innodisk

Total Solution For Industrial Flash Storage

# mSATA

## 3ME3 Series

**Customer:** _____

**Customer Part Number:** _____

**Innodisk Part Number:** _____

**Innodisk Model Name:** _____

**Date:** _____

| Innodisk Approver | Customer Approver |
|---|---|
| | |

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# REVISION HISTORY

| Revision | Description | Date |
|---|---|---|
| Preliminary | First Released | Sep., 2014 |
| 1.1 | Add 256GB | Nov., 2014 |
| 1.2 | Add 512GB | Aug., 2015 |
| 1.3 | Add 15nm flash performance, CE, FCC certification | Nov., 2015 |
| 1.4 | Update 2CH and 4CH performance | April, 2016 |
| 1.5 | Update product photo | May, 2016 |
| 1.6 | Update mechanical dimensions diagram | May, 2016 |
| 1.7 | Remove 64GB 4CH BGA(D08) item | Aug., 2016 |
| 1.8 | Add 32/64GB TSOP 4CH performance | Sep., 2016 |
| 1.9 | Add SMART Feature set | Oct., 2016 |

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# 1. Product Overview

## 1.1 Introduction of Innodisk mSATA 3ME3

Innodisk mSATA 3ME3 is designed with mSATA form factor by MO-300/MO-300B which established by JEDEC , and supports SATA III standard (6.0Gb/s) with excellent performance. Regarding of mechanical interference, Innodisk mSATA 3ME3 absolutely replaces the traditional hard disk and makes personal computer, in any field, smaller and easier.

Innodisk mSATA 3ME3 effectively reduces the booting time of operation system and the power consumption is less than hard disk drive (HDD), and complies with ATA protocol, no additional drives are required, and can be configured as a boot device or data storage device

## 1.2 Product View and Models

Innodisk mSATA 3ME3 is available in follow capacities within MLC flash ICs.

mSATA 3ME3 08GB

mSATA 3ME3 16GB

mSATA 3ME3 32GB

mSATA 3ME3 64GB

mSATA 3ME3 128GB

mSATA 3ME3 256GB

mSATA 3ME3 512GB

**Figure 1: Innodisk mSATA 3ME3**

## 1.3 SATA Interface

Innodisk mSATA 3ME3 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 3ME3 device parameters are shown in Table 1.

**Table 1: Device parameters**

| Capacity | Cylinders | Heads | Sectors | LBA | User Capacity(MB) |
|---|---|---|---|---|---|
| 08GB | 15525 | 16 | 63 | 15649200 | 7,641 |
| 16GB | 16383 | 16 | 63 | 31277232 | 15,272 |
| 32GB | 16383 | 16 | 63 | 62533296 | 30,533 |
| 64GB | 16383 | 16 | 63 | 125045424 | 61,057 |
| 128GB | 16383 | 16 | 63 | 250069680 | 122,104 |
| 256GB | 16383 | 16 | 63 | 500118192 | 244,198 |
| 512GB | 16383 | 16 | 63 | 1000215216 | 488,386 |

## 2.2 Performance

Burst Transfer Rate: 6.0Gbps

**Table 2: Performance**

| Capacity | 08GB | 16GB | | 32GB | | 64GB | | 128GB | | 256GB | 512GB |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1CH | 2CH | 2CH (D09) | 4CH (D08) | 2CH (D09) | 4CH (D08) | 2CH (D09) | 4CH (D08) | | |
| Sequential Read (max.) MB/Sec | 100 | 100 | 200 | 200 | 380 | 220 | 380 | 220 | 415 | 400 | 400 |
| Sequential Write (max.) MB/Sec | 20 | 20 | 45 | 40 | 90 | 80 | 80 | 130 | 145 | 200 | 200 |
| 4KB Random** Read (QD32) IOPS | 4,000 | 3,900 | 6,900 | 6,200 | 9,900 | 7,100 | 9,600 | 8,300 | 10,000 | 9,700 | 9,200 |
| 4KB Random** Write (QD32) IOPS | 5,900 | 5,400 | 9,700 | 8,600 | 15,000 | 15,000 | 14,000 | 22,000 | 23,000 | 30,000 | 30,000 |

Note: the information is based on CrystalDiskMark 3.01 with file size 1000MB test pattern

