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Automotive Microcontroller Unit (MCU) Industry Report, 2024

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With policy support, the localization rate of automotive MCU will surge.

Chinese electric vehicle companies are quickening their pace of purchasing domestic chips to reduce their dependence on imported ones and expedite the development of China's semiconductor industry system. According to unofficial goals, the overall penetration rate of homegrown automotive chips will be increased to over 20% in 2025, and state-owned and private automakers are encouraged to buy homemade chips as priority. Amid the long mass production cycle of automotive MCUs and the extremely low localization rate for a long time, the policy support will help local automotive MCUs boom.

In January 2024, the Ministry of Industry and Information Technology released the Guidelines for the Construction of the National Automotive Chip Standard System, suggesting that: in 2025, more than 30 key automotive chip standards should be formulated to clarify the basic requirements concerning environment and reliability, electromagnetic compatibility, functional safety, information security and more, and the technical specifications for key products and applications including control, computing, storage, power and communication chips should be formulated to meet the basic needs for safe and reliable application and pilot demonstration of automotive chip products; in 2030, more than 70 automotive chip standards should be formulated. Favorable policies facilitate the development of Chinese automotive MCU vendors.

International giants gain first-mover advantages in automotive MCUs. Chinese vendors started with body control with relatively low safety requirements, and some leading companies also work to make layout in power/chassis, cockpit, and autonomous driving fields. Chinese vendors gradually improve their automotive MCU product line layout and narrow the gap with international tycoons in product performance.

Performance of Chinese MCU Products Has Been Gradually Close to International Giants

Performance	Overview
Process	<ul style="list-style-type: none">Currently most automotive MCU products in China use a 110/55/40nm process; Chinese chip company SemiDrive has adopted TSMC's 22nm process.
Functional Safety	<ul style="list-style-type: none">At present SemiDrive, Flagchip, and Yuntu among others have released chips up to the highest functional safety level ASIL-D.
Operating Temperature / Voltage	<ul style="list-style-type: none">The supply voltage of general-purpose MCUs is often 3.3V or 5V. Novosense NUSC1610 adopts high-temperature and high-voltage process, and can support 12V direct power supply, with operating temperature up to 150°C.
Kernel	<ul style="list-style-type: none">Chipower Technology's THA6510 utilizes 5 pairs of lockstep cores with computing power up to 4000 DMIPS .

Source: ResearchInChina

Chinese automotive MCU vendors have made an all-round layout of low-, mid- and high-end products

1. Chinese automotive MCU vendors have made an all-round layout of low-, mid- and high-end products.

High-end automotive MCUs have always been monopolized by international giants. For example, Infineon has a monopoly in the autonomous driving field; NXP and Renesas prevail in the gateway and power/chassis fields.

In recent years, Chinese vendors have been vigorously laying out high-end automotive MCU products, and some of them such as SemiDrive, AutoChips have already made a foray into the high-end market.

Product Line Layout of Chinese Automotive MCU Vendors

Vendor	Body MCU	Power / Chassis MCU	Cockpit MCU	Autonomous Driving MCU
SemiDrive	3100 / 3400 / 3600 Series	E3800 / 3600 / 3200 / 3300 / 3400 Series	E3400 Series / E3300 Display Series / E3200 Series	E3100 Series / E3400 Series / E3200 Series / E3300 Series
Flagchip	FC4150	FC7300 / FC7240	/	FC7300
ChipON	KF32A1x6 / KF8Axxx / KF32A14x / KF32A15x	KF32A1x6 / KF32A1x8	/	/
GigaDevice	GD32A503 Series / GD32A490 Series	/	GD32A490 Series	/
AutoChips	AC781x Series / AC7802x Series	AC7840x / AC7870x	/	/
CCore Technology	CCFC2012BC / CCFC2011BC / CCFC2016BC / CCFC2017BC	CCFC2007PT / CCFC3008PT / CCFC3009PT / CCFC3008PT / CCFC3007PT	CCFC2011BC / CCFC2010BC	CCFC3009 Series / CCFC3012 Series
Yuntu Micro	YTM32B1L / YTM32B1M / YTM32B1H / YTM32Z1M	YTM32B1H / YTM32B1M	YTM32B1M / YTM32B1L	YTM32B1M / YTM32B1L / YTM32B1H
MindMotion Microelectronics	MM32A / MM32F	YTM32B1MMM32SPIN	/	/
Binary Semiconductor	/	Fuxi 2360	/	/
HP Micro	HPM5300 Series	/	HPM6750 Series / HPM6800 Series	/

Source: ResearchInChina

SemiDrive launched the E3 series of automotive MCUs

SemiDrive: it launched the E3 series of automotive MCUs for domain control, body, chassis, power, ADAS, battery management system (BMS) and other applications in 2022, and has shipped more than a million pieces. Suspension controllers (CDC) mounted on models like Chery Tiggo 9 and EXEED Stellar are powered by SemiDrive E3 series products.

