

KIOXIA

How E3.S is Replacing the 2.5" Form Factor

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the Future of Memory and Storage 2024



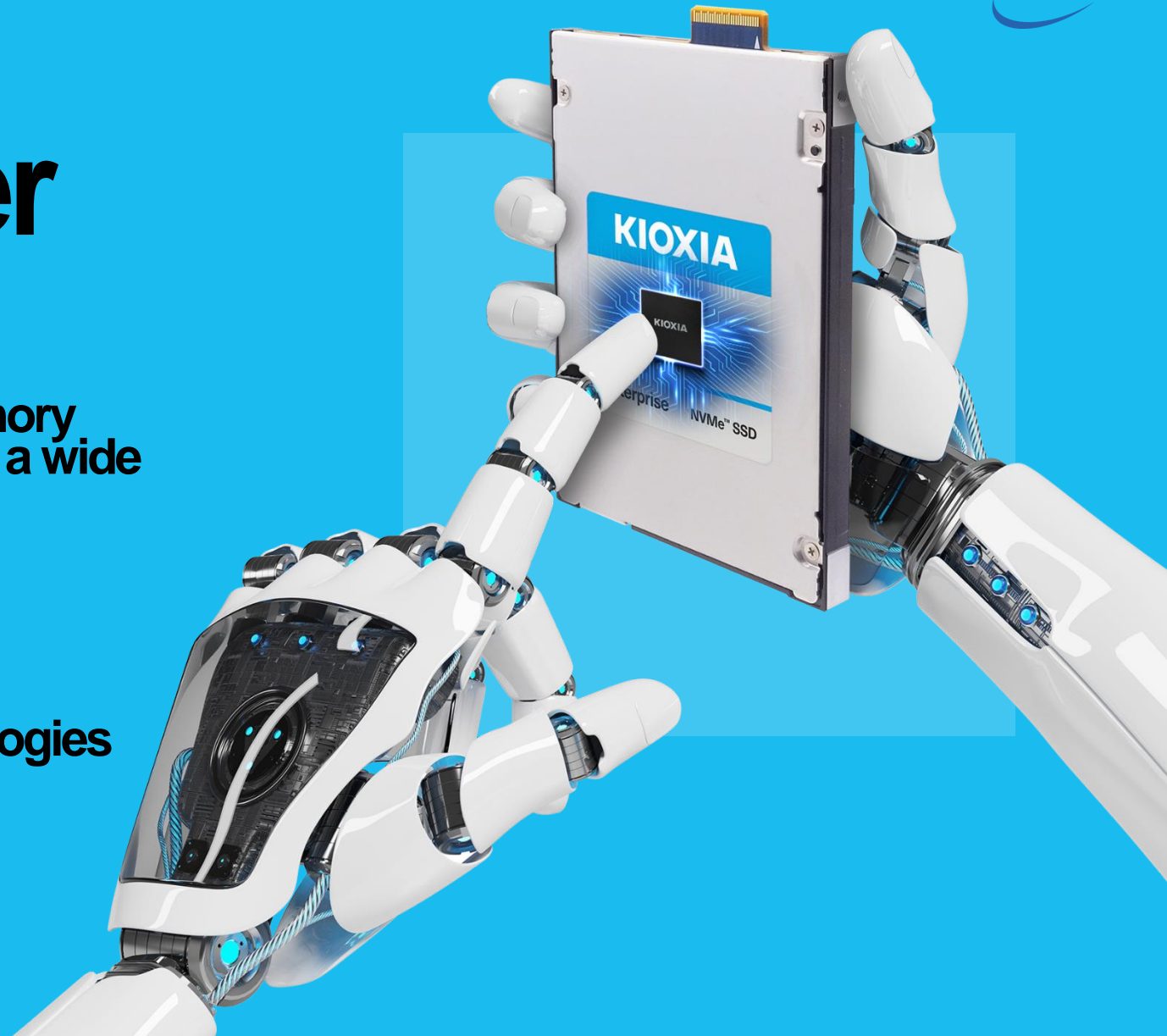
KIOXIA Memory Maker

A leading worldwide supplier of flash memory and solid-state drives (SSDs) that address a wide range of applications

Owner and operator of world-class flash memory plants

Inventor of NAND flash memory & technologies

Trusted by leading server, storage & hyperscale vendors



A Long Legacy of Innovation



With our proven track record of success and reputation for innovation, KIOXIA will build on our history as we continue our journey as an independent company...

