endpoint	3Ah	0011_101xb
Basic Management Command	D4h	1101_010xb

7.2. Identify Device Data

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

Table 7-7 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)	TBD
63:24	M	Model Number (MN)	TBD
71:64	M	Firmware Revision (FR)	TBD
72	M	Recommended Arbitration Burst (RAB)	0x00
75:73	M	IEEE OUI Identifier (IEEE)	TBD*
76	O	Controller Multi-Path I/O and Namespace Sharing Capabilities (CMIC)	0x00 1 port 0x03 2 ports
77	M	Maximum Data Transfer Size (MDTS)	0x09
79:78	M	Controller ID (CNTLID)	0x0000
83:80	M	Version (VER)	0x00020000
87:84	M	RTD3 Resume Latency (RTD3R)	0x001E8480 (2 Sec)
91:88	M	RTD3 Entry Latency (RTD3E)	0x00989680
95:92	M	Optional Asynchronous Events Supported (OAES)	0x00004300
99:96	M	Controller Attributes (CTRATT)	0x00000290
101:100	O	Read Recovery Levels Supported (RRLS):	0x0000
110:102	-	Reserved	0x00
111	M	Controller Type (CNTRLTYPE)	0x01
127:112	O	FRU Globally Unique Identifier (FGUID):	TBD
129:128	O	Command Retry Delay Time 1 (CRDT1):	0x0000
131:130	O	Command Retry Delay Time 2 (CRDT2):	0x0000
133:132	O	Command Retry Delay Time 3 (CRDT3):	0x0000
239:134		Reserved	
252:240		Reserved for the NVMe Management Interface	
253	M	NVM Subsystem Report (NVMSR)	0x01
254	M	VPD Write Cycle Information (VWCI)	0x00
255	M	Management Endpoint Capabilities (MEC)	0x03
257:256	M	Optional Admin Command Support (OACS)	0x045F
258	M	Abort Command Limit (ACL)	0x07
259	M	Asynchronous Event Request Limit (AERL)	0x0F
260	M	Firmware Updates (FRMW)	0x1F
261	M	Log Page Attributes (LPA)	0x3E
262	M	Error Log Page Entries (ELPE)	0xFF
263	M	Number of Power States Support (NPSS)	5
264	M	Admin Vendor Specific Command Configuration (AVSCC)	0x01
265	O	Autonomous Power State Transition Attributes (APSTA)	0x00
267:266	M	Warning Composite Temperature Threshold (WCTEMP)	0x015E
269:268	M	Critical Composite Temperature Threshold (CCTEMP)	0x0166
271:270	O	Maximum Time for Firmware Activation (MTFA)	0x0032
275:272	O	Host Memory Buffer Preferred Size (HMPRE)	0x00000000
279:276	O	Host Memory Buffer Minimum Size (HMMIN)	0x00000000
295:280	O	Total NVM Capacity (TNVMCAP)	**
311:296	O	Unallocated NVM Capacity (UNVMCAP)	**
315:312	O	Replay Protected Memory Block Support (RPMBS)	0x00000000
317:316	O	Extended Device Self-test Time (EDSTT)	0x0002
318	O	Device Self-test Options (DSTO)	0x01
319	O	Firmware Update Granularity (FWUG)	0xFF
321:320	O	Keep Alive Support (KAS)	0x0000
323:322	O	Host Controlled Thermal Management Attributes (HCTMA)	0x0001
325:324	O	Minimum Thermal Management Temperature (MNTMT)	0x0111
327:326	O	Maximum Thermal Management Temperature (MXTMT)	0x01A2

Bytes	O/M	Description	Default Value
331:328	O	Sanitize Capabilities (SANICAP)	0x40000002 nonSED 0x40000003 SED 0x40000003 ISE 0x40000003 FIPS
335:332	O	Host Memory Buffer Minimum Descriptor Entry Size (HMMINDS):	0x00000000
337:336	O	Host Memory Maximum Descriptors Entries (HMMAXD):	0x0000
339:338	O	NVM Set Identifier Maximum (NSETIDMAX):	0x0000
341:340	O	Endurance Group Identifier Maximum (ENDGIDMAX):	0x0001
342	O	ANA Transition Time (ANATT):	0x00
343	O	Asymmetric Namespace Access Capabilities (ANACAP):	0x00
347:344	O	ANA Group Identifier Maximum (ANAGRPMAX):	0x00000000
351:348	O	Number of ANA Group Identifiers (NANAGRPID):	0x00000000
355:352	O	Persistent Event Log Size (PELS):	0x63
511:356		Reserved	0x0

