PCIe 2242 M.2 SSD

MTE452T-I

Datasheet

Products

TS512GMTE452T-I
TS256GMTE452T-I
TS128GMTE452T-I

Product Description

M.2 2242, PCIe Gen3x2, B+M Key, 3D TLC, PE: 3K, Wide Temp.

Datasheet version

1.2

Transcend®

Revision History

Revision No.	History	Released Date	Editor by
1.0	First version (WD BICS4)	2020/03/03	TSD
1.1	Add 2.6 Recommended Measurement Point Revise 5.2.5 PS(Power shield) description Remove hardware purge	2020/08/18	TSD
1.2	Revise Active Power Consumption from 3.5W to 3.0W Revise Idle Power Consumption from 0.63W to 0.6W Revise 2.5 Table 5 Power Consumption Revise 8.1 Table 17 Command Table	2020/09/15	TSD

Transcend MTE452T-I Features

Part Name	Capacity
TS512GMTE452T-I	512GB
TS256GMTE452T-I	256GB
TS128GMTE452T-I	128GB

FEATURES

- PCI Express Gen3 x 2, NVMe
- 3D TLC NAND Flash
- Wide-temperature operation
- M.2 PCIe 2242 B+M Key
- DDR3 DRAM cache
- Global wear-leveling function
- Enhance Bad block management
- Power shield function
- LDPC ECC (Error correction code) functionality
- NVM command support
- Advanced Garbage Collection
- Internal RAID Engine
- Supports S.M.A.R.T. function
- Dynamic Thermal Throttling (Default)
- Self-encrypting drives(SED) with AES-256 (Optional)
- Corner Bond (Key components)

PERFORMANCE[1]

- Data Transfer Rate
  - Sequential Read   Up to 1700 MB/s
  - Sequential Write   Up to 1250 MB/s

RELIABILITY[1]

- TBW
  - 512GB   1,080TB
  - 256GB   540TB
  - 128GB   270TB

- UBER 10^{-15}
- DWPD   2 DWPD
- MTBF   3,000,000 hours
- Data Retention   1 year
- Warranty   3 years

ENVIRONMENTAL SPECIFICATIONS[1]

- Temperature
  - Operating   -40°C to 85°C
  - Non-operating   -40°C to 85°C
- Humidity(non-condensing)   5%~95%
- Shock   1500G, 0.5ms
- Vibration   20G, 7~2000Hz

POWER REQUIREMENTS[1]

- Supply voltage / Tolerance   3.3V±5%
- Active (max)   3.0W
- Idle (max)   0.6W

PHYSICAL DIMENSION

- Width   22.00±0.15mm
- Length   42.00±0.15mm
- Height(max)   3.58mm
- Weight   Up to 5g

Note:
1) For detail information, please refer to document content.

Table of Content

1. Introduction

1.1 General Feature Information

Hardware Feature
- PCI Express Gen3 x 2, NVMe
- Controller SM2263EN
- 3D TLC NAND Flash
- Wide-temperature operation from -40°C to 85°C
- M.2 PCIe 2242 B+M Key
- Embedded DDR3 DRAM cache
- Power shield function
- TCG-Opal function (Optional)
- Corner bond in key components

Firmware Feature
- Global wear-leveling function
- Enhance Bad block management function
- LDPC ECC(Error Correction Code) function
- NVM Command function
- Advanced Garbage Collection function
- StaticDataRefresh function
- Dynamic Thermal Throttling
- Internal RAID Engine
- S.M.A.R.T. function
- AES-256 function (Optional)

TS512GMTE452T-I

Software Feature
- Transcend SSD Scope Pro

1.2 Product List

Form Factor	Part Name	Capacity
2242-D2-B-M	TS512GMTE452T-I	512GB
	TS256GMTE452T-I	256GB
	TS128GMTE452T-I	128GB