KIOXIA 2019 KIOXIA Corporation established

Memory

1987 Invented NAND flash memory

1992 Yokkaichi Plant established

2016 Started production of 64-layer BiCS FLASH™

2017 Prototyped QLC BiCS FLASH™ memory

2018 Started operation of Yokkaichi Fab 6

2020 Announced 112-layer BiCS FLASH™

2022 Started operation of Yokkaichi Fab 7

2023 Announced 218-layer BiCS FLASH™

1991 Started production of NAND flash memory

2007 Announced 3D flash memory technology

2016 Started operation of Yokkaichi Fab 2

2018 Started production of 96-layer BiCS FLASH™

2019 Completed Kitakami Fab 1 construction

2021 Announced 162-layer BiCS FLASH™

2022 Started construction of Kitakami Fab 2

KIOXIA understands the importance of storage in people's lives. Whether in your business or day-to-day life, our solutions create new value.

SSDs

2001 Introduced SLC PATA SSDs

2012 Delivered enterprise MLC 12Gb/s SAS SSDs

2016 Announced Client SATA TLC SSDs

2020 Announced 24G SAS SSDs

2021 Announced SCM SSDs using KIOXIA XL-FLASH

2021 Announced OCP EDSFF¹ E3.S SSDs

2023 KIOXIA & HPE team up for HPE's Spaceborne Computer-2

2010 Introduced enterprise SLC 6Gb/s SAS SSDs

2015 Commercialized NVMe™ single package SSDs

2018 Introduced native NVMe-oF™ SSDs

2020 Announced OCP² EDSFF E1.S SSDs

2021 Announced Data Center PCIe® 5.0 SSDs

2022 Announced Enterprise PCIe® 5.0 SSDs

¹ EDSFF stands for Enterprise and Datacenter Small Form Factor. The initial version of the EDSFF specification was created by SNIA SFF Technology Affiliate organization to address the concerns of data center storage. ² The Open Compute Project and OCP marks are owned by and used with the permission of the Open Compute Project Foundation.

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A Brief History of Form Factors



- Enterprise storage form factors were established for the needs of HDD technology
 - Only in the last 2 decades have SSD-optimized form factors been introduced
 - EDSFF is optimized for the needs of enterprise storage and SSD technology



5.25"



3.5"



2.5" 1



M.2

EDSFF



The product images shown are a representation of the design models and not an accurate product depiction.

1980

- 100~1000s of Megabytes²
- 5~10lbs each

1990

- 100s~1000s of Gigabytes
- Still relevant today up to 20+ TB

2000

- 100s~1000s of Gigabytes in a tiny form factor

2010

- New SSD specific form factors begin to gain traction

2020

- EDSFF brings SSD-optimized form factors to enterprise

NVMe and NVMe-oF are registered or unregistered marks of NVM Express, Inc. in the United States and other countries. Other company names, product names, and service names may be trademarks of third-party companies. ¹. "2.5-inch indicates the form factor of the SSD and not its physical size. ². Definition of capacity: KIOXIA defines a megabyte (MB) as 1,000,000 bytes, a gigabyte (GB) as 1,000,000,000 bytes and a terabyte (TB) as 1,000,000,000,000 bytes. A computer operating system, however, reports storage capacity using powers of 2 for the definition of 1GB = 2³⁰ = 1,073,741,824 bytes and therefore shows less storage capacity. Available storage capacity (including examples of various media files) will vary based on file size, formatting, settings, software and operating system, such as Microsoft Operating System and/or pre-installed software applications, or media content. Actual formatted capacity may vary.



