Product Guide

Industrial, enterprise and automotive storage solutions
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About Exascend

Exascend is a leader in industrial and enterprise data storage specialized in fully customizable advanced storage solutions developed entirely in-house. Our passion is to develop flash storage solutions that deliver enterprise-grade performance and industrial-grade stability to the world’s most demanding storage applications.

Recognizing the benefit that in-house development brings to our customers, we engineer our products from the ground up – from hardware to software – and manufacture them in-house to ensure only the highest quality. Since our founding in 2006, we have accumulated over 60 U.S. and global patents on flash storage technology, firmly establishing Exascend as a leading innovator in the storage industry.

For over a decade, our storage solutions have been qualified and deployed by Fortune 500 companies, top defense contractors and government agencies around the world. Our unique commitment to 100% in-house development of hardware and firmware, our leading validation suite, ISO 9001- and IATF 16949-certified manufacturing and quality management processes makes us the ideal partner for leaders no matter their location or industry.

Our unwavering commitment to deliver the best-engineered, most reliable and truly innovative solutions allows us to push the boundaries of what is possible for our products and our customers’ applications.

Inspiration to Innovation.
A partner that delivers

At Exascend, we are all about making our customers and their applications excel at what they do. By leveraging our best-in-class products combined with our unique customization services, we provide a superior experience that guarantees the best results. We measure our success in how successful we make our customers. That is our commitment.

Raise your profit margin

Deliver perfectly engineered and truly differentiated products and services by leveraging Exascend’s fully optimized storage products – enabling you to put yourself ahead of the competition and avoid competing on price.

Accelerate your time to market

Exascend is the industry’s only one-stop solution provider – with design, validation and manufacturing all done in-house – reducing the time and complexity of bringing even the most thoroughly customized products to life.

Focus on what you do best

Let us take care of your storage challenges for you, helping you save resources and mitigate the risk of uncertainty and delays.

Stop worrying about reliability

Rest assured that your storage devices are at no risk of unexpected failure with Exascend’s unwavering commitment to product quality and industry-best reliability. Our products are designed, validated and manufactured according to the highest standards, including 10,000 sudden power-loss testing cycles and fully dynamic -45–90 ºC wide temperature chamber testing.

Commodity SSD

International module houses

- "Me too" products based on third-party turnkey solutions offering inadequate customization, in-depth engineering know-how and support.
- Late to market with little or no differentiation dependent on competing on price to gain market share in existing markets.
- Little or no control over product quality, reliability, technical support or after-sales service.

Value-added SSD

Exascend

- Differentiated product with unique features, optimized for customer’s operation profile, carving out uncontested market space where the customer does not need to compete on price.
- Quick turnaround time allowing the customer to seize windows of opportunity in the market, thus being able to seize market share and charge a premium on its products.
- High-quality products with unparalleled reliability, supported directly from the engineering team and outstanding after-sales service.
Customization

Engineering Imagination to Innovation

**Hardware**
- Capacity and form factor
- Interface and connector
- ESD protection
- Conformal coating
- Hardware erase and erase protocol
- Temperature sensor and thermal management
- LED configuration and polarity
- Power and performance modes
- Hardware power loss protection
- Flash and DRAM capacity (ODM)
- Auxiliary function

**Firmware**
- Firmware power loss protection
- RAID ECC data protection
- Encryption (SED/TCG)
- Data erase protocols
- Full-drive pSLC
- SLC cache mode
- Custom flash support (ODM)
- Sequential and random performance tuning
- QoS and latency tuning
- Write amplification (WAF) tuning
- Wide temperature flash tuning
- Power management tuning
- Thermal and power throttling

**Configuration and testing**
- Endurance target
- ESD, shock and vibration testing
- System compatibility and interoperability
- Unlimited over-provisioning
- Power consumption measurement
- Power loss testing
- Specific workload regression
- Wide temperature testing
- MP testing flow (ODM)
- Optional leaded process
- Write protect/read-only mode
Core competency

Enterprise performance, industrial ruggedness – engineered by Exascend.

In a world of ever-accelerating data generation, Exascend empowers organizations and individuals in capturing, preserving, accessing and transforming data.

Focused and exclusive

Exascend is the only industrial and enterprise SSD manufacturer among its peers with engineering expertise to fully utilize Marvell’s premium SATA & NVMe controllers. We distinguish ourselves from the competition with our full range of Marvell-based SSDs featuring our in-house hardware and firmware designs, extreme customizability and perfect combination of enterprise-grade performance and industrial-grade ruggedness.

Exascend customization

We offer our Marvell-based SSD products in standard form factors and entirely custom designs. In standard form factors, we offer capacities ranging from 128 GB all the way up to 8 TB. With custom designs, we go as high as 32 TB on a single SSD. We provide tailored hardware, firmware, performance, latency and QoS tuning, power and thermal throttling and much more – making our customization services second to none in the flash storage industry.

In-house design, validation and testing

We take pride in holding our design and total solution validation and testing to the highest standards. With our ISO 9001:2015-certified manufacturing and quality management system and our over 10 years of experience delivering products to Fortune 500 companies and leading global OEMs, we are fully dedicated to ushering in a new – and much higher – quality standard for our industry. In addition to using well-known commercially available testing programs, Exascend also develops its own testing platform to continuously improve product stability, reliability and quality.

Product quality assurance and consistency

Exascend guarantees fixed BOM for key components such as NAND flash, controller and firmware. All our SSDs are fully tested at the mass production stage for being delivered to customers. Moreover, our exclusive quality management system guarantees 100 percent transparency and traceability for all our products.

Failure analysis and one-stop resolution service

With our full control over hardware and firmware in our solutions, we are uniquely positioned to provide customers with swift resolutions to any issues. In the event of an issue, we provide failure analysis, root cause report as well as fully resolving the issue encountered by our customer. Upon request, we can also provide an 8D report.

Factory data recovery

An SSD’s most valuable asset is not the device itself but rather the data stored within. Exascend is fully committed to safeguarding customers’ data with unequalled product quality, stringent testing and advanced data security technologies such as RAID ECC. In the unlikely event that a customer’s Exascend device experiences issues, whether due to a defect or an accident, we offer exclusive on-site resolution and factory data recovery service to ensure that the customer’s data has the highest chances of full recovery. Our unique control over both hardware and firmware puts us in the perfect position to carry out deep-level data recovery unlike any of our peers in the industry. Our customers’ data is our number-one priority. Always.
Corporate profile

Company overview

Founded | 2006
Established as Exasoend | 2016
R&D center | Shanghai, China
Service centers | Shanghai, Shenzhen, Taipei, Sunnyvale (CA, USA) and Eindhoven (Netherlands)
Manufacturing | Available in Taiwan and China
Products | SSD (PCIe NVMe & SATA-III), CFexpress, CFast, e.MMC, SD & microSD cards, card readers, portable SSD, DRAM

Our vision and mission

Vision
To be the most respected provider of reliable customized storage solutions across the industrial and enterprise markets.

Mission
To provide innovative tailored storage technology solutions that empower users to push the boundaries of what is possible.

Engineering imagination to innovation

Recent company highlights

- Launched SATA III with 3D TLC-support
- Became ISO 9001:2015-certified
- Introduced 8 TB U.2 SSD, wide-temp, CFexpress with up to 2 TB capacity
- Introduced the world's first Gen. 4 low-power PCIe NVMe SSD
- Established company's second production line in Taiwan
- Launched the world's first third-party RED-approved CFexpress for RED V-RAPTOR
- Launched PCle NVMe SSD with 3D TLC-support
- Manufacturing capacity expansion to over 35,000 sq. ft.
- 21 additional design patents certified and filed
- Launched co-branded CFast with Z CAM
- Launched RED-certified CFast
- Mass production of Exasoend's Gen. 4 M.2 SSD
- Took the world's first industrial-grade E1.5 SSD to market
- Launched first 16 TB U.2 & E1.5 SSDs
- Introduced Portable SSD product line
- Established new offices in Eindhoven, the Netherlands and Singapore
- Relocation and renovation of Taipei, Shanghai and Wuhan offices

We are deeply passionate about flash storage and the technologies that power the future of computing. Each day, we bring that passion into action by being an early adopter of the latest form factors, interfaces and standards that push our industry forward. Whether you require performance, ruggedness, stability or security – we offer uniquely capable technologies for giving your applications a real storage upgrade.
Data integrity & security

Data integrity

Data recovery

Your data is in safe hands with Exascend’s flash storage devices. However, in the unlikely event of a user accident or a device malfunction, Exascend goes above and beyond to give your data the highest chances of full recovery. Our on-site resolution and factory data recovery services are second to none in the industry – ensuring that your data is in safe hands even if disaster strikes.

