

# mSATA

## 3TEB Series

**Customer:** \_\_\_\_\_

**Customer**

**Part**

**Number:** \_\_\_\_\_

**Innodisk**

**Part**

**Number:** \_\_\_\_\_

**Innodisk**

**Model Name:** \_\_\_\_\_

**Date:** \_\_\_\_\_

<b>Innodisk Approver</b>	<b>Customer Approver</b>

**Total Solution For  
Industrial Flash Storage**

**Features:**

- SATA III
- Kioxia 3D TLC NAND
- mSATA
- Standard & Wide-temperature
- iPower Guard
- iData Guard
- Dynamic Thermal Management

**Performance:**

- Sequential Read up to 560 MB/s
- Sequential Write up to 480 MB/s

**Power Requirements:**

Input Voltage:	3.3V±5%
Max Operating Wattage:	1.3W
Idle Wattage:	0.4W

**Reliability:**

Capacity	TBW(Client)	DWPD
64GB	65	1.09
128GB	150	1.26
256GB	260	1.09
512GB	582	1.22
1TB	900	0.94
2TB	1800	0.94

Data Retention	10 Years
Warranty	3 Years

For warranty details, please refer to:

[https://www.innodisk.com/en/support\\_and\\_service/warranty](https://www.innodisk.com/en/support_and_service/warranty)

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## REVISION HISTORY

Revision	Description	Date
V1.0	First Released	May, 2024
V1.1	Revise SMART Attributes	Aug., 2024

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# 1. Product Overview

## 1.1 Introduction of Innodisk mSATA 3TEB

Innodisk mSATA 3TEB which is designed with mSATA form factor by JEDEC MO-300/MO-300B , supporting SATA III standard (6.0Gb/s), achieves excellent performance by cost effective controller with 2CH. Regarding of mechanical interference, Innodisk mSATA 3TEB absolutely replaces the traditional hard disk and makes personal computer, in any field, smaller and easier. With Innodisk L<sup>3</sup> FW architecture, combining our signature 4K mapping algorithm L<sup>2</sup> FW architecture with powerful LDPC technology, 3TEB series has outstanding high IOPS, better data integrity and extended lifespan through reducing the bad block number happening.

For real industrial application, 3TEB series is built in thermal sensor to monitor the environment temperature. iData Guard, the power loss management mechanism developed by Innodisk, ensures data integrity while power sudden loss happened.

## 1.2 Product View and Models

Innodisk mSATA 3TEB is available in follow capacities within 3D NAND flash ICs.

[mSATA 3TEB 64GB](#)   [mSATA 3TEB 128GB](#)   [mSATA 3TEB 256GB](#)

[mSATA 3TEB 512GB](#)   [mSATA 3TEB 1TB](#)   [mSATA 3TEB 2TB](#)



**Figure 1: Innodisk mSATA 3TEB**

## 1.3 SATA Interface

Innodisk mSATA 3TEB supports SATA III(6.0Gb/s) interface, and compliant with SATA I (1.5Gb/s) and SATA II(3.0Gb/s).



## 2. Product Specifications

### 2.1 Capacity and Device Parameters

mSATA 3TEB device parameters are shown in Table 1.

**Table 1: Device parameters**

Capacity	Cylinders	Heads	Sectors	LBA	User Capacity(MB)
64GB	16383	16	63	117231408	57242
128GB	16383	16	63	234441648	114473
256GB	16383	16	63	468862128	228936
512GB	16383	16	63	937703088	457862
1TB	16383	16	63	1875385008	915715
2TB	16383	16	63	3750748848	1831420

### 2.2 Performance

Burst Transfer Rate: 6.0Gbps

**Table 2: Performance – 112 Layers 3D TLC**

Capacity	Unit	64GB	128GB	256GB	512GB	1TB	2TB
Sequential** Read (Q32T1)	MB/s	430	560	550	560	550	550
Sequential** Write (Q32T1)		290	450	470	470	480	480
Sustained Sequential Read (Avg.)***		250	490	500	500	500	500
Sustained Sequential Write (Avg.)***		100	180	210	220	250	230
4KB Random** Read (QD32)	IOPS	19,000	57,000	73,000	57,000	73,000	66,000
4KB Random** Write (QD32)		52,000	59,000	61,000	62,000	63,000	62,000

Note:

\*. Performance results are 3TEB with Kioxia BiCS5 NAND composition measured in Room Temperature with Out-of-Box devices and may vary depending on overall system setup. In addition, 3TEB series adopt hybrid mode which enables SLC

cache followed by TLC direct write to strike balance between burst performance and steady overall stability.

