innodisk

Total Solution For Industrial Flash Storage

mSATA

3ME4 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	Aug., 2016

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1. Product Overview

1.1 Introduction of Innodisk mSATA 3ME4

Innodisk mSATA 3ME4 which is designed with mSATA form factor by JEDEC MO-300/MO-300B , supporting SATA III standard (6.0Gb/s), achieves excellent performance up to 4CH standard by cost effective controller with 2CH. Regarding of mechanical interference, Innodisk mSATA 3ME4 absolutely replaces the traditional hard disk and makes personal computer, in any field, smaller and easier.

With Innodisk L^3 FW architecture, combining our signature 4K mapping algorithm L^2 FW architecture with powerful LDPC technology, 3ME4 series has outstanding high IOPS, better data integrity and extended lifespan through reducing the bad block number happening.

For real industrial application, 3ME4 series is built in thermal sensor to monitor the environment temperature. iData Guard, the power loss management mechanism developed by Innodisk, ensures data integrity while power sudden loss happened.

1.2 Product View and Models

Innodisk mSATA 3ME4 is available in follow capacities within MLC flash ICs.

mSATA 3ME4 08GB mSATA 3ME4 16GB mSATA 3ME4 32GB

mSATA 3ME4 64GB mSATA 3ME4 128GB mSATA 3ME4 256GB



Figure 1: Innodisk mSATA 3ME4

1.3 SATA Interface

Innodisk mSATA 3ME4 supports SATA III(6.0Gb/s) interface, and compliant with SATA I (1.5Gb/s) and SATA II(3.0Gb/s).

2. Product Specifications

2.1 Capacity and Device Parameters

mSATA 3ME4 device parameters are shown in Table 1.

Table 1: Device parameters

Capacity	Cylinders	Heads	Sectors	LBA	User Capacity(MB)
08GB	16383	16	63	15649200	7,641
16GB	31029	16	63	31277232	15,272
32GB	62037	16	63	62533296	30,533
64GB	124053	16	63	125045424	61,057
128GB	248085	16	63	250069680	122,104
256GB	496149	16	63	500118192	244,198

2.2 Performance

Burst Transfer Rate: 6.0Gbps

Table2: Performance

Capacity	08GB	16GB		32GB	64GB	128GB	256GB
		1CH	2CH				
Sequential Read (max.)	140 MB/sec	220 MB/sec	270 MB/sec	450 MB/sec	530 MB/sec	530 MB/sec	530 MB/sec
Sequential Write (max.)	25 MB/sec	25 MB/sec	60 MB/sec	50 MB/sec	100 MB/sec	190 MB/sec	210 MB/sec
4KB Random** Read (QD32)	8,700 IOPS	10,000 IOPS	15,000 IOPS	17,000 IOPS	27,000 IOPS	32,000 IOPS	32,000 IOPS
4KB Random** Write (QD32)	6,900 IOPS	6,100 IOPS	14,000 IOPS	12,000 IOPS	25,500 IOPS	31,000 IOPS	26,000 IOPS

Note: the information is based on CrystalDiskMark 3.01 with file size 1000MB test patent

2.3 Electrical Specifications

2.3.1 Power Requirement

Table 3: Innodisk mSATA 3ME4 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	130 (max.)
Write	205 (max.)
Idle	84 (max.)

* Target: 256GB mSATA 3ME4

2.4 Environmental Specifications

2.4.1 Temperature Ranges

Table 5: Temperature range for mSATA 3ME4

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 3ME4

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 3ME4 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 3ME4 MTBF

Product	Condition	MTBF (Hours)
Innodisk mSATA 3ME4	**Telcordia SR-332 GB, 25°C**	**>3,000,000**

2.5 CE and FCC Compatibility

mSATA 3ME4 conforms to CE and FCC requirements.

2.6 RoHS Compliance

mSATA 3ME4 is fully compliant with RoHS directive.

