China's 32-bit MCU in High Standard Applications

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Contents

1. Key findings

- The worldwide semiconductor market will continue its decline and hit a trough in 2023. Mainland China's semiconductor shipment revenue is expected to return to growth in 2024.

- Despite general weakness in the overall semiconductor market, the 32-bit MCU market is forecast to keep growing in 2023.

- Automotive electronics were the dominant application in China's 32-bit MCU market in 2022. Body, chassis domain, and xEV held a majority share of the MCU automotive market in 2022.

- Automation and power & energy accounted for more than half of China's 32-bit MCU industrial market in 2022.

- High-performance MCUs—particularly 32-bit MCUs for automotive and industrial applications—show good growth potential. China's domestic MCU makers are benefiting and growing, even with heightening barriers to entry.

2. Worldwide and China semiconductor market overview

2.1 Worldwide semiconductor market will keep declining in 2023 but recover afterward

In 2022, global semiconductor revenue was about $596bn, a slight 0.5% growth compared to 2021. Omdia forecasts 2023 revenue will decline to $548bn. One reason is that demand for end devices (such as smartphones and PCs) continues to weaken; another is memory price erosion. However, with supply and demand expected to be restored and turning onto the next cycle, the market is forecast to rebound in 2024 and grow to reach $728bn in 2027 at a 4.1% CAGR.

**Figure 1: Global semiconductor market and forecast**
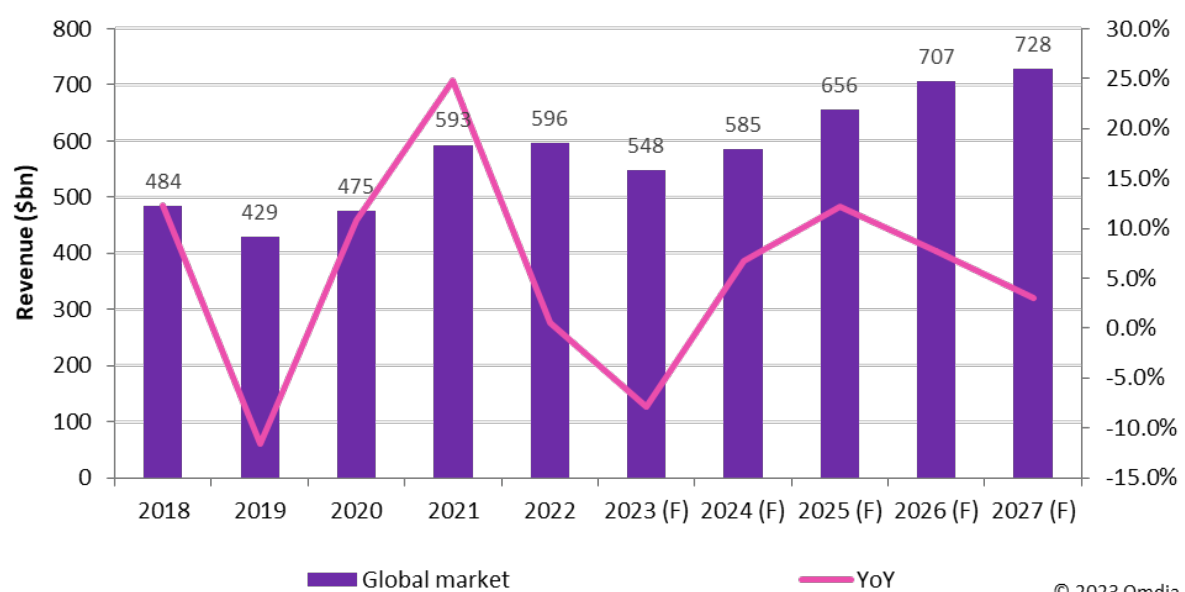
Source: Omdia

2.2 Mainland China's semiconductor market shipped revenue will return to growth in 2024

About $293bn worth of semiconductors was shipped into mainland China in 2022. It is a 2.9% drop in comparison to the historical high point in 2021, largely driven by lower memory prices and weaker demand. This number is expected to continue declining in 2023 to $265bn but reverse to grow in 2024 with a 3.5% CAGR to 2027.

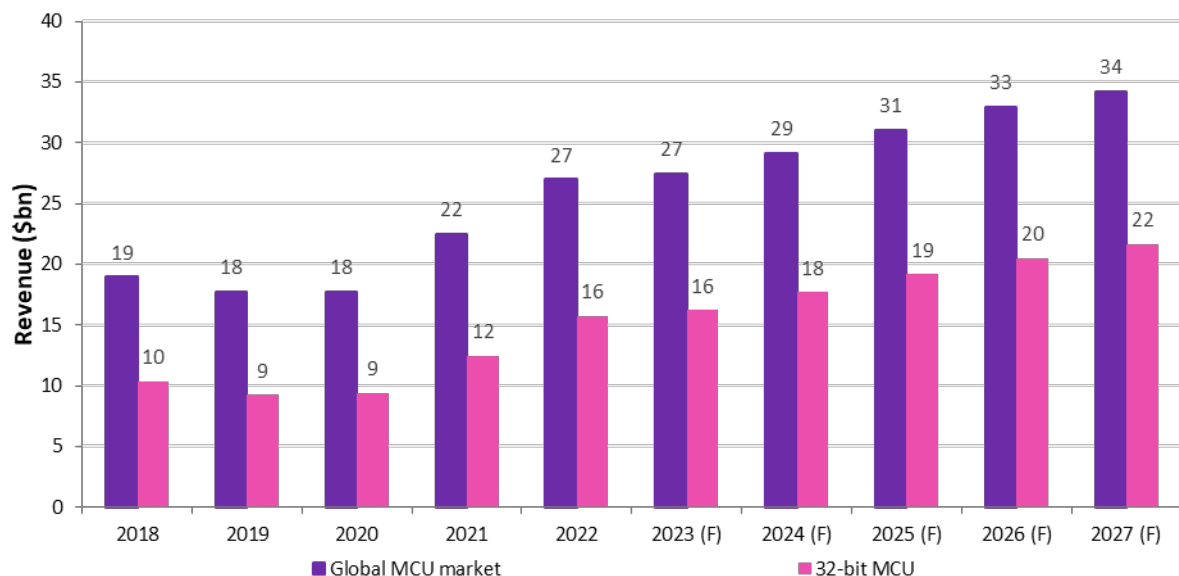**Figure 2: China's semiconductor market and forecast**
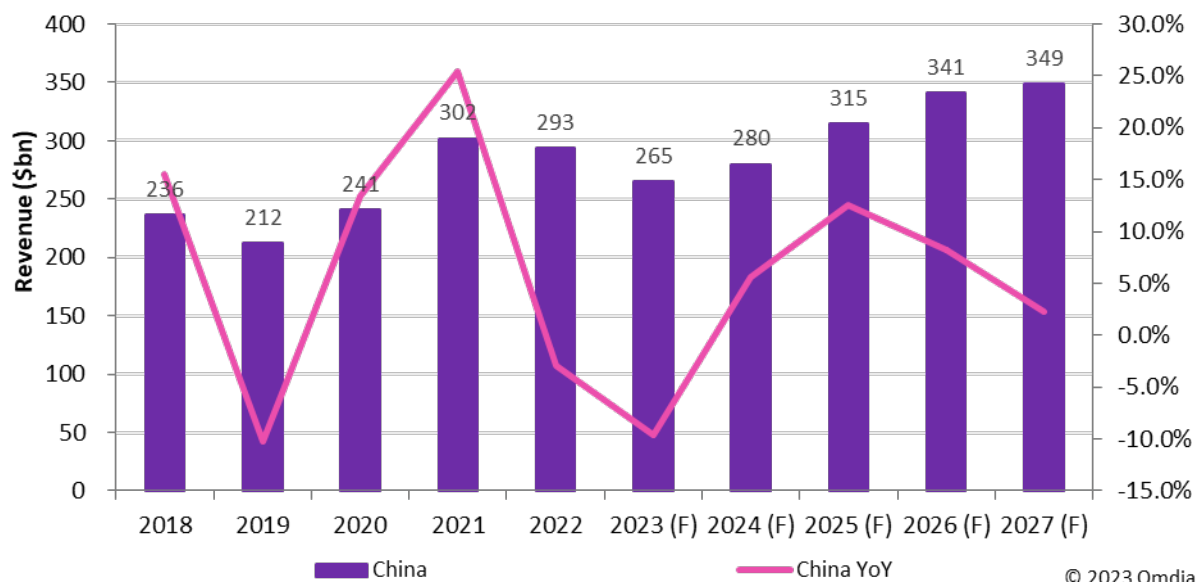
Source: Omdia

3. Mainland China's 32-bit MCU market overview

3.1 The 32-bit MCU market is forecast to keep growing in 2023

The 32-bit MCUs dominate over because of their popularity with embedded applications. They offer higher processing power, larger addressable memory, good performance-power trade-off, and a rich support ecosystem. China's 32-bit MCU market is forecast to keep growing in 2023 by 4.5% YoY, even though the overall market is forecast to be comparably promising in 2023.

