Toshiba ships early samples of 1200V SiC MOSFETs in bare die format

New devices offer low resistance and high reliability for automotive traction inverters

Düsseldorf, Germany, 12th November 2024 – Toshiba Electronics Europe GmbH ("Toshiba") has developed new 1200V silicon carbide (SiC) MOSFETs with low on-resistance ($R_{DS(ON)}$) and high levels of reliability. The devices are particularly suited to applications within automotive traction inverters. They are now available and shipping as early test samples in bare die format – allowing customers to customise them to meet the needs of their applications.

The new X5M007E120 uses a manufacturing process that reduces on-resistance per unit area by up to 30%. Unlike existing methods that utilise a striped-pattern construction, the new devices arrange the embedded Schottky barrier diodes (SBDs) in a check-pattern to achieve lower on-resistance.

Many SiC MOSFETs increase on-resistance as body diodes are energised during reverse conduction, which can lead to reliability issues. Toshiba SiC MOSFETs alleviate this issue by preventing body diodes from operating as SBDs are embedded into the MOSFETs. This approach maintains the reduction in on-resistance while ensuring reliability during reverse conduction.

With electric motors consuming over 40% of the world's electrical energy[1], efficient operation is essential to sustainability. The re-arrangement of SBDs in this device has suppressed body diode energisation, and the upper limit of unipolar operation has increased to around double without increasing the SBD mounting area. Additionally, channel density is improved. These enhancements contribute to energy efficiency in applications, including motor control inverters.

Reducing $R_{DS(ON)}$ within a SiC MOSFET can cause excess current flow during short-circuit operations. By adopting a deep barrier structure, the X5M007E120 reduces excessive current within the MOSFET section and leakage current in the SBDs section during short-

circuit operation. This enables durability during short-circuit conditions while maintaining high levels of reliability against reverse conduction operation.

The new X5M007E120 has a V_{DSS} of 1200V and is rated for a drain current (I_D) of 229A continuously, with 458A for pulsed operation ($I_{D\ Pulse}$). $R_{DS(ON)}$ is as low as 7.2mΩ, and the device can operate with channel temperatures (T_{ch}) as high as 175°C. The devices are AEC-Q100 qualified for automotive applications.

Engineering samples of the new X5M007E120 are expected to ship during 2025, with mass production samples scheduled to start in 2026.

Toshiba will continue to seek ways to further improve the characteristics of its products. The company will contribute to realising a decarbonised society by providing customers with power semiconductors for applications where energy efficiency is essential, such as inverters for motor control and power control systems for electrical vehicles.

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Notes

1 - https://www.iea.org/reports/energy-efficiency-policy-opportunities-for-electric-motor-driven-systems

About Toshiba Electronics Europe

Toshiba Electronics Europe GmbH (TEE) offers European consumers and businesses a wide variety of hard disk drive (HDD) products plus semiconductor solutions for automotive, industrial, IoT, motion control, telecoms, networking, consumer and white goods applications. Next to HDDs, the company's broad portfolio encompasses power semiconductors and other discrete devices ranging from diodes to logic ICs, optical semiconductors as well as microcontrollers and application specific standard products (ASSPs) amongst others.

In addition, TEE also offers Toshiba's SCiB™ battery cells and modules with lithium titanium oxide (LTO) for heavy-duty applications and Silicon Nitride (SiN) ceramic substrates used in power semiconductor modules, inverters and converters for their heat dissipation characteristics and strength.

TEE has its headquarters in Düsseldorf, Germany, with branch offices in France, Italy, Spain, Sweden and the United Kingdom providing marketing, sales and logistics services.

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