Transcend®

Product Overview

Embedded Solutions

Advanced Technologies

DRAM Modules | SSD Solutions | Memory Cards | Flash Solutions

About Us

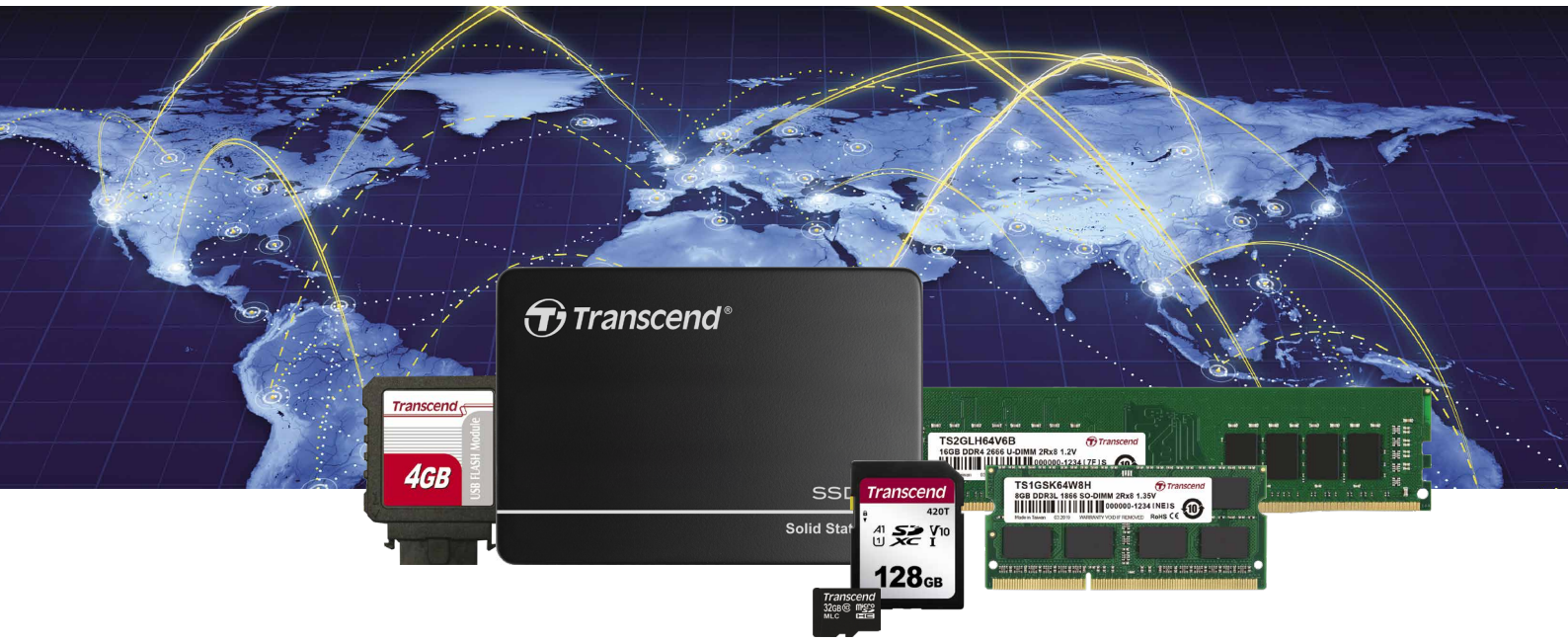
Transcend Information. Inc. was founded in 1988 by Mr. Peter Chung-won Shu, with headquarters in Taipei, Taiwan. Today, Transcend is a leading global brand of embedded solutions with twelve branch offices worldwide. Transcend continues to tap its deep reservoir of design resources to create advanced products for industrial computing applications across the globe. All of Transcend's products are designed for extreme reliability and endurance. At Transcend, we seek to provide the highest quality products and world-class professional service. As a customer-focused company, Transcend responds quickly to the market's changing needs by maintaining strong ties and close partnerships with first-tier suppliers. Over the years, Transcend has garnered over 140 patents, and employs more than 100 skilled R&D engineers to research, develop, and optimize its technical and production procedures. By continuing to enhance its R&D expertise and implementing stringent in-house quality control, Transcend has established a track record of reliably supplying customers with high-quality products and services.

As a declaration of our commitment to quality, Transcend has implemented the Total Quality Control concept throughout the company. Transcend was the first memory module manufacturer in Taiwan—and the second in the world—to receive ISO9001, ISO14001, and QC080000 certifications and was recently certified with the automotive-grade IATF16949. Every Transcend device is individually inspected using sophisticated testing equipment and customized testing software. Production staff undergo intensive training to ensure that all products meet the company's rigorous quality standards.

Transcend has established offices in Los Angeles, Maryland, Silicon Valley, Hamburg, Rotterdam, London, Tokyo, Seoul, Shanghai, Beijing, Shenzhen, and Hong Kong. Our manufacturing plant is located in Taipei, creating an optimum product supply system with a global perspective. The strength of our logistics network lies in our ability to link employees and customers to our latest products through state-of-the-art technology, and also in our commitment to quality.

Remaining focused on the future, Transcend predicts, plans, and delivers quality products and services the market wants, keeping the firm at the forefront of the industry. With an ever-increasing demand for industrial applications, we see the future providing limitless opportunities. Good memories start here!

Key Strengths



Comprehensive Product Lines

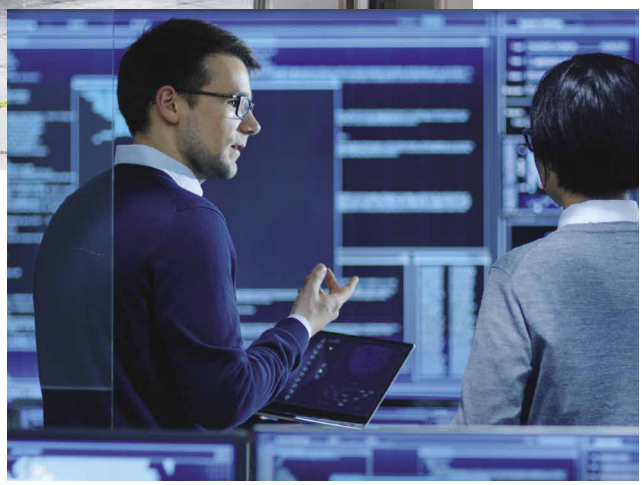
Transcend provides a complete product line of storage solutions for industrial computing applications. We offer memory modules ranging from DDR1 to DDR4, NAND flash from SLC, MLC, to 3D TLC and corresponding products for all solid-state drive interfaces. We also provide customized solutions to satisfy customers' specific demands with advanced technologies such as Wide Temperature, Anti-Sulfur, Intelligent Power Shield, Corner Bond, Underfill, Conformal Coating and AES Encryption.

Professional Worldwide Support

With twelve branch offices established worldwide, Transcend collaborates with OEM suppliers in providing technical analysis reports, on-site technical support and firmware adjustments to comply with the requirements of customers' terminal devices. Localized Sales and FAE staff are well-trained to offer in-time professional technical support to our customers worldwide.

Steady Supply & Longevity Support

Transcend utilizes the highest quality NAND, DRAM, and controller ICs manufactured by world leading suppliers, with whom Transcend has forged long-term alliances and strategic collaborations. We enforce rigorous flash wafer and memory card packaging and testing procedures with our partnered assembly houses, ensuring the quality of our products. By upholding financial stability, Transcend is able to strategically stock up on supplies to address our customers' long-term needs.



Efficient Management of Product Life Cycle

Transcend developed its own in-house ERP system, the Transcend Information System (TIS), to provide worldwide access to real-time information, including product availability, component pricing, sales data and logistics. This allows Transcend to respond quickly to customers' needs and provide them with the latest information, facilitating seamless internal coordination and timely, accurate external communication.

Transcend incorporates fixed BOM (Bill of Materials) management, which allows customers to identify product solutions. By ensuring component changes are kept to a minimum, Transcend makes sure customers receive fixed solutions with consistent compatibility. Furthermore, we offer road maps, EOL (End of Life) letters and PCNs (Product Change Notice) for our customers to streamline the transition to alternative solutions when necessary, thus fostering a more effective and efficient product life cycle management.

Total Quality Control

Transcend was the first memory module manufacturer in Taiwan – and the second in the world – to receive ISO9001, ISO14001, and QC080000 certifications and was recently certified with the automotive-grade IATF16949. Transcend operates its own factory in Taipei, which hosts more than 16 high-speed Surface Mount Technology (SMT) production lines. All industrial products we manufacture are subjected to rigorous reliability, compatibility, thermal stress, intense read/write cycles, and dynamic burn-in quality tests to ensure the highest reliability and stability of our products.

Wide Temperature

Industrial applications often expose flash and DRAM modules to extreme working temperatures. To ensure that our devices can operate under the harshest conditions, Transcend has implemented a proprietary Wide Temperature testing process to ensure the reliability of both its flash products and DRAM modules. Each product is tested in a wide-temperature cycle chamber, and has passed rigorous internal tests to deliver reliable performance in temperatures ranging from -40°C to 85°C.

While not a default feature for all current Transcend embedded flash or DRAM products, wide-temperature functionality can be made available by request. Please contact our sales representatives for more information.

Suitable for: full range of embedded-use flash and DRAM products.

Grade	Temperature Range	Description
Standard Temperature	0°C ~ 70°C	Products rated to operate within this range can deliver reliable performance under general thermal conditions, but may not be best suited for industries where harsh environments are present.
Wide Temperature	-40°C ~ 85°C	Products are stringently tested at the component level or as a whole to prove reliable operation within an extended thermal range, making them better suited for demanding embedded applications.

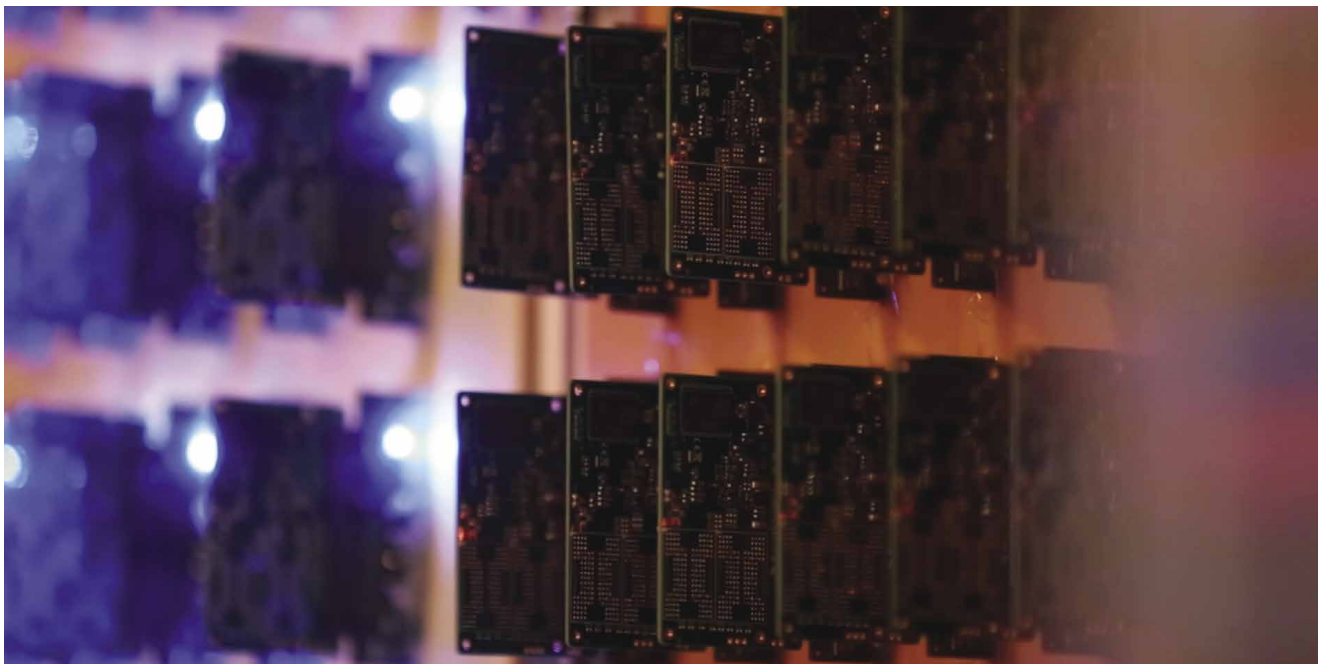


Figure 1: Walk-in chamber

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Corner Bond / Underfill

Embedded systems are marked by a need for small components, unmatched reliability, and the ability to withstand harsh conditions. Transcend offers Corner Bond / Underfill as a customization option for its embedded products to increase reliability under high thermal stress, high gravitational acceleration, and high fatigue cycle applications.

