

UD info Corp.

Enterprise PCIe U.2/U.3 SSD

EA Series

Product DataSheet



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Revision History

Revision	Draft Date	History	Author
1.0	2023/5/3	New release	Golden Lee
1.1	2023/8/4	Update Performance/Power consumption	Golden Lee



Product Overview

- **Capacity**
 - OP=7%:
1920/3840/7680/15360/30720 GB
 - OP=28%:
800/1600/3200/6400/12800/25600 GB
- **Form Factor**
 - U.2/U.3 15mm
 - U.2/U.3 7mm
- **PCIe Interface**
 - PCIe Gen4 x4
 - Single Port x4 lanes/Single 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% and 99.999%)^{Note1}
- **Power Consumption**^{Note2}
 - Active Power: 25 W
 - Inrush Current: 1.5A
 - Idle Power: 6.0 W / 8.0 W (16T)
- **Reliability**
 - MTBF^{Note3}: 2.5 million hours
 - UBER: < 1 sector per 10¹⁸ bits
 - TBW^{Note4}
 - DWPD^{Note4}
 - 1 DWPD:
1920, 3840, 7680, 15360, 30720 GB
 - 3 DWPD:
800, 1600, 3200, 6400, 12800,
25600 GB
- **Advanced Flash Management**
 - ECC
 - Static and Dynamic Wear Leveling
 - Bad Block Management
 - Deallocate (TRIM) Command
 - SMART
 - Over-Provision
- **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
 - Reservation
 - Metadata Protection Thermal throttling
 - Power Loss Protection
- **Hardware AES-XTS 256-bit Encryption**
- **TCG OPAL support**
- **Support SMBus**
- **Support NVMe-MI (Management Interface)**
- **Physical Dimension**
 - U.2/U.3 15mm 100(L) x 70(W) x 15(H)mm
 - U.2/U.3 7mm 100(L) x 70(W) x 7(H)mm
- **Data Retention – 3 months**
- **Compliance**
 - PCIe Express Base 4.0
 - NVMe Express 1.4
 - NVMe Express Management Interface Rev 1.1

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 3.2 for details.

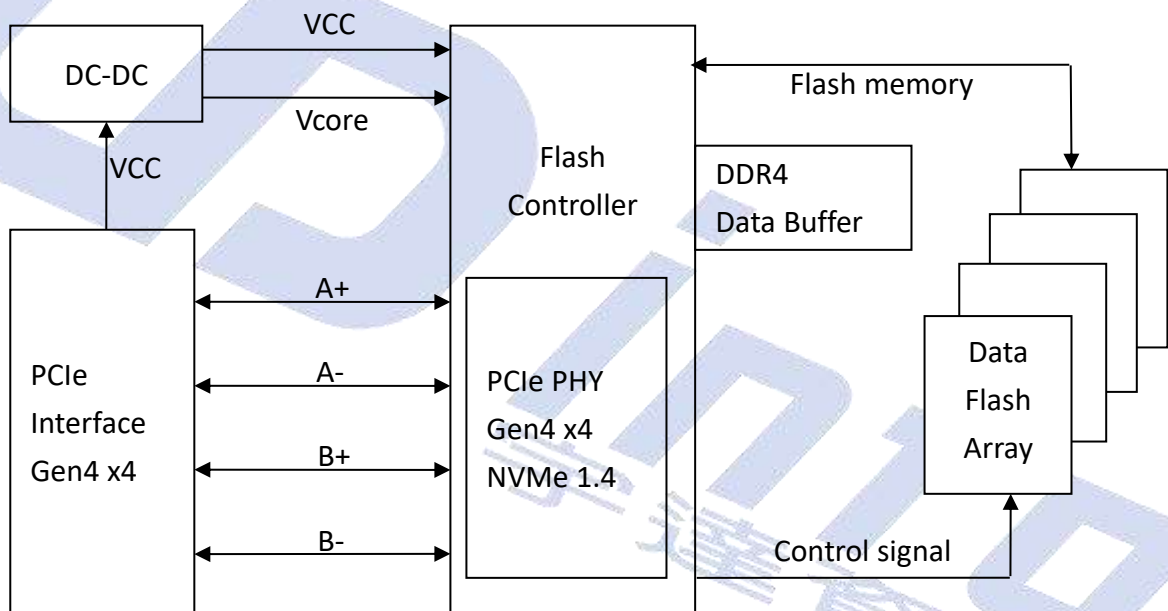


1. INTRODUCTION

1.1. General Description

UDinfo's U.2/U.3 Solid State Disk (SSD) delivers all the advantages of flash disk technology with PCIe Gen4 x4 interface, including being fully compliant with standard U.2/U.3 form factor, providing low power consumption compared to traditional hard drive and hot-swapping when removing/replacing/upgrading flash disks. It's offer a wide range of capacities up to 30,720GB and performance can reach up to 7000 MB/s (for sequential read) and 7000 MB/s (for sequential write) based on eTLC NAND flash with the DDR4. Moreover, the power consumption of U.2/ U.3 SSD is much lower than traditional hard drives, making it the best embedded solution for new platforms.

