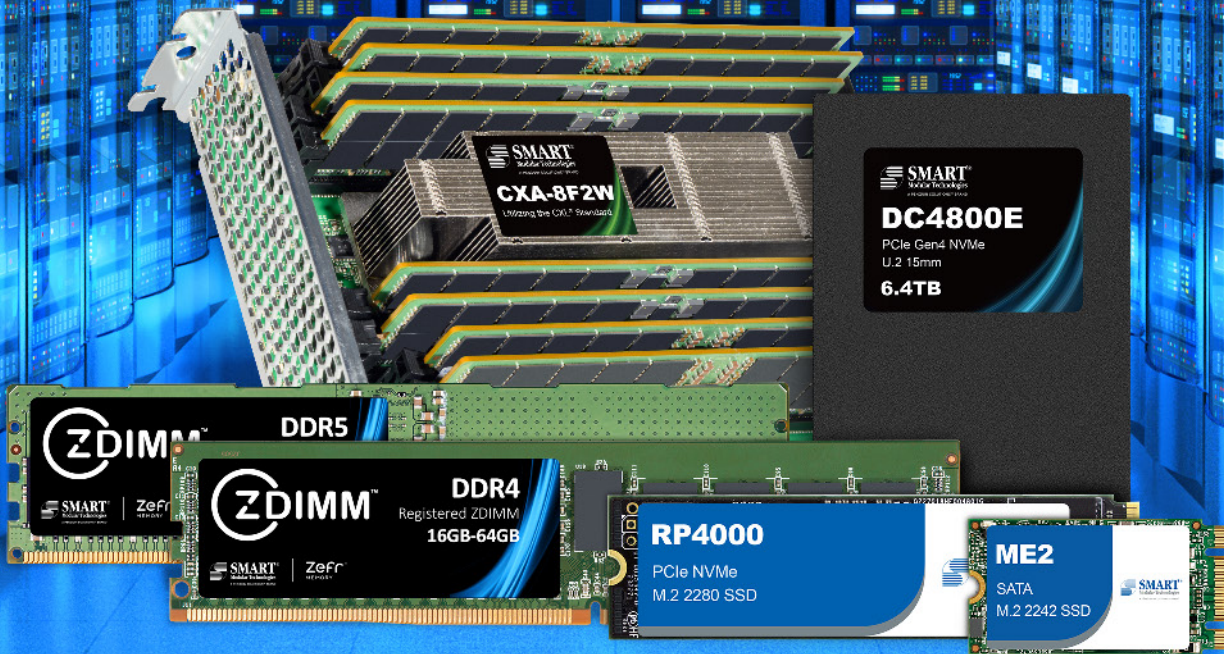




SMART[®]
Modular Technologies

A PENGUIN SOLUTIONS™ BRAND



**Think Memory.
Think SMART.**

Memory Modules / Flash Storage

Zefr™ ZDIMMs / Data Center SSDs / CXL® Memory

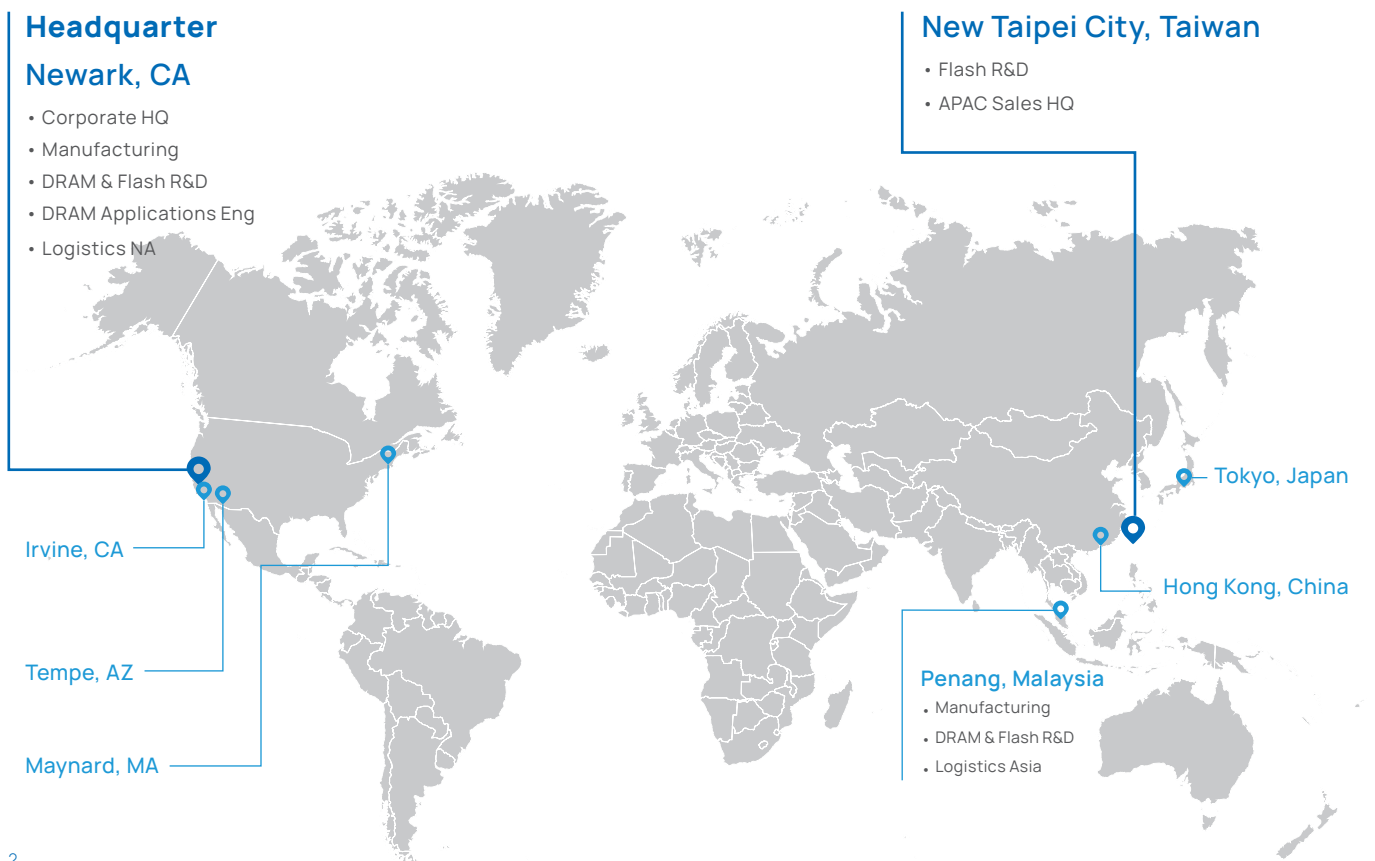
About SMART Modular Technologies

SMART Modular Technologies, a subsidiary of SGH (NASDAQ: SGH), is a global leader in specialty memory, storage and hybrid solutions serving the electronics industry for over 30 years. In addition to standard and ruggedized product lines, SMART Modular offers custom designs to various applications, including computing, networking, communications, storage, mobile, military, defense, aerospace and industrial markets. Focused on providing extensive customer-specific design capabilities, technical support and value-added testing services, SMART collaborates closely with their global OEM customers throughout their design process and across multiple projects to create reliable and efficient solutions for demanding applications with differentiated requirements.

Why SMART Modular

- **Serving the Industry for Over 30 Years:** Dedicated in specialty memory, Flash storage and hybrid solutions for leading OEMs.
- **Advanced Products with Quality Assurance:** Taking innovations from the design stage through manufacturing and the supply chain.
- **Trusted Customer Relationships:** Customer-specific design capabilities, technical support and testing services.
- **Long-Term Partnerships with Suppliers:** Leveraging leading suppliers' pricing component availability to the customer's advantage.
- **Build-to-Order Manufacturing with Lifecycle Management:** Long-term, consistent support throughout all market and technology cycles.
- **Broad Customer Base in Diverse Industry Sectors:** Include Data center, storage server, HPC, edge computing, IIoT, networking, and industrial markets.