Figure 3: Global MCU revenue and 32-bit MCU

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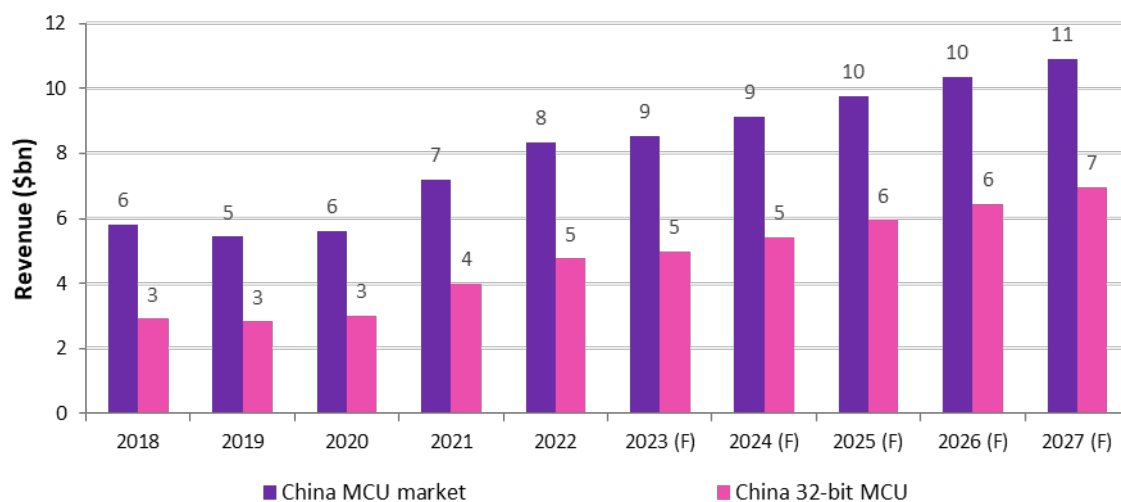**Figure 4: 32-bit MCU market share, 2022**

Others, 42%

32-bit MCU, 58%

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Source: Omdia

Global MCU revenue reached a record high of $26.9bn in 2022. The worldwide chip shortage boosted the average selling price (ASP), and downstream players actively built inventory to safeguard supply. A turning point was reached in 4Q22 when the market turned to oversupply and demand softened. A growth rate of 1.6% YoY is forecast in 2023. However, 32-bit MCU, which accounted for 58.3% of the total MCU market in 2022, will still grow as predicted, with a 6.6% CAGR from 2022 to 2027. As end-application requirements keep rising and 32-bit MCU prices and costs continue to be optimized, the market share of 32-bit class MCU is certain to increase.
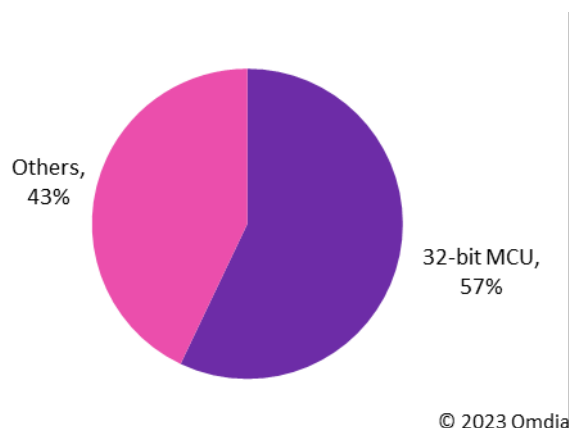
Figure 5: China's MCU revenue and 32-bit MCU

Source: Omdia

Figure 6: China's 32-bit MCU market share
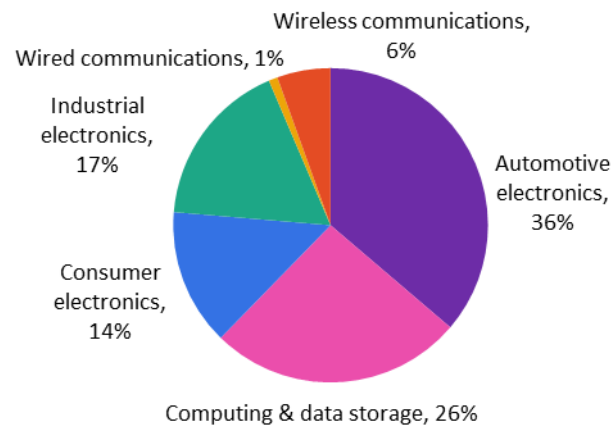

Others, 43%

32-bit MCU, 57%

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Source: Omdia

For China's MCU market, total MCU sales increased significantly in the past three years to exceed $8bn in 2022. However, that anomalous, accelerated growth had flipped by the end of 2022. In 2023, a drop is predicted owing to the high level of inventory and lessened demand for end products. The 32-bit MCU took 57.1% of the Chinese MCU market. Thanks to abundant applications and complex usage scenarios, Omdia believes demand will hold up and forecasts 32-bit MCU will keep leading the market, growing at a CAGR of 7.9% from 2022 to 2027, which is higher than China's overall MCU CAGR of 5.5%.

