

# UD info Corp.

## Industrial 2.5" PCIe Solid State Drive PFD-25DC Series Product DataSheet



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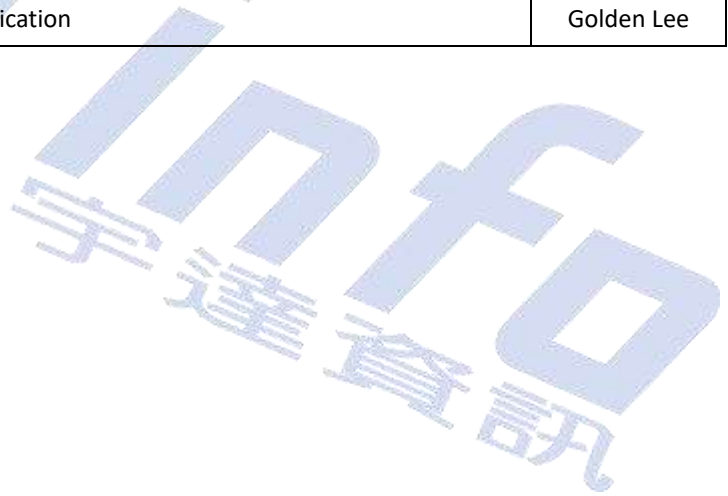
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## Revision History

Revision	Draft Date	History	Author
1.0	2019/8/15	New release	Golden Lee
1.1	2019/10/28	Update Performance & TBW	Golden Lee
1.2	2020/3/19	Update Wide Temperature support for 8TB	Golden Lee
1.3	2021/4/28	Added B16 support	Golden Lee
1.4	2021/10/1	Added BiCS4 support	Golden Lee
1.5	2022/3/17	Added 16TB support	Golden Lee
1.6	2022/4/11	Added BiCS5 support	Golden Lee
1.7	2022/8/29	1. Added BiCS5 Wide Temperature support 2. Removed B16 data	Golden Lee
1.8	2023/1/12	Add Quick Erase and Write Protect function	Golden Lee
1.9	2023/3/29	Removed safety certification	Golden Lee



## Product Overview

- **Capacity**
  - 240GB up to 15360GB (16TB)
- **Form Factor**
  - U.2
- **PCIe Interface**
  - NVMe PCIe Gen3 x4
  - NVMe 1.3d
  - PCI Express Base 3.1
- **Flash Interface**
  - 3D TLC BGA
  - Up to 16pcs of BGA152 flash
- **Performance**<sup>Note1</sup>
  - Read up to 3,400 MB/s
  - Write up to 1,000 MB/s
- **Power Consumption**<sup>Note2</sup>
  - Active mode: < 9,500 mW
  - Idle mode: < 2,000 mW
- **Reliability**
  - MTBF: 2,000,000 hours
  - UBER<sup>Note5</sup> < 1 sector per 10<sup>16</sup> bits read
- **ECC**
  - LDPC / RAID ECC
  - Low density parity check code (>120bit/KBytes)
- **Temperature Range**<sup>Note3</sup>
  - Operation Temperature:
    - Standard: 0°C ~ 70°C (BiCS4/BiCS5)
    - Wide: -40°C ~ 85°C (BiCS3/BiCS5)
  - Storage Temperature: -40°C ~ 85°C
- **RoHS Compliant**
- **EMI Compliant**
  - EN55032, CISPR 32 (CE)
  - AS/NZS CISPR 32 (CE)
  - ANSI C63.4 (FCC)
  - CNS 13438 (BSMI)
  - VCCI-CISPR 32 (VCCI)
- **Features Support List**
  - TCG Pyrite/OPAL<sup>Note4</sup>
  - Thermal throttling
  - Write Protect
  - Secure Erase
- **Hardware Power Loss Protection Support**

### Notes:

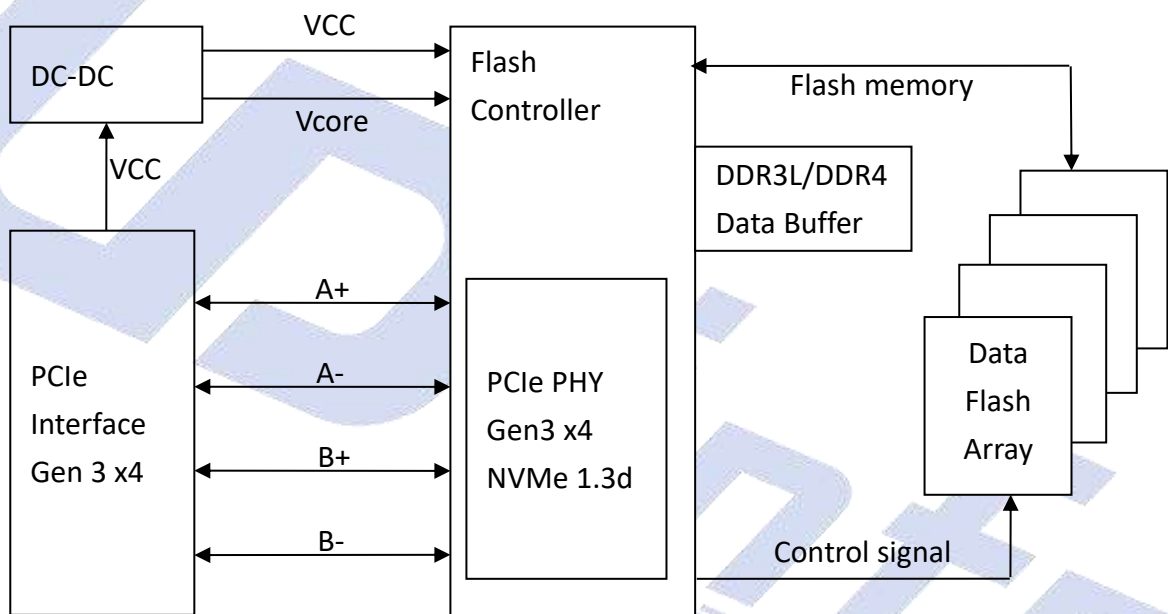
1. Refer to Chapter 2 for more details.
2. Refer to Chapter 4, section 4.2 power consumption for more details.
3. Support by a separate firmware version. Further information available upon request.
4. The operation temperature means the case temperature, in which can be detected via the S.M.A.R.T.
5. Uncorrectable Bit Error Rate (UBER)

# 1. INTRODUCTION

## 1.1. General Description

UDinfo's 2.5" PCIe SSD delivers all the advantages of flash disk technology with PCIe Gen3 x4 interface, including being compliant with standard 2.5-inch form factor and SFF-8639 connector. The device is designed based on the standard 38-pin interface for data segment and 15-pin for power segment. Its capacity could provide a wide range up to 15,360GB(16TB). Moreover, it can reach up to 3,400MB/s read as well as 3,000MB/s write performance.

## 1.2. Block Diagram



**U.2 PCIe SSD Block Diagram**

## 2. PRODUCT SPECIFICATIONS

### 2.1. Product Specifications

- **Capacity**
  - 240GB up to 15360GB (16TB)
- **Electrical/Physical Interface**
  - PCI Express Base Ver 3.1
  - Compliant with NVMe 1.3d
  - PCIe Gen3 x 4 lane & backward compatible to PCIe Gen2 and Gen1
- **Support Hardware Write Protect function (Optional)**
- **Support Hardware Quick Erase function (Optional)**
- **Support Hardware Power Loss Protection (Optional)**
  - Protect data loss, even the last data, during write process when power sudden off.
  - Add-on Polymer Tantalum Capacitors hold-up several milliseconds to keep DRAM data write to NAND Flash.

