ABSTRACT

Electric power distribution system is an intermediate through which power is distributed to the end users. Power electronic loads connected to the distribution system draw non-sinusoidal current from the mains, degrading the power quality by causing harmonic distortion. This thesis mainly focuses on compensation of current based distortions due to the presence of nonlinear loads in the power distribution system. The Distributed Static Compensator (DSTATCOM) is the efficient custom power device that can resolve the power quality problems in the distribution system. However, this conventional DSTATCOM does not offer continuous compensation when nonlinear loads are connected permanently to the power distribution system. Therefore, this thesis proposes a solution to provide continuous compensation by means of Photovoltaic (PV) array and battery storage unit. The interconnection of renewable energy sources into the utility grid gives lot of issues. The important issues faced by the systems are synchronized with the utility grid, power quality and others. The DSTATCOM interconnects the PV system into the utility grid with enhancement the power quality.

The DSTATCOM system comprises of three-leg Voltage Source Inverter (VSI) with a DC (Direct Current)-link storage capacitor. To be able to provide continuous compensation, the DC-link voltage has to be maintained as constant voltage magnitude. Hence, PV array and battery unit with a power conditioning circuit such as the voltage doubler boost converter is connected to the DC-link of the DSTATCOM. In daytime, the PV integrated DSTATCOM provides the essential compensation and during the night time battery operated DSTATCOM is used for the required compensation. Therefore, continuous compensation is achieved for the whole day in the power distribution system. The Second Order Generalized Integrator (SOGI)- Phase Locked Loop (PLL) based Unit Vector Template (UVT) control scheme is
employed for extraction of reference current to generate gating signals of DSTATCOM. The proposed control algorithm is used for compensation of current harmonics, reactive power and voltage interruption. The DC link storage capacitor of the DSTATCOM is utilized to interconnect the PV system into the utility grid and it is controlled by the SOGI-PLL based UVT controller. The PV supported DSTATCOM provides uninterrupted active and reactive power compensation, when the disturbances occurs in the power distribution system. The PV supported DSTATCOM systems are verified by MATLAB (Matrix Laboratory)/Simulink software.

The simulation results obtained for PV-DSTATCOM employing UVT based control scheme reveals that current harmonic distortions has been realistically diminished at the distribution system. To be able to improve the harmonic elimination capability of the PV integrated DSTATCOM, SOGI-PLL has been employed in the UVT control algorithm. The reduction of THDs in source current is studied using simulation results and comparisons. From the comparison of results, it is found that the proposed SOGI-PLL employed in UVT control algorithm for PV supported DSTATCOM operation has very less THD in the source current. Uninterrupted clean power supply can be given to the end users by implementing the simple coordinating logic that control the different modes of operations such as PV power generation mode, voltage interruption compensation mode and battery backup mode. The proposed PV supported DSTATCOM employed with the SOGI-PLL based UVT control scheme provides an effective long duration compensation during the irregular voltage and current disturbances. To validate the results, an experimental prototype has been constructed and tested. The experimental results show that the system effectively reduces the THDs in the source current within the limit specified by the Institute of Electrical and Electronics Engineers (IEEE) 519-1992 standards for all the three phases.