SATA III 2280 M.2 SSD

MTS970TI-VS1

Datasheet

Products	Product Description
TS4TMTS970TI-VS1	M.2 2280 SSD, SATA3 B+M Key, 3D TLC BiCS5, PE: 3K, Wide temp.
TS2TMTS970TI-VS1	
TS1TMTS970TI-VS1	**Datasheet version**
TS512GMTS970TI-VS1	1.0
TS256GMTS970TI-VS1	
TS128GMTS970TI-VS1	

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Revision History

Revision No.	History	Released Date	Editor by
1.0	First version (WD BICS5)	2024/08/22	PM

Transcend MTS970TI-VS1 Features

Part Name	Capacity
TS4TMTS970TI-VS1	4TB
TS2TMTS970TI-VS1	2TB
TS1TMTS970TI-VS1	1TB
TS512GMTS970TI-VS1	512GB
TS256GMTS970TI-VS1	256GB
TS128GMTS970TI-VS1	128GB

FEATURES

- SATA 6Gbps
- 3D TLC NAND Flash
- M.2 SATA 2280 B+M Key
- DDR3 DRAM cache
- Global wear-leveling function
- Enhance Bad block management
- Power shield function
- LDPC ECC (Error correction code) functionality
- TRIM and NCQ command function
- Advanced Garbage Collection
- Internal RAID Engine
- Supports S.M.A.R.T. Function
- PCB Gold Finger 30u”
- Dynamic Thermal Throttling (Default)
- Supports DEVSLP mode (Optional)
- Self-encrypting drives(SED) with AES-256 (Optional)
- Corner Bond (Controller / DRAM Chip)
- Anti-sulfur resistor

PERFORMANCE[1)]

- Data Transfer Rate
  - Sequential Read Up to 560 MB/s
  - Sequential Write Up to 520 MB/s

RELIABILITY[1)]

- TBW
  - 4TB 9680TB
  - 2TB 4840TB
  - 1TB 2420TB
  - 512GB 1210TB
  - 256GB 514TB
  - 128GB 259TB
- UBER 10^{-15}
- DWPD Up to 2.21DWPD
- MTBF 3,000,000 hours
- Data Retention 1 year
- Warranty 3 years

ENVIRONMENTAL SPECIFICATIONS[1)]

- Temperature
  - Operating -40°C to 85°C
  - Non-operating -55°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) 4.1W
- Idle (max) 1.2W

PHYSICAL DIMENSION

- Width 22.00±0.15mm
- Length 80.00±0.15mm
- Height(max) 3.58mm
- Weight 9g

Note:

1) For detail information, please refer to document content

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1. Introduction

1.1 General Feature Information

Hardware Feature

- SATA 6Gbps
- Controller SM2259H-AC
- 3D TLC NAND Flash
- Temperature operation from -40°C to 85°C
- M.2 SATA 2280 B+M Key
- Embedded DDR3 DRAM cache
- Power shield function
- PCB Gold Finger 30u”
- TCG-Opal function (Optional)
- Corner bond(Controller / DRAM Chip)
- Anti-sulfur resistor

Firmware Feature

- Global wear-leveling function
- Early Move function
- Read Retry function
- Enhance Bad block management function
- LDPC ECC(Error Correction Code) function
- TRIM Command function
- Advanced Garbage Collection function
- StaticDataRefresh function
- Internal RAID Engine
- S.M.A.R.T. Function
- Dynamic Thermal Throttling (Default)
- DEVSLP mode (Optional)
- AES-256 function (Optional)

Software Feature

- Transcend Scope Pro
- Transcend Control Center
- Transcend One Touch Recovery

1.2 Product List

Form Factor	Part Name	Capacity
2280-D2-B-M	TS4TMTS970TI-VS1	4TB
	TS2TMTS970TI-VS1	2TB
	TS1TMTS970TI-VS1	1TB
	TS512GMTS970TI-VS1	512GB
	TS256GMTS970TI-VS1	256GB
	TS128GMTS970TI-VS1	128GB

1.3 Ordering Information

TS XXX G MTS 970TI-VS1

1 2 3 4 5

1 – Transcend
2 – SD Density
3 – G: Gigabyte; T: Terabyte
4 – M.2 SATA device
5 – 2280 form factor with 3D TLC NAND flash
PCB Gold Finger 30u”
Temperature operation from -40°C to 85°C
Temperature storage from -55°C to 85°C
Default Dynamic Thermal Throttling
Corner bond(Controller / DRAM Chip)
Anti-sulfur resistor
Wide-temperature operation

