innodisk

mSATA
3SE Series

Customer: _____

Customer Part Number: _____

Innodisk Part Number: _____

Innodisk Model Name: _____

Date: _____

Innodisk Approver	Customer Approver

Total Solution For Industrial Flash Storage

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REVISION HISTORY

Revision	Description	Date
Preliminary	First Released	May, 2013
1.0	Official release	July, 2013
1.1	Add 64GB	Nov, 2013
1.2	Modify pin assignment	April, 2014
1.3	Renew the CE and FCC and Modify TBW based on NAND Flash specifications	February,2015
1.4	Update mechanical drawing	AUG, 2015
1.5	Add 24nm NAND Compositions	July, 2020
1.6	Add DAS LED Definition	Oct., 2020

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1. Product Overview

1.1 Introduction of Innodisk mSATA 3SE

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

Innodisk mSATA 3SE 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 3SE is available in follow capacities within SLC flash ICs.

mSATA 3SE 1GB

mSATA 3SE 2GB

mSATA 3SE 4GB

mSATA 3SE 8GB

mSATA 3SE 16GB

mSATA 3SE 32GB

mSATA 3SE 64GB

Figure 1: Innodisk mSATA 3SE

1.3 SATA Interface

Innodisk mSATA 3SE 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 mSATA 3SE 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

mSATA 3SE device parameters are shown in Table 1.

Table 1: Device parameters

Capacity	Cylinders	Heads	Sectors	LBA	User Space
1GB	1959	16	63	1974672	964
2GB	3897	16	63	3928176	1,918
4GB	7773	16	63	7835184	3,826
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

2.2 Performance

Burst Transfer Rate: 6.0Gbps

Table 2: Performance*

Capacity	1GB		2GB		4GB		8GB	
	32nm	24nm***	32nm	24nm***	32nm	24nm***	32nm	24nm***
Sequential** Read (max.)	23 MB/sec	30 MB/sec	50 MB/sec	60 MB/sec	250 MB/sec	67 MB/sec	400 MB/sec	67 MB/sec
Sequential** Write (max.)	9 MB/sec	14 MB/sec	27 MB/sec	26MB/sec	50 MB/sec	53 MB/sec	110 MB/sec	60 MB/sec

Capacity	16GB	32GB	64GB
Sequential** Read (max.)	400 MB/sec	460 MB/sec	460 MB/sec
Sequential** Write (max.)	130 MB/sec	230 MB/sec	230 MB/sec

Note: * Performance results are measured in Room Temperature with Out-of-Box devices and may vary depending on overall system setup.

Note: ** Performance results are based on CrystalDiskMark 3.0.2 with file size 1000MB.

Note: *** Performance results are based on CrystalDiskMark 6.0.2 with file size 100MB.

2.3 Electrical Specifications

2.3.1 Power Requirement

Table 3: Innodisk mSATA 3SE 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	310 (max.)
Write	320 (max.)
Idle	120 (max.)

* Target: 32GB mSATA 3SE

2.4 Environmental Specifications

2.4.1 Temperature Ranges

Table 5: Temperature range for mSATA 3SE

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 3SE

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 3SE 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 3SE MTBF

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

2.5 CE and FCC Compatibility

mSATA 3SE conforms to CE and FCC requirements.

2.6 RoHS Compliance

mSATA 3SE 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	
1GB	54 (Sequential write)
2GB	108 (Sequential write)
4GB	216 (Sequential write)
8GB	432 (Sequential write)
16GB	864 (Sequential write)
32GB	1728 (Sequential write)
64GB	3456 (Sequential write)

2.8 Transfer Mode

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

Table 8: Innodisk mSATA 3SE 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

Rev 1.6 TPS, Oct., 2020

NC	5	6	NC
NC	3	4	GND
NC	1	2	+3.3V

* DAS default setting: low active. (Mother board is designed "pull high voltage to 3.3V", LED actions: Idle: no signal; Read/Write: flicker)

