# innodisk

# M.2 (S42)
## 3ME3 Series

**Total Solution For Industrial Flash Storage**

**Customer:** _____

**Customer Part Number:** _____

**Innodisk Part Number:** _____

**Innodisk Model Name:** _____

**Date:** _____

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

# Table of contents

# REVISION HISTORY

| Revision | Description | Date |
|---|---|---|
| Preliminary | First Released | August, 2015 |
| Rev 1.0 | Update IOPS, Power Consumption and TBW, Modify Mechanical dimension Add CE/FCC | October, 2015 |
| Rev 2.0 | Add performance and update part number rule for Toshiba 15nm | December, 2015 |
| Rev 2.1 | Update performance | January, 2017 |

# List of Tables

# List of Figures

# 1. Product Overview

## 1.1 Introduction of Innodisk M.2 (S42) 3ME3

Innodisk M.2 (S42) 3ME3 is designed as the standard M.2 form factor with SATA interface, and supports SATA III standard (6.0Gb/s) with excellent performance. The form factor refers to the M.2(NGFF) specification which established by JEDEC. Regarding of mechanical interference, Innodisk M.2 (S42) 3ME3 absolutely replaces the traditional hard disk and makes personal computer, in any field, smaller and easier.

Innodisk M.2 (S42) 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 M.2 (S42) 3ME3 is available in follow capacities within MLC flash ICs.

M.2 (S42) 3ME3 08GB (type 2242)

M.2 (S42) 3ME3 16GB (type 2242)

M.2 (S42) 3ME3 32GB (type 2242)

M.2 (S42) 3ME3 64GB (type 2242)

M.2 (S42) 3ME3 128GB (type 2242)



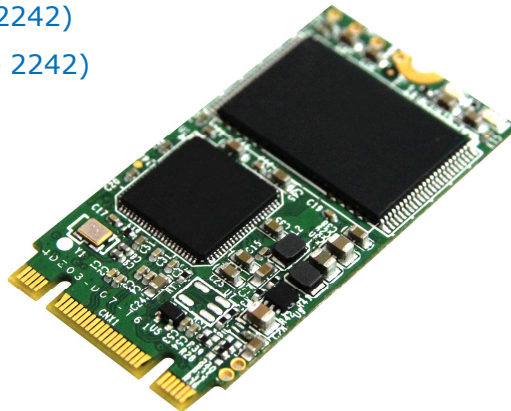**Figure 1: Innodisk M.2 (S42) 3ME3 (type 2242)**

## 1.3 SATA Interface

Innodisk M.2 (S42) 3ME3 supports SATA III interface, and compliant with SATA I and SATA II. SATA III interface can work with Serial Attached SCSI (SAS) host system, which is used in server computer. Innodisk M.2 (S42) 3ME3 is compliant with Serial ATA Gen 1, Gen 2 and Gen 3 specification (Gen 3 supports 1.5Gbps /3.0Gbps/6.0Gbps data rate).

# 2. Product Specifications

## 2.1 Capacity and Device Parameters

M.2 (S42) 3ME3 device parameters are shown in Table 1.

**Table 1: Device parameters**

| Capacity | Cylinders | Heads | Sectors | LBA | user space |
|----------|-----------|-------|---------|-----|------------|
| 8GB | 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 |