1.2. Block Diagram



U.2/U.3 PCIe SSD Block Diagram

2. PRODUCT SPECIFICATIONS

2.1. Product Specifications

- PCIe Interface
- Compliant with NVMe 1.4
- PCI Express Base Ver 4.0
- PCIe Gen4 x 4 lane & backward compatible to PCIe Gen3, Gen2 and Gen1
- PCIe Express SFF-8639 Module Specification Revision 4.0, Version1.0, SFF-TA-1001 r1.1

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	30,005,842,608	
30,720GB	60,011,664,048	
DWPD = 3	User Addressable Sectors	Bytes per Sector
800GB	1,562,824,368	512 Byte
1,600GB	3,125,627,568	
3,200GB	6,251,233,968	
6,400GB	12,502,446,768	
12,800GB	25,004,872,368	
25,600GB	50,009,723,568	

Notes:

1. 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	Flash Structure	Maximum Performance ^{Note1}			
		Sequential 128KB (QD=32, Workers=1)		4K Sustained Random (QD=64, Workers=8)	
		Read (MB/s)	Write (MB/s)	Read (IOPS)	Write (IOPS)
800GB	256GB x4, QDP, 16CE	7,000	1,800	1,000,000	130,000
1,600GB	256GB x8, QDP, 32CE	7,000	3,500	1,600,000	280,000
1,920GB	256GB x8, QDP, 32CE	7,000	3,500	1,600,000	95,000
3,200GB	256GB x16, QDP, 64CE	7,000	6,700	1,600,000	430,000
3,840GB	256GB x16, QDP, 64CE	7,000	6,700	1,600,000	170,000
6,400GB	512GB x16, ODP, 128CE	7,000	6,800	1,600,000	450,000
7,680GB	512GB x16, ODP, 128CE	7,000	6,800	1,600,000	180,000
12,800GB	512GB x32, ODP, 128CE	7,000	6,800	1,600,000	480,000
15,360GB	512GB x32, ODP, 128CE	7,000	6,800	1,600,000	180,000
25,600GB	1TB x32, HDP, 128CE	7,000	6,000	1,600,000	450,000
30,720GB	1TB x32, HDP, 128CE	7,000	6,000	1,600,000	180,000

Notes:

1. Performance was estimated based on eTLC 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	Flash Structure	4K Sustained Random (QD=1, Workers=1)		4K Sustained Random (QD=32, Workers=1)		4K Sustained Random (QD=64, Workers=8)	
		Read	Write	Read	Write	Read	Write
		μs	μs	μs	μs	μs	μs
800GB	256GB x4, QDP, 16CE	90	15	100	280	560	4,500
1,600GB	256GB x8, QDP, 32CE	90	15	100	130	320	2,000
1,920GB	256GB x8, QDP, 32CE	90	15	100	350	320	5,600
3,200GB	256GB x16, QDP, 64CE	90	15	100	80	320	1,250
3,840GB	256GB x16, QDP, 64CE	90	15	100	200	320	3,150
6,400GB	512GB x16, ODP, 128CE	90	15	100	80	320	1,250
7,680GB	512GB x16, ODP, 128CE	90	15	100	200	320	3,150
12,800GB	512GB x32, ODP, 128CE	90	15	100	80	320	1,100
15,360GB	512GB x32, ODP, 128CE	90	15	100	180	320	2,800
25,600GB	1TB x32, HDP, 128CE	90	15	100	90	320	1,250
30,720GB	1TB x32, HDP, 128CE	90	15	100	200	320	3,150

Notes:

1. Performance was estimated based on eTLC 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	Flash Structure	4K Sustained Random (QD=1, Workers=1)		4K Sustained Random (QD=32, Workers=1)		4K Sustained Random (QD=64, Workers=8)	
		Read	Write	Read	Write	Read	Write
		%	%	%	%	%	%
800GB	256GB x4, QDP, 16CE	95	95	95	95	95	95
1,600GB	256GB x8, QDP, 32CE	95	95	95	95	95	95
1,920GB	256GB x8, QDP, 32CE	95	95	95	95	95	95
3,200GB	256GB x16, QDP, 64CE	95	95	95	95	95	95
3,840GB	256GB x16, QDP, 64CE	95	95	95	95	95	95
6,400GB	512GB x16, ODP, 128CE	95	95	95	95	95	95
7,680GB	512GB x16, ODP, 128CE	95	95	95	95	95	95
12,800GB	512GB x32, ODP, 128CE	95	95	95	95	95	95
15,360GB	512GB x32, ODP, 128CE	95	95	95	95	95	95
25,600GB	1TB x32, HDP, 128CE	95	95	95	95	95	95
30,720GB	1TB x32, HDP, 128CE	95	95	95	95	95	95

Notes:

1. Consistency Definition: $100 - [(mean_IOPS - min_IOPS) / mean_IOPS]$
2. Performance was estimated based on eTLC 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%)

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

Capacity	Flash Structure	4KB Sustained Random Read/Write Quality of Service (QoS=99%)					
		QD=1, Workers=1		QD=32, Workers=1		QD=64, Workers=8	
		Read	Write	Read	Write	Read	Write
		μs	μs	μs	μs	μs	μs
800GB	256GB x4, QDP, 16CE	100	12	200	280	2,400	4,500
1,600GB	256GB x8, QDP, 32CE	100	12	160	130	1,000	2,000
1,920GB	256GB x8, QDP, 32CE	100	12	160	350	1,000	5,700
3,200GB	256GB x16, QDP, 64CE	100	12	140	100	600	2,000
3,840GB	256GB x16, QDP, 64CE	100	12	140	200	600	3,200
6,400GB	512GB x16, ODP, 128CE	100	12	130	100	600	1,800
7,680GB	512GB x16, ODP, 128CE	100	12	130	200	600	3,200
12,800GB	512GB x32, ODP, 128CE	100	12	120	80	600	1,600
15,360GB	512GB x32, ODP, 128CE	100	12	120	200	600	3,000
25,600GB	1TB x32, HDP, 128CE	100	12	120	110	600	1,600
30,720GB	1TB x32, HDP, 128CE	100	12	120	200	600	3,200

Notes:

1. Performance was estimated based on eTLC 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. Weight

Table 2-6 15mm Weight

Capacity	Flash Structure	Weight (g)
800GB	256GB x4, 512Gb, QDP, 16CE	197
1,600GB	256GB x8, 512Gb, QDP, 32CE	198
1,920GB	256GB x8, 512Gb, QDP, 32CE	198
3,200GB	256GB x16, 512Gb, QDP, 64CE	200
3,840GB	256GB x16, 512Gb, QDP, 64CE	200
6,400GB	512GB x16, 512Gb, ODP, 128CE	203
7,680GB	512GB x16, 512Gb, ODP, 128CE	203
12,800GB	512GB x32, 512Gb, ODP, 128CE	205
15,360GB	512GB x32, 512Gb, ODP, 128CE	205
25,600GB	1TB x32, 512Gb, HDP, 128CE	208
30,720GB	1TB x32, 512Gb, HDP, 128CE	208



