innodisk

nanoSSD

3ME3 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
Preliminary	First Released	Aug, 2013
Rev. 0.1	Modify pin assignment Modify block diagram Add performance	Sep., 2013
Rev. 1.0	1. Update 3ME3 SPEC 2. Update RoHS/REACH/MSL 3. Update Ball and Signal Description	Mar., 2019
Rev. 1.1	1. Update power supply requirement and power consumption 2. Remove appendix	Sep., 2021

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1. Product Overview

1.1 Introduction of Innodisk nanoSSD 3ME3

Innodisk nanoSSD is an integrated SATA storage device, it combines Innodisk ID108 NAND flash controller and latest NAND flash in a JEDEC MO-276(μSSD) form factor with ball grid array (BGA) package.

The nanoSSD supports SATA III 6Gbps within a tiny dimension, as well as low power consumption and high reliability. It offers an ideal solution for embedded, automotive, medical, gaming and most industrial applications.

1.2 Product View and Models

Innodisk nanoSSD 3ME is available in follow capacities:

nanoSSD 3ME3 16GB nanoSSD 3ME3 64GB
nanoSSD 3ME3 32GB nanoSSD 3ME3 128GB

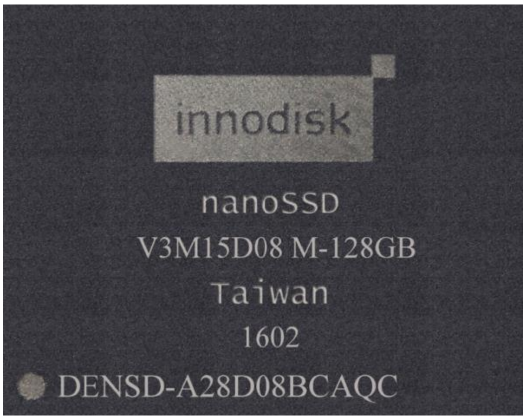


Figure 1: Innodisk nanoSSD 3ME3

1.3 SATA Interface

Innodisk nanoSSD 3ME3 supports 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).

1.4 JEDEC MO-276 Form Factor

The Innodisk nanoSSD 3ME is offered in JEDEC MO-276F form factor with a 16mm x 20mm 156 ball TFBGA package for capacities 16GB to 128GB. The MO-276F is one of micro SSD standard from factor from JEDEC, and is available at http://www.jedec.org/standards-documents/docs/mo-276f. The small form factor enables further miniaturization of embedded system designs as well as for a whole range of other applications that have mechanical restriction.

2. Product Specifications

2.1 Capacity and Device Parameters

nanoSSD 3ME3 device parameters are shown in Table 1.

Table 1: Device parameters

Capacity	Cylinders	Heads	Sectors	LBA	User Space (MB)
16GB	16383	16	63	31277232	15272
32GB	16383	16	63	62533296	30533
64GB	16383	16	63	125045424	61057
128GB	16383	16	63	250069680	122104

2.2 Performance

Burst Transfer Rate: 6.0Gbps

Table 2: Performance

Capacity	16GB	32GB	64GB	128GB
Sequential Read (max.)	100 MB/sec	200 MB/sec	370 MB/sec	410 MB/sec
Sequential Write (max.)	20 MB/sec	40 MB/sec	80 MB/sec	140 MB/sec

Note: Base on CrystalDiskMark 3.01 with file size 1000MB

2.3 Electrical Specifications

2.3.1 Power Requirement

Table 3: Innodisk nanoSSD 3ME3 Power Requirement

Input Voltage	Item	Symbol	Rating	Unit
	Main power supply	V_{IN}	3.3V± 5%	V
	Flash IO supply		1.8V ± 5%	
	Controller core supply		1.2V ± 5%	

2.3.2 Power Consumption

Table 4: Power Consumption

Mode	Power Consumption (W)
Read	1.5
Write	1.6
Idle	0.7

* Target: nanoSSD 3ME3 128GB

2.4 Environmental Specifications

2.4.1 Temperature Ranges

Table 5: Temperature range for nanoSSD 3ME3

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 nanoSSD 3ME3

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 nanoSSD 3ME3 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: nanoSSD 3ME3 MTBF

Product	Condition	MTBF (Hours)
Innodisk nanoSSD 3ME3	Telcordia SR-332 GB, 25°C	>3,000,000

2.5 RoHS Compliance

nanoSSD 3ME3 is fully compliant with RoHS directive.