3.2 Automotive electronics was the dominant application in China's 32-bit MCU market in 2022

Today, 8-bit MCUs remain widely used in multiple markets. For that reason, 32-bit MCUs may see less penetration than one would otherwise expect, despite having higher profit margins.

Figure 7: China's MCU share by application, 2022

Wired communications, 1%
Wireless communications, 6%
Industrial electronics, 17%
Automotive electronics, 36%
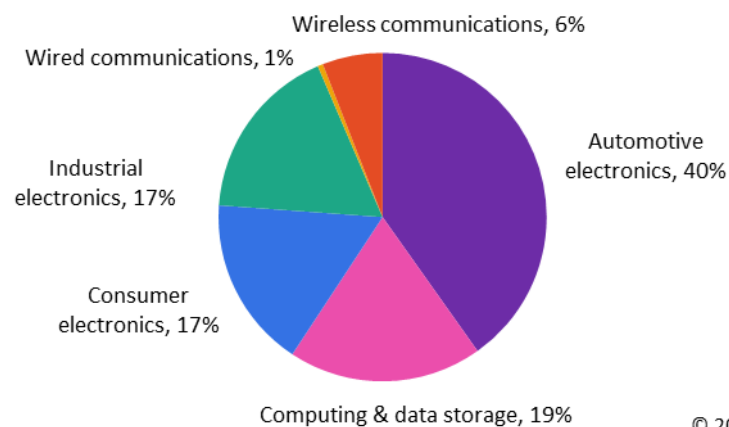Consumer electronics, 14%
Computing & data storage, 26%

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Source: Omdia

Today, 32-bit MCUs for automotive account for 40% of China's total 32-bit market—the largest share of any application. **Figure 8** shows the shares of major applications. Those ranked behind automotive are "Computing & data storage," "Industrial electronics," and "Consumer electronics," accounting for 19%, 17%, and 17%, respectively.

Figure 8: China's 32-bit MCU share by application, 2022

Wired communications, 1%
Wireless communications, 6%
Industrial electronics, 17%
Automotive electronics, 40%
Consumer electronics, 17%
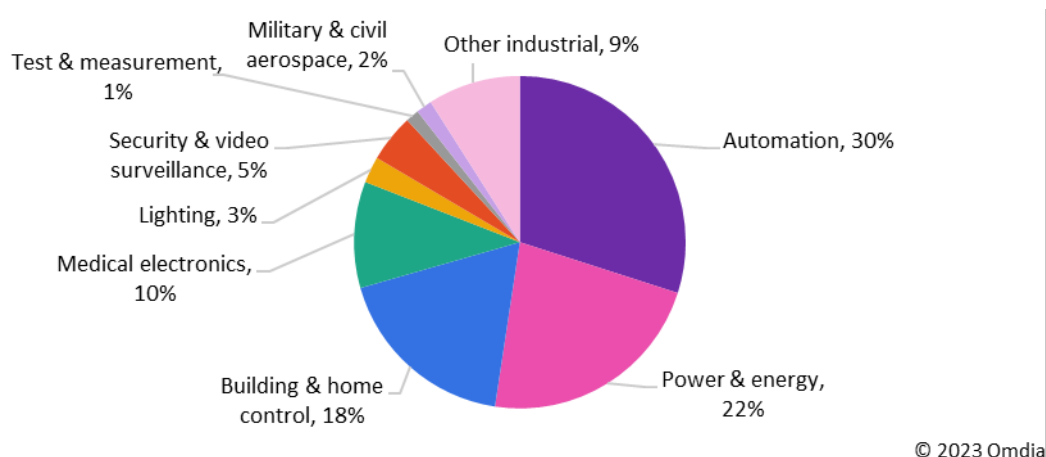Computing & data storage, 19%

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Source: Omdia

3.3 Automation and power & energy took more than half of China's 32-bit MCU industrial market in 2022

In alignment with China's plan to have carbon dioxide emissions peak before 2030 and achieve carbon neutrality before 2060, plenty of detailed strategies and plans have been issued and are carried out in China. With the readiness of technology and public infrastructure, such as industrial automation, NB-IoT, and 5G network, clean and smart energy applications are booming in China. High-standard 32-bit MCU seized the opportunity and widely penetrated the manufacturing & process automation, power & energy, and building & home control markets, which make up about 70% of China's total industrial 32-bit MCU market.