## 2.2 Performance

Burst Transfer Rate:   6.0Gbps

**Table 2: Performance**

| | Capacity | 8GB | 16GB | 32GB | 64GB | 128GB |
|---|----------|-----|------|------|------|-------|
| Toshiba A19nm | Sequential* Read (max.) | 100 MB/s | 200 MB/s | 200 MB/s | 200 MB/s | 200 MB/s |
| | Sequential* Write (max.) | 20 MB/s | 35 MB/s | 70 MB/s | 70 MB/s | 80 MB/s |
| | 4KB Random** Read (QD32) | 4,100 IOPS | 5,900 IOPS | 7,700 IOPS | 7,780 IOPS | 7,300 IOPS |
| | 4KB Random** Write (QD32) | 5,000 IOPS | 8,000 IOPS | 13,000 IOPS | 13,200 IOPS | 15,400 IOPS |
| Toshiba 15nm | Capacity | 8GB | 16GB | 32GB | 64GB | 128GB |
| | Sequential* Read (max.) | 100 MB/s | 100 MB/s | 200 MB/s | 220 MB/s | 220 MB/s |
| | Sequential* Write (max.) | 20 MB/s | 20 MB/s | 40 MB/s | 80 MB/s | 80 MB/s |
| | 4KB Random** Read (QD32) | 3,900 IOPS | 3,800 IOPS | 6,100 IOPS | 6,600 IOPS | 7,000 IOPS |
| | 4KB Random** Write (QD32) | 5,900 IOPS | 5,300 IOPS | 6,900 IOPS | 8,700 IOPS | 7,600 IOPS |

Note: * Sequential performance is based on CrystalDiskMark 3.03 with file size 1000MB

   ** Random performance is based on IO meter with Queue Depth 32

## 2.3 Electrical Specifications

## 2.3.1 Power Requirement

**Table 3: Innodisk M.2 (S42) 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 | 200 (max.) |
| Write | 300 (max.) |
| Idle | 130 (max.) |

\* Target: 64GB M.2 (S42) 3ME3

## 2.4 Environmental Specifications

## 2.4.1 Temperature Ranges

**Table 5: Temperature range for M.2 (S42) 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 M.2 (S42) 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 M.2 (S42) 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: M.2 (S42) 3ME3 MTBF**

| Product | Condition | MTBF (Hours) |
|---------|-----------|--------------|
| Innodisk M.2 (S42) 3ME3 | Telcordia SR-332 GB, 25°C | >3,000,000 |

## 2.5 CE and FCC Compatibility

M.2 (S42) 3ME3 conforms to CE and FCC requirements.

## 2.6 RoHS Compliance

M.2 (S42) 3ME3 is fully compliant with RoHS directive.

## 2.7 Reliability

| Parameter | Value |
|-----------|-------|
| Read Cycles | Unlimited Read Cycles |
| Wear-Leveling Algorithm | Support |
| Bad Blocks Management | Support |
| Error Correct Code | Support |
| iData Guard | Support |
| Thermal Sensor | WT only |
| Flash endurance | 3,000 P/E cycles |
| TBW* (Total Bytes Written) | Unit: TB |
| 8GB | 2.3 |
| 16GB | 4.7 |
| 32GB | 9.4 |
| 64GB | 18.8 |
| 128GB | 37.5 |
| * Total bytes written is based on JEDEC 218 (Solid-State Drive Requirements and Endurance Test Method) ** Lifespan is calculated by device written per day | |

## 2.8 Transfer Mode

M.2 (S42) 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 M.2 (S42) 3ME3 uses a standard SATA pin-out. See Table 8 for M.2 (S42) 3ME3 pin assignment.

**Table 8: Innodisk M.2 (S42) 3ME3 Pin Assignment**

| Signal Name | Pin # | Pin # | Signal Name |
|:---:|:---:|:---:|:---:|
|  |  | 75 | GND |
| 3.3V | 74 | 73 | GND |
| 3.3V | 72 | 71 | GND |
| 3.3V | 70 | 69 | GND |
| SUSCLK | 68 | 67 | NC |
| Notch | 66 | 65 | Notch |
| Notch | 64 | 63 | Notch |
| Notch | 62 | 61 | Notch |
| Notch | 60 | 59 | Notch |
| Reserved/ MFG Clock | 58 |  |  |
| Reserved/ MFG Data | 56 | 57 | GND |
| NC | 54 | 55 | NC |
| NC | 52 | 53 | NC |
| NC | 50 | 51 | GND |
| NC | 48 | 49 | RX+ |
| NC | 46 | 47 | RX- |
| NC | 44 | 45 | GND |
| NC | 42 | 43 | TX- |
| NC | 40 | 41 | TX+ |
| DEVSLP | 38 | 39 | GND |
| NC | 36 | 37 | NC |

