innodisk

Total Solution For Industrial Flash Storage

2.5" SATA SSD

3TR6-P Series

AES function

Customer: _____

Customer Part Number: _____

Innodisk Part Number: _____

Innodisk Model Name: _____

Date: _____

Innodisk Approver	Customer Approver

Features:

- SATA III
- 2.5” SATA SSD
- Standard & Wide-temperature
- AES-256 encryption
- iPower Guard
- iData Guard
- Dynamic Thermal Management

Performance:

- Sequential Read up to 560 MB/s
- Sequential Write up to 500 MB/s

Power Requirements:

Input Voltage:	5V±5%
Max Operating Wattage:	4.2W
Idle Wattage:	1.5W

Reliability:

Capacity	TBW	DWPD
128GB	289	2.1
256GB	578	2.1
512GB	1154	2.1
1TB	2308	2.1
2TB	4615	2.1

Data Retention (EOL)	1 Year
Warranty	3 Years

For warranty details, please refer to:

https://www.innodisk.com/en/support_and_service/warranty

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REVISION HISTORY

Revision	Description	Date
V1.0	Official Release	Dec., 2020
V1.1	Correct QE/SE Triggering Pins Add QE Description	Apr., 2021
V1.2	TPS format adjustment Update TBW	Oct., 2021
V1.3	Update pin headers drawing	Mar., 2022
V1.4	Correct pin headers description in Write Protect part	Mar., 2022
V1.5	Improve the content	Apr., 2022
V1.6	Revised the image of Security Erase	May., 2022
V1.7	Add AES function on the cover	May., 2022
V1.8	Fix typo	Aug., 2022
V1.9	Update Assembly Torque Information	Mar., 2023
V2.0	Update Performance on the cover page	Dec., 2023
V2.1	Revised Write Protect Command	Feb., 2024

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1. Product Overview

1.1 Introduction of Innodisk 2.5” SATA SSD 3TR6-P

Innodisk 2.5” SATA SSD 3TR6-P is the newest member of InnoRobust product line, which adopts industrial 3D TLC NAND. 3TR6-P aims to provide high performance, high capacity flash memory Solid State Drive (SSD) that electrically complies with Serial ATA 3 (SATA3) standard and beyond. 3TR6-P models are designed with advanced firmware features such as Quick Erase, Security Erase, Destroy and AES 256 bit encryption capability. As for hardware, 3TR6-P is equipped with iPower Guard, iCell and MIL-810G level mechanical design. 3TR6-P is developed with Innodisk owned technical knowhow to ensure the data integrity and highest levels of reliability.

CAUTION TRIM must be enabled.

TRIM enables SSD’s controller to skip invalid data instead of moving. It can free up significant amount of resources, extends the lifespan of SSD by reducing erase, and write cycles on the SSD. Innodisk’s handling of garbage collection along with TRIM command improves write performance on SSDs.

1.2 Product View and Models

Innodisk 2.5” SATA SSD 3TR6-P is available in follow capacities:

2.5” SATA SSD 3TR6-P 128GB 2.5” SATA SSD 3TR6-P 512GB 2.5” SATA SSD 3TR6-P 2TB

2.5” SATA SSD 3TR6-P 256GB 2.5” SATA SSD 3TR6-P 1TB

Figure 1: Innodisk 2.5” SATA SSD 3TR6-P

1.3 SATA Interface

Innodisk 2.5” SATA SSD 3TR6-P supports SATA III interface and backward compatible with SATA SATA II and I.

1.4 2.5-inch Form Factor

The Industry-standard 2.5-inch form factor design with metal material case is easy for installation, which has a compact design 69.85mm (W) x 100.00mm (L) x 9.50mm (H)

2. Product Specifications

2.1 Capacity and Device Parameters

2.5” SATA SSD 3TR6-P device parameters are shown in Table 1.

Table 1: Device parameters

Capacity	Cylinders	Heads	Sectors	LBA	User Capacity(MB)
128GB	16383	16	63	214906608	104934
256GB	16383	16	63	468862128	228936
512GB	16383	16	63	937703088	457862
1TB	16383	16	63	1875385008	915715
2TB	16383	16	63	3750748848	1831420

2.2 Performance

Burst Transfer Rate: 6.0Gbps

Table 2: Performance*

Capacity	Unit	128GB	256GB	512GB	1TB	2TB
Sequential** Read (Q32T1)	MB/s	560	550	560	540	500
Sequential** Write (Q32T1)		130	290	500	460	420
Sustained Sequential Read (Avg.) ***		510	510	510	460	430
Sustained Sequential Write (Avg.) ***		120	270	470	420	400
4KB Random** Read (Q32T1)	IOPS	41,000	65,000	65,000	65,000	67,000
4KB Random** Write (Q32T1)		34,000	61,000	59,500	59,500	57,000

Note: * Performance results are measured in Room Temperature with Out-of-Box devices and may vary depending on overall system setup. In addition, 3TR6-P series adopt hybrid mode which enables SLC Cache followed by TLC direct write to strike balance between burst performance and steady overall stability.

