

Intelligent Power Stages (IPSSs)

Principal Investigator: Alex Q. Huang **Affiliation:** The University of Texas at Austin

Team Members: Alex Q. Huang, Zibo Chen, Chen Chen, Sanjay Rajendran, Houshang Salimian

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Project Summary

With more and more power electronics-based resources and loads being integrated into the grid, there is a strong desire to standardize the grid power electronics building block to further reduce the cost. This project is to design, develop and validate an intelligent power stage (IPS) for bidirectional DC/AC applications with standardized power ports and communication ports to allow maximum flexibility to operate with other similar IPS and to interface with an external controller.

Technical Approach

This project presents the design and implementation of a high-power density, low cost air-cooled 75kVA SiC Intelligent Power Stage (IPS) as a possible solution for this purpose. The six-phase leg IPS is developed using discrete SiC devices, hence achieving very high power density and low cost. An intelligent gate driver is designed with integrated overcurrent protection, on-state voltage measurement, and temperature sensing functions to enable versatile and intelligent functionalities. The integrated auxiliary power supply is designed to start the system from both DC and AC sides. The IPS has built-in communication interface to communicate with other controllers to form a much larger and multiple converter systems and microgrids.

Accomplishments

The proposed IPS is successfully developed and tested to its full power rating while communicating with a master controller and online monitoring of the SiC device health conditions. The developed IPS is tested at 75kW in a two-stage DC-AC mode. The DC-DC stage is a closed loop controlled by the local controller, while the DC-AC stage responds to the modulation index from an external system controller. Measured full load two-stage power stage efficiency is 98.1% at 75kW.

Impact/Commercialization

Two Intelligent Power Stages (IPSSs) have been delivered to the Oak Ridge National Laboratory. The UT-IPS design has attracted interest from the U.S. Army Engineer Research and Development Center (ERDC) and leveraged into a research project on non-isolated solid state transformers for US-EU equipment.

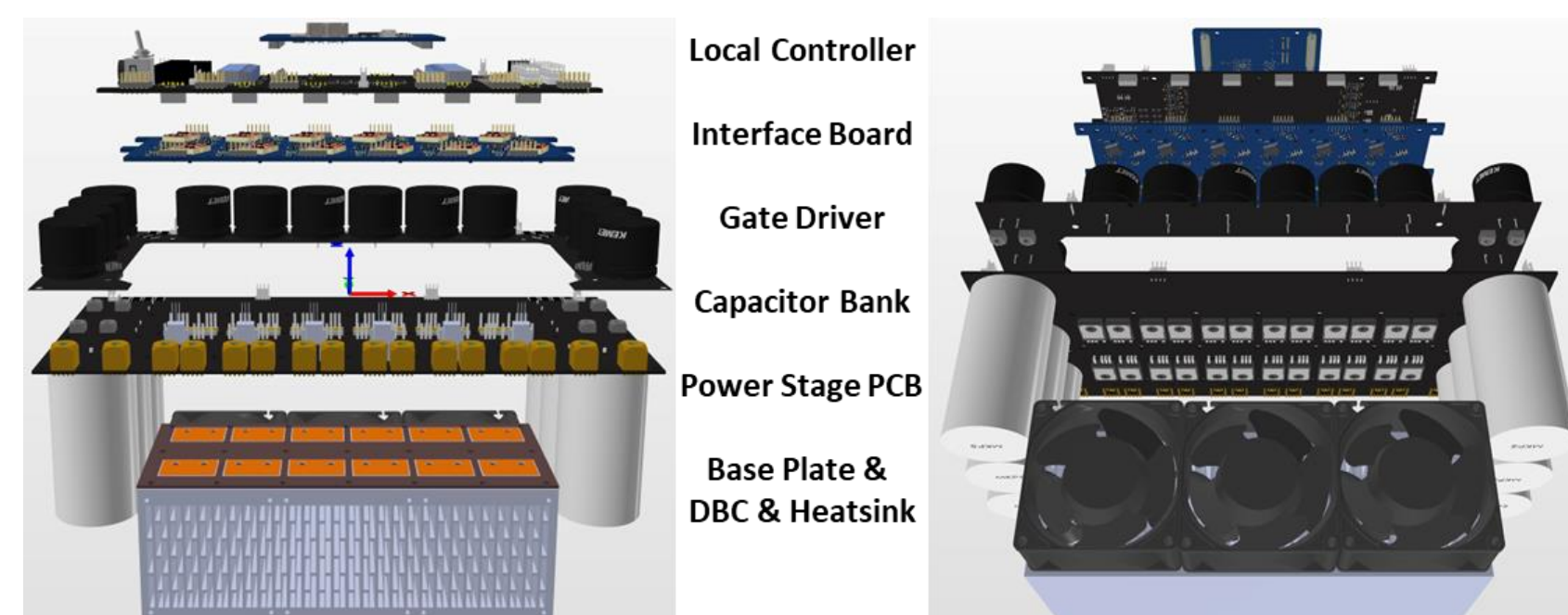


Fig. 1. 150kW high power density six-phase SiC power unit

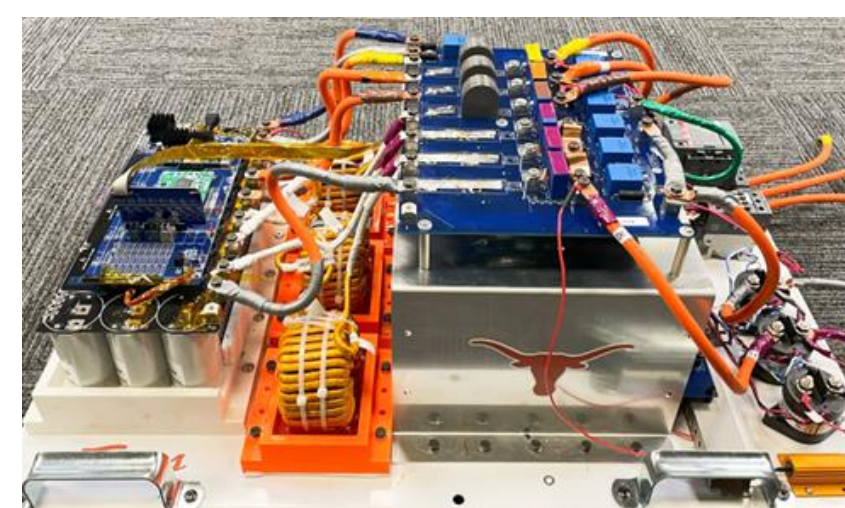


Fig. 2. 75kVA SiC Intelligent Power Stage (IPS)