innodisk

Total Solution For Industrial Flash Storage

# 1.8" SATA SSD

## 3MG3-P Series

**Customer:** _____

**Customer Part Number:** _____

**Innodisk Part Number:** _____

**Innodisk Model Name:** _____

**Date:** _____

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

# Table of Contents

# Revision History

| Revision | Description | Date |
|---|---|---|
| Rev. 1.0 | First Released | Feb., 2016 |
| Rev. 1.1 | Add CE/FCC<br>Update power consumption | July, 2016 |

# List of Tables

# List of Figures

# 1. Product Overview

## 1.1 Introduction of Innodisk 1.8” SATA SSD 3MG3-P

Innodisk 1.8” SATA SSD 3MG3-P products provide high capacity flash memory Solid State Drive (SSD) that electrically complies with Serial ATA (SATA) standard. It supports SATA III standard (6.0GHz) with high performance. Innodisk 1.8” SATA SSD 3MG3-P is designed for industrial field, and supports several standard features, including NCQ, and S.M.A.R.T. The SSD has good performance with no latency time and small seek time. It effectively reduces the booting time of operation system and the power consumption is less than hard disk drive (HDD).

## 1.2 Product View and Models

Innodisk 1.8” SATA SSD 3MG3-P is available in follow capacities within MLC flash ICs.

1.8” SATA SSD 3MG3-P 8GB  1.8” SATA SSD 3MG3-P 128GB
1.8” SATA SSD 3MG3-P 16GB  1.8” SATA SSD 3MG3-P 256GB
1.8” SATA SSD 3MG3-P 32GB  1.8” SATA SSD 3MG3-P 512GB
1.8” SATA SSD 3MG3-P 64GB


**Figure 1: Innodisk 1.8” SATA SSD 3MG3-P**

## 1.3 SATA Interface

Innodisk 1.8” SATA SSD 3MG3-P 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 1.8” SATA SSD 3MG3-P is compliant with Serial ATA Gen 1, Gen 2 and Gen 3 specification (Gen 3 supports 1.5Gbps /3.0Gbps/6.0Gbps data rate). SATA connector uses a 7-pin signal segment and a 9-pin power segment.

## 1.4 1.8-inch Form Factor

The Industry-standard 1.8-inch form factor is designed with metal material case, which is easy for

installation because 1.8-inch is a commonly used form factor in industrial field. Innodisk 1.8” SATA SSD 3MG3-P has a compact design 54.0mm (W) x78.5mm (L) x 5.0mm (H).

# 2. Product Specifications

## 2.1 Capacity and Device Parameters

1.8” SATA SSD 3MG3-P device parameters are shown in Table 1.

**Table 1: Device parameters**

| Capacity | LBA | Cylinders | Heads | Sectors | User Capacity(MB) |
|---|---|---|---|---|---|
| 8GB | 13695696 | 16383 | 16 | 63 | 6687 |
| 16GB | 29323728 | 16383 | 16 | 63 | 14318 |
| 32GB | 60579792 | 16383 | 16 | 63 | 29580 |
| 64GB | 121138416 | 16383 | 16 | 63 | 59150 |
| 128GB | 242255664 | 16383 | 16 | 63 | 118289 |
| 256GB | 484490160 | 16383 | 16 | 63 | 236567 |
| 512GB | 968959152 | 16383 | 16 | 63 | 473125 |

## 2.2 Performance

Burst Transfer Rate: 6.0Gbps

**Table 2: Performance**

| Capacity | 8GB | 16GB | 32GB | 64GB | 128GB | 256GB | 512GB |
|---|---|---|---|---|---|---|---|
| Sequential Read* (max.) MB/sec | 120 | 120 | 230 | 350 | 440 | 480 | 480 |
| Sequential Write* (max.) MB/sec | 25 | 20 | 40 | 80 | 150 | 220 | 220 |
| 4KB Random** Read (QD32) | 8,800 IOPS | 8,600 IOPS | 15,200 IOPS | 25,000 IOPS | 31,700 IOPS | 30,000 IOPS | 30,000 IOPS |
| 4KB Random** Write (QD32) | 6,000 IOPS | 5,500 IOPS | 8,800 IOPS | 14,400 IOPS | 24,400 IOPS | 32,000 IOPS | 32,500 IOPS |

