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OVERVIEW OF THE GLOBAL SEMICONDUCTOR INDUSTRY

Key Growth Drivers of the Semiconductor Market in the AI Era

In the 21st century, artificial intelligence is undoubtedly one of the most transformative technologies. Leveraging advanced algorithms and training on big data, it enables machine systems to simulate, extend, and expand human cognitive and decision-making abilities across multiple dimensions. From a data perspective, the total amount of data generated globally in 2024 has approached 200ZB. This massive volume of data directly drives the semiconductor market, including memory products, towards rapid growth.

Storage power, computing power, and interconnect power are the core infrastructure of AI, and the three are interdependent. Storage power is the foundation, undertaking the storage, management, and scheduling of the massive data required for AI training, directly determining the efficiency and reliability of data supply. The exertion of computing power relies on storage power; insufficient storage power or inefficient scheduling can lead to idle computing power, failing to fully unleash computational potential. Interconnect power ensures efficient data transfer between storage and computing power. The synergy of these three is essential to support AI operations. As the core infrastructure for AI data storage and supply, the performance of storage power directly constrains AI training efficiency and implementation effectiveness. Currently, the massive data demand brought by AI has directly driven the rapid growth of the memory product market.

Edge AI:

Consumer-Grade — Consumer-grade AI products have expanded the scope of AI applications, enabling traditional terminal devices to move towards intelligence transformation. It is a key direction for the implementation of AI technology. With the popularization of consumer-grade products such as AI phones and AI PCs, requirements for memory product capacity, read/write speeds, etc., are increasing, promoting their iteration. The explosive growth of data volume highlights the importance of memory products in consumer-grade application scenarios. Their collaborative development with AI becomes a major driver of growth in the semiconductor market.

Automotive-Grade — The vehicles are accelerating their evolution towards electrification, intelligence, and connectivity. With the deep integration of features such as intelligent driving and intelligent cockpits, the complexity of electronic systems in smart vehicles has significantly increased compared to that of traditional vehicles. The advancement of vehicle "electrification, intelligence, and connectivity" features makes application scenarios in the automotive field more complex. Systems such as intelligent driving assistance and intelligent cockpits generate data requiring high-performance storage guarantees. The increase in functional modules leads to a surge in data volume, driving the expansion of memory product capacity and performance enhancement, leading to overall growth in memory product demand in the automotive-grade application scenarios.

Cloud AI:

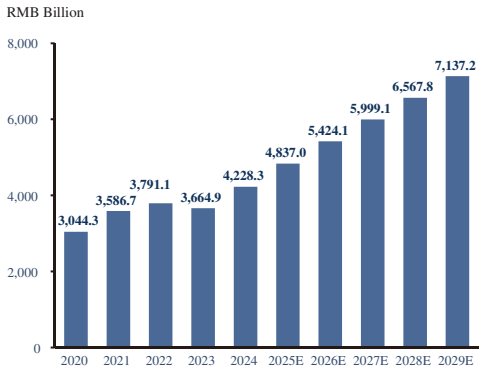
Enterprise-Grade — Targeting the enterprise-grade application scenarios, it is necessary to rely on large-scale data centers and cloud servers to provide stable and efficient infrastructure support for enterprise digitalization needs, AI business deployment, and massive data processing. With the increase in AI model parameters and training data volume, memory products requiring ultra-large capacity, high read/write speeds, strong stability, and error correction mechanisms, along with optimized power consumption, are needed. Their development multi-dimensionally drives memory product upgrades, aiding the advancement of the AI industry.

Overview of The Global Semiconductor Market Size

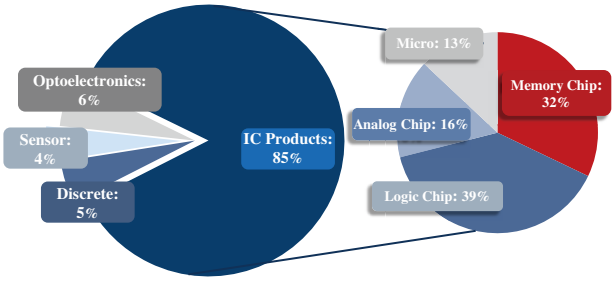
Driven by the rapid development of key fields such as consumer electronics, automotive electronics, and corporate digitalization, the global semiconductor market achieved significant growth during the period from 2020 to 2024. The market size increased from RMB3.0 trillion in 2020 to RMB4.2 trillion in 2024, with a compound annual growth rate (CAGR) of 8.6%. Looking ahead, the market size will continue to expand. From 2025 to 2029, the CAGR is expected to reach 10.2%, with the market size reaching RMB7.1 trillion in 2029.

Semiconductor products include integrated circuit products which account for 85%, of which memory chips account for 32%. This indicates that memory chips occupy an important position in the global semiconductor market, and are the core infrastructure for various electronic devices to achieve data preservation and retrieval, playing a crucial role in the stable operation of electronic systems.

Global Semiconductor Market Size, by Revenue, 2020–2029E



Global Semiconductor Market Structure, Breakdown by Product Type, 2024



Source: Frost & Sullivan

Core Value of Memory Products

Within the semiconductor industry chain, memory products occupy a core position, serving as the key carrier for data storage and processing and playing a vital role. They can store various types of data such as text, images, video, and audio in binary form. When data is called upon, they enable fast and accurate reading and transmission, laying a solid foundation for the stable operation of the digital world.

Memory products demonstrate key value in multiple downstream fields. In the consumer-grade application scenarios, embedded storage products such as eMMC and UFS ensure fast device loading by providing sufficient data storage space, and they enhance the user experience. Furthermore, highly integrated memory products like ePOP are important prerequisites for meeting the storage needs of space-constrained devices such as smart watches and AI glasses. In the automotive-grade application scenarios, automotive-grade embedded storage products, with high reliability and stability, ensure data security in harsh environments, safeguarding driving safety, while effectively supporting data storage and fast retrieval for in-vehicle entertainment and intelligent driving systems. For the enterprise-grade application scenarios, memory products,

relying on characteristics of high capacity, high bandwidth, and low latency, meet enterprises' needs for large-scale data storage and fast access, playing a key supporting role in the operation of businesses such as cloud computing and big data analytics.

The rapid development of AI technology imposes higher requirements on the capacity, performance, and reliability of memory products. This makes memory products not only key basic components supporting downstream technology iteration but also one of the core forces driving growth in the semiconductor market.

Analysis of the Core Value of the Controller Chips in Memory Products under the AI Process

In AI scenarios, memory products need to meet clear performance requirements such as high throughput and low latency. The controller chip, as the core control unit, is the key supporting carrier to achieve these requirements. By continuously optimizing internal algorithms, the controller chip can more intelligently schedule data read/write operations within the memory product, enabling data transmission along the optimal path, avoiding congestion and delays, thereby improving overall throughput. It can be said that the controller chip acts like the control center of the memory product. Through its own optimization and upgrades, it helps memory products better meet high-demand data storage and fast response requirements in AI scenarios, becoming a key link in ensuring the smooth operation of AI applications.

INDUSTRY ANALYSIS OF MEMORY PRODUCTS

Definition and Classification of Memory Products

Memory products are hardware components used to achieve data storage for temporary or permanent access. They can be systematically classified based on the types of wafers, performance characteristics, and application scenarios, covering various forms such as embedded storage, SSDs, DRAM, mobile storage.

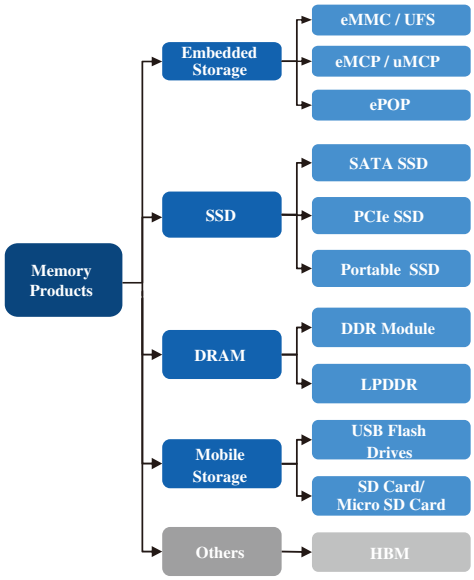
Embedded storage products use NAND Flash as the core and are divided into two forms: one consists of only NAND Flash chip, representative products include eMMC and UFS, featuring high integration, low power consumption, and miniaturization, capable of stably achieving long-term data storage; the other consists of a combination of "NAND Flash + LPDDR", representative products being eMCP, uMCP, and ePOP. With higher integration, they are particularly suitable for consumer-grade application scenarios.

SSDs also use NAND Flash as the storage medium. Compared to HDDs, they possess faster read/write speeds and stronger vibration resistance, supporting various interface standards such as SATA and PCIe. They are core solutions for consumer-grade and enterprise-grade storage upgrades.

DRAM primarily uses DRAM wafers. Among them, DDR modules provide high-bandwidth volatile storage, providing processors with high-speed temporary data access capability. It is the core carrier of system memory; LPDDR features low power consumption and high bandwidth. While ensuring high data transmission efficiency, it effectively reduces power consumption, providing high-speed temporary data storage and computing support.

Mobile storage uses NAND Flash as the core wafer, emphasizing portability and ease of expansion. Main products include USB flash drives, SD cards/Micro SD cards, etc., suitable for data transfer and backup scenarios in consumer-grade application scenarios.

Definition and Classification of Memory Products



	Storage Medium	Key Performance Characteristics	Downstream Field
eMMC / UFS	NAND Flash	• Independent unit	• Smartphones, tablets, smart imaging devices, robotics…
eMCP / uMCP	NAND Flash + DRAM	• Integrated, space efficient	• Smartphones, tablets, smart imaging devices…
ePOP	NAND Flash + DRAM	• Integrated, space efficient	• Wearables devices…
SATA SSD	NAND Flash	• Cost-effective, high throughput	• PCs…
PCIe SSD	NAND Flash	• High-speed, low latency, high IOPS	• PCs, servers…
Portable SSD	NAND Flash	• Portable, high data transfer speed	• Data transfer & backup…
DDR Module	DRAM	• Volatile	• PCs, servers…
LPDDR	DRAM	• Volatile	• Smartphones, tablets, robotics, automotive-grade applications…
USB Flash Drives	NAND Flash	• Small, portable	• Data transfer & backup, robotics, smart imaging devices…
SD Card/ Micro SD Card	NAND Flash	• Small, portable	• Data transfer & backup, smart imaging devices…
HBM	DRAM	• Ultra-high bandwidth, 3D-stacked, efficient power	• AI high-performance computing…