### 2.2. Device Capacity

Capacity	IDEMA Standard		User Data Size
	512Bytes/Sector	4KBytes/Sector	
	Total Sectors (LBA)	Total Sectors (LBA)	
240GB	468,862,128	58,607,766	Depended on file management
480GB	937,703,088	117,212,886	
960GB	1,875,385,008	234,423,126	
1920GB	3,750,748,848	468,843,606	
3840GB	7,501,476,528	937,684,566	
7680GB	15,002,931,888	1,875,366,486	
15360GB	30,005,842,608	3,750,730,326	

**Notes:**

1. 1 Gigabyte (GB) is equal to 1,000,000,000 Bytes; 1 sector is equal to 512 Bytes.
2. The calculation is following IDEMA Standard.
3. The total actual user data size of the SSD may be less than device capacity due to SSD format,



SSD partition, operating system.

EX: OS shows 447.13GB (NTFS) with 480GB SSD.

## 2.3. Performance

Capacity	Flash Structure	Sequential		4K Random	
		Read (MB/s)	Write (MB/s)	Read (IOPS)	Write (IOPS)
240GB	64GB x4, BGA, Kioxia BiCS3	3,000	340	100K	13K
480GB	64GB x 8, BGA, Kioxia BiCS3	3,000	520	200K	20K
960GB	128GB x 8, BGA, Kioxia BiCS3	3,200	1,000	360K	25K
1920GB	128GB x 16, BGA, Kioxia BiCS3	3,200	1,000	360K	28K
3840GB	256GB x 16, BGA, Kioxia BiCS3	2,900	970	400K	30K
7680GB	512GB x 16, BGA, Kioxia BiCS3	2,900	970	400K	30K
1920GB	128GB x 16, BGA, Kioxia BiCS4	3,400	980	360K	20K
3840GB	256GB x 16, BGA, Kioxia BiCS4	3,400	950	400K	18K
7680GB	512GB x 16, BGA, Kioxia BiCS4	3,400	950	400K	18K
480GB	128GB x 4, BGA, Kioxia BiCS5	3,300	350	100K	80K
960GB	128GB x 8, BGA, Kioxia BiCS5	3,300	750	200K	160K
1920GB	128GB x 16, BGA, Kioxia BiCS5	3,300	1,000	400K	200K
3840GB	256GB x 16, BGA, Kioxia BiCS5	3,300	900	600K	200K
7680GB	512GB x 16, BGA, Kioxia BiCS5	3,300	900	600K	200K
15360GB <sup>Note6</sup>	1TB x 16, BGA, Kioxia BiCS5 (Only C-Temp.)	3,200	950	550K	210K

### Notes:

- Performance may differ according to flash configuration and platform.
- Performance specification is under Thermal Throttling inactivated.
- The data shows the sustained and average performance.
- Performance is measured with the follow conditions
  - CrystalDiskMark 6.0, 1GB range, QD32T1 for sequential
  - FIO on Linux version with QD32 for BiCS3/BiCS4 IOPS
  - IOmeter, 1GB range, 4K data size, QD32 for BiCS5 IOPS
  - OS: Win10 64bit was, version 1709
  - Intel Core i7-8700K CPU @ 3.70GHz



5. Measurement environment: Room temperature: 20~25°C, humidity: 40~60%RH, DC+12V condition.
6. Only support 0~70°C

## 2.4. POR/SPOR Standby Ready Time

- **POR/SPOR Ready Time**

Capacity	POR ready time		SPOR ready time	
	Typ.	Max.	Typ.	Max.
240GB	150	1,000	2,000	10,000
480GB	150	1,000	2,000	10,000
960GB	150	1,000	3,000	10,000
1920GB	150	1,000	4,000	10,000
3840GB	200	1,000	8,000	10,000
7680GB	200	1,000	10,000	10,000
15360GB	200	1,000	10,000	10,000

Unit: ms

- **POR/SPOR Ready Time for PLP function**

Capacity	Flash Type	POR ready time		SPOR ready time	
		Typ.	Max.	Typ.	Max.
240GB	BiCS3	500	3,000	1,500	30,000
480GB	BiCS3	500	3,000	1,500	30,000
960GB	BiCS3	900	3,000	2,500	30,000
1920GB	BiCS3	1,500	3,000	4,000	30,000
3840GB	BiCS3	1,800	3,000	8,000	30,000
7680GB	BiCS3	2,500	3,000	10,000	30,000

Unit: ms

**Notes:**

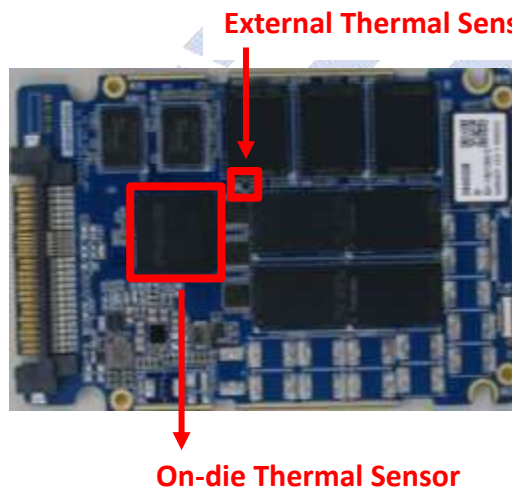
1. POR/SPOR stands for following:
  - (a.) POR: Power On Ready. (The ready time variation depends on data recover size.)
  - (b.) SPOR: Power On Ready after Sudden Power Off. (The ready time variation depends on data recover size.)
2. POR/SPOR ready time stands for following:
 

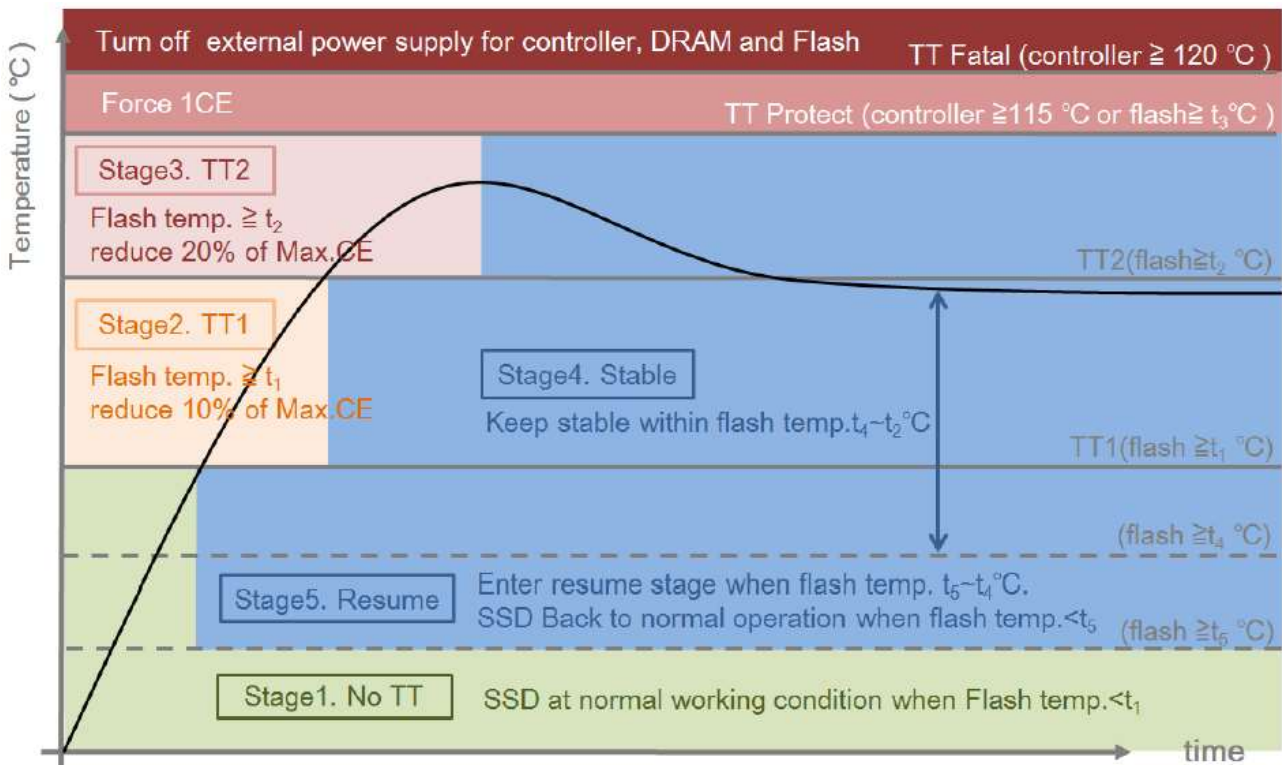
Power on Time: From Power On to SSD response after drive ready.
3. Measurement environment: Room temperature: 20~25°C, humidity: 40~60%RH, DC+12V condition.