Note: ** Performance results are based on CrystalDiskMark 6.0.2 with typical tolerances for range from 1% to 10%. Unit of 4KB items is I.O.P.S.

Note: *** Performance results are based on AIDA 64 v5.98 with block size 1MB of Linear Read & Write Test

2.3 Electrical Specifications

2.3.1 Power Requirement

Table 3: Innodisk 2.5” SATA SSD 3TR6-P Power Requirement

Item	Symbol	Rating	Unit
Input voltage	V_{IN}	+5 DC +- 5%	V

2.3.2 Power Consumption

Table 4: Typical Power Consumption

Mode	Power Consumption (W)
Read	3.3
Write	4.2
Idle	1.5
Power-on Peak	4.2

Target: 2.5” SATA SSD 3TR6-P 2TB

Note: Current results may vary depending on system components and power circuit design.

Please refer to the test report for other capacities.

2.4 Environmental Specifications

2.4.1 Temperature Ranges

Table 5: Temperature range for 2.5” SATA SSD 3TR6-P

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 2.5” SATA SSD 3TR6-P

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 2.5” SATA SSD 3TR6-P 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: 2.5” SATA SSD 3TR6-P MTBF

Product	Condition	MTBF (Hours)
Innodisk 2.5” SATA SSD 3TR6-P	Telcordia SR-332 GB, 25°C	>3,000,000

2.5 CE and FCC Compatibility

2.5” SATA SSD 3TR6-P conforms to CE and FCC requirements.

2.6 RoHS Compliance

2.5” SATA SSD 3TR6-P is fully compliant with RoHS directive.

2.7 Reliability

Parameter	Value	
Flash endurance	3,000 P/E cycles	
Error Correct Code	Support	
Data Retention	Under 40 ˚C: 10 Years at Initial NAND status (PE cycles under 100)；1 Year at NAND Life End (PE cycles reach 3,000)	
TBW* (Total Bytes Written) Unit:TB		
Capacity	**Sequential workload**	**Client workload**
128GB	341	289
256GB	682	578
512GB	1364	1154
1TB	2663	2308
2TB	5327	4615
*Note: 1. Sequential: Mainly sequential write are estimated by PassMark Burnin Test v8.1 pro. 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

2.5” SATA SSD 3TR6-P support following transfer mode:

