EXASCEND

STORAGE
SOLUTIONS

PRODUCT
OVERVIEW

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ABOUT EXASCEND

Exascend is a leader in industrial and enterprise data storage, specializing in fully customizable, in-house developed advance storage solution, delivering enterprise-grade performance and stability to high-reliability applications. Established in 2006 by a group of engineers with deep experience in solid state storage, our passion is creating value added, best in class SSDs for embedded and server applications.

Recognizing the benefit in-house development brings to our customer, our products are engineered from the ground up. Since founding, we have accumulated over 45 US and worldwide patents on SSD technology, firmly established as a global innovation leader in Flash storage solutions. Exascend pioneered the design and manufacturing of industrial SSD, starting from 100% internally developed hardware and firmware, on to our validation suite, ISO 9001 certified manufacturing and quality management process, enabling unrivaled quality and customer service response.

For over 10 years, our solutions are qualified and deployed Fortune 500 companies and government agencies in mission critical applicitions around the world. As storage applications across different industries evolve into their own unique set of requirements, we continue to deliver superiorly engineered, most reliable and innovative solutions from one generation to the next.

Exascend products are tailored to serve customer needs and optimize user experience while meeting the highest technology & safety requirements, empowering them to push the boundaries of what is possible. We endeavor to be the most respected provider of reliable, customized storage solution across industrial and enterprise space.

EXASCEND IS TO DELIVER

Exascend is passionate about bring to culmination our best “creation” with partner and customers. Our mission is to work together with partners to deliver best in class products and service for end users; and the ability to execute and deliver on these commitments, is our core value.

Capture Incremental Margin

Generates incremental margin through uniquely engineered, value-added products, along with our differentiated services, breaking the vicious cycle of competing only on cost.

Accelerate Time to Market

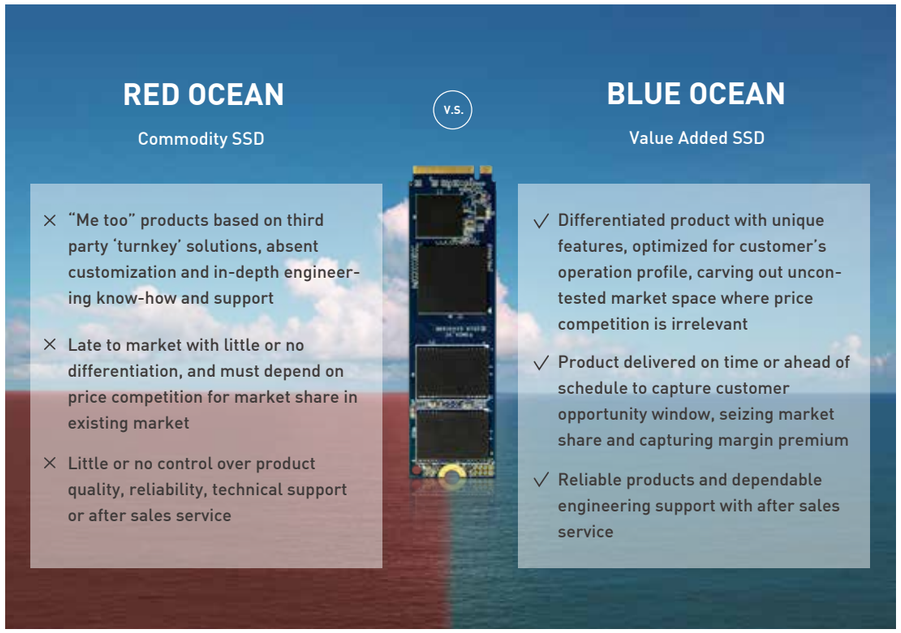
Exascend is the only one-stop solution provider, design, validate and manufactures to customer requirements and specifications, guaranteeing compatibility and interoperability with non-standard systems.

Reduction Resources

Let the storage expert solve your storage issues for you, while saving cost, engineering resources, and mitigate delivery uncertainty.

Worry Free Reliability

Design, validate and manufactured with the highest quality and reliability standard (for example, in-house 10,000 sudden power-loss cycle testing, 100% dynamic -45˚C~90˚C wide temperature chamber cyling test)



CUSTOMIZATION

Engineering Imagination to Innovation

Hardware

- Capacity and Form Factor
- Interface / Connector
- ESD Protection
- Conformal Coating
- Hardware Erase / Erase Protocol
- Temp Sensor / Thermal Management
- LED Configuration / Polarity
- Power / Performance Modes
- Power Loss Protection
- Flash / DRAM Capacity (ODM)
- Auxiliary Function

Firmware

- Power Loss Protection
- RAID ECC Data Protection
- Encryption (SED / TCG)
- Data Erasure Protocols
- Full Drive pSLC
- SLC Cache Mode
- Custom Flash Support (ODM)
- Seq. / Random Performance Tuning
- QoS / Latency Tuning
- Write Amplification (WAF) Tuning
- Wide-Temp Flash Tuning
- Power Management Tuning
- Thermal & Power Throttling
- **Data Recovery Service**

Configuration and Testing

- Endurance Target
- ESD / Shock / Vibration Testing
- System Compatibility / Interoperability
- Over Provision Setting
- Power Consumption Measurement
- Power Loss Testing
- Specific Workload Regression
- Wide-Temperature Testing
- MP Testing Flow (ODM)
- Optional Leaded Process
- Write Protect/ Read-Only Mode

CORPORATE PROFILE

Company Overview

Founded | 2006
R&D Center | Shanghai, China
Service Centers | Shanghai, Shenzhen, Taipei, Sunnyvale - CA
Manufacturing | Production Available in Asia & USA.
Products | SSD (SATA3 & PCIe NVMe), CF Express

Our Vision and Mission

Vision

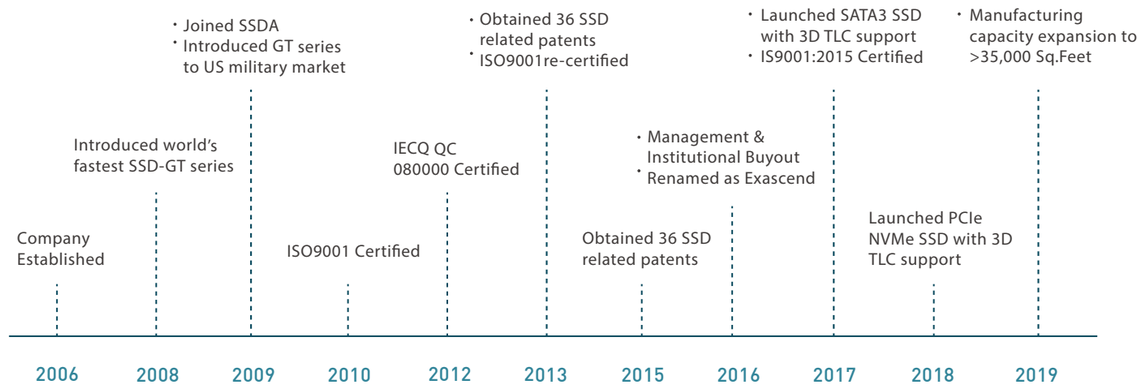
To be the most respected provider of reliable, customized storage solution across industrial and enterprise market. To inspire and serve our customer's needs with innovative technology.