With our unique position as fully in control of hardware engineering, firmware design and manufacturing, we are uniquely qualified to carry out advanced data recovery unlike any of our peers.

Dual Power Loss Protection

Sudden loss of power can cause severe issues in flash storage devices, putting data integrity at risk. Exascend’s standard firmware power loss protection provides a first line of defense against these issues. For applications particularly sensitive to loss of power or subject to unstable power supply, Exascend’s hardware-based power loss protection provides an invaluable extra line of defense against data integrity issues by leveraging tantalum capacitors that guarantee that all in-flight data is safely stored before controlled storage device shutdown.

<table>
<thead>
<tr>
<th>Exascend SSD</th>
<th>Hardware PLP</th>
<th>Firmware PLP</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCIe M.2</td>
<td>Upon request</td>
<td>V</td>
</tr>
<tr>
<td>U.2, E1.S and 2.5”</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>SATA-III M.2</td>
<td>Upon request</td>
<td>V</td>
</tr>
</tbody>
</table>

RAID ECC

RAID ECC is an exclusive Exascend technology that, alongside our industry-best LDPC algorithm, guarantee unparalleled error checking and correction capabilities in our flash storage devices. By leveraging RAID5 technology on a flash memory block-level, RAID ECC can retrieve and reconstruct severely corrupted data.
Firmware corruption and firmware loss are rare events that risk rendering storage devices entirely inoperable under critical operation. Firmware Integrity Plus™ is an advanced Exascend-engineered technology that keeps multiple firmware images backed up and ready to replace a faulty firmware image at a moment’s notice. Firmware integrity plus provides an extra layer of protection against device malfunction perfect for equipment used in mission-critical applications.

From the moment data enters the flash storage device from the host until it reaches its resting place in the NAND flash, data passes through many intermediate points where corruption can occur. Exascend’s Data Path Protection ensures the highest level of data integrity by leveraging error-checking throughout the data’s entire path from host computer to the NAND flash and back.

Malicious firmware tampering is a security threat that risks compromising the very heart of the flash storage device, posing a potentially critical threat to device and system security. Tamper-Proof Firmware technology mitigates these risks with firmware encryption featuring a tamper-proof cryptographic signature, guaranteeing that any unauthorized firmware modification is rejected.

Exascend’s secure storage solutions offer the highest level of data protection with virtually unbreakable AES-256 encryption, guaranteeing unbeatable encryption compliant with federal agencies’ stringent data security requirements.
Exascend's secure storage solutions are fully compliant with TCG Opal 2.0 – a set of specifications for SEDs established by the Trusted Computing Group (TCG). Compliance with the TCG Opal 2.0 specifications protects user data from unauthorized access with features such as hardware encryption and LBA-based read/write permissions while guaranteeing industry-wide device interoperability.

**Custom Data Sanitization**

Rapid purging of sensitive data is a critical feature in mission-critical applications. Exascend’s storage devices offer customizable secure data sanitization, including normal erasure as well as software and hardware-triggered data erasure fully compliant with federal agencies’ data sanitization protocols – ensuring rapid-fast and fully secure data erasure.

**Firmware-supported modes**
- NSA 9-12
- NSA 130-2
- AFSSI 5020
- DoD52220.22-M
- USA Army 380-19
- USA Navy NAVSO P-5239-26
- IIRG 106-7

Customized modes available upon request.

**Hardware triggers**

Standard trigger with customized hardware triggers available upon request.

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**Write Protection**

Triggered by the user using either firmware or hardware, write protection technology safeguards data stored on the flash storage device by setting it to read-only mode, thereby blocking the host device from deleting or making any changes to the data.
Ruggedness

**IP67-compliance**

Thoroughly tested and thoroughly robust, our IP67-rated products protects your data from storage failure caused by dangers such as dust and water. In tough applications, IP67 provides ample protection against the elements.

**Underfill**

Underfill is a rugged SSD technology that dramatically reduces the likelihood of BGA-related malfunction by bonding the integrated circuits to the PCB with epoxy.

**Conformal Coating**

Conformal coating is a rugged technology that protects the entire Exascend SSD against environmental threats by applying a water and particle-resistant coating to the printed circuit board and all embedded components.

**Sidefill**

Exascend's sidefill technology boosts SSD ruggedness by applying a resin on the sides of all BGA-mounted components, ensuring a strong connection that can handle mechanical and thermal stress.
With Exascend’s MIL-STD-810-compliant products, you get flash storage that has been tested to withstand extreme environmental stress – making them suitable for even the most demanding applications.

**Neutron Shield™**

Exascend’s Neutron Shield™ technology shields your data from neutron-induced single-event upsets (SEUs). Caused by cosmic rays and other types of ionizing radiation, SEUs jeopardize data integrity in any type of application.

**Wide Temperature**

Extreme-temperature environments poses a major challenge to flash storage devices, requiring high-end components and a thermally-optimized design to guarantee stable operation in the -40–85 °C (-40–185 °F) wide-temperature range. Exascend’s wide temperature-optimized storage solutions use only the best components, are perfectly engineered and manufactured for demanding operation and undergo stringent validation to guarantee flawless operation in thermally challenging applications.

Extreme-temperature chamber testing at one of Exascend’s manufacturing facilities.
Next-generation PCIe NVMe flash storage brings incredible performance to demanding applications and ushers in a new era where we must look beyond sequential transfer rates and random IOPS as the most important performance indicators. Exascend optimizes its flash storage devices for ultra-low latency and high Quality of Service (QoS) – going beyond a focus on raw speed to also guarantee that devices meet the ever-growing demands for low-latency and high-reliability operation in enterprise and industrial applications.

Over-provisioning (OP) is an important technology that allows storage devices to be configured to achieve specific performance profiles suitable for specific workloads and operational requirements. With Exascend’s flash storage devices, over-provisioning is completely unlocked, allowing us to meet your exact needs without being limited to the industry-standard 7% and 28% rates of over-provisioning – ensuring that your application can reach its full potential.
Developed by Exascend and exclusively available for Exascend’s flash storage devices, SuperCruise™ is an extremely sophisticated firmware technology that optimizes write performance for stability over time. The SuperCruise™ algorithm monitors the flash storage device’s ratio of free block production and consumption and adjusts read/write behavior in order to achieve consistent performance that does not fluctuate over time.

Figure 1: Typical SSD performance over time (sequential/random mixture)  
Figure 2: Exascend SSD with SuperCruise™ performance over time

Exascend’s proprietary Adaptive Thermal Control™ technology tackles the issue of overheating and thermal throttling that is unavoidable in high-performance PCIe NVMe flash storage devices. Typically, flash storage devices maintain thermals under a set threshold by throttling performance – causing massive drops and spikes in performance as the devices try to keep up with changes in temperature. Exascend’s Adaptive Thermal Control™ technology mitigates this issue by intelligently finding the perfect equilibrium point between performance and device thermals where a consistently high level of performance holds steady over time – avoiding the constant performance bursts and drops endemic with high-speed NVMe devices.

SSD write burn-in performance going from 65 °C to 85 °C with typical thermal throttling  
SSD write burn-in performance going from 65 °C to 85 °C with Exascend’s Adaptive Thermal Control™
Our unique level of control over hardware, firmware and manufacturing enables us to provide unmatched tuning services. By tuning the performance of our product specifically for your applications, we can achieve the highest possible performance to thermal and performance to power ratios.

Our extreme-capacity flash storage solutions leverage the best high-capacity NAND flash in the industry and blazing-fast controllers. The firmware we write ourselves, guaranteeing support for capacity configurations like no other – even in small form factors.

Afterburner™ is a performance-enhancing Exascend technology that leverages SLC cache to boost sequential read and write speeds in storage devices with 3D TLC NAND.
Exascend for business

We are passionate about storage technologies and the innovations they enable across every industry. With dependable high-performance storage, there are no limits to what innovators and industry leaders can make possible. We strive to be a storage partner that enables our customers to make our smart future possible.

Exascend’s patented enterprise storage technologies are fully focused on pushing the envelope in storage performance and stability – allowing the rapid pace of industrial, enterprise, and automotive data storage innovation to continue.
Life in industrial environments is tough. Machines vibrate, spins things around and slam things in their place. Temperatures go low and rise high. Flawless industrial precision, high speed and constant production are the expectation.