1.3 Ordering Information

<u>T S</u> <u>X X X</u> <u>G</u> <u>M T E</u> <u>4 5 2</u> <u>T</u>-<u>I</u>

   1   2   3   4   5   6

1 – Transcend

2 – SSD Density

3 – G: Gigabyte; T: Terabyte

4 – M.2 PCIe device

5 – 2242 form factor with 3D TLC NAND flash

6 – Wide-temperature operation

2. Product Specifications

2.1 Interface and Compliance

- Compatible with PCI Express specification Rev. 3.1
- Compatible with NVM Express specification Rev. 1.3
- PCI Express Gen3 x 2 Lanes
- NVM command support
- RoHS Compliance
- CE, FCC and BSMI Compliance

2.2 Drive Capacity

[Table 1] User Capacity and Addressable Sectors

	128GB	256GB	512GB
User-Addressable Sectors	250,069,680	500,118,192	1,000,215,216
Byte per Sector	512 Byte		

2.3 System Performance

[Table 2] Sequential Read / Write Performance

Read / Write	128GB	256GB	512GB
Sequential Read	1700MB/s	1700MB/s	1700MB/s
Sequential Write	600MB/s	1250MB/s	900MB/s

Note: Maximum transfer speed recorded

1) 25°C, test on ASUS Z170-E, 4GB, Windows®10 64bit Professional, benchmark utility CrystalDiskMark (version 5.1.2), copied file 1000MB.

2) The recorded performance is obtained while the SSD is not operated as an OS disk Physical Specification.

[Table 3] Random Read / Write Performance

Read / Write	128GB	256GB	512GB
Random Read IOPS	100K	200K	150K
Random Write IOPS	150K	250K	230K

Note: Maximum transfer speed recorded

1) 25°C, test on ASUS Z170-E, 4GB, Windows®10 Professional, benchmark utility IOmeter 1.1.0 with 4K file size and queue depth of 32, unit IOPs

2) The recorded performance is obtained while the SSD is not operated as an OS disk Physical Specification.

2.4 Supply Voltage

[Table 4] Supply Voltage

Item	Requirements
Allowable voltage	3.3V$\pm$5%
Allowable noise / ripple	100 mV p-p or less

2.5 System Power Consumption

[Table 5] Power Consumption

Read / Write	128GB	256GB	512GB
Active Write (Max.)[1]	2.5W	3.0W	3.0W
Active Read (Max.)[1]	2.4W	2.7W	2.8W
Idle	0.6W	0.6W	0.6W

Note:

1) The power consumption is measured under SSD operation at maximum performance. The value is affected by system operation performance and workload.

2.6 Environment Specifications

[[Table 6] Environment Specification

Features	Operating[1]	Non-Operating[2]
Temperature	-40°C to 85°C	-40°C to 85°C
Temperature Gradient	60°C/Hr	60°C/Hr
Humidity	5% to 95%, non-condensing	
Shock	1500G, duration 0.5 ms, 3 axis[3]	
Vibration	20G, 7~2000Hz, 3 axis[4]	

Note:

1) The operating specification is regarded as Ambient Temperature. Standard grade (0°C to +70°C) and Industrial grade (-40°C to +85°C) indicate the temperature conditions for testing devices on programmable temperature and humidity chamber room.

2) The non-operating specification is regarded as storage specification.

3) Refer IEC 68-2-27 standard.

4) Refer IEC 68-2-6 standard

Recommended Measurement Point

Recommended temperature measurement point is in the center of the connector inserted by the device. Sufficient airflow is recommended for proper operation on heavier workloads within the device operating temperature.

