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IMPROVEMENT OF POWER QUALITY IN RESIDENTIAL HOME USING FLC BASED MULTILEVEL INVERTER

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ABSTRACT:

To improve the power quality of a single-phase residential home, a multilayer transformer less hybrid series active filter is presented in this project. The suggested topology replicates current consumer tendencies toward electronic polluting loads and renewable energy integration, which might lead to a more dependable and sustainable supply. this project contributes to the enhancement of energy quality in the current singlephase system, with a focus on compensating compensation and energy conservation to ensure long-term supply.
The controller uses a proportionate resonant (P+R) regulator to avoid current harmonic distortions from diverse non-linear loads from flowing into the utility. the important advantages of the proposed network topology includes its ability to concurrently fix the power factor and clean the grid while protective customers from power conflicts, sags and swells during a grid perturbation, it looks at the subject of harmonic compensation. it looks at harmonic compensation and evaluates the effect of control selection and time delays on real-time usage. The following results will be verified in MATLAB/SIMULINK environment.

Index Terms—*Hybrid active filters, power quality, renewable energy sources, multilevel converters, smart grids, real-time control, resonant controller, nonlinear loads.*

I.INTRODUCTION

Future trends toward the usage of smart grids, as well as the ever-increasing number of indirect industrial, commercial, and residential buildings polluting the environment, which has resulted in 100 percent of the total current harmonic pollution in grids, have raised serious concerns about future energy metrics energy efficiency. The growth of electrical equipment, as shown in Fig.1, which is linked to rapid charging with devices with external power sources requires prior research on the correction of compatible and inefficient power. The prevalent harmonic pollution device not only affects system efficiency but also increases grid disruption levels. Similarly, a warped current waveform causes extra heat losses and causes sensitive electrical components to fail. There are a few indications in the literature that address particular or frequent scenarios relating to energy quality problems caused by electrical distortions or current harmonics. This research includes new research difficulties confronting power converters in order to actively engage in lowering pollutant kinds and, as a result, establishing a grid to offer clean and dependable electricity for the fast expanding nonlinear energy and duration loads.

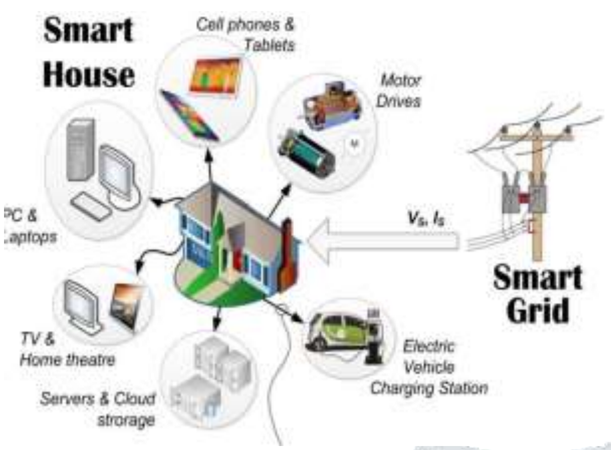

Fig 1.1Typical modern residential consumer with non-linear electronic loads

similarly to a Dynamic voltage restorer (DVR) the point of common coupling (PCC) and utility smart meters will be protected from voltage distortions so as to avoid wrong computation of power and energy balance. This compensator could inject or absorb active power during grid voltage variations to ensure high quality supply along with complete decoupling from polluted loads. The increase of charging stations in a residential neighborhood and commercial buildings becomes crucial to monitor and evaluates their power quality characteristics. In addition, pushed by social efforts, distributed generation and renewable energy sources are been popularized requiring more research and investigation on their wide application on the power quality of the system. This work proposes an efficient Transformerless Hybrid Series Active Filter (THSeAF) capable of rectifying current related issues in such micro grid application and provides sustainable and reliable voltage supply at the PCC where important residential consumers are connected. The main goal of this paper is an efficient Transformer less Hybrid Series Active Filter (THSeAF), capable rectifying current related issues in such micro- grid application and provides sustainable and reliable voltage supply at the PCC where important residential consumers are connected.

II.SYSTEM CONFIGURATION

The THSeAF shown in Fig. 2.1is 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.