Source: Frost & Sullivan, compiled from publicly available information

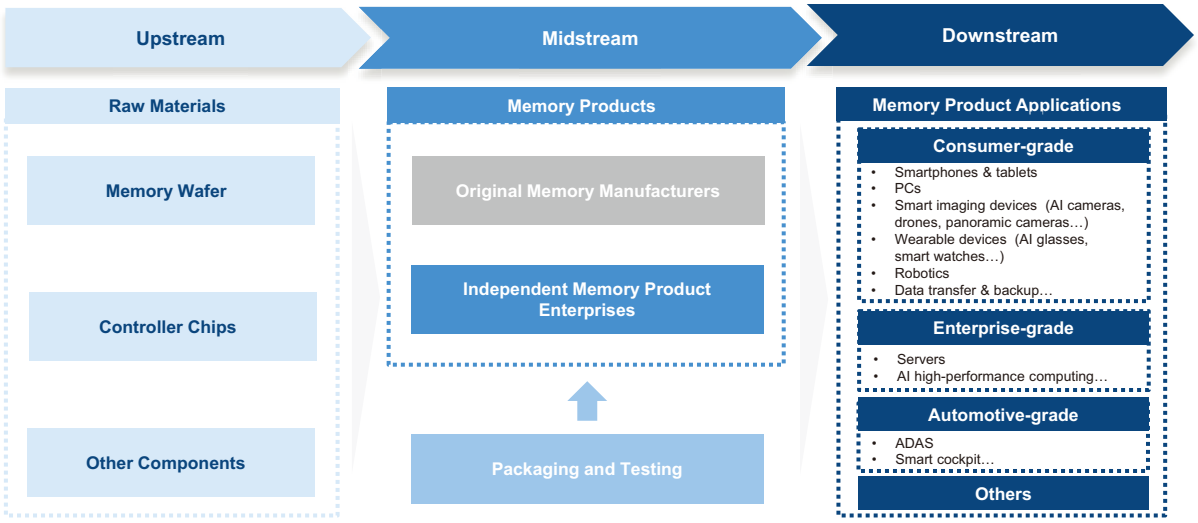
Memory Product Industry Chain Analysis

The memory product industry chain can be divided into three main segments: upstream wafer and controller chip design and manufacturing, midstream memory product enterprises, and downstream terminal applications. Among these, the midstream segment plays a key value-creating role as the core hub of the industrial chain, connecting upstream and downstream.

The upstream primarily provides core basic resources for the industry, including memory wafer manufacturers and controller chip manufacturers. The midstream is the key conversion segment for applying memory products to terminal scenarios, encompassing two major modules: memory product developing and packaging & testing. Within memory product manufacturing, there are two models: The first is the independent memory product enterprise model, where enterprises focus on the design, production, and scaled delivery of memory products, quickly responding to the diverse market demand for memory products by integrating upstream memory wafers, controller chips and outsourced packaging and testing facilities; the second is the original memory manufacturer model, covering the entire process from memory wafer manufacturing to finished product production. The packaging and testing segment involves first subjecting the memory products to packaging processes to achieve physical protection, electrical connection, and thermal management for the bare dies. Subsequently, performance verification, defect detection, and yield improvement are carried out. This is a necessary procedure to ensure that the product quality meets market requirements.

Downstream application scenarios are diverse, including consumer-grade, enterprise-grade, automotive-grade, and other fields. Different terminal demands have their own characteristics, driving the continuous evolution of memory products in terms of capacity, speed, power consumption, and reliability. Midstream enterprises enhance memory product adaptability to diverse downstream demands through differentiated memory products and advanced packaging and testing processes.

Industrial Chain of Memory Product



Source: Frost & Sullivan

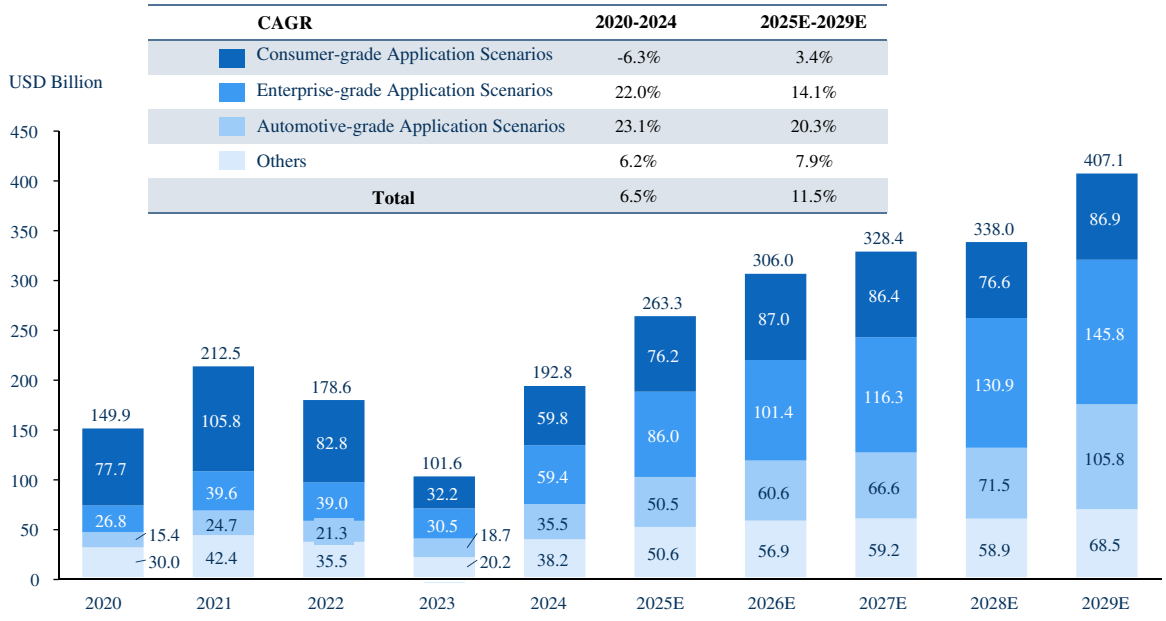
Market Size of Memory Products

The global memory product market has shown a long-term growth trend, underpinned by a solid demand foundation. In 2020, the global market size of memory products was USD149.9 billion. Benefiting from the extensive demand for memory products across various sectors within the digital economy, the market size continued to expand, and reached USD192.8 billion in 2024, with a CAGR of 6.5% during the period, demonstrating the resilient development of the memory product market.

