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Power Electronics and Electric Machinery Research

Oak Ridge National Laboratory's Power Electronics and Electric Machinery (PEEM) research group is the Department of Energy's premiere resource for the development of electric drive technologies. During this decade, PEEM has dramatically advanced the state of the art in advanced inverters, DC-DC converters, motor control techniques, efficient, compact electric machines, and high voltage, high speed power systems.

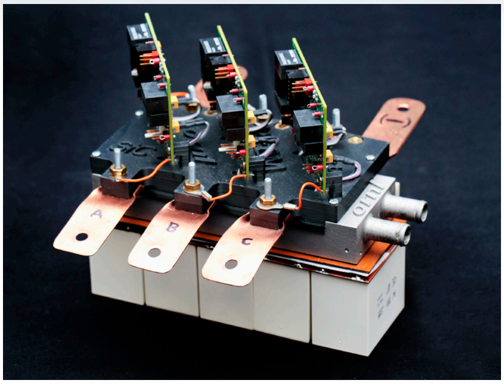
Working with PEEM

The PEEM laboratory is based at the National Transportation Research Center, a designated DOE National User Facility. This designation enables industry, and academia to utilize the laboratory facility and work alongside PEEM researchers for short duration research needs. Research is often conducted with outside companies through contractual work for other arrangements for extended term research activities.

Staff

PEEM consists of more than 60 staff members and routinely collaborates with numerous researchers in industry and academia. Staff members hold advanced degrees in physics, electrical, and mechanical engineering. Most are active members of professional societies such as IEEE, IEE, ASME, and SAE, and hold leadership positions in these organizations.

Since 1990, more than 60 patents have been granted with several more pending. Researchers have published more than 360 technical papers with more than 98 papers published in IEEE Transactions of the following societies: Power Electronics, Industry Applications, Energy Conversion, Power Delivery, Industrial Electronics, Instrumentation and Measurement, and Magnetics.



Areas of Expertise

- Advanced Power Electronics
- Electric Machines
- Device, Module, and System Level Packaging
- Power Quality and Utility Interconnection

Advanced Power Electronics

- Advanced hard and soft-switching power electronics topology development
- Power device and module level packaging techniques for thermal control, EMI minimization as well as space and weight reduction
- Control algorithm development for motor drives
- Electric, hybrid-electric, plug-in hybrid, and fuel cell vehicle traction drives
- Motor-assisted turbochargers and auxiliary drives
- Multilevel inverters for high voltage and/or high power motor drives
- Wide bandgap (SiC and GaN) power electronics and high temperature packaging
- System, module, and device level testing, characterization, modeling and simulation
- DC-to-DC converters

Facilities

PEEM laboratories located at NTRC comprise more than 9,000 square feet of space for developing, building, and testing the next-generation prototype power electronics and electric machine technologies. Two dynamometer cells, a wide bandgap characterization station and a power module packaging lab enhance the capabilities of the state-of-the-art facilities. Staff members utilize the latest analysis, simulation, and modeling software to develop designs prior to hardware implementation.

The Distributed Energy Communications and Controls Facility Laboratory located at the main campus of ORNL was established for power electronic-based distributed energy resources and the laboratory equipment interfaces to the ORNL distribution system.

Electric Machines

- Radial and axial gap permanent magnet machines
- Switched reluctance and synchronous reluctance machines
- DC homopolar and soft-commutated machines
- Superconducting motors, generators, and transformers
- Field weakening and enhancement techniques
- Advanced manufacturing technologies for electric machines
- Finite element analysis of electromagnetics, mechanical stresses, and thermal analysis

Packaging and Thermal Management

- Module designs for higher temperature operation
- Novel die bonding development techniques
- New power modules for increased reliability, smaller size and weight
- Hybrid electric vehicle drive train and system-level thermal control R&D
- Implementation and development of new materials and processes for module improvements

Power Quality and Utility Interconnection

- Utility grid interface inverters for distributed energy resources such as fuel cells, solar cells, or microturbines
- STATCOMs for reactive power compensation
- Active power filters for harmonic compensation
- Multilevel converters for utility applications such as static var generation, voltage regulation, harmonic compensation, back-to-back intertie of two asynchronous systems, HVDC applications, and distributed generation/utility interfaces
- Development of novel techniques to calculate active and reactive power under unbalanced or nonlinear conditions