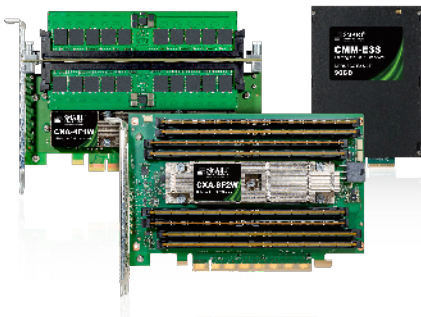
SMART Modular Global Footprint



DRAM Module

Durable Industrial Memory Modules for Intensive Workloads

SMART's DRAM module portfolio sets the standard for industrial-grade memory solutions, delivering exceptional quality and reliability. Backed by SMART's extensive expertise in design, production, rigorous testing, and logistics, these modules are built to excel in the most demanding industrial applications. As an active participant in industry standards, SMART is committed to leading the way by offering advanced memory solutions tailored to meet the efficient computing requirements of today's data-intensive applications. Choosing SMART's industrial memory modules provides businesses with a significant advantage in reliability and performance, ensuring that these modules not only meet but exceed industry benchmarks, consistently delivering optimal performance and unmatched durability in even the most challenging industrial environments.



CXL[®] Memory Solutions Advanced Serial Memory

CXL memory solutions leverage the CXL protocol to provide high-speed, low-latency memory expansion.



Memory Modules

SMART's Memory Module designation conveys its continued commitment to provide durable and reliable memory modules required by industrial workloads.



Zefr ZDIMM

ZDIMMs (Zefr Memory Module) utilize SMART's Zefr™ proprietary screening process, ensuring the industry's highest levels of uptime and reliability.

Advanced Serial Memory

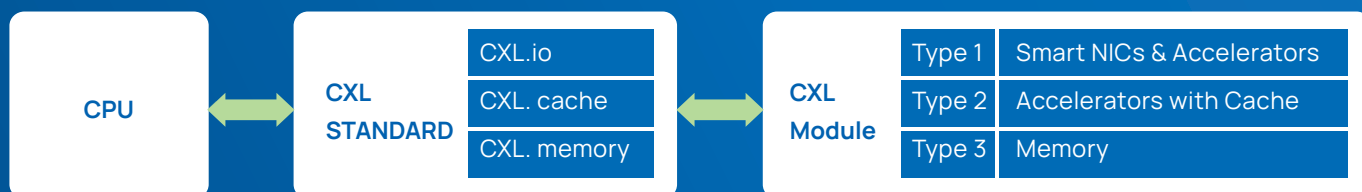
For Memory Expansion and Memory Pooling

CXL® (Compute Express Link®) is an industry standard, open protocol for high speed and low latency communications between host accelerator, which are increasingly used in emerging applications, such as Artificial Intelligence (AI) and Machine Learning (ML).

SMART Modular, along with other industry leaders, such as Alibaba, Cisco, Dell EMC, Facebook, Google, Hewlett Packard Enterprise, Intel Corporation and Microsoft have teamed up to form an open industry standard group to develop technical specifications that facilitate breakthrough performance for emerging usage models while supporting an open ecosystem for data center accelerators and other high-speed enhancements.

CXL Use Cases

The CXL standard defines 3 protocols that are dynamically multiplexed together before being transported via a standard PCIe 5.0 PHY at 32 GT/s:



CXL.io

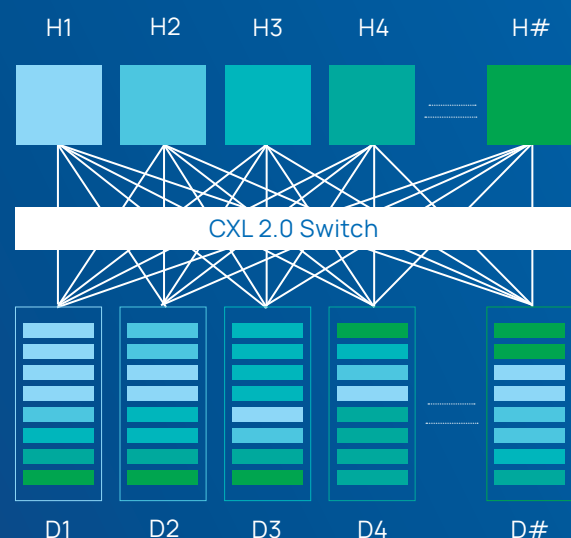
It can be seen as an enhanced version of a PCIe 5.0 protocol, providing I/O devices an interface for configuration, initialization, DMA (direct memory access).

CXL.cache

It specifies the interaction between host CPU and connected devices, allowing the devices to directly access and cache host memory with ultra-low latency.

CXL.mem

It enables a host CPU to access and utilize device-attached memory using load/store commands.



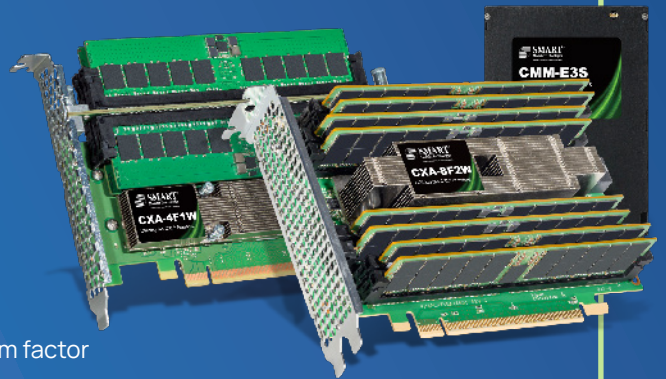
Memory Pooling

CXL 2.0 supports switching to enable memory pooling for efficient memory allocation. At 2.0 level, device can be partitioned as Multiple Logical Devices (MLD), allowing up to 16 hosts to simultaneously access different portions of the memory.

As an example, Host 1 (H1) can use half the memory in Device 1 (D1) and a quarter of the memory in D2 to finely match the memory requirements of its workload to the available capacity in the memory pool. The remaining capacity in D1 and D2 can be used by H2-H#. This architecture makes a better use of available resources without stranded memory.

Key to Memory Capacity & Bandwidth Expansion

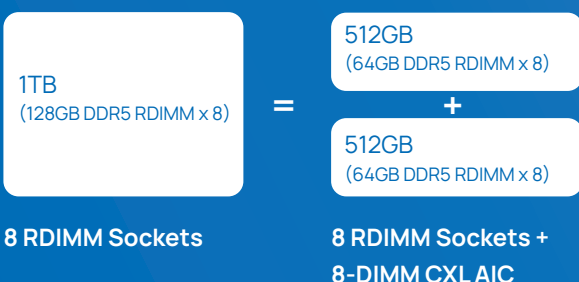
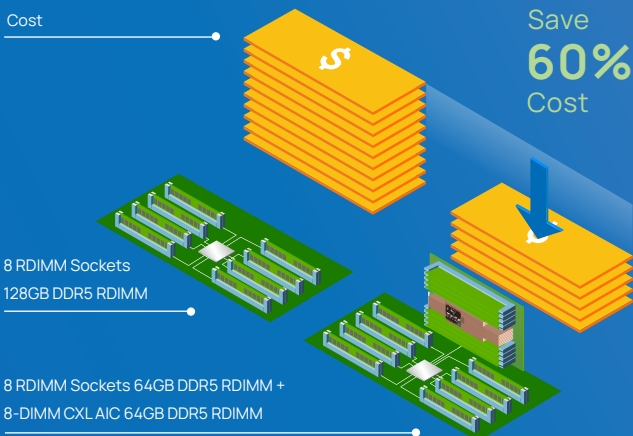
Advanced Serial Memory Utilizing CXL[®] Standard



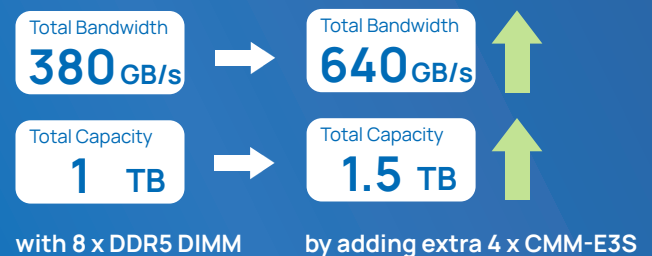
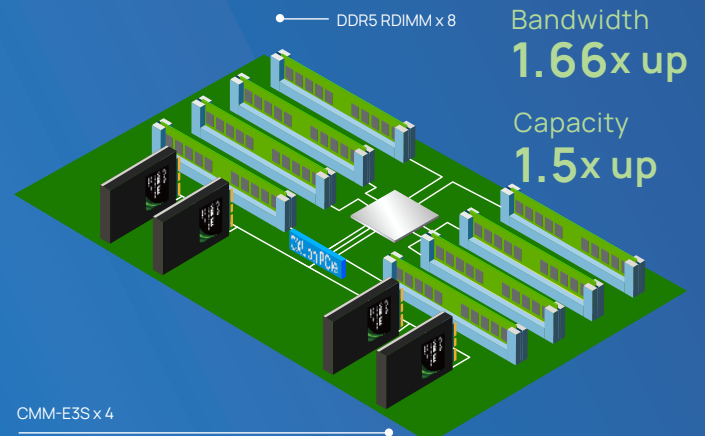
Features