Looking ahead, the semiconductor industry is entering a strong upward cycle driven by both AI-driven demand changes and supply structure optimization. This trend is not a short-term fluctuation but a long-term resonance formed by technological iteration, application upgrades, and industry chain restructuring. As a core segment of the semiconductor industry, the global memory chip industry gradually evolved into an AI-driven "super cycle" in 2025. This strong upward trend is clear and is expected to break the traditional 3-4 year cycle pattern. In the second half of 2025, pricing performance was robust, with both DRAM and NAND Flash showing an upward trend, and monthly increases exceeding 30% for certain DRAM products. Overall industry profit expectations continued to improve. On the demand side, AI-driven demand for high-performance memory products was particularly strong. On the supply side, structural tightness continued to intensify. Leading industry players were concentrating resources on high-value products and compressing traditional capacity products, leading to a shortage of traditional capacity products. Meanwhile, the

expansion of advanced capacity lagged far behind demand growth, with overall capacity utilization rates expected to approach full capacity. Benefiting from the upward momentum of the semiconductor super cycle, the global memory product industry's growth trend possesses strong sustainability and certainty. The market size is expected to increase continuously from USD263.3 billion in 2025 to USD407.1 billion in 2029, with an expected CAGR of 11.5% during the period.

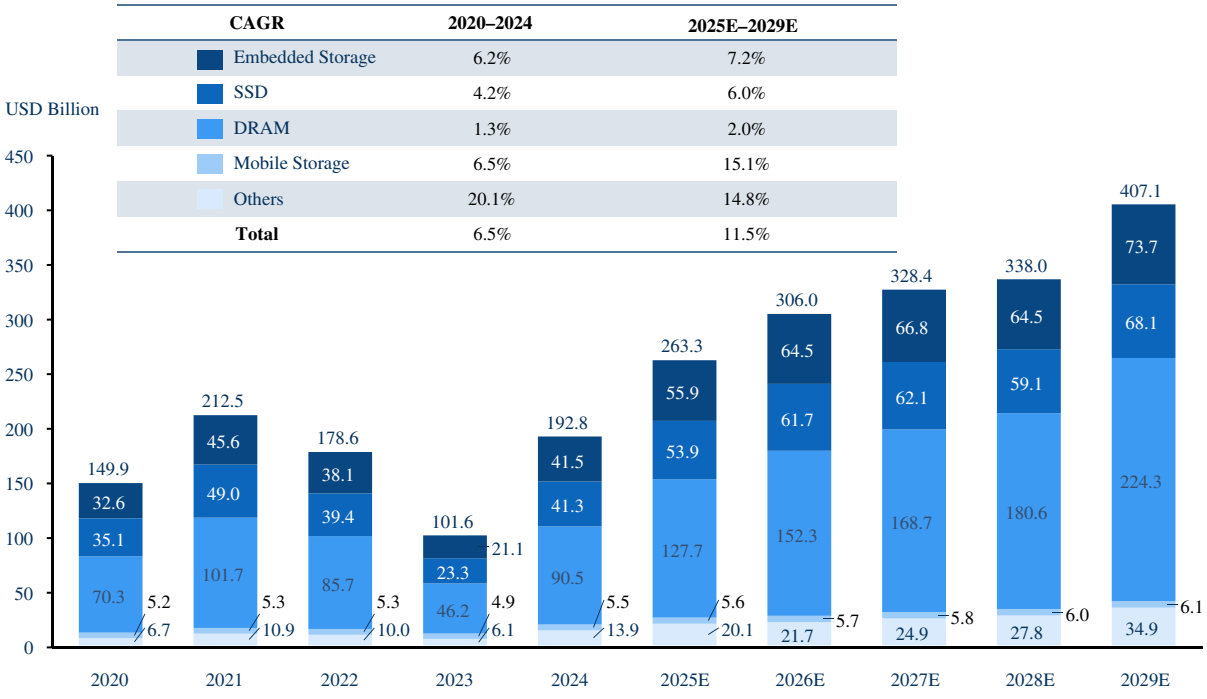
Market Size of Memory Product Market (by Application Scenarios), Global, 2020–2029E



Source: Frost & Sullivan

Analyzed by downstream application, driven by the robust development of emerging scenarios such as intelligent driving and AI servers, the enterprise-grade and automotive-grade application scenarios are experiencing the fastest market size growth rates, becoming key driving force for the growth of the global memory product market. Although the consumer-grade application segment exhibits a relatively moderate growth rate, this reflects the industry norm that the consumer electronics market has entered a mature and stable stage, and the demand for end-device inventory continues to be steadily released. Nevertheless, this segment remains one of the core foundational pillars of the memory product market, maintaining a large demand over the long term.

Market Size of Memory Product Market (by Product Types), Global, 2020–2029E



Source: Frost & Sullivan

Analyzed by product type, driven by demand from emerging scenarios such as AI servers and intelligent driving, different memory products show differentiated growth trends, collectively propelling the expansion of the global memory product market. Among them, embedded storage recorded a CAGR of 6.2% from 2020 to 2024. With the release of demand for highly integrated storage from intelligent vehicles and industrial IoT terminals, its CAGR is expected to increase to 7.2% from 2025 to 2029. SSDs recorded a CAGR of 4.2% from 2020 to 2024, supported by demand for hot data storage in data centers and in-vehicle data logging/content storage in automotive electronics, leading to steady market growth. Its CAGR is expected to increase to 6.0% from 2025 to 2029, with continued penetration of enterprise-grade and in-vehicle SSDs being the primary growth driver. DRAM grew at a CAGR of 6.5% from USD70.3 billion in 2020 to USD90.5 billion in 2024. Benefiting from surging demand for high-bandwidth, large-capacity memory from AI servers, as well as the expanding application of high-performance memory in intelligent driving domain controllers, its CAGR is expected to further increase to 15.1% in future, making it the fastest-growing category among all memory products and reflecting the continuous explosion in demand for next-generation memory (e.g., DDR5) in fields such as data centers and automotive electronics. The growth rate in the mobile storage segment remains relatively stable, with a CAGR of 1.3% from 2020 to 2024. It is projected to grow steadily at a CAGR of 2.0% from 2025 to 2029, driven by sustained demand in the consumer-grade application scenarios.