Corner Bond / Underfill is typically a polymer or liquid epoxy that provides a strong mechanical bond between key components and the underlying printed circuit board (PCB). By spreading stresses throughout the chip and PCB interface with a mechanical bond, less stress is concentrated on the solder joints, increasing device reliability.

Corner Bond applies adhesives to the perimeter, whereas the Underfill adhesive is absorbed underneath key components via capillary action.

Transcend recommends Corner Bond / Underfill for embedded flash and DRAM products used in handheld devices, automotive electronics, and military applications that require stringent thermal cycling performance and shock resistance.

Suitable for: full range of embedded-use SSDs and DRAM modules.

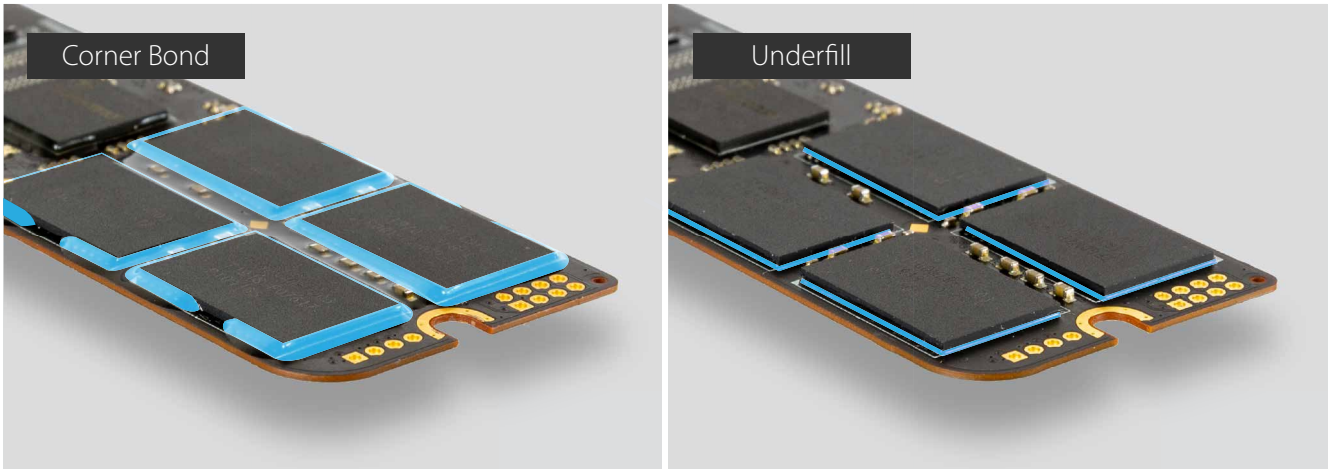

Figure 2: Transcend's SSDs with Corner Bond and Underfill.

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Conformal Coating

Transcend offers conformal coating as a customization option on its full range of embedded-use SSDs and DRAM products to increase their protection against a wide variety of environmental conditions such as moisture, dust, corrosion, and chemical contaminants.

Transcend utilizes automated spraying machines for its conformal coating application due to their speed and accuracy. With automated spraying application, Transcend is able to maintain a precise coating thickness with optimal results.

Transcend's coating process meets IPC-A-610D standards, which specify coating color, coverage, and thickness. Our coating material contains fluorescents to aid final inspection of the product. The coating is 100% inspected under UV light for distribution, quality, and uniformity.

We recommend conformal coated SSDs and memory modules for use in harsh environments with high moisture (forests), high dust (factory, desert), or chemical contaminants. These include chemical refinery plants, automotive applications, military environments, railroad systems, and traffic control systems.

Suitable for: full range of embedded-use SSDs and DRAM modules.

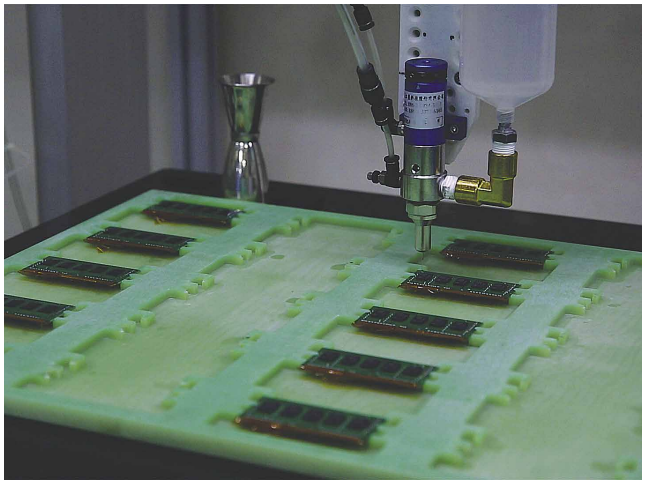

Figure 3: Automated spraying machine

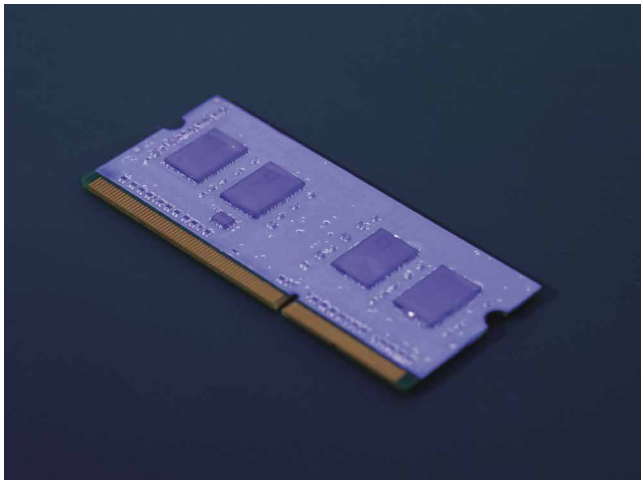

Figure 4: A coated module under UV inspection

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Anti-Sulfur

Anti-sulfur modules are designed to prevent sulfur buildup from resulting in abnormal operations. Such modules may be used in environments featuring extremes of temperature, humidity, or pollution in which sulfur is present in high concentration, such as near the end of exhaust pipes or in mines.

Sulfuration is the chemical process when sulfur reacts with air or water, produces hydrogen sulfide. When this is absorbed by metallic surfaces, a chemical reaction begins, creating a sulfide.

To prevent Sulfuration, resistors should be made sulfur-resistant. The first is to use a different material for the electrode, for example gold or alloys. The other anti-sulfur approach is to cover and therefore isolate the electrode, thus preventing hydrogen sulfide from coming into contact with the silver. The second method is more commonly used.

All Transcend's wide-temperature / ECC / registered modules come with anti-sulfuration qualities, allowing them to stay reliable in environments where sulfur is present in high concentrations.

Suitable for: full range of embedded-use DRAM modules.

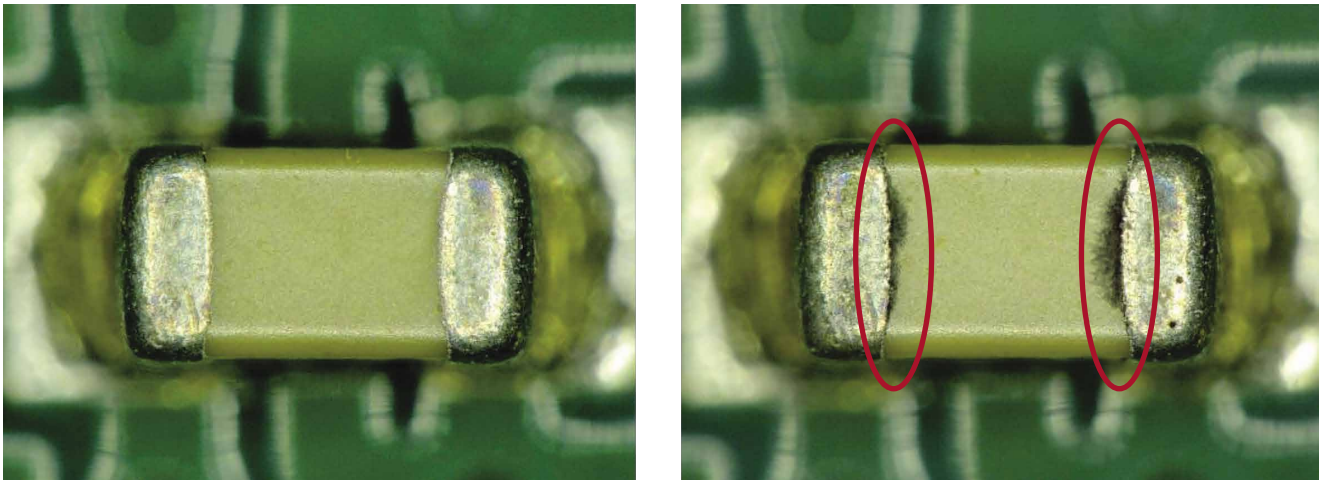

Figure 5: Sulfuration comparison.
Left: Without sulfuration. Right: With sulfuration. Needle-like crystal (Ag_2S) visible.

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96-Layer 3D NAND

Transcend offers a comprehensive line of flash products with optimized performance and lifespan of MLC to 3D TLC NAND flash.

Transcend's NAND Flash products are distinctively designed to be highly reliable and stable under extreme environmental conditions. We employ the best quality of Flash particles and Wafer technologies for the manufacturing of our industrial-grade NAND flash products.

Groundbreaking 96-layer 3D NAND flash solution

Transcend has been working closely with the world's leading flash chip manufacturers to offer the industry a wide range of selection for flash memory form factors. Our flash products are available in chips from multi-level cells at 15nm to 3D triple-level cells at 96 layers. Such products greatly contribute to the industrial, automotive, Internet and communication markets. They are tailored to meet the demands of these industries by way of our commitment to long-term availability. Transcend's distinctive SLC mode technology and 3D TLC flash products rated to endure 3K P/E cycles integrate the advantages of high-performance, exceptional endurance, and intensive read/write cycles, making them ideal for demanding industrial-grade applications.

NAND Types	SLC	MLC	3D TLC	3D TLC (96 layers)
Bit/Cell	1	2	3	3
Performance	****	**	*	**
Endurance (P/E cycles)	50K	3K	1K	3K
Reliability (Data retention)	****	**	*	**
Power Consumption	Low	Average	Average	Low
Cost	$$$$	$$	$	$

Cost-effective with great reliability

The production process of Transcend's 3D TLC flash products has advanced over the years, from producing 64-layer NAND to offering 96-layer NAND flash products today. 3D triple-level cells product is a cost-effective solution that offers performance close to that of a multi-level NAND flash at a more affordable price. 3D TLCs also require higher ECC correction requirement than those of MLCs. On top of that, 3D TLCs with 96 layers are able to keep up with the high quality of data retention as that of MLCs while enjoying a lower cost per bit for the mass production of NAND products.

AES Encryption

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.

The AES algorithm is a symmetric block cipher that can encrypt and decrypt data. As shown in Figure 6, encryption converts data (plain-text) to an unintelligible form called cipher-text, while decryption converts this cipher-text back to the original plain-text.

Transcend's SSDs offer hardware-based and firmware-based AES encryption option on request for superior data protection and performance over competing offerings that utilize software-based encryption.

Suitable for: embedded SSDs with DRAM cache.

