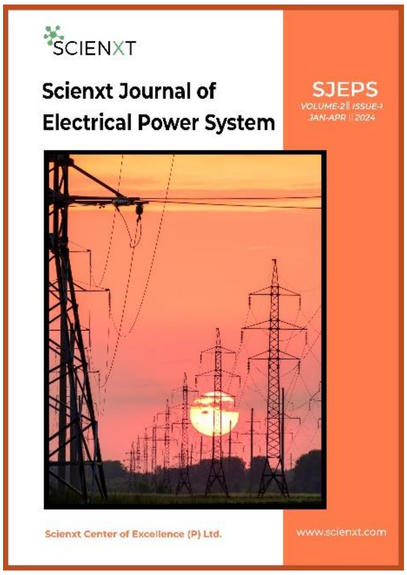

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Smart grid power quality improvement using modified upqc

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Abstract:

The Smart Grid system typically deals with different issues involving security and Power Quality improvement. With frequent usage of power electronic devices and nonlinear load, harmonics are inserted into the system. The well-known Flexible AC Transmission System devices like Unified Power Quality Conditioners are usually employed to resolve the issues related to voltage sag, swell, flicker, PQ, and neutral current reduction of distribution systems. An UPQC itself inserts harmonics into the system that affects the system stability for sensitive loads. This paper describes proposed controller for harmonics elimination techniques for modified UPQC connected with SG. Lower order harmonics are eliminated by proper selection of switching angles and at the same time the higher order harmonics are suppressed by injecting same order harmonics with equal magnitude but opposite in phase from the other converter. The excitation of Modified UPQC converters are obtained from PV panel. The firing angles of series-shunt converter are obtained in real-time from the already stored angles in the microcontroller memory.

Keywords:

Smart Grid system, Transmission System, power electronic devices, series-shunt converter, PV panel

1. Introduction:

Smart grid power quality improvement using modified Unified Power Quality Conditioner (UPQC) is a technology that enhances the quality of electrical power supplied to consumers in smart grid systems. UPQC is a power conditioning device that is used to improve the quality of electrical power by compensating for power quality issues such as voltage sags, swells, harmonics, and flickers. However, the traditional UPQC system is limited in its ability to compensate for power quality issues that occur at different points in the electrical grid. The modified UPQC system improves upon the traditional UPQC by using a series of cascaded H-bridge multilevel inverters (CHB-MLI) to control and regulate the voltage and current at different points in the electrical grid. This allows for better compensation of power quality issues throughout the grid, resulting in improved power quality for consumers. Some of the benefits of using a modified UPQC for power quality improvement in smart grid systems include:

Improved voltage regulation: The modified UPQC can regulate voltage fluctuations and maintain a constant voltage level throughout the electrical grid, which helps to improve the reliability and stability of the grid.

Reduced harmonic distortion: The modified UPQC can reduce harmonic distortion in the electrical grid, which can improve the quality of power supplied to consumers and reduce the likelihood of equipment damage.

Faster response time: The modified UPQC has a faster response time than traditional UPQC systems, allowing it to quickly compensate for power quality issues as they occur.

Enhanced power flow control: The modified UPQC can control the power flow in the electrical grid, allowing for better management of power demand and supply.

Overall, the use of a modified UPQC for power quality improvement in smart grid systems is an effective way to enhance the quality and reliability of electrical power supplied to consumers. It can also help to reduce energy consumption and costs, while contributing to a more sustainable and efficient electrical grid.

2. Literature survey:

Smart grid power quality improvement using modified UPQC (Unified Power Quality Conditioner) is an active research area in the field of power electronics and power systems. A literature survey on this topic reveals the following information Introduction to Smart Grid: Smart grid is an advanced power distribution system that uses digital communication and automation technologies to monitor and control the flow of electricity in real-time. It is designed to improve the reliability, efficiency, and sustainability of the power grid. Power Quality Issues: Power quality issues such as voltage sags, voltage swells, harmonics, and reactive power can cause significant damage to the electrical equipment and affect the performance of the power grid. These issues can be mitigated by using power electronics based devices such as UPQC. Unified Power Quality Conditioner (UPQC): UPQC is a power electronics-based device that combines series and shunt active power filters to improve the power quality of the grid. It is capable of compensating for voltage sags, voltage swells, harmonics, and reactive power in real-time.