Increased Rack Density

E3.S features a 7.5mm thickness, half of a standard 2.5"¹ drive. This allows chassis designers to fit up to twice the number of storage slots, increasing performance and density



Better Performance

Improved signal integrity characteristics make it easier for systems to support higher frequency interfaces such as PCIe[®] 5.0, enabling higher performance



Thermal Profile

The slimmer profile of E3.S enables more flexibility for chassis designers to increase airflow through their systems and increase cooling efficiency



Robust Signal Integrity

The EDSFF connector incurs significantly lower signal impedance than the SFF-8639, enabling better end to end signal integrity



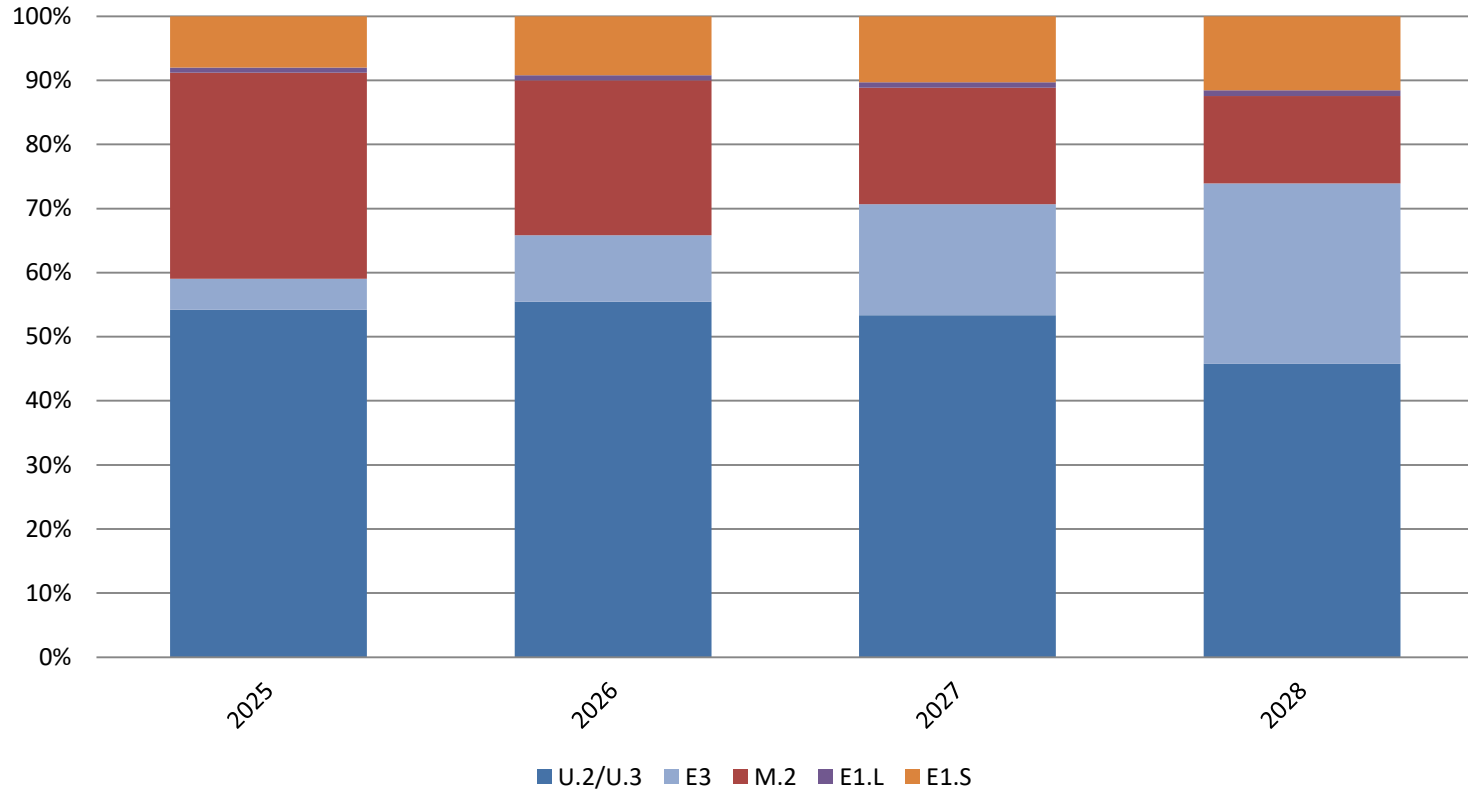
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Market Share View of E3.S Form Factor SSDs