2.10 Mechanical Dimensions

TOLERANCE:±0.20 mm
UNIT:mm
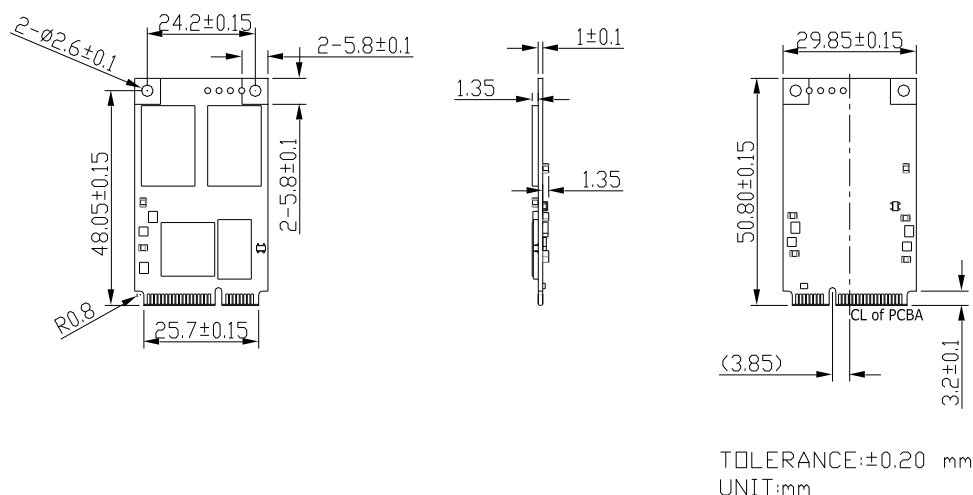
2.11 Assembly Weight

An Innodisk mSATA 3SE within flash ICs, 32GB's weight is 8 grams approximately.

2.12 Seek Time

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

2.13 NAND Flash Memory

Innodisk mSATA 3SE uses Single Level Cell (SLC) NAND flashes memory, which is non-volatility, high reliability and high speed memory storage. There are only two statuses 0 or 1 of one 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 3SE from the system level, including the major hardware blocks.
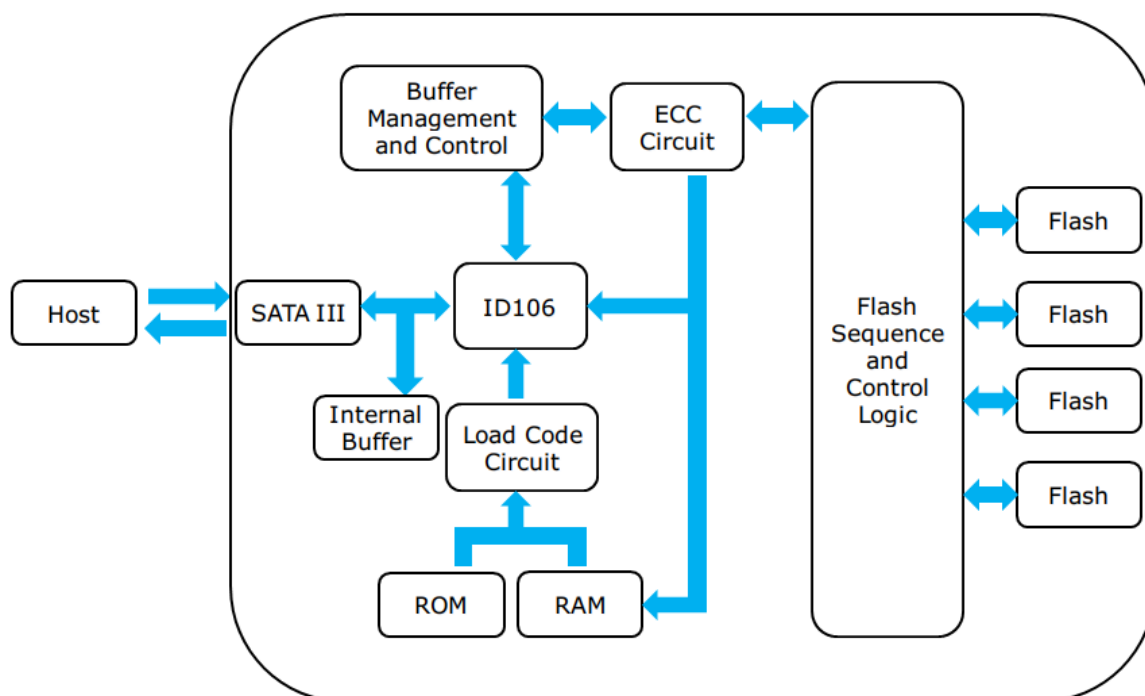

