

KIOXIA SSD and Memory Products for Finance IT

STAC Event, October 19, 2023



KIOXIA Corporation

One of world's largest flash memory plants located in Yokkaichi*

Where approx. 30% of the world's flash capacity is made



Fab K1 in Kitakami

Kitakami K2 plant started construction in Apr 2022 to further increase production capacity.

New Fab Y7
Dedicated 3D flash memory production system

Y7 Phase1 started its operation in fall of 2022.



Headquartered in Tokyo

* Source: KIOXIA Corporation, including the capacity of Joint Venture with Western Digital Corporation as of July 31, 2023

Next Generation Fabs For Next Generation Technology...

At 694,000m²*, KIOXIA's Yokkaichi Plant is one of the world's largest flash memory plant** using artificial intelligence (AI)

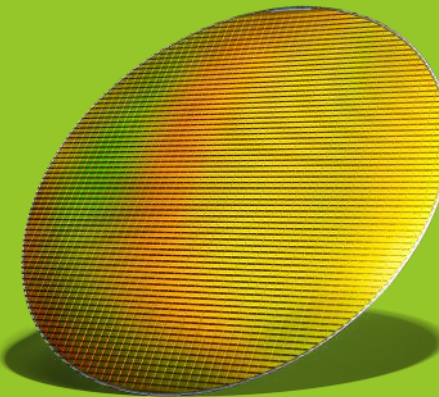
100% | manufactured in-house in Japan***

30% | of the world's manufactured flash memory*



Together, we elevate the digital world.

We are memory. We are SSDs. We are innovators. We are KIOXIA...and together, we elevate the digital world.