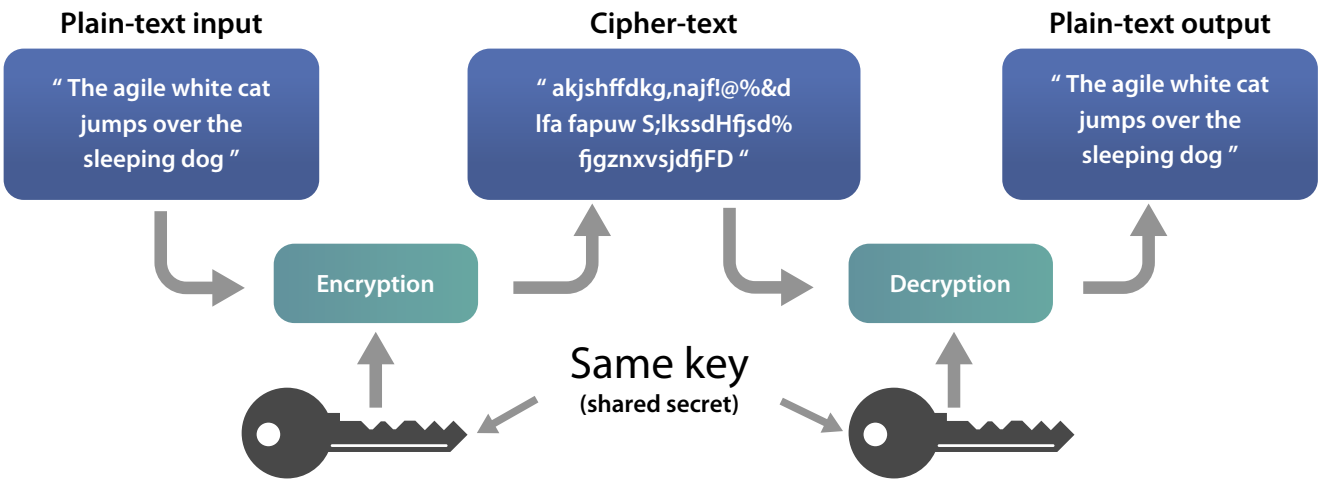
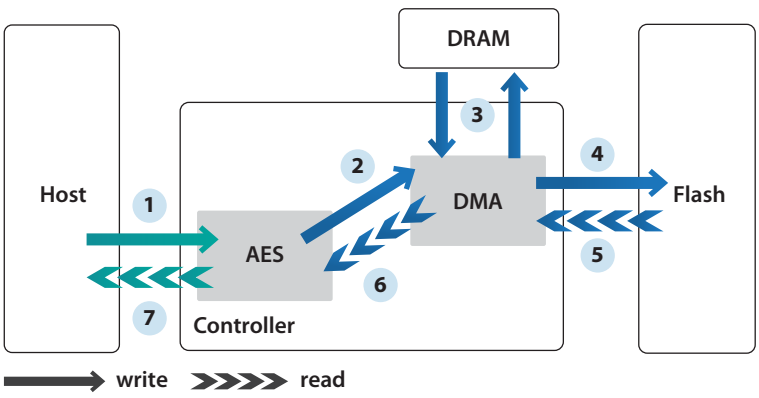


Figure 6: Symmetric block cipher



① Host writes data to SSD
② Write-in data is encrypted by AES engine
③ DMA handles data access, DRAM is for data cache before getting info flash
④ DMA puts data into flash
⑤ DMA pulls out data from flash
⑥ Read-out data is decrypted by AES engine
⑦ Host gets data from SSD

Figure 7: AES working process

TCG Opal Specifications

The Trusted Computing Group (TCG) created the Opal Security Subsystem Class (SSC) as one class of security management protocol for storage devices. Storage devices which conform to Opal SSC specification have the following features:

1. SED (Self-encrypting Device): the encryption/decryption process is operated on the device without passing through the host (see Figure 8.)

2. Authentication: a pre-boot identification is conducted in the shadow MBR. Only when the authentication is passed, the device can be booted and connected (see Figure 8.)

3. Table Management: the device manager can create a LBA (logical block address) range, and assign different permissions to different users for each LBA range (see Figure 9.)

Aside from the AES encyprtion technology available, customers can also, based on their specific interests and needs, request that our AES-equipped SSDs be compliant with the TCG Opal 2.0 standards.

Suitable for: Transcend's AES SSDs.

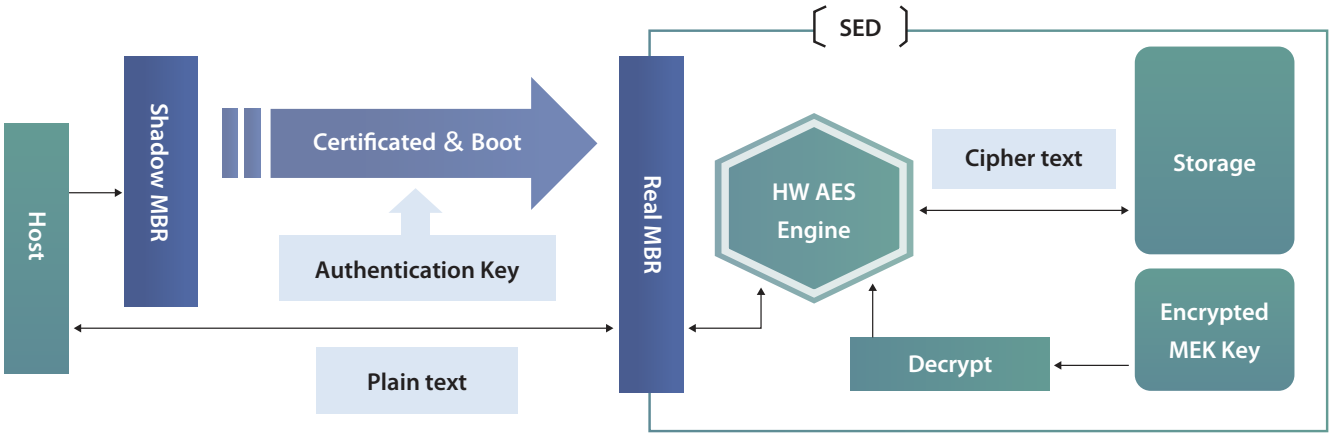


Figure 8: Opal storage device working process

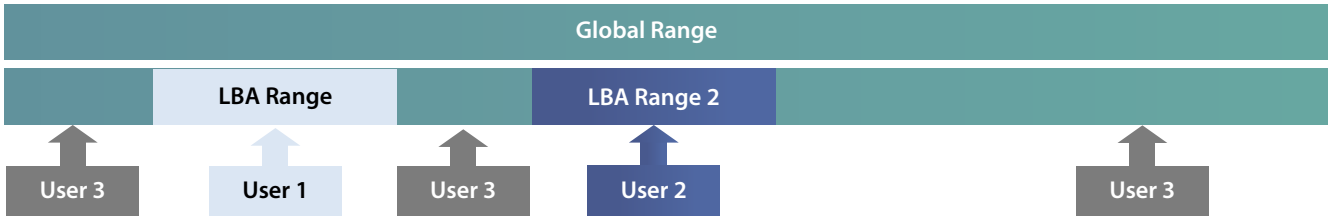


Figure 9: LBA range assignments

SSD Scope Pro

Transcend's SSD Scope Pro is a fully-featured software package that helps users monitor and manage SSD status via an intuitive user interface. It offers various useful features, including drive information and S.M.A.R.T. status monitoring, diagnostic scanning, secure erase, health monitoring, and system cloning.

Main functions:

STATUS

Monitors the SSD health status with intuitive, adjustable indicator lights and status bar. The software will notify users when an SSD needs attention.

TOOL

Monitors the SSD read/write performance and manage the SSD with convenient scan and erase tools.

SYSTEM CLONE

A disk imaging tool designed for cloning the entire original drive, including the operating system (OS), programs, and data, to a new Transcend SSD.

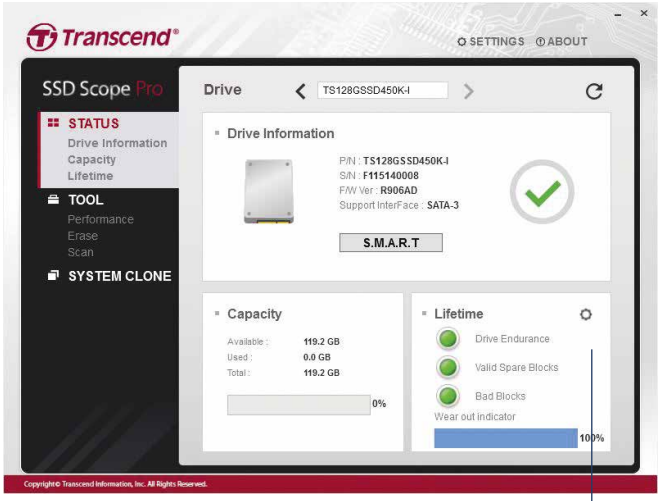


Figure 10: UI of Transcend's SSD Scope Pro

SSD Health Status

Includes Drive Endurance, Valid Spare Blocks, Bad Blocks, and Wear out indicator.

- Healthy / Good
- Early Warning
- At Risk / Bad

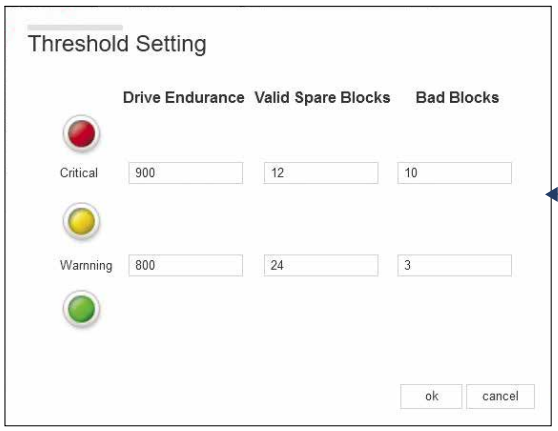


Figure 11: Threshold setting

Transcend provides different default settings for different embedded SSDs. However, the threshold setting can be manually adjusted by specific requirements.

Suitable for: all Transcend's embedded SSDs, CFast and CompactFlash cards.

Power Shield

Power Shield (PS) is a technology for Transcend's embedded SSDs, operating at 5V & 3.3V to prevent internal NAND flash data loss in the event of a sudden power outage. By using the internal voltage detection circuit of the controller to detect the external power supply, the voltage of external power drops to a certain extent and activates the PS power detect mechanism.

When a sudden power outage occurs, internal power shield circuit would trigger PS function and stop accepting new write commands. The write operation is stopped to ensure the firmware and data that has been in NAND undamaged.

The SSD's internal power detecting mechanism can monitor power provided by the host. When power is lost suddenly, the voltage drops:

(A) The voltage detector of the SSD will trigger PS to ensure that data stored in NAND are undamaged.
(B) SSD controller stops programming data into NAND flash.

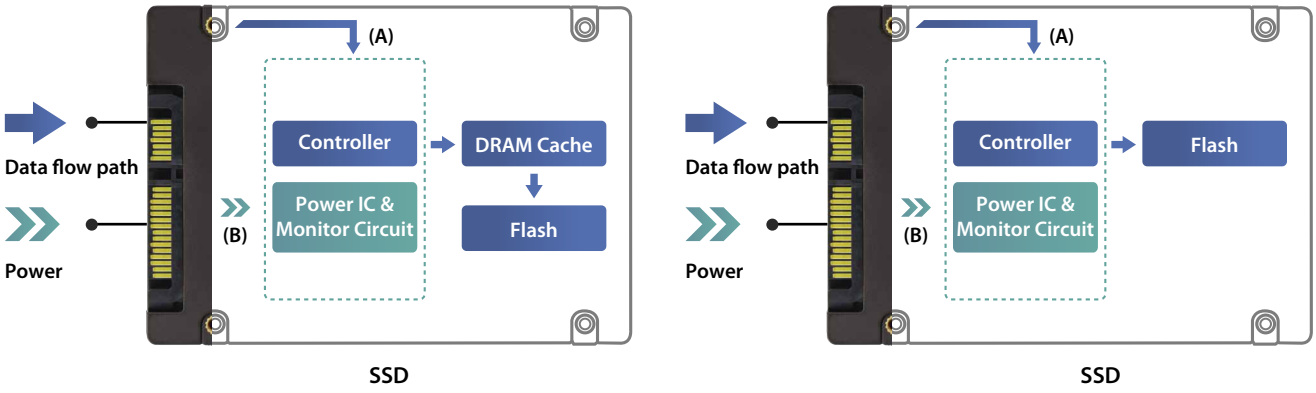


Figure 12: How PS works.
Left: SSD with DRAM cache. Right: SSD without DRAM cache

Suitable for: full range of embedded-use SSDs.