Analysis of Downstream Applications of Memory Products

Consumer-grade Application Scenarios

- *Smartphones*

Global smartphone shipments were approximately 1.34 billion units and 1.25 billion units in 2020 and 2024, respectively, and are expected to increase to 1.27 billion units and 1.43 billion units in 2025 and 2029, respectively, with an expected CAGR of 3.0% from 2025 to 2029. Among them, AI phone shipments grew rapidly, reaching 0.20 billion units in 2024, and are expected to continue growing to 0.77 billion units in 2029, with penetration rate increasing to 54.0%.

Smartphones are a core application scenario for embedded storage. Memory products play a key role in operating system operation, application loading, and multimedia content storage, directly determining the smoothness of the terminal and the user experience. With the continuous iteration of application ecosystems and operating systems, the trend of storage power upgrades is significant. Future demand will focus on larger capacity, higher bandwidth, and lower power consumption, driving continuous iteration in the performance and architecture of memory products such as embedded storage.

- *PC*

Global PC shipments were 299.8 million units and 258.9 million units in 2020 and 2024, respectively, and are expected to increase to 264.3 million units and 311.5 million units in 2025 and 2029, respectively, with an expected CAGR of 4.2% from 2025 to 2029. Concurrently, AI PC shipments are expected to rapidly increase from 48.0 million units in 2024 to 215.3 million units in 2029, with penetration projected to reach nearly 70%, indicating significant market expansion.

PCs are an important application scenario for SSDs and DRAM. SSDs handle core tasks such as system startup, application loading, and file processing. DRAM serves as the temporary storage and high-speed data retrieval component within the system, providing real-time data caching support for system operations and program execution. As AI PCs become more and more popular, local inference and multi-tasking computing increasingly rely on large bandwidth and low latency, further driving iterative upgrades in interface standards and architecture of memory products such as SSDs and DRAM.

- *Smart Imaging*

Global smart camera shipments were 119.3 million units and 205.6 million units in 2020 and 2024, respectively, and are expected to increase to 223.1 million units and 292.6 million units in 2025 and 2029, respectively, with an expected CAGR of 7.0% from 2025 to 2029. Among them, the growth of AI cameras has been particularly rapid, the penetration rate of AI cameras is also expected to increase concurrently to 45.9% in 2029. Meanwhile, global consumer drone shipments increased from 5.1 million units in 2020 to 9.9 million units in 2025, and are expected to reach 15.6 million units in 2029, with an expected CAGR of 12.0% from 2025 to 2029.

Smart imaging devices have become an important application direction for memory products, widely covering product forms such as smart cameras, drones and panoramic cameras. In these diverse scenarios, memory products play a core role in system operation, data caching, and high-speed reading and writing. As high resolution, low power consumption, and instant transmission become mainstream trends, the demand from smart imaging devices for memory products in terms of bandwidth, power consumption, and reliability will continue to increase.

- *Wearable Devices*

Global wearable device shipments were 0.44 billion units and 0.54 billion units in 2020 and 2024, respectively, with a CAGR of 4.9% during the period, and are expected to increase to 0.56 billion units and 0.63 billion units in 2025 and 2029, respectively, with an expected CAGR of 3.0% from 2025 to 2029. Among them, AI glasses and smartwatches are growing rapidly. Global of AI glasses shipments are expected to reach 5.5 million units in 2024 and are expected to rapidly increase to 58.7 million units in 2029, with an expected CAGR of 80.7% from 2025 to 2029. Global smartwatch shipments reached approximately 0.15 billion units in 2024 and are expected to increase to 0.19 billion units in 2025 and further increase to 0.44 billion units in 2029, with an expected CAGR of 23.6% from 2024 to 2025.

Wearable devices emphasize miniaturization and low power consumption. Embedded storage (such as ePOP) provides support for system data and application caching. With the rapid development of emerging scenarios such as AI glasses and smartwatches, the low power consumption and high efficiency of memory products play a key role here.

Enterprise-grade Application Scenarios

Global server shipments were 13.6 million units and 16.0 million units in 2020 and 2024, respectively, with a CAGR of 4.2% during the period, and are expected to increase to 16.3 million units and 18.8 million units in 2025 and 2029, respectively, with an expected CAGR of 3.6% from 2025 to 2029. Among them, AI servers are growing significantly, with the shipments expected to

increase from 2.0 million units in 2024 to 5.4 million units in 2029 and the penetration rate expected to rise rapidly from less than 12.6% to nearly 30%, making them the core growth driver of the market.

Servers are a core application scenario for SSDs and DRAM. Memory products support high-load tasks such as databases, virtualization, and AI training and inference, requiring far higher throughput and lower latency than traditional applications. SSDs provide persistent storage and high-speed access capabilities, while DRAM offer high-speed cache for computing processes. As the scale of AI training expands, the market demands higher performance and low power consumption from memory products, driving continuous optimization of controller chips in data scheduling, error correction, and low-latency algorithms to ensure memory products can stably support large-model training and the deployment of intelligent applications.

Automotive-grade application scenarios

In 2020, the global vehicle shipments were approximately 76.7 million units, and grew to 89.3 million units in 2024. It is projected to reach 96.0 million units in 2029, reflecting steady overall market expansion. Among them, global sales of smart vehicles (L2 and above) were 1.1 million units and 10.1 million units in 2020 and 2024, respectively, and are expected to increase 13.9 million units and 36.2 million units in 2025 and 2029, respectively, with an expected CAGR of 26.9% from 2025 to 2029.

In the context of rapid development in intelligent driving and vehicle connectivity, vehicles have unprecedented demands for memory products. Embedded storage supports in-vehicle operating systems and multimedia interaction, and SSDs are used for high-frequency sensor data logging, map updates, and remote upgrades. With the accelerated adoption of smart vehicles, massive sensor data processing, onboard AI inference, and vehicle-cloud collaboration are continuously enhanced. Memory products have evolved from a "supporting role" to core infrastructure for intelligent vehicles.