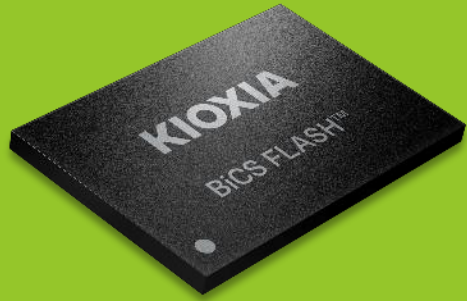


Memory



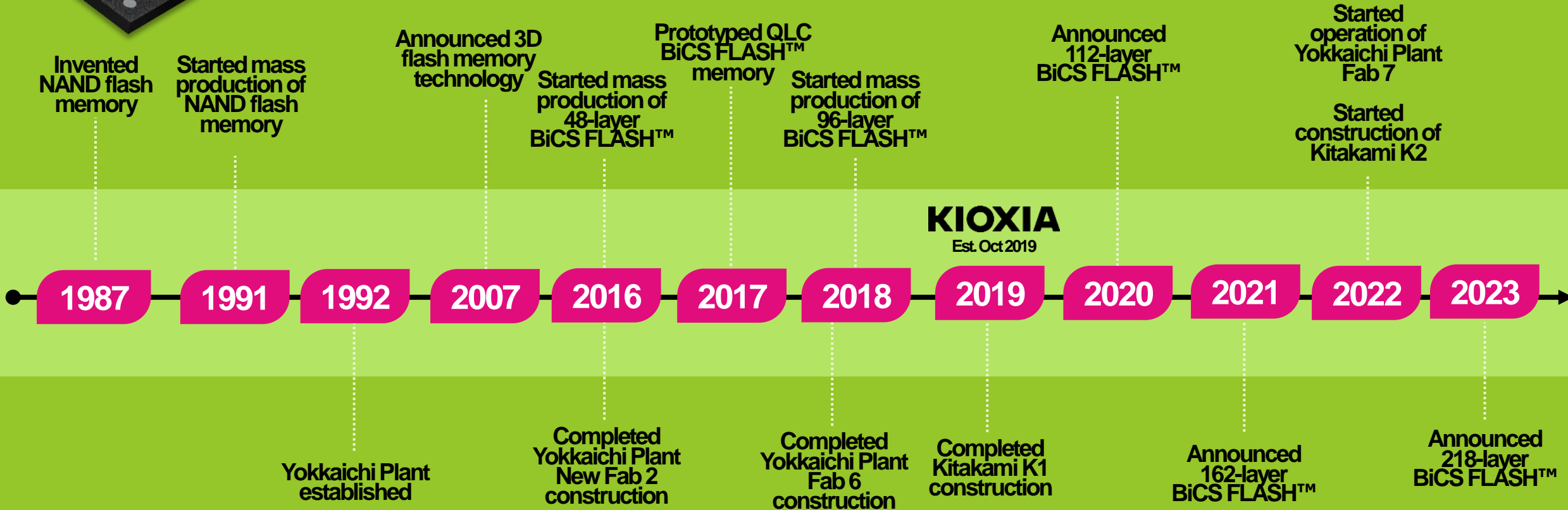
SSDs

OUR LEGACY OF INNOVATION COMES WITH US



The inventor of flash memory.

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...

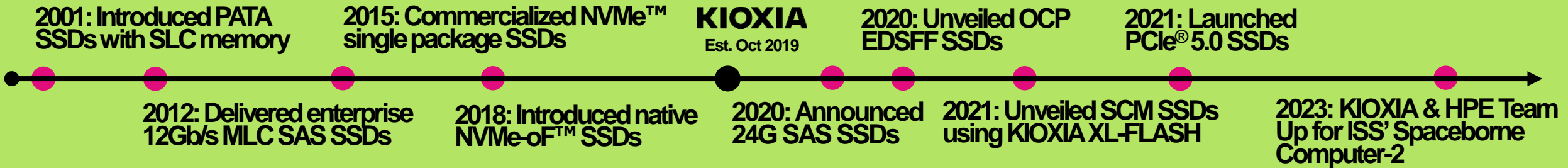


AND CONTINUES WITH SOLID STATE STORAGE



Innovative. Trusted.
“Out of this World.”

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



Engaged with major OEM customers



Supporting key Hyperscale customers

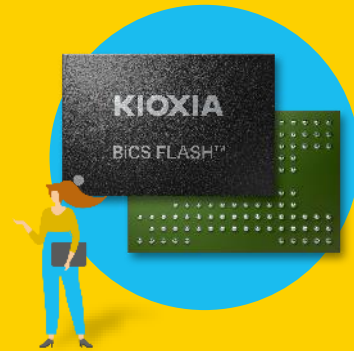
Memory Products

Solutions for storage, automotive & electronics



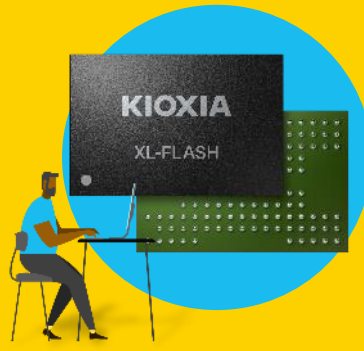
KIOXIA Flash Memory Solutions

Scalable 3D
Technology



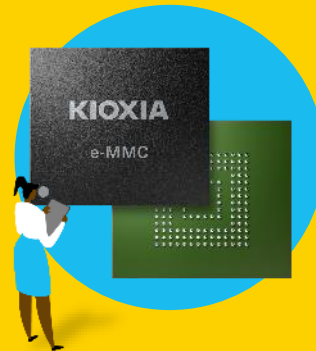
BiCS FLASH™
QLC | TLC

Storage Class
Memory



XL-FLASH

Consumer/Industrial
Managed Flash



UFS | e-MMC

Automotive
Managed Flash



Automotive
UFS | e-MMC

SLC
NAND



SLC NAND
Serial Interface NAND
BENAND™

Mobile | Consumer | Industrial | Automotive | Enterprise | Data Center

KIOXIA's powerful, scalable, high-performing flash memory technology is shaping the future of storage. From mobile to industrial to automotive and hyperscale applications, the next frontier of storage is built on KIOXIA's visionary flash memory.

