innodisk

Total Solution For
Industrial Flash Storage

nanoSSD

Design Manual

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REVISION HISTORY

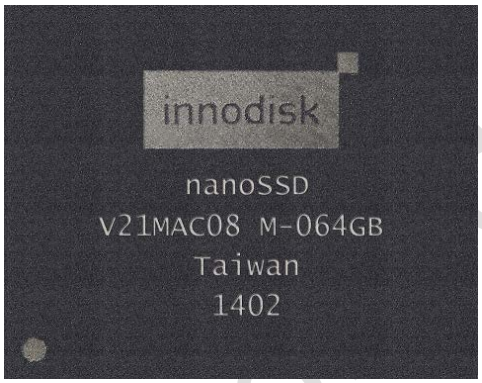
Revision	Description	Date
Preliminary	First Released	July, 2013
Rev. 0.1	Modify Ball and pin definition	July, 2013
Rev. 0.2	Modify block diagram Modify pin assignment	Sep, 2013
Rev. 0.3	Wording correction Modify pin assignment	Sep, 2013
Rev. 0.4	Modify Power supply info. Modify Block diagram Update attached files Added chapter 10 (table for attachment files)	Nov, 2013
Rev. 0.41	Modify schematic symbol	Nov, 2013
Rev. 0.5	Update product photo, Add "UART" in pin L16, L17 in description, Modify description of attachment table and add nanoSSD demo board design guide item, Change demo board Gerber file name from RAR to txt (due to file compatibility issue in various PDF readers)	Jan, 2014
Rev. 0.51	Update attached file – nanoSSD schematic from Ver. A01 to Ver. A1	Feb, 2014
Rev. 0.6	Update mechanical drawing, Update reflow profile, Update demo board related documents.	Feb, 2014
Rev. 061	Update GPIO table and related attachment	Feb, 2014
Rev. 062	Update nanoSSD design guide (added power sequence info)	JUL, 2014
Rev. 063	add nanoSSD 3SE performance and LBA info	AUG, 2014
Rev. 064	Update 2.1.1 power supply info. (MLC & iSLC) Add 2.1.2 power consumption (MLC & iSLC)	SEP, 2014
Rev. 065	Add 2.1.1 power supply info. (SLC)	OCT, 2014
Rev. 066	Update 2.1.1 power consumption (MLC & iSLC)	NOV, 2014
Rev. 067	Revise MLC and iSLC LBA info.	NOV, 2014
Rev. 068	Added nanoSSD power sequence requirement as attachment. Add SLC 16GB performance info.	DEC, 2014
Rev. 069	Added ESD test report, ROHS and REACH declaration of conformity	JAN, 2015
Rev. 070	Added GPIO table Revised MLC / iSLC performance by using firmware version S141002C.	MAR, 2015
Rev. 1.0	Official release	July, 2015
Rev. 1.1	Modify chapter 8 by adding order information	AUG, 2015
Rev. 1.2	Modify chapter 8, laser marking and order information Modify page 5, 3ME 32GB performance	OCT, 2015

Rev. 1.3	***Add 2.3 Reliability section***	***NOV, 2015***
Rev. 1.4	***Modify 3.1 GPIO2 and GPIO3 Type and description*** ***Modify Chapter 8 description***	***FEB, 2016***
Rev. 1.5	***Update 3.1 GPIO description*** ***Update Chapter 9 Apendix***	***MAR, 2016***

1. Introduction

Innodisk nanoSSD is an integrated SATA storage device that combines Innodisk ID167 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 having lower power consumption and being high reliable. It offers an ideal solution for embedded, automotive, medical, gaming and most industrial applications.



Features:

- Compliant with JEDEC MO-276 footprint #11 Specification

- SATA III 6Gbps

- Support NCQ

- Intelligent flash management & real time garbage collection

- Supports S.M.A.R.T, and iSMART utility

- Zero mechanical interference

Performance:

Item		8GB	16GB	32GB	64GB
nanoSSD 3ME	Sequential Read	120 MB/s	240 MB/s	440 MB/s	480 MB/s
	Sequential Write	20 MB/s	40 MB/s	80 MB/s	160 MB/s
nanoSSD 3IE	Sequential Read	250 MB/s	470 MB/s	480 MB/s	N/A
	Sequential Write	70 MB/s	140 MB/s	270 MB/s	N/A

Item		2GB	4GB	8GB	16GB
nanoSSD 3SE	Sequential Read	110 MB/s	220 MB/s	340 MB/s	450 MB/s
	Sequential Write	28 MB/s	55 MB/s	110 MB/s	200 MB/s

