

PRESS RELEASE

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Fraunhofer IAF presents user-friendly GaN voltage converter highly integrated in a compact package

PCB-embedded GaN-on-Si half bridge circuits for modular use

Researchers at the Fraunhofer-Institute for Applied Solid State Physics IAF have integrated their monolithically integrated GaN power ICs using PCB embedding technology as a half bridge circuit, including gate and DC link capacitors. The result is an extremely compact and efficient highly integrated voltage converter of the 600 volts class in a user-friendly package. The integrated functionality in the chip and all critical passive components on the package allow it to be used in a modular fashion, thus reducing the effort required for the development of future power electronic systems.

Energy-efficient power electronics for energy conversion and transmission are becoming increasingly important, as future-oriented and sustainable energy concepts, such as electric mobility or power supply via renewable energies, depend on them. For this purpose, the Fraunhofer Institute for Applied Solid State Physics IAF has developed a user-friendly, highly integrated GaN voltage converter in a compact package that is extremely resource-efficient and can be used in a modular fashion.

For years, power semiconductors have been used in voltage converters to meet the increasing demands on energy supply and usage. However, it is not only the semiconductor materials themselves that are decisive, but also the packaging and design of the components; because the more compact and efficient the packaging is, the more resource-efficiently they work. However, a compact system design is often difficult to reconcile with the discrete standard components that dominate the GaN power electronics market. Most of the time, the critical conductor loops between transistors and power supply have to be individually designed and wired as circuits from discrete components.

A user-friendly alternative is now offered by scientists of the Fraunhofer-Institute for Applied Solid State Physics IAF in Freiburg. They have embedded their innovative gallium nitride-based integrated power circuits (GaN Power ICs) as a half bridge in a printed circuit board (PCB), which features all critical wiring, including gate and DC link capacitors, within the package. The result is an extremely compact and efficient voltage converter suited for all 600 volts applications. It allows a reliable and modular system design, thus facilitating design and production processes.

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Monolithically integrated GaN Power ICs

The Fraunhofer-Institute for Applied Solid State Physics IAF has many years of experience in the monolithic integration of power electronic GaN chip technologies. Last year, in the course of the »GaNIAL« research project, the scientists from Freiburg managed to monolithically integrate current and temperature sensors, 600 V power transistors, freewheeling diodes and gate drivers in a single GaN Power IC. The semiconductor material gallium nitride was deposited on low-cost silicon substrate (GaN-on-Si), making the chip technology suitable for cost-efficient mass production, and therefore very attractive to industry.

The high integration density of the GaN Power ICs of Fraunhofer IAF not only enables a higher switching frequency and therefore a higher performance density than comparable circuits, but also higher reliability and compactness due to the integrated sensor technology. With their GaN Power ICs in a half bridge circuit, the Freiburg researchers have already achieved DC-DC efficiencies of over 98.8 % at 350 V, and have demonstrated a high switching frequency of 40 MHz in continuous operation at 250 V and resonant operation.

Highly integrated half bridge circuits via PCB embedding

“GaN-on-Si technology allows monolithically integrated circuits for half bridge converters, but does not solve the wiring problem to external capacitors. However, these critical connections to gate drivers and DC link capacitors are essential for clean and efficient switching behavior. With our goal of a perfect voltage converter in mind, we were looking to find the optimal highly integrated packaging technology for our GaN Power ICs”, remembers Stefan Mönch, researcher at Fraunhofer IAF. For this purpose, he and his team processed their ICs with a thick copper electroplating on both sides, making them suitable for PCB embedding.

This adaptation of the metallization made it possible for the company Würth Elektronik CBT to build the chips using the reliable ET Microvia Embedding Technology suitable for series production. Together with the project partners Bosch and the University of Stuttgart, the researchers were able to design a PCB package that is only 12 mm wide and 0.4 mm flat. It integrates two monolithic GaN Power ICs as a half bridge and provides the critical decoupling capacities for the gate driver and DC link capacitors already on the package. The embedding technology eliminates the need for bonding wires, which also minimizes parasitic inductances. The critical connections between GaN IC and capacitors are thus already optimized and no longer need to be elaborately designed by users. The result is a user-friendly solution that provides all critical components of a voltage converter already optimized in one package.

Fraunhofer IAF will present its latest GaN power electronics at the leading international trade fair for power electronics, intelligent drive technology, renewable energies and energy management, which will take place in a digital format during the “PCIM Europe

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digital days” on July 7-8, 2020. The GaN Power IC of Fraunhofer IAF is also part of a presentation by Dominik Koch (University of Stuttgart) at the accompanying PCIM Europe conference.