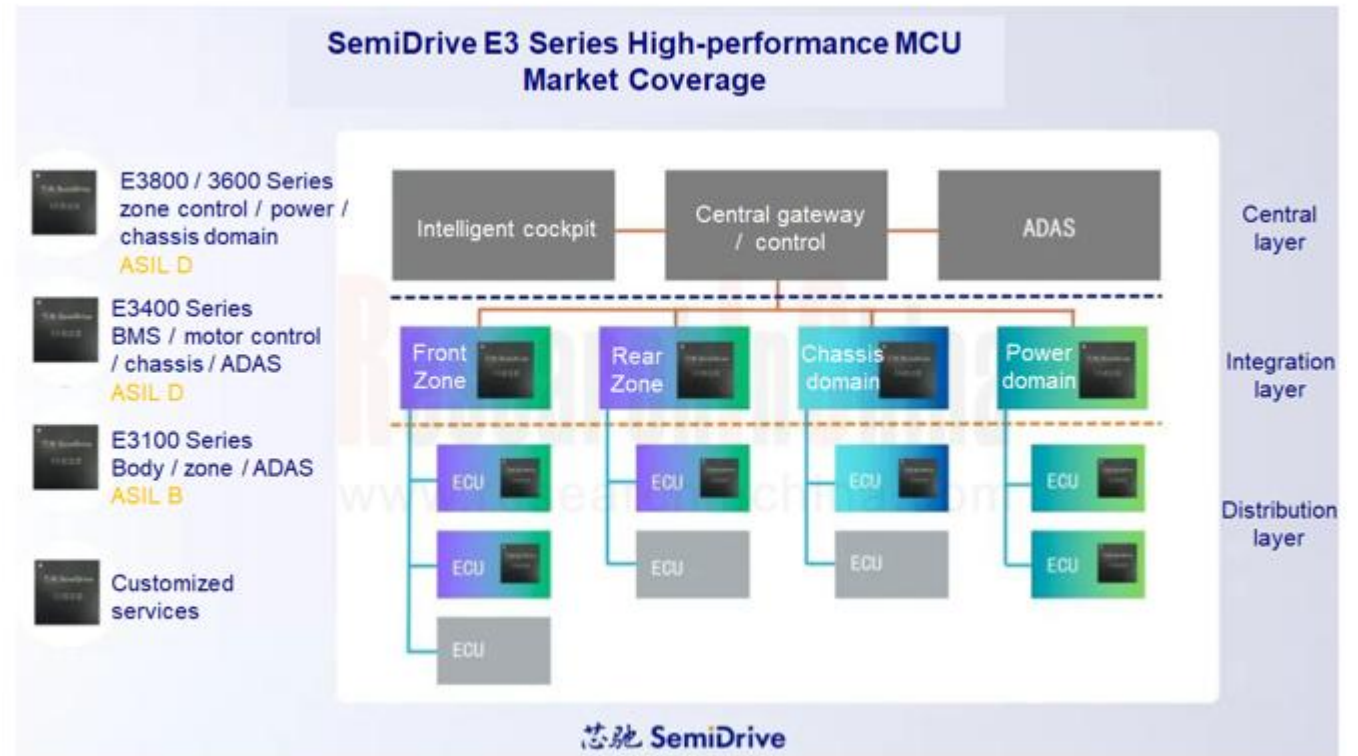
In March 2024, SemiDrive further improved the E3 series and released E3119F8/E3118F4, targeting such application fields as body domain control, zone controllers, front-view all-in-one, and LiDAR. The new product uses ARM Cortex R5F CPU, and packs at most two independent 400MHz high-performance application kernels, with the main frequency of the information security kernel up to 200MHz. In terms of tool chain, SemiDrive supports IAR and Greenhills, adapts to the mainstream ARM debugger, and provides SDK/MCAL basic software support. Currently, SemiDrive is partnering with multiple Chinese and foreign AutoSAR vendors and working on BSW adaptation.

In current stage, SemiDrive's products have covered high-end fields of zone control, chassis and intelligent driving.



AutoChips: In October 2023, it introduced AC7870x, its first multi-kernel high-frequency MCU that meets the ASIL-D functional safety level and is based on Arm Cortex R52 kernel. AC7870x is primarily applied in the fields of power chassis, “three electrics” for new energy vehicles, and zone controllers under new EEA. The company thus officially entered the high-end automotive MCU field.