Is your equipment up for the task?

**Requirements**

**Precision and performance above all**

New manufacturing processes rely on unbeatable precision and performance to produce high-quality products at a staggering pace. Our flash storage devices are designed to deliver the cutting-edge sustained performance required by industrial applications.

**Stability for minimized downtime**

Downtime can be extremely costly in industrial applications, making stability and reliability paramount. Our solutions put stability and reliability first, making sure that modules remain operational no matter the challenges.

**Truly customized solutions**

Industrial applications vary greatly in terms of environmental challenges and requirements. Each solution must be tuned to meet the specific needs of its application. Exascend’s customization services offer second-to-none in-house hardware and firmware tailoring – ensuring that each solution is perfectly optimized for its intended use.

**Recommended product series**

<table>
<thead>
<tr>
<th>PI4 Series</th>
<th>Industrial-grade PCIe Gen4 SSDs</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>The world's first industrial-grade PCIe Gen4 SSD lineup</td>
</tr>
<tr>
<td></td>
<td>The world's only industrial-grade E1-S, also available in M.2 and U.2 form factors</td>
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<tr>
<td></td>
<td>Wide temperature support (-40–85°C)</td>
</tr>
<tr>
<td></td>
<td>Up to 8 TB capacity</td>
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<tr>
<td></td>
<td>Extreme sustained and write performance</td>
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<table>
<thead>
<tr>
<th>SI4 Series</th>
<th>SATA-III made for industrial applications</th>
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<tbody>
<tr>
<td></td>
<td>Industrial-grade hardware and wide temperature support (-40–85°C)</td>
</tr>
<tr>
<td></td>
<td>2.5&quot;, M.2 and mSATA form factors</td>
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<tr>
<td></td>
<td>Up to 8 TB capacity</td>
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<tr>
<td></td>
<td>Guaranteed long-term supply</td>
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<table>
<thead>
<tr>
<th>Industrial CFexpress</th>
<th>Compact card storage for rigged applications</th>
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<tbody>
<tr>
<td></td>
<td>Industrial-grade hardware and wide temperature support (-40–85°C)</td>
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<tr>
<td></td>
<td>CFexpress Type B form factor</td>
</tr>
<tr>
<td></td>
<td>Up to 1 TB capacity</td>
</tr>
<tr>
<td></td>
<td>For applications that demand ruggedness and portability, including industrial automation, ADAS, data loggers and rugged edge equipment</td>
</tr>
</tbody>
</table>
How would you describe the ideal enterprise-grade SSD? Enterprise applications never settle for anything less than the best. They demand the highest capacity, the best performance, the highest reliability and unwavering stability. Otherwise, end users will be disappointed and unnecessary costs will be incurred.

**Requirements**

**Non-stop performance**

Due to massive workloads, enterprise applications require sustained top performance that does not waver. Our enterprise-class solutions are designed to deliver the highest possible level of sustained performance that enterprise applications require.

**A long-term solution**

For storage devices working in demanding applications to be economically feasible, long-term reliability is a must. We design our storage products to last, and our generous warranty services reflects this commitment.

**Dependable security**

Enterprise applications often handle sensitive data, making data security a major concern. At Exascend, we treat security not as an afterthought but as a top priority, providing customers with a wealth of built-in and optional security-enhancing features and technologies.

**Recommended product series**

<table>
<thead>
<tr>
<th>PE4 Series</th>
<th>Ultra-low latency and blistering PCIe Gen4 performance</th>
</tr>
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<tbody>
<tr>
<td>• Enterprise-class PCIe Gen4 SSDs with extreme quality of service (QoS)</td>
<td></td>
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<tr>
<td>• 3,500 MB/s sustained read</td>
<td></td>
</tr>
<tr>
<td>• 3,000 MB/s sustained read</td>
<td></td>
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<tr>
<td>• Up to 6 TB capacity</td>
<td></td>
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<tr>
<td>• Optimized for demanding enterprise workloads</td>
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<table>
<thead>
<tr>
<th>PE3 Series</th>
<th>Ultra-low latency and PCIe Gen3 performance</th>
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<tbody>
<tr>
<td>• Enterprise-class PCIe Gen3 SSDs with extreme quality of service (QoS)</td>
<td></td>
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<tr>
<td>• U.2 and M.2 2280 form factors</td>
<td></td>
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<tr>
<td>• Up to 16 TB capacity</td>
<td></td>
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<tr>
<td>• Up to 3,500 MB/s sustained write</td>
<td></td>
</tr>
<tr>
<td>• Guaranteed long-term supply</td>
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</table>

<table>
<thead>
<tr>
<th>SE4 Series</th>
<th>SATA-III enterprise applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 2.5” and M.2 2280 form factors</td>
<td></td>
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<tr>
<td>• Up to 8 TB capacity</td>
<td></td>
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<tr>
<td>• Up to 535 MB/s sustained write</td>
<td></td>
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<tr>
<td>• Guaranteed long-term supply</td>
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</table>
The Automotive sector encompasses applications such as in-vehicle infotainment (IVI), data loggers, advanced driver-assistance systems (ADAS), navigation systems and vehicle-to-everything (V2X) communication. Whether it is driverless cars, high-speed trains, 18-wheelers, aircraft or container ships, all vehicles require rugged, high-quality storage to address common challenges such as intense data-writing, small form factors and extreme ambient temperatures.

## Requirements

### Massive data collection capabilities
Automotive systems are essentially like data centers on wheels. Each minute, they generate excessive amounts of data, which requires not only high-capacity storage, but also storage with unrelenting performance to handle.

### Fail-safe ruggedness and reliability
Vibrations, high temperatures, and tough environmental conditions are typical threats for Automotive systems. As a result, automobile storage must support wide-temperature operation and sustain all kinds of environmental hazards, including humidity, vibrations and sudden power failures. This is where our industrial hardware and power loss protection services come in.

### Data security for networked connection
A growing number of networked systems and autonomous vehicles emphasizes the need for data security and integrity. Out flash storage solutions feature hardware- and firmware-based security technologies, mitigating any risks of data corruption and leakage.

### Customizable form factor
Our Automotive flash storage offering includes NVMe PCIe and legacy SATA-III SSD in U.2, E1.S, M.2, and mSATA form factors. Also available are our Industrial e.MMC, CFexpress and CFast memory. These form factors can be fully customized to tailor to the unique requirements of your automotive application.

## Recommended product series

### PA4 Series
Automotive-grade thermally-optimized SSD
- Blistering PCIe Gen4 performance
- 3,500 MB/s sustained read
- 3,000 MB/s sustained read
- Wide temperature support (−40–85°C)
- Optimized for ADAS trucking and in-vehicle data logging

### SA4 Series
Automotive-grade SATA-III storage
- M.2, mSATA and 2.5” form factors
- Up to 4 TB capacity
- 535 MB/s sustained write
- Wide temperature support (−40–85°C)
- Optimized for ADAS trucking and in-vehicle data logging
Advanced driver-assistance systems (ADAS) are central to the future of driving, improving car and road safety while making driving more enjoyable than ever before.

The basic structure of ADAS has three main parts:

- Data generation: sensors, cameras and other data sources generate data about the car and its surroundings.
- Data processing: a computing platform processes data using powerful hardware and intelligent software.
- Data logging: the system stores raw and processed data onto a storage platform for analysis and further processing.

In terms of data logging, ADAS demands not only incredible storage capacities to store all the data generated by the system but also unrelenting storage performance that can keep up with a constant flood of data.

That’s not easy, and that’s where Exascend comes in.

Certified for ADAS

We’re a proven ADAS storage partner whose products have undergone testing and certification with major advanced driver-assistance system (ADAS) manufacturers.
The ADAS data challenge
Advanced driver-assistance systems (ADAS) generate extreme amounts of data through their numerous sensors, LiDAR, cameras and more.

More accurate systems = more data = higher data rates and larger storage capacities required:

- In 2017, Intel and Micron found that ADAS requires around 1 GB of data to be processed per second.
- In Intel’s latest Mobileye system, EyeQ5 from 2020, up to 7.25 GB/s of data must be processed each second.
- In next-generation systems, even higher bitrates are required.