20.00°
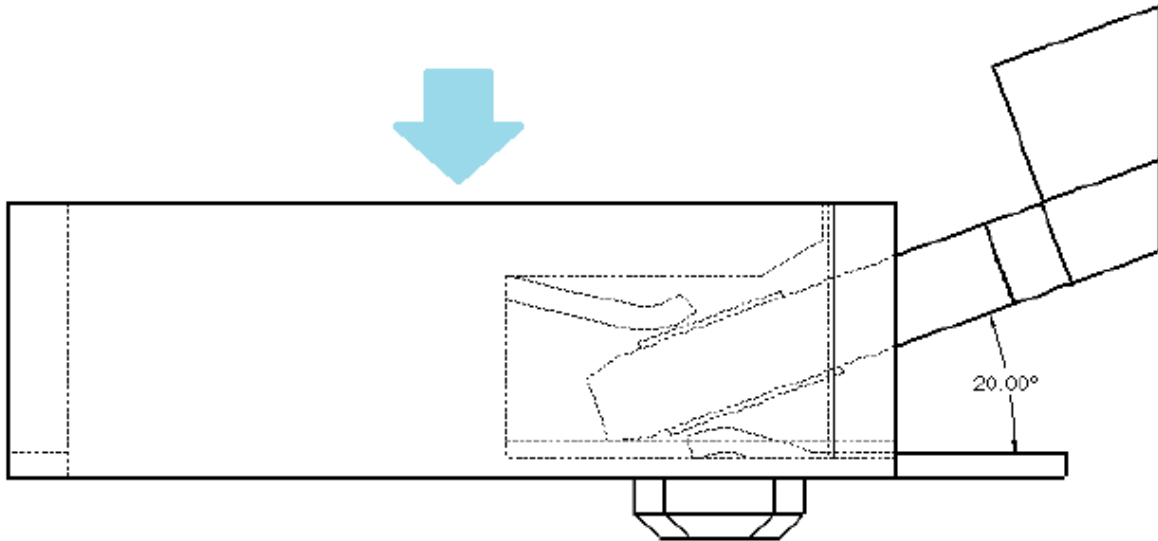
2.7   System Reliability

[Table 7] Telcordia SR332 issue 4 MTBF Specifications

Parameter	128GB	256GB	512GB
MTBF	3,000,000 hours		

Note:

1) The calculation is based on 25°C.

[Table 8] UBER Specifications

Parameter	128GB	256GB	512GB
UBER	10^{-15}		

Note:

1) Uncorrectable Bit Error Rate (UBER) is a metric for the rate of occurrence of data errors, equal to the number of data errors per bits read as specified in the JESD218 document of JEDEC standard. For the client application, JEDEC recommends that UBER shall be below 10^{-15}.

[Table 9] TBW (Terabytes Written) Specifications

Parameter	128GB	256GB	512GB
TBW	270TB	540TB	1080TB

Note:

1) TBW specification follows JESD219A Client workload.

[Table 10] Drive Write Per Day (DWPD) Specifications

Parameter	128GB	256GB	512GB
DWPD[1]	2 (3 Years)		

Note:

1)   DWPD is based on [Table 13] Warranty year to calculate.

[Table 11] Data Retention Specifications

Parameter	128GB	256GB	512GB
Data Retention	1 year		

Note:

1) Data retention was measured by assuming that SSD reaches the maximum rated endurance at 30°C under power-off state.

2) The data retention is defined in JESD218 Requirements for standard classes of SSDs.

[Table 12] Power On to Ready

Parameter	128GB	256GB	512GB
Setup time	9.41 s[1]		

Note:

1) Tested by using Drive Master and power on to ready with proper shutdown condition.

## [Table 13] Warranty

Parameter	128GB	256GB	512GB
Warranty	3 years limited		

[Table 14] Regulations

Parameter	128GB	256GB	512GB
Compliance	CE, FCC and BSMI		

3. Mechanical Specification

The figure below illustrates the Transcend M.2 Type 2242-D2-B-M Solid State Drive.