Intelligent Power Shield

Intelligent Power Shield (IPS) is an optional, advanced technology for DRAM SSDs, operating at 5V to ensure the integrity of data in the event of a sudden power outage. By adding capacitors, IPS can prolong the time to complete the flushing process after an outage. When the power is turned on, these capacitors act as batteries and are charged with electricity from the computer. During an unexpected power loss, the charged capacitors can continue offering power to the SSD, allowing the data to complete the writing process.

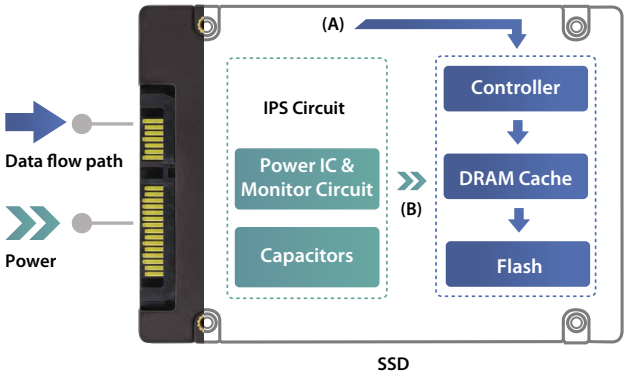


Figure 13: How IPS is triggered

When sudden power is lost, the voltage drops from 5V to 4V:
(A) The voltage detector of the SSD will trigger IPS to ensure that data stored in NAND are undamaged.
(B) The built-in capacitors continue to offer enough power for data to flush from the DRAM cache into the NAND flash.

IPS can prolong the time (C) between sudden power loss (A) and the write protection mode (B) to complete more writes from the DRAM cache to the NAND flash. (See figures 14.)

(A) When the power is suddenly lost, the power starts to drop
(B) When the voltage drops to 2.3V, NAND flash enters write protection mode
(C) The time to complete data writing

Figure 14: How IPS works
Left: Without IPS. Right: With IPS

Suitable for: embedded SSDs with DRAM cache.

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	Territory	Issue Date	Patent No.
Our Patents	USA	Oct. 21. 2014	8,867,297
	Taiwan	Feb. 21. 2015	I474332

DDR4 Unbuffered DIMMs

Module Type	DDR4	
	Long-DIMM	SO-DIMM
Product Image		
Standard	JEDEC	
Frequency	3200/2666/2400/2133 MHz	
Capacity	2GB~32GB	
Voltage	1.2V	
Pin Count	Long-DIMM: 288 pin	SO-DIMM: 260 pin
PCB Height	Standard: 1.23 inches Very Low Profile: 0.74 inches	1.18 inches
Operating Temperature	Standard Temperature: 0°C~ 85°C Wide Temperature: -40°C~ 85°C	

Ordering Information

DDR4-2400 Long-DIMM

Capacity	Component Composition	Rank x Org.	Standard (1.2V)	Wide Temp. (-40°C~ 85°C)	Very Low Profile (VLP)
2GB	(256Mx16)x4	1Rx16	TS256MLH64V4X	TS256MLH64V4X-I	TS256MLH64V4XL
4GB	(512Mx16)x4	1Rx16	TS512MLH64V4D	TS512MLH64V4D-I	TS512MLH64V4DL
4GB	(512Mx8)x8	1Rx8	TS512MLH64V4H	TS512MLH64V4H-I	TS512MLH64V4HL
8GB	(512Mx8)x16	2Rx8	TS1GLH64V4H	TS1GLH64V4H-I	TS1GLH64V4HL
8GB	(1Gx8)x8	1Rx8	TS1GLH64V4B	TS1GLH64V4B-I	TS1GLH64V4BL
16GB	(1Gx8)x16	2Rx8	TS2GLH64V4B	TS2GLH64V4B-I	TS2GLH64V4BL
32GB	(2Gx8)x16	2Rx8	TS4GLH64V4E	TS4GLH64V4E-I	TS4GLH64V4EL

DDR4-2400 SO-DIMM

Capacity	Component Composition	Rank x Org.	Standard (1.2V)	Wide Temp. (-40°C~ 85°C)
2GB	(256Mx16)x4	1Rx16	TS256MSH64V4X	TS256MSH64V4X-I
4GB	(512Mx16)x4	1Rx16	TS512MSH64V4D	TS512MSH64V4D-I
4GB	(512Mx8)x8	1Rx8	TS512MSH64V4H	TS512MSH64V4H-I
8GB	(512Mx8)x16	2Rx8	TS1GSH64V4H	TS1GSH64V4H-I
8GB	(1Gx8)x8	1Rx8	TS1GSH64V4B	TS1GSH64V4B-I
16GB	(1Gx8)x16	2Rx8	TS2GSH64V4B	TS2GSH64V4B-I
32GB	(2Gx8)x16	2Rx8	TS4GSH64V4E	TS4GSH64V4E-I

DDR4-2133 Long-DIMM

Capacity	Component Composition	Rank x Org.	Standard (1.2V)	Wide Temp. (-40°C~ 85°C)	Very Low Profile (VLP)
2GB	(256Mx16)x4	1Rx16	TS256MLH64V1X	TS256MLH64V1X-I	TS256MLH64V1XL
4GB	(512Mx16)x4	1Rx16	TS512MLH64V1D	TS512MLH64V1D-I	TS512MLH64V1DL
4GB	(512Mx8)x8	1Rx8	TS512MLH64V1H	TS512MLH64V1H-I	TS512MLH64V1HL
8GB	(512Mx8)x16	2Rx8	TS1GLH64V1H	TS1GLH64V1H-I	TS1GLH64V1HL
8GB	(1Gx8)x8	1Rx8	TS1GLH64V1B	TS1GLH64V1B-I	TS1GLH64V1BL
16GB	(1Gx8)x16	2Rx8	TS2GLH64V1B	TS2GLH64V1B-I	TS2GLH64V1BL

DDR4-2133 SO-DIMM

Capacity	Component Composition	Rank x Org.	Standard (1.2V)	Wide Temp. (-40°C~ 85°C)
2GB	(256Mx16)x4	1Rx16	TS256MSH64V1X	TS256MSH64V1X-I
4GB	(512Mx16)x4	1Rx16	TS512MSH64V1D	TS512MSH64V1D-I
4GB	(512Mx8)x8	1Rx8	TS512MSH64V1H	TS512MSH64V1H-I
8GB	(512Mx8)x16	2Rx8	TS1GSH64V1H	TS1GSH64V1H-I
8GB	(1Gx8)x8	1Rx8	TS1GSH64V1B	TS1GSH64V1B-I
16GB	(1Gx8)x16	2Rx8	TS2GSH64V1B	TS2GSH64V1B-I

DDR4-2666 Long-DIMM

Capacity	Component Composition	Rank x Org.	Standard (1.2V)	Wide Temp. (-40°C~ 85°C)	Very Low Profile (VLP)
2GB	(256Mx16)x4	1Rx16	TS256MLH64V6X	TS256MLH64V6X-I	TS256MLH64V6XL
4GB	(512Mx16)x4	1Rx16	TS512MLH64V6D	TS512MLH64V6D-I	TS512MLH64V6DL
4GB	(512Mx8)x8	1Rx8	TS512MLH64V6H	TS512MLH64V6H-I	TS512MLH64V6HL
8GB	(512Mx8)x16	2Rx8	TS1GLH64V6H	TS1GLH64V6H-I	TS1GLH64V6HL
8GB	(1Gx8)x8	1Rx8	TS1GLH64V6B	TS1GLH64V6B-I	TS1GLH64V6BL
16GB	(1Gx8)x16	2Rx8	TS2GLH64V6B	TS2GLH64V6B-I	TS2GLH64V6BL
32GB	(2Gx8)x16	2Rx8	TS4GLH64V6E	TS4GLH64V6E-I	TS4GLH64V6EL

DDR4-2666 SO-DIMM

Capacity	Component Composition	Rank x Org.	Standard (1.2V)	Wide Temp. (-40°C~ 85°C)
2GB	(256Mx16)x4	1Rx16	TS256MSH64V6X	TS256MSH64V6X-I
4GB	(512Mx16)x4	1Rx16	TS512MSH64V6D	TS512MSH64V6D-I
4GB	(512Mx8)x8	1Rx8	TS512MSH64V6H	TS512MSH64V6H-I
8GB	(512Mx8)x16	2Rx8	TS1GSH64V6H	TS1GSH64V6H-I
8GB	(1Gx8)x8	1Rx8	TS1GSH64V6B	TS1GSH64V6B-I
16GB	(1Gx8)x16	2Rx8	TS2GSH64V6B	TS2GSH64V6B-I
32GB	(2Gx8)x16	2Rx8	TS4GSH64V6E	TS4GSH64V6E-I

DDR4-3200 Long-DIMM

Capacity	Component Composition	Rank x Org.	Standard (1.2V)	Wide Temp. (-40°C~ 85°C)
8GB	(1Gx8)x8	1Rx8	TS1GLH64V2B	TS1GLH64V2B-I
16GB	(1Gx8)x16	2Rx8	TS2GLH64V2B	TS2GLH64V2B-I

DDR4-3200 SO-DIMM

Capacity	Component Composition	Rank x Org.	Standard (1.2V)	Wide Temp. (-40°C~ 85°C)
8GB	(1Gx8)x8	1Rx8	TS1GSH64V2B	TS1GSH64V2B-I
16GB	(1Gx8)x16	2Rx8	TS2GSH64V2B	TS2GSH64V2B-I

DDR4 ECC DIMMs

Module Type	DDR4	
	ECC Long-DIMM	ECC SO-DIMM
Product Image		
Standard	JEDEC	
Frequency	2666/2400/2133 MHz	
Capacity	4GB~32GB	
Voltage	1.2V	
Pin Count	ECC Long-DIMM: 288 pin	ECC SO-DIMM: 260 pin
PCB Height	Standard: 1.23 inches Very Low Profile: 0.74 inches	1.18 inches
PCB Gold Finger Thickness	30µ"	
Anti-Sulfuration	Default	
Operating Temperature	Standard Temperature: 0°C~ 85°C Wide Temperature: -40°C~ 85°C	

Ordering Information

DDR4-2400 ECC Long-DIMM

Capacity	Component Composition	Rank x Org.	Standard (1.2V)	Wide Temp. (-40°C~ 85°C)	Very Low Profile (VLP)
4GB	(512Mx8)x9	1Rx8	TS512MLH72V4H	TS512MLH72V4H-I	TS512MLH72V4HL
8GB	(512Mx8)x18	2Rx8	TS1GLH72V4H	TS1GLH72V4H-I	TS1GLH72V4HL
8GB	(1Gx8)x9	1Rx8	TS1GLH72V4B	TS1GLH72V4B-I	TS1GLH72V4BL
16GB	(1Gx8)x18	2Rx8	TS2GLH72V4B	TS2GLH72V4B-I	TS2GLH72V4BL
32GB	(2Gx8)x18	2Rx8	TS4GLH72V4E	TS4GLH72V4E-I	-

DDR4-2400 ECC SO-DIMM

Capacity	Component Composition	Rank x Org.	Standard (1.2V)	Wide Temp. (-40°C~ 85°C)
4GB	(512Mx8)x9	1Rx8	TS512MSH72V4H	TS512MSH72V4H-I
8GB	(512Mx8)x18	2Rx8	TS1GSH72V4H	TS1GSH72V4H-I
8GB	(1Gx8)x9	1Rx8	TS1GSH72V4B	TS1GSH72V4B-I
16GB	(1Gx8)x18	2Rx8	TS2GSH72V4B	TS2GSH72V4B-I
32GB	(2Gx8)x18	2Rx8	TS4GSH72V4E	TS4GSH72V4E-I

