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**Automotive
Management
Circuits (PMIC)
Report, 2023**

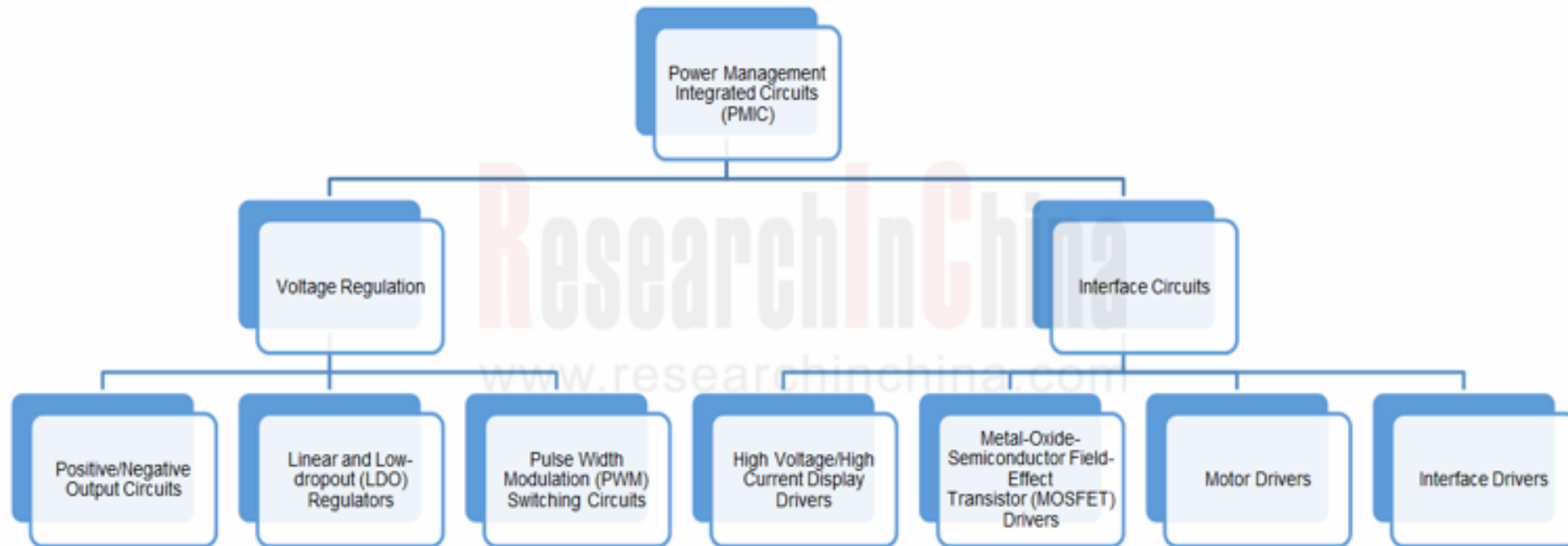
**Power
Integrated
Industry**

Mar. 2023

Automotive PMIC research: the process of domestic automotive PMICs replacing foreign ones in China in the “crisis of chip shortage”.

Automotive power management integrated circuits (PMIC) find broad application in vehicle intelligent cockpits, autonomous driving, body electronics, clusters and entertainment systems, lighting systems, and BMS. By product, PMICs fall into AC/DC, DC/DC, LDO, driver IC, and battery management IC.