Mission

To provide innovative, tailored storage technology solutions empowering user to push the boundaries of what is possible.

Engineering Imagination to Innovation

Timeline Highlights



CORE COMPETENCY

Exascend Engineered. Enterprise performance, Industrial rugged.
In a world of ever-accelerating data creation, Exascend is empowering organizations and individuals to capture, preserve, access and transform data.

Focused and Exclusive

Exascend is the only industrial and enterprise SSD manufacturer in the world with the engineering expertise to fully utilize Marvell's premium SATA & NVMe controllers. We pride and distinguish ourselves with our full range of Marvell based SSD,100% internally developed hardware and firmware design, fully customizable, unifying enterprise grade performance with industrial ruggedness.

Exascend Customization

Our Marvell based SSD products range from standard form factors to custom design, with standard monolithic designs spanning 128GB to 8TB in capacity, and custom designs up to 32TB. Leveraging Exascend's unique expertise in hardware and firmware, our customization ability is second to none. We provide tailored hardware, firmware design, performance, latency and QoS tuning, power and thermal throttling, etc, thus our motto "Engineering Imagination into Reality".

In-House Design, Validation, and Testing

More than 10 years of experience supplying military-grade and enterprise-grade SSD to Fortune 500 and leading OEMs worldwide. Our design and total solution validation and testing are tuned and certified for the most critical applications and guaranteed by our ISO 9001:2015 certified manufacturing and quality management system. In addition to commercially available third-party testing programs, Exascend develops own testing platform to continuously improve product stability, reliability, and quality.

Product Quality Assurance and Consistency

Exascend guarantees fix BOM key components (NAND Flash / Controller / Firmware). Every SSD is 100% tested at mass production stage before shipping to customers. Our internally developed QMS system (Exascend's quality management system) guarantees 100% transparency and 100% traceability.

Failure Analysis and One-Stop Resolution Service

Leveraging in-house hardware and firmware capability, Exascend is uniquely positioned and committed to swift customer issue resolution. We provide quick response on customer failure analysis, root cause report, and issue resolution. 8D report is available upon request.

Data Recovery Service

Exascend recognizes the data stored in the storage device is the most valuable asset, but even with the most rigorous manufacturing and testing process, components do fail in the field in some corner cases. Therefore, in addition to implementing drive level RAID ECC to further ensure data integrity, in the most unfortunate event where the SSD is experiencing sustained damage and is no longer responsive, Exascend offers an exclusive on-site resolution and data recovery service (a separate contract service). The engineering know-how to perform this service is only available from the manufacture which owns 100% hardware and firmware design structure.

TECHNOLOGY HIGHLIGHTS

Data Integrity & Security

Data Recovery

For the ultimate peace of mind, in the unfortunate event where an Exascend SSD is experiencing sustained damage and is no longer responsive, Exascend offers an exclusive on-site resolution and data recovery service (a separate contract service). Recovery service is possible because Exascend does not use third-party turnkey solutions to build SSD products. The engineering know-how and service flexibility is only available from supplier who develops and owns 100% hardware and firmware design IP.

Comparison table for Exascend's recovery service with common service provider

Service Provider	3rd party tool	Common module house	Exascend
Cenarios of Recovery Service Support	• Mapping table got deleted • Mapping table got corrupted	• Mapping table got deleted • Mapping table got corrupted • Firmware damaged	• Mapping table got deleted • Mapping table got corrupted • Firmware damaged • Firmware lost • Flash data damages
Recovery %	20~30%	40~50%	80~90%

Disk Error

Exascend Data Recovering Progress

Data Saved

Multiple Firmware Image Backup

Loss of firmware is an uncommon event but does happen rarely and unexpectedly, at the most un-opportune situation. Exascend developed multiple firmware image backup scheme to ensure, in an event of a firmware image corruption, backups copies are readily available and corrupted image is repaired automatically, restoring system integrity. This feature is another extra layer of protection to safeguard devices from malfunction.

Customized Hardware and Firmware Security Erase

One common feature in defense applications is rapid purging of sensitive data, Exascend offers customized secure erase, supporting normal erase, software and hardware trigger-based data sanitization complying to multiple government agency erase protocols, guaranteeing fast data removal from the device.

Firmware Supported Mode

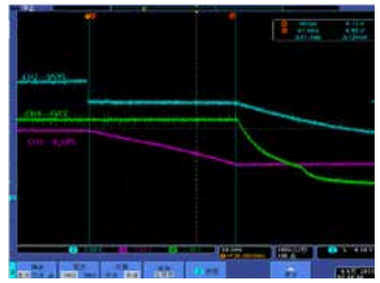
- NSA 9-12
- NSA 130-2
- AFSSI 5020
- DoD5220.22-M
- USA Army 380-19
- USA Navy NAVSO P-5239-26
- IRIG 106-7
- Customized Mode Available Upon Request

Hardware Trigger

- Standard Trigger
- Customized Trigger Available Upon Request

Power Loss Protection

In addition to hardened firmware algorithm based sudden power loss protection to ensure data integrity, Tantalum capacitors are available as an optional feature for end users to guarantee all in-flight data are safely stored in an unstable environment.



Firmware Encryption with Tamper Proof Cryptographic Signature

To better protect data from malicious hacking attempts or unintended accidental modification compromising data security, Exascend developed firmware encryption with cryptographic signature, so un-authorized firmware modifications are rejected, ensuring the heart of the SSD is not manipulated.

AES256bit/FIPS197 Compliant

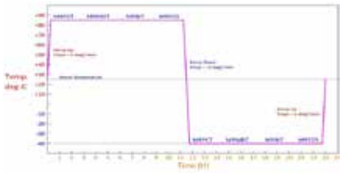
AES 256-bit security is very popular for general usage of basic security protection, Exascend is offering significantly more rigorous hardware encryption – US Agency certified FIPS197, to fulfill the highest data security requirements.

TCG OPAL

Initiated by the Trusted Computing Group (TCG), committed to provide specific security system mainly focus on hardware security protection, TCG Opal is a set of specifications describing the protocol to communicate with self-encrypting disk drive, features include shadow MBR (Pre-Boot Authentication), LBA based read / write permissions, and AES 256-bit Hardware Encryption.

Wide Temperature Support

Only top-quality design and components can withstand wide temperature (-40~85C operational temperature) operation. Complementing our expertise in design and BOM selection, Exascend have in-house facility and internally developed validation and manufacturing process to guarantee system-level wide temperature support, this is an optional service available to all Exascend products.



Wear Leveling and Active Data Refresh

Exascend developed algorithm to dynamically refresh data contents on the drive based on usage pattern, facilitating even drive wear leveling, protection from read, program and erase disturb, ensuring data residing in NAND Flash are always reliable.

TECHNOLOGY HIGHLIGHTS

System Performance Optimization

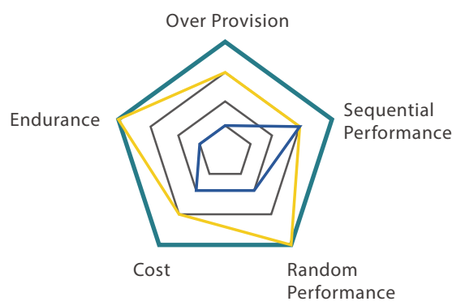
(Exascend Exclusive)

Ultra-Fast Response Time (Low Latency) and High QoS Consistency

Looking beyond sequential transfer rate and the random IOPS, Exascend's products are developed targeting ultra-fast response time (low latency) and QoS consistency. Escalating performance requirements in both enterprise and industrial applications, with the emergence of high-speed PCIe NVMe SSD, latency and QoS (Quality of Service) is quickly becoming the key metrics to evaluating drive performance, Exascend's firmware is designed from ground up as an enterprise-class solution suited for both enterprise and industrial applications.

