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New Energy Vehicle Thermal Management System Market Research Report, 2024

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xEV thermal management research: develop towards multi-port valve + heat pump + liquid cooling integrated thermal management systems

The thermal management system of new energy vehicles evolves from the decentralized to the integrated, and then to the intelligent:

- Distributed thermal management system: simple structure but low efficiency. The circuits of battery, motor and ECU, and air conditioning system are independent of each other. Although the structure is simple, the energy efficiency is low and the integration is also low;
- Integrated thermal management system: use multi-port valves or pipelines to connect various systems. By using multi-port valves or pipelines, the circuits of various systems are connected to form a large circulation loop, improving the energy efficiency;
- Intelligent thermal management system: the future development trend, realizing the integration of thermal management system functions, modular structure, and intelligent control to achieve the lowest energy consumption and optimal energy distribution for vehicles.

Installation of heat pump systems in new energy passenger cars

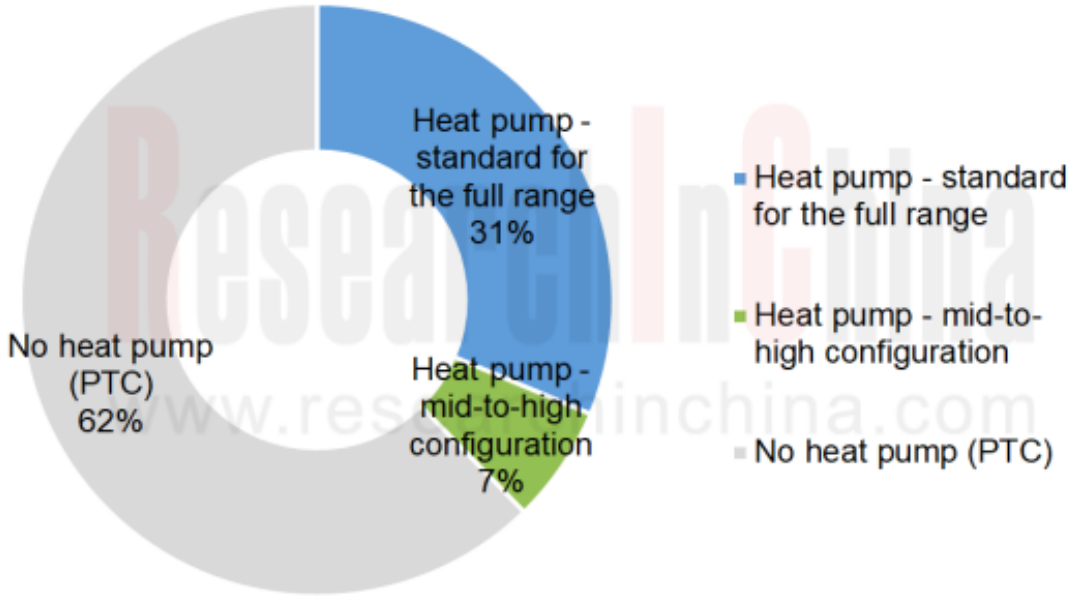
There are 368 new energy passenger car models (EV&PHEV&REEV) on sale, including 240 battery electric passenger car models (EV), 106 plug-in hybrid electric passenger car models (PHEV), and 22 range-extended electric passenger car models (REEV). By heat pump installation, battery electric passenger car models account for 47.5%, plug-in hybrid passenger car models 6.6%, and range-extended electric passenger car models 4.5%.

Statistics on Thermal Management Systems for New Energy Passenger Cars (by Number of Vehicle Models Equipped) in China, 2024H1

Installation of Heat Pump Systems	EV	PHEV	REEV	Total
CO2 heat pump - mid-to-high configuration	3			3
CO2 heat pump - optional	4			4
Heat pump - standard for the full range	77	2	1	80
Heat pump - mid-to-high configuration	25	5		30
Heat pump - optional	5			5
No heat pump (PTC)	126	99	21	246
Total	**240**	**106**	**22**	**368**
Percentage of models installed with heat pump system	**47.5%**	**6.6%**	**4.5%**	**33.2%**

