TP3000 M.2 NVME SSD
Datasheet

Version 1.0

深圳市金泰克半导体有限公司
地址：深圳市坪山区龙田街道长方照明工业区厂房 B 栋 1-4 楼
电话：86-755-2526 1999

Product Overview

- **Capacity**
  - 256GB,512GB,1TB
- **Interface**
  - PCIe Gen 3.0 x 4 Lane
  - Compliant with PCIe Base Specification Revision 3.1
- **NAND Flash Interface**
  - 3D Flash
- **Performance(measured by CrystalDiskMark)**
  - Read: up to 2500MB/s
  - Write: up to 1800 MB/s
- **MTBF**
  - 1,200,000 hours
- **Temperature Range**
  - Operation: 0°C ~ 70°C
  - Storage: -40°C ~ 85°C
- **Advanced Flash Management**
  - PCIe Gen 3.0 x 4 Lane
  - Supports NVMe 1.3 Protocol
  - S.M.A.R.T
  - Firmware Update
  - Support data security erase and quick erase
  - LDPC
  - Software/Hardware write protect option
  - On-chip RAID

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Performance

Capacity	CrystalDiskMark（up to）	
	Read (MB/s)	Write (MB/s)
256GB	2500	1100
512GB	2500	1800
1TB	2100	1800

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电话：86-755-2526 1999

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1. INTRODUCTION

1.1. General Description

Tigo M.2 2280 PCIE SSD delivers all the advantages of flash disk technology with the PCIe interface and is fully compliant with the standard M.2 2280 form factor. Its capacity could provide a wide range up to 1TB. Moreover, it can reach up to 2500MB/s read as well as 1800MB/s write high performance based on TLC flash (measured by CrystalDiskMark). Meanwhile, the power consumption of the M.2 2280 module is much lower than traditional hard drives.