Classification of PMIC by Device

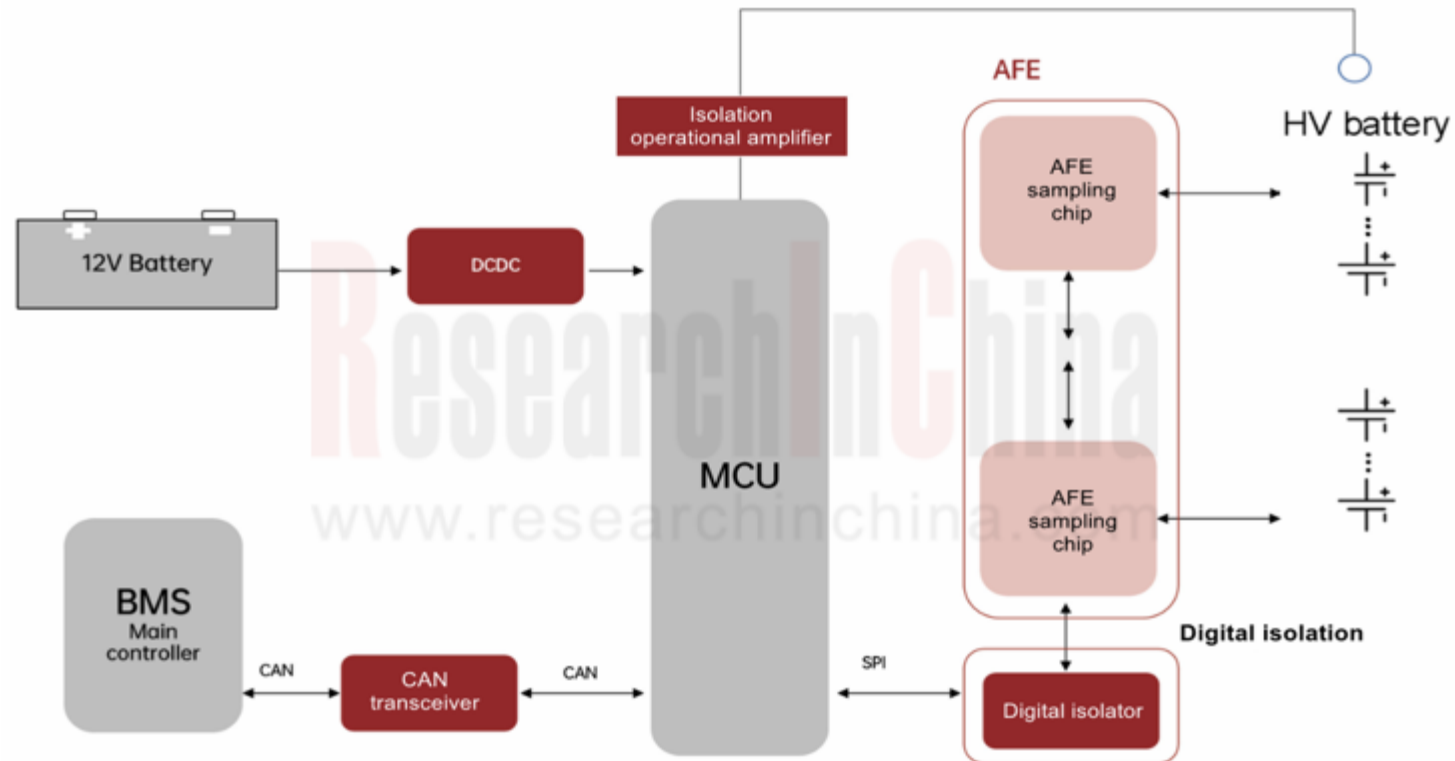


Source: ResearchInChina

The enormous supply gap in automotive power battery management system AFE ICs creates a strong desire to replace foreign products in China.

Among automotive PMICs, AFE ICs for battery management systems (BMS) are in the shortest supply. The analog front end (AFE) IC is the most important device in BMS, responsible for collecting voltage and temperature of battery cells. AFE IC uses specific algorithms to estimate battery parameters (eg. SOC and SOH), and sends the results to the control chip.