Driving Factors and Development Trends of the Memory Product Market

- *Accelerated Digital Transformation and Explosive Data Growth Driving Storage Demand*

The digital transformation process in various industries continues to deepen. The extensive penetration of technologies such as cloud computing, big data, and IoT has led to an explosive growth in global data. From social and audio-video data in consumer-grade application scenarios to real-time data caching and long-term archiving of massive data in enterprise-grade application

scenarios, the expansion of data scale directly drives a comprehensive increase in demand for storage capacity, performance, and reliability, serving as the fundamental driver for the growth of the memory products market.

- *Expansion of Emerging Application Scenarios to Generate Diversified Storage Demand*

The rise of emerging application scenarios such as artificial intelligence, intelligent driving, and the metaverse has brought differentiated and segmented demands to the memory product market. AI model training and inference requires high-bandwidth, low-latency memory products to support rapid access to massive datasets. Intelligent driving systems rely on automotive-grade storage to ensure high data reliability and real-time reading and writing in complex environments. The metaverse's requirements for storing, rendering, and interacting with virtual content demand memory products that combine large capacity with high-speed random access. These scenarios not only impose stricter requirements on storage technical parameters but also drive memory product enterprises to develop customized products for different scenarios, further expanding the growth boundaries of the memory market.

- ***Technological Innovation and Iteration to Continuously Breaking the Bottlenecks in Performance and Capacity***

Continuous innovation in storage technology is the core engine for market development. The evolution of 3D NAND stacking technology has continuously increased storage density, significantly raising the amount of data storable per unit area. Algorithm optimizations and architectural innovations in controller chips have effectively improved the reading and writing efficiency and response speed of memory products. Upgrades in high-speed interface protocols such as PCIe and UFS has further expanded data transmission channels and reduced latency. These technological breakthroughs not only meet the downstream demand for higher performance and larger capacity storage but also gradually reduce storage costs through process maturity, promoting the adoption and replacement of memory products in more scenarios, and continuously activating market growth potential.

- ***Strengthened Global Policy Orientation and Dual-Track Drive of Data Security and Green Development to Upgrade the Memory Product Market***

Global policy demands for data security and low-carbon development are driving upgrades in the memory product market. On one hand, as data scale and cloud computing applications expand, risks of data breaches, tampering, and attacks have significantly increased. Enterprises and individual users have growing demands for data security. Memory product enterprises are strengthening designs such as encryption algorithms, tamper-resistant firmware, trusted execution environments, and secure erase mechanisms to ensure data security throughout the entire process

of collection, transmission, and storage in high-security fields such as finance and government affairs. On the other hand, green development requirements under dual-carbon goals are promoting the application of low-power storage chips and energy-saving storage architectures. This makes green and low-carbon a key direction for the technological evolution and market expansion of memory products.

Analysis of the Controller Chip Sector in the Memory Product Industry

Definition and classification of controller chips in the memory product industry

The controller chip is the core logic unit of a memory product, and is regarded as the brain of the entire system. It is primarily responsible for coordinating data interaction between the host and the storage medium, realizing read/write scheduling, storage unit management and protocol conversion, and enabling the storage medium to be utilized by operating systems and applications in a standardized form. Within memory products, the controller chip is typically paired with NAND Flash. Controller chip has compensated for the physical constraints (such as requiring erasure before programming, limited lifetime and an increasing error rate) of NAND Flash through mechanisms such as logical mapping, wear leveling and error management, enabling it to stably support diverse application scenarios. From the perspective of product forms and application scenarios, the controller chip mainly includes three categories:

- Embedded Storage Controller Chips (such as eMMC/UFS), whose core features are high integration, low power consumption and strong read/write stability, is mainly used in smartphones, tablets, smart wearable devices and vehicle system;

- SSD Controller Chips (such as SATA/PCIe), whose core feature is to support multi-channel parallel read/write, and at the same time, it has perfect error correction mechanism and flash memory life management capability. It is mainly used in PC, server, data center and other scenarios that require high storage speed and capacity;

- Mobile Storage Controller Chips (such as USB flash drives/SD Cards), the core features are low cost and low power consumption, and is mainly used in scalable storage scenarios such as digital cameras, driving recorders and surveillance cameras.

Technological evolution of controller chips in the memory product industry and adaptive upgrade of memory products

The technological iteration of controller chips in the memory product industry primarily revolves around three dimensions: interface upgrade, algorithm optimization and process and density breakthroughs. Its ultimate goal is to address pain points of memory products in terms of performance, reliability and power consumption, and to unlock their core value by establishing a synergistic evolution logic of "storage medium upgrade — controller chip adaptation".

- **Regarding interface upgrades:** controller chips primarily enhance data transfer bandwidth to meet the growing demands of data-intensive applications such as artificial intelligence and high-performance computing. This evolution is manifested in the upgrade from eMMC to UFS in the embedded storage field, and in the gradual shift from traditional SATA SSDs to the higher-speed PCIe SSDs in the SSD field. The generational leaps in PCIe technology, while achieving bandwidth growth, also impose higher requirements on the design of controller chips.

- **At the level of algorithm and architecture optimization:** the reliability and operational efficiency of controller chips in data processing have also been improved significantly. To address the inherent physical bottlenecks of the storage medium, such as endurance and error rates, controller chips commonly incorporate a DSP (Digital Signal Processor) and adopt advanced error correction algorithms such as LDPC (Low-Density Parity-Check) code, compensating for the physical limitations of the storage medium through a combination of hardware and firmware.

- **At the level of process and density breakthroughs:** process optimization is the core path for controller chips to achieve a balance of performance, power consumption, area and cost. The industry exhibits an evolution trend from intensive refinement of mature processes to active adoption of advanced processes, with process nodes continuously advancing toward refinement. This shrinks chip size, and optimizes production costs, while significantly improving computing performance and integration density. Density breakthroughs focus on unlocking the potential of storage medium and upgrading controller chip adaptation capabilities. The core is to meet the low-cost and high-reliability demands of massive data storage by overcoming technical challenges of advanced storage medium technologies.