<table>
<thead>
<tr>
<th>Year</th>
<th>Data Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>1 GB/s</td>
</tr>
<tr>
<td>2020</td>
<td>7.25 GB/s</td>
</tr>
<tr>
<td>202X</td>
<td>1X.X GB/s</td>
</tr>
</tbody>
</table>

The ADAS power and thermal challenge
Powerful ADAS hardware means high power-draw
- **GPU**: up to 350 W per installation.
- **Server CPU**: up to 285 W per installation.
- **Enterprise SSD**: 15–20 W active power consumption.
- Throttles performance at 149 °F (65 °C), causing unpredictable performance and sudden drops in transfer speeds.

Compact ADAS systems and high power-draw means high temperatures
- **Thermal management** is becoming a critical part of high-power systems.
- **Low power** and intelligent thermal management are cornerstones in achieving sustainable high performance.

The ADAS environmental challenge
Advanced driver-assistance systems face some of the toughest environmental challenges imaginable, both from their operating environment and the outside ambient environment.

For example, they’re up against:
- **Extreme temperatures** and sudden swings in temperature.
- **Vibrations, shocks and pressure** – both continuous and sudden.
- **Particles, contaminants, pollution** and humidity.
At the intersection of enterprise and industrial storage

We are deeply passionate about creating innovative and pioneering products at the intersection of our core areas of expertise: enterprise-class and industrial-grade flash storage. By combining the unbeatable performance and stability in our enterprise-class products with our rugged expertise from our industrial-grade products, we craft truly unique products that combine the best of both worlds. That’s the perfect recipe for ADAS and data logging applications: enterprise performance everywhere.

Next-generation form factors – or something special

Why limit yourself to form factors optimized for consumer products and controlled environments? We love the standard M.2 and 2.5” form factors, but that doesn’t mean they’re the perfect form factors for every application. That’s why we offer next-generation form factors like E1.5 and U.2 that have performance and thermal profiles ideal for applications like ADAS and data logging. But why stop there – we also provide fully customized form factors tailored for your application and its unique requirements.

PA4 series

The PA4 series is Exascend’s automotive-grade PCIe 4.0 storage lineup featuring extreme sustained read and write speeds and incredible storage capacity. With Exascend’s technologies, the PA4 series bridges the gap between the PCIe 4.0 interface and the future of the automotive industry.

- PCIe 4.0 Interface
- 3D TLC Flash
- Automotive-grade Design
- Up to 3,500 MB/s Sustained read
- Up to 3,000 MB/s Sustained write

SA4 series

The SA3 series is Exascend’s automotive-grade SATA-III storage devices available in the M.2, mSATA and 2.5” form factors. With Exascend’s technologies, the SA3 series bridges the gap between the SATA interface and the future of the automotive industry.

- SATA-III Interface
- 3D TLC Flash
- Automotive-grade Design
- Up to 550 MB/s Sustained read
- Up to 535 MB/s Sustained write
As we enter the era of autonomous driving, complex computing devices are replacing human inputs. While we lay back and enjoy the convenience that autonomous vehicles bring to our lives, computer systems deal with heavy workloads as they process enormous amounts of sensory information, carry out simulations and do complex calculations to keep us safe.

Exascend worked with a client that engineers advanced data logging and testing equipment for autonomous vehicle manufacturers. Their sophisticated system collects, analyses and responds to sensor data with precision and in time, even in harsh environments with threats such as shocks, vibrations and extreme temperatures. The tough requirements demanded storage designed to provide extreme performance and rugged features, which is why the client decided to work together with Exascend and leverage its industry-leading rugged storage products.

**Challenges**

- The storage must have a high minimum performance level for necessary output, but most storage solutions only focus on maximum performance rather than consistent, stable performance.
- The storage must still reach a certain performance level even in extreme temperatures.
- The application requires maximum storage capacity for collecting sensor data, but most of the off-the-shelf solutions either do not have big enough capacity or are not built for consistent performance nor can they guarantee the required minimum performance.

**Solutions**

Exascend storage with server-grade performance, guaranteeing low latency and a high minimum performance level in extreme operating temperatures. Ultra-high capacity of over 4 TB and MIL-STD-810G compliant.

**Added-value services**

- Customized over-provisioning and capacity.
- Customized hardware features, e.g., form factor and interface.
- Customized firmware features, e.g., security features such as crypto erase.
- Thorough analysis for performance tuning according to each system's unique requirements.
- Factory data recovery service.
With edge computing, processing power comes closer to where it is needed the most. But the edge is challenging. Exposed to the elements and often located in places hard to reach, edge devices require efficiency, ruggedness and power.

Are your devices ready for life on the edge?

**Key challenges**

**Limited space, unlimited power**
Edge devices are often compact but require high-performing components to carry out their increasingly complex tasks.

**Long-term economic feasibility**
Edge infrastructure is built for the long haul, requiring devices to remain fully functional with minimal downtime to be a worthwhile investment.

**Tough working environments**
Often exposed to challenging outdoor conditions, tough industrial environments and remote settings, edge devices must be engineered with ruggedness as a priority.

**Our solutions**

**Compact and competent**
We offer exceptional performance across form factors of all sizes, including customized form factors for particularly compact or unique edge systems.

**Reliable hardware and stable performance**
Our hardware is engineered to last and our firmware is designed to provide applications with a consistently high level of performance.

**Rugged to the core**
Our rugged storage devices are designed from the ground up to withstand severe environmental challenges and mechanical stress – ideal for the rugged edge.

**Recommended products**

<table>
<thead>
<tr>
<th>PI3 M.2 2280 3.84 TB</th>
<th>SI3 mSATA 1.92 TB</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High-capacity industrial M.2 PCIe Gen3 SSD</strong></td>
<td><strong>Legacy mSATA for demanding edge applications</strong></td>
</tr>
<tr>
<td>- Industrial-grade hardware designed for the rugged edge</td>
<td>- Industrial-grade hardware designed for the rugged edge</td>
</tr>
<tr>
<td>- Wide temperature-support (-40 to 85 °C)</td>
<td>- Wide temperature-support (-40 to 85 °C)</td>
</tr>
<tr>
<td>- 3,200 MB/s sustained read</td>
<td>- Legacy SATA-III interface</td>
</tr>
<tr>
<td>- 1,000 MB/s sustained write</td>
<td>- 3D TLC NAND flash</td>
</tr>
<tr>
<td>- Massive 3.84 TB capacity</td>
<td></td>
</tr>
</tbody>
</table>
Success story

Edge server with ultra low latency

Edge servers used in edge computing is a new type of application that has gained traction in recent years. Edge servers combine traditional industrial computers with server-grade performance, providing extreme performance away from traditional datacenters. According to the Market Study Report, edge computing is expected to have a CAGR of 41.9% between 2020 and 2025, making it one of the fastest-growing industries. Most edge computing solutions are purpose-built with unique functions and system requirements.

In order to maximize the value of data collected locally and to provide efficient, effective feedback in time, server-grade performance is needed to achieve the minimal latency required. These computing devices are typically operating in outside environments, meaning that the devices must withstand a wide temperature range.

A recent Exascend user case is from a railway system that has adopted AI that needed enterprise-level performance SSDs with a specific latency target operating in -40–85 °C temperatures.

Challenges

- Typical industrial storage vendors do not offer enterprise-grade solutions and are unable to guarantee specific latencies.
- Most of the enterprise SSDs available in the market do not support wide temperature ranges.
- New-generation platforms utilize the PCIe interface which often faces heat dissipation issues in fan-less box PCs, as well as performance issues after a period of usage.
- When encountering data corruption issues, critical data cannot be fully recovered using any available tools.

Solutions

- Exascend has several patented designs on SSD technology, focusing on enterprise grade performance for operation in wide-temperature environments.
- Exascend’s exclusive Adaptive Thermal Control algorithm finds the perfect balance between temperature and speed – allowing the SSD to sustain the highest level of performance while maintaining a manageable temperature.
- All the product’s flash transaction layers are designed by Exascend’s R&D department, enabling Exascend to provide a tool for deep data recovery.

Added-value services

- Customized hardware features, e.g., form factor and interface.
- Customized performance for operating consistently in a given temperature range, e.g., a minimum 400 MB/s write performance in a 70 °C environment.
- Extended warranty services.
- Factory data recovery tool.
Mission critical applications require only the best. As the name explicitly states, the mission is critical – and failure is not an option – no matter what challenges stand in its way. Even in the face of harsh conditions and unexpected variables, every component must continue operating at its best.

Are your devices ready for action?

**Key challenges**

**Extreme environments and unique threats**
Mission critical applications present extreme environmental challenges and unique threats to device integrity and functionality.

**Fail-safe for life**
Mission success is critical, leaving no room for error or fatal device malfunctions. Top-level stability and device reliability are absolute must – as is providing maximum security.

