SIMULINK DESIGN OF SAPF FOR HARMONIC CURRENT AND REACTIVE POWER COMPENSATION

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ABSTRACT

In the recent decades, the world has seen an expansion in the use of non-linear loads. These loads draw harmonic non-sinusoidal currents and voltages in the connection point with the utility and distribute them through it. The propagation of these currents and voltages into the grid affect the power systems in addition to the other clients' equipment. As a result, the power quality has become an important issue for both consumers and distributers of electrical power. Active power filters have been proposed as efficient tools for power quality improvement and reactive power compensation. In this work, harmonic problem is introduced and discussed. The different traditional and modern harmonic solutions topologies are presented. Shunt active power filter as the most famous and used active filter type is introduced. The use of SAPF for harmonic current and reactive power compensation is studied. Different control methods of APF in addition to different harmonic extraction methods are presented and discussed. Self-Tuning Filter for the improvement of the SAPF's efficiency in the case of distorted and unbalance voltage system is presented and discussed. Different studied SAPF control strategies are implemented in MATLAB\Similink and results are discussed.

Kewwords -- Active Power Filters, Non-Linear Loads, MATLAB

I.INTRODUCTION

The increasing use in the industry of nonlinear loads based on the power electronic elements introduced serious perturbation problems in the electric power distribution grids. Also, regular increase in the harmonic emissions and current unbalance in addition to high consumption of reactive power can be noticed. The flow of harmonic currents in the electric grids can cause also voltage harmonics and disturbance. These harmonic currents can interact adversely with a wide range of power system equipment, control systems, protection circuits, and other harmonic sensible loads. The energy distributers as like as consumers were then concerned by imposing some regulations protecting against the expansion of harmonic problem. Many regulations concerning the harmonic emissions have been proposed by the international electrical committees like IEC-61000 and by the recommendations IEEE Std. 519-92 [1, 2].

During the last three decades, researchers were encouraged by the development of power electronics industry, the revolution in digital signal processing production and the increasing demand for efficient solutions of power quality problems including harmonics problem. They were encouraged to develop modern, flexible, and more efficient solutions for power quality problems. These modern solutions have been given the name of active compensators or active power filters. The objective of these active power filter abbreviated mostly APF is to compensate harmonic currents and voltages in addition to selective reactive power compensation. The use of APFs for harmonic and reactive power compensation and DC power generation was proposed in [4]. The main advantages of the APFs are their flexibility to fit load parameters' variations and harmonic frequencies in addition to high compensation performance.

Many types of APF have been proposed and used in harmonic compensation. Series APF is used for voltage harmonics compensation. Shunt APF was proposed for current harmonics and reactive power compensation. The Unified Power Quality Filter or Conditioner combines the two types Shunt and Series APF in one device responsible for the simultaneous compensation of voltage, current harmonics and reactive power. Different combinations of APFs with passive filters have been also used and proposed in the literary in the so-called Hybrid APFs (HAPFs). The combination between the traditional and the modern in one HAPF has the aim of amelioration of different types of APF compensation performance, also the minimization of cost and complexity of compensation systems. It is considered to combine the advantages of old passive filter and the new APFs and reject the drawbacks related to each of them when used individually.

II. SIMULATION AND RESULTS

The use of a shunt active harmonic filter (AHF) to minimize the harmonic content propagated to the source from a non-linear load is shown below using matlab Simulink.
After going through the results we find that the shunt active power filters are very helpful in reducing the harmonic voltages and currents in the system.
The shunt APF has been used for compensating the source current harmonics and it reduces the source current THD from 21.83 % to 0.42 % for RL load and from 25.43 % to 2.03 % for DC machine load which shows that the quality of source current improves sharply.