2. Product Specifications

2.1 Interface and Compliance

- SATA3, compatible to SATA2 and SATA1
- Compatible with ATA/ATAPI-7 Standard
- Native Command Queuing(NCQ) Command Set
- RoHS Compliance
- CE, UKCA, 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		

	1TB	2TB	4TB
User-Addressable Sectors	2,000,409,264	4,000,797,360	8,001,573,552
Byte per Sector	512 Byte		

2.3 System Performance

[Table 2] Sequential Read / Write Performance

Read / Write	128GB	256GB	512GB	1TB	2TB	4TB
Sequential Read	550MB/s	560MB/s	560MB/s	560MB/s	560MB/s	560MB/s
Sequential Write	400MB/s	490MB/s	520MB/s	520MB/s	520MB/s	520MB/s

Note: Maximum transfer speed recorded

1) 25°C, test on GIGABYTE GA-Z87X-D3H, 4GB, Windows® 7 Professional with AHCI mode, benchmark utility CrystalDiskMark (version 6.0.2), 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	1TB	2TB	4TB
Random Read IOPS	40K	70K	90K	90K	90K	90K
Random Write IOPS	75K	80K	85K	85K	85K	80K

Note: Maximum transfer speed recorded

1) 25°C, test on GIGABYTE GA-Z87X-D3H, 4GB, Windows® 7 Professional with AHCI mode, benchmark utility IOmeter2006 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±5%
Allowable noise / ripple	100 mV p-p or less

2.5 System Power Consumption

[Table 5] Power Consumption

Read / Write	128GB	256GB	512GB	1TB	2TB	4TB
Active Write (Max.)[1)]	2.6W	3.1W	3.6W	3.8W	4.0W	4.1W
Active Read (Max.)[1)]	2.3W	3.0W	3.1W	3.3W	3.4W	2.8W
Idle	1.0W	1.0W	1.1W	1.2W	1.2W	1W
DEVSLP	5mW					

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	-55°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. Extended grade (-20°C to +75°C) and Industrial grade (-40°C to +85°C) indicate the temperature conditions for testing devices on programmable temperature and humidity chamber room.

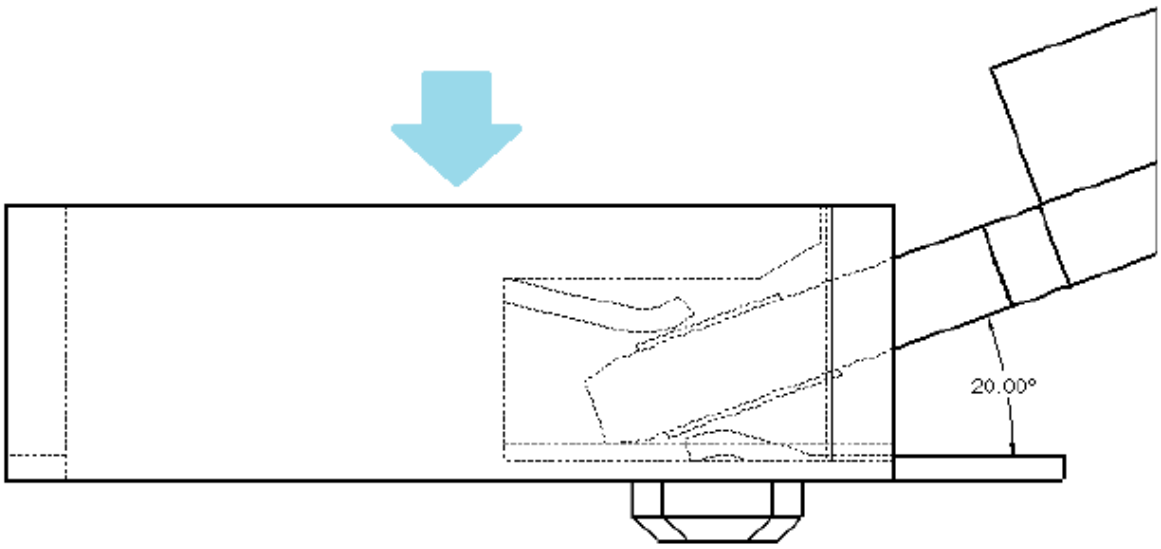
2) The non-operating specification is regarded as storage specification.