3. Proposed system:

The power electronic devices due to their inherent non-linearity draw harmonic and reactive power from the supply. In three phase systems, they could also cause unbalance and draw excessive neutral currents. The injected harmonics, reactive power burden, unbalance, and excessive neutral currents cause low system efficiency and poor power factor. The quality of the Electrical power is effected by many factors like harmonic contamination, due to non-linear loads, voltage and current flickering due to arc in arc furnaces, sag and swell due to the switching of the loads etc. One of the many solutions is the use of a combined system of shunt and active series filters like unified power quality conditioner. Basic Configuration of UPQC is the integration of series and shunt active power filters, connected back to back on the dc side, sharing a common DC capacitor. The series component of the UPQC is responsible for mitigation of the supply side disturbances. The shunt component is responsible for mitigating the current quality problems caused by the consumer. Operation of UPQC the Unified Power Quality Conditioner (UPQC) combines the Shunt Active Power Filter with the Series Active Power Filter, sharing the same DC Link, in order to compensate both voltages and currents, so that the load voltages become sinusoidal and at nominal value, and the source currents become sinusoidal and in phase with the source voltages. (Journal of Engineering Sciences Vol 14 Issue 04, 2023 ISSN: 0377-9254 jespublication.com Page 488)

1. UPQC can compensate both voltage-related problems such as voltage harmonics, voltage sags/swells, voltage flicker as well as current-related problems like reactive power compensation, power factor correction, current harmonics and load unbalances compensation.

2. There is a significant increase in interest for using UPQC in distributed generation associated with smart grids because of the availability of high-frequency switching devices and advanced fast computing devices (microcontrollers, DSP, FPGA) at lower cost

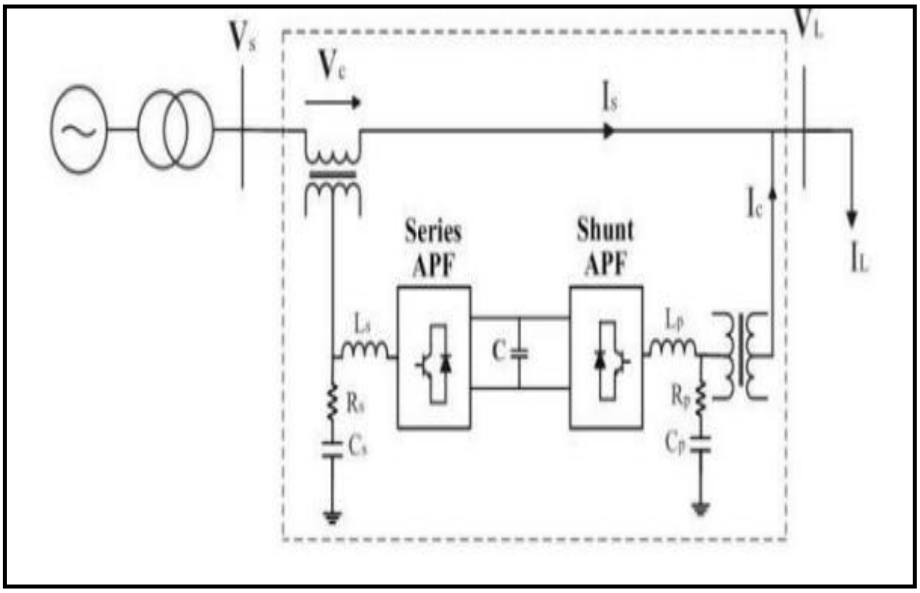

Figure. 1: General configuration of UPQC

4. Simulation results:

Simulink is a software package for modeling, simulating, and analyzing dynamical systems. It supports linear and nonlinear systems, modeled in continuous time, sampled time, or a hybrid of the two. For modeling, Simulink provides a graphical user interface (GUI) for building models as block diagrams, using click-and-drag mouse operations. Models are hierarchical, so we can build models using both top-down and bottom-up approaches. We can view the system at a high level, then double-click on blocks to go down through the levels to see increasing levels of model detail. This approach provides insight into how a model is organized and how its parts interact. After we define a model, we can simulate it, using a choice of integration methods, either from the Simulink menus or by entering commands in MATLAB's command window. Using scopes and other display blocks, we can see the simulation results while the simulation is running. In addition, we can change parameters and immediately see what happens, for "what if" exploration. The simulation results can be put in the MATLAB workspace for post processing and visualization. Simulink can be used to explore the behavior of a wide range of real-world (Journal of Engineering Sciences Vol 14 Issue 04, 2023 ISSN: 0377-9254 jespublication.com Page 489) dynamic systems, including electrical circuits, shock absorbers, braking systems, and many other electrical, mechanical, and thermodynamic systems.

