2.5" SATA SSD
3SE4 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
Rev. 1.0	First Released	July, 2017
Rev. 1.1	Performance and TBW Revised.	September, 2017
Rev. 1.2	Add TRIM note Update RoHS report	April, 2019
Rev. 1.3	Add SMART attribute table.	April, 2020
Rev. 1.4	Add Mechanical Dimensions tolerance.	May, 2020

List of Tables

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1. Product Overview

1.1 Introduction of Innodisk 2.5″ SATA SSD 3SE4

Innodisk 2.5″ SATA SSD 3SE4 is characterized by L^3 architecture with the latest SATA III (6.0GHz) Marvell NAND controller. Innodisk's exclusive L^3 architecture is L^2 architecture multiplied LDPC (Low Density Parity Check). L^2 (Long Life) architecture is a 4K mapping algorithm that reduces WAF and features a real-time wear leveling algorithm to provide high performance and prolong lifespan with exceptional reliability. Innodisk 2.5″ SATA SSD 3SE4 is designed for industrial field, and supports several standard features, including TRIM, NCQ, and S.M.A.R.T. In addition, Innodisk's exclusive industrial-oriented firmware provides a flexible customization service, making it perfect for a variety of industrial applications.

CAUTION *TRIM must be enabled.*

TRIM enables SSD's controller to skip invalid data instead of moving. It can free up significant amount of resources, extends the lifespan of SSD by reducing erase, and write cycles on the SSD. Innodisk's handling of garbage collection along with TRIM command improves write performance on SSDs.

1.2 Product View and Models

Innodisk 2.5″ SATA SSD 3SE4 is available in follow capacities:

2.5″ SATA SSD 3SE4 8GB   2.5″ SATA SSD 3SE4 32GB

2.5″ SATA SSD 3SE4 16GB   2.5″ SATA SSD 3SE4 64GB

Figure 1: Innodisk 2.5″ SATA SSD 3SE4

1.3 SATA Interface

Innodisk 2.5″ SATA SSD 3SE4 support SATA III interface, and 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 15-pin power segment.

1.4 2.5-inch Form Factor

The Industry-standard 2.5-inch form factor design with metal material case is easy for installation, which has a compact design 69.85mm (W) x100.00mm (L) x 6.90mm (H).

2. Product Specifications

2.1 Capacity and Device Parameters

2.5" SATA SSD 3SE4 device parameters are shown in Table 1.

Table 1: Device parameters

Capacity	LBA	Cylinders	Heads	Sectors	User Capacity(MB)
8GB	15649200	15525	16	63	7641
16GB	31277232	16383	16	63	15272
32GB	62533296	16383	16	63	30533
64GB	125045424	16383	16	63	61057

2.2 Performance

Burst Transfer Rate: 6.0Gbps

Table 2: Performance

Capacity	8GB	16GB	32GB	64GB
Sequential Read (max.)*	375	520	520	520
Sequential Write (max.)*	75	150	280	360
4KB Random** Read (QD32)	23,000 IOPS	24,000 IOPS	32,000 IOPS	32,000 IOPS
4KB Random** Write (QD32)	13,000 IOPS	26,000 IOPS	29,000 IOPS	29,000 IOPS

Note: * Sequential performance based on CrystalDiskMark 5.1.2 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 2.5" SATA SSD 3SE4 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
Read	186.5 (max.)
Write	220.3 (max.)
Idle	87.2 (max.)

* Target: 2.5″ SATA SSD 3SE4 64GB

2.4 Environmental Specifications

2.4.1 Temperature Ranges

Table 5: Temperature range for 2.5″ SATA SSD 3SE4

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 2.5″ SATA SSD 3SE4

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 2.5″ SATA SSD 3SE4 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: 2.5" SATA SSD 3SE4 MTBF

Product	Condition	MTBF (Hours)
Innodisk 2.5" SATA SSD 3SE4	Telcordia SR-332 GB, 25°C	>3,000,000

2.5 CE and FCC Compatibility

2.5" SATA SSD 3SE4 conforms to CE and FCC requirements.