Adjustable OP

OP (Over-provision) can be configured to achieve a specific level of performance or targeted endurance. Normally this feature is offered with limited adjustment of a certain percentage (7% or 28%), Exascend is providing un-limited OP adjustments, all product lines can be uniquely configured.

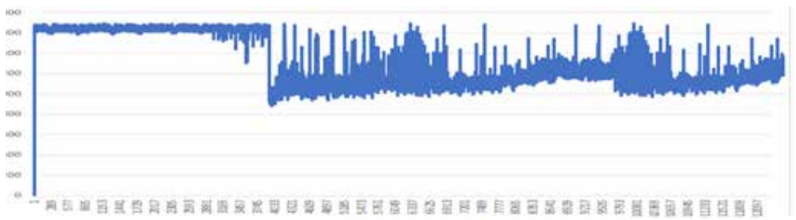


SuperCruise Technology

SuperCruise is a cutting-edge firmware algorism where this technology can be best utilize to optimize the performance in different aspect.

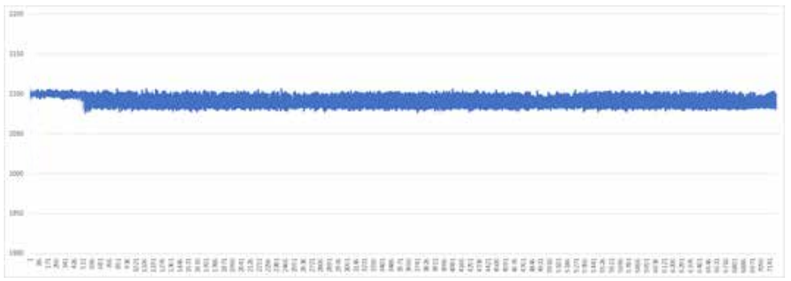
A common phenomenon in SSD across the board is that write performance drops as the SSD is filled up with contents and the longer time in usage, the worse it gets. Adapting the enterprise storage solution's Quality of Service (QoS) idea, Exascend had been focusing on delivering the performance in a most consistent mode, make sure that the performance does not fluctuate nor drop over time. Besides having Over-Provision (OP) implemented, Exascend's advance firmware algorism will monitor the ratio of free block production and consumption of the SSD, and regulates the response speed to control it to a certain ratio and ensure the tasks are reasonably allocated to improve the response time of user commands. This can avoid any sudden increase in the free block and make stable, consistent performance over time.

Figure 1: Typical SSD under continuing writing for a period of time



Sequential Write in MB/s

Figure 2: Enable SuperCruise Technology under continuing writing for a period of time



Sequential Write in MB/s

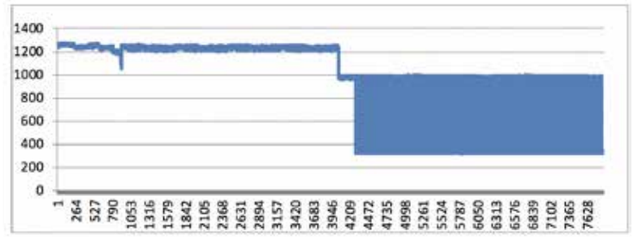
Adaptive Thermal Control

Exascend proprietary Adaptive Thermal Throttling feature improves drive reliability and enhances sustained performance while preventing SSD from overheating.

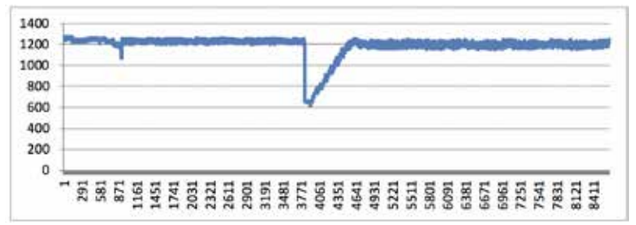
SSD performance is increased dramatically with the recent transition from SATA to PCIe, and power consumption generally scaling up with performance. Power consumption then leads to an overheating issue. Overheating in SSD not only increases the potential hardware damage, it also puts data at risk. Therefore, thermal throttling is being widely implemented in the SSD technology. Thermal throttling is a protective action that slows down the performance when SSD reached to a certain temperature rage and to speed up when temperature comes back to normal range.

A critical drawback for this typical thermal throttling is that the performance will fluctuation to some extent which might cause issues where the performance must be consistent or must work on a certain level. Exascend quickly realized this and an exclusive design- "Adaptive Thermal Throttling" is introduced to the market.

The goal for "Adaptive Thermal Throttling" is to achieve the fine balance of highest sustained performance while keeping the drive operating under a defined temperature threshold. Exascend's firmware algorithm takes multiple iterations to reach the equilibrium point, where the SSD will sustain at the highest performance while maintaining the temperature under threshold. By implementing this technology, both hardware components and the data inside SSD are working in a safe environment with the minimum effect on performance drop.



SSD Write Burn-in Performance from 75°C -→ 85°C with Typical Thermal Throttling



SSD Write Burn-in Performance from 75°C -→ 85°C with Adaptive Thermal Throttling

FOCUSED MARKET

Aerospace & High Reliability System

Aerospace and High Reliability System bring forth mission critical applications demanding the most rugged, reliable, and secure SSD under the most extreme environments.
Exascend products are designed to meet the high shock, vibration, wide temperature range, long life cycle, locked bill-of-material requirements. Exascend products are built to withstand MIL-STD-810G environmental testing, but when an application has specific requirements, we can perform custom testing and product modifications conforming to these unique conditions. In addition, recognizing the growing need for performance and consistency, we introduce enterprise-grade performance to complement our rugged industrial design. Exascend products guarantee the lowest latency and best performance consistency under extreme operating condition. In addition to rugged design, security related features are also one of our product highlights. Military grade encryption (FIPS197), wide range of military security erase protocols, hardware triggered sanitized erase, tamper proof firmware protection are some exclusive product features upon request.

Feature Set

- MIL-STD-810G
- Wide Temperature Range
- Conformal Coating
- Enterprise Performance
- Support AES 256-Bit and FIPS197
- Military Grade Security Erase Protocol
- Hardware Secure Erase Optional
- Optional Leaded Process

FOCUSED MARKET

Industrial

In addition to reliability and stability, the proliferation of IoT and Industry 4.0 further necessitate the adoption of high performance data-intensive storage solutions. Requirements for flash storage in industrial systems are as diverse as the applications, depending on the environment in which they will be used and the usage model, as well as the overall cost and durability of the entire system. Criteria to consider in products selection, endurance, extended temperature, performance, capacity, latency, power, thermal; Exascend can assist with identifying and customizing the right industrial storage product for the application.

