

SATADOM-ML

3IE3 Series (v2)

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	Apr., 2016
1.0	Official Released	Aug., 2016
1.1	Modify the format	Nov., 2016
1.2	Update TBW and storage temperature Remove appendix	Mar., 2022
1.3	Update Product Photo & Mechanical Drawing	Apr., 2024

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1. Product Overview

1.1 Introduction of Innodisk SATADOM-ML 3IE3 V2

Innodisk Serial ATA Disk on Module (SATADOM) supports SATA III standard (6.0Gb/s) interface with excellent performance, and SATADOM-ML 3IE3 V2 is designed as the smallest form factor size that could enhance compatibility with various design applications. The innovative Pin8 uses the SATA connector itself as a power supply to drive the device without external cables. It could be connected directly to the SATA on-board socket on customers' system without additional power cable. Besides, the booting time for operation and the power consumption is less than hard disk drive (HDD), and can work under harsh environment compile with ATA protocol, no additional drives are required, and the SSD can be configured as a boot device or data storage device.

1.2 Product View and Models

Innodisk SATADOM-ML 3IE3 V2 is available in follow capacities within MLC flash ICs.

[SATADOM-ML 3IE3 V2 16GB](#)

[SATADOM-ML 3IE3 V2 32GB](#)

[SATADOM-ML 3IE3 V2 64GB](#)

[SATADOM-ML 3IE3 V2 128GB](#)

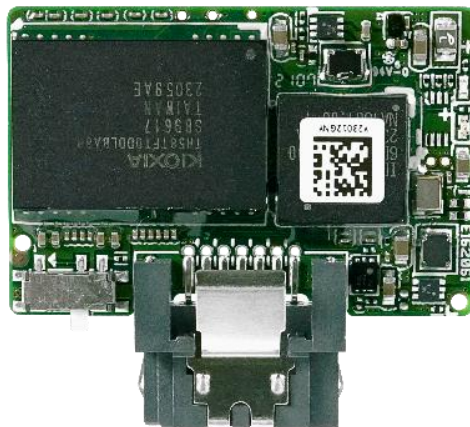


Figure 1: Innodisk SATADOM-ML 3IE3 V2

1.3 SATA Interface

Innodisk SATADOM-ML 3IE3 V2 supports SATA III interface, and compliant with SATA I and SATA II.

2. Product Specifications

2.1 Capacity and Device Parameters

SATADOM-ML 3IE3 V2 device parameters are shown in Table 1.

Table 1: Device parameters

Capacity	LBA	Cylinders	Heads	Sectors	User Capacity(MB)
16GB	31277232	16383	16	63	15,272
32GB	62533296	16383	16	63	30,533
64GB	125045424	16383	16	63	61,057
128GB	2500668096	16383	16	63	122,104

2.2 Performance

Burst Transfer Rate: 6.0Gbps

Table 2: Performance

Capacity	16GB	32GB	64GB	128GB
Sequential Read (max.)	210 MB/s	380 MB/s	400 MB/s	400 MB/s
Sequential Write (max.)	90 MB/s	160 MB/s	180 MB/s	180 MB/s
4KB Random Read (QD32)	6300 IOPS	11200 IOPS	11200 IOPS	11200 IOPS
4KB Random Write (QD32)	8300 IOPS	27300 IOPS	28300 IOPS	28300 IOPS

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

2.3 Electrical Specifications

2.3.1 Power Requirement

Table 3: Innodisk SATADOM-ML 3IE3 V2 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 (mA)
Read	180.3 (max.)
Write	247.3 (max.)
Idle	93.1 (max.)
Pin 7/ Pin8 VCC Initial*	1000 (max.)