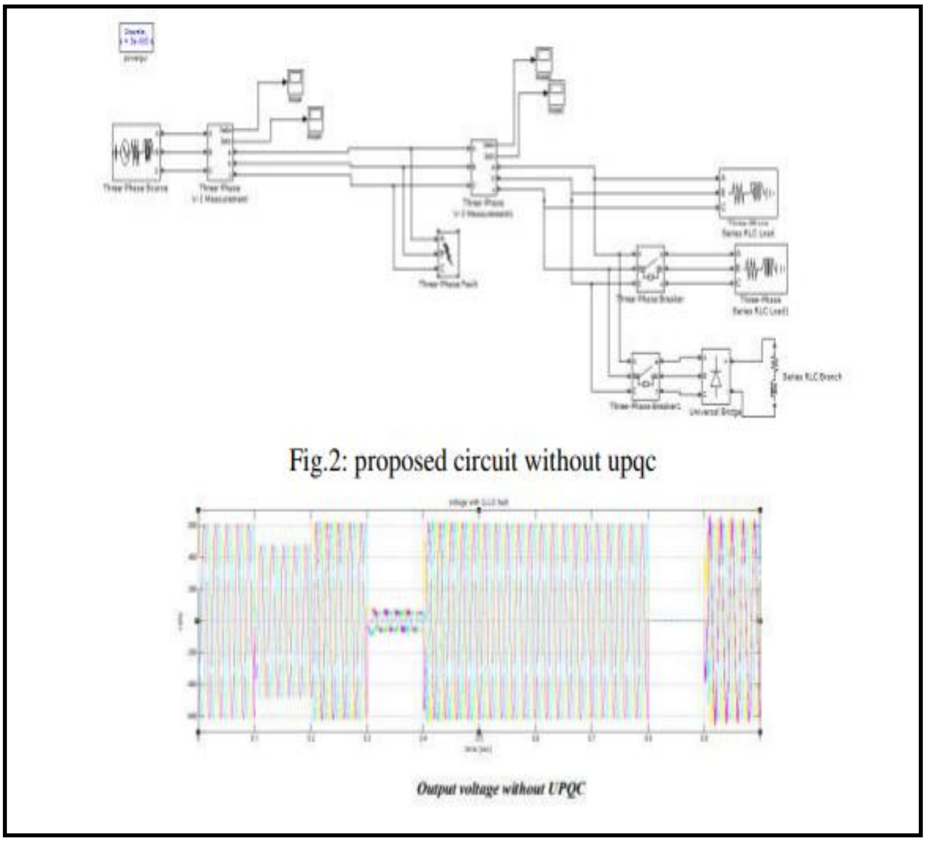

Figure. 2: Proposed circuit without upqc

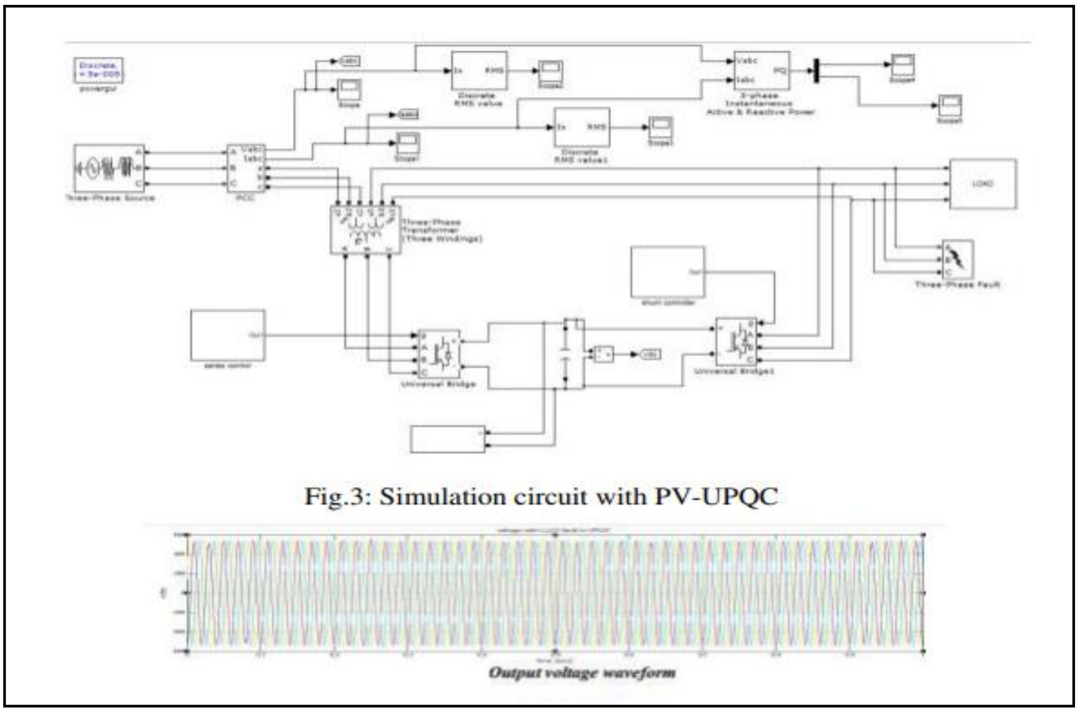

Figure. 3: Simulation circuit with PV-UPQC

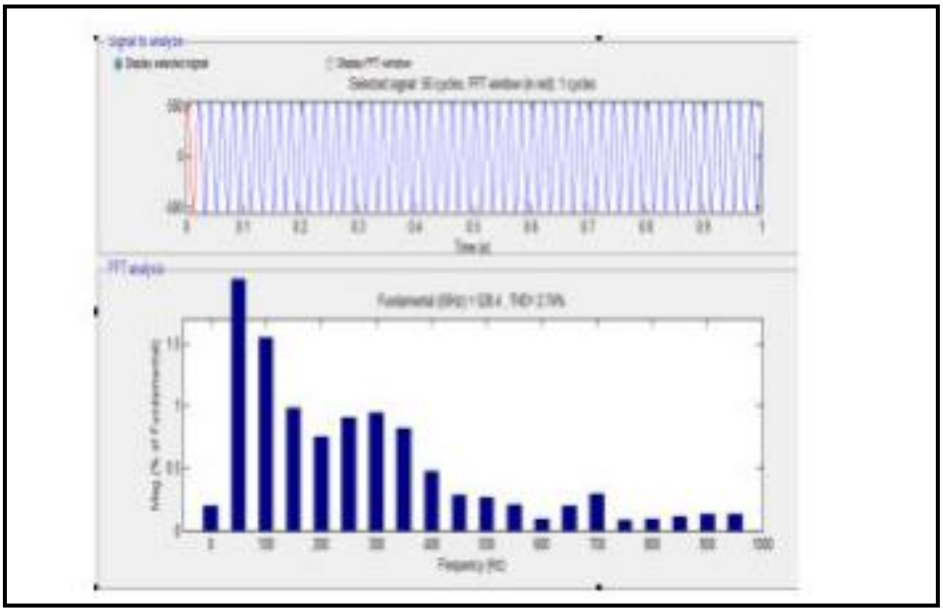

Figure. 4: THD with UPQC

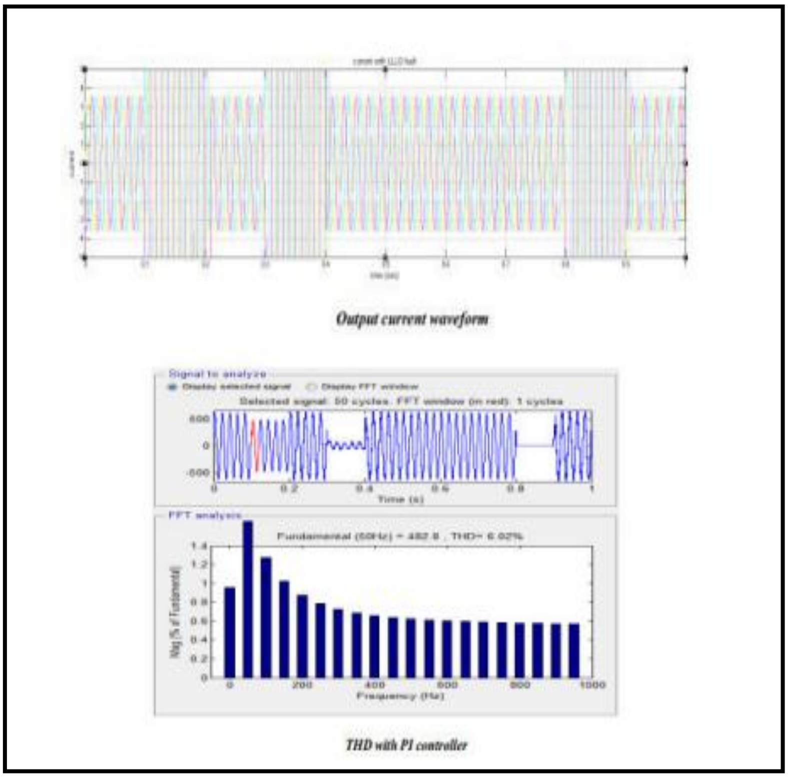

Figure. 5: Output Current Waveform

5. Conclusion:

A noticeable trend in distribution systems is the emergence of distributed harmonic-producing loads. These loads typically have comparable sizes and are distributed all over an electric network. There is a need to develop new techniques to assess harmonic distortions for systems with distributed harmonic sources. The objective of the project is to minimize the power quality problems with the implementation of the power quality enhancement device UPQC. This device has the capacity to improve the power quality at the point of installation. Without UPQC the system voltage and currents are unbalanced under fault conditions with THD of 6.02%. When we applied UPQC with PI controller the VO output voltage is balanced and still some distortions observed in current waveforms under fault conditions the THD issue reduced to 2.74%. By using the proposed Hybrid controller with UPQC the system output voltage and currents are balanced without any distortion and the THD is reduced finally to 0.08%. Hence the analysis proves that the proposed Hybrid controller with UPQC achieved better results when compared to the existing models.