2.6 Reliability

Parameter	**Value**
Read Cycles	Unlimited Read Cycles
Wear-Leveling Algorithm	Support
Bad Blocks Management	Support
Error Correct Code	Support
Flash endurance	3000 P/E cycles
TBW(Sequential Write)	
16GB	4.7
32GB	9.4
64GB	18.8
128GB	37.5

2.7 Transfer Mode

nanoSSD 3ME3 support following transfer mode:

Serial ATA III 6.0Gbps

Serial ATA II 3.0Gbps

Serial ATA I 1.5Gbps

2.8 Ball and Signal Description

The following table provides the pin definition of nanoSSD balls.

TYPE: Input - nanoSSD receives signal from host.

TYPE: Output - nanoSSD drives/transmits signal to host device.

TYPE: IO - Signal is bi-directional.

Table 8: Innodisk nanoSSD 3ME3 Pin Assignment

SATA interface signals			
Ball #	***Ball name***	***Type***	***Description***
P7	*SATA_RXP*	*Input*	*SATA Receive Signal Differential Pair*
R7	*SATA_RXN*	*Input*	*SATA Receive Signal Differential Pair*
U7	*SATA_TXN*	*Output*	*SATA Transmit Signal Differential Pair*
V7	*SATA_TXP*	*Output*	*SATA Transmit Signal Differential Pair*
R11	*A1V2*	*Supply*	*SATA PHY VDDC*

T11	*A1V2*	*Supply*	*SATA PHY VDDC*
P8	*A1V2*	*Supply*	*SATA PHY VDDC*
R8	*A1V2*	*Supply*	*SATA PHY VDDC*
T7	*AGND*	*GND*	*SATA_VSS*
N7	*AGND*	*GND*	*SATA_VSS*
W7	*AGND*	*GND*	*SATA_VSS*
Debug signals			
Ball #	***Ball name***	***Type***	***Description***
L16	*GPIO 3*	*Output*	*RS232 TXD (UART)*
L17	*GPIO 2*	*Input*	*RS232 RXD (UART)*
Power supply signals			
Ball #	***Ball name***	***Type***	***Description***
L12	*D3V3*	*Supply*	*3.3V Power Supply*
M11	*D3V3*	*Supply*	*3.3V Power Supply*
R13	*D3V3*	*Supply*	*3.3V Power Supply*
R14	*D3V3*	*Supply*	*3.3V Power Supply*
R15	*D3V3*	*Supply*	*3.3V Power Supply*
R16	*D3V3*	*Supply*	*3.3V Power Supply*
R19	*D3V3*	*Supply*	*3.3V Power Supply*
R20	*D3V3*	*Supply*	*3.3V Power Supply*
T16	*D3V3*	*Supply*	*3.3V Power Supply*
U8	*A3V3*	*Supply*	*Analog 3.3V*
U16	*D3V3*	*Supply*	*3.3V Power Supply*
V8	*A3V3*	*Supply*	*Analog 3.3V*
V11	*VCC_IO*	*Supply*	*3.3 GPIO Supply*
V16	*VCCQ*	*Supply*	*1.8V VCCQ*