**Customized everything**
Unique form factors, unique technologies and unique features are necessary to guarantee a perfect fit and performance you can count on no matter what.

**Our solutions**

**Devices engineered for maximum ruggedness**
Our industrial-class storage devices are designed for extreme ruggedness at both the hardware and firmware levels, guaranteeing enterprise-level performance everywhere.

**Unparalleled stability and security**
We optimize our products to deliver top-level sustained performance, delivering best-in-class stability and performance in any environment. This, combined with our security features, means that our products are always ready for action.

**Customization like no other**
We provide the industry’s most extensive customization services with thorough customization of both hardware and firmware always available as an option.

![20 TB fully customized SATA-III SSD](image)
Example of an Exascend-designed fully customized form factor that enables an ultra-rigid storage connection in a client’s mission-critical application.
Success story

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- Customized performance for operating consistently in a given temperature range, e.g., a minimum 400 MB/s write performance in a 70 °C environment.
- Extended warranty service.
- Factory data recovery tool.
NVMe performance over networking fabrics

NVMe-oF is an implementation of the NVMe standard that enables the use of the NVMe protocol across storage networking fabrics. With performance just shy of direct-attached storage (DAS), NVMe-oF is an increasingly popular implementation of NVMe that overcomes the challenges of relying on DAS for NVMe-level storage performance.

**Key benefits**

**High scalability**
By separating storage from compute, each can be scaled independently according to the network operator’s needs.

**Fabric agnostic**
NVMe-oF can be used across any networking fabric, e.g., Fibre Channel, RDMA (InfiniBand, RoCE, iWARP and more), TCP and more.

**Little impact on performance**
NVMe-oF offers speeds near local NVMe with a close to negligible impact on storage latency.

Exascend offers its enterprise series NVMe SSDs with firmware enabled for NVMe-oF, making integration into next-generation storage infrastructure a breeze.

**Minimal latency overhead**

Remote storage, local latency

The NVMe-oF standard is designed to provide local NVMe-like performance across a distance. The specification allows a latency overhead compared to local NVMe of a minuscule 10 μs.

What NVMe-oF’s minimal latency overhead means in practice is that the storage network provides instantaneous response times just like with local NVMe storage. With NVMe-oF storage access, gone are the days of slow networked storage that is a clear downgrade from DAS.
PE4 series
The PE4 series is Exascend’s enterprise-grade lineup of high-performing PCIe 4.0 devices. With extreme sustained read and write speeds along with Exascend’s technologies, the PE4 series brings the PCIe 4.0 interface to the next level.

- PCIe 4.0 Interface
- 3D TLC Flash
- Enterprise-grade Design
- Up to 3,500 MB/s Sustained read
- Up to 3,000 MB/s Sustained write

PE3 series
The PE3 series brings high-level performance to enterprise applications without compromising on stability. Available in a wide variety of configurations and storage capacities, the PE3 series fits any demanding enterprise application.

- PCIe 3.0 Interface
- Enterprise-grade Design
- Up to 7,680 GB Capacity
- Up to 3,200 MB/s Sustained read
- Up to 2,000 MB/s Sustained write

Or are you looking for a customized NVMe-of storage solution? Send us an inquiry: sales@exascend.us

NVMe-of SSDs customized and optimized to perfection
Our commitment to the NVMe-of standard means that Exascend’s exclusive technologies and unique customization services are available in NVMe-of-capable SSDs. For network infrastructure operators, this brings an incredible level of flexibility to deploy NVMe-of in essentially any environment.
Get serious about security

The current era of rugged edge computing and the Internet of Things (IoT) brings incredible opportunity for innovation. However, the inherent security challenges in edge computing environments risks stifling innovation. That is why Exascend’s self-encrypting drive (SED) solutions present a unique opportunity to double-down on edge innovation without jeopardizing data security. Better yet, SEDs’ negligible impact on system performance means that encryption and data security no longer come with notable tradeoffs. With impenetrable AES-256 encryption, powerful protocols like TCG Opal 2.0 and intelligent features such as user-specific locking ranges, SEDs make it easy to get serious about security.

Exascend SED benefits

- **Perfect for the edge**
  Edge and IoT devices are uniquely exposed to external security threats. Exascend’s secure SSDs ensure that data is safe even in the event of device theft.

- **Unbeatable security**
  The combination of the AES cipher and hardware encryption provides data security invulnerable to software and operating system-level breaches.

- **Blazing-fast performance**
  Hardware encryption ensures that the task of encrypting and decrypting data does not waste valuable system resources.

Data security for any system

- Self-encrypting drive (SED)
- Full disk encryption (FDE)
- TCG Opal 2.0
- AES-256
- IEEE 1667
- BitLocker
Data sanitization options

Crypto erase
The near-instant crypto erase protocol is only available on SEDs and works by simply replacing the key that encrypts/decrypts all data stored inside the device. Without the original key, the data is scrambled beyond even a theoretical chance of recovery.

Normal erase
The normal erase protocol thoroughly sanitizes data by overwriting the storage device’s mapping table and data, removing all original data. Unlike the two other options, data is not only rendered irrecoverable – it is no longer on the device.

Fast erase
Fast erase quickly sanitizes data by only overwriting the storage device’s mapping table. While the encrypted data still technically resides on the device, without the mapping table, the system has no way of recovering it.

Understand SEDs

Full disk encryption (FDE)
With full disk encryption, also known as whole disk encryption, all data stored inside the storage device is encrypted. That means that if the storage device gets in the wrong hands, none of the data can be accessed by the perpetrator.

FDE benefits:
• Negligible impact on system performance with hardware-based implementations.
• Encryption is not limited to specific partitions, folders or files.

Self-encrypting drive (SED)
A common implementation of FDE is self-encrypting drives. SEDs achieve full disk encryption by leveraging purpose-designed storage devices that implement encryption on the hardware level. With SEDs, the storage device automatically encrypts data before storing it on the device, leaving no data unencrypted.

SED benefits:
• Negligible impact on system performance as the storage device leverages an integrated encryption engine – not the host device.
• Many different implementations available, allowing a high degree of flexibility.

256-bit AES encryption
Exascend’s implementation of AES-256 leverages a dedicated crypto processor inside the flash storage device, allowing encryption and decryption of data stored on the device to take place independently of the host. The result is a software-independent military-grade encryption that you can trust with both data and not slowing down your system.

AES-256 benefits:
• Utilizes an uncrackable 256-bit cipher, also known as the Rijndael cipher.
• Approved by the United States for the highest level of classified information, i.e., Top Secret.
• Well-supported industry standard used across a wide range of product categories and industries.

TCG Opal 2.0
Exascend’s compliance with the TCG Opal 2.0 specifications means that our SEDs protect user data from unauthorized access with features such as hardware encryption and LBA-based read/write permissions. TCG Opal 2.0 also guarantees industry-wide device interoperability, making it a platform-agnostic way to implement the secure features that a self-encrypting drive brings to users and applications.

TCG Opal benefits:
• Innovative features such as user-specific locking ranges make it easy to subdivide device data on a per-user basis.
• Near-instant cryptographic erase that works by destroying the Media Encryption Key (MEK).
• Well-supported industry standard used across a wide range of product categories and industries.
# Recommended SED products

## PI4 series
The PI4 series brings together Exascend’s industrial expertise with the high-speed PCIe 4.0 interface and high-density 3D TLC. The result is a highly competent lineup of industrial-grade storage with enterprise-class performance available in the M.2, U.2 and E1.S form factors.

<table>
<thead>
<tr>
<th>PCIe 4.0 Interface</th>
<th>3D TLC Flash</th>
<th>Industrial-grade Design</th>
<th>Up to 3,500 MB/s Sustained read</th>
<th>Up to 3,000 MB/s Sustained write</th>
</tr>
</thead>
</table>

## PI3 series
The PI3 series brings together Exascend’s industrial expertise with the high-speed PCIe 3.0 interface and high-density 3D TLC – resulting in a highly competent lineup of industrial-grade storage.

<table>
<thead>
<tr>
<th>PCIe 3.0 Interface</th>
<th>3D TLC Flash</th>
<th>Industrial-grade Design</th>
<th>Up to 3,100 MB/s Sustained read</th>
<th>Up to 1,600 MB/s Sustained write</th>
</tr>
</thead>
</table>

## PE3 series
The PE3 series brings high-level performance to enterprise applications without compromising on stability. Available in a wide variety of configurations and storage capacities, the PE3 series fits any demanding enterprise application.

