M.2 (S42)

3SE2-P Series

Customer:

Customer Part Number:

Innodisk Part Number:

Innodisk Model Name:

Date:

Innodisk Approver	Customer Approver

Total Solution For
Industrial Flash Storage

Table of contents

REVISION HISTORY

Revision	Description	Date
Rev 1.0	First Released	Jul. 2018
Rev 1.1	Update performance data and power consumption	Mar. 2020

List of Tables

List of Figures

1. Product Overview

1.1 Introduction of Innodisk M.2 (S42) 3SE2-P

Innodisk M.2 (S42) 3SE2-P 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) 3SE2-P absolutely replaces the traditional hard disk and makes personal computer, in any field, smaller and easier.

Innodisk M.2 (S42) 3SE2-P 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) 3SE2-P is available in follow capacities within SLC flash ICs.

M.2 (S42) 3SE2-P 08GB (type 2242)
M.2 (S42) 3SE2-P 16GB (type 2242)
M.2 (S42) 3SE2-P 32GB (type 2242)
M.2 (S42) 3SE2-P 64GB (type 2242)

Figure 1: Innodisk M.2 (S42) 3SE2-P (type 2242)

1.3 SATA Interface

Innodisk M.2 (S42) 3SE2-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 M.2 (S42) 3SE2-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).

2. Product Specifications

2.1 Capacity and Device Parameters

M.2 (S42) 3SE2-P device parameters are shown in Table 1.

Table 1: Device parameters

Capacity	Cylinders	Heads	Sectors	LBA	user space
08GB	16383	16	63	13695696	6,687
16GB	16383	16	63	29323728	14,318
32GB	16383	16	63	60579792	29,579
64GB	16383	16	63	121138416	59,149

2.2 Performance

Burst Transfer Rate: 6.0Gbps

Table 2: Performance

Capacity	08GB	16GB	32GB	64GB
Sequential* Read (QD32)	240 MB/s	460 MB/s	520 MB/s	520 MB/s
Sequential* Write (QD32)	60 MB/s	120 MB/s	240 MB/s	330 MB/s
4KB Random* Read (QD32)	33,700 IOPS	65,000 IOPS	74,000 IOPS	76,000 IOPS
4KB Random* Write (QD32)	15,800 IOPS	34,000 IOPS	65,000 IOPS	72,000 IOPS

Note: the information is based on CrystalDiskMark 6.2.2 with file size 1000MB test pattern

2.3 Electrical Specifications

2.3.1 Power Requirement

Table 3: Innodisk M.2 (S42) 3SE2-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
Read	470 mA (max.)
Write	590 mA (max.)
Idle	095 mA (max.)

DEVSLP Mode	3 mW (min.)
Slumber Mode	30 mW (min.)

* Target: 64GB M.2 (S42) 3SE2-P

2.4 Environmental Specifications

2.4.1 Temperature Ranges

Table 5: Temperature range for M.2 (S42) 3SE2-P

Temperature	Range
Operating	Standard Grade: 0°C to +70°C
	Industrial Grade:-40°C to +80°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) 3SE2-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 M.2 (S42) 3SE2-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: M.2 (S42) 3SE2-P MTBF

Product	Condition	MTBF (Hours)
Innodisk M.2 (S42) 3SE2-P	Telcordia SR-332 GB, 25°C	>3,000,000

2.5 CE and FCC Compatibility

M.2 (S42) 3SE2-P conforms to CE and FCC requirements.

2.6 RoHS Compliance

M.2 (S42) 3SE2-P is fully compliant with RoHS directive.

2.7 Reliability

Parameter	Value
Read Cycles	Unlimited Read Cycles
Flash endurance	60,000 P/E cycles
Wear-Leveling Algorithm	Support
Bad Blocks Management	Support
Error Correct Code	Support
(Total Bytes Written)　Unit:TB	

Capacity	Sequential workload	Client workload
8GB	426	375
16GB	852	750
32GB	1704	1500
64GB	3410	3000

* 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

M.2 (S42) 3SE2-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 M.2 (S42) 3SE2-P uses a standard SATA pin-out. See Table 8 for M.2 (S42) 3SE2-P pin assignment.

