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**Automotive Power Supply
(OBC+DC/DC+PDU) and
Integrated Circuits (IC)
Industry Report, 2023**

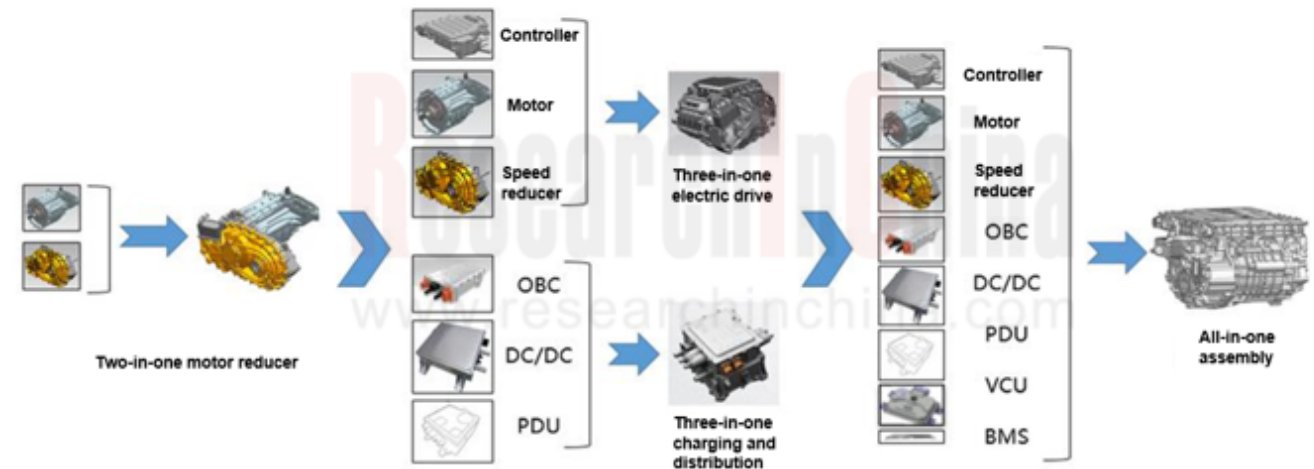
Sept. 2023

Automotive power supply and IC: Chinese chips are promising in the evolution from physical integration to system integration

As the core component of a new energy vehicle, automotive power supply is mainly used to convert the electric energy of the power battery into the voltage and current suitable for the vehicle, and also provides stable power support for the electrical equipment inside the vehicle. The surging new energy vehicle sales spur the boom of automotive power supply market.

OBCs, DC/DC converters and PDUs in automotive power supply can be independent components or integrated systems. As per the product structure of mainstream suppliers in recent two years, the proportion of independent components is declining sharply, while the shipments of "two-in-one", "three-in-one" and "all-in-one" integrated forms are jumping.

Automotive Power Supply Heads in the Direction "all-in-one" Integration



Source: FinDreams Powertrain

All-in-one solution from physical integration to system integration

The integration trend of automotive power supply is clear, and OBCs, DC/DC converters and PDUs are further integrated with electric drive and ECU. FinDreams Powertrain, Changan NE, Huawei Digital Power, etc. are all promoting the all-in-one electric drive assembly integrated with OBCs. The mode of high integration can save space, reduce weight and improve the overall efficiency.

"All-in-one" Integrated Products of Automotive Power Supply

Vendor	All-in-one Integration Mode	Overview
BYD	Eight-in-one	<ul style="list-style-type: none"> Drive motor, reducer, drive motor controller, low/high voltage DC-to-DC converter (DC-DC), bidirectional on-board charger (OBC), power distribution unit (PDU), battery management system (BMS), and vehicle control unit (VCU) are integrated. Compared with the previous generation, the power density is increased by 20%, the weight and volume are reduced by 15% and 20% respectively, and the comprehensive efficiency of the system reaches up to 89%.
Changan Deepal	Seven-in-one	<ul style="list-style-type: none"> Motor, electric controller, reducer, on-board charger, DC/DC, DC/AC, PDU are integrated. The weight is lessened by 10%, the volume is reduced by 5%, the efficiency is improved by 4.9%, the power density is enhanced by 37%, and the highest comprehensive efficiency of the system is improved to 95%.
Huawei	Six-in-one	<ul style="list-style-type: none"> Motor control unit (MCU), permanent magnet synchronous motor, reducer, on-board charger (OBC), voltage converter (DC/DC) and power distribution unit (PDU) are integrated. Peak efficiency $\geq 93\%$
	Ten-in-one	<ul style="list-style-type: none"> Drive motor, motor controller, reducer, PDU, OBC, DC/DC, VCU, TMCU, BMS, and PTC are integrated. The cost of the entire vehicle is reduced, the passenger compartment is expanded by 50mm, and the development efficiency is improved by 30%.
Enpower	Six-in-one	<ul style="list-style-type: none"> Motor controller, PDU, DC/DC converter, on-board charger, motor and reducer are integrated. Maximum system efficiency: 93%
JAC	Nine-in-one	<ul style="list-style-type: none"> Motor, motor controller, reducer, DC/DC converter, charger, VTOL, PDU, PTC controller, and super flash charging are integrated.

