

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.

1. INTRODUCTION

The power quality of the electrical grid is crucial to the reliable operation of power systems. Power quality issues such as voltage sags, swells, harmonics, and flicker can cause equipment malfunction, system instability, and even power outages. To address these issues, various power quality improvement techniques have been proposed, one of which is the Unified Power Quality Conditioner (UPQC).

The UPQC is a device that combines both shunt and series active power filters to mitigate voltage and current disturbances simultaneously. However, the conventional UPQC suffers from a few limitations, such as poor harmonic compensation and low power factor correction. To overcome these limitations, a modified UPQC (MUPQC) has been proposed.

The MUPQC uses a novel control strategy that improves harmonic compensation and power factor correction. The MUPQC consists of two voltage source inverters (VSIs), one connected in shunt and the other in series with the load. The shunt VSI injects current to compensate for load current harmonics and corrects the power factor, while the series VSI injects voltage to compensate for voltage harmonics and regulate the load voltage.

The MUPQC control strategy is based on a combination of a proportional-integral (PI) controller and a fuzzy logic controller (FLC). The PI controller is used to regulate the DC link voltage, while the FLC is used to control the active and reactive power flow between the shunt and series inverters. The FLC improves the dynamic response of the MUPQC and allows it to quickly compensate for power quality disturbances.

In conclusion, the MUPQC is an effective solution for improving power quality in the electrical grid. Its novel control strategy improves harmonic compensation and power factor correction, making it a viable option for mitigating voltage and current disturbances in power systems.

2. LITERATURE SURVEY

Johan H. R. Enslin and Peter J. M. Heskes “Harmonic interaction between a large number of distributed power inverters and the distribution network,” In this paper discussed the harmonic interaction between a large number of distributed power inverters and the distribution network. This paper is to analyze the observed phenomena of harmonic interference of large populations of these inverters and to compare the network interaction of different inverter topologies and control options.

UffeBorup, FredeBlaabjerg and Prasad N. Enjeti “Sharing of nonlinear load in parallel-connected three-phase converters,” Presented about the sharing of linear and nonlinear loads in three-phase power converters connected in parallel, without communication between the converters. The paper focuses on solving the problem that arises when two converters with harmonic compensation are connected in parallel. Pichai Jintakosonwit Hideaki Fujita, Hirofumi Akagi and Satoshi Ogasawara “Implementation and performance of cooperative control of shunt active filters for harmonic damping throughout a power distribution system,” This paper proposes cooperative control of multiple active filters based on voltage detection for harmonic damping throughout a power distribution system. The arrangement of a real distribution system would be changed according to system operation, and/or fault conditions. In addition, shunt capacitors and loads are individually connected to, or disconnected from, the distribution system.

Pedro Rodríguez, Josep Pou, Joan Bergas, J. Ignacio Candela, Rolando P. Burgos and Dushan Boroyevich “Decoupled double synchronous reference frame PLL for power converters control,” Presented the detection of the fundamental-frequency positive-sequence component of the utility voltage under unbalanced and distorted conditions. Specifically, it proposes a positive-sequence detector based on a new decoupled double synchronous reference frame phase-locked loop (PLL), which completely eliminates the detection errors of conventional synchronous reference frame PLL's. This is achieved by transforming both positive- and negative-sequence components of the utility voltage into the double SRF, from which a decoupling network is developed in order to cleanly extract and separate the positive- and negative-sequence components.

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 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.

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

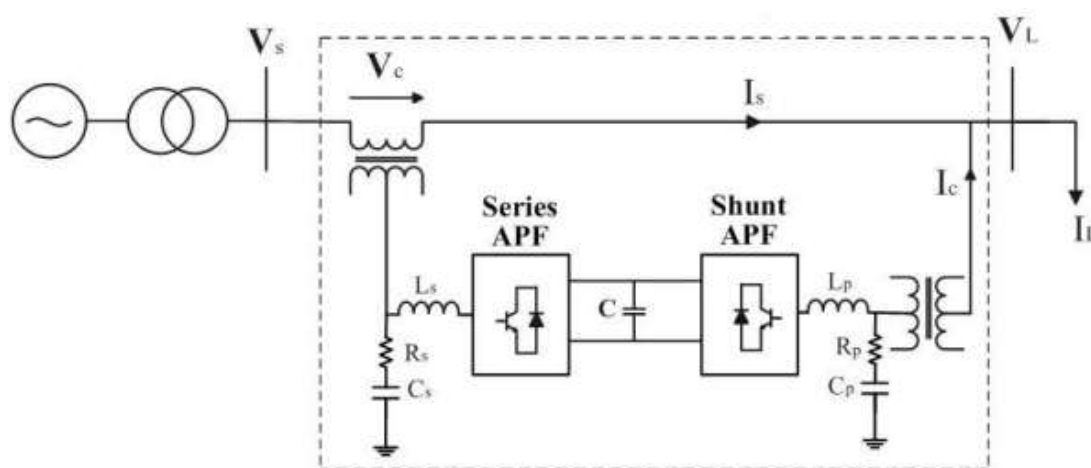


Fig.1: General Configuration of UPQC

3. 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 dynamic systems, including electrical circuits, shock absorbers, braking systems, and many other electrical, mechanical, and thermodynamic systems.