SSD Solutions

Storage for enterprise, data center & client



KIOXIA Solid State Drive Solutions Deliver Best-in-class Quality, Performance & Reliability

Enterprise Class - High-performance and high-availability servers and storage systems for the most demanding workloads



PCIe® 4.0 SSDs
XL-FLASH
Dual-Port
2.5 inch (15mm Thickness)
Up to 3,200GB



PCIe® 5.0 SSDs
5th generation BiCS FLASH™
Dual-Port
E3.S (7.5mm Thickness)
2.5 inch (15mm Thickness)
Up to 30,720GB



SAS 24G SSDs
5th generation BiCS FLASH™
Dual-Port
2.5 inch (15mm Thickness)
Up to 30,720GB

Data Center Class - Data centers and Cloud-based applications with a balanced power to performance ratio



PCIe® 4.0 SSDs
5th generation BiCS FLASH™
2.5 inch (15mm Thickness)
Up to 15,360 GB



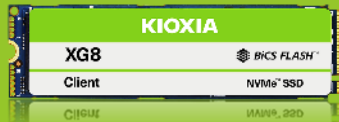
SSDs designed to PCIe® 5.0 specification*
4th generation BiCS FLASH™
E3.S (7.5mm Thickness)
/ 2.5-inch (15mm Thickness)
Up to 15,360 GB

*The 2.5-inch SSD complies with PCIe® 4.0 specification.



PCIe® 4.0 SSDs
5th generation BiCS FLASH™
E1.S, 9.5 / 15 / 25mm Thickness
Up to 7,680 GB

Client Class - High performance workstations, desktop and mobile PCs





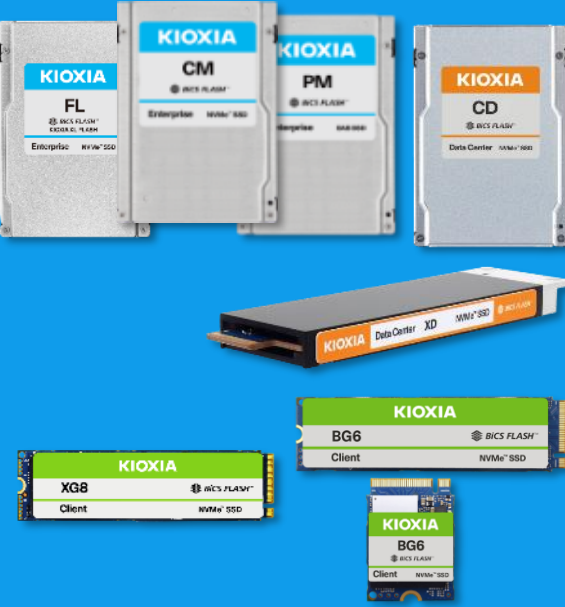











PCIe® 4.0 SSDs
5th generation BiCS FLASH™
M.2 2280
Up to 4,096GB



PCIe® 4.0 SSDs
6th generation BiCS FLASH™
M.2 2230 / M.2 2280
Up to 2,048GB

Definition of capacity: 1 GB = 1,000,000,000 (10⁹) bytes (see full disclaimer at end of presentation). PCIe is a registered trademark of PCI-SIG. NVMe is registered or unregistered mark of NVM Express, Inc. in the United States and other countries.

Data Security & Encryption – Building Blocks

Data Sanitization		Data Sanitization + Data Encryption	
Non-SED (No Encryption)	Sanitize Instant Erase (SIE)	Self Encrypting Drive (SED)	CMVP FIPS (SED + FIPS-140-2 / -3)
			
ATA Compliant Block Erase 	Onboard Crypto-Processor  ATA Compliant Block Erase 	User Authentication (PIN/Password)  Onboard Crypto-Processor  ATA Compliant Block Erase 	Validation of Encryption Engine  User Authentication (PIN/Password)  Onboard Crypto-Processor  ATA Compliant Block Erase 

Thank You!

**Vito Chiarella, Sr. Director Global and
Data Center Sales**

Vito.Chiarella@kioxia.com

Please remember to tick the KIOXIA box, if you'd like to be contacted

KIOXIA

Innovative. Award-winning. Trusted.

