UD info Corp.

Enterprise PCIe 5.0 U.2 SSD
ED/EF Series
Product DataSheet

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Revision History

Revision	Draft Date	History	Author
1.0	2025/1/20	New release	Golden Lee
1.1	2025/3/28	Modify Total sectors (LBA)	Golden Lee
1.2	2025/4/8	1. Update performance & power consumption 2. Added Thermal Throttling Mechanism & Security Features	Golden Lee

Product Overview

- **Capacity**
  - OP=7%:
    1920/3840/7680/15360/30720 GB
  - OP=28%:
    1600/3200/6400/12800/25600 GB
- **Form Factor**
  - U.2 15mm
- **PCIe Interface**
  - PCIe Gen5 x4
  - Single Port x4 lanes / Dual Port x2 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%)[Note1]
- **Power Consumption[Note2]**
  - Active Power: 25 W
  - Inrush Current: 2.5A
  - Idle Power: <5W
- **Reliability**
  - MTBF[Note3]: 2.5 million hours
  - UBER: < 1 sector per 10^{18} bits
  - TBW[Note4]
  - DWPD[Note4]
    - 1 DWPD:
      1920, 3840, 7680, 15360, 30720 GB
    - 3 DWPD:
      1600, 3200, 6400, 12800, 25600 GB
- **LBAF**
  - 512 / 512+8 / 4K / 4K+8 / 4K+64 Bytes
- **Temperature Range**
  - Operation Temperature:
    - 0°C ~ 70°C with specified airflow
  - Storage Temperature: -40°C ~ 85°C
- **RoHS Compliant**
- **Enterprise Features Support List**
  - Namespace
  - Single Port / Dual Port
  - Reservation
  - Metadata Protection
  - Thermal throttling
  - Power Loss Protection
- **Hardware AES-XTS 256-bit Encryption**
- **TCG OPAL Support**
- **Support SMBus**
- **Support NVMe-MI (Management Interface)**
- **Data Retention – 3 months**
- **Physical Dimension**
  - 15mm: 100(L) x 70(W) x 15(H)mm
- **Compliance**
  - PCIe Express Base 5.0
  - NVMe Express 2.0
  - NVMe Express Management Interface Rev 1.2
  - PCIe Express SFF-8639 Module Specification Revision 5.0, Version 0.7

Notes:

1. Please see “Performance to Quality of Service (QoS)” Chapter 2.6 for details.
2. Please see “Power Consumption” Chapter 4.2 for details.

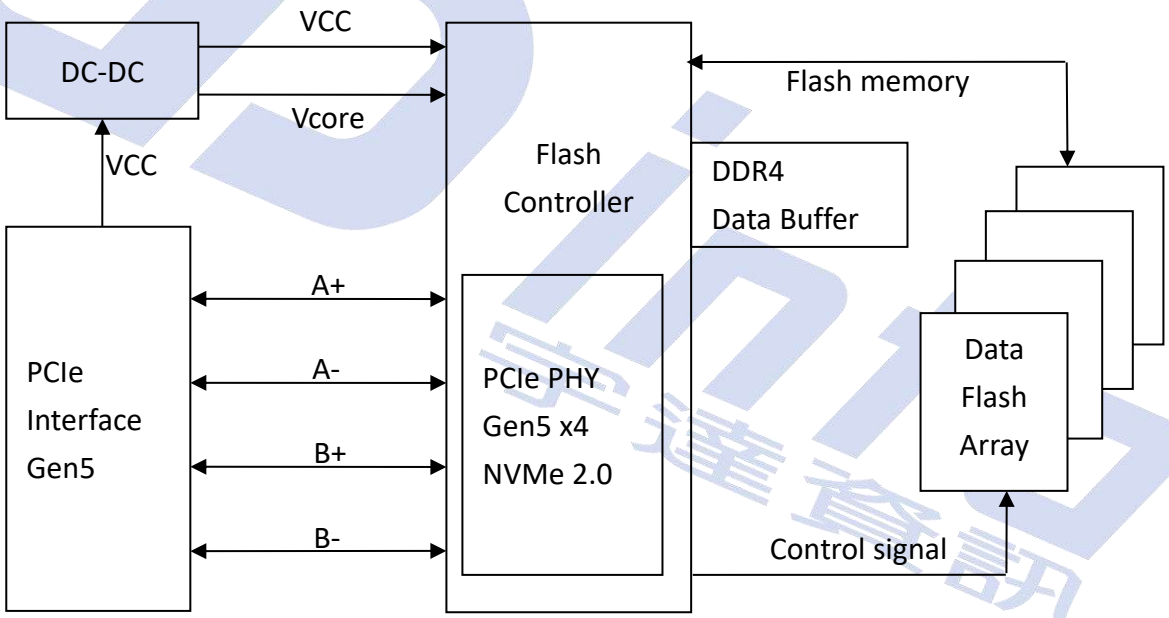
3. MTBF is a prediction simulation based on Telcordia SR-332 model.
4. Please see “TBW & DWPD” Chapter 2.7 for details.