Table 7-8 NVMe Command Set Attributes

NVMe Command Set Attributes			
512	M	Submission Queue Entry Size (SQES)	0x66
513	M	Completion Queue Entry Size (CQES)	0x44
515:514		Maximum Outstanding Commands (MAXCMD)	0x0400 1 port 0x0200 2 ports
519:516	M	Number of Namespaces (NN)	0x00000080
521:520	M	Optional NVM Command Support (ONCS)	0x00FF
523:522	M	Fused Operation Support (FUSES)	0x0001
524	M	Format NVM Attributes (FNA)	0x04
525	M	Volatile Write Cache (VWC)	0x06
527:526	M	Atomic Write Unit Normal (AWUN)	0x00FF
529:528	M	Atomic Write Unit Power Fail (AWUPF)	0x00FF
530	M	NVM Vendor Specific Command Configuration (NVSCC)	0x01
531	M	Namespace Write Protection Capabilities (NWPC):	0x00
533:532	O	Atomic Compare & Write Unit (ACWU)	0x00FF
535:534	M	Reserved	0x0000
539:536	O	SGL Support (SGLS)	0x000F0001
543:540	O	Maximum Number of Allowed Namespaces (MNAN):	0x00000000
767:544	M	Reserved	0x00
1023:768	M	NVM Subsystem NVMe Qualified Name (SUBNQN):	TBD

Table 7-9 I/O Command Set Attributes

I/O Command Set Attributes			
2079:2048	M	Power State 0 Descriptor (PSD0)	
Bit[255:184]		Reserved	0x0
Bit[183:182]		Active Power Scale (APS)	0x2
Bit[181:179]		Reserved	0x0
Bit[178:176]		Active Power Workload (APW)	0x0
Bit[175:160]		Active Power (ACTP)	0xBB8
Bit[159:152]		Reserved	0x0
Bit[151:150]		Idle Power Scale (IPS)	0x0
Bit[149:144]		Reserved	0x0
Bit[143:128]		Idle Power (IDLP)	0x0
Bit[127:125]		Reserved	0x0

I/O Command Set Attributes			
Bit[124:120]		Relative Write Latency (RWL)	0x0
Bit[119:117]		Reserved	0x0
Bit[116:112]		Relative Write Throughput (RWT)	0x0
Bit[111:109]		Reserved	0x0
Bit[108:104]		Relative Read Latency (RRL)	0x0
Bit[103:101]		Reserved	0x0
Bit[100:96]		Relative Read Throughput (RRT)	0x0
Bit[95:64]		Exit Latency (EXLAT)	0x0
Bit[63:32]		Entry Latency (ENLAT)	0x0
Bit[31:26]		Reserved	0x0
Bit[25]		Non-Operational State (NOPS)	0x0
Bit[24]		Max Power Scale (MPS)	0x0
Bit[23:16]		Reserved	0x0
Bit[15:0]		Maximum Power (MP)	0xBB8
2111:2080	O	Power State 1 Descriptor (PSD1)	
Bit[255:184]		Reserved	0x0
Bit[183:182]		Active Power Scale (APS)	0x2
Bit[181:179]		Reserved	0x0
Bit[178:176]		Active Power Workload (APW)	0x0
Bit[175:160]		Active Power (ACTP)	0x9C4
Bit[159:152]		Reserved	0x0
Bit[151:150]		Idle Power Scale (IPS)	0x0
Bit[149:144]		Reserved	0x0
Bit[143:128]		Idle Power (IDLP)	0x0
Bit[127:125]		Reserved	0x0
Bit[124:120]		Relative Write Latency (RWL)	0x1
Bit[119:117]		Reserved	0x0
Bit[116:112]		Relative Write Throughput (RWT)	0x1
Bit[111:109]		Reserved	0x0
Bit[108:104]		Relative Read Latency (RRL)	0x1
Bit[103:101]		Reserved	0x0
Bit[100:96]		Relative Read Throughput (RRT)	0x1
Bit[95:64]		Exit Latency (EXLAT)	0x0
Bit[63:32]		Entry Latency (ENLAT)	0x0
Bit[31:26]		Reserved	0x0
Bit[25]		Non-Operational State (NOPS)	0x0
Bit[24]		Max Power Scale (MPS)	0x0
Bit[23:16]		Reserved	0x0
Bit[15:0]		Maximum Power (MP)	0x9C4
2143:2112	O	Power State 2 Descriptor (PSD2)	
Bit[255:184]		Reserved	0x0
Bit[183:182]		Active Power Scale (APS)	0x2
Bit[181:179]		Reserved	0x0
Bit[178:176]		Active Power Workload (APW)	0x0
Bit[175:160]		Active Power (ACTP)	0x7D0
Bit[159:152]		Reserved	0x0
Bit[151:150]		Idle Power Scale (IPS)	0x0
Bit[149:144]		Reserved	0x0
Bit[143:128]		Idle Power (IDLP)	0x0
Bit[127:125]		Reserved	0x0
Bit[124:120]		Relative Write Latency (RWL)	0x2
Bit[119:117]		Reserved	0x0