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.



2.7 System Reliability

[Table 7] Telcordia SR332 issue 4 MTBF Specifications

Parameter	128GB	256GB	512GB	1TB	2TB	4TB
MTBF	3,000,000 hours					

Note:

1) The calculation is based on 25°C.

[Table 8] UBER Specifications

Parameter	128GB	256GB	512GB	1TB	2TB	4TB
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	1TB	2TB	4TB
TBW	259 TB	514 TB	1210 TB	2420 TB	4840 TB	9680 TB

Note:

1) TBW specification follows JESD219A Client workload.

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

Parameter	128GB	256GB	512GB	1TB	2TB	4TB
DWPD[1)]	1.84	1.83	2.16	2.21	2.21	2.21

Note:

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

[Table 11] Data Retention Specifications

Parameter	128GB	256GB	512GB	1TB	2TB	4TB
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	1TB	2TB	4TB
Setup time	0.23 s					

[Table 13] Warranty

Parameter	128GB	256GB	512GB	1TB	2TB	4TB
Warranty	3 years limited					

[Table 14] Regulations

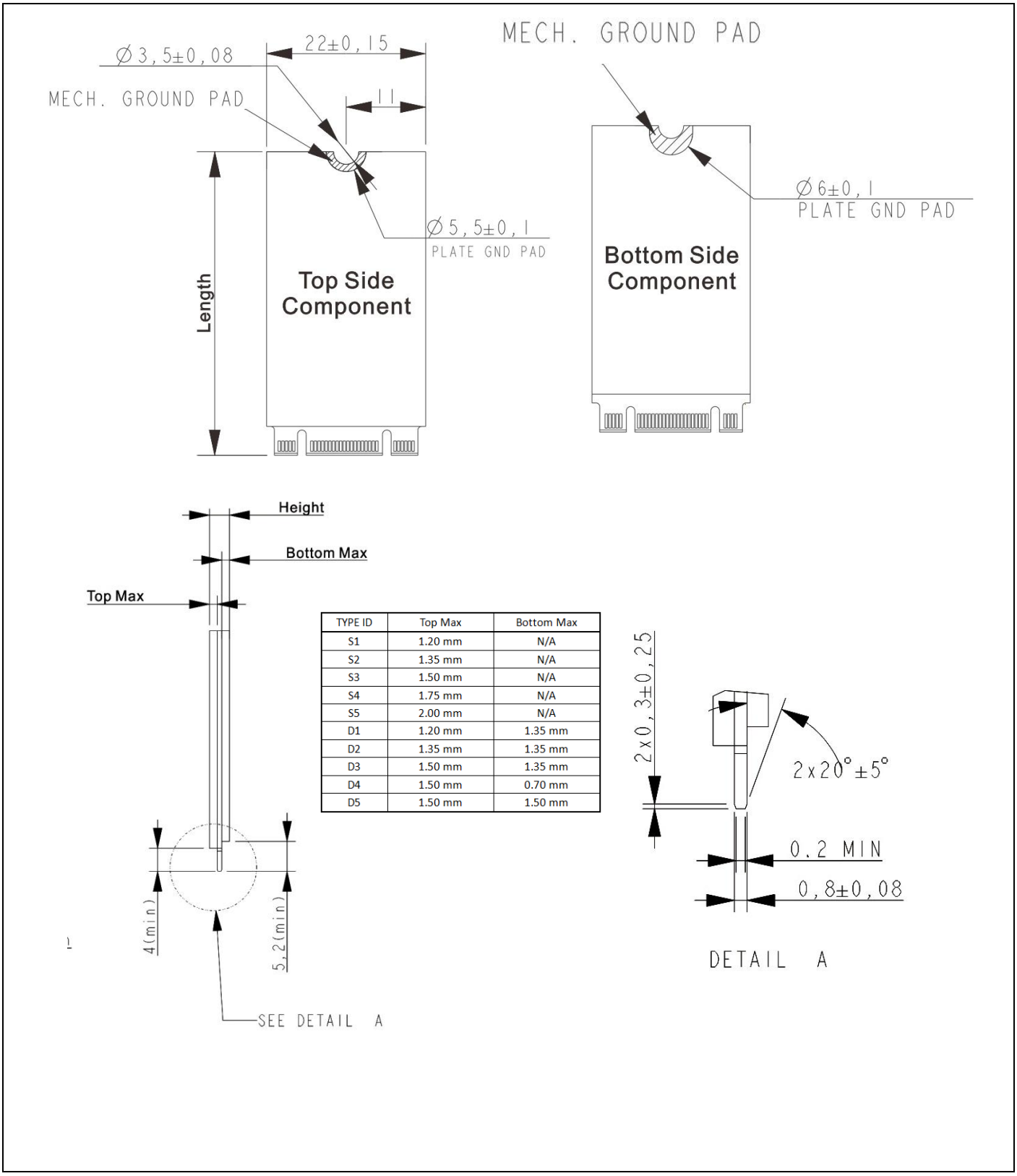
Parameter	128GB	256GB	512GB	1TB	2TB	4TB
Compliance	CE, UKCA, FCC and BSMI					