C.H.S & LBA:

Item		Head	Sector	Cylinder	LBA
nanoSSD 3ME	8GB	16	63	13587	13695696
	16GB	16	63	16383	29323728
	32GB	16	63	16383	60579792
	64GB	16	63	16383	121138416

Item		Head	Sector	Cylinder	LBA
nanoSSD 3IE	8GB	16	63	13587	13695696
	16GB	16	63	16383	29323728
	32GB	16	63	16383	60579792

Item		Head	Sector	Cylinder	LBA
nanoSSD 3SE	2GB	16	63	3897	3928176
	4GB	16	63	7773	7835184
	8GB	16	63	15525	15649200
	16GB	16	63	16383	31277232

2. *External Components Specification*

The nanoSSD is designed to have minimal peripheral circuits. It requires three power voltage

level and a few passive components to be completely functional. The required specifications for these components are listed below. The reference design section of this document has the list of recommended components which meet these specifications.

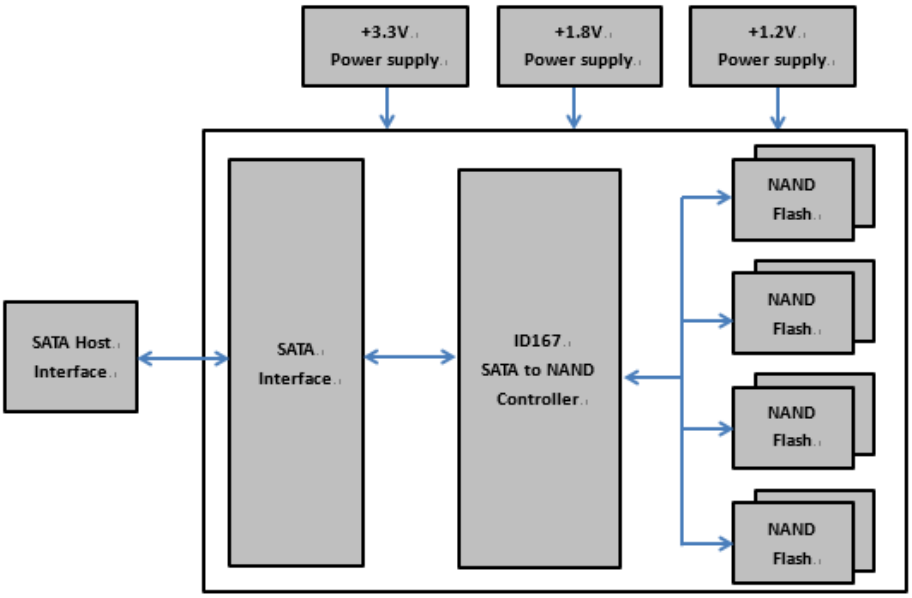


Figure 1 Block diagram of nanoSSD

2.1 Power Supply

This section lists the specifics for input power that is required by the nanoSSD.

2.1.1 Power supply

The power values defined in the table, below, are typical and subject to process and variation of up to ±10%.

	Voltage rail	Specification
Input voltage	Main power supply	3.3V± 10%
	Flash IO supply	1.8V ± 10%
	Controller core supply	1.2V ± 10%

Table 1 VCC Power Supply Specification

2.1.2 Power consumption

Voltage Rail	Parameter	MLC 8GB	MLC 16GB	MLC 32GB	MLC 64GB
SATA 6Gb/s Host interface					
Main power supply	Read (mA)	186	310	408	440
	Write(mA)	194	219	321	560
	Idle(mA)	137	153	158	160
Flash IO supply	Read (mA)	227	240	277	345
	Write(mA)	202	230	260	320
	Idle(mA)	137	161	169	176
Controller core supply	Read (mA)	320	328	335	350
	Write(mA)	303	321	325	330
	Idle(mA)	145	148	152	160

Voltage Rail	Parameter	iSLC 8GB	iSLC 16GB	iSLC 32GB
SATA 6Gb/s Host interface				
Main power supply	Read (mA)	310	408	440
	Write(mA)	219	321	560
	Idle(mA)	153	158	160
Flash IO supply	Read (mA)	240	277	345
	Write(mA)	230	260	320
	Idle(mA)	161	169	176
Controller core supply	Read (mA)	328	335	350
	Write(mA)	321	325	330
	Idle(mA)	148	152	160

