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Simulation and Design of UPQC to Improve Power Quality in Micro Grid Applications

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ABSTRACT:

Power quality problems have become more complex at all level of power system. By using power electronics devices can be effective improve the quality of power supplied to the distributed system. The topology of UPQC to have a reduced dc-link voltage without compromising its compensation capability. This proposed topology also helps to match the dc-link voltage requirement of the shunt and series active filters of the UPQC.

The equipment corresponds to the back-to-back connection of a series and a shunt active filter, solar panel connected to DC link by boost converter which is able to reduce the voltage sag and swell and voltage interruption, harmonics and reactive power control. The average switching frequency of the switches in the VSI also reduces; consequently the switching losses in the inverters reduce. A simulation study of the proposed topology has been study by using MATLAB/SIMULINK.

Key words:

UPQC controller, Power quality (PQ), Series Active Filter (SEF), Shunt Active Filter (SAF), Active power filter (APF), harmonics.

I.INTRODUCTION:

Power quality problems have been increasingly causing concern due to the wide use of nonlinear loads such as adjustable speed drives, electric arc welders, and the switching power supplies in distribution systems. Nonlinear loads cause harmonic currents in networks and consequently distort the voltage waveform at the point of common Coupling (PCC) due to system impedances.

This distorted voltage waveform harmfully affects the other loads connected at the PCC. To avoid this problem and to protect loads from distortions, the harmonic components of the voltage and current must be fully compensated. LC passive filters and shunt active power filters (APFs) are regularly used to mitigate harmonic currents.

The power quality is an essential customer focused measure and it's greatly affected by the operation of a distribution and transmission network. Nowadays, generation of electricity from renewable sources has improved very much. Since most renewable energy sources are intermittent in nature, it is a challenging task to integrate a significant portion of renewable energy resources into the power grid infrastructure.

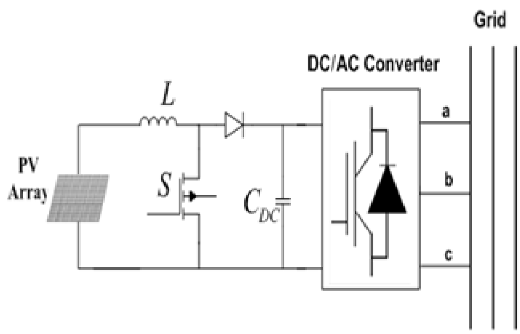

Fig. 1: General structure of grid connected PV systems

In order to simultaneously deal with harmonic voltage and current problems, an advanced solution, i.e., the unified power quality conditioner (UPQC) has been developed.

The UPQC is composed of a shunt and a series active power filter to ensure that both the load voltage and the supply current become sinusoidal, where the shunt APF is operated as a controlled current source to compensate the harmonic currents produced by nonlinear loads.

Meanwhile, the series APF acts as a controlled voltage source to compensate the harmonics of the supply voltage. Various UPQC control schemes have been developed to mitigate harmonic voltages and currents. UPQC is able to compensate current harmonics reactive power, voltage distortions and control load flow but cannot compensate voltage interruption because of not having sources.

The interest in renewable energy has been increasing rapidly because renewable energy might play an important role in the future power system. A small distributed generation (DG) should be interconnected with the power system in order to maintain the frequency and voltage.

In this paper a new structure is proposed for UPQC, for reducing the Dc link voltage. In this case, UPQC finds the ability of injecting power to sensitive load during source voltage interruption. This proposed topology also helps to match the dc-link voltage requirement of the shunt and series active filters of the UPQC. The equipment corresponds to the back-to-back connection of a series and a shunt active filter, connected to DC link by boost converter which is able to reduce the voltage sag and swell and voltage interruption, harmonics and reactive power control. A simulation study of the proposed topology has been study by using MATLAB/SIMULINK.

II. Flexible AC Transmission System (FACTS):

The objective of incorporating FACTS is into the power system lines are similar to HVDC but greater flexibility are involved like improving real power transfer capability in the lines, prevention of sub- synchronous resonance (SSR)oscillations and damping of power swings [9]. FACTS devices have four well- known types which are used in many power systems in the world. Single type controller is the types of FACTS that installed in series or shunt in an AC transmission line, while unified type controller are the combined converters type of FACTS controllers like UPFC and HVDC. The following types of FACTS devices are VSC type based controllers:

Shunt controller:

example device, STATCOM emulates like a variable inductor or can be a capacitor in shunt or parallel connection in the transmission line. This type of device is capable of imitating inductive or capacitive reactance in turns to regulate line voltage at the point of coupling. Shunt controller in general controls the voltage injection.