Target: 32GB SATADOM-ML 3IE3 V2

***To design in Pin7/8 VCC on motherboard, 5V with 1A power supply is requested.**

2.4 Environmental Specifications

2.4.1 Temperature Ranges

Table 5: Temperature range for SATADOM-ML 3IE3 V2

Temperature	Range
Operating	Standard Grade: 0°C to +70°C
	Industrial Grade: -40°C to +85°C
Storage	-40°C to +85°C

2.4.2 Humidity

Relative Humidity: 10-95%, non-condensing

2.4.3 Shock and Vibration

Table 6: Shock/Vibration Testing for SATADOM-ML 3IE3 V2

Reliability	Test Conditions	Reference Standards
Vibration	7 Hz to 2K Hz, 20G, 3 axes	IEC 60068-2-6
Mechanical Shock	Duration: 0.5ms, 1500 G, 3 axes	IEC 60068-2-27

2.4.4 Mean Time between Failures (MTBF)

Table 7 summarizes the MTBF prediction results for various SATADOM-ML 3IE3 V2 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: SATADOM-ML 3IE3 V2 MTBF

Product	Condition	MTBF (Hours)
Innodisk SATADOM-ML 3IE3 V2	Telcordia SR-332 GB, 25°C	>3,000,000

2.5 CE and FCC Compatibility

SATADOM-ML 3IE3 V2 conforms to CE and FCC requirements.

2.6 RoHS Compliance

SATADOM-ML 3IE3 V2 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
iData Guard	Support
Thermal Sensor	WT only
Flash endurance	20,000 P/E cycles
TBW* (Total Bytes Written)	
16GB	43.4
32GB	86.8
64GB	173.6
128GB	347.2
* Total bytes written is based on JEDEC 218 (Solid-State Drive Requirements and Endurance Test Method)	
** Lifespan is calculated by device written per day	

2.8 Transfer Mode

SATADOM-ML 3IE3 V2 support following transfer mode:

Serial ATA I 1.5Gbps

Serial ATA II 3.0Gbps

Serial ATA III 6.0Gbps

2.9 Pin Assignment

Innodisk SATADOM-ML 3IE3 V2 uses a standard SATA pin-out. See Table 8 for SATADOM-ML 3IE3 V2 pin assignment.

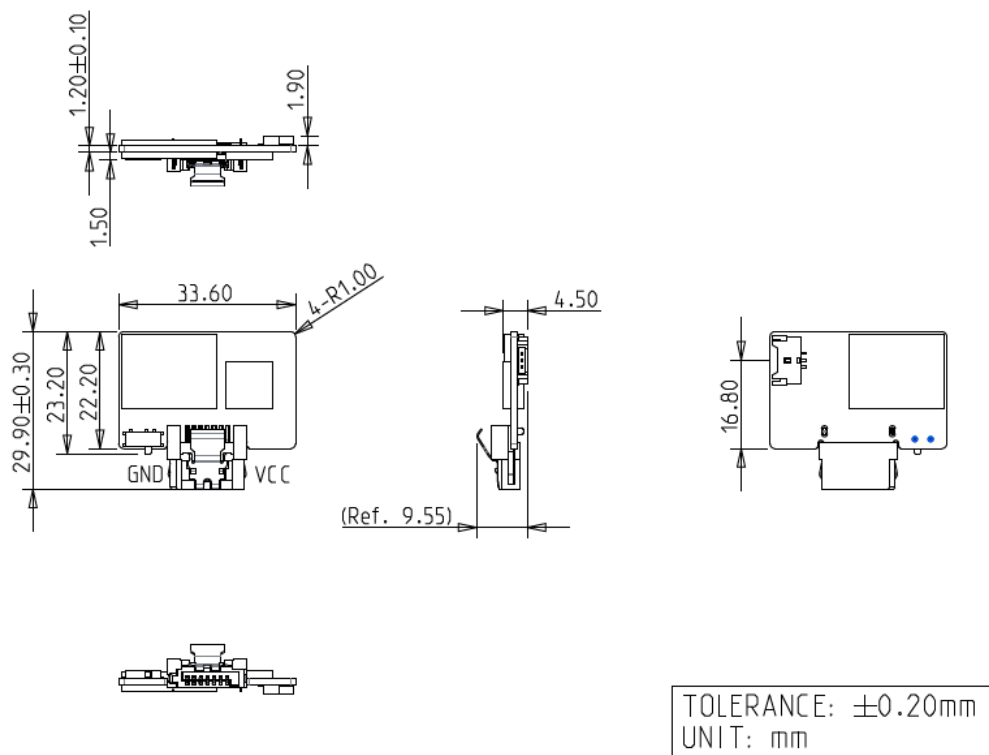
Table 8: Innodisk SATADOM-ML 3IE3 V2 Pin Assignment