2.6 RoHS Compliance

2.5" SATA SSD 3SE4 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	
TBW* (Total Bytes Written) Unit:TB		
Capacity	Sequential workload	Client workload
08GB	468.8	312.5
16GB	937.5	625
32GB	1,875	1,250
64GB	3,750	2,500

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

2.5" SATA SSD 3SE4 support following transfer mode:

Serial ATA III 6.0Gbps

Serial ATA II 3.0Gbps

Serial ATA I 1.5Gbps

2.9 Pin Assignment

Innodisk 2.5" SATA SSD 3SE4 uses a standard SATA pin-out. See Table 8 for 2.5" SATA SSD 3SE4 pin assignment.

Table 8: Innodisk 2.5″ SATA SSD 3SE4 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	NC	NA
P2	NC	NA
P3	NC	NA
P4	GND	NA
P5	GND	NA
P6	GND	NA
P7	V5	5V Power, Pre-Charge
P8	V5	5V Power
P9	V5	5V Power
P10	GND	NA
P11	DAS/DSS	Device Activity Signal / Disable Staggered
P12	GND	NA
P13	NC	NA
P14	NC	NA
P15	NC	NA

2.10 Mechanical Dimensions
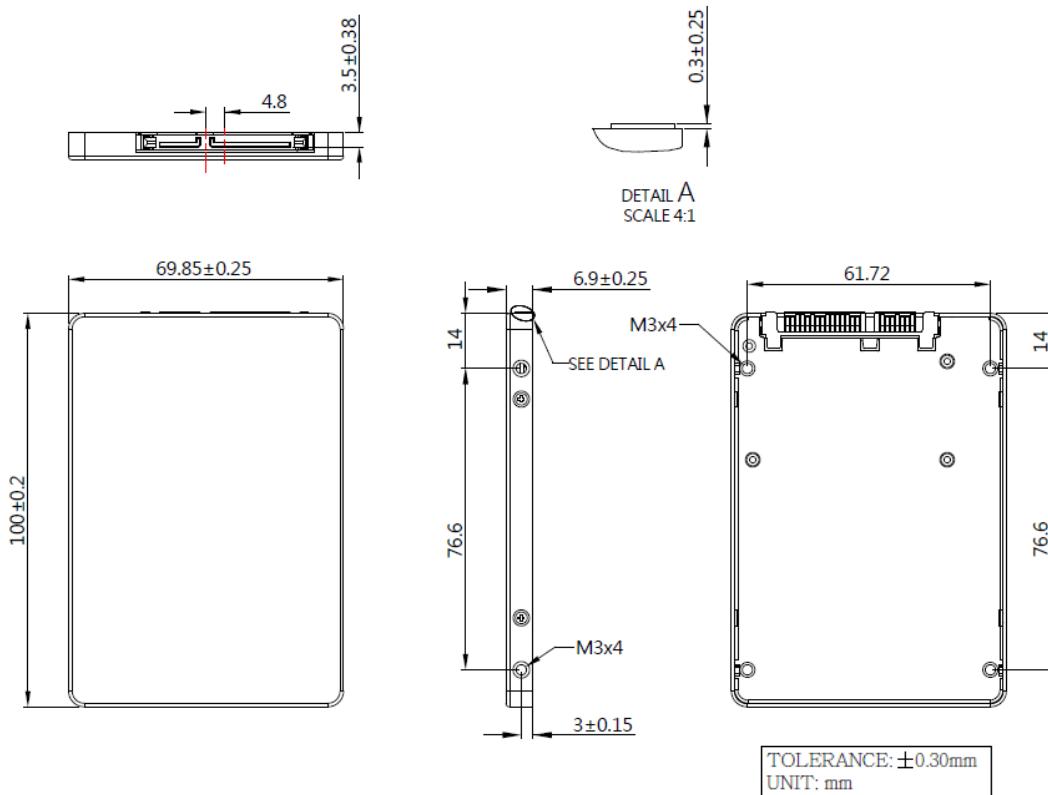
2.11 Assembly Weight

An Innodisk 2.5" SATA SSD 3SE4 within SLC flash ICs, 16GB's weight is 100 grams approx. The total weight of SSD will be less than 135 grams.