Figure 9: China's industrial 32-bit MCU revenue share, 2022

Test & measurement, 1%
Military & civil aerospace, 2%
Other industrial, 9%
Security & video surveillance, 5%
Lighting, 3%
Medical electronics, 10%
Automation, 30%
Building & home control, 18%
Power & energy, 22%
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Source: Omdia

The industrial market is one of the key markets for microcontrollers. The natural design of an MCU combines many modules, including CPU cores, eNVM memory, timer register, AD/DA, and IOs, which are perfectly suitable for automation control and flexible for massive applications.

Factory automation, including industrial robotics and, more generally, Industry 4.0, will be the fastest-growing sub-segment. Agriculture, shipping, transportation infrastructure, mining, and other markets are heavily invested in advancing the Industrial Internet of Things (IIoT) and fog computing strategies. MCUs can be used for digital power supply and in various servo motors and industrial automation.

Power & energy includes energy generation, conversion & storage, and distribution. It also includes energy-related meters, such as electricity, water, and gas, as they transition from simple to smart

meters. The building & home control category includes all kinds of buildings and home control systems, including HVAC, smoke & gas detectors, and safety applications. It's not only in China; globally, "smart industry" and "smart city" are becoming the next big step after urbanization.

Medical applications continue to see services evolve toward connected clinical, portable, and mobile applications to centralized health services. As a result, medical applications such as oximeters continued their strong growth throughout the pandemic.

From a quality and reliability point of view, an industrial microcontroller that meets IC standard JEDEC and factory standard TS16949 requires a lower defect parts per million (DPPM) level than consumer products. With applications becoming more complex and 32-bit MCU ASPs falling, 32-bit high-standard security MCUs are gaining more penetration market share than 8-bit ones. The ARM-based ecosystem has been built so strong that it outclassed other architectures on most applications. ARM Cortex-M and Cortex-R for real-time control dominated advanced MCU architecture solutions. It is similar to SOCs with multi-cores like Cortex A and high-end Cortex M cores. On the other hand, as a "rising star" for CPU architecture, RISC-V has been used in low-power embedded system controllers and processors for massive edge IoT scenarios. The more powerful part is that it can also be used as a data server CPU for HPC-class high-end CPUs. Omdia does not expect one to replace the other; both ARM and RISC-V are booming in the low-power and mobile application and industry fields.

3.4 Body, chassis domain, and xEV took the major share of the MCU automotive market

Vehicle OEMs are driven by the demand for solutions that communicate vast data to fulfill trends of decentralized control, enhanced functional safety levels, and efficient diagnostics & maintenance. 32-bit MCU is the perfect choice for various functions within the body & convenience application segment, such as body control modules, LED lighting systems, USB Type-C power delivery, and so on.

Driven by the Chinese government's development plan for the new energy vehicle (NEV) industry, NEV sales in China's mainland boomed in 2022, increasing 93.4% compared to 2021. As this proactive plan and promising market carry on, the xEV system secures its position as the leading sub-application in automotive 32-bit MCU.

Body & convenience, chassis & safety, and powertrain are the legacy domains for microcontrollers, consuming 27%, 16%, and 6%, respectively. The microcontroller is widely implemented within the ECU or domain controller, whether in traditional ICEVs, luxury cars, or hybrid electric vehicles. Meanwhile, automotive electronics architecture is transforming. Modern vehicles require more sensors for autonomous driving, more fashionable instruments in the infotainment domain, more cybersecurity, and convenient controls. These aspects led to vehicle electronics architecture shifting away from today's domain-specific electrical/electronic (E/E) architecture toward zonal and centralized E/E architectures. Therefore, high-end MCU has broad market prospects.

For the ADAS and infotainment (smart cockpit) domains, both MCU and whole revenue has kept increasing. In this segment, powerful xPU/SoCs take the central control position. At the same time, the MCU, as a security sub-controller, mainly focuses on low-level signal processing and control and feedback to the main processor. That's the reason SoC revenue increases much faster than MCU revenue in this segment.