DDR4-2133 ECC Long-DIMM

Capacity	Component Composition	Rank x Org.	Standard (1.2V)	Wide Temp. (-40°C~ 85°C)	Very Low Profile (VLP)
4GB	(512Mx8)x9	1Rx8	TS512MLH72V1H	TS512MLH72V1H-I	TS512MLH72V1HL
8GB	(512Mx8)x18	2Rx8	TS1GLH72V1H	TS1GLH72V1H-I	TS1GLH72V1HL
8GB	(1Gx8)x9	1Rx8	TS1GLH72V1B	TS1GLH72V1B-I	TS1GLH72V1BL
16GB	(1Gx8)x18	2Rx8	TS2GLH72V1B	TS2GLH72V1B-I	TS2GLH72V1BL

DDR4-2133 ECC SO-DIMM

Capacity	Component Composition	Rank x Org.	Standard (1.2V)	Wide Temp. (-40°C~ 85°C)
4GB	(512Mx8)x9	1Rx8	TS512MSH72V1H	TS512MSH72V1H-I
8GB	(512Mx8)x18	2Rx8	TS1GSH72V1H	TS1GSH72V1H-I
8GB	(1Gx8)x9	1Rx8	TS1GSH72V1B	TS1GSH72V1B-I
16GB	(1Gx8)x18	2Rx8	TS2GSH72V1B	TS2GSH72V1B-I

DDR4-2666 ECC Long-DIMM

Capacity	Component Composition	Rank x Org.	Standard (1.2V)	Wide Temp. (-40°C~ 85°C)	Very Low Profile (VLP)
4GB	(512Mx8)x9	1Rx8	TS512MLH72V6H	TS512MLH72V6H-I	TS512MLH72V6HL
8GB	(512Mx8)x18	2Rx8	TS1GLH72V6H	TS1GLH72V6H-I	TS1GLH72V6HL
8GB	(1Gx8)x9	1Rx8	TS1GLH72V6B	TS1GLH72V6B-I	TS1GLH72V6BL
16GB	(1Gx8)x18	2Rx8	TS2GLH72V6B	TS2GLH72V6B-I	TS2GLH72V6BL
32GB	(2Gx8)x18	2Rx8	TS4GLH72V6E	TS4GLH72V6E-I	TS4GLH72V6EL

DDR4-2666 ECC SO-DIMM

Capacity	Component Composition	Rank x Org.	Standard (1.2V)	Wide Temp. (-40°C~ 85°C)
4GB	(512Mx8)x9	1Rx8	TS512MSH72V6H	TS512MSH72V6H-I
8GB	(512Mx8)x18	2Rx8	TS1GSH72V6H	TS1GSH72V6H-I
8GB	(1Gx8)x9	1Rx8	TS1GSH72V6B	TS1GSH72V6B-I
16GB	(1Gx8)x18	2Rx8	TS2GSH72V6B	TS2GSH72V6B-I
32GB	(2Gx8)x18	2Rx8	TS4GSH72V6E	TS4GSH72V6E-I

DDR4 Registered DIMMs

Module Type	DDR4 Registered DIMM
Product Image	
Standard	JEDEC
Frequency	2666/2400/2133 MHz
Capacity	4GB~32GB
Voltage	1.2V
Pin Count	R-DIMM: 288 pin
PCB Height	Standard: 1.23 inches Very Low Profile: 0.74 inches
PCB Gold Finger Thickness	30µ"
Anti-Sulfuration	Default
Operating Temperature	Standard Temperature: 0°C~ 85°C

Ordering Information

DDR4-2400 Registered DIMM

Capacity	Component Composition	Rank x Org.	Standard (1.2V)	Very Low Profile (VLP)
4GB	(512Mx8)x9	1Rx8	TS512MHR72V4H	-
8GB	(512Mx8)x18	2Rx8	TS1GHR72V4H	TS1GHR72V4HL
8GB	(1Gx8)x9	1Rx8	TS1GHR72V4B	-
16GB	(1Gx8)x18	2Rx8	TS2GHR72V4B	TS2GHR72V4BL
16GB	(2Gx4)x18	1Rx4	TS2GHR72V4C	TS2GHR72V4CL
32GB	(2Gx4)x36	2Rx4	TS4GHR72V4C	-
32GB	(2Gx8)x18	2Rx8	TS4GHR72V4E	TS4GHR72V4EL

DDR4-2133 Registered DIMM

Capacity	Component Composition	Rank x Org.	Standard (1.2V)	Very Low Profile (VLP)
4GB	(512Mx8)x9	1Rx8	TS512MHR72V1H	TS512MHR72V1HL
8GB	(512Mx8)x18	2Rx8	TS1GHR72V1H	TS1GHR72V1HL
8GB	(1Gx8)x9	1Rx8	TS1GHR72V1B	TS1GHR72V1BL
16GB	(1Gx8)x18	2Rx8	TS2GHR72V1B	TS2GHR72V1BL
16GB	(2Gx4)x18	1Rx4	TS2GHR72V1C	TS2GHR72V1CL
32GB	(2Gx4)x36	2Rx4	TS4GHR72V1C	-

DDR4-2666 Registered DIMM

Capacity	Component Composition	Rank x Org.	Standard (1.2V)	Very Low Profile (VLP)
4GB	(512Mx8)x9	1Rx8	TS512MHR72V6H	-
8GB	(512Mx8)x18	2Rx8	TS1GHR72V6H	TS1GHR72V6HL
8GB	(1Gx8)x9	1Rx8	TS1GHR72V6B	-
16GB	(1Gx8)x18	2Rx8	TS2GHR72V6B	TS2GHR72V6BL
16GB	(2Gx4)x18	1Rx4	TS2GHR72V6C	-
32GB	(2Gx4)x36	2Rx4	TS4GHR72V6C	-
32GB	(2Gx8)x18	2Rx8	TS4GHR72V6E	TS4GHR72V6EL

DDR3 Unbuffered DIMMs

Module Type	DDR3	
	Long-DIMM	SO-DIMM
Product Image		
Standard	JEDEC	
Frequency	1866/1600/1333 MHz	
Capacity	1GB~8GB	
Voltage	Standard voltage: 1.5V Low voltage: 1.35V	
Pin Count	Long-DIMM: 240 pin	SO-DIMM: 204 pin
PCB Height*	1.18 inches	
Operating Temperature	Standard Temperature: 0°C~ 85°C Wide Temperature: -40°C~ 85°C	

Ordering Information

DDR3-1600 Long-DIMM

Capacity	Component Composition	Rank x Org.	Standard (1.5V)	Wide Temp. (-40°C~ 85°C)	Low Voltage (1.35V)	Low Voltage + Wide Temp.
1GB	(128Mx8)x8	1Rx8	TS128MLK64V6U	TS128MLK64V6U-I	TS128MLK64W6U	TS128MLK64W6U-I
2GB	(128Mx8)x16	2Rx8	TS256MLK64V6U	TS256MLK64V6U-I	TS256MLK64W6U	TS256MLK64W6U-I
2GB	(256Mx8)x8	1Rx8	TS256MLK64V6N	TS256MLK64V6N-I	TS256MLK64W6N	TS256MLK64W6N-I
4GB	(256Mx8)x16	2Rx8	TS512MLK64V6N	TS512MLK64V6N-I	TS512MLK64W6N	TS512MLK64W6N-I
4GB	(512Mx8)x8	1Rx8	TS512MLK64V6H	TS512MLK64V6H-I	TS512MLK64W6H	TS512MLK64W6H-I
8GB	(512Mx8)x16	2Rx8	TS1GLK64V6H	TS1GLK64V6H-I	TS1GLK64W6H	TS1GLK64W6H-I

DDR3-1600 SO-DIMM

Capacity	Component Composition	Rank x Org.	Standard (1.5V)	Wide Temp. (-40°C~ 85°C)	Low Voltage (1.35V)	Low Voltage + Wide Temp.
1GB	(128Mx8)x8	1Rx8	TS128MSK64V6U	TS128MSK64V6U-I	TS128MSK64W6U	TS128MSK64W6U-I
2GB	(128Mx8)x16	2Rx8	TS256MSK64V6U	TS256MSK64V6U-I	TS256MSK64W6U	TS256MSK64W6U-I
2GB	(256Mx8)x8	1Rx8	TS256MSK64V6N	TS256MSK64V6N-I	TS256MSK64W6N	TS256MSK64W6N-I
4GB	(256Mx8)x16	2Rx8	TS512MSK64V6N	TS512MSK64V6N-I	TS512MSK64W6N	TS512MSK64W6N-I
4GB	(512Mx8)x8	1Rx8	TS512MSK64V6H	TS512MSK64V6H-I	TS512MSK64W6H	TS512MSK64W6H-I
8GB	(512Mx8)x16	2Rx8	TS1GSK64V6H	TS1GSK64V6H-I	TS1GSK64W6H	TS1GSK64W6H-I

* DDR3 Long-DIMM VLP modules (0.74 inches) are also available.

DDR3-1333 Long-DIMM

Capacity	Component Composition	Rank x Org.	Standard (1.5V)	Wide Temp. (-40°C~ 85°C)	Low Voltage (1.35V)	Low Voltage + Wide Temp.
1GB	(128Mx8)x8	1Rx8	TS128MLK64V3U	TS128MLK64V3U-I	TS128MLK64W3U	TS128MLK64W3U-I
2GB	(128Mx8)x16	2Rx8	TS256MLK64V3U	TS256MLK64V3U-I	TS256MLK64W3U	TS256MLK64W3U-I
2GB	(256Mx8)x8	1Rx8	TS256MLK64V3N	TS256MLK64V3N-I	TS256MLK64W3N	TS256MLK64W3N-I
4GB	(256Mx8)x16	2Rx8	TS512MLK64V3N	TS512MLK64V3N-I	TS512MLK64W3N	TS512MLK64W3N-I
4GB	(512Mx8)x8	1Rx8	TS512MLK64V3H	TS512MLK64V3H-I	TS512MLK64W3H	TS512MLK64W3H-I
8GB	(512Mx8)x16	2Rx8	TS1GLK64V3H	TS1GLK64V3H-I	TS1GLK64W3H	TS1GLK64W3H-I

DDR3-1333 SO-DIMM

Capacity	Component Composition	Rank x Org.	Standard (1.5V)	Wide Temp. (-40°C~ 85°C)	Low Voltage (1.35V)	Low Voltage + Wide Temp.
1GB	(128Mx8)x8	1Rx8	TS128MSK64V3U	TS128MSK64V3U-I	TS128MSK64W3U	TS128MSK64W3U-I
2GB	(128Mx8)x16	2Rx8	TS256MSK64V3U	TS256MSK64V3U-I	TS256MSK64W3U	TS256MSK64W3U-I
2GB	(256Mx8)x8	1Rx8	TS256MSK64V3N	TS256MSK64V3N-I	TS256MSK64W3N	TS256MSK64W3N-I
4GB	(256Mx8)x16	2Rx8	TS512MSK64V3N	TS512MSK64V3N-I	TS512MSK64W3N	TS512MSK64W3N-I
4GB	(512Mx8)x8	1Rx8	TS512MSK64V3H	TS512MSK64V3H-I	TS512MSK64W3H	TS512MSK64W3H-I
8GB	(512Mx8)x16	2Rx8	TS1GSK64V3H	TS1GSK64V3H-I	TS1GSK64W3H	TS1GSK64W3H-I

DDR3-1866 Long-DIMM

Capacity	Component Composition	Rank x Org.	Standard (1.5V)	Wide Temp. (-40°C~ 85°C)	Low Voltage (1.35V)	Low Voltage + Wide Temp.
1GB	(128Mx8)x8	1Rx8	TS128MLK64V8U	TS128MLK64V8U-I	TS128MLK64W8U	TS128MLK64W8U-I
2GB	(128Mx8)x16	2Rx8	TS256MLK64V8U	TS256MLK64V8U-I	TS256MLK64W8U	TS256MLK64W8U-I
2GB	(256Mx8)x8	1Rx8	TS256MLK64V8N	TS256MLK64V8N-I	TS256MLK64W8N	TS256MLK64W8N-I
4GB	(256Mx8)x16	2Rx8	TS512MLK64V8N	TS512MLK64V8N-I	TS512MLK64W8N	TS512MLK64W8N-I
4GB	(512Mx8)x8	1Rx8	TS512MLK64V8H	TS512MLK64V8H-I	TS512MLK64W8H	TS512MLK64W8H-I
8GB	(512Mx8)x16	2Rx8	TS1GLK64V8H	TS1GLK64V8H-I	TS1GLK64W8H	TS1GLK64W8H-I

DDR3-1866 SO-DIMM

Capacity	Component Composition	Rank x Org.	Standard (1.5V)	Wide Temp. (-40°C~ 85°C)	Low Voltage (1.35V)	Low Voltage + Wide Temp.
1GB	(128Mx8)x8	1Rx8	TS128MSK64V8U	TS128MSK64V8U-I	TS128MSK64W8U	TS128MSK64W8U-I
2GB	(128Mx8)x16	2Rx8	TS256MSK64V8U	TS256MSK64V8U-I	TS256MSK64W8U	TS256MSK64W8U-I
2GB	(256Mx8)x8	1Rx8	TS256MSK64V8N	TS256MSK64V8N-I	TS256MSK64W8N	TS256MSK64W8N-I
4GB	(256Mx8)x16	2Rx8	TS512MSK64V8N	TS512MSK64V8N-I	TS512MSK64W8N	TS512MSK64W8N-I
4GB	(512Mx8)x8	1Rx8	TS512MSK64V8H	TS512MSK64V8H-I	TS512MSK64W8H	TS512MSK64W8H-I
8GB	(512Mx8)x16	2Rx8	TS1GSK64V8H	TS1GSK64V8H-I	TS1GSK64W8H	TS1GSK64W8H-I

* DDR3 Long-DIMM VLP modules (0.74 inches) are also available.

