

**Welldisk Technology Corp.**

**2.5inch SATA SSD Datasheet**

**W25S32-XXXXX**

**2GB、 4GB、 8GB、 16GB、 32GB、 64GB、  
128GB、 256GB、 512GB、 1TB**

**Version B1.6**



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## Revision History

| Revision | Draft Date | History                   | Author     |
|----------|------------|---------------------------|------------|
| 1.0      | 2016/7/14  | New release               | Golden Lee |
| 1.1      | 2016/12/13 | Change physical dimension | Golden Lee |
| 1.2      | 2017/3/31  | Add 32GB capacity support | Golden Lee |
| 1.3      | 2017/4/18  | Add 8GB/16GB support      | Golden Lee |
| 1.4      | 2017/5/2   | Add pSLC support          | Golden Lee |
| 1.5      | 2017/11/9  | Modify TBW                | Golden Lee |
| 1.6      | 2017/11/21 | Add 3D TLC Flash support  | Golden Lee |

## Product Overview

- **Capacity**
  - MLC: 4GB up to 512GB
  - pSLC: 2GB up to 256GB
  - 3D TLC: 30/32GB up to 960GB/1TB
- **SATA Interface**
  - SATA Revision 3.2
  - SATA 1.5Gbps, 3Gbps, and 6Gbps interface
- **Flash Interface**
  - Flash Type: MLC, 3D TLC
- **Performance**
  - Read up to 550 MB/s
  - Write up to 490 MB/s
- **Power Consumption**<sup>Note1</sup>
  - Active mode: < 2,650 mW
  - Idle mode: < 325 mW
- **TBW (Terabyte Written)**<sup>Note2</sup>
  - MLC: 540 TBW for 512GB
  - pSLC: 1,510 TBW for 256GB
  - 3D TLC: 2,510 TBW for 1TB
- **MTBF**
  - MLC/3D TLC: 2,000,000 hours
  - pSLC: 2,500,000 hours
- **Advanced Flash Management**
  - Static and Dynamic Wear Leveling
  - Bad Block Management
  - TRIM
  - SMART
  - Over-Provision
- **Low Power Management**
  - DIPM/HIPM Mode
  - DEVSLP Mode (Optional)
- **Temperature Range**
  - Operation (Standard): 0°C ~ 70°C (3D TLC)
  - Operation (Wide): -40°C ~ 85°C
  - Storage: -40°C ~ 85°C
- **Compliant**
  - RoHS
  - CE & FCC

