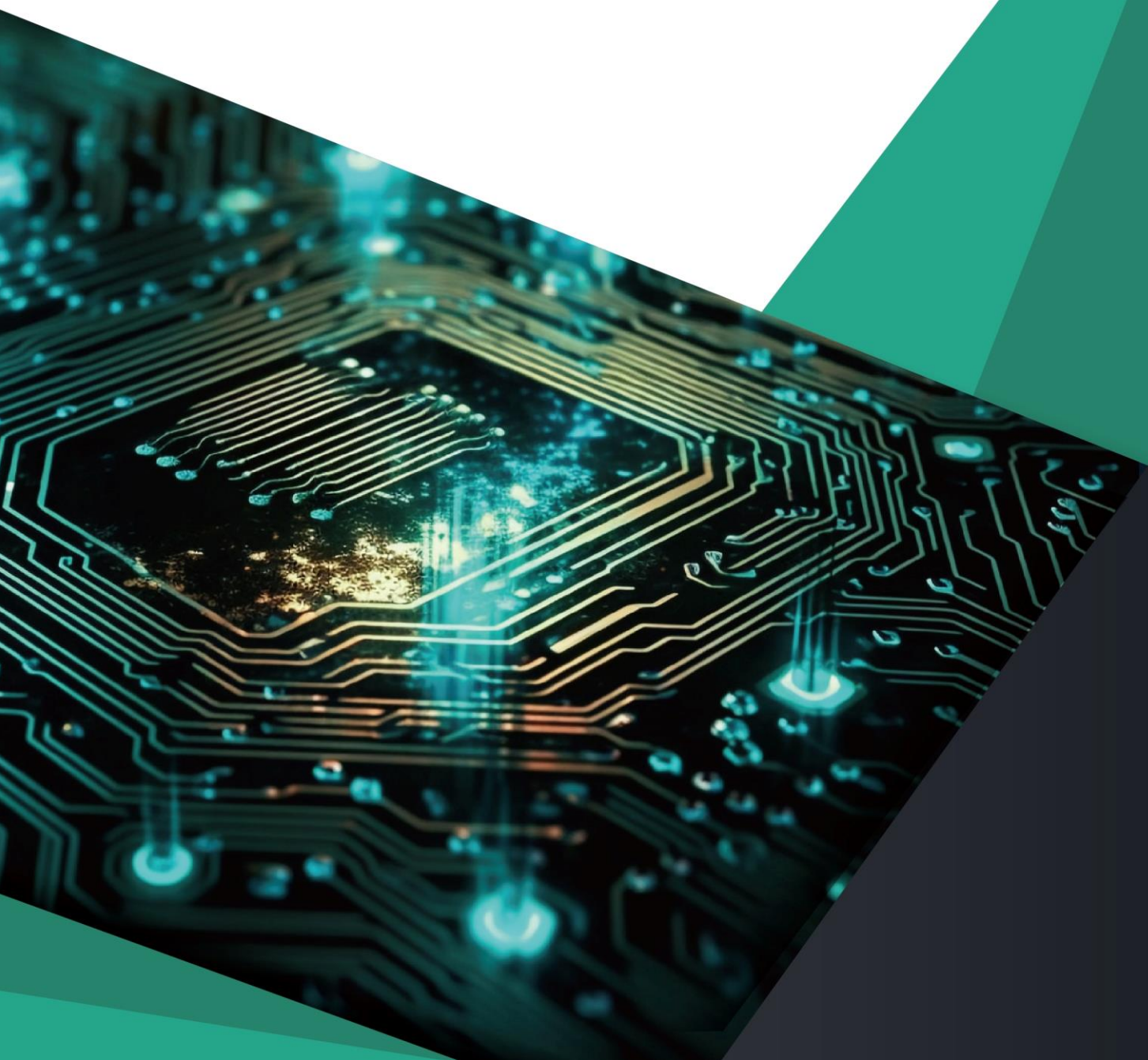
BRIOCEAN

Monthly #MarketMatters Report

December 2023



Contents

Executive Summary

This report provides an overview of the semiconductor industry in December 2023 and attempts to identify potential market opportunities and risks over the next month. Based on the relevant data available, the report analyses macroeconomic factors, industry supply chains, applications, and product market trends.

The semiconductor sector in the Americas is expected to gain a strong growth in 2024 and memory products market size will grow substantially. Countries have sought to strengthen their semiconductor supply chains through the implementation of restrictive policies or by forming alliances. Furthermore, many leading chipmakers will increase prices of products, indicating that the industry may step into a period of recovery.

As major chipmakers reduce production, DRAM prices will increase, and Artificial Intelligence has continued to drive the demand for logic chips. However, MCU prices are not likely to rise in the short term.

1. Macro Environment Overview

1.1 Global Economy Growth Remains Soft

The global manufacturing PMI in December was 49.0, a month-on-month decline, and remained at a weak level overall, which has been below the boom-and-bust line for 16 consecutive months.

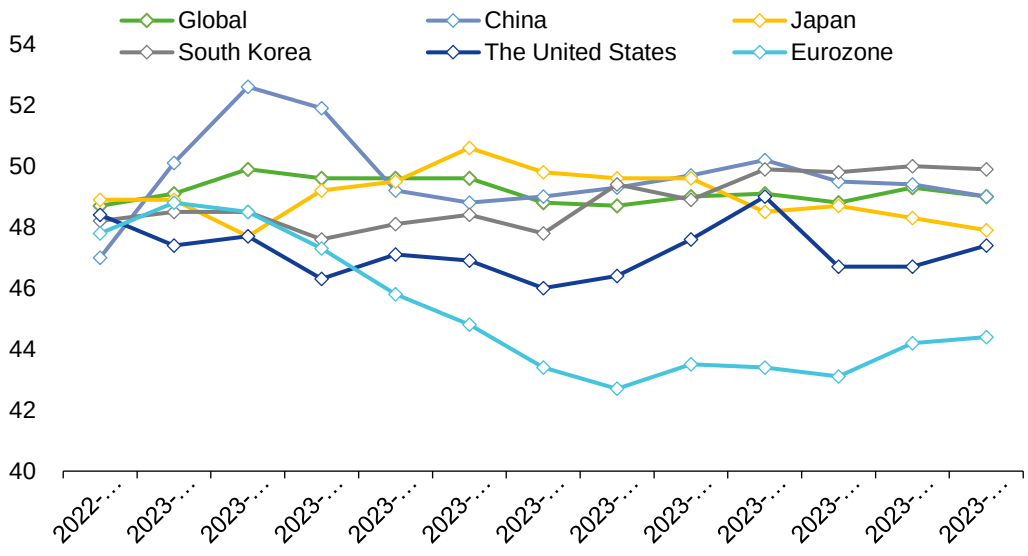
By regions, the manufacturing PMI of major countries in the world in December was below the boom-and-bust line.

In Asia, China's manufacturing PMI continued to decline slightly (49.0), but the high-tech manufacturing PMI was still in the expansion range (50.3). New orders index of computer, communication and electronic equipment and other industries continued to be above the boom-and-bust line, and the demand for high-end manufacturing continued to expand. Japan and South Korea are also showing a downward trend, and the overall economic prosperity is at a low level.

In the Americas, the U.S. manufacturing PMI rose slightly month-on-month, slightly higher than the market expectation of 47.1. In terms of sub-items index, the U.S. manufacturing PMI output index was 50.3, back to the expansion range, and the U.S. new export orders index was 49.9, a sharp increase from the previous value. Institute for Supply Management (ISM) is optimistic about the future export activities of the United States to the Asia-Pacific region and Europe, and the U.S. manufacturing PMI new orders are on a rebounding trend as a whole.

In Europe, the euro area rebounded slightly, and the economic outlook may show signs of stabilising at a low level.

Manufacturing PMIs



Data Source: Choice

1.2 Outlook for the Americas Semiconductor Market Is Promising and Memory Chip Market Will Recover Significantly

According to WSTS forecasts, the global semiconductor market is expected to reach approximately USD 588.4 billion in 2024, a year-on-year growth of 13.1%.

The semiconductor market size of Asia-Pacific region (including China and Japan) is expected to be approximately USD 366.7 billion, a year-on-year increase of 10.9%, and the global share is as high as 62.3%.

The semiconductor market size of the Americas is expected to be approximately USD 162.2 billion, with the highest year-on-year growth (+22.3%), accounting for 27.6% of the global market share.

