Fraunhofer ISE

Press Release

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Towards Smaller Sizes, Lower Weight and Higher Efficiency with Gallium Nitride Devices

Fraunhofer ISE Explores the Limits of a New Technology

Scientists at the Fraunhofer Institute for Solar Energy Systems ISE have successfully tested new types of power transistors made of gallium nitride in power electronic systems. With these transistors for example the size of charging inverters for electric vehicles and the weight of power converters for aircraft can be reduced, power supplies for server farms will gain efficiency.

Gallium nitride (GaN) has been in the center of interest of many semiconductor researchers for a long time. First prototype devices are available by now. "With power transistors made of gallium nitride, significantly higher switching frequencies are achievable than with ordinary silicon power transistors. In contrast to silicon carbide, gallium nitride is particularly suited for the lower voltage range. Especially resonant topologies can fully utilize the advantages of gallium nitride power transistors," says Professor Bruno Burger, head of the department "Power Electronics" at Fraunhofer ISE.

Despite the substantial need for research, impressing results have been obtained in an internal study. A DC/DC converter with rated output power of one kilowatt was operated at a switching frequency of one megahertz providing 94 percent peak efficiency. "With regard to the 600 volt gallium nitride transistor the switching frequency and also the efficiency of the DC/DC converter could have been raised to an even higher level. The limiting factor was the high-frequency

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transformer," states Arne Hendrik Wienhausen who performed the experiments.

Until today, only transistors made of silicon have been used in power electronic systems with voltages up to 600 volts. Switching and conduction losses of these transistors are significantly higher than those of transistors made of gallium nitride. Therefore high losses are generated in the transistors which need to be dissipated in a complex way. In addition to the higher efficiency, gallium nitride provides the opportunity of increasing the switching frequency to exceed the state-of-the-art manyfold. As a result the passive components like inductors, transformers and capacitors can be dimensioned much smaller leading to more compact and light-weight designs. Expensive materials can be saved.

The scientists at Fraunhofer ISE predict that gallium nitride will permanently change the world of power electronics. In all applications where system weight and volume are crucial, power transistors made of gallium nitride and operated at high frequency offer great advantages over other technologies. It can be assumed that the switching frequency of one megahertz demonstrated in the DC/DC converter is only a first step towards much higher switching frequencies while maintaining high efficiency.

First developed over the last years, the semiconductor gallium nitride is much used for optical devices such as blue and white diodes, however, up to now has hardly been used in power electronics. The Fraunhofer Institute for Solar Energy Systems ISE is one of the leading research facilities in the field of highly efficient power electronics for renewable energy systems and the application of state-of-the-art semiconductors like gallium nitride and silicon carbide.

The gallium nitride power transistors used in the converter were produced by Panasonic. Panasonic is one of the leading

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companies in the development of semiconductors based on gallium nitride.

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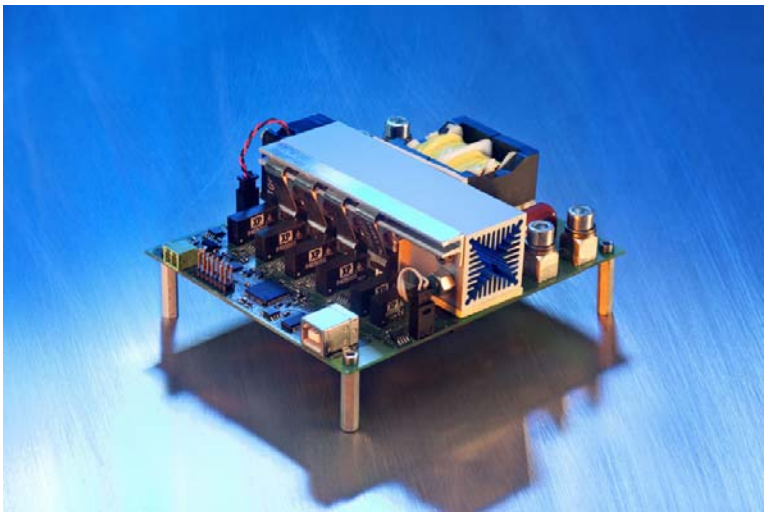

Developed 1MHz LLC resonant converter with rated output power of 1kW and equipped with 600V gallium nitride power transistors. ©Fraunhofer ISE

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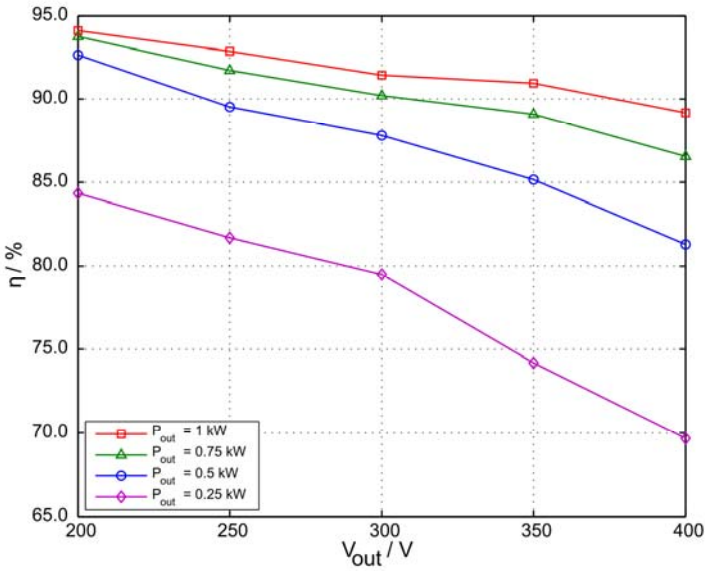

Measured converter efficiency of the 1 MHz resonant converter for various values of output power and output voltage at an input voltage of 380 volt. ©Fraunhofer ISE

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