**Notes:**

1. Please see “Power Consumption” for details.
2. Please see “TBW (Terabytes Written)” in chapter 2 for details.

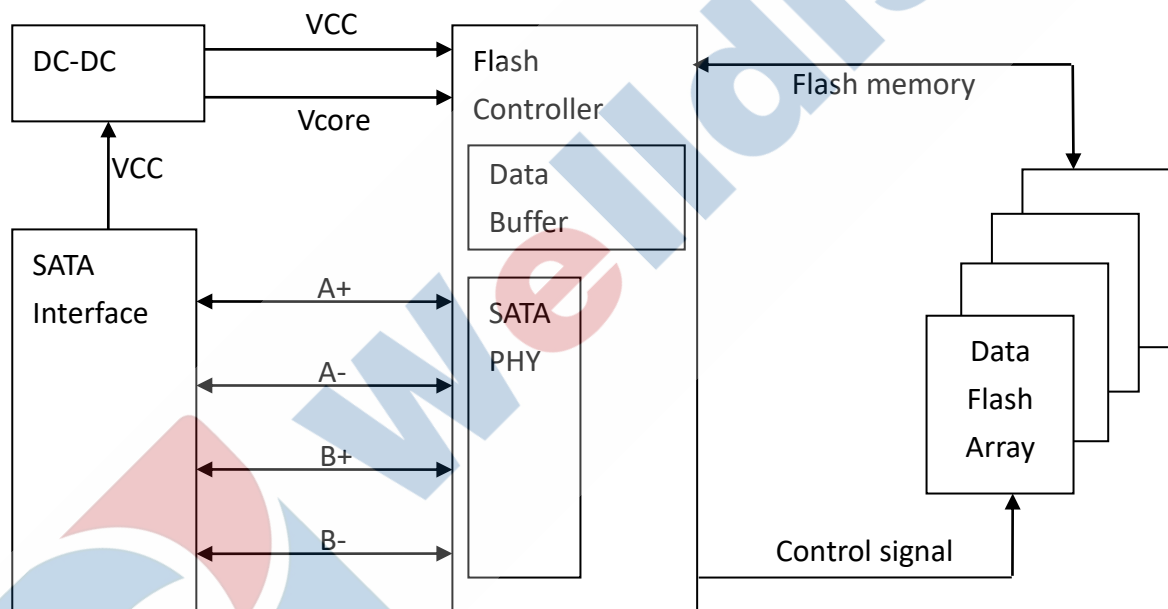
## 1. INTRODUCTION



### 1.1. General Description

Welldisk 2.5" SATA SSD delivers all the advantages of flash disk technology with Serial ATA I/II/III interface, including being fully compliant with standard 2.5-inch form factor, 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 7-pin interface for data segment and 15-pin for power segment, as well as operating at a maximum operating frequency of 200MHz with 30MHz external crystal. Its capacity could provide a wide range up to 512GB. Moreover, it can reach up to 550MB/s read as well as 490MB/s write high performance based on Toshiba's NAND flash (with 32MB SDR cache enabled and measured by CrystalDiskMark v5.0).

### 1.2. Block Diagram



2.5" SATA SSD Block Diagram

## 2. PRODUCT SPECIFICATIONS

---

- **Capacity**
  - MLC: From 4GB up to 512GB (support 48-bit addressing mode)
  - pSLC: From 2GB up to 256GB (support 48-bit addressing mode)
  - 3D TLC: From 30/32GB up to 960GB/1TB (support 48-bit addressing mode)
- **Electrical/Physical Interface**
  - SATA Interface
    - ◆ Compliant with SATA Revision 3.2
    - ◆ Compatible with SATA 1.5Gbps, 3Gbps and 6Gbps interface
    - ◆ Support power management
    - ◆ Support expanded register for SATA protocol 48 bits addressing mode
    - ◆ Embedded BIST function for SATA PHY for low cost mass production
- **Built-in 2-channel NAND flash interface controller**
  - Compliant with Toggle 1.0 and Toggle 2.0 NAND Flash interface
  - Compliant with ONFI 4.0 interface:
    - ◆ SDR up to mode 5
    - ◆ NV-DDR up to mode 5
    - ◆ NV-DDR2 up to mode 7
    - ◆ NV-DDR3 up to mode 8
- **Supported NAND Flash**
  - Support up to 16 Flash Chip Enables (CE) within single design
  - Toshiba 15nm/3D-NAND MLC and TLC
  - Support all types of SLC/MLC/TLC/3D-NAND, 8KB/page and 16K/page NAND flash
- **ECC Scheme**
  - Applies the LDPC (Low Density Parity Check) of ECC algorithm
- **UART function**
- **GPIO**
- **Support SMART and TRIM commands**

- **Capacity Information**

| Capacity | Cylinders | Heads | Sectors | Total Sectors | User Data Size              |
|----------|-----------|-------|---------|---------------|-----------------------------|
| 2GB      | 3,897     | 16    | 63      | 3,928,176     | Depended on file management |
| 4GB      | 7,773     | 16    | 63      | 7,835,184     |                             |
| 8GB      | 15,525    | 16    | 63      | 15,649,200    |                             |
| 16GB     | 16,383    | 16    | 63      | 31,277,232    |                             |
| 30GB     | 16,383    | 16    | 63      | 58,626,288    |                             |
| 32GB     | 16,383    | 16    | 63      | 62,533,296    |                             |
| 60GB     | 16,383    | 16    | 63      | 117,231,408   |                             |
| 64GB     | 16,383    | 16    | 63      | 125,045,424   |                             |
| 120GB    | 16,383    | 16    | 63      | 234,441,648   |                             |
| 128GB    | 16,383    | 16    | 63      | 250,069,680   |                             |
| 240GB    | 16,383    | 16    | 63      | 468,862,128   |                             |
| 256GB    | 16,383    | 16    | 63      | 500,118,192   |                             |
| 480GB    | 16,383    | 16    | 63      | 937,703,088   |                             |
| 512GB    | 16,383    | 16    | 63      | 1,000,215,216 |                             |
| 960GB    | 16,383    | 16    | 63      | 1,875,385,008 |                             |
| 1TB      | 16,383    | 16    | 63      | 2,000,409,264 |                             |