Working Principle of AFE IC

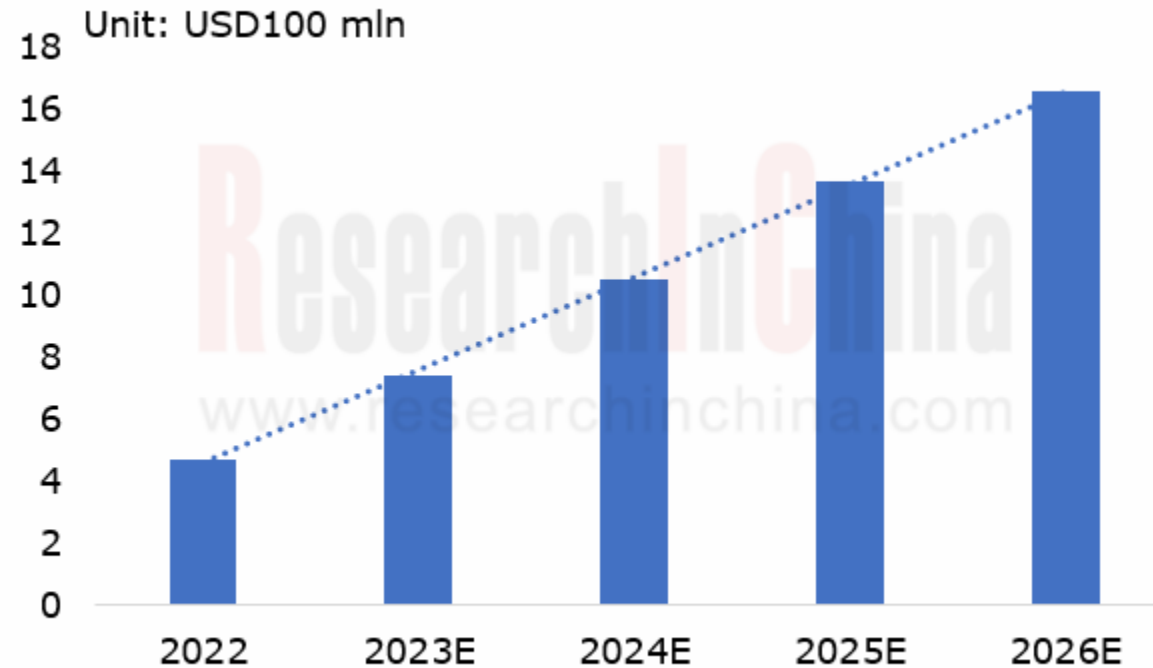


Source: Joulwatt

(1) Demand for automotive AFE ICs: in the evolution from 400V to 800V platform, the demand for AFE ICs doubles.

Considering endurance range and charging efficiency of new energy vehicles, mainstream automakers have begun to deploy high-voltage platforms. The evolution from the current mainstream 400V platform to 800V platform has become a megatrend. For higher voltage requires an almost equal proportion of more battery cells in series, the demand for AFE ICs thus surges. It is expected that the platform voltage will increase from 400V to 800V, doubling the demand for automotive AFE ICs.

Global Automotive AFE IC Market Size, 2022-2026E



Source: ResearchInChina

(2) Supply of automotive AFE ICs: the Chinese market relies on imports, creating a huge gap, so replacing foreign products with the homemade is a matter of great urgency.

High technical barriers, high automotive certification requirements, big challenges, and long cycle are constraints on the mass production of automotive AFE ICs in China. More than 90% of the AFE ICs used in vehicle power batteries still need to be imported. This market is monopolized by foreign analog chip giants like TI, ADI and Infineon. Chinese AFE IC vendors still make initial deployments in the automotive power battery field.

As a mainstream supplier in the automotive battery management integrated circuits (BMIC) market, TI has extended its order delivery time to 2023 as its BQ Series chips are out of stock and become more expensive, producing a large gap in the market.

Due to the gap between supply and demand in the Chinese automotive AFE IC market, domestic terminal manufacturers and lithium battery suppliers with strong demand for homemade chips are trying to enter the power BMIC segment from different angles.