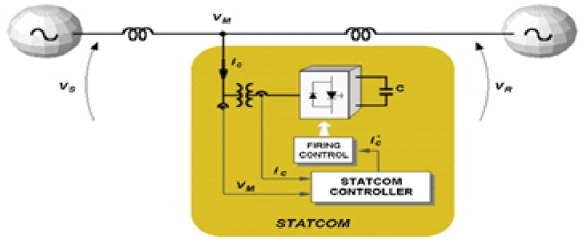

Fig 2: STATCOM circuit diagram

Series controller:

example device, SSSC emulates like a variable inductor or a capacitor in series with a transmission line and it imitates inductive or capacitive reactance in turn to regulate effective line reactance between the two ends. Series controller in general controls current injection.

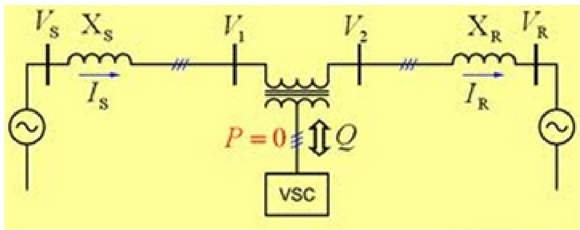

Fig 3: SSSC circuit diagram

Shunt-series controller:

can be a standalone controller as STATCOM and SSSC. This type of controller is a reactive Compensator with the exception of producing its own losses. It is also recognized as "unified" controller and requires small amount of power for DC circuit exchange occurring between the shunt and series converters. See Fig.2 for shunt- series controller.

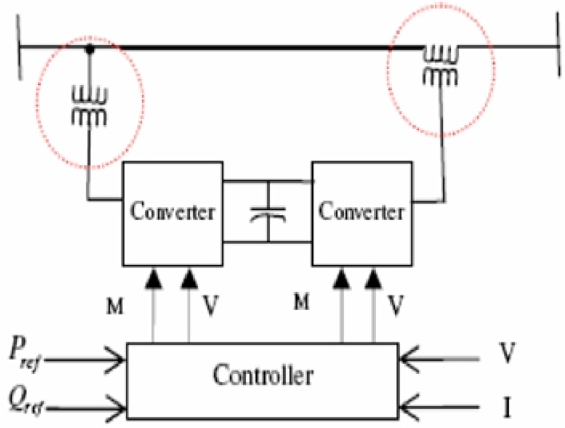

Fig.4: Block diagram of UPQC controller .

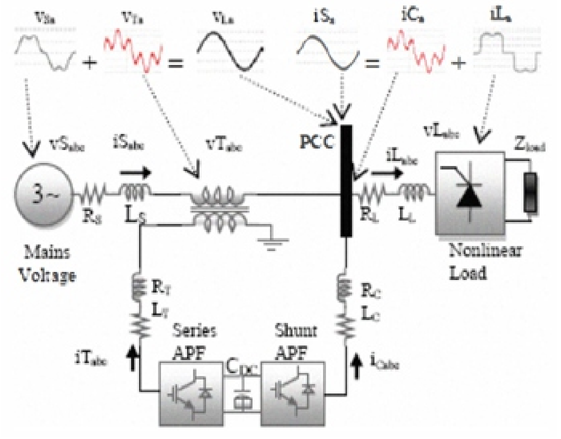

Fig 5: Generalized Diagram of UPQC system

The UPQC consists of two voltage source inverters Connected back to back with each of them sharing a common dc link.

Fig-2 shows the control diagram of UPQC system. One inverter work as a variable voltage source is called series APF, and the other as a variable current source in called shunt Active Power Factor.The main aim of the series APF is harmonic isolation between load and Supply; it has the capability of voltage flicker/ imbalance compensation as well as voltage regulation and harmonic compensation at the utility-consumer PCC. The shunt APF is used to absorb current harmonics, compensate for reactive power and negative-sequence current, and regulate the dc link voltage between both APFs.

The proposed circuit is the combination of STATCOM AND SSSC ie., UPQC. The topology of UPQC to have a reduced dc-link voltage without compromising its compensation capability. This proposed topology also helps to match the dc-link voltage requirement of the shunt and series active filters of the UPQC. The equipment corresponds to the back-to-back connection of a series and a shunt active filter connected to DC link which is able to reduce the voltage sag and swell and voltage interruption, harmonics and reactive power control.