- **Performance**

- **MLC:**

| Capacity    | Flash Structure | Flash Type | Sequential  |              |
|-------------|-----------------|------------|-------------|--------------|
|             |                 |            | Read (MB/s) | Write (MB/s) |
| 4GB         | 4GB x 1         | 15nm, TSOP | 160         | 50           |
| 8GB         | 8GB x 1         | 15nm, TSOP | 160         | 90           |
| 16GB        | 16GB x 1        | 15nm, TSOP | 320         | 80           |
| 30GB/32GB   | 16GB x 2        | 15nm, TSOP | 550         | 160          |
| 60GB/64GB   | 16GB x 4        | 15nm, TSOP | 550         | 310          |
| 120GB/128GB | 32GB x 4        | 15nm, BGA  | 550         | 460          |
|             | 64GB x 2        | 15nm, BGA  | 550         | 460          |
| 240GB/256GB | 64GB x 4        | 15nm, BGA  | 550         | 490          |
| 480GB/512GB | 128GB x 4       | 15nm, BGA  | 550         | 490          |

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**■ pSLC:**

| Capacity    | Flash Structure | Flash Type | Sequential  |              |
|-------------|-----------------|------------|-------------|--------------|
|             |                 |            | Read (MB/s) | Write (MB/s) |
| 2GB         | 4GB x 1         | 15nm, TSOP | 160         | 50           |
| 4GB         | 8GB x 1         | 15nm, TSOP | 160         | 90           |
| 8GB         | 16GB x 1        | 15nm, TSOP | 300         | 80           |
| 16GB        | 16GB x 2        | 15nm, TSOP | 550         | 160          |
| 30GB/32GB   | 16GB x 4        | 15nm, TSOP | 550         | 310          |
| 60GB/64GB   | 32GB x 4        | 15nm, BGA  | 550         | 460          |
|             | 64GB x 2        | 15nm, BGA  | 550         | 460          |
| 120GB/128GB | 64GB x 4        | 15nm, BGA  | 550         | 490          |
| 240GB/256GB | 128GB x 4       | 15nm, BGA  | 550         | 490          |

**■ 3D TLC:**

| Capacity    | Flash Structure | Flash Type      | Sequential  |              |
|-------------|-----------------|-----------------|-------------|--------------|
|             |                 |                 | Read (MB/s) | Write (MB/s) |
| 30GB/32GB   | 32GB x 1        | TSB Bics3, TSOP | 300         | 35           |
| 60GB/64GB   | 32GB x 2        | TSB Bics3, TSOP | 550         | 100          |
| 120GB/128GB | 64GB x 2        | TSB Bics3, TSOP | 550         | 450          |
|             |                 | TSB Bics3, BGA  | 550         | 450          |
| 240GB/256GB | 64GB x 4        | TSB Bics3, TSOP | 550         | 490          |
|             | 128GB x 2       | TSB Bics3, TSOP | 550         | 490          |
|             | 128GB x 2       | TSB Bics3, BGA  | 550         | 490          |
| 480GB/512GB | 128GB x 4       | TSB Bics3, TSOP | 550         | 490          |
|             | 256GB x 2       | TSB Bics3, BGA  | 550         | 490          |
| 960GB/1TB   | 128GB x 8       | TSB Bics3, TSOP | 550         | 490          |
|             | 256GB x 4       | TSB Bics3, BGA  | 550         | 490          |

**Notes:**

1. The performance was estimated based on Toshiba NAND flash.
2. Performance may differ according to flash configuration and platform.
3. The table above is for reference only.