SemiDrive Automotive MCU Series



Source: SemiDrive

2. Build an independent domestic chip supply chain.

From 2021 to 2022, automotive MCUs were difficult to buy, with soaring prices, which made Chinese automakers realize the importance of an independent supply chain system and also gave scope to China's local automotive MCUs.

Chinese MCU vendors are trying hard to build a local supply chain:

Yuntu Micro: More than half of upstream partners are domestic. The company has achieved full localization in multiple links from upstream wafer fabs to packaging and testing. The localized supply chain makes products more cost-effective.

OmniVision: OMX14xN in the OMX14x series is an automotive MCU with a fully localized supply chain from fab to packaging and testing.

AutoChips: AC7802x, an automotive MCU mass-produced in August 2023, is a fully localized chip.

Conventional automobiles need about 40-50 MCUs. As EEA gets upgraded, the MCU requirements of autonomous driving, cockpit, body & zone control, power, chassis, central computing and so on have also changed. MCU products head in the direction of high performance.

MCU Application Requirements of Each Functional Domain

Domain	MCU Application
Body Control	<ul style="list-style-type: none">Conventional body control functional requirements have not changed much, and the body control domain can use several MCUs simultaneously. For example, BMW's BCP-01 uses up to 4 MCUs, namely, STMicroelectronics' SPC58NH92C5HMI0, SPC58NH92C3HMI0 and ST33G768A, and NXP S32K116BF.
Autonomous Driving	<ul style="list-style-type: none">MCU demand is growing and performance requirements are higher. Especially in L3 and above autonomous driving functions, MCU is a very important safety chip.
Cockpit	<ul style="list-style-type: none">As the demand for HMI increases, cockpit MCUs evolve towards high compute and begin to add image processing functions such as Infineon's new TRAVEO™ T2G (CYT2C... / CYT2D...).
Power and Chassis	<ul style="list-style-type: none">Electrification drives up MCU demand. High-performance MCUs in functional domains can achieve centralization of computing power. For example, a Stellar P MCU from STMicroelectronics can replace the MCU in multiple ECUs, achieving centralization of computing power.
Zonal Controller and Central Computing	<ul style="list-style-type: none">Demand for MCU has decreased, but requirements for MCU such high compute and multiple cores get higher.

Source: ResearchInChina

Autonomous Driving Domain Control MCU Product Layout of Mainstream Vendors

For autonomous driving domain control, mainstream MCU products include Infineon TC297X/397X Series and the latest TC4X Series, ST Stellar Series, Renesas RH850 Series, TI Hercules, and SemiDrive E3 Series.

Product Model	Vendor	Selling Points	Application
TC397	Infineon	<ul style="list-style-type: none"> Integrate TTTech Auto's MotionWise software stack to provide customers with highly optimized solutions for safety-critical applications; Integrate rich peripheral devices (e.g., 12-channel CAN-FD and Ethernet Gbit/s) and Full-EVITA HSM to meet the requirements of future sensor fusion systems for safety and security performance and data flow. 	Most ADAS domain controllers use this series of products.
TC4X		<ul style="list-style-type: none"> Introduce the resistive random access memory (RRAM), a type of non-volatile memory (NVM); Enter the parallel processing unit (PPU). 	The new-generation TC4X will come into mass production in H2 2024.
Stellar Series	ST	<ul style="list-style-type: none"> Combine the benefits of on-chip phase change memory (PCM) and 28nm FD-SOI technology as well as advanced packaging technology. 	Honda, Volkswagen, etc.
RH850 Series	Renesas	<ul style="list-style-type: none"> Use 40nm / 28nm process; Combine with the company's other automotive electronics (R-Car V3U, PMIC, power devices, etc.) to achieve efficient development. 	Nissan, Honda, Toyota, Volkswagen ID.3's front camera, etc.
E3 Series	SemiDrive	<ul style="list-style-type: none"> Use TSMC's 22nm process; ASIL D functional safety level; One of the few China-made high-end MCU products. 	Hongjing Drive's driving-parking integrated domain controller, Refine RF8, etc.