Serial ATA III 6.0Gbps

Serial ATA II 3.0Gbps

Serial ATA I 1.5Gbps

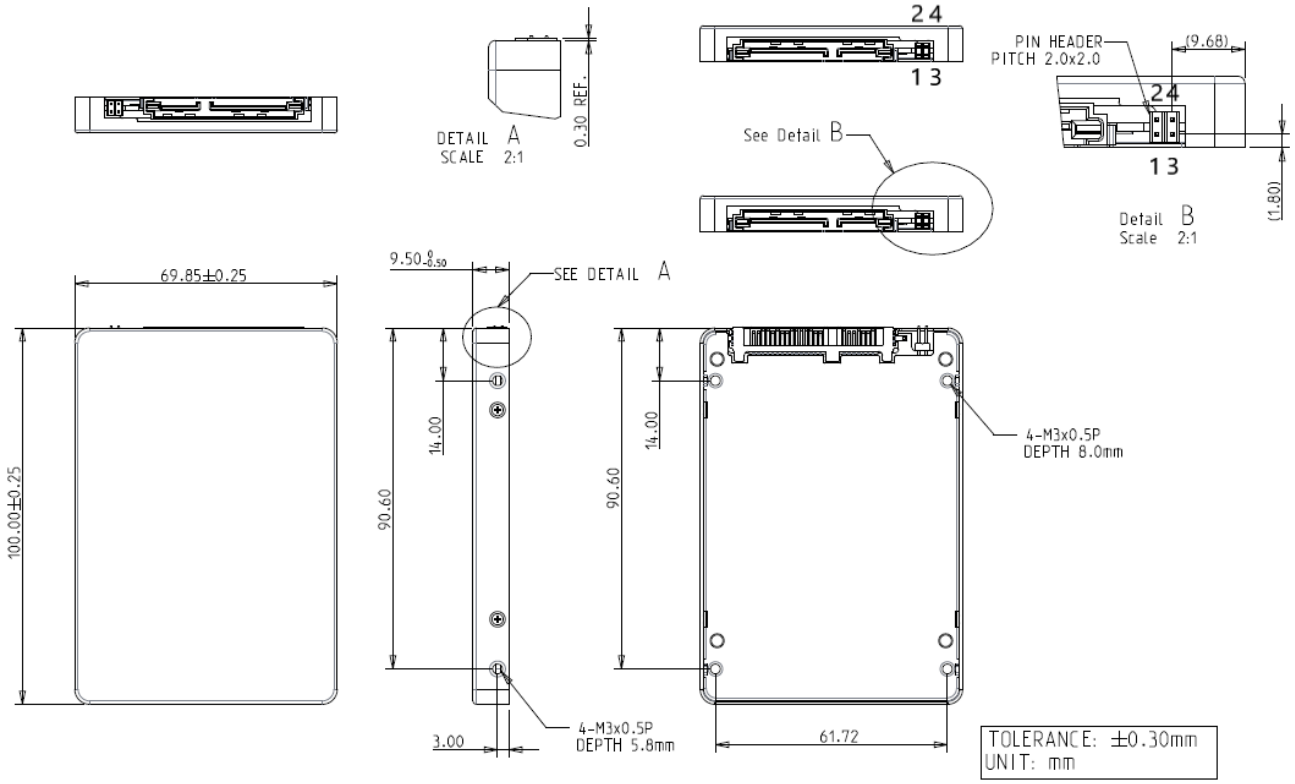
2.9 Pin Assignment

Innodisk 2.5” SATA SSD 3TR6-P uses a standard SATA pin-out. See Table 8 for 2.5” SATA SSD 3TR6-P pin assignment.

Table 8: Innodisk 2.5” SATA SSD 3TR6-P 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	Default GND. Reserved for GPIO 19 for function trigger
P6	GND	Default GND.Reserved for GPIO 23 for function trigger
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 2.5” SATA SSD 3TR6-P within 3D TLC flash ICs, 2TB’s weight is 90 grams approx.

2.12 Seek Time

Innodisk 2.5” SATA SSD 3TR6-P 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 2.5” SATA SSD 3TR6-P uses 3D TLC NAND flash memory, with 3,000 program & erase cycles, 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 2.5” SATA SSD 3TR6-P from the system level, including the major hardware blocks.

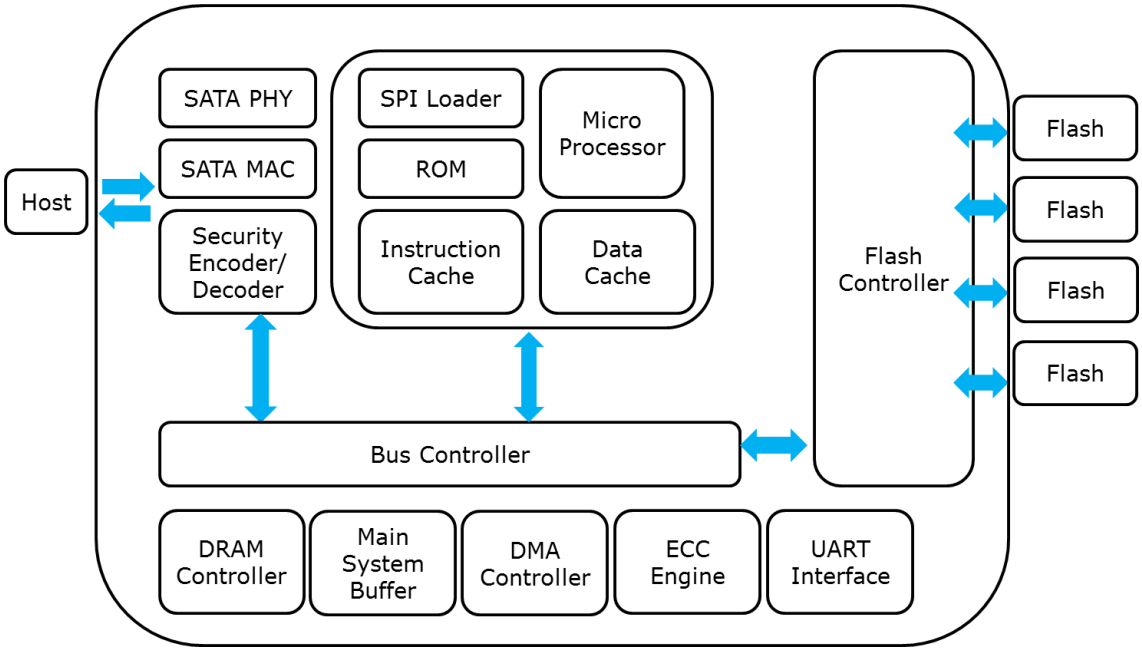


Figure 2: Innodisk 2.5” SATA SSD 3TR6-P Block Diagram

Innodisk 2.5” SATA SSD 3TR6-P 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 Controller

Innodisk 2.5” SATA SSD 3TR6-P is designed with 88SS1080, a SATA III 6.0Gbps 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

Innodisk 2.5”SATA SSD 3TR6-P 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 2.5” SATA SSD 3TR6-P 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

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. iData Guard provides effective power cycling management, preventing data stored in flash from degrading with use.

3.7 Garbage Collection/TRIM

Garbage collection and TRIM 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 iCell Technology

iCell circuit is designed with several capacitors to be able to provide power after host power off. The SSD controller can write all DRAM buffer data to flash, so that is why 2.5” SATA SSD 3TR6-P can ensure all data can be written to disk without any data loss.

