innodisk

Total Solution For
Industrial Flash Storage

2.5" SATA SSD

3TEB Series

Customer: _____

Customer Part Number: _____

Innodisk Part Number: _____

Innodisk Model Name: _____

Date: _____

Innodisk Approver	Customer Approver

Features:

- SATA III
- Kioxia 3D TLC NAND
- 2.5” SATA SSD
- Standard & Wide-temperature
- iPowerguard
- iDataguard
- Dynamic Thermal Management

Performance:

- Sequential Read up to 550 MB/s
- Sequential Write up to 500 MB/s

Power Requirements:

Input Voltage:	5V±5%
Max Operating Wattage:	1.3W
Idle Wattage:	0.4W

Reliability:

Capacity	TBW	DWPD
64GB	75	1.09
128GB	150	1.09
256GB	300	1.09
512GB	600	1.09
1TB	1200	1.09
2TB	2400	1.09

Data Retention	10 Years
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
1.0	First Released	Sep., 2023
1.1	Add 112 Layers 3D TLC wide temperature	Apr., 2024
1.2	Add 64GB and 2TB Information	June, 2024

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1. Product Overview

1.1 Introduction of Innodisk 2.5” SATA SSD 3TEB.

Innodisk 2.5” SATA SSD 3TEB products provide high capacity flash memory Solid State Drive (SSD) that electrically complies with Serial ATA (SATA) standard. It supports SATA III standard (6.0GHz) with high performance., achieves excellent performance up to 2CH standard by cost effective controller with 2CH.

With Innodisk L^3 FW architecture, combining our signature 4K mapping algorithm L^2 FW architecture with powerful LDPC technology, 3TEB series has outstanding high IOPS, better data integrity and extended lifespan through reducing the bad block number happening.

For real industrial application, 3TEB series has built-in thermal sensor to monitor the environment temperature. iData Guard, the power loss management mechanism developed by Innodisk, ensures data integrity while power sudden loss happened.

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 3TEB is available in follow capacities within TLC flash ICs.

2.5” SATA SSD 3TEB 64GB
2.5” SATA SSD 3TEB 128GB
2.5” SATA SSD 3TEB 256GB
2.5” SATA SSD 3TEB 512GB
2.5” SATA SSD 3TEB 1TB
2.5” SATA SSD 3TEB 2TB

Figure 1: Innodisk 2.5” SATA SSD 3TEB

1.3 SATA Interface

Innodisk2.5” SATA SSD 3TEB supports SATA III(6.0Gb/s) interface, and compliant with SATA I (1.5Gb/s) and SATA II(3.0Gb/s).

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 7.00mm (H)

2. Product Specifications

2.1 Capacity and Device Parameters

2.5” SATA SSD 3TEB device parameters are shown in Table 1.

Table 1: Device parameters

Capacity	Cylinders	Heads	Sectors	LBA	User Capacity(MB)
64GB	16383	16	63	117231408	57242
128GB	16383	16	63	234441648	114473
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 - 112 Layers 3D TLC*

Capacity	Unit	64GB	128GB	256GB	512GB	1TB	2TB
Sequential** Read (Q32T1)	MB/s	430	550	550	530	540	550
Sequential** Write (Q32T1)		280	470	490	490	500	480
Sustained*** Sequential Read (Avg.)		260	470	510	490	490	500
Sustained*** Sequential Write (Avg.)		110	180	210	220	220	250
4KB Random** Read (Q32T1)	IOPS	21,000	54,000	75,000	70,000	68,000	64,000
4KB Random** Write (Q32T1)		52,000	71,000	72,000	72,000	73,000	77,000

Note:

*. Performance results are 3TEB with Kioxia BiCS5 NAND composition measured in Room Temperature with Out-of-Box devices and may vary depending on overall system setup. In addition, 3TEB series adopt hybrid mode which enables SLC cache followed by TLC direct write to strike balance between burst performance and steady overall stability.