Analysis of future development trends for controller chips within the memory product industry in the AI era

- *High-level Collaborative Design: Deep Integration of Computing and Storage*

The computing landscape in the AI era features a pattern of diverse collaboration among CPUs, GPUs, NPUs and storage. Controller chips need to achieve deep collaboration with upstream AI chips and downstream memory products. This deep collaboration refers to the controller chip not only performing basic transmission along the data path, but also actively adapting to the invocation rhythm of computing chips through bandwidth allocation, cache management and task scheduling, thereby keeping storage and computing power synchronized in operation, minimizing latency and improving overall power consumption. This design trend is becoming a key requirement in AI training and inference scenarios.

- *Scenario-based Customization: Differentiated Development for Diverse Applications*

With the diversification of AI applications, general controller chip designs struggle to meet the differentiated needs, making scenario-based customization an inevitable direction. In the AI server field, controller chips will focus on optimizing the reliability and power consumption ratio of high-capacity SSDs; in smart vehicles, they need to meet automotive-grade standards for wide temperature ranges, high reliability, functional safety, and supply stability over a long lifecycle; in the edge AI, emphasis is placed on low power consumption and real-time response capabilities. Through customized development, controller chips can precisely adapt to the performance, safety and power consumption requirements of different scenarios, strengthening their core enabling position within storage systems.

COMPETITIVE ANALYSIS OF THE GLOBAL MEMORY PRODUCT MARKET

Overview of the Global Memory Product Market Competitive Landscape

Currently, the global memory product industry landscape exhibits distinct characteristics. Original memory manufacturers dominate the mainstream market, accounting for over 95% of the market share, and forming a strong dominant position. Meanwhile, domestic independent memory product enterprises are accelerating their breakthroughs. Although their current share base remains small, their growth momentum is robust, and their market share is rapidly increasing. From the perspective of the market competitive landscape, it presents a stratified state. Leveraging the profound technological accumulations and strong production capacity advantages, international leading independent memory product enterprises have occupied the major share of the high-end storage market. Following the path of differentiated innovation, domestic enterprises are intensifying breakthroughs in consumer-grade storage and industry customization fields, focusing

on narrowing the gap in storage architecture and cost-control technologies, while leveraging unique advantages of the domestic industrial chain to meticulously develop solutions tailored to domestic demands. Their future market development space is considerable.

Global Memory Product Market Ranking

In the global memory product market for 2024, independent memory product enterprises competed around technological innovation and market share. From a revenue dimension, the Company ranked fifth globally with a revenue of US$1.2 billion, also being the largest unlisted independent memory product enterprise in China.

Global Independent Memory Product Enterprise Ranking for Memory Products (by Revenue), 2024

Ranking	Company	Revenue in 2024
		(USD Billion)
1	Company A.	7.5
2	Company B.	2.4
3	Company C.	1.3
4	Company D.	1.2
5	The Company	1.2

Notes:

1) Company A was founded in the United States in 1987, and is an unlisted company. Company A is an independent memory product enterprise focusing on the R&D, manufacturing and supply chain management service of memory solutions.

2) Company B was founded in Shenzhen, Guangdong in 1999, and is a listed company. Company B is an enterprise specializing in the design and R&D in relation to semiconductor memory products, providing packaging & testing, sales and multi-scenario memory application solutions.

3) Company C was founded in Taiwan, China in 2000, and is a listed company. Company C is a provider of NAND Flash control chips and memory solutions, with products covering consumer, automotive and other application scenarios.

4) Company D was founded in Taiwan, China in 2001, and is a listed company. Company D is a full-memory solution supplier focused on the R&D and sales of memory, SSDs and other products.

Global Embedded Storage Market Ranking

In the global embedded storage product market, the Company was the second largest independent memory product enterprise with a revenue of US$0.8 billion in 2024.

Global Independent Memory Product Enterprise Ranking for Embedded Storage Products (by Revenue), 2024

Ranking	Company	Revenue in 2024
		(USD Billion)
1	Company B	1.2
2	The Company	0.8
3	Company E	0.6

Note:

1) Company E was founded in Shenzhen, China in 2010, and is a listed company. Company E is a semiconductor memory and advanced packaging & testing enterprise focused on the R&D design, packaging & testing, production and sales of semiconductor memory products.

Market Ranking for Memory Products Applied in Smartphones

In the global market for memory products applied in smartphones for 2024, the Company was the largest independent memory product enterprise with a revenue of US$0.8 billion.

Global Independent Memory Product Enterprise Ranking for Memory Products Applied in Smartphones (by Revenue), 2024

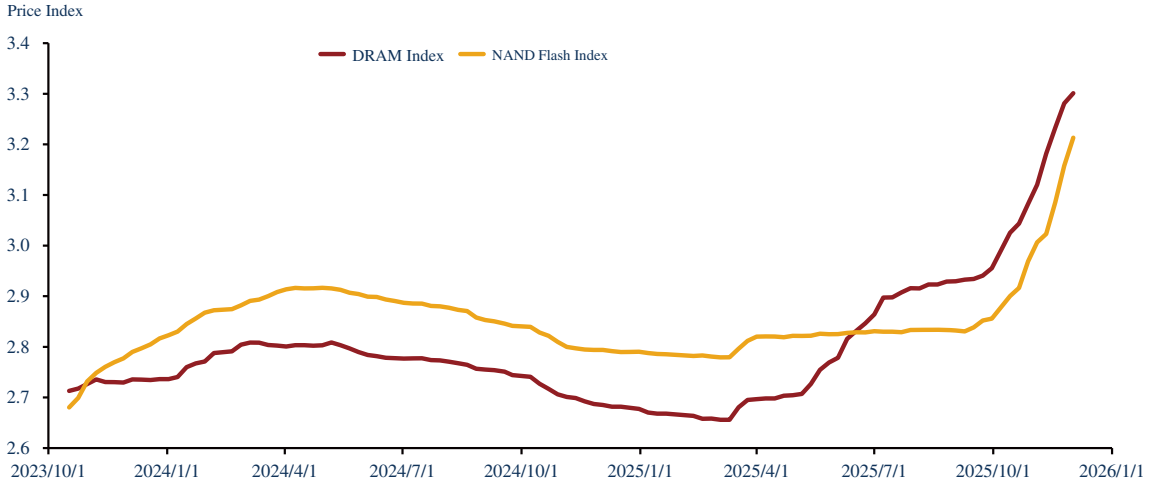
Ranking	Company	Revenue in 2024
		(USD Billion)
1	The Company	0.8
2	Company B.	0.4
3	Company A.	0.1