1. INTRODUCTION

1.1. General Description

UDinfo's U.2 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. It's offers a wide range of capacities up to 32TB and its performance can reach up to 14,000 MB/s (for sequential read) and 8,500 MB/s (for sequential write) based on TLC NAND flash with the DDR4. Moreover, the power consumption of U.2 SSD is much lower than traditional hard drives, making it the best embedded solution for new platforms.

1.2. Block Diagram



U.2 PCIe SSD Block Diagram

1.3. Thermal Throttling

The purpose of thermal throttling is to prevent any components in a SSD from over-heating during read and write operations. The U.2 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.

Item	Description	CE Judgement
Stage 1 No TMT	Idle state for entering TMT1 or TMT2 Tflash ~ 76 °C	Full CE
Stage 2 TMT1	When flash temperature reaches TMT1 (77°C ~ 83°C), the drive will speed down to TMT1 with performance (< 7300MB/S)	
Stage 3 TMT2	When flash temperature reaches TMT2 (83°C ~ 85°C), the drive will speed down to TMT2 with performance (< 1700MB/S)	
Stage 4 TT Stable	To Keep TT stable within flash temp ~ 76°C. Would monitor temperature every second.	
TMT Protect	Turn off PMIC when flash temperature ≥ 85°C or controller temperature ≥ 115°C	
Fatal	Perform thermal shutdown process when flash temperature ≥ 85°C or controller temperature ≥ 115°C	
Resume TMT2 - TMT1	Tflash ≤ 75°C	Can only exit TT when temperature ≤ 75°C after enter TMT2. Will not change from TMT2 state to TMT 1 state
Resume TMT1 - Normal	Tflash ≤ 75°C	

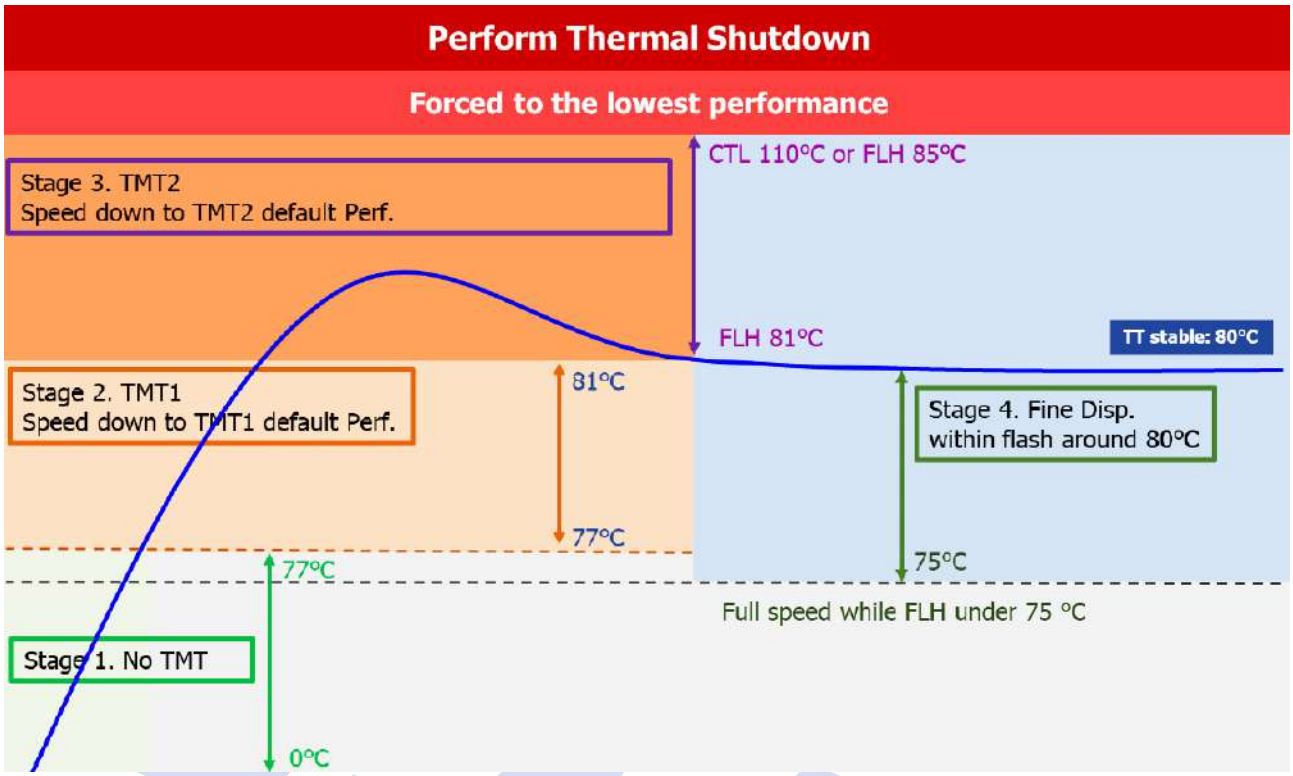


Figure 2-1 Thermal Throttling Schematic

Notes:

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

1.4. Advanced Device Security Features

1.4.1. Secure Erase

Secure Erase is a standard ATA 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.