**. Performance results are based on CrystalDiskMark 8.0.1 with file size 1000MB. Unit of 4KB item is IOPS.

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

2.3 Electrical Specifications

2.3.1 Power Requirement

Table 3: Innodisk 2.5” SATA SSD 3TEB 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 (RMS)[1]	1.3
Write (RMS)[1]	1.3
Idle	0.4
Boot Up	5.1

* Target: 2.5” SATA SSD 3TEB 2TB

2.4 Environmental Specifications

2.4.1 Temperature Ranges

Table 5: Temperature range for 2.5” SATA SSD 3TEB

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 3TEB

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 3TEB 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 3TEB MTBF

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

2.5 CE and FCC Compatibility

2.5” SATA SSD 3TEB conforms to CE and FCC requirements.

2.6 RoHS Compliance

2.5” SATA SSD 3TEB is fully compliant with RoHS directive.

2.7 Reliability

Table 8: 2.5” SATA SSD 3TEB TBW

Parameter	Value	
Flash endurance	3,000 P/E cycles	
Error Correct Code	Support	
Data Retention	Under 40℃: 10 Years at Initial NAND Status; 1 Year at NAND Life End	
TBW* (Total Bytes Written) Units: TB		
Capacity	**Sequential workload**	**Client workload**
64GB	170	75
128GB	341	150
256GB	682	300
512GB	1364	600
1TB	2727	1200
2TB	5454	2400

* 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.
3. Based on out-of-box performance.

2.8 Transfer Mode

2.5” SATA SSD 3TEB support following transfer mode:

Serial ATA III 6.0Gbps

Serial ATA II 3.0Gbps

Serial ATA I 1.5Gbps

2.9 Pin Assignment

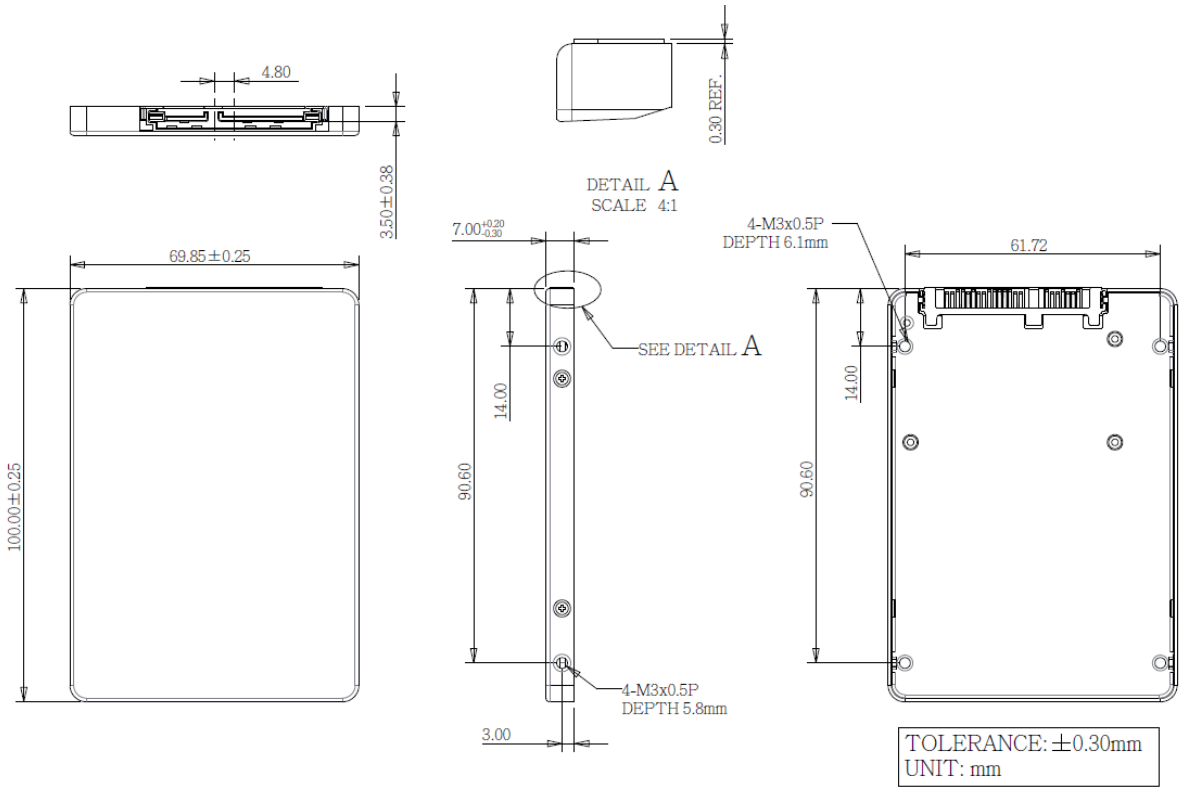
Innodisk 2.5” SATA SSD 3TEB uses a standard SATA pin-out.