3. Mechanical Specification

The figure below illustrates the Transcend M.2 Type 2280-D2-B-M Solid State Drive.

[Table 15] Physical Dimensions and Weight

Model	Height (mm)	Width (mm)	Length (mm)	Weight (gram)
128GB/256GB/512GB/1TB/2TB/4TB	Max 3.58	22.00±0.15	80.00±0.15	Max 9g



4. Pin Assignments

4.1 Pin Assignments

[Table 16] Pin Assignments

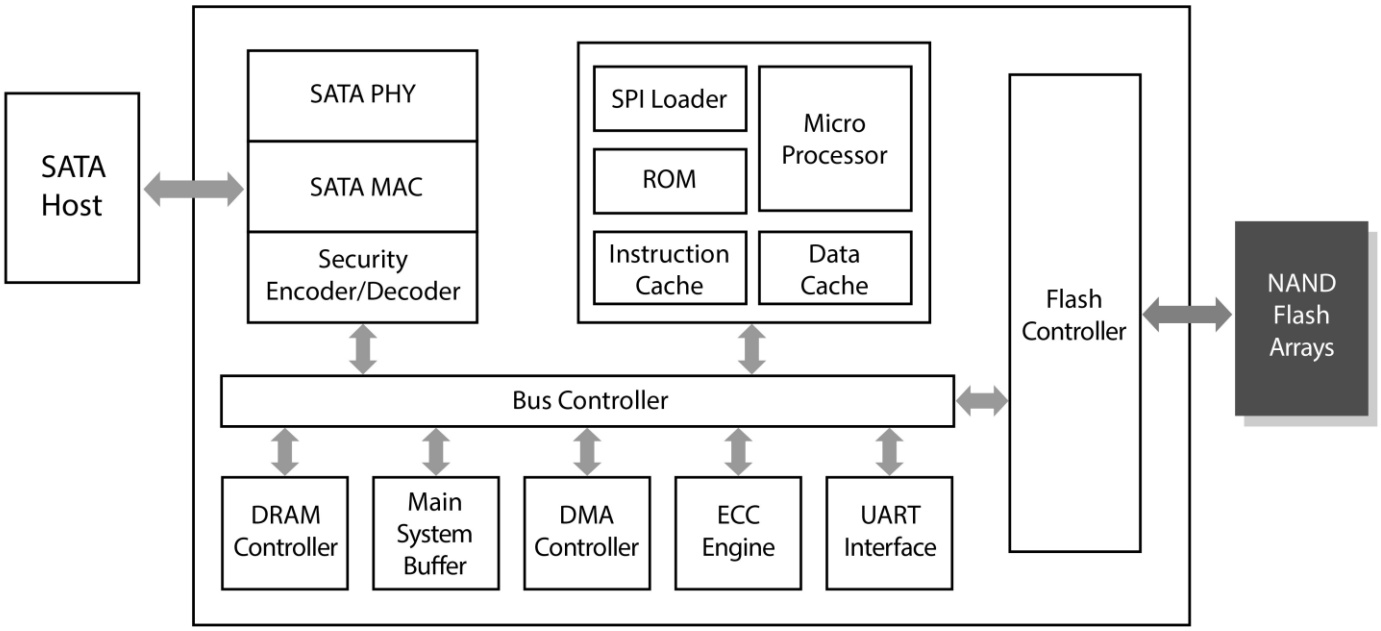
Pin No.	Pin Name	Pin No.	Pin Name	Pin No.	Pin Name	Pin No.	Pin Name
01	CONFIG_3[1)]	02	3.3V	39	GND	40	NC
03	GND	04	3.3V	41	TX+	42	NC
05	NC	06	NC	43	TX-	44	NC
07	NC	08	NC	45	GND	46	NC
09	NC	10	DAS/DSS[2)]	47	RX-	48	NC
11	NC	12	NOTCH	49	RX+	50	NC
13	NOTCH	14	NOTCH	51	GND	52	NC
15	NOTCH	16	NOTCH	53	NC	54	NC
17	NOTCH	18	NOTCH	55	NC	56	MFG1[4)]
19	NOTCH	20	NC	57	GND	58	MFG2[4)]
21	CONFIG_0[1)]	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	NC	30	NC	67	NC	68	NC
31	NC	32	NC	69	CONFIG_1[1)]	70	3.3V
33	GND	34	NC	71	GND	72	3.3V
35	NC	36	NC	73	GND	74	3.3V
37	NC	38	DEVSLP[3)]	75	CONFIG_2[1)]		

