**FOR IMMEDIATE RELEASE**

# Hitachi to Develop Inverter for Eco-friendly Cars that Applies a Double-sided-cooling Full-SiC Power Module

*Reducing power loss by 60% and doubling power capacity (from the same bulk) by applying multi-parallelization of SiC chips*

Hitachi Ltd. (TSE: 6501) and Hitachi Automotive Systems, Ltd. today announced that they have developed a high-efficiency and high-power output inverter for eco-friendly cars.

This inverter will contribute to comfortable acceleration and long-distance performance of eco-friendly cars. Through utilization of a power module, equipped with multiple SiC power semiconductors[*1] (SiC-MOSFET[*2]), which enable loss reduction,, in parallel arrangement and a wiring and mounting structure for achieving high-speed switching, this inverter reduces power loss by 60% and doubles power capacity from the same bulk in comparison with the equivalent performance of one of Hitachi's conventional inverters.[*3]

In regions such as the US and Europe, environmental regulations that are aimed at reducing $CO_2$, nitrous oxides, etc., are being strengthened in a step-by-step manner therefore the need for eco-friendly cars is growing. As this trend continues, it is becoming necessary to reduce electricity costs and improve carrying capacity in order to spread the popularity of eco-friendly cars such as Hybrid Electric Vehicles(HEVs). It is essential to improve the efficiency and power output of the components fitted in electric vehicles in order to satisfy these needs. Hitachi and Hitachi Automotive Systems have been striving to improve efficiency and power output by minimizing the power loss of inverters that control electric motors that are vital for power generation and running of vehicles. Regarding current development, an inverter for eco-friendly cars which utilizes a full-SiC power module incorporating previously developed SiC/GaN parallel-mounting technology[*4] and double-sided-cooling power-module technology[*5] has been developed. The key features of these technologies are summarized below.

## 1. Mounting technology for control-signal wiring of power semiconductors that equalizes load current

As for power semiconductors connected in parallel, if the switching timing deviates (due to differences in the electrical characteristics of the peripheral wiring), the electrical current is concentrated in the semiconductors that are quickly switched on and in the semiconductors that are slowly switched off. As for the semiconductors in which the current is concentrated, the current must be restricted in order to maintain the reliability

of the device.
It was not possible to increase the consequent power capacity. Due to this circumstance, to unify the on and off timing of each semiconductor, previously developed parallel-mounting technology was applied. As a result of that application, it became possible to successfully develop an interconnection substrate for equalizing the lengths of the control-signal lines to each semiconductor and to match the resistance characteristics[*6] of each interconnection. Consequently, it became possible to sufficiently exploit the low-resistance property of SiC and increase power capacity.

**2. Technology for reducing magnetic-field energy generated by metal cooling fins and realizing high-speed switching**

To reduce an inverter's power loss, it is necessary to switch the power semiconductors on and off instantly. To satisfy this necessity, smoothly switching load current and voltage and lowering the loss generated in the semiconductors, by lowering the magnetic-field energy accumulated in the interconnections during switching, was set as a technical challenge. As for the configuration of the developed inverter, the interconnections are stacked so that the flow directions of the load currents in each interconnection are mutually opposite and are mounted in the center of the metal cooling fins of the can-shaped double-sided-cooling power module. The result of this configuration was that the cooling fins canceled the magnetic fields generated by the internal interconnections and thereby lowered the magnetic-field energy accumulated in them.

The developed inverter achieves 60% lower loss than conventional inverters and twofold higher electrical-power capacity than conventional inverters with the same bulk volume, by utilizing a parallel-mounting technique for equalizing the electrical currents flowing in SiC-MOSFETS, which lower electrical losses, and an interconnection-mounting technique ,which enables high-speed switching.
Going further, in order to improve the efficiency and power output of inverters fitted in eco-friendly cars, such as electric vehicles and HEVs, Hitachi and Hitachi Automotive Systems will continue to advance ground-breaking technological developments that will contribute to improving performance by applying key technologies such as the double-sided-cooling power module described in this report.

Further, the developed double-sided-cooling SiC power module is scheduled to be presented at the 44th Tokyo Motor Show (2015) held at Tokyo Big Site from October 30th, 2015 (public opening day).

Fig. 1: Developed inverter

Fig. 2: Double-sided-cooling full-SiC power module

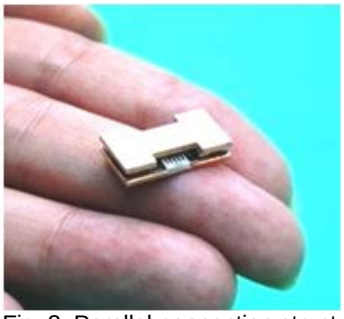

Fig. 3: Parallel-connection structure of the chip

[*1] Power semiconductor: A semiconductor used in systems for controlling power sources and supplying electrical power by, for example, transforming DC to AC and driving motors and actuating microcomputers and control circuitry.

[*2] SiC-MOSFET: Silicon-Carbide Metal-Oxide Semiconductor Field-Effect Transistor

[*3] In comparison with a conventional vehicle-mounted inverter using Si-IGBTs

[*4] SiC/GaN parallel-mounting techology (announced June 26th, 2014): A parallel-mounting technique (which matches the resistance characteristics of main interconnections and the control-signal interconnection lengths of power semiconductors) was developed, and power capacity was increased by 200% (in comparison with single-sided-cooling power modules).

[*5] Double-sided-cooling SiC power module (November 21st, 2011): A test power module (in which Si power semiconductors are cooled from both sides) was manufactured, and its heat-dissipation performance was improved by 35% while the space it occupies was reduced by 50%.

[*6] Resistance characteristic: A characteristic that expresses the ease that a current flows in electrical wiring carrying AC or DC current.

**About Hitachi Automotive Systems, Ltd.**

Hitachi Automotive Systems, Ltd. is a wholly owned subsidiary of Hitachi, Ltd., headquartered in Tokyo, Japan. The company is engaged in the development, manufacture, sales and services of automotive components, transportation related components, industrial machines and systems, and offers a wide range of automotive systems including engine management systems, electric power train systems, drive control systems and car information systems. For more information, please visit the company's website at http://www.hitachi-automotive.co.jp/en/.

**About Hitachi, Ltd.**

Hitachi, Ltd. (TSE: 6501), headquartered in Tokyo, Japan, delivers innovations that answer society’s challenges with our talented team and proven experience in global markets. The company’s consolidated revenues for fiscal 2014 (ended March 31, 2015) totaled 9,761 billion yen ($81.3 billion). Hitachi is focusing more than ever on the Social Innovation Business, which includes power & infrastructure systems, information & telecommunication systems, construction machinery, high functional materials & components, automotive systems, healthcare and others. For more information on Hitachi, please visit the company's website at http://www.hitachi.com.

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