## 2.3 Electrical Specifications

### 2.3.1 Power Requirement

**Table 3: Innodisk mSATA 3ME3 Power Requirement**

| Item | Symbol | Rating | Unit |
|---|---|---|---|
| Input voltage | $V_{IN}$ | +3.3 DC +- 5% | V |

### 2.3.2 Power Consumption

**Table 4: Power Consumption**

| Mode | Power Consumption (mA) |
|---|---|
| Read | 374 (max.) |
| Write | 433 (max.) |
| Idle | 75.4 (max.) |

* Target: 256GB mSATA 3ME3

## 2.4 Environmental Specifications

### 2.4.1 Temperature Ranges

**Table 5: Temperature range for mSATA 3ME3**

| Temperature | Range |
|---|---|
| Operating | Standard Grade: 0°C to +70°C |
| | Industrial Grade: -40°C to +85°C |
| Storage | -55°C to +95°C |

### 2.4.2 Humidity

Relative Humidity: 10-95%, non-condensing

### 2.4.3 Shock and Vibration

**Table 6: Shock/Vibration Testing for mSATA 3ME3**

| Reliability | Test Conditions | Reference Standards |
|---|---|---|
| Vibration | 7 Hz to 2K Hz, 20G, 3 axes | IEC 68-2-6 |
| Mechanical Shock | Duration: 0.5ms, 1500 G, 3 axes | IEC 68-2-27 |

### 2.4.4 Mean Time between Failures (MTBF)

Table 7 summarizes the MTBF prediction results for various mSATA 3ME3 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 3ME3 MTBF**

| Product | Condition | MTBF (Hours) |
|---|---|---|
| **Innodisk mSATA 3ME3** | **Telcordia SR-332 GB, 25°C** | **>3,000,000** |

## 2.5 CE and FCC Compatibility

mSATA 3ME3 conforms to CE and FCC requirements.

## 2.6 RoHS Compliance

mSATA 3ME3 is fully compliant with RoHS directive.

## 2.7 Reliability

| Parameter | Value |
|---|---|
| Read Cycles | Unlimited Read Cycles |
| Flash endurance | 3,000 P/E cycles |
| Wear-Leveling Algorithm | Support |
| Bad Blocks Management | Support |
| Error Correct Code | Support |
| **TBW* (Total Bytes Written)** Unit:TB | |
| 08GB | 2.4 |
| 16GB | 4.8 |
| 32GB | 9.6 |
| 64GB | 19.2 |
| 128GB | 38.4 |
| 256GB | 76.8 |
| 512GB | 153.6 |
| * Total bytes written is based on JEDEC 218 (Solid-State Drive Requirements and Endurance Test Method) | |

## 2.8 Transfer Mode

mSATA 3ME3 support following transfer mode:

Serial ATA III 6.0Gbps

Serial ATA II 3.0Gbps

Serial ATA I 1.5Gbps

## 2.9 Pin Assignment

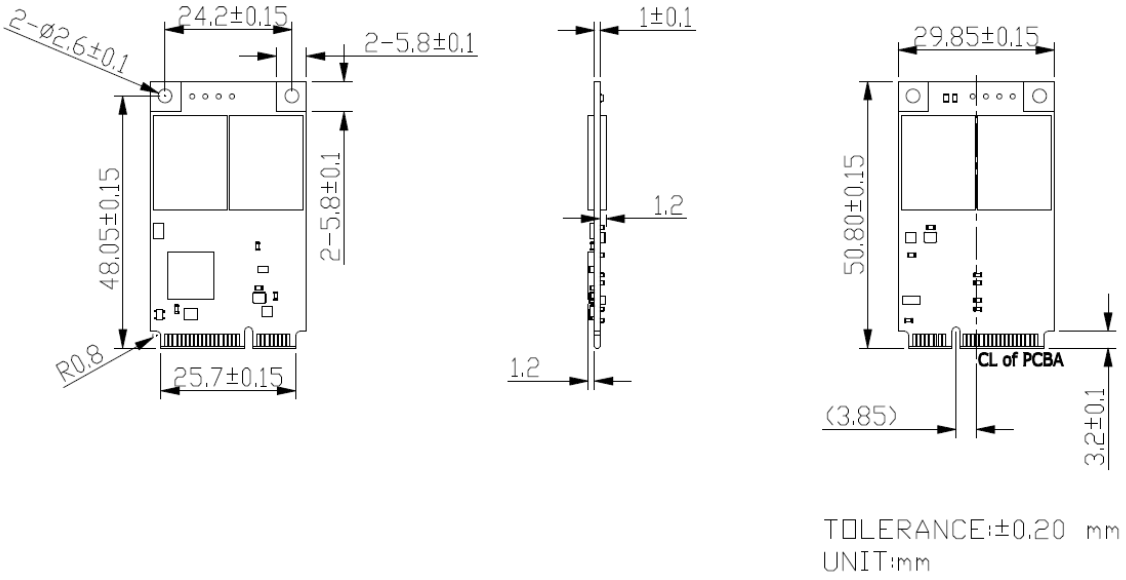
Innodisk mSATA 3ME3 uses a standard SATA pin-out. See Table 8 for mSATA 3ME3 pin assignment.