Automotive AFE IC Layout in China

Company	Layout	SOP
BYD Semiconductor	In 2020, BYD Semiconductor introduced BF8X15A Series, its first-generation 16-section automotive AFE IC which delivers accuracy of $\pm 2.5mV$, conforms to the ISO 26262 functional safety standard, and meets the AEC-Q100 Grade 1.	At present, the product has been massively applied to the new energy vehicle market. It is also China's first automotive BMS AFE IC to be largely used in vehicles.
Datang NXP Semiconductors (DNS)	In 2022, DNS successfully built the DNB116x series automotive battery monitoring chip that reaches the highest ISO 26262 functional safety level ASIL-D. This BMS AFE IC integrates voltage monitoring, temperature monitoring, and AC impedance monitoring, and is applicable to BMS of various types of electric vehicles such as BEV, EREV, PHEV, and HEV.	DNB1168 now has engineering samples available and will be produced in quantities in 2023.
Chipways	To break the technical barriers of foreign automotive chips, Chipways has built its own automotive chip platform, grouped software and hardware platform and algorithm, production test platform, and automotive laboratory, and established China's first Automotive package line together with Tongfu Microelectronics, adding advanced process chipset combined solutions and algorithms. Chipways has developed and spawned serialized automotive BMS core chip products: <ul style="list-style-type: none"> XL8806/XL8812 series products are automotive battery pack monitor chips that meet both the AEC-Q100 automotive reliability standard and the ISO 26262 ASIL-C automotive functional safety standard, and are applied to new energy vehicles. XL8814/XL8816/XL8818 series products are China's first automotive battery pack monitor chips that meet both the AEC-Q100 automotive reliability standard and the ISO 26262 ASIL-D automotive functional safety standard. 	<ul style="list-style-type: none"> XL8806/XL8812 series: mass-produced, using LQFP 48 package; XL8814/XL8816/XL8818 series: to be mass-produced.
CellWise Microelectronics	The company is developing automotive AFE IC products, and plans to first launch the AFE products for sweepers, vacuum cleaners, garden tools, electric two-wheelers, medical power supplies, household/interoperable energy storage, base stations and other markets, and then the AFE products for new energy fields such as automotive battery management system and large-scale energy storage.	
Devechip	Devechip DVC1024 is a multi-section lithium battery pack monitoring chip designed with Automotive high-voltage BCD technology. It is suitable for such projects as electric two-wheelers and energy storage.	

Source: ResearchInChina

Chipways has made several breakthroughs in core technologies of BMS chipsets

Chipways: it has made several breakthroughs in core technologies of BMS chipsets, including automotive BMS AFE sampling chip (ASIL C/D), automotive BMS digital isolation and communication interface chip, and automotive 32-bit microcontroller unit (MCU), and can provide complete grouped software development tools for product development.

Chipways' XL8806/XL8812 series automotive battery pack monitor chips can meet both the AEC-Q100 automotive reliability standard and the ISO 26262 ASIL-C automotive functional safety standard. With LQFP 48 package, they can work in a temperature range of -40°C~125°C, single chip supporting 4 to 12 series of batteries. They adopt the high-precision $\Sigma\Delta$ ADC method with measurement accuracy up to $\pm 1.5\text{mV}$, and support multiple series of chips and master-slave reversible two-way communication.

The XL8814/XL8816/XL8818 series automotive battery pack monitor chips can meet the AEC-Q100 automotive reliability standard and the ISO 26262 ASIL-D automotive functional safety standard. They add another more than 30 safety mechanisms, reaching the ASIL D functional safety level. While ensuring the measurement accuracy, they increase the monitoring strings on a single chip. They support up to 14/16/18 battery strings in series, and control the measurement time within 120us. They feature the maximum built-in equalizing current of 400mA, and also add such capabilities as busbar monitoring, sleep monitoring and reverse wake-up.

Datang NXP Semiconductors (DNS): DNB1168 is a BMS AFE IC that integrates voltage monitoring, temperature monitoring, and AC impedance monitoring. It supports 250 rings of cascading chips, and daisy chain communication, and meets automotive certification, having passed the ISO 26262:2018 ASIL-D certification. For example, for thermal runaway that is hard to control in power batteries, DNB1168 solution uses the AC impedance monitoring function for rapid detection of thermal runaway. Compared with the conventional NTC (thermocouple) method, AC impedance monitoring can provide a second-level response, which greatly improves the safety threshold of power batteries and prolongs the service life of batteries.

DNS DNB1168 series automotive AFE ICs offer three benefits in application, namely, material saving, space saving, and faster and safer 3D monitoring. They are applicable to the BMS of various types of electric vehicles like BEV, EREV, PHEV, and HEV. DNB1168 now has engineering samples available and will start volume production in 2023.

Battery Monitoring Unit of DNS DNB1168 IC



Source: EEWorld

BYD Semiconductor: in 2020, it unveiled BF8X15A Series, its first-generation 16-section automotive AFE IC which delivers accuracy of $\pm 2.5\text{mV}$, conforms to the ISO 26262 functional safety standard, and meets the AEC-Q100 Grade 1.

