

# Abstract

Maximizing renewable energy integration and providing reliable supply with improved power quality are important objectives of a microgrid, an emerging technology of the day. Among the renewable sources, solar photovoltaic (PV) penetration is increasing rapidly due to its modular nature, ease of installation and economic viability. This thesis addresses some of the challenges in integrating solar power with the existing grid and the relevant control of microgrid.

Mitigating the impact of partial shading in solar PV plant is an important concern as it reduces the output power substantially. Further, multiple peaks in the power-voltage characteristics of a PV array under partial shading make it challenging to track the global peak power. Available strategies to mitigate the effect of partial shading have limited capability to increase the array power. In this thesis, two solutions i) voltage balancing technique and ii) current injection based dynamic array reconfiguration, are provided to reduce the impact of partial shading. The superiority of the proposed methods compared to the available strategies is clear from the results obtained through simulations and experimental setup in the laboratory.

Analysis, detection and classification of faults in a solar PV array in the presence of protection diodes (bypass and reverse blocking) is complex. This is because variations in the electrical parameters are often not distinguishable from one type of fault to another or from fault to partial shading. It has been observed that the available analysis and detection techniques cannot identify faults under all practical scenarios. In this thesis, a detailed fault analysis is presented, and a new fault detection and classification technique is proposed. The results from simulations and experiment in the laboratory setup demonstrate that the proposed technique is superior to the available techniques in detecting and classifying the fault.

A microgrid is often a resistive network when connected by cables possessing high R/X ratio. Literature shows that in a resistive microgrid the power-voltage (P-V) and reactive power-frequency (Q-F) droop control strategy provides better power sharing and improved system stability compared to the P-F and Q-V droop control option. Adopting P-V and Q-F droop method for a resistive microgrid with synchronous generator is challenging, because of its inherent P-F relationship. In this thesis, a new excitation and governor control strategy is proposed for the synchronous generator to operate in P-V and Q-F droop control mode for a stand-alone resistive microgrid. The effectiveness of the proposed control strategies is established by small signal and transient stability analysis.

**Keywords:** PV Array, Partial shading, DAR, Array reconfiguration, MPPT, PV array fault, Thevenin equivalent, Microgrid, Droop control, Small signal stability, Load sharing.