\*\* . Performance results are based on CrystalDiskMark 8.0.1 with file size 1000MB. Unit of 4KB item is IOPS.

\*\*\* . Performance results are based on AIDA 64 v5.98 with block size 1MB of Linear Read & Write Test Item.

## 2.3 Electrical Specifications

### 2.3.1 Power Requirement

**Table 3: Innodisk mSATA 3TEB Power Requirement**

Item	Symbol	Rating	Unit
Input voltage	V <sub>IN</sub>	+3.3 DC +- 5%	V

### 2.3.2 Power Consumption

**Table 4: Typical Power Consumption**

Mode	Power Consumption (W)
Read	1.3
Write	1.3
Idle	0.4
Power-on peak	1.8

Target: mSATA 3TEB 2TB

## 2.4 Environmental Specifications

### 2.4.1 Temperature Ranges

**Table 5: Temperature range for mSATA 3TEB**

Temperature	Range
Operating	Standard Grade: 0°C to +70°C
	Industrial Grade: -40°C to +85°C
Storage	-40°C to +85°C

### 2.4.2 Humidity

Relative Humidity: 10-95%, non-condensing

### 2.4.3 Shock and Vibration

**Table 6: Shock/Vibration Testing for mSATA 3TEB**

Reliability	Test Conditions	Reference Standards
Vibration	7 Hz to 2K Hz, 20G, 3 axes	IEC 60068-2-6
Mechanical Shock	Duration: 0.5ms, 1500 G, 3 axes	IEC 60068-2-27

### 2.4.4 Mean Time between Failures (MTBF)

The following table summarizes the MTBF prediction results for various mSATA 3TEB configurations. The analysis was performed using a RAM Commander™ failure rate prediction.

- **Failure Rate:** The total number of failures within an item population, divided by the total number of life units expended by that population, during a particular measurement interval under stated condition.
- **Mean Time between Failures (MTBF):** A basic measure of reliability for repairable items: The mean number of life units during which all parts of the item perform within their specified limits, during a particular measurement interval under stated conditions.

**Table 7: mSATA 3TEB MTBF**

Product	Condition	MTBF (Hours)
Innodisk mSATA 3TEB	Telcordia SR-332 GB, 25°C	>3,000,000

### 2.5 CE and FCC Compatibility

mSATA 3TEB conforms to CE and FCC requirements.

### 2.6 RoHS Compliance

mSATA 3TEB is fully compliant with RoHS directive.

## 2.7 Reliability

Parameter	Value	
Flash endurance	3,000 P/E cycles	
Error Correct Code	Support	
Data Retention	Under 40°C: 10 Years at Initial NAND Status; 1 Year at NAND Life End	
<b>TBW* (Total Bytes Written) Units: TB</b>		
<b>Capacity</b>	<b>Sequential workload</b>	<b>Client workload</b>
64GB	170	65
128GB	341	150
256GB	682	260
512GB	1364	582
1TB	2727	900
2TB	5455	1800
<p>* Note:</p> <ol style="list-style-type: none"> <li>1. Sequential: Mainly sequential write are estimated by PassMark Burnin Test v8.1 pro.</li> <li>2. Client: Follow JESD218 Test method and JESD219A Workload, tested by ULINK. (The capacity 64GB client workload is not specified in JEDEC219A, the values are estimated.)</li> <li>3. Based on out-of-box performance.</li> </ol>		

## 2.8 Transfer Mode

mSATA 3TEB support following transfer mode:

Serial ATA III 6.0Gbps

Serial ATA II 3.0Gbps

Serial ATA I 1.5Gbps

## 2.9 Pin Assignment

Innodisk mSATA 3TEB uses a standard SATA pin-out.

