Design and Performance Analysis of Three-Phase Solar PV Integrated UPQC

ABSTRACT:

This paper deals with the design and performance analysis of a three-phase single stage solar photovoltaic integrated unified power quality conditioner (PV-UPQC). The PV-UPQC consists of a shunt and series connected voltage compensators connected back to back with common DC-link. The shunt compensator performs the dual function of extracting power from PV array apart from compensating for load current harmonics. An improved synchronous reference frame control based on moving average filter is used for extraction of load active current component for improved performance of the PV-UPQC. The series compensator compensates for the grid side power quality problems such as grid voltage sags/swells. The compensator injects voltage in-phase/out of phase with point of common coupling (PCC) voltage during sag and swell conditions respectively. The proposed system combines both the benefits of clean energy generation along with improving power quality. The steady state and dynamic performance of the system are evaluated by simulating in Matlab-Simulink under a nonlinear load. The system performance is then verified using a scaled down laboratory prototype under a number of disturbances such as load unbalancing, PCC voltage sags/swells and irradiation variation.

KEYWORDS:

1. Power Quality
2. Shunt compensator
3. Series compensator
4. UPQC
5. Solar PV
6. MPPT
SOFTWARE: MATLAB/SIMULINK

CIRCUIT DIAGRAM:

Fig. 1. System Configuration PV-UPQC

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EXPECTED SIMULATION RESULTS:

Fig. 2. Performance of PV-UPQC under Voltage Sag and Swell Conditions
Fig. 3. Performance PV-UPQC during Load Unbalance Condition

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Fig. 4. Performance PV-UPQC at Varying Irradiation Condition

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Fig. 5. Load Current Harmonic Spectrum and THD

Fig. 6. Grid Current Harmonic Spectrum and THD

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CONCLUSION:
The design and dynamic performance of three-phase PVUPQC have been analyzed under conditions of variable irradiation and grid voltage sags/swells. The performance of the system has been validated through experimentation on scaled down laboratory prototype. It is observed that PVUPQC mitigates the harmonics caused by nonlinear load and maintains the THD of grid current under limits of IEEE-519 standard. The system is found to be stable under variation of irradiation, voltage sags/swell and load unbalance. The performance of d-q control particularly in load unbalanced condition has been improved through the use of moving average filter. It can be seen that PV-UPQC is a good solution for modern distribution system by integrating distributed generation with power quality improvement.

REFERENCES: