

2.5" SATA SSD

3TG9-P Series

Customer: _____

Customer

Part

Number: _____

Innodisk

Part

Number: _____

Innodisk

Model Name: _____

Date: _____

Innodisk Approver	Customer Approver

Total Solution For
Industrial Flash Storage

Features:

- SATA III
- Kioxia 3D TLC NAND
- 2.5" SATA SSD
- Standard Temperature
- Dynamic Thermal Management
- iPowerguard
- iDataguard
- iCell

Performance:

- Sequential Read up to 550 MB/s
- Sequential Write up to 530 MB/s

Power Requirements:

Input Voltage:	5V±5%
Max Operating Wattage:	4.0
Idle Wattage:	1.6

Capacity	TBW	DWPD
256GB	387	1.6
512GB	899	1.9
1TB	1514	1.6
2TB	4133	2.2
4TB	8644	2.3
8TB	19095	2.5

Reliability:

Data Retention	1 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
Preliminary0.1	First Released	Oct., 2024

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1. Product Overview

1.1 Introduction of Innodisk 2.5" SATA SSD 3TG9-P

Innodisk 2.5" SATA SSD 3TG9-P products provide high capacity and high performance flash memory Solid State Drive (SSD) that complies with Serial ATA (SATA) up to SATA III standard (6.0 Gb/s). The Innodisk 2.5" SATA SSD 3TG9-P is designed for industrial field and packs with several features like wear-leveling, garbage collection.

With the outstanding performance, 3TG9-P has minimal latency, small seek time, and effectively reduces the booting time of operation system.

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 3TG9-P is available in follow capacities:

2.5" SATA SSD 3TG9-P 256GB

2.5" SATA SSD 3TG9-P 512GB

2.5" SATA SSD 3TG9-P 1TB

2.5" SATA SSD 3TG9-P 2TB

2.5" SATA SSD 3TG9-P 4TB

2.5" SATA SSD 3TG9-P 8TB



Figure 1: Innodisk 2.5" SATA SSD 3TG9-P

1.3 SATA Interface

Innodisk 2.5" SATA SSD 3TG9-P supports SATA III interface, and backward compliant with SATA I and SATA II.

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 3TG9-P device parameters are shown in Table 1.

Table 1: Device parameters

Capacity	LBA	Cylinders	Heads	Sectors	User Capacity(MB)
256GB	468862128	16383	16	63	228937
512GB	937703088	16383	16	63	457862
1TB	1875385008	16383	16	63	915715
2TB	3750748848	16383	16	63	1831420
4TB	7501476528	16383	16	63	3662830
8TB	15002931888	16383	16	63	7325650

2.2 Performance

Burst Transfer Rate: 6.0Gbps

Table 2: Performance¹

Capacity	Unit	256GB	512GB	1TB	2TB	4TB	8TB
Sequential ² Read (max.)	MB/s	540	550	520	520	550	550
Sequential ² Write (max.)		170	350	530	530	530	530
4KB Random ² Read (Q32T1)	IOPS	94,000	100,000	99,000	101,000	105,000	105,000
4KB Random ² Write (Q32T1)		45,000	90,000	98,000	97,000	97,000	97,000

Note: 1. Performance based on CrystalDiskMark 8.0.4 with file size 1000MB of Queue Depth 32

2. Performance may vary based on various firmware version or test platform

2.3 Electrical Specifications

2.3.1 Power Requirement

Table 3: Innodisk 2.5" SATA SSD 3TG9-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(RMS)	3.0
Write(RMS)	4.0
Idle	1.6
Boot-Up	8.6

Target: 2.5" SATA SSD 3TG9-P 8TB

2.4 Environmental Specifications

2.4.1 Temperature Ranges

Table 5: Temperature range

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 3TG9-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 3TG9-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 3TG9-P MTBF

Product	Condition	MTBF (Hours)
Innodisk 2.5" SATA SSD 3TG9-P	Telcordia SR-332 GB, 25°C	>3,000,000

2.5 CE and FCC Compatibility

2.5" SATA SSD 3TG9-P conforms to CE and FCC requirements.