6. References:

(1) J. H. R. Enslin and P. J. M. Heskes, "Harmonic interaction between a large number of distributed power inverters and the distribution network," IEEE Trans. Power Electron., vol. 19, no. 6, pp. 1586-1593, Nov. 2004.

(2) U. Borup, F. Blaabjerg, and P. N. Enjeti, "Sharing of nonlinear load in parallel-connected three-phase converters," IEEE Trans. Ind. Appl., vol. 37, no. 6, pp. 1817-1823, Nov./Dec. 2001.

(3) P. Jintakosonwit, H. Fujita, H. Akagi, and S. Ogasawara, "Implementation and performance of cooperative control of shunt active filters for harmonic damping throughout a power distribution system," IEEE Trans. Ind. Appl., vol. 39, no. 2, pp. 556-564, Mar./Apr. 2003.

(4) P. Rodríguez, J. Pou, J. Bergas, J. I. Candela, R. P. Burgos, and D.Boroyevich, "Decoupled double synchronous reference frame PLL for power converters control," IEEE Trans. Power Electron, vol. 22, no. 2, pp. 584-592, Mar. 2007.

(5) S. B. Kjaer, J. K. Pedersen, and F. Blaabjerg, "A review of single-phase grid-connected inverters for photovoltaic modules," IEEE Trans. Ind. Appl., vol. 41, no. 5, pp. 1292-1306, Sep./Oct. 2005