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

	Type	Acceleration	Pulse Duration
Shock	Operation	500G	2ms
		1000G	1000ms
	Non-operation	500G	2ms
		1000G	1000ms

3.1.3. Vibration

	Type	Frequency	Amplitude
Vibration	Operation	200 ~ 2000 Hz	2.17 Grms
	Non-operation	10 ~ 2000 Hz	16.3 Grms
		2 ~ 5 ~ 500Hz	3 Grms

3.1.4. Altitude

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

3.2. TBW (Terabytes Written) and DDPD (Drive Write Per Day)

Capacity	Flash Structure	Flash Type	TBW	DDPD
800GB	256GB x4, 512Gb, QDP, 16CE	3D eTLC	4,380	3
1,600GB	256GB x8, 512Gb, QDP, 32CE	3D eTLC	8,760	3
1,920GB	256GB x8, 512Gb, QDP, 32CE	3D eTLC	3,504	1
3,200GB	256GB x16, 512Gb, QDP, 64CE	3D eTLC	17,520	3
3,840GB	256GB x16, 512Gb, QDP, 64CE	3D eTLC	7,008	1
6,400GB	512GB x16, 512Gb, ODP, 128CE	3D eTLC	35,040	3
7,680GB	512GB x16, 512Gb, ODP, 128CE	3D eTLC	14,016	1
12,800GB	512GB x32, 512Gb, ODP, 128CE	3D eTLC	70,080	3
15,360GB	512GB x32, 512Gb, ODP, 128CE	3D eTLC	28,032	1
25,600GB	1TB x32, 512Gb, HDP, 128CE	3D eTLC	140,160	3
30,720GB	1TB x32, 512Gb, HDP, 128CE	3D eTLC	56,064	1

Notes:

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

3.3. Power On/Off Cycles

The definition of power on/off cycles is that the power is withdrawn from the SSD device, and then restored. The test is to simulate the behavior that SSD still can be restored and active normally when host platforms go into suspend and shutdown.

During the Power On/Off cycles test, the SSD can be protective if the SSD encounters 24 times of power on/off per day within warranty period.

3.4. UBER

Capacity	UBER
800GB	$< 1 \text{ sector per } 10^{18} \text{ bits read}$
1,600GB	
1,920GB	
3,200GB	
3,840GB	
6,400GB	
7,680GB	
12,800GB	
15,360GB	
25,600GB	
30,720GB	

Notes:

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

3.5. 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

4. ELECTRICAL SPECIFICATIONS



4.1. Supply Voltage

Parameter	Rating
Operating Voltage	12V ± 10%
Noise Level	240mV _{p-p} , 0 ~ 20MHz
Min. off Time ^{Note1}	500ms
3.3V Aux	3.3V ± 15%

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	Random Read(Typ.,W)	Random Write(Typ.,W)	Sequential Read(Typ.,W)	Sequential Write(Typ.,W)	Idle (Typ.,W)
15mm High Performance	800GB	8.8	8.7	9.2	8.3	4.90
	1,600GB	12.8	12.5	10.4	13.3	5.51
	1,920GB	12.4	11.9	10.1	12.8	5.46
	3,200GB	13.8	16.4	11.0	18.3	5.83
	3,840GB	13.3	15.5	10.6	17.9	5.80
	6,400GB	15.9	17.8	11.9	19.9	5.88
	7,680GB	15.7	17.4	11.6	19.1	5.75
	12,800GB	16.5	20.2	12.6	20.8	7.43
	15,360GB	16.2	19.6	12.3	20.1	7.32
	25,600GB	17.5	21.1	13.7	21.9	8.42
30,720GB	17.2	20.7	13.4	21.2	8.36	

Unit: W

Notes:

1. Power consumption is measured on full speed mode.

4.3. Inrush Current

Operating Voltage	Inrush Current
12V	1.5A

5. INTERFACE



5.1. Pin Assignment and Descriptions

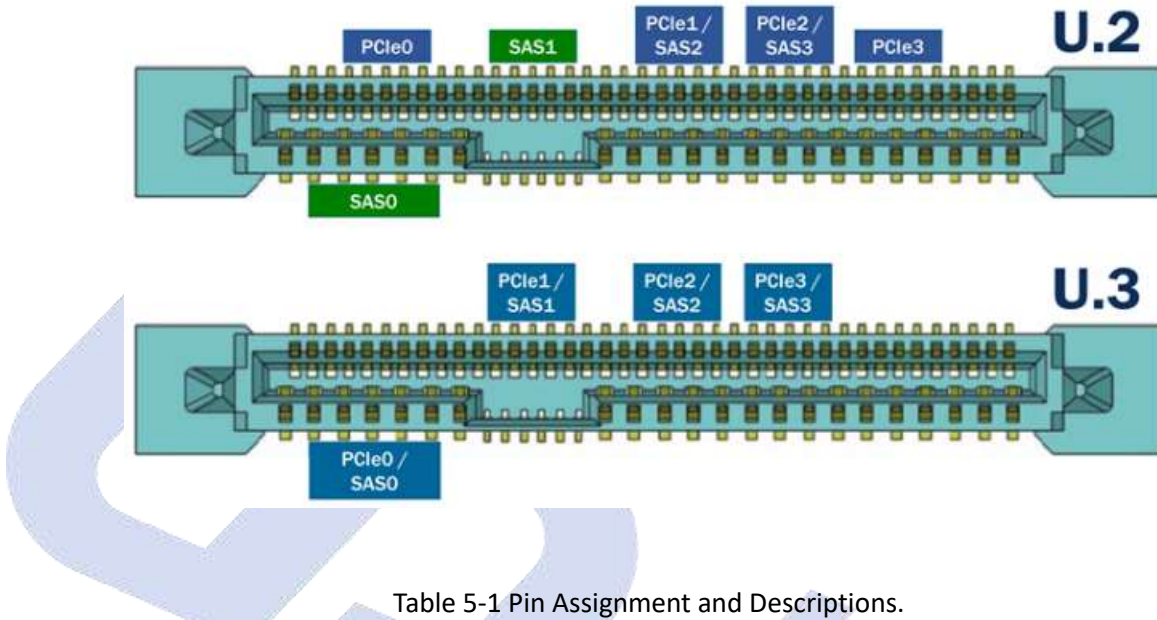


Table 5-1 Pin Assignment and Descriptions.