| | | | |
|---|---|---|---|
| NC | 34 | 35 | NC |
| NC | 32 | 33 | GND |
| NC | 30 | 31 | NC |
| NC | 28 | 29 | NC |
| NC | 26 | 27 | GND |
| NC | 24 | 25 | NC |
| NC | 22 | 23 | NC |
| NC | 20 | 21 | GND |
| Notch | 18 | 19 | Notch |
| Notch | 16 | 17 | Notch |
| Notch | 14 | 15 | Notch |
| Notch | 12 | 13 | Notch |
| DAS/DSS | 10 | 11 | NC |
| NC | 8 | 9 | NC |
| NC | 6 | 7 | NC |
| 3.3V | 4 | 5 | NC |
| 3.3V | 2 | 3 | GND |
| | | 1 | GND |

## 2.10 Mechanical Dimensions



Dimension tolerance: ±0.15mm
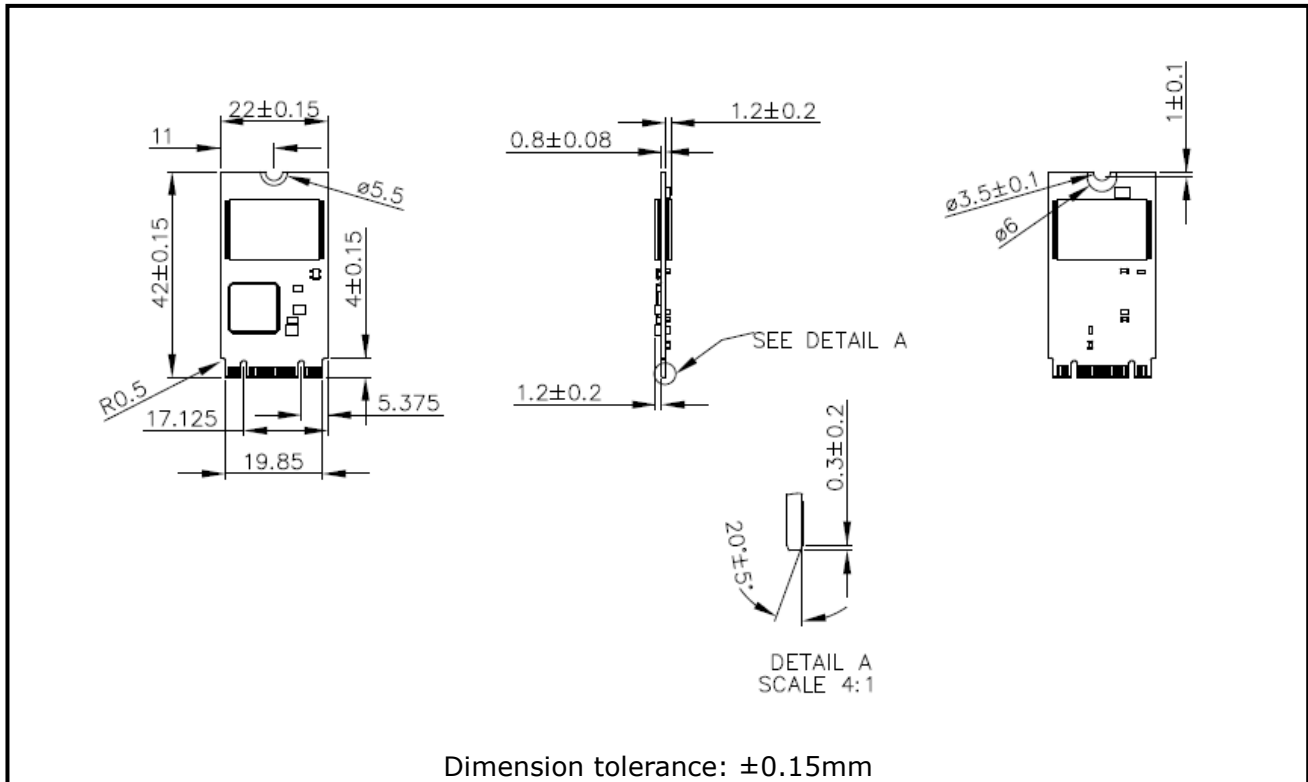
## 2.11 Assembly Weight

An Innodisk M.2 (S42) 3ME3 within flash ICs, 64GB's weight is 8 grams approximately.