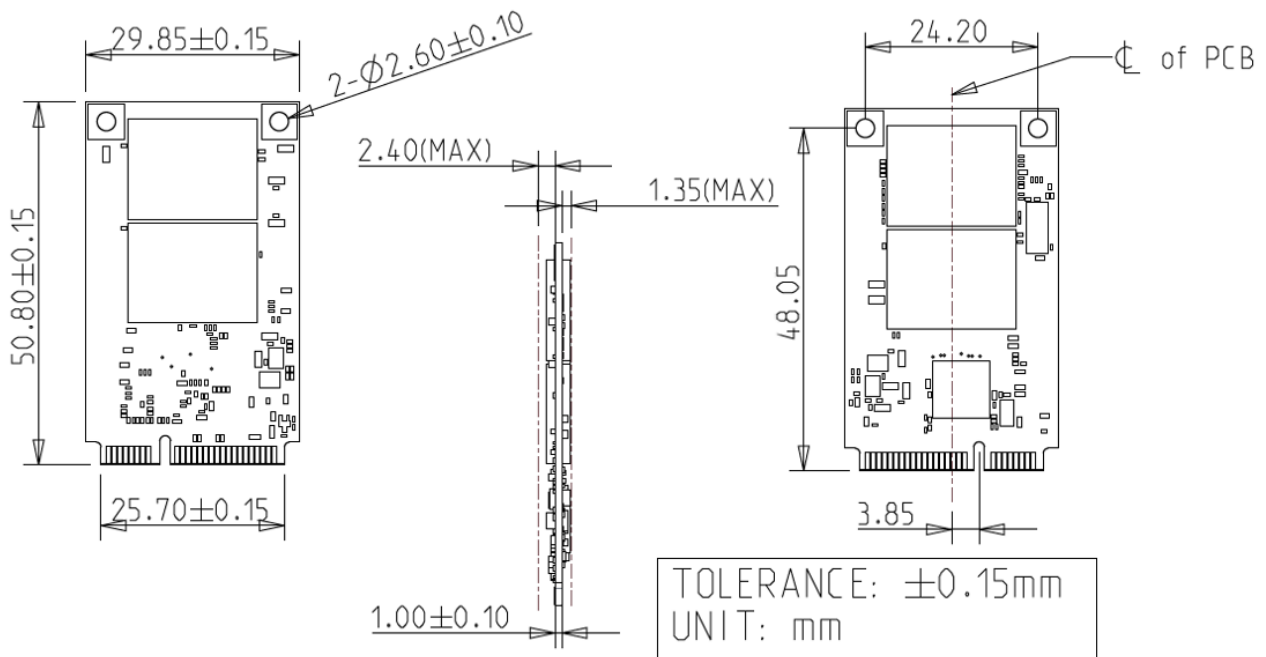
See following table for mSATA 3TEB pin assignment.

**Table 8: Innodisk mSATA 3TEB Pin Assignment**

Signal Name	Pin #	Pin #	Signal Name
GND	51	52	+3.3V
DAS	49	50	GND
NC	47	48	NC
NC	45	46	NC
NC	43	44	DEVSLP
+3.3V	41	42	NC
+3.3V	39	40	GND
GND	37	38	NC
GND	35	36	NC
RX+	33	34	GND
RX-	31	32	NC
GND	29	30	NC
GND	27	28	NC
TX-	25	26	GND
TX+	23	24	+3.3V
GND	21	22	NC
NC	19	20	NC
NC	17	18	GND
GND	15	16	NC
NC	13	14	NC
NC	11	12	NC

GND	9	10	NC
NC	7	8	NC
NC	5	6	NC
NC	3	4	GND
NC	1	2	+3.3V

## 2.10 Mechanical Dimensions



## 2.11 Assembly Weight

An Innodisk mSATA 3TEB within flash ICs, 1TB's weight is 10 grams approximately.

## 2.12 Seek Time

Innodisk mSATA 3TEB is not a magnetic rotating design. There is no seek or rotational latency required.