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

** Random performance based on IOmeter with Queue Depth 32

## 2.3 Electrical Specifications

### 2.3.1 Power Requirement

**Table 3: Innodisk 1.8” SATA SSD 3MG3-P Power Requirement**

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

### 2.3.2 Power Consumption

**Table 4: Power Consumption**

| Mode | Power Consumption (mA) |
|---|---|
| Read | 260 mA (max.) |
| Write | 340 mA (max.) |
| Idle | 140 mA (max.) |

* Target: 1.8” SATA SSD 3MG3-P 512GB

## 2.4 Environmental Specifications

### 2.4.1 Temperature Ranges

**Table 5: Temperature range for 1.8” SATA SSD 3MG3-P**

| 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 1.8” SATA SSD 3MG3-P**

| 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 1.8” SATA SSD 3MG3-P 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: 1.8” SATA SSD 3MG3-P MTBF**

| Product | Condition | MTBF (Hours) |
|---|---|---|
| Innodisk 1.8” SATA SSD 3MG3-P | Telcordia SR-332 GB, 25°C | >3,000,000 |

## 2.5 CE and FCC Compatibility

1.8” SATA SSD 3MG3-P conforms to CE and FCC requirements.

## 2.6 RoHS Compliance

1.8” SATA SSD 3MG3-P 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 |
| TBW (Unit: TB) | |
| 8GB | 2.3 |
| 16GB | 4.7 |
| 32GB | 9.4 |
| 64GB | 18.8 |
| 128GB | 37.5 |
| 256GB | 75.2 |
| 512GB | 150.4 |
| * 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

1.8” SATA SSD 3MG3-P support the following transfer modes,

Serial ATA III 6.0Gbps

Serial ATA II 3.0Gbps

Serial ATA I 1.5Gbps

## 2.9 Pin Assignment

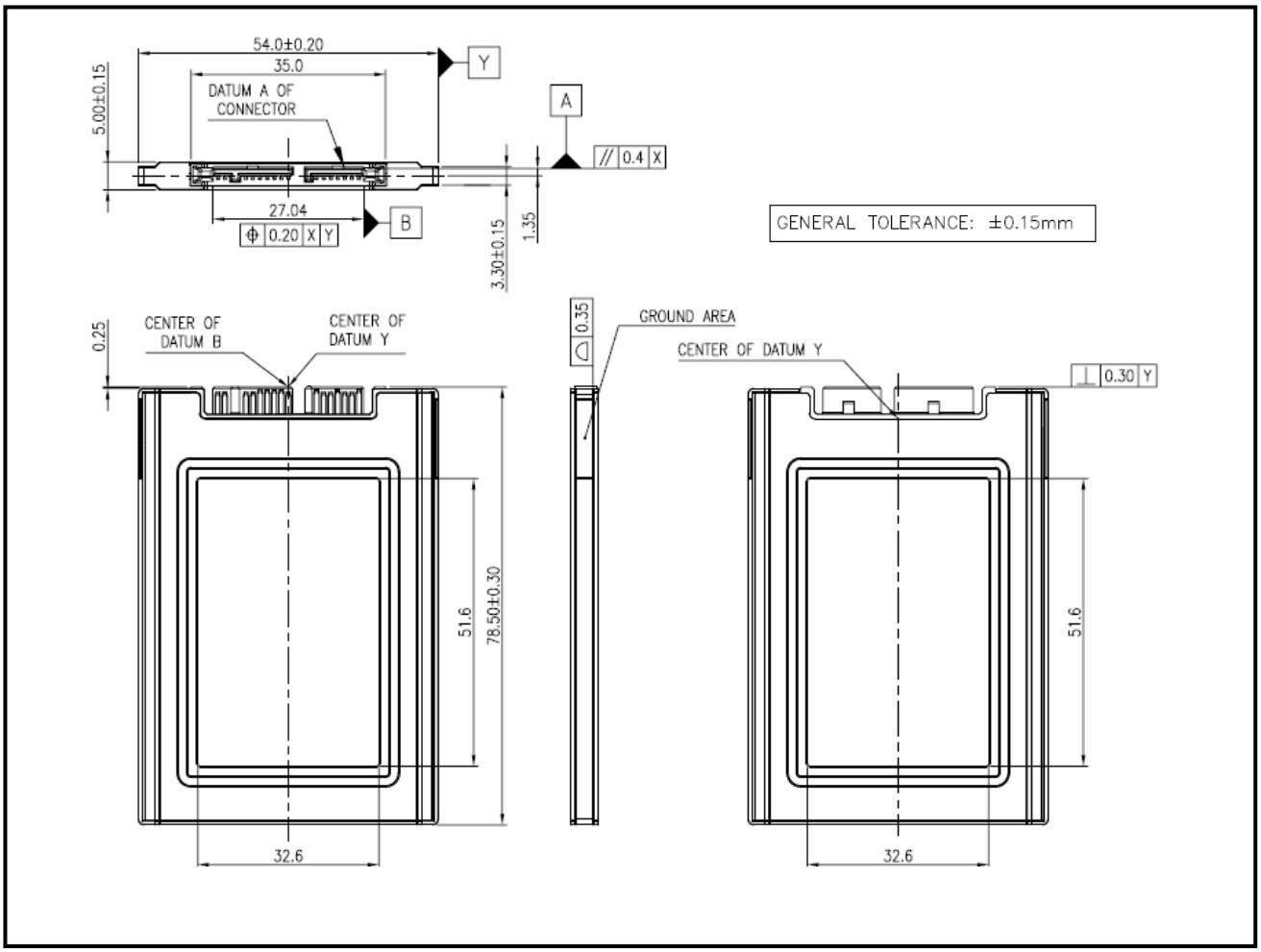
Innodisk 1.8” SATA SSD 3MG3-P uses a standard SATA pin-out. See Table 8 for 1.8” SATA SSD 3MG3-P pin assignment.