## 2.12 Seek Time

Innodisk M.2 (S42) 3ME3 is not a magnetic rotating design. There is no seek or rotational latency required.

## 2.13 Hot Plug

The SSD support hot plug function and can be removed or plugged-in during operation. User has to avoid hot plugging the SSD which is configured as boot device and installed operation system.

Surprise hot plug : The insertion of a SATA device into a backplane (combine signal and power) that has power present. The device powers up and initiates an OOB sequence.

Surprise hot removal: The removal of a SATA device from a powered backplane, without first being placed in a quiescent state.

## 2.14 NAND Flash Memory

Innodisk M.2 (S42) 3ME3 uses Multi Level Cell (MLC) NAND flash memory, 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 M.2 (S42) 3ME3 from the system level, including the major hardware blocks.
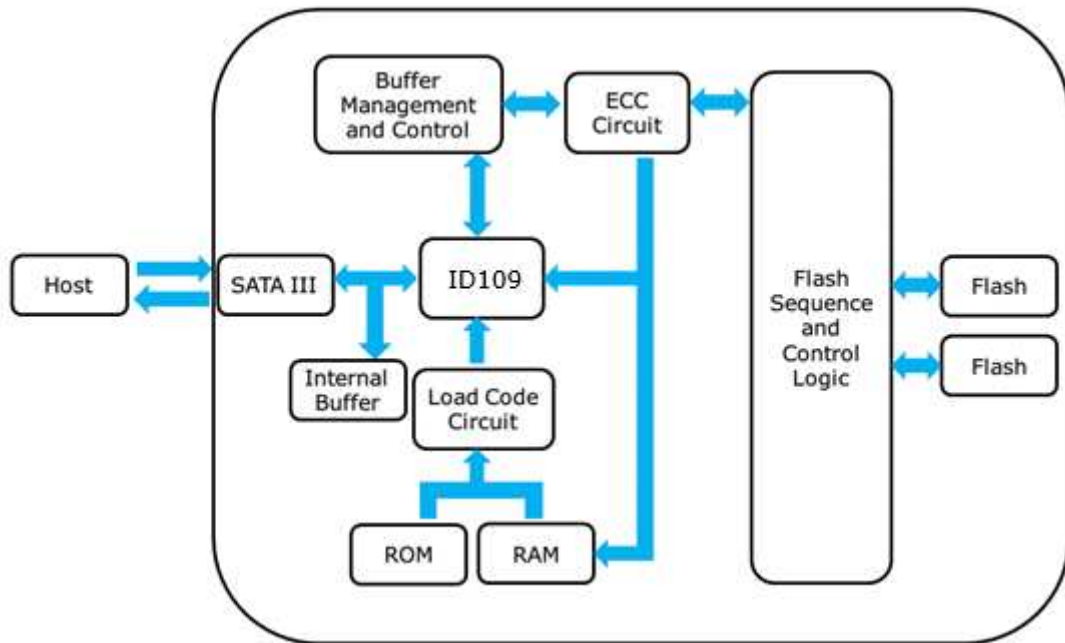


**Figure 2: Innodisk M.2 (S42) 3ME3 Block Diagram**

Innodisk M.2 (S42) 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 M.2 (S42) 3ME3 is designed with ID 109, 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

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 M.2 (S42) 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 Power Cycling

Innodisk's power cycling management 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 power cycling 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.

