innodisk

Total Solution For Industrial Flash Storage

1.8" SATA SSD

3IE2-P 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	Jan., 2016
Rev 1.1	Revise Capacity	Aug.,2018
Rev 1.2	Update input voltage and Part number rule and TBW	Oct., 2020

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1. Product Overview

1.1 Introduction of Innodisk 1.8” SATA SSD 3IE2-P

Innodisk 1.8” SATA SSD 3IE2-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 3IE2-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 3IE2-P is available in follow capacities within MLC flash ICs.

1.8” SATA SSD 3IE2-P 512GB

Figure 1: Innodisk 1.8” SATA SSD 3IE2-P

1.3 SATA Interface

Innodisk 1.8” SATA SSD 3IE2-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 3IE2-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 3IE2-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 3IE2-P device parameters are shown in Table 1.

Table 1: Device parameters

Capacity	LBA	Cylinders	Heads	Sectors	User Capacity(MB)
512GB	968959152	16383	16	63	473124

2.2 Performance

Burst Transfer Rate: 6.0Gbps

Table 2: Performance[1]

Capacity	512GB
Sequential* Read (max.)	520
Sequential* Write (max.)	430
4KB Random* Read (QD32)	76,700 IOPS
4KB Random* Write (QD32)	72,300 IOPS

Note: *. Performance based on CrystalDiskMark 5.1.2 with file size 1000MB of Queue Depth 32

*. Performance may vary based on various firmware version or test platform

2.3 Electrical Specifications

2.3.1 Power Requirement

Table 3: Innodisk 1.8” SATA SSD 3IE2-P 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	303.4 mA (max.)
Write	408.4 mA (max.)
Idle	74.6 mA (max.)

* Target: 1.8” SATA SSD 3IE2-P 512GB

2.4 Environmental Specifications

2.4.1 Temperature Ranges

Table 5: Temperature range for 1.8” SATA SSD 3IE2-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 3IE2-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 3IE2-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 3IE2-P MTBF

Product	Condition	MTBF (Hours)
Innodisk 1.8” SATA SSD 3IE2-P	Telcordia SR-332 GB, 25°C	>3,000,000

2.5 CE and FCC Compatibility

1.8” SATA SSD 3IE2-P conforms to CE and FCC requirements.

2.6 RoHS Compliance

1.8” SATA SSD 3IE2-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)		
Capacity	**Sequential workload**	**Client workload**
512GB	10200	5000
*Note: 1. Sequential: Mainly sequential write, tested by Vdbench. 2. Client: Follow JESD218 Test method and JESD219A Workload, tested by ULINK. (The capacity lower than 64GB client workload is not specified in JEDEC219A, the values are estimated.) 3. Based on out-of-box performance.		