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 power
P15	+12V	Power	+12V power
SG1	Ground	Ground	Ground
SG2	Ground	Ground	Ground
S1	Ground	Ground	Ground

Pin #	Name	Type	Description
S2	U.3 TX p0	Diff-Pair	Transmitter differential pair, U.3 Lane 0
S3	U.3 TX n0	Diff-Pair	Transmitter differential pair, U.3 Lane 0
S4	Ground	Ground	Ground
S5	U.3 RX n0	Diff-Pair	Receiver differential pair, U.3 Lane 0
S6	U.3 RX p0	Diff-Pair	Receiver differential pair, U.3 Lane 0
S7	Ground	Ground	Ground
S8	Ground	Ground	Ground
S9	U.3 TX p1	Diff-Pair	Transmitter differential pair, U.3 Lane 1
S10	U.3 TX n1	Diff-Pair	Transmitter differential pair, U.3 Lane 1
S11	Ground	Ground	Ground
S12	U.3 RX n1	Diff-Pair	Receiver differential pair, U.3 Lane 1
S13	U.3 RX p1	Diff-Pair	Receiver differential pair, U.3 Lane 1
S14	Ground	Ground	Ground
S15	HPT0	Output	Host port type
S16	Ground	Ground	Ground
S17	U.3 TX p2 / U.2 TX p1	Diff-Pair	Transmitter differential pair, U.3 Lane 2, or U.2 Lane 1
S18	U.3 TX n2 / U.2 TX n1	Diff-Pair	Transmitter differential pair, U.3 Lane 2, or U.2 Lane 1
S19	Ground	Ground	Ground
S20	U.3 RX n2 / U.2 RX n1	Diff-Pair	Receiver differential pair, U.3 Lane 2, or U.2 Lane 1
S21	U.3 RX p2 / U.2 RX p1	Diff-Pair	Receiver differential pair, U.3 Lane 2, or U.2 Lane 1
S22	Ground	Ground	Ground
S23	U.3 TX p3 / U.2 TX p2	Diff-Pair	Transmitter differential pair, U.3 Lane 3, or U.2 Lane 2
S24	U.3 TX n3 / U.2 TX n2	Diff-Pair	Transmitter differential pair, U.3 Lane 3, or U.2 Lane 2
S25	Ground	Ground	Ground
S26	U.3 RX n3 / U.2 RX n2	Diff-Pair	Receiver differential pair, U.3 Lane 3, or U.2 Lane 2
S27	U.3 RX p3 / U.2 RX p2	Diff-Pair	Receiver differential pair, U.3 Lane 3, or 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)

Pin #	Name	Type	Description
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
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	N	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	Y	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	Y	Keep Alive Timer
10h	O	-	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	-	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	-	-	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	-	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	-	Endurance Group Event Aggregate
10h - 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 - BFh	O	-	Reserved
C0h - FFh	O	-	

Notes:

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

Table 6-6 SMBus / I2C Elements Supported

SMBus / I ² C Element	SMBus / I ² C Address(8bit)	
	Hex Format	Binary format
FRU Information Device (for NVMe Storage Device)	A6h	1010_011xb
SMBus / I ² C 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)	0x01
75:73	M	IEEE OUI Identifier (IEEE)	TBD*
76	O	Controller Multi-Path I/O and Namespace Sharing Capabilities (CMIC)	0x03
77	M	Maximum Data Transfer Size (MDTS)	0x09
79:78	M	Controller ID (CNTLID)	0x0001
83:80	M	Version (VER)	0x00010400
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)	0x00000300
99:96	M	Controller Attributes (CTRATT)	0x00000000
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	
255:240	-	Refer to the NVMe Management Interface Specification for definition	0x00
257:256	M	Optional Admin Command Support (OACS)	0x005F
258	M	Abort Command Limit (ACL)	0x01
259	M	Asynchronous Event Request Limit (AERL)	0x0E
260	M	Firmware Updates (FRMW)	0x1C
261	M	Log Page Attributes (LPA)	0x1E

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Bytes	O/M	Description	Default Value
262	M	Error Log Page Entries (ELPE)	0x3E
263	M	Number of Power States Support (NPSS)	3
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)	0x0157 (70C)
269:268	M	Critical Composite Temperature Threshold (CCTEMP)	0x0161 (80C)
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)	0x01
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)	0x0157
331:328	O	Sanitize Capabilities (SANICAP)	0x60000003
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)	0x0000
342	O	ANA Maximum Transition Time (anatt)	0x00
343	O	Asymmetric Namespace Access Capabilities (ANACAP)	0x00

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Bytes	O/M	Description	Default Value
347:344	O	ANA Group ID Maximum (anagrpmx)	0x00000000
351:348	O	Number of ANA Group IDs (nanagrpId)	0x00000000
355:352	O	Persistent Event Log Size (PELS)	0x63
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 port
519:516	M	Number of Namespaces (NN)	0x00000080
521:520	M	Optional NVM Command Support (ONCS)	0x00FF
523:522	M	Fused Operation Support (FUSES)	0x0000
524	M	Format NVM Attributes (FNA)	0x04
525	M	Volatile Write Cache (VWC)	0x07
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)	0x0000
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)	0x00
Bit[255:184]		Reserved	0x0
Bit[183:182]		Active Power Scale (APS)	0x0
Bit[181:179]		Reserved	0x0
Bit[178:176]		Active Power Workload (APW)	0x0
Bit[175:160]		Active Power (ACTP)	0x0