1.4.2. Physical Presence SID (PSID)

Physical Presence SID (PSID) is defined by TCG as a 32-character string and the purpose is to revert SSD back to its manufacturing setting. PSID code is printed on an SSD label.

1.4.3. Crypto Erase

Crypto Erase (TCG) is a feature that erases all data of an OPAL-activated SSD 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.

1.4.4. TCG OPAL

Trusted Computing Group (TCG) provides a scalable infrastructure for managing encryption of user data in a Storage Device, as well as extensibility to enable feature. One set of capabilities defined in the Core Spec includes mechanisms for managing access control to user data stored on the Storage Device, including controlling media encryption, Key Management, and Read/Write Lock State.

1.4.5. IEEE1667

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 1-2 illustrates the types of Sanitize Operation supported.

Drive Security Type	AES-256 Encryption	Sanitize Operation			TCG Commands		IEEE 1667
		Overwrite	Block Erase	Crypto Erase	PSID Revert Process	Instant Security Erase	Windows eDrive
SED (TCG Opal)	Yes	No	Yes	Yes	Yes[1]	Yes[2]	Yes[3]
ISE	Yes	No	Yes	Yes	No	No	No

Notes:

1. Crypto Erase is a feature that erases all data of AES encrypted data structure by resetting the cryptographic key of the disk. The previously encrypted data will become irretrievable.
2. Instant Security Erase is a feature that erases all data of SED drive with Opal-activated encrypted data structure by reverting SSD with PSID. Since the key is reset, the previously encrypted data cannot be accessed anymore.

3. 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.

2. PRODUCT SPECIFICATIONS

2.1. Product Specifications

- 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, Version 0.7
- 256 IO queues supported (1 admin queue and 8 IO queue). Each IO queue support 8K entries

2.2. Device Capacity

Table 2-1 User Capacity and Addressable Sectors

DWPD = 1	User Addressable Sectors	Bytes per Sector
1,920GB	3,750,748,848	512 Byte
3,840GB	7,501,476,528	
7,680GB	15,002,931,888	
15,360GB	30,001,856,512	
30,720GB	60,001,615,872	
DWPD = 3	**User Addressable Sectors**	**Bytes per Sector**
1,600GB	3,125,627,568	512 Byte
3,200GB	6,251,233,968	
6,400GB	12,502,446,768	
12,800GB	25,000,148,992	
25,600GB	50,000,297,984	

Notes:

1. Gigabyte (GB) is equal to 1,000,000,000 Bytes; 1 sector is equal to 512 Bytes.
2. 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.
3. The count of User Addressable Sectors is calculated by the formula of IDEMA.

2.3. Performance

Table 2-2 15mm High Performance Sequential Read/Write and 4K Sustained Random Read/ Write Performance

Capacity	Model	Maximum Performance[Note1]			
		Sequential 128KB (QD=32, Workers=1)		4K Sustained Random (QD=128, Workers=8)	
		Read (MB/s)	Write (MB/s)	Read (IOPS)	Write (IOPS)
1,600GB	EMU2H	14,000	4,200	2,350,000	390,000
1,920GB	ERU2H	14,000	4,200	2,350,000	140,000
3,200GB	EMU2H	14,000	8,500	3,300,000	790,000
3,840GB	ERU2H	14,000	8,500	3,300,000	320,000
6,400GB	EMU2H	14,000	8,500	3,200,000	880,000
7,680GB	ERU2H	14,000	8,500	3,200,000	390,000
12,800GB	EMU2H	14,000	8,400	2,800,000	900,000
15,360GB	ERU2H	14,000	8,400	2,800,000	420,000
25,600GB	EMU2H	14,000	7,500	2,300,000	615,000
30,720GB	ERU2H	14,000	7,500	2,300,000	265,000

Notes:

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

2.4. Latency

Table 2-3 15mm High Performance 4KB Sustained Random Read/Write Latency

Capacity	Model	4K Sustained Random (QD=1, Workers=1)		4K Sustained Random (QD=8, Workers=4)	
		Read	Write	Read	Write
		µs	µs	µs	µs
1,600GB	EMU2H	60	9	70	100
1,920GB	ERU2H	60	9	70	250
3,200GB	EMU2H	60	9	70	50
3,840GB	ERU2H	60	9	70	110
6,400GB	EMU2H	60	9	70	50
7,680GB	ERU2H	60	9	70	100
12,800GB	EMU2H	60	9	70	50
15,360GB	ERU2H	60	9	70	100
25,600GB	EMU2H	65	9	70	60
30,720GB	ERU2H	65	10	70	130

Notes:

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

2.5. IOPS Consistency

Table 2-4 15mm High Performance 4KB Sustained Random Read/Write IOPS Consistency

Capacity	Model	4K Sustained Random (QD=1, Workers=1)		4K Sustained Random (QD=8, Workers=4)	
		Read	Write	Read	Write
		%	%	%	%
1,600GB	EMU2H	95	95	95	90
1,920GB	ERU2H	95	95	95	95
3,200GB	EMU2H	95	95	95	90
3,840GB	ERU2H	95	95	95	95
6,400GB	EMU2H	95	95	95	90
7,680GB	ERU2H	95	95	95	95
12,800GB	EMU2H	95	95	95	90
15,360GB	ERU2H	95	95	95	95
25,600GB	EMU2H	95	95	95	90
30,720GB	ERU2H	95	95	95	95

Notes:

1. Consistency Definition: (IOPS in the 99.9% 1-second interval) / (average IOPS during the test)
2. Performance was estimated based on TLC NAND flash.
3. Performance may differ according to flash configuration and platform.
4. The tables are for reference only. Any criteria for accepting goods shall be further discussed based on different flash configurations.

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

Table 2-5 15mm High Performance: 4KB Sustained Random Read/Write Quality of Service (QoS=99%), 1ms =1000us

Capacity	Model	Quality of Service (QoS=99%)			
		QD=1, Workers=1		QD=8, Workers=4	
		Read	Write	Read	Write
		µs	µs	µs	µs
1,600GB	EMU2H	70	10	140	120
1,920GB	ERU2H	70	10	140	250
3,200GB	EMU2H	70	10	130	120
3,840GB	ERU2H	70	10	130	150
6,400GB	EMU2H	70	10	120	120
7,680GB	ERU2H	70	10	120	120
12,800GB	EMU2H	70	10	120	120
15,360GB	ERU2H	70	10	120	120
25,600GB	EMU2H	70	10	120	120
30,720GB	ERU2H	70	10	120	150

Table 2-6 15mm High Performance: 4KB Sustained Random Read/Write Quality of Service (QoS=99.99%), 1ms =1000us

Capacity	Model	Quality of Service (QoS=99.99%)			
		QD=1, Workers=1		QD=8, Workers=4	
		Read	Write	Read	Write
		µs	µs	µs	µs
1,600GB	EMU2H	75	13	240	500
1,920GB	ERU2H	75	13	240	500
3,200GB	EMU2H	75	13	200	500
3,840GB	ERU2H	75	13	200	500
6,400GB	EMU2H	75	13	180	500
7,680GB	ERU2H	75	13	180	500
12,800GB	EMU2H	75	13	160	500
15,360GB	ERU2H	75	13	160	500
25,600GB	EMU2H	75	13	160	500
30,720GB	ERU2H	75	13	160	500

Notes:

1. Performance was estimated based on TLC NAND flash.

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

2.7. Reliability

2.7.1. TBW (Terabytes Written) and DWPD (Drive Write Per Day)

Capacity	Flash Structure	Flash Type	TBW	DWPD
1,600GB	256GB x8, 512Gb, QDP, 32CE	3D TLC	8,760	3
1,920GB	256GB x8, 512Gb, QDP, 32CE	3D TLC	3,504	1
3,200GB	256GB x16, 512Gb, QDP, 64CE	3D TLC	17,520	3
3,840GB	256GB x16, 512Gb, QDP, 64CE	3D TLC	7,008	1
6,400GB	512GB x16, 512Gb, ODP, 128CE	3D TLC	35,040	3
7,680GB	512GB x16, 512Gb, ODP, 128CE	3D TLC	14,016	1
12,800GB	512GB x32, 512Gb, ODP, 128CE	3D TLC	70,080	3
15,360GB	512GB x32, 512Gb, ODP, 128CE	3D TLC	28,032	1
25,600GB	1TB x32, 512Gb, HDP, 128CE	3D TLC	140,160	3
30,720GB	1TB x32, 512Gb, HDP, 128CE	3D TLC	56,064	1

Notes:

1. TBW is measured by JEDEC 219A Enterprise workload.
2. TBW may differ according to flash configuration and platform.
3. DWPD is calculated based on 5-year lifetime.

2.7.2. UBER

Capacity	UBER
1,600GB/1,920GB ~ 25,600GB/30,720GB	< 1 sector per 10^{18} bits read

Notes:

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

2.7.3. MTBF

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

Description	Value
Mean Time Between Failures	2.5 million hours

2.8. Weight

Table 2-7 15mm Weight

Capacity	Flash Structure	Weight (g)
1,600GB	256GB x8, 512Gb, QDP, 32CE	188
1,920GB	256GB x8, 512Gb, QDP, 32CE	188
3,200GB	256GB x16, 512Gb, QDP, 64CE	199
3,840GB	256GB x16, 512Gb, QDP, 64CE	199
6,400GB	512GB x16, 512Gb, ODP, 128CE	201
7,680GB	512GB x16, 512Gb, ODP, 128CE	201
12,800GB	512GB x32, 512Gb, ODP, 128CE	168
15,360GB	512GB x32, 512Gb, ODP, 128CE	168
25,600GB	1TB x32, 512Gb, HDP, 128CE	169
30,720GB	1TB x32, 512Gb, HDP, 128CE	169