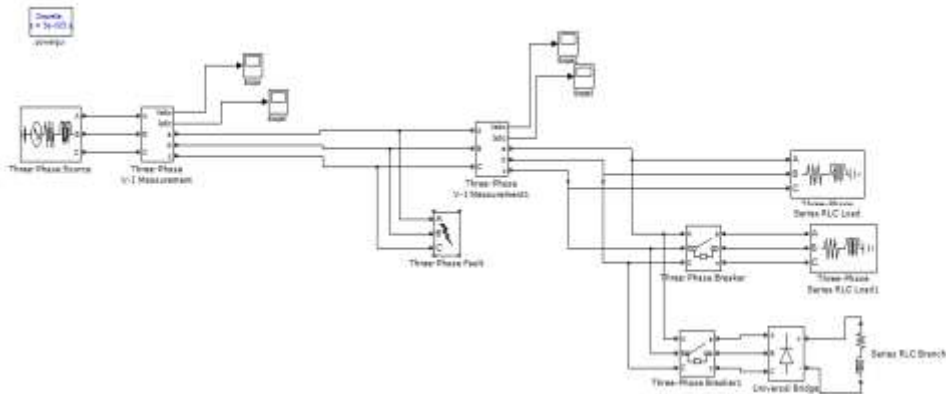
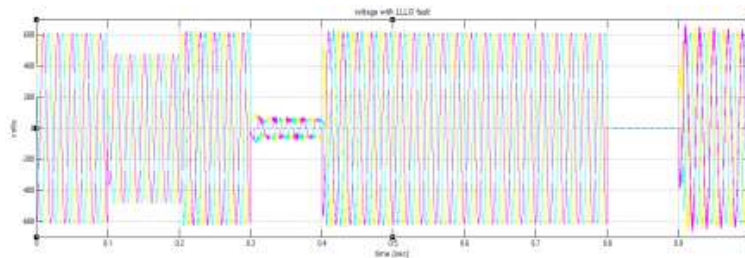
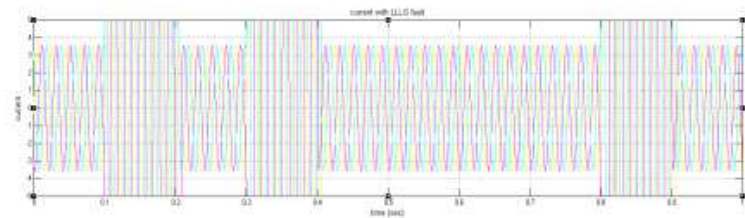