## 2.5. Thermal Throttling

The purpose of thermal throttling is to prevent any components in a SSD from over-heating during read and write operations. The controller is designed with an on-die thermal sensor and with its accuracy, firmware can apply different levels of throttling to achieve the purpose of protection efficiently and proactively via S.M.A.R.T. reading.

- **Purpose of Thermal Throttling:**
  - In order to keep the optimal performance in the safe range of the temperature.
- **Thermal sensors:**
  - We have external thermal sensor & on-die thermal sensor (internal controller) to detect temperature. There is 1pcs external thermal sensor on PCB, the position depends on different form factor (The thermal sensor is shown below. The picture is for reference only).
  - External thermal sensor would detect flash temperature; On-die thermal sensor detect controller temperature.





	Operation temp. of Normal-temp. grade: 0-70°C	Operation temp. of Wide-temp. grade: -40-85°C
<b>t<sub>1</sub></b>	68°C	82°C
<b>t<sub>2</sub></b>	70°C	85°C
<b>t<sub>3</sub></b>	80°C	95°C
<b>t<sub>4</sub></b>	64°C	78°C
<b>t<sub>5</sub></b>	60°C	74°C

**Notes:**

1. TT shown on Figure 2-1 means “Thermal Throttling”.
2. CE = Chip Enable.
3. temp. = temperature

## 2.6. TCG Opal 2.0

The Opal specification is a set of specifications for self-encrypting drives published by the Trusted Computing Group (TCG), a non-profit organization that develops, defines, and promotes standards and specifications for secure computing. The Opal Security Subsystem Class(SSC) 2.0 defines the details of data management in storage devices and the classes authority for data access, and secures data from theft and tampering by unauthorized persons who are able to gain access to the storage device or host system.

### TCG Opal 2.0 Main Features:

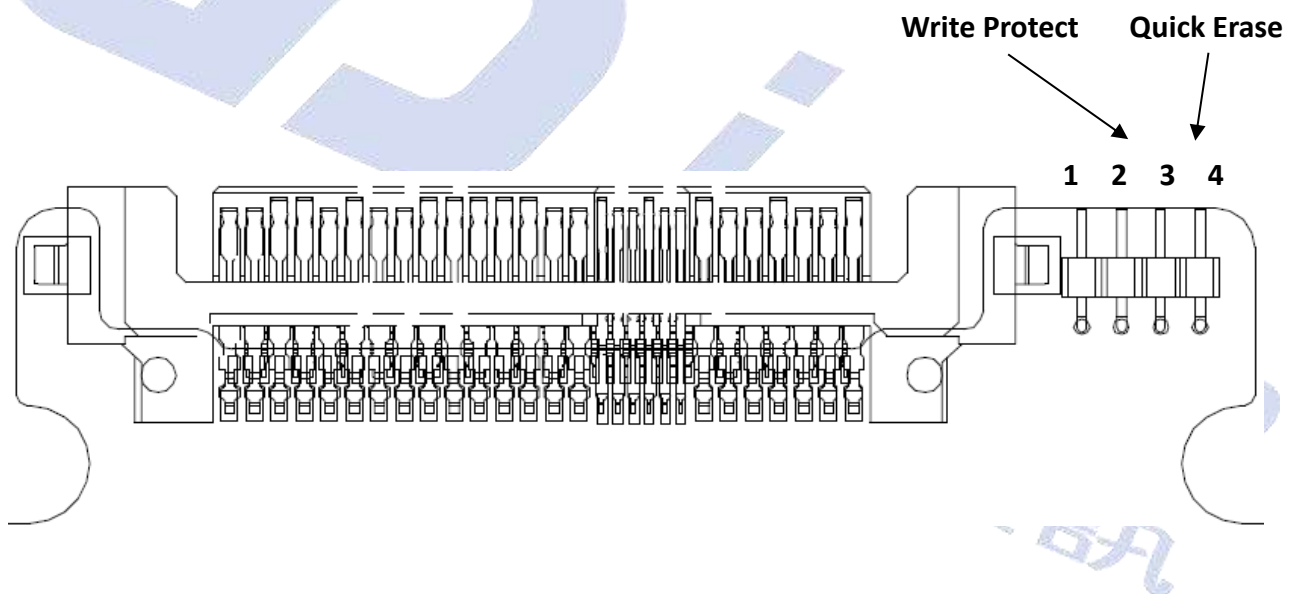
- AES 256-bit Hardware Self Encryption
- Deploy Storage Device & Take Ownership:  
The Storage Device is integrated into its target system and ownership transferred by setting or changing the Storage Device's owner credential.
- Activate or Enroll Storage Device:  
LBA ranges are configured and data encryption and access control credentials (re)generated and/or set on the Storage Device. Access control is configured for LBA range unlocking.
- Lock & Unlock Storage Device:  
Unlocking of one or more LBA ranges by the host and locking of those ranges under host control via either an explicit lock or implicit lock triggered by a reset event. MBR shadowing provides a mechanism to boot into a secure pre-boot authentication environment to handle device unlocking.
- Repurpose & End-of-Life:  
Erasure of data within one or more.
- Physical Presence SID (PSID):  
PSID is defined by TCG OPAL as a 32-character string and the purpose is to revert SSD back to its manufacturing setting when the drive is still OPAL-activated. PSID code can be printed on a SSD label when an OPAL-activated SSD supports PSID revert feature.

## 2.7. Write Protect Function (Optional)

The write protect function is triggered by pin2 and pin3 short of pin header. This used to set the device as a write protection device after power up. When the function is triggered, the data can't be written to the device. The device is then set as read only.

## 2.8. Quick Erase Function (Optional)

The Quick Erase is a special feature to allow users to erase user data of SSD by hardware trigger. When this feature is triggered by pin3 and pin4 short of pin header, the SSD controller will write all "0x00" to wipe all the data except firmware area, and the SSD will return to its factory default setting. This feature is particularly useful for emergent circumstances to quickly erase user data.