Figure 2: Innodisk mSATA 3SE Block Diagram

Innodisk mSATA 3SE 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 3SE is designed with ID106, 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 3SE 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 (iData Guard)

Innodisk iData Guard is a critical element to ensuring data integrity, and provides a reliable power failure protection to Innodisk's SSDs. Our circuit design enables a drive to complete the Power-Down Recovery Algorithm once the trigger detects low power. Innodisk has designed the iData Guard feature to aid in the prevention of data loss, and to protect our partner's data. Unexpected power loss may not be preventable, and data loss/corruption doesn't have to be inevitable. 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, please refer to below Block Diagram.
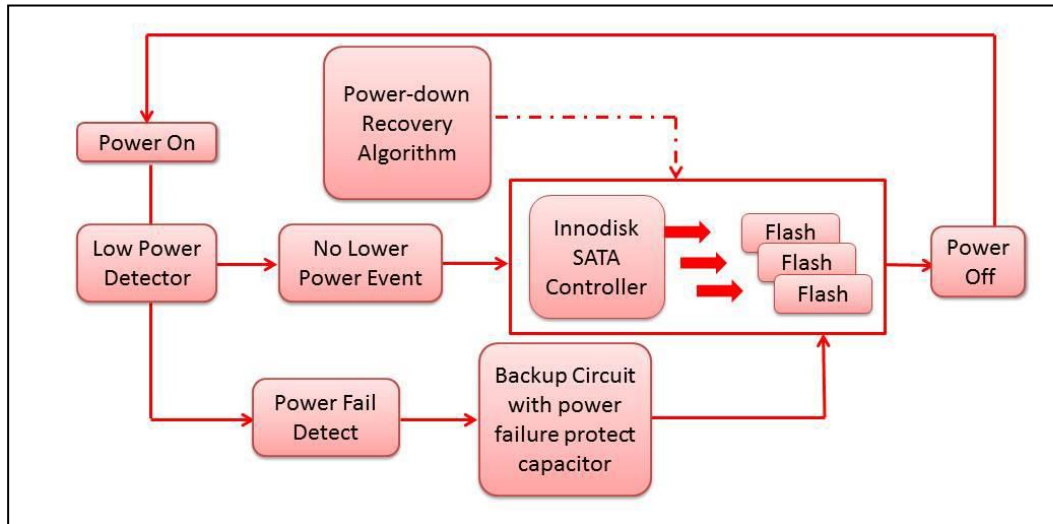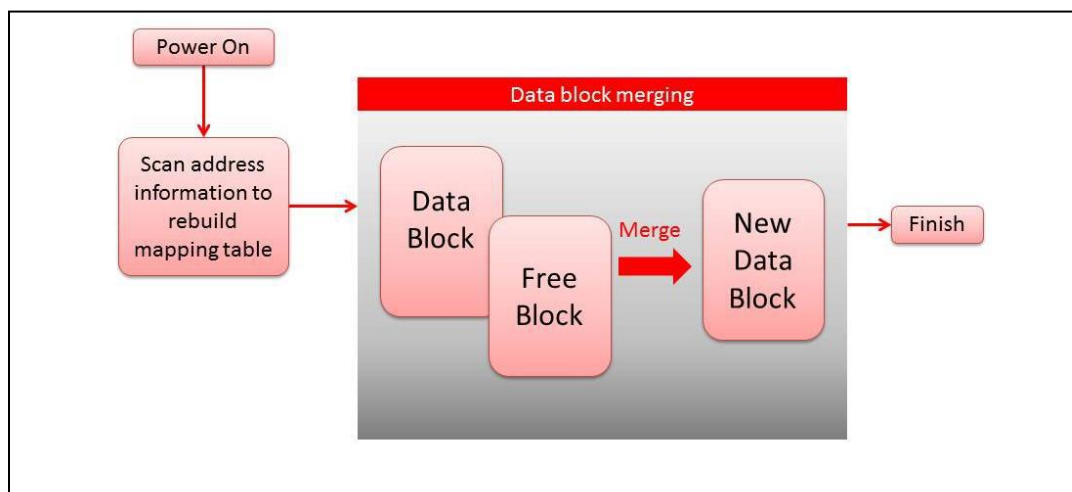
Figure 3: iDataGuard Block Diagram