The European region's semiconductor market size is expected to be approximately USD 59.5 billion, with a smaller growth rate (+4.3%), accounting for 10.1%.

USD, Billion	2022A	2023E	2024E
The Americas	141.1	132.5	162.2
yoy	*16.2%*	*-6.1%*	*22.3%*
share%	24.6%	25.5%	27.6%
Europe	53.9	57.0	59.5
yoy	*12.8%*	*5.9%*	*4.3%*
share%	9.4%	11.0%	10.1%
Asia Pacific (including China and Japan)	379.1	330.5	366.7
yoy	*-2.0%*	*-12.8%*	*10.9%*
share%	66.0%	63.6%	62.3%
Total World	**574.1**	**520.1**	**588.4**
yoy	*3.3%*	*-9.4%*	*13.1%*

From the perspective of products, the memory chip market will enter into a period of significant growth in 2024, with the estimated highest year-on-year growth rate (44.8%), and the market size reaching USD 129.77 billion.

The segmenting market with the second highest growth is logic devices. Its market size is expected to reach USD 191.69 billion, increasing by 9.6% yearly.

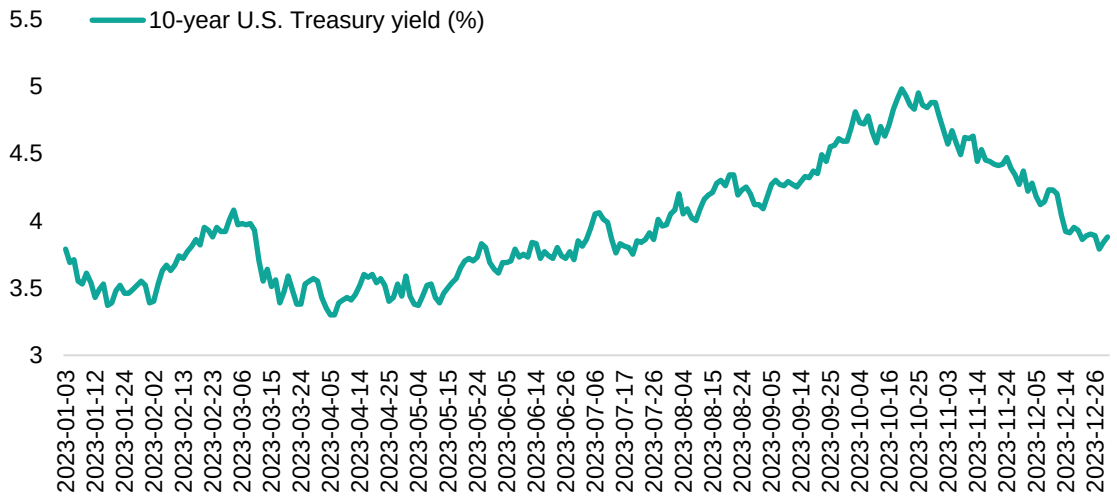
USD, Billion	2022A	2023E	2024E
Discrete Semiconductors	34.0	36.0	37.5
yoy	*12.0%*	*5.8%*	*4.2%*
Optoelectronics	43.9	42.6	43.3
yoy	*1.2%*	*-3.0%*	*1.7%*
Sensors	21.8	19.4	20.1
yoy	*13.7%*	*-10.9%*	*3.7%*
Integrated Circuits	474.40	422.17	487.45

USD, Billion	2022A	2023E	2024E
yoy	*2.5%*	*-11.0%*	*15.5%*
Analog	88.98	81.05	84.06
yoy	*20.1%*	*-8.9%*	*3.7%*
Micro	79.07	76.58	81.94
yoy	*-1.4%*	*-3.2%*	*7.0%*
Logic	176.58	174.94	191.69
yoy	*14.0%*	*-0.9%*	*9.6%*
Memory	129.77	89.60	129.77
yoy	*-15.6%*	*-31.0%*	*44.8%*
Total Products	574.1	520.1	588.4

1.3 Semiconductor Stock Market Gained a Strong Growth, while U.S. Interest Rate Has Declined, Possibly Benefiting Consumer Demand

In 2023, the Federal Reserve raised interest rates to curb inflation, causing the 10-year U.S. Treasury bond interest rate to once rise above 5%. Under the macro environment of high inflation and high interest rates, the growth of consumer demand slowed down significantly. Related consumer-oriented electronic products (such as smartphones and PCs) have experienced weak growth, which has led to electronic manufacturers slowing down production and suppressing chip procurement demand. However, the Federal Reserve has recently stopped its monetary tightening policy, and the 10-year Treasury bond interest rate has fallen sharply. As of December 29, 2023, the 10-year U.S. Treasury bond interest rate was 3.88%. According to the median forecast of major financial institutions around the world, the U.S. 10-year Treasury bond interest rate is expected to be 3.98% at the end of 2024.

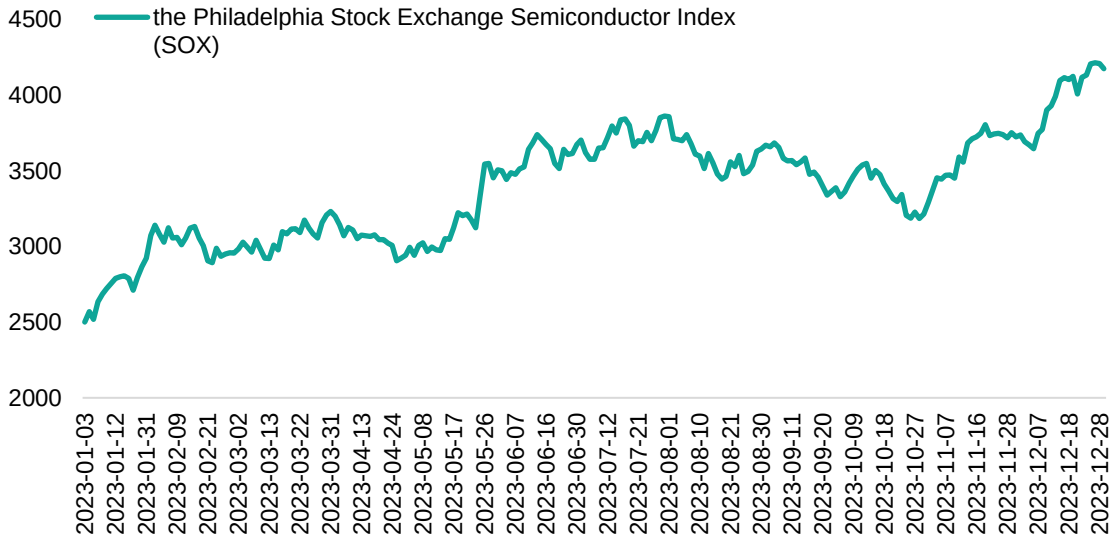
10-year U.S. Treasury Bond Interest Rate



Data Source: Choice

From a stock market perspective, the Philadelphia Stock Exchange Semiconductor Index rose 66% in 2023, the largest annual gain since 2009. NVIDIA is one of the most outstanding companies. Its explosive growth in the AI chip market has more than tripled its stock price and become the first chip manufacturer with a market value of more than USD 1 trillion.

The Philadelphia Stock Exchange Semiconductor Index



Data Source: Choice

1.4 South Korea and the Netherlands will Establish a Semiconductor Technology Alliance

Recently, President Yoon Seok-yue of South Korea, Lee Jae-yong, Chairman of Samsung Electronics, and Choi Tae-won, Chairman of SK Group, visited the ASML headquarters. President Yoon said that for the sake of semiconductor industry innovation and the stability of the global supply chain, he hopes that the two countries will cooperate closely. This is the first time that Yin Xiyue has visited a company during his overseas tour, and it is also the first time that ASML has disclosed its core facilities to foreign leaders.

Taking this visit as an opportunity, the semiconductor cooperation between South Korea and the Netherlands will now be upgraded to a semiconductor alliance. Samsung Electronics decided to jointly invest KRW 1 trillion with ASML to establish a new generation semiconductor technology research and development centre, and jointly develop ultra-micro manufacturing processes. SK hynix and ASML signed a memorandum of understanding to jointly develop EUV hydrogen recycling

technology.