2.7 Reliability

Parameter	Value
Read Cycles	Unlimited Read Cycles
Flash endurance	3,000 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	21.3	4.6
16GB	42.6	9.2
32GB	85.2	18.4
64GB	170.4	36.8
128GB	340.8	73.6
256GB	681.6	147.2

* 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 3ME4 support following transfer mode:

Serial ATA III 6.0Gbps

Serial ATA II 3.0Gbps

Serial ATA I 1.5Gbps

2.9 Pin Assignment

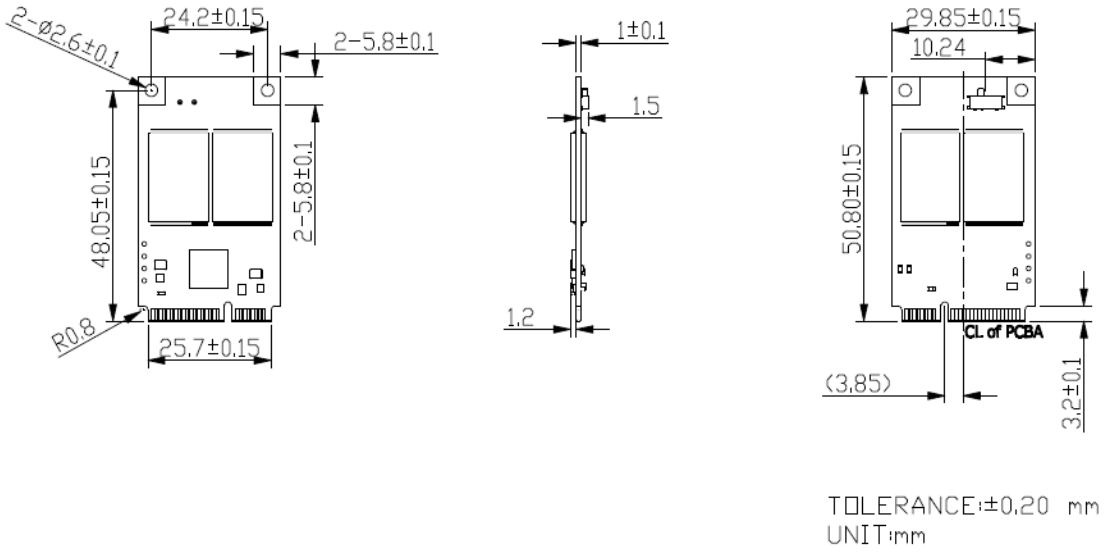
Innodisk mSATA 3ME4 uses a standard SATA pin-out. See Table 8 for mSATA 3ME4 pin assignment.

Table 8: Innodisk mSATA 3ME4 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
NC	5	6	NC
NC	3	4	GND
NC	1	2	+3.3V

2.10 Mechanical Dimensions



2.11 Assembly Weight

An Innodisk mSATA 3ME4 within flash ICs, 32GB's weight is 8 grams approximately.

2.12 Seek Time

Innodisk mSATA 3ME4 is not a magnetic rotating design. There is no seek or rotational latency required.

2.13 NAND Flash Memory

Innodisk mSATA 3ME4 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 3ME4 from the system level, including the major hardware blocks.