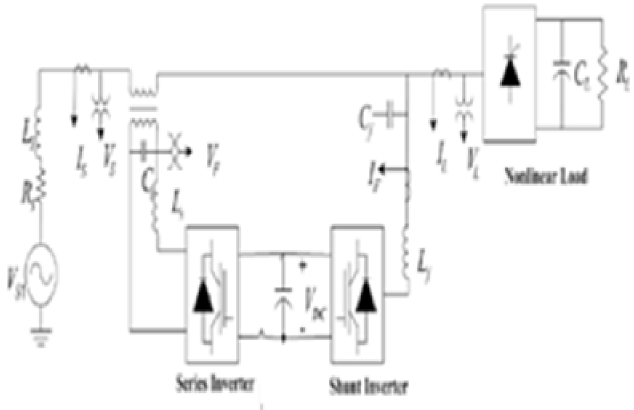

Fig 6: Proposed circuit diagram of an UPQC with DC link.

IV. RESULTS:

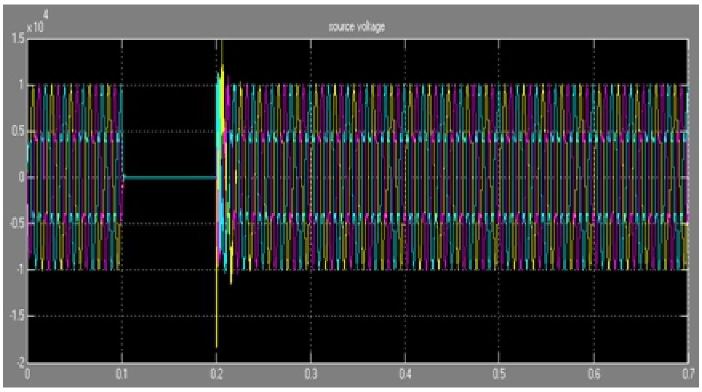

Fig 7: Source voltage

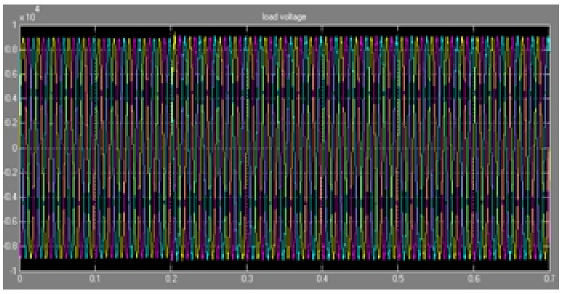

Fig 8: Load voltage.

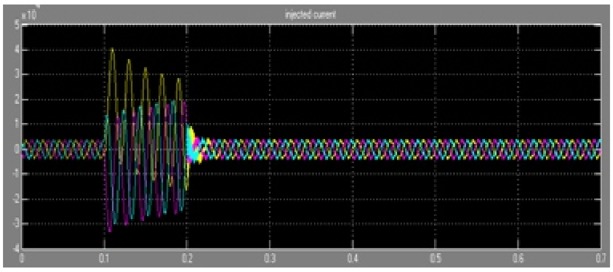

Fig 9: Injected voltage.

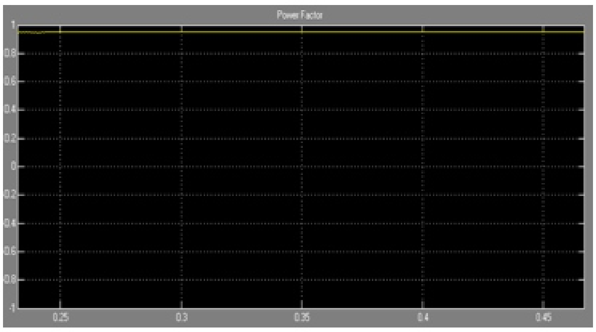

Fig 10: Power factor.

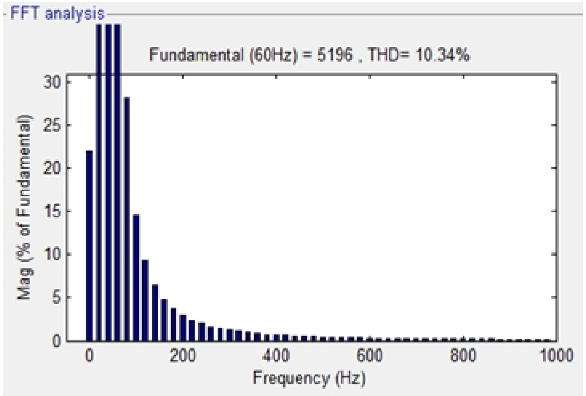

Fig 11: THD for UPQC.