2.6 RoHS Compliance

2.5" SATA SSD 3TG9-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: 1 Year at NAND Life End	
TBW* (Total Bytes Written) Unit:TB		
Capacity	Sequential workload	Client workload
256GB	682	387
512GB	1364	899
1TB	2727	1514
2TB	5454	4133
4TB	10909	8644
8TB	21818	19095
*Note:		
1. Sequential: Mainly sequential write.		
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 3TG9-P support following transfer mode:

Serial ATA III 6.0Gbps

Serial ATA II 3.0Gbps

Serial ATA I 1.5Gbps

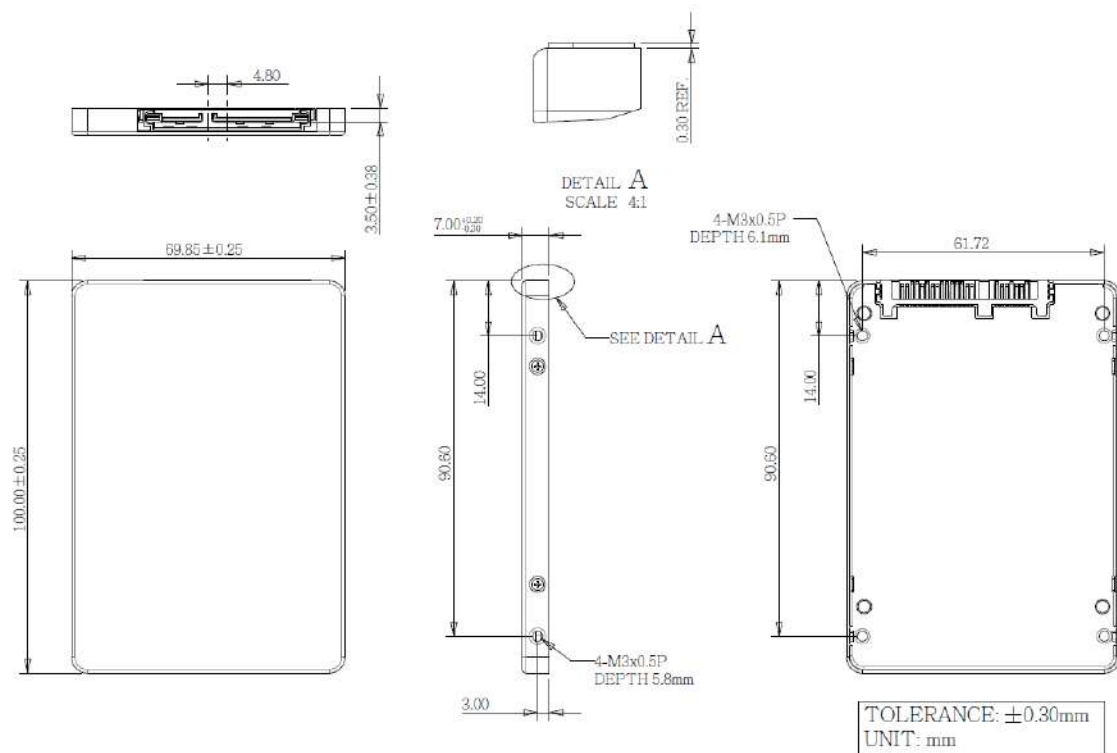
2.9 Pin Assignment

Innodisk 2.5" SATA SSD 3TG9-P uses a standard SATA pin-out. See Table 8 for 2.5" SATA SSD 3TG9-P pin assignment.

Table 8: Innodisk 2.5" SATA SSD 3TG9-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	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 3TG9-P within 3D TLC flash ICs, 1TB's weight is 60 grams approx.

2.12 Seek Time

Innodisk 2.5" SATA SSD 3TG9-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 3TG9-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 3TG9-P from the system level, including the major hardware blocks.

