innodisk

Total Solution For Industrial Flash Storage

mSATA

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	March, 2017
1.0	Officially released	April, 2017

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1. Product Overview

1.1 Introduction of Innodisk mSATA 3IE2-P

Innodisk mSATA 3IE2-P provides a totally brand new highly cost-effective SSD solution with good performance and longer lifespan. It costs much less than SLC flash but embraces longer life and performance than current MLC flash IC based SSD solution. mSATA 3IE2-P is designed and rigorously tested to ensure industrial-grade reliability. Featuring L^2 architecture, the life span of the SSD is maximized by an evolved wear leveling algorithm. Furthermore, mSATA 3IE2-P supports TRIM for Windows 7, it can improves performance when deleting files.

mSATA 3IE2-P provides high capacity flash memory within JEDEC MO-300 spec., which electrically compatible with Serial ATA (SATA) standard, and supports SATA III standard (6.0GHz) with high performance.

Better power management which is achieved with DEVSLP is available with the mSATA 3IE2-P. It also features Innodisk iData Guard to protect against unexpected power failures. When the SSD detects power is lost, a special power protection algorithm uses onboard power to save volatile data to non-volatile storage.

1.2 Product View and Models

Innodisk MSATA 3IE2-P is available in follow capacities within MLC flash ICs.

mSATA 3IE2-P 8GB
mSATA 3IE2-P 16GB
mSATA 3IE2-P 32GB
mSATA 3IE2-P 64GB
mSATA 3IE2-P 128GB
mSATA 3IE2-P 256GB

Figure 1: Innodisk mSATA 3IE2-P

1.3 SATA Interface

mSATA 3IE2-P supports SATA III interface, and backward compliant with Serial ATA Gen 1, Gen 2 and Gen 3 specification (Gen 3 supports 1.5Gbps /3.0Gbps/6.0Gbps data rate)..

1.4 Capacity

Innodisk MSATA 3IE2-P provides unformatted 8GB, 16GB, 32GB, 64GB, 128GB, and 256GB capacities within MLC Flash IC.

1.5 MO-300 Form Factor

mSATA 300 has a compact design 29.85 mm (W) x 50.8 mm (L) x 4.85 mm (H) without metal material case, and is easy for installation.

2. Product Specifications

2.1 Capacity and Device Parameters

mSATA 3IE2-P device parameters are shown in Table 1.

Table 1: Device parameters

Capacity	LBA	Cylinders	Heads	Sectors	User Capacity(MB)
8GB	13695696	13587	16	63	6,687
16GB	29323728	16383	16	63	14,318
32GB	60579792	16383	16	63	29,580
64GB	121138416	16383	16	63	59,150
128GB	242255664	16383	16	63	118,289
256GB	484490160	16383	16	63	236,567

2.2 Performance

Burst Transfer Rate: 6.0 Gbps

Table 2: Performance

Capacity	8GB	16GB	32GB	64GB	128GB	256GB
Sequential Read (max.)	150 MB/s	300 MB/s	560 MB/s	560 MB/s	560 MB/s	560 MB/s
Sequential Write (max.)	60 MB/s	115 MB/s	245 MB/s	310 MB/s	470 MB/s	460 MB/s
4KB Random Read (QD32)	17,000 IOPS	34,000 IOPS	51,000 IOPS	52,000 IOPS	51,000 IOPS	50,000 IOPS
4KB Random Write (QD32)	15,000 IOPS	30,000 IOPS	49,000 IOPS	50,000 IOPS	50,000 IOPS	46,000 IOPS

Note: Based on CrystalDiskMark 5.1.2 with file size 1000MB

2.3 Electrical Specifications

2.3.1 Power Requirement

Table 3: Innodisk MSATA 3IE2-P Power Requirement

Item	Symbol	Rating	Unit
Input voltage	V_{IN}	+3.3 DC +- 5% 500mA (max.)	V

2.3.2 Power Consumption

Table 4: Power Consumption

Mode	Power Consumption
Read	466 mA (max.)
Write	865 mA (max.)
Idle	91 mA (max.)