Voltage Rail	Parameter	SLC 2GB	SLC 4GB	SLC 8GB	SLC 16GB
SATA 6Gb/s Host interface					
Main power supply	Read (mA)	162	245	292	315
	Write(mA)	140	190	252	440
	Idle(mA)	104	108	113	113
Flash IO supply	Read (mA)	130	155	182	228
	Write(mA)	112	140	156	190
	Idle(mA)	85	92	103	105
Controller core supply	Read (mA)	182	191	213	220
	Write(mA)	182	182	190	191
	Idle(mA)	106	106	106	110

Table 2 Power consumption

2.2 SATA AC Coupling capacitors

10nF X5R MLCC

For more details please refer to design kit

2.3 Reliability

Parameter	Value
Read Cycles	Unlimited Read Cycles
Wear-Leveling Algorithm	Support
Bad Blocks Management	Support
Error Correct Code	Support

TBW (Sequential)

Item	8GB	16GB	32GB	64GB
nanoSSD 3ME	21.6	43.2	86.4	172.8
nanoSSD 3IE	144	288	576	N/A

Item	2GB	4GB	8GB	16GB
nanoSSD 3SE	108	216	432	864

3. *Mechanical Specification*

Please refer to the attachments for mechanical drawing

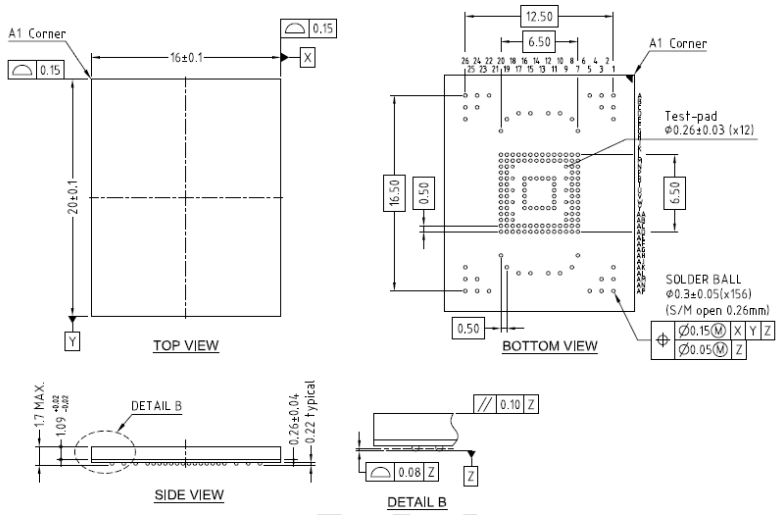


Figure 2 Mechanical drawing of nanoSSD

3.1 Ball and Signal Description

The following table provides the pin definition of the nanoSSD ball grid array.

TYPE: Input - nanoSSD receives signal from host.

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

TYPE: IO - Signal is bi-directional.

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	*Flash Vref*	*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*

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
L10	GPIO 16	Output	Reserved
L13	GPIO 17	Input	Low power detect
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*

Table 3 nanoSSD Ball and Signal Description

3.2 GPIO table with function description

Item	Function	pin type	Description
GPIO0	Thermal Sensor SDA	output	For I2C interface thermal sensor IC
GPIO1	Thermal Sensor SCL	output	For I2C interface thermal sensor IC
GPIO2	UART-RX	input	UART message for debugging
GPIO3	UART-TX	output	UART message for debugging
GPIO4	Reserved	input	No function
GPIO5	Loader Mode	input	Strapping input type when power on, Set it in high for entering loader mode, default is low.
GPIO6	NAND type0	input	for internal NAND flash type, leave it N.C.
GPIO7	NAND type1	input	for internal NAND flash type, leave it N.C.
GPIO8	Reserved	input	No function.
GPIO9	Reserved	input	For internal frequency type setting, leave it N.C.
GPIO10	Reserved	input	For internal frequency type setting, leave it N.C.
GPIO11	Reserved	input	For internal frequency type setting, leave it N.C.
GPIO12	Reserved	input	No function.
GPIO13	PHY LED	output	When SATA connected, it will output high for lighting LED.
GPIO14	DAS LED	output	When SSD is transferred data, it will output high and low for indicating data access.
GPIO15	FW_WP	input	Low active, it will be entering firmware write protection function if pull low
GPIO16	Reserved	input	no function
GPIO17	PWR loss	input	Low active, it will running internal cache data protect function when it triggered.

Table 4 nanoSSD GPIO table

4. Component Placement and Routing Requirements

This section states component placement and routing requirements of nanoSSD. Please refer to attachments for reference design.

4.1 SATA Differential Signals

To comply with SATA interface specifications, the SATA differential lines must have 100 Ohm differential impedance.