V.CONCLUSION:

In this paper, the results of analyzing operation of UPQC is explained. The proposed system is composed of series and shunt compensator, which can reduce the voltage sag, swell, interruption, reactive power and harmonics.In between series and shunt compensator one dc link is connected. To the DC link is connected with solar panel in proposed circuit. The topology of UPQC to have a reduced dc-link voltage without compromising its compensation capability. This proposed system's operation is analyzed using MATLAB software and simulation results confirm that the proposed system operates correctly. UPQC system can improve the power quality at the point of common coupling on power distribution systems under unbalanced and distorted load conditions. This proposed system's operation is analyzed using MATLAB software and simulation results confirm that the proposed system operates correctly.

REFERENCES:

(1)H. Akagi, H. Fuzita, A new power line conditional for harmonic compensation in power system, IEEE Trans. Power Del., vol.10, no.3, pp.1570-1575, Jul.1995.

(2)Aredes, M. and E.H. Watanabe, 1995. New control algorithms for series and shunt three-phase four-wire active power Filters. IEEE Transaction on Power Delivery, 10: 1649-1656. Digital Object Identifier (DOI): 10.1109/61.400952.

(3)Akagi, H., Y. Kanazawa and A. Nabae, 2007 Instantaneous reactive power compensator comprising switching devices without energy storage components IEEE Trans. Ind. Appl, 20: 625-630 Digital Object Identifier(DOI): 0.1109 /TPWRD.2005. 852348.

(4) V. Khadkikar, A. Chandra, A novel concept of simultaneous voltage sag/swell and load reactive power compensation utilizing service inverter for UPQC, IEEE Trans. Power Del., vol.26, no.9, Sep.2011.

(5) Y. Chen, X. Zha, and 1. Wang, "Unified power quality conditioner (UPQC): The theory, modeling and application, "Proc. Power System Technology Power Con Int. Corr!, vol. 3,pp. 1329-1333, 2000.

[6] M. Savaghebi, J. M. Guerrero, A. Jalilian, and J. C. Vasquez, "Experimental evaluation of voltage unbalance compensation in an islanded microgrid," in Proc. IEEE ISIE, 2011, pp. 1453–1458.

[7] M. Prodanovic and T. C. Green, "High-quality power generation through distributed control of a power parkmicrogrid," IEEE Trans. Ind. Electron., vol. 53, no. 5, pp. 1471–1482, Oct. 2006.

[8] J. C. Vasquez, R. A. Mastromauro, J. M. Guerrero, and M. Liserre, "Voltagesupport provided by a droop-controlled multifunctional inverter," IEEE Trans. Ind. Electron., vol. 56, no. 11, pp. 4510–4519, Nov. 2009.

[9] K. Borisov and H. L. Ginn, "Multifunctional VSC based on a novel Fortescue reference signal generator," IEEE Trans. Ind. Electron., vol. 57, no. 3, pp. 1002–1007, Mar. 2010.

[10] J. Dannehl, M. Liserre, and F. W. Fuchs, "Filter-based active damping of voltage source converters with LCL filter," IEEE Trans. Ind. Electron., vol. 58, no. 8, pp. 3623–3633, Aug. 2011.

[11] Z. Jiang and X. Yu, "Hybrid dc- and ac-linked microgrids: Towards integration of distributed energy resources," in Proc. IEEE Energy 2030Conf., 2008, pp. 1–8.

[12] J.-H. Jeon, J.-Y. Kim, H.-M. Kim, S.-K. Kim, C. Cho, J.-M. Kim, J.-B. Ahn, and K.-Y. Nam, "Development of hardware in-the-loop simulation for testing operation and control functions of microgrid," IEEETrans. Power Electron., vol. 25, no. 12, pp. 2919–2929, Dec. 2010.

[13] H. Fujita and H. Akagi, "The unified power quality conditioner: The integration of series- and shunt-active filters," IEEE Trans. Power Electron., vol. 13, no. 2, pp. 315–322, Mar. 1998.

[14] B. Han, B. Bae, H. Kim, and S. Baek, "Combined operation of unified power-quality conditioner with distributed generation," IEEE Trans.Power Del., vol. 21, no. 1, pp. 330–338, Jan. 2006.

[15] V. Khadkikar and A. Chandra, "A new control philosophy for a unified power quality conditioner (UPQC) to coordinate load-reactive power demand between shunt and series inverters," IEEE Trans. Power Del., vol. 23, no. 4, pp. 2522–2534, Oct. 2008.