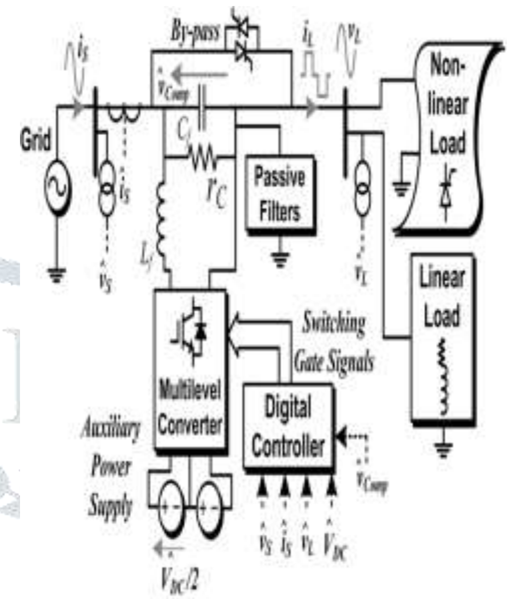

Fig 2.1. (a) Schematic of a single-phase smart load with the compensator installation.(b) Electrical diagram of the THSeAF in a single-phase utility.

The system is implemented for a rated power of 2200 VA. To ensure a fast transient response with sufficient stability margins over a wide range of operation, the controller is implemented on a dSPACE/dsp1103. The system parameters are identified in Table I. A variable source of120 Vrms is connected to a 1.1-kVA nonlinear load and a998-VA linear load with a 0.46 PF. The THSeAF is connected in series in order to inject the compensating voltage. On the dc side of the compensator, an auxiliary dc-link energy storage system is installed. Similar parameters are also applied for practical implementation.

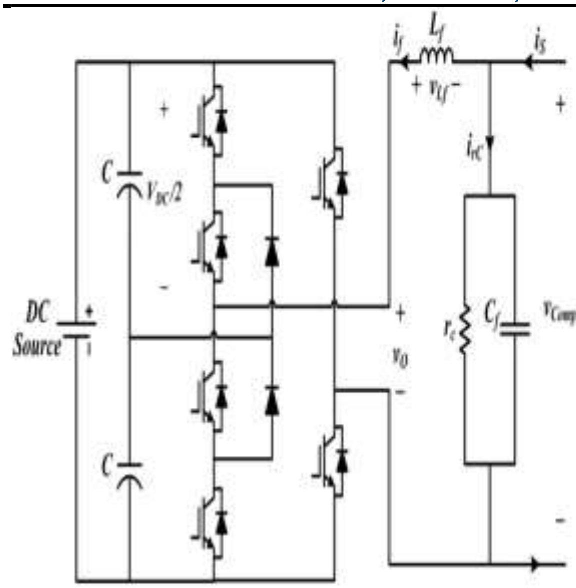

Fig.2.2 Hybrid converter topology for the proposed series compensator.

III. Operation Principle

The SeAF represents a controlled voltage source (VSI). In order to prevent current harmonics i_{Lh} to drift into the source.

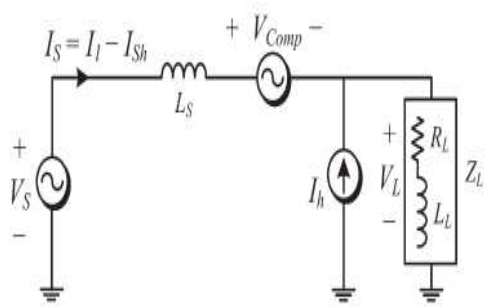

Fig. 3. THSeAF equivalent circuit for current harmonics.

This series source should present low impedance for the fundamental component and high impedance for all harmonics as shown in Fig. 3. The principle of such modeling is well documented in [20].The use of a well-tuned passive filter is then mandatory to perform the compensation of current issues and maintaining a constant voltage free of distortions at the load terminals. The behavior of the SeAF for a current control approach is evaluated from the phasor's equivalent circuit shown in Fig. 3.1 The nonlinear load could be modeled by a resistance representing the active power consumed and a current source generating current harmonics. Accordingly,the impedanceZ_L representsthe nonlinear load and the inductive load. TheSeAF operates as an ideal controlled voltage source (V_{comp})having a gain(G)proportional to the current harmonics (I_{sh})flowing to the grid (V_s)= G.I_{sh}-V_{Lh}. (1)This allows having individual equivalent circuit for the fundamental and harmonics