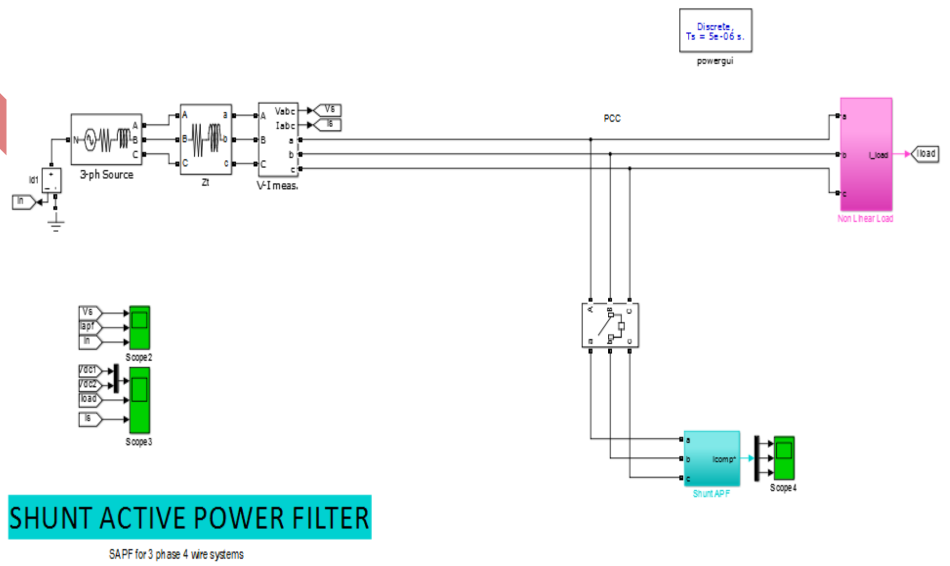

Figure.1Network without Shunt Active Filter

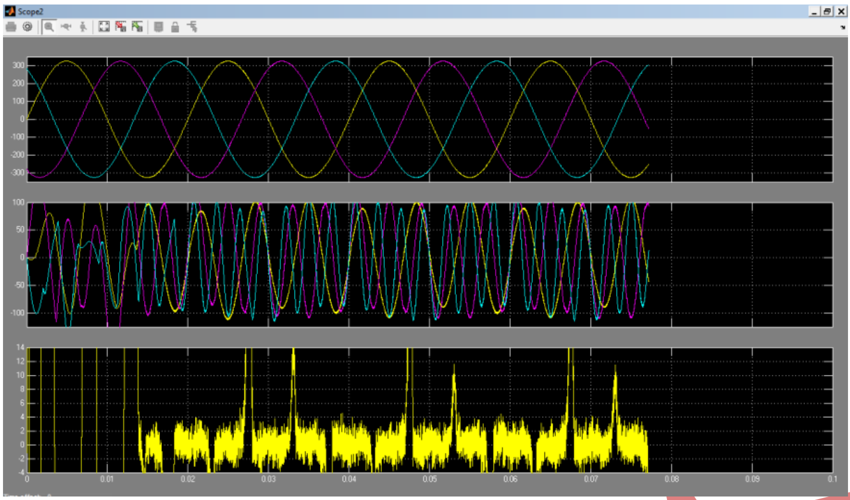

Figure.2Source voltage and neutral load current before compensation

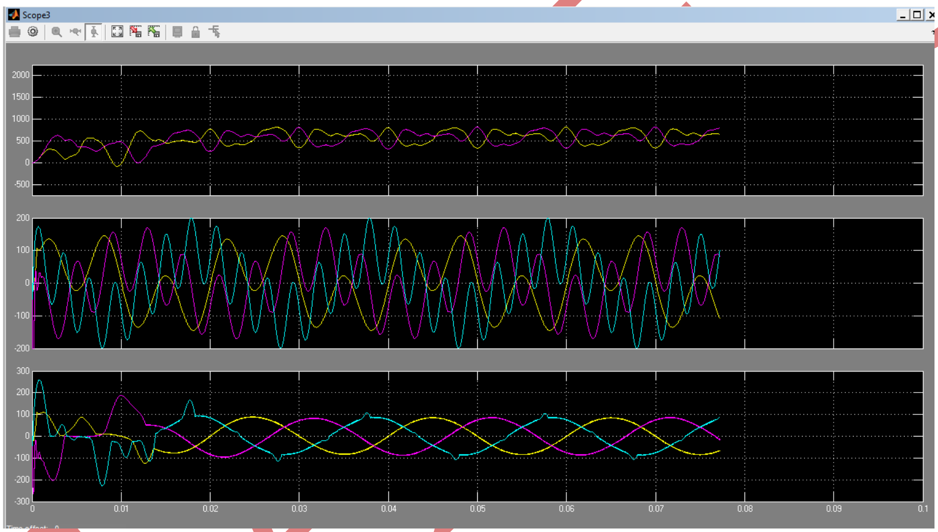

Figure.3Uncompensated V_{dc1}, V_{dc2}, load current and source current

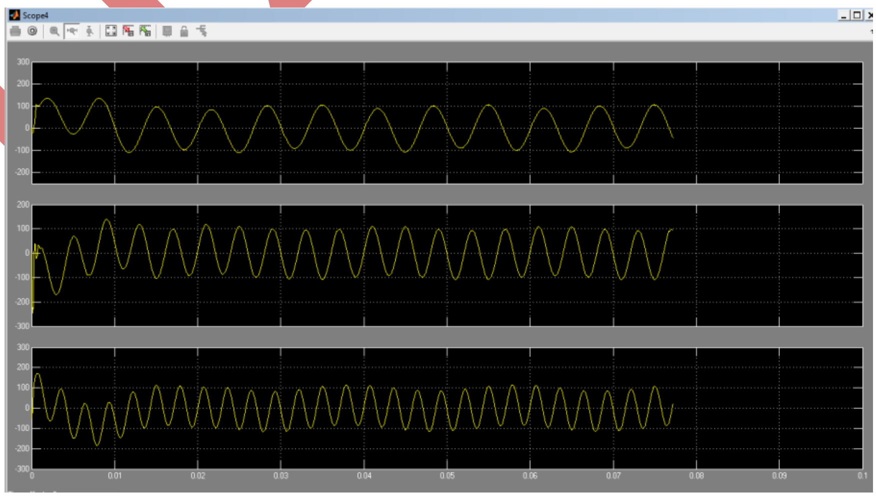

Figure.4I_{comp} at the o/p of shunt active filter still not applied to the network