1.2. Controller Block Diagram

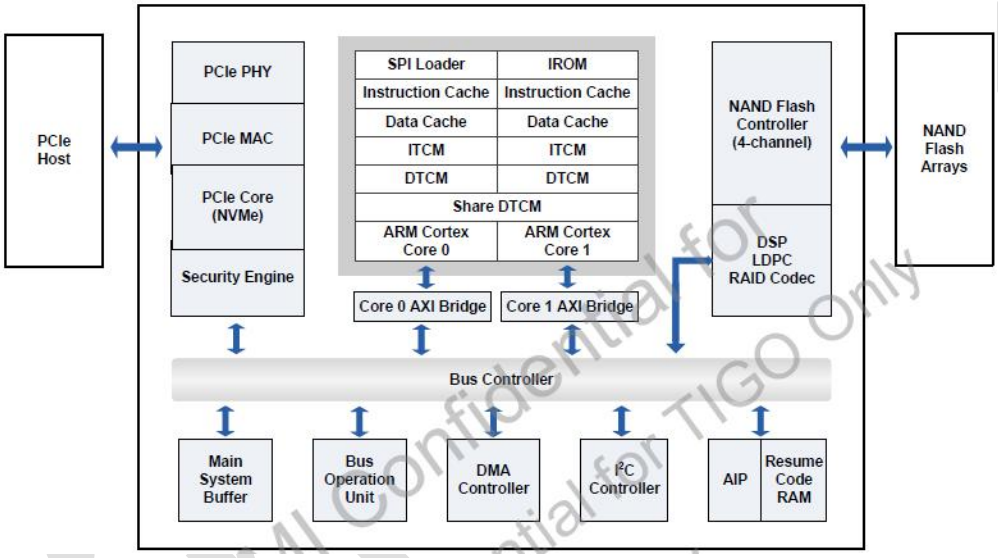

Figure 1- 1 M.2 2280 PCIE SSD Controller Block Diagram

1.3. Product Block Diagram

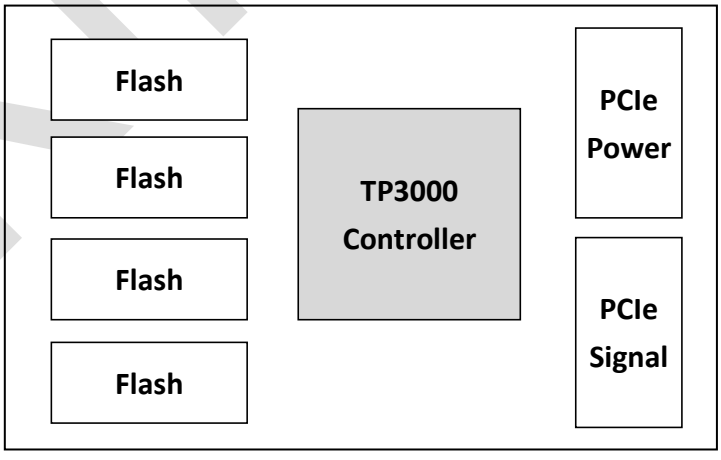

Figure 1- 2 M.2 2280 PCIE SSD Product Block Diagram

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1.4. Flash Management

1.4.1. Error Correction Code (ECC)

Flash memory cells will deteriorate with use, which might generate random bit errors in the stored data. Thus, M.2 2280 PCIE SSD Controller applies the LDPC ECC algorithm. The Hardware Error Correction Coding(ECC)engine executes parity generation and error detection/correction features, and enhances decoding throughput and data reliability, the powerful ECC engine is able to support the latest generation NAND flash.

1.4.2. Wear Leveling

NAND flash devices can only undergo a limited number of program/erase cycles, and in most cases, the flash media are not used evenly. If some areas get updated more frequently than others, the lifetime of the device would be reduced significantly. Wear leveling is to arrange data so that erasures and re-writes are distributed evenly across the Flash. In this way, no single erase block prematurely fails due to a high concentration of write cycles. Hence, it extends the lifespan of SSD.

Tigo provides advanced Wear Leveling algorithm, which can efficiently spread out the flash usage through the whole flash media area. Moreover, by implementing both dynamic and static Wear Leveling algorithms, the life expectancy of the NAND flash is greatly improved.

1.4.3. Bad Block Management

Bad blocks are blocks that include one or more invalid bits, and their reliability is not guaranteed. Blocks that are identified and marked as bad by the manufacturer are referred to as “Initial Bad Blocks”. Bad blocks that are developed during the lifespan of the flash are named “Later Bad Blocks”. Tigo implements an efficient bad block management algorithm to detect the factory-produced bad blocks and manages any bad blocks that appear with use. This practice further prevents data being stored into bad blocks and improves the data reliability.

1.4.4. SMART

SMART, an acronym for Self-Monitoring, Analysis and Reporting Technology, is an open standard that allows a hard disk drive to automatically detect its health and report potential failures. When a failure is recorded by SMART, users can choose to replace the drive to prevent unexpected outage or data loss. Moreover, SMART can inform users of impending failures while there is still time to perform proactive actions, such as copy data to another device.

1.4.4.1. Over-Provision

Over provisioning is the difference between physical capacity of the Flash and the logical capacity presented through OS as available for users. This additional space from over-provisioning helps to lower the

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write amplification when the controller writes to the Flash.

Over Provisioning refers to the inclusion of extra NAND capacity in a SSD, which is not visible and cannot be used by users. With Over Provisioning, the performance and IOPS (Input/Output Operations per Second) are improved by providing the controller additional space to manage P/E cycles, which enhances the reliability and endurance as well. Moreover, the write amplification of the SSD becomes lower when the controller writes data to the flash.

1.5. Advanced Device Security Features

1.5.1. Write Protect

When a SSD contains too many bad blocks and data are continuously written in, then the SSD might not be usable anymore. Thus, Write Protect is a mechanism to prevent data from being written in and protect the accuracy of data that are already stored in the SSD.

1.6. SSD Lifetime Management

1.6.1. Terabytes Written (TBW)

TBW (Terabytes Written) is a measurement of SSDs' expected lifespan, which represents the amount of data written to the device. To calculate the TBW of a SSD, the following equation is applied:

TBW = [(NAND Endurance) x (SSD Capacity) x (WLE)] / WAF

NAND Endurance: NAND endurance refers to the P/E (Program/Erase) cycle of a NAND flash.

SSD Capacity: The SSD capacity is the specific capacity in total of a SSD.

WLE: Wear Leveling Efficiency (WLE) represents the ratio of the average amount of erases on all the blocks to the erases on any block at maximum.