Source: ResearchInChina

Statistics on Thermal Management Systems for New Energy Passenger Cars (by Terminal Sales for Vehicle Models) in China, 2024H1



Source: ResearchInChina

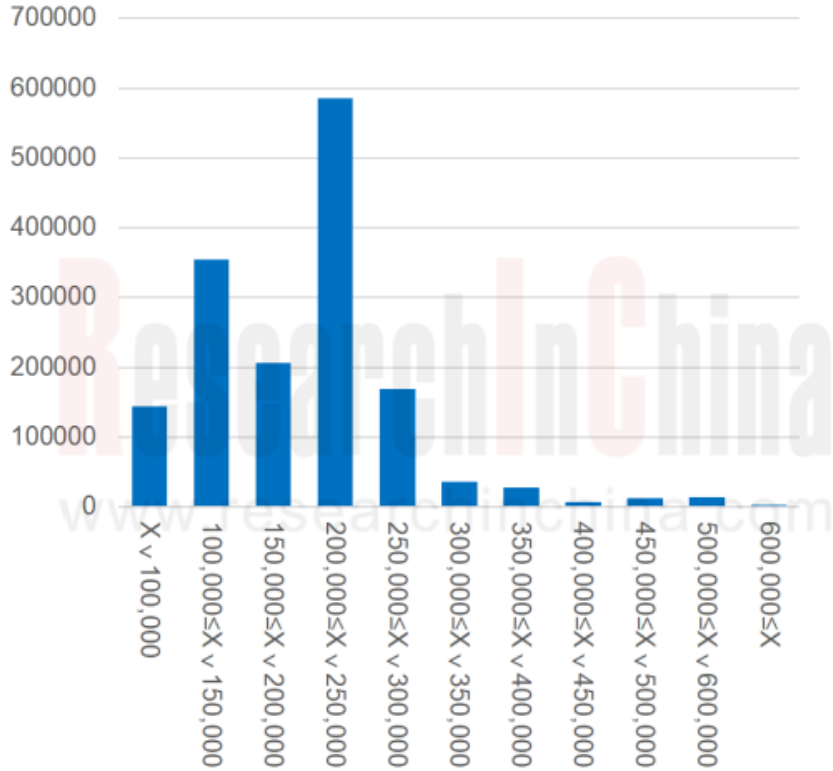
From January to June 2024, a total of 4.689 million new energy passenger cars (EV&PHEV&REEV) were sold. The full range of models installed with heat pump systems as standard took up 31.3% of the total sales; mid-to-high-configuration models with heat pump systems accounted for 6.4%; the models without heat pump systems but using PTC systems swept 62.3% (of which, about 1.3% of the models could be upgraded with optional heat pumps).

Installations of Heat Pump System in Battery Electric Passenger Cars in China

Seen from the price range of China's battery electric (EV) passenger cars (models equipped with heat pumps) in the first half of 2024, 586,000 units of models in the range of RMB200,000-250,000 were sold, making up 37.6% of the total sales of battery electric passenger cars; the sales of models in the range of RMB100,000-150,000 ranked second, up to 354,000 units, or 22.7% of the total sales; the models in the range of RMB150,000-200,000 were positioned third, with sales up to 207,000 units, or 13.2% of the total sales.

The overall selling price of battery electric passenger cars equipped with heat pump systems declines compared to 2023, mainly due to the price war among new energy passenger car manufacturers. As thermal management systems tend to be homemade, the system cost continues to fall.

Installations of Heat Pump Systems in Battery Electric Passenger Cars (by Price Range of Vehicle Models) in China, 2024H1



Source: ResearchInChina

The OEM thermal management system adopts a multi-way valve + heat pump + liquid cooling solution

As new energy vehicle technology advances, thermal management systems also keep innovating and improving. For example, some advanced thermal management systems adopt more intelligent control strategies, automatically adjusting the heat dissipation intensity according to actual conditions. The application of new materials and new technologies has also improved the efficiency and reliability of thermal management systems.

