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Smart GaN-Based Inverters for Grid-Tied Energy Storage Systems

InnoCit
Innovation City, Power and Energy Solutions

DOE/OE Energy Storage Peer Review 2019

Introduction

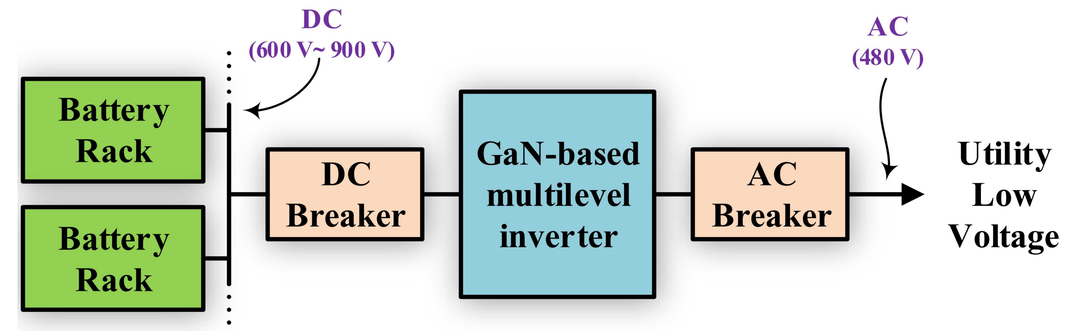
- Energy storage systems and high-power bidirectional converters are the backbone of the future grid.
- Si technology has relatively high conduction losses compared to wide bandgap switches.
- GaN switches can operate at higher switching frequencies.
- By 2022, over 40 GW of energy storage systems will be installed in grid-connected applications.

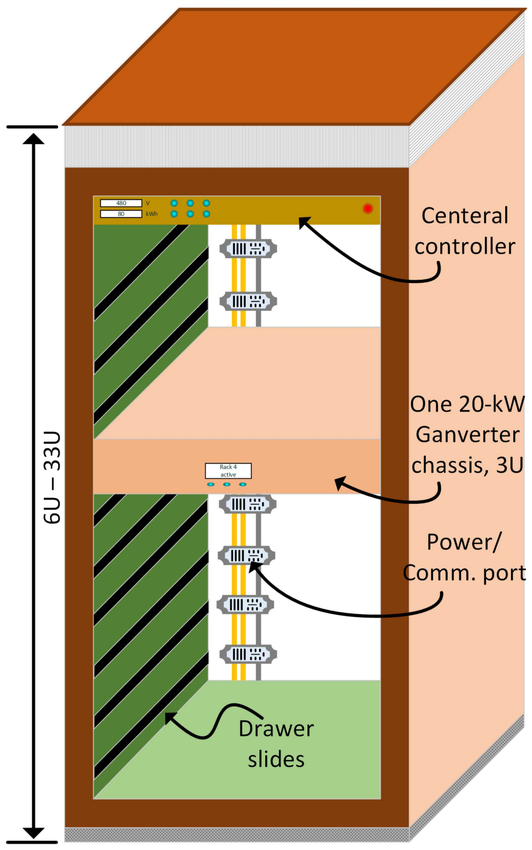
In this project, a GaN-based multilevel inverter is proposed for energy storage applications. This converter interfaces standard battery storage packs. These storage packs have a nominal voltage of 850V to 900V and can reach a low level of 600V under depleted conditions. Hence, a multilevel inverter is proposed to convert this range of input voltage to a 480V grid-tied output. The proposed converter is modular and can ragne from 20 kW to 200 kW.

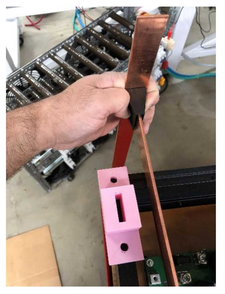
Technical Approach

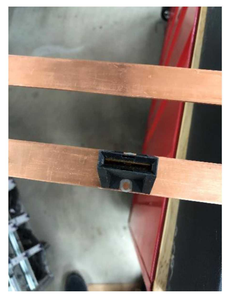
A neutral-point clamped multilevel inverter is selected to realize a 20-kW bidirectional inverter module. Then overall inverter is comprised of 1 to 10 modules working in parallel.

