

# UD info Corp.

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



**UD info CORP.**

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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 |

## Product Overview

- **Capacity**
  - 240GB up to 7680GB
- **Form Factor**
  - U.2
- **PCIe Interface**
  - NVMe PCIe Gen3 x4
- **Compliance**
  - NVMe 1.3
  - PCI Express Base 3.1
- **Flash Interface**
  - Flash Type: 3D TLC
  - Transfer rate up to 533Mbps
  - Up to 16pcs of BGA132/152 flash
- **Performance**<sup>Note1</sup>
  - Sequential Read up to 3,200 MB/s
  - Sequential Write up to 1,000 MB/s
- **Power Consumption**<sup>Note2</sup>
  - Active mode: < 9500mW
- **Reliability**
  - MTBF more than 1,500,000 hours
  - Uncorrectable Bit Error Rate(UBER)  
< 1 sector per 10<sup>16</sup> bits read
- **Advanced Flash Management**
  - Advanced Wear Leveling
  - Bad Block Management
  - TRIM
  - SMART
  - Over-Provision
- **Temperature Range**<sup>Note4</sup>
  - Operation (Standard): 0°C ~ 70°C
  - Operation (Wide): -40°C ~ 85°C
  - Storage: -40°C ~ 85°C
- **Features Support List**
  - End to end data path protection
  - Thermal throttling
  - SmartECC™
  - SmartRefresh™
  - Drive log
  - Support of AES/TCG OPAL<sup>Note3</sup>
- **Compliant**
  - RoHS
- **Hardware Power Loss Protection Support**

### Notes:

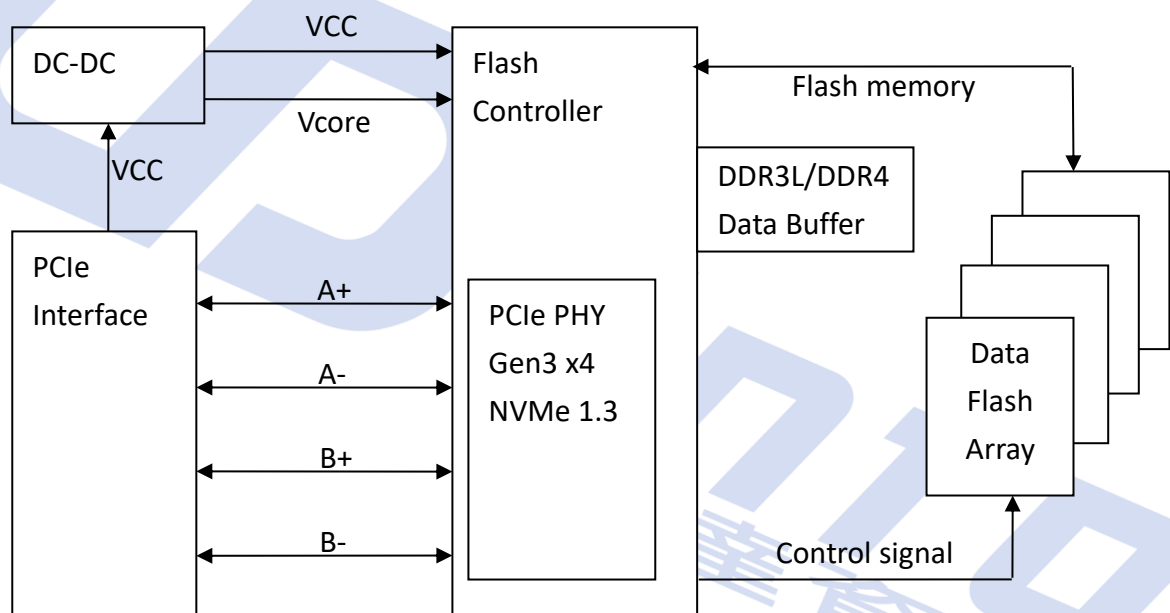
1. Refer to Chapter 2 for more details.
2. Refer to Chapter 4, section 4.2 power consumption for more details.
3. Support by a separate firmware version. Further information available upon request.
4. The operation temperature means the case temperature, in which can be detected via the S.M.A.R.T.

## 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, providing low power consumption compared to traditional hard drive and hot-swapping when removing/replacing/upgrading flash disks. The device is designed based on the standard 38-pin interface for data segment and 15-pin for power segment, as well as operating at a maximum operating frequency of 400MHz with 25MHz external crystal. Its capacity could provide a wide range up to 7,680GB(8TB). Moreover, it can reach up to 3,200MB/s read as well as 1,000MB/s write high performance based on Toshiba's Bics3 TLC flash.