Note:

1) For SATA M.2 SSD, these pins are connected to GND internally.
2) Device Activity Signal / Disable Staggered Spin-up
3) Device Sleep is an input pin. If driven high, the host is informing the SSD to enter a low power state.
4) Manufacturing pins. 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 DEVSLP Function(Optional)

DevSlp or DevSleep (regarded as device sleep or SATA DEVSLP) is a feature in SATA SSD which allows them to go into a low power "device sleep" mode when sent the appropriate signal, which uses one or two orders of magnitude less power than a traditional idle (about 5 mW). This function can help save battery power in platform idle, so that the user can operate the platform for longer time.

5.2.7 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.

5.2.8 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.

1) Customized firmware settings are required to support the hardware purge pin.

5.2.9 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.

5.2.10 Dynamic Thermal Throttling

For 3D TLC 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.

5.2.11 Transcend Scope Pro

Transcend's 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**

5.2.12 Early Move Function

Early move detects and corrects potential data errors. If error bits in a block reach upper limit, then the data should be moved to another block and the original block should be erased.

5.2.13 Read Retry Function

Read retry is designed for flash memory to adjust the read reference voltage and eliminate the read error.

5.2.14 Corner Bond (Controller / DRAM Chip)

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.

5.2.15 Anti-sulfur resistor

To prevent sulfurization, resistors should be made sulfur-resistant. Transcend`s anti-sulfur approach is to cover and therefore isolate the electrode, thus preventing hydrogen sulfide from coming into contact with the silver. Atmospheric sulfur is on the rise due to increasing levels of pollution, and the applications for anti-sulfur components are increasing. Transcend's anti-sulfur SSD modules all meet level G2 of ISA Standard S71.04-2013 and ASTM B809-95 standard, suitable for the Industrial Revolution 4.0, the Internet of Things, and the Internet of Vehicles, where the use of anti-sulfur technology is highly required.

5.2.16 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 – Telcorida SR332

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

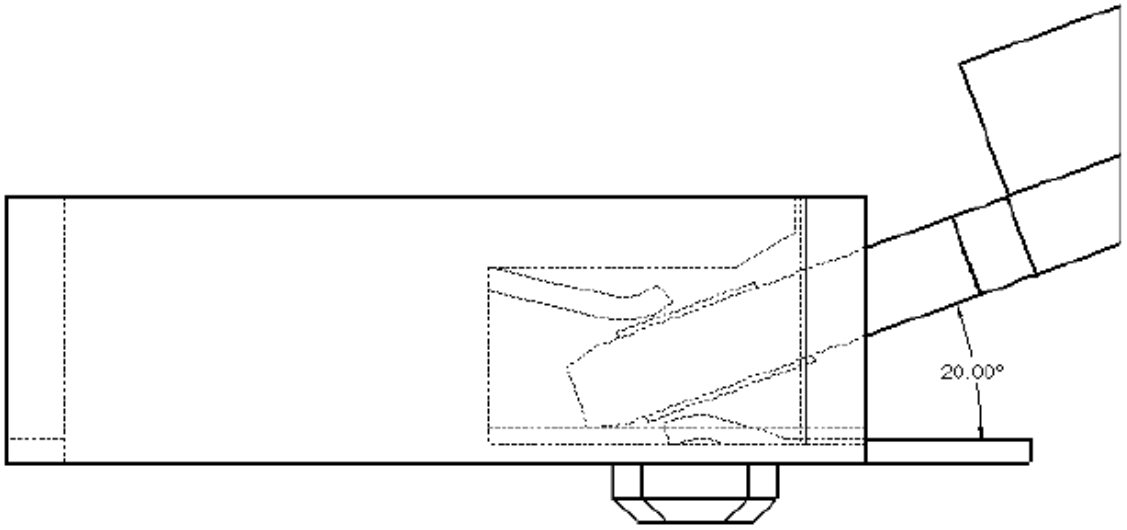
Angles insertion is allowable and preferred; the intention is to minimize the insertion/extraction force.