**Table 8: Innodisk 1.8” SATA SSD 3MG3-P Pin Assignment**

| Name | Type | Description |
|---|---|---|
| S1 | GND | NA |
| S2 | A+ | Differential Signal Pair A |

| | | |
|---|---|---|
| S3 | A- | |
| S4 | GND | NA |
| S5 | B- | Differential Signal Pair B |
| S6 | B+ | |
| S7 | GND | NA |
| **Key and Spacing separate signal and power segments** | | |
| P1 | V33 | 3.3V Power |
| P2 | V33 | 3.3V Power, Pre-charge |
| P3 | GND | NA |
| P4 | GND | NA |
| P5 | V5 | 5V Power, Pre-charge |
| P6 | V5 | 5V Power |
| P7 | R | Reserved |
| Key | Key | Key |
| P8 | Optional | Vendor Specific |
| P9 | Optional | Vendor Specific |

## 2.10 Mechanical Dimensions



## 2.11 Assembly Weight

An Innodisk 1.8” SATA SSD 3MG3-P within MLC flash ICs, 32GB’s weight is 55 grams approx. The total weight of SSD will be less than 60 grams.

## 2.12 Seek Time

Innodisk 1.8” SATA SSD 3MG3-P 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 1.8” SATA SSD 3MG3-P 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 1.8” SATA SSD 3MG3-P from the system level, including the major hardware blocks.