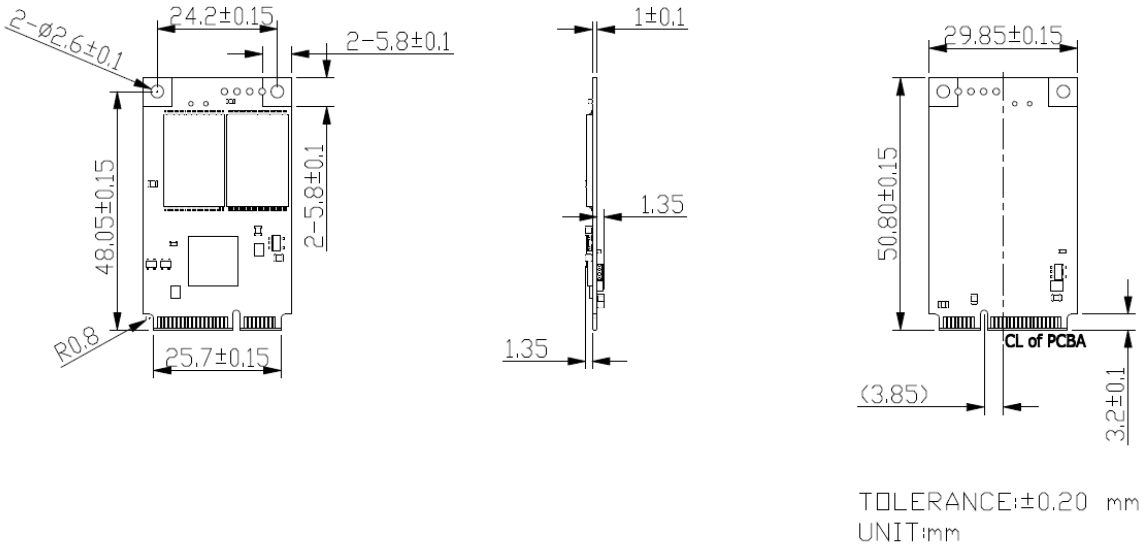
**Table 8: Innodisk mSATA 3ME3 Pin Assignment**

| 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 | NC |
| +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 3ME3 within flash ICs, 32GB's weight is 8 grams approximately.

## 2.12 Seek Time

Innodisk mSATA 3ME3 is not a magnetic rotating design. There is no seek or rotational latency required.

## 2.13 NAND Flash Memory

Innodisk mSATA 3ME3 uses Multi Level Cell (MLC) NAND flash memory, which is non-volatility, high reliability and high speed memory storage. Each cell stores 2 bits or holds four states per cell. Read or Write data to flash memory for SSD is control by microprocessor.

# 3. Theory of Operation

## 3.1 Overview

Figure 2 shows the operation of Innodisk mSATA 3ME3 from the system level, including the major hardware blocks.