W16	*VCCQ*	*Supply*	*1.8V VCCQ*
Y16	*VCCQ*	*Supply*	*1.8V VCCQ*
Y19	*VCC_IO*	*Supply*	*3.3 GPIO Supply*
Y20	*D3V3*	*Supply*	*3.3V Power Supply*
AA19	*VCC_IO*	*Supply*	*3.3 GPIO Supply*
AC8	*VCC_IO*	*Supply*	*3.3 GPIO Supply*
W11	*D1V2*	*Supply*	*1.2V Power Supply*
Y7	*D1V2*	*Supply*	*1.2V Power Supply*
Y8	*D1V2*	*Supply*	*1.2V Power Supply*
Y11	*D1V2*	*Supply*	*1.2V Power Supply*
Y12	*D1V2*	*Supply*	*1.2V Power Supply*
Y13	*D1V2*	*Supply*	*1.2V Power Supply*
AA7	*D1V2*	*Supply*	*1.2V Power Supply*
Ground (GND) signals			
Ball #	***Ball name***	***Type***	***Description***
L7	*VSS*	*GND*	*Ground*
L8	*VSS*	*GND*	*Ground*
L11	*VSS*	*GND*	*Ground*
L19	*VSS*	*GND*	*Ground*
L20	*VSS*	*GND*	*Ground*
M7	*VSS*	*GND*	*Ground*
M19	*VSS*	*GND*	*Ground*
M20	*VSS*	*GND*	*Ground*
N8	*VSS*	*GND*	*Ground*
N19	*VSS*	*GND*	*Ground*
P19	*VSS*	*GND*	*Ground*

P20	VSS	GND	Ground
R12	VSS	GND	Ground
T8	VSS	GND	Ground
U11	VSS	GND	Ground
U19	VSS	GND	Ground
U20	VSS	GND	Ground
V19	VSS	GND	Ground
Y14	VSS	GND	Ground
Y15	VSS	GND	Ground
AB7	VSS	GND	Ground
AC7	VSS	GND	Ground
AC20	VSS	GND	Ground
AD7	VSS	GND	Ground
AD8	VSS	GND	Ground
AD19	VSS	GND	Ground
AD20	VSS	GND	Ground
Analog signals			
L9	XTALOUT	Output	25MHz Crystal out
M10	XTALIN	Input	25MHz Crystal in
Do not use (DNU) signals			
Ball #	**Ball name**	**Type**	**Description**
M8	TMEN	DNU	Do not use
M16	NC	DNU	Do not use
AC13	NC	DNU	Do not use
AC10	NC	DNU	Do not use
AA8	NC	DNU	Do not use

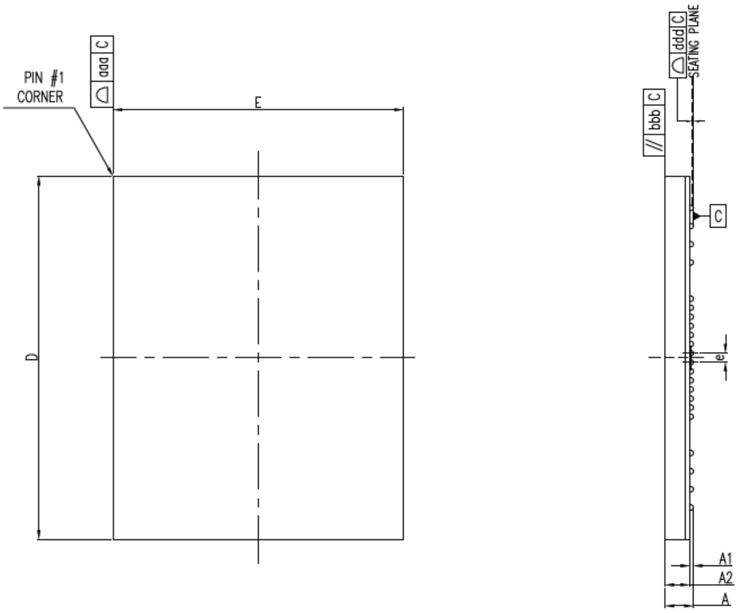
AD9	*NC*	*DNU*	*Do not use*
AD11	*NC*	*DNU*	*Do not use*
AD13	*NC*	*DNU*	*Do not use*
L14	*NC*	*DNU*	*Do not use*
M12	*NC*	*DNU*	*Do not use*
M14	*NC*	*DNU*	*Do not use*
M15	*NC*	*DNU*	*Do not use*
M17	*NC*	*DNU*	*Do not use*
M18	*NC*	*DNU*	*Do not use*
N20	*NC*	*DNU*	*Do not use*
T19	*NC*	*DNU*	*Do not use*
T20	*NC*	*DNU*	*Do not use*
V20	*NC*	*DNU*	*Do not use*
W8	*NC*	*DNU*	*Do not use*
W19	*NC*	*DNU*	*Do not use*
W20	*NC*	*DNU*	*Do not use*
AB8	*NC*	*DNU*	*Do not use*
AB19	*NC*	*DNU*	*Do not use*
AB20	*NC*	*DNU*	*Do not use*
AC12	*NC*	*DNU*	*Do not use*
AC15	*NC*	*DNU*	*Do not use*
AC17	*NC*	*DNU*	*Do not use*
AC18	*NC*	*DNU*	*Do not use*
AC19	*NC*	*DNU*	*Do not use*
AD14	*NC*	*DNU*	*Do not use*
L10	*NC*	*DNU*	*Do not use*

