Building a Robust Workforce in Electric Power Engineering

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UNIVERSITY of HOUSTON, CULLEN COLLEGE of ENGINEERING

Power Electronics, Microgrids & Subsea Electrical Systems Center (PEMSEC)

Power **E**lectronics, **M**icrogrids, and **S**ubsea **E**lectrical **S**ystems Center (PEMSEC) at the University of Houston, Texas research and educational efforts are focused on electric power & energy systems, including advanced power electronics, electric drive systems, subsea electrical systems, transportation electrification, and micro grid energy management technologies.

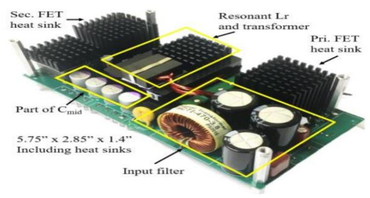
Selected Present Research Projects

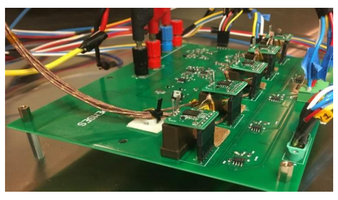
Sensorless Control of Permanent Magnet Motor with Long Cable for Subsea Applications

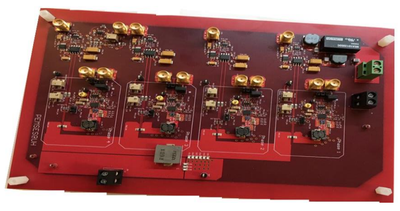
A typical subsea motor drive includes a sinewave filter, transformer, and long cable. The motors are located far from the Variable Speed Drive (VSD) unit and are connected through a long cable. Permanent Magnet (PM) motors are becoming increasingly popular in subsea applications for natural gas and oil extraction. Sensor-based position measurement is not practical as the motors are located several kilometers away from the VSD unit. Hence, the subsea industrial practice is to use V/Hz or I-f control to start the motor, then switch to the sensorless vector control. Accurate estimation of the system parameters and rotor position is necessary to achieve a stable and efficient performance. The current research is focused on achieving high-performance sensorless control of the PM motor across its full-speed range.

GaN FETs – Based High-Density DC-DC Power Conversion and Machine Learning-Based Prediction of System-Level Remaining Useful Life

This project aims to develop compact and robust power electronics systems for limited-space military installations like ships and aircraft. The U.S. Department of Defense is funding the project with a $2.5 million grant for three years starting in April 2020. The project has two parts. The first involves developing power converters using Gallium Nitride (GaN) devices to operate radar systems. The second part uses machine learning to predict the lifespan of GaN devices and circuits,







designing a health monitoring system to predict individual component lifetimes. Tagore Technology, an Illinois-based semiconductor company in the USA, supports the project.

(i) High power density isolated DC-DC converter for pulsed load applications
(ii) Characterization of GaN HEMTs at different load profiles
(iii) Characterization of electrolytic dc-link capacitors

Modeling and Stability Analysis of Grid Following and Grid Forming Converters:

Ensuring system stability and accurate reactive power sharing in the presence of feeder impedance mismatch has become a critical concern with the expanding use of power electronic converters in modern power systems. At PEMSEC, we use impedance-based models to investigate overall system stability from the DC side, and develop mathematical models based on Eigen-value analysis to assess AC microgrid stability. Additionally, we propose control strategies to ensure accurate sharing of active and reactive power in AC microgrids, which we verify using controller hardware in the loop.

Gallium Nitride-Based Miniaturized Pulsed Power System Architecture for Mission-Critical Applications (ARPA-E)

This project aims to enhance the power density, efficiency, and operational life of converter systems in pulsed power applications like healthcare tech and water purification. Miniaturization will reduce the cost of downhole well logging tools in fossil and geothermal energy production.

A $1 million grant from the U.S. Department of Energy's Advanced Research Projects Agency will fund the project for three years from April 2022. The project has two main components: designing a high-temperature DC-DC converter capable of producing a few kilowatts for sub-surface characterization and developing power converters for miniaturized MRI applications.

GaN-based Power Supply Design for 4G/5G Envelope Tracking

This project focuses on developing a power supply that utilizes envelope tracking (E.T.) technique for a 4G/5G power amplifier-based wireless communication system. Traditional RF power amplifiers (RFPAs) use fixed-voltage D.C. power supplies, leading to inefficiency and excess heat generation, resulting in bulky communication base station systems. E.T. power supplies extract the transmitted signal waveform's envelope and modulate the output voltage to track the envelope of the communication signal, leading to increased efficiency and smaller system size. However, for 4G/5G signals, E.T. power supplies must switch at several tens of MHz to avoid signal distortion.

Fault-tolerant architectures for distributed Electric/Hybrid Aircraft Propulsion systems

Hydrogen and Battery–Based Energy Storage System (ESS) for Future DC Microgrids

Computer Vision-based Framework for Power Converter Identification and Analysis

Facilities

SiC Converters

Typhoon HIL microgrid setup

Typhoon HIL 604/602+/402

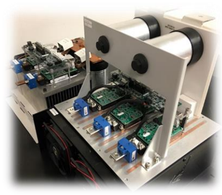
Temperature/Humidity Chamber

Grid Simulator

B1506A Power Device Analyzer / Curve Tracer

AC Machine Drive

Microwave & RF Signal Generators



Education

Master's program with a specialization in Power & Energy

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