

Air-conditioning System for Mitsubishi Motors OUTLANDER PHEV



Mitsubishi Heavy Industries
Automotive Thermal Systems Co., Ltd.

In January 2013, Mitsubishi Motors Corporation launched the Outlander PHEV (Plug-in Hybrid Electric Vehicle), the world's first plug-in hybrid electric vehicle in the 4WD and SUV categories. For the Outlander PHEV, Mitsubishi Heavy Industries Automotive Thermal Systems Co., Ltd. supplies the system controlling the temperature inside of the lithium ion battery pack in addition to air conditioning in the cabin. This system includes an HVAC (Heating, Ventilation and Air Conditioning) unit, an electrically-driven A/C compressor and an electric water heater for electrification, as well as a battery cooling unit. This paper presents a summary of the air conditioning system that Mitsubishi Heavy Industries Automotive Thermal Systems Co., Ltd. developed for the Outlander PHEV.

1. Features

(1) HVAC unit

The HVAC unit of the developed system is equipped with a thin type evaporator for cooling, a thin type heater core for heating, a built-in blower fan, and a thin walled plastic casing in order to realize a compact packaging. As a result, it achieved an approximately 15% reduction in weight compared with the existing one (the HVAC unit for the previous model of the Outlander).

The controller of the air conditioning system features newly developed hardware and software applicable to the new PHEV system, while its operation and display panel is carried over from that of the existing Outlander. The air conditioning system is operated to the optimal A/C condition along with the vehicle driving condition in order to reduce energy consumption, noise and vibration while the air conditioner is on (**Figure 1**).



Figure 1 HVAC unit and controller of air conditioner

(2) Electrically-driven A/C compressor

An electrically-driven scroll compressor is applied to the developed system, which has the same displacement (24 cc/rev) as that used in the i-MiEV and Minicab MiEV series of EVs (Electric Vehicles) manufactured by Mitsubishi Motors. The electrical A/C compressor is optimized to the Outlander PHEV in order to improve efficiency and suppress noise and vibration. As a result, the Outlander PHEV has sufficient air-conditioning performance in spite of the larger cabin volume than the i-MiEV and Minicab MiEV (**Figure 2**).



Figure 2 Electrically-driven A/C compressor

(3) Battery cooling unit

A battery cooling unit was newly developed for the Outlander PHEV. The cooling unit is installed in the lithium ion battery pack. This unit can be independently operated, and therefore, it can cool down the battery according to the temperature inside the lithium ion battery pack, without being affected by the operation of the cabin air conditioning. Consequently it contributes to the improvement of reliability and the extension of the service life of the high voltage lithium ion battery (**Figure 3**).



Figure 3 Battery cooling unit

(4) Electric water heater (optional)

In a typical A/C system without an electric water heater, engine coolant (hot water) is circulated to the heater core in the HVAC unit for heating operation (hot water heating system), and then the engine becomes a heat source whenever heating mode is necessary for cabin air conditioning, even if the battery power (charge level) is sufficient.

On the other hand, in the system of the Outlander PHEV, an electric water heater unit similar to that used in the i-MiEV and Minicab MiEV is added to the typical A/C system as optional equipment. The combined use of the electric water heater unit using battery power and the existing system using engine coolant realized the creation of a heat source for heating mode using electricity only when the battery power (charge level) is sufficient. Accordingly, the system can reduce the engine operating time period in comparison with the existing system and therefore contributes to the improvement of the fuel efficiency of the vehicle (**Figure 4**).



Figure 4 Electric water heater (optional)

2. Specifications

Table 1 shows the specifications of the air conditioning system components for the Outlander PHEV and **Figure 5** shows their layout on the vehicle.

Table 1 Specifications of Outlander PHEV air conditioning system components

HVAC unit	Cooling capability	5,500W
	Heating capability	5,700W
Battery cooling unit	Cooling capability	1,000W
Electric water heater	Heating capability	4,000W
Refrigerant		HFC-134a 590g

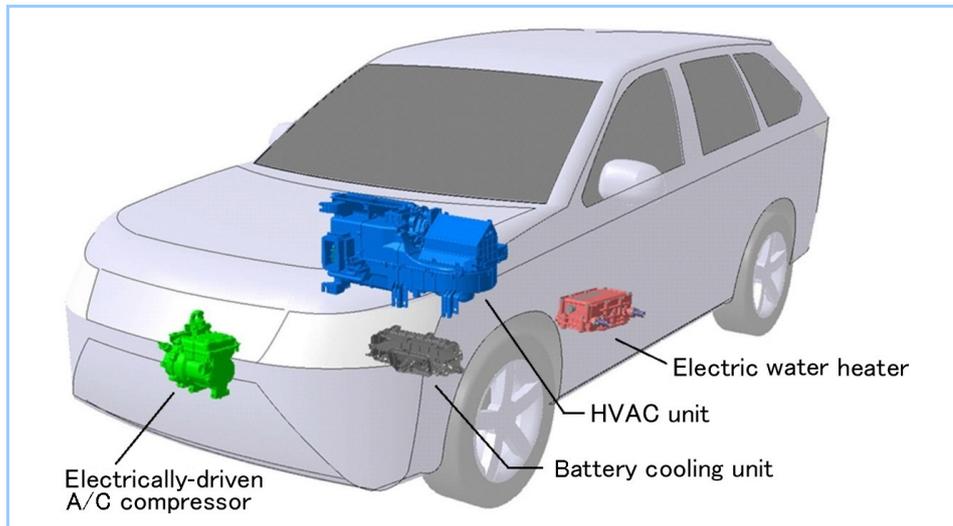


Figure 5 Layout of Outlander PHEV air conditioning system components