Figure 4: iDataGuard Power-down Recovery Algorithm Block Diagram

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
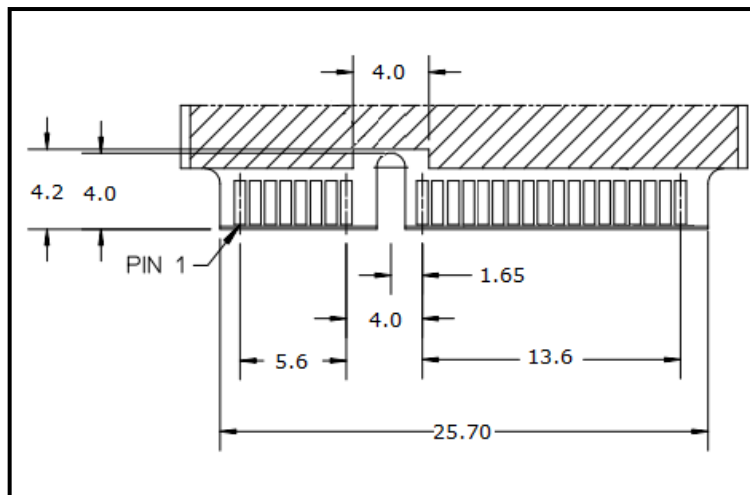
4.1 mSATA 3SE Pin Directions

Figure 5: Signal Segment and Power Segment

4.2 Electrical Connections for mSATA 3SE

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 3SE 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	S	R	-	3	2	G	D	0	6	S	C	X	Q	B	-	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)	A~Z: BGA PCB version. / 1~9: TSOP PCB version
MSR: mSATA Regular	**Code 16th (Channel of data transfer)**
Code 7th ~9th (Capacity)	S: Single Channel
01G: 1GB / 02G: 2GB / 04G: 4GB / 08G: 8GB	D: Dual Channels
16G: 16GB. / 32G: 32GB / 64G: 64GB	Q: Quad channels
Code 10th ~12th (Controller)	**Code 17th (Flash Type)**
D06: ID106 / D07: ID107	B: Toshiba SLC
Code 13th (Flash mode)	**Code 18th**
S: Synchronous NAND.	**Code 19th~21st (Customize code)**
A: Asynchronous NAND.	

Appendix

CE/FCC/RoHS

Verification of Compliance

Product Name	: mSATA
Model Number	: mSATA 3$*#-&

$:Flash type: (S:SLC,I:iSLC,M:MLC)

*: Product line: (E:Embedded, G: EverGreen)

#:controller:

(empty:606/607/667/670, 2: SMI 2246XT/ 2246EN, 3:608/609)

&: 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
	AS/NZS CISPR22:2009+A1:2010 Class B ITE
	EN 55024:2010
	EN 61000-4-2:2009
	EN 61000-4-3:2006+A1:2008+A2:2010
	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 iin 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

Central Research Technology Co.
EMC Test Laboratory
11. Lane 41. Fushuen St.. Jungshan Chiu.
Taipei, Taiwan, 104, R.O.C.
Tel : 886-2-25984568
Fax: 886-2-25984546

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

Verification of Compliance

Product Name : mSATA

Model Number : mSATA 3$*#-&

$:Flash type: (S:SLC,I:iSLC,M:MLC)

*: Product line: (E:Embedded, G: EverGreen)

#:controller:

(empty:606/607/667/670, 2: SMI 2246XT/ 2246EN, 3:608/609)

&: 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
ANSI C63.4:2009
Industry Canada ICES-003 Issue 5
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

Central Research Technology Co.
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11, Lane 41, Fushuen St., Jungshan Chiu.
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Fax: 886-2-25984546

(Tsun-Yu Shih/ General Manager)

Date: December 10, 2014

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）將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�蝶亮__

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

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)