# 4. Installation Requirements
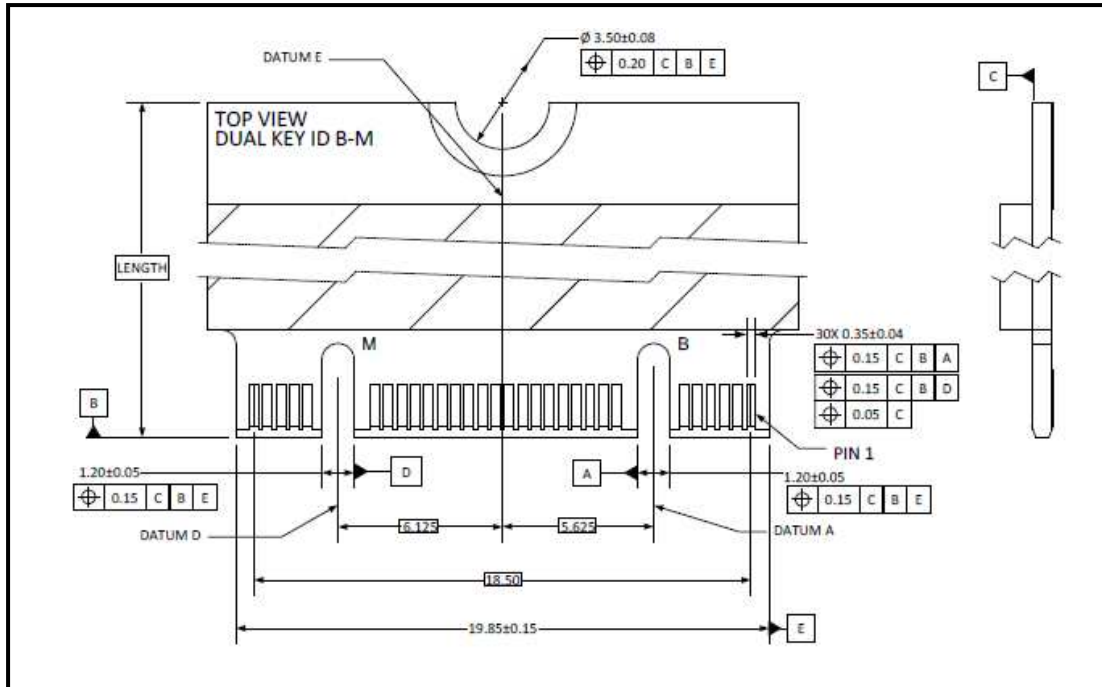
## 4.1 M.2 (S42) 3ME3 Pin Directions



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

## 4.2 Electrical Connections for M.2 (S42) 3ME3

A Serial ATA device may be either directly connected to a host or connected to a host through a cable. For connection via cable, the cable should be no longer than 1meter. 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 M.2 (S42) 3ME3 can be configured as a boot device.

# 5. 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 | 2 | 4 | - | 3 | 2 | G | D | 0 | 9 | B | C | 1 | D | C | - | X | X | X |

| Definition | |
|---|---|
| **Code 1st (Disk)** | **Code 14th (Operation Temperature)** |
| D : Disk | C: Standard Grade (0℃～+70℃) |
| **Code 2nd (Feature set)** | W: Industrial Grade (-40℃～+85℃) |
| E : Embedded series | **Code 15th (Internal control)** |
| **Code 3rd ~5th (Form factor)** | 1~9: TSOP PCB version. |
| M24: M.2-SATA Type 2242 | **Code 16th (Channel of data transfer)** |
| **Code 7th ~9th (Capacity)** | S: Single Channel |
| 08G: 8GB \| 16G: 16GB. \| 32G: 32GB \| 64G: 64GB \| A28: 128GB | D: Dual Channels |
| **Code 10th ~12th (Controller)** | **Code 17th (Flash Type)** |
| D09: ID109 | C: Toshiba MLC |
| **Code 13th (Flash mode)** | **Code 19th~21st (Customize code)** |
| S: Synchronous NAND. | |
| B: Synchronous NAND for Toshiba 15nm | |

# Appendix

**innodisk**

## 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/

### 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） | < 1000 ppm |
| Polybrominated Biphenyls（PBB） | < 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 李鐘亮___

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)