Overview of Thermal Management System Solutions of Major OEMs

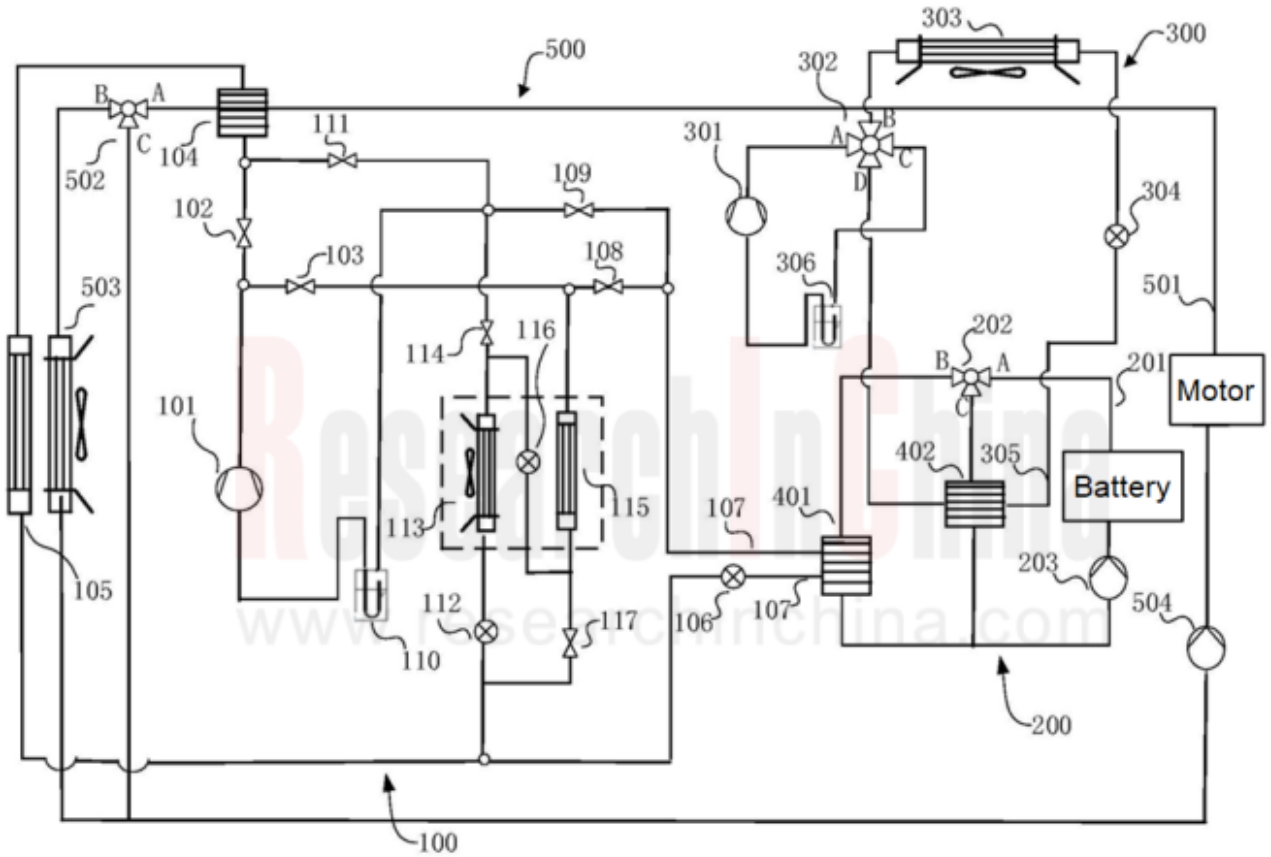
OEM		Thermal Management System Solution
TESLA	Tesla	**Tesla's 4th-generation thermal management system: Octovalve 8-port valve + heat pump system + liquid cooling + waste heat recovery** • Tesla Model Y's vehicle thermal management architecture (8-port valve heat pump solution)
BYD	BYD	**BYD E3.0 platform based thermal management system: Nonavalve (9-port valve) + heat pump system + refrigerant direct cooling + waste heat recovery** **2nd-generation vehicle integrated thermal management system: large valve body for high-voltage 4WD medium-to-large vehicles + integrated system + 800V high voltage** • BYD e 3.0 platform - wide temperature range, high-efficiency heat pump system; vehicle integrated thermal management system; 16-in-1 integrated thermal management system (2nd generation);
蔚来 NIO	NIO	**NIO ET7's thermal management system: PTC/heat pump air conditioning + liquid cooling + waste heat recovery** • NIO NT3.0 thermal management system (PTC + heat pump system)
理想	Li Auto	**Li Auto's BEV thermal management system: 800V high voltage + heat pump (PTC auxiliary) + liquid cooling Qilin structure** • Li MEGA (thermal management system with wide temperature range); Li L9's thermal management system (plug-in hybrid solution)