### 1.2. Block Diagram



U.2 PCIe SSD Block Diagram

## 2. PRODUCT SPECIFICATIONS



### 2.1. Product Specifications

- **Capacity**
  - 240GB up to 7680GB
- **Electrical/Physical Interface**
  - PCI Express Base Ver 3.1
  - Compliant with NVMe 1.3
  - PCIe Gen3 x 4 lane & backward compatible to PCIe Gen2 and Gen1
- **Supported NAND Flash**
  - Support Toshiba BiCS3 TLC
  - Support up to 16pcs of BGA132/152 flash
- **ECC Scheme**
  - Applies LDPC of ECC algorithm
- **Sector Size Support**
  - 512Bytes
  - 4KB
- **UART / GPIO**
- **Support SMART and TRIM commands**
- **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.

- **LBA Range**

- IDEMA standard

| Capacity | Total Sectors (LBA) | User Data Size              |
|----------|---------------------|-----------------------------|
| 240GB    | 468,862,128         | Depended on file management |
| 480GB    | 937,703,088         |                             |
| 960GB    | 1,875,385,008       |                             |
| 1920GB   | 3,750,748,848       |                             |
| 3840GB   | 7,501,476,528       |                             |
| 7680GB   | 15,002,931,888      |                             |

- **Performance**

- BiCS3 TLC

| Capacity | Flash Structure | Flash Type | Sequential  |              | Random      |              |
|----------|-----------------|------------|-------------|--------------|-------------|--------------|
|          |                 |            | Read (MB/s) | Write (MB/s) | Read (IOPS) | Write (IOPS) |
| 240GB    | 64GB x 4        | BiCS3, BGA | 3,000       | 340          | 100K        | 13K          |
| 480GB    | 64GB x 8        | BiCS3, BGA | 3,000       | 520          | 200K        | 20K          |
| 960GB    | 128GB x 8       | BiCS3, BGA | 3,200       | 1,000        | 360K        | 25K          |
| 1920GB   | 128GB x 16      | BiCS3, BGA | 3,200       | 1,000        | 360K        | 28K          |
| 3840GB   | 256GB x 16      | BiCS3, BGA | 2,900       | 970          | 400K        | 30K          |
| 7680GB   | 512GB x 16      | BiCS3, BGA | 2,900       | 970          | 400K        | 30K          |

**Notes:**

1. The performance was estimated based on Toshiba BiCS3 TLC NAND flash.
2. Performance may differ according to flash configuration and platform.
3. The table above is for reference only. Any criteria for accepting goods shall be discussed based on different flash configurations.
4. Performance is measured with the follow conditions
  - (a) CrystalDiskMark 6.0, 1GB range, QD=32, Thread=1
  - (b) IOMeter, 4K data size, QD=256

- TBW (Terabytes Written)

- BiCS3 TLC

| Capacity | Flash Type | TBW    |
|----------|------------|--------|
| 240GB    | BiCS3 TLC  | 394    |
| 480GB    | BiCS3 TLC  | 806    |
| 960GB    | BiCS3 TLC  | 1,586  |
| 1920GB   | BiCS3 TLC  | 3,031  |
| 3840GB   | BiCS3 TLC  | 6,286  |
| 7680GB   | BiCS3 TLC  | 12,044 |

**Notes:**

1. Samples were built using Toshiba BiCS3 TLC NAND flash.
2. The test followed JEDEC218/219A client endurance workload.
3. TBW may differ according to flash configuration and platform.



## 2.2. 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.

- **SSD Configuration:**

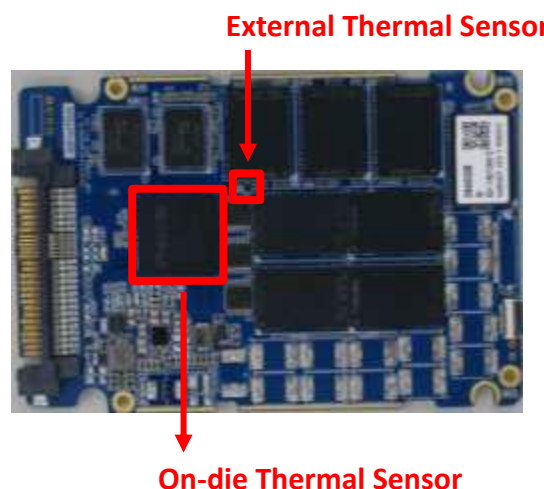
- Example 480GB SSD: (BiCS3 256Gb x 2CE) x 8pcs BGA132/152, total 16CE
- CE = Chip Enable pins, max CE = All 16CE enabled. Total CE numbers depends on SSD configuration