[Table 15] Physical Dimensions and Weight

Model	Height (mm)	Width (mm)	Length (mm)	Weight (gram)
128GB/256GB/512GB	Max 3.58	22.00±0.15	42.00±0.15	Max 5g
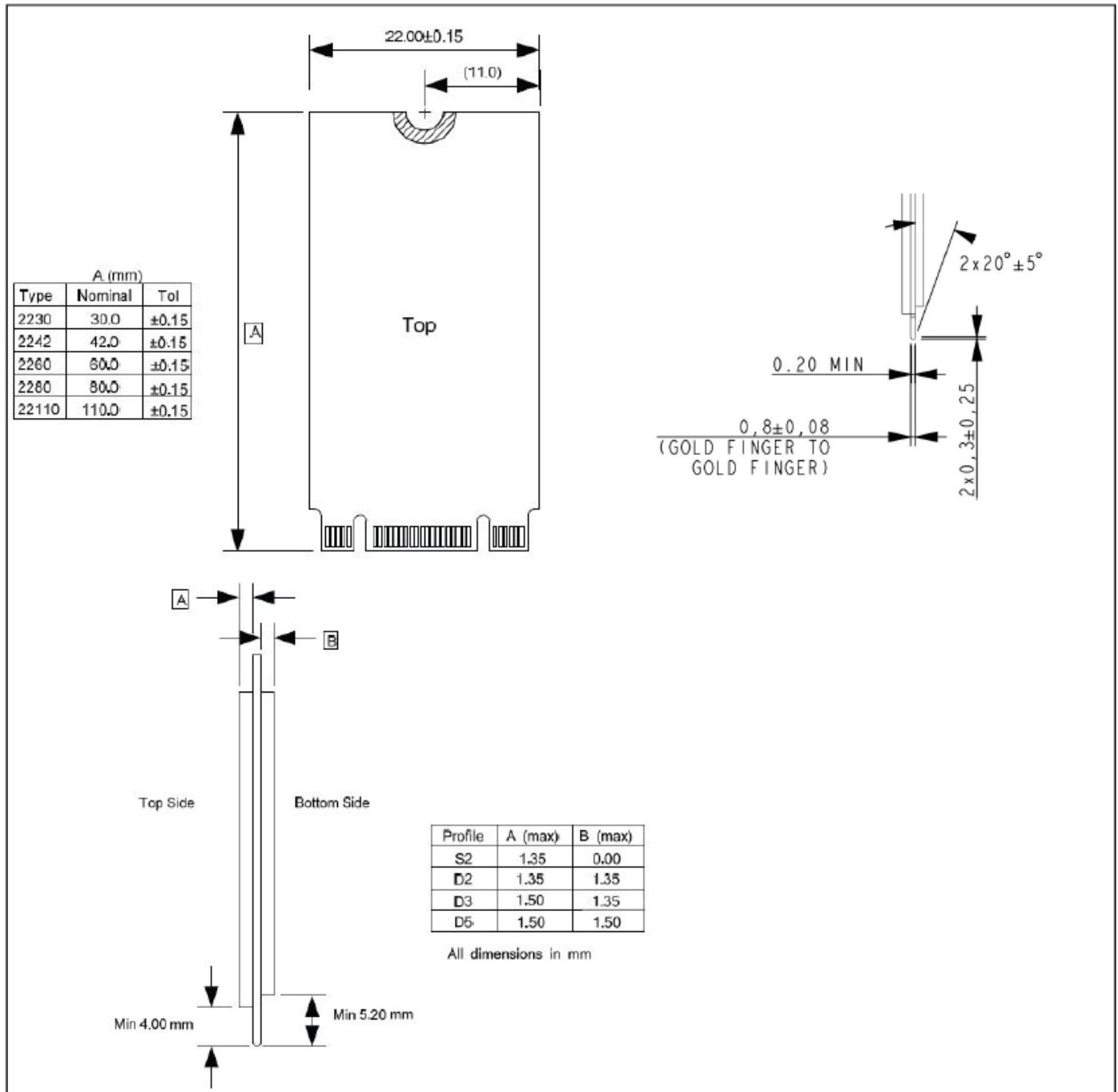
4. Pin Assignments