3.9 iPower Guard

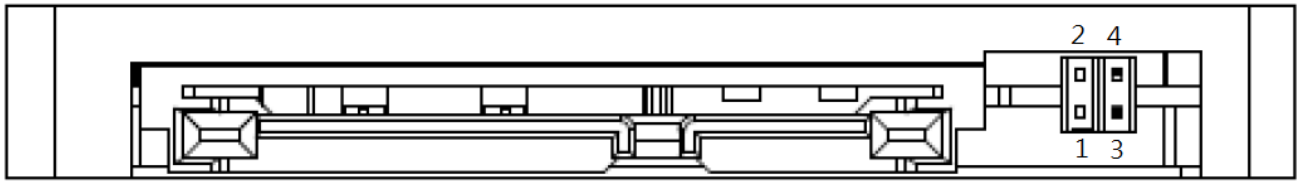
iPower Guard technology is a set of preventive measures that protect the SSD in an unstable power supply environment. This comprehensive package comprises safeguards for start-up and shut-down to maintain device performance and ensure data integrity.

3.10 Die RAID

Die RAID is a controller function, which leveraged user capacity to back up the data in NAND flash. Die RAID supported can ensure the user data in the NAND Flash more consistent in certain scenario. Innodisk 2.5” SATA SSD 3TR6-P series is default enable the Die RAID function for the industrial application.

3.11 Quick Erase

Quick Erase function is designed for emergency data erase within a few seconds. Quick Erase functions can be triggered by shorting Quick Erase Pins (Pin 3 and Pin 4) or by sending ATA Command.



3.11.1 Quick Erase Command

- Protocol: No Data

-Inputs

Table 9: Execute Quick Erase command for inputs information

Register	7	6	5	4	3	2	1	0
Features	21h							
Sector Count	41h							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	1	1	1	0	Na			
Command	82h							

-Normal Outputs

Table 10: Quick Erase command for normal output information

Register	7	6	5	4	3	2	1	0
Error	Na							
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	obs	Na	obs	DEV	Na	Na	Na	Na
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Device register-

DEV shall specify the selected device.

Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

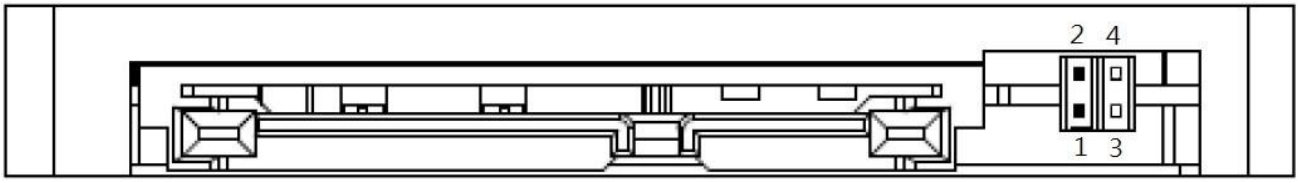
DF (Device Fault) will be cleared to zero.

DRQ will be cleared to zero

ERR will be cleared to zero.

3.12 Security Erase

Security Erase functions are designed to comply with military emergency data erase standards. Security Erase functions can be triggered by shorting Security Erase Pins (Pin 1 and Pin 2) or by sending ATA Command. All data on flash chips will be erased. SE Pin can be set as one of following military Security Erase standards. Default standard for pin triggering is DoD 5220.22-M.



Innodisk provides the following Security Erase for options:

(1) AFFSI 5020

(2) DoD 5220.22-M

(3) USA Navy NAVSO P-5239-26

(4) NSA Manual 130-2

(5) USA-Army 380-19

(6) NISPOMSUP Chap 8, Sect. 8-501

(7) NSA Manual 9-12

(8) IRIG 106

3.12.1 Secure Erase Command

Identify Information

Word 159 of Identify Table shows the SE pin’s function. Identify Table can be read by sending ECh ATA command.

Table 9: Identify Information

154	Secure Function Support	
	7-15 Reserved	0
	6 1= Secure Erase ATA Vendor Command Supported	X
	5 Reserved	0

	4 1=Quick Erase ATA Vendor Command Supported 3 1=Destroy ATA Vendor Command Supported 2 1=Jumper Secure Erase Supported 1 1=Jumper Write Protect Supported 0 1=Jumper Quick Erase Supported	X X X X X
155	Secure Function Status(Enable/Disable) 2-15 Reserved 1 1= Write Protect Enabled 0 Reserved	 X 0
156-158	Vendor Specific	
159	8~15 Function of Jumper “QE” 0x20: Destroy 0x21 or Others: Quick Erase 0~7 Secure Erase Function of Jumper “SE” **0x22: AFFSI 5020** **0x23: DoD 5220.22-M** **0x24: USA Navy NAVSO P-5239-26** **0x25: NSA Manual 130-2** **0x26: USA-Army 380-19** **0x27: NISPOMSUP Chap 8, Sect. 8-501** **0x28: NSA Manual 9-12** **0x29: IRIG106**	XXXXh

1. AFFSI5020

This function is compliant with AFFSI 5020 specification.