Memory Solutions

Extensive product lineup

Excellent reliability & quality

Leading density & capacity



SSD Solutions

In-house SoC & firmware

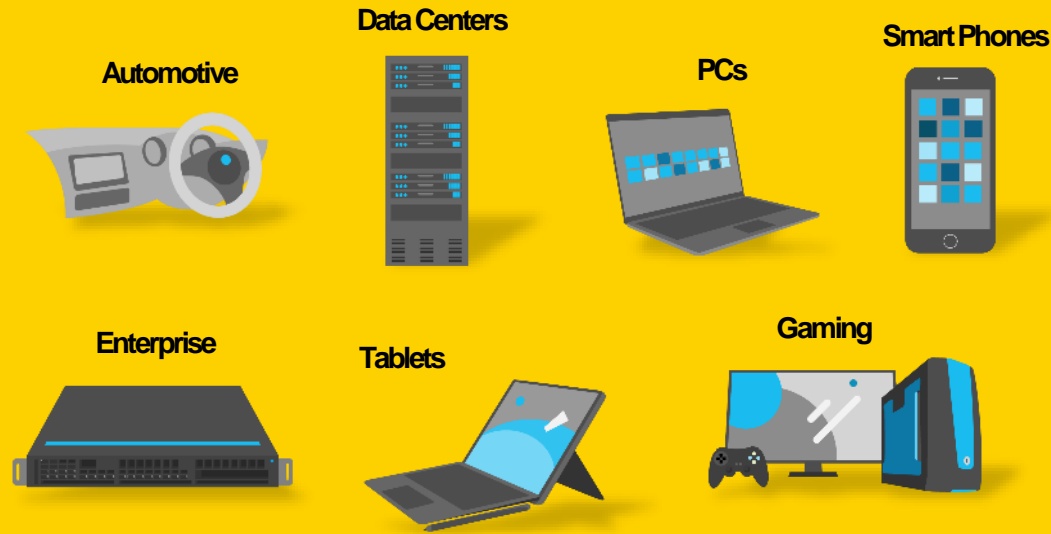
Latest interfaces & form factors

Broad portfolio of SSDs



BiCS FLASH™ - The Future of High-Density 3D Flash Memory

BiCS FLASH™ is a 3D vertical flash memory cell structure enabling it to surpass the capacity of mainstream 2D (planar) flash memory and enhance the reliability of write/erase endurance while boosting write speeds

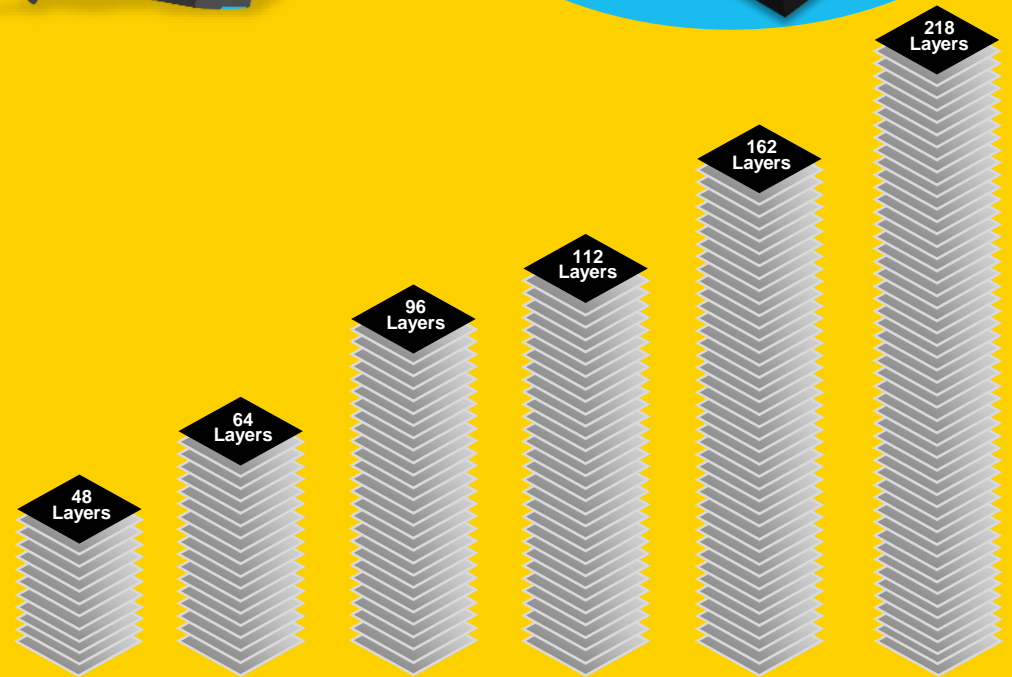


- High storage density per die
- Lower cost per bit
- High performance
- Improved power efficiency
- High reliability

Product density is identified based on the density of memory chip(s) within the Product, not the amount of memory capacity available for data storage by the end user. Consumer-usable capacity will be less due to overhead data areas, formatting, bad blocks, and other constraints, and may also vary based on the host device and application. For details, please refer to applicable product specifications. The definition of 1Gb = 2³⁰ bits = 1,073,741,824 bits. The definition of 1GB = 2³⁰ bytes = 1,073,741,824 bytes.