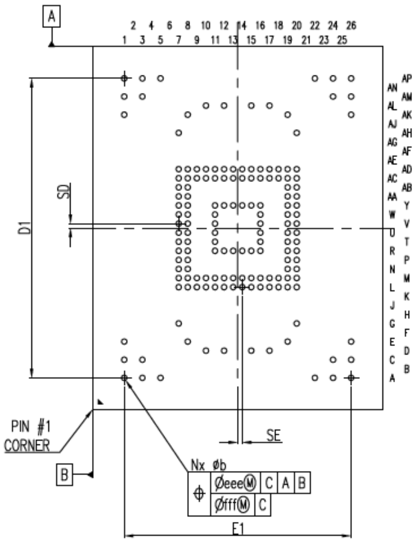
Reserved signals			
Ball #	**Ball name**	**Type**	**Description**
L15	GPIO 0	Output	SDA
AD10	GPIO 1	Output	SCL
AD16	GPIO 4	Input	Reserved
L18	GPIO 5	In &Out	Load mode
AD18	GPIO 6	Output	Reserved
AC14	GPIO 7	Input	Reserved
AC11	GPIO 8	Output	Reserved
AD17	GPIO 9	Output	Reserved
AC16	GPIO 10	Output	Reserved
AD15	GPIO 11	Output	Reserved
AC9	GPIO 12	Input	Reserved
AA20	GPIO 13	Output	PHY LED
M13	GPIO 14	Output	DAS
AD12	GPIO 15	Input	Write Protect
L13	GPIO 16	Output	Reserved
M9	RESET	Input	SSD Reset
Mechanical ground balls			
Ball #	**Ball name**	**Type**	**Description**
A1	ME. GND	GND	Ground
A3	ME. GND	GND	Ground
A5	ME. GND	GND	Ground
A22	ME. GND	GND	Ground
A24	ME. GND	GND	Ground
A26	ME. GND	GND	Ground