One new arising application in the industrial field is 5G technology. 5G is a technology evolution for existing (including 2G, 3G, 4G and WiFi). According to the International Standard Planning, 5G is divided into three application scenarios: eMMB (enhanced Mobile BroadBand, enhanced mobile bandwidth), mMTC (Massive Machine Type Communication), and uRLLC (Ultra- Reliable Low Latency Connection), these three application scenarios are respectively designed to ensure a large number of data transmission, multi-device connection, and stable transmission with low delay. 5G is foreseen not only used in the daily communication field, but it will be the foundation of the development of the Internet of Things in near future: shared car, remote operation, automatic and collaborative driving, and replace or supplement existing connection technologies.

Storage in the 5G era requires higher transmission rate and a lower latency to be used in data centers, transportation facilities, and mobile connectivity.

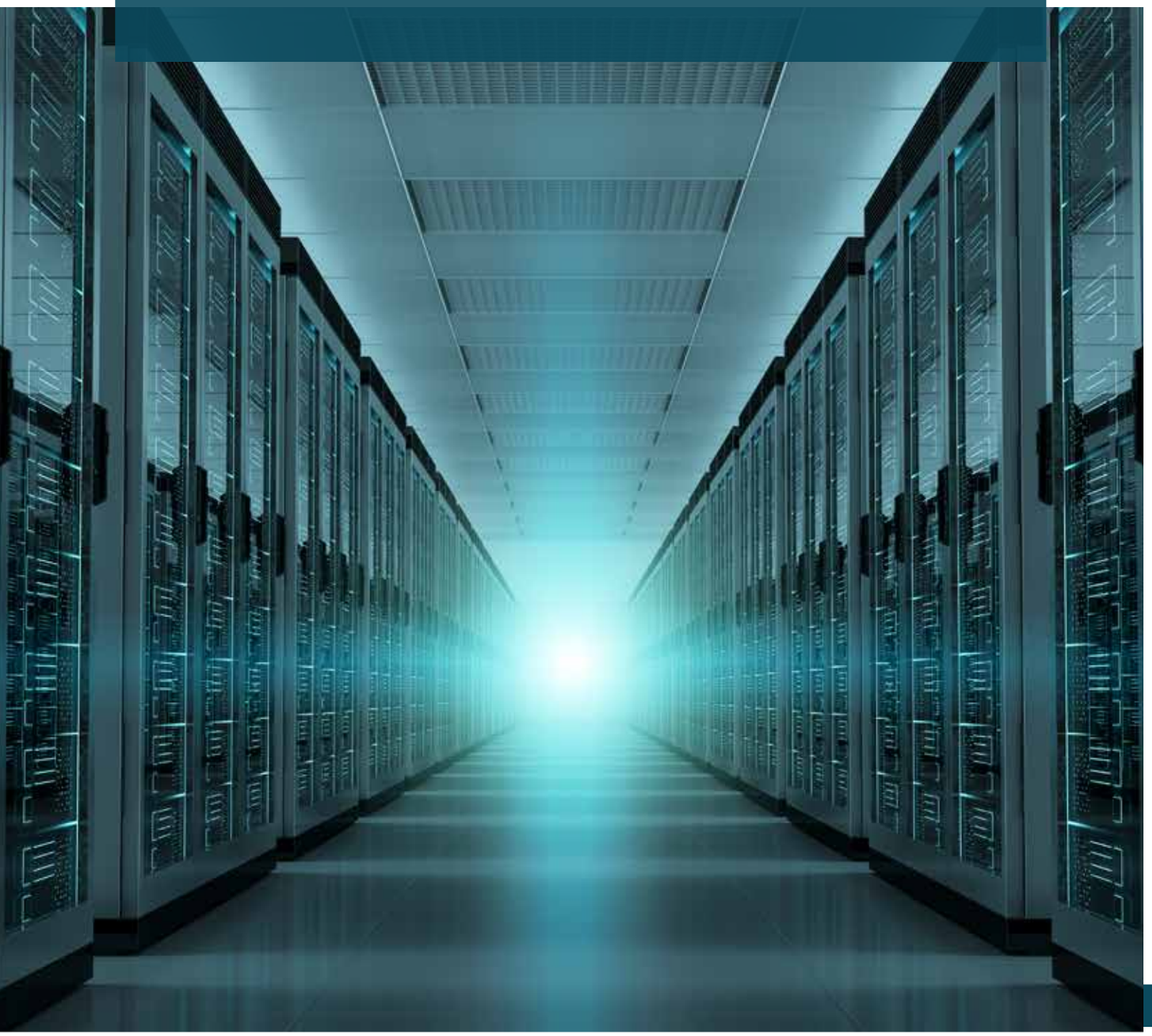
Exascend plans to introduce 80Gbps storage bandwidth for PCIe Gen 4 x 4 products in 2020. The next generation of self-driving cars will require faster, more reliable and cost-effective solid-state storage. The performance of PCIe, combined with the reliability structure of 3D NAND FLASH, high data retention, lower cost, and higher capacity will make it the most popular solution.

Feature Set

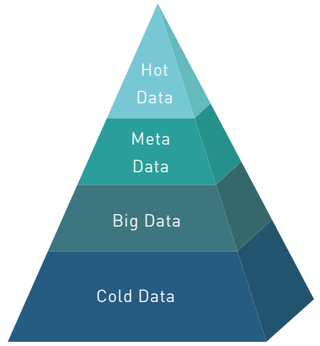
- Extended Endurance
- Wide Temperature Range
- Enterprise Performance, QoS, Low Latency
- Fix Major BOM (Controller/Flash/Firmware)
- Highly Customizable (Hardware / Software / Configuration and Testing)

FOCUSED MARKET

— Server / Enterprise Storage —



Storage devices in high-end server applications has always been the performance bottleneck awaiting breakthrough, constantly searching for higher IOPS (input/ output operations per second), and lower latency. To achieve consistent and stable system performance, QoS (Quality of Service) and latency are the most important aspects impacting overall server performance. Exascend products offers enterprise-grade QoS (low latency) with customizable capacity, form factor, and tailored performance tuning for specific use scenario, and data recovery services, optimizing customer experience.