I/O Command Set Attributes			
Bit[116:112]		Relative Write Throughput (RWT)	0x2
Bit[111:109]		Reserved	0x0
Bit[108:104]		Relative Read Latency (RRL)	0x2
Bit[103:101]		Reserved	0x0
Bit[100:96]		Relative Read Throughput (RRT)	0x2
Bit[95:64]		Exit Latency (EXLAT)	0x0
Bit[63:32]		Entry Latency (ENLAT)	0x0
Bit[31:26]		Reserved	0x0
Bit[25]		Non-Operational State (NOPS)	0x0
Bit[24]		Max Power Scale (MPS)	0x0
Bit[23:16]		Reserved	0x0
Bit[15:0]		Maximum Power (MP)	0x7D0
2175:2144	O	Power State 3 Descriptor (PSD3)	-
Bit[255:184]		Reserved	0x0
Bit[183:182]		Active Power Scale (APS)	0x2
Bit[181:179]		Reserved	0x0
Bit[178:176]		Active Power Workload (APW)	0x0
Bit[175:160]		Active Power (ACTP)	0x708
Bit[159:152]		Reserved	0x0
Bit[151:150]		Idle Power Scale (IPS)	0x0
Bit[149:144]		Reserved	0x0
Bit[143:128]		Idle Power (IDLP)	0x0
Bit[127:125]		Reserved	0x0
Bit[124:120]		Relative Write Latency (RWL)	0x3
Bit[119:117]		Reserved	0x0
Bit[116:112]		Relative Write Throughput (RWT)	0x3
Bit[111:109]		Reserved	0x0
Bit[108:104]		Relative Read Latency (RRL)	0x3
Bit[103:101]		Reserved	0x0
Bit[100:96]		Relative Read Throughput (RRT)	0x3
Bit[95:64]		Exit Latency (EXLAT)	0x0
Bit[63:32]		Entry Latency (ENLAT)	0x0
Bit[31:26]		Reserved	0x0
Bit[25]		Non-Operational State (NOPS)	0x0
Bit[24]		Max Power Scale (MPS)	0x0
Bit[23:16]		Reserved	0x0
Bit[15:0]		Maximum Power (MP)	0x708
2207:2176	O	Power State 4 Descriptor (PSD4)	-
Bit[255:184]		Reserved	0x0
Bit[183:182]		Active Power Scale (APS)	0x2
Bit[181:179]		Reserved	0x0
Bit[178:176]		Active Power Workload (APW)	0x0
Bit[175:160]		Active Power (ACTP)	0x5DC
Bit[159:152]		Reserved	0x0
Bit[151:150]		Idle Power Scale (IPS)	0x0
Bit[149:144]		Reserved	0x0
Bit[143:128]		Idle Power (IDLP)	0x0
Bit[127:125]		Reserved	0x0
Bit[124:120]		Relative Write Latency (RWL)	0x4
Bit[119:117]		Reserved	0x0
Bit[116:112]		Relative Write Throughput (RWT)	0x4
Bit[111:109]		Reserved	0x0

I/O Command Set Attributes			
Bit[108:104]		Relative Read Latency (RRL)	0x4
Bit[103:101]		Reserved	0x0
Bit[100:96]		Relative Read Throughput (RRT)	0x4
Bit[95:64]		Exit Latency (EXLAT)	0x0
Bit[63:32]		Entry Latency (ENLAT)	0x0
Bit[31:26]		Reserved	0x0
Bit[25]		Non-Operational State (NOPS)	0x0
Bit[24]		Max Power Scale (MPS)	0x0
Bit[23:16]		Reserved	0x0
Bit[15:0]		Maximum Power (MP)	0x5DC
2239:2208	O	Power State 5 Descriptor (PSD5)	-
Bit[255:184]		Reserved	0x0
Bit[183:182]		Active Power Scale (APS)	0x2
Bit[181:179]		Reserved	0x0
Bit[178:176]		Active Power Workload (APW)	0x0
Bit[175:160]		Active Power (ACTP)	0x4B0
Bit[159:152]		Reserved	0x0
Bit[151:150]		Idle Power Scale (IPS)	0x0
Bit[149:144]		Reserved	0x0
Bit[143:128]		Idle Power (IDLP)	0x0
Bit[127:125]		Reserved	0x0
Bit[124:120]		Relative Write Latency (RWL)	0x5
Bit[119:117]		Reserved	0x0
Bit[116:112]		Relative Write Throughput (RWT)	0x5
Bit[111:109]		Reserved	0x0
Bit[108:104]		Relative Read Latency (RRL)	0x5
Bit[103:101]		Reserved	0x0
Bit[100:96]		Relative Read Throughput (RRT)	0x5
Bit[95:64]		Exit Latency (EXLAT)	0x0
Bit[63:32]		Entry Latency (ENLAT)	0x0
Bit[31:26]		Reserved	0x0
Bit[25]		Non-Operational State (NOPS)	0x0
Bit[24]		Max Power Scale (MPS)	0x0
Bit[23:16]		Reserved	0x0
Bit[15:0]		Maximum Power (MP)	0x4B0
2271:2240	O	Power State 6 Descriptor (PSD6)	0x00
2303:2272	O	Power State 7 Descriptor (PSD7)	0x00
2335:2304	O	Power State 8 Descriptor (PSD8)	0x00
2367:2336	O	Power State 9 Descriptor (PSD9)	0x00
2399:2368	O	Power State 10 Descriptor (PSD10)	0x00
2431:2400	O	Power State 11 Descriptor (PSD11)	0x00
2463:2432	O	Power State 12 Descriptor (PSD12)	0x00
2495:2464	O	Power State 13 Descriptor (PSD13)	0x00
2527:2496	O	Power State 14 Descriptor (PSD14)	0x00
2559:2528	O	Power State 15 Descriptor (PSD15)	0x00
2591:2560	O	Power State 16 Descriptor (PSD16)	0x00
2623:2592	O	Power State 17 Descriptor (PSD17)	0x00
2655:2624	O	Power State 18 Descriptor (PSD18)	0x00
2687:2656	O	Power State 19 Descriptor (PSD19)	0x00
2719:2688	O	Power State 20 Descriptor (PSD20)	0x00
2751:2720	O	Power State 21 Descriptor (PSD21)	0x00
2783:2752	O	Power State 22 Descriptor (PSD22)	0x00

