ADVANCED POWER ELECTRONICS WITH WIDE BAND-GAP DEVICES

Power electronics is a key element for future electrical energy systems with a growing share of renewable energy. Beyond meeting the efficiency and reliability requirements set by each application, power electronics usually plays a crucial role since it substantially lowers system costs.

Advanced power electronics with wide band-gap devices is one of the main research fields in the business area Energy Efficient Power Electronics. We focus on new power converter topologies and system designs realized using the most recent wide band-gap semiconductors with blocking voltages up to 1,700 V.

Economically sustainable and technically feasible solutions are the premise of our work. Our expertise can be applied in various applications requiring advanced power converters.

Special Lab Equipment
- 15 kWp roof-mounted PV generator
- 30 kW three-phase grid simulator
- 128 kW DC source / PV simulator
- high-precision power analyzers
- semiconductor test bench up to 20 kV
- precision RLC analyzers (up to 150 A bias / 3 MHz bandwidth)
- EMC test equipment
- high-resolution thermography equipment
- burst and surge generators
- development environments for µC, DSP and FPGA
- numerous simulation software
- reflow / BGA soldering equipment
**Future Devices**

Power semiconductors are essential components for power electronic circuits. Indeed, they usually have a direct influence on the performance of the total system efficiency, switching frequency and thermal management. As a consequence, they usually set the limits in terms of power density and have a direct impact on the cost of numerous passive components used in filters.

Especially in the field of wide band-gap devices, we have early access to almost all new devices, especially Silicon Carbide (SiC) and Gallium Nitride (GaN) semiconductors.

Wide band-gap semiconductors improve both power electronics circuits and system designs. They allow developing innovative DC / DC and DC / AC power converters, whose performance and designs usually draw a lot of attention. Since the market release of 1,200 V SiC power semiconductors in 2009, plenty of new products based on these devices have been developed.

Based on our knowledge of the market and on many years of experience in the application of MOSFETs, on-JFETs, off-JFETs, BJTs and HEMTs made of SiC or GaN, we can offer our clients and partners broad and reliable expertise.

Furthermore, the characterization of semiconductor devices is also part of our daily work. Our equipment and expertise allow us to test all kinds of devices, from single chips to multi-level semiconductor modules. Also, the equipment covers a broad voltage range, from a few volts up to 20 kV.

In addition, our specifically developed test benches are easily adaptable to almost every application. They allow us to perform comparative tests on all major key components of power electronics. Also, in-house prototypes can be analyzed and optimized at every development step with e.g. high-precision power meters, thermal imaging and EMC equipment.

**New Technologies**

Beyond technologies for renewable power sources, we also develop efficient, compact and innovative solutions for railway applications, aviation systems and industrial applications. The research and development in these directions has already significantly contributed to the introduction of new technologies in these well-established, strong markets. These fields can benefit greatly from innovations already realized in the renewable energy sector.

In addition to semiconductors, another major focus in the business area Energy Efficient Power Electronics is the design of passive components, such as inductors and high-frequency transformers. We offer our expertise in winding techniques, such as with round, rectangular or litz wires and in the choice of a suitable core material and core shape. We strongly believe that a well-designed inductive component will noticeably improve the efficiency and reduce the cost of power converters.

**Services**

Detailed electrical and thermal simulations of power electronic circuits are a prerequisite to the designs of electrical schematics and Printed Circuit Boards (PCB). We use different PCB materials and designs, from fine-pitched digital layouts to boards with copper inlays and metal cores for enhanced thermal management. We also create innovative mechanical setups for power converter prototypes with high power densities. We can also support our clients and partners in choosing semiconductors, device ratings and the dimensioning of customized power modules.

In addition to hardware developments, we also offer our skills and expertise in the field of control software. Our scientists and engineers develop highly sophisticated analog and digital control circuits for converters using high switching frequencies. For example, the design and programming of DSPs and FPGAs are part of our daily work. The control algorithms are usually simulated and tested with tools such as MATLAB® / Simulink® and PLECS®.

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1 Test bench for the characterization of power semiconductor modules.
2 Lateral GaN transistor.
3 Simulation of LLC resonant converter.