1 In Memory Computing
DRAM, NVDIMM / OPTANE

2 Cache / Journaling
Enterprise NVMe SSD
EXASCEND Products Focus

3 Frequently Accessed
Enterprise SATA SSD
EXASCEND Products Focus

4 Infrequently accessed
Large capacity SATA HDD

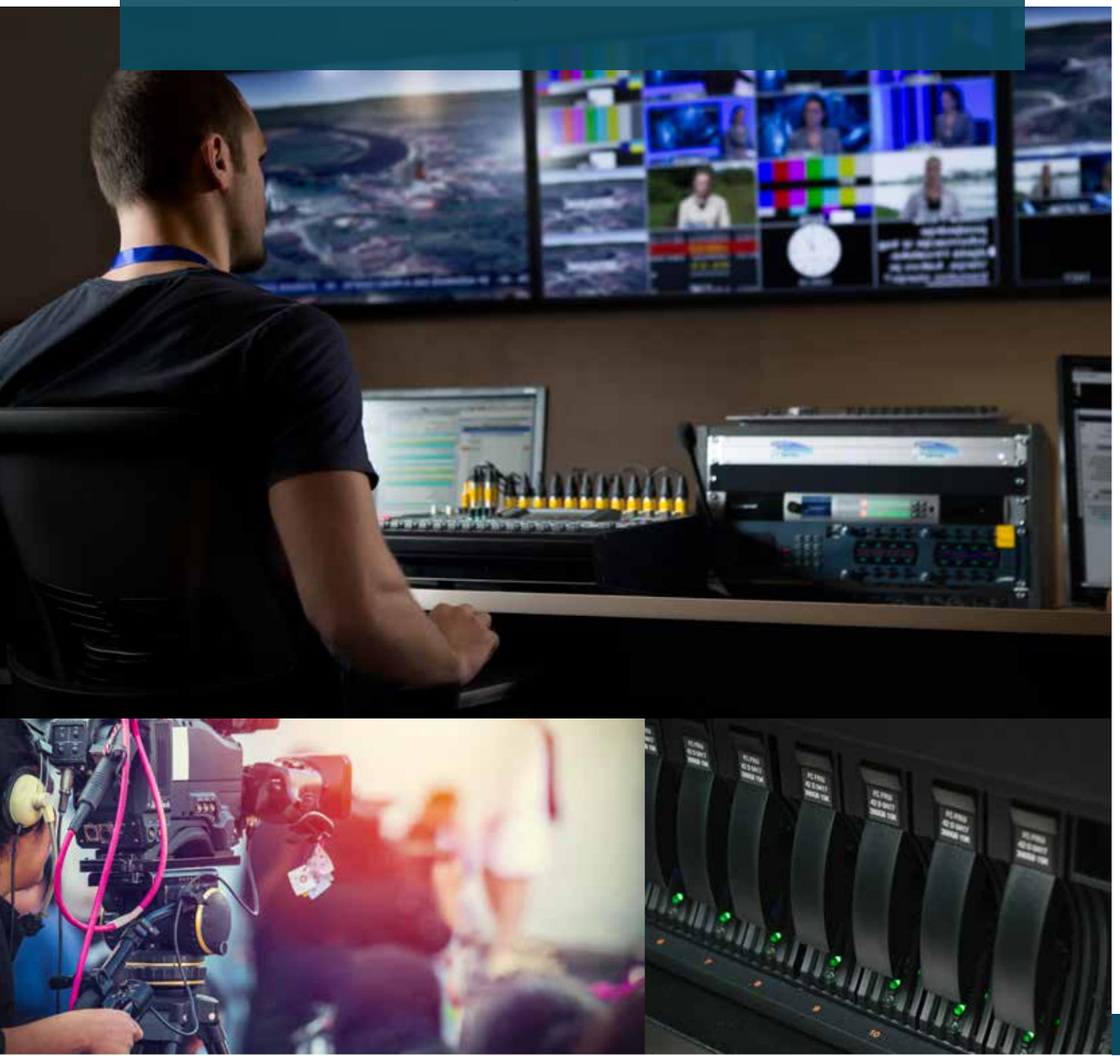
* SATA SSD / PCIe SSD for OS booting
EXASCEND Products Focus

Feature Set

- High QoS (@99.99%)
- High Capacity (up to 8TB)
- Flexible OP Adjustment (from 7% to 28% or more)
- Support AES256bit/FIPS197
- Optional Hardware Power Loss Protection
- Customize Sustained Performance Level / Power Consumption Level

FOCUSED MARKET

Broadcasting & Post Production



As audience's eyes are now accustomed to 4k/8k high resolution and 3D cinema, with VR on the horizon, higher performance video capture equipments are in demand. In 24/7 non-stop recording professional cameras, several key metrics contribute to filming quality: stable sequential performance, small data handling, and consistent low latency. These are extremely important metrics to ensure no lagging and no frame drop during filming. Exascend acknowledges that every camera has its designed specification and expected performance criteria along with power settings, it's hardly one to fit all scenario, Exascend is offering highly customizable SATA and PCIe NVMe SSD, these products are qualified by leading professional cameras manufactures from SATA to PCIe generation, tested and validated by multiple studio systems, for use in both production and post production.

Feature Set

- High Performance
- Low Latency and Stable QoS (Quality of Service)
- Adjustable Performance and Power Consumption at Active Mode
- Customize Form Factor

FOCUSED MARKET

Built for 8K DSLR and Video Cameras

To meet the high data transfer demand of 8K RAW continuous shooting and video recording for future premium DSLR and video cameras.
Exascend's CFexpress feature incredible read and write speed with the design of PCIe Gen3x2 interface (Type-B), the card performs at blazing speeds up to 1700 MB/s read and 1700 MB/s write, which is over 3 times faster than the best CFast™ 2.0 and XQD™ form factor, yet it is backwards compatible with XQD™ form factor.

Exascend CFexpress is designed from the ground up, leveraging the quality of service technology delivered in the enterprise SSD, Exascend is the first in the industry to support VPG4.0 Profile Level 2 (Video Performance Guarantee of 400MB/s minimum), targeting cinema-quality 8K video recording (8192x4320p).

Feature Set

- Extremely High Sustained Performance
- Build for Sustained Enterprise Workload and QoS
- VPG4.0 Profile Level 2 Support
- Built for 8K Video & Photo
- SuperCruise Technology Enabled
- Ultimate Durability
- XQD Compatibility (with updated camera firmware)
- PCIe Gen 4 x 2 Compatibility

PRODUCT - SATA3 SSD

Basic Feature

*Backwards compatible with SATAII (3Gb/s) and SATAI (1.5Gb/s)
*Supports TRIM, NCQ, DEVSLP, SMART, ATA Security
*Advanced ECC and global wear-leveling algorithm
*Power shield for basic data protection
*AES256bit/FIPS197 Compliant

Exclusive Feature

*RAID ECC Protection within SSD
*Firmware Encryption with Tamper Proof Cryptographic Signature
*Multiple Firmware Image Backup (ROM Based)
*In-Field Firmware Update
*Read Disturb Protection

Optional Feature

*pSLC Mode
*TCG OPAL 2.0
*Hardware Security Erase
*Hardware Power Loss Protection
*Performance, Power, Thermal Throttling
*30µ Gold Finger for all Series

Product Series	SI2	SC3	SC4
Physical Information			
Form Factor	2.5" ; M.2 ; mSATA		2.5" ; M.2 2280
Interface	SATAIII, 6.0Gbps		
Capacity	120GB~3840GB	256GB~4TB	512GB~4TB
Flash Type	MLC	3D TLC	3D TLC
Input Voltage	5V±5%; 3.3V±5%		
Power Consumption	Active<5W; Idle<0.5W		Active<4.5W; Idle<0.5W
Performance			
Maximum Sequencial Read (MB/s)	540	540	540
Maximum Sequencial Write (MB/s)	520	520	520
Max. 4K Random Read (IOPS)	90,000	90,000	95,000
Max. 4K Random Write (IOPS)	85,000	85,000	85,000
Reliability/ Endurance			
Operational Temperature (°C)	-40 - 85°	0 - 70°	0-70°
Storage Temperature (°C)	-45 - 90°	-40 - 85°	-45 -85°
UBER	1 sector per 10^{-17} bits read		
TBW (max.)**	2,400	2,400	2,400
MTBF (hours)	2,000,000		
Warranty (years)	3	3	3
Planned Schedule	MP		2021 Q1

■ M.2 2280 ■ 2.5"