### 3. ENVIRONMENTAL SPECIFICATIONS



#### 3.1. Environmental Conditions

##### 3.1.1. Temperature Specification

	Mode	Min.	Max.	Unit
Temperature Ranges	Operation (Standard)	0	70	°C
	Operation (Wide)	-40	85	°C
	Storage	-40	85	°C
Humidity	Operation	5	95	%
	Storage	5	95	%
Temperature Cycle Test	Operation (Standard)	0	70	°C
	Operation (Wide)	-40	85	°C
	Storage	-40	85	°C

**Notes:**

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

##### 3.1.2. Mechanical Specification

Items			Condition
<b>Shock</b>	Non-operational	Acceleration Force	1500G 0-p with half sine wave (0.5ms)
<b>Vibration</b>	Non-operational	Frequency/Displacement	20Hz~80Hz/1.52mm
		Frequency/Acceleration	80Hz~2000Hz/20G p-p with sine wave
<b>Drop</b>	Non-operational	Height of Drop	80cm free fall
		Number of Drop	6 face of each unit
		Conflicting Material	Concrete floor

##### 3.1.3. Electrostatic Discharge (ESD)

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



### 3.1.4. EMI Compliance

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

### 3.2. TBW (Terabytes Written)

Capacity	Flash Type	TBW	DWPD
240GB	64GB x4, BGA, Kioxia BiCS3	390	0.8
480GB	64GB x 8, BGA, Kioxia BiCS3	800	0.8
960GB	128GB x 8, BGA, Kioxia BiCS3	1,580	0.8
1920GB	128GB x 16, BGA, Kioxia BiCS3	3,000	0.8
3840GB	256GB x 16, BGA, Kioxia BiCS3	6,280	0.8
7680GB	512GB x 16, BGA, Kioxia BiCS3	12,000	0.8
1920GB	128GB x 16, BGA, Kioxia BiCS4	2,800	0.8
3840GB	256GB x 16, BGA, Kioxia BiCS4	5,600	0.8
7680GB	512GB x 16, BGA, Kioxia BiCS4	10,000	0.8
480GB	128GB x 4, BGA, Kioxia BiCS5	690	0.8
960GB	128GB x 8, BGA, Kioxia BiCS5	1,500	0.8
1920GB	128GB x 16, BGA, Kioxia BiCS5	3,200	0.9
3840GB	256GB x 16, BGA, Kioxia BiCS5	6,400	0.9
7680GB	512GB x 16, BGA, Kioxia BiCS5	12,900	0.9
15360GB	1TB x 16, BGA, Kioxia BiCS5	25,900	0.9

**Notes:**

1. TBW is measured by JEDEC Client 219A workload and calculated with PE count = 3000.
2. TBW may differ according to flash configuration and platform.
3. DWPD is calculated based on 5-year lifetime.
4. The SSD supports trim function. If Operation System does not support trim command, performance and TBW will be affected. (Like certain Windows OS, Linux kernel version before 2.6.33, other OS please reference each own user manual)
5. The endurance of SSD could be estimated based on user behavior, NAND endurance cycles, and write amplification factor.



### 3.3. UBER (Uncorrectable Bit Error Rates)

Capacity	UBER
240GB	< 1 sector per 10 <sup>16</sup> bits read
480GB	
960GB	
1920GB	
3840GB	
7680GB	
15360GB	

**Notes:**

1. UBER (Uncorrectable Bit Error Rates) means the uncorrectable error per bits read.
2. UBER = FER (fail rate) / Data Size (user data bit).
3. FER = uncorrectable ECC frame number / total ECC frame number.
4. The LDPC for TLC ECC capability > 120bit/KB.

### 3.4. MTBF

MTBF, Mean Time between Failures, is a measure of reliability of a device. Its value represents the average time between a repair and the next failure. The unit of MTBF is in hours. The higher the MTBF value, the higher the reliability of the device.

Our MTBF result is based on simulation software (Relex 7.3). Please note that a lower MTBF should be expected for higher capacity drives, and we apply the lowest MTBF for all capacities.

Capacity	MTBF
240GB	2 million hours
480GB	
960GB	
1920GB	
3840GB	
7680GB	
15360GB	

## 4. ELECTRICAL SPECIFICATIONS



### 4.1. Supply Voltage

Parameter	Rating
Operating Voltage	12V $\pm$ 5%
Rise Time (Max/Min)	100ms / 0.1ms
Fall Time (Max/Min)	5s / 1ms
Min. off Time <sup>Note1</sup>	1s

**Notes:**

1. Minimum time between power removed from SSD ( $V_{cc} < 100$  mV) and power re-applied to the drive.
2. Ensure the voltage of each power domain in SSD has enough time to discharge less than 0.1V.
3. Rise Time during from 10% to 90% of 12V.
4. Fall Time during from 90% to 10% of 12V.

### 4.2. Power Consumption

Capacity	Flash Type	Read	Write	Idle
240GB	64GB x4, BGA, Kioxia BiCS3	5,600	3,200	2,000
480GB	64GB x 8, BGA, Kioxia BiCS3	6,100	3,400	2,000
960GB	128GB x 8, BGA, Kioxia BiCS3	6,300	4,600	2,000
1920GB	128GB x 16, BGA, Kioxia BiCS3	8,000	5,500	2,000
3840GB	256GB x 16, BGA, Kioxia BiCS3	8,500	6,000	2,000
7680GB	512GB x 16, BGA, Kioxia BiCS3	9,500	6,600	2,000
1920GB	128GB x 16, BGA, Kioxia BiCS4	7,300	8,500	2,000
3840GB	256GB x 16, BGA, Kioxia BiCS4	7,800	8,700	2,000
7680GB	512GB x 16, BGA, Kioxia BiCS4	8,300	9,000	2,000
480GB	128GB x 4, BGA, Kioxia BiCS5	5,300	5,500	2,000
960GB	128GB x 8, BGA, Kioxia BiCS5	5,500	5,500	2,000
1920GB	128GB x 16, BGA, Kioxia BiCS5	6,500	6,500	2,000
3840GB	256GB x 16, BGA, Kioxia BiCS5	7,000	6,500	2,000
7680GB	512GB x 16, BGA, Kioxia BiCS5	7,000	6,500	2,000
15360GB	1TB x 16, BGA, Kioxia BiCS5	7,200	7,500	2,500

Unit: mW

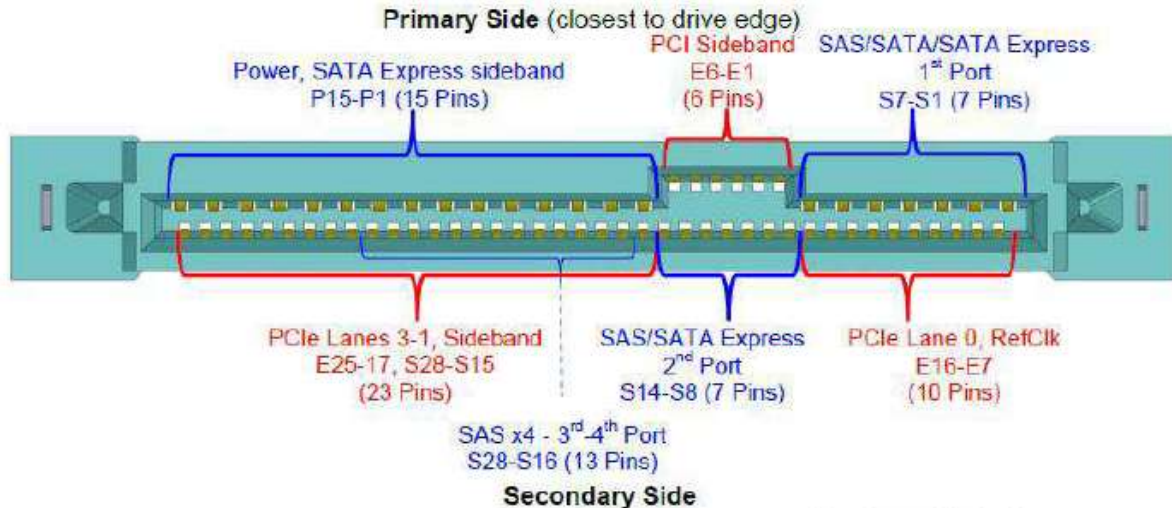
**Notes:**

1. Use CrystalDiskMark 6.0 with the setting of 1000MB. Sequentially read and write the disk for 5 times, and measure power consumption during sequential Read [1/5]~[5/5] or sequential Write [1/5]~[5/5].
2. Power Consumption may differ according to flash configuration and platform.
3. The measured power voltage is 12V.
4. Measurement environment: Room temperature: 20~25°C, humidity: 40~60%RH.



