Reactive Power Control Strategy for Z-Source Inverter Based Reconfigurable Photovoltaic Microgrid Architectures

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Abstract : This research presents a reconfigurable architecture for residential microgrid systems utilizing Z-Source Inverter (ZSI) to optimize solar photovoltaic (SPV) system utilization and enhance grid resilience. The proposed system addresses challenges associated with high solar power penetration through various modes, including current control, voltage-frequency control, and reactive power control. It ensures uninterrupted power supply during grid faults, providing flexibility and reliability for grid-connected SPV customers. Challenges and opportunities in reactive power control for microgrids are explored, with simulation results and case studies validating proposed strategies. From a control and power perspective, the ZSI-based inverter enhances safety, reduces failures, and improves power quality compared to traditional inverters. Operating seamlessly in grid-connected and islanded modes guarantees continuous power supply during grid disturbances. Moreover, the research addresses power quality issues in long distribution feeders during off-peak and night-peak hours or fault conditions. Using the Distributed Static Synchronous Compensator (DSTATCOM) for voltage stability, the control objective is nighttime voltage regulation at the Point of Common Coupling (PCC). In this mode, disconnection of PV panels, batteries, and the battery controller allows the ZSI to operate in voltage-regulating mode, with critical loads remaining connected. The study introduces a structured controller for Reactive Power Controlling mode, contributing to a comprehensive and adaptable solution for residential microgrid systems. Mathematical modeling and simulations confirm successful maximum power extraction, controlled voltage, and smooth voltage-frequency regulation.

Keywords : reconfigurable architecture, solar photovoltaic, microgrids, z-source inverter, STATCOM, power quality, battery storage system
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