Product Series	SI2	SC3	SC4
120GB	■ ■		
240GB	■ ■	■ ■	■ ■
480GB	■ ■	■ ■	■ ■
960GB	■ ■	■ ■	■ ■
1920GB	■ ■	■ ■	■ ■
3840GB	■	■ ■	■ ■

- Warranty is until the sataed warranty years or reached the guaranteed TBW
- pSLC is optional and upon request
- 「—」Usage does not typically request such information
- DWPD stands for Drive Writes Per Day. TBW = DWPD * capacity * warranty * 365 / 1000
- ** TBW and DWPD are JESD47 Compliant

PRODUCT - SATA3 SSD

Basic Feature

*Backwards compatible with SATAII (3Gb/s) and SATAI (1.5Gb/s)
*Supports TRIM, NCQ, DEVSLP, SMART, ATA Security
*Advanced ECC and global wear-leveling algorithm
*Power shield for basic data protection
*AES256bit/FIPS197 Compliant

Exclusive Feature

*RAID ECC Protection within SSD
*Firmware Encryption with Tamper Proof Cryptographic Signature
*Multiple Firmware Image Backup (ROM Based)
*In-Field Firmware Update
*Read Disturb Protection

Optional Feature

*TCG OPAL 2.0
*Hardware Security Erase
*Hardware Power Loss Protection
*Performance, Power, Thermal Throttling
*30µ Gold Finger for all Series

Product Series	SI3			SI4		
Sub-Series	Standard	Extended	pSLC	Standard	Extended	pSLC
Physical Information						
Form Factor	2.5" ; M.2 2280					
Interface	SATAIII, 6.0Gbps					
Capacity	240GB~3840GB	240GB~1920GB	240GB~960GB	240GB~3840GB	240GB~1920GB	240GB~960GB
Flash Type	3D TLC					
Input Voltage	5V±5%; 3.3V±5%					
Power Consumption	Active<5W; Idle<0.5W			Active<5W; Idle<0.5W		
Performance						
Maximum Sequencial Read (MB/s)	540			540		
Maximum Sequencial Write (MB/s)	520			520		
Max. 4K Random Read (IOPS)	95,000			95,000		
Max. 4K Random Write (IOPS)	85,000			85,000		
Reliability/ Endurance						
Operational Temperature (°C)	-40 - 85°					
Storage Temperature (°C)	-45 - 90°					
UBER	1 sector per 10^{-17} bits read					
TBW (max.)**	2,400	2,400	6,000	2,400	2,400	6,000
MTBF (hours)	2,000,000					
Warranty (years)	3	3	3	3	3	3
Planned Schedule	MP	Upon Request		2021 Q1	Upon Request	

■ M.2 2280 ■ 2.5"

Product Series	Standard	Extended	pSLC	Standard	Extended	pSLC
240GB	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■
480GB	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■
960GB	■ ■	■ ■	■	■ ■	■ ■	■
1920GB	■ ■	■		■ ■	■	
3840GB	■			■		

- Warranty is until the sataed warranty years or reached the guaranteed TBW
- 「—」Usage does not typically request such information
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- ** TBW and DWPD are JESD47 Compliant

PRODUCT - SATA3 SSD

Basic Feature

*Backwards compatible with SATAII (3Gb/s) and SATAI (1.5Gb/s)
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*Advanced ECC and global wear-leveling algorithm
*Power shield for basic data protection
*AES256bit/FIPS197 Compliant

Exclusive Feature

*RAID ECC Protection within SSD
*Firmware Encryption with Tamper Proof Cryptographic Signature
*Multiple Firmware Image Backup (ROM Based)
*In-Field Firmware Update
*Read Disturb Protection
*Enterprise Grade QoS (Consistent Low Latency)

Optional Feature

*TCG OPAL 2.0
*Hardware Security Erase
*Hardware Power Loss Protection
*Performance, Power, Thermal Throttling
*30µ Gold Finger for all Series

Product Series	SE3				SE4			
Sub-Series	Streaming	Boot	Pro	Max	Streaming	Boot	Pro	Max
Physical Information								
Form Factor	2.5" ; M.2 2280							
Interface	SATAIII, 6.0Gbps							
Capacity	480GB~3840GB	240GB, 480GB	480GB~1920GB	240GB~960GB	480GB~3840GB	240GB, 480GB	480GB~3840GB	240GB~960GB
Flash Type	3D TLC							
Input Voltage	5V±5%; 3.3V±5%							
Power Consumption	Active<5W; Idle<0.5W				Active<4.5W; Idle<0.5W			
Performance								
Maximum Sequencial Read (MB/s)	540	540	540	540	540	540	540	540
Maximum Sequencial Write (MB/s)	520	410	520	520	520	410	520	520
Max. 4K Random Read (IOPS)	95,000	80,000	95,000	95,000	95,000	80,000	95,000	95,000
Max. 4K Random Write (IOPS)	16,000	18,000	30,000	50,000	16,000	18,000	30,000	50,000
Latency (Read/Write)	120µs / 80µs							
QoS (Read/Write)	200µs / 300µs (@99.99)							
Reliability/ Endurance								
Operational Temperature (°C)	0 - 75°							
Storage Temperature (°C)	-40 - 85°							
UBER	1 sector per 10^{-17} bits read							
DWPD (max.)** JESD218	0.6	1	1.5	5	0.6	1	1.5	5
MTBF (hours)	2,000,000							
Warranty (years)	5	5	5	5	5	5	5	5
Planned Schedule	MP	2020 Q2			2021 Q1			

■ M.2 2280 ■ 2.5"

Product Series	Streaming	Boot	Pro	Max	Streaming	Boot	Pro	Max
240GB		■ ■		■ ■		■ ■		■ ■
480GB	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■
960GB	■ ■		■ ■	■	■ ■		■ ■	■
1920GB	■ ■		■		■ ■		■	
3840GB	■				■			

- Warranty is until the sataed warranty years or reached the guaranteed TBW
- 「—」 Usage does not typically request such information
- DWPD stands for Drive Writes Per Day. TBW = DWPD * capacity * warranty * 365 / 1000
- ** TBW and DWPD are JESD47 Compliant

Product -PCIe Gen3x4 SSD

Basic Feature

*PCIe NVMe 1.2/1.3, Gen3x4
*Supports TRIM, SMART
*Advanced ECC and global wear-leveling algorithm
*Power shield for basic data protection
*AES256bit/FIPS197 Compliant

Exclusive Feature

*RAID ECC Protection within SSD
*Firmware Encryption with Tamper Proof Cryptographic Signature
*Multiple Firmware Image Backup (ROM Based)
*In-Field Firmware Update
*Read Disturb Protection
*Enterprise Grade QoS (Consistent Low Latency)

Optional Feature

*TCG OPAL 2.0
*Hardware Security Erase
*Hardware Power Loss Protection
*Performance, Power, Thermal Throttling
*30µ Gold Finger for all Series