I/O Command Set Attributes			
2815:2784	O	Power State 23 Descriptor (PSD23)	0x00
2847:2816	O	Power State 24 Descriptor (PSD24)	0x00
2879:2848	O	Power State 25 Descriptor (PSD25)	0x00
2911:2880	O	Power State 26 Descriptor (PSD26)	0x00
2943:2912	O	Power State 27 Descriptor (PSD27)	0x00
2975:2944	O	Power State 28 Descriptor (PSD28)	0x00
3007:2976	O	Power State 29 Descriptor (PSD29)	0x00
3039:3008	O	Power State 30 Descriptor (PSD30)	0x00
3071:3040	O	Power State 31 Descriptor (PSD31)	0x00
4095:3072	O	Vendor Specific.	0x00

Table 7-10 I/O Vendor Specific

Vendor Specific			
4095:3072	O	Vendor Specific (VS)	Phison Reserved

NOTES:

26. * The OUI shall be a valid IEEE/RAC assigned identifier that may be registered at http://standards.ieee.org/develop/regauth/oui/public.html.
27. ** Depends on the using of capacity

Table 7-11 Identify Namespace Data Structure & NVM Command Set Specific

Bytes	O/M	Description	Default Value
7:0	M	Namespace Size (NSZE)	TBD*
15:8	M	Namespace Capacity (NCAP)	TBD*
23:16	M	Namespace Utilization (NUSE)	TBD*
24	M	Namespace Features (NSFEAT)	0x10
25	M	Number of LBA Formats (NLBAF)	0x04
26	M	Formatted LBA Size (FLBAS)	0x00
27	M	Metadata Capabilities (MC)	0x03
28	M	End-to-end Data Protection Capabilities (DPC)	0x13
29	M	End-to-end Data Protection Type Settings (DPS)	0x00
30	O	Namespace Multi-path I/O and Namespace Sharing Capabilities (NMIC)	0x01 1 port 0x02 2 ports
31	O	Reservation Capabilities (RESCAP)	0x83
32	O	Format Progress Indicator (FPI)	0x80
33	O	Deallocate Logical Block Features (DLFEAT):	0x19
35:34	O	Namespace Atomic Write Unit Normal (NAWUN)	0x0000
37:36	O	Namespace Atomic Write Unit Power Fail (NAWUPF)	0x0000
39:38	O	Namespace Atomic Compare & Write Unit (NACWU)	0x0000
41:40	O	Namespace Atomic Boundary Size Normal (NABSN)	0x0000
43:42	O	Namespace Atomic Boundary Offset (NABO)	0x0000
45:44	O	Namespace Atomic Boundary Size Power Fail (NABSPF)	0x0000
47:46	O	Namespace Optimal I/O Boundary (NOIOB):	0x0000
63:48	O	NVM Capacity (NVMCAP)	TBD*
65:64	O	Namespace Preferred Write Granularity (NPWG):	0x0000 4K LBA size 0x0007 512B LBA size
67:66	O	Namespace Preferred Write Alignment (NPWA):	0x0000 4K LBA size 0x0007 512B LBA size