See following table for 2.5” SATA SSD 3TEB pin assignment.

Table 9: Innodisk 2.5” SATA SSD 3TEB 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 2.5” SATA SSD 3TEB within flash ICs, 2TB’s weight is 45 grams approximately.

2.12 Seek Time

Innodisk2.5” SATA SSD 3TEB is not a magnetic rotating design. There is no seek or rotational latency required.

2.13 NAND Flash Memory

Innodisk 2.5” SATA SSD 3TEB 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 3TE8 from the system level, including the major hardware blocks.

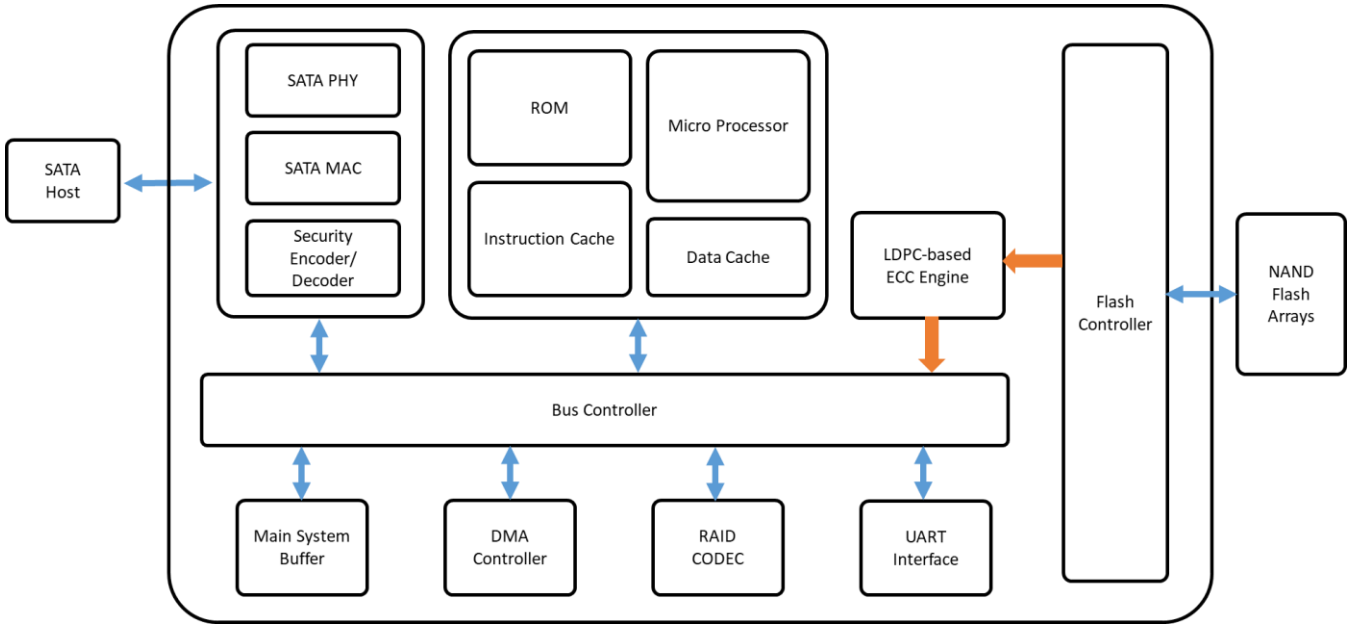


Figure 2 : Innodisk 2.5” SATA SSD 3TEB Block Diagram

Innodisk 2.5” SATA SSD 3TEB 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 2.5” SATA SSD 3TEB is designed with 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 2 channels for flash interface.