(6) F. Blaabjerg, R. Teodorescu, M. Liserre, and A. V. Timbus, "Overview of control and grid synchronization for distributed power generation systems," IEEE Trans. Ind. Electron., vol. 53, no. 5, pp. 1398-1409, Oct. 2006.

(7) J. M. Carrasco, L. G. Franquelo, J. T. Bialasiewicz, E. Galván, R. C. P. Guisado, M. Á. M. Prats, J. I. León, and N. M. Alfonso, "Power electronic systems for the grid integration of renewable energy sources: A survey," IEEE Trans. Ind. Electron., vol. 53, no. 4, pp. 1002- 1016, Aug. 2006.

(8) B. Renders, K. De Gusseme, W. R. Ryckaert, K. Stockman, L. Vandevelde, and M. H. J. Bollen, "Distributed generation for mitigating voltage dips in low-voltage distribution Grids," IEEE Trans. Power.Del., vol. 23, no. 3, pp. 1581-1588, Jul. 2008.

(9) V. Khadkikar, A. Chandra, A. O. Barry, and T. D. Nguyen, "Application of UPFC to protect a sensitive load on a polluted distribution network," in Proc. Annu. Conf. IEEE Power Eng. Soc. Gen. Meeting, 2006, pp. 867-872.

(10) M. Singh and A. Chandra, "Power maximization and voltage sag/swell ride-through capability of PMSG based variable speed wind energy conversion system," in Proc. IEEE 34th Annu. Conf. Indus. Electron. Soc., 2008, pp. 2206-2211.