Source: ResearchInChina

"All-in-one" integrated solution of Huawei

In the future, the "all-in-one" integrated solution will evolve from mechanical hardware integration to power components integration, and deeply integrate software with the backend to form a control domain for the drive system - fully combining battery data, electric drive data, charging data, etc., evolving towards the power domain controller.

Huawei: the hyper-converged "ten-in-one" power domain module launched in April 2023 pioneers chip integration, power integration, function integration and domain controller integration to reduce the BOM by 40% and the number of chips by 60%, thus improving the development efficiency of automakers by 30%. In addition, it enables more concise layout of the front cabin of vehicles, releases more interior space and provides better comfort experiences for occupants.



Hyperconvergence

- Chip fusion, power fusion
- Function fusion, domain controller fusion

Platformization

- Minimalist architecture platform
- A module
- The hardware platform is reused, and the software is always new.

Vehicle ↓¥1xxx Passenger compartment ↑50mm

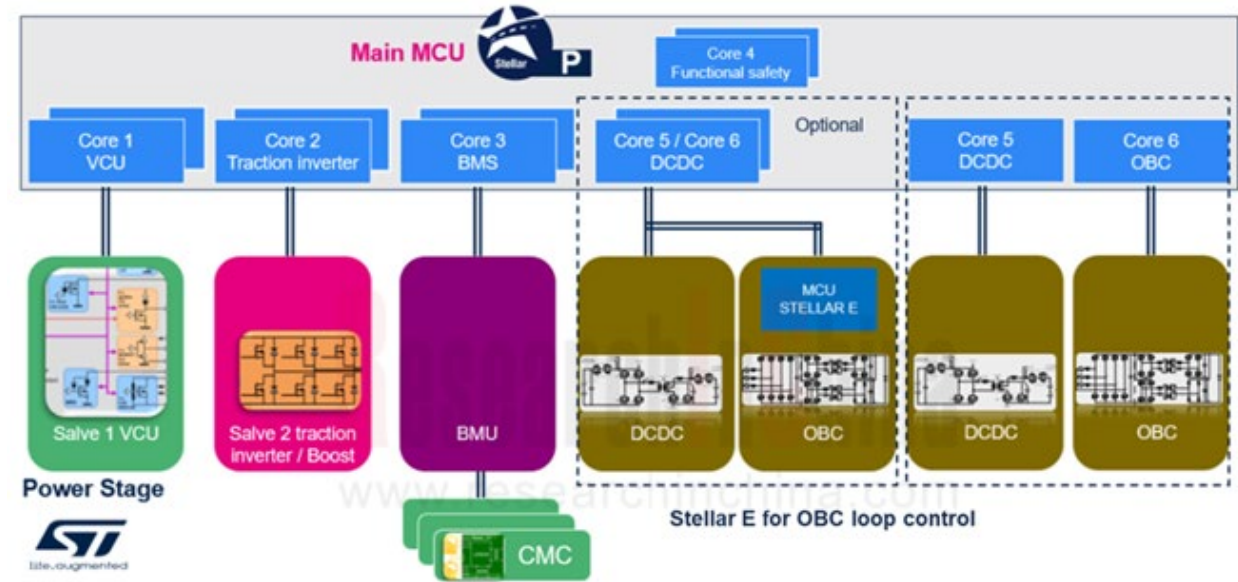
Source: Huawei

"All-in-one" integrated solution of ST

ST: ST New Energy Vehicle Innovation Center has built a range of system solutions based on Stella series, including the 22kW Stellar E-based OBC-DC/DC combined solution and the Stella P-based all-in-one powertrain domain controller.

The all-in-one powertrain domain controller is based on ST's latest Stellar P series automotive MCU, and integrates the following components: main drive inverter, vehicle control unit (VCU), battery management unit (BMU) motherboard, on-board charger (OBC) and DC/DC converter. The highly integrated solution improves power density, reduces the number of high/low-voltage connectors, and optimizes the cost of hardware BOM and software development and maintenance.