4.1 Pin Assignments

[Table 16] Pin Assignments

Pin No.	Pin Name	Pin No.	Pin Name	Pin No.	Pin Name	Pin No.	Pin Name
01	GND	02	3.3V	39	GND	40	NC
03	GND	04	3.3V	41	PETn0	42	NC
05	NC	06	NC	43	PETp0	44	NC
07	NC	08	NC	45	GND	46	NC
09	GND	10	LED1	47	PERn0	48	NC
11	NC	12	NOTCH	49	PERp0	50	PERST#
13	NOTCH	14	NOTCH	51	GND	52	CLKREQ#
15	NOTCH	16	NOTCH	53	REFCLKN	54	NC
17	NOTCH	18	NOTCH	55	REFCLKP	56	NC
19	NOTCH	20	NC	57	GND	58	NC
21	GND	22	NC	59	NOTCH	60	NOTCH
23	NC	24	NC	61	NOTCH	62	NOTCH
25	NC	26	NC	63	NOTCH	64	NOTCH
27	GND	28	NC	65	NOTCH	66	NOTCH
29	PETn1	30	NC	67	NC	68	NC
31	PETp1	32	NC	69	NC	70	3.3V
33	GND	34	NC	71	GND	72	3.3V
35	PERn1	36	NC	73	GND	74	3.3V
37	PERp1	38	NC	75	GND		

Note:
1) NC. Do not connect.

5. Block Diagram and Function Explanations

5.1 Block Diagram
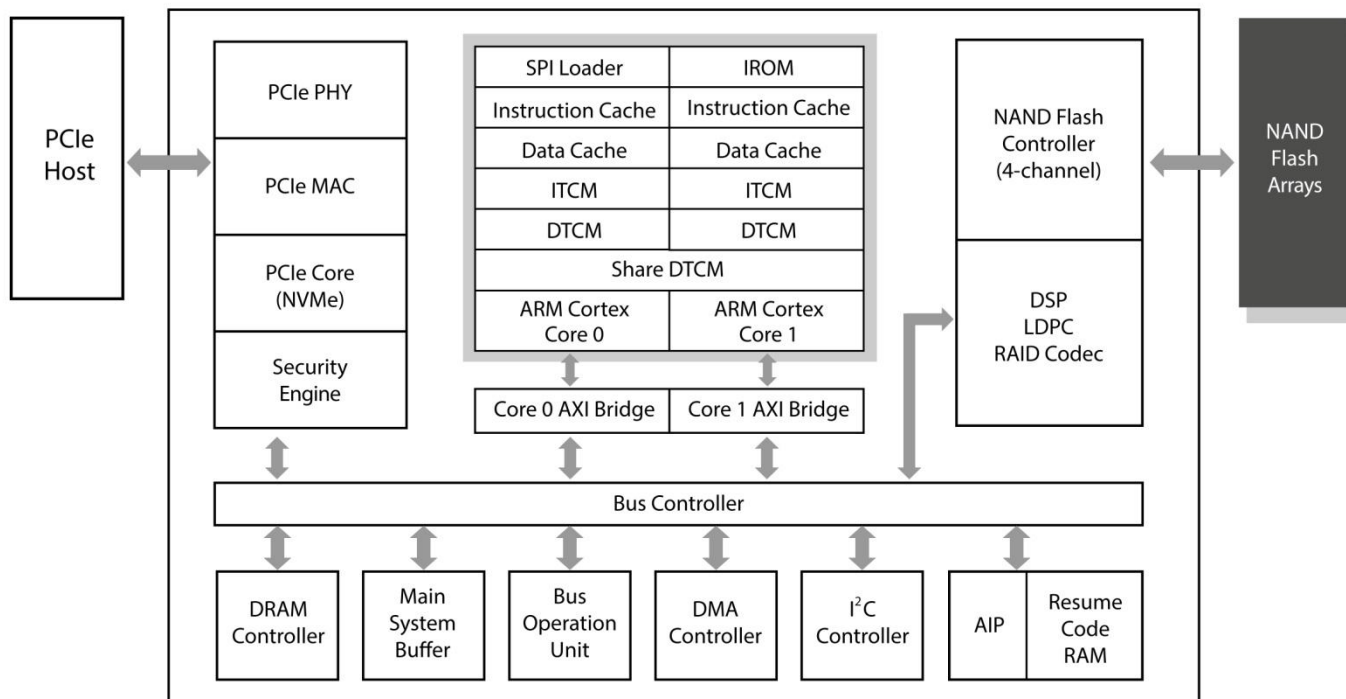
5.2 Function Explanations

5.2.1 Global Wear Leveling Function

Global wear leveling ensures that every block has an even erase count. This helps to extend the life expectancy of an SSD.