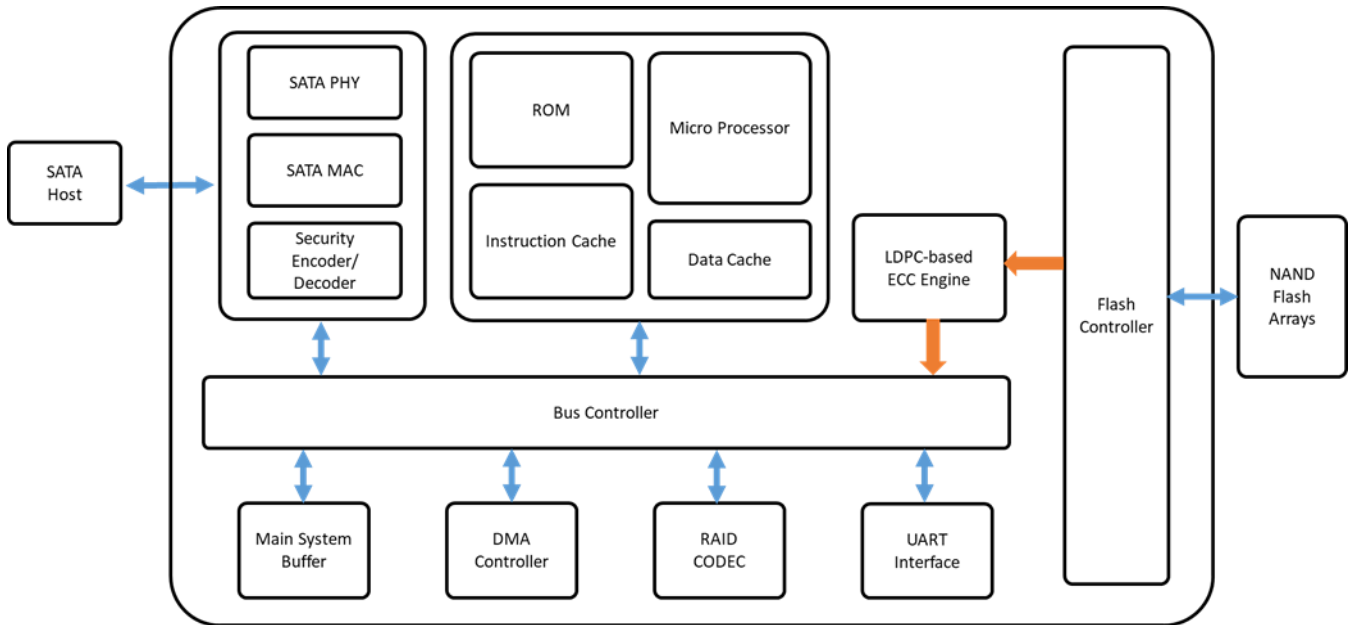
## 2.13 NAND Flash Memory

Innodisk mSATA 3TEB uses 3D TLC NAND flash memory, with 3,000 program & erase cycles, which is non-volatility, high reliability and high speed memory storage.

### 3. Theory of Operation

#### 3.1 Overview

Figure 2 shows the operation of Innodisk mSATA 3TEB from the system level, including the major hardware blocks.



**Figure 2: Innodisk mSATA 3TEB Block Diagram**

Innodisk mSATA 3TEB integrates a SATA III controller and NAND flash memories. Communication with the host occurs through the host interface, using the standard ATA protocol. Communication with the flash device(s) occurs through the flash interface.

#### 3.2 SATA III Controller

Innodisk mSATA 3TEB is designed with a SATA III 6.0Gbps (Gen. 3) controller. The Serial ATA physical, link and transport layers are compliant with Serial ATA Gen 1, Gen 2 and Gen 3 specification (Gen 3 supports 1.5Gbps/3.0Gbps/6.0Gbps data rate). The controller has 2 channels for flash interface.

#### 3.3 Error Detection and Correction

Innodisk mSATA 3TEB is designed with hardware LDPC ECC engine with hard-decision and Soft-decision decoding. Low-density parity-check (LDPC) codes have excellent error correcting Performance close to the Shannon limit when decoded with the belief-propagation (BP) algorithm using soft-decision information.



### 3.4 Wear-Leveling

Flash memory can be erased within a limited number of times. This number is called the **erase cycle limit** or **write endurance limit** and is defined by the flash array vendor. The erase cycle limit applies to each individual erase block in the flash device.

