

New Electric Water Heater for Electric Vehicle/Plug-in Hybrid Electric Vehicle



Mitsubishi Heavy Industries
Automotive Thermal Systems Co., Ltd.

Mitsubishi Heavy Industries Automotive Thermal Systems Co., Ltd. has developed and manufactured electric water heaters for heating the interior of electric vehicles (EVs) or plug-in hybrid electric vehicles (PHEVs) since 2009. In EV heating systems, electric water heaters serve as a heat source (as a substitute for engine waste heat). In PHEVs, the use of electric water heaters eliminates the need to run the car's engine to obtain a working heat source, which as a result can contribute to better fuel economy.

This report introduces our new models of electric water heaters (Generation 3), which feature better functionality than the previous model.

1. Features and main specifications

In our new model, as in the previous one, a positive temperature coefficient (PTC) ceramic semiconductor is used as a heating element, whereby safety and reliable quality have been retained. Even in the case of problems caused by a loss of controllability due to a malfunctioning circuit board and other causes, the heating element does not grow hotter than a certain temperature, and therefore it is less likely to result in a serious event such as spontaneous ignition or fire. PTC ceramic semiconductors have a proven record of use in many EVs and PHEVs.

As in the previous model, the inner flow path is also aligned to sandwich the heating element plates from above and below, and is designed to minimize heat loss to the outside together with downsizing (**Figure 1**). In the new models, in addition to such structural contrivances, we have re-examined the details, thus successfully reducing the volume of the body casing by nearly 30% compared with the previous model (**Figure 2**).

Moreover, the functionality has been improved through the built-in electric control unit (ECU).

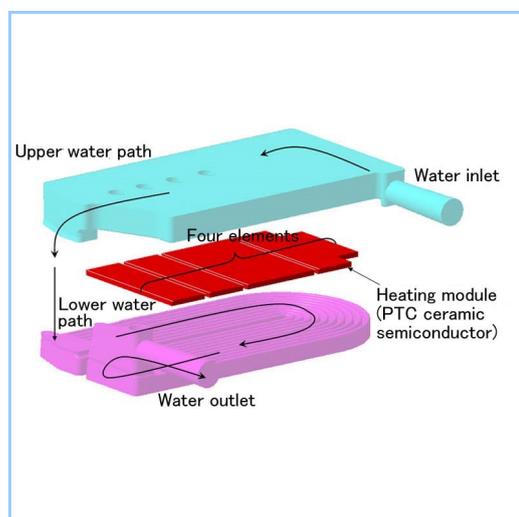


Figure 1 Internal structure

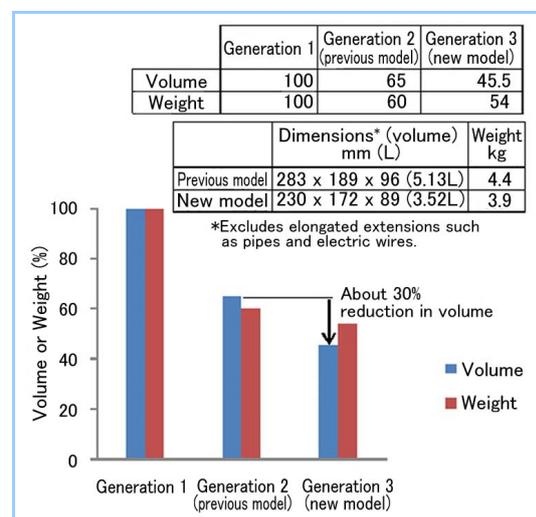


Figure 2 Size and weight comparisons
(among three generations)

2. Improved functionality

Figure 3 compares the system configuration and functions between the new model and the previous one. In the previous model, although a power circuit board was embedded to mainly control the electrical current to the heating element, many of the controls depended on an external ECU. On the other hand, the new model has a built-in ECU and therefore can automatically regulate the water temperature if information on the desired temperature level is transmitted. The new model is also equipped with a built-in water temperature sensor, parts temperature sensor, and current and voltage-measuring circuits in the high voltage system, thereby improving the self-protection and failure diagnosis functionality. In conclusion, while the new model has a function to stop its operation safely in the cases of an abnormal event, it is also easier to coordinate with other devices in the car.