Bytes	O/M	Description	Default Value
69:68	O	Namespace Preferred Deallocate Granularity (NPDG):	0x0000 4K LBA size 0x0007 512B LBA size
71:70	O	Namespace Preferred Deallocate Alignment (NPDA):	0x0000 4K LBA size 0x0007 512B LBA size
73:72	O	Namespace Optimal Write Size (NOWS):	0x0000 4K LBA size 0x0007 512B LBA size
91:74	-	Reserved	0x00
95:92	O	ANA Group Identifier (ANAGRPID):	0x00000000
98:96	-	Reserved	
99	O	Namespace Attributes (NSATTR):	0x00
101:100	O	NVM Set Identifier (NVMSETID):	0x0000
103:102	O	Endurance Group Identifier (NEDGID)	0x0001
119:104	O	Namespace Globally Unique Identifier (NGUID)	TBD**
127:120	O	IEEE Extended Unique Identifier (EUI64)	TBD**
131:128	M	LBA Format 0 Support (LBAF0)	0x00090000
135:132	O	LBA Format 1 Support (LBAF1)	0x00090008
139:136	O	LBA Format 2 Support (LBAF2)	0x000C0000
143:140	O	LBA Format 3 Support (LBAF3)	0x000C0008
147:144	O	LBA Format 4 Support (LBAF4)	0x000C0040
151:148	O	LBA Format 5 Support (LBAF5)	0x00000000
155:152	O	LBA Format 6 Support (LBAF6)	0x00000000
159:156	O	LBA Format 7 Support (LBAF7)	0x00000000
163:160	O	LBA Format 8 Support (LBAF8)	0x00000000
167:164	O	LBA Format 9 Support (LBAF9)	0x00000000
171:168	O	LBA Format 10 Support (LBAF10)	0x00000000
175:172	O	LBA Format 11 Support (LBAF11)	0x00000000
179:176	O	LBA Format 12 Support (LBAF12)	0x00000000
183:180	O	LBA Format 13 Support (LBAF13)	0x00000000
187:184	O	LBA Format 14 Support (LBAF14)	0x00000000
191:188	O	LBA Format 15 Support (LBAF15)	0x00000000
383:192		Reserved	0x00
4095:384	O	Vendor Specific (VS)	0x00

NOTES:

28. *According to IDEMA SPEC
29. ** According to IEEE EUI-64 SPEC

Table 7-12 List of Identify Namespace Data Structure for Each Capacity (512+0)

Capacity (GB)	Byte [7:0]: Namespace Size (NSZE)(Hex)	Byte [7:0]: Namespace Size (NSZE)(Dec)
30720	DF8600000	60,001,615,872
15360	6FC400000	30,001,856,512
30720	DF8F952B0	60,011,664,048
15360	6FC7CD2B0	30,005,842,608
7680	37E3E92B0	15,002,931,888

3840	1BF1F72B0	7,501,476,528
1920	DF8FE2B0	3,750,748,848

7.3. SMART Attributes

Table 7-13 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
[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 (Current Temperature)
[203:202]	2	Temperature Sensor 2 (N/A)
[205:204]	2	Temperature Sensor 3 (N/A)
[207:206]	2	Temperature Sensor 4 (N/A)
[209:208]	2	Temperature Sensor 5 (N/A)
[211:210]	2	Temperature Sensor 6 (N/A)
[213:212]	2	Temperature Sensor 7 (N/A)
[215:214]	2	Temperature Sensor 8 (N/A)
[219:216]	4	Thermal Management Temperature 1 Transition Count
[223:220]	4	Thermal Management Temperature 2 Transition Count
[227:224]	4	Total Time For Thermal Management Temperature 1 (seconds)
[231:228]	4	Total Time For Thermal Management Temperature 2 (seconds)
[511:232]	280	Reserved

Table 7-14 SMART Attributes (Log Identifier C0h)

Bytes Index	Bytes	Description
[15:0]	16	Physical Media Units Written
[31:16]	16	Physical Media Units Read
[39:32]	8	Bad User NAND Blocks
[47:40]	8	Bad System NAND Blocks
[55:48]	8	XOR Recovery Count
[63:56]	8	Uncorrectable Read Error Count
[71:64]	8	Soft ECC Error Count
[79:72]	8	End to End Correction Counts
[80]	1	System Data % Used
[87:81]	7	Refresh Counts

Bytes Index	Bytes	Description
[95:88]	8	User Data Erase Counts
[97:96]	2	Thermal Throttling Status and Count
[103:98]	6	DSSD Specification Version
[111:104]	8	PCIe Correctable Error Count
[115:112]	4	Incomplete Shutdowns
[119:116]	4	Reserved
[120]	1	% Free Blocks
[127:121]	7	Reserved
[129:128]	2	Capacitor Health
[130]	1	NVMe Errata Version
[135:131]	5	Reserved
[143:136]	8	Unaligned I/O
[151:144]	8	Security Version Number
[159:152]	8	Total NUSE
[175:160]	16	PLP Start Count
[191:176]	16	Endurance Estimate
[199:192]	8	PCIe Link Retraining Count
[207:200]	8	Power State Change Count
[493:208]	286	Reserved
[495:494]	2	Log Page Version
[511:496]	16	Log Page GUID

Table 7-15 SMART Attributes (Log Identifier D2h)

Bytes Index	Bytes	Description
[7:0]	8	Device Capacity
[15:8]	8	User Capacity
[23:16]	8	NAND Read
[31:24]	8	NAND Write
[39:32]	8	NAND Erase Sector
[47:40]	8	SSD Life Remaining Percent D3
[55:48]	8	SSD Life Used Percent D3
[56]	1	WP Water Mark
[58:57]	2	Highest temperature
[62:59]	4	Read Fail Count
[66:63]	4	Data E3D Error
[70:67]	4	PHY Error Count
[74:71]	4	Total Bad Block Count
[78:75]	4	Total Early Bad Blcok Count
[82:79]	4	Total Later Bad Blcok Count
[86:83]	4	Read Fail Count
[90:87]	4	Program Fail Count
[94:91]	4	Erase Failure Count
[102:95]	8	System Table Copy Count
[110:103]	8	ReadMoveTableCnt
[114:111]	4	Data read retry count
[118:115]	4	RAID ECC retry count
[122:119]	4	RAID ECC failed count
[130:123]	8	Total Erase Count
[134:131]	4	D2/D3 Max Erase Cnount
[138:135]	4	D2/D3 Average Erase Count