Analysis of DRAM and NAND Flash Price Indexes in the Memory Product Market

Since 2023, the price indexes of DRAM and NAND Flash in the memory product market have exhibited distinct phased fluctuation characteristics. From 2023 to mid-2025, both indexes fluctuated within a relatively low range for an extended period. This was due to the earlier capacity expansion by memory product enterprises combined with high inventory levels in consumer-grade products, resulting in loose supply and demand within the industry, and a lack of demand growth momentum. In 2023, the overall trend was first fall and then rise. In the first three quarters, it continued to bottom out due to the imbalance between supply and demand, and bottomed out and stabilized at the end of the third quarter; Entering the fourth quarter, the prices of the two started to rebound strongly, with NAND Flash rising ahead of DRAM, and the market heating up rapidly. Entering the mid-to-late period of 2025, however, the price indexes for both

types of memory products experienced a significant surge. The core driver was the large-scale deployment of AI applications, which spurred demand for "computing-with-storage". The memory requirement per AI server is several times that of a regular server. This drove leading original memory manufacturers to shift their production capacity toward high-margin, high-end products like HBM and DDR5, leading to a rapid contraction in the capacity dedicated to traditional memory products. Meanwhile, existing servers and consumer electronics still rely on mature products like DDR4. This supply-demand mismatch directly pushed up prices. Among them, the DRAM index rose more significantly. This is because demand for high-bandwidth DRAM (such as HBM) in AI scenarios is more inelastic, and its production capacity was locked in early. In contrast, the recovery of demand for NAND Flash in the consumer electronics sector has been relatively moderate, resulting in a slightly smaller price increase compared to DRAM.

DRAM and NAND Flash Price Indexes



Source: CFM, Frost & Sullivan

Analysis of Entry Barriers in the Memory Product Market

- ***Technological Barriers***

The technological barriers in the global memory product market are concentrated in core technology R&D and complex system integration capabilities. Controller chips, as the core component of memory products, require multi-dimensional technological breakthroughs, including the integration of complex algorithms to ensure data read/write stability and deep adaptation capabilities with memory products. Memory product manufacturing necessitates mastery of precise process technologies, involving precise control technologies across multiple stages, and needs to meet performance requirements under different scenarios, such as low latency and high throughput.

Furthermore, hardware-software co-design capability is crucial, and achieving memory product architecture optimization requires long-term technological accumulation, making it difficult for new entrants to complete technology reserve and system verification within a short period.

- ***Supply Chain Barriers***

The memory product industry supply chain exhibits high concentration and coordination complexity, creating significant entry barriers. The supply market for upstream core raw materials such as memory wafers is highly concentrated, with their production capacity of key raw materials controlled by a few original memory manufacturers, making it difficult for new entrants to secure stable capacity support. The midstream segment requires deep coordination among controller chips, firmware and storage particles, involving technical verification and adaptation processes with multiple entities, which is challenging for those lacking industry experience to balance cost and delivery efficiency. The downstream assembly and testing segment relies on specialized equipment and mature quality control systems. Building a complete supply chain system requires long-term resource accumulation and partnership sedimentation, posing challenges of low supply chain coordination efficiency for new entrants.

- ***Customer Retention Barriers***

After memory products are deeply integrated with customers' business systems, replacing suppliers would require customers to not only conduct full-process testing and verification on newly supplied products, which extends the product launch cycle, but also bear the potential risk of quality instability of new components. The significant switching costs drive customers to tend to maintain long-term and stable cooperative relationships with their original partners. Meanwhile, the brand trust and stable supply capacity accumulated through long-term cooperation also make customers more dependent on mature suppliers when facing market fluctuations, further consolidating customer retention.

- ***Policy and Regulatory Barriers***

Policy and regulatory barriers in the memory product market are reflected in multi-dimensional compliance requirements. Information security policies in various countries impose clear standards on aspects such as domestic adaptation and data security of memory products, requiring that products need to pass specific certifications before entering into the market. Additionally, international technology export controls restrict the flow of advanced equipment and technology. New entrants need to cope with diverse policy constraints and risks of international policy changes, making compliance capability and cost control important entry conditions.

FROST & SULLIVAN REPORT

We engaged Frost & Sullivan to conduct market research on the semiconductor industry and to prepare the Frost & Sullivan Report. Frost & Sullivan is an independent global consultancy established in New York in 1961, providing industry research and market strategy services. We have contracted to pay Frost & Sullivan RMB550,000 for the preparation of the Frost & Sullivan Report. In preparing the Frost & Sullivan Report, Frost & Sullivan conducted detailed primary research, including discussions with several leading industry participants and interviews with relevant parties. Frost & Sullivan also conducted secondary research, which included reviewing company reports, independent research reports, and data from its own research database. Frost & Sullivan compared historical data analysis with macroeconomic data and, considering the primary drivers of the aforementioned industry, derived figures estimating the total market size. Its market engineering forecasting approach combines various forecasting techniques with a system based on market engineering metrics, relying on the expertise of the analyst team to integrate key market elements investigated during the project research phase. These elements mainly include expert opinion forecasting methods, integration of market drivers and constraints, integration of market challenges, integration of market engineering metric trends, and consolidation of economic variables.

The Frost & Sullivan Report was prepared based on the following assumptions: (i) the social, economic, and political environments globally and in China are likely to remain stable during the forecast period; and (ii) the primary drivers of the relevant industry may propel the market during the forecast period.