Table 8: Innodisk M.2 (S42) 3SE2-P 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
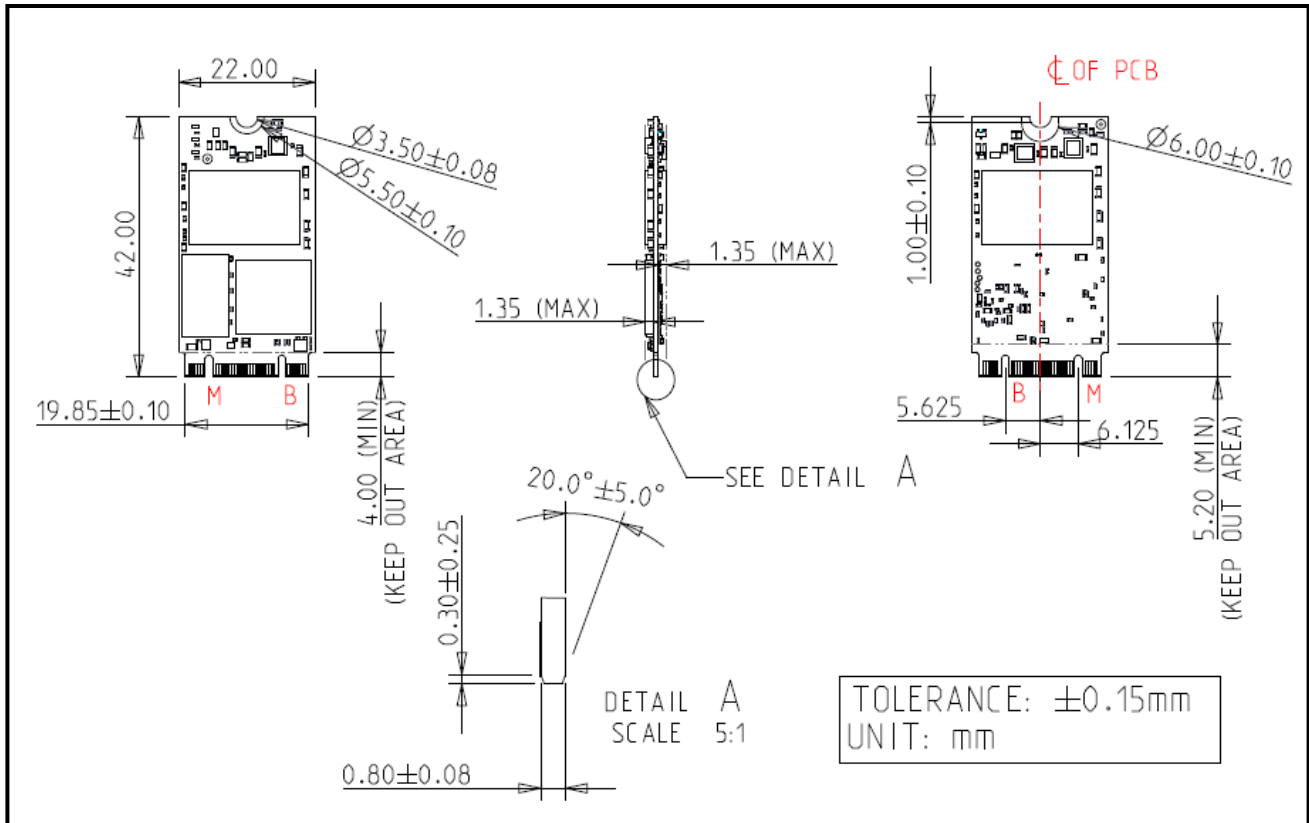
2.11 Assembly Weight

An Innodisk M.2 (S42) 3SE2-P within flash ICs, 64GB's weight is 8 grams approximately.