<table>
<thead>
<tr>
<th>PCIe 3.0 Interface</th>
<th>Enterprise-grade Design</th>
<th>Up to 7,680 GB Storage capacity</th>
<th>Up to 3,200 MB/s Sustained read</th>
<th>Up to 2,000 MB/s Sustained write</th>
</tr>
</thead>
</table>

## SI4 series
The SI4 series is a high-end product line featuring industrial-grade SATA-III storage devices available in the M.2 and 2.5" form factors.

<table>
<thead>
<tr>
<th>SATA-III Interface</th>
<th>3D TLC Flash</th>
<th>Industrial-grade Design</th>
<th>Up to 550 MB/s Sustained read</th>
<th>Up to 535 MB/s Sustained write</th>
</tr>
</thead>
</table>

Or are you looking for a customized SED storage solution? Send us an inquiry: sales@exascend.us
Global telecommunications is experiencing a period of rapid change with massive upgrades to wireless and wired connectivity across mobile networking, Wi-Fi and broadband underway. Faster networks and added bandwidth means new business opportunities and new innovations.

Are you positioned to capitalize on the future of telecom?

**Key challenges**

**Extreme performance**
The point of new telecommunications infrastructure is higher bandwidth, higher connection density, and lower latencies. And all hardware must be able to keep up.

**Tough environments**
Telecommunications devices are deployed far and wide, including in environmentally-exposed infrastructure as well as in challenging industrial environments. For such applications, ample ruggedness is an absolute must.

**Cost-efficient maintenance**
The scale of telecommunications infrastructure is vast, which means that maintenance needs to be kept at a minimum to make infrastructure investments economically feasible.

**Our solutions**

**Telecom performance in excess**
Our storage devices provide incredible performance that meet and exceed the requirements of next-generation telecommunications infrastructure.

**Tuned to tackle any challenge**
With Exascend’s unique customization and tuning services, we make sure that our devices provide the best possible performance in tough environments and facing any workload.

**Uniquely reliable flash storage devices**
We engineer our devices to provide the highest levels of reliability, ensuring that maintenance and repairs can be kept to a minimum.

**Recommended product series**

**PE4 Series**
Ultra-low latency and blistering PCIe Gen4 performance
- Enterprise-class PCIe Gen4 SSDs with extreme quality of service (QoS)
- 3,500 MB/s sustained read
- 3,000 MB/s sustained write
- Features Exascend’s unique performance and stability-enhancing technologies
- Ultra-low latency optimal for telecommunications infrastructure

**SE4 series**
Legacy SATA-III for demanding telecom applications
- SATA-III interface with 3D TLC NAND flash
- 2.5”, M.2 and mSATA form factors
- Up to 4 TB capacity
- Guaranteed long-term supply
Success story

A combination of key factors make up the ideal SSD solution for the telecommunications sector. Technical aspects such as stable random IOPS performance, low power consumption, long endurance, extended temperature range and compact size are all critical factors. However, services provided by the manufacturer are also hugely important, including a fixed bill of materials and – most importantly – long-term support and supply.

For example, critical telecommunications infrastructure such as routers utilized in a railway system must function flawlessly for at least five years. Therefore, the manufacturer’s long-term services and support are just as important as providing the right solution in the first place.

A customer of Exascend utilized 64 GB M.2 SSDs based on MLC technology from a different vendor and was facing some challenges as MLC technology got increasingly difficult to obtain each year, making the customer unable to fulfill urgent upstream demand.

Challenges

- Endurance tends to decrease from one generation of flash storage technology to the next.
- Newer flash storage technology used to change every three years but now almost every year there is a "new" generation, making a fixed bill of materials difficult to manage.
- Once SSDs receive an end-of-life (EOL) notice, issues will no longer be resolved by the manufacturer.

Solutions

Exascend’s commitment to flexible solutions and unique configurations allows Exascend to provide extra-endurance products with extended warranty service. After discussing with the customer, it turned out that the application only needed up to 32 GB capacity, so Exascend’s SATA enterprise (SE3) Max series that provides over five times the number of endurance cycles than the customer’s MLC solution proved a perfect replacement.

Moreover, since Exascend’s firmware is designed in-house, the customer is guaranteed full resolutions to potential issues after each failure analysis – even after the EOL product notice – making Exascend’s replacement solution a clear upgrade.

Added-value services

- Customized hardware features, e.g., unique compact form factors.
- Customized product endurance to prolong SSD lifespan, e.g., pseudo SLC solution.
- Extended warranty service with both standard and customized products.
- Factory data recovery service.
### PCIe Gen4

#### Basic features
- PCIe NVMe 1.2/1.3/1.4
- Supports TRIM and SMART
- Advanced ECC and global wear-leveling algorithm
- Firmware power loss protection (PLP) for additional data protection
- Hardware power loss protection

#### Exclusive features
- RAID ECC for full data integrity
- Tamper-proof firmware with cryptographic signature
- Firmware Integrity Plus™: ROM-based backup of multiple firmware images
- In-field firmware updates
- Data Retention Plus™: dynamically refreshes data to strengthen data retention
- High quality of Service (QoS): consistently low latency

#### Optional features
- TCG Opal 2.0
- Hardware secure erase
- Performance, power and thermal throttling
- 30 µs end-to-end latency for all product series
- AES-256 encryption

<table>
<thead>
<tr>
<th>Solution</th>
<th>Industrial / Automotive</th>
<th>Enterprise</th>
<th>Commercial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface</td>
<td>PCIe 4.0 (NVMe 1.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Form factor</td>
<td>M.2 2280</td>
<td>M.2 2242</td>
<td>M.2 2230</td>
</tr>
<tr>
<td>Capacity</td>
<td>960-7,680 GB</td>
<td>960-1,920 GB</td>
<td>240-600 GB</td>
</tr>
<tr>
<td>Flash type</td>
<td>3D TLC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input voltage</td>
<td>3.3V±5%; 12V±5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power consumption</td>
<td>Active &lt;12.0W; Idle &lt;1.0W</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. seq. read</td>
<td>2,200 MB/s</td>
<td>3,200 MB/s</td>
<td>3,200 MB/s</td>
</tr>
<tr>
<td>Max. seq. write</td>
<td>2,200 MB/s</td>
<td>3,000 MB/s</td>
<td>1,800 MB/s</td>
</tr>
<tr>
<td>Max. TBW*</td>
<td>4,800 TB</td>
<td>1,200 TB</td>
<td>600 TB</td>
</tr>
<tr>
<td>Operational temp.</td>
<td>-40–85°C</td>
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<td></td>
</tr>
<tr>
<td>Warranty</td>
<td>3 years</td>
<td></td>
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</tr>
<tr>
<td>P44</td>
<td>EXP4M8960GB</td>
<td>EXP4Q60GB</td>
<td>EXP4R4240GB</td>
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<tr>
<td></td>
<td>EXP4M1920GB</td>
<td>EXP4Q1920GB</td>
<td>EXP4R480GB</td>
</tr>
<tr>
<td></td>
<td>EXP4M3840GB</td>
<td>EXP4R660GB</td>
<td>EXP4R860GB</td>
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<tr>
<td></td>
<td>EXP4M7680GB</td>
<td>EXP4R960GB</td>
<td>EXP4R960GB</td>
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<td>P4A</td>
<td>EXP4AM8960GB</td>
<td>EXP4AQ60GB</td>
<td>EXP4R4240GB</td>
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<td></td>
<td>EXP4AM1920GB</td>
<td>EXP4AQ1920GB</td>
<td>EXP4R480GB</td>
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<tr>
<td></td>
<td>EXP4AM3840GB</td>
<td>EXP4R660GB</td>
<td>EXP4R860GB</td>
</tr>
<tr>
<td></td>
<td>EXP4AM7680GB</td>
<td>EXP4R960GB</td>
<td>EXP4R960GB</td>
</tr>
</tbody>
</table>

*TBW and DWPD are JEDEC JESD 47-compliant

*Warranty valid for the stated number of years or until the device has reached the guaranteed TBW

*DWPD stands for Drive Writing Per Day. TBW = DWPD * capacity * warranty / 365/1000

*SLC version available upon request for M.2 2220 and U.2 SSDs

*Pro version of SSDs with DWPD rated at 15 available upon request
## PCIe Gen3

### Basic features
- PCIe NVMe 1.2/1.3
- Supports TRIM and SMART
- Advanced RCC and global wear-leveling algorithm
- Firmware power loss protection (PLP) for additional data protection
- Hardware power loss protection