- Available in Add-in Card (AIC) and EDSFF E3.S 2T (2U short) form factor
- ASIC and FPGA-based memory modules supporting multiple interconnect standards
- Customization of features like RAS, memory interleaving, performance tuning, and support for low-power mode
- Debug capabilities for memory and Phy
- Custom packaging, processing, and testing

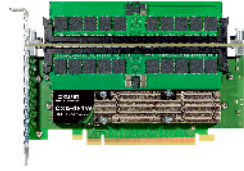
AIC Form Factor Use Case



E3.S Form Factor Use Case



Advanced Serial Utilizing CXL[®] Standard



| Product | CXA-4F1W | CXA-8F2W |
|---------------|------------------------------|-------------------------------|
| Bus | CXL 2.0 x16 | CXL 2.0 x16 (dual x8) |
| Form Factor | FHHL, 1W | FHHL, 2W |
| Configuration | 4 x DDR5 DIMMs | 4 x DDR5-4800 DIMMs |
| Max Capacity | 2TB (TSV) 256GB (SDP) | 4TB (TSV) 512GB (SDP) |
| NV Option | - | - |
| Performance | 64GB/s | 64GB/s |
| Latency | 200ns | 200ns |
| Power | 64W for 2TB 45W for 256GB | 135W for 4TB 90W for 512GB |



| Product | CMM-E3S | NV-CMM-E3S |
|---------------|-------------|------------|
| Bus | CXL 2.0 x16 | CXL 2.0 x8 |
| Form Factor | E3.S 2T | E3.S 2T |
| Configuration | DDR5-4800 | DDR4-3200 |
| Max Capacity | 128GB | 32GB |
| NV Option | - | Yes |
| Performance | 32GB/s | 32GB/s |
| Latency | 200ns | 200ns |
| Power | 30W | 30W |

*C Temp (0°C to +70°C); I Temp (-40°C to +85°C); Ambient Temp (+40°C to +70°C)

Memory Modules

Durable and Reliable Memory for Industrial Workloads

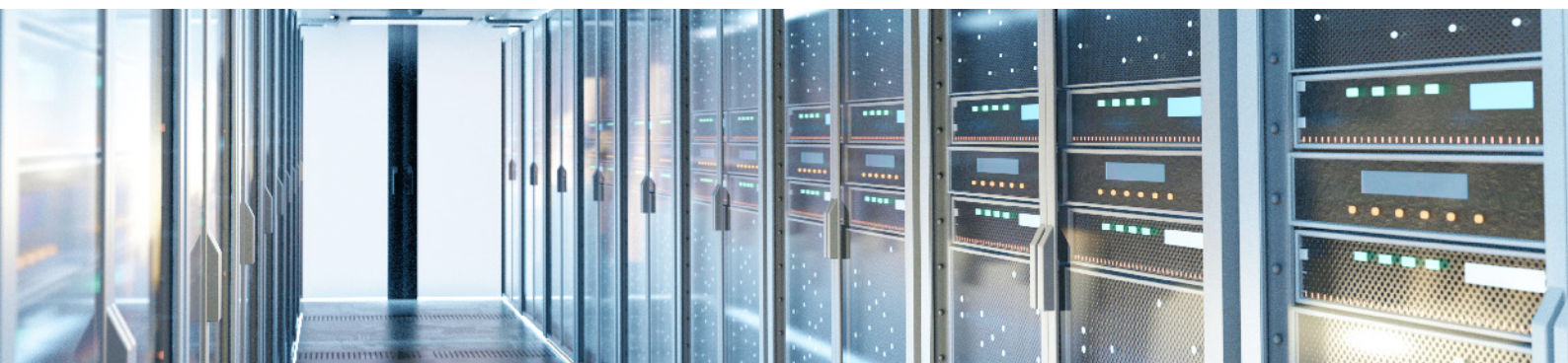
SMART's DRAM module portfolio provides a superior level quality, durability and reliability to meet the needs of today's demanding industrial specifications and applications. All DRAM modules are backed by SMART's extensive expertise in design, manufacturing, testing and logistical support.

SMART's industrial memory modules provide an added level of confidence and security, knowing that these products will perform to the highest standards for durability and reliability, while meeting industrial workload requirements and exceeding performance expectations.

Enterprise Quality for
High Reliability

Undergoes Triple Stress
Testing and Burn-In

Encryption and
Other Features Available



Memory Modules Product Family

DDR5 / DDR4 / DDR3



NVDIMM



LRDIMM



RDIMM



UDIMM



SODIMM



Mini DIMM



MIP™

Liquid Immersion Memory for Next-Gen Cooling Systems

Enhanced Reliability and Cost-effective Operation for
Immersion-cooled Data Center Applications



DDR5 Liquid Immersion RDIMM with Conformal Coating

Combining superior performance of DDR5 technology with enhanced protection for liquid immersion environments, SMART's conformally coated RDIMMs ensure the reliability and longevity in the most demanding data center applications.

Benefits of Conformally Coated RDIMMs

Ensures
long-term reliability in
liquid cooling

Maintains
component
identification for
easier maintenance
and tracking

Maximizes
liquid immersion
cooling benefits
without
compromising
performance

Servers/Data Centers



| DIMM Type | RDIMM | | LRDIMM |
|------------------------|------------|-----------|--------------|
| Technology | DDR5 | DDR4 | DDR4 |
| Density | 16GB-128GB | 4GB-256GB | 128GB, 256GB |
| Height | 31.25mm | 31.25mm | 31.25mm |
| Configuration | 80bit | 72bit | 72bit |
| Speed (MT/s) | 4800-5600 | 2666-3200 | 3200 |
| Voltage | 1.1V | 1.2V | 1.2V |
| Operating Temperature* | C/I Temp | C/I Temp | C Temp |



Liquid Immersion RDIMM



| IMM Type | RDIMM/ |
|------------------------|------------|
| Technology | DDR5 |
| Density | 32GB-256GB |
| Height | 31.25mm |
| Configuration | 80bit |
| Speed (MT/s) | 4800-5600 |
| Voltage | 1.1V |
| Operating Temperature* | C Temp |



Registered ZDIMM



| DIMM Type | RDIMM | |
|------------------------|------------|-----------|
| Technology | DDR5 | DDR4 |
| Density | 32GB-128GB | 16GB-64GB |
| Height | 31.25mm | 31.25mm |
| Configuration | 80bit | 72bit |
| Speed (MT/s) | 5600 | 3200 |
| Voltage | 1.1V | 1.2V |
| Operating Temperature* | C Temp | C Temp |

*C Temp (0°C to +70°C); I Temp (-40°C to +85°C); Ambient Temp (+40°C to +70°C)

Blade/Compact Servers



| DIMM Type | VLP RDIMM | | VLP/ULP Mini RDIMM | |
|------------------------|-----------|-----------|--------------------|---------------|
| Technology | DDR5 | DDR4 | DDR4 | DDR4 |
| Density | 32GB-48GB | 4GB-64GB | 8GB-32GB | 8GB-32GB |
| Height | 18.75mm | 18.75mm | 18.75/17.78mm | 18.75/17.78mm |
| Configuration | 80bit | 72bit | 72bit | 72bit |
| Speed (MT/s) | 4800-5600 | 2666-3200 | 2666-3200 | 2666-3200 |
| Voltage | 1.1V | 1.2V | 1.2V | 1.2V |
| Operating Temperature* | C/I Temp | C/I Temp | C/I Temp | C/I Temp |