Name	Type	Description
Pin 0	GND	Shielding
Pin 1	GND	Shielding
Pin 2	A+	Differential signal to A
Pin 3	A-	Differential signal to A-
Pin 4	GND	Shielding
Pin 5	B-	Differential signal to B-
Pin 6	B+	Differential signal to B
Pin 7	GND/	Shielding/ +5V Power*
Pin 8	VCC	+5V Power

* SATADOM-ML 3IE3 V2 default power supply through pin 8 or extra power cable.

Pin 7 power supply as an optional function with separated PN end of B.

2.10 Mechanical Dimensions



2.11 Assembly Weight

An Innodisk SATADOM-ML 3IE3 V2 within flash ICs, 32GB's weight is 7 grams approximately.

2.12 Seek Time

Innodisk SATADOM-ML 3IE3 V2 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 SATADOM-ML 3IE3 V2 uses 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 SATADOM-ML 3IE3 V2 from the system level, including the major hardware blocks.

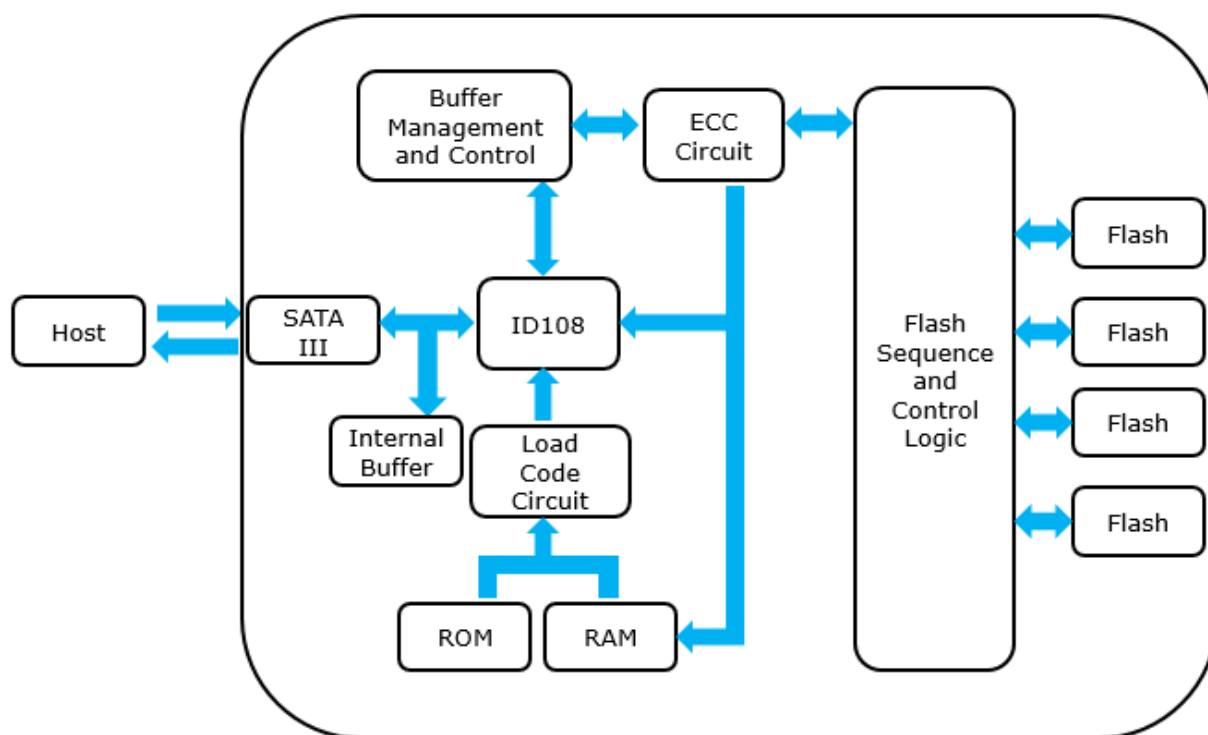


Figure 2: Innodisk SATADOM-ML 3IE3 V2 Block Diagram