3.3 Error Detection and Correction

Innodisk2.5” SATA SSD 3TEB 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 3TEB 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

Innodisk’s 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. Innodisk’s 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 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.

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 startup and shutdown to maintain device performance and ensure data integrity.

4. Installation Requirements

4.1 2.5” SATA SSD 3TEB Pin Directions

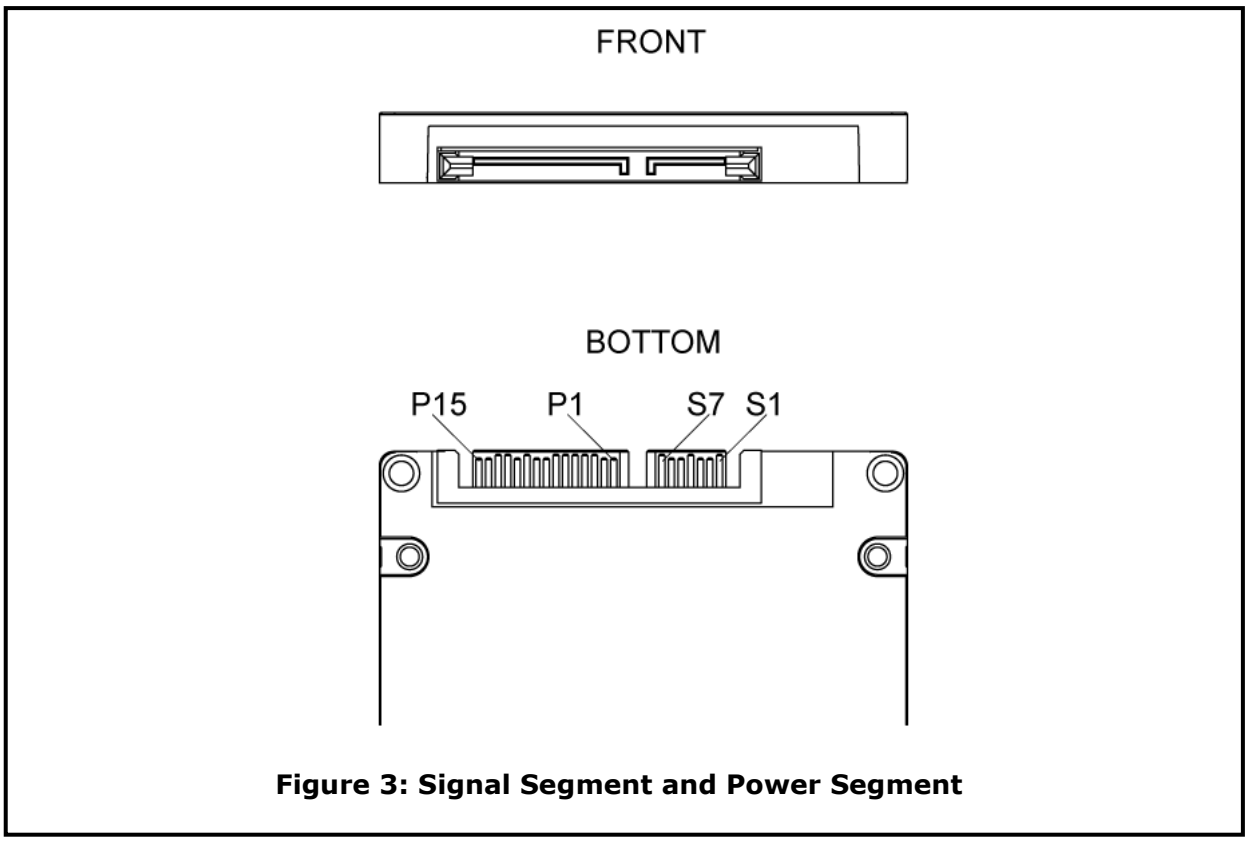


Figure 3: Signal Segment and Power Segment

4.2 Electrical Connections for 2.5” SATA SSD 3TEB

A Serial ATA device may be either directly connected to a host or connected to a host through an adaptor card. 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 2.0 kgf-cm ~ 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.