ST's All-in-one Power Domain Architecture



Source: ST

Localization is promising in the upstream supply chain of automotive power supply

Silicon carbide is widely used in automotive power supply products.

Conventional silicon-based power semiconductors can only limitedly improve the efficiency and power density of automotive power supply, while SiC power devices have advantages in on-resistance, blocking voltage and junction capacitance, and are rapidly introduced in high-end new energy electric vehicles.

OBCs and DC/DC converters have started wide adoption of SiC devices, for instance, PFC diodes are replaced by SiC SBDs, or DC/DC primary circuit MOS tubes of OBCs are substituted by SiC MOS, and all-SiC solution is expected to enter the stage of mass application soon.

So far, BYD, Tesla, Hyundai, Jaguar Land Rover, Geely, Renault, SAIC Volkswagen and Nissan among others have used the third-generation SiC semiconductor devices in automotive power supply.

SiC Application

Automaker/Tier 1 Supplier	Product	SiC Application
Toyota	OBC, DC/DC converter of bZ4X	Equipped with SiC technology from Denso Corporation
Lucid	Air series OBC (19.2 kW)	Roma SiC MOSFET (80 miles of driving range after 1 hour of charging)
MAHLE	800V and 11kW CDU	SiC is adopted to integrate OBC, DC/DC and PDU, supporting up to 3.6kW V2L, V2X and DC/DC.
Visteon	11 kW OBC and DC/DC charger are integrated	For 800V, SiC is adopted, and 11kW OBC and 3kW DC/DC are integrated to realize V-G, V-L and V-V.
Stercom	22kW/32A OBC	SiC enables an efficiency of up to 94%
KOSTAL	Next-Generation OBC Platform	Infineon's CoolSiC MOSFET is used.
Zhejiang EV-Tech	Automotive charging solution	Wolfspeed E series SiC MOSFET is adopted.
DEREN-Meta	22kW 800V SiC power OBC	Supplied to Porsche Mission E (production Taycan)
Stercom	22kW OBC	SiC semiconductor and efficient cooling technology are used
Innoelectric	22kW OBC	Innoelectric cooperates with STMicroelectronics to develop SiC technology

Source: ResearchInChina

Infineon presents its new generation of 1200 V CoolSiC MOSFETs

Infineon: In June 2023, Infineon presents its new generation of 1200 V CoolSiC MOSFETs in TO263-7 for automotive applications. The automotive-graded silicon carbide (SiC) MOSFET generation offers high power density and efficiency, enables bi-directional charging and significantly reduces system cost in on-board charging (OBC) and DC-DC applications.

In addition, the 1200 V CoolSiC family member offers best-in-class switching performance through 25% lower switching losses and lowers the SiC MOSFET junction temperature by 25%, compared to the first generation.

The pace of homemade automotive power supply MCUs in China replacing imported counterparts quickens.

At present, major automotive power supply IC vendors are working to improve product performance to meet ever higher requirements.



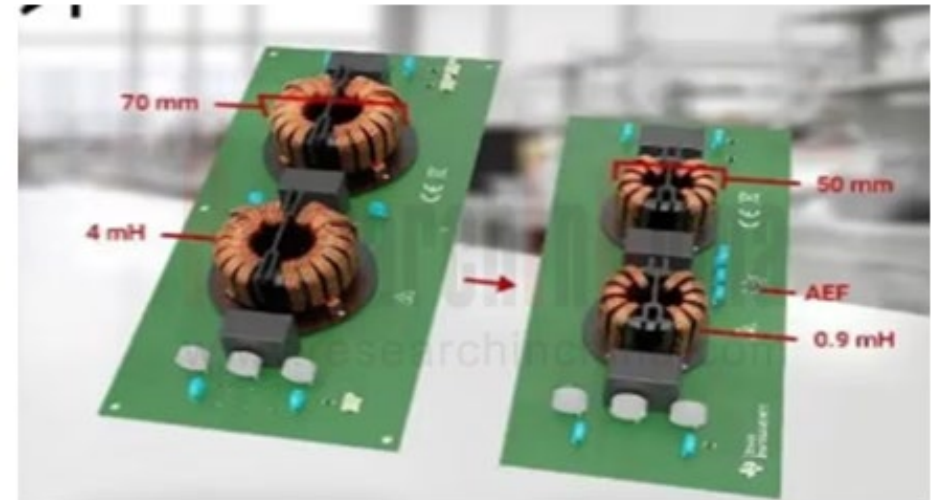
Source: Infineon

TI introduced standalone active EMI filter ICs

TI: In the existing automotive power supply system, customers often have high requirements for high efficiency and better thermal performance. Both OBCs and communication power supply products are getting smaller, and the switching frequency is also becoming higher, posing bigger EMI challenges. In March 2023, TI introduced standalone active electromagnetic interference (EMI) filter integrated circuits (ICs), enabling engineers to implement smaller, lighter EMI filters, to enhance system functionality at reduced system cost while simultaneously meeting EMI regulatory standards.

