innodisk

Total Solution For Industrial Flash Storage

M.2 (P30)

3TE7 Series

Customer: _____

Customer Part Number: _____

Innodisk Part Number: _____

Innodisk Model Name: _____

Date: _____

Innodisk Approver	Customer Approver

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REVISION HISTORY

Revision	Description	Date
Preliminary 0.1	Preliminary released	Jul., 2021
Preliminary 0.2	Updates: - product feature list - endurance/TBW	Jul., 2021
Rev. 1.0	Updates: - data retention (PE cycle 100%, 3000 cycles, 2 year retention @ 55℃) - performance - storage temperature - mechanical drawings Remove: RoHS, REACH and MSL	Jul., 2021
Rev. 1.1	Updates: - Pin assignment	Feb., 2022
Rev. 1.2	Update mechanical drawing	Apr., 2022

Features:

- PCIe Gen.3 x 2
- Micron 3D TLC NAND
- M.2 2230-S3-B-M
- Standard & Wide-temperature
- Dynamic Thermal Management
- Hybrid Write

Power Requirements:

Input Voltage	3.3V±5%
Max Operating Wattage	1.6W
Idle Wattage	0.4W

Performance:

- Sequential Read up to 1,650 MB/s
- Sequential Write up to 1,350 MB/s

Reliability:

Capacity	[Client] TBW	[Client] DWPD
32GB	19	0.81
64GB	38	0.81
128GB	76	0.81
256GB	152	0.81
512GB	304	0.81

Data Retention	2 years*
Warranty	2 Years

*2 years duration after 100% (3000) P/E cycles at 55℃

For warranty details, please refer to:

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

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1. Product Overview

1.1 Introduction of Innodisk M.2 (P30) 3TE7

Innodisk M.2 (P30) 3TE7 is an NVM Express storage device designed as the standard M.2 form factor with PCIe interface and 3D TLC NAND Flash. M.2 (P30) supports PCIe Gen III x2 within a tiny dimension, and it is compliant with NVM 1.3 providing excellent performance. Moreover, it adopts industrial 3D TLC NAND Flash providing high endurance and reliability, as well as low power consumption and high reliability. It offers an ideal solution for embedded, automotive, medical, gaming and most industrial applications.

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 M.2 (P30) 3TE7 is available in follow capacities:

M.2 (P30) 3TE7 32GB M.2 (P30) 3TE7 64GB

M.2 (P30) 3TE7 128GB M.2 (P30) 3TE7 256GB

M.2 (P30) 3TE7 512GB

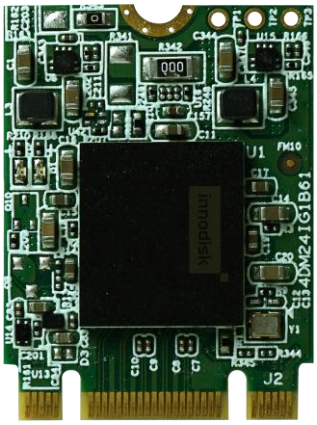


Figure 1: Innodisk M.2 (P30) 3TE7

2. Product Specifications

2.1 Capacity and Device Parameters

M.2 (P30) 3TE7 device parameters are shown in Table 1.

Table 1: Device parameters

Capacity	LBA	User Capacity (MB)
32GB	62533296	30533
64GB	125045424	61057
128GB	250069680	122104
256GB	500118192	244198
512GB	1000215216	488386

2.2 Performance

Burst Transfer Rate: 4GB/s

Table 2: Performance

Capacity	32GB	64GB	128GB	256GB	512GB
Sequential Read (Max)	300 MB/s	600 MB/s	1,150 MB/s	1,600 MB/s	1,650 MB/s
Sequential Write (Max)	130 MB/s	280 MB/s	550 MB/s	1,100 MB/s	1,350 MB/s
4KB Random Read (QD32)	26,000	52,000	101,700	155,000	157,000
4KB Random Write (QD32)	30,000	64,000	126,000	132,000	136,000

Note: * Performance is based on CrystalDiskMark 6.0.2 with file size 1000MB of Queue Depth 32

2.3 Electrical Specifications

2.3.1 Power Requirement

Table 3: Innodisk M.2 (P30) 3TE7 Power Requirement

Item	Symbol	Rating	Unit
Input voltage	V_{IN}	+3.3 DC +- 5%	V

2.3.2 Power Consumption

Table 4: Typical Power Consumption

Mode	Power Consumption (W)
Read	1.6
Write	1
Idle	0.4
Power-on Peak	2

* Target: M.2 (P30) 3TE7 512GB

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

Please refer to the test report for the capacities.