* Target: mSATA 3IE2-P 128GB (Toshiba)

2.4 Environmental Specifications

2.4.1 Temperature Ranges

Table 5: Temperature range for mSATA 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 mSATA 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 mSATA 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: mSATA 3IE2-P MTBF

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

2.5 CE and FCC Compatibility

mSATA 3IE2-P conforms to CE and FCC requirements.

2.6 RoHS Compliance

mSATA 3IE2-P is fully compliant with RoHS directive.

2.7 Reliability

Parameter	Value	
Read Cycles	Unlimited Read Cycles	
Flash Endurance	20,000 P/E cycles	
Wear-Leveling Algorithm	Support	
Bad Blocks Management	Support	
Error Correct Code	Support	
iData Guard	Support	
Thermal Sensor	Support	
TBW* (Total Bytes Written)		**Unit: TB**
Capacity	**Sequential workload**	**Client workload**
08GB	142	78.1
16GB	284.1	156.3
32GB	568.2	312.5
64GB	1136	625
128GB	2273	1250
256GB	4545	2500

* 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

MSATA 3IE2-P 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 3IE2-P uses a standard SATA pin-out. See Table 8 for mSATA 3IE2-P pin assignment.

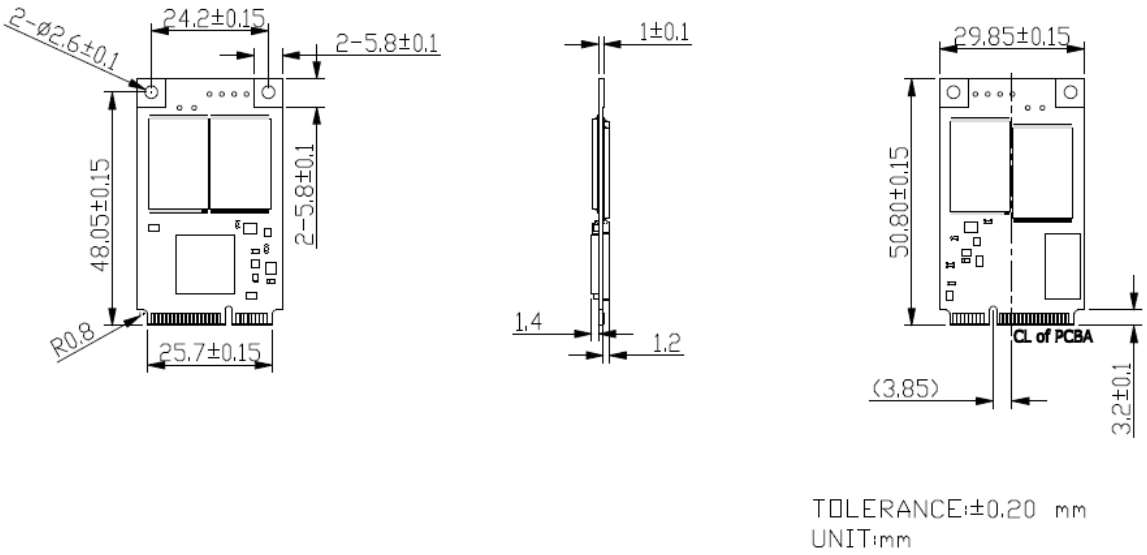
Table 8: Innodisk mSATA 3IE2-P Pin Assignment

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	DEVSLP
+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