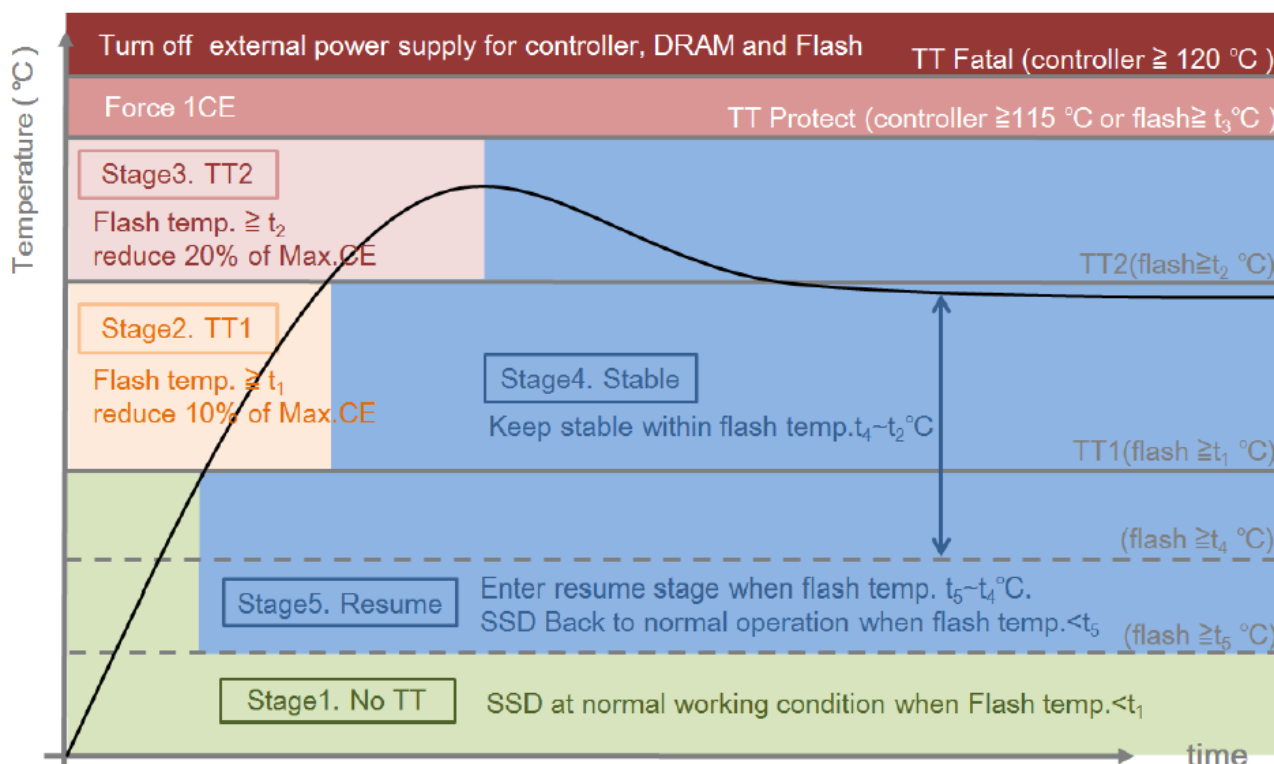
- **Purpose of Thermal Throttling:**

- 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<br>Normal-temp. grade: 0-70°C | Operation temp. of<br>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

### 3. ENVIRONMENTAL SPECIFICATIONS



#### 3.1. Environmental Conditions

##### 3.1.1. Temperature and Humidity

- ◆ Operational (Standard grade): 0°C to 70°C
- ◆ Operational (Wide grade): -40°C to 85°C
- ◆ Storage: -40°C to 85°C

##### ■ High Temperature Test Condition

|           | Temperature | Humidity |
|-----------|-------------|----------|
| Operation | 70°C/85°C   | 0% RH    |
| Storage   | 85°C        | 0% RH    |

##### ■ Low Temperature Test Condition

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

##### ■ High Humidity Test Condition

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

##### ■ Temperature Cycle Test

|           | Temperature |
|-----------|-------------|
| Operation | 0°C/-40°C   |
|           | 70°C/85°C   |
| Storage   | -40°C       |
|           | 85°C        |

##### Notes:

1. Operation temperature is measured by device temperature sensor. Airflow is suggested and it will allow device to be operated at appropriate temperature for each component during heavy workloads environment.
2. Operation temperature shows in case temperature not ambient temperature.

## 3.1.2. Shock

### ■ Shock Specification

|                 | Acceleration Force |
|-----------------|--------------------|
| Non-Operational | 1500G              |
| Operational     | 1500G              |

## 3.1.3. Vibration

### ■ Vibration Specification

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

## 3.1.4. Drop

### ■ Drop Specification

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

## 3.1.5. Bending

### ■ Bending Specification

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

## 3.1.6. Electrostatic Discharge (ESD)

| Specification                                        | +/- 4KV                                                                                               |
|------------------------------------------------------|-------------------------------------------------------------------------------------------------------|
| EN 55024, CISPR 24<br>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. |

## 3.1.7. EMI Compliance

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

### 3.2. MTBF

MTBF, Mean Time Between Failures, is a measure of reliability 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 (Relex7.3). Please note that a lower MTBF should be expected for higher capacity drives, and we apply the lowest MTBF all capacities.