DDR3 ECC DIMMs

Module Type	DDR3	
	ECC Long-DIMM	ECC SO-DIMM
Product Image		
Standard	JEDEC	
Frequency	1866/1600/1333 MHz	
Capacity	2GB~8GB	
Voltage	Standard voltage: 1.5V Low voltage: 1.35V	
Pin Count	Long-DIMM: 240 pin	SO-DIMM: 204 pin
PCB Height*	1.18 inches	
PCB Gold Finger Thickness	30µ"	
Anti-Sulfuration	Default	
Operating Temperature	Standard Temperature: 0°C~ 85°C Wide Temperature: -40°C~ 85°C	

Ordering Information

DDR3-1600 ECC Long-DIMM

Capacity	Component Composition	Rank x Org.	Standard (1.5V)	Wide Temp. (-40°C~ 85°C)	Low Voltage (1.35V)	Low Voltage + Wide Temp.
2GB	(128Mx8)x18	2Rx8	TS256MLK72V6U	TS256MLK72V6U-I	TS256MLK72W6U	TS256MLK72W6U-I
2GB	(256Mx8)x9	1Rx8	TS256MLK72V6N	TS256MLK72V6N-I	TS256MLK72W6N	TS256MLK72W6N-I
4GB	(256Mx8)x18	2Rx8	TS512MLK72V6N	TS512MLK72V6N-I	TS512MLK72W6N	TS512MLK72W6N-I
4GB	(512Mx8)x9	1Rx8	TS512MLK72V6H	TS512MLK72V6H-I	TS512MLK72W6H	TS512MLK72W6H-I
8GB	(512Mx8)x18	2Rx8	TS1GLK72V6H	TS1GLK72V6H-I	TS1GLK72W6H	TS1GLK72W6H-I

DDR3-1600 ECC SO-DIMM

Capacity	Component Composition	Rank x Org.	Standard (1.5V)	Wide Temp. (-40°C~ 85°C)	Low Voltage (1.35V)	Low Voltage + Wide Temp.
2GB	(256Mx8)x9	1Rx8	TS256MSK72V6N	TS256MSK72V6N-I	TS256MSK72W6N	TS256MSK72W6N-I
4GB	(256Mx8)x18	2Rx8	TS512MSK72V6N	TS512MSK72V6N-I	TS512MSK72W6N	TS512MSK72W6N-I
4GB	(512Mx8)x9	1Rx8	TS512MSK72V6H	TS512MSK72V6H-I	TS512MSK72W6H	TS512MSK72W6H-I
8GB	(512Mx8)x18	2Rx8	TS1GSK72V6H	TS1GSK72V6H-I	TS1GSK72W6H	TS1GSK72W6H-I

* DDR3 ECC Long-DIMM VLP modules (0.74 inches) are also available.

DDR3-1333 ECC Long-DIMM

Capacity	Component Composition	Rank x Org.	Standard (1.5V)	Wide Temp. (-40°C~ 85°C)	Low Voltage (1.35V)	Low Voltage + Wide Temp.
2GB	(128Mx8)x18	2Rx8	TS256MLK72V3U	TS256MLK72V3U-I	TS256MLK72W3U	TS256MLK72W3U-I
2GB	(256Mx8)x9	1Rx8	TS256MLK72V3N	TS256MLK72V3N-I	TS256MLK72W3N	TS256MLK72W3N-I
4GB	(256Mx8)x18	2Rx8	TS512MLK72V3N	TS512MLK72V3N-I	TS512MLK72W3N	TS512MLK72W3N-I
4GB	(512Mx8)x9	1Rx8	TS512MLK72V3H	TS512MLK72V3H-I	TS512MLK72W3H	TS512MLK72W3H-I
8GB	(512Mx8)x18	2Rx8	TS1GLK72V3H	TS1GLK72V3H-I	TS1GLK72W3H	TS1GLK72W3H-I

DDR3-1333 ECC SO-DIMM

Capacity	Component Composition	Rank x Org.	Standard (1.5V)	Wide Temp. (-40°C~ 85°C)	Low Voltage (1.35V)	Low Voltage + Wide Temp.
2GB	(256Mx8)x9	1Rx8	TS256MSK72V3N	TS256MSK72V3N-I	TS256MSK72W3N	TS256MSK72W3N-I
4GB	(256Mx8)x18	2Rx8	TS512MSK72V3N	TS512MSK72V3N-I	TS512MSK72W3N	TS512MSK72W3N-I
4GB	(512Mx8)x9	1Rx8	TS512MSK72V3H	TS512MSK72V3H-I	TS512MSK72W3H	TS512MSK72W3H-I
8GB	(512Mx8)x18	2Rx8	TS1GSK72V3H	TS1GSK72V3H-I	TS1GSK72W3H	TS1GSK72W3H-I

DDR3-1866 ECC Long-DIMM

Capacity	Component Composition	Rank x Org.	Standard (1.5V)	Wide Temp. (-40°C~ 85°C)	Low Voltage (1.35V)	Low Voltage + Wide Temp.
2GB	(128Mx8)x18	2Rx8	TS256MLK72V8U	TS256MLK72V8U-I	TS256MLK72W8U	TS256MLK72W8U-I
2GB	(256Mx8)x9	1Rx8	TS256MLK72V8N	TS256MLK72V8N-I	TS256MLK72W8N	TS256MLK72W8N-I
4GB	(256Mx8)x18	2Rx8	TS512MLK72V8N	TS512MLK72V8N-I	TS512MLK72W8N	TS512MLK72W8N-I
4GB	(512Mx8)x9	1Rx8	TS512MLK72V8H	TS512MLK72V8H-I	TS512MLK72W8H	TS512MLK72W8H-I
8GB	(512Mx8)x18	2Rx8	TS1GLK72V8H	TS1GLK72V8H-I	TS1GLK72W8H	TS1GLK72W8H-I

* DDR3 ECC Long-DIMM VLP modules (0.74 inches) are also available.

DDR3 Registered DIMMs

Module Type	DDR3 Registered DIMM
Product Image	
Standard	JEDEC
Frequency	1866/1600/1333 MHz
Capacity	4GB~32GB
Voltage	Standard voltage: 1.5V Low voltage: 1.35V
Pin Count	R-DIMM: 240 pin
PCB Height	Standard: 1.18 inches Very Low Profile: 0.74 inches
PCB Gold Finger Thickness	30μ"
Anti-Sulfuration	Default
Operating Temperature	Standard Temperature: 0°C~ 85°C

Ordering Information

DDR3-1600 Registered DIMM

Capacity	Component Composition	Rank x Org.	Standard (1.5V)	Low Voltage (1.35V)	Very Low Profile (VLP)
4GB	(256Mx8)x18	2Rx8	TS512MKR72V6N	TS512MKR72W6N	TS512MKR72V6NL
4GB	(512Mx8)x9	1Rx8	TS512MKR72V6H	TS512MKR72W6H	TS512MKR72V6HL
8GB	(512Mx8)x18	2Rx8	TS1GKR72V6H	TS1GKR72W6H	TS1GKR72V6HL
8GB	(1Gx4)x18	1Rx4	TS1GKR72V6Z	TS1GKR72W6Z	-
16GB	(1Gx4)x36	2Rx4	TS2GKR72V6Z	TS2GKR72W6Z	-
16GB	(2Gx4)x18	2Rx4	-	-	TS2GKR72V6PL
32GB	(2Gx4)x36	4Rx4	TS4GKR72V6P	TS4GKR72W6P	-

DDR3-1333 Registered DIMM

Capacity	Component Composition	Rank x Org.	Standard (1.5V)	Low Voltage (1.35V)	Very Low Profile (VLP)
4GB	(256Mx8)x18	2Rx8	TS512MKR72V3N	TS512MKR72W3N	TS512MKR72V3NL
4GB	(512Mx8)x9	1Rx8	TS512MKR72V3H	TS512MKR72W3H	TS512MKR72V3HL
8GB	(256Mx8)x36	4Rx8	TS1GKR72V3N	TS1GKR72W3N	-
8GB	(512Mx8)x18	2Rx8	TS1GKR72V3H	TS1GKR72W3H	TS1GKR72V3HL
8GB	(1Gx4)x18	1Rx4	TS1GKR72V3Z	TS1GKR72W3Z	-
16GB	(512Mx8)x36	4Rx8	TS2GKR72V3H	TS2GKR72W3H	-
16GB	(1Gx4)x36	2Rx4	TS2GKR72V3Z	TS2GKR72W3Z	-
16GB	(2Gx4)x18	2Rx4	-	-	TS2GKR72V3PL
32GB	(2Gx4)x36	4Rx4	TS4GKR72V3P	TS4GKR72W3P	-

DDR3-1866 Registered DIMM

Capacity	Component Composition	Rank x Org.	Standard (1.5V)	Low Voltage (1.35V)	Very Low Profile (VLP)
4GB	(256Mx8)x18	2Rx8	TS512MKR72V8N	TS512MKR72W8N	TS512MKR72V8NL
4GB	(512Mx8)x9	1Rx8	TS512MKR72V8H	TS512MKR72W8H	TS512MKR72V8HL
8GB	(512Mx8)x18	2Rx8	TS1GKR72V8H	TS1GKR72W8H	TS1GKR72V8HL

PCIe M.2 SSDs (2280/2242/2230)

Interface	PCIe Gen3x4	PCIe Gen3x2	PCIe Gen3x2
Type	**2280-D2-M**	**2242-D2-B-M**	**2230-S2-B-M**
Flash		**3D TLC**	
Product Image			
Capacity	128GB~512GB	64GB~512GB	64GB~512GB
Sequential R/W*	2,100/1,000 MB/s	1,700/1,250 MB/s	1,700/1,000 MB/s
TBW*	1,080 TB	1,080 TB	200 TB
MTBF*		3,000,000 hours	
DWPD*	2.0 (3 years)	2.0 (3 years)	0.4 (3 years)
Operating Temperature		Standard Temperature: 0°C~70°C Wide Temperature: -40°C~85°C	
Storage Temperature		-40°C~85°C	
Dimensions	80±0.15 x 22±0.15 x 3.58 mm	42±0.15 x 22±0.15 x 3.58 mm	30±0.15 x 22±0.15 x 2.23 mm
Operating Voltage		3.3V±5%	
Max. Power Consumption	3.3W	3.5W	3.3W
Power Shield		Supported	
Thermal Sensor		Supported	
S.M.A.R.T.		Supported	
DRAM Cache		Supported (2280/2242)	

Ordering Information

	Capacity	Standard (0°C~ 70°C)	Wide Temp. (-40°C~ 85°C)
PCIe M.2 SSDs (2280/3D TLC)	128GB	TS128GMTE652T	TS128GMTE652T-I
	256GB	TS256GMTE652T	TS256GMTE652T-I
	512GB	TS512GMTE652T	TS512GMTE652T-I

	Capacity	Standard (0°C~ 70°C)	Wide Temp. (-40°C~ 85°C)
PCIe M.2 SSDs (2242/3D TLC)	64GB	TS64GMTE452T	TS64GMTE452T-I
	128GB	TS128GMTE452T	TS128GMTE452T-I
	256GB	TS256GMTE452T	TS256GMTE452T-I
	512GB	TS512GMTE452T	TS512GMTE452T-I

	Capacity	Standard (0°C~ 70°C)	Wide Temp. (-40°C~ 85°C)
PCIe M.2 SSDs (2230/3D TLC)	64GB	TS64GMTE352T	TS64GMTE352T-I
	128GB	TS128GMTE352T	TS128GMTE352T-I
	256GB	TS256GMTE352T	TS256GMTE352T-I
	512GB	TS512GMTE352T	TS512GMTE352T-I

* Value varies by capacity, user hardware, system configuration, and calculation method.

