

KARLSRUHE INSTITUTE OF TECHNOLOGY (KIT)

Elektrotechnisches Institut (ETI) – Institute of Electrical Engineering

The Institute of Electrical Engineering (ETI) was established and built in 1895 by Engelbert Arnold. It is currently led by Prof. Dr.-Ing. Michael Braun, chair for Electrical Drives and Power Electronics. In 2011 and 2015 two additional chairs have been established, one focusing on hybrid and electric vehicles, headed by Prof. Dr.-Ing. Martin Doppelbauer, and one for power electronic systems, headed by Prof. Dr.-Ing. Marc Hiller. A colloquium with presentations and discussions about current research projects and innovative product developments is held regularly at the institute.

Electrical Drives and Power Electronics

Fields of activity and current research projects:

- Modular Multilevel Converters
- Short time storage systems with Double Layer Capacitors
- E-Mobility and Smart Grids (joint research projects IZEUS and grid-control)
- Control of Permanent Magnet Synchronous Motor with strongly nonlinear magnetic characteristics
- Modular and flexible Power Electronic Systems for prototyping and test stands

Several converter systems with different power levels up to 300kW have been developed at the ETI which can be used for various applications, e.g. converters for electrical machines, active-frond-ends, as DC-DC-Converter or in combination with

electrical energy storage systems for their integration in the power grid. Their flexible configuration and adjustment of the signal processing allows a defined usage in test and prototype systems.



Single PCB converter (DC-Link voltage: 900V, max. output current: 130A, maximum power: 25kW)

Hybrid Electric Vehicles

The requirements for motors and power electronics as traction drives differ significantly from conventional designs for industrial applications. An optimized design of an electrical drive train can only be achieved in an interdisciplinary context. Therefore, the research fields are split into three focus areas:

- Mechanical Motor Design
- Power Drive System (motor, power electronics, mechanical drive train)
- Electromagnetic Motor Design

Three test stands have been set up for the characterization of prototypes and for parameterization and validation of simulations. With powers up to 250 kW, speeds up to 18,000 /min (or 30,000 /min with gearbox) and torques of up to 540 Nm they are an

ideal match to the power range of hybrid and electric vehicles. Studies of the dynamics of electric motors, analyzes of drive cycles, development of control algorithms and many more tasks can be performed.



Motor test benches for hybrid and full-electric drive trains

Power Electronic Systems

Power Electronics are used in an increasing number of different applications. The optimized design of the power semiconductors and passives is one of the keys to comply with the requirements regarding energy and cost efficiency. The research topics focus on

- simulation, design and setup of new topologies
- optimization of power electronic systems
- investigation of new devices and materials

Additional test stands for medium voltage power electronics and the characterization of power semiconductors are in preparation. This will enhance the ETI test environment and enables new areas of research.