小鹏	Xpeng	**X-HP2.0 intelligent thermal management system: 10-port valve + heat pump + vehicle integrated thermal management**
哪吒汽车	Neta Auto	**Neta Auto's Haozhi Platform based vehicle integrated thermal management technology: heat pump air conditioning + 3 sets of electronic water pumps + 2 sets of 4-port valve bodies**
LEAPMOTOR 零跑汽车	Leapmotor	**Leapmotor's extended-range intelligent thermal management technology: PTC air conditioning + water cooling** • Predictive intelligent thermal management (PITM) technology + integrated thermal management system battery pack
AION	GAC Aion	**Aion's new energy thermal management system solution: heat pump air conditioning + liquid cooling + magazine battery**
mi	Xiaomi Auto	**Xiaomi Auto's 10-port valve full vehicle thermal management system: 10-port valve + heat pump air conditioning + 800V**
SAIC	SAIC	**SAIC's new energy vehicle thermal management system: heat pump air conditioning + battery thermal management**
吉利汽车 GEELY AUTO	Geely	**Geely Galaxy L7's intelligent thermal management system: heat pump air conditioning (auxiliary PTC heater) + liquid cooling + Aegis battery safety system**
VW	Volkswagen	**Volkswagen's new energy vehicle thermal management system: CO2 refrigerant + heat pump air conditioning + liquid cooling**