1.5 The U.S. EV Supply Chain Attempts to "de-China"

On December 1, 2023, the United States stated that the use of parts and minerals made in China will be excluded from tax incentives for pure electric vehicle (EV) buyers. The U.S. government announced that it will apply new regulations to battery components from 2024 and to important minerals such as nickel and lithium from 2025.

In this new regulation, U.S. companies will be excluded from the exemptions if they purchase from companies headquartered in China. For enterprises outside China, if Chinese-related capital accounts for more than 25%, they cannot be exempted. Even if it does not meet the standards, it may be considered a "Chinese enterprise" if it is influenced by the Chinese government.

1.6 China Bans Export of some Rare Earth and IC Technologies

On December 21, 2023, the Ministry of Commerce as well as the Ministry of Science and Technology in China have issued an announcement to adjust the "China's Catalog of Export Prohibited and Restricted Technologies", which involves rare earth refining, processing and utilisation, and technologies closely related to the integrated circuit industry chain, such as crystal materials, laser sources, SAW devices and sensors.

This adjustment of the ban has attracted the attention of news media: Financial Times believes that China's announcement to ban the export of technology for processing rare earths is the latest sign of its counterattack against the US-led move to restrict the sale of advanced chips to Chinese companies. Reuters pointed out that China has significantly tightened its export control policies on several key metals in 2023, and competition with the West over the control of key minerals has continued to escalate.

China is strengthening the management of scarce resources involving high-tech fields. It has required rare earth export companies to report rare earth types and export destinations. What’s more, it has changed the export of gallium used for semiconductor materials and graphite, a battery material used for EVs, to licensing.

2. Semiconductor Industry Updates

2.1 Short-term Implications

Overview: In the short term, major chipmakers have successively issued price increase notices, indicating that semiconductor industry is expected to recover. Additionally, Nvidia's leading position in AI chips may not be affected in the short term because it has resumed shipments of chip catered to mainland China.

2.1.1 Semiconductor Industry Has Bottomed Out with Price Increase Notices Issued by Leading Chipmakers

Samsung increases its CIS product quotation: According to reports, Samsung has issued a CIS (CMOS image sensor) price increase notice to customers and will increase its CIS product quotation in Q1 2024. This notice mainly involves products with specifications above 32 million pixels, with an average increase of 25% and an increase of 30% for individual products. The industry believes that starting from the second half of 2023, mobile phone brand manufacturers' inventories will gradually return to reasonable levels and begin to replenish inventory, and CIS stock levels will be significantly reduced. It is expected that CIS market will usher in a price increase as China's chipmaker OmniVision Technology may follow suit.

ADI increases the price of old products: Analog chipmaker ADI recently issued a price increase notice to dealers in mainland China, and plans to increase the price starting from February 4, 2024, with an increase of 10%-20%, including both new and existing orders. To encourage users to switch to new products, ADI has also implemented different increases for new and old products. Products that have been in mass production for 20 years will have a 15% increase, and others that have been in mass production for 25-30 years will have a 20% increase.

Western Digital cyclically increases price of NAND Flash products: Western Digital, the world's fourth largest NAND Flash supplier, recently issued a price increase notice to customers, emphasising that the price of NAND Flash products will be increased cyclically in the next few quarters. It is expected to accumulatively rise by 55%. In addition, Western Digital also pointed out that the company's HDD products will also weekly review pricing, and prices are expected to increase in the first half of 2024.

2.1.2 Nvidia Pays Cash Upfront to Micron and SK hynix to Secure HBM Supply

In order to ensure the stable supply of HBM, Nvidia has paid hundreds of millions of dollars in advance payments to SK hynix and Micron, which is equivalent to a

confirmed supply contract. Samsung Electronics also recently ended product testing and signed an HBM supply agreement with Nvidia. It can be seen that the price of HBM may remain high.

In terms of market size, Omdia research shows that the compound annual growth rate of HBM market size is expected to soar by 52% from 2023 to 2027. HBM products are anticipated to account for more than 10% of the DRAM market in 2023 and close to 20% by 2027. From the perspective of market structure, the leading manufacturers in the HBM field are SK hynix, Samsung, and Micron. Among them, SK hynix is the company with the highest market share with a market share of 50%, Samsung has a market share of about 40%, and Micron has a market share of about 10%.

2.1.3 Nvidia Launches Downgraded GPU for Mainland China

Nvidia officially launched the GeForce RTX 4090 D gaming graphics card for the mainland China market, and the AI inference performance was significantly reduced. In response to the latest U.S. export restrictions to China in October 2023, the product has been downgraded on the basis of the original RTX 4090. According to Nvidia, the RTX 4090D will be available from January 2024, with an official suggested retail price of RMB 12,999, consistent with the RTX4090.

In addition, Nvidia will resume AI GPU shipments to mainland China, and will begin mass production of H20 and other AI GPUs in the second quarter of 2024. The main substrate will be handled by supplier Wistron. Although the computing performance of H20 is lower than that of H100, its lower price, support for high-speed interconnection technology NVLink and CUDA and other features make this chip expected to be more widely used in the Chinese market. Despite facing fierce competition in the Chinese market, the launch of H20 will provide new impetus for Nvidia to maintain its leading position in the artificial intelligence chip market.

2.2 Mid-term Implications

Overview: In the mid-term, the application of 2nm advanced process chips has been accelerated with the launch of 2nm lithography machines. In order to increase chip self-sufficiency and deal with global geopolitics and trade risks, Japan's leading manufacturers will actively invest in building wafer production capacity. What’s more, catalysed by the emergence of AI innovations such as AI PC and MR with increasing shortage of global computing power, the demand for advanced chip packaging is rising.

2.2.1 ASML Launches 2nm Lithography Equipment to Accelerate the Application of Advanced Process Chips

ASML announced that it will launch chip manufacturing equipment for the 2nm process node in the coming months, improving the numerical aperture optical performance from 0.33 to 0.55, and plan to mass produce 10 devices in 2024. Intel has procured six of them, which are expected to cost more than USD 300 million each.

Samsung is also gradually deploying 2nm chip manufacturing equipment. Recently, ASML announced that it will cooperate with Samsung to jointly invest KRW 1 trillion to establish a research centre in South Korea and will conduct ultra-fine semiconductor manufacturing processes research using next-generation EUV lithography machines. In the research centre, engineers from ASML and Samsung will work together to improve EUV chip manufacturing technology. The focus of Samsung's collaboration with ASML is not simply to bring 2nm chip manufacturing equipment to South Korea, but to build a partnership to better leverage next-generation devices.

2.2.2 TSMC's New Plant in Japan Plans to Produce 55,000 12-inch Wafers per Month

After TSMC's new factory in Japan starts mass production in the fourth quarter of 2024, it will gradually increase its production capacity with a target of 55,000 12-inch wafers per month. It will also boost the proportion of Japan's local semiconductor supply chain and ecosystem, with the goal of increasing it to 60% by 2030, much higher than the current 25%. The main shareholders of TSMC's new Kumamoto plant include TSMC (more than half of the shares), Sony (less than 20% of the shares), and Nippon Denso (about 10% of the shares). The new plant's production capacity is mainly 28/22 nanometers and 16/12 nanometers.

Most of the production capacity of TSMC's Japanese joint venture factory is used for Sony, and the remaining part is for Denso Corporation. Initially, most of the capacity will be allocated to image signal processors required for CMOS image sensors as part of Sony's outsourcing. The remaining production capacity will be dedicated to automotive MCUs for auto parts manufacturer Denso Corporation.

It can be seen that Japanese semiconductor companies have been building production capacity through joint ventures with wafer foundries to consolidate the Japanese chip supply chain.

2.2.3 Leading Packaging and Testing Manufacturers Expand Advanced Packaging Production Capacity to Cope with Rising Demand for AI Chips

ASE Investment Holdings recently announced that its subsidiary, ASE Semiconductor, has leased the Kaohsiung Nanzi factory of Foray Electronics in Taiwan, mainly to expand ASE's advanced AI chip packaging production capacity.

As the top three packaging and testing companies in mainland China, Changdian Technology, Tongfu Microelectronics, and Huatian Technology are also developing advanced packaging. For example, Huatian Technology announced that its subsidiary Huatian Jiangsu plans to invest RMB 60 million to establish Pangu Company with related parties to promote the company's layout in the advanced packaging field and improve the company's packaging and testing technology and business system.