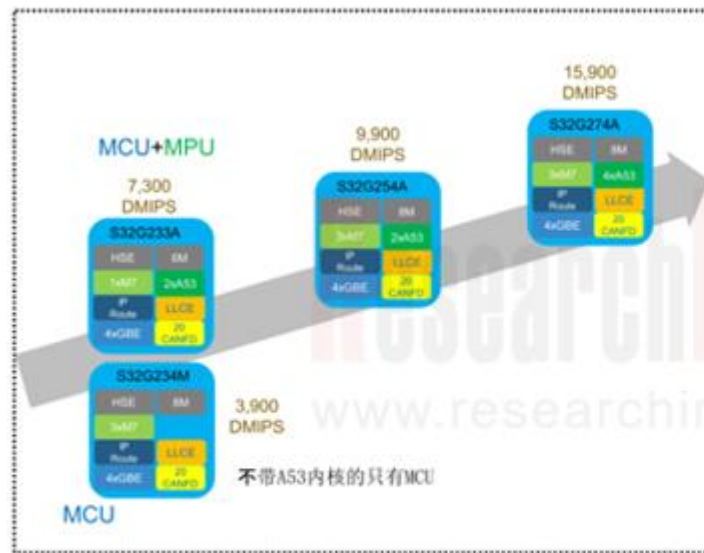
Source: ResearchInChina

Central supercomputing platforms have higher requirements on chips' functional safety

Central supercomputing platforms have higher requirements on chips' functional safety. For example, Leapmotor's Four Leaf Clover central supercomputing platform adopts NXP S32G. Wherein, the Standard Configuration version adopts Qualcomm 8155 (3rd Generation Snapdragon Cockpit Platform) + NXP S32G (3 cores); the Medium Configuration version adopts Qualcomm 8295 (4th Generation Snapdragon Cockpit Platform) + NXP S32G (7 cores).

NXP S32G Family utilizes three 400MHz Arm Cortex-M7 cores, and provides support for different products according to cost requirements and application scenarios.

S32G Family Scalability



Reference Point: SPC5748G (Calypso) is 700 DMIPS

	S32G234M	S32G233A	S32G254A	S32G274A
Cortex-M7 @ 400 MHz	3	1	3	3
ASIL D DMIPS	3,900	1,300	3,900	3,900
Cortex-A53 @ 1 GHz	-	2	2	4
ASIL B DMIPS	-	6,000	6,000	12,000
ASIL D DMIPS	-	3,000	3,000	6,000
DOR	No	Yes	Yes	Yes
System RAM	8MB	6MB	8MB	8MB
PCIe	1x2 Lane PCIe 2.1 (10 GT/s)		2x2 Lane PCIe 3.0 (32 GT/s)	
USB 2.0 OTG	0		1	
Security	Hardware Security Engine (HSE)			
Gigabit Ethernet*		3 + 1		
CAN*		16 + 4		
LIN*		4 + 3		
FlexRay*		1 + 1		
SPI*		4 + 6		
Package	525 FC-PBGA, 19x19mm, 0.8mm pitch			

* Comm Accelerators interfaces + Common Chassis interfaces



Source: NXP

MCU core design trends include GPU, new storages, built-in HSM security components, etc.

Conventional MCU products mainly integrate eight components such as CPU, memory, I/O port, serial port, timer, interrupt system and special function register. The development of domain control architecture brings new demand for high-performance and high-security MCUs.

Furthermore with the increasingly high MCU performance, the difference between MCU and MPU becomes ever smaller. From some moves of international giants in current stage, it can be seen that crossover MCU or crossover MPU is a layout direction they head in. Putting some hardware only available in MPU into MCU not only realizes low power consumption, low cost and simplicity of MCU, but also enables applications that were enabled only by MPU in the past.

MCU's graphics processing capabilities are being enhanced.

As vehicles pose ever higher requirements for image definition, zoomable maps, video play, etc., MCU vendors have begun to compete in graphics processing in recent year. International tycoons like ST, Infineon, Renesas and NXP have launched MCU products with GPU integrated. Chinese vendors such as GigaDevice and HPMicro have also been working to make layout.