Innodisk mSATA 3TEB uses a static wear-leveling algorithm to ensure that consecutive writes of a specific sector are not written physically to the same page/block in the flash. This spreads flash media usage evenly across all pages, thereby extending flash lifetime.

### 3.5 Bad Blocks Management

Bad Blocks are blocks that contain one or more invalid bits whose reliability are not guaranteed. The Bad Blocks may be presented while the SSD is shipped, or may develop during the life time of the SSD. When the Bad Blocks is detected, it will be flagged, and not be used anymore. The SSD implement Bad Blocks management, Bad Blocks replacement, Error Correct Code to avoid data error occurred. The functions will be enabled automatically to transfer data from Bad Blocks to spare blocks, and correct error bit.

### 3.6 iData Guard

iData Guard is a comprehensive data protection mechanism that functions before and after a sudden power outage to SSD. Low-power detection terminates data writing before an abnormal power-off, while table-remapping after power-on deletes corrupt data and maintains data integrity. iData Guard provides effective power cycling management, preventing data stored in flash from degrading with use.

### 3.7 Garbage Collection

Garbage collection is used to maintain data consistency and perform continual data cleansing on SSDs. It runs as a background process, freeing up valuable controller resources while sorting good data into available blocks, and deleting bad blocks. It also significantly reduces write operations to the drive, thereby increasing the SSD's speed and lifespan.

### 3.8 Trim

The Trim command is designed to enable the operating system to notify the SSD which pages no longer contain valid data due to erases either by the user or operating system itself. During a delete operation, the OS will mark the sectors as free for new data and send a Trim command to the SSD to mark them as not containing valid data. After that the SSD knows not to preserve the contents of the block when writing a page, resulting in less write amplification with fewer writes to the flash, higher write speed, and increased drive life.

### **3.9 iPower Guard**

iPower Guard technology is a set of preventive measures that protect the SSD in an unstable power supply environment. This comprehensive package comprises safeguards for startup and shutdown to maintain device performance and ensure data integrity.

### **3.12 Thermal Throttling**

Thermal throttling is a protective mechanism designed to safeguard components from potential damage caused by excessive temperatures. When an SSD approaches a critical temperature threshold, Innodisk firmware activates the thermal throttling mechanism to regulate the SSD's temperature. Thermal throttling is crucial for SSDs since it prevents drive damage, which could otherwise result in data loss. However, it's worth noting that when thermal throttling is activated, read and write tasks may experience a reduction in speed.

## 4. Installation Requirements

### 4.1 mSATA 3TEB Pin Directions

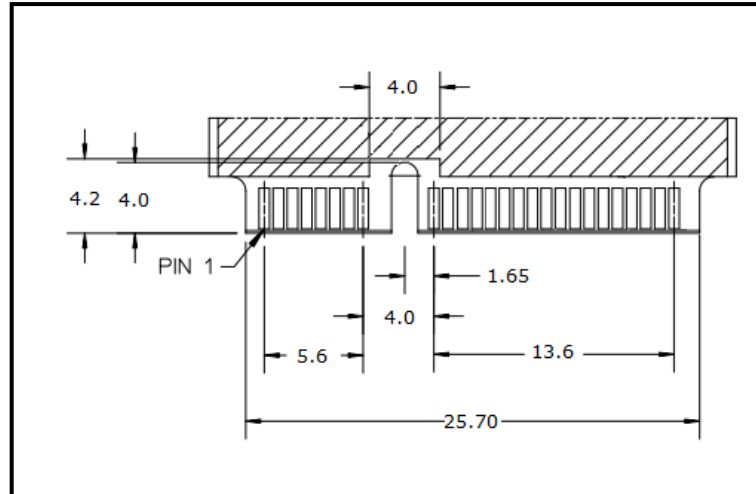


Figure 3: Signal Segment and Power Segment

### 4.2 Electrical Connections for mSATA 3TEB

A Serial ATA device may be either directly connected to a host or connected to a host through an adaptor card. The SATA interface has a separate connector for the power supply. Please refer to the pin description for further details.

### 4.3 Device Drive

No additional device drives are required. The Innodisk mSATA 3TEB can be configured as a boot device.

