SATA Slim

3SE3 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
1.0	First Released	Mar., 2016
1.1	Update Reliability	Aug., 2024

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1. Product Overview

1.1 Introduction of Innodisk SATA Slim 3SE3

Innodisk SATA Slim 3SE3 is designed with standard SATA interface (7+15 SATA connector), which could support most platforms with standard SATA port. Besides, with its smaller dimension, SATA Slim 3SE3 is an alternative solution of 2.5" SSD for those embedded system that may have mechanical and space concerns. SATA Slim 3SE3 operates under SATA III (6.0Gb/s) protocol with good performance.

SATA Slim 3SE3 is also suitable in industrial field. It effectively reduces the booting time of operation system and the power consumption is less than hard disk drive (HDD). SATA Slim 3SE3 is compatible with ATA protocol, no additional drivers are required, and the SATA Slim 3SE3 can be configured as a boot device or data storage device.

1.2 Product View and Models

Innodisk SATA Slim 3SE3 is available in follow capacities within SLC flash ICs.

SATA Slim 3SE3 8GB   SATA Slim 3SE3 64GB
SATA Slim 3SE3 16GB   SATA Slim 3SE3 128GB
SATA Slim 3SE3 32GB

Figure 1: Innodisk SATA Slim 3SE3

1.3 SATA Interface

Innodisk SATA Slim 3SE3 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 Capacity

Innodisk SATA Slim 3SE3 provides unformatted 8GB, 16GB, 32GB, 64GB and 128GB capacities within SLC Flash IC.

1.5 MO-297 Form Factor

SATA Slim 3SE3 has a compact design 54.0mm (W) x 39.0mm (L) x 4.0mm (H) without metal material case, and is easy for installation.

2. Product Specifications

2.1 Capacity and Device Parameters

Innodisk SATA Slim 3SE3 device parameters are shown in Table 1.

Table 1: Device parameters

Capacity	LBA	Cylinders	Heads	Sectors	User Capacity(MB)
8GB	15649200	15255	16	63	7,641
16GB	31277232	16383	16	63	15,272
32GB	62533296	16383	16	63	30,533
64GB	125045424	16383	16	63	61,057
128GB	250069680	16383	16	63	122,104

2.2 Performance

Burst Transfer Rate: 6.0Gbps

Table 2: Performance

Capacity	8GB	16GB	32GB	64GB	128GB
Sequential Read (max.)	320 MB/sec	320 MB/sec	360 MB/sec	360 MB/sec	370 MB/sec
Sequential Write (max.)	110 MB/sec	110 MB/sec	180 MB/sec	210 MB/sec	220 MB/sec
4K Random Read (QD32)	12,000 IOPS	12,400 IOPS	13,200 IOPS	12,000 IOPS	12,200 IOPS
4K Random Write (QD32)	11,600 IOPS	12,800 IOPS	19,700 IOPS	19,800 IOPS	21,100 IOPS

Note: Base on CrystalDiskMark 3.01 with file size 1000MB

2.3 Electrical Specifications

2.3.1 Power Requirement

Table 3: Innodisk SATA Slim 3SE3 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	318 (max.)
Write	400 (max.)
Idle	127 (max.)

* Target: SATA Slim 3SE3 128GB

2.4 Environmental Specifications

2.4.1 Temperature Ranges

Table 5: Temperature range for SATA Slim 3SE3

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 SATA Slim 3SE3

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 SATA Slim 3SE3 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: SATA Slim 3SE3 MTBF

Product	Condition	MTBF (Hours)
Innodisk SATA Slim 3SE3	Telcordia SR-332 GB, 25°C	>3,000,000

2.5 CE and FCC Compatibility

SATA Slim 3SE3 conforms to CE and FCC requirements.

2.6 RoHS Compliance

SATA Slim 3SE3 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
Data Retention	Under 40℃: 1 Year at NAND Life End
TBW (Unit: TB)	
8GB	46.8
16GB	93.7
32GB	187.5
64GB	375
128GB	750
* 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

SATA Slim 3SE3 support following transfer mode:

Serial ATA III 6.0Gbps

Serial ATA II 3.0Gbps

Serial ATA I 1.5Gbps

2.9 Pin Assignment

Innodisk SATA Slim 3SE3 uses a standard SATA pin-out. See Table 8 for SATA Slim 3SE3 pin assignment.