There are three main processes in global wear leveling:

(1) Record the block erase count and save this in the wear-leveling table.

(2) Find the static-block and save this in the wear-leveling pointer.

(3) Check the erase count when a block is pulled from the pool of spare blocks. If the block erase count is larger than WEARCNT, then swap the static-block and the over-count-block.

5.2.2 Bad Block Management Function

When the flash encounters ECC fail, program fail or erase fail, the controller will mark the block as a bad block. This will prevent the usage of bad blocks which may result in data loss in the future.

5.2.3 Enhanced S.M.A.R.T. function

Transcend SSD supports S.M.A.R.T. command (Self-Monitoring, Analysis, and Reporting Technology) that allows users to read the health information of the SSD. Transcend also define some innovated S.M.A.R.T. features which allows the user to evaluate the status of the SSD in a much more efficient way.

5.2.4 StaticDataRefresh Technology

Normally, ECC engine corrections are taken place without affecting the host normal operations. As time passes by, the number of error bits accumulated in the read transaction exceeds the correcting capability

of the ECC engine, resulting in corrupted data being sent to the host. In order to prevent such occurrence, the controller monitors the error bit levels at each read operation; when it reaches the preset threshold value, the controller automatically performs data refresh to "restore" the correct charge levels in the cell. This implementation practically restores the data to its original, error-free state, and hence lengthening data life.

5.2.5 PS(Power shield) Function

Power Shield (PS) is a basic technology supported by all Transcend's embedded SSDs to prevent internal NAND flash data loss in event of a sudden power outage. The internal voltage detection circuit (VDT) of the controller monitors the external power supply. When the external voltage drops from 5V to 4V or from 3.3V to 2.7V, the VDT activates the PS detection mechanism. When a sudden power outage occurs, the internal power shield circuit would trigger the PS function so that the controller will stop accepting new write commands. The write operation is terminated to ensure that the firmware and the data in the NAND flash are undamaged.

When the external voltage drops to a certain level, the internal voltage detection circuit (VDT) of the controller activates the PS mechanism. The SSD controller then stops accepting new write commands from the host, ensuring the integrity of existing data for the NAND flash.

The PS function ensures the safety of the data which has already been written into the flash before sudden power outage.

5.2.6 AES-256 Function(Optional)

Defined by the National Institute of Standards and Technology (NIST) under the Federal Information Processing Standards Publication 197 (FIPS PUB 197), the Advanced Encryption Standard (AES) specifies a FIPS-approved cryptographic algorithm that can be used to protect electronic data.

Transcend Information's SSDs, equipped with hardware-based AES-256 encryption, offer superior data protection and performance compared to competing offerings that utilize software-based or firmware-based encryption. With hardware-based encryption, all data are encrypted before being stored in NAND Flash. After the encrypted data has been written into the flash, it becomes virtually impossible to decrypt the data without the original key. Performance is also improved as compared to software-based solutions, since hardware-based encryption does not require system resources to perform the encryption/decryption process.

5.2.7 TCG-Opal Function(Optional)

Opal is a comprehensive set of guidelines. The target audience includes manufacturers of storage devices, software vendors, system integrators, and academia. These specifications cover the manufacture of storage devices, system setup, management, and use; they allow for password protection and hierarchical storage management, while preventing data from being stolen or tampered with.

They are self-encrypting devices: Data encryption is performed on the device, without need to pass through the host. The encryption key is also stored on the device (commonly AES is utilized).

