Pushing on-state resistance below the milliohm

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Philips has demonstrated the world's **first sub-milliohm MOSFET**. The device displays a number of technology developments that will increase efficiency, reduce device footprints and improve performance in power management applications across all markets.

Energy efficiency and device size are key considerations in many market segments, particularly for battery-powered and handheld equipment. Philips Semiconductors is leading the way in improving these properties with the demonstration of the world's first MOSFET to exhibit an on-state resistance (RDS(on)) of less than 1 milliohm – a reduction of around 40%.

This important step in MOSFET development was achieved primarily through copper clip technology; an area where Philips leads the industry. Typically MOSFETs are connected to the top of the package using a weld and wire bond. However, copper clips allow the entire surface of the chip to be connected – rather than just a single point. This improves current distribution and thermal performance, significantly lowering on-state resistance. Careful design of the copper clip and package leadframe was needed to ensure accurate control of the clip position and a workable assembly process.

The device uses many other technology breakthroughs – such as Philips' patented self-aligned process, which enables the manufacture of silicon with low enough resistance. In addition, accommodating the copper clip arrangement required solderable top metallization. In this way, Philips

took the best available silicon technology and packaging technology, then combined and optimized them to reach the required sub-milliohm target.

“As the number of portable electronics products continues to grow, power management devices with greater functionality, performance and reliability are required,” said Manuel Frade, Vice President and General Manager of Philips Semiconductors’ Power Management Business Line. “Philips continues to find new methods to improve chips and ensure the industry can meet customer requirements.”

MOSFETs with such low RDS(on) values will be real advantage in applications where power loss and heat dissipation are critical, such as computer motherboards. They will also be important in automotive applications where ever-higher currents need to be switched with minimum power loss. Many of the technology developments made during the sub-milliohm MOSFET program have already been implemented in Philips’ recently announced LFPAK MOSFETs and P-channel µTrenchMOS devices.

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