Innodisk SATADOM-ML 3IE3 V2 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 SATADOM-ML 3IE3 V2 is designed with ID 108, 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 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 40 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 SATADOM-ML 3IE3 V2 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 SATADOM-ML 3IE3 V2 Pin Directions

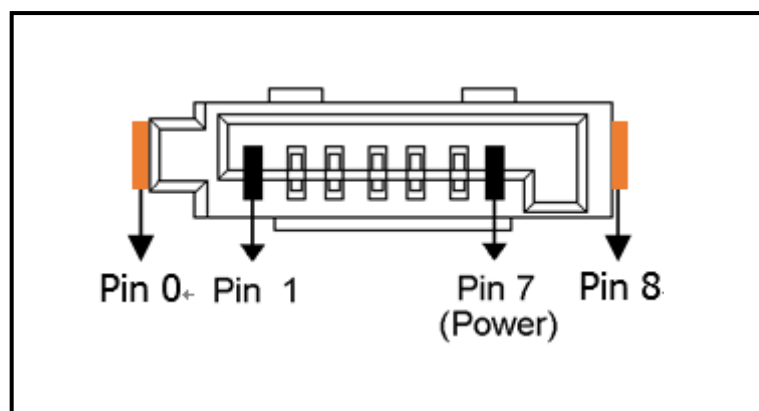


Figure 3: Signal Segment and Power Segment

* SATADOM-ML 3IE3 V2 default power supply through pin 8 or extra power cable.

Pin 7 power supply as an optional function with separate PN end of B.

4.2 Electrical Connections for SATADOM-ML 3IE3 V2

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

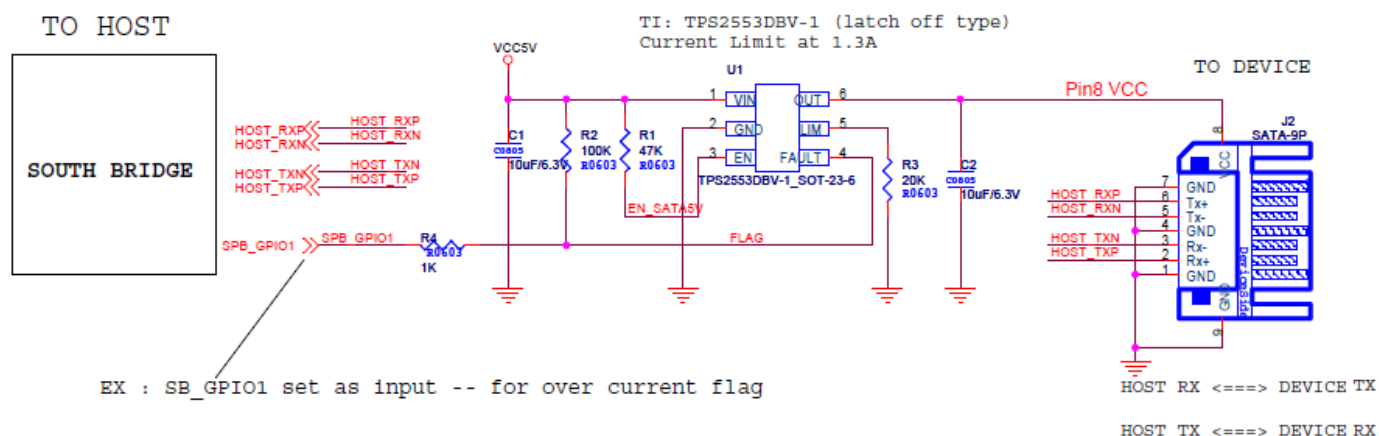
No additional device drives are required. The Innodisk SATADOM-ML 3IE3 V2 can be configured as a boot device.