TLC Triple-Level Cell	QLC Quad-Level Cell
1TB Single-package device with 512Gb die	2.66TB Single-package device with 1.33Tb die
2TB Single-package device with 1Tb die	<p>Benefits of QLC</p> <ul style="list-style-type: none"> Highest density flash (2.66TB single package) Lowest cost per bit

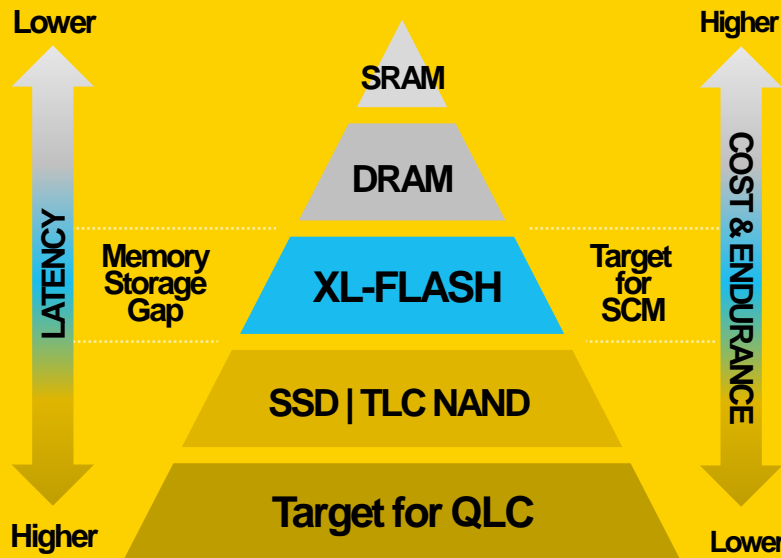
Based on 16-die stacked architecture in a single package



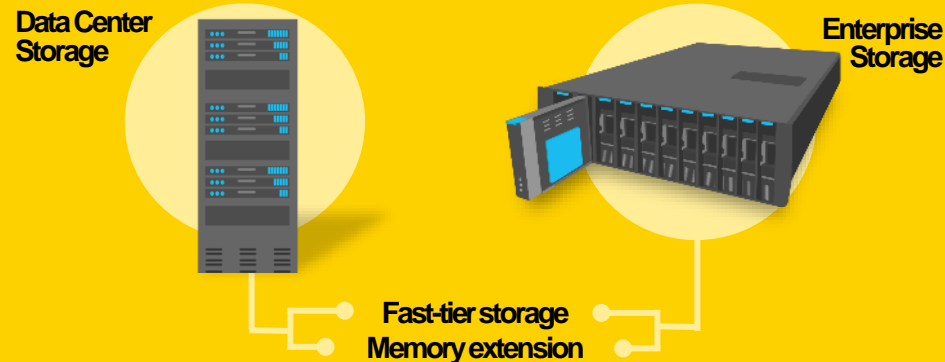
XL-FLASH Storage Class Memory - Designed for Speed

Addressing the performance gap between existing volatile memories & NAND flash, XL-FLASH is extremely low-latency, high-performance flash memory based on BiCS FLASH™ technology

- Based on the latest 3D BiCS FLASH™ 3D flash memory technology
- Lower cost compared to DRAM and cross point type SCM
- Fast page read and program time
- Compatible flash protocol/ package
- 128Gb die (SLC) / 256Gb die (MLC) – 2-die, 4-die, 8-die packages available now
- 4KB page size for more efficient operating system reads and writes
- 16-plane architecture for improved latency
- High cell reliability



Applications Targeting Storage Class Memory Layer



KIOXIA UFS for Consumer & Industrial Applications

UFS (Universal Flash Storage) is a JEDEC-standard, non-volatile managed flash device developed to be the high-performance replacement to e-MMC for embedded memory solutions