2.3 Long-term Implications

Overview: In the long term, Chinese chipmakers have accelerated to build manufacturing and packaging and testing capacity in Southeast Asia market. Japanese leading companies ROHM and Toshiba teamed up to make power semiconductor, especially SiC, which will strengthen and upgrade Japanese power semiconductor supply chain.

2.3.1 Chinese Chipmakers Enter the Malaysian Market to Assemble High-end Chips

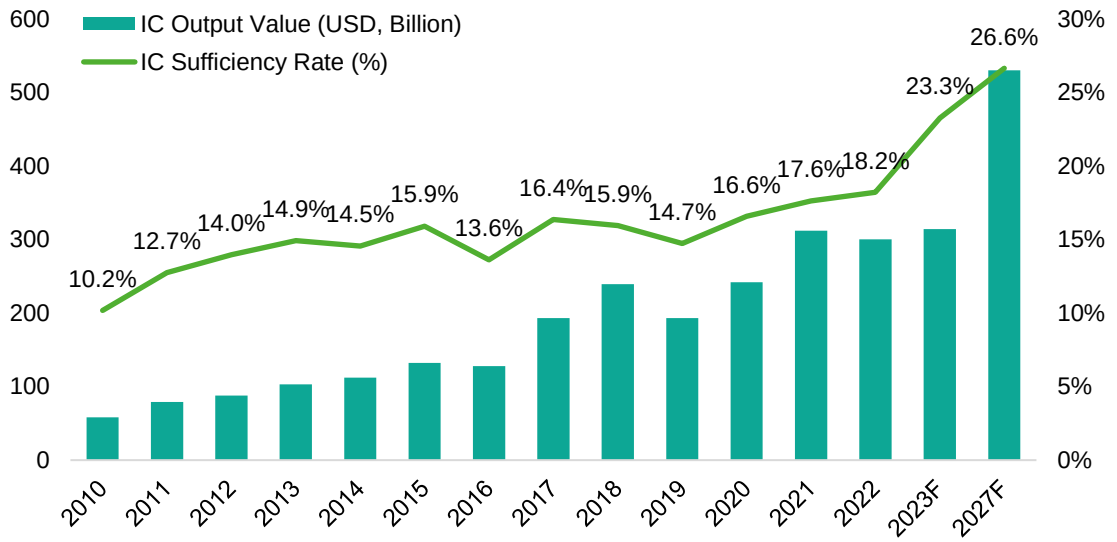
According to Reuters, an increasing number of Chinese semiconductor design companies are collaborating with Malaysian companies to assemble some high-end chips. Due to trade sanctions and supply chain issues, many Chinese chip design companies have accelerated overseas investments or cooperation to support their businesses within and outside China.

Chinese semiconductor companies' business in Malaysia		
Companies	**Type**	**Business**
Xfusion	IC Design	Partnering with NationGate Malaysia to manufacture GPU servers
StarFive	IC Design	Established its first Southeast Asia regional design centre in Penang, Malaysia, and will invest MYR 250 million in the next five years to expand the Malaysian company's business
Tongfu Microelectronics	Packaging & Testing	Expand its Malaysian factory (joint venture with US chipmaker AMD)

Southeast Asian regions has accelerated the construction of chip manufacturing and packaging and testing production capacity: Leading European and American IDM and OSAT companies have begun to increase investments in the Southeast Asian market. Southeast Asia is expected to play an increasingly important role in the semiconductor packaging and testing market, with Malaysia and Vietnam being regions worthy of focus for the development of the OSAT field. IDC predicts that Southeast Asia's share of the global semiconductor packaging and testing market will reach 10% in 2027.

There is still great potential for growth in future production capacity as China's chip self-sufficiency rate is low: According to statistics from Techinsights, China's IC output value was USD 30 billion in 2022, and the IC self-sufficiency rate, including Chinese and foreign investment, will be 18.2%. The output value of the Chinese IC manufacturing industry will reach USD 15.2 billion, a year-on-year increase of 13%. According to Techinsights forecast, China's IC output value is expected to reach USD 53 billion in 2027, the CAGR of output value is expected to reach 12% from 2022 to 2027, and the IC self-sufficiency rate, including Chinese and foreign investment, will reach 26.6%.

IC Output Value in China



Data Source: Techinsights

2.3.2 ROHM Plans to Jointly Invest USD 2.7 billion with Toshiba to Manufacture Power Chips

Japanese companies Toshiba and ROHM have once again joined forces, investing approximately USD 2.7 billion to jointly produce power chips. According to the latest plan, ROHM will invest JPY 289.2 billion in a new factory in Miyazaki Prefecture, southern Kyushu Island, to produce silicon carbide power chips. At the same time, Toshiba will invest JPY 99.1 billion to build an advanced 300mm chip manufacturing plant in Ishikawa City, central Japan, to produce silicon power chips. The cooperation between ROHM and Toshiba aim to increase the production of power semiconductors (planned to more than double) to meet the demand for more efficient and stable chip equipment in areas such as electric vehicles and factory automation.

Companies	Power Chip Business Updates
Mitsubishi Electric	As of March 2026, it will double its previous investment plan to a total of approximately JPY 260 billion, mainly for the construction of new wafer fabs to increase the production of SiC power semiconductors.
Fuji Electric	It plans to start production of power chips at a wafer fab in Malaysia in fiscal 2023 and plans to start mass production at the Tsugaru Factory in Aomori Prefecture in fiscal 2024, establishing a production system with two bases.
Toshiba	Plans to start mass production of silicon carbide power chips in 2025 and continue to promote the R&D of gallium nitride (GaN) power semiconductors.
Renesas	Production of next-generation power semiconductor products using SiC to reduce losses will begin in 2025, and mass production is planned at the Takasaki Factory in Gunma Prefecture, which currently produces silicon-based power semiconductors.
ROHM	It is planned to inject JPY 510 billion into SiC by the end of March 2028 to develop the silicon carbide industry chain. The goal is to increase SiC wafer production capacity by 35 times by 2030 compared with 2021. ROHM SiC production capacity will increase 6.5 times by 2025.
Nippon Denso	It will reach an agreement with global semiconductor foundry United Microelectronics to produce power semiconductors at the USJC 300mm wafer fab to meet the growing demand of the automotive market.

3. Application Updates

3.1 Artificial Intelligence

3.1.1 Nvidia Partners with Malaysia's YTL Power to Build AI Infrastructure

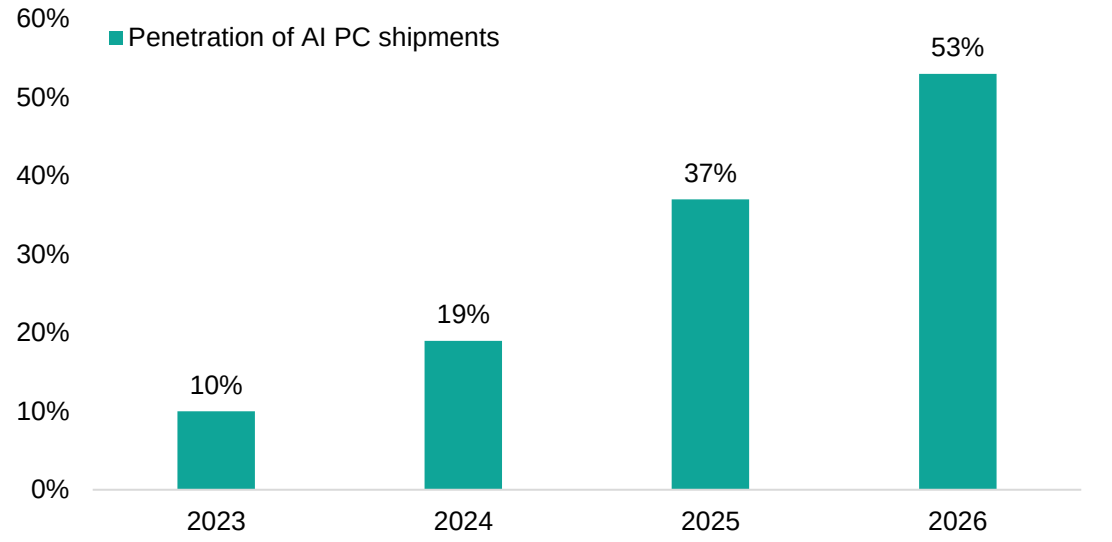
Nvidia is partnering with Malaysian energy utility YTL Power to build AI infrastructure in Malaysia, with the first phase expected to be operational by mid-2024. YTL Power will deploy Nvidia H100 TensorCore GPUs in data centers and use Nvidia AI Enterprise software to streamline AI production. The partnership will target Southeast Asian enterprises, providing Southeast Asian enterprises with computing power supported by Nvidia AI chips through cloud computing. It can be seen that the artificial intelligence industry is expected to grow in the Malaysian market.