### Exclusive features
- RAID RCC for full data integrity
- Tamper-proof firmware with cryptographic signature
- Firmware Integrity Plus™: ROM-based backup of multiple firmware images
- In-field firmware updates
- Data Retention Plus™: dynamically refreshes data to strengthen data retention
- High quality of service (QoS): consistently low latency

### Optional features
- TC6 Opal 2.0
- Hardware secure erase
- Performance, power and thermal throttling
- 30 µ” gold finger for all product series
- AES-256 encryption
- Hardware PLP available upon request for M.2 2280 SSDs

<table>
<thead>
<tr>
<th>Solution</th>
<th>Industrial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface</td>
<td>PCIe 3.0 (NVMe 1.2)</td>
</tr>
<tr>
<td>Form factor</td>
<td>M.2 2280</td>
</tr>
<tr>
<td>Capacity</td>
<td>600–3,840 GB</td>
</tr>
<tr>
<td>Flash type</td>
<td>3D TLC</td>
</tr>
<tr>
<td>Input voltage</td>
<td>3.3V±5%; 12V±5%</td>
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</tr>
<tr>
<td>Max. seq. write</td>
<td>2,200 MB/s</td>
</tr>
<tr>
<td>Max. TBW*</td>
<td>4,800 TB</td>
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<tr>
<td>Operational temp.</td>
<td>-40–85°C</td>
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<tr>
<td>Warranty</td>
<td>3 years</td>
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<tr>
<td>PI3</td>
<td>EXP3M240GB</td>
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<tr>
<td></td>
<td>EXP3M480GB</td>
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<tr>
<td></td>
<td>EXP3M960GB</td>
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<td></td>
<td>EXP3M1920GB</td>
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<tr>
<td></td>
<td>EXP3M3840GB</td>
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<td>EXP3M3840GB</td>
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<tr>
<td>CFexpress</td>
<td>EXP3S128GB-I</td>
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<tr>
<td></td>
<td>EXP3S256GB-I</td>
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<td></td>
<td>EXP3S512GB-I</td>
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<td>EXP3S1024TB-I</td>
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</table>

*TBW and DWPD are JEDEC JE5D47-compliant

*Warranty valid for the stated number of years or until the device has reached the guaranteed TBW

*DWPD stands for Drive Writes Per Day. TBW = DWPD * capacity * warranty * (1.26/1000)

* pSLC version available upon request for M.2 2280 and U.2 SSDs

* Pre-version of SSDs with DWPD rated at 1.5 available upon request.
### PCIe Gen3

#### Basic features
- PCIe NVMe 1.2/1.3
- Supports TRIM and SMART
- Advanced ECC and global wear-leveling algorithm
- Firmware power loss protection (PLP) for additional data protection
- Hardware power loss protection

#### Exclusive features
- RAID ECC for full data integrity
- Tamper-proof firmware with cryptographic signature
- Firmware Integrity Plus™: ROM-based backup of multiple firmware images
- In-field firmware updates
- Data Retention Plus™: dynamically refreshes data to strengthen data retention
- High quality of service (QoS): consistently low latency

#### Optional features
- TCG Ocelot 2.0
- Hardware secure erase
- Performance, power and thermal throttling
- 30 µg gold finger for all product series
- AES-256 encryption
- Hardware FLR available upon request for M.2 2280 SSDs

<table>
<thead>
<tr>
<th>Solution</th>
<th>Enterprise</th>
<th>Commercial</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interface</strong></td>
<td>PCIe 3.0 (NVMe 1.2)</td>
<td></td>
</tr>
<tr>
<td><strong>Form factor</strong></td>
<td>M.2 2280</td>
<td>U.2</td>
</tr>
<tr>
<td><strong>Capacity</strong></td>
<td>240–3,840 GB</td>
<td>480–15,360 GB</td>
</tr>
<tr>
<td><strong>Flash type</strong></td>
<td>3D TLC</td>
<td></td>
</tr>
<tr>
<td><strong>Input voltage</strong></td>
<td>3.3V±5%, 12V±5%</td>
<td></td>
</tr>
<tr>
<td><strong>Power consumption</strong></td>
<td>Active &lt;12.0W, Idle &lt;1.0W</td>
<td>Active &lt;9.0W, Idle &lt;1.5W</td>
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<tr>
<td><strong>Max. seq. read</strong></td>
<td>3,100 MB/s</td>
<td>3,500 MB/s</td>
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<tr>
<td><strong>Max. seq. write</strong></td>
<td>1,600 MB/s</td>
<td>3,500 MB/s</td>
</tr>
<tr>
<td><strong>Max. TBW</strong></td>
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<td>16,000 TB</td>
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<tr>
<td><strong>Max. DWPD</strong></td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td><strong>Operational temp.</strong></td>
<td>0–70°C</td>
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</tr>
<tr>
<td><strong>Warranty</strong></td>
<td>5 years</td>
<td></td>
</tr>
</tbody>
</table>

*TBW and DWPD are JEDEC JE5047-compliant
**Warranty valid for the stated number of years or until the device has reached the guaranteed TBW
**DWPD stands for Drive Writes Per Day, TBW = DWPD * capacity * warranty * 365/1000

* pSLC version available upon request for M.2 2280 and U.2 SSDs
** Pro version of SSDs with DWPD rated at 1.5 available upon request

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**PC3**

- EXPCE3M120GB
- EXPCE3M210GB
- EXPCE3M420GB
- EXPCE3M820GB
- EXPCE3M1620GB
- EXPCE3M3220GB
- EXPCE3M120GB
- EXPCE3M210GB
- EXPCE3M420GB
- EXPCE3M820GB
- EXPCE3M1620GB
- EXPCE3M3220GB
## Basic features
- Backwards compatible with SATA-III (6 Gbps) and SATA-I (1.5 Gbps)
- Supports TRIM, NCQ, DEVSLP, SMART and ATA security
- Advanced ECC and global wear-leveling algorithm
- Firmware power loss protection (PLP) for additional data protection

## Exclusive features
- RMD ECC for full data integrity
- Tamper-proof firmware with cryptographic signature
- Firmware Integrity Plus™, ROM-based backup of multiple firmware images
- In-field firmware updates
- Data Rotation Plus™: dynamically refreshes data to strengthen data retention

## Optional features
- TSG Optal 2.0
- Hardware secure erase
- Performance, power and thermal throttling
- 26 µm gold finger for all product series
- AES-256 encryption
- Hardware PLP available upon request

<table>
<thead>
<tr>
<th>Solution</th>
<th>Industrial / Automotive</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interface</strong></td>
<td>SATA-III, 6.0 Gbps</td>
</tr>
<tr>
<td><strong>Form factor</strong></td>
<td>M.2 2280</td>
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<tr>
<td><strong>Capacity</strong></td>
<td>240~3,840 GB</td>
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<tr>
<td><strong>Flash type</strong></td>
<td>3D TLC</td>
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<tr>
<td><strong>Input voltage</strong></td>
<td>5V±5%, 3.3V±5%</td>
</tr>
<tr>
<td><strong>Power consumption</strong></td>
<td>Active &lt;6W, Idle &lt;0.9W</td>
</tr>
<tr>
<td><strong>Max. seq. read</strong></td>
<td>550 MB/s</td>
</tr>
<tr>
<td><strong>Max. seq. write</strong></td>
<td>535 MB/s</td>
</tr>
<tr>
<td><strong>Max. TBW</strong></td>
<td>2,400 TB</td>
</tr>
<tr>
<td><strong>Operational temp.</strong></td>
<td>-40~85°C</td>
</tr>
<tr>
<td><strong>Warranty</strong></td>
<td>3 years</td>
</tr>
</tbody>
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### SI3
- EXSI3M240GB
- EXSI3M480GB
- EXSI3M960GB
- EXSI3M120GB
- EXSI3M3840GB
- EXSI3A240GB
- EXSI3A480GB
- EXSI3A960GB
- EXSI3A120GB
- EXSI3A3840GB
- EXSI3A7680GB
- EXSI3B120GB
- EXSI3B240GB
- EXSI3B480GB
- EXSI3B960GB

### SI4
- EXSI4M240GB
- EXSI4M480GB
- EXSI4M960GB
- EXSI4M120GB
- EXSI4M3840GB
- EXSI4A240GB
- EXSI4A480GB
- EXSI4A960GB
- EXSI4A120GB
- EXSI4A3840GB
- EXSI4A7680GB
- EXSI4B120GB
- EXSI4B240GB
- EXSI4B480GB
- EXSI4B960GB