Product Series	PI2	PC3	PC4
Physical Information			
Form Factor	U.2 ; M.2 2280		
Interface	PCIe 3.0 (NVMe 1.2)		PCIe 4.0 (NVMe 1.3)
Capacity	480GB~3840GB	512GB~8TB	512GB~4TB
Flash Type	MLC	3D TLC	3D TLC
Input Voltage	3.3V±5% ; 12V±5%		
Power Consumption	Active<8W; Idle<0.5W		Active<9W; Idle<0.5W
Performance			
Maximum Sequencial Read (MB/s)	2,300	3,200	3,500
Maximum Sequencial Write (MB/s)	2,100	2,100	3,000
Max. 4K Random Read (IOPS)	330,000	330,000	600,000
Max. 4K Random Write (IOPS)	250,000	250,000	500,000
Reliability/ Endurance			
Operational Temperature (°C)	-40 - 85°	0 - 70°	0-70°
Storage Temperature (°C)	-45 - 90°	-40 - 85°	-40 -85°
UBER	1 sector per 10^{-17} bits read		
TBW (max.)**	2,400	4,800	2,400
MTBF (hours)	2,000,000		
Warranty (years)	3	3	3
Planned Schedule	MP		2021 Q2

■ M.2 2280 ■ U.2

Product Series	PI2	PC3	PC4
480GB	■ ■	■	■
960GB	■ ■	■ ■	■ ■
1920GB	■ ■	■ ■	■ ■
3840GB	■	■ ■	■
7680GB (Upon Request)		■	

- Warranty is until the sataed warranty years or reached the guaranteed TBW
- pSLC is optional and upon request
- 「—」 Usage does not typically request such information
- DWPD stands for Drive Writes Per Day. TBW = DWPD * capacity * warranty * 365 / 1000
- ** TBW and DWPD are JESD47 Compliant

Product -PCIe Gen3x4 SSD

Basic Feature

*PCIe NVMe 1.2/1.3, Gen3x4
**Supports TRIM, SMART
*Advanced ECC and global wear-leveling algorithm
*Power shield for basic data protection
*AES256bit/FIPS197 Compliant

Exclusive Feature

*RAID ECC Protection within SSD
*Firmware Encryption with Tamper Proof Cryptographic Signature
*Multiple Firmware Image Backup (ROM Based)
*In-Field Firmware Update
*Read Disturb Protection
*Enterprise Grade QoS (Consistent Low Latency)

Optional Feature

*TCG OPAL 2.0
*Hardware Security Erase
*Hardware Power Loss Protection
*Performance, Power, Thermal Throttling
*30µ Gold Finger for all Series

Product Series	PI3			PI4		
Sub-Series	Standard	Extended	pSLC	Standard	Extended	pSLC
Physical Information						
Form Factor	M.2 2280; U.2					
Interface	PCIe 3.0 (NVMe 1.2)			PCIe 4.0 (NVMe 1.3)		
Capacity	480GB~7680GB	480GB~3840GB	240GB~1920GB	480GB~7680GB	480GB~3840GB	240GB~1920GB
Flash Type	3D TLC					
Input Voltage	3.3V±5%; 12V±5%					
Power Consumption	Active<8W; Idle<0.5W			Active<6W; Idle<0.3W		
Performance						
Maximum Sequencial Read (MB/s)	3,200	3,200	3,200	2,200	2,200	2,200
Maximum Sequencial Write (MB/s)	1,800	1,800	1,800	2,000	2,000	2,000
Max. 4K Random Read (IOPS)	330,000	330,000	330,000	450,000	450,000	450,000
Max. 4K Random Write (IOPS)	250,000	250,000	250,000	400,000	400,000	400,000
Reliability/ Endurance						
Operational Temperature (°C)	-40 - 85°					
Storage Temperature (°C)	-45 - 90°					
UBER	1 sector per 10^{-17} bits read					
TBW (max.)**	4,800	4800	12,000	2,400	2,400	6,000
MTBF (hours)	2,000,000					
Warranty (years)	3	3	3	3	3	3
Planned Schedule	MP	Upon Request		2021 Q1	Upon Request	

■ M.2 2280 ■ U.2

Product Series	Standard	Extended	pSLC	Standard	Extended	pSLC
240GB			■ ■			■ ■
480GB	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■
960GB	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■
1920GB	■ ■	■ ■	■	■ ■	■ ■	■
3840GB	■ ■	■		■ ■	■	
7680GB	■			■		

- Warranty is until the sataed warranty years or reached the guaranteed TBW
- 「ー」Usage does not typically request such information
- DWPD stands for Drive Writes Per Day. TBW = DWPD * capacity * warranty * 365 / 1000
- ** TBW and DWPD are JESD47 Compliant

Product -PCIe Gen3x4 SSD

Basic Feature

*PCIe NVMe 1.2/1.3, Gen3x4
*Supports TRIM, SMART
*Advanced ECC and global wear-leveling algorithm
*Power shield for basic data protection
*AES256bit/FIPS197 Compliant

Exclusive Feature

*RAID ECC Function within SSD
*Firmware Encryption with Tamper Proof Cryptographic Signature
*Multiple Firmware Image Backup (ROM Based)
*In-Field Firmware Update
*Read Disturb Protection
*Enterprise Grade QoS (Consistent Low Latency)

Optional Feature

*TCG OPAL 2.0
*Hardware Security Erase
*Hardware Power Loss Protection
*Performance, Power, Thermal Throttling
*SLC Cache On
*30µ Gold Finger for all Series

Product Series	PE3				PE4			
Sub-Series	Streaming	Boot	Pro	Max	Streaming	Boot	Pro	Max
Physical Information								
Form Factor	M.2; U.2							
Interface	PCIe 3.0 (NVMe 1.2)				PCIe 4.0 (NVMe 1.3)			
Capacity	480GB~7680GB	240GB, 480GB	240GB~3840GB	480GB~1920GB	480GB~7680GB	240GB, 480GB	240GB~3840GB	480GB~1920GB
Flash Type	3D TLC							
Input Voltage	3.3V±5%; 12V±5%							
Power Consumption	Active<8W; Idle<0.5W				Active<6W; Idle<0.3W			
Performance								
Maximum Sequencial Read (MB/s)	3100	3100	3100	3100	3100	3100	3100	3100
Maximum Sequencial Write (MB/s)	2000	2000	2000	2000	2000	2000	2000	2000
Max. 4K Random Read (IOPS)	340,000	340,000	340,000	340,000	340,000	340,000	340,000	340,000
Max. 4K Random Write (IOPS)	32,000	30,000	65,000	65,000	32,000	30,000	50,000	65,000
Latency (Read/Write)	100µs / 27µs							
QoS (Read/Write)	160µ/200µ (@99.99)							
Reliability/ Endurance								
Operational Temperature (°C)	0 - 75°							
Storage Temperature (°C)	-40 - 85°							
UBER	1 sector per 10^{-17} bits read							
DWPD (max.)** JESD218	0.6	1	1.5	5	0.6	1	1.5	5
MTBF (hours)	2,000,000							
Warranty (years)	5	5	5	5	5	5	5	5
Planned Schedule	MP	Upon Request			2020 Q2	Upon Request		

■ M.2 2280 ■ U.2

Product Series	Streaming	Boot	Pro	Max	Streaming	Boot	Pro	Max
240GB		■ ■	■ ■	■ ■		■ ■	■ ■	■ ■
480GB	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■
960GB	■ ■		■ ■	■	■ ■		■ ■	■
1920GB	■ ■		■ ■		■ ■		■ ■	
3840GB	■ ■		■		■ ■		■	
7680GB	■				■			