Networking



| DIMM Type | UDIMM | | ECC UDIMM | |
|------------------------|-----------|-----------|-----------|-----------|
| Technology | DDR5 | DDR4 | DDR5 | DDR4 |
| Density | 8GB-48GB | 4GB-32GB | 16GB-48GB | 4GB-32GB |
| Height | 31.25mm | 31.25mm | 31.25mm | 31.25mm |
| Configuration | 64bit | 64bit | 72bit | 72bit |
| Speed (MT/s) | 4800-5600 | 2666-3200 | 4800-5600 | 2666-3200 |
| Voltage | 1.1V | 1.2V | 1.1V | 1.2V |
| Operating Temperature* | C/I Temp | C/I Temp | C/I Temp | C/I Temp |

Telecommunication



| DIMM Type | SODIMM | | ECC SODIMM | | |
|------------------------|-----------|-----------|------------|-----------|------------|
| Technology | DDR5 | DDR4 | DDR5 | DDR4 | DDR3 |
| Density | 8GB-48GB | 2GB-32GB | 16GB-48GB | 4GB-32GB | 2GB-16GB |
| Height | 30mm | 30mm | 30mm | 30mm | 30/25.4mm |
| Configuration | 64bit | 64bit | 64bit | 72bit | 72bit |
| Speed (MT/s) | 4800-5600 | 2400-3200 | 4800-5600 | 2666-3200 | 1600-1866 |
| Voltage | 1.1V | 1.2V | 1.1V | 1.2V | 1.35V/1.5V |
| Operating Temperature* | C/I Temp | C/I Temp | C/I Temp | C/I Temp | C/I Temp |

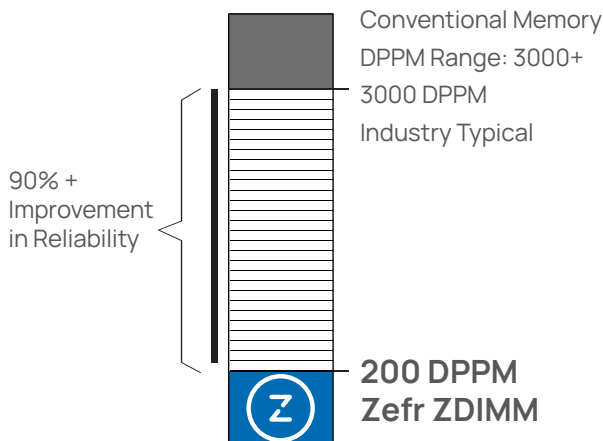
*C Temp (0°C to +70°C); I Temp (-40°C to +85°C); Ambient Temp (+40°C to +70°C)



Ultra-High Reliability Zefr™ ZDIMM Memory

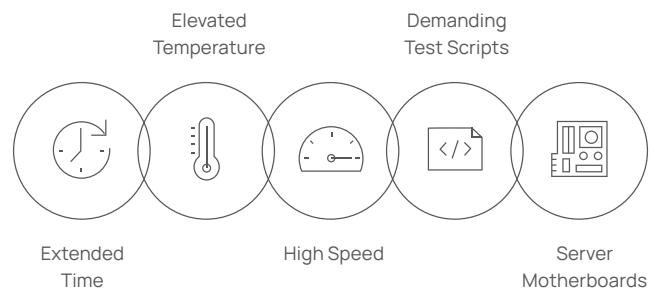
Eliminate over **90%** of Memory Reliability Failures

Industry Standard Memory Reliability isn't Sufficient



Zefr Screens Memory to Real-World Conditions

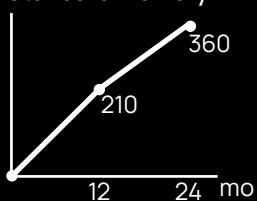
Zefr ZDIMM has been intensely processed to filter out weak memory modules. The Zefr Process combines five key testing ingredients.



Case Study

An HPC System Integrator built identical systems with standard and Zefr memory.

Standard Memory



Purchase 18,384 Standard RDIMMs
Build Cluster A:
• 1,532 Nodes
• Twelve 16GB RDIMMs per Node

Field Failures since Platform Bring up:
360 Failures

Zefr Memory



1Purchase 18,384 Standard RDIMMs
Build Cluster B:
• 1,532 Nodes
• Twelve 16GB RDIMMs per Node

Field Failures since Platform Bring up:
0 Failures

Compact Systems



| DIMM Type | VLP UDIMM | | VLP/ULP ECC UDIMM | |
|------------------------|------------|-----------|-------------------|--------------|
| Technology | DDR3 | DDR5 | DDR4 | DDR3 |
| Density | 4GB-8GB | 32GB-48GB | 16GB-32GB | 4GB-8GB |
| Height | 18.3mm | 18.75mm | 17.78mm | 18.75/18.3mm |
| Configuration | 64bit | 72bit | 72bit | 72bit |
| Speed (MT/s) | 1600 | 4800-5600 | 2666-3200 | 1600 |
| Voltage | 1.35V/1.5V | 1.1V | 1.2V | 1.35V/1.5V |
| Operating Temperature* | C Temp | C/I Temp | C/I Temp | C Temp |

Aerospace/Military



| DIMM Type | ECC SODIMM | |
|------------------------|------------|------------|
| Technology | DDR4 | DDR3 |
| Density | 4GB-32GB | 2GB-16GB |
| Height | 30mm | 30/25.4mm |
| Configuration | 72bit | 72bit |
| Speed (MT/s) | 2666-3200 | 1600-1866 |
| Voltage | 1.2V | 1.35V/1.5V |
| Operating Temperature* | C/I Temp | C/I Temp |



| DIMM Type | MIP | |
|------------------------|-----------|---------|
| Technology | DDR4 | DDR3 |
| Density | 2GB-16GB | 2GB |
| Height | 22.25mm | 22.25mm |
| Configuration | 72bit | 72bit |
| Speed (MT/s) | 2933-3200 | 1866 |
| Voltage | 1.2V | 1.35V |
| Operating Temperature* | C/I Temp | CTemp |

*C Temp (0 °C to +70 °C); I Temp (-40 °C to +85 °C); Ambient Temp (+40 °C to +70 °C)

Flash Storage

High-Performance and Reliable Flash Storage for Demanding Environments

SMART's Flash product line exemplifies the company's dedication to providing durable and reliable storage solutions for a wide array of applications. From data center infrastructure to the most demanding aerospace and defense scenarios, SMART offers a comprehensive range of Flash storage products designed to ensure data integrity and security throughout processing and transmission. Leveraging the latest NAND technology, SMART's PCIe NVMe and SATA SSDs deliver exceptional performance and endurance while minimizing power consumption, meeting the exacting standards of data-intensive applications. For environments requiring extra resilience, SMART's RUGGED SSDs integrate high performance, superior reliability, and enhanced data security into a single, ruggedized design. This diverse portfolio underscores SMART's commitment to meeting the varied and critical storage needs across industries.



Data Center SSDs

SMART's Data Center SSDs are everything you need for data center storage – fast, cool and consistent.



Embedded SSDs

SMART's Flash product designation conveys its continued commitment to provide durable and reliable Flash storage required by diversified applications.



RUGGED SSDs

SMART's RUGGED SSD combines high performance, superior reliability and data security into a single ruggedized design.

Next-Generation Data Center SSDs

Meet three major demands for data center applications

SMART Modular's next-generation SSD family is designed for demanding Applications and stringent SLA's. Today's compute applications place extraordinary demands on data center servers and continue to increase the need for consistent and reliable performance from the underlying hardware. The ability to meet Service Level Agreements (SLA's) that rely on frequent access to data is highly dependent on the SSD storage controller design.

Architected for Low Power

SMART's DC SSD family uses a hardware-accelerated architecture that runs cooler while maintaining maximum performance. Low power operation helps achieve energy conservation standards and also increases server density per square foot. Save up to 200W per server in a standard 2U/24 configuration.



Peak Performance



Low Power



Enterprise Features

SMART's data center SSDs run full-throttle for maximum throughput.