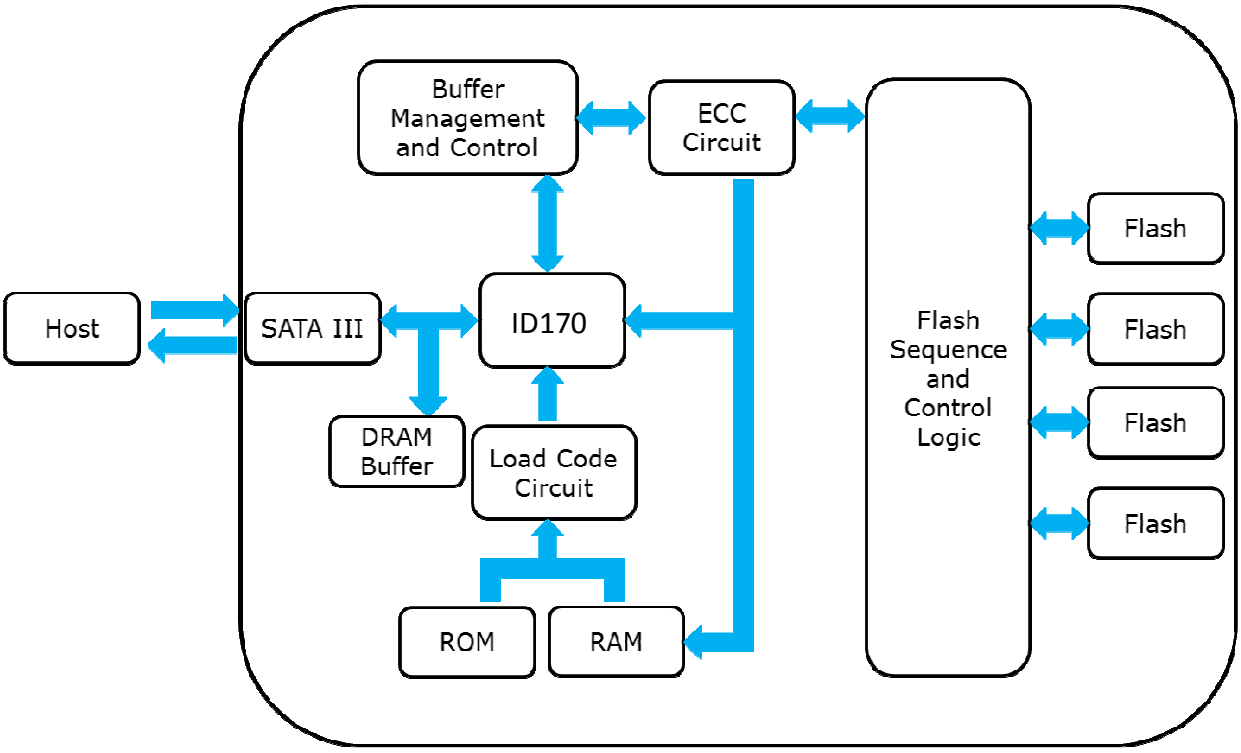



**Figure 2: Innodisk 1.8” SATA SSD 3MG3-P Block Diagram**

Innodisk 1.8” SATA SSD 3MG3-P 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 1.8” SATA SSD 3MG3-P is designed with ID 167, a SATA III 6.0Gbps (Gen. 3) controller, which supports external DDDR3 DRAM. 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 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 1.8” SATA SSD 3MG3-P 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/TRIM

Garbage collection and TRIM technology 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 1.8” SATA SSD 3MG3-P Pin Directions