2.8 Transfer Mode

1.8” SATA SSD 3IE2-P support the following transfer modes,

Serial ATA III 6.0Gbps

Serial ATA II 3.0Gbps

Serial ATA I 1.5Gbps

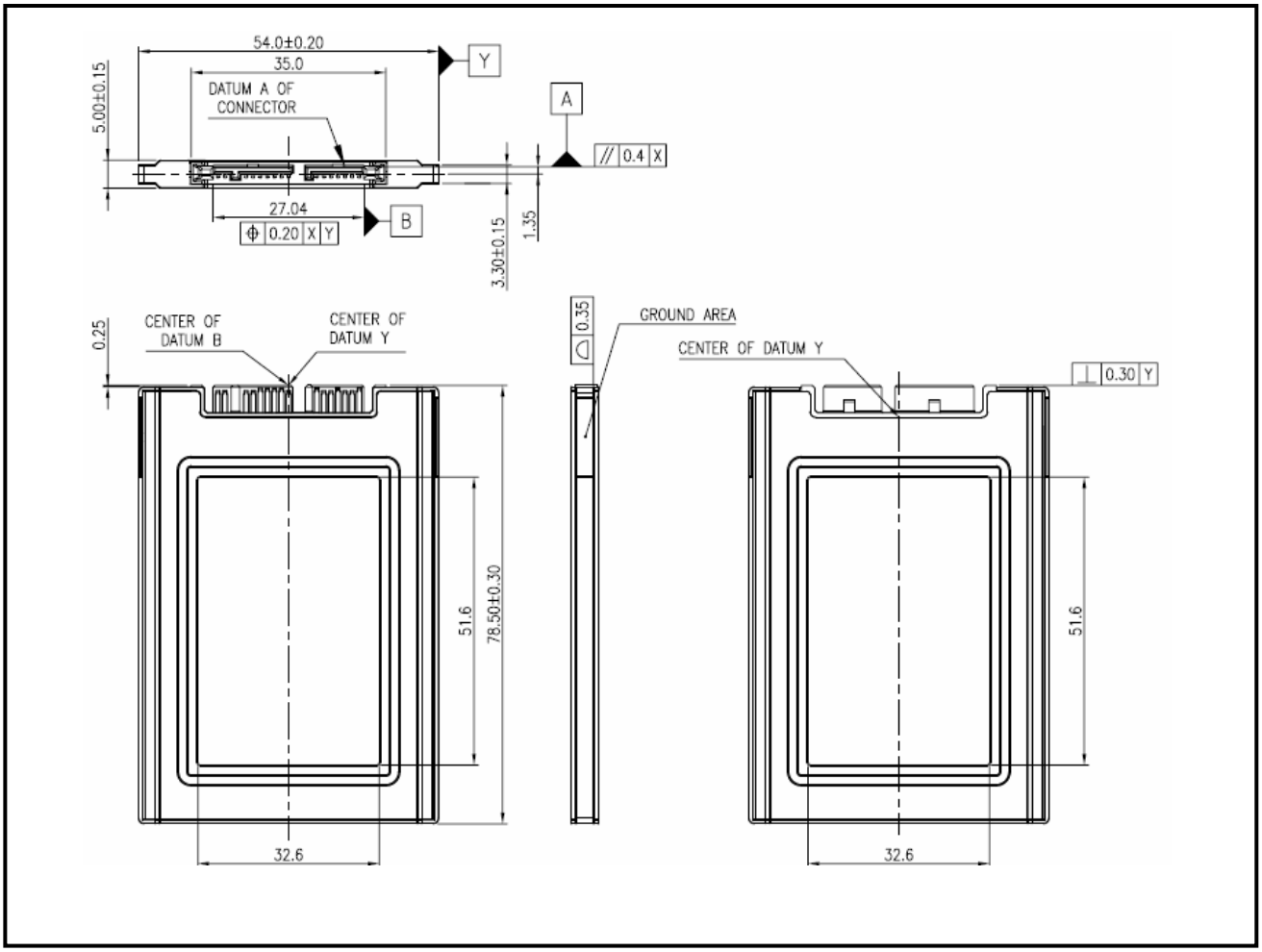
2.9 Pin Assignment

Innodisk 1.8” SATA SSD 3IE2-P uses a standard SATA pin-out. See Table 8 for 1.8” SATA SSD 3IE2-P pin assignment.

Table 8: Innodisk 1.8” SATA SSD 3IE2-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 3IE2-P within MLC flash ICs, 512GB’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 3IE2-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 3IE2-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 3IE2-P from the system level, including the major hardware blocks.

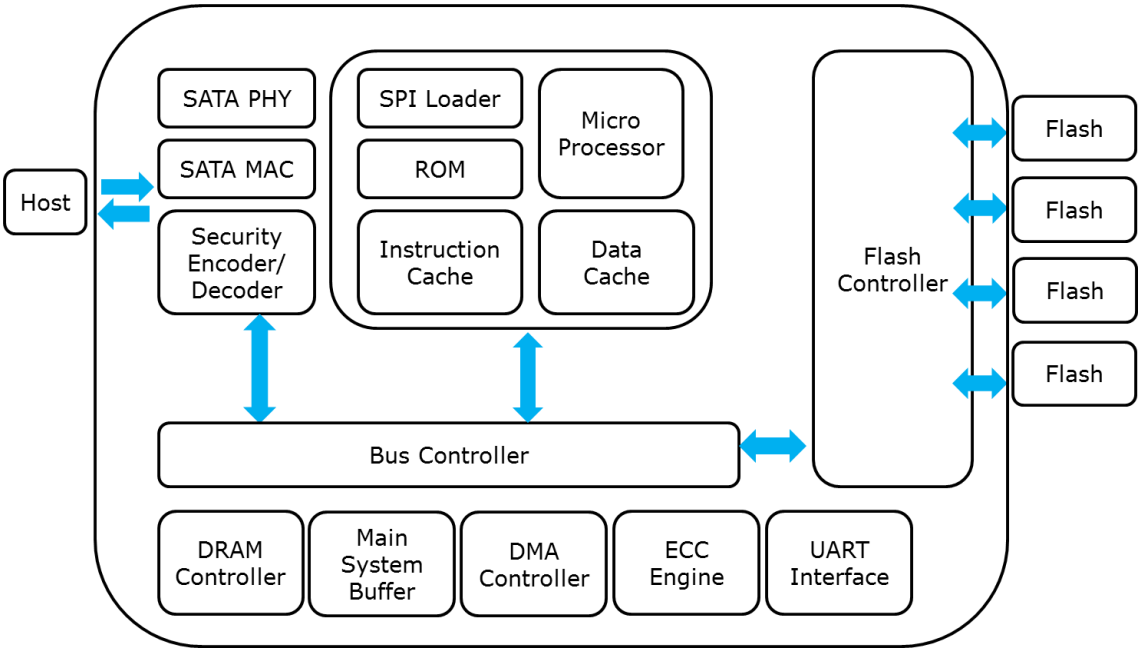


Figure 2: Innodisk 1.8” SATA SSD 3IE2-P Block Diagram

Innodisk 1.8” SATA SSD 3IE2-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 3IE2-P is designed with 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 66 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 3IE2-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.

3.8 Quick Erase (Optional: Customized Firmware)

QEraser function is designed for emergency data erase in few seconds by providing ATA command.