2.12 Seek Time

Innodisk M.2 (S42) 3SE2-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.
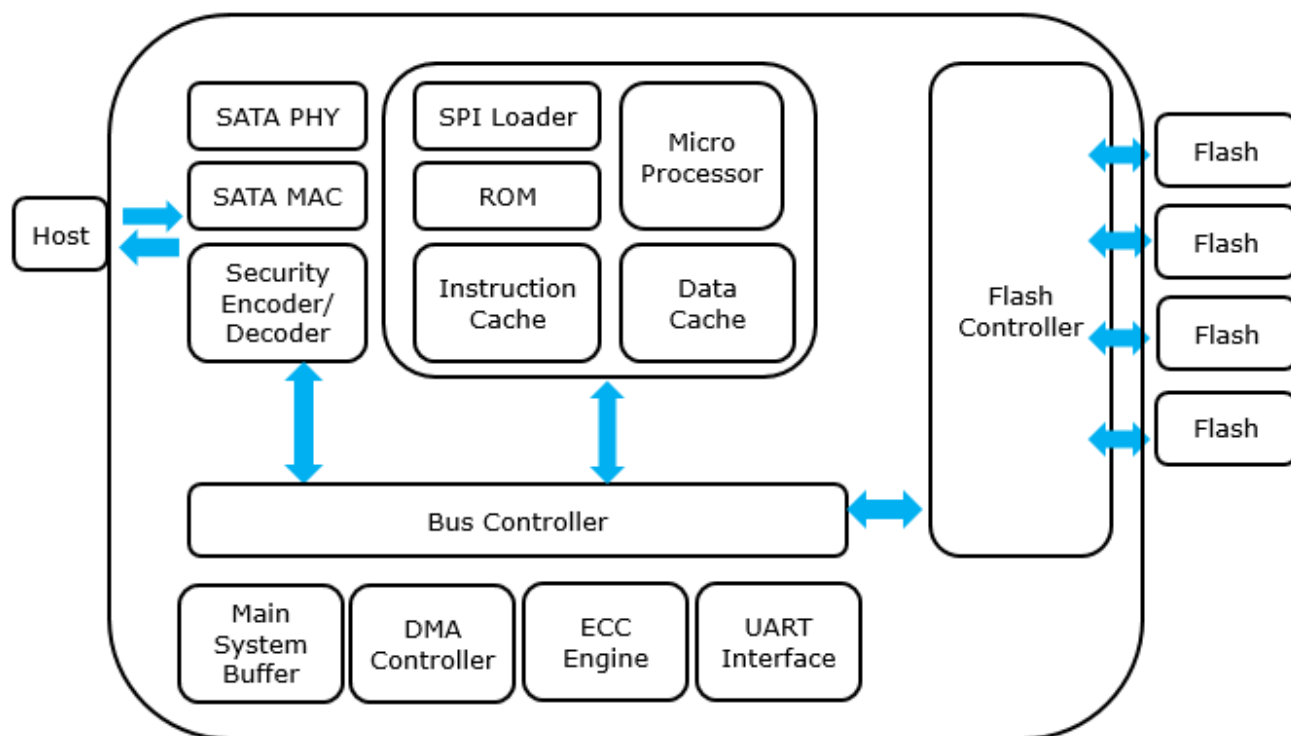
2.14 NAND Flash Memory

Innodisk M.2 (S42) 3SE2-P uses single Level Cell (SLC) 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) 3SE2-P from the system level, including the major hardware blocks.

Figure 2: Innodisk M.2 (S42) 3SE2-P Block Diagram

Innodisk M.2 (S42) 3SE2-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 M.2 (S42) 3SE2-P is designed with ID 202, 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 24 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) 3SE2-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

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) 3SE2-P Pin Directions
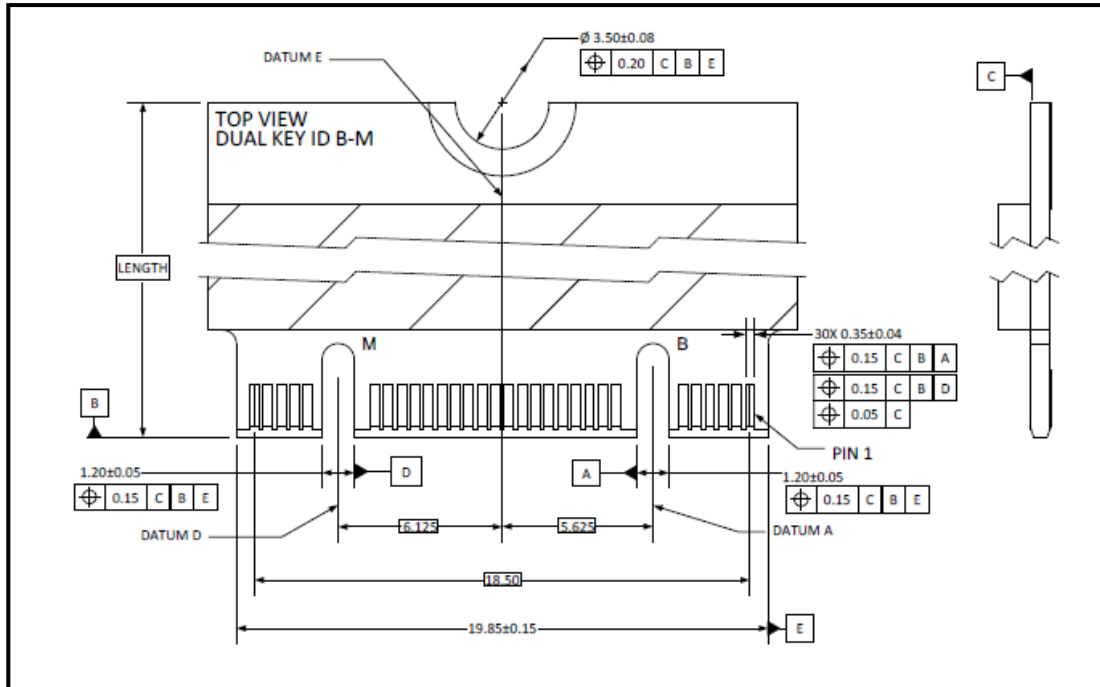
Figure 3: Signal Segment and Power Segment

4.2 Electrical Connections for M.2 (S42) 3SE2-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. The Innodisk M.2 (S42) 3SE2-P can be configured as a boot device.