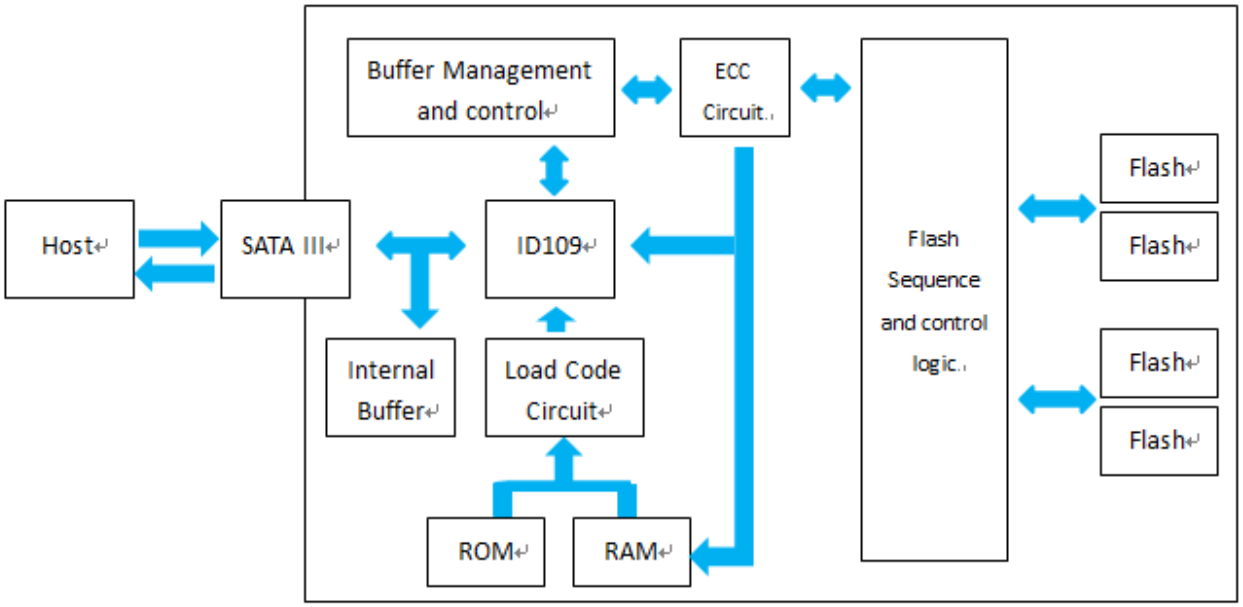



**Figure 2: Innodisk mSATA 3ME3 Block Diagram**

Innodisk mSATA 3ME3 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 3ME3 is designed with ID 109 / ID108, 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 / 4 channels for flash interface.

## 3.3 Error Detection and Correction

Highly sophisticated Error Correction Code algorithms are implemented. The ECC unit consists of the Parity Unit (parity-byte generation) and the Syndrome Unit (syndrome-byte computation). This unit implements an algorithm that can correct 40 bits per 1024 bytes in an ECC block. Code-byte generation during write operations, as well as error detection during read operation, is implemented

on the fly without any speed penalties.

## 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 3ME3 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

Innodisk's 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. Innodisk's 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

# 4. Installation Requirements

## 4.1 mSATA 3ME3 Pin Directions

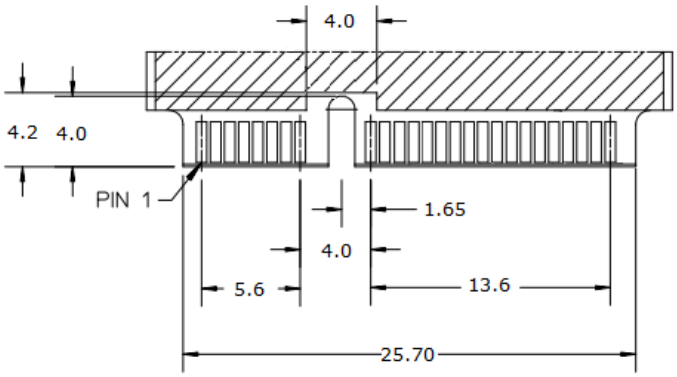



**Figure 3: Signal Segment and Power Segment**

## 4.2 Electrical Connections for mSATA 3ME3

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 3ME3 can be configured as a boot device.

# 5. SMART Feature Set

Innodisk 3ME3 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 3ME3 series SMART data attributes are listed in following table.