Bytes	O/M	Description	Default Value
Bit[159:152]		Reserved	0x0
Bit[151:150]		Idle Power Scale (IPS)	0x0
Bit[149:144]		Reserved	0x0
Bit[143:128]		Idle Power (IDL P)	0x0
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)	0x37A
2111:2080	O	Power State 1 Descriptor (PSD1)	0x00
Bit[255:184]		Reserved	0x0
Bit[183:182]		Active Power Scale (APS)	0x0
Bit[181:179]		Reserved	0x0
Bit[178:176]		Active Power Workload (APW)	0x0
Bit[175:160]		Active Power (ACTP)	0x0
Bit[159:152]		Reserved	0x0
Bit[151:150]		Idle Power Scale (IPS)	0x0
Bit[149:144]		Reserved	0x0
Bit[143:128]		Idle Power (IDL P)	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

Bytes	O/M	Description	Default Value
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)	0xE6
2143:2112	O	Power State 2 Descriptor (PSD2)	0x00
Bit[255:184]		Reserved	0x0
Bit[183:182]		Active Power Scale (APS)	0x0
Bit[181:179]		Reserved	0x0
Bit[178:176]		Active Power Workload (APW)	0x0
Bit[175:160]		Active Power (ACTP)	0x0
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)	0xB4
2175:2144	O	Power State 3 Descriptor (PSD3)	0x00

Bytes	O/M	Description	Default Value
Bit[255:184]		Reserved	0x0
Bit[183:182]		Active Power Scale (APS)	0x0
Bit[181:179]		Reserved	0x0
Bit[178:176]		Active Power Workload (APW)	0x0
Bit[175:160]		Active Power (ACTP)	0x0
Bit[159:152]		Reserved	0x0
Bit[151:150]		Idle Power Scale (IPS)	0x0
Bit[149:144]		Reserved	0x0
Bit[143:128]		Idle Power (IDL P)	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)	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)	0xB4
2207:2176	0	Power State 4 Descriptor (PSD4)	0x00
Bit[255:184]		Reserved	0x0
Bit[183:182]		Active Power Scale (APS)	0x0
Bit[181:179]		Reserved	0x0
Bit[178:176]		Active Power Workload (APW)	0x0
Bit[175:160]		Active Power (ACTP)	0x0
Bit[159:152]		Reserved	0x0
Bit[151:150]		Idle Power Scale (IPS)	0x0
Bit[149:144]		Reserved	0x0
Bit[143:128]		Idle Power (IDL P)	0x0
Bit[127:125]		Reserved	0x0

Bytes	O/M	Description	Default Value
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
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)	0xB4
2239:2208	O	Power State 5 Descriptor (PSD5)	0x00
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

Bytes	O/M	Description	Default Value
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)	0x1E
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)	0x1B
29	M	End-to-end Data Protection Type Settings (DPS)	0x00
30	O	Namespace Multi-path I/O and Namespace Sharing Capabilities (NMIC)	0x01
31	O	Reservation Capabilities (RESCAP)	0xAB
32	O	Format Progress Indicator (FPI)	0x00
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

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Bytes	O/M	Description	Default Value
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
67:66	O	Namespace Preferred Write Alignment (NPWA)	0x0000
69:68	O	Namespace Preferred Deallocation(Trim) Granularity (NPDG)	0x0000
71:70	O	Namespace Preferred Deallocation(Trim) Alignment (NPDA)	0x0000
73:72	O	Namespace Optimal Write Size (NOWS)	0x0000
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 // NVMe 1.4 add (endgid)	0x0000
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)	0x02090000
135:132	O	LBA Format 1 Support (LBAF1)	0x00000000
139:136	O	LBA Format 2 Support (LBAF2)	0x00000000
143:140	O	LBA Format 3 Support (LBAF3)	0x00000000
147:144	O	LBA Format 4 Support (LBAF4)	0x00000000
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

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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)
800GB	5D26CEB0h
1,600GB	BA4D4AB0h
1,920GB	DF8FE2B0h
3,200GB	1749A42B0h
3,840GB	1BF1F72B0h
6,400GB	2E93432B0h
7,680GB	37E3E92B0h
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
[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	Wear Range Delta (%)
[55:48]	8	SSD Life Used Percent D3
[56]	1	WP Water Mark
[58:57]	2	Highest temperature
[64:59]	8	Flash UNC Error Count
[68:65]	4	Data E3D Error
[72:69]	4	PHY Error Count
[76:73]	4	Total Bad Block Count
[80:77]	4	Total Early Bad Blcok Count
[84:81]	4	Total Later Bad Blcok Count
[88:85]	4	Read Fail Count
[92:89]	4	Program Fail Count
[96:93]	4	Erase Failure Count
[104:97]	8	System Table Copy Count
[112:105]	8	ReadMoveTableCnt
[116:113]	4	Data read retry count
[120:117]	4	RAID ECC retry count
[124:121]	4	RAID ECC failed count
[132:125]	8	Total Erase Count
[136:133]	4	D2/D3 Max Erase Cnount
[140:137]	4	D2/D3 Average Erase Count
[144:141]	4	D2/D3 Min Erase Count
[152:145]	8	Background read count
[156:153]	4	Host Write Uncorrectable Sector Count
[160:157]	4	PS3 Enter Success
[164:161]	4	PS4 Enter Success
[168:165]	4	Wear Leveling Count
[170:169]	2	Chip internal temperature
[172:171]	2	Thermal throttling

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[174:173]	2	Thermal throttling time
[176:175]	8	FW Code Update Count
[177]	1	Current D1 SSD Life Used Percent
[511:178]	326	Reserved

Table 6-14 SMART Attributes (Log Identifier D2h)