3. ENVIRONMENTAL SPECIFICATIONS

3.1. Environmental Conditions

3.1.1. Temperature and Humidity

Temperature	Operation	0°C to 70°C
	Non-operation	-40°C to 85°C
Relative Humidity	Operation	5% to 95%
	Non-operation	5% to 95%

3.1.2. Shock

Shock	Operation	500G	2ms
		1000G	0.5ms
	Non-operation	500G	2ms
		1000G	0.5ms

3.1.3. Vibration

Vibration	Operation	7 ~ 800 Hz	2.17 Grms
	Non-operation	10 ~ 2000 Hz	16.3 Grms
		2 ~ 5 ~ 500Hz	0.4G / 3G

3.1.4. Altitude

Altitude	Operation	0 to 18,000 feet
	Non-operation	0 to 40,000 feet

3.1.5. Electrostatic Discharge (ESD)

Specification	+/- 4KV
EN 55035, 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.

3.1.6. EMI Compliance

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

4. ELECTRICAL SPECIFICATIONS

4.1. Supply Voltage

Parameter	Rating
12V Operating Voltage	12V ± 10%
12V Noise Level	240mV$_{p-p}$, 0 ~ 20MHz
12V Min. off Time[Note1]	500ms
3.3V Aux	3.3V +5%/-10%

Notes:

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

4.2. Power Consumption

Form Factor	Capacity	Read (max.)	Write (max.)	Idle (max.)
15mm High Performance	1,600GB	16	16	5
	1,920GB	16	16	5
	3,200GB	18	22	5
	3,840GB	17	22	5
	6,400GB	20	23	5
	7,680GB	20	23	5
	12,800GB	21	24	5
	15,360GB	22	24	5
	25,600GB	23	25	5
	30,720GB	23	25	5

Unit: W

Notes:

1. Power consumption is measured on full speed mode.
2. Power consumption may differ according to flash configuration, use condition, environment and platform.

4.3. Inrush Current

Operating Voltage	Inrush Current	
	1,600GB ~ 15,360GB	25,600GB / 30,720GB
12V	2.5A	3A

5. INTERFACE

5.1. Pin Assignment and Descriptions

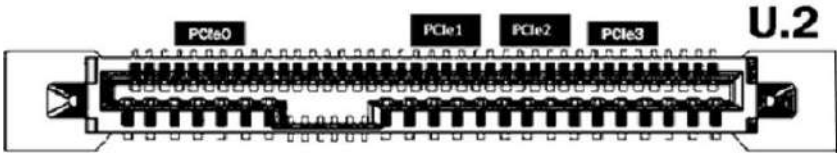


Table 5-1 Pin Assignment and Descriptions.

Pin #	Name	Type	Description
P1	WAKE#	Input	Reserved
P2	Reserved	Reserved	Reserved
P3	PWRDIS	Output	Power disable
P4	IfDet#	Input	Interface Type Detect
P5	Ground	Ground	Ground
P6	Ground	Ground	Ground
P7	+5V	Power	Reserved
P8	+5V	Power	Reserved
P9	+5V	Power	Reserved
P10	PRSNT#	Input	Presence detect
P11	Activity#	Input	Activity indicator
P12	Ground	Ground	Ground
P13	+12V Precharge	Power	+12V Precharge power
P14	+12V	Power	+12V for SFF-8639 power
P15	+12V	Power	+12V for SFF-8639 power
SG1	Ground	Ground	Ground
SG2	Ground	Ground	Ground
S1	Ground	Ground	Ground
S2	NC	NC	NC
S3	NC	NC	NC
S4	Ground	Ground	Ground
S5	NC	NC	NC
S6	NC	NC	NC
S7	Ground	Ground	Ground
S8	Ground	Ground	Ground

Pin #	Name	Type	Description
S9	NC	NC	NC
S10	NC	NC	NC
S11	Ground	Ground	Ground
S12	NC	NC	NC
S13	NC	NC	NC
S14	Ground	Ground	Ground
S15	HPT0	Output	Host port type-0
S16	Ground	Ground	Ground
S17	U.2 TX p1	Diff-Pair	Transmitter differential pair, U.2 Lane 1
S18	U.2 TX n1	Diff-Pair	Transmitter differential pair, U.2 Lane 1
S19	Ground	Ground	Ground
S20	U.2 RX n1	Diff-Pair	Receiver differential pair, U.2 Lane 1
S21	U.2 RX p1	Diff-Pair	Receiver differential pair, U.2 Lane 1
S22	Ground	Ground	Ground
S23	U.2 TX p2	Diff-Pair	Transmitter differential pair, U.2 Lane 2
S24	U.2 TX n2	Diff-Pair	Transmitter differential pair, U.2 Lane 2
S25	Ground	Ground	Ground
S26	U.2 RX n2	Diff-Pair	Receiver differential pair, U.2 Lane 2
S27	U.2 RX p2	Diff-Pair	Receiver differential pair, U.2 Lane 2
S28	Ground	Ground	Ground
E1	REFCLKB+	Diff-Pair	Reference clock (differential pair) for second X2 port
E2	REFCLKB-	Diff-Pair	Reference clock (differential pair) for second X2 port
E3	+3.3 Vaux	Power	3.3 V auxiliary power
E4	CLKREQ#/PERSTB#	Bi-dir	Clock request/Fundamental reset for second x2 port
E5	PERST#	Output	Fundamental reset (if Single Port mode enabled, first x2 port)
E6	IFDet2#	Input	Interface Type Detect
E7	REFCLK+	Diff-Pair	Reference clock (if dual-port enabled, first X2 port)
E8	REFCLK-	Diff-Pair	Reference clock (if dual-port enabled, first X2 port)
E9	Ground	Ground	Ground
E10	U.2 TX p0	Diff-Pair	Transmitter differential pair, U.2 Lane 0
E11	U.2 TX n0	Diff-Pair	Transmitter differential pair, U.2 Lane 0
E12	Ground	Ground	Ground
E13	U.2 RX n0	Diff-Pair	Receiver differential pair, U.2 Lane 0
E14	U.2 RX p0	Diff-Pair	Receiver differential pair, U.2 Lane 0
E15	Ground	Ground	Ground