**Table 10: SMART attribute**

| Attribute ID (hex) | Attribute Name |
|---|---|
| 01 | Read Error Rate |
| 05 | Later Bad |
| 09 | Power-On hours Count |
| 0C | Drive Power Cycle Count |
| A3 | Total Bad Block Count |
| A5 | Max Erase count |
| A7 | Avg Erase count |
| A9 | Device Life |
| AA | Spare Block Count |
| AB | Program fail count |
| AC | Erase fail count |
| C0 | Unexpected Power Loss Count |
| C2 | Temperature |
| E5 | Flash ID |
| EB | Later Bad Block |
| F1 | Total LBAs written (each write unit = 32MB) |
| F2 | Total LBAs read (each write unit = 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **D** | **E** | **M** | **S** | **R** | **-** | **3** | **2** | **G** | **D** | **0** | **9** | **B** | **C** | **2** | **D** | **C** | **-** | **X** | **X** | **X** |
| Description | Disk | mSATA Regular | | | | | Capacity | | | Controller | | | Flash Mode | Operation Temp. | Internal Control | CH. | Flash Type | - | Customized Code | | |

| **Definition** | |
|---|---|
| **Code 1st (Disk)** | **Code 13th (Flash Mode)** |
| D : Disk | B: 15nm Synchronous Flash |
| **Code 2nd ~ 5th (Form Factor)** | **Code 14th (Operation Temperature)** |
| EMSR: mSATA Regular | C: Standard Grade (0℃~ +70℃) |
| | W: Industrial Grade (-40℃~ +85℃) |
| **Code 7th ~9th (Capacity)** | **Code 15th (Internal control)** |
| 08G: 08GB | 1~9: TSOP PCB version |
| 16G: 16GB | A~Z: BGA PCB version |
| 32G: 32GB | **Code 16th (Channel of data transfer)** |
| 64G: 64GB | S: Single Channel |
| A28: 128GB | D: Dual Channels |
| B56:256GB | Q:Quad Channels |
| C12:512GB | **Code 17th (Flash Type)** |
| **Code 10th ~12th (Controller)** | C: Toshiba MLC |
| D09: ID109 | **Code 19th~21th (Customized Code)** |
| D08: ID108 | |

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# RoHS 自我宣告書(RoHS Declaration of Conformity)

## Manufacturer Product: All Innodisk EM Flash and Dram products

一、 宜鼎國際股份有限公司（以下稱本公司）特此保證售予貴公司之所有產品，皆符合歐盟 2011/65/EU 關於 RoHS 之規範要求。

Innodisk Corporation declares that all products sold to the company, are complied with European Union RoHS Directive (2011/65/EU) requirement

二、 本公司同意因本保證書或與本保證書相關事宜有所爭議時，雙方宜友好協商，達成協議。

Innodisk Corporation agrees that both parties shall settle any dispute arising from or in connection with this Declaration of Conformity by friendly negotiations.

| Name of hazardous substance | Limited of RoHS ppm（mg/kg） |
|---|---|
| Cd | < 100 ppm |
| Pb | < 1000 ppm |
| Hg | < 1000 ppm |
| Chromium VI（Cr+6） | < 1000 ppm |
| Polybromodiphenyl ether（PBDE）<br>Polybrominated Biphenyls（PBB） | < 1000 ppm<br>< 1000 ppm |

**立 保 證 書 人 (Guarantor)**

Company name 公司名稱： Innodisk Corporation 宜鼎國際股份有限公司

Company Representative 公司代表人： Richard Lee 李綉亮

Company Representative Title 公司代表人職稱： CEO 執行長

Date 日期： 2014 / 07 / 29

(Company Stamp/公司大小章)

宜鼎國際股份有限公司
Innodisk Corporation

Tel:(02)7703-3000 Fax:(02) 7703-3555 Internet: http://www.innodisk.com/

# REACH Declaration of Conformity

## Manufacturer Product: All Innodisk EM Flash and Dram products

1.宜鼎國際股份有限公司（以下稱本公司）特此保證此番予貴公司之產品，皆符合歐盟化學品法案(Registration , Evaluation and Authorization of Chemicals：REACH)之規定(http://www.echa.europa.eu/de/candidate-list-table **last updated: 16/06/2014**)。所提供之產品包含：(1) 產品或產品所使用到的所有原物料；(2)包裝材料；(3)設計、生產及重工過程中所使用到的所有原物料。

We Innodisk Corporation hereby declare that our products are in compliance with the requirements according to the REACH Regulation (http://www.echa.europa.eu/de/candidate-list-table **last updated: 16/06/2014**). Products include： 1) Product and raw material used by the product； 2) Packaging material ；3) Raw material used in the process of design, production and rework

2.本公司同意因本保證書或與本保證書相關事宜有所爭議時，雙方宜友好協商，達成協議。

InnoDisk Corporation agrees that both parties shall settle any dispute arising from or in connection with this Declaration of Conformity by friendly negotiations.