Source: ResearchInChina

4-Port Vale Structure of Li Auto

Li Auto

The design concept of Li Auto's thermal management system is multi-port valve + heat pump + waste heat recovery. The super thermal management module integrates 16 main functional components such as valve body, pump, gas separator and heat exchanger, reducing a lot of system components and realizing the separation of physical components and ECUs.



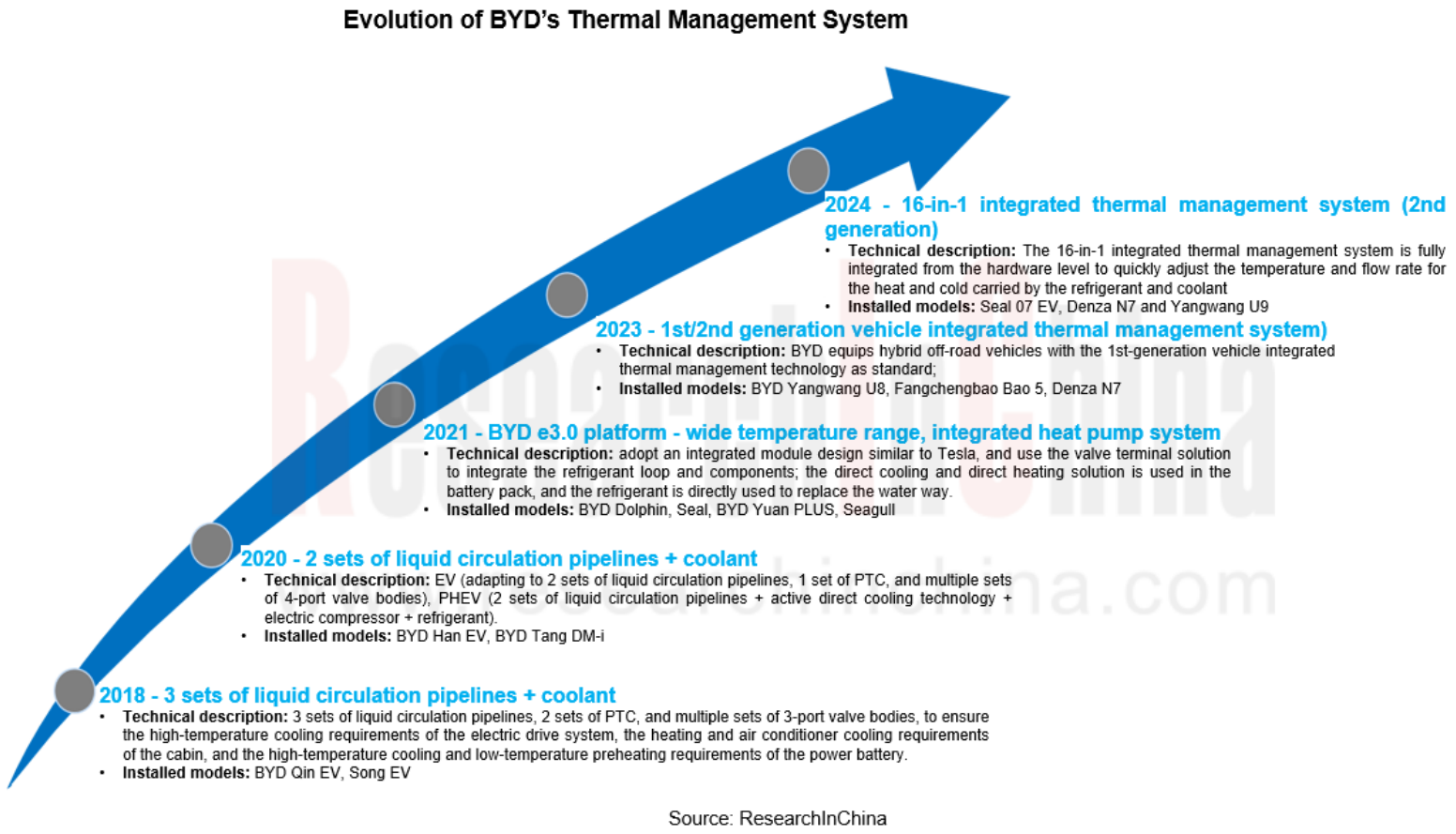
Source: Li Auto's Thermal Management System Patent – 4-port Valve Structure

Evolution of BYD's Thermal Management System

BYD's "16-in-1" integrated thermal management system

The integrated thermal management system based on the BC series heat pump air conditioner under the e-platform 3.0 architecture first reduces energy consumption and loss. It not only enables cold and heat interactions around the cabin and power battery, but also is controlled by the operating system BYD OS at the domain control level, sending cold air directly to the blade battery and cabin, and transferring heat among the electric drive system, cabin and blade battery.

The "16-in-1" integrated thermal management system matching Seal 07 EV can provide high-temperature heating, high-temperature cooling, low-temperature preheating, waste heat recovery and low-temperature refrigeration servo in the five temperature requirements for each system of the vehicle.