Table 8: Innodisk SATA Slim 3SE3 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
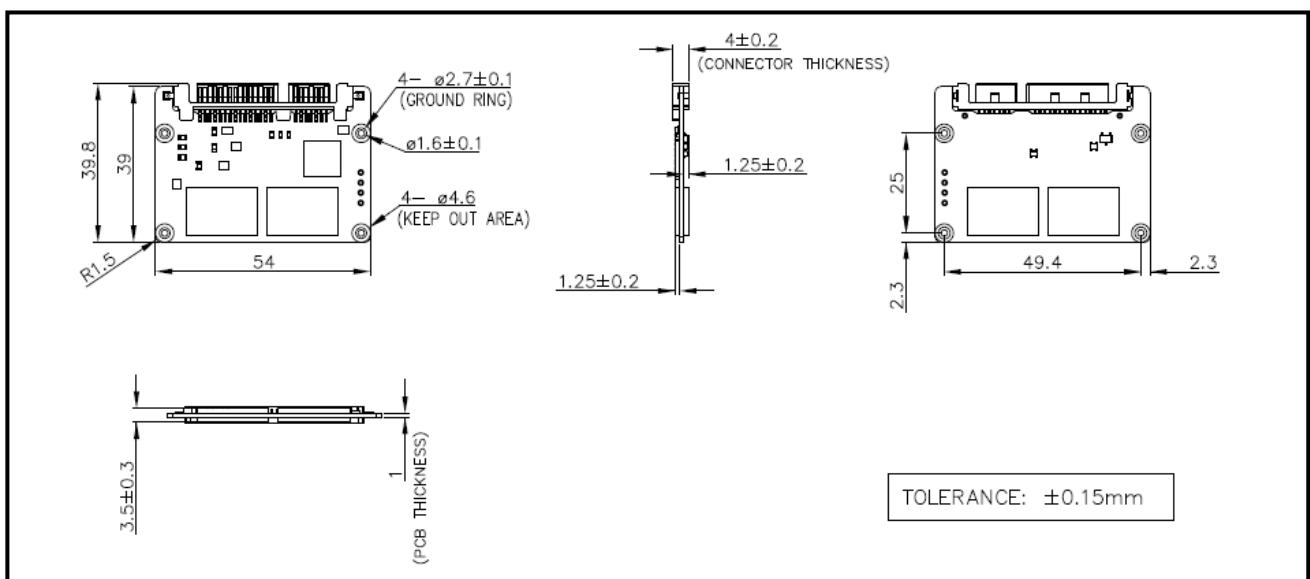
2.11 Assembly Weight

An Innodisk SATA Slim 3SE3 within SLC flash ICs, 16GB's weight is 9 grams approx. The total weight of SSD will be less than 12 grams.

2.12 Seek Time

Innodisk SATA Slim 3SE3 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.
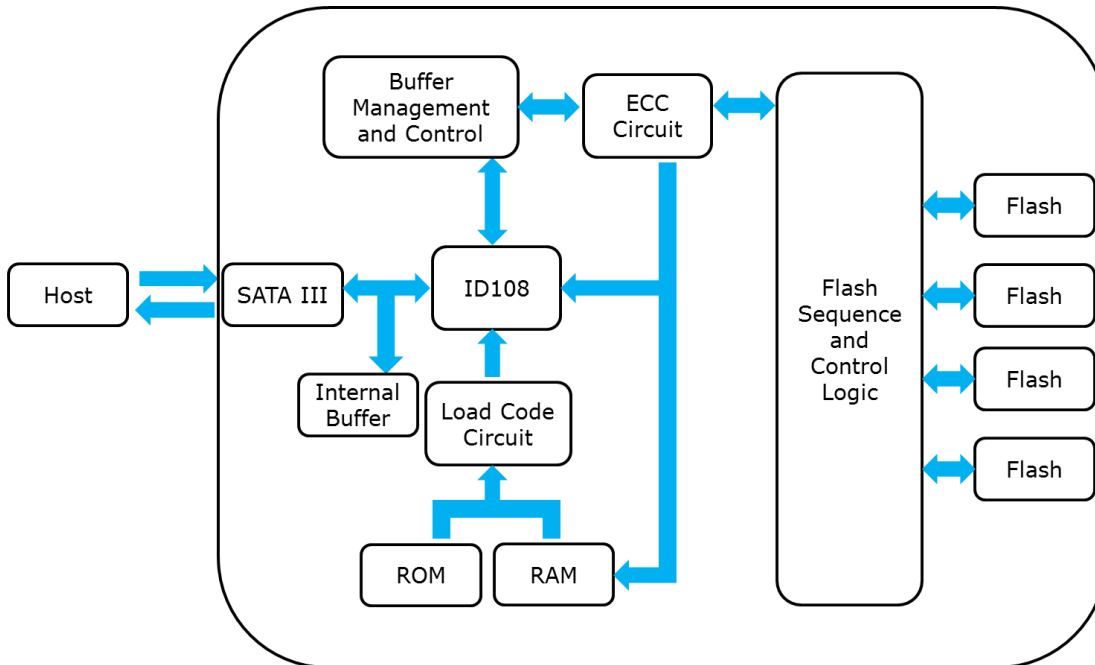
2.14 NAND Flash Memory