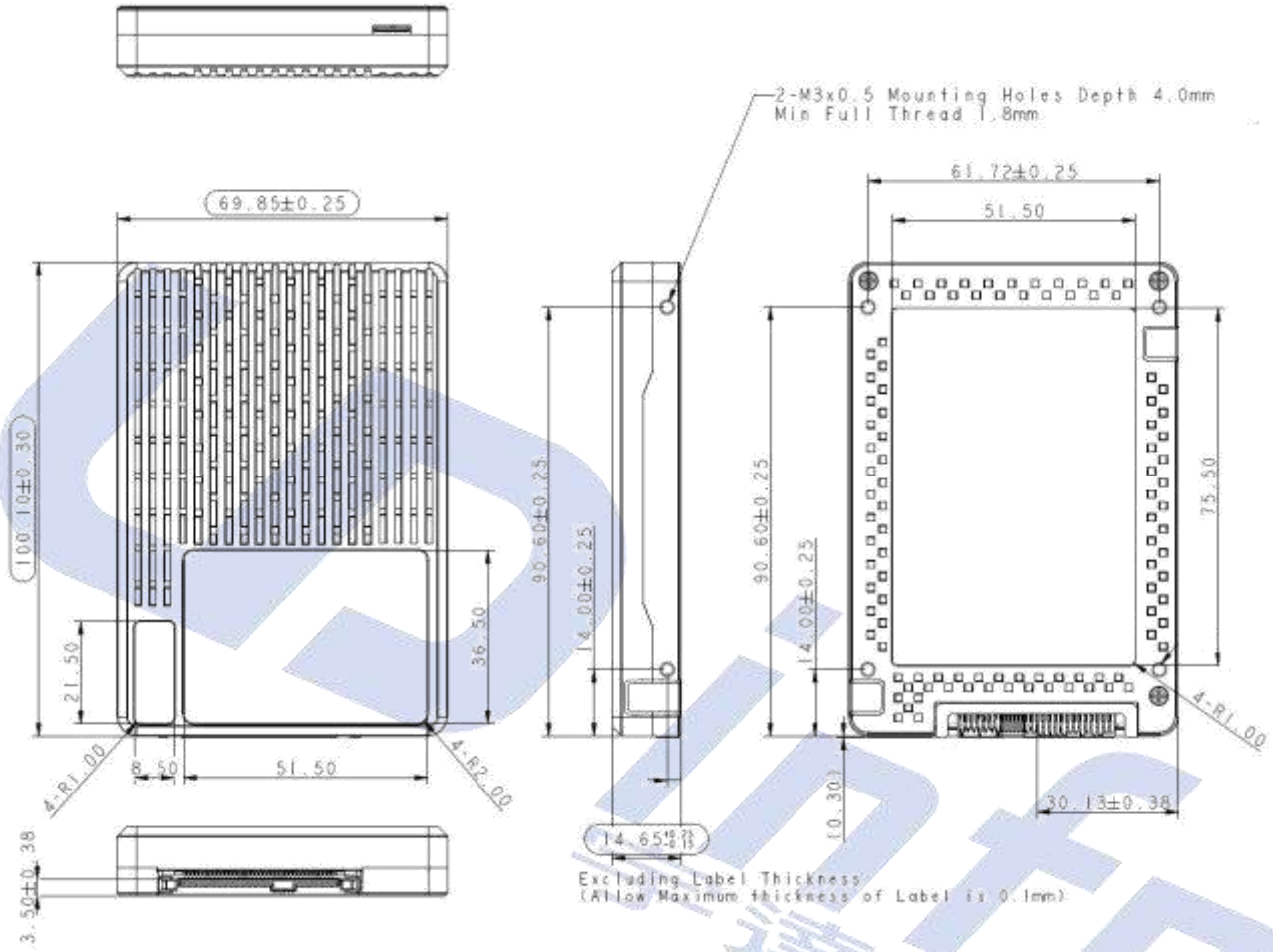
Bytes Index	Bytes	Description
[7:0]	8	Device Capacity
[15:8]	8	User Capacity
[23:16]	8	NAND Read
[31:24]	8	NAND Write
[39:32]	8	NAND Erase Sector
[47:40]	8	Wear Range Delta (%)
[55:48]	8	SSD Life Used Percent D3
[56]	1	WP Water Mark
[58:57]	2	Highest temperature
[62:59]	4	Read Fail Count
[66:63]	4	Data 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	PS3 Enter Success (N/A)
[162:159]	4	PS4 Enter Success (N/A)
[166:163]	4	Wear Leveling Count
[168:167]	2	Chip internal temperature
[170:169]	2	Thermal throttling
[172:171]	2	Thermal throttling time
[180:173]	8	FW Code Update Count
[188:181]	8	Flash UNC Error Count
[192:189]	4	HB retry count
[196:193]	4	SB retry count
[511:197]	315	Reserved