Bytes Index	Bytes	Description
[142:139]	4	D2/D3 Min Erase Count
[150:143]	8	Background read count (N/A)
[154:151]	4	Host Write Uncorrectable Sector Count
[158:155]	4	Wear Leveling Count
[160:159]	2	Chip internal temperature
[162:161]	2	Thermal throttling
[164:163]	2	Thermal throttling time
[172:165]	8	FW Code Update Count
[180:173]	8	Flash UNC Error Count
[184:181]	4	HB retry count
[188:185]	4	SB retry count
[190:189]	2	Previous Average Erase Count
[194:191]	4	Power CAP init error count
[198:195]	4	Data RAID ECC Recovery Success
[202:199]	4	Data RAID ECC Recovery Failed
[206:203]	4	Table RAID ECC Recovery Success
[210:207]	4	Table RAID ECC Recovery Failed
[211]	1	SSD Life Used Percent with Previous Average Erase Count
[215:212]	4	ddr decode 1-bit error count
[217:216]	2	error count of thermal sensor 1
[219:218]	2	error count of thermal sensor 2
[221:220]	2	error count of thermal sensor 3
[223:222]	2	error count of thermal sensor 4
[231:224]	8	raw dara of thermal sensor (raw data(2Byte)*4sensor= 8Byte)
[235:232]	4	Data Soft RAID Recovery Success
[239:236]	4	Data Soft RAID Recovery Fail
[243:240]	4	ddr corrected error count
[247:244]	4	ddr detected error count
[251:248]	4	cop1 sram corrected error count
[255:252]	4	cop1 sram detected error count
[259:256]	4	nvme sram corrected error count
[263:260]	4	nvme sram detected error count
[267:264]	4	pcie mac0 pl sram corrected error count
[271:268]	4	pcie mac0 pl sram detected error count
[275:272]	4	pcie mac0 tl sram corrected error count
[279:276]	4	pcie mac0 tl sram detected error count
[283:280]	4	pcie mac1 pl sram corrected error count
[287:284]	4	pcie mac1 pl sram detected error count
[291:288]	4	pcie mac1 tl sram corrected error count
[295:292]	4	pcie mac1 tl sram detected error count
[299:296]	4	host sram corrected error count
[303:300]	4	host sram detected error count
[307:304]	4	hdma sram corrected error count
[311:308]	4	hdma sram detected error count
[315:312]	4	ddr0 sram corrected error count
[319:316]	4	ddr0 sram detected error count
[323:320]	4	fip0 sram corrected error count
[327:324]	4	fip0 sram detected error count
[331:328]	4	fip1 sram corrected error count
[335:332]	4	fip1 sram detected error count
[339:336]	4	fip2 sram corrected error count
[343:340]	4	fip2 sram detected error count

Bytes Index	Bytes	Description
[347:344]	4	fip3 sram corrected error count
[351:348]	4	fip3 sram detected error count
[355:352]	4	aepu sram corrected error count
[359:356]	4	aepu sram detected error count
[363:360]	4	sys0 sram corrected error count
[367:364]	4	sys0 sram detected error count
[371:368]	4	smbm sram corrected error count
[375:372]	4	smbm sram detected error count
[379:376]	4	sec sram corrected error count
[383:380]	4	sec sram detected error count
[387:384]	4	dbuf sram corrected error count
[391:388]	4	dbuf sram detected error count
[395:392]	4	dmac sram corrected error count
[399:396]	4	dmac sram detected error count
[403:400]	4	corrected error count
[407:404]	4	detected error count
[415:408]	8	tlc nand read
[423:416]	8	tlc nand write
[431:424]	8	Nand_error_count
[439:432]	8	dqs_timeout_counter0
[447:440]	8	dqs_timeout_counter1
[455:448]	8	fip_dqs_timeout_flg_counter
[511:455]	56	Reserved

8. AIR FLOW PROFILE

Figure 8-1 depicts the minimum airflow a U.2 15mm (8TB) needs to operate without triggering thermal throttling at ambient temperatures varied from 35°C to 65°C.