## 4. ELECTRICAL SPECIFICATIONS



### 4.1. Supply Voltage

| Parameter         | Rating |
|-------------------|--------|
| Operating Voltage | 12V    |

### 4.2. Power Consumption

- Power consumption of U.2 PCIe SSD

| Capacity | Flash Type                | CE# | Read (mW) | Write (mW) |
|----------|---------------------------|-----|-----------|------------|
| 240GB    | 64GB x4, Bics3 TLC, BGA   | 8   | 5,600     | 3,200      |
| 480GB    | 64GB x8, Bics3 TLC, BGA   | 16  | 6,100     | 3,400      |
| 960GB    | 128B x8, Bics3 TLC, BGA   | 32  | 6,300     | 4,600      |
| 1920GB   | 128GB x16, Bics3 TLC, BGA | 32  | 8,000     | 5,500      |
| 3840GB   | 256GB x16, Bics3 TLC, BGA | 64  | 8,500     | 6,000      |
| 7680GB   | 512GB x16, Bics3 TLC, BGA | 64  | 9,500     | 6,600      |

Unit: mW

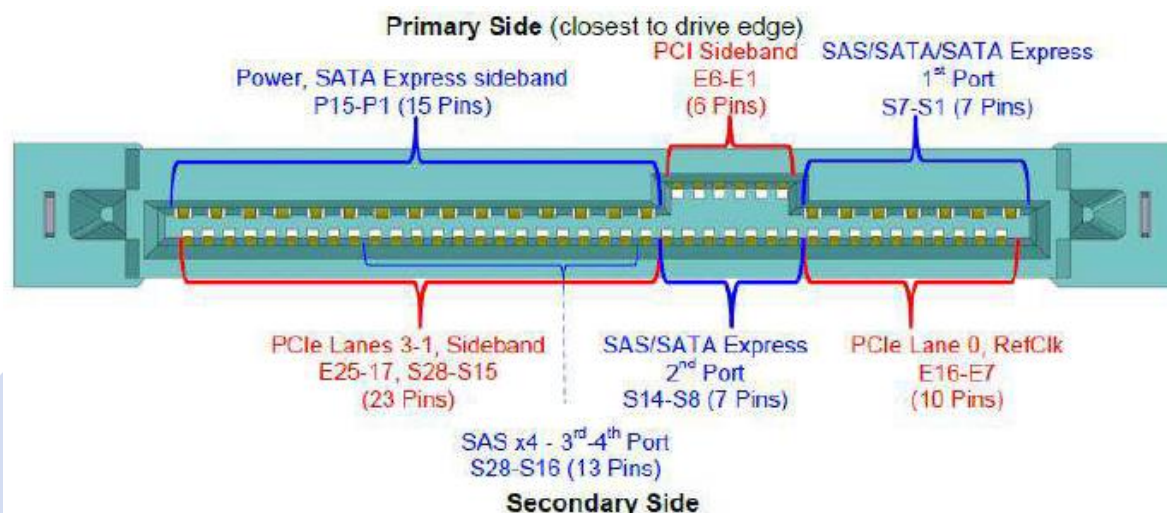
#### Notes

- Based on ECFM1xxx-series under ambient temperature.
- The average value of power consumption is achieved based on 100% conversion efficiency.
- Sequential R/W is measured while testing 1GB sequential R/W 5 times by CyrstalDiskMark.
- Power Consumption may differ according to flash configuration and platform.
- The measured power voltage is 12V.

## 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    | Idet#          | 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      |

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| 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                   |



| 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 | Default Value      | Description                                                         |
|---------|-----|--------------------|---------------------------------------------------------------------|
| 01:00   | M   | 0x1987             | PCI Vendor ID (VID)                                                 |
| 03:02   | M   | 0x1987             | PCI Subsystem Vendor ID (SSVID)                                     |
| 23:04   | M   | TBD                | Serial Number (SN)                                                  |
| 63:24   | M   | TBD                | Model Number (MN)                                                   |
| 71:64   | M   | TBD                | Firmware Revision (FR)                                              |
| 72      | M   | 0x01               | Recommended Arbitration Burst (RAB)                                 |
| 75:73   | M   | TBD *              | IEEE OUI Identifier (IEEE)                                          |
| 76      | O   | 0x00               | Controller Multi-Path I/O and Namespace Sharing Capabilities (CMIC) |
| 77      | M   | 0x09               | Maximum Data Transfer Size (MDTS)                                   |
| 79:78   | M   | 0x0001             | Controller ID (CNTLID)                                              |
| 83:80   | M   | 0x00010300         | Version (VER)                                                       |
| 87:84   | M   | 0x001E8480(2sec)   | RTD3 Resume Latency (RTD3R)                                         |
| 91:88   | M   | 0x00989680(10sec)  | RTD3 Entry Latency (RTD3E)                                          |
| 95:92   | M   | 0x00000300         | Optional Asynchronous Events Supported (OAES)                       |
| 99:96   | M   | 0x0002             | Controller Attributes (CTRATT)                                      |
| 239:100 | -   | 0x00               | Reserved                                                            |
| 255:240 | -   | 0x00               | Refer to the NVMe Management Interface Specification for definition |
| 257:256 | M   | 0x0017             | Optional Admin Command Support (OACS)                               |
| 258     | M   | 0x03               | Abort Command Limit (ACL)                                           |
| 259     | M   | 0x03               | Asynchronous Event Request Limit (AERL)                             |
| 260     | M   | 0x1F               | Firmware Updates (FRMW)                                             |
| 261     | M   | 0x0C               | Log Page Attributes (LPA)                                           |
| 262     | M   | 0x3E               | Error Log Page Entries (ELPE)                                       |
| 263     | M   | 4                  | Number of Power States Support (NPSS)                               |
| 264     | M   | 0x01               | Admin Vendor Specific Command Configuration (AVSCC)                 |
| 265     | O   | 0x01               | Autonomous Power State Transition Attributes (APSTA)                |
| 267:266 | M   | 0x0157 (70C)       | Warning Composite Temperature Threshold (WCTEMP)                    |
| 269:268 | M   | 0x0161 (80C)       | Critical Composite Temperature Threshold (CCTEMP)                   |
| 271:270 | O   | 0x0000 (No report) | Maximum Time for Firmware Activation (MTFA)                         |
| 275:272 | O   | 0x00000000         | Host Memory Buffer Preferred Size (HMPRE)                           |
| 279:276 | O   | 0x00000000         | Host Memory Buffer Minimum Size (HMMIN)                             |