**Figure 10: China's automotive 32-bit MCU revenue share, 2022**
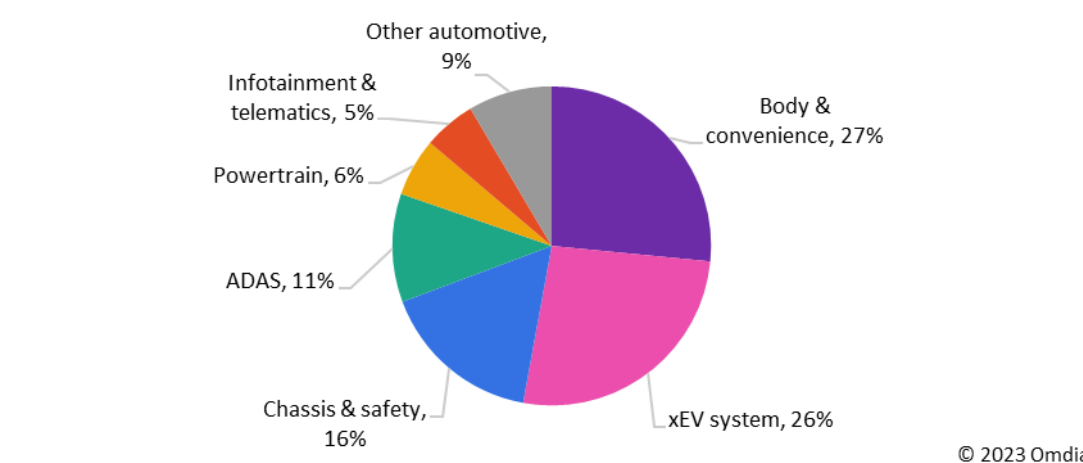
Source: Omdia

The xEV system is the second-largest segment in automotive. Across the world, countries have set carbon emission targets. For instance, China will support areas for clean energy to peak carbon emissions in 2030, so xEV systems will proliferate as expected. BMS, DC converters, and onboard chargers, which need MCUs to manage operations and communicate with other modules, are becoming essential parts of an electric vehicle.

The opportunity for MCUs in automotive is great. However, since automotive semiconductors have standard specifications (such as AEC-Q100 and ISO26262 [ASIL]) that are significantly higher compared with consumer electronics and extremely tight DPPM requirements (0 DPPM for critical parts), high-end IC components theoretically face challenges during the whole manufacturing process—including chip design, wafer fabrication, CP testing, assembly, FT testing, and related quality and reliability qualifications and monitoring. Due to this long process, the automotive chip supply chain usually remains stable. For auto OEMs, supply chain stabilization and security are key. The chip shortage, which has caused ASPs to increase irrationally, cannot sustain in the long run. OEMs will tend to choose chip makers offering stable supply, and MCU markers should always bear this in mind for the auto business.

3.5 Major home appliances dominate China's 32-bit MCU consumer electronics application market

In 2022, so-called "white goods," which include massive home applications, such as AC, refrigerators, washing machines, dishwashers & dryers, bakers, heaters, microwaves and ovens, and robotic appliances, made up 62% of the consumer 32-bit MCUs market in China. Meanwhile, "black goods," which include home audio- and video-related electronics and fitness & wellness wearable electronics, took the second-largest share of around 35% of China's consumer 32-bit MCU market.

Figure 11: China's consumer 32-bit MCU revenue share, 2022
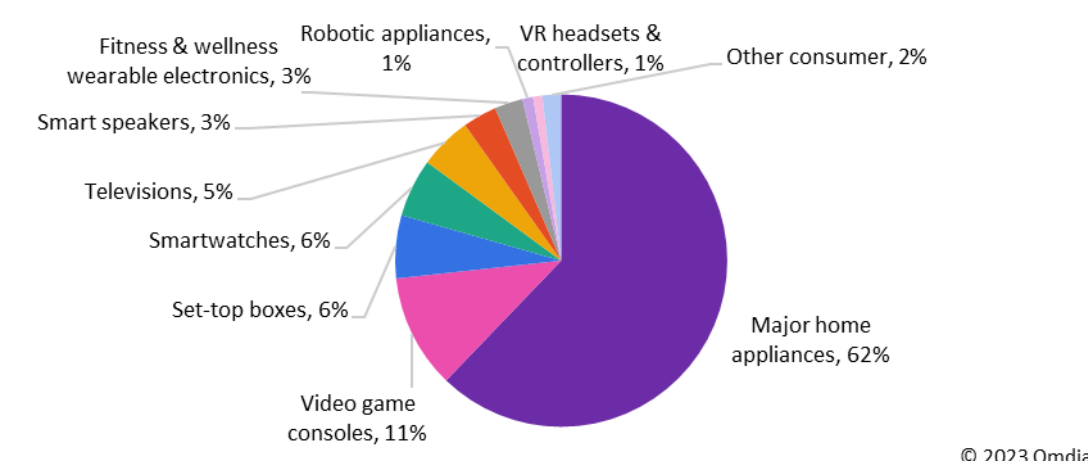
Source: Omdia

This market is so mature and closely linked to people's daily life for each family. Even though some high-end applications migrate to SoC solutions, microcontrollers (whether specific integrated or general-purpose microcontrollers) have still been widely used in each application for auto motor controls, interface communication, monitors, and chargers. Both classical 8-bit, a few 16-bit, and a large portion of 32-bit MCUs have already been used for years. Again, 32-bit MCUs can always hold a good position, obtaining significant shares in a growing market and smoothly penetrating the lower-bit MCU applications.