The Ideal Replacement for e-MMC

- A faster interface
- Higher performance
- Higher density
- Better power efficiency
- Support for full duplexing



e-MMC	UFS
Performance up to 400MB/s*	Performance up to 4640MB/s**
Capacity options 4GB ~ 128GB	Capacity options 32GB ~ 1TB

* e-MMC version 5.0/5.1 interface speed
** UFS version 4.0 interface speed

KIOXIA UFS and e-MMC for Automotive Applications



Capacity options
32GB ~ 512GB

Compared to e-MMC, UFS delivers:



Higher performance

Support for full duplexing



Better power efficiency

Added functions such as thermal control, extended diagnostics

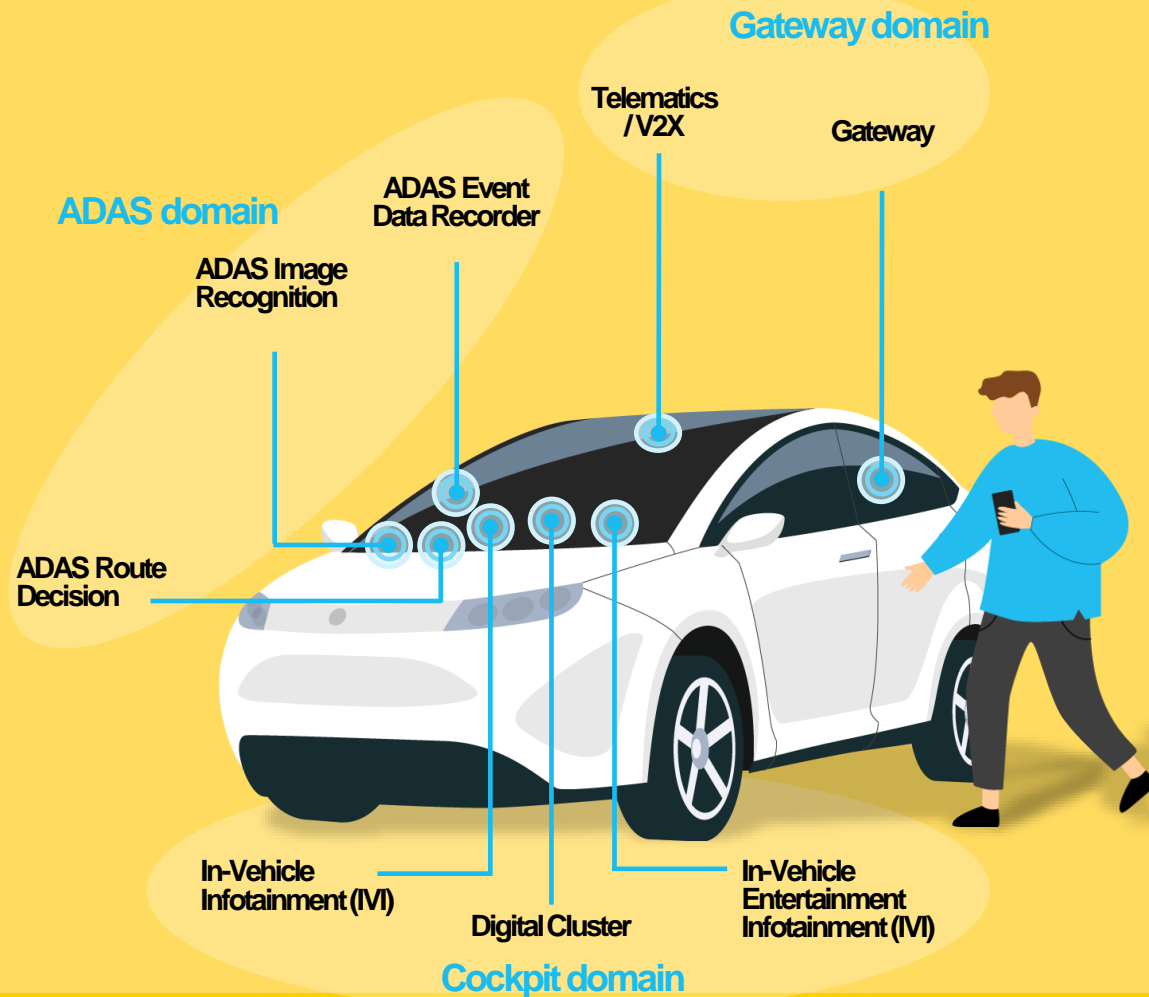


Faster boot times



An improved user experience

Automotive Applications Needing Flash



Capacity options
8GB ~ 256GB

For the vehicles of today and tomorrow, automotive UFS and e-MMC offer accelerated processing power and increased data storage capacity to enable the next generation of automotive systems and anytime, anywhere connectivity...