Steps:

1. The whole disk is erased using Flash Erase Command.

2. The whole disk is filled with random data.

-Protocol: Non Data Command

-Inputs

Execute AFFSI 5020 command for inputs information

Register	7	6	5	4	3	2	1	0
Features	22h							
Sector Count	41h							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	1	1	1	0	Na			
Command	82h							

-Normal Outputs

AFFSI 5020 command for normal output information

Register	7	6	5	4	3	2	1	0
Error	Na							
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	obs	Na	obs	DEV	Na	Na	Na	Na
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Device register-

DEV shall specify the selected device.

Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

DF (Device Fault) will be cleared to zero.

DRQ will be cleared to zero

ERR will be cleared to zero.

2. DoD 5220.22-M

This function is compliant with DoD 5220.22-M specification.

Steps:

1. The whole disk is filled with fixed character pattern 0x55.

2. The whole disk is erased using Flash Erase Command.

-Protocol: Non Data Command

-Inputs

Execute DoD 5220.22-M command for inputs information

Register	7	6	5	4	3	2	1	0
Features	23h							
Sector Count	41h							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	1	1	1	0	Na			
Command	82h							

-Normal Outputs

DoD 5220.22-M command for normal output information

Register	7	6	5	4	3	2	1	0
Error	Na							
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	obs	Na	obs	DEV	Na	Na	Na	Na
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Device register-

DEV shall specify the selected device.

Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

DF (Device Fault) will be cleared to zero.

DRQ will be cleared to zero

ERR will be cleared to zero.

3. USA Navy NAVSO P-5239-26

This function is compliant with USA Navy NAVSO P-5239-26 specification.

Steps:

1. The whole disk is erased using Flash Erase Command.

2. The whole disk is filled with random data.

3. The whole disk is erased using Flash Erase Command.

-Protocol: Non Data Command

-Inputs

Execute USA Navy NAVSO P-5239-26 command for inputs information

Register	7	6	5	4	3	2	1	0
Features	24h							
Sector Count	41h							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	1	1	1	0	Na			
Command	82h							

-Normal Outputs

USA Navy NAVSO P-5239-26 command for normal output information

Register	7	6	5	4	3	2	1	0
Error	Na							
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	obs	Na	obs	DEV	Na	Na	Na	Na
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Device register-

DEV shall specify the selected device.

Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

DF (Device Fault) will be cleared to zero.

DRQ will be cleared to zero

ERR will be cleared to zero.

4. NSA Manual 130-2

This function is compliant with NSA Manual 130-2 specification.

Steps:

1. The whole disk is erased using Flash Erase Command.

2. The whole disk is filled with random data.

3. The whole disk is filled with random data again.

4. The whole disk is erased using Flash Erase Command. The whole disk is filled with fixed character pattern 0x55.

-Protocol: Non Data Command

-Inputs

Execute NSA Manual 130-2 command for inputs information

Register	7	6	5	4	3	2	1	0
Features	25h							
Sector Count	41h							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	1	1	1	0	Na			
Command	82h							

-Normal Outputs

NSA Manual 130-2 command for normal output information

Register	7	6	5	4	3	2	1	0
Error	Na							
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	obs	Na	obs	DEV	Na	Na	Na	Na
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Device register-

DEV shall specify the selected device.

Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

DF (Device Fault) will be cleared to zero.

DRQ will be cleared to zero

ERR will be cleared to zero.

5. USA-Army 380-19

This function is compliant with USA-Army 380-19 specification.

Step:

1. The whole disk is erased using Flash Erase Command.
2. The whole disk is filled with random data.
3. The whole disk is filled with fixed character pattern 0x55.
4. The whole disk is filled with fixed character pattern 0xAA.

-Protocol: Non Data Command

-Inputs

Execute USA Army 380-19 command for inputs information

Register	7	6	5	4	3	2	1	0
Features	26h							
Sector Count	41h							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	1	1	1	0	Na			
Command	82h							

-Normal Outputs

USA Army 380-19 command for normal output information

Register	7	6	5	4	3	2	1	0
Error	Na							
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							

Device	obs	Na	obs	DEV	Na	Na	Na	Na
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Device register-

DEV shall specify the selected device.

Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

DF (Device Fault) will be cleared to zero.

DRQ will be cleared to zero

ERR will be cleared to zero.

6. NISPOMSUP Chap 8, Sect. 8-501

This function is compliant with NISPOMSUP Chap 8, Sect. 8-501 specification.

Steps:

1. The whole disk is filled with fixed character pattern 0x55.

2. The whole disk is filled with fixed character pattern 0xAA.

3. The whole disk is filled with random data.

-Protocol: Non Data Command

-Inputs

Execute NISPOMSUP Chap 8, Sect. 8-501 command for inputs information

Register	7	6	5	4	3	2	1	0
Features	27h							
Sector Count	41h							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	1	1	1	0	Na			
Command	82h							

-Normal Outputs

NISPOMSUP Chap 8, Sect. 8-501 command for normal output information

Register	7	6	5	4	3	2	1	0

Error	Na							
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	obs	Na	obs	DEV	Na	Na	Na	Na
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Device register-

DEV shall specify the selected device.

Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

DF (Device Fault) will be cleared to zero.

DRQ will be cleared to zero

ERR will be cleared to zero.