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- **TBW (Terabytes Written)**

- **MLC:**

| Capacity    | Flash Structure | TBW |
|-------------|-----------------|-----|
| 4GB         | 4GB x 1         | 1   |
| 8GB         | 8GB x 1         | 3   |
| 16GB        | 16GB x 1        | 6   |
| 30GB/32GB   | 16GB x 2        | 13  |
| 60GB/64GB   | 16GB x 4        | 30  |
| 120GB/128GB | 32GB x 4        | 87  |
| 240GB/256GB | 64GB x 4        | 198 |
| 480GB/512GB | 128GB x 4       | 540 |

- **pSLC:**

| Capacity    | Flash Structure | TBW  |
|-------------|-----------------|------|
| 2GB         | 4GB x 1         | 4    |
| 4GB         | 8GB x 1         | 10   |
| 8GB         | 16GB x 1        | 21   |
| 16GB        | 16GB x 2        | 49   |
| 30GB/32GB   | 16GB x 4        | 106  |
| 60GB/64GB   | 32GB x 4        | 215  |
| 120GB/128GB | 64GB x 4        | 649  |
| 240GB/256GB | 128GB x 4       | 1510 |

- **3D TLC:**

| Capacity    | Flash Structure | TBW  |
|-------------|-----------------|------|
| 30GB/32GB   | 32GB x 1        | 60   |
| 60GB/64GB   | 32GB x 2        | 121  |
| 120GB/128GB | 64GB x 2        | 234  |
| 240GB/256GB | 128GB x 2       | 540  |
| 480GB/512GB | 256GB x 2       | 1330 |
| 960GB/1TB   | 256GB x 4       | 2510 |

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**Notes:**

1. Samples were built using Toshiba NAND flash.
2. TBW may differ according to flash configuration and platform.
3. The endurance of SSD could be estimated based on user behavior, NAND endurance cycles, and write amplification factor. It is not guaranteed by flash vendor.



### 3. ENVIRONMENTAL SPECIFICATIONS



#### 3.1. Environmental Conditions

##### 3.1.1. Temperature and Humidity

- Temperature:
  - ◆ Storage: -40°C to 85°C
  - ◆ Operational (Standard grade): 0°C to 70°C
  - ◆ Operational (Wide grade): -40°C to 85°C
- Humidity:
  - ◆ Standard grade: RH 90% under 40°C (operational)
  - ◆ Wide grade: RH 95% under 55°C (operational)

##### ■ High Temperature Test Condition

|                      | Temperature | Humidity | Test Time |
|----------------------|-------------|----------|-----------|
| Operation (Standard) | 70°C        | 0% RH    | 72 hours  |
| Operation (Wide)     | 85°C        | 0% RH    | 72 hours  |
| Storage (Standard)   | 85°C        | 0% RH    | 72 hours  |
| Storage (Wide)       | 85°C        | 0% RH    | 168 hours |

**Result:** No any abnormality is detected.

##### ■ Low Temperature Test Condition

|                      | Temperature | Humidity | Test Time |
|----------------------|-------------|----------|-----------|
| Operation (Standard) | 0°C         | 0% RH    | 72 hours  |
| Operation (Wide)     | -40°C       | 0% RH    | 72 hours  |
| Storage (Standard)   | -40°C       | 0% RH    | 72 hours  |
| Storage (Wide)       | -40°C       | 0% RH    | 168 hours |

**Result:** No any abnormality is detected.

##### ■ High Humidity Test Condition

|                      | Temperature | Humidity | Test Time |
|----------------------|-------------|----------|-----------|
| Operation (Standard) | 40°C        | 93% RH   | 24 hours  |
| Operation (Wide)     | 55°C        | 95% RH   | 72 hours  |
| Storage (Standard)   | 40°C        | 95% RH   | 72 hours  |
| Storage (Wide)       | 55°C        | 95% RH   | 96 hours  |