(1) Features boot authentication:

When the user starts the device, the shadow MBR will conduct a pre-boot identification; where the user is cleared, the normal boot process will begin and connections to the devices are to be made.

(2) Sector specific permissions:

The device manager may create a logical block address (LBA) range and assign different permissions for each LBA range. Only users with the correct key for a particular LBA range may perform permitted actions. Where drive locations are password-protected, only users with the correct key will be authorized entry.

5.2.8 RAID engine

RAID engine technology stores data parity information in a specific area. The parity information can restore damaged data back which can enhance data reliability.

5.2.9 Dynamic Thermal Throttling

For PCIe SSD applications, when operation temperature increases, system CLK will decrease to protect the SSD and controller with dynamic thermal throttling algorithm. The read/write speeds of the SSD will change at different temperature levels in order to extend its lifespan.

5.2.10 Transcend SSD Scope Pro

Transcend's SSD Scope Pro is a convenient software package that helps users monitor and manage SSD status via an intuitive interface. It offers various useful features, including drive information and S.M.A.R.T. status monitoring, diagnostic scan, secure erase, health indication, system clone, and monitoring. For more information, please refer the website link. **https://us.transcend-info.com/Embedded/Essay-20**

5.2.11 Corner Bond (Key Components)

Corner bond is used as a stress relieving agent, evenly distributing the expansion and contraction effects. By spreading stresses throughout the chip and PCB interface with a mechanical bond, less stress is concentrated on the solder joints, increasing device reliability.

5.2.12 Other Functions

Transcend SSD embedded a lot of cutting-edge technology. Should you have any technical request, please contact the local support team or send us an e-mail.

6 Technology Term Explanations

6.1 TBW

Terabytes Written (TBW) directly measures how much you can write cumulatively into the drive over its lifetime. Essentially, it just includes the multiplication conducted above in the measurement itself.

For example, if your drive is rated for 365 TBW, that means you can write 365 TB into it before a replacement is required.

If its warranty period is 5 years, that works out to 365 TB ÷ (5 years × 365 days/year) = 200 GB of writes per day. If your drive was 200 GB in size, that's equivalent to 1 DWPD. Correspondingly, if your drive was rated for 3.65 PBW = 3,650 TBW, that works out to 2 TB of writes per day, or 10 DWPD.

As you can see, if you know the drive's size and warranty period, you can always calculate TBW from DWPD and vice-versa with simple multiplications or divisions. The two measurements are very similar.

6.2 DWPD

Drive Writes Per Day (DWPD) measures how many times you could overwrite the drive's entire size each day of its life. For example, suppose your drive is 200 GB and its warranty period is 5 years. If its DWPD is 1, that means you can write 200 GB (its size, one time) into it every single day for the next five years.

If you multiply that out, that's 200 GB per day × 365 days/year × 5 years = 365 TB of cumulative writes before you may need to replace it.

If the DWPD is 10 instead of 1, that means you can write 10 × 200 GB = 2 TB (its size, ten times) into it every day. Correspondingly, that's 3,650 TB = 3.65 PB of cumulative writes over 5 years.

