International Journal of Emerging Technologies in Engineering Research (IJETER)
Volume 4, Issue 11, November (2016) www.ijeter.everscience.org

Simulation of Harmonic Suppression and Reactive Power Compensation in Power System

Menaka.S
Assistant Professor,Coimbatore Institute of Engineering and Technology, Coimbatore, India.

Mahendiran.R
Assistant Professor, Tamilnadu Agricultural University, Coimbatore, India.

Abstract – Power quality is an important measure of an electrical power system. The term power quality means to maintain purely sinusoidal current waveform in phase with a purely sinusoidal voltage waveform. The power generated at the generating station is purely sinusoidal in nature. The deteriorating quality of electric power system is mainly because of current and voltage harmonics due to wide spread application of static power electronics converters, zero and negative sequence components originated by the use of single phase and unbalanced loads, reactive power, voltage interruption etc.

The main objective of the dissertion is to design and implement high performance shunt active power filter systems .This dissertion proposes shunt active power filter based on d-q-o power theory for reactive power compensation and harmonic suppression. The simulation results are provided to verify the effectiveness of the proposed active power filter systems which increases the power factor, reduce the current harmonics and enhance the robustness of the transient response.

Index Terms – APF-Active power Filter,IGBT-Insulated Gate Bi-polar transistor,PWM-Pulse width modulation,S&H-Sample and old Circuit.

1. INTRODUCTION

Reactive power plays an important role in supporting the real power transfer. This support becomes especially important when an increasing number of transactions are utilizing the transmission system and voltages become a bottleneck in preventing additional power transfer. The purpose of reactive power dispatch is to determine the proper amount and location of reactive support in order to maintain a proper voltage profile. Traditionally, its objective function is to minimize the transmission losses.

The problem of reactive power dispatch (RPD) is to allocate reactive power generation so as to minimize the real power transmission losses and keep all the voltage within the limits, while satisfying a number of equality and inequality constraints including the power flow equations, upper and lower voltage limits and capacity restrictions in various reactive power sources, generators, shunt capacitor banks and transformer taps.

The passive filters have been used as a conventional solution to solve harmonic currents problems, but they present some disadvantages: they only filter the frequencies they were previously tuned for; its operation cannot be limited to a certain load or group of loads; resonance can occur due to the interaction between the passive filters and others loads, with unexpected results.

To cope with these disadvantages, recent efforts have been concentrated on the development of active power filters. In this paper the development of a shunt active filter is proposed, with a control system based on the d-q-o theory. With this filter it is possible to effectively compensate the harmonic currents and the reactive power (correcting power factor to the unity), and also to balance the power supply currents (distributing the loads for the three-phases in equal form, and compensating zero sequence current).

In this project the harmonic reduction is done by using three phase shunt active power filter and the reactive power compensation is by instantaneous current control. The harmonic detecting that based on instantaneous reactive power theory can reduces the time and increases the accuracy.

2. PRINCIPLE OF SHUNT ACTIVE POWER FILTER

The system constitution and operation principle of single-phase SAPF, which is mainly composed of harmonics and reactive currents detecting circuit, current tracking control circuit and APF main circuit are discussed here.

The main APF circuit that depicted in the Fig.1.is composed of a current control single-phase voltage inverter, which is used to generate compensation current. Each bridge of this inverter is implemented by IGBT and anti-parallel diode. The DC side of inverter is paralleled with capacitor C, which plays an important role in the steady of DC voltage and compensates reactive power. While require compensate harmonics and reactive currents for nonlinear loads, the harmonics and reactive currents is detected by APF from compensated object, then, makes it anti-polarity and as the command signal of compensation current. Thus, generate the necessary PWM pulse through current tracking control circuit and drive the switch of inverter by some control method. Finally, the inverter generates compensation current.