**Result:** No any abnormality is detected.

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**■ Temperature Cycle Test**

|                      | Temperature | Test Time | Cycle     |
|----------------------|-------------|-----------|-----------|
| Operation (Standard) | 0°C         | 30 min    | 10 cycles |
|                      | 70°C        | 30 min    |           |
| Operation (Wide)     | -40°C       | 30 min    | 20 cycles |
|                      | 85°C        | 30 min    |           |
| Storage (Standard)   | -40°C       | 30 min    | 10 cycles |
|                      | 85°C        | 30 min    |           |
| Storage (Wide)       | -40°C       | 30 min    | 50 cycles |
|                      | 85°C        | 30 min    |           |

**Result:** No any abnormality is detected.

**3.1.2. Shock**
**■ Shock Specification**

|                 | Acceleration Force | Half Sin Pulse Duration |
|-----------------|--------------------|-------------------------|
| Non-Operational | 1500G              | 0.5ms                   |
| Operational     | 1500G              | 0.5ms                   |

**Result:** No any abnormality is detected when power on.

**3.1.3. Vibration**
**■ Vibration Specification**

|             | Condition              |                        | Vibration Orientation        |
|-------------|------------------------|------------------------|------------------------------|
|             | Frequency/Displacement | Frequency/Acceleration |                              |
| Operational | 20Hz~80Hz/1.52mm       | 80Hz~2000Hz/20G        | X, Y, Z axis/60 min for each |

**Result:** No any abnormality is detected when power on.

**3.1.4. Drop**
**■ Drop Specification**

|                 | Height of Drop | Number of Drop                    |
|-----------------|----------------|-----------------------------------|
| Non-operational | 80cm free fall | 6 face of each unit, 2 times each |

**Result:** No any abnormality is detected when power on.

**3.1.5. Bending**
**■ Bending Specification**

|  | Force | Action |
|--|-------|--------|
|--|-------|--------|

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

**Result:** No any abnormality is detected when power on.

### 3.1.6. Torque

#### ■ Torque Specification

|                 | Force               | Action           |
|-----------------|---------------------|------------------|
| Non-operational | 1.263N-m or ±10 deg | Hold 1min/5times |

**Result:** No any abnormality is detected when power on.

### 3.1.7. Electrostatic Discharge (ESD)

#### ■ Contact ESD Specification

| Device   | Capacity | Temperature | Relative Humidity | +/- 4KV                                                                                               | Result |
|----------|----------|-------------|-------------------|-------------------------------------------------------------------------------------------------------|--------|
| 2.5" SSD | 256GB    | 24.0°C      | 49% (RH)          | Device functions are affected, but EUT will be back to its normal or operational state automatically. | PASS   |
|          | 512GB    |             |                   |                                                                                                       |        |

### 3.2. MTBF

MTBF, an acronym for Mean Time between Failures, is a measure of a device's reliability. Its value represents the average time between a repair and the next failure. The measure is typically in units of hours. The higher the MTBF value, the higher the reliability of the device. The predicted result of Welldisk's 2.5" SATA SSD is up to 2,500,000 hours.

### 3.3. Certification

- RoHS
- CE / FCC

### 3.4. Compliance

- SATA III (SATA Rev. 3.2)
- Up to ATA/ATAPI-8 (Including S.M.A.R.T)

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## 4. ELECTRICAL SPECIFICATIONS



### 4.1. Supply Voltage

| Parameter         | Rating      |
|-------------------|-------------|
| Operating Voltage | 5V $\pm$ 5% |