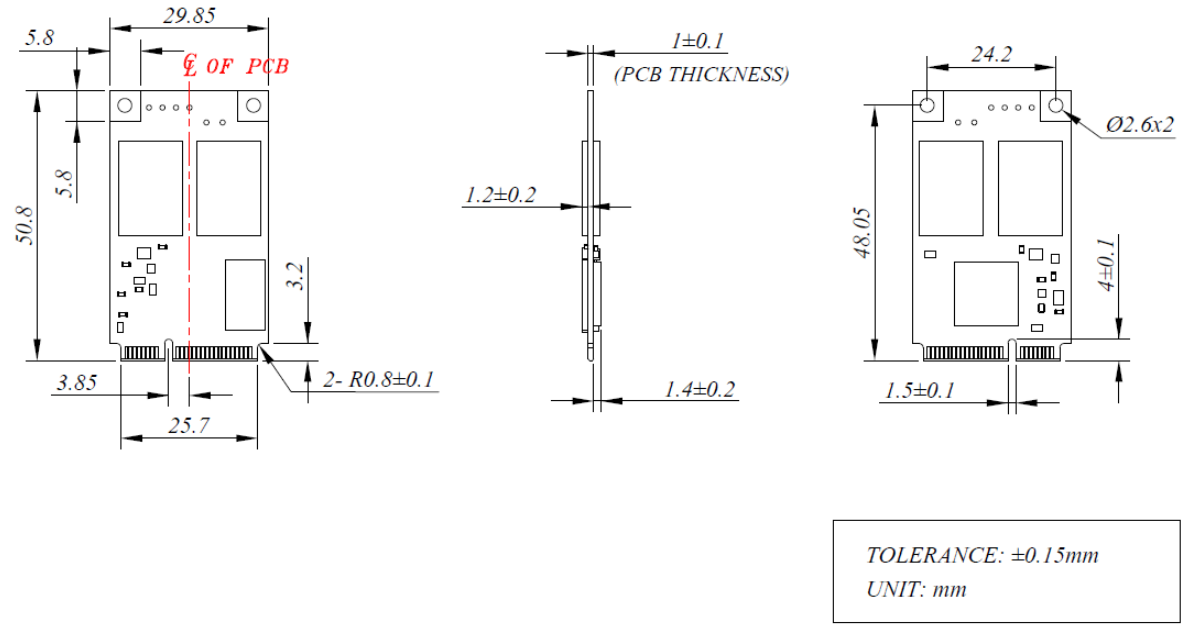
GND	9	10	NC
NC	7	8	NC
NC	5	6	NC
NC	3	4	GND
NC	1	2	+3.3V

2.10 Mechanical Dimensions

TSOP



BGA 256GB



2.11 Assembly Weight

An Innodisk mSATA 3IE2-P within MLC flash ICs, 32GB's weight is 10 grams approx.

2.12 Seek Time

Innodisk mSATA 3IE2-P is not a magnetic rotating design. There is no seek or rotational latency required.

2.13 NAND Flash Memory

Innodisk mSATA 3IE2-P 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 3IE2-P from the system level, including the major hardware blocks.