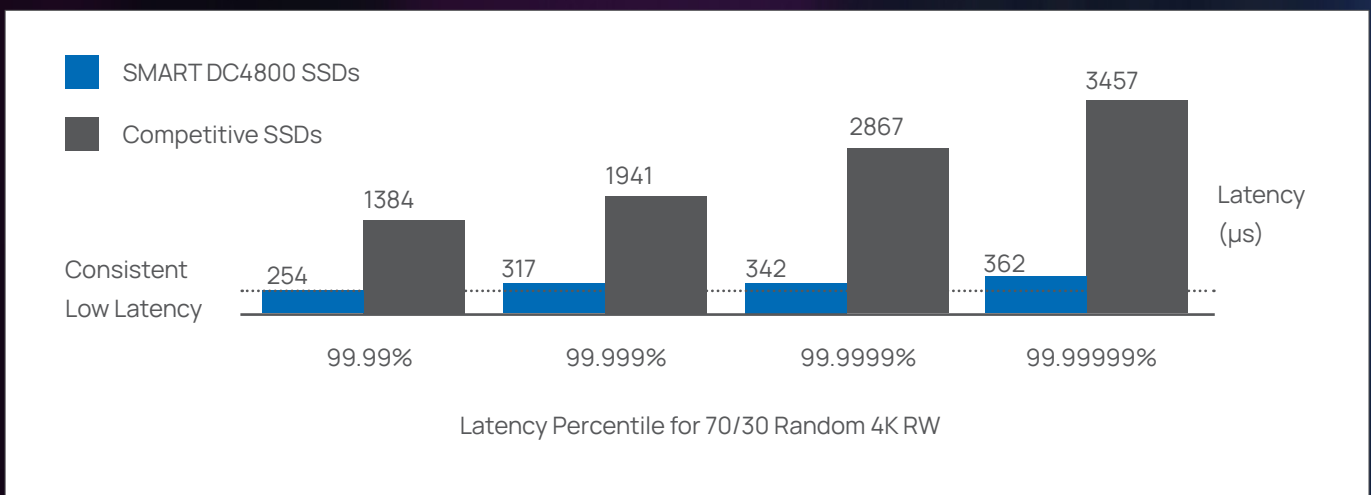
SMART's low power architecture keeps the SSDs running cool.

Our SSDs are designed for a diverse range of data center applications

| | Read | Write |
|-------------------|----------|----------|
| Sequential (GB/s) | 7.1 GB/s | 4.6 GB/s |
| Random (KIOP/s) | 1,490 | 180 |

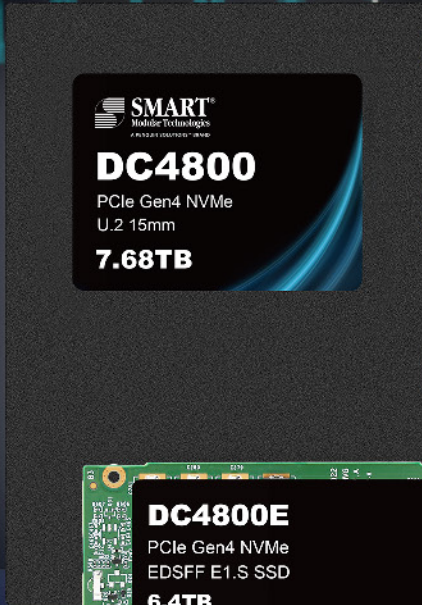
- Industry-leading low Idle and Active Power
- Less heat leaving more headroom for NAND to run fast
- Reduced OpEx costs for SSDs and cooling

- E2E Data protection, TCG, OPAL, eDrive
- Secure Platform Boot
- Multiple Namespaces
- 1 and 3 DWPD
- SMART/Health Log Telemetry
- External Power Loss Protection



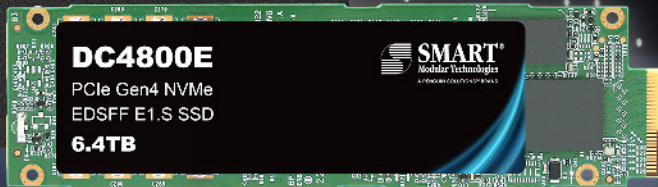


OPEN
Compute Project
SOLUTION PROVIDER[®]



| | Read(GB/s) |
|--------------|------------|
| Competitor M | 4,026 |
| Competitor T | 3,194 |
| Competitor W | 3,300 |

| | Write(GB/s) |
|--------------|-------------|
| Competitor M | 2,180 |
| Competitor T | 1,253 |
| Competitor W | 3,196 |



DC4800/E PCIe NVMe Data Center SSDs Fast, Cool and Consistent

Designed for data center, hyperscaler and cloud server applications

Maximum sustained performance capable of fully saturating the server's PCIe Gen 3/4/5

Superior Quality of Service (QoS) with 7-nines (99.99999%) of latency consistency

Hardware-accelerated SSD design to significantly reduce thermal throttling

Product Family

| Form Factor | Form Factor | Capacity | DWPD |
|-------------|-------------|----------------------------|------|
| DC4800 | U.2 | 1.92TB, 3.84TB, 7.68TB | 1 |
| | EDSFF E1.S | | |
| DC4800E | U.2 | 0.8TB, 1.6TB, 3.2TB, 6.4TB | 3 |
| | EDSFF E1.S | | |

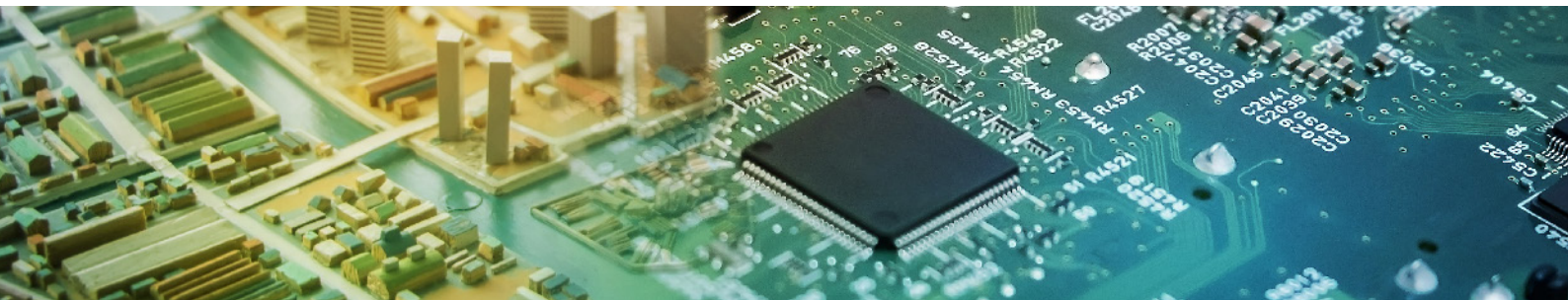
Embedded SSDs

Durable and Reliable Industrial Flash Solutions

SMART Modular is dedicated to providing a diverse range of Flash storage form factors, meticulously designed and manufactured to meet the rigorous demands of rapidly evolving embedded applications across various sectors, including telecom, networking, storage, industrial control, medical, IIoT, transportation, and video surveillance. SMART Modular’s comprehensive capabilities and meticulous attention to detail ensure that quality controls and stringent processes are integrated into every phase of its design, procurement, and manufacturing cycle. From the careful selection of specialized materials and components that adhere to SMART’s strict standards, to the completion of the product, each unit undergoes a rigorous design verification test (DVT) process, passing extensive checklists of criteria, followed by a final inspection before release.