Pin #	Name	Type	Description
E16	HPT1	Output	Host port type
E17	U.2 TX p3	Diff-Pair	Transmitter differential pair, U.2 Lane 3
E18	U.2 TX n3	Diff-Pair	Transmitter differential pair, U.2 Lane 3
E19	Ground	Ground	Ground
E20	U.2 RX n3	Diff-Pair	Receiver differential pair, U.2 Lane 3
E21	U.2 RX p3	Diff-Pair	Receiver differential pair, U.2 Lane 3
E22	Ground	Ground	Ground
E23	SMCLK	Bi-Dir	SMBus (System Management Bus) clock
E24	SMDAT	Bi-Dir	SMBus (System Management Bus) data
E25	DualPortEn#	Output	Dual-port Enable

6. SUPPORTED COMMANDS

6.1. NVMe Command List

Table 6-1 Admin Commands

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 Features
0Ah	M	Y	Get Features
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 6-2 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 6-3 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 6-4 Get Log Page Commands

Identifier	O/M	Supported	Command Description
00h	O	Y	Reserved
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
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 6-5 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
0Dh - BFh	O	-	Reserved
C0h - FFh	O	-	Vendor Specific

Notes:

1. “Y” means “Support”.
2. “O” means “Option, default No support”.
3. “-” means “No support”.

Table 6-6 SMBus / I^2C Elements Supported

SMBus / I^2C Element	SMBus / I^2C Address(8bit)	
	Hex Format	Binary Format
FRU Information Device	A6h	1010_011xb

(for NVMe Storage Device)		
SMBus / I^2C Management Endpoint	3Ah	0011_101xb
Basic Management Command	D4h	1101_010xb

6.2. Identify Device Command

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

Table 6-7 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 Level support bitmap (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	-	Refer to 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

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

Bytes	O/M	Description	Default Value
511:356	-	Reserved	0x00

Table 6-8 NVM Command Set Attributes

Bytes	O/M	Description	Default Value
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 Namespace (MNAN)	0x00000000
767:544	M	Reserved	0x00
1023:768	M	NVM Subsystem NVMe Qualified Name (SUBNQN)	TBD

Table 6-9 IO Command Set Attributes

Bytes	O/M	Description	Default Value
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

Bytes	O/M	Description	Default Value
Bit[127:125]		Reserved	0x0
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

Bytes	O/M	Description	Default Value
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
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

Bytes	O/M	Description	Default Value
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

Bytes	O/M	Description	Default Value
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

Bytes	O/M	Description	Default Value
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
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 State26 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

Table 6-10 IO Vendor Specific

Bytes	O/M	Description	Default Value
4095:3072	O	Vendor Specific (VS)	Vendor Reserved

Notes:

***** The OUI shall be a valid IEEE/RAC assigned identifier that may be registered at

http://standards.ieee.org/develop/regauth/oui/public.html.

****** Depends on the using of capacity

Table 6-11 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 IO 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
69:68	O	Namespace Preferred Deallocation(Trim) Granularity (NPDG)	0x0000, 4K LBA size 0x0007, 512B LBA size
71:70	O	Namespace Preferred Deallocation(Trim) 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 Groput Identifier (ANAGRPID)	0x00000000

Bytes	O/M	Description	Default Value
98:96	-	Reserved	
99	O	Namespace Attributes (NSATTR)	0x00
101:100	O	NVM Set Identifier (NVMSETID)	0x0000
103:102	O	Endurange Group Identifier // NVMe 1.4 add (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:

* According to IDEMA SPEC

** According to IEEE EUI-64 SPEC

- **List of Identify Namespace Data Structure for Each Capacity**

Capacity (GB)	Byte[7:0]: Namespace Size (NSZE)
1,600GB	BA4D4AB0h
1,920GB	DF8FE2B0h
3,200GB	1749A42B0h
3,840GB	1BF1F72B0h
6,400GB	2E93432B0h