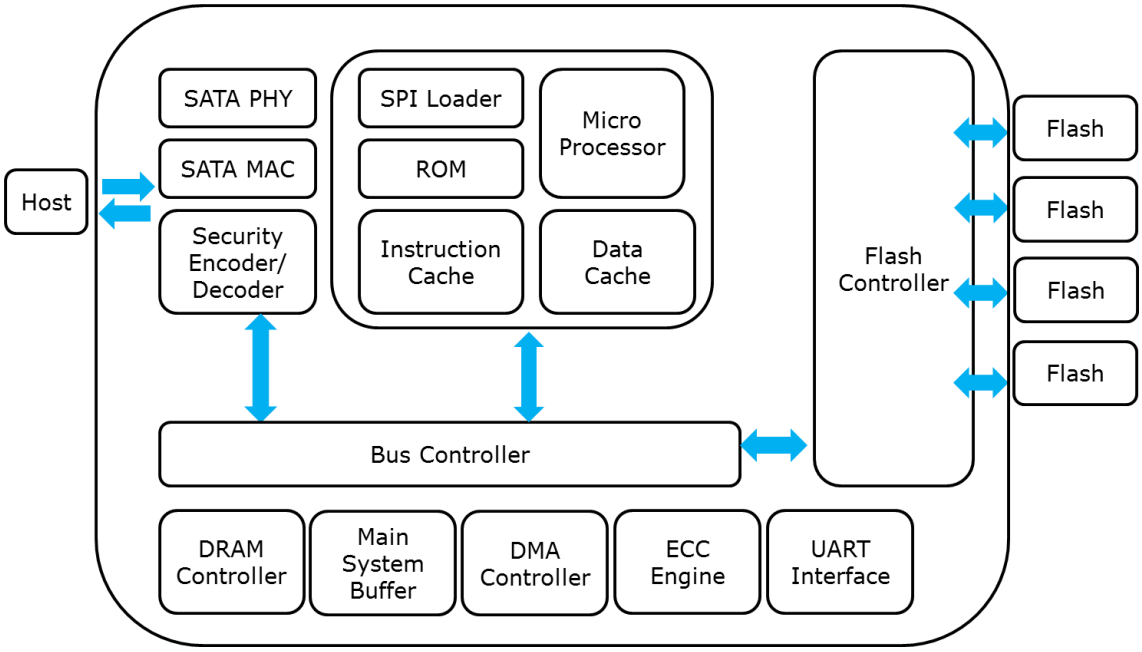


Figure 2: Innodisk mSATA 3IE2-P Block Diagram

Innodisk 2 mSATA 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 mSATA 3IE2-P is designed with ID 201, 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 mSATA 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 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/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 mSATA 3IE2-P Pin Directions

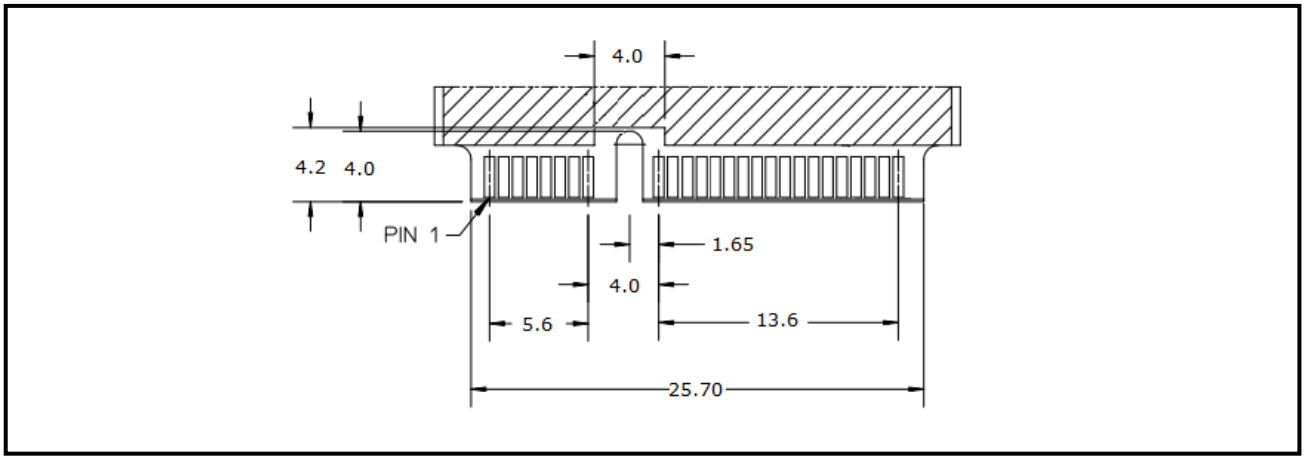


Figure 3: Signal Segment and Power Segment

4.2 Electrical Connections for mSATA 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 mSATA 3IE2-P can be configured as a boot device.

5. SMART Feature Set

Innodisk 3IE2-P support the SMART command set and defines some vendor-specific data to report SMART attributes of SSD.

Value	Command
D0h	Read Data
D1h	Read Attribute Threshold
D2h	Enable/Disable Autosave
D3h	Save Attribute Values
D4h	Execute OFF-LINE Immediate
D5h	Read Log
D6h	Return Status
D8h	Enable SMART Operations
D9h	Disable SMART Operations
DAh	Return Status

5.1 SMART Attributes

Innodisk's 3IE2-P series SMART data attributes are listed in following table.