Innodisk SATA Slim 3SE3 uses Single Level Cell (SLC) NAND flash memory, which is non-volatility, high reliability which has 60,000 program/erase times and high speed memory storage.

3. Theory of Operation

3.1 Overview

Figure 2 shows the operation of Innodisk SATA Slim 3SE3 from the system level, including the major hardware blocks.

Figure 2: Innodisk SATA Slim 3SE3 Block Diagram

Innodisk SATA Slim 3SE3 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 SATA Slim 3SE3 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 SATA Slim 3SE3 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 SATA Slim 3SE3 Pin Directions

Figure 3: Signal Segment and Power Segment
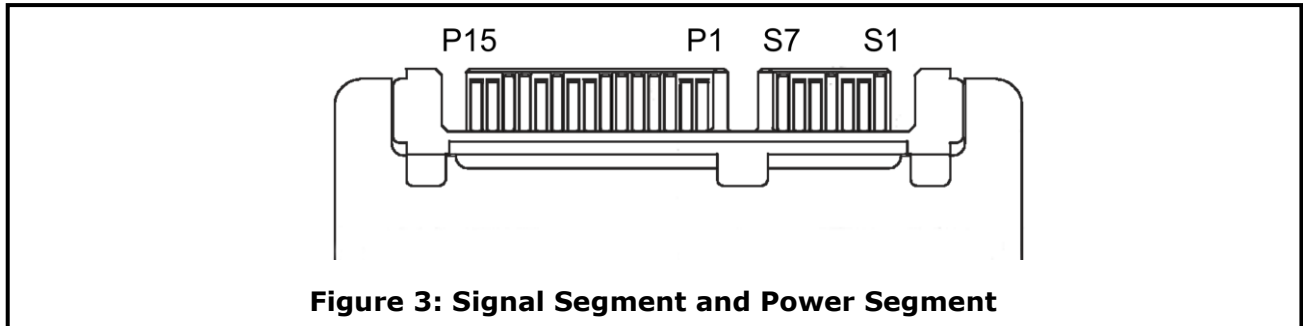
4.2 Electrical Connections for SATA Slim 3SE3

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 SATA Slim 3SE3 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
	D	E	S	L	M	-	3	2	G	D	0	8	S	C	A	Q	B	-	X	X

Definition	
Code 1ˢᵗ (Disk)	**Code 13ᵗʰ (Flash Mode)**
D : Disk	S: Synchronous flash
Code 2ⁿᵈ ~ 5ᵗʰ (Form Factor)	**Code 14ᵗʰ (Operation Temperature)**
ESLM: SATA Slim 3SE3	C: Standard Grade (0℃~ +70℃)
Code 7ᵗʰ ~9ᵗʰ (Capacity)	W: Industrial Grade (-40℃~ +85℃)
08G: 8GB	**Code 15ᵗʰ (Internal control)**
16G: 16GB	**Code 16ᵗʰ (Channel of data transfer)**
32G: 32GB	D: Dual Channels
64G: 64GB	Q: Quad Channels
A28: 128GB	**Code 17th (Flash Type)**
	B: Toshiba SLC
Code 10ᵗʰ ~12ᵗʰ (Series)	**Code 19ᵗʰ~20ᵗʰ (Customized Code)**
D08: ID108	