2.12 Seek Time

Innodisk 2.5" SATA SSD 3SE4 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 2.5" SATA SSD 3SE4 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 2.5" SATA SSD 3SE4 from the system level, including the major hardware blocks.
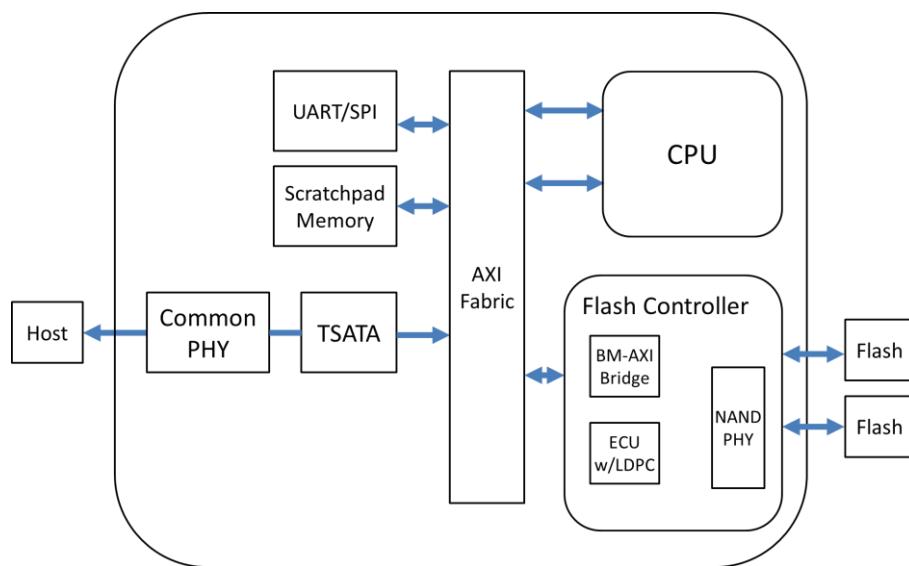
Figure 2: Innodisk FiD 2.5" SATA SSD 3SE4 Block Diagram

Innodisk 2.5" SATA SSD 3SE4 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 2.5" SATA SSD 3SE4 is designed with 88NV1120, 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

Innodisk 2.5" SATA SSD 3SE4 is designed with hardware LDPC ECC engine with hard-decision and soft-decision decoding. Low-density parity-check (LDPC) codes have excellent error correcting performance close to the Shannon limit when decoded with the belief-propagation (BP) algorithm using soft-decision information.

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 2.5" SATA SSD 3SE4 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.

3.8 Write Protect (Optional)

Write protect can prevent the disk from data modification or data deletion. Write-protected data in disk is read-only, that is, users could not write to it, edit it, append data to it, or delete it.

3.8.1 Enable Write Protect Command

This command enable SSD into write protect mode, which is read-only. The SSD under write protect

will overpass any write command.

-Protocol: Non Data Command

-Inputs

Table 9: Execute Enable Write Protect command for inputs information

Register	7	6	5	4	3	2	1	0
Features	01h							
Sector Count	41h							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	1	1	1	0	Na			
Command	84h							

-Normal Outputs

Table 10: Execute Enable Write Protect 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.

3.8.2 Disable Write Protect Command

This command disable SSD's write protect feature.

-Protocol: Non Data Command

-Inputs

Table 11: Execute Disable Write Protect command for inputs information

Register	7	6	5	4	3	2	1	0
Features	00h							
Sector Count	41h							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	1	1	1	0	Na			
Command	84h							

-Normal Outputs

Table 12: Execute Disable Write Protect 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.

3.9 TRIM

The TRIM command is designed to enable the operating system to notify the SSD which pages no longer contain valid data due to erases either by the user or operating system itself. During a delete operation, the OS will mark the sectors as free for new data and send a TRIM command to the SSD to mark them as not containing valid data. After that the SSD knows not to preserve the contents of the block when writing a page, resulting in less write amplification with fewer writes to the flash, higher write speed, and increased drive life.