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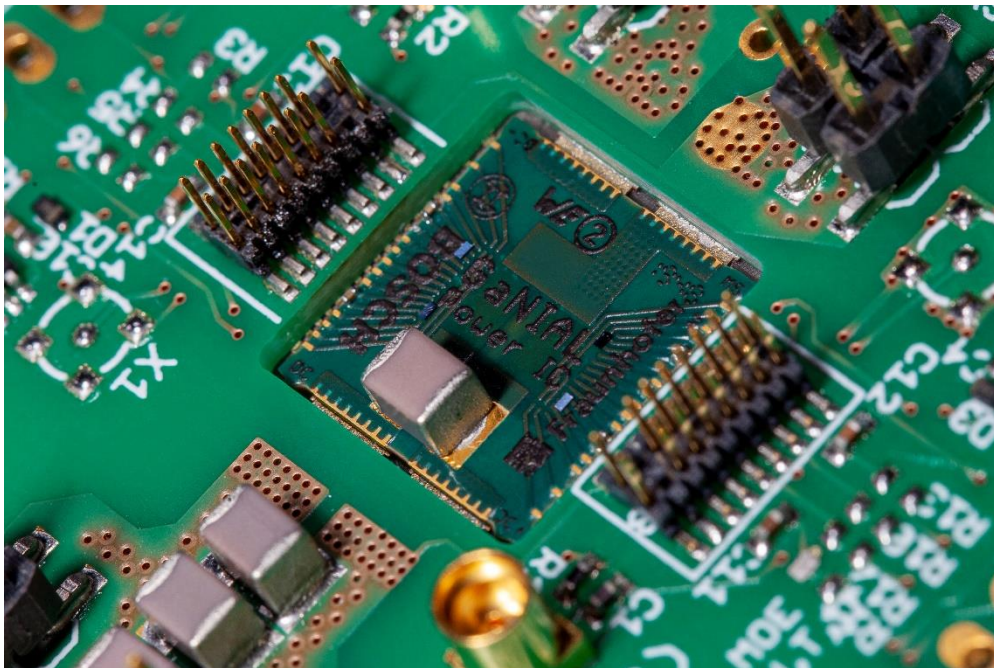
About Fraunhofer IAF

The Fraunhofer Institute for Applied Solid State Physics IAF is one of the world's leading research institutions in the field of III-V compound semiconductors and synthetic diamond. Fraunhofer IAF develops electronic, optoelectronic as well as diamond components, thus advancing the research and the development of innovative semiconductor technologies like electronic circuits for leading-edge communication technology and electromobility, laser systems for real-time spectroscopy, innovative hardware for quantum computing and diamond-based quantum sensors.

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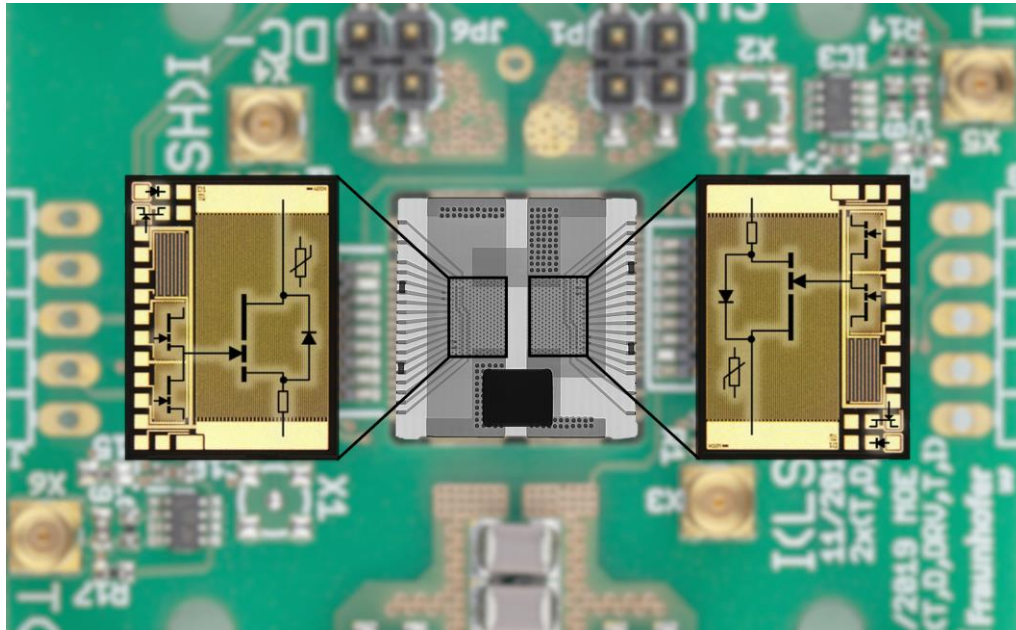
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PCB-embedded GaN-on-Si half bridge circuit including gate and DC link capacitors
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X-ray image of the half bridge circuit and circuit diagram of the integrated GaN Power ICs

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