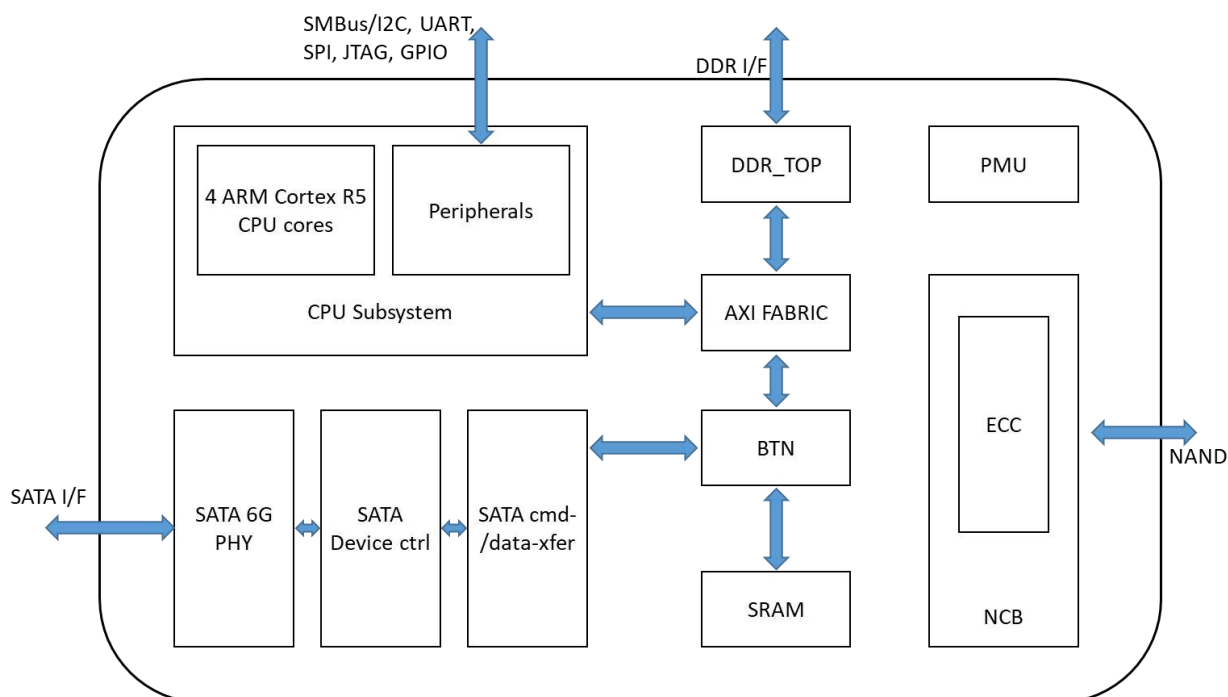


Figure 2: Innodisk 2.5" SATA SSD 3TG9-P Block Diagram

Innodisk 2.5" SATA SSD 3TG9-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 3TG9-P is designed with 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 8 channels for flash interface.

3.3 Error Detection and Correction

Innodisk 2.5"SATA SSD 3TG9-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 3TG9-P uses a combination of two types of wear leveling- dynamic and static wear leveling- to distribute write cycling across an SSD and balance erase count of each block, 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 3TG9-P can ensure all data can be written to disk without any data loss. Once the SSD controller receives this feedback signal, the SSD firmware triggers a mechanism to write the data into flash storage. As a result, iCell is able to provide power during power outage, preventing any data loss from happening.



Figure 3: Diagram of 2.5" SATA SSD with iCell

3.9 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 3TG9-P series is default enable the Die RAID function for the industrial application.