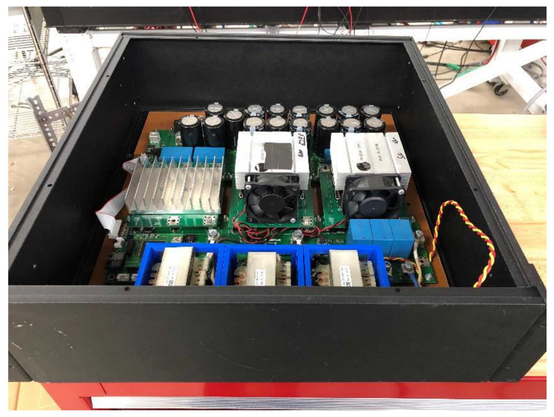
- The converter will emulate the natural dampening behavior of droop controllers.
- By adding virtual rotating mass dynamics to the control algorithm, overall inverter will appear as a synchronous generator and can participate in stabilization of the local grid.
- Stacked printed circuit boards (PCB) which include surface mount GaN switches will be used to maximize modularity and reduce the manufacturing cost.

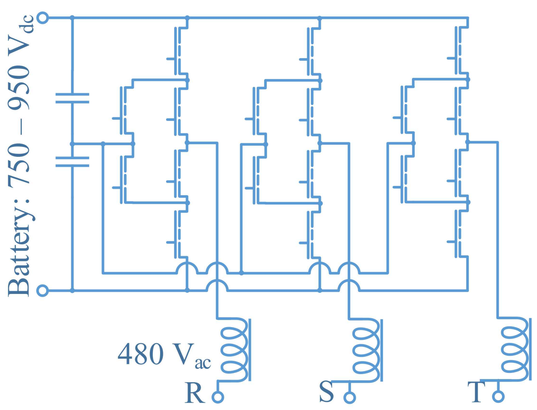


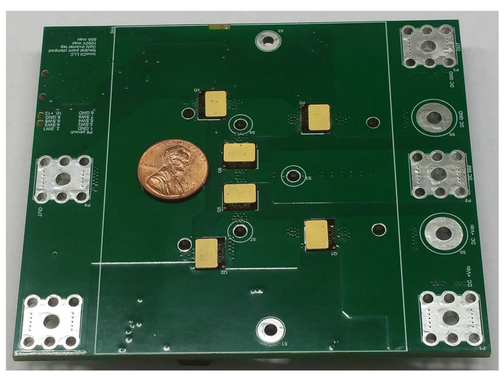


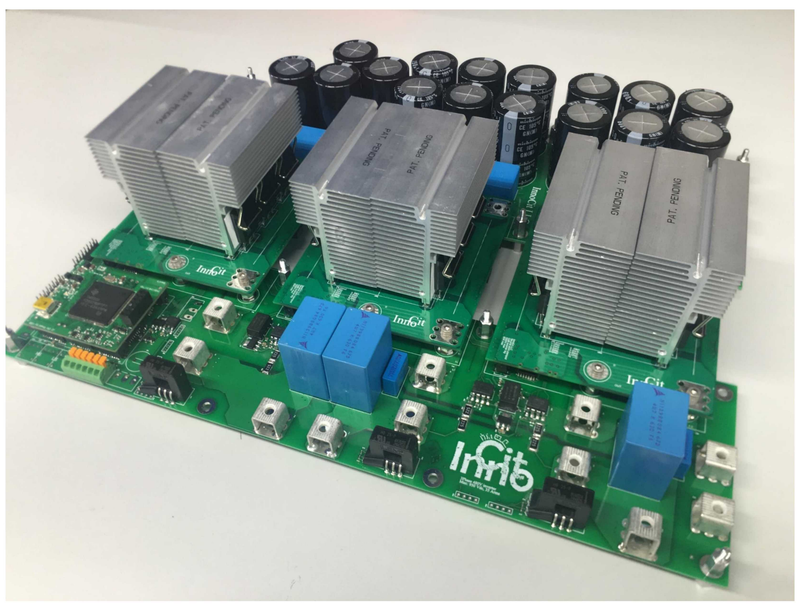












Specific Objectives

- Designing 3U rack-chassis-based enclosures for inverter modules
- Conduct thermal analysis on the enclosures
- Controls and hardware for hot-swap capabilities
- Validate final metrics: efficiency of at least 98.6%, weight < 2.2 lb./kW, volume <0.1 ft^3/kW, noise <45 dBa
- Reliability testing including active bypass and hot-swap features
- IEEE 1547 and UL 1741 and 1741-SA testing for islanding, fault ride-through, …
- UL certification testing
- Remote control and monitoring backbone structure development

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