## 5. INTERFACE

### 5.1. Pin Assignment and Descriptions



The follow table defines the signal assignment of the 2.5" PCIe SSD SFF-8639 Connector Pin Assignment and Descriptions.

Pin #	Name	Type	Description
P1	WAKE#	Input	Signal for Link reactivation
P2	-	-	Outside scope of this specification
P3	CLKREQ#	Bi-Dir	Clock request
P4	lfDet#	Input	Interface Type Detect
P5	Ground	Ground	Ground
P6	Ground	Ground	Ground
P7	-	-	Outside scope of this specification
P8	-	-	Outside scope of this specification
P9	-	-	Outside scope of this specification
P10	PRSNT#	Input	Presence detect
P11	Activity	Input	
P12	Ground	Ground	Ground
P13	+12V Precharge	Power	+12V Precharge power for SFF-8639 module
P14	+12V	Power	+12V power for SFF-8639 module
P15	+12V	Power	+12V power for SFF-8639 module
S1	Ground	Ground	Ground
S2	-	-	Outside scope of this specification
S3	-	-	Outside scope of this specification

Pin #	Name	Type	Description
S4	Ground	Ground	Ground
S5	-	-	Outside scope of this specification
S6	-	-	Outside scope of this specification
S7	Ground	Ground	Ground
S8	Ground	Ground	Ground
S9	-	-	Outside scope of this specification
S10	-	-	Outside scope of this specification
S11	Ground	Ground	Ground
S12	-	-	Outside scope of this specification
S13	-	-	Outside scope of this specification
S14	Ground	Ground	Ground
S15	Reserved	-	Reserved
S16	Ground	Ground	Ground
S17	PETp1	Diff-Pair	Transmitter differential pair, Lane 1
S18	PETn1	Diff-Pair	Transmitter differential pair, Lane 1
S19	Ground	Ground	Ground
S20	PERn1	Diff-Pair	Receiver differential pair, Lane 1
S21	PERp1	Diff-Pair	Receiver differential pair, Lane 1
S22	Ground	Ground	Ground
S23	PETp2	Diff-Pair	Transmitter differential pair, Lane 2
S24	PETn2	Diff-Pair	Transmitter differential pair, Lane 2
S25	Ground	Ground	Ground
S26	PERn2	Diff-Pair	Receiver differential pair, Lane 2
S27	PERp2	Diff-Pair	Receiver differential pair, 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	PERSTB#	Output	Fundamental reset for second X2 port
E5	PERST#	Output	Fundamental reset (if dual-port enabled, first X2 port)
E6	Reserved	-	Reserved
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	PETp0	Diff-Pair	Transmitter differential pair, Lane 0

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Pin #	Name	Type	Description
E11	PETn0	Diff-Pair	Transmitter differential pair, Lane 0
E12	Ground	Ground	Ground
E13	PERn0	Diff-Pair	Receiver differential pair, Lane 0
E14	PERp0	Diff-Pair	Receiver differential pair, Lane 0
E15	Ground	Ground	Ground
E16	Reserved	-	Reserved
E17	PETp3	Diff-Pair	Transmitter differential pair, Lane 3
E18	PETn3	Diff-Pair	Transmitter differential pair, Lane 3
E19	Ground	Ground	Ground
E20	PERn3	Diff-Pair	Receiver differential pair, Lane 3
E21	PERp3	Diff-Pair	Receiver differential pair, 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

Op-Code	O/M	Command Description
00h	M	Delete I/O Submission Queue
01h	M	Create I/O Submission Queue
02h	M	Get Log Page
04h	M	Delete I/O Completion Queue
05h	M	Create I/O Completion Queue
06h	M	Identify
08h	M	Abort
09h	M	Set Features
0Ah	M	Get Features
0Ch	M	Asynchronous Event Request
10h	O	Firmware Activate
11h	O	Firmware Image Download
14h	O	Device Self-test
80h	O	Format NVM
81h	O	Security Send
82h	O	Security Receive
84h	O	Sanitize

Table 6-2 I/O Commands

Op-Code	O/M	Command Description
00h	O	Flush
01h	O	Write
02h	O	Read
04h	O	Write Uncorrectable
05h	O	Compare
08h	O	Write Zeroes
09h	O	Dataset Management



**Table 6-3 Set Feature Commands**

Op-Code	O/M	Command Description
00h		Reserved
01h	M	Arbitration
02h	M	Power Management
03h	O	LBA Range Type
04h	M	Temperature Threshold
05h	M	Error Recovery
06h	O	Volatile Write Cache
07h	M	Number of Queues
08h	M	Interrupt Coalescing
09h	M	Interrupt Vector Configuration
0Ah	M	Write Atomicity Normal
0Bh	M	Asynchronous Event Configuration
0Ch	O	Autonomous Power State Transition
0Dh	O	Host Memory Buffer
0Eh	O	Timestamp
10h	O	Host Controlled Thermal Management
11h	O	Non-Operational Power State Config
0Eh – 7Dh		Reserved
80h	O	Software Progress Marker

**Table 6-4 Get Log Page Commands**

Op-Code	O/M	Command Description
00h		Reserved
01h	M	Error Information
02h	M	SMART / Health Information
03h	M	Firmware Slot Information
04h	O	Changed Namespace List
06h	O	Device Self-test
09h – 7Fh		Reserved
81h	O	Sanitize Status
82h - FFh		Reserved

## 6.2. Identify Device Data

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

### ■ 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)	0x00
77	M	Maximum Data Transfer Size (MDTS)	0x09
79:78	M	Controller ID (CNTLID)	0x0001
83:80	M	Version (VER)	0x00010300
87:84	M	RTD3 Resume Latency (RTD3R)	0x001E8480(2sec)
91:88	M	RTD3 Entry Latency (RTD3E)	0x00989680(10sec)
95:92	M	Optional Asynchronous Events Supported (OAES)	0x00000300
99:96	M	Controller Attributes (CTRATT)	0x0002
239:100	-	Reserved	0x00
255:240	-	Refer to the NVMe Management Interface Specification for definition	0x00
257:256	M	Optional Admin Command Support (OACS)	0x0017
258	M	Abort Command Limit (ACL)	0x03
259	M	Asynchronous Event Request Limit (AERL)	0x03
260	M	Firmware Updates (FRMW)	0x1F
261	M	Log Page Attributes (LPA)	0x0C
262	M	Error Log Page Entries (ELPE)	0x3E
263	M	Number of Power States Support (NPSS)	4
264	M	Admin Vendor Specific Command Configuration (AVSCC)	0x01
265	O	Autonomous Power State Transition Attributes (APSTA)	0x01
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)	0x0000 (No report)

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Bytes	O/M	Description	Default Value
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
511:316	-	Reserved	Non-zero
<b>NVM Command Set Attributes</b>			
512	M	Submission Queue Entry Size (SQES)	0x66
513	M	Completion Queue Entry Size (CQES)	0x44
515:514	-	Reserved	0x0000
519:516	M	Number of Namespaces (NN)	0x00000001
521:520	M	Optional NVM Command Support (ONCS)	0x001F
523:522	M	Fused Operation Support (FUSES)	0x0000
524	M	Format NVM Attributes (FNA)	0x00
525	M	Volatile Write Cache (VWC)	0x01
527:526	M	Atomic Write Unit Normal (AWUN)	TBD
529:528	M	Atomic Write Unit Power Fail (AWUPF)	TBD
530	M	NVM Vendor Specific Command Configuration (NVSCC)	0x01
531	-	Reserved	0x00
533:532	O	Atomic Compare & Write Unit (ACWU)	0x0000
535:534	-	Reserved	0x0000
539:536	O	SGL Support (SGLS)	0x00000000
703:540	-	Reserved	0x00
<b>IO Command Set Attributes</b>			
2047:704	-	Reserved	0x00
2079:2048	M	Power State 0 Descriptor (PSD0)	TBD
2111:2080	O	Power State 1 Descriptor (PSD1)	0x00
2143:2112	O	Power State 2 Descriptor (PSD2)	0x00
2175:2144	O	Power State 3 Descriptor (PSD3)	0x00
2207:2176	O	Power State 4 Descriptor (PSD4)	0x00
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

