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Improvement of Power Quality Smart Households Using a Multilevel transformerless Hybrid series active filter with PR Controller

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ABSTRACT

In this paper a multilevel transformer less hybrid series active filter is proposed to enhance the power quality of a single-phase residential household. The proposed topology reflects new trends of consumers toward electronic polluting loads and integration of renewable sources which in fact may lead to the scope of a reliable and sustainable supply. This project contributes to improvement of power quality for a modern single-phase system and emphasis integration of a compensator with energy storage capacity to ensure a sustainable supply.

A proportional resonant (P+R) regulator is implemented in the controller to prevent current harmonic distortions of various non-linear loads to flow into the utility. The main significant features of the proposed topology include the great capability to correct the power factor as well as cleaning the grid simultaneously, while protecting consumers from voltage disturbances, sags, and swells during a grid perturbation. It investigates aspects of harmonic compensation and assesses the influence of the controller's choice and time delay during a real-time implementation. Results should be obtained in MATLAB/SIMULINK environment.

KEY WORDS: Power Quality, Multilevel Inverter, Active Power Filter, PR Controller and Smart appliances.

1.INTRODUCTION:

Basically, the microgrid system is a combination of loads and different micro sources operating as a single system providing power. The structure of a microgrid system consists of different parts such as interface control, control and protection devices for each micro sources as well as microgrid voltage control, power flow controlling devices, load sharing during islanding conditions, protection and stability [1]. The ability of the Microgrid to operate when connected to the grid, smooth transition to and from the island mode is another important function.

The main consideration for interconnection of microgrid to the distribution system is the impact of power quality problems on the overall power systems. Generally, these power quality problems are classified as voltage and frequency deviations in grid voltage and harmonic contents in load current. In order to overcome this type of power quality problems this paper proposes a concept of flexible ac distribution system for microgrid. This widespread harmonic polluting device not only reduce the system's efficiency, but also has detrimental impacts on grid voltage distortion levels. Likewise, distorted current waveform creates additional heating losses, and causes failure in sensitive electrical devices. Several references could be found in the literature addressing specified or common cases dealt with power quality issues either related to voltage distortions or current harmonics. This paper addresses the new research challenges that are facing the power electronics converters to participate actively in mitigating electric types of pollution and consequently enhance the grid so as to supply clean and reliable energy to the fastgrowing energy demand by highly nonlinear and time varying loads.

DISCRIPTION OF PROPOSED SYSTEM:

In an electrical power system, the microgrid is commonly a group of electrical loads and power generations from different generating sources like solar, wind etc. these microgrid plays an important role to enhance the reliability, increasing efficiency and voltage sag correction. The complete structure of the proposed FACTS device and microgrid structure is shown in Figure 1 [3].

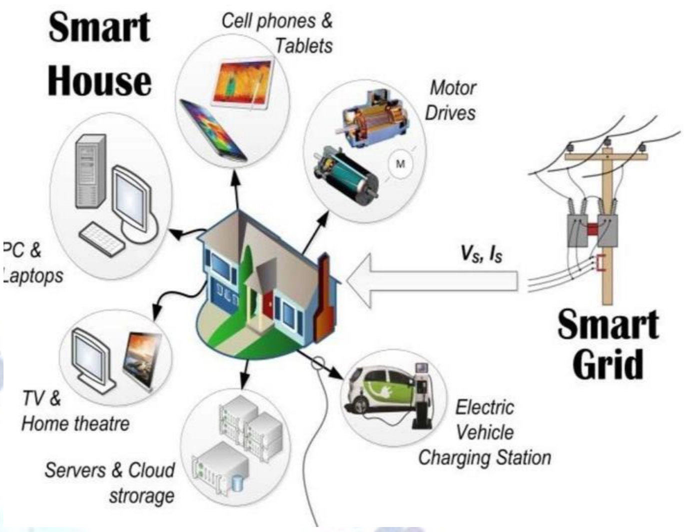

Figure 1 Configuration of Proposed CPD device based Microgrid system

From this figure 1, the structure of microgrid consists of three feeder terminals. And the flexible ac transmission system is used for power quality compensation. And the device is also used for compensating harmonic content in both gird voltage and load currents [4].