### 4.2. Power Consumption

#### ■ MLC

| Capacity | Flash Structure | Flash Type | Read  | Write | Partial | Slumber | Idle | DEVSLP |
|----------|-----------------|------------|-------|-------|---------|---------|------|--------|
| 4GB      | 4GB x 1         | 15nm, TSOP | 1,120 | 1,150 | 13      | 9       | 265  | 4.9    |
| 8GB      | 8GB x 1         | 15nm, TSOP | 1,150 | 1,180 | 13      | 9       | 265  | 4.9    |
| 16GB     | 16GB x 1        | 15nm, TSOP | 1,180 | 1,200 | 13.5    | 9       | 265  | 4.9    |
| 32GB     | 16GB x 2        | 15nm, TSOP | 1,200 | 1,280 | 14      | 10      | 265  | 4.9    |
| 64GB     | 16GB x 4        | 15nm, TSOP | 1,200 | 1,320 | 15      | 11      | 265  | 4.9    |
| 128GB    | 32GB x 4        | 15nm, BGA  | 1,280 | 1,700 | 15      | 10      | 280  | 4.9    |
|          | 64GB x 2        | 15nm, BGA  | 1,250 | 1,600 | 15      | 10      | 275  | 4.9    |
| 256GB    | 64GB x 4        | 15nm, BGA  | 1,350 | 2,600 | 15      | 10      | 280  | 4.9    |
| 512GB    | 128GB x 4       | 15nm, BGA  | 1,500 | 2,650 | 16.5    | 11      | 318  | 4.9    |

Unit: mW

#### ■ pSLC

| Capacity | Flash Structure | Flash Type | Read  | Write | Partial | Slumber | Idle | DEVSLP |
|----------|-----------------|------------|-------|-------|---------|---------|------|--------|
| 2GB      | 4GB x 1         | 15nm, TSOP | 1,120 | 1,150 | 13      | 9       | 265  | 4.9    |
| 4GB      | 8GB x 1         | 15nm, TSOP | 1,150 | 1,180 | 13      | 9       | 265  | 4.9    |
| 8GB      | 16GB x 1        | 15nm, TSOP | 1,180 | 1,200 | 13.5    | 9       | 265  | 4.9    |
| 16GB     | 16GB x 2        | 15nm, TSOP | 1,200 | 1,280 | 14      | 10      | 265  | 4.9    |
| 32GB     | 16GB x 4        | 15nm, TSOP | 1,200 | 1,320 | 15      | 11      | 265  | 4.9    |
| 64GB     | 32GB x 4        | 15nm, BGA  | 1,280 | 1,700 | 15      | 10      | 280  | 4.9    |
|          | 64GB x 2        | 15nm, BGA  | 1,250 | 1,600 | 15      | 10      | 275  | 4.9    |
| 128GB    | 64GB x 4        | 15nm, BGA  | 1,350 | 2,600 | 15      | 10      | 280  | 4.9    |
| 256GB    | 128GB x 4       | 15nm, BGA  | 1,500 | 2,650 | 16.5    | 11      | 318  | 4.9    |

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**■ 3D TLC**

| Capacity    | Flash Structure | Flash Type      | Read | Write | Partial | Slumber | Idle | DEVSLP |
|-------------|-----------------|-----------------|------|-------|---------|---------|------|--------|
| 30GB/32GB   | 32GB x 1        | TSB Bics3, TSOP | 970  | 880   | 22.5    | 15.5    | 325  | 4.9    |
| 60GB/64GB   | 32GB x 2        | TSB Bics3, TSOP | 1230 | 1020  | 20      | 14      | 320  | 4.9    |
| 120GB/128GB | 64GB x 2        | TSB Bics3, TSOP | 1260 | 1350  | 20      | 14      | 320  | 4.9    |
|             |                 | TSB Bics3, BGA  | 1450 | 1550  | 20      | 15      | 325  | 4.9    |
| 240GB/256GB | 64GB x 4        | TSB Bics3, TSOP | 1330 | 1450  | 20      | 14      | 325  | 4.9    |
|             | 128GB x 2       | TSB Bics3, TSOP | 1170 | 1360  | 19      | 14      | 315  | 4.9    |
|             | 128GB x 2       | TSB Bics3, BGA  | 1260 | 1490  | 20.5    | 15      | 320  | 4.9    |
| 480GB/512GB | 128GB x 4       | TSB Bics3, TSOP | 1360 | 1660  | 22      | 16      | 320  | 4.9    |
|             | 256GB x 2       | TSB Bics3, BGA  | 1430 | 1670  | 20      | 15      | 320  | 4.9    |
| 960GB/1TB   | 128GB x 8       | TSB Bics3, TSOP | 1620 | 1750  | 22      | 16      | 320  | 4.9    |
|             | 256GB x 4       | TSB Bics3, BGA  | 1570 | 1610  | 20      | 15      | 320  | 4.9    |