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

\* 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

## ■ 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)	0x00
25	M	Number of LBA Formats (NLBAF)	0x01
26	M	Formatted LBA Size (FLBAS)	0x00
27	M	Metadata Capabilities (MC)	0x00
28	M	End-to-end Data Protection Capabilities (DPC)	0x00
29	M	End-to-end Data Protection Type Settings (DPS)	0x00
30	O	Namespace Multi-path I/O and Namespace Sharing Capabilities (NMIC)	0x00
31	O	Reservation Capabilities (RESCAP)	0x00
32	O	Format Progress Indicator (FPI)	0x00
33	-	Reserved	0x00
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	-	Reserved	0x0000
63:48	O	NVM Capacity (NVMCAP)	0x00
103:64	-	Reserved	0x00
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

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Bytes	O/M	Description	Default Value
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

\* See IDEMA SPEC

\*\* See IEEE EUI-64 SPEC

## ■ List of Identify Namespace Data Structure for Each Capacity

Capacity (GB)	Byte[7:0]: Namespace Size (NSZE)
240	1BF244B0h
480	37E436B0h
960	6FC81AB0h
1920	DF8FE2B0h
3840	1BF1F72B0h
7680	37E3E92B0h
15360	6FC7CD2B0h



### 6.3. SMART Attributes

■ SMART Attributes (Log Identifier 02h)

Bytes Index	Bytes	Description
[0]	1	Critical Warning: Error occurred if value of the bits are not zero
[2:1]	2	Composite Temperature: Flash temp value will be detected on-board thermal sensor (Unit: K)
[3]	1	Available Spare: Remaining spare capacity available. (Unit: %)
[4]	1	Available Spare Threshold: Spare capacity threshold. (Unit: %)
[5]	1	Percentage Used: Average of the Flash's block erase count / NAND EOL erase count (Unit: %)
[31:6]	26	Reserved
[47:32]	16	Data Units Read (in LBAs): Contains the number of 512byte data units the host has read from the controller. This value is reported in thousands (i.e, a value of 1 corresponds to 1000 units of 512 bytes read).
[63:48]	16	Data Units Written (in LBAs): Contains the number of 512byte data units the host has written from the controller. This value is reported in thousands (i.e, a value of 1 corresponds to 1000 units of 512 bytes written).
[79:64]	16	Host Read Commands: The number of read commands completed by the controller.
[95:80]	16	Host Write Commands: The number of read commands completed by the controller.
[111:96]	16	Controller Busy Time: The amount of time the controller is busy with I/O commands.
[127:112]	16	Power Cycles: Normal power on/off cycles count
[143:128]	16	Power On Hours (Unit: hour)
[159:144]	16	Unsafe Shutdowns: Abnormal power on/off cycles count
[175:160]	16	Media and Data Integrity Errors: The number of occurrences where the controller detected an unrecovered data integrity error.
[191:176]	16	Number of Error Information Log Entries: The number of Error Information log entries over the life of the controller.
[195:192]	4	Warning Composite Temperature Time: The amount of time that temp. over warning threshold (85°C) but less than critical threshold (95°C). (Unit: min)
[199:196]	4	Critical Composite Temperature Time: The amount of time that temp. over critical threshold (95°C). (Unit: min)
[201:200]	2	Temperature Sensor 1 (Current Temperature) (Unit: K)
[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)
[511:216]	296	Reserved



## 7. PHYSICAL DIMENSION

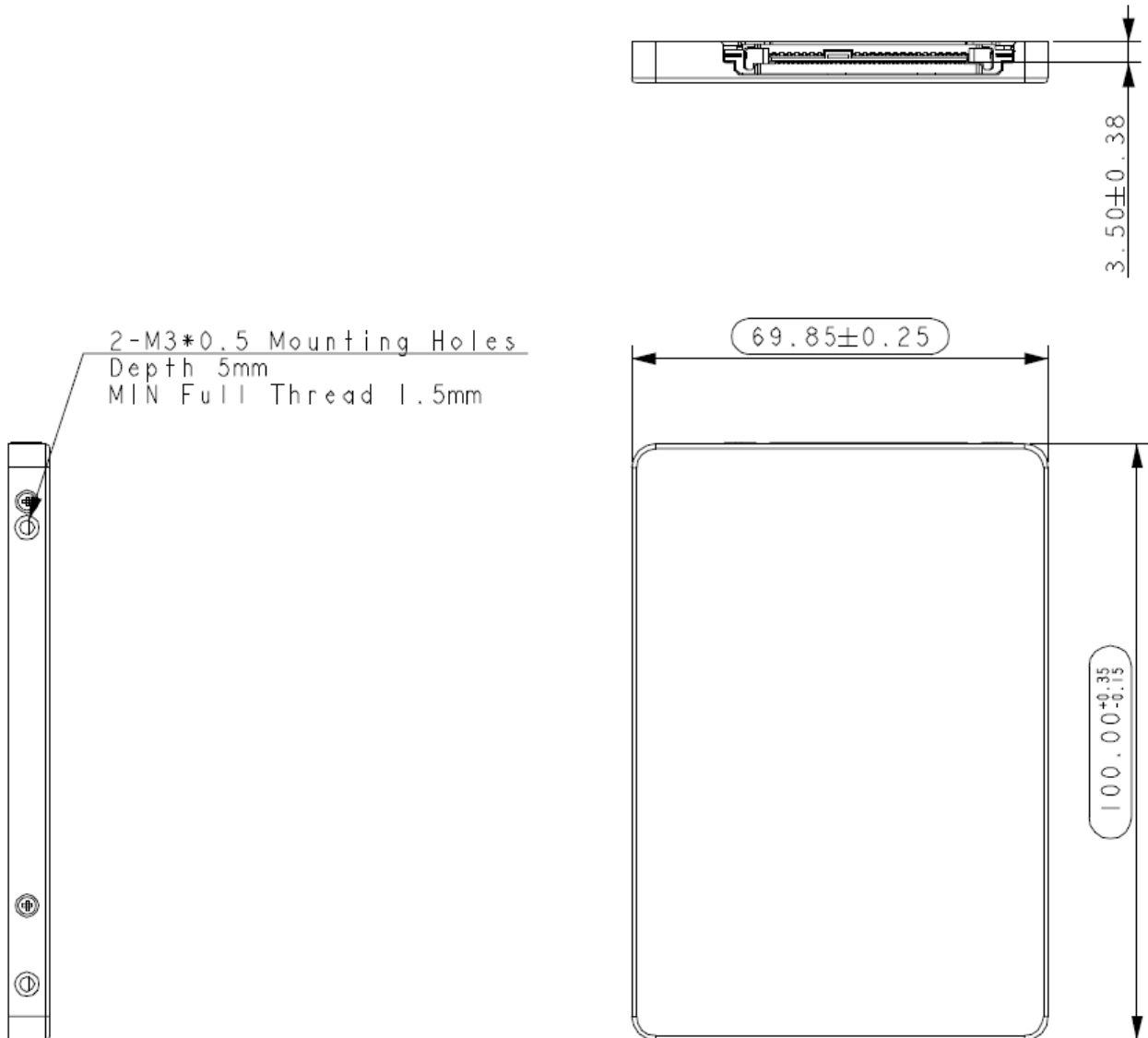


Type1: Dimension: 100.00mm (L) x 69.85mm (W) x 7.00mm (H)