$$V_{source} = V_{s1} + V_{sh},\ V_L = V_{L1} + V_{Lh}. \quad (2)$$

The source harmonic current could be evaluated

$$V_{sh} = -Z_s.I_{sh} + V_{comp} + V_{Lh}$$

$$V_{Lh} = Z_L(I_h - I_{sh}). \ .....(4)$$

Combining (3) and (4) leads to (5)

$$I_{sh} = \frac{V_{sh}}{(G - Z_s)} \quad (5)$$

If gain G is sufficiently large (G→∞), the source current will become clean of any harmonics(Ish→0). This will help improve the voltage distortion at the grid side. In this approach, the THSeAF behaves as high-impedance open circuit for current harmonics, while the shunt high-pass filter tuned at the system frequency creates a low-impedance path for all harmonics and open circuit for the fundamental; it also helps for PF correction.

IV.PROPOSED H-BRIDGE CONVERTER

The THSeAF shown in Fig. 4 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 [19].

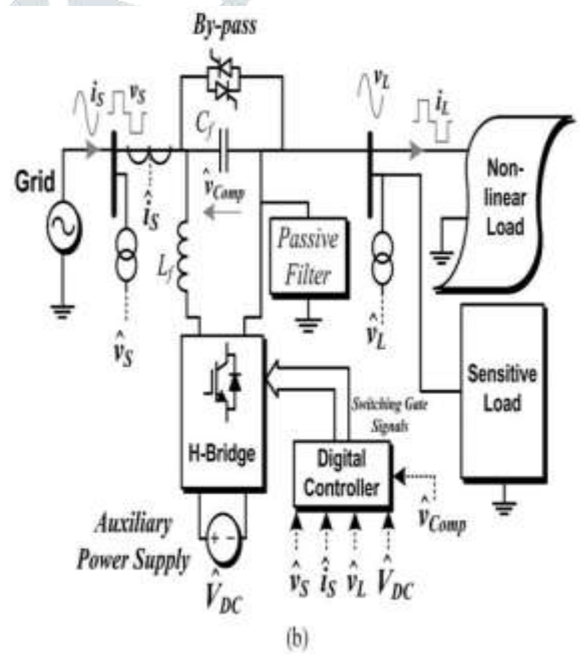

Fig4:Electrical diagram of the THSeAF in a single-phase utility

V. Simulation Block Diagrams:

The compensator depicted in Fig.5.1 is composed of a multilevel single-phase converter connected in series between the utility and the house's entrance connected terminals. The transformer less 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. To ensure a fast transient response with sufficient stability margins over a wide range of dynamic operations, the controller is implemented on an Opal-RT/Wanda real-time simulator. For an accurate real-time measurement of electrical variables, the Opal-RT OP8665 probes are performing the measurement task.

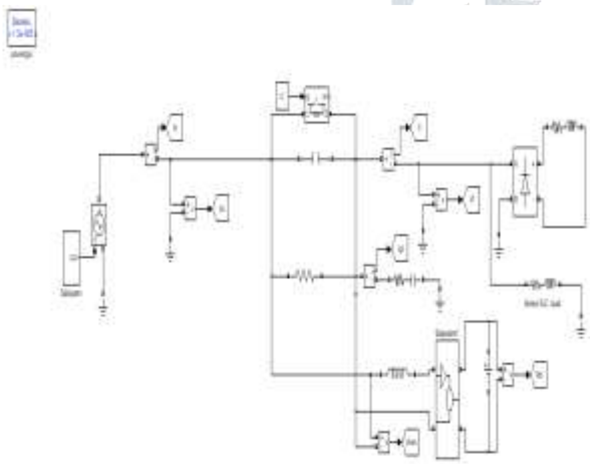

Fig 5.1 Simulation diagram of Multilevel THSeAF

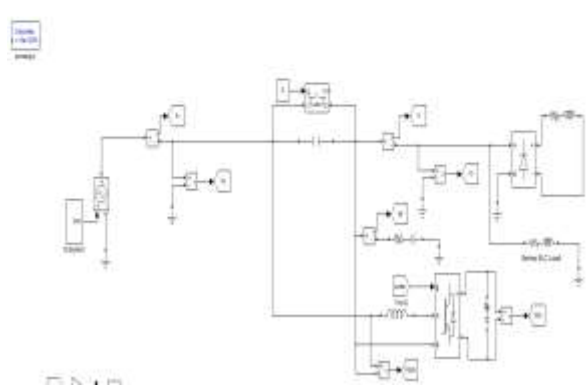

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Fig 5.2 Simulation diagram of H-bridge Converter THSeAF