GPU Layout of Some MCU Vendors

Vendor	Time	MCU Graphics Processing Capability Layout
HP Micro	Mar. 2024	<ul style="list-style-type: none"> Launched HPM6800 Series, a new-generation digital cluster display and human-machine interface system application platform; HPM6800 is equipped with VeriSilicon's high-performance 2.5D OpenVG GPU, MIPI, LVDS dual-display interface and dual-camera interface, and suitable for high-resolution graphics display.
ST	Jan. 2024	<ul style="list-style-type: none"> Launched new STM32U5 microcontrollers (MCU) - STM32U5F9/G9 and STM32U5F7/G7, which contain ST's NeoChromVG graphics processor (GPU) to handle graphical effects usually associated with microprocessor-based (MPU) products.
Infineon	Jan. 2024	<ul style="list-style-type: none"> Collaborated with Qt Group.
	Late 2023	<ul style="list-style-type: none"> Announced the new TRAVEO™ T2G Cluster family of automotive microcontrollers (MCU) with a new graphic engine; The TRAVEO T2G cluster microcontroller family with its dedicated graphics accelerator enables cluster, infotainment and cockpit systems with MPU like performance at MCU cost.
Renesas	Dec. 2023	<ul style="list-style-type: none"> Introduced RA8D1, the second product in RA8 series. It is equipped with a 2D graphics drawing engine. The graphics LCD controller supports resolutions up to WXGA (1280x800), parallel RGB and MIPI-DSI interfaces to external LCD and/or TFT display, powerful 2D drawing engine, 16bit CEU camera interface, and 32bit external SDRAM interface.
GigaDevice	May 2023	<ul style="list-style-type: none"> Launched the Cortex-M7 core ultra-high-performance MCU GD32H7 series MCU, with built-in TFT LCD LCD driver and graphics processing accelerator IPA (Image Processing Accelerator), supporting 2D image overlay, rotation, scaling and multiple color format conversion functions.
NXP	2020	<ul style="list-style-type: none"> i.MX RT500 Crossover MCUs integrate 2D GPU and combines Cadence Tensilica Fusion F1 DSP core and Arm Cortex-M33 core.

Source: ResearchInChina

For example, the new TRAVEO[™] T2G Cluster family of automotive microcontrollers (MCU) with a new graphics engine enables cluster, infotainment and cockpit systems with MPU like performance at MCU cost.

In terms of memory, the graphics engine within the MCUs minimizes the memory required for graphics processing by a factor of 3 to 5, resulting in lower power consumption and lower costs.



Source: Infineon

The requirements for MCU security are higher

MCU is an important node in vehicle networks and interacts with other ECUs (electronic control unit) via communication protocols such as CAN (controller area network) bus or Ethernet. These communication protocols, if not encrypted or authenticated, will easily be intercepted and tampered by attackers, leading to malicious vehicle control or other safety incidents.

MCU thus plays a critical role in automotive cybersecurity. To cope with increasingly severe cybersecurity threats, effective measures need to be taken to strengthen automotive cybersecurity. Major automotive MCU vendors are also vigorously deploying high-security MCU products.

SemiDrive: SemiDrive E3 series meets the AEC-Q100 Grade 1 reliability certification. It is China's first MCU to pass German TUV ASIL D/SIL 3 functional safety level certification and China's national cryptographic product Level 2 certification, and has passed the TUV ASPICE CL2 evaluation. It is known that the new automotive MCU products E3119F8 and E3118F4 unveiled in March 2024 integrate hardware security modules (HSM), comply with the Full EVITA information security level, and cooperate with the industry's leading information security solution providers, and support ISO 21434-compliant information security firmware. This sub-series can support ISO 26262 ASIL-B functional safety level. SemiDrive will provide functional safety software library, FMEDA and various functional safety documents, and complete the ASIL-B level product functional safety certification.

Renesas: The RH850 series MCUs have a built-in intelligent cryptography unit (ICU), which stores the secret key in a separate storage area that cannot be directly accessed by the CPU. A dedicated mechanism is required to enhance the actual anti-tampering function and support high-end encryption operations such as RSA and ECC. They can provide security services such as software operation prevention, hardware and software connection, secure boot, and verification of ECUs in network nodes.

Automotive Microcontroller Unit (MCU) Industry Report, 2024 released by ResearchInChina highlights the following:

- Automotive MCU market (status quo, size, pattern, supply and demand, etc.);
 - Application, localization and main product cases of automotive MCU in different application fields (body control, autonomous driving, intelligent cockpit, power chassis, central computing domain control, etc.);
 - Key points in automotive MCU industry development (process, core technology, storage technology, image processing function, functional safety, etc.);
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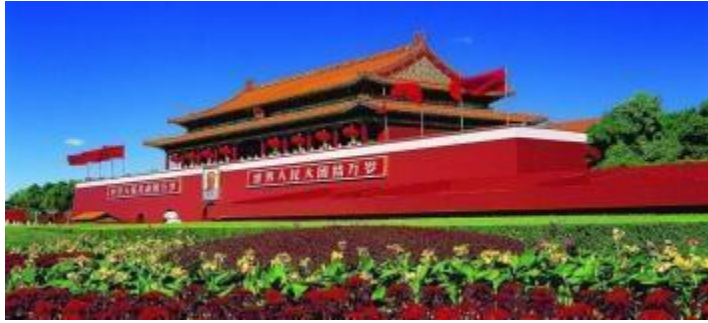
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