4. Installation Requirements

4.1 2.5” SATA SSD 3SE4 Pin Directions
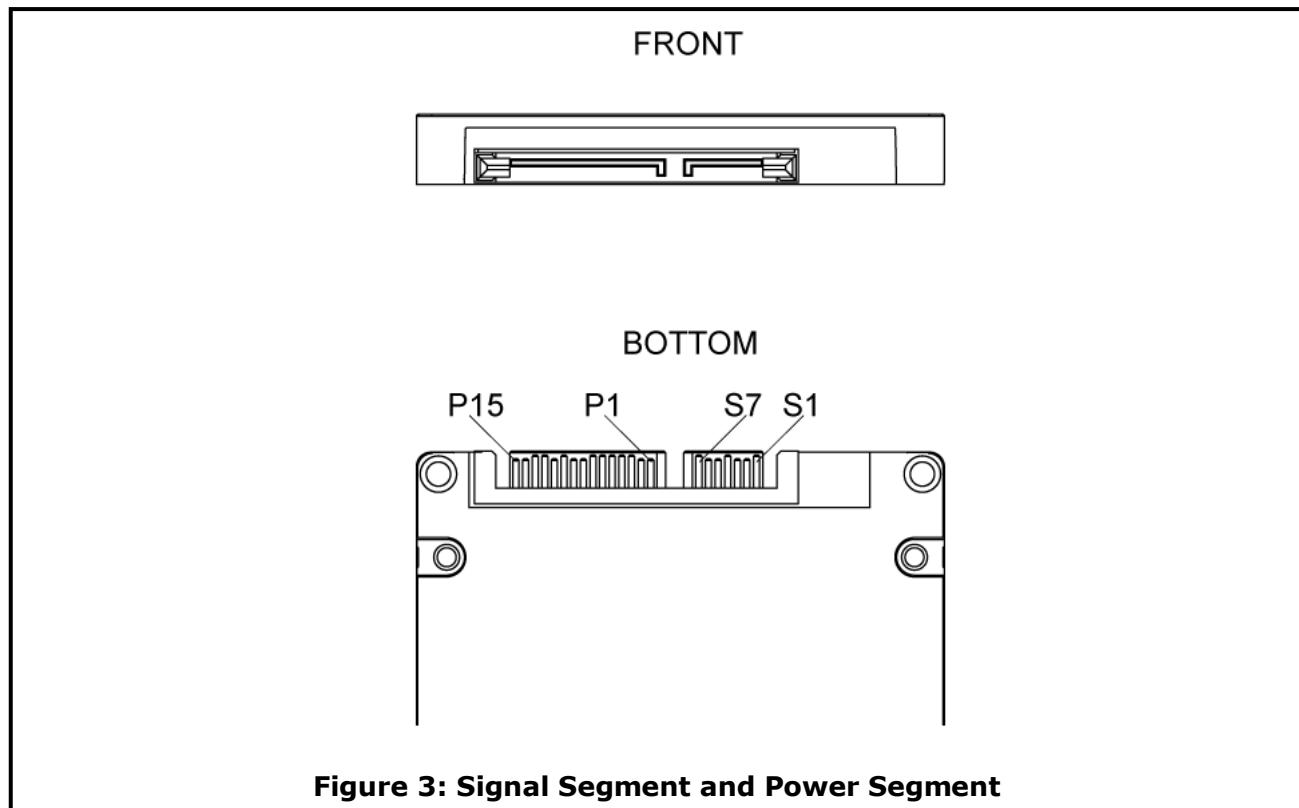
Figure 3: Signal Segment and Power Segment

4.2 Electrical Connections for 2.5” SATA SSD 3SE4

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 Form Factor

Please prepare following things:

➢ Screw driver.
➢ Four M3 screws.
➢ SATA single cable (7-pin, Maximum length l meter).
➢ SATA power cable (15-pin).

Please turn off your computer, and open your computer's case. Find one of available 2.5-inch slot, and plug the SSD in. To use the screws fix the SSD. Plug in the SATA single cable, and power cable. Please boot the installation Operation System from CD-ROM, and install Operation System into SSD.