Attribute ID (hex)	**Raw Attribute Value**							**Attribute Name**
1 (01h)	MSB	00	00	00	00	00	00	Raw Read Error Rate
5 (05h)	LSB	MSB	00	00	00	00	00	Reallocated Sector Count
9 (09h)	LSB			MSB	00	00	00	Power-on Hours
12 (0Ch)	LSB			MSB	00	00	00	Power Cycle Count

160 (A0h)	LSB			MSB	00	00	00	Uncorrectable sector count when read/write
161 (A1h)	LSB	MSB	00	00	00	00	00	Number of valid spare block
163 (A3h)	LSB	MSB	00	00	00	00	00	Number of initial invalid block
164 (A4h)	LSB	MSB	00	00	00	00	00	Total erase count
165 (A5h)	LSB			MSB	00	00	00	Maxumum erase count
166 (A6h)	LSB			MSB	00	00	00	Minimum erase count
167 (A7h)	LSB			MSB	00	00	00	Average erase count
168 (A8h)	LSB			MSB	00	00	00	Max erase count of spec
169 (A9h)	LSB			MSB	00	00	00	Reman Life (percentage)
175 (AFh)	LSB			MSB	00	00	00	Program fail count in worst die
176 (B0h)	LSB			MSB	00	00	00	Erase fail count in worst die
177 (B1h)	LSB			MSB	00	00	00	Total wear level count
178 (B2h)	LSB	MSB	00	00	00	00	00	Runtime invalid block count
181 (B5h)	LSB			MSB	00	00	00	Total program fail count
182 (B6h)	LSB	MSB	00	00	00	00	00	Total erase fail count
187 (BBh)	LSB			MSB	00	00	00	Uncorrectable error count
192 (C0h)	LSB	MSB	00	00	00	00	00	Power-Off Retract Count
194 (C2h)	MSB	00	00	00	00	00	00	Controlled temperature
195 (C3h)	LSB			MSB	00	00	00	Hardware ECC recovered
196 (C4h)	LSB			MSB	00	00	00	Reallocation event count
198 (C6h)	LSB			MSB	00	00	00	Uncorrectable error count off-line
199 (C7h)	LSB	MSB	00	00	00	00	00	UltraDMA CRC error count
225 (E1h)	LSB						MSB	Total LBAs written (each write unit = 32MB)
232 (E8h)	LSB	MSB	00	00	00	00	00	Available reserved space
241 (F1h)	LSB						MSB	Total LBAs written (each write unit = 32MB)
242 (F2h)	LSB						MSB	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
	D	**H**	**M**	**S**	**R**	**-**	**3**	**2**	**G**	**D**	**8**	**1**	**B**	**C**	**1**	**D**	**C**	**-**	**X**	**X**
Description	Disk	mSATA 3IE2-P					Capacity			Category			Flash Mode	Operation Temp.	Internal Control	CH.	Flash	-	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)**
HMSR: mSATA 3IE2-P	C: Standard Grade (0℃~ +70℃)
Code 7th ~9th (Capacity)	W: Industrial Grade (-40℃~ +85℃)
08G: 8GB	**Code 15th (Internal control)**
16G: 16GB	1~9 : TSOP PCB version
32G: 32GB	A~Z: BGA PCB version
64G: 64GB	**Code 16th (Channel of data transfer)**
A28: 128GB	D: Dual Channels
B56: 256GB	Q: Quad Channels
Code 10th ~12th (Series)	**Code 17th (Flash Type)**
D81: ID201	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)

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.
EMC Test Laboratory
11, Lane 41, Fushuen St., Jungshan Chiu,
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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	:	**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 in compliance with the EMC standards cited above.

CE

TAF 0905
FCC CAB Code TW1053
NVLAP Lab Code 200575-0
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J. Y.

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

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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Date 日期： 2014 / 07 / 29

(Company Stamp/公司大小章)