Value-Added Features:

- Optimized for Enterprise and Industrial Applications
- Available in C Temp (0°C to +70°C) and I Temp (-40°C to +85°C)
- Multiple NAND Options: TLC, eTLC, MLC, SLC, and pSLC
- Extensive Burn-In to Ensure Field Reliability
- Customized Options with Advanced Features Available
- SafeDATA™ Technology Safeguards In-Flight Data During Sudden Power Loss (SPL)
- Available in Broad Range of Capacities
- NVMSentry™ customized firmware support



Embedded SSDs Product Family



Embedded SSDs

- 2.5"
- M.2 (2230/2242/2280/22110)
- mSATA
- Slim SATA
- EDSFF E1.S



BGA

- eMMC
- BGA NVMe



Memory Cards

- SD Cards
- microSD Cards
- CF Cards



USB

- eUSB
- USB Flash Drives



Enterprise/ Data Center SSDs

- EDSFF E1.S, E3.S
- U.2

The Ideal SSD Boot Drives for Embedded and Data Center

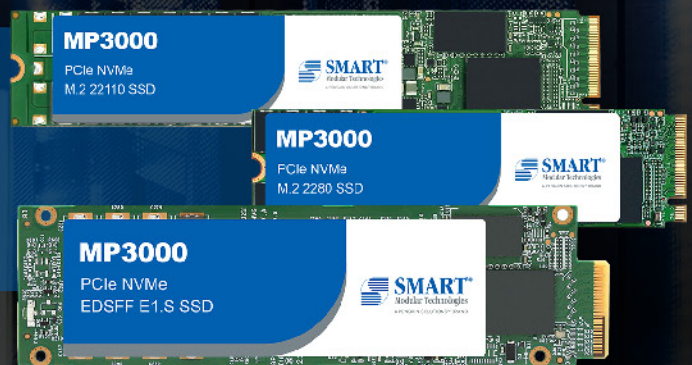
- The Latest Generation 3D NAND Technology
- 1 DWPD For Five Years
- SMART's Proprietary NVMSentry™ Firmware
- Optional SafeDATA™ Power Loss Data-Protection Technology
- TCG OPAL 2.0 and AES 256 Encryption
- Support I-Temp (-40°C to +85°C)
- Single Event Upset (SEU) Mitigation Technology



ME2 SATA SSDs



MP3000 PCIe NVMe SSDs



ME2 SATA SSDs



| Specifications | | | | | | |
|------------------------|---|--|----------------------------|----------------------------|----------------------------|----------------------------|
| Interface | | SATA III 6Gb/s | | | | |
| Form Factor | | 2.5" | M.2 2242-D3-B-M | M.2 2280-D3-B-M | mSATA (MO-300A) | Slim SATA (MO-297) |
| Max. Performance | Read | 540MB/s | 540MB/s | 540MB/s | 540MB/s | 540MB/s |
| | Write | 460MB/s | 460MB/s | 460MB/s | 460MB/s | 460MB/s |
| Capacity | | 240GB-1920GB | 240GB-960GB | 240GB-1920GB | 240GB-1920GB | 240GB-1920GB |
| DRAM | | V | V | V | V | V |
| Input Voltage | | 5V ± 10% | 3.3V ± 5% | 3.3V ± 5% | 3.3V ± 5% | 3.3V ± 5% |
| Data Integrity | SafeDATA | Optional | - | Optional | - | - |
| | Advanced Error Detection & Correction | V | V | V | V | V |
| Security | AES 256 Encryption | V | V | V | V | V |
| | TCG OPAL 2.0 | V | V | V | V | V |
| | Security Erase (ATA) | V | V | V | V | V |
| Reliability | MTBF | > 2,000,000 hours | | | | |
| | Shock Operating | 1500 g half-sine, 0.5 msec, 1 shock along each axis, X, Y, Z in each direction | | | | |
| | Vibration Operating | 20G 80-2000Hz, 1.52mm 20-80Hz, 3 axis | | | | |
| Operating Temperature* | | C/I Temp | C/I Temp | C/I Temp | C/I Temp | C/I Temp |
| Durability | DWPD (for 5 Years) | 1 (Enterprise Workload) | 1 (Enterprise Workload) | 1 (Enterprise Workload) | 1 (Enterprise Workload) | 1 (Enterprise Workload) |
| | Pseudo-SLC | - | - | - | - | - |
| | Thermal Throttling | V | V | V | V | V |
| | Wear-Leveling / Garbage Collection / TRIM | V | V | V | V | V |

Recommended/Suggested Applications

- AI
- Data Center
- Industrial
- Networking
- Surveillance

*C Temp (0 °C to +70 °C) ; E Temp (-25 °C to +85 °C) ; I Temp (-40 °C to +85 °C)

MP3000 PCIe NVMe SSDs



Specifications

| | | | | |
|------------------------|---|--|----------------------------|----------------------------|
| Interface | | PCIe Gen4 x4 | | |
| Form Factor | | EDSFF E1.S | M.2 2280-D3-M | M.2 22110-D3-M |
| Max. Performance | Read | 3500MB/s | 3500MB/s | 3500MB/s |
| | Write | 2900MB/s | 2900MB/s | 2900MB/s |
| Capacity | | 240GB-1920GB | 240GB-1920GB | 240GB-1920GB |
| DRAM | | V | V | V |
| Input Voltage | | 12V ± 10% | 3.3V ± 5% | 3.3V ± 5% |
| SafeDATA | | Optional | Optional | Optional |
| Data Integrity | Advanced Error Detection & Correction | V | V | V |
| | AES 256 Encryption | V | V | V |
| Security | TCG OPAL 2.0 | V | V | V |
| | Security Erase (ATA) | V | V | V |
| Reliability | MTBF | > 2,000,000 hours | | |
| | Shock Operating | 1500 g half-sine, 0.5 msec, 1 shock along each axis, X, Y, Z in each direction | | |
| | Vibration Operating | 20G 80-2000Hz, 1.52mm 20-80Hz, 3 axis | | |
| Operating Temperature* | | C/I Temp | C/I Temp | C/I Temp |
| Durability | DWPD (for 5 Years) | 1 (Enterprise Workload) | 1 (Enterprise Workload) | 1 (Enterprise Workload) |
| | Pseudo-SLC | Optional | - | - |
| | Thermal Throttling | V | V | V |
| | Wear-Leveling / Garbage Collection / TRIM | V | V | V |

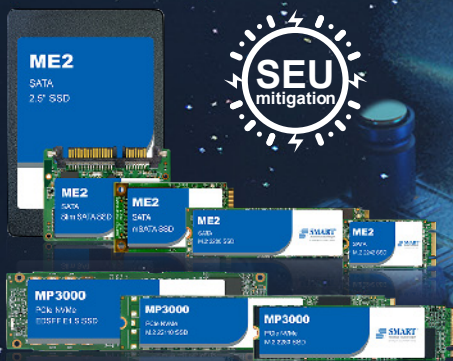
Recommended/Suggested Applications

- AI
- Data Center
- HPC
- Networking
- Storage
- Telecommunication

*C Temp (0 °C to +70 °C) ; E Temp (-25 °C to +85 °C) ; I Temp (-40 °C to +85 °C)

SEUs Mitigation Technology

Reduce Service Costs and Improve Up-time in Critical
24/7 applications



ME2 SATA SSD Series & MP3000 PCIe/NVMe SSD Series

Single-event upsets (SEUs) are inadvertent changes in bit status that occur in digital systems when high-energy neutrons or alpha particles randomly strike. SEUs pose a significant threat to electronic devices, particularly SSDs, by causing temporary errors that can lead to abnormal operation or even total system failure.

Engineered with advanced SEU mitigation technology, ME2 and MP3000 SSDs deliver exceptional reliability and performance in the most demanding environments, especially important for tough-to-repair remote deployments.

Advanced SEU Mitigation

Protect data with ECC and self-recovery watchdog timers

Reduced Failure Rate

Reduce potential service cost with much lower Annual Failure Rate
(less than 10/Mu (Million units))

Optimal Performance

Optimize for 24/7 operations with consistent and reliable performance

Maximized Runtimes

Eliminate the need for system reboots or power cycles

RP4000 PCIe NVMe SSDs



Specifications

| | | |
|------------------|---|--|
| Interface | | PCIe Gen4 x4 |
| Form Factor | | M.2 2280-D3-M |
| Max. Performance | Read | 6000MB/s |
| | Write | 2000MB/s |
| Capacity | | 480GB-1920GB |
| DRAM | | V |
| Input Voltage | | 3.3V ± 5% |
| Data Integrity | SafeDATA | Standard |
| | Advanced Error Detection & Correction | V |
| | AES 256 Encryption | V |
| Security | TCG OPAL 2.0 | V |
| | Security Erase (ATA) | V |
| Reliability | MTBF | > 2,000,000 hours |
| | Shock Operating | 1500 g half-sine, 0.5 msec, 1 shock along each axis, X, Y, Z in each direction |
| | Vibration Operating | 20G 80-2000Hz, 1.52mm 20-80Hz, 3 axis |
| | Operating Temperature* | C Temp |
| Durability | DWPD (for 5 Years) | 0.7 (Enterprise Workload) |
| | Pseudo-SLC | - |
| | Thermal Throttling | V |
| | Wear-Leveling / Garbage Collection / TRIM | V |
| | | |