2.4 Environmental Specifications

2.4.1 Temperature Ranges

Table 5: Temperature range for M.2 (P30) 3TE7

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 M.2 (P30) 3TE7

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 M.2 (P30) 3TE7 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: M.2 (P30) 3TE7 MTBF

Product	Condition	MTBF (Hours)
Innodisk M.2 (P30) 3TE7	Telcordia SR-332 GB, 25°C	>3,000,000

2.5 CE and FCC Compatibility

M.2 (P30) 3TE7 conforms to CE and FCC requirements.

2.6 RoHS Compliance

M.2 (P30) 3TE7 is fully compliant with RoHS directive.

2.7 Reliability

Table 8: M.2 (P30) 3TE7 TBW

Parameter	Value	
Flash endurance	3,000 P/E cycles	
Error Correct Code	Support (LDPC)	
Data Retention	Under 55°C: 10 Yeas at initial NAND Status (PE cycles under 300) ; 2 Years at NAND Life End (PE cycles reach 3,000)	
TBW* (Total Bytes Written) Unit: TB		
Capacity	**Sequential workload**	**Client workload**
32GB	85	19
64GB	170	38
128GB	340	76
256GB	680	152
512GB	1360	304

* Note:

1. Sequential: Mainly sequential write, tested by Vdbench.
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

M.2 (P30) 3TE7 support following transfer mode:

PCIe Gen III 4GB/s

PCIe Gen II 2GB/s

2.9 Pin Assignments

Innodisk M.2 (P30) 3TE7 follows standard M.2 spec, key B+M PCIe-based SSD pinout. See Table 9 for M.2 (P30) 3TE7 pin assignment.

Table 9: Innodisk M.2 (P30) 3TE7 Pin Assignment

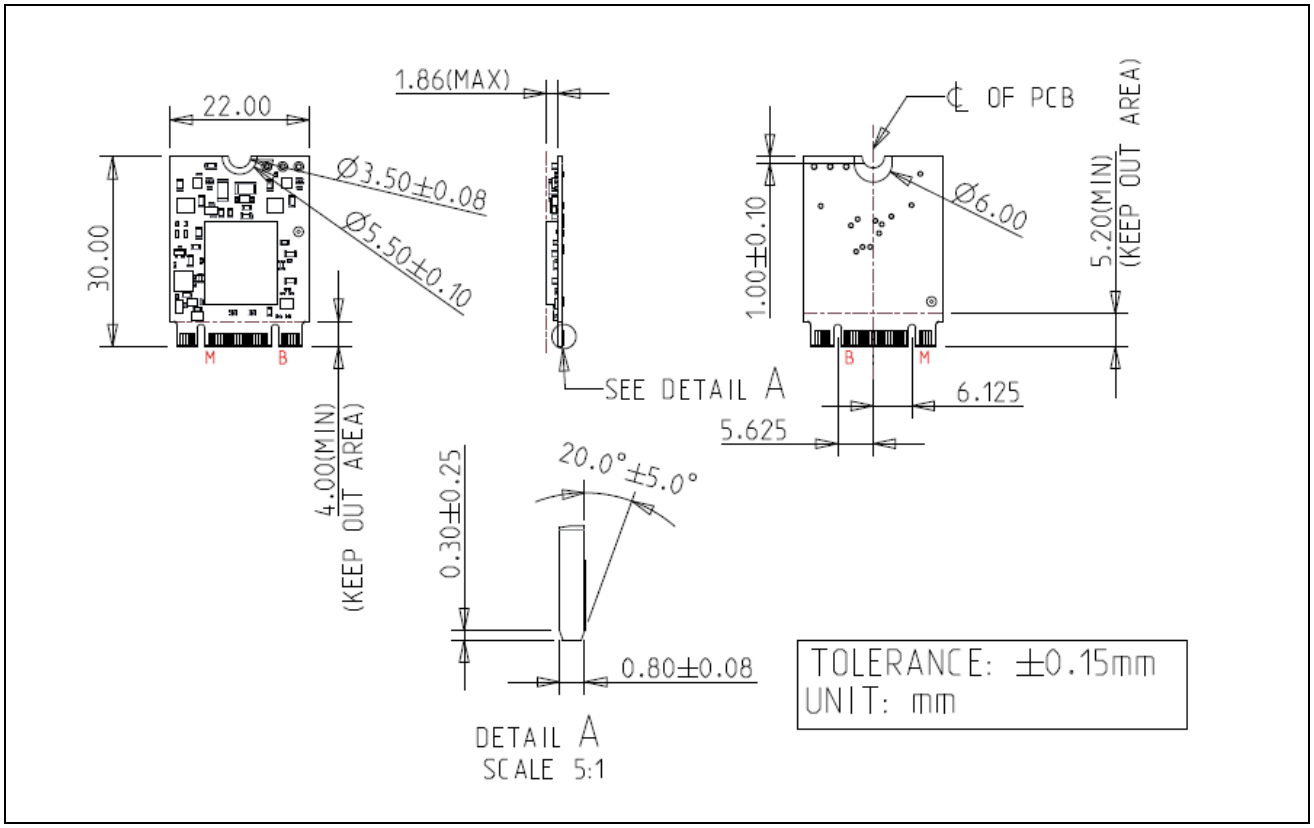
Signal Name	Pin #	Pin #	Signal Name
		75	GND
3.3V	74	73	GND
3.3V	72	71	GND
3.3V	70	69	NC
NC	68	67	NC
Notch	66	65	Notch
Notch	64	63	Notch
Notch	62	61	Notch
Notch	60	59	Notch
NC	58		
NC	56	57	GND
PEWAKEN	54	55	REFCLKp
CLKREQ# (I/O)(0/3.3V)	52	53	REFCLKn
PERST# (I)(0/3.3V)	50	51	GND
NC	48	49	PERp0
NC	46	47	PERn0
ALERTN	44	45	GND
NC (reserved for SMB_DATA)	42	43	PETp0
NC (reserved for SMB_CLK)	40	41	PETn0
NC	38	39	GND
NC	36	37	PERp1
NC	34	35	PERn1
NC	32	33	GND
NC	30	31	PETp1
NC	28	29	PETn1
NC	26	27	GND
NC	24	25	NC
NC	22	23	NC