SLC NAND: Reliable, High-Performing, Low-Density NAND

SLC (Single-level cell) NAND provides high write/erase cycle endurance and high reliability

- 24nm process technology
- Small 6.5 x 8mm BGA package available*
- Wide-ranging line-up (1Gb - 256Gb)
- High performance & reliability
- Commercial & industrial temperatures
- 3.3V and 1.8V power supply voltages

Product density is identified based on the density of memory chip(s) within the Product, not the amount of memory capacity available for data storage by the end user. Consumer-usable capacity will be less due to overhead data areas, formatting, bad blocks, and other constraints, and may also vary based on the host device and application. For details, please refer to applicable product specifications. The definition of 1Gb = 2³⁰ bits = 1,073,741,824 bits. The definition of 1GB = 2³⁰ bytes = 1,073,741,824 bytes.



Parallel Interfaces



- Available in 1 ~ 256Gb
- 63 BGA, 67 BGA, TSOP and 132 BGA*
- C-Temp and I-Temp



- Available in 1 ~ 8Gb
- 63 BGA, 67 BGA, and TSOP
- C-Temp and I-Temp
- Uses NAND interface

Serial Interface NAND



- Available in 1 ~ 8Gb
- WSON8 package
- I-Temp
- Very low pin count (6 active pins)



KIOXIA Enterprise SSDs

Designed to boost high-performance and high-availability servers and storage systems for the most demanding workloads



FL6 Series

PCIe® 4.0
NVMe™ 1.4
Dual-Port
Storage Class
Memory (SCM)
2.5 inch (15mm Thickness)
Up to 3,200GB



CM7 Series

PCIe® 5.0
NVMe™ 2.0
Dual-Port
EDSFF E3.S or
2.5 inch (15mm Thickness)
Up to 30,720GB



PM7 Series

SAS-4 24G
Dual-Port
2.5 inch (15mm
Thickness)
Up to 30,720GB

Definition of capacity: 1 GB = 1,000,000,000 (10⁹) bytes (see full disclaimer at end of presentation)

PCIe is a registered trademark of PCI-SIG. NVMe is registered or unregistered mark 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.

KIOXIA Data Center SSDs

Designed to elevate data centers and cloud-based applications with a balanced power to performance ratio



CD8 Series

PCIe® 4.0
NVMe™ 1.4
2.5 inch (15mm Thickness)
Up to 15,360 GB



CD7 Series

Designed to
PCIe® 5.0 Specification*
NVMe™ 1.4
2.5 inch (15mm Thickness)
EDSFF E3.S (7.5mm Thickness)
Up to 15,360 GB

*The 2.5-inch SSD complies with PCIe® 4.0 specification.



XD7P Series

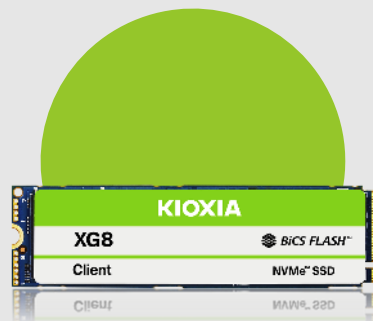
PCIe® 4.0
NVMe™ 2.0
EDSFF E1.S,
9.5 / 15 / 25mm Thickness
Up to 7,680GB

Definition of capacity: 1 GB = 1,000,000,000 (10⁹) bytes (see full disclaimer at end of presentation)

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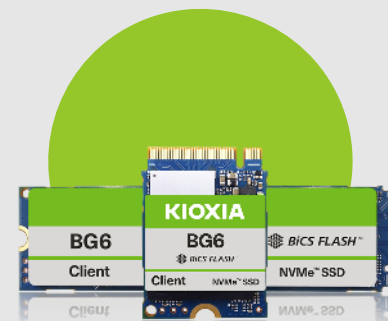
KIOXIA Client SSDs