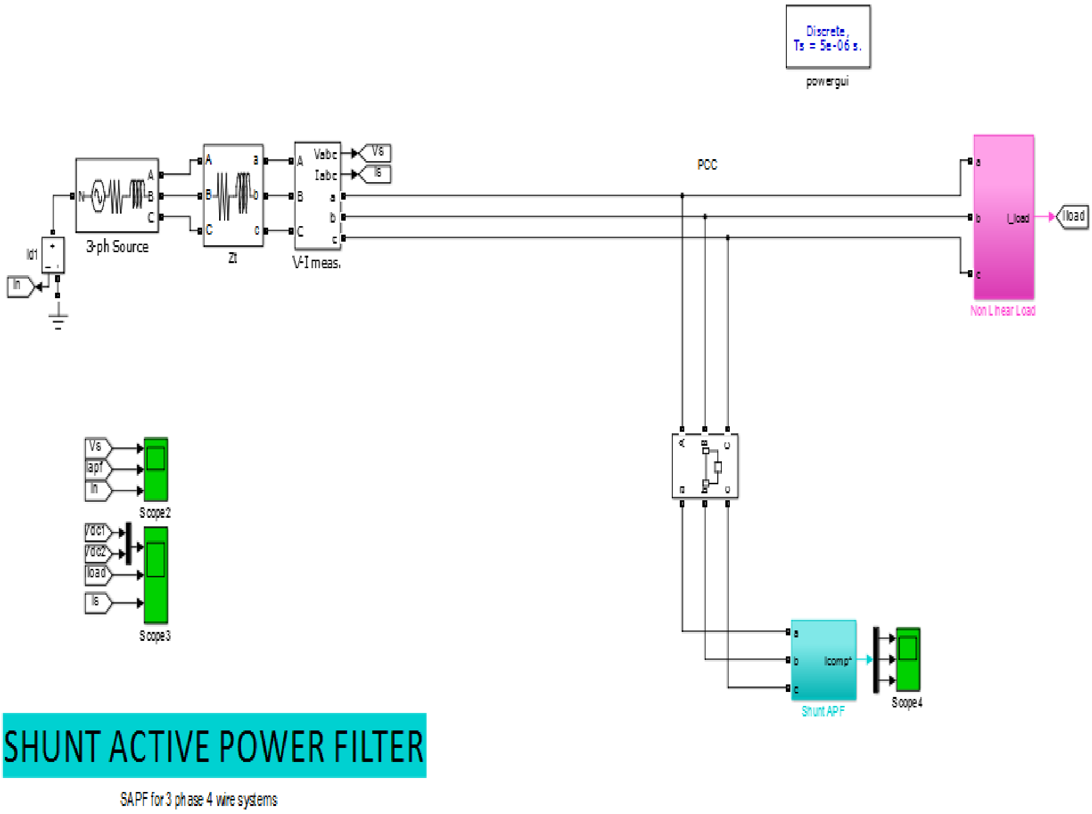

Figure.5Network with shunt active filter enabled

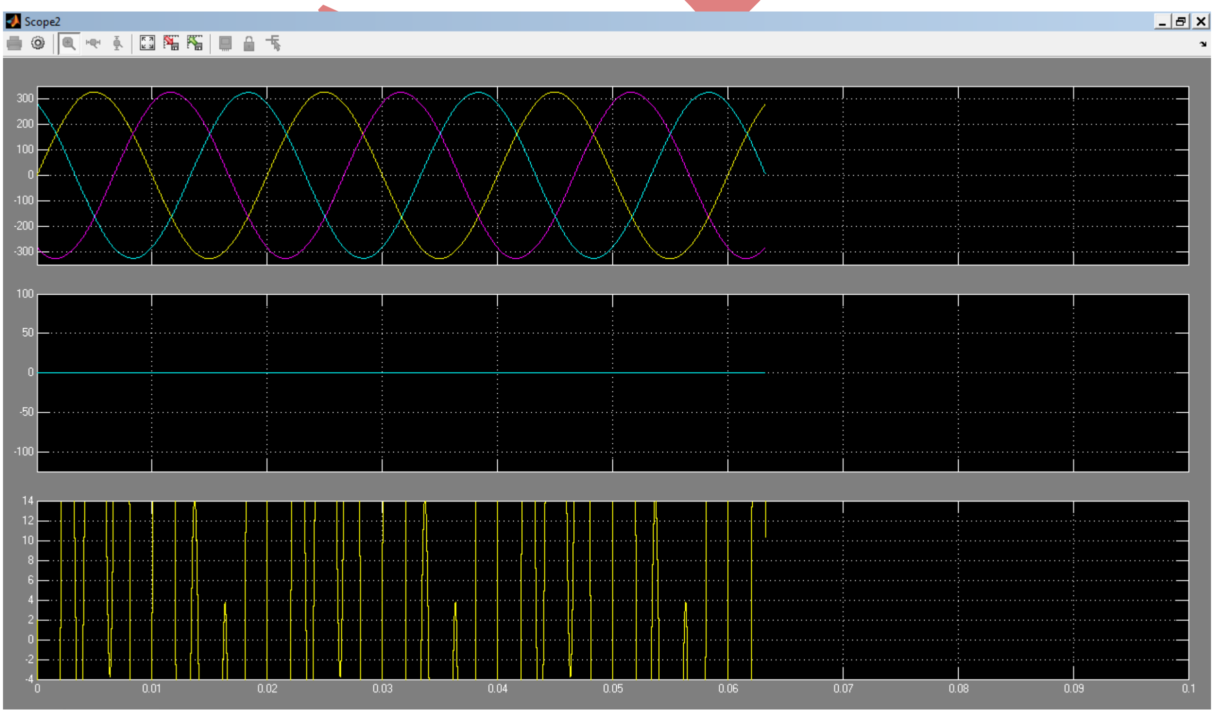

Figure.6Source voltage and neutral load current after compensation

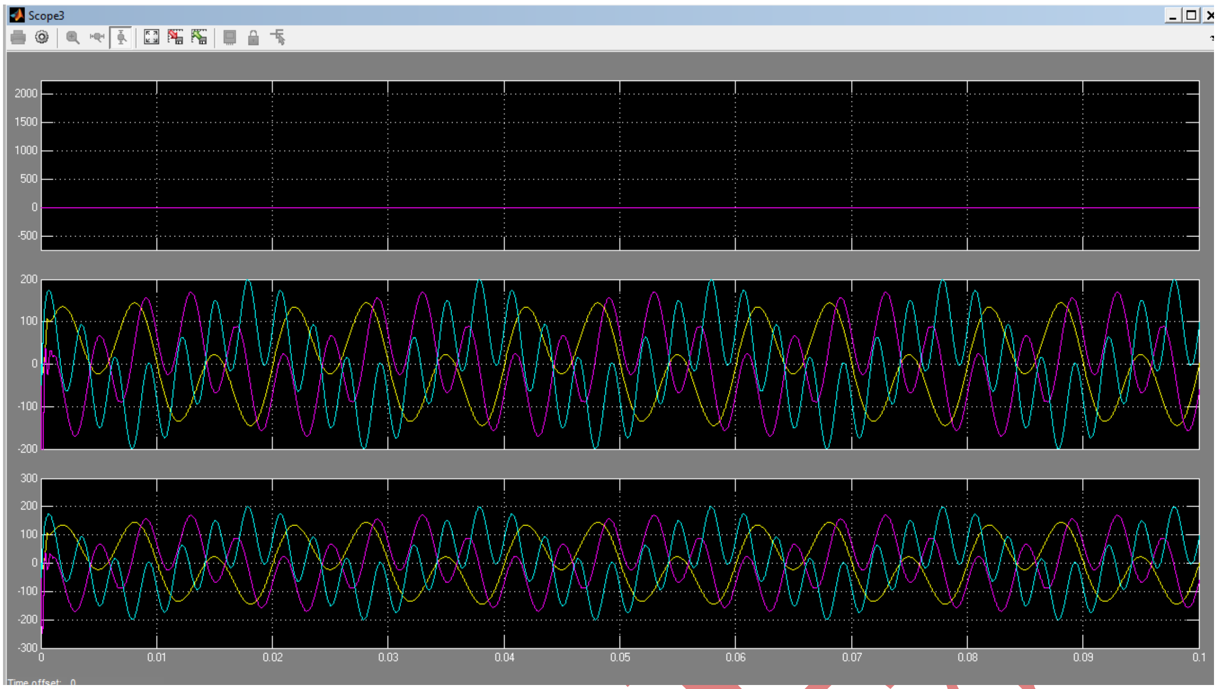

Figure.7Compensated V_{dc1}, V_{dc2}

III. CONCLUSION

The simulation results show that shunt APF, series APF can be used for effectively improving the power quality of an electrical power system. The shunt APF has been used for compensating the source current harmonics and it reduces the source current THD from 21.83 % to 0.42 % for RL load and from 25.43 % to 2.03 % for DC machine load which shows that the quality of source current improves sharply.

IV. FUTURE SCOPE

In high power applications, the filtering task cannot be performed for the whole spectrum of harmonics by using a single converter due to the limitations on switching frequency and power rating of the semiconductor devices. Therefore, compensating the reactive harmonic components to improve the power quality of the DG integrated system as well as to avoid the large capacity centralized APF, parallel operation of multiple low power APF units are increasing. Like APF, UPQC can also be placed at the PCC or at a high voltage distribution line as a part of DG integrated network or in micro grid system to work both in interconnected or islanded mode. At this place, capacity enhancement is achieved by using Multi-level topologies to reach the higher power levels. These option s are as follows:

i. Multi-level converter based UPQC
ii. Multi-module converter based UPQC
iii. Multi-module (power cell) unit based UPQC

REFERENCES

[1] IEEE-519, IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems, 1992.

[2] IEC 61000-3-4, Limitations of Emissions of Harmonic Currents Low-voltage Power Supply Systems for Equipment with Rated Current Greater than 16A, 1998.

[3] A. Sahbani, M. Labben-Ben Braiek, M. A.Dami et M. Jemli, „„Commande d'un Filtre Actif Triphasé Shunt par la Logique Floue"", 3rd International Conference, SETIT, Tunisia, March 27-31, 2005.

[4] M. AlaaEddin Alali, „„Contribution à l'Etude des Compensateurs Actifs des Réseaux Electriques Basse Tension"", Thèse Doctorat de l'Université Louis Pasteur, Strasbourg I, 2002.

[5] Hanane Kouara, „„Application d'un Filtre Série au Contrôle de la Tension d'un Réseau Basse Tension"", Mémoire de Magister, Univ. Batna, Février 2006.

[6] M. Fatiha, „„Etude et Commande d'un Filtre Actif Parallèle à Structure de Tension"", Mémoire de Magister, Univ. Oran, Octobre 2001.

[7] N. Hanna Mandalek, „„Qualité de L'onde Electrique et Moyens de Mitigation"", Thèse de Doctorat, Ecole de Technologie Supérieure Univ. Québec, 2003.

