Advanced Power Electronics for Impedance-Based Stability Analysis of Offshore Wind Power System

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INTRO

- The varying wind speeds at each turbine within an offshore wind farm can introduce potential instability issues into the power grid. The mechanical and electrical systems of distributed wind turbines oscillate with the power systems, leading to stability concerns. The power electronics inverter with advanced control strategies plays a pivotal role in stabilizing the power distribution grid between the wind turbines and loads.

METHODS

- A novel three-phase inverter topology and corresponding multi-inverter control system are proposed. An analysis is conducted on this topology consisting of dual-active-bridge (DAB) and cycloconverter, which effectively decouples power flow in each individual phase. Output impedance of the inverter is characterized, and the proportional integral resonant (PIR) controller is designed to manage the output power of inverters.

RESULTS

- Simulation Results show that the isolated phase voltage and isolated phase power control are achieved with the proposed three-phase inverter architecture. The designed PIR controller is effective in sharing the power between two inverters.

DISCUSSION

- A proposed three-phase grid-tie inverter is analyzed with operating principles and output impedance. The designed hardware prototype will be tested in the future with a multi-inverter system.

AUTHOR AFFILIATIONS: Princeton University

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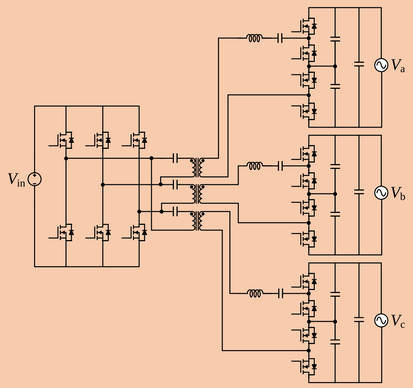

Fig. 1. Proposed Three-Phase Grid-Tie Inverter

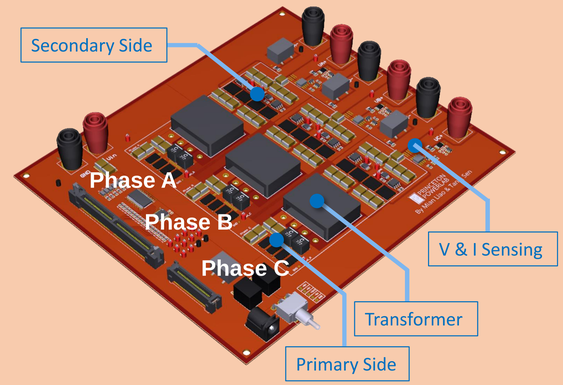

Fig. 2. Hardware Prototype of Three-Phase Inverter

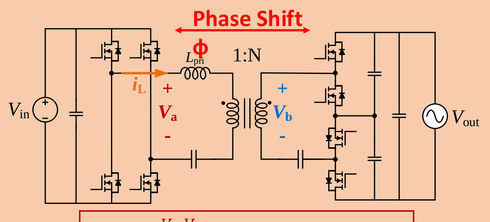

Fig. 3. Simplified Single-Phase Diagram and Power Flow

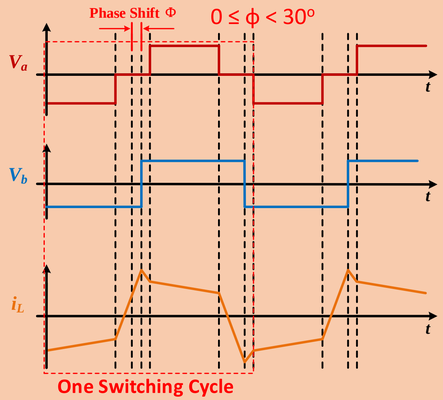

Fig. 4. Switching Voltages and Inductor Currents

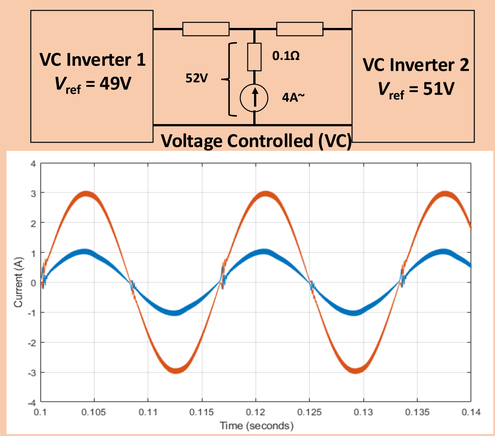

Fig. 5. Two Inverter System with Sharing Power Flow

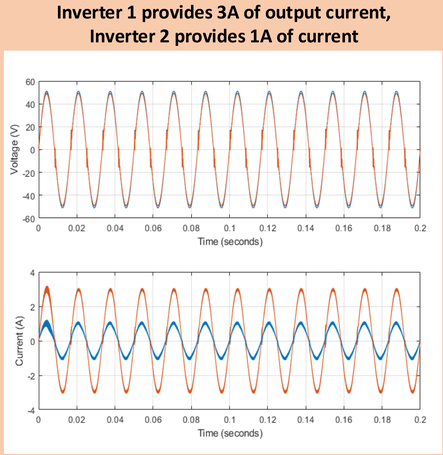

Fig. 6. Simulation Waveforms for Power Sharing