SATA III 2.5” SSDs

Interface	SATA III 6Gb/s	
Type	2.5" SATA (7+15 pin)	
Flash	3D TLC	MLC
Product Image		
Capacity	64GB~2TB	16GB~1TB
Sequential R/W*	560/520 MB/s	530/470 MB/s
TBW*	3,520 TB	2,940 TB
MTBF*	3,000,000 hours	2,000,000 hours
DWPD*	1.61 (3 years)	2.6 (3 years)
Operating Temperature	Standard Temperature: 0°C~70°C Wide Temperature: -40°C~85°C	
Storage Temperature	-40°C~85°C	
Dimensions	100±0.25 x 69.85±0.25 x 6.8±0.2 mm	
Operating Voltage	5V±5%	
Max. Power Consumption	3.5W	2.65W
Power Shield	Supported	
Thermal Sensor	Supported	
ATA Security	Supported	
S.M.A.R.T.	Supported	
DRAM Cache	Supported	

Ordering Information

	Capacity	Standard (0°C~ 70°C)	Wide Temp. (-40°C~ 85°C)
SATA III 2.5" SSDs (3D TLC)	64GB	TS64GSSD452K	TS64GSSD452K-I
	128GB	TS128GSSD452K	TS128GSSD452K-I
	256GB	TS256GSSD452K	TS256GSSD452K-I
	512GB	TS512GSSD452K	TS512GSSD452K-I
	1TB	TS1TSSD452K	TS1TSSD452K-I
	2TB	TS2TSSD452K	TS2TSSD452K-I

	Capacity	Standard (0°C~ 70°C)	Wide Temp. (-40°C~ 85°C)
SATA III 2.5" SSDs (MLC)	16GB	TS16GSSD420K	TS16GSSD420I
	32GB	TS32GSSD420K	TS32GSSD420I
	64GB	TS64GSSD420K	TS64GSSD420I
	128GB	TS128GSSD420K	TS128GSSD420I
	256GB	TS256GSSD420K	TS256GSSD420I
	512GB	TS512GSSD420K	TS512GSSD420I
	1TB	TS1TSSD420K	TS1TSSD420I

* Value varies by capacity, user hardware, system configuration, and calculation method.

SATA III M.2 SSDs (2280)

Interface	SATA III 6Gb/s	
Type	2280-D2-B-M	
Flash	**3D TLC**	**MLC**
Product Image		
Capacity	64GB~2TB	16GB~1TB
Sequential R/W*	560/520 MB/s	530/460 MB/s
TBW*	3,520 TB	2,360 TB
MTBF*	3,000,000 hours	2,500,000 hours
DWPD*	1.61 (3 years)	2.6 (3 years)
Operating Temperature	Standard Temperature: 0°C~70°C Wide Temperature: -40°C~85°C	
Storage Temperature	-40°C~85°C	
Dimensions	80±0.15 x 22±0.15 x 3.58 mm	
Operating Voltage	3.3V±5%	
Max. Power Consumption	2.1W	2.64W
Power Shield	Supported	
Thermal Sensor	Supported	
ATA Security	Supported	
S.M.A.R.T.	Supported	
DRAM Cache	Supported	

Ordering Information

	Capacity	Standard (0°C~ 70°C)	Wide Temp. (-40°C~ 85°C)
SATA III M.2 SSDs (2280/3D TLC)	64GB	TS64GMTS952T	TS64GMTS952T-I
	128GB	TS128GMTS952T	TS128GMTS952T-I
	256GB	TS256GMTS952T	TS256GMTS952T-I
	512GB	TS512GMTS952T	TS512GMTS952T-I
	1TB	TS1TMTS952T	TS1TMTS952T-I
	2TB	TS2TMTS952T	TS2TMTS952T-I

	Capacity	Standard (0°C~ 70°C)	Wide Temp. (-40°C~ 85°C)
SATA III M.2 SSDs (2280/MLC)	16GB	TS16GMTS800	TS16GMTS800I
	32GB	TS32GMTS800	TS32GMTS800I
	64GB	TS64GMTS800	TS64GMTS800I
	128GB	TS128GMTS800	TS128GMTS800I
	256GB	TS256GMTS800	TS256GMTS800I
	512GB	TS512GMTS800	TS512GMTS800I
	1TB	TS1TMTS800	TS1TMTS800I

* Value varies by capacity, user hardware, system configuration, and calculation method.

SATA III M.2 SSDs (2242)

Interface	SATA III 6Gb/s	
Type	2242-D2-B-M	
Flash	3D TLC	MLC
Product Image		
Capacity	64GB~512GB	16GB~512GB
Sequential R/W*	560/510 MB/s	530/470 MB/s
TBW*	880 TB	1,100 TB
MTBF*	3,000,000 hours	2,500,000 hours
DWPD*	1.61 (3 years)	2.0 (3 years)
Operating Temperature	Standard Temperature: 0°C~70°C Wide Temperature: -40°C~85°C	
Storage Temperature	-40°C~85°C	
Dimensions	42±0.15 x 22±0.15 x 3.58 mm	
Operating Voltage	3.3V±5%	
Max. Power Consumption	1.7W	2.48W
Power Shield	Supported	
Thermal Sensor	Supported	
ATA Security	Supported	
S.M.A.R.T.	Supported	
DRAM Cache	Supported	

Ordering Information

	Capacity	Standard (0°C~ 70°C)	Wide Temp. (-40°C~ 85°C)
SATA III M.2 SSDs (2242/3D TLC)	64GB	TS64GMTS552T	TS64GMTS552T-I
	128GB	TS128GMTS552T	TS128GMTS552T-I
	256GB	TS256GMTS552T	TS256GMTS552T-I
	512GB	TS512GMTS552T	TS512GMTS552T-I

	Capacity	Standard (0°C~ 70°C)	Wide Temp. (-40°C~ 85°C)
SATA III M.2 SSDs (2242/MLC)	16GB	TS16GMTS400	TS16GMTS400I
	32GB	TS32GMTS400	TS32GMTS400I
	64GB	TS64GMTS400	TS64GMTS400I
	128GB	TS128GMTS400	TS128GMTS400I
	256GB	TS256GMTS400	TS256GMTS400I
	512GB	TS512GMTS400	TS512GMTS400I

* Value varies by capacity, user hardware, system configuration, and calculation method.

SATA III M.2 SSDs (2260)

Interface	**SATA III 6Gb/s**
Type	**2260-D2-B-M**
Flash	**MLC**
Product Image	
Capacity	32GB~512GB
Sequential R/W*	530/450 MB/s
TBW*	1,480 TB
MTBF*	2,500,000 hours
DWPD*	2.6 (3 years)
Operating Temperature	Standard Temperature: 0°C~70°C Wide Temperature: -40°C~85°C
Storage Temperature	-40°C~85°C
Dimensions	60±0.15 x 22±0.15 x 3.58 mm
Operating Voltage	3.3V±5%
Max. Power Consumption	2.50W
Power Shield	Supported
Thermal Sensor	Supported
ATA Security	Supported
S.M.A.R.T.	Supported
DRAM Cache	Supported

Ordering Information

	Capacity	Standard (0°C~ 70°C)	Wide Temp. (-40°C~ 85°C)
SATA III M.2 SSDs (2260/MLC)	32GB	TS32GMTS600	TS32GMTS600I
	64GB	TS64GMTS600	TS64GMTS600I
	128GB	TS128GMTS600	TS128GMTS600I
	256GB	TS256GMTS600	TS256GMTS600I
	512GB	TS512GMTS600	TS512GMTS600I

* Value varies by capacity, user hardware, system configuration, and calculation method.

SATA III mSATA SSDs

Interface	SATA III 6Gb/s	
Type	mSATA (52 pin)	
Flash	3D TLC	MLC
Product Image		
Capacity	64GB~1TB	16GB~1TB
Sequential R/W*	560/520 MB/s	550/450 MB/s
TBW*	1,760 TB	2,360 TB
MTBF*	3,000,000 hours	2,500,000 hours
DWPD*	1.61 (3 years)	2.6 (3 years)
Operating Temperature	Standard Temperature: 0°C~70°C Wide Temperature: -40°C~85°C	
Storage Temperature	-40°C~85°C	
Dimensions	50.8±0.15 x 29.85±0.15 x 4.85 mm	
Operating Voltage	3.3V±5%	
Max. Power Consumption	2.4W	2.64W
Power Shield	Supported	
Thermal Sensor	Supported	
ATA Security	Supported	
S.M.A.R.T.	Supported	
DRAM Cache	Supported	

Ordering Information

	Capacity	Standard (0°C~ 70°C)	Wide Temp. (-40°C~ 85°C)
SATA III mSATA SSDs (3D TLC)	64GB	TS64GMSA452T	TS64GMSA452T-I
	128GB	TS128GMSA452T	TS128GMSA452T-I
	256GB	TS256GMSA452T	TS256GMSA452T-I
	512GB	TS512GMSA452T	TS512GMSA452T-I
	1TB	TS1TMSA452T	TS1TMSA452T-I

	Capacity	Standard (0°C~ 70°C)	Wide Temp. (-40°C~ 85°C)
SATA III mSATA SSDs (MLC)	16GB	TS16GMSA370	TS16GMSA370I
	32GB	TS32GMSA370	TS32GMSA370I
	64GB	TS64GMSA370	TS64GMSA370I
	128GB	TS128GMSA370	TS128GMSA370I
	256GB	TS256GMSA370	TS256GMSA370I
	512GB	TS512GMSA370	TS512GMSA370I
	1TB	TS1TMSA370	TS1TMSA370I

* Value varies by capacity, user hardware, system configuration, and calculation method.

SATA III mSATA mini SSDs

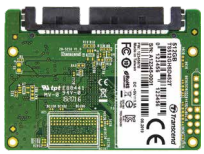
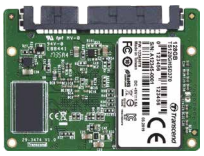
Interface	**SATA III 6Gb/s**
Type	**mSATA (52 pin)**
Flash	**MLC**
Product Image	
Capacity	16GB~128GB
Sequential R/W*	520/220 MB/s
TBW*	168 TB
MTBF*	2,500,000 hours
DWPD*	1.19 (3 years)
Operating Temperature	Standard Temperature: 0°C~70°C Wide Temperature: -40°C~85°C
Storage Temperature	-40°C~85°C
Dimensions	29.85±0.15 x 26.8±0.15 x 3.85 mm
Operating Voltage	3.3V±5%
Max. Power Consumption	2.0W
Power Shield	Supported
Thermal Sensor	Supported
ATA Security	Supported
S.M.A.R.T.	Supported

Ordering Information

	Capacity	Standard (0°C~ 70°C)	Wide Temp. (-40°C~ 85°C)
SATA III mSATA mini SSDs (MLC)	16GB	TS16GMSM360	TS16GMSM360I
	32GB	TS32GMSM360	TS32GMSM360I
	64GB	TS64GMSM360	TS64GMSM360I
	128GB	TS128GMSM360	TS128GMSM360I

* Value varies by capacity, user hardware, system configuration, and calculation method.

