

## **Abstract of PhD Thesis**

### **“Design and Implementation of Solar PV Grid Interfaced Systems and Applications to EV Charging” Mrs. Vandana Jain (2015EEZ8114), Research Scholar, Department of Electrical Engineering**

This thesis presents the solar photovoltaic based electrical vehicle charging station interfaced to the three phase grid. The EV battery is charged using the power generated by the PV array and the surplus power is supplied to the grid. During the grid failure, the PV array is used to feed the power to the local loads connected at the charging station. However, in case of insufficient PV array generation, the EV battery discharges to provide the power to the local load. The design of the charging station is further extended by connecting an auxiliary battery energy storage, which acts as buffer to provide uninterrupted power to the charging stations during emergency situations. The configurations of the EV charging station are identified on the basis of the connection/disconnection with the grid as grid connected mode/standalone mode, number of stages of power conversion as single stage or double stage, battery energy storage connection i.e., directly connected at the DC-link or via DC-DC (bidirectional) converter. In a double stage system, a boost converter performs the MPPT (Maximum Power Point Tracking) operation for the extraction of the maximum power from the PV array and the second stage is VSC (Voltage Source Converter), which is used for the conversion of DC power generated by the PV array to the AC power to be interfaced with the grid. However, in a single stage topology, boost converter stage is eliminated and VSC is used to perform both the MPPT and DC-AC conversion. There are several issues with the grid like harmonics in the grid currents, deterioration in the power factor, distortion and unbalance in the grid voltages. The VSC switching pulses are generated by implementation of the proper control algorithm, mitigates all the above mentioned issues. An improved generalized integrator-based control is presented for the three phase double-stage grid interfaced PV system. It is used for harmonics mitigation, reactive power compensation, unity power factor operation, and grid currents balancing. The perturb and observe based MPPT algorithm is implemented for the extraction of the peak power from the PV array used in the system. Moreover, an adaptive synchronization controller is used to feed the local load in the absence of the grid. The new adaptive control is demonstrated for the three-phase single stage grid connected PV array based EV charging system. The system is tested under different condition such as with and without local loads, grid connected mode, standalone mode of operation, etc. The positive sequence component of the grid voltage is used for the estimation of the unit templates to generate the balanced and sinusoidal grid currents even under abnormal operating scenarios. The synchronization technique is used to switch between the grid connected control and the standalone mode of operation. The generalized integrator-based control is used to achieve optimal operation of three-phase double stage and single stage grid interfaced electric vehicle charging stations while feeding the power to the local loads. The bi-directional buck-boost converter-based electric vehicle load is used under various operating scenarios. Detailed performance is studied under abnormalities in the grid such as voltage sag, voltage swell, grid outage, recovery of the grid, etc. The controller is developed for an optimal operation of the three-phase grid interfaced solar photovoltaic array system-based electric vehicle charging station with and without a buck-boost converter controlled battery energy storage. The dynamic performance of the system has been demonstrated for several practical scenarios such as grid outage, grid recovery, charging and discharging of electric vehicles, etc. Moreover, a synchronization controller is used to facilitate the smooth transition between grid-connected mode to islanded mode and vice-versa. All the identified configurations are modeled and simulated in the MATLAB/Simulink and the simulated results are validated by test results on the prototype developed in the laboratory.