7. NSA Manual 9-12

This function is compliant with NSA Manual 9-12 specification.

Step:

1. The whole disk is erased using Flash Erase Command.

2. The whole disk is filled with unclassified pattern.

3. Verify the overwrite procedure by randomly rereading the overwritten information.

-Protocol: Non Data Command

-Inputs

Execute NSA Manual 9-12 command for inputs information

Register	7	6	5	4	3	2	1	0
Features	28h							
Sector Count	41h							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	1	1	1	0	Na			
Command	82h							

-Normal Outputs

NSA Manual 9-12 command for normal output information

Register	7	6	5	4	3	2	1	0
Error	Na							
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	obs	Na	obs	DEV	Na	Na	Na	Na
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Device register-

DEV shall specify the selected device.

Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

DF (Device Fault) will be cleared to zero.

DRQ will be cleared to zero

ERR will be cleared to zero.

8. IRIG1006

This function is compliant with IRIG106 specification.

Step:

1. The whole disk is erased using Flash Erase Command.

2. The whole disk is filled with pattern 0x55, and read back to verify.

3. The whole disk is erased using Flash Erase Command.

4. The whole disk is filled with pattern 0xAA, and read back to verify.

5. The whole disk is erased using Flash Erase Command.

6. Write 0x00 to all bad blocks. If there is any bit is still 1, the page is re-written 0 again. This procedure this repeated up to 16 times.

7. Erase all bad blocks and checked to determine if any zero are found. If any zeros are found, erase this block again. This procedure this repeated up to 16 times.

8. Write “Secure Erase” string to all blocks.

-Protocol: Non Data Command

-Inputs

Execute IRIG160 command for inputs information

Register	7	6	5	4	3	2	1	0
Features	29h							
Sector Count	41h							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	1	1	1	0	Na			
Command	82h							

-Normal Outputs

IRIG160 command for normal output information

Register	7	6	5	4	3	2	1	0
Error	Na							
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	obs	Na	obs	DEV	Na	Na	Na	Na
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Device register-

DEV shall specify the selected device.

Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

DF (Device Fault) will be cleared to zero.

DRQ will be cleared to zero

ERR will be cleared to zero.

3.13 Destroy (Firmware Destroy)

Innodisk Unrecoverable FW Destroy function implements an ultimate data erase of the SSD. Once Unrecoverable Destroy is triggered, beside all the user data and SSD information, also SSD firmware

will be erased and which is unusable. Triggered pin definition is set for optional and available for customization (Pin 1/2 or Pin 3/4).

3.13.1 Unrecoverable Destroy Command

-Protocol: Non Data Command

-Inputs

Execute Unrecoverable Destroy command for inputs information

Register	7	6	5	4	3	2	1	0
Features	20h							
Sector Count	41h							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	1	1	1	0	Na			
Command	82h							

-Normal Outputs

Unrecoverable Destroy command for normal output information

Register	7	6	5	4	3	2	1	0
Error	Na							
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	obs	Na	obs	DEV	Na	Na	Na	Na
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Device register-

DEV shall specify the selected device.

Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

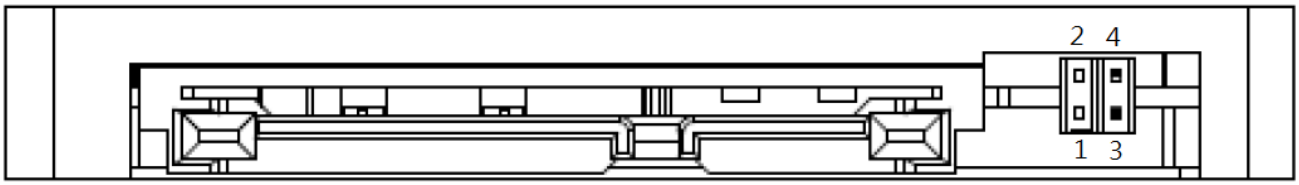
DF (Device Fault) will be cleared to zero.

DRQ will be cleared to zero

ERR will be cleared to zero.

3.14 Write Protect

When Write Protect pins are shorted, Write Protect function would be enabled, and ATA write command would be aborted, which can prevent the disk from data modification or data deletion. Write-protected data in disk is read-only, that is, users could not write to it, edit it, append data to it, or delete it. Write Protect pin definition is set for optional and available for customization (Pin 3/4).



3.14.1 Enable Write Protect Command

This command enable SSD into write protect mode, which is read-only. The SSD under write protect will overpass any write command.

-Protocol: Non Data Command

-Inputs

Execute Enable Write Protect command for inputs information

Register	7	6	5	4	3	2	1	0
Features	01h							
Sector Count	41h							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	1	1	1	0	Na			
Command	84h							

-Normal Outputs

Execute Enable Write Protect command for normal output information

Register	7	6	5	4	3	2	1	0
Error	Na							
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	obs	Na	obs	DEV	Na	Na	Na	Na
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Device register-

DEV shall specify the selected device.

Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

DF (Device Fault) will be cleared to zero.

DRQ will be cleared to zero

ERR will be cleared to zero.