76.60

M3
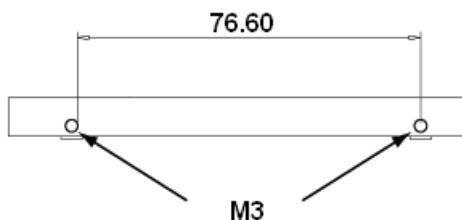
Figure 4: 2.5″ SATA SSD 3SE4 Mechanical Screw Hole

4.4 Device Drive

No additional device drives are required. Innodisk 2.5″ SATA SSD 3SE4 can be configured as a boot device.

5. SMART Feature Set

Innodisk 3SE4 series 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 3SE4 series SMART data attributes are listed in following table.

Attribute ID (hex)	Raw Attribute Value							Attribute Name
5 (05h)	LSB	MSB	00	00	00	00	00	Later Bad
9 (09h)	LSB	MSB	00	00	00	00	00	Power-On hours Count
12 (0Ch)	LSB	MSB	00	00	00	00	00	Drive Power Cycle Count
163 (A3h)	LSB			MSB	00	00	00	Total Bad Block Count
165 (A5h)	LSB			MSB	00	00	00	Max Erase count
167 (A7h)	LSB			MSB	00	00	00	Avg Erase count
169 (A9h)	LSB	00	00	00	00	00	00	Device Life
170 (AAh)	LSB	MSB	00	00	00	00	00	Spare Block Count
171 (ABh)	LSB	MSB	00	00	00	00	00	Program fail count
172 (ACh)	LSB	MSB	00	00	00	00	00	Erase fail count
192 (C0h)	LSB	MSB	00	00	00	00	00	Unexpected Power Loss Count
194 (C2h)			MIN		MAX	00	00	Temperature
229 (E5h)	ID 0	ID 1	ID 2	ID 3	ID 4	ID 5		Flash ID
235 (EBh)		MSB	LSB	MSB	LSB	MSB	LSB	Later bad block info (Read/Write/Erase)
241 (F1h)	LSB			MSB	00	00	00	Total LBA written(LBA=32MB)
242 (F2h)	LSB			MSB	00	00	00	Total LBA read(LBA=32MB)

Cur. * =Current

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	**E**	**S**	**2**	**5**	**-**	**3**	**2**	**G**	**M**	**4**	**1**	**S**	**C**	**A**	**D**	**B**	**-**	**X**	**X**
Description	Disk	\multicolumn{4}{2.5″ SATA SSD 3SE4}				Capacity			Category			Flash mode	Operation Temp.	Internal Control	CH.	Flash	-	Customized Code	

Definition	
Code 1st (Disk)	**Code 13th (Flash mode)**
D : Disk	S: Synchronous Flash
Code 2nd ~ 5th (Form Factor)	**Code 14th (Operation Temperature)**
ES25: 2.5″ SATA SSD 3SE4	C: Standard Grade (0℃～ +70℃)
Code 7th ~9th (Capacity)	W: Industrial Grade (-40℃～ +85℃)
08G: 8GB	**Code 15th (Internal control)**
16G: 16GB	A: Slim PCBA compliant to 7mm height housing
32G: 32GB	**Code 16th (Channel of data transfer)**
64G: 64GB	D: Dual Channels
	Code 17th (Flash Type)
Code 10th ~12th (Series)	B: Toshiba SLC
M41: 88NV1120	**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 及（EU）2015/863 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) and (EU) 2015/863 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）
鉛（Pb）	< 1000 ppm
汞（Hg）	< 1000 ppm
鎘（Cd）	< 100 ppm
六價鉻（Cr 6+）	< 1000 ppm
多溴聯苯（PBBs）	< 1000 ppm
多溴二苯醚（PBDEs）	< 1000 ppm
鄰苯二甲酸二(2-乙基己基)酯（DEHP）	< 1000 ppm
鄰苯二甲酸丁酯苯甲酯（BBP）	< 1000 ppm
鄰苯二甲酸二丁酯（DBP）	< 1000 ppm
鄰苯二甲酸二異丁酯（DIBP）	< 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： Randy Chien 簡川勝