4. Installation Requirements

4.1 2.5" SATA SSD 3TG9-P Pin Directions

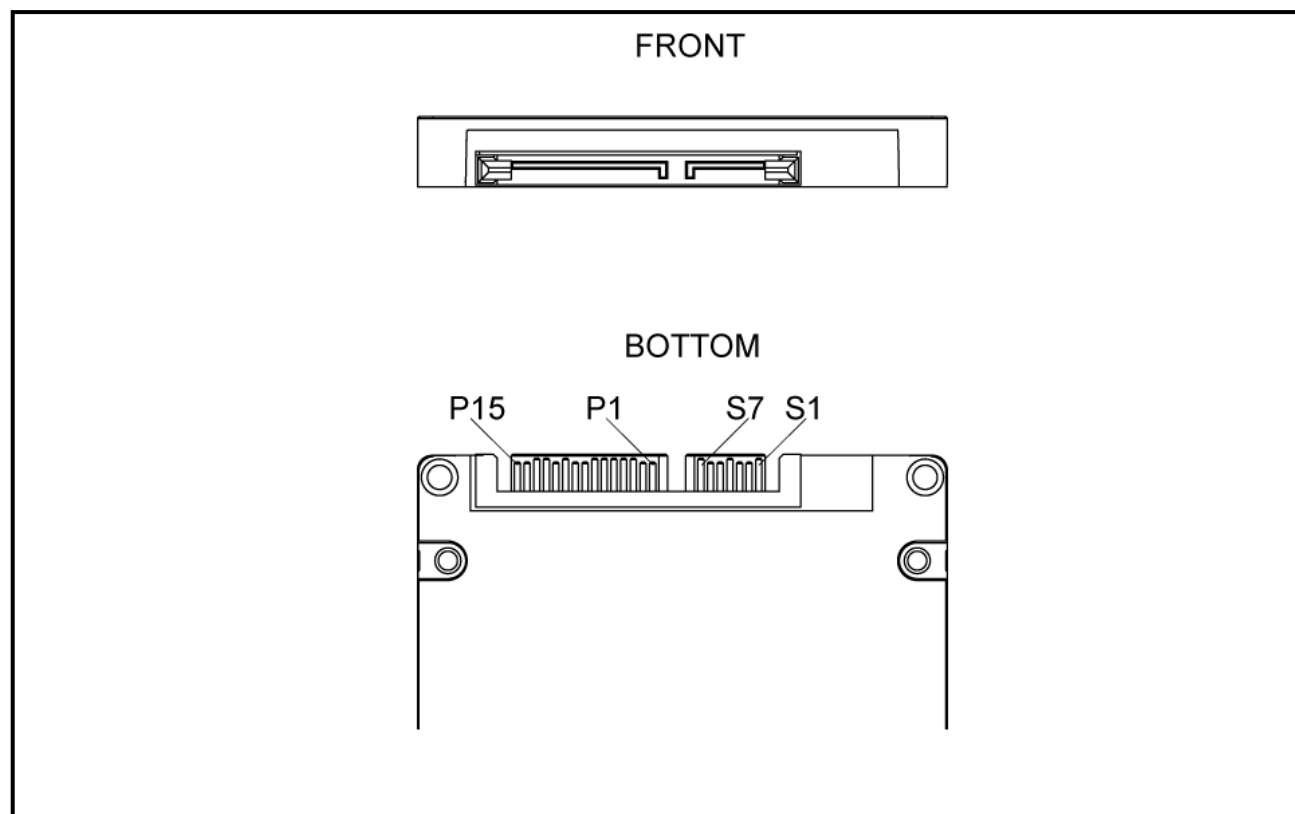


Figure 4: Signal Segment and Power Segment

4.2 Electrical Connections for 2.5" SATA SSD 3TG9-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 1 meter. 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 1 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.

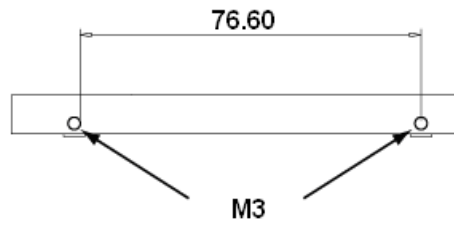


Figure 5: 2.5" SATA SSD 3TG9-P Mechanical Screw Hole

4.4 Device Drive

No additional device drives are required. Innodisk 2.5" SATA SSD 3TG9-P can be configured as a boot device.

5. SMART Feature Set

5.1 SMART Attributes

Innodisk 3TG9-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
175 (AFh)	LSB	MSB	LSB	MSB	LSB	MSB	00	iCell Health status (Total number of tests/Minutes since last test/last test result(ms))
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)

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	G	S	2	5	-	C	1	2	D	T	1	K	C	A	Q	F	P	-	X	X
Definition																					
Code 1 st (Disk)											Code 14 th (Operation Temperature)										
D : Disk											C: Standard Grade (0°C~ +70°C)										
											W: Industrial Grade (-40°C~ +85°C)										
Code 2 nd ~ 5 th (Form Factor)											Code 15 th (Internal control)										
GS25: 2.5" SATA SSD											A~Z: PCB type										
Code 7 th ~9 th (Capacity)											Code 16 th (Channel of data transfer)										
B56: 256GB											Q: Quad Channels										
C12: 512GB																					
01T: 1TB																					
02T: 2TB																					
04T: 4TB																					
08T: 8TB																					
Code 10 th ~12 th (Series)											Code 17 th (Flash Type)										
DT1: SATA 3TG9-P											F: Kioxia 3D TLC										
Code 13 th (Flash mode)											Code 18 th (iCell)										
K: 112 layers 3D TLC											P: iCell										