Series Active Power Filter (Series APF)

The series APF's goal is to change the grid's impedance at a local level. It is a harmonic voltage source that cancels grid voltage perturbations or those caused by harmonic current circulation into the grid impedance. The harmonic currents created by the loads, however, cannot be compensated by series APFs.

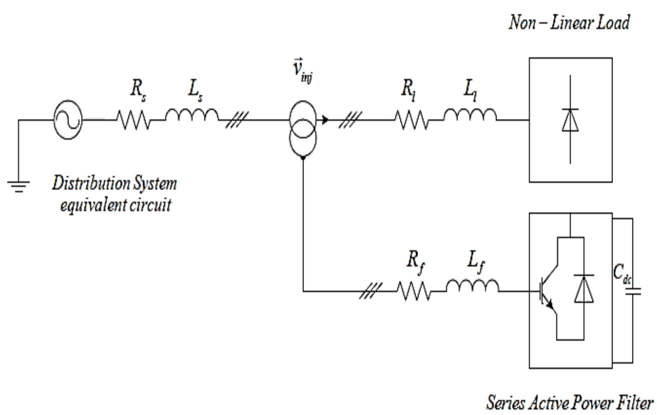

Figure 2: Grid connected series active power filter

Multilevel Transformerless Hybrid Series Active Filter:

The THSeAF shown in Figure 3 is composed of an H-bridge converter connected in series between the source and the load. A shunt passive capacitor ensures a low impedance path for current harmonics. A dc auxiliary source could be connected to inject power during voltage sags. The dc-link energy storage system is described in.

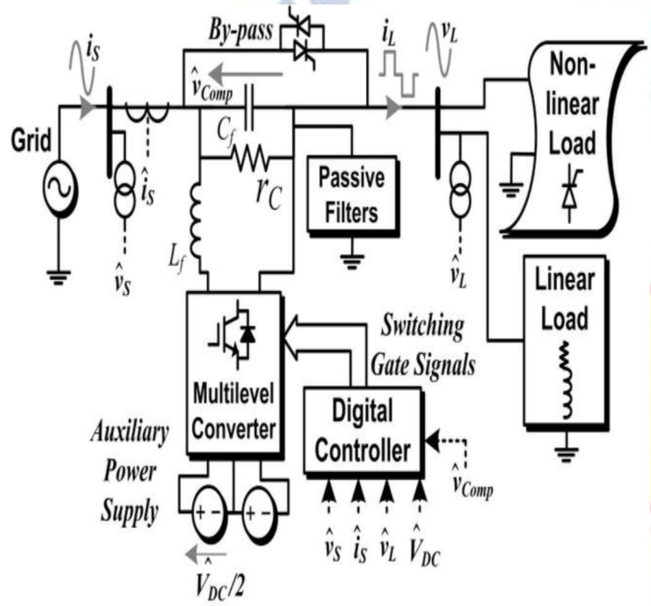

Figure 3: Schematic of a single-phase smart load with the compensator installation

APF closed loop controller

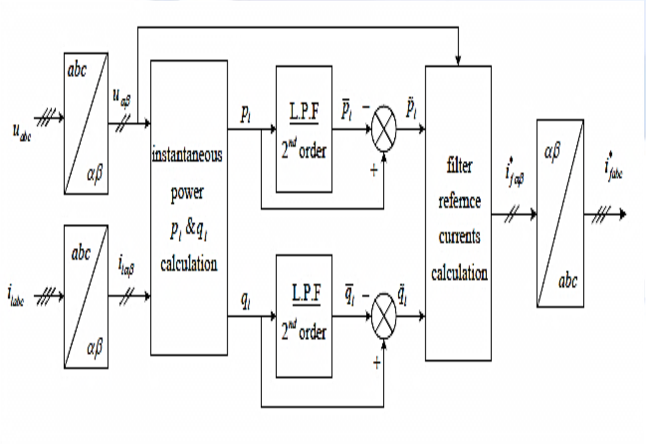

Figure 4: Block diagram for series APF

Researchers are constantly working to improve the SAPF's control methods in order to achieve better results, whether it's through better perturbation extraction methods, improved dynamic regimes, lower THD values, the development of new control methods to improve the APF's performance with various non-linear loads. There are primarily two approaches for compensating harmonic currents that are proportional to the measured current.