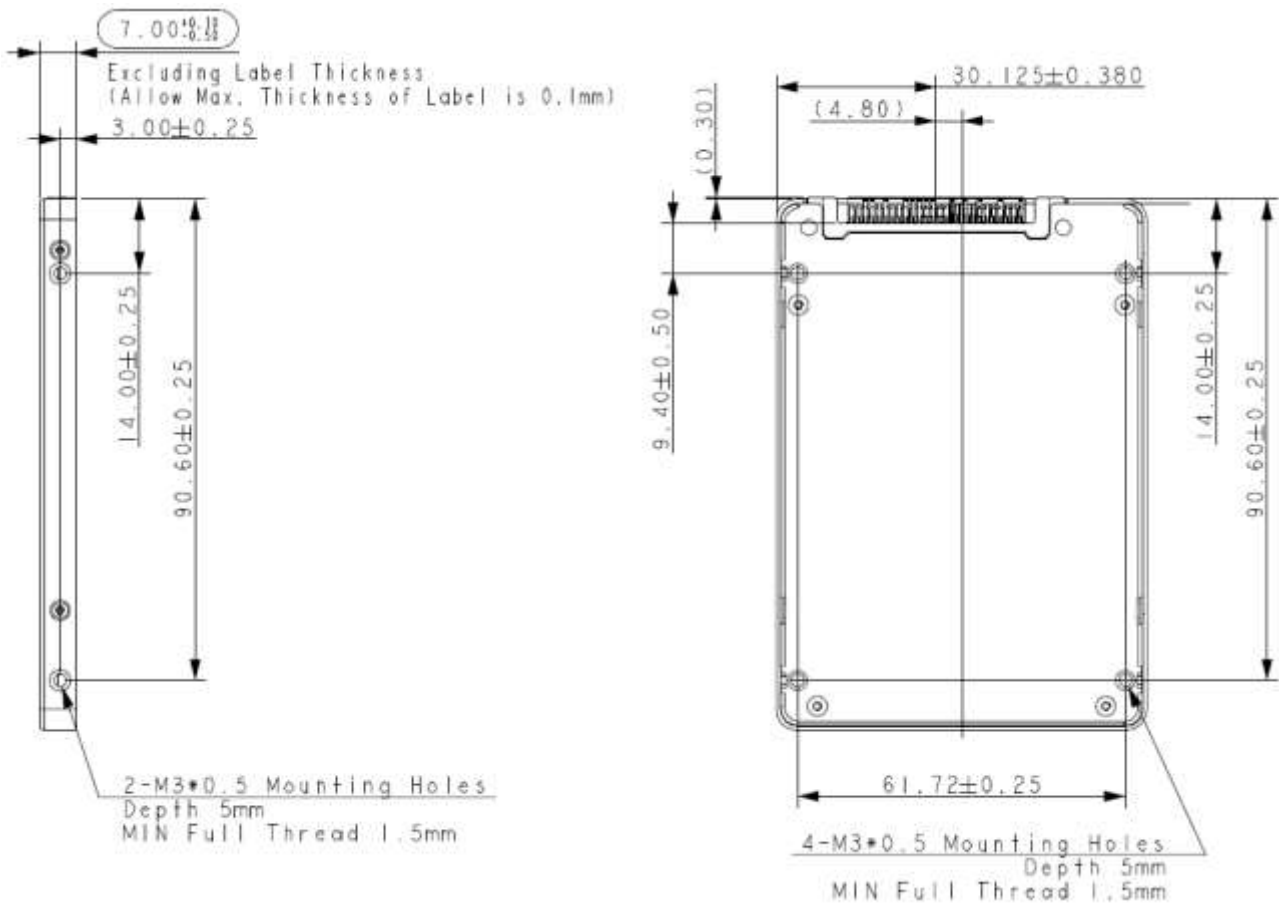
Type2: Dimension: 100.00mm (L) x 69.85mm (W) x 15.00mm (H)

**Type1:**

Top View



**Bottom View**



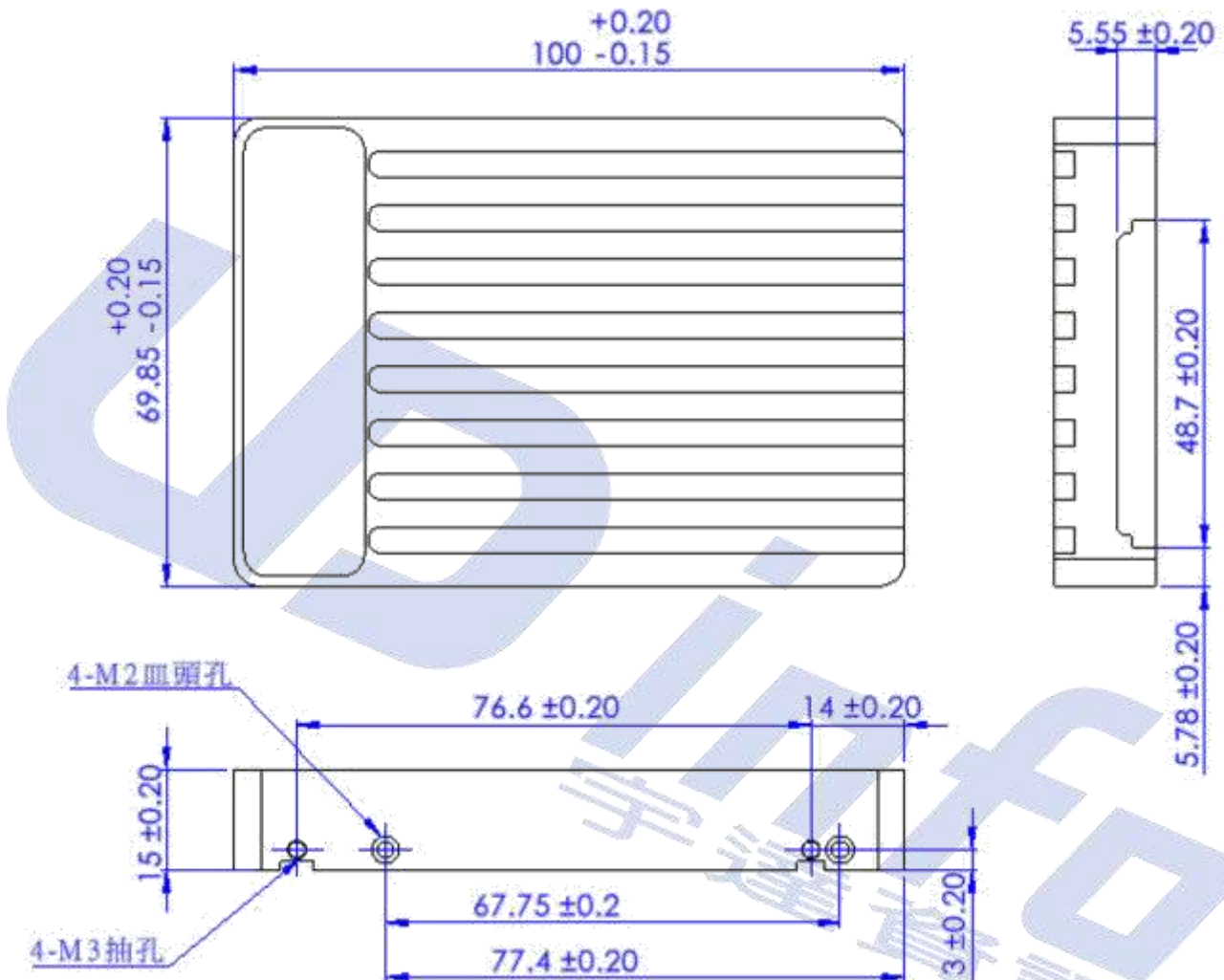
**Notes:**

1. Common tolerance refers to class (B).
2.  $\circ$  are critical dimensions.
3. All of dimension except critical dimension, please perform real assembly.
4. ( ) is reference dimension.