In China automotive DC/DC ICs will enter the cycle of replacing foreign ones.

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DC/DC ICs have a wide range of uses in automotive electronics, and apply to scenarios from vehicle intelligent cockpits, charging piles and motor controllers to on-board chargers and automotive lighting. At present, Chinese PMIC vendors successively achieve mass production of automotive products in categories like LDO and DC/DC.

Automotive DC/DC IC Layout in China

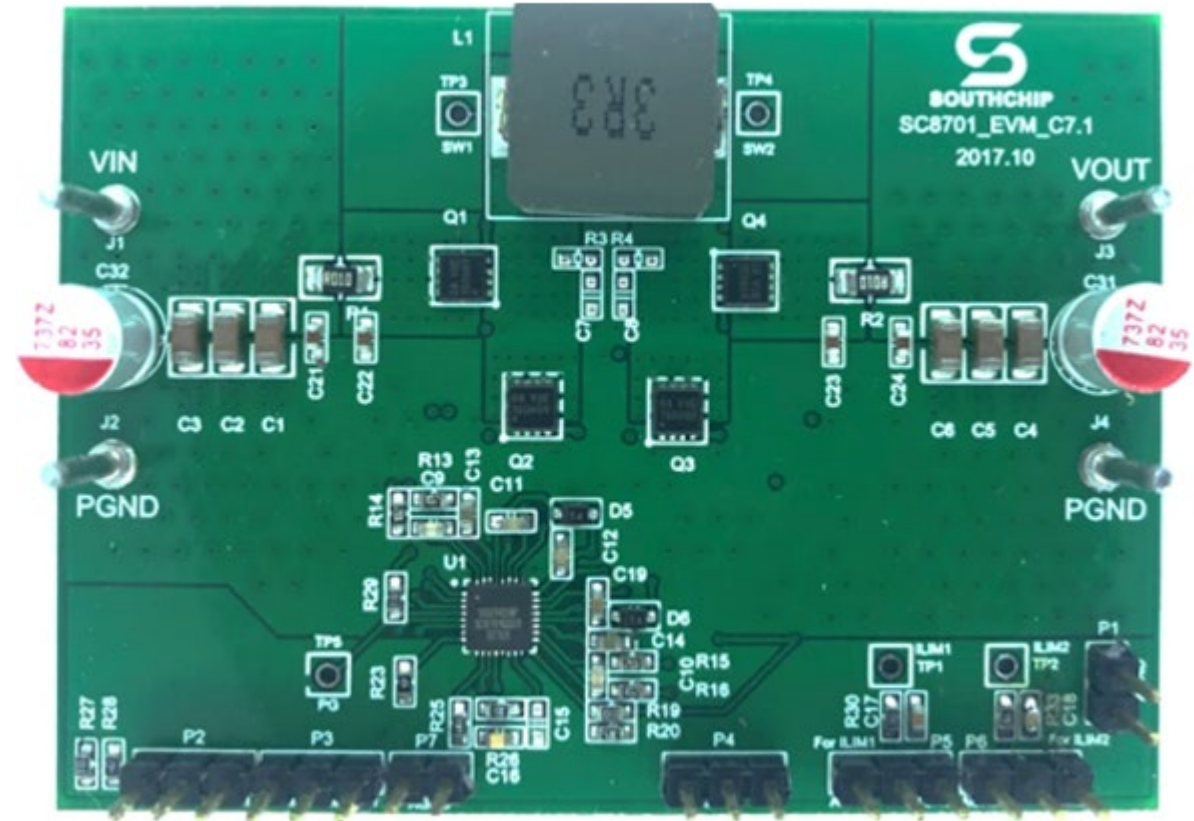
Company	DC/DC IC Business	SOP
Halo Microelectronics	<ul style="list-style-type: none"> Self-developed automotive PMIC products have reached the AEC-Q100 standard. 	DC/DC ICs have entered Qualcomm Connected Car Reference Design and has been introduced into the supply chain of AITO M7.
Joulwatt	<ul style="list-style-type: none"> Joulwatt now has 6 AEC-Q100-compliant DC/DC products produced on the BCD process platform and widely used in body charging, intelligent cockpit, intelligent connectivity and driving assistance. 	Introduced into supply chain systems of BYD, Changan Auto, etc.
Southchip Semiconductor	<p>In vehicle power management, Southchip has deployed multiple automotive products, e.g., SC8101Q Series and SC8701Q Series, which are largely used in vehicle charging.</p> <ul style="list-style-type: none"> SC8101Q is an automotive 32V/5A synchronous step-down DC/DC converter with Flip-Chip QFN package. It can eliminate the oscillation caused by the internal bonding wire on the switch node, thereby offering good EMI performance. SC8701Q, an automotive buck-boost DC/DC IC, can be used in the ECUs for vehicle 60W wired fast charging and ADAS 360° surround view system to power cameras. 	SC8101Q has made its way into quite a few customers.
Trimitec	<p>Trimitec has built automotive power management product lines. Through the national key model projects in 2021, Trimitec has laid out 3 20V DC/DC products. It is expected that Trimitec will make breakthroughs in 40V and 100V in 2023, covering three types of vehicles, i.e., conventional vehicles (12V), special vehicles (24V), and new energy mild hybrid vehicles (48V) in automotive power management.</p> <ul style="list-style-type: none"> For example, an AEC-Q100-compliant automotive DC/DC IC, an equivalent of TI's chip, adopts 3mm x 3mm VQFN-16 packaging technology, supports up to 1A continuous output current, and is applicable to automotive point-of-load (POL) power supplies and embedded systems, as well as infotainment systems, CAN, and USB power supplies. 	In the field of automotive electronics, Trimitec is cooperating with Changzhou Xingyu Automotive Lighting Systems Co., Ltd., China's largest and only listed automotive lighting company.