PCIe® SSD Units by Form Factor



- 2.5”¹ is and will remain a ubiquitous (value) form factor, but E3 is expected to replace it for SSD-optimized applications.
 - PCIe 5.0 is 1st inflection point, PCIe 6.0 will accelerate transition
- E1 form factor SSDs are replacing M.2 for dense storage applications, but M.2 remains de-facto form factor for consumer sockets

Permission to use chart approved by Forward Insights.

E3 is projected to replace almost 50% of 2.5” SSD slots by 2028²

Available Chassis Examples



1U Servers

Supermicro® ASG-1115S-NE316R

Dell® PowerEdge™ R6625

HPE® ProLiant™ DL360 Gen11

Typical 2.5" Slots: 12

16 E3.S Slots (+33%)

18 E3.S slots (+50%)

20 E3.S slots (+67%)

2U Servers

Supermicro® ASG-2115S-NE332R

Dell® PowerEdge™ R7625

HPE® ProLiant™ DL385 Gen11

Typical 2.5" Slots: 24

32 E3.S Slots (+33%)

36 E3.S slots (+50%)

36 E3.S slots (+50%)

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E3.S Enterprise NVMe™ SSDs

- PCIe® 5.0 x4 saturation
- Excellent performance¹
- Dual-port capable
- SR-IOV, CMB, FIPS capable
- Multiple sector sizes

Focus Applications:

High Performance Computing (HPC)
Artificial Intelligence (AI)
Machine Learning (ML)
Enterprise Storage



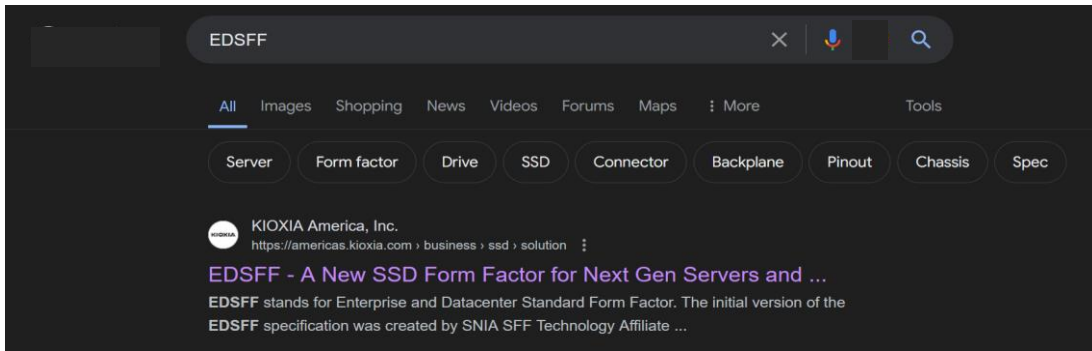
E3.S Data Center NVMe SSDs

- Blend of cost-optimization and performance
- PCIe 5.0 support
- High random performance
- Single-port only
- 512/4K sector size

Focus Applications:

Private/Public Cloud
Content Delivery Networks (CDN)
General Purpose Data Center Compute and Storage

Valuable EDSFF Resources Available Online




- Form factor specifications
- Whitepapers
- Product details
- Chassis partners

Companies Offering EDSFF E3.S-enabled Platforms

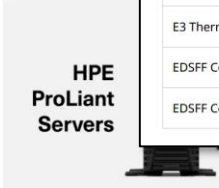
EDSFF E3.S server and storage platforms are becoming available in the market. Here are some E3.S enabled currently available, as of September 2023.