C1	*ME. GND*	*GND*	*Ground*
C3	*ME. GND*	*GND*	*Ground*
C24	*ME. GND*	*GND*	*Ground*
C26	*ME. GND*	*GND*	*Ground*
D10	*ME. GND*	*GND*	*Ground*
D12	*ME. GND*	*GND*	*Ground*
D15	*ME. GND*	*GND*	*Ground*
D17	*ME. GND*	*GND*	*Ground*
E1	*ME. GND*	*GND*	*Ground*
E8	*ME. GND*	*GND*	*Ground*
E19	*ME. GND*	*GND*	*Ground*
E26	*ME. GND*	*GND*	*Ground*
G7	*ME. GND*	*GND*	*Ground*
G20	*ME. GND*	*GND*	*Ground*
AH7	*ME. GND*	*GND*	*Ground*
AH20	*ME. GND*	*GND*	*Ground*
AK1	*ME. GND*	*GND*	*Ground*
AK8	*ME. GND*	*GND*	*Ground*
AK19	*ME. GND*	*GND*	*Ground*
AK26	*ME. GND*	*GND*	*Ground*
AL10	*ME. GND*	*GND*	*Ground*
AL12	*ME. GND*	*GND*	*Ground*
AL15	*ME. GND*	*GND*	*Ground*
AL17	*ME. GND*	*GND*	*Ground*
AM1	*ME. GND*	*GND*	*Ground*
AM3	*ME. GND*	*GND*	*Ground*

AM24	*ME. GND*	*GND*	*Ground*
AM26	*ME. GND*	*GND*	*Ground*
AP1	*ME. GND*	*GND*	*Ground*
AP3	*ME. GND*	*GND*	*Ground*
AP5	*ME. GND*	*GND*	*Ground*
AP22	*ME. GND*	*GND*	*Ground*
AP24	*ME. GND*	*GND*	*Ground*
AP26	*ME. GND*	*GND*	*Ground*

2.9 Mechanical Dimensions





SYMBOL	DIMENSION IN MM			DIMENSION IN INCH		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	---	---	1.70	---	---	0.067
A1	0.16	---	---	0.006	---	---
A2	---	1.36	---	---	0.054	---
b	0.25	0.30	0.35	0.010	0.012	0.014
D	19.90	20.00	20.10	0.783	0.787	0.791
E	15.90	16.00	16.10	0.626	0.630	0.634
e	0.50 BSC.			0.020 BSC.		
JEDEC	MO-276(REF.)/MM					
aaa	0.15					
bbb	0.20					
ddd	0.08					
eee	0.15					
fff	0.05					

N	SE (mm)	SD (mm)	E1 (mm)	D1 (mm)
156	0.25 BSC.	0.25 BSC.	12.50 BSC.	16.50 BSC.

2.10 Assembly Weight

1.3g (32GB)

2.11 Seek Time

Innodisk nanoSSD 3ME3 is not a magnetic rotating design. There is no seek or rotational latency required.

2.12 NAND Flash Memory

Innodisk nanoSSD 3ME3 uses Multi Level Cell (MLC) 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 nanoSSD 3ME3 from the system level, including the major hardware blocks.