NC	20	21	GND
Notch	18	19	Notch
Notch	16	17	Notch
Notch	14	15	Notch
Notch	12	13	Notch
LED1# (0V/1.8V/Output)	10	11	NC
NC	8	9	GND
NC	6	7	NC
3.3V	4	5	NC
3.3V	2	3	GND
		1	GND

LED Color	Function
Green	Power on

2.10 Mechanical Dimensions

M.2 Type 2230-S3-B-M



2.11 Assembly Weight

An Innodisk M.2 (P30) 3TE7 within NAND flash ICs, 128GB's weight is 5 grams approximately.

2.12 Seek Time

Innodisk M.2 (P30) 3TE7 is not a magnetic rotating design. There is no seek or rotational latency required.

2.13 NAND Flash Memory

Innodisk M.2 (P30) 3TE7 uses 3D TLC 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 M.2 (P30) 3TE7 from the system level, including the major hardware blocks.

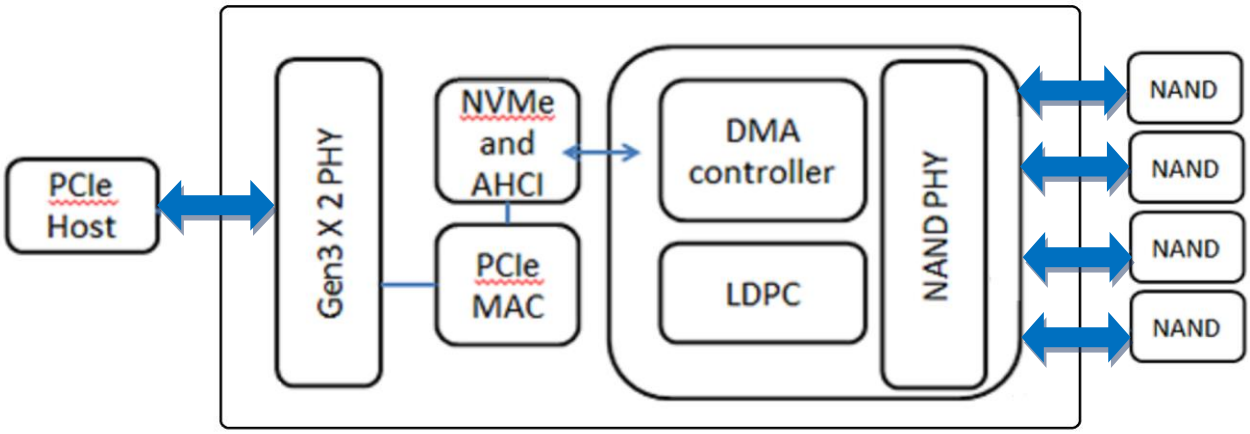


Figure 2: Innodisk M.2 (P30) 3TE7 Block Diagram

Innodisk M.2 (P30) 3TE7 is designed with a nanoSSD which integrates a PCIe Gen 3x2 controller and NAND flash memories. The nanoSSD is integrated a 4-channel controller with four native CEs. The PCIe Gen3 x2 interface to manage the embedded NAND flash array consisting of 1/2/4/8/16 NAND dies

3.2 PCIe III controller

Innodisk M.2 (P30) 3TE7 is a PCIe Gen IIIx4 controller is compliant with NVMe 1.3, up to 32.0Gbps transfer speed. Also it is compliant with PCIe Gen 1, Gen 2 and Gen 3 specification.