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| Bytes                             | O/M | Default Value | Description                                       |
|-----------------------------------|-----|---------------|---------------------------------------------------|
| 295:280                           | O   | **            | Total NVM Capacity (TNVMCAP)                      |
| 311:296                           | O   | **            | Unallocated NVM Capacity (UNVMCAP)                |
| 315:312                           | O   | 0x00000000    | Replay Protected Memory Block Support (RPMBS)     |
| 511:316                           | -   | Non-zero      | Reserved                                          |
| <b>NVM Command Set Attributes</b> |     |               |                                                   |
| 512                               | M   | 0x66          | Submission Queue Entry Size (SQES)                |
| 513                               | M   | 0x44          | Completion Queue Entry Size (CQES)                |
| 515:514                           | -   | 0x0000        | Reserved                                          |
| 519:516                           | M   | 0x00000001    | Number of Namespaces (NN)                         |
| 521:520                           | M   | 0x001F        | Optional NVM Command Support (ONCS)               |
| 523:522                           | M   | 0x0000        | Fused Operation Support (FUSES)                   |
| 524                               | M   | 0x00          | Format NVM Attributes (FNA)                       |
| 525                               | M   | 0x01          | Volatile Write Cache (VWC)                        |
| 527:526                           | M   | TBD           | Atomic Write Unit Normal (AWUN)                   |
| 529:528                           | M   | TBD           | Atomic Write Unit Power Fail (AWUPF)              |
| 530                               | M   | 0x01          | NVM Vendor Specific Command Configuration (NVSCC) |
| 531                               | -   | 0x00          | Reserved                                          |
| 533:532                           | O   | 0x0000        | Atomic Compare & Write Unit (ACWU)                |
| 535:534                           | -   | 0x0000        | Reserved                                          |
| 539:536                           | O   | 0x00000000    | SGL Support (SGLS)                                |
| 703:540                           | -   | 0x00          | Reserved                                          |
| <b>IO Command Set Attributes</b>  |     |               |                                                   |
| 2047:704                          | -   | 0x00          | Reserved                                          |
| 2079:2048                         | M   | TBD           | Power State 0 Descriptor (PSD0)                   |
| 2111:2080                         | O   | 0x00          | Power State 1 Descriptor (PSD1)                   |
| 2143:2112                         | O   | 0x00          | Power State 2 Descriptor (PSD2)                   |
| 2175:2144                         | O   | 0x00          | Power State 3 Descriptor (PSD3)                   |
| 2207:2176                         | O   | 0x00          | Power State 4 Descriptor (PSD4)                   |
| 2239:2208                         | O   | 0x00          | Power State 5 Descriptor (PSD5)                   |
| 2271:2240                         | O   | 0x00          | Power State 6 Descriptor (PSD6)                   |
| 2303:2272                         | O   | 0x00          | Power State 7 Descriptor (PSD7)                   |
| 2335:2304                         | O   | 0x00          | Power State 8 Descriptor (PSD8)                   |
| 2367:2336                         | O   | 0x00          | Power State 9 Descriptor (PSD9)                   |
| 2399:2368                         | O   | 0x00          | Power State 10 Descriptor (PSD10)                 |
| 2431:2400                         | O   | 0x00          | Power State 11 Descriptor (PSD11)                 |