**Innodisk Corporation**

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）特此保證此售予貴公司之產品，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.
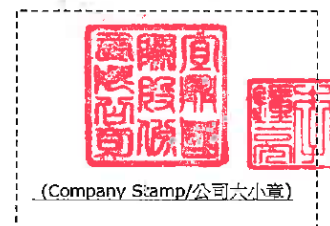
### 立 保 證 書 人 (Guarantor)

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 李鐘亮

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

Date 日期： 2014 / 07 / 29

(Company Stamp/公司六小章)

# Certificate

Issue Date: July 29, 2015
Ref. Report No.: ISL-15LE321CE

Product Name : M.2
Model(s) : M.2 (S42) 3$*#-&
(S:Flash type: (S:SLC,I:iSLC,M:MLC);
*:Product line: (E:Embedded, G:EverGreen, R:InnoRobust);
#:Controller: ( empty:106/107/167/170, 2:201/ 202, 3:108/109);
&:Product feature: (P:with DRAM, empty:without DRAM))
Responsible Party : Innodisk Corporation
Address : 5F.No.237, Sec. 1, Datong Rd., Xizhi Dist., New Taipei City 221, Taiwan (R.O.C.)

We, International Standards Laboratory, hereby certify that:

The device bearing the trade name and model specified above has been shown to comply with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in European Council Directive- EMC Directive 2004/108/EC. The device was passed the test performed according to :

CE

Standards:
EN 55022: 2010+AC2011 and CISPR 22: 2008 (modified)
EN 61000-3-2: 2006+A1:2009 +A2:2009 and IEC 61000-3-2: 2005+A1:2008 +A2:2009
EN 61000-3-3: 2013 and IEC 61000-3-3: 2013
EN 55024: 2010 and CISPR 24: 2010
EN 61000-4-2: 2009 and IEC 61000-4-2: 2008
EN 61000-4-3: 2006+A1: 2008 +A2: 2010 and
IEC 61000-4-3:2006+A1: 2007+A2: 2010
EN 61000-4-4:2012 and IEC 61000-4-4:2012

I attest to the accuracy of data and all measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

International Standards Laboratory

Jim Chu / Director

☐ Hsi-Chih LAB:
No. 65, Gu Dai Keng Street, Hsi-Chih Dist.,
New Taipei City 221, Taiwan
Tel: 886-2-2646-2550; Fax: 886-2-2646-4641

Nemko
ELA113A

☒ Lung-Tan LAB:
No. 120, Lane 180, Hsin Ho Rd., Lung-Tan Dist.,
Tao Yuan City 325, Taiwan
Tel: 886-3-407-1718; Fax: 886-3-407-1738

Nemko
ELA113B

# Certificate

Issue Date: July 29, 2015
Ref. Report No.: ISL-15LE321FB

Product Name : M.2
Model(s) : M.2 (S42) 3S*#-&
(S:Flash type: (S:SLC,I:iSLC,M:MLC);
*:Product line: (E:Embedded, G:EverGreen, R:InnoRobust);
#:Controller: ( empty:106/107/167/170, 2:201/ 202, 3:108/109);
&: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.)

We, **International Standards Laboratory**, hereby certify that:

The device bearing the trade name and model specified above has been shown to comply with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified. (refer to Test Report if any modifications were made for compliance).

## Standards:

FC

FCC CFR Title 47 Part 15 Subpart B: 2014- Section 15.107 and 15.109
ANSI C63.4-2009
Industry Canada Interference-Causing Equipment Standard ICES-003 Issue 5: 2012

Class B

I attest to the accuracy of data and all measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

**International Standards Laboratory**

Jim Chu / Director

☐ Hsi-Chih LAB:
No. 65, Gu Dai Keng Street, Hsi-Chih Dist.,
New Taipei City 221, Taiwan
Tel: 886-2-2646-2550; Fax: 886-2-2646-4641

☒ Lung-Tan LAB:
No. 120, Lane 180, Hsin Ho Rd., Lung-Tan Dist.,
Tao Yuan City 325, Taiwan
Tel: 886-3-407-1718; Fax: 886-3407-1738