3.1.2 Lenovo Releases AI PC Products with Optimism about the Future Consumer Electronics Market

Lenovo Group announced the launch of new business and consumer laptops, including the new ThinkPad X1 Carbon, ThinkPad X1 2-in-1, Xiaoxin Pro16 2024, and IdeaPad Pro 5i, all equipped with the latest Intel Core Ultra processors and Windows 11 systems. They all have three AI engine capabilities of CPU+GPU+NPU, which support local deployment of AI functions.

Data from Canalys shows that global AI PC shipments have exceeded 5 million units recently. As Intel-led x86 architecture begins to enhance its AI functions, it is expected that the number of models supporting AI functions will increase significantly from the first half of 2024. AI PC shipments will increase to 20 million units by Q4 2024, accounting for more than 25% of the global PC share by then.

Penetration of AI PC Shipments



Data Source: Canalys

In addition to PCs, the AI mobile phone market has stepped into a period of rapid growth. Research firm, Counterpoint Research, pointed out that with the launch of AIGC devices, the smartphone market may undergo revolutionary changes, such as providing pre-programmed responses, performing pre-defined tasks, and using AIGC to create original content. The agency predicts that generative AI smartphone shipments will be around 47 million units in 2023, accounting for approximately 4% of total smartphones. Shipments are expected to exceed 100 million units (accounting for 8%) in 2024 and reach 522 million units in 2027, accounting for 40% of smartphones. The average annual compound growth rate from 2023 to 2027 will be 83%.

3.1.3 Microsoft Implements Strategic Adjustment and will Reduce H100 AI Server Orders in 2024

Recently, Microsoft has announced a major strategic adjustment. It plans to reduce its H100 AI server orders from 120,000 to 80,000 units in 2024, and transfer some orders to B100, which is expected to be shipped in the fourth quarter of 2024. The computing power of B100 is at least twice of H100, but the price is only 50-60% higher. This means that Microsoft will achieve a more ideal balance between performance and cost, providing customers with more cost-effective solutions. This change is also seen as an important bet on the future server market, and how it will lead technology trends has attracted much attention. In addition to the reduction of H100 orders, Microsoft also plans to adjust its procurement of AMD MI300 and may postpone its advance payment for TSMC's CoWoS production capacity. This is not a move to cut orders, but to double the CoWoS production capacity required to meet

the B100 chip production capacity.

3.1.4 Medtronic and Cosmo Expand Collaboration to Apply AI to Endoscopic Care

Global medical device giant Medtronic recently announced that it will expand its partnership with Cosmo Intelligent Medical Devices to apply artificial intelligence to endoscopic care. Medtronic stated that this strategic alliance solidifies Medtronic's position in artificial intelligence-integrated healthcare solutions and represents a major leap forward in integrating artificial intelligence into endoscopic care.

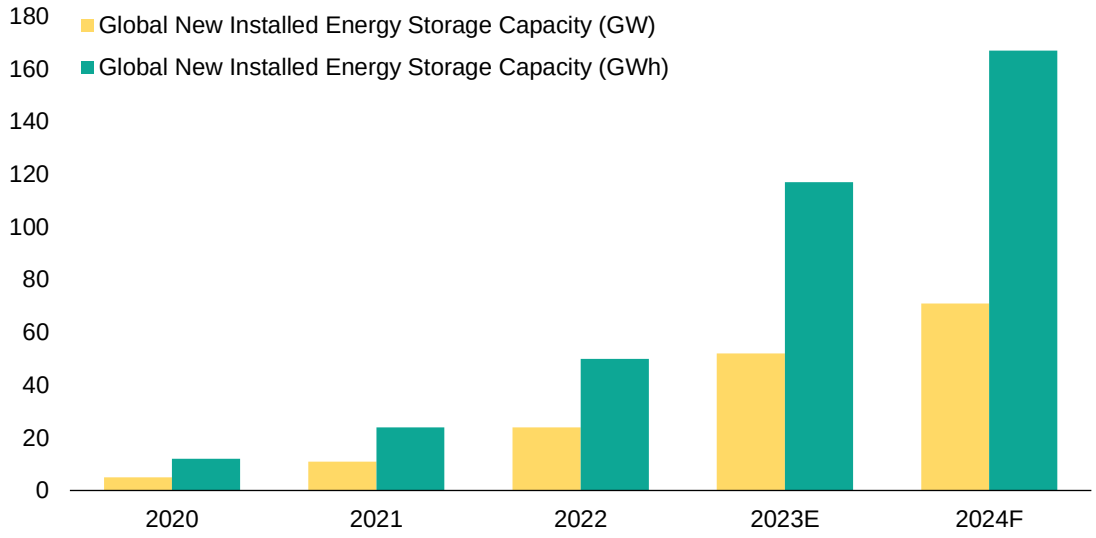
At present, most endoscope manufacturers have gradually integrated computer-aided diagnosis technology with hardware equipment. In the long term, competition in the field of endoscopy may shift from hardware to hardware and software in the future. However, in the short term, AI still has shortcomings in solving clinical pain points, and commercialisation will take time.

3.2 New Energy

3.2.1 Global Energy Storage Installed Capacity will Maintain High Growth in 2024, Benefiting High-power IGBT Modules Simultaneously

According to Trendforce data, it is expected that global new installed energy storage capacity will reach 71GW / 167GWh in 2024, a year-on-year increase of 36% / 43%. China, the United States, and Europe, as the main incremental markets, will account for 84% of the global total. Among them, China's newly installed energy storage capacity is expected to reach 29.2GW / 66.3GMh, a year-on-year increase of approximately 46%/50%.

Global New Installed Energy Storage Capacity



Data Source: TrendForce

According to the analysis of Guosen Securities, the electricity demand of industrial and commercial household owners is stable and large. As the power reform advances and the peak-valley electricity price gap continues to widen, it is highly economical to deploy energy storage, and it is expected that industrial and commercial storage will increase in volume. On the grid side, the demand for energy storage is becoming more urgent, especially the demand for large storage. Driven by the penetration of energy storage, the demand for IGBT modules used in medium and high power will increase simultaneously.

3.2.2 Sungrow and EDF Jointly Build a Wind, Solar and Storage Virtual Power Plant in South Africa

Recently, Sungrow signed a supply agreement with France's EDF Renewables to provide a 264MWh liquid-cooled energy storage system for South Africa's first wind, solar and storage integrated virtual power plant project.

This project is one of South Africa's Risk Mitigation Independent Power Producer Procurement Plan (RMIPPPP). After being connected to the grid, it will effectively alleviate South Africa's power crisis and improve the stability of energy supply. This is South Africa's first virtual power plant project, which consists of Avondale photovoltaic power storage station and Dasiesridge wind power storage station 900 kilometers apart. All of them use Sungrow's PowerTitan liquid-cooled energy storage system, which greatly enhances new energy consumption ratio.

The demand for energy storage in emerging household storage markets, represented by Africa, Southeast Asia, and the Middle East, is growing rapidly. In these areas, due to unstable power grids, the inverter's on-grid and off-grid switching capabilities directly affect the residents' experience, as well as inconvenience in using electricity in off-grid areas, there is an urgent need for backup power.