Considering its lower barriers to entry than other markets, consumer electronics is the "red ocean." Chip makers sometimes have to price more aggressively when demand goes soft. In this case, they either put more value into products, like merging individual modules to produce a "single chip solution," or explore opportunities in extension markets worldwide. In a word, pursue lower-cost solutions by aiming for high fabrication yields or designing for higher integration. Even when OEMs try to grow by innovating their products, there is always a place for MCUs.

4. High-standard MCU market and competitive landscape

4.1 High-standard 32-bit MCU introduction

From design to manufacturing to final testing, semiconductors for various application categories should comply with different standards. The qualification criteria, process, and SPEC could dramatically differ among industrial, automotive-grade MCUs, and commercial-grade MCUs. Generally, components used for industrial and automotive applications are considered high-standard ones owing to strict quality and reliability requirements.

Table 1: Various practice semiconductor component grades

		Commercial grade	Industrial grade	Automotive grade
Design stage		Baseline, additional self-ordained guidelines may be applied by the design house	Guided by ISO 26262-11, including design measures applied during the design of different kinds of ICs; functional safety is emphasized	
Manufacturing stage		Baseline	ISO 16949 complained ; qualified IP and process under stern requirements as product spec such as Cpk control; comprehensive SPICE model	
Test stage	Major chip standard complied	JESD-47	JESD-47	AEC-Q100
	Ambient temperature requirement	0℃ to 70℃ (mainstream)	-40℃ to 105℃ (trending requirement)	Grade 0: -40℃ to 150℃ Grade 1: -40℃ to 125℃ Grade 2: -40℃ to 105℃ Grade 3: -40℃ to 85℃
	Typical lifetime criteria	<=3–5 years	<=10 years	<=15 years
	Typical PPM level	<=500 DPPM	<=50 DPPM	<=10 DPPM

Function safety standard	Baseline	Guided by IEC 61508, the main standard for Functional Safety for the industry; devices used in building the Safety Instrumented Systems (SIS) have to be compliant with IEC 61508 (SIL1-4)
		Guided by IEC 60730, safety standard defines the test and diagnostic methods that ensure the safe operation of embedded control hardware and software for household appliances (class A–C)

Source: Omdia, ISO, Semiconductor Engineering, ADI Engineer Zone

The entry barriers for the high-standard MCU market are relatively high. First, to achieve an under-10 DPPM level product, comprehensive know-how from the design stage to the final application stage is vital. It involves enormous knowledge and experience scattered in each stage along the chip's life cycle.

Second, high-standard MCU applications are more complicated and advanced. Vast costs would be consumed by trying to obtain a share of such a market, such as research & development investments, labor expenses, and testing & verification costs. Meanwhile, the end-application partners globally also need to comply with industry standards and local requirements, such as the function safety certification requirement by Europe, and SIL1 to SIL4 will be mandated in specific applications. Thus, extra costs will be invested for sure.

Third, the time-to-market requirement by system vendors or end customers has become more aggressive. A complex solution designed to serve such requirements turns out to be very challenging for new entrants.

Moreover, ecosystem building will also take strategic moves. High-standard MCU makers should be able to connect each section of the value chain and utilize resources with a system-level view to obtain a remarkable market size and continue to thrive and grow.

4.2 China's high-standard 32-bit MCU competitive local landscape

In China, fabless or IDMs capable of developing high-standard MCUs (automotive grade, in particular) are considered competitive players. The complexity and total cost involved build up the entry barrier. Those with higher bit-width MCUs certificated by AEC-Q100 are a solid demonstration of technical competency in this arena.

In 32-bit class MCU, the global top five (STM, NXP, Renesas, Infineon, and TI) grew 28.3% YoY from 2021 to 2022, holding 86% of China's 32-bit MCU market. Consumer electronics and computing & data storage used to be the two largest MCU markets. Because demand in these markets is weakening dramatically, MCU suppliers anticipate growth in the automotive and industrial markets. In such fields, mainland China's leading local suppliers (GigaDevice, Geehy, C*Core, BYD semi, and Nationz) took 29%, 14%, 12%, 10%, and 8% of mainland China's top-10 market, respectively, recording a 38.5% YoY growth rate in 2022.