The new portfolio of stand-alone active EMI filter ICs can sense and cancel common-mode EMI by as much as 30 dB at frequencies between 100 kHz and 3 MHz in single- and three-phase AC power systems. This capability enables designers to reduce the size of chokes by 50%, compared to purely passive filter solutions.

Currently, ST and TI's solutions prevail in the automotive power supply market, especially TI's C2000 series chips that are still seen in popular electric models, such as Xpeng P7, and are used by mainstream OBC/DC-DC suppliers such as Shinry Technologies and Zhejiang EV-Tech as the main control chips.



Source: TI

Layout of chinese Vendors in Automotive Power Supply Control

In the recent two years, Chinese main control chip suppliers have stood a chance to replace foreign counterparts with the products made in China. Domestic suppliers have accelerated their layout in the field of main control chips, and are developing from basic OBC and DC-DC applications to all-in-one dynamic domains.

Layout of Chinese Vendors in Automotive Power Supply Control Chips

Vendor	Automotive Power Supply MCU
SemiDrive	E3600/E3400/E3200 series is applicable to BMS, brakes, chassis, ADAS/autonomous driving; In February 2023, SemiDrive cooperated with KOTEI to build a domestic power domain solution based on E3, a microcontroller. The solution will cover the power system all-in-one design scheme and deeply integrate OBCs, DC/DC converters, PDUs and other high-voltage electrical accessories.
ChipON	Some OEMs have applied KF32A156, the company's 32-bit automotive-grade MCU, to ECUs related to vehicle and chassis.
Geehy	APM32F072RBT7 that meets the automotive-grade reliability standard has been widely used in blind spot detection, alarms, OBCs, center consoles, driving recorders and automotive audio-visual systems.
NationalChip	New energy BMS control chips are used in BMS control, power battery DC/DC converters and OBCs.
Halo Microelectronics	High-performance automotive DC/DC converters feature a wide input voltage range, programmable working frequency, multiple operation modes (burst mode, pulse skip mode and continuous current mode) and spread spectrum clocking.

Source: ResearchInChina

Highlights of Automotive Power Supply (OBC+DC/DC+PDU) and Integrated Circuits (IC) Industry Report, 2023

Automotive Power Supply (OBC+DC/DC+PDU) and Integrated Circuits (IC) Industry Report, 2023 by ResearchInChina highlights the following:

- Automotive power supply (technology trends, market size, products & solutions, etc.);
- On-board charger (OBC) (product structure, technology development trends, market size, structure of main suppliers, price trend, etc.);
- DC/DC converter (technology trends, market size, competitive landscape, cost structure, main solutions, etc.);
- Power distribution unit (PDU) (product structure, technology trends, market size, competitive landscape, cost structure, solutions of main suppliers, etc.);
- Main automotive power supply components (MCU, power supply IC, relay, PFC converter, etc.) (product structure, main suppliers and products, etc.);
- Main automotive power supply suppliers (product line, technology layout, product price, main customers, market position, etc.).

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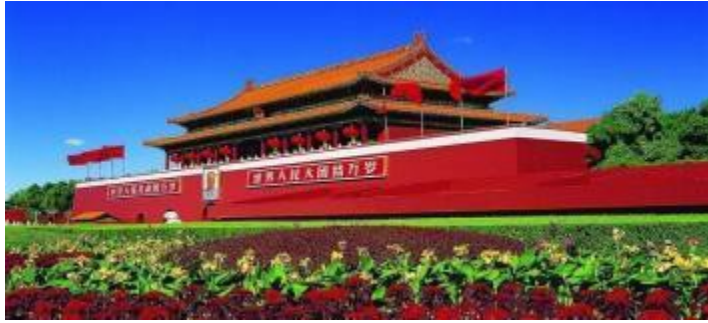
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Beijing Headquarters

TEL: 13718845418

Email: report@researchinchina.com



Chengdu Branch

TEL: 028-68738514

FAX: 028-86930659

Website: [ResearchInChina](http://ResearchInChina.com)

WeChat: Zuosiqiche