Dell PowerEdge Servers




[Dell PowerEdge™ Servers](#)

HPE ProLiant Servers



[HPE ProLiant™ Servers](#)
[HPE Alletra Data Storage Servers](#)
[KIOXIA SSDs in ProLiant Servers](#)

Supermicro Servers



[Supermicro® Servers](#)

PCIe® Lanes per Connector

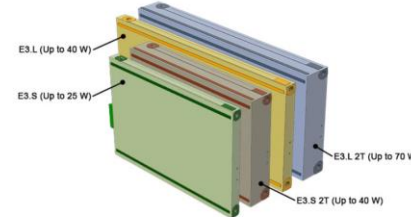
1C: Up to 4 PCIe Lanes

2C: Up to 8 PCIe Lanes

4C: Up to 16 PCIe Lanes

4C+: 16+ PCIe Lanes

E3 Max Power



Engineering Specifications from SNIA

E3 Mechanical/Electrical Specification	SFF-TA-1008
E3 Thermal Characterization Specification	SFF-TA-1023
EDSFF Connector Specification	SFF-TA-1002
EDSFF Connector Pinout (PCIe)	SFF-TA-1009

KIOXIA CD7-R E3.S Series

Data Center NVMe™ Read-Intensive SSD

[KIOXIA CD7-R E3.S Series | Product Brief \(PDF : 109KB\)](#)

KIOXIA CM7-V Series

Enterprise NVMe™ Mixed-use SSD

[KIOXIA CM7-V E3.S Series | Product Brief \(PDF : 130KB\)](#)

Why Deploy PCIe® 5.0 NVMe™ SSDs in Your Data Center? | Top 5 Reasons

[Why Deploy PCIe® 5.0 NVMe™ SSDs in Your Data Center? | Top 5 Reasons \(PDF : 174KB\)](#)

Questions You Should Ask About the PCIe® 5.0 Interface and EDSFF E3.S SSD Storage

[Questions You Should Ask About the PCIe® 5.0 Interface and EDSFF E3.S SSD Storage \(PDF : 226KB\)](#)

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Thank you



Please visit our booth,
#307

Demos:

- Accelerating Artificial Intelligence (AI) Workloads (BAM, AiSAQ)
- Optical SSD
- RAID Offload
- Live Migration
- CXL[®]
- BiCS FLASH[™] Generation 8 3D Flash Memory
- Automotive Solutions

KIOXIA Passport Program

Visit the KIOXIA booth to see Innovative Storage Solutions from KIOXIA

You'll learn more about KIOXIA's product offerings and see a wide variety of demos highlighting the latest in flash.

Once you receive 3 demo stamps, please see one of our company representatives to collect your KIOXIA branded space pen.

Demo #1

Demo #2

Demo #3

fisher SPACE PEN

Visit the KIOXIA BOOTH
Earn 3 demo stamps
Get a free KIOXIA space pen

First 750 participants to get 3 demo stamps will receive a KIOXIA branded space pen. Limit one space pen per person. While supplies last. No purchase necessary. Void where prohibited. © 2024 FISHER SPACE PEN CO. BOULDER CITY, NEVADA, USA - ALL RIGHTS RESERVED. © 2024 KIOXIA America, Inc. All rights reserved.

KIOXIA

Grand Prize Raffle
Win a VR Headset

Ask a KIOXIA Representative for Details

IoT AI Car Cloud

*No purchase necessary to enter to win. Do not need to be present to win. Void where prohibited. Visit the KIOXIA booth during the Future of Memory and Storage conference from August 6 - 8, 2024 and get your badge scanned. One winner will be chosen at the end of the conference from all eligible entries. Multiple entries will not increase your odds of winning. KIOXIA America, Inc. employees and relatives of KIOXIA America, Inc. are not eligible to win. After the winner is randomly selected, they will be notified via phone or email. The winner will be solely responsible for any and all federal, state, provincial and local taxes, if any, that apply to the prize. Prize is offered "as is" with no written, express, or implied warranty. The prize is not transferable and no substitutions are permitted.