立 保 證 書 人 (Guarantor)

Company name 公司名稱： InnoDisk Corporation 宜鼎國際股份有限公司

Company Representative 公司代表人： Richard Lee 李鎧亮

Company Representative Title 公司代表人職稱： CEO 執行長

Date 日期： 2014 / 07 / 29

(Company Stamp/公司大小章)

# Verification of Compliance

| | | |
|---|---|---|
| **Product Name** | : | **mSATA** |
| **Model Number** | : | **mSATA 3$*#-&**<br>**$:Flash type: (S:SLC,I:iSLC,M:MLC)**<br>***: Product line: (E:Embedded, G: EverGreen)**<br>**#:controller:**<br>**(empty:606/607/667/670, 2: SMI 2246XT/ 2246EN, 3:608/609)**<br>**&: Product feature: (P: with DRAM, empty: without DRAM)** |
| Applicant | : | **Innodisk Corporation** |
| Address | : | **5F.No.237, Sec. 1, Datong Rd., Xizhi Dist., New Taipei City 221, Taiwan (R.O.C.)** |
| Report Number | : | **S3O22-U070-1307-314** |
| Issue Date | : | **December 10, 2014** |
| Applicable Standards | : | **EN 55022:2010+AC:2011 Class B ITE**<br>**AS/NZS CISPR22:2009+A1:2010 Class B ITE**<br>**EN 55024:2010**<br>EN 61000-4-2:2009<br>EN 61000-4-3:2006+A1:2008+A2:2010<br>EN 61000-4-4:2004+A1:2010 |

Based on the EMC Directive 2004/108/EC and the specifications of the customer, one sample of the designated product has been tested in our laboratory and found to be in compliance with the EMC standards cited above.

CE

TAF 0905
FCC CAB Code TW1053
NVLAP Lab Code 200575-0
IC Code 4699A
VCCI Accep. No. R-1527, C-1609, T-1441, G-10, C-4400, T-1334, G-614

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Fax: 886-2-25984546

J. Y. Shih

(Tsun-Yu Shih/ General Manager)
Date: December 10, 2014

# Verification of Compliance

| | | |
|---|---|---|
| Product Name | : | mSATA |
| Model Number | : | mSATA 3$*#-&<br>$:Flash type: (S:SLC,I:iSLC,M:MLC)<br>*: Product line: (E:Embedded, G: EverGreen)<br>#:controller:<br>(empty:606/607/667/670, 2: SMI 2246XT/ 2246EN, 3:608/609)<br>&: Product feature: (P: with DRAM, empty: without DRAM) |
| Applicant | : | Innodisk Corporation |
| Address | : | 5F.No.237, Sec. 1, Datong Rd., Xizhi Dist., New Taipei City 221, Taiwan (R.O.C.) |
| Report Number | : | S3F-U070-1307-314 |
| Issue Date | : | December 10, 2014 |
| Applicable Standards | : | FCC Part 15, Subpart B Class B ITE<br>ANSI C63.4:2009<br>Industry Canada ICES-003 Issue 5<br>CAN/CSA-CISPR 22-10 Class B ITE |

One sample of the designated product has been tested in our laboratory and found to be in compliance with the FCC rules cited above.

NVLAP LAB CODE 200575-0
TAF 0905
FCC CAB Code TW1053
IC Code 4699A
VCCI Accep. No. R-1527, C-1609, T-1441, G-10, C-4400, T-1334, G-614

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Taipei, Taiwan, 104, R.O.C.
Tel : 886-2-25984568
Fax: 886-2-25984546

(Tsun-Yu Shih/ General Manager)

Date: December 10, 2014