VI. RESULTS

Compensator regulates the load voltage magnitude by injecting active power while compensating current and harmonics and correcting the PFExperimented 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 Fig6.1

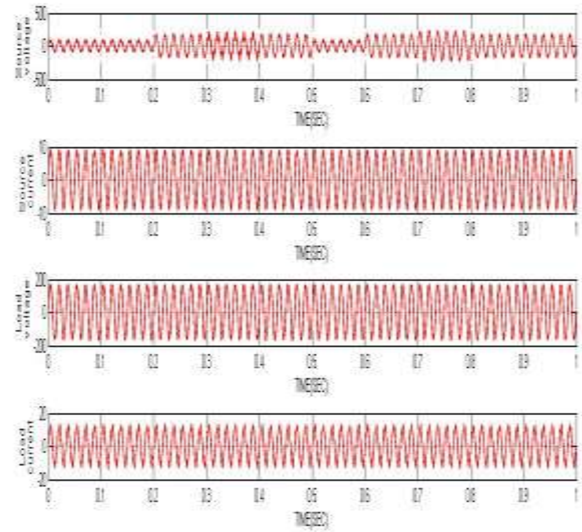

Fig 6.1 System response during grid sags and swells. (a) Source voltage vS, (b) source current iS, (c) load voltage vL

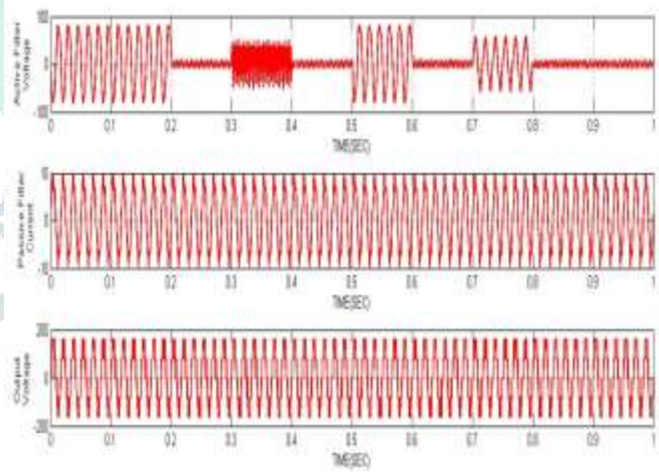

Fig 6.2(e) active-filter voltage VComp, (f) Harmonics current of the passive filter iPF, (g) Converter's output voltage VOut.

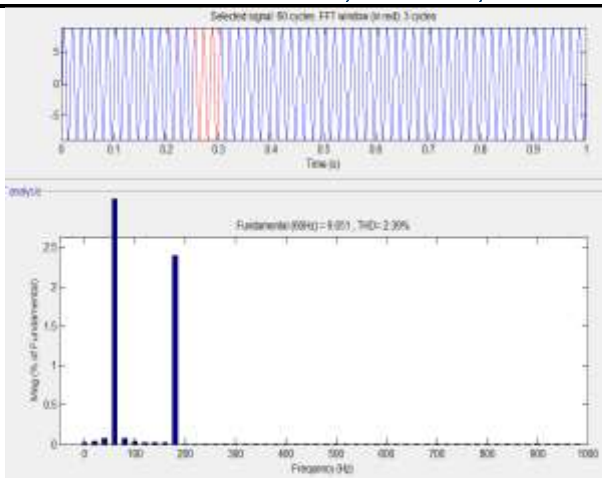

Fig6.3:THD graph for Multilevel THSeAF

CONCLUSION

In this project, a Transformer less 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 grid. 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 modelling of the proposed configuration was investigated. The proposed transformerless configuration was simulated.. 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. For the sake of simplicity, the resistance r_c of the switching capacitor filter C_f is neglected, and the inductance L_f has an ideal behavior. Simulation of without THSeAF system, with H-bridge THSeAF system and with multilevel THSeAF system is developed in this project. Total harmonic distortion is reduced in multilevel THSeAF system when compared to H-bridge topology. Results of various systems are to be verified in MATLAB/SIMULINK environment.

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