Designed to uplift high performance workstations, mobile and desktop PCs as well as embedded devices and systems



XG8 Series

PCIe® 4.0
NVMe™ 1.4
M.2 2280
Up to 4,096GB



BG6 Series

PCIe® 4.0
NVMe™ 1.4c
DRAM-less + HMB*
M.2 2230 / M.2 2280
Up to 2,048GB

*Host Memory Buffer

Definition of capacity: 1 GB = 1,000,000,000 (10⁹) bytes (see full disclaimer at end of presentation)

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Block Erase

- Used when the objective is to simply erase data on a device (i.e., SSD) that is to be retired or repurposed
- Data cells on the SSD are all reset to their original factory state
 - Deletes the user data from the SSD
- Does not rely nor require an on-board crypto processor
- Draw backs:
 - Lengthy, in terms of time it take to complete
 - Consumes the drives available P/E cycles which reduces drive's overall endurance
 - Can potentially leave some data still visible/accessible

Sanitize Instant Erase (SIE)

- SIE is another method of data sanitization
 - A super-set of the block erase function
- Unlike block erase, SIE drives use on-board crypto processors to:
 - Create an internal cypher key – media encryption key (MEK)
 - Cryptographically encrypt and decrypt the data as it is written to or read from the drive.
- SIE drives do not require access authentication, unlike an SED drive
- When the sanitize command is executed, the MEK is deleted and a new one is created
 - Renders all the user data undecipherable
 - The sanitization process is nearly instantaneous
- The main advantages of SIE (vs. Block Erase) are:
 - Comprehensive data sanitization (accessible data and hidden user data) no longer accessible
 - Faster data sanitization
 - Does not impact the SSD's endurance



Self-Encrypting Drive (SED)

- Leverages Advanced Encryption Services (AES) algorithm & an onboard crypto-processor
- Combination of a user-defined authentication credentials and a MEK to encrypt data
 - MEK is stored in a hidden section of the drive at the time of manufacture
- With host system powered on & proper credentials provided, the drive “unlocks” & the data is decrypted.
 - If the credentials are incorrect, then the SED remains locked with the data safely encrypted
- SED drives also offer instantaneous cryptographic erasure
 - Deletes the MEK and creates a new one
 - Helps reduce device retirement or redeployment costs
- SED is a superior solution vs. software based encryption
 - On-board crypto-processor vs. using the host processor’s resources
 - Greater protection – encryption key is stored on the SSD, vs. the OS memory which is easier to steal
 - Easier to deploy and use with better Compliance

Federal Information Processing Standard 140 (FIPS 140-2 / -3)

- FIPS is a US government computer security standard applied to cryptographic devices
 - ie: Self-encrypting drives (SED) SSDs
 - Standard defined by National Institute of Standards and Technology (NIST)
- Used when working with Sensitive but Unclassified (SBU) data.
- Certification of the encryption processor used in KIOXIA SSDs
- KIOXIA's FIPS 140-2 compliant SED SSD are certified by an independent accredited testing facility
- The certification process validates KIOXIA's FIPS 140-2 SED SSD:
 - meets the specific set of requirements designed to protect the drive – and the data stored on it
- FIPS 140 Level-2 SSDs are suited for use by government & regulated industries such as financial & health-care institutions.
- As of September 22nd, 2020, CMVP began validating cryptographic modules to Federal Information Processing Standard (FIPS) 140-3, Security Requirements for Cryptographic Modules.

Let's Review....

- Data encryption and security are important because they help organizations:
 - Protect corporate IP and asset
 - Reduce legal exposure
 - Compliance with regulatory mandates
 - Protect entrusted data
- SIE is a method of data sanitization. It does not encrypt the data on a drive
- Self Encrypting Drive (SED) uses an onboard crypto-processor, along with an user authentication layer, to fully encrypt data
- SED is a superior solution to software based data encryption
 - SED uses an onboard crypto-processor vs. software uses host processor & memory resources
 - Software encryption can impact system level performance

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 $1\text{GB} = 2^{30} = 1,073,741,824$ 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.

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