SATA III Half-Slim SSDs

Interface	SATA III 6Gb/s	
Type	Half-Slim SATA (7+15 pin)	
Flash	3D TLC	MLC
Product Image		
Capacity	64GB~512GB	16GB~128GB
Sequential R/W*	560/520 MB/s	530/200 MB/s
TBW*	880 TB	360TB
MTBF*	3,000,000 hours	2,500,000 hours
DWPD*	1.61 (3 years)	2.6 (3 years)
Operating Temperature	Standard Temperature: 0°C~70°C Wide Temperature: -40°C~85°C	
Storage Temperature	-40°C~85°C	
Dimensions	54±0.15 x 39.8±0.3 x 4±0.15 mm	
Operating Voltage	5V±5%	
Max. Power Consumption	2.7W	1.85W
Power Shield	Supported	
Thermal Sensor	Supported	
ATA Security	Supported	
S.M.A.R.T.	Supported	
DRAM Cache	Supported	

Ordering Information

	Capacity	Standard (0°C~ 70°C)	Wide Temp. (-40°C~ 85°C)
SATA III Half-Slim SSDs (3D TLC)	64GB	TS64GHSD452T	TS64GHSD452T-I
	128GB	TS128GHSD452T	TS128GHSD452T-I
	256GB	TS256GHSD452T	TS256GHSD452T-I
	512GB	TS512GHSD452T	TS512GHSD452T-I

	Capacity	Standard (0°C~ 70°C)	Wide Temp. (-40°C~ 85°C)
SATA III Half-Slim SSDs (MLC)	16GB	TS16GHSD370	TS16GHSD370I
	32GB	TS32GHSD370	TS32GHSD370I
	64GB	TS64GHSD370	TS64GHSD370I
	128GB	TS128GHSD370	TS128GHSD370I

* Value varies by capacity, user hardware, system configuration, and calculation method.

SD Cards

Flash	3D TLC	MLC
Product Image		
Capacity	32GB~128GB	8GB~128GB
Sequential R/W*	95/40 MB/s	24/22 MB/s
TBW*	320 TB	240 TB
Standard	SD 5.1	SD 3.0
Connector	9 pin	
Operating Temperature	Standard Temperature: -25°C~85°C Wide Temperature: -40°C~85°C	
Storage Temperature	-40°C~85°C	
Dimensions	32±0.1 x 24±0.1 x 2.1±0.15 mm	
Operating Voltage	2.7V~3.6V	
Max. Power Consumption	0.5W	0.72W

Ordering Information

	Capacity	Standard (-25°C~ 85°C)	Wide Temp. (-40°C~ 85°C)
SD Cards (3D TLC)	32GB	TS32GSDC420T	TS32GSDC420I
	64GB	TS64GSDC420T	TS64GSDC420I
	128GB	TS128GSDC420T	TS128GSDC420I

	Capacity	Standard (-25°C~ 85°C)	Wide Temp. (-40°C~ 85°C)
SD Cards (MLC)	8GB	TS8GSDHC10M	TS8GSDHC10I
	16GB	TS16GSDHC10M	TS16GSDHC10I
	32GB	TS32GSDHC10M	TS32GSDHC10I
	64GB	TS64GSDXC10M	-
	128GB	TS128GSDXC10M	-

* Value varies by capacity, user hardware, system configuration, and calculation method.

SD Cards

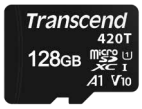
Flash	SLC
Product Image	
Capacity	128MB~4GB
Sequential R/W*	24/21 MB/s
TBW*	250 TB
Standard	SD 3.0
Connector	9 pin
Operating Temperature	Wide Temperature: -40°C~85°C
Storage Temperature	-40°C~85°C
Dimensions	32±0.1 x 24±0.1 x 2.1±0.15 mm
Operating Voltage	2.7V~3.6V
Max. Power Consumption	0.72W

Ordering Information

	Capacity	Wide Temp. (-40°C~ 85°C)
SD Cards (SLC)	128MB	TS128MSD100I
	256MB	TS256MSD100I
	512MB	TS512MSD100I
	1GB	TS1GSD100I
	2GB	TS2GSD100I
	4GB	TS4GSDHC100I

* Value varies by capacity, user hardware, system configuration, and calculation method.

microSD Cards

Flash	3D TLC	MLC
Product Image		
Capacity	32GB~128GB	8GB~64GB
Sequential R/W*	95/40 MB/s	21/17 MB/s
TBW*	320 TB	120 TB
Standard	SD 3.0	
Connector	8 pin	
Operating Temperature	Standard Temperature: -25°C~85°C Wide Temperature: -40°C~85°C	
Storage Temperature	-40°C~85°C	
Dimensions	15±0.1 x 11±0.1 x 0.7±0.1 mm	
Operating Voltage	2.7V~3.6V	
Max. Power Consumption	0.5W	0.72W

Ordering Information

	Capacity	Standard (-25°C~ 85°C)	Wide Temp. (-40°C~ 85°C)
microSD Cards (3D TLC)	32GB	TS32GUSD420T	TS32GUSD420I
	64GB	TS64GUSD420T	TS64GUSD420I
	128GB	TS128GUSD420T	TS128GUSD420I

	Capacity	Standard (-25°C~ 85°C)	Wide Temp. (-40°C~ 85°C)
microSD Cards (MLC)	8GB	TS8GUSDC10M	TS8GUSDC10I
	16GB	TS16GUSDC10M	TS16GUSDC10I
	32GB	TS32GUSDC10M	TS32GUSDC10I
	64GB	-	TS64GUSDC10I

* Value varies by capacity, user hardware, system configuration, and calculation method.

CompactFlash Cards

Flash	MLC	SLC	
Product Image			
Capacity	4GB~64GB	128MB~4GB	128MB~8GB
Sequential R/W*	87/68 MB/s	59/24 MB/s	56/44 MB/s
TBW*	85 TB	83 TB	159 TB
Standard	True IDE		
Connector	50 pin		
Operating Temperature	Standard Temperature: -25°C~85°C Wide Temperature: -40°C~85°C		
Storage Temperature	-40°C~85°C		-55°C~100°C
Dimensions	42.8±0.1 x 36.4±0.15 x 3.3±0.1 mm		
Operating Voltage	3.3V±5% / 5V±10%		
Max. Power Consumption	0.64W	0.33W	0.90W
S.M.A.R.T.	Supported		

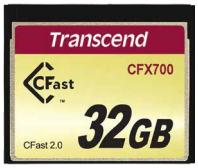
Ordering Information

	Capacity	Standard (-25°C~ 85°C)
CompactFlash Cards (MLC)	4GB	TS4GCF170
	8GB	TS8GCF170
	16GB	TS16GCF170
	32GB	TS32GCF170
	64GB	TS64GCF170

	Capacity	Standard (-25°C~ 85°C)	Wide Temp. (-40°C~ 85°C)
CompactFlash Cards (SLC)	128MB	TS128MCF300	TS128MCF220I
	256MB	TS256MCF300	TS256MCF220I
	512MB	TS512MCF300	TS512MCF220I
	1GB	TS1GCF300	TS1GCF220I
	2GB	TS2GCF300	TS2GCF220I
	4GB	TS4GCF300	TS4GCF220I
	8GB	-	TS8GCF220I

* Value varies by capacity, user hardware, system configuration, and calculation method.

CFast Cards

Flash	MLC	SLC
Product Image		
Capacity	16GB~256GB	16GB~32GB
Sequential R/W*	500/350 MB/s	530/256 MB/s
TBW*	705 TB	340 TB
Standard	SATA III 6Gb/s	
Connector	24 pin	
Operating Temperature	Standard Temperature: -5°C~70°C	
Storage Temperature	-40°C~85°C	
Dimensions	42.8±0.1 x 36.4±0.15 x 3.3±0.1 mm	
Operating Voltage	3.3V±5%	
Max. Power Consumption	2.05W	1.19W
S.M.A.R.T.	Supported	

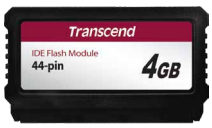
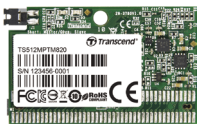
Ordering Information

	Capacity	Standard (-5°C~70°C)
CFast Cards (MLC)	16GB	TS16GCFX600
	32GB	TS32GCFX600
	64GB	TS64GCFX600
	128GB	TS128GCFX600
	256GB	TS256GCFX600

	Capacity	Standard (-5°C~70°C)
CFast Cards (SLC)	16GB	TS16GCFX700
	32GB	TS32GCFX700

* Value varies by capacity, user hardware, system configuration, and calculation method.

PATA DOMs

Standard	True IDE		
Connector	**40 pin Vertical**	**44 pin Vertical**	**44 pin Horizontal**
Flash	**SLC**	**SLC**	**SLC**
Product Image			
Capacity	128MB~4GB	512MB~4GB	512MB~1GB
Sequential R/W*	39/42 MB/s	39/42 MB/s	21/14 MB/s
Operating Temperature	0°C~70°C	0°C~70°C	0°C~70°C
Storage Temperature	-40°C~85°C	-40°C~85°C	-40°C~85°C
Dimensions	61±0.4 x 27.1±0.5 x 7.1±0.2 mm	52±0.4 x 29.5±0.5 x 7.1±0.2 mm	45±0.4 x 28±0.2 x 6±0.5 mm
Operating Voltage	3.3V±5% / 5V±5%	3.3V±5% / 5V±5%	3.3V±5% / 5V±5%
Max. Power Consumption	0.9W	0.9W	0.45W
S.M.A.R.T.	Supported	Supported	Supported

Ordering Information

	Capacity	Standard (0°C~70°C)
PATA DOMs (SLC / 40 Pin Vertical)	128MB	TS128MPTM520
	256MB	TS256MPTM520
	512MB	TS512MPTM520
	1GB	TS1GPTM520
	2GB	TS2GPTM520
	4GB	TS4GPTM520

	Capacity	Standard (0°C~70°C)
PATA DOMs (SLC / 44 Pin Vertical)	512MB	TS512MPTM720
	1GB	TS1GPTM720
	2GB	TS2GPTM720
	4GB	TS4GPTM720

	Capacity	Standard (0°C~70°C)
PATA DOMs (SLC / 44 Pin Horizontal)	512MB	TS512MPTM820
	1GB	TS1GPTM820

* Value varies by capacity, user hardware, system configuration, and calculation method.

Flash DOM / USB Flash Drive

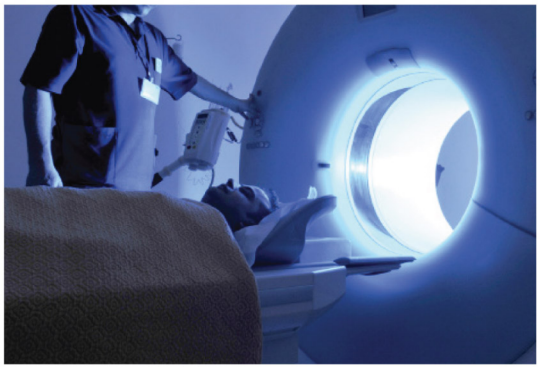
Standard	USB 2.0	
Connector	**10 pin USB port**	**USB Type-A**
Flash	**SLC**	**SLC**
Product Image		
Capacity	512MB~4GB	512MB~2GB
Sequential R/W*	18/16 MB/s	16/12 MB/s
Operating Temperature	0°C~70°C	0°C~70°C
Storage Temperature	-40°C~85°C	-40°C~85°C
Dimensions	31.8±1 x 26±1 x 7±1 mm	60.9±0.1 x 19.3±0.1 x 8.5±0.1 mm
Operating Voltage	5V±10%	5V±10%
Max. Power Consumption	0.6W	0.55W

Ordering Information

	Capacity	Standard (0°C~70°C)
Flash DOMs (SLC / Vertical)	512MB	TS512MUFM-V
	1GB	TS1GUFM-V
	2GB	TS2GUFM-V
	4GB	TS4GUFM-V

	Capacity	Standard (0°C~70°C)
USB Flash Drives (SLC)	512MB	TS512MJF170
	1GB	TS1GJF170
	2GB	TS2GJF170

* Value varies by capacity, user hardware, system configuration, and calculation method.



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