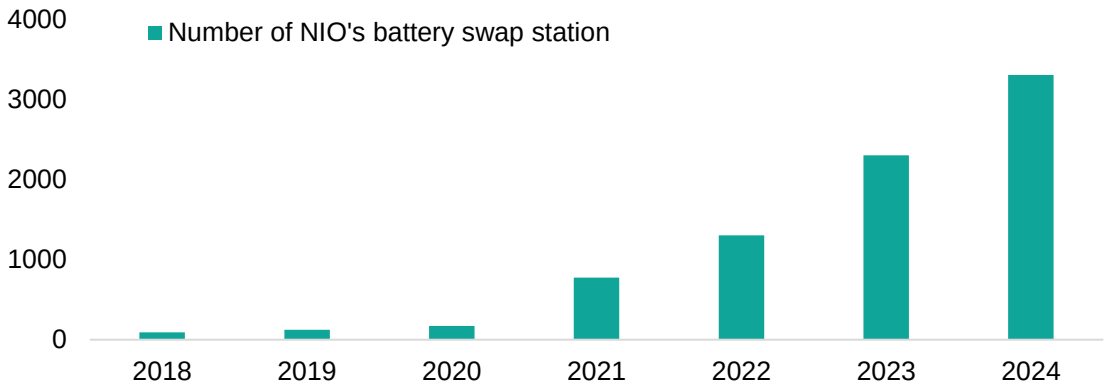
3.2.3 NIO Releases New Facilities for Charging Piles and Battery Swap Stations, and Investment in Construction will Drive Increased Demand for Chips

NIO released a 640kW fully liquid-cooled ultra-fast charging pile with a peak charging power of 640kW, a maximum output current of 765A, a maximum output voltage of 1000V, and a liquid-cooled charging cable of 2.4kg. It can intelligently allocate charging power in the station in real time.

NIO also released the fourth-generation battery swap station. The new battery swap station is equipped with 23 battery compartments, with a maximum daily service frequency of 480 times and a 22% reduction in battery swap time. Each fourth-generation battery swap station is equipped with 4 Orin X chips and will be launched in April 2024.

NIO has increased its investment in the construction of power swap stations in recent years: Throughout 2024, NIO will add 1,000 new power swap stations in the Chinese market, bringing the total to more than 3,310. It will also add 20,000 new charging piles, bringing the total to more than 41,000. The construction of charging and swapping network provides users with a more convenient power-up experience.

NIO's Battery Swap Facilities



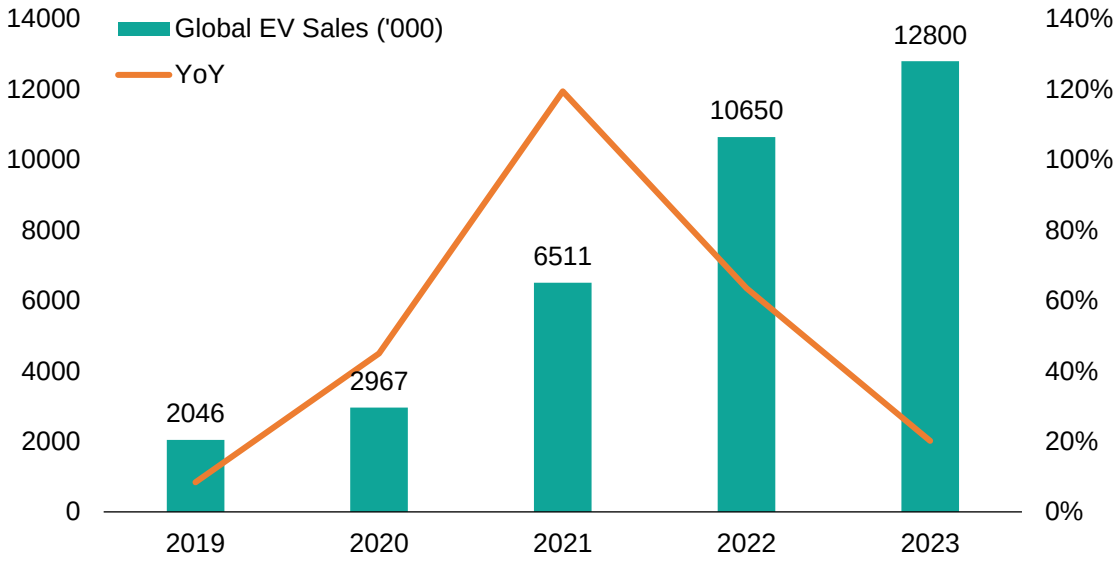
Data Source: NIO

3.3 Automotive

3.3.1 Global EV Sales are Growing Steadily, while the Growth Rate of the Chinese Market is Slowing Down

According to TrendForce, global sales of new energy vehicles (including BEVs, PHEVs, and FCVs) are expected to be approximately 12.8 million units in 2023, an annual increase of 20.2%. The sales proportions of each regional market are 60% in mainland China, 22% in Western Europe, 11% in the United States, and other regions 6%. However, with the gradual withdrawal of policy subsidies in mainland China and the steady increase in the penetration rate of the local EV market, the growth rate of China's EV market has begun to slow down. Coupled with the increasing demand for EV in overseas markets, many Chinese automotive brands have overseas business, especially Southeast Asia market, has seen significant growth. It is expected that Chinese automobile brands will account for approximately 67.5% of the new energy vehicle market in Southeast Asia this year.

Global EV Sales



Data Source: TrendForce

3.3.2 Japanese Car Companies Increase Investment in Thailand Market to Cope with Fierce Competition

According to reports, the Thailand government said that four Japanese automakers expect to invest USD 4.3 billion (equivalent to RMB 30.7 billion) in the next five years to produce electric vehicles in the country. The four Japanese automakers are Toyota, Honda, Isuzu and, Mitsubishi Motors. Toyota and Honda are expected to invest THB 50 billion each, while Isuzu and Mitsubishi Motors are expected to contribute THB 30 billion and THB 20 billion respectively. The Government of

Thailand Investment Committee said that some of the four Japanese companies will start producing electric vehicles in Thailand within two to three years.

Japanese cars are significantly lagging behind in the new energy transformation, and Chinese car companies are accelerating their entry into the Southeast Asian market to compete: According to Mark Lines data, Japanese new energy vehicles account for less than 5% of the overall global sales. However, as the demand for Southeast Asian countries to transition to new energy sources gradually increases and the local production of electric vehicles accelerates, Chinese car companies have seized the opportunity and begun to integrate into the transformation and production of the Southeast Asian automotive industry. Vehicle manufacturers, like SAIC, BYD, Geely, etc. all have plans to build production bases in Thailand, Malaysia, and other places, and Great Wall Motors has already launched local production in Thailand. In terms of parts suppliers, Gotion High-Tech, Svolt Energy, CATL, and others have built factories in Southeast Asian countries. In addition, Chery, Nezha, etc. have built localised production in Southeast Asia through KD factories or assembly. Taking Thailand, the largest car market in Southeast Asia, as an example, the number of registered electric vehicles in Thailand reached 67,056 from January to November 2023 according to AutoLife data. Models produced by Chinese car companies account for nearly 80% of the Thailand market.

3.3.3 Toyota Collaborate with Japanese Auto Giants and Chipmakers to Develop Cutting-edge Semiconductors for Autonomous Driving

It is reported that Toyota Motor has established a cutting-edge semiconductor research and development organisation, whose members include Japanese chipmaker, Renesas, and chip system company, Socionext. Parts makers affiliated with Nissan, Honda, Mazda, Subaru, Panasonic Automotive Systems, and Toyota are also expected to join. The project will be fully launched next year and will focus on cutting-edge semiconductors used in industries such as autonomous driving. It will work on SoC R&D that integrates semiconductors with circuit line widths below 10 nanometers onto a single chip.

3.3.4 Li Auto and ST Sign a Long-term SiC Supply Agreement

Li Auto and STMicroelectronics signed a long-term silicon carbide (SiC) supply agreement. According to the agreement, STMicroelectronics will provide silicon carbide MOSFETs to Li Auto to support Li Auto’s strategic plan to enter the high-voltage pure electric vehicle market.

In order to comply with the general trend of accelerating the introduction of SiC MOSFETs into cars and ensure the stability of the automotive supply chain, it has become the norm for new energy vehicle manufacturers and leading semiconductor power device companies to work together. Car companies adopt the method of directly introducing external mature technologies and products to quickly launch SiC models in order to gain first-mover advantages.

On the other hand, car companies are also gradually deepening the layout of the SiC industry chain. For example, Li Auto is accelerating production capacity construction and technology research and development. In August 2022, Li Auto's power semiconductor R&D and production base officially started construction in Suzhou High-tech Zone. The base is built by Suzhou Sco Semiconductor Company, a joint venture between Li Auto and Hunan Sanan Semiconductor. It is expected to be officially put into production in 2024 and will eventually reach annual production capacity of 2.4 million SiC half-bridge power modules. Recent signs also indicate that Li Auto is setting up a team in Singapore to develop SiC power chips.