3.3 Error Detection and Correction

Innodisk M.2 (P30) 3TE7 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 M.2 (P30) 3TE7 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 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 Power Management

- Support multi-level power states: PS0, PS1, PS2, PS3, PS4
- Support thermal throttling with configurable temperature threshold

4. Installation Requirements

4.1 M.2 (P30) 3TE7 Pin Directions

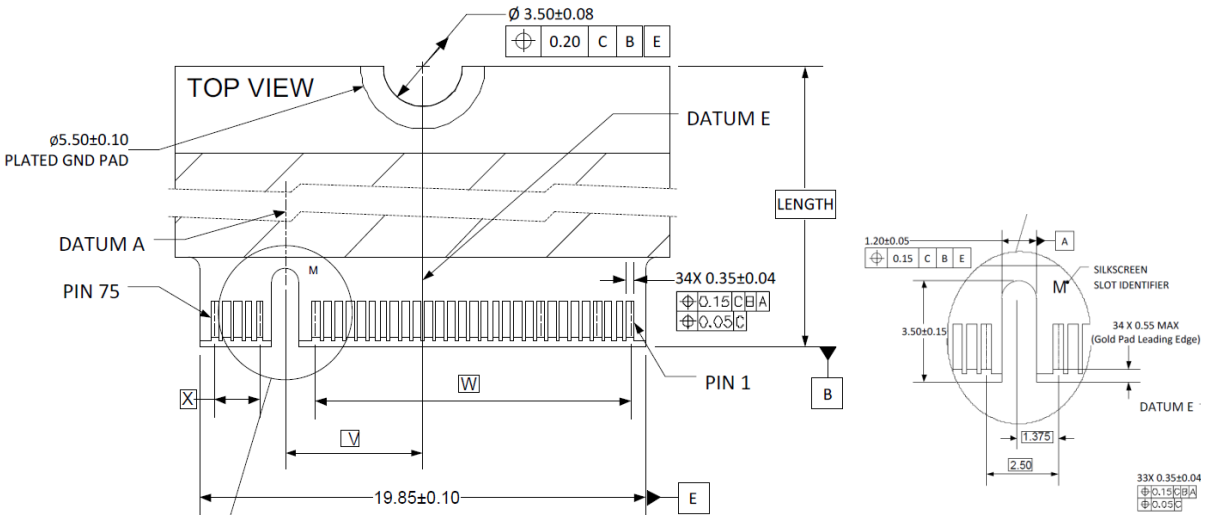


Figure 3: Signal Segment and Power Segment

4.2 Electrical Connections for M.2 (P30) 3TE7

M.2 interconnect is based on a 75 position Edge Card connector. The 75-position connector is intended to be keyed and to distinguish between families of host interfaces and the various Sockets used in general Platforms. M.2 (P30) 3TE7 is compliant with M.2 Socket 3 key M. M.2 (P30) 3TE7 is compatible with host connector H3.2 or H4.2.

4.3 Device Drive

M.2 (P30) 3TE7 is compliant with NVMe 1.3. Both Operation System and BIOS should include NVMe driver to compatible with NVMe device. Nowadays, most of OS includes NVMe in-box driver now. For more information about the driver support in each OS, please visit the website http://nvmexpress.org/resources/drivers. For BIOS NVMe driver support please contact with motherboard manufacturers.

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
	D	**E**	**M**	**2**	**3**	**-**	**C**	**1**	**2**	**I**	**G**	**1**	**E**	**W**	**A**	**Q**	**H**	**-**	**X**	**X**
Description	Disk	M.2 (P30) 3TE7					Capacity			Category			Flash Mode	Operation Temp.	Internal Control	CH.	Flash	-	Customized Code	

Definition	
Code 1st (Disk)	**Code 13th (Flash mode)**
D : Disk	E: 64 layers 3D flash
Code 2nd	**Code 14th (Operation Temperature)**
E: Embedded	C: Standard Grade (0℃~ +70℃)
	W: Industrial Grade (-40℃~ +85℃)
Code 3rd ~ 5th (Form Factor)	**Code 15th (Internal control)**
M23: M.2 Type 2230	A~Z: BGA version
Code 7th ~9th (Capacity)	**Code 16th (Channel of data transfer)**
32G: 32GB	S: Single Channel
64G: 64GB	D: Dual Channels
A28: 128GB	Q: Quad Channels
B56: 256GB	
C12: 512GB	**Code 17th (Flash Type)**
Code 10th ~12th (Series)	H: Industrial 3D TLC
IG1: M.2 (P30) 3TE7 Controller	
	Code 19th~20th (Customized Code)