Source: ResearchInChina

Southchip has launched SC8101Q and SC8701Q

For vehicle charging, Southchip has launched SC8101Q series automotive 32V/5A synchronous step-down converter, and SC8701Q series automotive buck-boost chip, which can be used in ECUs for 60W wired fast charging and ADAS 360° surround view system to power cameras, as well as vehicle wireless charging. Currently they have been adopted by many Tier 1 suppliers, and have been seen in models of multiple brands like BYD, SAIC-GM, FAW Hongqi and Hyundai. They will be mounted on several overseas models soon.

Southchip Semiconductor's Automotive IC - SC8701Q



Source: www.chongdiantou.com

Chinese fabs make breakthroughs in BCD process, and the " crisis of chip shortage" revs up the localization of automotive PMICs.

Chinese fabs make breakthroughs in BCD process, and the " crisis of chip shortage" revs up the localization of automotive PMICs.

PMICs pose relatively low requirements for manufacturing process instead of following Moore's Law. Compared with other types of integrated circuits, PMICs are a relatively mature and stable segment. At present, the mainstream mature process of PMICs is 8-inch process with nodes ranging from 0.32 μ m to 90nm. Fabs often use the special fabrication process of BCD (Bipolar-CMOS-DMOS), with many product numbers and types available. The market is highly fragmented.

In 2022, there was a structural shortage of chips in the automotive industry. Wherein, the 8-inch PMIC production capacity with mature process nodes above 0.18 μ m felt much pinch. Giant IDMs like TI, Infineon, ADI, STMicroelectronics and NXP boast most automotive PMIC capacity. Other chip design firms (Fabless mode) need to obtain capacity from wafer foundries.

In China, SMIC, GTA Semiconductor, HHGrace and Nexchip Semiconductor among others all can provide PMIC wafer foundry services, and they are also stepping up the expansion of production lines with mature and characteristic process. In 2022, SMIC completed development of 55nm BCD process platform (high-voltage display driver platform), and introduced to customers for mass production. The vendor will play an extremely important role in industrial control, intelligent vehicles, display drivers, and power management. The current mainstream BCD process in the world is 180/130/90nm, and the industry's top level is 60nm.