4.2 Power Distribution

- **The SATA AC coupling capacitors should be placed close to the host.**
- **All decoupling capacitors and filters must be placed as close to the power supply pads as possible.**
- **The PCB stack up must include at least one solid ground plane.**
- **All traces, except supply/ground and SATA differential pair, should have 50 ohm single-ended impedance.**

5. Temperature and Thermal

The maximum operating temperature of the nanoSSD is listed below, and must be maintained at any time the device is active.

Temperature	*Range*
Operating	*Standard Grade: 0°C to +70°C* *Industrial Grade: -40°C to +85°C* **The industrial grade item is only available in SLC item.*
Storage	*-55°C to +95°C*

Table 5 Temperature range of nanoSSD

Below are some recommendations for PCB design to lowest effect of thermal.

- **Maximize copper thickness and trace width for all pins to thermal features such as thermal vias, thermal side rails, and thermal conduction screw holes.**
- **Copper ground/supply planes in the PCB can provide very effective heat dissipation for the**

IC package. To maximize effectiveness, thermal vias should be added to connect the package's mechanical ground balls to the ground plane. There should be at least one thermal via allocated for each MGB of the package. The plating thickness of vias should be maximized to optimize thermal conduction.

6. Reference Design

A reference design using the nanoSSD has been provided here to help with the integration. All peripheral circuits are included in the design and meet specifications laid out in the earlier sections of this document. We recommend this circuit design to match the reference design as closely as possible. The schematic and bill of materials (BOM) are listed in attachments.

6.1 SCHEMATIC

Please refer to attachments for schematic files.

6.2 Layout guide

Refer to attached (NanoSSD design guide)

6.3 Demo board

Figure 3 Innodisk ServerDOM is as nanoSSD Demo board

7. Production guide

7.1 Preheat

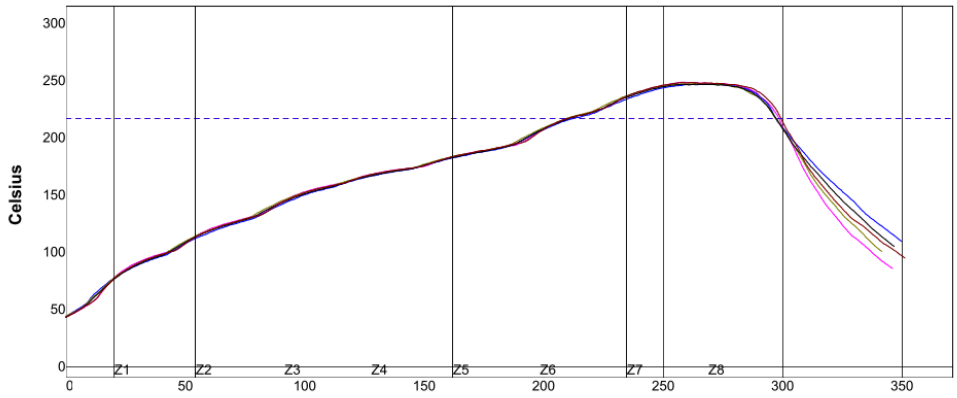
Before printed circuit board assembly, a process of preheat is requested.

Preheat condition: 16 HRs with 125°C

7.2 Reflow Profile

Please refer to attachments for reflow profile.

Setpoints (Celsius)								
Zone	1	2	3	4	5	6	7	8
Top	100	130	165	170	180	230	255	245
Bottom	100	130	165	170	180	230	255	245
Conveyor Speed (cm/min):	65.0							



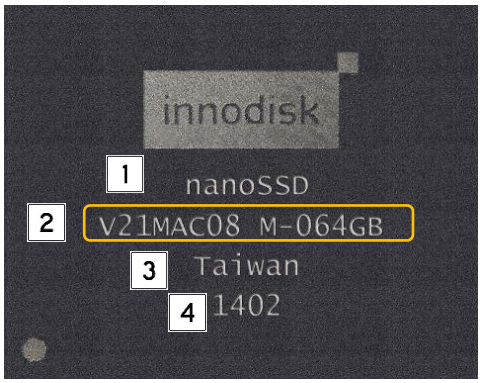
PWI= 97%	ax Rising Slop		ax Falling Slo		reheat 30-110		ak Time 110-15		flow Time /21		Peak Temp		lope1 (30-110		ope2 (217-255		Time 150-217	
2	1.84	49%	-3.85	-90%	50.97	27%	44.64	-2%	88.53	95%	248.81	38%	1.84	68%	0.91	-73%	113.84	79%
3	1.67	25%	-2.70	-13%	52.28	31%	47.50	17%	84.64	82%	247.17	22%	1.67	52%	0.85	-80%	112.70	76%
4	1.74	34%	-3.28	-52%	50.93	27%	46.26	8%	87.52	92%	247.40	24%	1.74	58%	0.87	-77%	112.90	76%
5	1.73	32%	-2.83	-22%	50.55	26%	47.44	16%	86.53	88%	246.95	20%	1.73	57%	0.86	-79%	112.13	74%
6	1.77	39%	-3.44	-63%	51.04	28%	45.85	6%	89.09	97%	248.43	34%	1.77	61%	0.91	-72%	112.75	76%
Delta	0.17		1.15		1.73		2.86		4.45		1.86		0.17		0.06		1.71	