[8] C. Sharmeela, M. R. Mohan, G. Uma, J. Baskaran et A.C. College, „„Fuzzy Logic Controller Based Three-Phase Shunt Active Filter for Line Harmonics Reduction"", Univ Anna, Vol. 3, No. 2, 2007, pp. 76-80.

[9] Leow Pei Ling, „„SVM Based Hysteresis Current Controller for a Three Phase Active Power Filter"", MSc Thesis, Universiti Teknologi Malaysia, 2004.

[10] M. Sc. Mariusz Cichowlas, „„PWM Rectifier with Active Filtering"", Ph. D. Thesis, Warsaw University of Technology, Poland, 2004.

[11] Smruti Ranjan Prusty, „„FPGA Based Active Power Filter for Harmonics Mitigation"", MSc. Thesis, National Institute of Technology Rourkela, India, 2011.

[12] Tan Perng Cheng, „„A Single-Phase Hybrid Active Power Filter with Photovoltaic Application"", Msc. Thesis, Universiti Teknologi Malaysia, 2007.

[13] Abdelmadjid Chaoui, Jean-Paul Gaubert, Fateh Krim, and Laurent Rambault, „„IP Controlled Three-Phase Shunt Active Power Filter for Power Improvement Quality"", IEEE, 1-4244-0136-4/06, pp 2384-2389, 2006.

[14] Ilhami Colak, Ramazan Bayindir, Orhan Kaplan, and Ferhat Tas, „„ DC Bus Voltage Regulation of an Active Power Filter Using a Fuzzy Logic Controller"", IEEE Ninth International Conference on Machine Learning and Applications, pp 692-696, 2010.