### Industrial CFast
- EXSD3X120GB-I
- EXSD3X256GB-I
- EXSD3X512GB-I
- EXSD3X1TB-I

### SA4
- EXSA4M240GB
- EXSA4M480GB
- EXSA4M960GB
- EXSA4M120GB
- EXSA4M3840GB
- EXSA4N240GB
- EXSA4N480GB
- EXSA4N960GB
- EXSA4O120GB
- EXSA4O240GB
- EXSA4O480GB
- EXSA4O960GB
- EXSA4A240GB
- EXSA4A480GB
- EXSA4A960GB
- EXSA4A120GB
- EXSA4A3840GB

* TBW and DWPD are JEDEC JE556 47-compliant
* Warranty valid for the stated number of years or until the device has reached the guaranteed TBW
* pSLC version available upon request for M.2 2280 and U.2 SSDs
* Higher-endurance SSDs available upon request
<table>
<thead>
<tr>
<th>Solution</th>
<th>Industrial</th>
<th>Commercial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface</td>
<td>SATA-III, 6.0Gbps</td>
<td></td>
</tr>
<tr>
<td>Form factor</td>
<td>M.2 2280</td>
<td>M.2 2280</td>
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<td>M.2 2242</td>
<td>mSATA</td>
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<tr>
<td>Capacity</td>
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<td>240 GB</td>
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<td>1,920 GB</td>
<td>120–960 GB</td>
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<td>Flash type</td>
<td>MLC</td>
<td>3D TLC</td>
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<tr>
<td>Input voltage</td>
<td>5V±5%, 3.3V±5%</td>
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</tr>
<tr>
<td>Power consumption</td>
<td>Active &lt;5W, Idle &lt;0.9W</td>
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</tr>
<tr>
<td>Max. seq. read</td>
<td>530 MB/s</td>
<td>530 MB/s</td>
</tr>
<tr>
<td></td>
<td>530 MB/s</td>
<td>530 MB/s</td>
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<tr>
<td>Max. seq. write</td>
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<td>350 MB/s</td>
</tr>
<tr>
<td></td>
<td>350 MB/s</td>
<td>350 MB/s</td>
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<tr>
<td>Max. TBW*</td>
<td>1,200 TB</td>
<td>1,200 TB</td>
</tr>
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<td>1,200 TB</td>
<td>2,400 TB</td>
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<td>Operational temp.</td>
<td>-40–85°C</td>
<td>-0–70°C</td>
</tr>
<tr>
<td>Warranty</td>
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<td>5 years</td>
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</tbody>
</table>

* TBW and DWPD are JEDEC JE5S-47-compliant.
* Warranty valid for the stated number of years or until the device has reached the guaranteed TBW.

- pSLC version available upon request for M.2 2280 and U.2 SSDs.
- Higher-endurance SSDs available upon request.
## Basic features
- Backwards compatible with SATA-II (3 Gbps) and SATA-I (1.5 Gbps)
- Supports TRIM, NCG, DEVSLP, SMART and ATA security
- Advanced ECC and global wear-leveling algorithm
- Firmware power loss protection (PLP) for additional data protection

## Exclusive features
- RAID ECC for full data integrity
- Tamper-proof firmware with cryptographic signature
- Firmware Integrity Plus™: ROM-based backup of multiple firmware images
- In-field firmware updates
- Data Retention Plus™: dynamically refreshes data to strengthen data retention

## Optional features
- TCG Opal 2.0
- Hardware secure erase
- Performance, power and thermal throttling
- 30 μm gold plating for all product series
- AES-256 encryption
- Hardware PLP available upon request

<table>
<thead>
<tr>
<th>Solution</th>
<th>Enterprise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface</td>
<td>SATA-III, 6.0Gbps</td>
</tr>
<tr>
<td>Form factor</td>
<td>M.2 2280</td>
</tr>
<tr>
<td>Capacity</td>
<td>240–7,680 GB</td>
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<tr>
<td>Flash type</td>
<td>3D TLC</td>
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<tr>
<td>Input voltage</td>
<td>5V±5%; 3.3V±5%</td>
</tr>
<tr>
<td>Power consumption</td>
<td>Active &lt;5W, Idle &lt;0.5W</td>
</tr>
<tr>
<td>Max. seq. read</td>
<td>550 MB/s</td>
</tr>
<tr>
<td>Max. seq. write</td>
<td>535 MB/s</td>
</tr>
<tr>
<td>Max. TBW*</td>
<td>8,000 TB</td>
</tr>
<tr>
<td>Max. DWPD**</td>
<td>0.6</td>
</tr>
<tr>
<td>Operational temp.</td>
<td>5 years</td>
</tr>
</tbody>
</table>

| SE4 | EXSE4M240GB | EXSE4M480GB | EXSE4M960GB | EXSE4M1920GB | EXSE4M3840GB | EXSE4M7680GB |
| SE1 | EXSE1A240GB | EXSE1A480GB | EXSE1A960GB | EXSE1A1920GB | EXSE1A3840GB | EXSE1A7680GB |

* TBW and DWPD are JEDEC JESD 47-compliant
* Warranty valid for the stated number of years or until the device has reached the guaranteed TBW

* pSLC version available upon request for M.2 2280 and U.2 SSDs
* Pro version of SSDs with DWPD rated at 1.5 available upon request
**Basic features**
- JEDEC e.MMC 5.1 compliant
- Advanced ECC and global wear-leveling algorithm
- Extended temperature support: -13~165 °F (-25~85 °C)
- For industrial, automotive and consumer applications

**Exclusive features**
- RAID ECC for full data integrity
- Supports LDPC ECC, Secure Erase and Write Protection
- Firmware Integrity Plus™: ROM-based backup of multiple firmware images
- In-field firmware updates
- Data Retention Plus™: dynamically refreshes data to strengthen data retention
- Certified for full compatibility with leading-brand system platforms

<table>
<thead>
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<th>Solution</th>
<th>Industrial</th>
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<tbody>
<tr>
<td><strong>Interface</strong></td>
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<tr>
<td><strong>Form factor</strong></td>
<td>e.MMC 5.1</td>
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<tr>
<td><strong>Capacity</strong></td>
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</tr>
<tr>
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</tr>
<tr>
<td><strong>Power consumption</strong></td>
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</tr>
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</tr>
<tr>
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<table>
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<tr>
<th>e.MMC</th>
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<th>ESEMSA032GYBG</th>
<th>ESEMSA064GYBG</th>
<th>ESEMSA128GYBG</th>
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<tbody>
<tr>
<td></td>
<td>ESEMSA004GQBG</td>
<td>ESEMSA008GQBG</td>
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</tbody>
</table>

*TBW and DMPD are JEDEC JESD 47-compliant
- Warranty valid for the stated number of years or until the device has reached the guaranteed TBW
### Basic features
- Built-in write protection
- Extended temperature support (-40–85°C)
- Built-in LDCE ECC functionality
- S.M.A.R.T function supported

### Exclusive features
- pSLC version for SD and microSD cards
- U3 and V30 performance classes
- Guaranteed endurance: 3,000 P/E cycles

<table>
<thead>
<tr>
<th>Solution</th>
<th>Industrial</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interface</strong></td>
<td>UHS-I</td>
</tr>
<tr>
<td><strong>Form factor</strong></td>
<td>SDHC / SDXC</td>
</tr>
<tr>
<td><strong>Capacity</strong></td>
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<tr>
<td><strong>Flash type</strong></td>
<td>3D TLC</td>
</tr>
<tr>
<td><strong>Speed class</strong></td>
<td>C10 / U3 / V30</td>
</tr>
<tr>
<td><strong>Input voltage</strong></td>
<td>3.3V±5%</td>
</tr>
<tr>
<td><strong>Max. seq. read</strong></td>
<td>550 MB/s</td>
</tr>
<tr>
<td><strong>Max. seq. write</strong></td>
<td>535 MB/s</td>
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<tr>
<td><strong>File system</strong></td>
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<tr>
<td><strong>Warranty</strong></td>
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<td><strong>Industrial SD</strong></td>
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<td>EX64GSDU1-HDE</td>
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<td></td>
<td>EX256GSDU1-HDE</td>
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<tr>
<td><strong>Industrial microSD</strong></td>
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<td>EX128GUSDU1-HDE</td>
</tr>
<tr>
<td></td>
<td>EX256GUSDU1-HDE</td>
</tr>
</tbody>
</table>
Exascend International
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