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Table 2: Mainland China's top 10 32-bit MCU suppliers, automotive and industrial, 2022

	Chinese name	MCU supplier	Sales, 2021 ($m)	Sales, 2022 ($m)	YoY%	Main products
1	兆易	GigaDevice Semiconductor	113	147	30.3%	MCU, DRAM, flash
2	极海	Geehy	38	70	82.5%	MCU, SoC
3	国芯	C*Core	48	59	23.9%	MCU, CPU IP
4	比亚迪	BYD semi	27	50	85.2%	Power, MCU
5	国民技术	Nationz Technologies	39	41	6.0%	MCU, SE, BLE
6	复旦微	Fudan Microelectronics	23	41	77.2%	MCU, FPGA
7	杰发	Autochips	22	31	41.3%	MCU, SoC, AMP for auto
8	华大小华	Huada Technology(XHSC)	18	27	52.0%	MCU, SE
9	钜泉	HiTrendtech	17	26	50.7%	MCU
10	芯海	Chipsea	15	20	36.4%	ADC, MCU, signal chain

Notes: Other Chinese companies, such as HSXP-HK, Ytmicro, ChipOn-IC, Sine micro, CVAchip, Indiemicro, Chipways Mindmotion, and Pai-ic, are also strong players in automotive and industrial fields but are not in the ranking because their information is not published.

Source: Omdia

5. China's high-standard 32-bit MCU market future trends

5.1 National challenge favors China's local design houses to a certain degree

Growing uncertainty toward China has urged the government to boost its localization progress. Chinese OEMs (PCs, smartphones, auto, etc.) must consider the local supply chain. This opens the window for China's local design houses, especially those that provide market-verified products locally manufactured on mature process nodes. The future growth prospects for these Chinese high-standard MCU brands in multiple applications appear promising.

5.2 NEV, supply equipment, and peripheral products will significantly drive the market

As a response to advocation for green energy by the China government, Chinese consumers highly welcome NEV, more than other giant auto-consuming markets.

From September 2022 to the end of February 2023, China's top-three most-sold car models were all NEVs. The supply of equipment, such as charging poles with smart management functions and peripheral products, would create huge demand for 32-bit industrial and automotive-grade MCUs.

5.3 Emerging solutions and products are more apt in China, compared to other market regions

China, the second-largest economy, contributed $18.1tn in nominal GDP in 2022. It is an enormous consumer market with great potential. The Great Bay Area built a mature backend system of supply chains, which is ultimately sensitive to market requirements and demands. New solutions or products are often brought to the market with surprising speed. This gives local MCU makers a shorter journey to the end customer and a plentiful resource for making it happen.

5.4 Industry upgrades in China boost high-standard MCU demand

Holding a huge consumer market size, China actively joins the race of the Industry 4.0 revolution, instead of waiting passively. Infrastructure like 5G base stations is built with a long visionary purpose. Tremendous opportunities for applications that require complex control and high performance are emerging. High-standard MCUs are a very necessary part of the solution. Being in close proximity to their customers is an important advantage for China's local high-standard MCU makers.

5.5 A long way and huge burdens to mediate for China's local IDHs

Independent design house (IDH) ecosystems in Europe and the US are relatively friendly owing to the tremendous knowledge and experience to leverage and the historical model of university-industry collaboration. Therefore, the most advanced core technologies, such as commercialized instruction set architectures (ISA), continue to develop in these regions, which have a leading position in terms of knowledge; most Chinese MCU makers still highly depend on leaders from abroad, like ARM. Even though RISC-V is one of the options, the heavy investment in building a new R&D team is against the existing business model. The containment made by dominant tech giants would pose extra risks that local China players always need to consider.

5.6 SoCs are competing with advanced MCUs for promising applications

By nature, MCUs mostly serve single-function applications with moderate memory sizes. Trending devices are easy to scale. However, the competition there leads to constant feature upgrades. As a result, MCU designs are more and more challenging. One example could be the cockpit controller in auto vehicles, which was used to control one monitor, but is now required to control more than three monitors (center stack display, control panel, HUD, and even rear seat entertainment), plus audio parts and sensors. An advanced SoC would be a better choice for such an application.

6. Further reading

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7. Appendix

Methodology

Raw data was derived from Omdia's primary and syndicated research, including (but not limited to) the Application Market Forecast Tool (AMFT) and Competitive Landscaping Tool (CLT) with analysts' insights and MCU's specific research.

Omdia's project team conducted interviews/questionnaires for major players to collect data & information for report completion.

Author

Sean Song
Senior Consultant, Semiconductor
Sean.Song@informa.com

Frank Xu
Senior Analyst, Semiconductor – MCU
Frank.Xu@informa.com

Evan Wang
Consultant Director, Semiconductor
Evan.Wang@omdia.com

OMDIA

Get in touch

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