3.4 Others

3.4.1 Ericsson Partners with AT&T to Create Open RAN

AT&T announced the award of a five-year Open RAN contract worth USD 14 billion to Ericsson. According to AT&T’s plan, up to 70% of its mobile network traffic will be transferred to the Open RAN architecture by 2026, which means Ericsson will become AT&T’s main 5G supplier. It is reported that the core of the strategic agreement between the two parties is to create an open programmable network. This will enable AT&T to accelerate commercial deployment of Open RAN equipment and open network management solutions from multiple vendors, leveraging purpose-built and virtualised commercial off-the-shelf (COTS) hardware.

3.4.2 Mobile Phone Manufacturers such as Samsung and OPPO Plan to Increase Production by 6%-9% in 2024

Smartphone manufacturers such as Samsung, and OPPO plan to increase production in 2024, with expected increases between 6% and 9%. Higher increases are expected to occur in higher-end market segments.

Samsung has told suppliers that it aims to produce more than 240 million smartphones in 2024. Samsung forecasts indicate that production of its flagship foldable smartphone Galaxy Z series will increase by about 8% in 2024, while sales of its more affordable Galaxy A and M series will increase by more than 10%, and

shipments of Galaxy S Ultra will also be a double-digit increase.

Besides, Chinese smartphone maker, OPPO, plans to produce as many as 150 million smartphones in 2024, an increase of more than 6% from about 141 million units in 2023.

4. Market Trends of Products

4.1 Memory: Outlook for Memory Chip is Promising with High Market Price Continuing

Price Updates: Morgan Stanley's latest report revised its projections, anticipating an upward trend in memory chip prices. It pointed out that memory chip market will enter a period of accelerated cyclical growth and significantly increased demand. DRAM and NAND prices are expected to rise by 20% in Q1 2024. The latest expectation is double the previous increase with the previous expectation was that DRAM price increases would be 8%-13%, Predicted NAND price increase is 5%-10%.

Inventory Side: Customers have begun to replenish inventory. Chinese smartphone OEM manufacturers will see a significant increase in orders in Q1 2024, and laptop ODM/OEM manufacturers are also building inventory. The replenishment of inventory by smartphone manufacturers will lead to price increases and inventory will return to normal levels – takes 4-6 weeks for mobile DRAM and 6-7 weeks for NAND.

Supply Side:

1) At the end of the third quarter in 2023, Samsung expanded production cuts in order to effectively alleviate inventory pressure, mainly targeting DDR4 products with high inventories. In the fourth quarter, the production reduction rate expanded to 30%, and the total production orders declined. Samsung believes that demand will recover during the peak season, so production orders will begin to increase in the second quarter of 2024.

2) SK hynix has benefited from the growth in HBM and DDR5 shipments, and its production capacity has recovered slightly. In addition, the penetration rate of DDR5 products in the application market is expected to increase in 2024, and the total wafer production volume will increase quarter by quarter.

3) Micron’s inventory level is relatively healthy due to production cuts. Wafer production volume in 2024 is expected to still increase slightly, and the focus of capacity expansion will be on the process change.

Demand Side:

After memory chip manufacturers have significantly reduced production and actively destocked, their output is far below demand. On the demand side, the demand for artificial intelligence will further boost the price of memory chips, which is specifically reflected in the impact of growth of HBM chip market size (USD 10 billion) in 2024, and the outbreak of AI demand will lead to an extension of the supply shortage cycle. In addition, Morgan Stanley predicts that starting from 2024, the demand for AI edge computing will become more and more common and may result in a wave of smartphone upgrade.

4.2 Power: Demand for Low-voltage MOSFETs is Relatively Weak, while Demand for High-voltage MOSFETs will Continue to Grow

In terms of inventory, power device inventories are overall higher, and the structure is differentiated. Starting from the second half of 2022, the inventory of low-voltage materials such as consumer or industrial products has been fully reduced after one year of inventory consumption. However, the inventory of high-voltage components such as automotive or photovoltaics is still at a high level.

In terms of production capacity, due to the slowdown in demand, overcapacity and downward price pressure, some manufacturers have slowed down their production expansion progress and their capital expenditures have been relatively stable.

MOSFET: The low-voltage and high-voltage MOSFET markets are differentiated. The supply situation of low-voltage MOSFETs has eased. The delivery time for low-voltage MOSFETs is about 46 weeks or more and that of high-voltage MOSFETs is more than 50 weeks. The shortage of high-voltage automotive MOSFETs will continue until the end of 2023.

IGBT: The orders of international major IGBT manufacturers such as Infineon, ON Semiconductor, and ST, are generally in a relatively full state, and prices are generally relatively stable. Product delivery times are generally more than 39 weeks, especially for wind and solar storage IGBTs and other parts. The delivery time for materials in short supply is still more than 52 weeks.

4.3 Analog: Overall inventory is still High, but some Devices may have Witnessed Price Increases

According to a Supplyframe report, demand for analog power and analog signal chain chips continued to decline in the fourth quarter of 2023. Due to the weak demand for consumer electronics, the analog chip market size is expected to decline

by 5%-10% throughout the year in 2023. Overall, analog chip inventories remain high, but the price of high-performance analog chips remains stable. Delivery time of consumer products has been shortened to 16-20 weeks, but the delivery time of communications and medical area is still as long as 56 weeks.

Analog chips have a long-life cycle. Manufacturers often raise the prices of existing products as a strategy to promote and introduce new ones. ADI increases the price of old products to encourage customers to replace them with new products. On the other hand, it also reflects ADI's optimism about the recovery of market demand. However, industry experts analyse that ADI's move has little impact on the Chinese spot market because of the inversion of spot prices and acceleration of China's substitution.

ADI's current shortages are still concentrated in industrial control and automotive-grade materials, and delivery time is basically more than 26 weeks. For example, LTC2262IUJ-14#TRPBF has a long delivery time, and the current market price is relatively high (maintained at around RMB 900). The delivery time of LTC6078HMS8#PBF, LTC2411IMS#TRPBF and other materials has improved.

Price of LTC2262IUJ-14#TRPBF

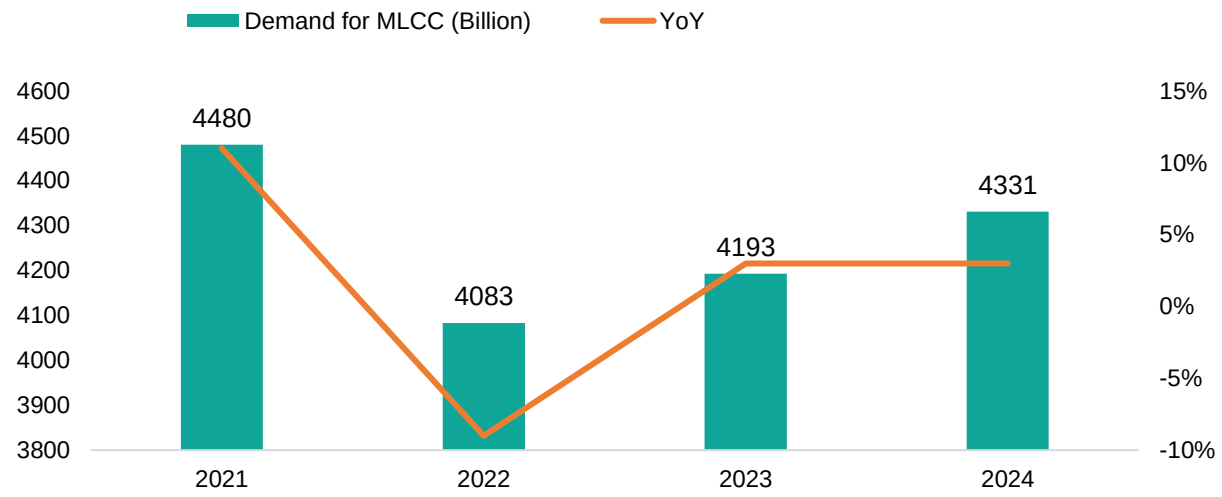
Data Source: ADI

4.4 Passive: The Market Bottoms Out and the Demand for MLCC Grows Steadily

According to a TrendForce forecast, global MLCC demand will reach 4,193 billion units in 2023, a year-on-year increase of 3%. The main driving force will come from the recovery of consumer electronics. Although the global economic environment is still unclear, TrendForce predicts that the demand for MLCCs will still grow steadily to

4,331 billion units in 2024, with the growth rate being the same as in 2023.