| Bytes                  | O/M | Default Value   | Description                       |
|------------------------|-----|-----------------|-----------------------------------|
| 2463:2432              | O   | 0x00            | Power State 12 Descriptor (PSD12) |
| 2495:2464              | O   | 0x00            | Power State 13 Descriptor (PSD13) |
| 2527:2496              | O   | 0x00            | Power State 14 Descriptor (PSD14) |
| 2559:2528              | O   | 0x00            | Power State 15 Descriptor (PSD15) |
| 2591:2560              | O   | 0x00            | Power State 16 Descriptor (PSD16) |
| 2623:2592              | O   | 0x00            | Power State 17 Descriptor (PSD17) |
| 2655:2624              | O   | 0x00            | Power State 18 Descriptor (PSD18) |
| 2687:2656              | O   | 0x00            | Power State 19 Descriptor (PSD19) |
| 2719:2688              | O   | 0x00            | Power State 20 Descriptor (PSD20) |
| 2751:2720              | O   | 0x00            | Power State 21 Descriptor (PSD21) |
| 2783:2752              | O   | 0x00            | Power State 22 Descriptor (PSD22) |
| 2815:2784              | O   | 0x00            | Power State 23 Descriptor (PSD23) |
| 2847:2816              | O   | 0x00            | Power State 24 Descriptor (PSD24) |
| 2879:2848              | O   | 0x00            | Power State 25 Descriptor (PSD25) |
| 2911:2880              | O   | 0x00            | Power State 26 Descriptor (PSD26) |
| 2943:2912              | O   | 0x00            | Power State 27 Descriptor (PSD27) |
| 2975:2944              | O   | 0x00            | Power State 28 Descriptor (PSD28) |
| 3007:2976              | O   | 0x00            | Power State 29 Descriptor (PSD29) |
| 3039:3008              | O   | 0x00            | Power State 30 Descriptor (PSD30) |
| 3071:3040              | O   | 0x00            | Power State 31 Descriptor (PSD31) |
| <b>Vendor Specific</b> |     |                 |                                   |
| 4095:3072              | O   | Vendor Reserved | Vendor Specific (VS)              |

\* 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 | Default Value | Description                                                        |
|---------|-----|---------------|--------------------------------------------------------------------|
| 7:0     | M   | TBD*          | Namespace Size (NSZE)                                              |
| 15:8    | M   | TBD*          | Namespace Capacity (NCAP)                                          |
| 23:16   | M   | TBD*          | Namespace Utilization (NUSE)                                       |
| 24      | M   | 0x00          | Namespace Features (NSFEAT)                                        |
| 25      | M   | 0x01          | Number of LBA Formats (NLBAF)                                      |
| 26      | M   | 0x00          | Formatted LBA Size (FLBAS)                                         |
| 27      | M   | 0x00          | Metadata Capabilities (MC)                                         |
| 28      | M   | 0x00          | End-to-end Data Protection Capabilities (DPC)                      |
| 29      | M   | 0x00          | End-to-end Data Protection Type Settings (DPS)                     |
| 30      | O   | 0x00          | Namespace Multi-path I/O and Namespace Sharing Capabilities (NMIC) |
| 31      | O   | 0x00          | Reservation Capabilities (RESCAP)                                  |
| 32      | O   | 0x00          | Format Progress Indicator (FPI)                                    |
| 33      | -   | 0x00          | Reserved                                                           |
| 35:34   | O   | 0x0000        | Namespace Atomic Write Unit Normal (NAWUN)                         |
| 37:36   | O   | 0x0000        | Namespace Atomic Write Unit Power Fail (NAWUPF)                    |
| 39:38   | O   | 0x0000        | Namespace Atomic Compare & Write Unit (NACWU)                      |
| 41:40   | O   | 0x0000        | Namespace Atomic Boundary Size Normal (NABSN)                      |
| 43:42   | O   | 0x0000        | Namespace Atomic Boundary Offset (NABO)                            |
| 45:44   | O   | 0x0000        | Namespace Atomic Boundary Size Power Fail (NABSPF)                 |
| 47:46   | -   | 0x0000        | Reserved                                                           |
| 63:48   | O   | 0x00          | NVM Capacity (NVMCAP)                                              |
| 103:64  | -   | 0x00          | Reserved                                                           |
| 119:104 | O   | TBD **        | Namespace Globally Unique Identifier (NGUID)                       |
| 127:120 | O   | TBD **        | IEEE Extended Unique Identifier (EUI64)                            |
| 131:128 | M   | 0x02090000    | LBA Format 0 Support (LBAF0)                                       |
| 135:132 | O   | 0x00000000    | LBA Format 1 Support (LBAF1)                                       |
| 139:136 | O   | 0x00000000    | LBA Format 2 Support (LBAF2)                                       |
| 143:140 | O   | 0x00000000    | LBA Format 3 Support (LBAF3)                                       |
| 147:144 | O   | 0x00000000    | LBA Format 4 Support (LBAF4)                                       |
| 151:148 | O   | 0x00000000    | LBA Format 5 Support (LBAF5)                                       |
| 155:152 | O   | 0x00000000    | LBA Format 6 Support (LBAF6)                                       |
| 159:156 | O   | 0x00000000    | LBA Format 7 Support (LBAF7)                                       |
| 163:160 | O   | 0x00000000    | LBA Format 8 Support (LBAF8)                                       |
| 167:164 | O   | 0x00000000    | LBA Format 9 Support (LBAF9)                                       |