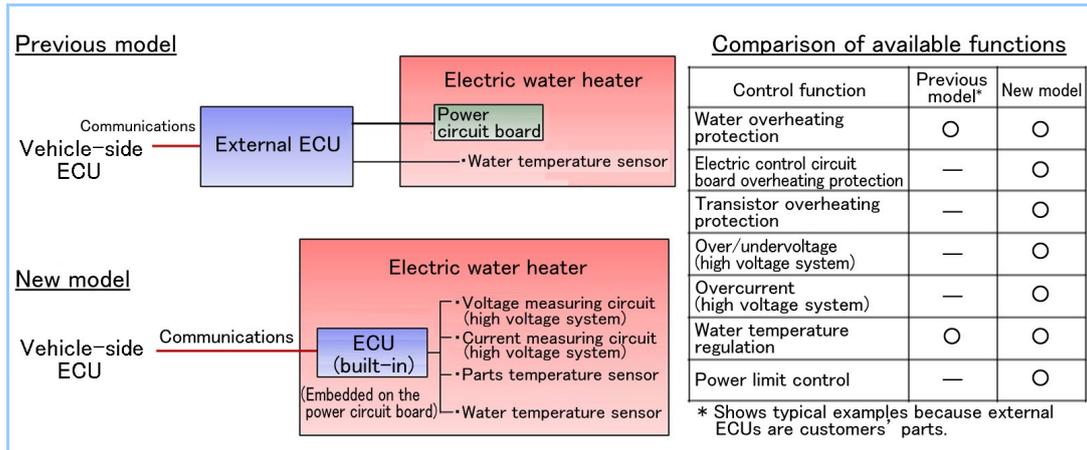


Figure 3 System configuration and functions – a comparison with the previous model

3. Future direction

As shown in **Figure 4**, we are developing electric water heaters that can satisfy market needs along with the realization of product downsizing and reduction in weight.

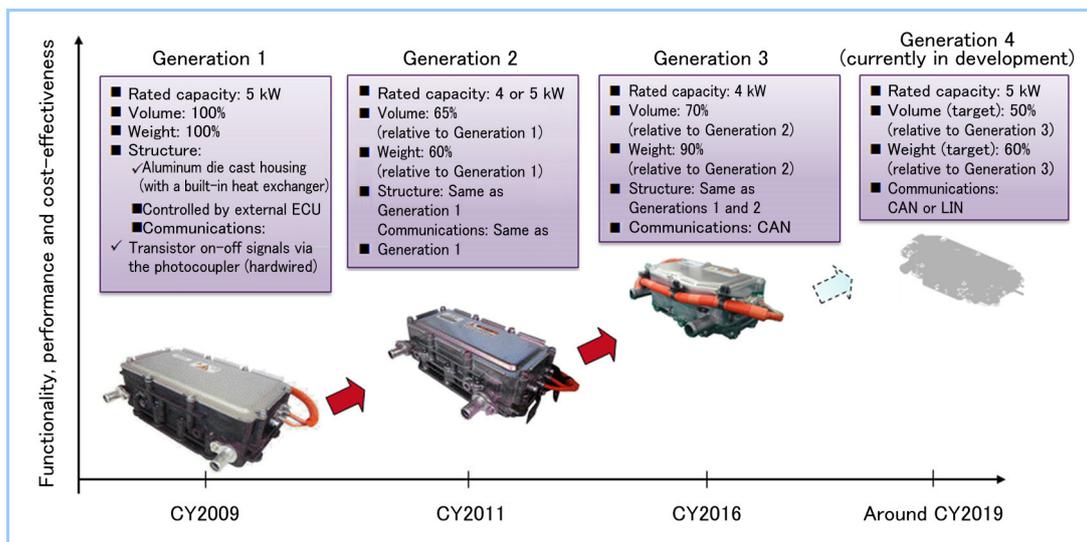


Figure 4 Evolution of electric water heaters for EVs and PHEVs and future direction