Cascaded Micro Inverter PV System for Reduced Costs

Delphi Electronics & Safety
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Cascaded Micro Inverter PV System for Reduced Costs

Team Members

- Delphi Electronics and Safety – Prime
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- University of Tennessee - Knoxville
  - Prof. Leon Tolbert, Co-PI

- Oak Ridge National Laboratory
  - Dr. Burak Ozpineci, Co-PI

- Global Power Electronics
  - Mr. David Ouwerkerk
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Delphi Electronics & Safety Background

- Delphi is the largest North American supplier of power electronics in the automotive industry
- Delphi’s strengths are well suited for the PV market and include:
  - Strong systems engineering expertise
  - Flexible and lean global engineering and manufacturing footprint
  - Proven field reliability of electronic controls in harsh environments at single digit parts per million
- Delphi’s production power electronics programs include:
  - High-voltage battery packs
  - High-voltage inverters and converters
  - Battery controllers and chargers
- Certifications
  - ISO/TS 16949 & 14001
  - CMM Level 3
  - A2LA Certified Physical Test Lab
- More than 7,000 patents with 120+ in power electronics
- Access to the significant resources of Delphi Corporation
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The University of Tennessee

- Constructed low power multilevel converter prototype and developed several multilevel PWM methods.
- Published more than 50 IEEE papers related to multilevel converters. (and several related to connection to solar panels).
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Oak Ridge National Laboratory

- Researched various multilevel configurations for vehicle, utility, fuel cell, and solar applications.
- Published more than 100 conference and journal papers on the subject.
- Related Patents:
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Global Power Electronics

- GPE is a start up company working to commercialize Silicon Carbide Power Electronics
- GPE brings extensive power electronics experience (over 60 man-years) of high quality, reliability, and durable designs at low costs
- Organization strengths include: system and circuit topology, analysis, requirements generation, and design to cost
- Extensive experience in DC-AC and AC-DC inverters and converters at power levels up to 100kW

Publications:

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<td>Development of SiC-based Inverter for High Efficiency and High Temperature Operation</td>
<td>WOFE2009</td>
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<td>18 kW Three Phase Inverter System Using Hermetically Sealed SiC Phase-Leg Power Modules</td>
<td>APEC2010</td>
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<td>High Power SiC Modules for HEVs and PHEVs</td>
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<td>Packaging of an all SiC High-Temperature Power Inverter</td>
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<td>Design and Characterization of a Three-phase Multichip SiC JFET Module</td>
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<td>High Density 50 kW SiC Inverter Systems Using a JFET Based Six-Pack Power Module</td>
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System Overview

9kW 3 phase
480VAC

Assumes (preliminary):
- 600W pulse inverters (15)
- 200W 72-cell PV modules (45)
Test and evaluate 3 phase--3kW, 9kW and 45kW cascaded inverter PV systems over the three program phases demonstrating performance and system efficiencies

Develop detailed system and component level requirements documents

Provide system and component level design documentation

Provide a system-level design failure modes and effects analysis and a reliability analysis

Develop a detailed commercialization strategy including cost and price models

Submit quarterly reports as required and annual presentations

Provide a final report
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Project Issues & Challenges

◆ Control strategy
  – MPPT / power source balancing
  – THD management

◆ AC ripple current
  – Distributed capacitors to reduce 120 Hz AC ripple at PV panels

◆ Architecture trade offs
  – Cost optimization
    » Switch technology (IGBT vs. MOSFET)
    » Packaging scale
  – Wiring/BOS impacts
    » Each bridge section requires separate wires to their respective PV sources

◆ Phase 3 system test power level
  – Difficult to obtain large PV array with ability to wire appropriately
    » i.e. existing large arrays will be difficult to temporarily reconfigure