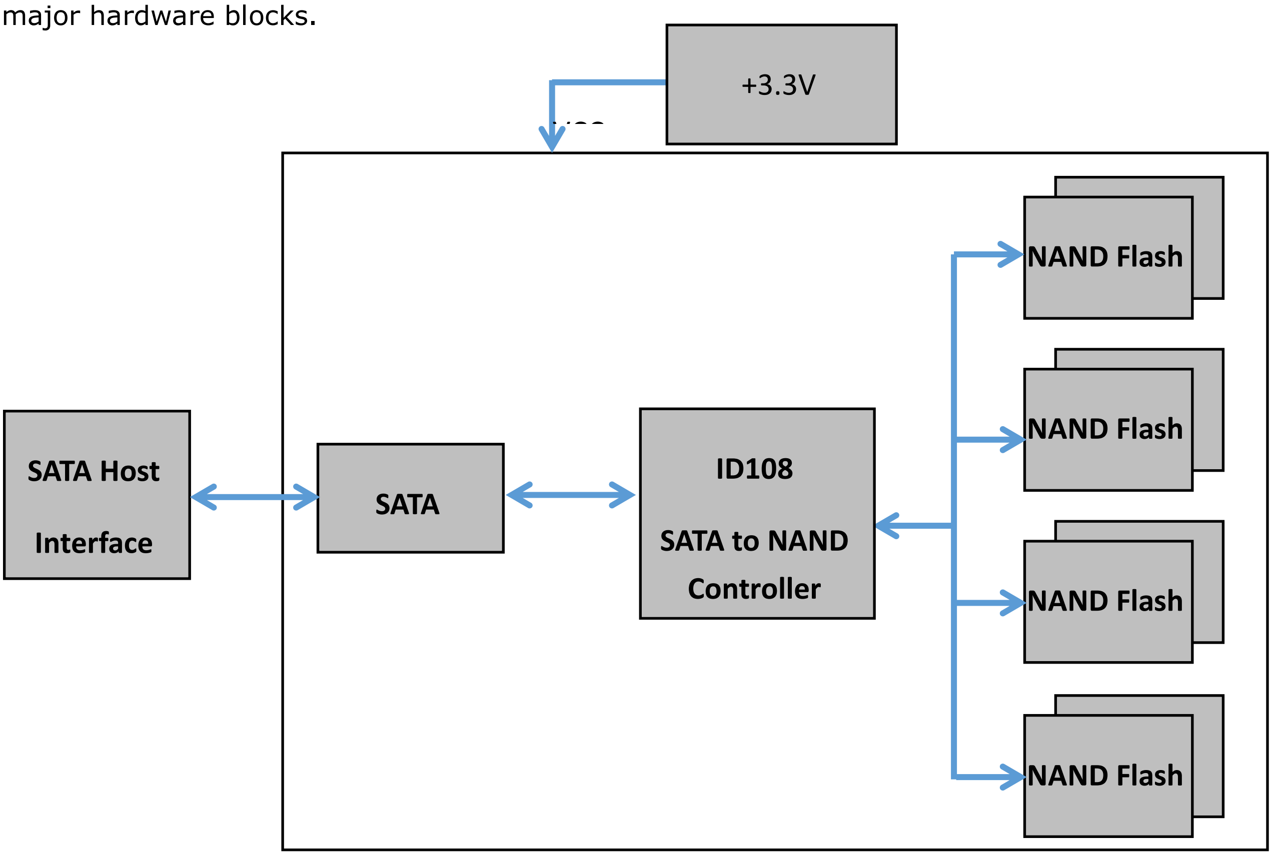


Figure 2: Innodisk nanoSSD 3ME3 Block Diagram

Innodisk nanoSSD 3ME3 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 nanoSSD 3ME3 is designed with ID108, 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 nanoSSD 3ME3 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 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 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

Please refer to Innodisk_nanoSSD_Design_Manual_Rev.1.1

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
CODE	**D**	**E**	**N**	**S**	**D**	**-**	**3**	**2**	**G**	**D**	**0**	**8**	**B**	**W**	**A**	**D**	**C**	**-**	**X**	**X**
Description	Disk	nanoSSD 3ME3					Capacity			Category			Flash Mode	Operation Temp.	Internal Control	CH.	Flash	-	Customized Code	

Definition

Code 1st (Disk)	**Code 13th (Flash mode)**
D : Disk	B: Toshiba 15nm MLC
Code 2nd	**Code 14th (Operation Temperature)**
E: Embedded	C: Standard Grade (0°C ~ +70°C)
	W: Industrial(-40°C~85°C)
Code 3rd ~ 5th (Form Factor)	**Code 15th (Internal control)**
NSD:nanoSSD	A: Product Version
	Code 16th (Channel of data transfer)
Code 7th ~9th (Capacity)	S: Single Channel
16G: 16GB	D: Dual Channels
32G: 32GB	Q: Quad Channels
64G: 64GB	**Code 17th (Flash Type)**
A28: 128GB	C: MLC
Code 10th ~12th (Series)	
D08: nanoSSD 3ME3	**Code 19th~20th (Customized Code)**