- Minimum of angle of insertion is 5°

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

M.2 Screw Selection Suggestion: (Reference Only)

- Please refer chapter 3: Mechanical Specification
- M2 or M3 screw matching stand-off.
- Screw head diameter: not exceed 5mm
- Tightening Torques: 0.8 kgf
- Please refer to the specifications of the locked object for its torque and screw length, since the specifications of the copper pillars of the locked object are different.



8. Command Descriptions

8.1 Support ATA Commands

This table and the following paragraphs summarize the ATA command set.

[Table 17] ATA Command Table

Support ATA/ATAPI Command	Code	Subcode / Page
NOP	00h	
Data Set Management	06h	
Trim		01h
Recalibrate	1Xh	
Read Sectors	20h	
Read Sectors (w/o retry)	21h	
Read Sectors Ext	24h	
Read DMA Ext	25h	
Read Native Max Address Ext	27h	
Read Multiple Ext	29h	
Read Log Ext	2Fh	
Log Directory		00h
Extended Comprehensive SMART Error Log		03h
Device Statistics Logs		04h
List of supported log pages		00h
General Statistics		01h
General Errors Statistics		04h
Transport Statistics		06h
SSD Statistics		07h
Extended SMART Self-test Log		07h
NCQ Error Log		10h
SATA Phy Event Counters Log		11h
Identify Device Data Log		30h
List of Supported Pages		00h
Copy of IDENTIFY DEVICE Data		01h
Capacity		02h
Supported Capabilities		03h
Current Settings		04h
ATA Strings		05h
Security		06h
Serial ATA		08h
Write Sectors	30h	
Write Sectors Ext	34h	
Write DMA Ext	35h	

Set Max Address Ext	37h	
Write Multiple Ext	39h	
Write DMA FUA Ext	3Dh	
Write Log Ext	3Fh	
Selective Self-Test log(SMART)		09h
Host Specific(SMART)		80h~9Fh
SCT Command/Status(SCT)		E0h
SCT Data Transfer(SCT)		E1h
Read Verify Sectors	40h	
Read Verify Sectors (w/o retry)	41h	
Read Verify Sectors Ext	42h	
Write Uncorrectable Ext	45h	
Pseudo-UECC with logging		55h
Read FPDMA Queued	60h	
Write FPDMA Queued	61h	
Seek	7Xh	
Execute Device Diagnostic	90h	
Initialize Drive Parameters	91h	
Download Microcode	92h	
Download with offsets and save microcode for immediate and future use.		03h
Download (without offsets) and save microcode		07h
Download with offsets and save microcode for future use / Activate downloaded microcode		0Eh/0Fh
SMART	B0h	
Read Data		D0h
Read Thresholds		D1h
Enable/Disable Attr Autosave		D2h
Exec Off-line Immediate		D4h
Execute Off-Line routine		00h
Execute Short Self-test routine (Off-Line)		01h
Execute Extended Self-test routine (Off-Line)		02h
Abort Off-Line Self-test routine		7Fh
Execute Short Self-test routine (Captive)		81h
Execute Extended Self-test routine (Captive)		82h
Read Log Sector		D5h
Write Log Sector		D6h
Enable Operations		D8h
Disable Operations		D9h
Return Status		Dah
Sanitize Device	B4h	