SIMULATION DESIGN AND RESULTS:

The compensator depicted in Figure 5 is composed of a multilevel single-phase converter connected in series between the utility and the house's entrance connected terminals. The transformerless hybrid series active filter is composed of a five-level NPC converter depicted, connected in series between the utility and the entrance of the building. An auxiliary supply is connected on the dc side. To filter high frequency switching harmonics, a passive filter is used at the output of the converter. A bank of tuned passive filters ensures a low impedance path for current harmonics. In this paper the studied system is implemented for a rated power of 1 kVA.

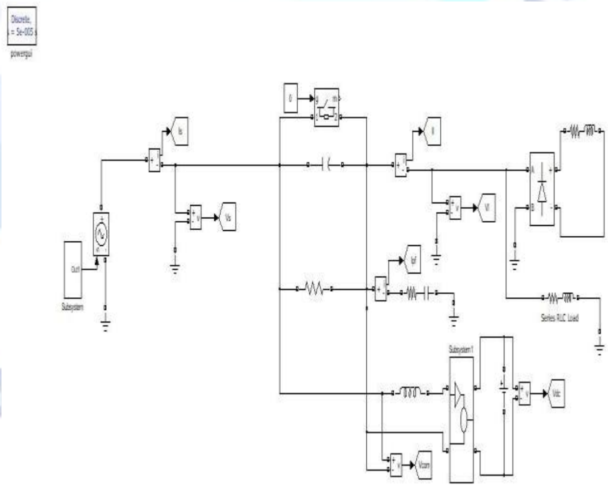

Figure 5: Simulation Circuit for Proposed system with controller

Compensator regulates the load voltage magnitude by injecting active power while compensating current and harmonics and correcting the PF Experimented results illustrate high fidelity towards simulations. During a grid's voltage sags, the compensator regulates the load voltage magnitude, compensates current harmonics and corrects the power factor as shown in Figure 6.

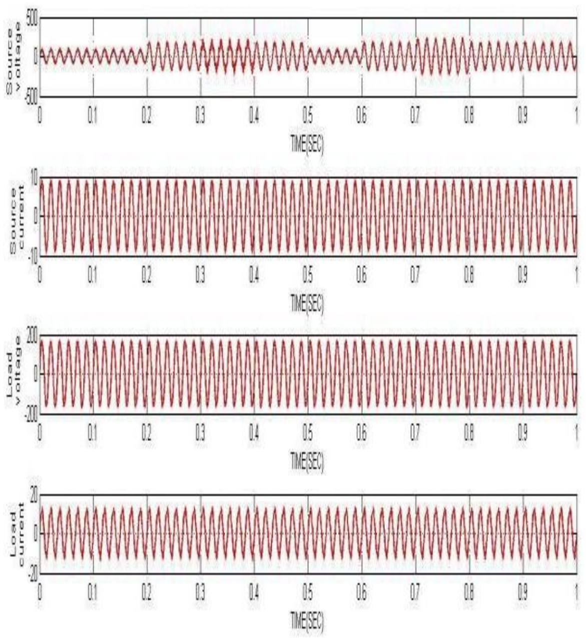

Figure 6: System response during grid sags and swells. (a) Source Voltage, (b) Source Current (c) Load Voltage