Company Representative Title 公司代表人職稱： Chairman 董事長

Date 日期： 2017 / 01 / 18

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 EP 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 及(EU) 2015/863 關於 RoHS 之規範要求。

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鉛（Pb）	＜ 1000 ppm
汞（Hg）	＜ 1000 ppm
鎘（Cd）	＜ 100 ppm
六價鉻（Cr 6+）	＜ 1000 ppm
多溴聯苯（PBBs）	＜ 1000 ppm
多溴二苯醚（PBDEs）	＜ 1000 ppm
鄰苯二甲酸二(2-乙基己基)酯（DEHP）	＜ 1000 ppm
鄰苯二甲酸丁酯苯甲酯（BBP）	＜ 1000 ppm
鄰苯二甲酸二丁酯（DBP）	＜ 1000 ppm
鄰苯二甲酸二異丁酯（DIBP）	＜ 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： Randy Chien 簡川勝

Company Representative Title 公司代表人職稱： Chairman 董事長

Date 日期： 2018 / 07 / 01

$C\,E$

VERIFICATION OF COMPLIANCE

This Verification of Compliance is hereby issued to the below named company. The test results of this report relate only to the tested sample identified in this report.

Technical Standard: EMC DIRECTIVE 2014/30/EU (EN55032)

General Information

Applicant: Innodisk Corporation
                 5F., No. 237, Sec. 1, Datong Rd., Xizhi Dist.,
                 New Taipei City 22161, Taiwan (R.O.C)

Product Description

EUT Description: 2.5" SATA SSD
Brand Name: Innodisk
Model Number: 2.5" SATA SSD 3$*#-&
                   $:Flash type: (S:SLC, I:iSLC, M:MLC, T:3D TLC)
                   *:Product line: (E:Embedded, G:EverGreen, R:InnoRobust)
                   #:Product Generation: (empty, 0~9)
                   &:Product line: (empty, P:Plus)

Measurement Standard

EN 55032: 2012 / AC: 2013
CISPR 32: 2012

Measurement Facilities

Xindian Lab.:   *Compliance Certification Services Inc.*
                 No.163-1, Jhongsheng Rd., Xindian Dist., New Taipei City, 23151 Taiwan.
                 Tel: +886-2-22170894 / Fax: +886-2-22171029

This device has been shown to be in compliance with and was tested in accordance with the measurement procedures specified in the Standards & Specifications listed above and as indicated in the measurement report number: T161004D15-E
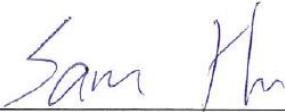
Sam Hu / Assistant Manager
Date: October 11, 2016

CCSRF
程智科技股份有限公司
Compliance Certification Services inc.

FC

VERIFICATION OF COMPLIANCE

This Verification of Compliance is hereby issued to the below named company. The test results of this report relate only to the tested sample identified in this report.

Technical Standard: FCC Part 15 Class B
IC ICES-003

General Information

Applicant: Innodisk Corporation
5F., No. 237, Sec. 1, Datong Rd., Xizhi Dist.,
New Taipei City 22161, Taiwan (R.O.C)

Product Description

EUT Description: 2.5" SATA SSD
Brand Name: Innodisk
Model Number: 2.5" SATA SSD 3$*#-&
$:Flash type: (S:SLC, I:iSLC, M:MLC, T:3D TLC)
*:Product line: (E:Embedded, G:EverGreen, R:InnoRobust)
#:Product Generation: (empty, 0~9)
&:Product line: (empty, P:Plus)

Measurement Facilities

Xindian Lab.:   *Compliance Certification Services Inc.*
No.163-1, Jhongsheng Rd., Xindian Dist., New Taipei City, 23151 Taiwan.
Tel: +886-2-22170894 / Fax: +886-2-22171029

This device has been shown to be in compliance with and was tested in accordance with the measurement procedures specified in the Standards & Specifications listed above and as indicated in the measurement report number: T161004D15-D

Sam Hu / Assistant Manager
Date: October 11, 2016

CCSRF
程智科技股份有限公司
Compliance Certification Services Inc.