7,680GB	37E3E92B0h
12,800GB	5D2200000h
15,360GB	6FC400000h
25,600GB	BA4400000h
30,720GB	DF8600000h
12,800GB	5D26812B0h
15,360GB	6FC7CD2B0h
25,600GB	BA4CFD2B0h
30,720GB	DF8F952B0h

6.3. SMART Attributes

Table 6-12 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 6-13 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
[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 6-14 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 Block Count
[82:79]	4	Total Later Bad Block 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
[110:96]	8	Read Move Table Count
[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 Count
[138:135]	4	D2/D3 Average Erase Count
[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

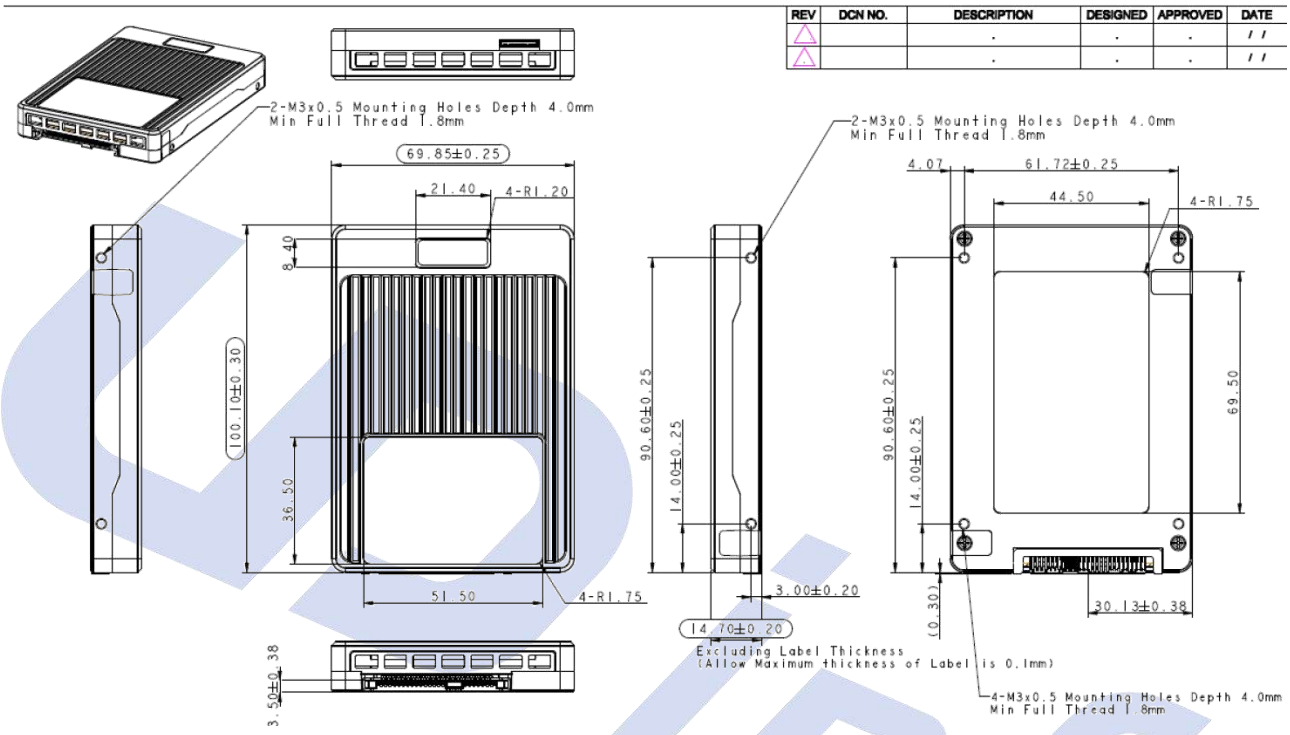
Bytes Index	Bytes	Description
[180:173]	8	Flash UNC Error Count
[184:181]	4	HB retry count
[188:185]	4	SB retry count
[190:189]	2	Previous Average Erase Count
[194:191]	4	Power CAP init error count
[198:195]	4	Data RAID ECC Recovery Success
[202:199]	4	Data RAID ECC Recovery Failed
[206:203]	4	Table 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

Bytes Index	Bytes	Description
[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
[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

7. PHYSICAL DIMENSION

Figure 7-1 shows the case mechanical information of U.2 15mm form factor.

Figure 7-1 U.2 15mm Mechanical information



Unit: mm

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.