Development of BCD Process Platforms in Fabs in China

Fab	BCD Process Features	BCD Platform Process Nodes	Future Layout /Application Scenarios
HHGrace	Bring the technical benefits of BCD and eNVM processes into full play, provide the two-process integrated solutions, and create high-end power management system-on-chips (SoC) for intelligent power supply products.	90nm/0.13 μ m/0.18 μ m/0.35 μ m/0.5 μ m/0.8 μ m/1.0 μ m	In the future, the company will still work on development and innovation of 8-inch production lines, and optimize and upgrade the existing 180nm BCD process that meets automotive requirements.
China Resources Microelectronics (CR Micro)	The process platform voltage ranges from 5V to 700V, and the process nodes cover 0.18 μ m /0.25 μ m /0.8 μ m /1.0 μ m, meeting all the needs of different applications for high voltage, high precision and high density. The company simultaneously provides 200-600V SOI-based BCD process options.	0.18 μ m/0.25 μ m/0.8 μ m/1.0 μ m	Widely used in various emerging markets, including power management, LED drivers, automotive electronics and audio circuits, etc.
SMIC	Medium and high voltage BCD platforms for industrial and automotive uses and automotive BCD platforms are being developed. The company also develops a 90nm BCD process platform to provide solutions for PMICs with high digital density and low on-resistance.	0.15-0.35 μ m, 55nm BCD platforms enter the introduction phase.	Industrial control, intelligent vehicles, display drivers, power management, etc.
Silan Microelectronics	In R&D of BCD process platforms, Silan Microelectronics has established new product and new process R&D teams based on 5/6-inch, 8-inch and 12-inch wafer fabrication lines.	0.18 μ m/0.25 μ m/0.6 μ m/0.8 μ m	The BCD circuit process platform based on the 12-inch production line of Xiamen Silan Microchip Manufacturing Co., Ltd. is also being developed.
Nexchip Semiconductor	In terms of PMIC technology, Nexchip Semiconductor plans to further develop BCD process platforms based on the existing 90nm process platform, supplemented by IP verification, model verification and simulation, to build 90nm PMIC platforms, and mass-produce in its second fab.	0.15 μ m/90nm	Power management integrate circuits (PMIC), display driver integrated circuits (DDIC)
TSMC	TSMC has been investing resources in power-related processes including the BCD process for PMICs, and moving towards the goal of reducing energy consumption.	Some of the automotive processes have evolved to 0.18 μ m second-generation BCD and 0.13 μ m BCD; the 0.18 μ m third-generation BCD process has completed AEC-Q100 verification.	In terms of PMICs, further expand the 90nm/55nm/22nm 12-inch BCD process portfolios.

Source: ResearchInChina

The big mismatch between supply and demand in the automotive PMIC market gives Chinese PMIC vendors scope for entry into the supply chain of the automotive industry

To deal with the surging demand from automotive and the insufficient capacity of automotive chips, wafer foundries like TSMC and UMC expand their automotive chip capacity. International IDMs have started large-scale capacity expansion while deploying their automotive chip capacity.

At present, the supply and demand in some automotive PMIC segments has improved, and the prices of some automotive chips have begun to be lowered, including driver ICs (e.g., LED driver and motor driver), PMICs, and some control ICs. Yet in the process of switching from fuel-powered vehicles to electric ones, the demand for the automotive products remains relatively stable, and the price will not take a nosedive.

This "crisis of chip shortage" buys more time for Chinese PMIC vendors to deploy automotive electronics and make breakthroughs in automotive PMICs, which accelerates the replacement of foreign automotive PMICs. Moreover, automakers also need to re-examine their industrial layout strategies in special circumstances, especially in cross-regional production and transportation of parts and components. The localization of the components supply chain may be more beneficial to organizing the whole supply chain, and build synergy with local vehicle dealers. Once force majeure hinders normal vehicle sales, components will also feel the pinch simultaneously. The big mismatch between supply and demand in the automotive PMIC market gives Chinese PMIC vendors scope for entry into the supply chain of the automotive industry.

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Beijing Headquarters

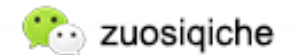
TEL: 010-82601561, 82863481

Mobile: 137 1884 5418

Email: report@researchinchina.com

Website:
www.researchinchina.com

WeChat: [zuosiqiche](https://www.wechat.com/p/zuosiqiche)



Chengdu Branch

TEL: 028-68738514

FAX: 028-86930659