Recommended/Suggested Applications

- Data Center
- HPC
- Networking
- Storage Server
- Telecommunication

*C Temp (0 °C to +70 °C) ; E Temp (-25 °C to +85 °C) ; I Temp (-40 °C to +85 °C)

eUSB Flash Drives



| Specifications | RU150e | HU250e | |
|------------------------|---|--|---------|
| Interface | USB 2.0 | USB 3.0 | |
| NAND Type | SLC | | |
| Max. Performance | Read | 35MB/s | 150MB/s |
| | Write | 27MB/s | 90MB/s |
| Capacity | 1GB-32GB | 8GB-32GB | |
| Operating Temperature* | C/I Temp | I Temp | |
| Connector | Pin pitch 2.54mm, H: 7.50mm Pin pitch 2.54mm, H: 9.78mm Pin pitch 2.00mm, H: 3.68mm | Pin pitch 2.00mm, H: 3.68mm Pin pitch 2.54mm, H: 7.42mm | |

Recommended/Suggested Applications

- Single-board computers for defense, gaming and industrial control applications
- ATCA compute blades
- Industry standard servers

USB Flash Drives



| Specifications | RU150 | RU350 | |
|------------------------|----------|------------|----------|
| Interface | USB 2.0 | USB 3.0 | |
| NAND Type | SLC | TLC | |
| Max. Performance | Read | 354MB/s | 2700MB/s |
| | Write | 27MB/s | 65MB/s |
| Capacity | 1GB-16GB | 16GB-256GB | |
| Operating Temperature* | C/I Temp | I Temp | |
| Connector | Type A | Type A | |

Recommended/Suggested Applications

- Single-board computers for defense, gaming and industrial control applications
- Telecom and networking routers and switches
- ATCA compute blades
- Industry standard servers
- Networking

*C Temp (0°C to +70°C) ; E Temp (-25°C to +85°C) ; I Temp (-40°C to +85°C)



| Specifications | BGAE 340 | BGAE 640 |
|------------------------|-------------------|-----------------------------|
| Interface | eMMC v5.1 (HS400) | |
| Form Factor | BGA | |
| NAND Type | SLC | |
| Max. Performance | Read | 170MB/s |
| | Write | 10MB/s |
| | | TLC: 170MB/s; pSLC: 250MB/s |
| Input Voltage | 1.8V± 10% | |
| Ball Counts | 153 | 100/153 |
| Operating Temperature* | I Temp | |

Recommended/Suggested Applications

- Gaming
- Communications
- Defense
- Industrial control equipment
- Networking
- Printers

CF Cards



| Specifications | H9 | XL |
|------------------------|--------------|-----------|
| Interface | CF 6.1 | CF 4.1 |
| Form Factor | CompactFlash | |
| NAND Type | SLC | |
| Max. Performance | Read | 100MB/s |
| | Write | 70MB/s |
| Capacity | 64MB-64GB | 128MB-8GB |
| Operating Temperature* | C/I Temp | C/I Temp |

Recommended/Suggested Applications

- Gaming
- Communications
- Defense
- Industrial control equipment
- Networking
- Printers

*C Temp (0 °C to +70 °C) ; E Temp (-25 °C to +85 °C) ; I Temp (-40 °C to +85 °C)

SD Cards



| Specifications | XL+ | RD230 |
|------------------------|----------|--------|
| Interface | SD 3.01 | SD 6.1 |
| Form Factor | SD Card | |
| NAND Type | SLC | TLC |
| Max. Performance | Read | 49MB/s |
| | Write | 38MB/s |
| Capacity | 4GB-32GB | 128GB |
| Operating Temperature* | C/I Temp | I Temp |

Recommended/Suggested Applications

- Automotive telematics, navigation, and infotainment
- Digital commercial camcorders
- Telecom and communications
- Embedded computing
- Medical equipment

MicroSD Cards



| Specifications | RD130m | RD230m | RD530m |
|------------------------|--------------|--------|------------|
| Interface | SD 3.01 | SD 6.1 | SD 6.1 |
| Form Factor | microSD Card | | |
| NAND Type | SLC | TLC | TLC |
| Max. Performance | Read | 68MB/s | 95MB/s |
| | Write | 50MB/s | 55MB/s |
| Capacity | 1GB-4GB | 32GB | 64GB-128GB |
| Operating Temperature* | E/I temp | I Temp | C Temp |

Recommended/Suggested Applications

- Automotive telematics, navigation, and infotainment
- Telecom and communications
- Embedded computing
- Digital commercial camcorders
- Industrial meters and industrial control
- Medical equipment
- Gaming

*C Temp (0°C to +70°C) ; E Temp (-25°C to +85°C) ; I Temp (-40°C to +85°C)

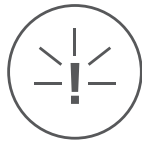
SMART RUGGED

WHEN FAILURE IS NOT AN OPTION

SMART RUGGED pioneered secure, ruggedized solid-state drives and continues to be a technology leader, employing current and next-generation defense-focused designs with physical ruggedization, conformal coating, HW-based erase triggers on each end of the drives, and more. Utilizing Flash technology backed with proven world-class support, SMART RUGGED designs and manufactures high performance military and industrial SSDs with military standard encryption, secure data elimination and write-protect features.