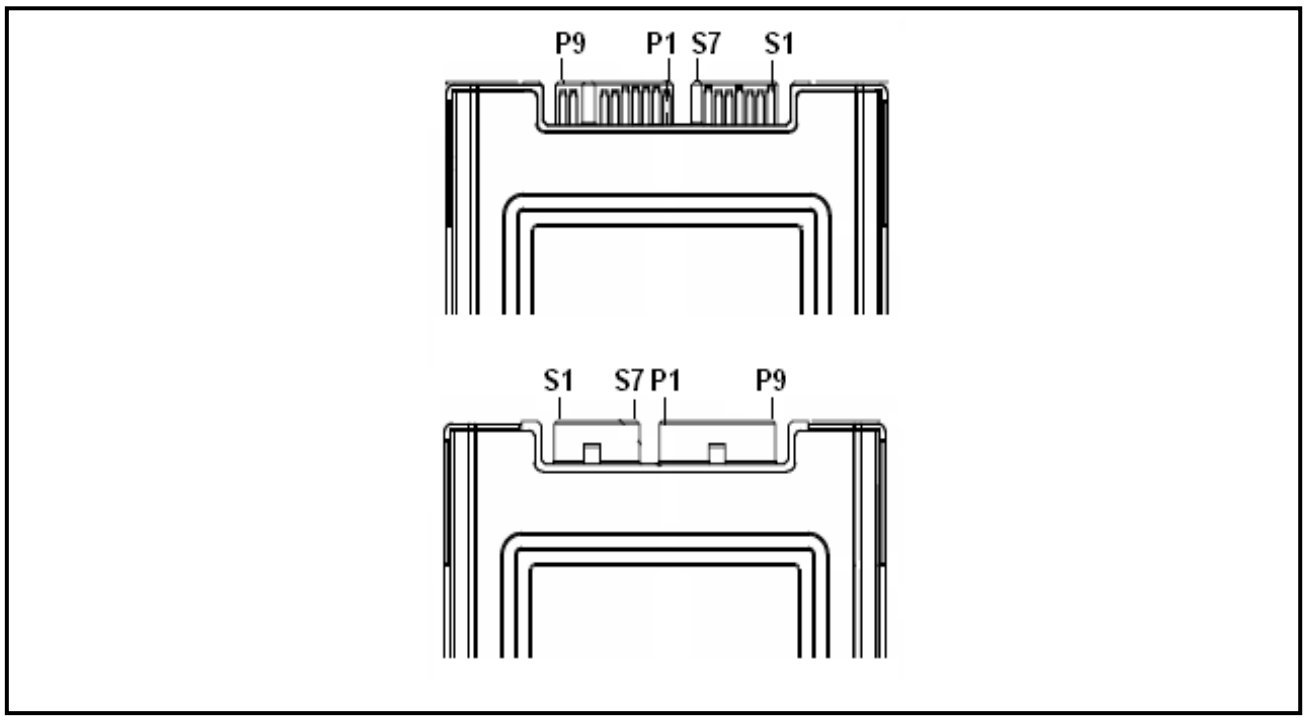



**Figure 3: Signal Segment and Power Segment**

## 4.2 Electrical Connections for 1.8” SATA SSD 3MG3-P

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. Innodisk 1.8” SATA SSD 3MG3-P 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **D** | **G** | **S** | **1** | **8** | **-** | **B** | **5** | **6** | **D** | **7** | **0** | **B** | **C** | **1** | **Q** | **C** | **-** | **X** | **X** |

| **Definition** | |
|---|---|
| **Code 1st (Disk)** | **Code 13th (Flash Mode)** |
| D : Disk | B: Toshiba 15nm Sync. Flash |
| | |
| **Code 2nd ~ 5th (Form Factor)** | **Code 14th (Operation Temperature)** |
| GS18: 1.8” SATA SSD 3MG3-P | C: Standard Grade (0℃~ +70℃) |
| | W: Industrial Grade (-40℃~ +85℃) |
| **Code 7th ~9th (Capacity)** | **Code 15th (Internal Control)** |
| 08G: 8GB | 1: PCB version |
| 16G: 16GB | |
| 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 10th ~12th (Controller)** | **Code 17th (Flash Type)** |
| D70: ID170 | C: Toshiba MLC |
| | |
| | **Code 19th~20th (Customized Code)** |
| | |

# 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 |

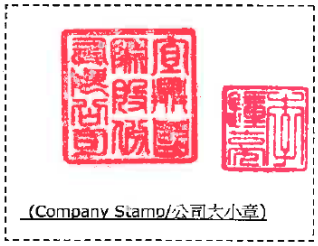
**立 保 證 書 人 (Guarantor)**

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)

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: 16/05/2014**)。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/公司大小章)

# Certificate

Issue Date: March 1, 2016
Ref. Report No. ISL-16LE078CE

| | | |
|---|---|---|
| Product Name | : | 1.8" SATA SSD |
| Model(s) | : | 1.8" SATA SSD 3$*#-&<br>($:Flash type: (S:SLC,I:iSLC,M:MLC);<br>*:Product line: (E:Embedded, G:EverGreen, R:InnoRobust);<br>#:Controller: (empty:106/107/167, 2:201/202, 3:108/109/170, 4~9:Others)<br>&: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 (marketed before 2016/04/19) 2014/30/EU (marketed after 2016/04/20). The device was passed the test performed according to :

CE

**Standards:**

EN 55022: 2010+AC2011 and CISPR 22: 2008 (modified)
EN 61000-3-2:2014 and IEC 61000-3-2:2014
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**

W.H. Chang / 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

TAF Nemko ELA113B

# Certificate

Issue Date: March 1, 2016
Ref. Report No. ISL-16LE078FB

| | | |
|---|---|---|
| Product Name | : | 1.8" SATA SSD |
| Model(s) | : | 1.8" SATA SSD 3$*#-&<br>($:Flash type: (S:SLC,I:iSLC,M:MLC);<br>*:Product line: (E:Embedded, G:EverGreen, R:InnoRobust);<br>#:Controller: (empty:106/107/167, 2:201/202, 3:108/109/170, 4~9:Others)<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.) |

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:**

FCC CFR Title 47 Part 15 Subpart B: 2014- Section 15.107 and 15.109
ANSI C63.4-2014
Industry Canada Interference-Causing Equipment Standard ICES-003 Issue 6: 2016

**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**

W.H. Chang / 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