WAF: Write Amplification Factor (WAF) is a numerical value representing the ratio between the amount of data that a SSD controller needs to write and the amount of data that the host's flash controller writes. A better WAF, which is near 1, guarantees better endurance and lower frequency of data written to flash memory.

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2. PRODUCT SPECIFICATIONS

- **Capacity**
  - 256GB,512GB,1TB
- **Electrical/Physical Interface**
  - PCIe Interface
    - PCIe Gen 3.0 x 4 Lane
    - Compliant with PCIe Base Specification Revision 3.1
    - Supports NVMe 1.3 Protocol
    - Support power management
- **ECC Scheme**
  - LDPC.
- **Support SMART commands**
- **Performance**

Capacity	Sequential (up to)	
	Read (MB/s)	Write (MB/s)
256GB	2500	1100
512GB	2500	1800
1TB	2100	1800

NOTES:

1. The performance was measured using CrystalDiskMark .
2. Performance may differ according to flash configuration, SDR configuration, and platform.
3. The table above is for reference only. The criteria for MP (mass production) and for accepting goods shall be discussed based on different flash configuration.

- **TBW (Terabytes Written)**

Capacity	TBW
256GB	80
512GB	160
1TB	320

NOTES:

1. TBW may differ according to flash configuration, SDR configuration, and platform.
2. The endurance of SSD could be estimated based on user behavior, NAND endurance cycles, and write amplification factor. It is not guaranteed by flash vendor.

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3. ENVIRONMENTAL SPECIFICATIONS

3.1. Environmental Conditions

3.1.1. Temperature

- Temperature:
  - Storage: -40°C to 85°C
  - Operational: 0°C to 70°C

3.2. MTBF

MTBF, an acronym for Mean Time between Failures, is a measure of a device's reliability. Its value represents the average time between a repair and the next failure. The measure is typically in units of hours. The higher the MTBF value, the higher the reliability of the device. The predicted result of 's M.2 2280 PCIe SSD is more than 1,200,000 hours.

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4. ELECTRICAL SPECIFICATIONS

4.1. Supply Voltage

Table 4- 1 Supply Voltage of M.2 2280 PCIE SSD

Parameter	Rating
Operating Voltage	3.3V

4.2. Power Consumption

Table 4- 2 Power Consumption of M.2 2280 PCIE SSD

Capacity	Read	Write	Idle
256GB	3700	3170	500
512GB	4000	3248	500
1TB	4500	3500	600

Unit: mW

NOTES:

1. The average value of power consumption is achieved based on 100% conversion efficiency.
2. The measured power voltage is 3.3V.
3. Sequential R/W is measured while testing 1000MB sequential R/W 5 times by CyrstalDiskMark.DevSleep is measured while entering device sleep mode for 5 minutes.
4. Power Consumption may differ according to flash configuration, SDR configuration, and platform.

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5. INTERFACE

5.1. Pin Assignment and Descriptions

Table 5-1 defines the signal assignment of the internal M.2 2280 connector for SSD usage, described in the PCI Express M.2 Specification version 1.0 of the PCIe

Table 5- 1 Pin Assignment and Descriptions of M.2 2280 SSD

Pin No.	Signal Name
P1	CONFIG_3=GND
P2	3.3V
P3	GND
P4	3.3V
P5	PETn3
P6	NC
P7	PETp3
P8	NC
P9	GND
P10	LED_1#
P11	PERn3
P12	3.3V
P13	PERp3
P14	3.3V
P15	GND
P16	3.3V
P17	PETn2
P18	3.3V
P19	PETp2
P20	NC
P21	CONFIG_0=GND
22	NC
23	PERn2

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24	NC
25	PERp2
26	NC
27	GND
28	NC
29	PETn1
30	NC
31	PETp1
32	NC
33	GND
34	NC
35	PERn1
36	NC
37	PERp1
38	NC
39	GND
40	SCL
41	PETn0
42	SDA
43	PETp0
44	ALERT
45	GND
46	NC
47	PERn0
48	NC
49	PERp0
50	PERST
51	GND
52	CLKREQ#
53	REFCLKn