3.14.2 Disable Write Protect Command

This command disable SSD’s write protect feature.

-Protocol: Non Data Command

-Inputs

Execute Disable Write Protect command for inputs information

Register	7	6	5	4	3	2	1	0
Features	00h							
Sector Count	41h							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	1	1	1	0	Na			
Command	84h							

-Normal Outputs

Execute Disable Write Protect command for normal output information

Register	7	6	5	4	3	2	1	0
Error	Na							
Sector Count	Na							
LBA Low	Na							
LBA Mid	Na							
LBA High	Na							
Device	obs	Na	obs	DEV	Na	Na	Na	Na
Status	BSY	DRDY	DF	Na	DRQ	Na	Na	ERR

Device register-

DEV shall specify the selected device.

Status register

BSY will be cleared to zero indicating command completion

DRDY will be set to one.

DF (Device Fault) will be cleared to zero.

DRQ will be cleared to zero

ERR will be cleared to zero.

3.15 AES function flow chart

In order to complete the physical security layer of protection, encryption needs to be paired with an ATA user password by ATA security command. After setting the authorized key by ATA security command, every time when you power on the system with SSD encrypted, you will be requested for a password to access the SSD. If the password is correct, the SSD will run well; if not, then you will not be able to access the SSD then.

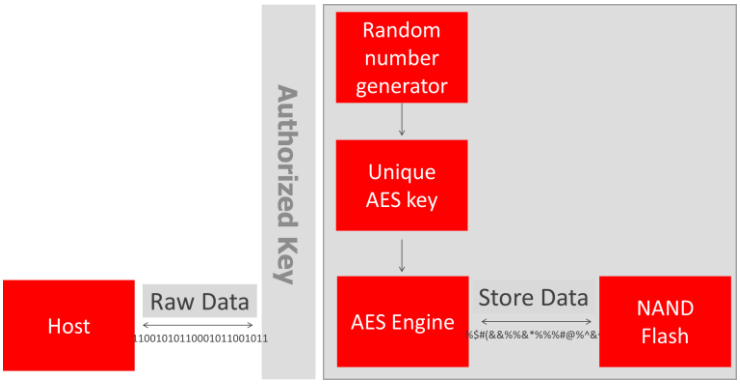


Figure 3: Innodisk 2.5” SATA SSD 3TR6-P AES flow chart

3.15.1 Encrypted Key Management

Innodisk 3TR6-P SSD includes two methods of key management to apply to different applications. The first is a standard approach that allows the firmware to generate a random number and a unique key when it leaves the factory. This method ensures that the user can easily apply the SSD with the data encrypted key. Another approach is to meet unique customer requirements with an encrypted key generated by an SSD from the SATA interface host. The SSD must keep the encrypted key value when receiving the reset commands. This method works best for the SSD as a removable device in different systems. Innodisk provides the test tool to execute the AES hardware encryption. This user-friendly tool, developed by Innodisk Corporation, allows the customer to use/test encryption functions.

3.15.2 Authorized Key Management

In order to complete the physical security layer of protection, encryption needs to be bundled with an ATA user password provided by an ATA Security command. Unlike the AES key, the authorized key must be set by the user via the BIOS configuration. Every time you power on the system with SSD encryption, a password request prompt is sent to access the SSD. If the password is correct, the SSD will run well; if not, you will not be able to access the SSD.

Command	Command Code
SECURITY SET PASSWORD	0XF1
SECURITY UNLOCK	0XF2
SECURITY ERASE PREPARE	0XF3
SECURITY ERASE UNIT	0XF4
SECURITY FREEZE LOCK	0XF5
SECURITY DISABLE PASSWORD	0XF6

3.15.3 TCG OPAL (In Dev.)

OPAL is a set of specifications for features of data storage devices that enhance security. These specifications are published by the Trusted Computing Group’s Storage Work Group. Innodisk 3TR6-P is compliant with TCG OPAL 2.0(*1). The capability of TCG OPAL Security mode allows multiple users with independent access control to read/write/erase independent data areas (LBA ranges). Each locking range adjusts by authenticated authority. Note that by default there is a single “Global Range” that encompasses the whole user data area. In TCG Opal Security Mode, Revert, Revert SP and GenKey command can erase all of data including global range and locking range; in the meantime generate the new encrypted key.

*1. You need to install TCG OPAL software to implement OPAL function, which is supplied by TCG OPAL software developed company