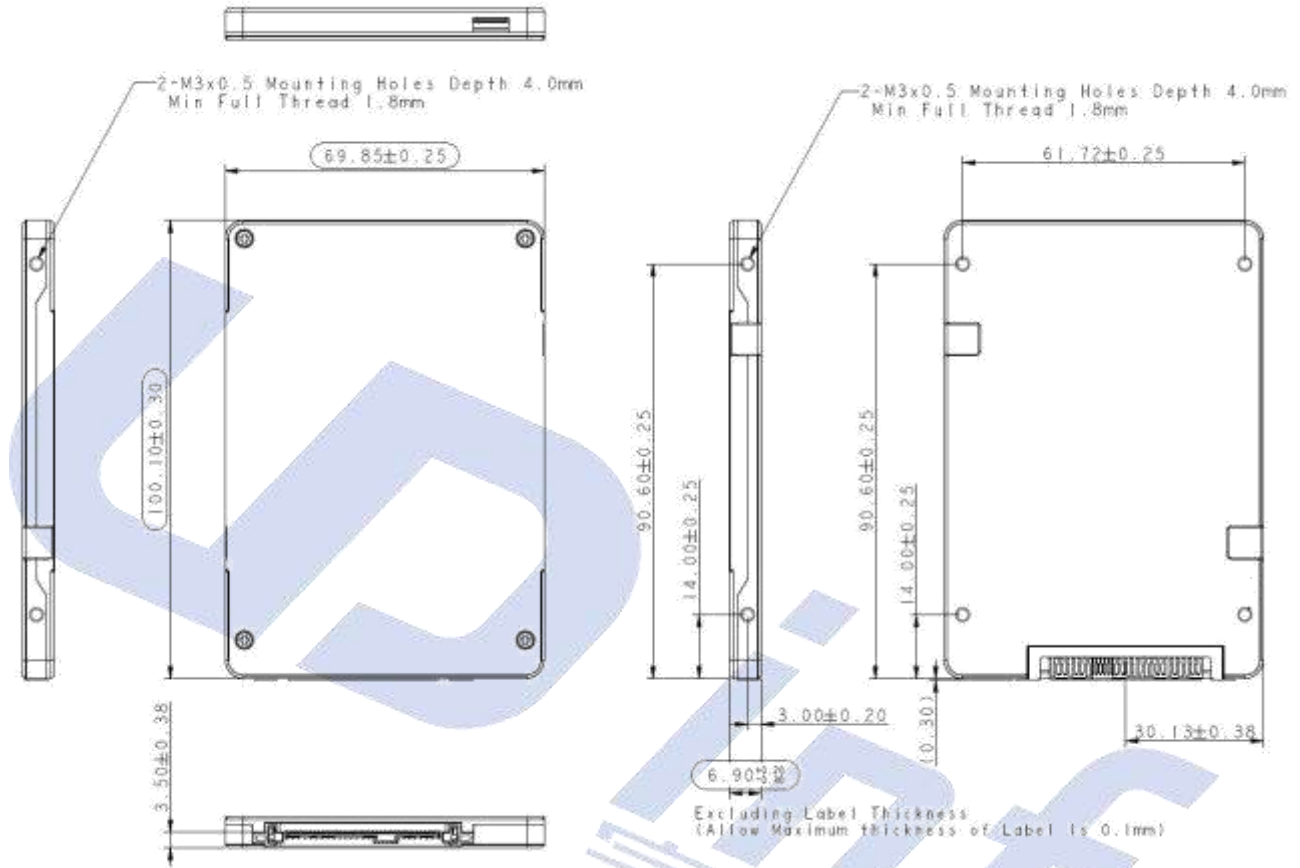
7. PHYSICAL DIMENSION

Type1: U.2 / U.3 2.5-inch 15mm Mechanical information



	Nominal (mm)	Tolerance (mm)
Length	100.1	± 0.30
Width	69.85	± 0.25
Height	14.65	$+ 0.25 / - 0.15$

Type2: U.2 / U.3 2.5-inch 7mm Mechanical information



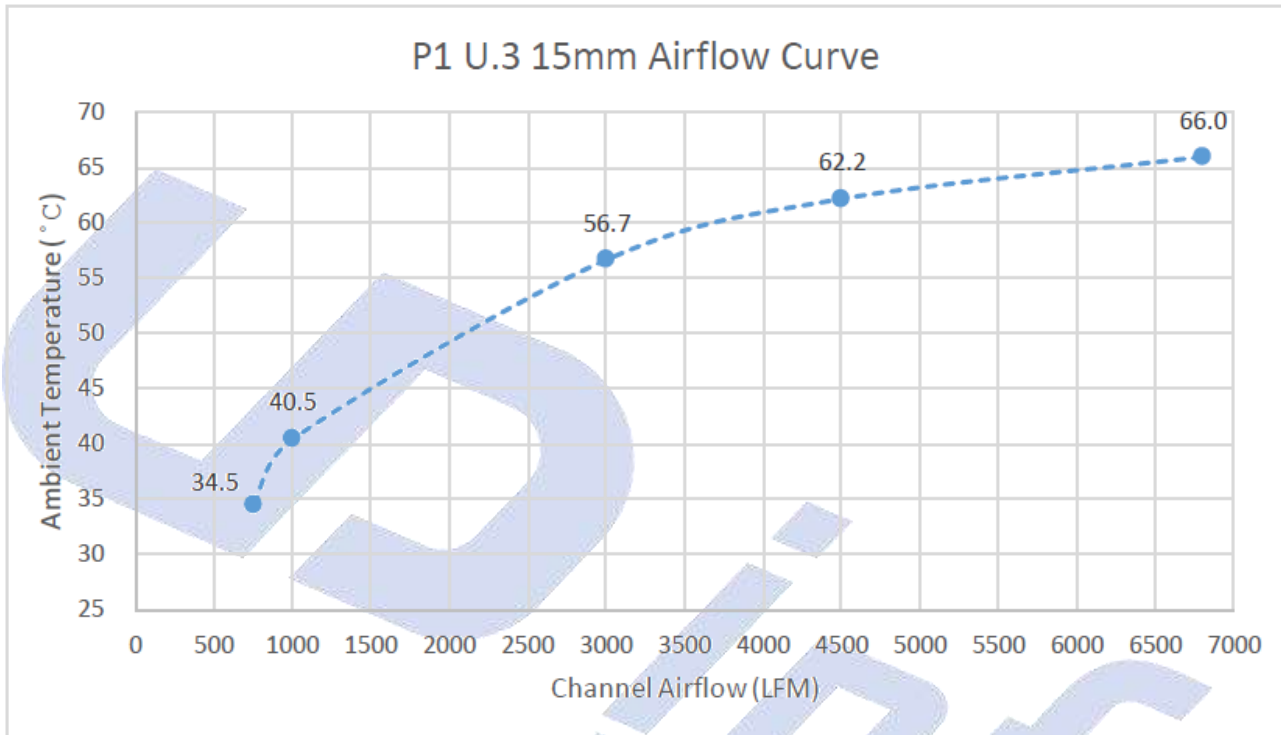
	Nominal (mm)	Tolerance (mm)
Length	100.1	± 0.30
Width	69.85	± 0.25
Height	6.9	+ 0.20 / - 0.40

8. AIR FLOW PROFILE



Figure 8-1 depicts the minimum airflow a U.3 15mm (8TB) needs to operate without triggering thermal throttling at ambient temperatures varied from 35°C to 65°C.