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54	PEWAKE#
55	REFCLKp
56	Reserved for MFG_DATA
57	GND
58	Reserved for MFG_CLOCK
59	ADD IN CARD KEY M
60	ADD IN CARD KEY M
61	ADD IN CARD KEY M
62	ADD IN CARD KEY M
63	ADD IN CARD KEY M
64	ADD IN CARD KEY M
65	ADD IN CARD KEY M
66	ADD IN CARD KEY M
67	NC
68	SUSCLK
69	PEDET
70	3.3V
71	GND
72	3.3V
73	GND
74	3.3V
75	CONFIG_2=GND

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6. SUPPORTED COMMANDS

6.1. NVM Command List

Table 6- 1 NVM Command List

Opcode	O/M	Command
00h	M	Flush
01h	M	Write
02h	M	Read
04h	O	Write Uncorrectable
05h	O	Compare
08h	O	Write Zeros
09h	O	Dataset Management
0Dh	O	Reservation Register
0Eh	O	Reservation Report
11h	O	Reservation Acquire
15h	O	Reservation Release

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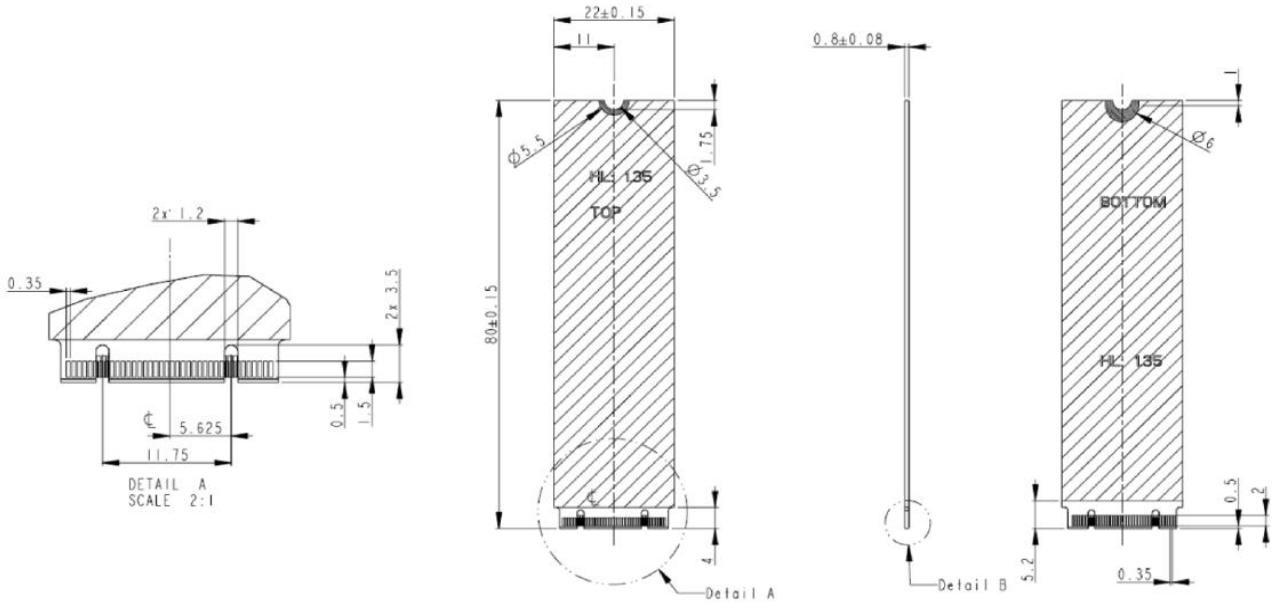
7. PHYSICAL DIMENSION

Dimension: 80.00mm(L) x 22mm(W)



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8. REFERENCES

The following table is to list out the standards that have been adopted for designing the product.

Table 8- 1List of References

Title	Acronym/Source
M.2	http://www.pcisig.com/

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9. TERMINOLOGY

The following table is to list out the acronyms that have been applied throughout the document.

Table 9- 1 List of Terminology

Term	Definitions
ATTO	Commercial performance benchmark application
DEVSLP	Device sleep mode
LBA	Logical block addressing
MB	Mega-byte
MTBF	Mean time between failures
NCQ	Native command queue
SDR	Synchronous dynamic access memory
S.M.A.R.T.	Self-monitoring, analysis and reporting technology
SSD	Solid state disk

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