## 5. SMART Feature Set

Innodisk 3TEB series support the SMART command set and defines some vendor-specific data to report SMART attributes of SSD.

**Table 9: SMART command**

Value	Command	Value	Command
D0h	Read Data	D5h	Read Log
D1h	Read Attribute Threshold	D6h	Return Status
D2h	Enable/Disable Auto save	D8h	Enable SMART Operations
D3h	Save Attribute Values	D9h	Disable SMART Operations
D4h	Execute OFF-LINE Immediate	DAh	Return Status

### 5.1 SMART Attributes

Innodisk 3TEB series SMART data attributes are listed in following table.

**Table 10: SMART attribute**

Attribute ID (hex)	Raw Attribute Value							Attribute Name
	MSB						LSB	
01	MSB	00	00	00	00	00	00	Read error rate
05	LSB	MSB	00	00	00	00	00	Reallocated sectors count
09	LSB			MSB	00	00	00	Power on hours
0C	LSB			MSB	00	00	00	Power cycle count
A0	LSB			MSB	00	00	00	Online Uncorrectable sector count
A1	LSB	MSB	00	00	00	00	00	Number of valid spare blocks
A3	LSB	MSB	00	00	00	00	00	Number of initial invalid block
A4	LSB			MSB	00	00	00	Total erase count
A5	LSB			MSB	00	00	00	Max. erase count
A6	LSB			MSB	00	00	00	Min. erase count
A7	LSB			MSB	00	00	00	Average erase count
A9	LSB			MSB	00	00	00	Remain Life (percentage)
B1	LSB			MSB	00	00	00	Wearleveling count
B5	LSB			MSB	00	00	00	Total program fail count
B6	LSB	MSB	00	00	00	00	00	Total erase fail count
C0	LSB	MSB	00	00	00	00	00	Sudden Power Count

C2	MSB	00	00	00	00	00	00	Enclosure Temperature
C3	LSB			MSB	00	00	00	Hardware ECC recovered
C6	LSB	MSB	00	00	00	00	00	Uncorrectable error count Off Line
C7	LSB						MSB	Ultra DMA CRC Error Count
F1	LSB						MSB	Total LBA written(LBA=32MB)
F2	LSB						MSB	Total LBA read(LBA=32MB)

## 6. Part Number Rule

CODE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	<b>D</b>	<b>E</b>	<b>M</b>	<b>S</b>	<b>R</b>	<b>-</b>	<b>C</b>	<b>1</b>	<b>2</b>	<b>I</b>	<b>C</b>	<b>1</b>	<b>K</b>	<b>C</b>	<b>A</b>	<b>D</b>	<b>F</b>	<b>-</b>	<b>X</b>	<b>X</b>	<b>X</b>
<b>Definition</b>																					
<b>Code 1<sup>st</sup> (Disk)</b>											<b>Code 13<sup>th</sup> (Flash Mode)</b>										
D : Disk											K: 112 layers 3D TLC										
<b>Code 2<sup>nd</sup> (Feature Set)</b>											<b>Code 14<sup>th</sup> (Operation Temperature)</b>										
E: Embedded											C: Standard Grade (0°C~ +70°C)										
											W: Industrial Grade (-40°C~ +85°C)										
<b>Code 3<sup>rd</sup>~5<sup>th</sup> (Form Factor)</b>																					
MSR: mSATA Regular											<b>Code 15<sup>th</sup> (Internal control)</b>										
											A: PCB version										
<b>Code 7<sup>th</sup> ~9<sup>th</sup> (Capacity)</b>																					
64G: 64GB											<b>Code 16<sup>th</sup> (Channel of data transfer)</b>										
A28: 128GB											S: Single Channel										
B56: 256GB											D: Dual Channels										
C12: 512GB																					
01T: 1TB											<b>Code 17<sup>th</sup> (Flash Type)</b>										
02T: 2TB											F: Kioxia 3D TLC										
<b>Code 10<sup>th</sup> ~12<sup>th</sup> (Controller)</b>											<b>Code 19<sup>th</sup>~21<sup>th</sup> (Customized Code)</b>										
IC1: SATA 3TEB																					