ESTD
Engineering Science & Technology Division

Power Electronics & Electric Machinery Research Center

The Power Electronics & Electric Machinery Research Center (PEEMRC) at Oak Ridge National Laboratory (ORNL) is the United States Department of Energy's premiere broad-based research center for power electronic converters and electric machinery development. During this decade, the center has dramatically advanced the technology of soft-switched inverters, multilevel inverters, DC-DC converters, motor control techniques, and efficient, compact electric machines.

Personnel

The ORNL PEEMRC has 30 employees working in Oak Ridge, Tennessee. More than half of the research personnel have Ph.D.'s, and several of the personnel are registered professional engineers. Group members hold advanced degrees in electrical engineering, mechanical engineering, nuclear engineering, and physics. Most are active members of professional societies such as the IEEE, IEE, ASME, and SAE, and hold leadership positions in these organizations.

Since 1990, the center has had 34 patents granted with several more pending. Researchers have published more than 472 technical papers with 51 papers published in IEEE Transactions of the following societies: Power Electronics, Industry Applications, Energy Conversion, Power Delivery, Industrial Electronics, Instrumentation and Measurement, and Magnetics.

Facilities and Equipment

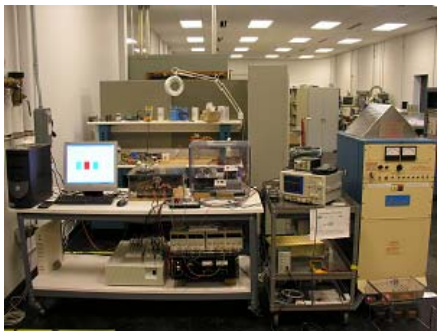
The laboratory area of the ORNL Power Electronics & Electric Machinery Research Center is located in the recently constructed National Transportation Research Center (NTRC) and has more than 9,000 square feet of space for developing, building, and testing the next generation prototypes of converters and electric machine technology. Team members use and develop the latest analysis, simulation, and design software to provide proof of principle prior to hardware implementation of their circuit and motor designs.

Areas of Expertise

Advanced Inverters and Adjustable Speed Drives

- Advanced soft-switching inverter topologies
- Packaging technologies for EMI minimization as well as space and weight reductions.
- DSP-based control technologies for motor drives.
- Transportation applications such as electric and/or hybrid electric and fuel cell electric vehicle traction drives, motor-assisted turbocharger, electric air conditioning, fuel cell inverters, and other auxiliary drives.
- Multilevel inverters for high voltage and/or high power motor drives.
- Silicon carbide-based dc-dc converters and inverters.
- Testing, characterization, and modeling of power devices.
- Modeling and simulation of advanced power converters.
- High temperature (>200 °C) converters.

Cascaded multilevel inverter.



Bench top setup of a STATCOM system.

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.

Electric Machines

- Radial and axial air-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 stator, rotor, and brush manufacturing technology for electric machines.
- Finite element analysis of electromagnetics, mechanical stresses, and thermal analysis.

Rotor structure of an ORNL interior permanent magnet machine.

Direct cooling of power electronics using refrigerant as the coolant.

Thermal Control

- Direct cooling of control circuitry and power electronics devices and systems.
- Single-phase and two-phase cooling research; automotive applications for related floating refrigerant loop.
- Coolant compatibility and comparison studies.
- Hybrid vehicle drive train system-level thermal management R&D.
- Power device mounting, cooling research and development.
- High temperature packaging techniques.

Point of Contact:
Don Adams, Center Director
Oak Ridge National Laboratory
2360 Cherahala Blvd.
Knoxville, TN 37831-6121
Phone: 865-946-1321
E-mail: adamsdj@ornl.gov
http://www.ornl.gov/sci/engineering_science_technology/peemrc/