5. SMART Feature Set

Innodisk 3SE2-P series support the SMART command set and defines some vendor-specific data to report SMART attributes of SSD.

Table 9: SMART command

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

5.1 SMART Attributes

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

Table 10: SMART attribute

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	Maximum 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	Remain 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. AES Algorithm Certification

The following provides technical information about controller implementations that have been validated as confirming to the Advanced Encryption Standard (AES) Algorithm, Deterministic Random Bit Generator (DRBG) Algorithm, and Secure Hash Standard (SHS).

6.1 AES Algorithm

Val. No	Operational Environment	Val. Date	Modes/States/Key sizes/Description/Notes
2474	Cadence NC-verilog hardware simulator v10.20	May/24/2013	Using the tests found in The Advanced Encryption Standard Algorithm Validation Suite (AESAVS). This testing is performed by NVLAP accredited Cryptographic And Security Testing (CST) Laboratories. ECB (e/d; 128, 192, 256) XTS (KS: XTS_128) KS: XTS_256

6.2 DRBG Algorithm

Val. No	Operational Environment	Val. Date	Modes/States/Key sizes/Description/Notes
337	Cadence NC-verilog hardware simulator v10.20	May/24/2013	Using the tests found in The DRBG Validation Suite (DRBGVS). This testing is performed by NVLAP accredited Cryptographic And Security Testing (CST) Laboratories. HashBased DRBG:

			Prediction Resistance Tested: enabled and not enabled (SHA-256)

6.3 SHS Algorithm

Val. No	Operational Environment	Val. Date	Modes/States/Key sizes/Description/Notes
2093	Cadence NC-verilog hardware simulator v10.20	May/24/2013	Has been validated as confirming to the Secure Hash Algorithm specified in Federal Information Processing Standard (FIPS) 180-3, Secure Hash Standard (SHS), using tests described in the Secure Hash Algorithm Validation System (SHAVS). This testing is performed by NVLAP accredited Cryptographic And Security Testing (CST) Laboratories. SHA-256

7. 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	-	6	4	G	D	8	2	S	W	B	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.
M24: M.2-SATA Type 2242	**Code 16th (Channel of data transfer)**
Code 7th ~9th (Capacity)	D: Dual Channels
08G:8GB / 16G:16GB / 32G:32GB / 64G:64GB	Q: Quad Channels
Code 10th ~12th (Controller)	**Code 17th (Flash Type)**
D82: 3SE2-P with AES engine	B: Toshiba SLC
Code 13th (Flash mode)	**Code 19th~21st (Customize code)**
S: Synchronous NAND.	

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.

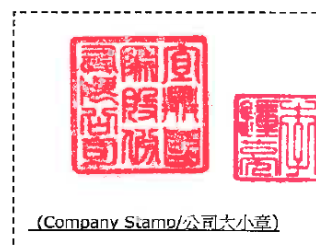| Name of hazardous substance	Limited of RoHS ppm（mg/kg）
Cd	＜ 100 ppm
Pb	＜ 1000 ppm
Hg	＜ 1000 ppm
Chromium VI（Cr+6）	＜ 1000 ppm
Polybromodiphenyl ether（PBDE）	＜ 1000 ppm
Polybrominated Biphenyls（PBB）	＜ 1000 ppm

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

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.
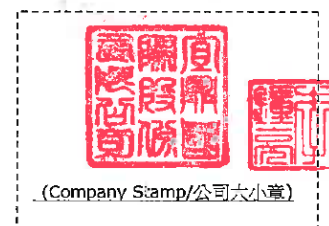
立 保 證 書 人 (Guarantor)

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 :

$C\epsilon$

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

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New Taipei City 221, Taiwan
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Nemko
ELA113A

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Tao Yuan City 325, Taiwan
Tel: 886-3-407-1718; Fax: 886-3-407-1738

TAF   Nemko
ELA113B

Certificate

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

Product Name : M.2
Model(s) : M.2 (S42) 3$*#-&
($: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).
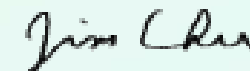
FC

Standards:

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

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