Demand for MLCC



Data Source: TrendForce

According to the latest MLCC market report released by Grand View Research, the global MLCC market size will be USD 11.46 billion in 2023, a year-on-year increase of 5%. The global market is expected to grow at a CAGR of 5.6% to USD 16.77 billion by 2030.

The overall market inventory situation of the passive component industry in Q4 2023 will continue to improve, and inventory levels will gradually decrease. Passive component dealers in Taiwan, said that the average customers' inventory dropped from 3.5 months to about 1.7 months, the average dealer market inventory also dropped from 3.5 months to about 2.1 months, and the factory inventory dropped to about 1-1.5 months.

5. Market Opportunities and Risks

5.1 Opportunities

5.1.1 Memory Chipmakers' Future Price Increasing may Shift to DRAM

According to reports, leading chipmakers such as Samsung, and Micron plan to increase DRAM prices by 15%-20% in the first quarter of 2024, which will be implemented from January, urging customers to plan in advance for future demand. It can be seen that the focus of chipmakers' price increases will shift from NAND to DRAM. DDR4 and DDR5 are expected to become the focus of the next round of price increases, while DDR3 production capacity and demand are relatively stable, and the increase is expected to be gradual.

Cutting production capacity remains an important price-preserving strategy for chipmakers. In the second half of 2023, Korean DRAM manufacturers have been reducing DRAM capacity utilisation and gradually increasing the output of high-end processes. Taking Samsung as an example, Q4 DRAM output in 2023 only accounts for about 70% of Q1 2023. It is understood that the overall DRAM production capacity supply in Q1 2024 will still tend to be restrained and cautious. In the future, suppliers will continue to reduce production of mature processes and shift to advanced process technologies.

5.1.2 AI-driven computing chip demand

AI chips, servers, and data centres will expand significantly in scale due to the increasing iteration speed of large AI models, manufacturers' huge investments in intelligent computing power, and manufacturers' major investment in computation power. IDC data shows that China's AI chip shipments will reach 1.335 million pieces in 2023, a year-on-year increase of 22.5%.

5.1.3 Chip replacement in the domestic market

As Internet giants seek advanced computing power chips from domestic semiconductor manufacturers, they are cooperating with semiconductor manufacturers. The domestic memory chip industry has made significant advances in some areas and has gradually closed the gap with foreign original manufacturers when it comes to memory chips. The top 3 NOR Flash vendors are GigaDevice, Juchen Technology, which ranks third in the world for EEPROM chips, and Yangtze River Storage has launched a 128-layer 3D NAND memory chip, catching up with foreign manufacturers' advanced technology.

5.2 Risks

5.2.1 The Short-term Outlook for MCU is Subdued with Small Chance of Price Uptrend

Morgan Stanley's latest report points out that as market demand growth continues to be weak, dealers do not expect MCU prices to increase in the short term, and customers are selling part of their inventory for capital return. Inventory adjustments are still ongoing. If demand does not rise significantly, spot prices are likely to remain stable in the next 1-2 quarters.

According to DigiTimes, the overall MCU market situation has not yet seen a significant recovery, and consumer market demand is generally weak. Many MCU manufacturers are facing inventory adjustment problems. In addition, the global economy is weak resulting in poor motivation for customers to purchase goods.

Customers still adopt a conservative attitude towards new orders, causing chipmakers to gradually reduce their orders for chip manufacturing.

Conclusion

In December 2023, the global economy remained sluggish, and the manufacturing PMIs of major countries in Asia have declined. According to WSTS, in 2024, the Americas' semiconductor sector will gain a strong growth and memory chip market is expected to reach a highest growth rate contributing to the increase of overall market.

The United States and China have put forward some restrictions to protect their domestic supply chains and increase semiconductor self-sufficiency. In terms of leading chip manufacturers, they have announced to increase prices of some products, such as CIS, memory chips and analog devices, indicating that their optimism about recovery of semiconductor industry.

DRAM's price will rise as major chipmakers reduce production, and Samsung's new quotation and the wave of artificial intelligence may result in increasing demand for logic chips. However, in the short term, prices for MCUs are not expected to increase.

To conclude, the semiconductor industry will show signs of structured growth and some segmenting sectors will perform better. Since export restrictions around the world have been tighter, companies in the industry should take geopolitics risks into consideration and manage to stablise their supply chains.

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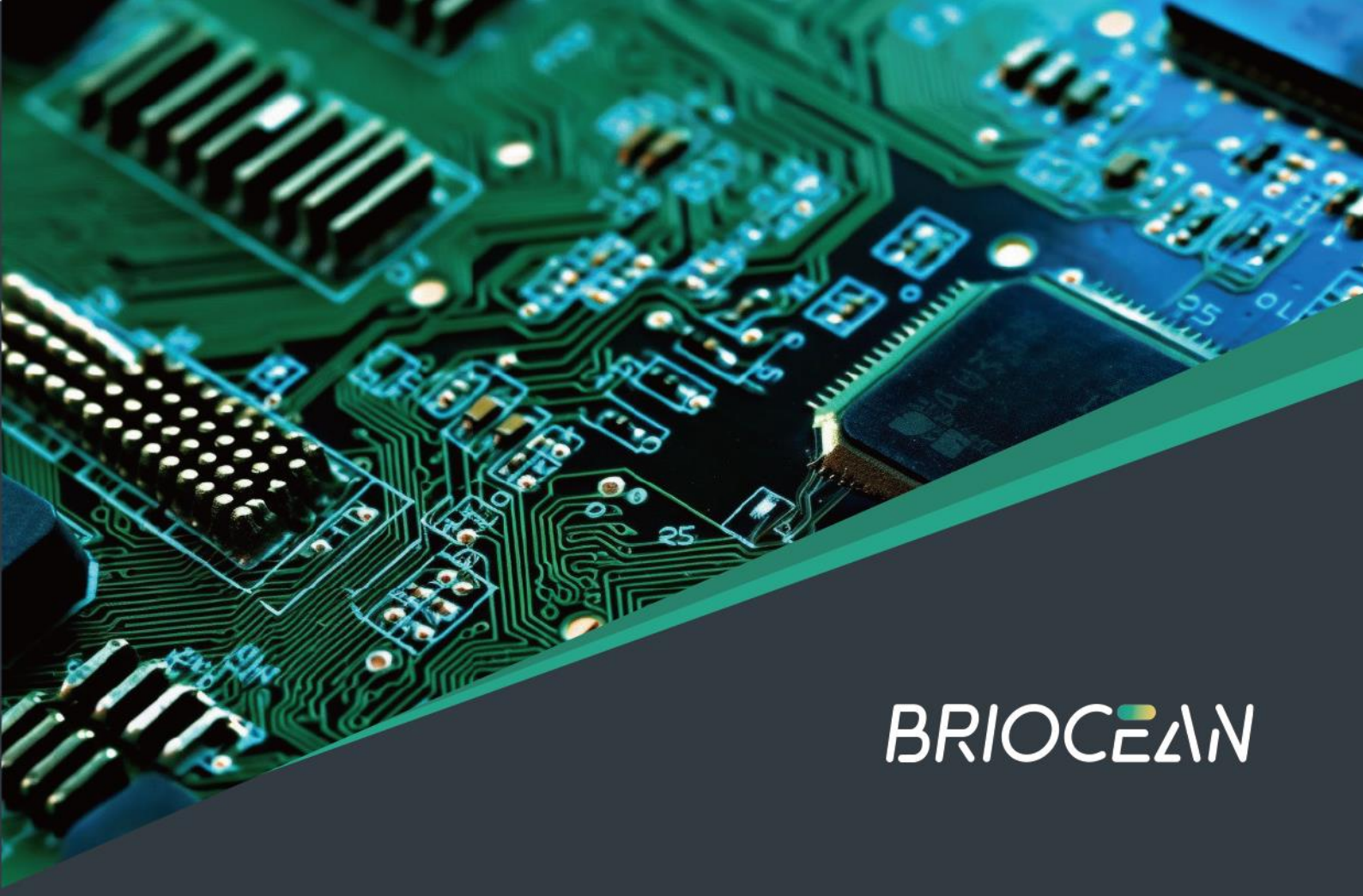

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