

## ABSTRACT

A micro-grid approach plays an enormous role in the increased penetration of renewable energy resource into grid thus reducing the emissions due to large coal fired power plants. The energy management in micro-grid is a challenging task as a major share of the generation is from Renewable Energy Sources. Usually, there are Power electronic interfaces through which the local generators are connected to the micro-grid which enables the control capabilities such as generation-demand management through active reactive power control, synchronization of the inverter to grid, meeting the power quality standards for the injected currents, maximum power point tracking etc. The active-reactive power delivered by the inverter is controlled by current control with the objective of the steady state and transient state performance requirements. Simple PI regulators are preferred to obtain these control capabilities which can handle only dc quantities. However, in grid connected systems, the ac currents injected to the grid are to be controlled and so, the ac quantities are transformed into dc quantities using synchronously rotating reference frame transformations (SRF), so as to derive dc control loop. Due to the *abc-dq* transformation a cross coupling term is introduced between the d and q control loops which, results in the loss of independency in the control of active reactive powers. Usually the cross

coupling is removed by feed forward and feedback based control loops using grid impedance value in a decoupling term.

This research work is formulated based on the observation of the SRF decoupled current controllers when used in micro-grid fails in achieving a perfect decoupling during transient periods, because of the change in the grid impedance value due to configuration changes of micro-grid. Due to the imperfect decoupling, the active and reactive powers cannot be controlled independently, and the control loops tend to reach unstable operating regions during certain operating conditions. These problems are addressed in the present research work by dynamically measuring the grid impedance value online using a non-characteristic harmonic voltage injection method and subsequent use of the measured value for updating the control loop, so as to achieve a superior active-reactive power decoupling and better system stability specifically during the transient periods.

This research work also developed a novel non iterative open circuit and short circuit values based maximum power point tracking method for solar PV array which can be applied directly in the outer power loop of the grid connected inverter control. The developed algorithm is tested under different ambient conditions including partial shading conditions and the results are compared with the datasheet value and compliance is confirmed.

Development of a solar PV emulator, capable of setting repeatable ambient conditions to test the reliability of the developed grid connected power converters is quite essential in PV system design. This provides the facility to evaluate the PV energy conversion system modules such as DC-DC converters, DC-AC converters, maximum power point tracking algorithms, grid synchronization circuits etc. These emulators are primarily intended to act as a PV power source in experiments. A model based hardware solar PV emulator is designed and developed as a part of this research work for setting repeatable operating points for testing the developed converters. The so developed simulator replicates any commercial module available in the market as the mathematical model in it uses the physical parameters which are extracted from the datasheet of the actual PV modules. The PV emulator is hardware implemented and tested for user entered ambient conditions and the output is compared with the datasheet values.