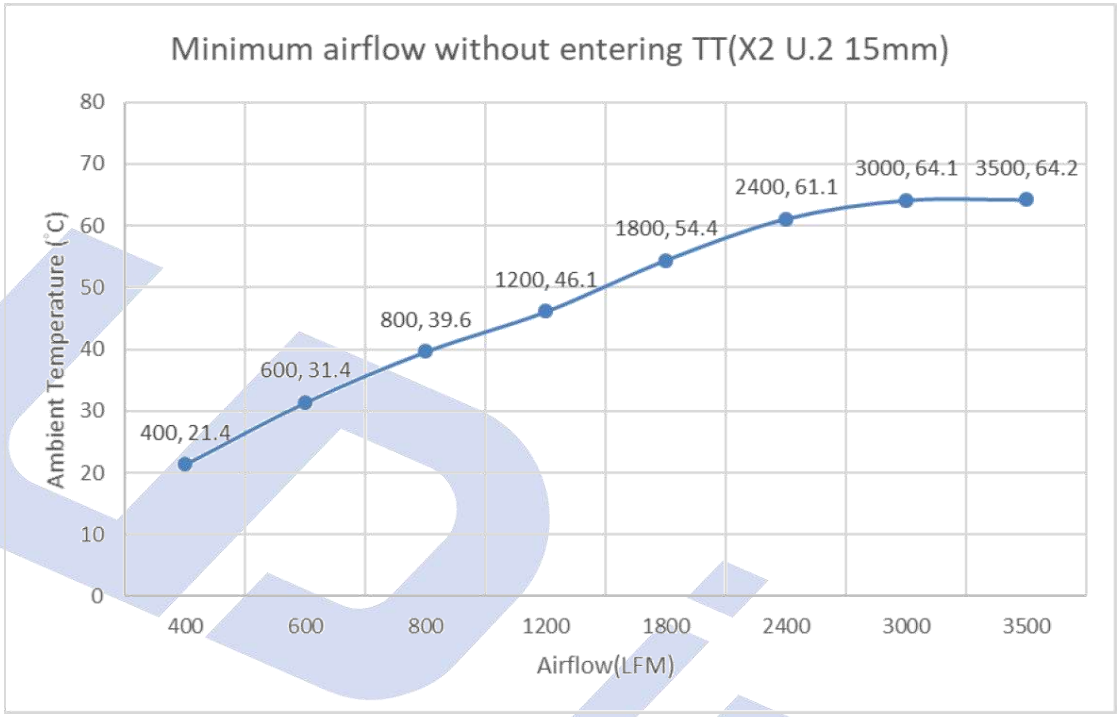


Figure 8-1 U.2 15mm Airflow Curve

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: 900secs

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
       a. IO Depth = 1
       b. Number of jobs = 1
    3. RND 4k write/read Q8T4
       a. IO Depth = 8
       b. Number of jobs = 4

9.2.3. Latency 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
       a. IO Depth = 1
       b. Number of jobs = 1
    3. RND 4k write/read Q8T4
       a. IO Depth = 8
       b. Number of jobs = 4

9.2.4. QoS 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
       a. IO Depth = 1
       b. Number of jobs = 1
    3. RND 4k write/read Q8T4
       a. IO Depth = 8
       b. Number of jobs = 4

- 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 10^{th}
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

- 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
    1. Pre-con - 300% 4K random. write to full disk
    2. 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/32T 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 = 32
       b. Number of jobs = 1
    2. Test script (100% seq. write / 100% seq. read)
       a. IO Depth = 32

b. Number of jobs = 1
c. Test duration: 900secs (for each performance)

- 4k random write/read
  1. Pre-con - 300% 4K random. write to full disk
  2. Test script
     100% ran. write / 100% ran. read / 70% ran. read + 30% ran write / 30% ran. read + 70% ran write
     a. IO Depth = 32
     b. Number of jobs = 8
     c. Test duration: 900secs (for each performance)

- Data collection procedure - Max Average (over 500ms duration)
  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 samples of each 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 each condition.
  d) Note the largest value as the peak.
  e) 3pcs samples of each capacity.

- Data collection procedure - Power on
  a) Run power on procedure until drive is ready to use.
  b) Measure power to get Average RMS power and maximum peak current.
  c) 3pcs samples of each capacity.

- Data collection procedure - Idle
  a) After completing each condition, Idle for 30 seconds.
  b) Do nothing and measure power to get Average RMS Idle power.
  c) 3pcs samples of each capacity.

10. VITAL PRODUCT DATA

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. PART NUMBER DECODER

X^1	X^2	X^3	X^4	X^5	-	X^6	X^7	X^8	X^9	X^{10}	X^{11}	X^{12}	-	X^{13}	X^{14}	X^{15}	-	X^{16}	X^{17}
E	R	U	2	H	-	E	D	3	0	T	7	B	-	E	L	P			

X^1

E: PCIe SSD

X^2

R: Read intensive workload (DWPD 1)

M: Mix workload (DWPD 3)

X^3X^4

U2: U.2

X^5

H: 15mm Height

X^6X^7

ED: Single Port

EF: Dual Port

$X^8X^9X^{10}X^{11}X^{12}$

1600G: 1600GB	6400G: 6400GB	25T6B: 25600GB
1920G: 1920GB	7680G: 7680GB	30T7B: 30720GB
3200G: 3200GB	12T8B: 12800GB	
3840G: 3840GB	15T3B: 15360GB	

X^{13}

E: 3D eTLC Standard (0ºC ~ +70ºC)

X^{14}

L: Gen5 x4

X^{15}

P: PCB version

$X^{16}X^{17}$

Blank: Standard