Unit: mW

**Notes:**

1. It's average value of power consumption is achieved based on 100% conversion efficiency.
2. The measured power voltage is 5V.
3. Samples were built using Toshiba NAND flash and measured under normal temperature.
4. Sequential R/W is measured while testing 4000MB sequential R/W 5 times by CrystalDiskMark.
5. Power Consumption may differ according to flash configuration and platform.

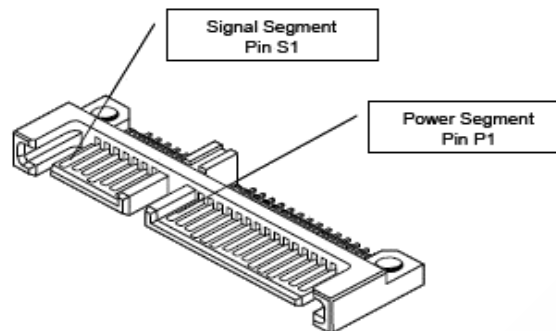
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## 5. INTERFACE



### 5.1. Pin Assignment and Descriptions



| Signal Segment Pin Assignment | Pin Number | Function                         |
|-------------------------------|------------|----------------------------------|
|                               | S1         | GND                              |
|                               | S2         | A+ (Differential Signal Pair A)  |
|                               | S3         | A – (Differential Signal Pair A) |
|                               | S4         | GND                              |
|                               | S5         | B – (Differential Signal Pair B) |
|                               | S6         | B+ (Differential Signal Pair B)  |
|                               | S7         | GND                              |
| Power Segment Pin Assignment  | Pin Number | Function                         |
|                               | P1         | Not Used (3.3V)                  |
|                               | P2         | Not Used (3.3V)                  |
|                               | P3         | DEVSLP                           |
|                               | P4         | GND                              |
|                               | P5         | GND                              |
|                               | P6         | GND                              |
|                               | P7         | 5V pre-charge                    |
|                               | P8         | 5V                               |
|                               | P9         | 5V                               |
|                               | P10        | GND                              |
|                               | P11        | Reserved                         |
|                               | P12        | GND                              |
|                               | P13        | Not Used (12V pre-charge)        |
|                               | P14        | Not Used (12V)                   |
|                               | P15        | Not Used (12V)                   |

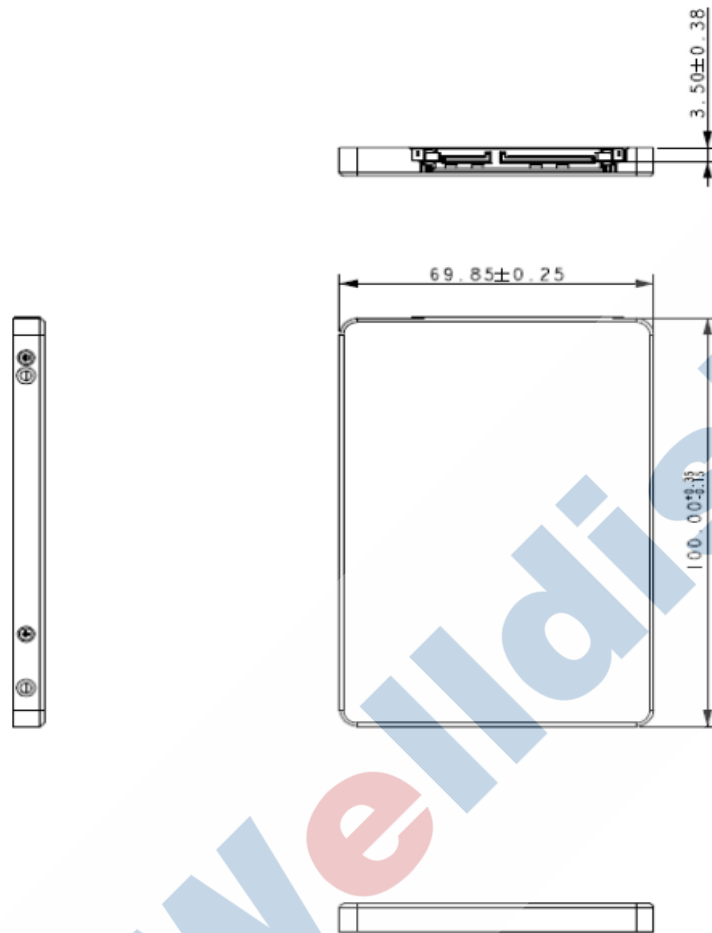
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## 6. PHYSICAL DIMENSION