Source: ResearchInChina

Haozhi Platform Integrated Thermal Management System

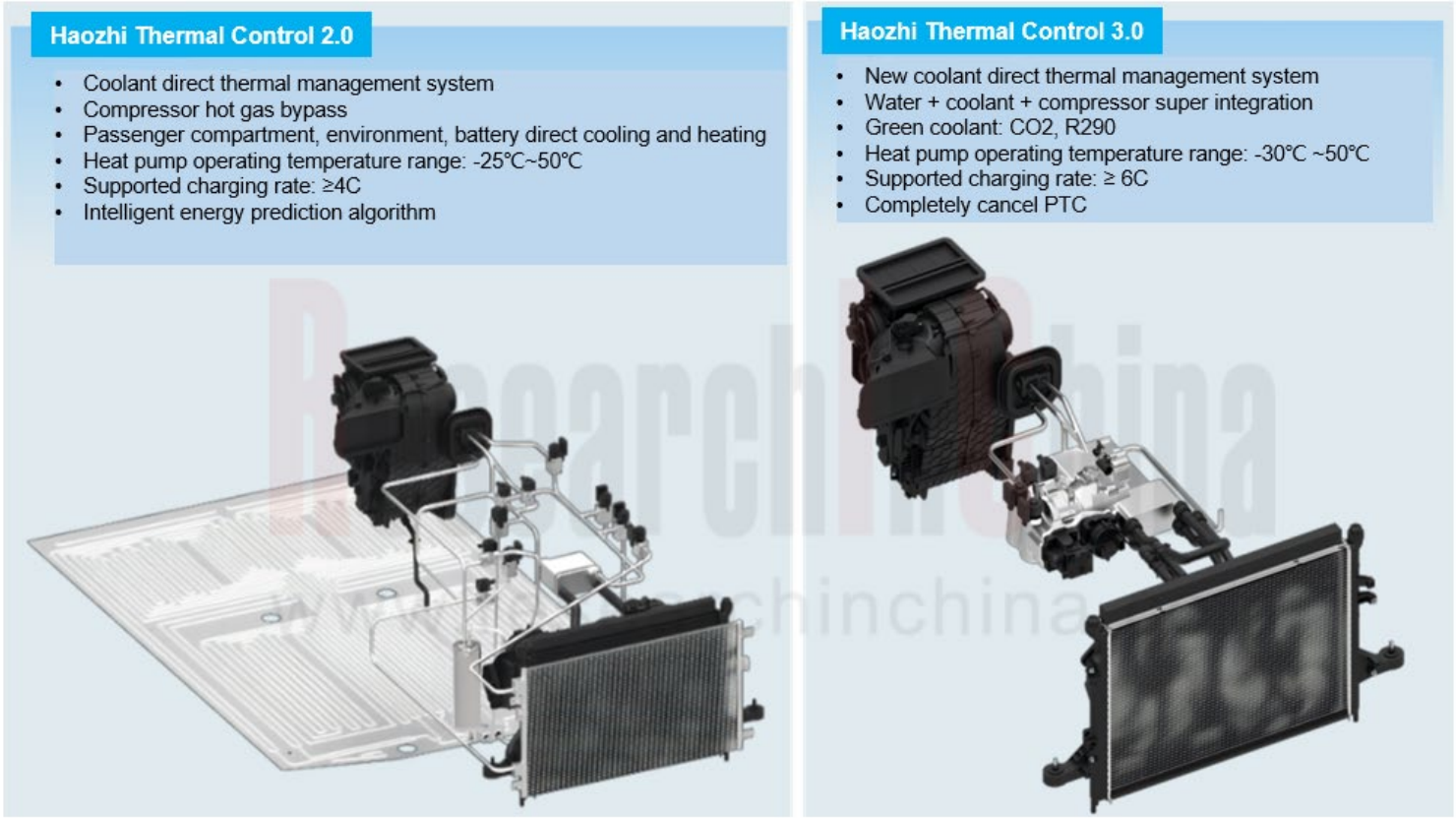
Neta Haozhi Thermal Control - Haozhi Platform Integrated Thermal Management System

Haozhi Thermal Control highlights heat pump air conditioning technology, and features low energy consumption, wide temperature range, and high integration. With heating power consumption less than 800W, it increases cruising range by up to 20% in winter. In addition, the operating temperature of the Haozhi thermal control system is as low as -35℃, and -20℃ in heat pump mode. It has an integrated module and a dual-source heat pump, and supports 3C fast charging.

Haozhi Thermal Control 1.0 is equipped with an integrated module and a dual-source low-temperature heat pump, allowing the battery to be charged fully within half an hour;

Haozhi Thermal Control 2.0 adopts a direct heat pump architecture, uses compressor hot gas bypass technology, and is equipped with an intelligent control algorithm, allowing the battery to be charged fast and fully within 15 minutes;

Haozhi Thermal Control 3.0 uses a new type of coolant, and leads the industry in terms of integration, efficiency and temperature range.



Source: Neta Auto

Intelligent thermal management: Innovative solutions such as integrated controllers and sensors spring up

Thermal management controller - mainstream integrated modules include: water pump drive, water valve drive, electronic expansion valve drive, solenoid valve control, sensor acquisition, network communication, circuit self-diagnosis, OBD diagnosis, hardware, etc.