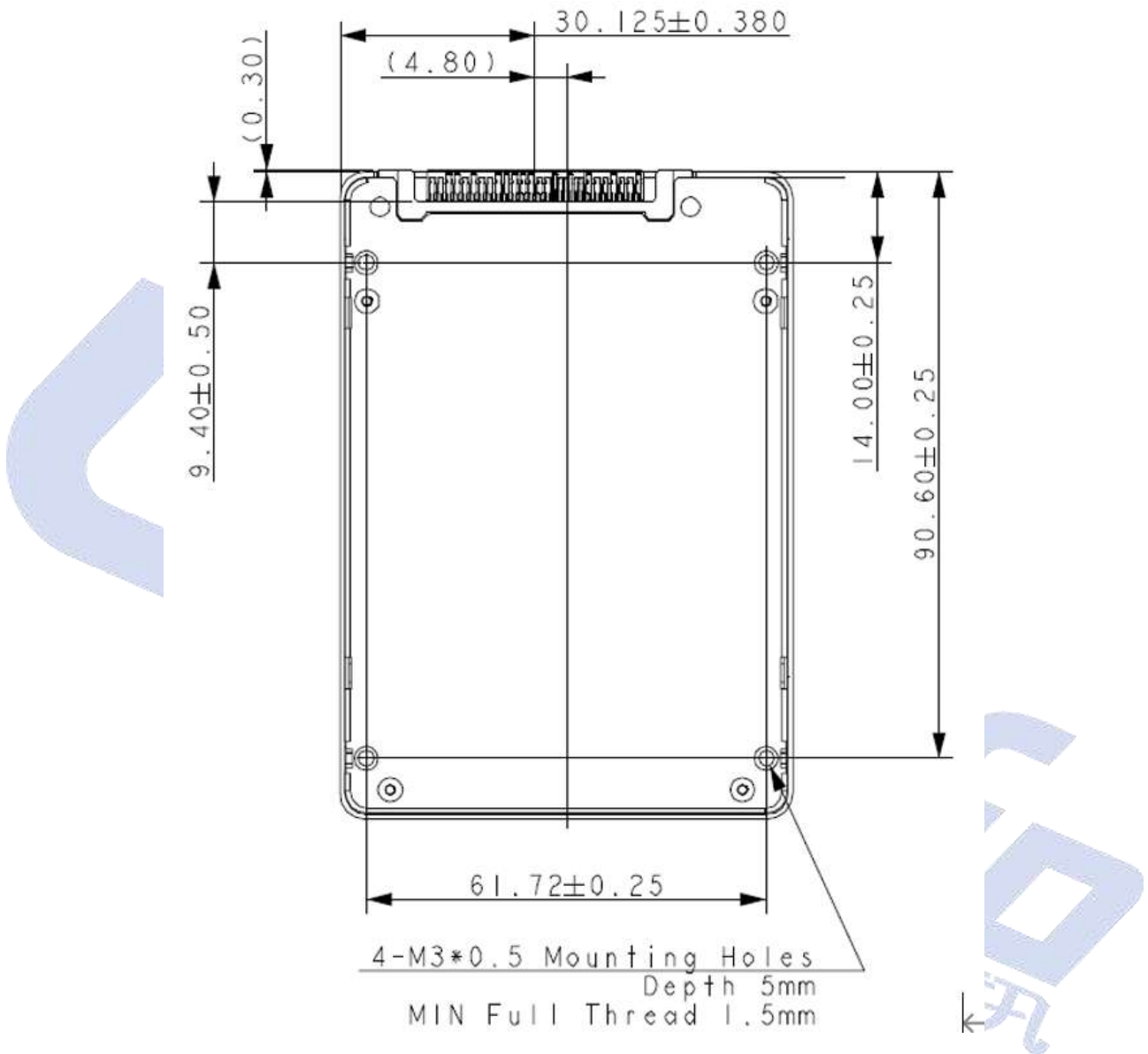


**Type2:**


Top View



**Bottom View**



**Notes:**

1. Common tolerance refers to class (B).
2.  are critical dimensions.
3. All of dimension except critical dimension, please perform real assembly.
4. ( ) is reference dimension.

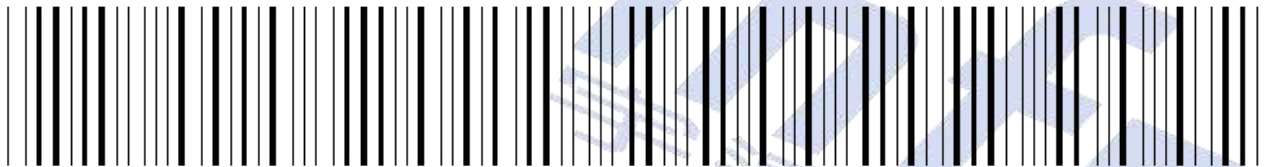
## 8. TERMINOLOGY



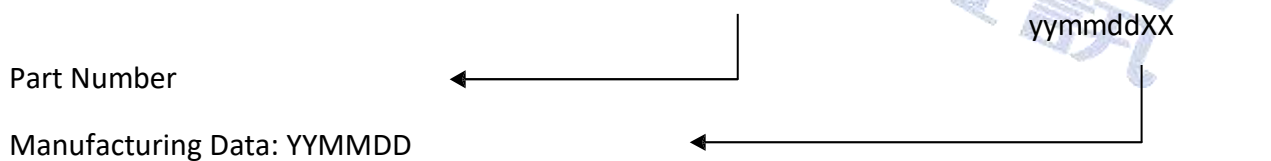
The following table is to list out the acronyms that have been applied throughout the document.

Term	Definitions
DDR	Double data rate (SDRAM)
ASPM	Active States Power Management
APST	Autonomous Power State Transition
LBA	Logical block addressing
MTBF	Mean time between failures
PCIe	PCI Express / Peripheral Component Interconnect Express
S.M.A.R.T.	Self-monitoring, analysis and reporting technology

## 9. BARCODE DESCRIPTION



P F D 2 5 D C 9 6 0 G B A E P



# 10. PARTNUMBER DECODER



PFD-25DCX<sup>8</sup>X<sup>9</sup>X<sup>10</sup>X<sup>11</sup>X<sup>12</sup>X<sup>13</sup>X<sup>14</sup>X<sup>15</sup>X<sup>16</sup>X<sup>17</sup>

X <sup>1</sup> X <sup>2</sup> X <sup>3</sup>	X <sup>4</sup> X <sup>5</sup>	X <sup>6</sup> X <sup>7</sup>	X <sup>8</sup> X <sup>9</sup> X <sup>10</sup> X <sup>11</sup> X <sup>12</sup>	X <sup>13</sup>	X <sup>14</sup>	X <sup>15</sup>	X <sup>16</sup> X <sup>17</sup>
PFD	25	DC	240GB 480GB 960GB 1920G 3840G 7680G 15T3B	A: 3D TLC Standard (0°C ~ +70°C) B: 3D TLC Industrial (-40°C ~ +85°C)	E	P	blank

X <sup>16</sup> X <sup>17</sup>
Blank: standard 01: Write Protection (WP) 03: Quick Erase Jumper (QEJ) 06: Conformal Coating (CC) 07: CC + WP 09: CC + QEJ 20: PLP 21: PLP + Conformal Coating (CC) 24: PLP + Quick Erase Jumper (QEJ) 28: PLP + AES 31: AES + OPAL 32: PLP + AES + OPAL 35: PLP + WP 36: PLP + WP + CC 37: PLP + AES + CC 43: AES + OPAL + CC 44: AES + OPAL + QEJ