4. Installation Requirements

4.1 2.5” SATA SSD 3TR6-P Pin Directions

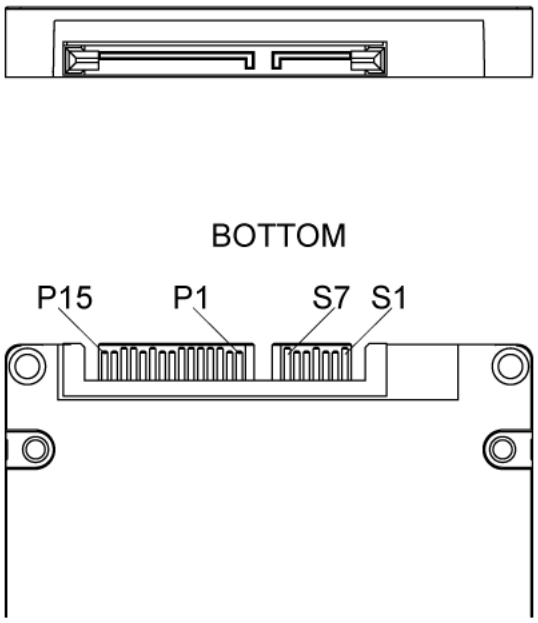


Figure 3: Signal Segment and Power Segment

4.2 Electrical Connections for 2.5” SATA SSD 3TR6-P

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 Form Factor

Please prepare following things:

- Screw driver.
- Four M3 screws. (Torque value is 2.0 ~ 2.5 Kgf.cm)
- SATA single cable (7-pin, Maximum length l meter).
- SATA power cable (15-pin).

Please turn off your computer, and open your computer’s case. Find one of available 2.5-inch slot, and plug the SSD in. To use the screws fix the SSD. Plug in the SATA single cable, and power cable. Please boot the installation Operation System from CD-ROM, and install Operation System into SSD.

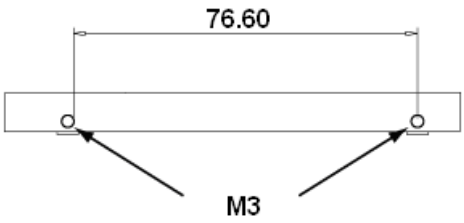


Figure 4: 2.5” SATA SSD 3TR6-P Mechanical Screw Hole

4.4 Device Drive

No additional device drives are required. Innodisk 2.5” SATA SSD 3TR6-P can be configured as a boot device.

5. SMART Feature Set

Innodisk 3TR6-P series support the SMART command set and defines some vendor-specific data to report SMART attributes of SSD.

Value	Command
D0h	Read Data
D1h	Read Attribute Threshold
D2h	Enable/Disable Autosave
D3h	Save Attribute Values
D4h	Execute OFF-LINE Immediate
D5h	Read Log
D6h	Return Status
D8h	Enable SMART Operations
D9h	Disable SMART Operations
DAh	Return Status

5.1 SMART Attributes

Innodisk 3TR6-P series SMART data attributes are listed in following table.

Attribute ID (hex)	Raw Attribute Value							Attribute Name
5 (05h)	LSB			MSB	00	00	00	Later Bad
9 (09h)	LSB			MSB	00	00	00	Power-On hours Count
12 (0Ch)	LSB			MSB	00	00	00	Drive Power Cycle Count
163 (A3h)	LSB					MSB	00	Total Bad Block Count
165 (A5h)	LSB			MSB	00	00	00	Max Erase count
167 (A7h)	LSB			MSB	00	00	00	Avg Erase count
169 (A9h)	LSB	00	00	00	00	00	00	Device Life
170 (AAh)	LSB					MSB	00	Spare Block Count
171 (ABh)	LSB					MSB	00	Program fail count
172 (ACh)	LSB					MSB	00	Erase fail count
184 (B8h)	LSB			MSB	00	00	00	Error Corrected Count
187 (BBh)	LSB			MSB	00	00	00	Reported Uncorrect Count
192 (C0h)	LSB			MSB	00	00	00	Unexpected Power Loss Count
194 (C2h)	Cur.*	00	MIN	00	MAX	03	Cur. *	Temperature
229 (E5h)	ID 0	ID 1	ID 2	ID 3	ID 4	ID 5	00	Flash ID
235 (EBh)		MSB	LSB	MSB	LSB	MSB	LSB	Later bad block info (Read/Write/Erase)
241 (F1h)	LSB					MSB	00	Total LBA written(LBA=32MB)
242 (F2h)	LSB					MSB	00	Total LBA read(LBA=32MB)

Cur. * =Current

6. 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	**R**	**S**	**2**	**5**	**-**	**A**	**2**	**8**	**M**	**7**	**2**	**E**	**C**	**1**	**Q**	**F**	**P**	**-**	**X**	**X**

Definition	
Code 1st (Disk)	**Code 13th (Flash mode)**
D : Disk	E: 64 layers 3D TLC
Code 2nd ~ 5th (Form Factor)	**Code 14th (Operation Temperature)**
RS25: InnoRobust 2.5” SATA SSD	C: Standard Grade (0℃~ +70℃)
Code 7th ~9th (Capacity)	W: Industrial Grade (-40℃~ +85℃)
A28: 128GB	**Code 15th (Internal control)**
B56: 256GB	1: First TSOP PCB
C12:512GB	A: Frist BGA PCB
01T: 1TB	
02T: 2TB	
	Code 16th (Channel of data transfer)
Code 10th ~12th (Series)	Q: Quad Channels
M72: 3TR6-P with AES encryption engine	
	Code 17th (Flash Type)
	F: Kioxia 3D TLC
	Code 18th (iCell)
	P: iCell
	Code 20th ~21th (Customized code)