3.8.1 Quick Erase Command

Use to erase data blocks. When the command is issued, the flash is erased immediately. This

command causes the SSD to erase all user data blocks, including any reallocated blocks, while retaining all other system data and bad block information.

- Protocol: No Data

-Inputs

Table 9: Execute Quick Erase command for inputs information

Register	7	6	5	4	3	2	1	0
Features	21h							
Sector Count	41h							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	1	1	1	0	Na			
Command	82h							

-Normal Outputs

Table 10: Quick Erase command for normal output information

Register	7	6	5	4	3	2	1	0
Error	Na							
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	obs	Na	obs	DEV	Na	Na	Na	Na
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Device register-

DEV shall specify the selected device.

Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

DF (Device Fault) will be cleared to zero.

DRQ will be cleared to zero

ERR will be cleared to zero.

4. Installation Requirements

4.1 1.8” SATA SSD 3IE2-P Pin Directions

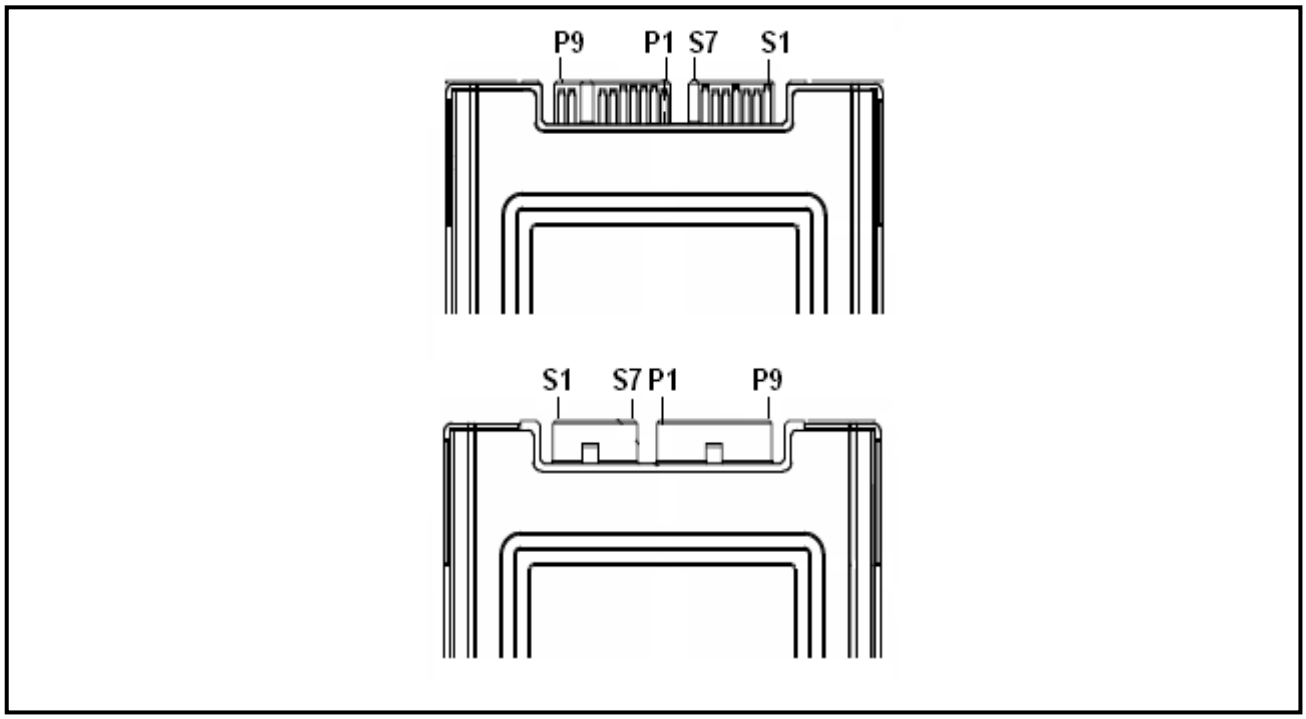


Figure 3: Signal Segment and Power Segment

4.2 Electrical Connections for 1.8” SATA SSD 3IE2-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 3IE2-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	**H**	**S**	**1**	**8**	**-**	**C**	**1**	**2**	**D**	**8**	**1**	**B**	**C**	**A**	**Q**	**C**	**-**	**X**	**X**

Definition	
Code 1st (Disk)	**Code 13th (Flash Mode)**
D : Disk	B: Kioxia 15nm Sync. Flash
Code 2nd ~ 5th (Form Factor)	**Code 14th (Operation Temperature)**
HS18: 1.8” SATA SSD 3IE2-P	C: Standard Grade (0℃~ +70℃)
	W: Industrial Grade (-40℃~ +85℃)
Code 7th ~9th (Capacity)	**Code 15th (Internal Control)**
C12: 512GB	A: PCB version
	Code 16th (Channel of Data Transfer)
	Q: Quad Channels
Code 10th ~12th (Controller)	**Code 17th (Flash Type)**
D81: ID201	C: Kioxia MLC
	Code 19th~20th (Customized Code)

Appendix

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。

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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)