Sanitize Status Ext		00h
Block Erase Ext		12h
Sanitize Freeze Lock Ext		20h
Read Multiple	C4h	
Write Multiple	C5h	
Set Multiple Mode	C6h	
Read DMA	C8h	
Read DMA (w/o retry)	C9h	
Write DMA	CAh	
Write DMA (w/o retry)	CBh	
Write Multiple FUA Ext	CEh	
Standby Immediate	E0h	
Idle Immediate	E1h	
Standby	E2h	
Idle	E3h	
Read Buffer	E4h	
Check Power Mode	E5h	
Sleep	E6h	
Flush Cache	E7h	
Write Buffer	E8h	
Flush Cache Ext	EAh	
Identify Device	ECh	
Set Features	EFh	
Security Set Password	F1h	
Security Unlock	F2h	
Security Erase Prepare	F3h	
Security Erase Unit	F4h	
Security Freeze Lock	F5h	
Security Disable Password	F6h	
Read Native Max Address	F8h	
Set Max Address	F9h	
Set Max Set Password		01h
Set Max Lock		02h
Set Max Unlock		03h
Set Max Freeze Lock		04h
Set Max Set Password DMA		05h
Set Max Unlock DMA		06h

8.2 SMART Data Structure

[Table 18] SMART Data Structure

BYTE	F / V	Description
0-1	X	Revision code
2-361	X	Vendor specific
362	V	Off-line data collection status
363	X	Self-test execution status byte
364-365	V	Total time in seconds to complete off-line data collection activity
366	X	Vendor specific
367	F	Off-line data collection capability
368-369	F	SMART capability
370	F	Error logging capability 7-1 Reserved 0 1=Device error logging supported
371	X	Vendor specific
372	F	Short self-test routine recommended polling time (in minutes)
373	F	Extended self-test routine recommended polling time (in minutes)
374	F	Conveyance self-test routine recommended polling time (in minutes)
375-385	R	Reserved
386-395	F	Firmware Version/Date Code
396-399	F	Reserved
400-409	V	SMI2259TLC
410-510	X	Vendor specific
511	V	Data structure checksum

Note:

1) F = content (byte) is fixed and does not change.
2) V= content (byte) is variable and may change depending on the state of the device or the commands executed by the device.
3) X= content (byte) is vendor specific and may be fixed or variable.
4) R= content (byte) is reserved and shall be zero.

8.3 SMART Attributes

The following table shows the vendor specific data in byte 2 to 361 of 512-byte SMART data.

[Table 19] SMART Attributes

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
94	LSB	-	-	MSB	00	00	00	SLC Total Erase Count
95	LSB	-	-	MSB	00	00	00	SLC Max Erase Count
96	LSB	-	-	MSB	00	00	00	SLC Min Erase Count
97	LSB	-	-	MSB	00	00	00	SLC Average Erase Count
9F	LSB	-	-	MSB	00	00	00	DRAM one bit error count
A0	LSB	-	-	MSB	00	00	00	Uncorrectable sectors count when read/write
A1	LSB	MSB	00	00	00	00	00	Number of valid spare blocks
A3	LSB	MSB	00	00	00	00	00	Number of initial invalid blocks
A4	LSB	-	-	MSB	00	00	00	TLC Total erase count
A5	LSB	-	-	MSB	00	00	00	TLC Maximum erase count
A6	LSB	-	-	MSB	00	00	00	TLC Minimum erase count
A7	LSB	-	-	MSB	00	00	00	TLC Average erase count
A8	LSB	-	-	MSB	00	00	00	Max erase count of spec
A9	LSB	-	-	MSB	00	00	00	Remain Life (percentage)
B1	LSB	-	-	MSB	00	00	00	Total wear level count
B5	LSB	-	-	MSB	00	00	00	Total program fail count
B6	LSB	MSB	00	00	00	00	00	Total erase fail count
C0	LSB	MSB	00	00	00	00	00	Power-off retract Count
C2	MSB	00	00	00	00	00	00	Controller temperature[1)]
C3	LSB	-	-	MSB	00	00	00	Hardware ECC recovered
C4	LSB	-	-	MSB	00	00	00	Reallocation event count
C7	LSB	MSB	00	00	00	00	00	Ultra DMA CRC Error Count
E8	LSB	MSB	00	00	00	00	00	Available reserved space
F1	LSB	-	-	-	-	-	MSB	Total LBA written (each write unit = 32MB)
F2	LSB	-	-	-	-	-	MSB	Total LBA read (each read unit = 32MB)
F5	LSB	-	-	-	-	-	MSB	Flash write sector count

Note:

1) Controller temperature is only presented as a positive value.

9. Contact Information

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