4.4 Pin8 VCC

SATADOM-ML 3IE3 V2 series with Pin8 VCC, it is defined Pin8 as VCC on the SATA connector. Thus the power would come from SATA connector Pin8 VCC. Customers DO NOT have to use the power cable for power supply. Such a wireless design of SATADOM-ML 3IE3 V2 series with Pin8 VCC brings more convenience to customers' system. The followings are the points customers have to be careful of while designing in SATADOM-ML 3IE3 V2 series with Pin8 VCC.

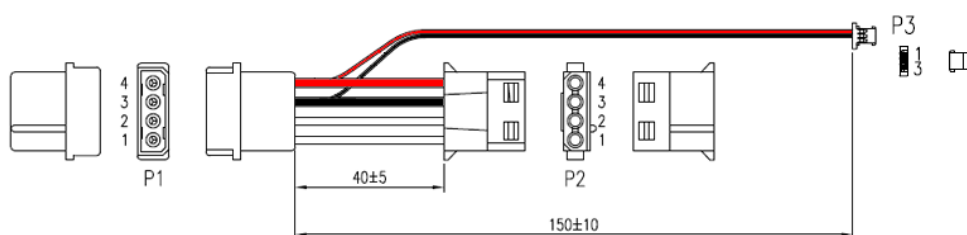
When customers use SATADOM with Pin8 VCC and the host SATA socket does not have power on Pin8, external power must be provided to the SATADOM from the 3pin connector on the side.

To have the advantages of SATADOM-ML 3IE3 V2 series with Pin8 VCC, and to avoid any potential damage to customers' board designed with VCC power supply, Innodisk suggests that customers MUST design their board with a fuse which should be designed before the SATA socket Pin8 VCC. In other words, customers are suggested NOT TO layout 5V VCC to SATA socket on board directly. A circuit diagram example to explain this is shown as below.



4.5 Power cable

A power cable is shipped with each SATADOM product, which has standard 4pins power connector and special 3 pins power connector for SATADOM. The male and female power connector of SATADOM have foolproof design to avoid misconnection, please check it before power on.



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	H	S	M	L	-	3	2	G	D	0	8	B	C	A	Q	C	A	X	X	X
Definition																					
Code 1 st (Disk)											Code 14th (Operation Temperature)										
D : Disk											C: Standard Grade (0°C~ +70°C)										
Code 2 nd (Feature set)											W: Industrial Grade (-40°C~ +85°C)										
H : iSLC series											Code 15th (Internal control)										
Code 3 rd ~5 th (Form factor)											A~Z: BGA PCB version										
SML: SATADOM-ML											Code 16th (Channel of data transfer)										
Code 7th ~9th (Capacity)											D: Dual Channels										
16G:16GB		32G: 32GB				64G:64GB					Q: Quad Channels										
A28:128GB																					
Code 10th ~12th (Controller)											Code 17th (Flash Type)										
D08: ID108											C: Toshiba MLC										
Code 13th (Flash mode)											Code 18th (pin7 type)										
B: Synchronous flash (Toshiba 15nm)											A: Pin8 version / Standard version										
											B: Pin8 & Pin7 version										
											Code 19th~21st (Customize code)										