Process Window:

Solder Paste:	System Default for Reflow		
Statistic Name	**Low Limit**	**High Limit**	**Units**
Max Rising Slope (Target=1.5)	0.7	2.2	Degrees/Second
(Calculate Slope over 20 Seconds)			
Slope1 (Target=1.1)			
Between 30.0 and 110.0	0	2.2	Degrees/Second
(Calculate Slope over 20 Seconds)			
Slope2 (Target=1.5)			
Between 217.0 and 255.0	0.7	2.2	Degrees/Second
(Calculate Slope over 20 Seconds)			
Max Falling Slope	-4	-1	Degrees/Second
(Calculate Slope over 20 Seconds)			
Preheat Time 30-110C	0	80	Seconds
Soak Time 110-150C	30	60	Seconds
Soak Time 150-217C-(2)	60	120	Seconds
Time Above Reflow - 217C	30	90	Seconds
Peak Temperature	235	255	Degrees Celsius

Table 6 Reflow Profile

8. Product specification / Order information



Line	Description
1	Product name
2	Product specification
3	Place of origin
4	Date code (YYWW)

Product Specification code	Description	Part number
V21MAC01 M-008GB	nanoSSD 3ME 08GB, 1CH, MLC	DENSD-08GD06SCASY
V21MAC02 M-016GB	nanoSSD 3ME 16GB, 2CH, MLC	DENSD-16GD06SCADY
V21MAC04 M-032GB	nanoSSD 3ME 32GB, 4CH, MLC	DENSD-32GD06SCAQY
V21MAC08 M-064GB	nanoSSD 3ME 64GB, 4CH, MLC	DENSD-64GD06SCAQY
V21MAC02 I-008GB	nanoSSD 3IE 08GB, 2CH, MLC	DHNSD-08GD062CADY
V21MAC04 I-016GB	nanoSSD 3IE 16GB, 4CH, MLC	DHNSD-16GD062CAQY
V21MAC08 I-032GB	nanoSSD 3IE 32GB, 4CH, MLC	DHNSD-32GD062CAQY
V21SAA01 S-002GB	nanoSSD 3SE 02GB, 1CH SLC	DENSD-02GD06SCASX DENSD-02GD06SWASX
V21SAA02 S-004GB	nanoSSD 3SE 04GB, 2CH SLC	DENSD-04GD06SCADX DENSD-04GD06SWADX
V21SAA04 S-008GB	nanoSSD 3SE 08GB, 4CH SLC	DENSD-08GD06SCAQX DENSD-08GD06SWAQX
V21SAA08 S-016GB	nanoSSD 3SE 16GB, 4CH SLC	DENSD-16GD06SCAQX DENSD-16GD06SWAQX

9. Appendix

File name	Description
gerber-4DADP000X42_rar	*Demo board Gerber file (Due to PDF file compatibility issue, please change file extension from .txt to .rar and decompress with Winrar or 7-zip)*
BGA156P0D5-16X20.dra	*Mechanical drawing*
BGA156P0D5-16X20.dxf	*Component symbol*
BGA156P0D5-16X20.psm	*Component symbol*
Innodisk nanoSSD ESD test report	*nanoSSD ESD test report*
NANOSSD_BGA156_Reference_A3_160329.DSN	*Schematic*
nanossd_bga156_reference_a3_160329.pdf	*Schematic*
nanoSSD design guide.pdf	*design guide*
nanoSSD power sequence requirement.pdf	*Power sequence information*
nano-ssd_16x20_156BALLS.pdf	*Mechanical drawing*
Reflow profile en.pdf	*Reflow profile*
REACH declaration of conformity	*Declaration*
ROHS declaration of conformity	*Declaration*

***To get the files list above, please check the attachment of this PDF.**