Standard



Shock & Vibration



Security



Conformal Coat



Humidity
Condensation



Altitude



Industrial
Temperature

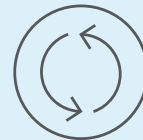
Optional



Specific
Shock & Vibration



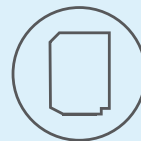
Underfill & Staking



Leaded Process



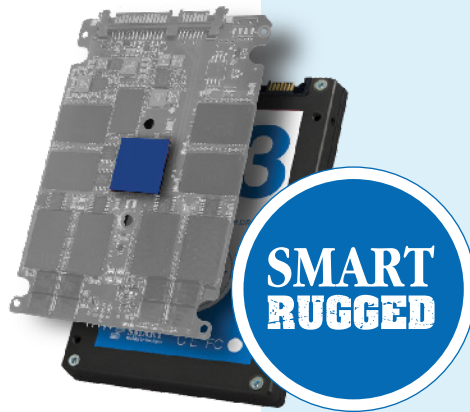
Custom FW



Custom HW



Extreme
Temperature
Screening



SMART RUGGED SSD LINE-UP



| | T6CN | | | T6EN | | | T5EN | |
|---|---|------------------------------------|------------------------------------|---|------------------------------------|------------------------------------|--|--|
| Interface | PCIe | | | PCIe | | | PCIe | |
| Form Factor | E1.S | U.2 | M.2 2280 | E1.S | U.2 | M.2 2280 | U.2 | M.2 2280 |
| NAND Flash Type | 3D TLC | | | 3D TLC | | | 3D TLC | |
| Capacity | 960GB-7,680GB | 960GB-15,360GB | 960GB-3,480GB | 960GB-7,680GB | 960GB-15,360GB | 960GB-3,480GB | 3D TLC: 480GB-7,680GB pSLC: 160GB-2,560GB | 3D TLC: 480GB-3,840GB pSLC: 160GB-1,280GB |
| Sustained Read/Write Performance | 3,500MB/s Read, 3,000MB/s Write | 3,500MB/s Read, 3,000MB/s Write | 3,200MB/s Read, 3,200MB/s Write | 3,500MB/s Read, 3,000MB/s Write | 3,500MB/s Read, 3,000MB/s Write | 3,200MB/s Read, 3,200MB/s Write | 3,200MB/s Read, 1,600MB/s Write | |
| Reliability | | | | | | | | |
| MTBF | 2M Hours, Telcordia 20°C | | | 2M Hours, Telcordia 20°C | | | 2M Hours, Telcordia 25°C | |
| Data Reliability | 1 in 10 ¹⁷ bits read | | | | | | | |
| Data Retention | 10 years @ 25°C | | | 10 years @ 25°C | | | 10 years @ 25°C | |
| Endurance | C-Temp: 16,800 TBW (with 15,360GB) I-Temp: 9,600 TBW (with 15,360GB) | | | I-Temp: 9,600 TBW (with 15,360GB) | | | 3D TLC: 625 TDW pSLC: 6,250 TDW | |
| Power Loss Protection | U.2 & E1.S only | | | U.2 & E1.S only | | | pFail | No pFail |
| Warranty | 1 Year | | | 1 Year | | | 1 Year | |
| Environmental | | | | | | | | |
| Operating Temperature ⁵ | C/I-Temp ⁵ | | | I-Temp ⁵ | | | I-Temp ⁵ | |
| Storage Temperature | Commercial (-40°C to 85°C); Industrial (-50°C to 95°C) | | | Commercial (-40°C to 85°C); Industrial (-50°C to 95°C) | | | -55°C to +95°C | |
| Operating Shock | 50G (11 ms,duratio, half sine wave) ³ | | | 50G (11 ms,duratio, half sine wave) ³ | | | 50g half-sine, 11 ms, 3 shocks along each axis ³ | |
| Operating Vibration | 10G (peak, 10-2000Hz) ³ | | | 10G (peak, 10-2000Hz) ³ | | | 10g rms, 10-2000Hz ³ | |
| Relative Humidity | 5% - 95% non-condensing ³ | | | 5% - 95% non-condensing ³ | | | 5% - 95% non-condensing ³ | |
| Altitude | 24,384 m (80,000 ft) ³ | | | 24,384 m (80,000 ft) ³ | | | 24,384 m (80,000 ft) ³ | |
| Conformal Coating | Optional | | | Optional | | | Optional | |
| Security (Protection & Data Elimination) | | | | | | | | |
| ATA Password | V | V | V | - | - | - | - | - |
| AES 256-bit | V | V | V | V | V | V | V | V |
| Write Protect | - | - | - | V | V | V | V | V |
| External HW Trigger | - | - | - | V | V | V | V | V |
| Erase Key and Flash | - | - | - | V | V | V | V | V |
| TCG Opal 2.0 | - | - | - | V | V | V | V | V |
| FIPS 140-2 | - | - | - | - | - | - | - | - |
| MIL Erase Sequences | | | | | | | | |
| NSA-9-12 | - | - | - | V | V | V | V | V |
| DoD NISPOM 5220.22-M | - | - | - | V | V | V | V | V |
| DoD NISPOM 5220.22-M-Sup 1 | - | - | - | V | V | V | V | V |
| NSA/CSS Manual 130-2 | - | - | - | V | V | V | V | V |
| NSA/CSS Manual 9-12 | - | - | - | V | V | V | V | V |
| Army AR 380-19 | - | - | - | V | V | V | V | V |
| Navy NAVSO P-5239-26 | - | - | - | V | V | V | V | V |
| Air Force AFSSI-5020 | - | - | - | V | V | V | V | V |
| RCC -TG IIRIG 106-07 | - | - | - | V | V | V | V | V |

¹ Estimated. Official MTBF pending

² Based on 128 KByte block transfers and continuous, sequential writes to the drive. The number does not include file system overhead, which may vary depending on the file system. The total life span of the drive depends on both the write endurance numbers and MTBF. TDW → Total Drive Writes = (Terabytes Written) *1000 / (Drive Capacity GB)

³ Design Specification, Testing Pending

⁴ FIPS 140-2 Inside

⁵ C-Temp (0°C to +70°C); I-Temp (-40°C to +85°C)



| | T5E | | S5E | T5PF | T5PFLC | |
|---|--|---|---|--|--|----------------|
| Interface | SATA | | SATA | SATA | SATA | |
| Form Factor | 2.5" | M.2 2280 | 2.5" | 2.5" | 2.5" | M.2 2280 |
| NAND Flash Type | 3D TLC | | SLC | 3D TLC | 3D TLC | |
| Capacity | 3D TLC: 120GB-3,840GB pSLC: 40GB-1,280GB | 3D TLC: 120GB-1,920GB pSLC: 40GB-640GB | 60GB-480GB | 480GB-3,840GB | 120GB-1,920GB | 240GB-960GB |
| Sustained Read/Write Performance | 520MB/s Read, 500MB/s Write | | 530MB/s Read, 490MB/s Write | 500MB/s Read, 470MB/s Write | 500MB/s Read, 470MB/s Write | |
| Reliability | | | | | | |
| MTBF | 2M Hours, Telcordia 25°C | | 2M Hours, Telcordia 25°C | 2M Hours, Telcordia 25°C ¹ | 2M Hours, Telcordia 25°C ¹ | |
| Data Reliability | 1 in 10 ¹⁷ bits read | | | | | |
| Data Retention | 10 years @ 25°C | | 10 years @ 25°C | 10 years @ 25°C | 10 years @ 25°C | |
| Endurance | 3D TLC: 1,000 TDW pSLC: 10,000 TDW | | 30,000 TDW | 2,100 TDW | 2,100 TDW | |
| Power Loss Protection | pFail | No pFail | pFail | pFail | No pFail | |
| Warranty | 1 Year | | 1 Year | 1 Year | 1 Year | |
| Environmental | | | | | | |
| Operating Temperature ⁵ | C/I-Temp ⁵ | I-Temp ⁵ | I-Temp ⁵ | I-Temp ⁵ | C/I-Temp ⁵ | |
| Storage Temperature | -55°C to +95°C | | -55°C to +95°C | -55°C to +95°C | -55°C to +95°C | |
| Operating Shock | 50g half-sine, 11 ms, 3 shocks along each axis ³ | | 50g half-sine, 11 ms, 3 shocks along each axis | 50g half-sine, 11 ms, 3 shocks along each axis ³ | 50g half-sine, 11 ms, 3 shocks along each axis ³ | |
| Operating Vibration | 16.4g rms, 10-2,000 Hz | 10g rms, 10-2000Hz ² | 16.4g rms, 10-2,000 Hz | 16.4g rms, 10-2,000 Hz ² | 16.4g rms, 10-2,000 Hz ² | |
| Relative Humidity | 5%-95% non-condensing | | | | | |
| Altitude | 24,384m (80,000 ft) | | 24,384 m (80,000 ft) | 24,384 m (80,000 ft) | 24,384 m (80,000 ft) | |
| Conformal Coating | Optional | | Optional | Optional | Optional | |
| Security (Protection & Data Elimination) | | | | | | |
| ATA Password | V | V | V | V | V | V |
| AES 256-bit | V | V | V | V | V | V |
| Write Protect | V | Optional | V | V | - | - |
| External HW Trigger | V | - | V | V | - | - |
| Erase Key and Flash | V | - | V | V | - | - |
| TCG Opal 2.0 | V | V | V | V | V | V |
| FIPS 140-2 | - | - | - | V ⁴ | V ⁴ | V ⁴ |
| MIL Erase Sequences | | | | | | |
| NSA-9-12 | V | - | V | - | - | - |
| DoD NISPOM 5220.22-M | V | - | V | V | - | - |
| DoD NISPOM 5220.22-M-Sup 1 | V | - | V | V | - | - |
| NSA/CSS Manual 130-2 | V | - | V | V | - | - |
| NSA/CSS Manual 9-12 | V | - | V | V | - | - |
| Army AR 380-19 | V | - | - | V | - | - |
| Navy NAVSO P-5239-26 | V | - | V | V | - | - |
| Air Force AFSSI-5020 | V | - | V | V | - | - |
| RCC -TG IRIG 106-07 | V | - | V | - | - | - |

¹ Estimated. Official MTBF pending

² Based on 128 KByte block transfers and continuous, sequential writes to the drive. The number does not include file system overhead, which may vary depending on the file system.

The total life span of the drive depends on both the write endurance numbers and MTBF. TDW → Total Drive Writes = (Terabytes Written) *1000 / (Drive Capacity GB)

³ Design Specification. Testing Pending

⁴ FIPS 140-2 Inside

⁵ C-Temp (0°C to +70°C); I-Temp (-40°C to +85°C)



Think Memory. Think SMART.

For more product details, please contact the SMART sales team or visit our website.

**Product images are for promotional purposes only.
Labels may not be representative of the actual product.*

Headquarters - Newark, CA

39870 Eureka Dr. Newark CA 94560.

☎: (+1) 510-623-1231

📠: (+1) 510-623-1434

✉: info@smartm.com

Branch Office - Taiwan

6F, Unit A, No. 1, Yuan Dong Rd.,

Banqiao District, New Taipei City 220, Taiwan, R.O.C.

☎: (+886) 2-7705-2700

📠: (+886) 2-7705-2701

✉: sales.asia@smartm.com



www.smartm.com



[Follow us on LinkedIn](#)