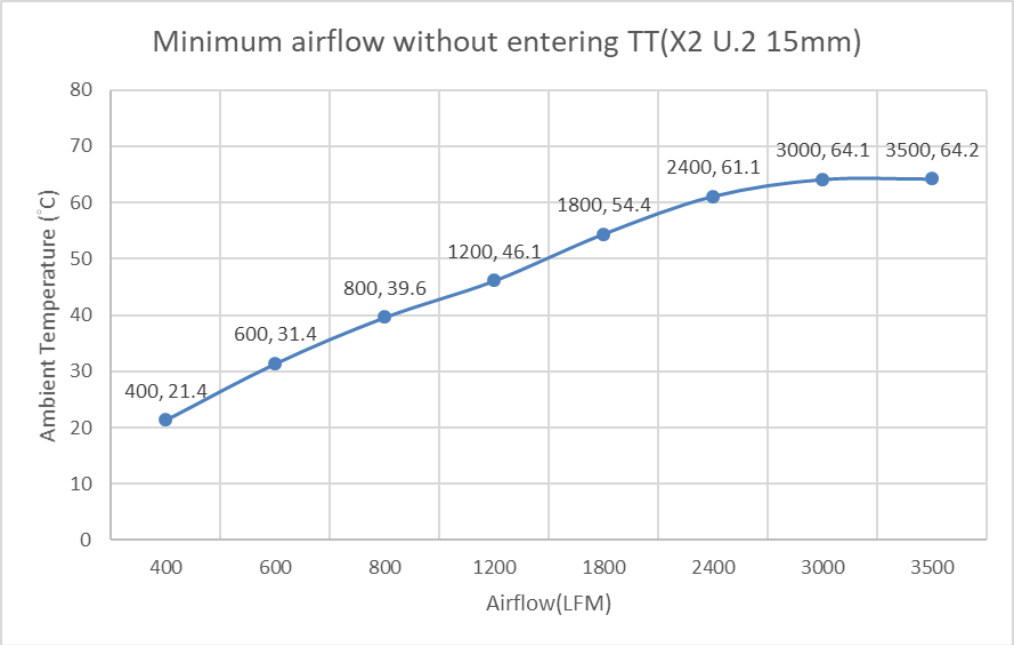

Figure 8-1 X200 U.2 15mm Airflow Curve

9. PERFORMANCE AND POWER SOP

The methodologies and platform used to obtain the power and performance numbers will be listed in the following sections. Again, performance and power may differ according to the flash configuration and platform used.

9.1. Performance Test Platform

- Mother board: MS03-CE0-000
- CPU: Intel Xeon Gold 5416S
- DRAM: DDR5 64G
- OS version: Ubuntu 20.04.2 LTS

9.2. Performance methodologies

9.2.1. FIO Test procedure

- Secure erase - > no need format drive
  - 128K Seq. write/read
    1. Pre-con - 200% seq. write to full disk
       (a) IO Depth = 32
       (b) Number of jobs = 1
    2. Test script
       (a) IO Depth = 32
       (b) Number of Jobs= 1
       (c) Test duration: 900 secs

9.2.2. IOPS consistency Test procedure

- Secure erase - > no need format drive
  - 4k random write/read
    1. Pre-con - 300% 4K random. write to full disk
       (a) IO Depth = 32
       (b) Number of jobs = 1
    2. RND 4k write/read Q1T1
       (c) IO Depth = 1
       (d) Number of jobs =1
    3. RND 4k write/read Q32T1
       (e) IO Depth = 32
       (f) Number of jobs = 1

4. RND 4k write/read Q64T8

   (g) IO Depth = 64

   (h) Number of jobs = 8

9.2.3. *Latency Test procedure*

- Secure erase - > no need format drive
  - 4k random write/read

5. Pre-con - 300% 4K random. write to full disk

   (i) IO Depth = 32

   (j) Number of jobs = 1

6. RND 4k write/read Q1T1

   (k) IO Depth = 1

   (l) Number of jobs =1

7. RND 4k write/read Q32T1

   (m) IO Depth = 32

   (n) Number of jobs = 1

8. RND 4k write/read Q64T8

   (o) IO Depth = 64

   (p) Number of jobs = 8

9.2.4. *QoS test procedure*

- Secure erase - > no need format drive
  - 4k random write/read

9. Pre-con - 300% 4K random. write to full disk

   (q) IO Depth = 32

   (r) Number of jobs = 1

10. RND 4k write/read Q1T1

    (s) IO Depth = 1

    (t) Number of jobs =1

11. RND 4k write/read Q32T1

    (u) IO Depth = 32

    (v) Number of jobs = 1

12. RND 4k write/read Q64T8

    (w) IO Depth = 64

    (x) Number of jobs = 8

- Data collection Procedure:
  1. Run entire test script one time.
  2. Run every condition in this script for 900 seconds
  3. Calculate average value for every condition.
  4. Get the average value, add some buffer and round down to the closest 10th
  5. Verify number with what was requested in PRD.