Figure 8-1 U.3 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: X570 AORUS MASTER Default string

CPU: AMD Ryzen 7 5800X 8-Core Processor

DRAM: DDR4 3200MHz 16GB

OS version: Windows 10 (10.0) Professional 64-bit

9.2. Performance methodologies

9.2.1. FIO Test procedure

- Secure erase -> no need format drive
 - 128K Seq. write/read
 1. Pre-con - 300% 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: 300secs

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 = 1
 - b. Number of jobs = 1
 2. Pre-con - 300% 4K random. write to full disk
 - a. IO Depth = 32
 - b. Number of jobs = 1
 3. Pre-con - 300% 4K random. write to full disk
 - a. IO Depth = 64
 - b. Number of jobs = 8

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 = 1
 - b. Number of jobs = 1
 2. Pre-con - 300% 4K random. write to full disk
 - a. IO Depth = 32
 - b. Number of jobs = 1
 3. Pre-con - 300% 4K random. write to full disk
 - a. IO Depth = 64
 - b. Number of jobs = 8

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 = 1
 - b. Number of jobs = 1
 2. Pre-con - 300% 4K random. write to full disk
 - a. IO Depth = 32
 - b. Number of jobs = 1
 3. Pre-con - 300% 4K random. write to full disk
 - a. IO Depth = 64
 - b. Number of jobs = 8

■ Data collection Procedure:

1. Run entire test script one time.
2. Run every condition in this script for 300 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: X570 AORUS MASTER Default string

CPU: AMD Ryzen 7 5800X 8-Core Processor

DRAM: DDR4 3200MHz 16GB

OS version: Ubuntu 16.04.3 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)
 - 2048K 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. 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
 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

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1. 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 (10ms resolution)
 - a) Run entire test script one time.
 - b) Run every condition in this script.
 - c) Calculate average value for every condition then choose maximum average.
 - d) Note value for every condition.
 - e) 6pcs 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) 6pcs 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 Max Ave power and Max Peak power.
 - c) 6pcs 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 Max Ave Idle power and Max Peak power.
 - c) 6pcs sample for every capacity.

10. VITAL PRODUCT DATA



U.2/U.3 devices can support Read and Write to Vital Product Data (VPD). Please refer to Figure 10-1 U.3 PCIe SSD Controller Block Diagram for details on VPD Data Structure. VPD contains:

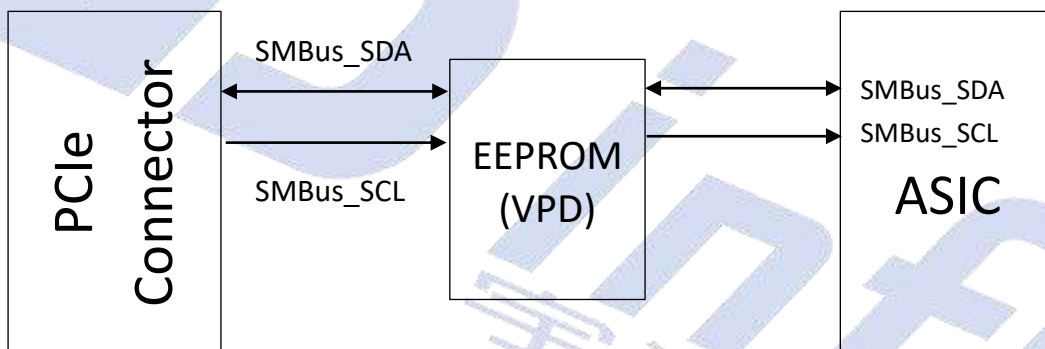
- Basic inventory information such as type and size of Enterprise PCIe SSD, manufacture, date, revision, and GUID.
- Power management data such as power level and power modes.
- Vendor specific data.

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.

Figure 10-1 U.3 PCIe SSD Controller Block Diagram



11. PARTNUMBER 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	3	H	-	E	A	3	0	T	7	B	-	E	F	P			

X¹ E: PCIe SSD														
X² R: Read intensive workload (DWPD 1) M: Mix workload (DWPD 3)														
X³X⁴ U3: U.3														
X⁵ S: 7mm Height H: 15mm Height														
X⁶X⁷ EA: Controller														
X⁸X⁹X¹⁰X¹¹X¹² <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 33%;">800G: 800GB</td> <td style="width: 33%;">3840G: 3840GB</td> <td style="width: 33%;">15T3B: 15360GB</td> </tr> <tr> <td>1600G: 1600GB</td> <td>6400G: 6400GB</td> <td>25T6B: 25600GB</td> </tr> <tr> <td>1920G: 1920GB</td> <td>7680G: 7680GB</td> <td>30T7B: 30720GB</td> </tr> <tr> <td>3200G: 3200GB</td> <td>12T8B: 12800GB</td> <td></td> </tr> </table>			800G: 800GB	3840G: 3840GB	15T3B: 15360GB	1600G: 1600GB	6400G: 6400GB	25T6B: 25600GB	1920G: 1920GB	7680G: 7680GB	30T7B: 30720GB	3200G: 3200GB	12T8B: 12800GB	
800G: 800GB	3840G: 3840GB	15T3B: 15360GB												
1600G: 1600GB	6400G: 6400GB	25T6B: 25600GB												
1920G: 1920GB	7680G: 7680GB	30T7B: 30720GB												
3200G: 3200GB	12T8B: 12800GB													
X¹³ E: 3D eTLC Standard (0°C ~ +70°C)														
X¹⁴ F: Gen4 x4														
X¹⁵ P: PCB version														
X¹⁶X¹⁷ Blank: Standard														