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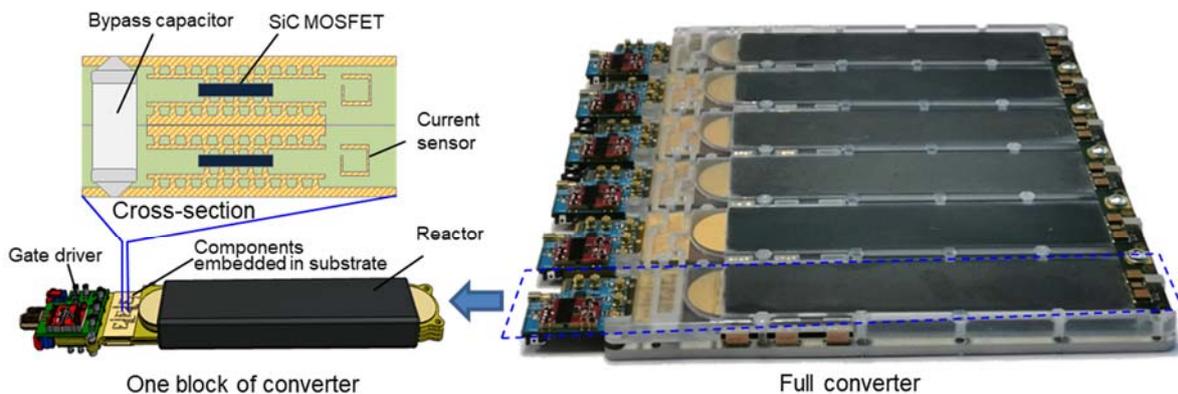
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Mitsubishi Electric Develops Technology for High-power-density Converters with Embedded Components

Will contribute to downsizing of power electronic equipment

TOKYO, March 25, 2020 – [Mitsubishi Electric Corporation](http://www.mitsubishielectric.com) (TOKYO: 6503) announced today that it has developed a new technology to integrate power devices, passives, sensors and other embedded components in the same substrate, which the company deployed in a 100kW (continuous) bidirectional DC-DC converter to achieve what is believed to be the world's most power-dense* power converter, rated at 136kW/L, or eight times more power dense than conventional converters. The new technology is expected to contribute to the downsizing of power electronics equipment.

* According to Mitsubishi Electric research as of March 25, 2020



Demonstrator of new 136kW/L (24×18×1.7cm) high-power-density power converter

Key Features

Mitsubishi Electric's new integration technology enables the parasitic inductance of the switching current loop to be reduced to less than 1/10th that of conventional converters. The resulting clean switching allows high-speed commutation for high-operating frequencies in silicon-carbide (SiC) metal-oxide semiconductor field-effect transistors (MOSFETs). The technology leads to considerably smaller passive components, such as reactors for current smoothing, and capacitors, which take up much space in DC-DC converters.

Background and Details

In the effort to downsize power converters used in power electronic equipment, one of the main targets is reactors. Mitsubishi Electric's new technology reduces the parasitic inductance of the switching current loop to less than 1nH**, resulting in a high operating frequency that enables reactors to be miniaturized for higher power density.

** nano-Henry, in which H is the unit of electrical inductance and n is the unit 10^{-9}

In the case of conventional technology for power converters, the parasitic inductance of the switching current loop is large because the packaging consists of wire-bonds and passive components located outside of the case (red line in Fig. 1 below). Switching at high speed with a large parasitic inductance causes significant voltage oscillations (red waveform in Fig. 2), which can damage power devices and increase noise levels. To avoid these problems, switching speed is purposefully limited (black waveform in Fig. 2), but low-speed switching is inefficient because the loss per commutation is large (Fig. 3). Also, limited high operating frequency hinders the downsizing of reactors in power converters.

Mitsubishi Electric's new technology allows components to be embedded in the same substrate, which reduces the parasitic inductance of the switching current loop (red line in Fig. 4) to sub-nano henry (less than 1nH) levels. As a result, the power converter achieves switching at high speed, an inherent and desired feature of SiC devices (Fig. 5). Since the converter can be operated at high frequency (Fig. 6), passive components can be miniaturized by as much as 80%.

Future Development

Further levels of integration will be explored through the use of multi-functional components.

Conventional technology using wire-bonding

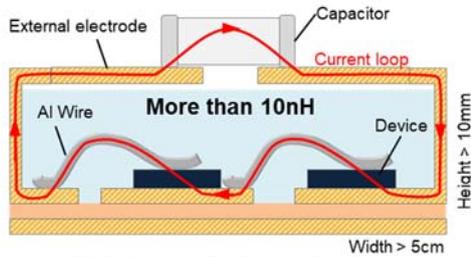


Fig.1 Cross section (Conventional)

Integrated technology with embedded components

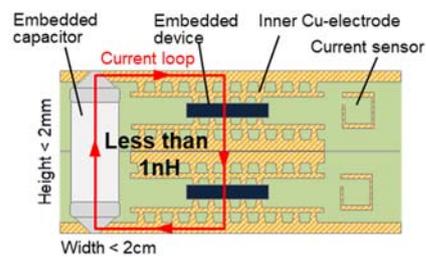


Fig.4 Cross section (New)

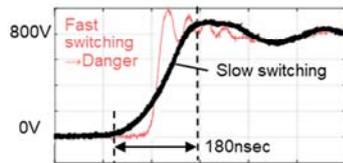


Fig.2 Voltage waveform when switching (Conventional)

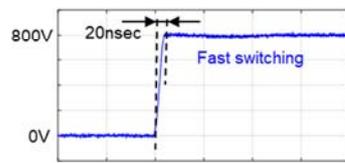


Fig.5 Voltage waveform when switching (New)

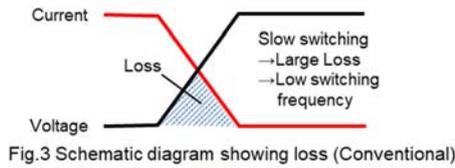


Fig.3 Schematic diagram showing loss (Conventional)

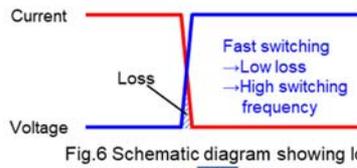


Fig.6 Schematic diagram showing loss (New)

Limited high power density

Higher power density

Contribution to the Environment

The new technology will help to reduce the space occupied by power electronic equipment.

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About Mitsubishi Electric Corporation

With nearly 100 years of experience in providing reliable, high-quality products, Mitsubishi Electric Corporation (TOKYO: 6503) is a recognized world leader in the manufacture, marketing and sales of electrical and electronic equipment used in information processing and communications, space development and satellite communications, consumer electronics, industrial technology, energy, transportation and building equipment. Embracing the spirit of its corporate statement, Changes for the Better, and its environmental statement, Eco Changes, Mitsubishi Electric endeavors to be a global, leading green company, enriching society with technology. The company recorded a revenue of 4,519.9 billion yen (US\$ 40.7 billion*) in the fiscal year ended March 31, 2019. For more information visit:

www.MitsubishiElectric.com

*At an exchange rate of 111 yen to the US dollar, the rate given by the Tokyo Foreign Exchange Market on March 31, 2019