GR-23-02: Compact, GaN-Based, 25kW 480VAC Bidirectional Inverter

1. Company or University Name, as well as partnering organizations

University of South Carolina, University of Arkansas, Kohler, Eaton.

2. Project Title

GR-23-02: Compact, GaN-Based, 25kW 480VAC Bidirectional Inverter

3. Project PI/Contact

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4. Technology Roadmap Target Area

Power Electronics Systems and Distributed Energy Resources.

5. Project Summary

Electrical power converters are crucial in multi-source AC and DC energy systems, especially as demand rises for higher efficiency, reliability, flexibility, and cost and size reduction. Currently, multi-kilowatt converters use silicon (Si) and silicon carbide (SiC) technologies, but gallium nitride (GaN) devices, a new wide bandgap semiconductor, offer reduced losses, higher operating temperatures, and increased reliability. This project will develop a 25kW, 950VDC/480VAC three-level neutral point clamp (NPC) inverter using GaN field-effect transistors (FETs), advancing switching frequency and size reduction for applications in grid systems, automotive, and distributed generation.

6. Technology Gap/Market Need

The industry needs efficient, compact, reliable and low-cost power converters for various applications.

8. Target Application

Generation, Distribution, End Use, Power Packaging, Modeling and Control
Circuits and Converters, Smart Inverters, Solar Inverter, UPS, Battery Storage Systems

8. Accomplishments/Deliverables

- *Designed compact 25kW, 480VAC grid connected bidirectional converter.*
- *Tested 3-phase 3L-ANPC benchtop controlled with FPGA and verified converter output.*
- *Determined the EMI noise sources and modeled common and differential modes*
- *Designed a PCB-based planar inductor to reduce size and tolerance on inductance*
- *Designed air-cooled heat sinks for GaN switches of 3L-ANPC at two sides of the board.*
- *Developed a compact 12”x11”x3” PCB board including all power elements.*

10. Impact/Benefits

The outcomes of this project will generate valuable knowledge for GRAPES IAB and universities on high-frequency GaN-based converters. It will also establish a generalized process for designing and developing such converters, including control strategies, power stages, gate drives, EMI noise mitigation, and EMI filter design.

11. Images

A picture of the developed converter (left) and a view from top (right)