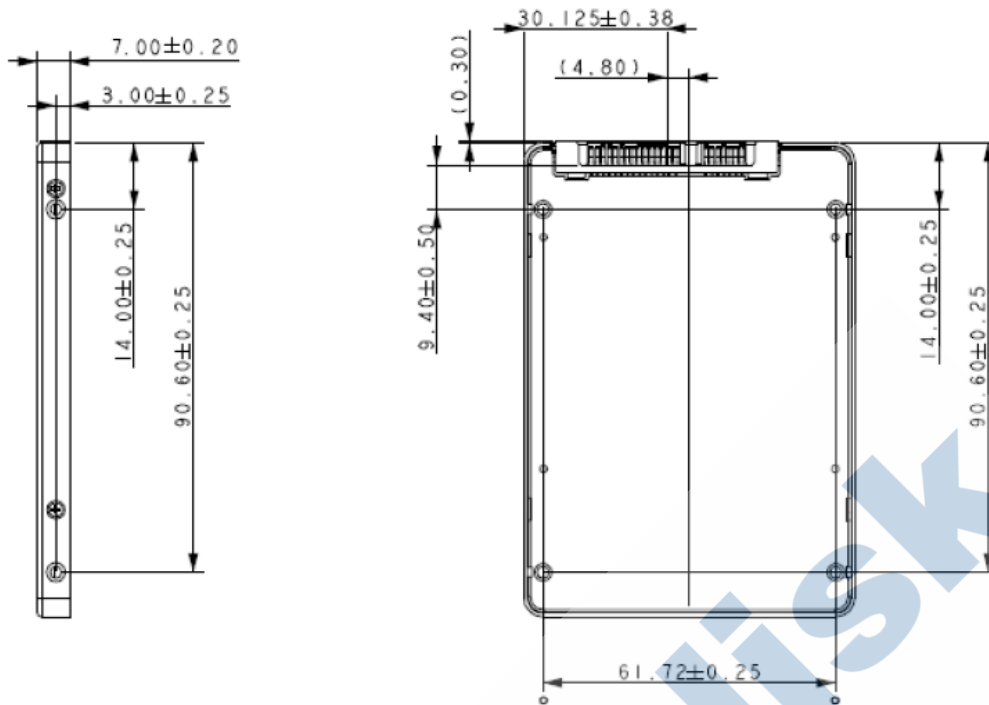


Dimension: 100.10mm(L) x 69.85mm(W) x 7.00mm(H)



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## 7. 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)                           |
| DIPM       | Device initiated power management                  |
| HIPM       | Host initiated power management                    |
| LBA        | Logical block addressing                           |
| MB         | Mega-byte                                          |
| MTBF       | Mean time between failures                         |
| NCQ        | Native command queue                               |
| SATA       | Serial advanced technology attachment              |
| S.M.A.R.T. | Self-monitoring, analysis and reporting technology |
| SSD        | Solid state disk                                   |

**8. PARTNUMBER DECODER****W 25 S3 2 – XXXX X**