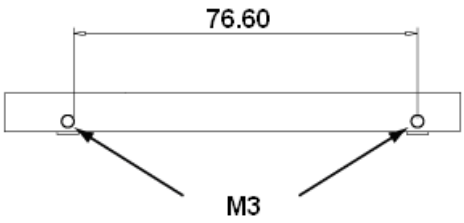


Figure 4: 2.5” SATA SSD 3TEB Mechanical Screw Hole

4.4 Device Drive

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

5. SMART Feature Set

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

Table 10: SMART command

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

5.1 SMART Attributes

Innodisk 3TEB series SMART data attributes are listed in following table.

Table 11: SMART attribute

Attribute ID (hex)	Raw Attribute Value							Attribute Name
01	MSB	00	00	00	00	00	00	Read error rate
05	LSB	MSB	00	00	00	00	00	Reallocated sectors count
09	LSB			MSB	00	00	00	Power on hours
0C	LSB			MSB	00	00	00	Power cycle count
A0	LSB			MSB	00	00	00	Uncorrectable sector count when read/write
A1	LSB	MSB	00	00	00	00	00	Number of spare block
A3	LSB	MSB	00	00	00	00	00	Number of initial invalid block
A4	LSB			MSB	00	00	00	Total erase count
A5	LSB			MSB	00	00	00	Max erase count
A6	LSB			MSB	00	00	00	Min erase count
A7	LSB			MSB	00	00	00	Average erase count
A8	LSB			MSB	00	00	00	Max erase count in spec
A9	LSB			MSB	00	00	00	Remain life percentage

AF	LSB			MSB	00	00	00	Program fail count in worst Die
B0	LSB	MSB	00	00	00	00	00	Erase fail count in worst Die
B1	LSB			MSB	00	00	00	Total wear leveling count
B2	LSB	MSB	00	00	00	00	00	Runtime invalid block count
B5	LSB			MSB	00	00	00	Total program fail count
B6	LSB	MSB	00	00	00	00	00	Total erase fail count
BB	LSB			MSB	00	00	00	Uncorrectable error count
C0	LSB	MSB	00	00	00	00	00	Power off retract count
C2	MSB	00	00	00	00	00	00	Temperature
C3	LSB			MSB	00	00	00	Hardware ECC recovered
C4	LSB			MSB	00	00	00	Reallocation event count
C6	LSB	MSB	00	00	00	00	00	Uncorrectable error count Off Line
C7	LSB						MSB	UDMA CRC error count
E8	LSB	MSB	00	00	00	00	00	Available reserved space
F1	LSB						MSB	Total LBA written(LBA=32MB)
F2	LSB						MSB	Total LBA read(LBA=32MB)

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	**E**	**S**	**2**	**5**	**-**	**A**	**2**	**8**	**I**	**C**	**1**	**K**	**C**	**C**	**D**	**F**	**-**	**X**	**X**	**X**
Description	Disk	2.5” SATA SSD					Capacity			Category			Flash mode	Operation Temp.	Internal Control	CH.	Flash		Customized Code		

Definition	
Code 1st (Disk)	**Code 13th (Flash Mode)**
D : Disk	K: 112 layers 3D TLC
Code 2nd ~ 5th (Form Factor)	**Code 14th (Operation Temperature)**
ES25: 2.5” SATA SSD	C: Standard Grade (0℃~ +70℃)
	W: Industrial Grade (-40℃~ +85℃)
Code 7th ~9th (Capacity)	**Code 15th (Internal control)**
64G: 64GB	C: Slim PCBA version
A28: 128GB	
B56: 256GB	**Code 16th (Channel of data transfer)**
C12: 512GB	S: Single Channels
01T: 1TB	D: Dual Channels
02T: 2TB	
Code 10th ~12th (Controller)	**Code 17th (Flash Type)**
IC1: SATA 3TEB	F: Kioxia 3D TLC
	Code 19th~21th (Customized Code)