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| Bytes    | O/M | Default Value | Description                    |
|----------|-----|---------------|--------------------------------|
| 171:168  | O   | 0x00000000    | LBA Format 10 Support (LBAF10) |
| 175:172  | O   | 0x00000000    | LBA Format 11 Support (LBAF11) |
| 179:176  | O   | 0x00000000    | LBA Format 12 Support (LBAF12) |
| 183:180  | O   | 0x00000000    | LBA Format 13 Support (LBAF13) |
| 187:184  | O   | 0x00000000    | LBA Format 14 Support (LBAF14) |
| 191:188  | O   | 0x00000000    | LBA Format 15 Support (LBAF15) |
| 383:192  | -   | 0x00          | Reserved                       |
| 4095:384 | O   | 0x00          | Vendor Specific (VS)           |

\* See IDEMA SPEC

\*\* See IEEE EUI-64 SPEC

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

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



## 6.3. SMART Attributes

### ■ SMART Attributes (Log Identifier 02h)

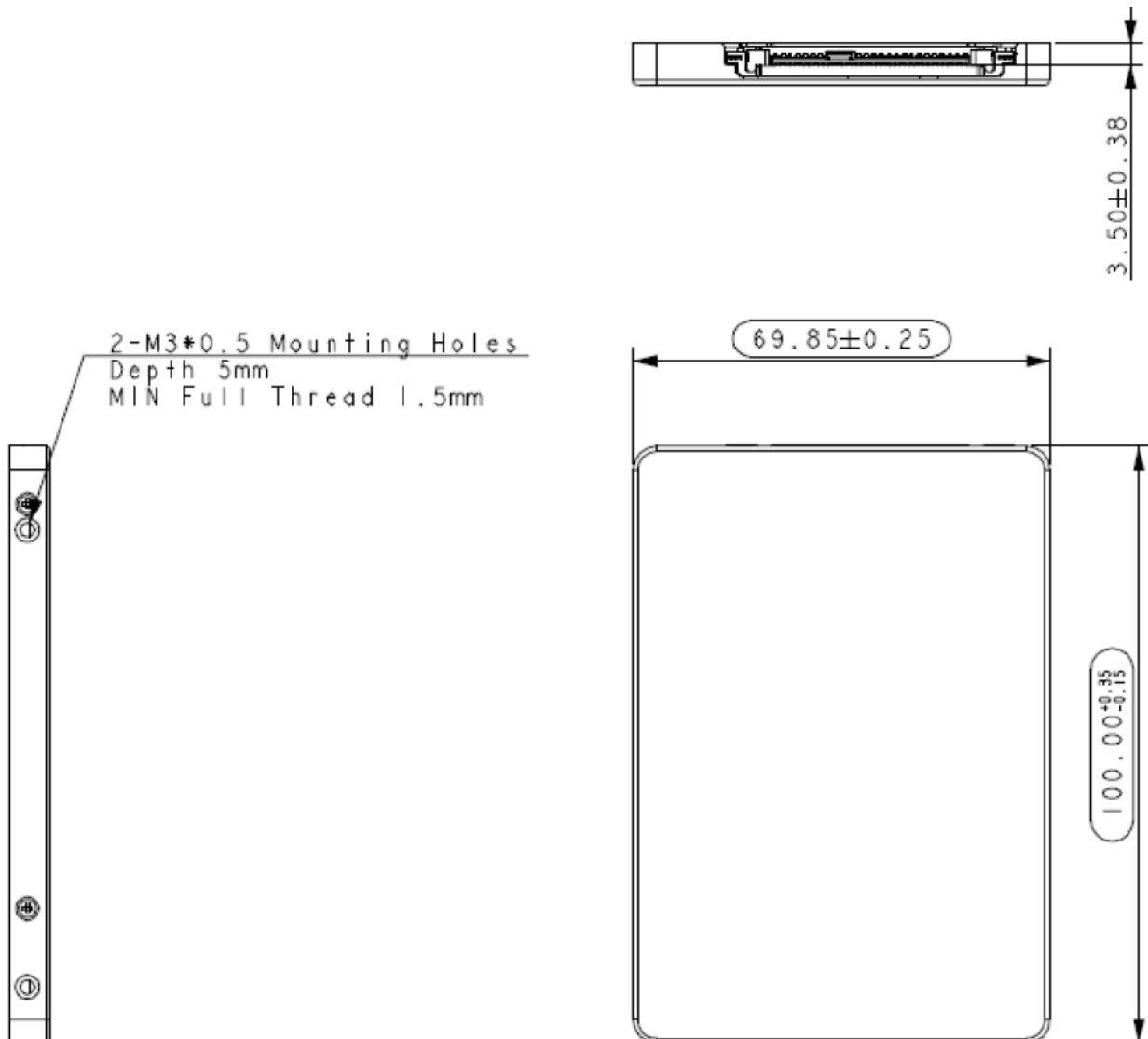
| Bytes Index | Bytes | Description                                |
|-------------|-------|--------------------------------------------|
| [0]         | 1     | Critical Warning                           |
| [2:1]       | 2     | Composite Temperature                      |
| [3]         | 1     | Available 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)                 |
| [511:216]   | 296   | Reserved                                   |