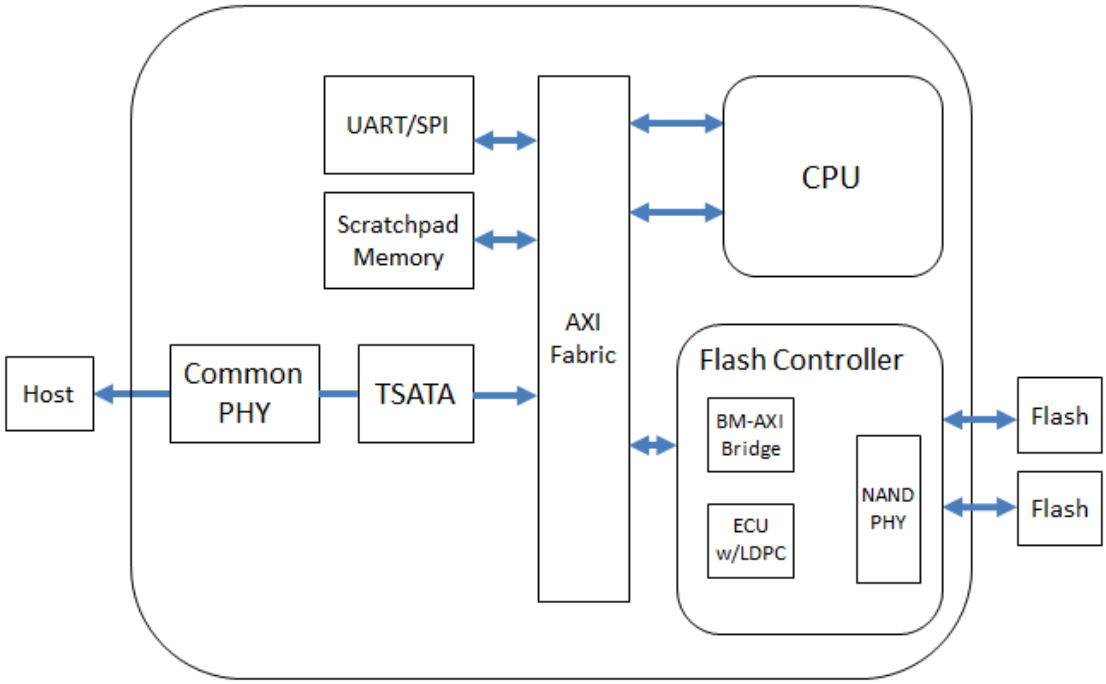


Figure 2: Innodisk mSATA 3ME4 Block Diagram

Innodisk mSATA 3ME4 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 3ME4 is designed with ID 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 mSATA 3ME4 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 mSATA 3ME4 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

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.

3.8 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 mSATA 3ME4 Pin Directions

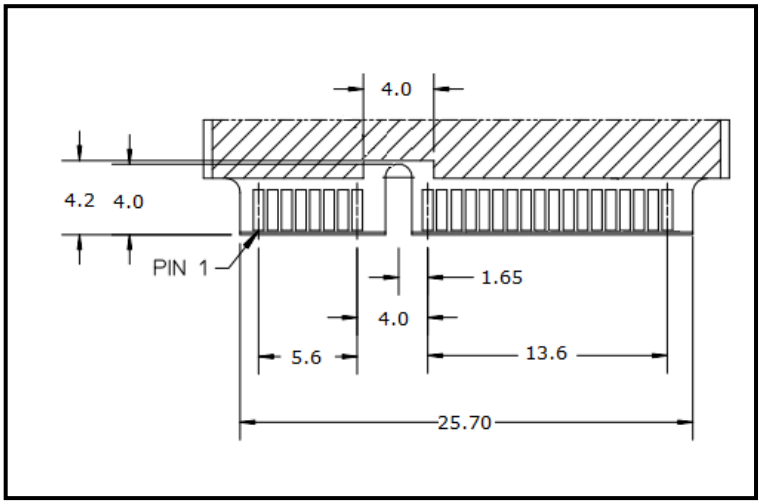


Figure 3: Signal Segment and Power Segment

4.2 Electrical Connections for mSATA 3ME4

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 3ME4 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**	**M**	**4**	**1**	**B**	**C**	**1**	**D**	**C**	**-**	**X**	**X**	**X**
Description	Disk	mSATA Regular					Capacity			Controller			Flash Mode	Operation Temp.	Internal Control	CH.	Flash Type	-	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)**
EMSR: mSATA Regular	C: Standard Grade (0℃~ +70℃)
	W: Industrial Grade (-40℃~ +85℃)
Code 7th ~9th (Capacity)	**Code 15th (Internal control)**
08G: 08GB	1~9: TSOP PCB version
16G: 16GB	
32G: 32GB	**Code 16th (Channel of data transfer)**
64G: 64GB	S: Single Channel
A28: 128GB	D: Dual Channels
B56: 256GB	
	Code 17th (Flash Type)
Code 10th ~12th (Controller)	C: Toshiba MLC
M41: 88NV1120	**Code 19th~21th (Customized Code)**

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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）特此保證售予新漢股份有限公司之所有產品，皆符合歐盟 2011/65/EU 關於 RoHS 之規範要求。

Innodisk Corporation declares that all products sold to Nexcom, 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）
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

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： 2016 / 08 / 04

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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 李鎧亮

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	:	**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
IC Code 4699A
VCCI Accep. No. R-1527, C-1609, T-1441, G-10, C-4400, T-1334, G-614

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J. Y. Shih

(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

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(Tsun-Yu Shih/ General Manager)

Date: December 10, 2014