

Power Electronics and Electric Machinery Research

Oak Ridge National Laboratory's Power Electronics and Electric Machinery (PEEM) researchers are the Department of Energy's premiere resource for the development of electric drive technologies. During the past decade, these activities have dramatically advanced the state of the art in advanced inverters; dc-dc converters; motor control techniques; efficient, compact electric motors; and packaging.

Areas of Expertise

Advanced Power Electronics

- Wide bandgap (SiC and GaN) power electronics
- Current source inverters
- dc-to-dc converters
- Wired and wireless chargers
- System level packaging techniques for electromagnetic interference minimization
- 3D printed packages and heat sinks
- Advanced hard and soft-switching power electronics topology development
- Control algorithm development for motor drives
- Electric, hybrid-electric, plug-in hybrid, and fuel cell vehicle traction drive systems
- Multilevel inverters for high voltage and/or high power motor drives
- System, module, and device level testing, characterization, modeling and simulation
- Monolithic integrated gate drive technologies
- System level integration issues
- Power electronics and component level characterization and benchmarking



Electric Machines

- Electric motor controls optimization
- Motor characterization, benchmarking, and testing
- Radial and axial gap permanent magnet motors
- Switched reluctance and synchronous reluctance motors
- dc homopolar and soft-commutated motors
- Superconducting motors, generators, and transformers
- Field weakening and enhancement techniques
- Advanced manufacturing technologies for electric motors
- Finite element analysis of electromagnetics, mechanical stresses, and thermal analysis

Packaging

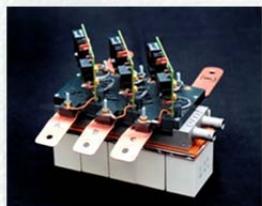
- 3D printed packages
- Innovative power modules for increased reliability, smaller size and weight
- Module designs for higher temperature operation
- Novel die bonding techniques
- Module materials and process optimization
- Low parasitic packaging techniques for wide bandgap applications
- Double sided cooling

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3D manufactured inverter with advanced materials

R&D Facilities

The PEEM laboratory area at the National Transportation Research Center (NTRC) is comprised of 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.



Working with PEEM Researchers

- PEEM research is conducted at the NTRC, which is a designated National User Facility. This designation enables industry, and academia to utilize the laboratory facility and work alongside PEEM researchers for short duration research needs.
- Extended and short term private or public research activities are often conducted with industry through contractual arrangements.

Staff

- The PEEM group consists of more than 20 staff members and routinely collaborates with numerous researchers in industry and academia. Staff members hold advanced degrees in device physics and mechanical engineering. Most are active members of professional societies such as the IEEE 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 a third published in IEEE Transactions of the following societies: Power Electronics, Industry Applications, Energy Conversion, Power Delivery, Industrial Electronics, Instrumentation and Measurement, and Magnetics.



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