9.3. Power consumption Test Platform

- Mother board: MS03-CE0-000
- CPU: Intel Xeon Gold 5416S
- DRAM: DDR5 64G
- OS version: Ubuntu 20.04.2 LTS

9.4. Power consumption methodologies

9.4.1. Test Procedure

- 1T/2T/4T/8T device:
- Secure erase - > no need format drive -> Connect power board (Measure Current)
  - 128k Seq. write/read
    1. Pre-con - 100% seq. write to full disk
       (a) IO Depth = 1024
       (b) Number of jobs = 1
    2. Test script (100% seq. write / 100% seq. read)
       (a) IO Depth = 1024
       (b) Number of Jobs= 1
       (c) Test duration: 900secs (for each performance)
  - 4k random write/read
    Pre-con – 300% 4K random write to full disk
    1. Test script
       – 100% ran. write / 100% ran. read / 70% ran. read + 30% ran write / 30% ran. read + 70% ran write
       (a) IO Depth = 256
       (b) Number of Jobs= 12
       (c) Test duration: 900secs (for each performance)
- 16T device:

- Secure erase - > no need format drive -> Connect power board (Measure Current)
  - 128K Seq. write/read

    3. Pre-con - 100% seq. write to full disk

       (a) IO Depth = 32

       (b) Number of jobs = 1

    4. Test script (100% seq. write / 100% seq. read)

       (d) IO Depth = 32

       (e) Number of Jobs= 1

       (f) Test duration: 900secs (for each performance)

  - 4k random write/read

    Pre-con – 300% 4K random write to full disk

    1. Test script
       – 100% ran. write / 100% ran. read / 70% ran. read + 30% ran write / 30% ran. read + 70% ran write

       (d) IO Depth = 32

       (e) Number of Jobs= 8

       (f) Test duration: 900secs (for each performance)

- Data collection procedure – Average RMS (500ms resolution)

  (a) Run entire test script one time.

  (b) Run every condition in this script

  (c) Calculate average value for every condition then choose Average RMS

  (d) Note value for every condition

  (e) 3pcs sample for every capacity.

- Data collection procedure – Peak (1us resolution)

  (a) Run entire test script one time.

  (b) Run every condition in this script

  (c) Choose Maximum Value for every condition

  (d) Note the largest value as the Peak

  (e) 3pcs sample for every capacity.

- Data collection procedure – Power on

  (a) Run power on procedure until drive being ready to use.

  (b) Measure power to get Average RMS power and Max Peak current.

  (c) 3pcs sample for every capacity.

- Data collection procedure – Idle

  (a) After completing every condition, Idle for 30 secs.

(b) Do nothing and measure power to get Average RMS Idle power.

(c) 3pcs sample for every capacity.

10. VITAL PRODUCT DATA

X200 U.2 devices can support Read and Write to Vital Product Data (VPD). VPD contains:

- Basic inventory information such as type and size of Enterprise PCIe SSD, manufacture, date, revision, and GUID.
- Power management data such as power level and power modes.
- Vendor specific data.

VPD is stored in a SMBus device with a slave address of 0xA6. VPD page can be read via SMBUS through address 0x53. Writes to the VPD page uses 0x53.

11. PCIE ID (APPENDIX)

Table 11-1 PCIe ID

ID Name	Description	U.2 15mm	PCIe Register Location	Identify Controller Location	Vital Product Data Location
Vendor ID (VID)	Vendor ID assigned by PCI-SIG	0x1BB1	PCI Header Offset 0x2	Identify Controller Data Structure Bytes 01:00	TBD
Device ID (DID)	Device ID assigned by vendor	0x5020	PCI Header Offset 0x0	N/A	TBD
Subsystem Vendor ID	Indicates Sub-system vendor ID	0x1987	PCI Header Offset 0x2C	Identify Controller Data Structure Bytes 03:02	TBD
Subsystem ID	Sub-system identifier	0x1987	PCI Header Offset 0x2E	N/A	TBD

12. PRODUCT WARRANTY POLICY

For any other products manufactured and supplied by Phison ("Phison Products"), Phison hereby certify that in the event Phison Product does not conform to the specification for the period ending on the date at which customer's use of a Phison Product exceeds Phison Product's total Terabytes Written as recorded by or derived from Phison Product's S.M.A.R.T. Attribute, including but not limited to Phison Product's drive life is used up in accordance with the S.M.A.R.T. Attribute, ("Warranty Period") and such inconformity is confirmed by Phison to be solely attributable to Phison, Phison agrees to repair or replace the nonconforming Phison Product, free of charge.

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 Phison Product;

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

(3) Phison's compliance with or use of the instructions, technologies, designs, specifications, devices, materials, components, parts, software and firmware provided, instructed or approved by Buyer (including any of its parents, subsidiaries, affiliates, suppliers, subcontractors or downstream customers);

(4) combination of Phison Product with other materials, components, parts, goods, hardware, firmware or software not supplied by Phison;

(5) any claim brought by a third party who is commonly known as intellectual property right assertion entity or patent troll;

(6) NAND flash itself or NAND flash which is embedded into Phison Products;

(7) Phison's compliance with general industry standards;

(8) 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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13. REFERENCE

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

Table 13-1 List of References

Title	Acronym/Source
RoHS	Restriction of Hazardous Substances Directive; for further information, please contact us at sales@phison.com or support@phison.com .
PCI Express Base 4.0	https://www.pcisig.com/specifications/pciexpress/base3/
SFF-8639	https://members.snia.org/document/dl/26728
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
PUBLISHED_SFF-8639	https://members.snia.org/document/dl/26837

14. TERMINOLOGY

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

Table 14-1 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