## 7. PHYSICAL DIMENSION

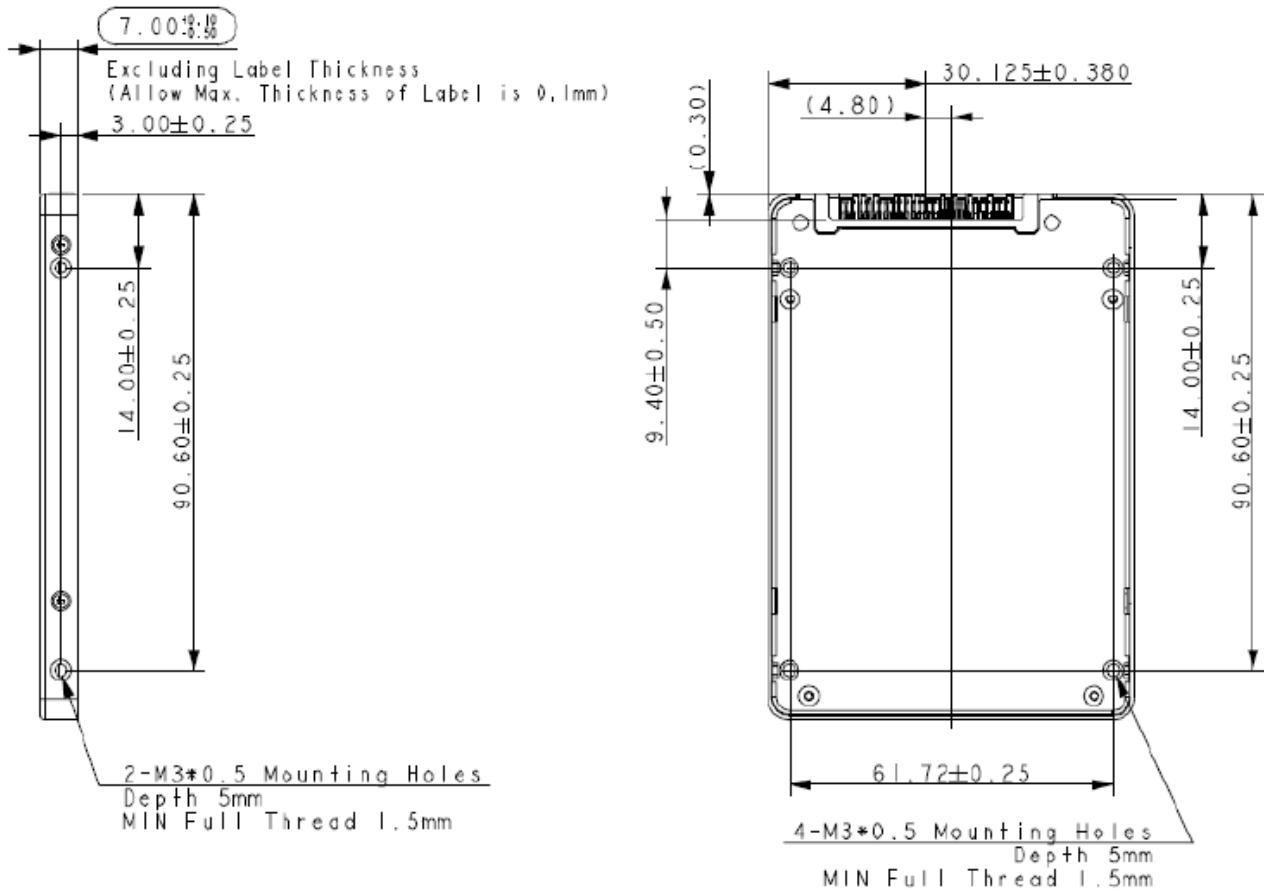


Dimension: 100.00mm (L) x 69.85mm (W) x 7.00mm (H)

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                                             |
|------------|---------------------------------------------------------|
| ATTO       | Commercial performance benchmark application            |
| 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

yymmddXX

Part Number

Manufacturing

Data: YYMMDD Flash Type:

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## 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<br>480GB<br>960GB<br>1920G<br>3840G<br>7680G                            | A: 3D TLC Standard (0°C ~ +70°C)<br>B: 3D TLC Industrial (-40°C ~ +85°C) | E               | P               | blank                           |
| X <sup>16</sup> X <sup>17</sup><br>Blank: standard<br>06: Conformal Coating (CC)<br>31: AES+OPAL (PSID code)<br>32: PLP+AES+OPAL (PSID code) |                               |                               |                                                                               |                                                                          |                 |                 |                                 |