Self-Oscillating WBG-based VHF Power Conversion for FREEDM Applications

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Overview

System electrification requires power supplies that are:
- >99.99% efficient
- Contribute the least to system volume and weight (i.e., high power density)
- Make up the lowest percentage of system cost

Switching frequencies entering the system cost and weight (i.e., high power density)

Alignment with FREEDM mission
- Front-end DC-DC converter applications for Smart-Grid (PV, energy storage, data centers, transportation, space, etc.)

Method

Grid modernization through innovation
- Simplistic ZVS self-oscillating power circuit topology incorporating WBG devices (GaN, SiC) enhances reliability and lowers overall system cost by eliminating external gate drive circuit

Enables plug-n-play power electronics for interfacing renewables and energy storage with "N+1" redundancy and self-balancing load sharing via passive impedance matching (PIM) across intercoupled resonant tanks [35][36]

Synchronous Switching

Results

Achievements
- Simulation of 1.2kW self-oscillating LLC resonant converter
- Improved efficiency by eliminating external gate driver circuit losses
- Concept for 3 stacked, load sharing PIM inter-coupled power modules

Future Work
- Finalize electro-physical layout and multi-physics simulation of self-oscillating VHF converter
- Fabricate and test individual and intercoupled power conversion systems
- Extend concept to full-bridge and synchronous rectifier circuits
- Study VHF switching of WBG devices

References

Power Conversion System Specification

<table>
<thead>
<tr>
<th>Input DC Voltage (V)</th>
<th>800 V</th>
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<tbody>
<tr>
<td>Output DC Voltage (V)</td>
<td>48 V</td>
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<tr>
<td>Switching Frequency (kHz)</td>
<td>≥ 100/208kHz</td>
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<tr>
<td>Output Power (W)</td>
<td>1200 W</td>
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<tr>
<td>Efficiency (%)</td>
<td>≥ 95%</td>
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</table>

Achievements

Simulation of 1.2kW self-oscillating LLC resonant converter

Future Work
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Partners