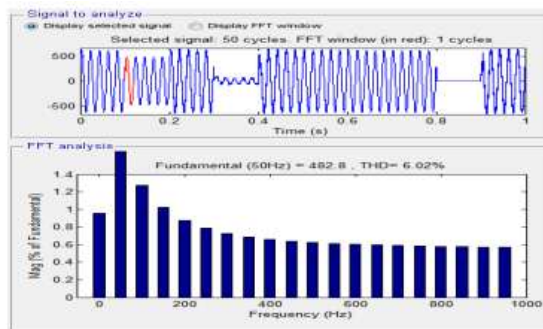
Fig.2: proposed circuit without upqc



Output voltage without UPQC



Output current waveform



THD with PI controller

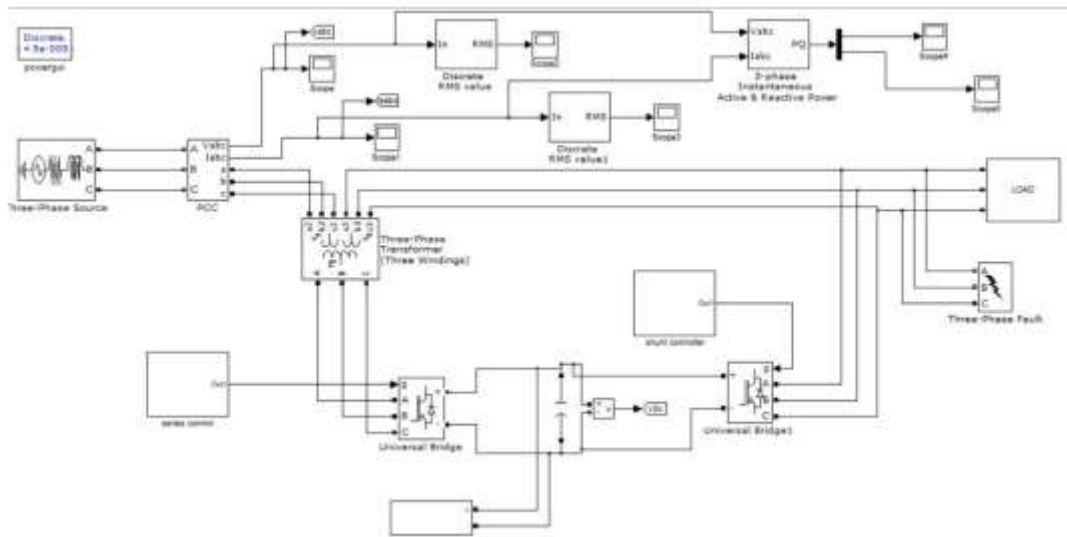


Fig.3: Simulation circuit with PV-UPQC

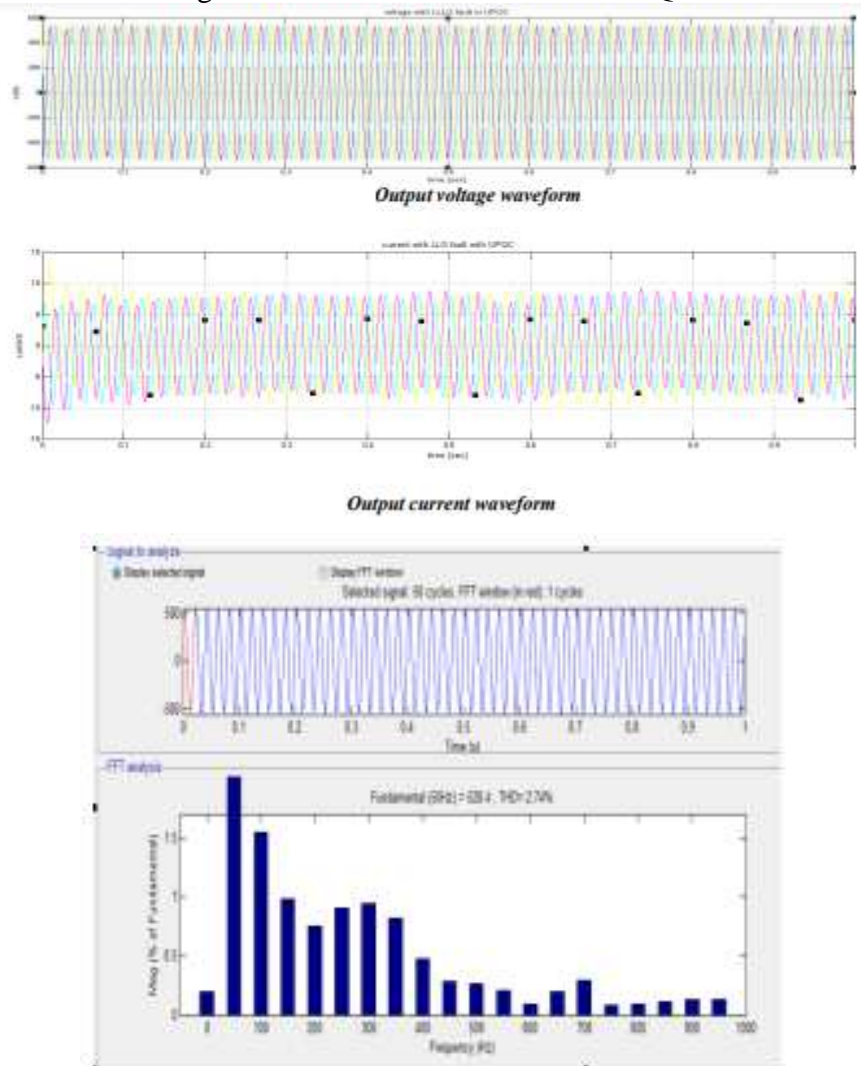


Fig.4: THD with UPQC

4. 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 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 condition with THD of 6.02%. When we applied UPQC with PI controller the vooutput voltage is balanced and still some distortions observed in current waveforms under fault conditions the THD iss 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.

5. REFERENCES

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