6.3 MTBF – Telcordia SR-332

MTBF (mean time between failures) is a measure of how reliable a hardware product or component is. For most components, the measurement is typically in thousands or even tens of thousands of hours between failures. For example, a SSD may have a mean time between failures of 200,000 hours. A desired MTBF can be used as a quantifiable objective when designing a new product. The MTBF figure can be developed as the result of intensive testing, based on actual product experience, or predicted by analyzing known factors. The manufacturer may provide it as an index of a product's or component's reliability and, in some cases, to give customers an idea of how much service to plan for. In Transcend MTBF data, we use Telcordia SR-332 Issue 4 method to do estimated calculation.
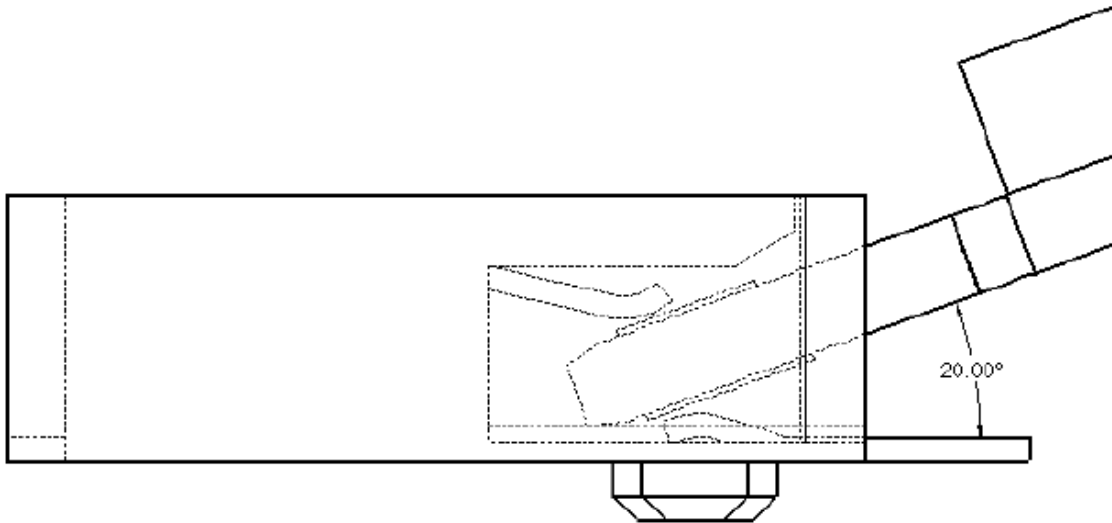
7 Installation Requirements

7.1 Card Insertion

Angles insertion is allowable and preferred; the intention is to minimize the insertion/extraction force.

● Minimum of angle of insertion is 5°

Minimum two step insertion is desirable; the intention is to minimize the insertion/extraction force.

8 Command Descriptions

8.1 Support Admin Command Register

The Admin command set is the commands that are submitted to the Admin Submission Queues. The detailed specifications are described in NVM Express specification document.
[Table 17] Command Table

Command Name	Code (Hex)
Delete I/O Submission Queue	00h
Create I/O Submission Queue	01h
Get Log Page	02h
Delete I/O Completion Queue	04h
Create I/O Completion Queue	05h
Identify	06h
Abort	08h
Set Features	09h
Get Features	0Ah
Asynchronous Event Request	0Ch
Namespace Management	0Dh
Firmware Commit	10h
Firmware Image Download	11h
Namespace Attachment	15h
Keep Alive	18h
I/O Command Set Specific	80h – BFh
Vendor Specific	C0h – FFh

8.2 SMART / Health Log Page

[Table 18] SMART Data information

BYTE	Description		Default Value
0	Critical Warning		0
	Bits	Description	
	07:05	Reserved	
	04	If set to'1', then the volatile memory backup device has failed. This field is only valid if the controller has a volatile memory backup solution.	
	03	If set to'1', then the media has been placed in read only mode.	
	02	If set to'1', then the NVM subsystem reliability has been degraded due to significant media related errors or any internal error that degrades NVM subsystem reliability.	
	01	If set to'1', then a temperature is above an over temperature threshold or below an under temperature threshold.	
	00	If set to'1', then the available spare has fallen below the threshold.	
2:1	Composite Temperature		Current temperature
3	Available Spare		100
4	Available Spare Threshold		10
5	Percentage Used		0
31:6	Reserved		-
47:32	Data Units Read		0
63:48	Data Units Written		0
79:64	Host Read Commands		0
95:80	Host Write Commands		0
111:96	Controller Busy Time		0
127:112	Power Cycles		0
143:128	Power On Hours		0
159:144	Unsafe Shutdowns		0
175:160	Media and Data Integrity Errors		0
191:176	Number of Error Information Log Entries		0
195:192	Warning Composite Temperature Time		0
199:196	Critical Composite Temperature Time		0

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