- Warranty is until the sataed warranty years or reached the guaranteed TBW
- 「ー」Usage does not typically request such information
- DWPD stands for Drive Writes Per Day. TBW = DWPD * capacity * warranty * 365 / 1000
- ** TBW and DWPD are JESD47 Compliant

Product -PCIe Gen4x2 SSD

Basic Feature

*PCIe NVMe 1.3, Gen4x2
*Supports TRIM, SMART
*Advanced LDPC ECC and global wear-leveling algorism
*Power shield for basic data protection
*AES256bit/FIPS197 Compliant

Exclusive Feature

*RAID ECC Protection within SSD
*Firmware Encryption with Tamper Proof Cryptographic Signature
*Multiple Firmware Image Backup (ROM Based)
*In-Field Firmware Update
*Read Disturb Protection
*Enterprise Grade QoS (Consistent Low Latency)

Optional Feature

*TCG OPAL 2.0
*Hardware Security Erase
*Hardware Power Loss Protection
*Performance, Power, Thermal Throttling
*30µ Gold Finger for all Series

Product Series	PE4			
Sub-Series	Streaming	Boot	Pro	Max
Physical Information				
Form Factor	E1.S			
Interface	PCIe 4.0 (NVMe 1.3)			
Capacity	480GB~7680GB	240GB, 480GB	480GB~3840GB	480GB~1920GB
Flash Type	3D TLC			
Input Voltage	12V± 5%			
Power Consumption	TBD			
Performance				
Maximum Sequencial Read (MB/s)	3100	3100	3100	3100
Maximum Sequencial Write (MB/s)	2000	2000	2000	2000
Max. 4K Random Read (IOPS)	340,000	340,000	340,000	340,000
Max. 4K Random Write (IOPS)	32,000	30,000	50,000	65,000
Latency (Read/Write)	100µs / 27µs			
QoS (Read/Write)	160µ/200µ (@99.99)			
Reliability/ Endurance				
Operational Temperature (°C)	0 - 70°			
Storage Temperature (°C)	-40 - 85°			
UBER	1 sector per 10^{-17} bits read			
DWPD (max.)** JESD218	0.6	1	1.5	5
MTBF (hours)	2,000,000			
Warranty (years)	5	5	5	5
Planned Schedule	2020 Q3			

- Warranty is until the sataed warranty years or reached the guaranteed TBW
- 「—」 Usage does not typically request such information
- DWPD stands for Drive Writes Per Day. TBW = DWPD * capacity * warranty * 365 / 1000
- ** TBW and DWPD are JESD47 Compliant

CF Express

Basic Feature

*PCIe NVMe 1.3, Gen 3 x 2
*Build in ECC and global wear-leveling algorism
*Power shield for basic data protection

Exclusive Feature

*RAID ECC Function within SSD
*Firmware Encryption with Tamper Proof Cryptographic Signature
*Multiple Firmware Image Backup
*Read Disturb Protection

Optional Feature

*pSLC mode
*Performance, power, thermal throttling tunning

Product Series	CFE4	CFE4 Lite
Physical Information		
Form Factor	Cfexpress TypeB	
Interface	PCIe Gen 3 x2	
Capacity	256GB ~1TB	256GB ~2TB
Flash Type	3D TLC	
Input Voltage	3.3V±5%	
Power Consumption	Active: <3.5W ; Idel: <0.3W	Active: <2.5W ; Idel: <0.3W
Performance		
Maximum Sequencial Read (MB/s)	1,700	1,600
Maximum Sequencial Write (MB/s)	1,700	1,000
Sustained Sequencial Read (MB/s)	1,600	1,600
Sustained Sequencial Write (MB/s)	1,000	1,000
Maximum 4K Random Read (IOPS)	300,000	180,000
Maximum 4K Random Write (IOPS)	250,000	40,000
Sustained 4K Random Read (IOPS)	200,000	150,000
Sustained 4K Random Write (IOPS)	30,000	15,000
Reliability/ Endurance		
Operational Temperature (°C)	-10 - 70°	
Storage Temperature (°C)	-40 - 85°	
UBER	1 sector per 10^{-17} bits read	
TBW (max. capacity)	1000	2000
MTBF (hours)	2,000,000	
Compliance	VPG4.0	—
Planned Schedule	2020 Q1	2020 Q2
Warranty (years)	5	5

- Warranty is until the sataed warranty years or reached the guaranteed DWPD
- DWPD stands for Drive Writes Per Day. TBW = DWPD * capacity * warranty * 365 / 1000

Product -PCIe Gen 4x4 SSD

Basic Feature

*PCIe NVMe 1.4, Gen4x4
*Supports TRIM, SMART
*Advanced LDPC ECC and global wear-leveling algorism
*Power shield for basic data protection
*AES256bit/FIPS197 Compliant

Exclusive Feature

*RAID ECC Function within SSD
*Firmware Encryption with Tamper Proof Cryptographic Signature
*Multiple Firmware Image Backup
*In-Field Firmware Update
*Read Disturb Protection
*Enterprise Grade QoS (Consistent Low Latency)

Optional Feature

*pSLC Mode
*TCG OPAL 2.0
*Hardware Security Erase
*Hardware Power Loss Protection
*Performance, Power, Thermal Throttling

Product Series	PI5	PC5	PE5
Physical Information			
Form Factor	M.2 2280 ; U.2 ; E1.S		
Interface	M.2 2280 ; U.2 ; E1.S		
Capacity	480GB~16TB		
Flash Type	3D TLC / QLC		
Input Voltage	5V±5%; 3.3V±5%		
Power Consumption	TBD		
Performance			
Maximum Sequencial Read (MB/s)	7,500		
Maximum Sequencial Write (MB/s)	6,000		
Maximum 4K Random Read (IOPS)	1,500,00		
Maximum 4K Random Write (IOPS)	800,000		
Latency (Read/Write)	TBD		
QoS (Read/Write)	TBD		
Reliability/ Endurance			
Operational Temperature (°C)	-40-85°	0 - 70°	
Storage Temperature (°C)	-45-90°	-40 - 85°	
UBER	TBD		
TBW (max. capacity)	TBD		
DWPD* (max. capacity)	TBD		
Warranty (years)	3	5	5
Planned Schedule	Engineering Sample: Q2, 2021 ; MP Schedule: Q3, 2021		

PRODUCT NAMING RULE

EX SA Mx * **** ** ** * * *

Exascend

Drive Interface
SA = SATA
P3 = PCIe 3.0

Drive Controller
M1 = Marvell 88SS1074
M2 = Marvell 88SS1093
M3 = Marvell 88SS1079
M4= Marvell 88SS1092
M6= Marvell 88SS1321

Internal Classification

Drive Capacity
120G = 120GB
128G = 128GB
240G = 240GB
256G = 256GB
480G = 480GB
512G = 512GB
960G = 960GB
001T = 1TB
0019 = 1920GB
002T = 2048GB
0038 = 3840GB
004T = 4TB
0076 =7680GB
008T = 8TB

Reserved / Customized

UPS
0 = no UPS
C/E = 20ms UPS

Operating Temperature
I = Industrial (-40°C ~ 85°C)
C = Ctemp (0°C ~ 70°C)

Form Factor
25 = 2.5 inches 7mm
M1 = mSATA
N6 = M2 2260
N8 = M2 2280
U2 = U.2
C1 = CFexpress

Flash Type

EXASCEND

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