For example, EVPT's thermal management module (TMM) uses NXP FS32K146 as the main control chip, with bus frequency of 80 MHz, and a connector with 80 Pins (40+40). It offers IP5K1 protection and supports the ISO26262 ASIL-B functional safety level.

Under zonal architecture, zones re-integrate the vehicle power grid architecture, communication architecture and controller architecture. Faced with the trend towards thermal management system integration, the independent thermal management controller can integrate the control systems of core components such as electronic expansion valve, water pump, and water valve into the thermal management controller (TMC). On the one hand, it can reduce a large number of discrete backplane drivers and save system costs. On the other hand, it can ensure the platformization of the vehicle architecture and zone control modules as much as possible while coping with diversified topology architectures of the thermal management system. The integrated thermal management controller can also greatly lower the failure rate of component ECUs, facilitating system intelligence and full life cycle diagnosis and maintenance.

In the future, the main challenges in integrated thermal management systems for new energy vehicles include inaccurate temperature control and energy waste. To solve the problems, it is necessary to further research and develop more advanced temperature and pressure sensing technologies to improve the accuracy and sensitivity of temperature and pressure monitoring.

As MEMS sensors are used ever more widely in vehicles, OEMs need to seize the opportunity and establish industrial partnerships in a short time, so that these new sensor technologies can be successfully integrated into vehicle design.

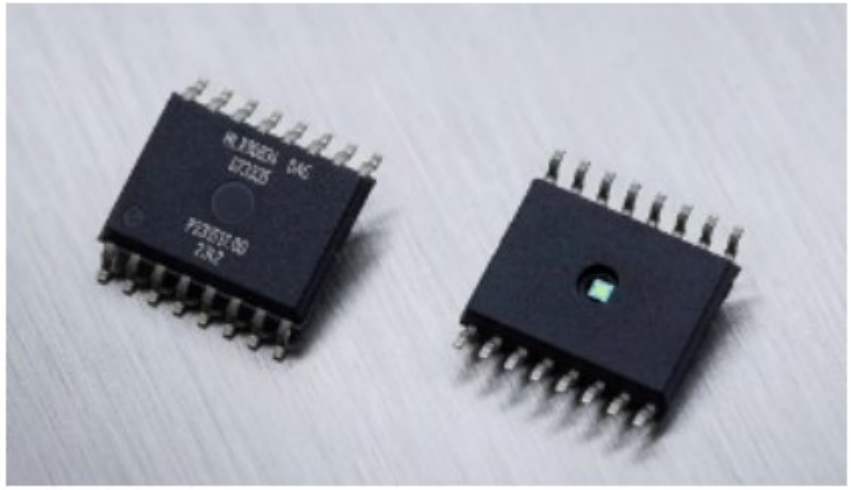
Intelligent thermal management Solutions: TDK & Melexis

TDK's temperature and pressure integrated sensor

It integrates both temperature and pressure measurement functions, and features high accuracy, small size, light weight, quick response, and diverse installation modes. It can be applied to key components such as thermal management systems and automotive electric compressors to monitor heat exchange efficiency in real time.

Melexis MEMS digital output pressure sensor MLX90834

In September 2024, Melexis, a global microelectronics engineering company, expanded its TriphibianTM family with the MLX90834 pressure sensor, designed for automotive applications such as EV thermal management. This robust, factory-calibrated MEMS solution accurately measures pressure in both gas and liquid media from 2 to 70 bar. Its digital SENT output delivers absolute pressure information, diagnostic and temperature data, enabling enhanced system performance and reliability.



Source: Melexis

Reliability is the basic requirement for the development of thermal management systems for new energy vehicles. As the new energy vehicle market continues to expand, the reliability requirements for thermal management systems are becoming ever higher. Using high-quality components and strict manufacturing processes, as well as sufficient testing and verification can ensure the stability and reliability of thermal management systems, thereby improving competitive edges of vehicles.

Table of Content (1)

Table of Content (2)

Table of Content (3)

Table of Content (4)

Table of Content (5)

Table of Content (6)

Table of Content (7)

Table of Content (8)

Table of Content (9)

Table of Content (10)

Table of Content (11)

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