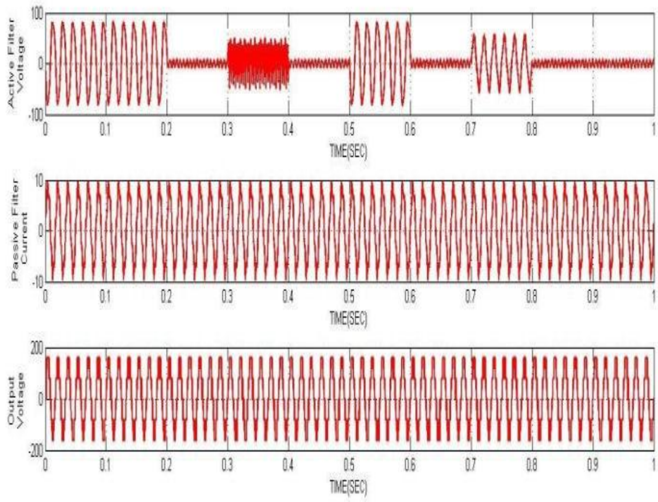

Figure 7: (a) Active Filter Voltage, (b) Harmonic Current, (c) Converter output voltage

The above Wave forms shown by X-axis from 0.5 to 0.85 as given bellow:

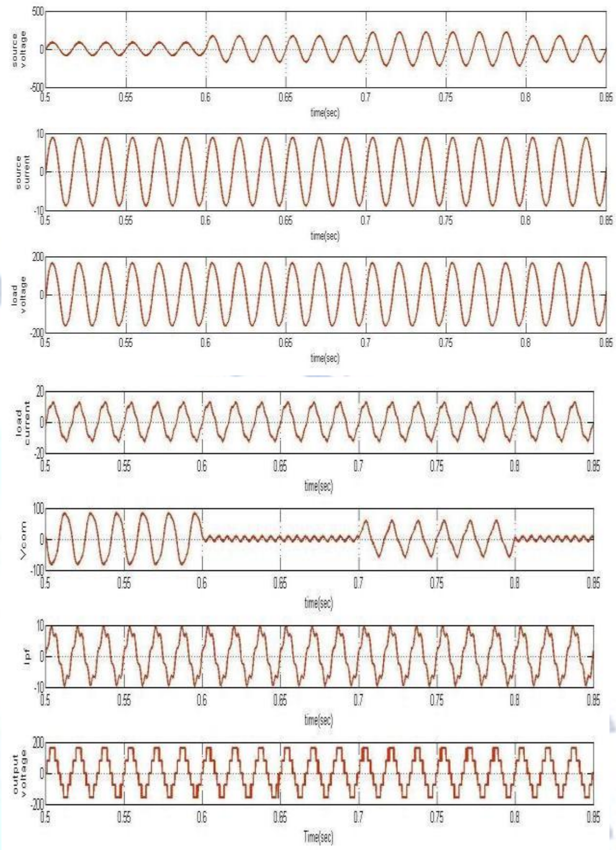

Figure 8: Source voltage vS, source current iS load voltage vL active-filter voltage VComp, Harmonics current of the passive filter iPF, Converter's output voltage VOut

1. CONCLUSION

In this paper, a Transformerless HSeAF for power quality improvement was developed and tested. The project highlighted the fact that, with the ever increase of nonlinear loads and higher exigency of the consumer for a reliable supply, concrete actions should be taken into consideration for future smart grids in order to smoothly integrate electric car battery chargers to the grid. The key novelty of the proposed solution is that the proposed configuration could improve the power quality of the system in a more general way by compensating a wide range of harmonics current, even though it can be seen that the THSeAF regulates and improves the PCC voltage. Connected to a renewable auxiliary source, the topology is able to counteract actively to the power flow in the system. This essential capability is required to ensure a consistent supply for critical loads. Behaving as high-harmonic impedance, it cleans the power system and ensures a unity PF. The theoretical modeling of the proposed configuration was investigated. The proposed transformerless configuration was simulated and experimentally validated. It was demonstrated that this active compensator responds properly to source voltage variations by providing a constant and distortion free supply at load terminals. Furthermore, it eliminates source harmonic currents and improves the power quality of the grid without the usual bulky and costly series transformer.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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