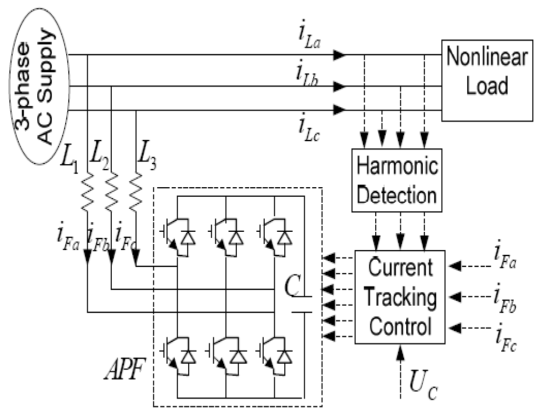

Fig.1. System Constitution of Shunt Active Filter

3. DETECTION METHOD FOR HARMONICS AND REACTIVE CURRENTS

The three-phase instantaneous reactive power theory is proposed in the 1980s and has obtained successfully application already, which completely define the instantaneous reactive power and instantaneous active power that based on instantaneous reactive power theory is the most successful method for harmonic and reactive current detection, whose principle diagram is shown in Fig.2.

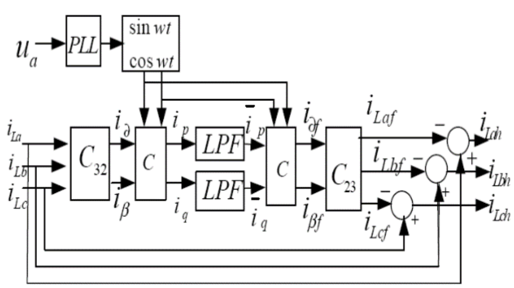

Fig.2. Diagram of detection method for harmonics and reactive currents.

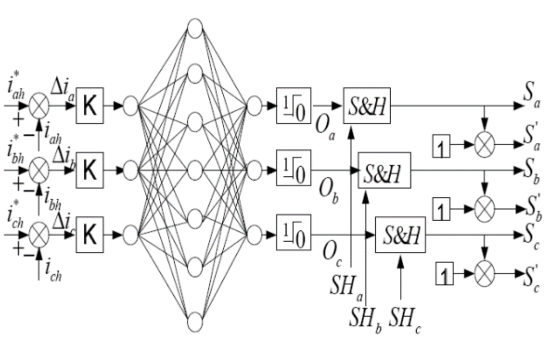

Fig.3. Diagram of Instantaneous current PWM control based on neural network

4. INSTANTANEOUS CURRENT PWM CONTROL BASED ON NEURAL NETWORK

As for the compensation currents generated circuit three-phase voltage source inverter, this paper introduces the method for instantaneous current PWM control based on neural network that shown in Fig.3. The advantage of an ANN-based PWM are constant switching frequency of the inverter, which unlike hysteresis-band PWM, does not vary with the dc supply voltage, load parameters.

Take harmonic current as reference signal, compensation current that produce by inverter as feedback signal, the network receives the current error signals($a\ \Delta i$, $b\ \Delta i$, and $c\ \Delta i$) through the respective gain or scale factor K. This network using three feed forward neural network, whose output signal of the ANN are passed through hard limiters and sample & hold (S&H) circuits to impress the logic signals at the inverter input. The S&H elements are activated by signals a SH_a, SH_b,and SH_c, with a sampling period T_c that corresponds to the switching frequency of the inverter, frequency of the inverter selects 20KHz, The binary values of S_a, S_b and S_c constitute the eight switching states of the inverter. The neural network is trained such that if the current error exceeds the threshold value $\pm\delta$, the state change occurs in the respective output.

The threshold value of trained neural network selects $\pm 0.05A$, the output of a phase a channel S_a will be 1 after S&H if 0.05 $\Delta i > A$, then the upper bridge arm of IGBT turn-on; and S_a^1 will be 1 if 0.05 $\Delta i < -A$, then the lower bridge arm of IGBT turn on. For the range 0.05, 0.05 $a - A \le \Delta i \le A$, the output remains unchanged, makes the input and output of network meet the effective PWM switching mode of inverter after off-line training.

5. SIMULATION RESULTS

The simulation waveform for various parameters are shown in Fig.4,Fig.5, Fig.6.

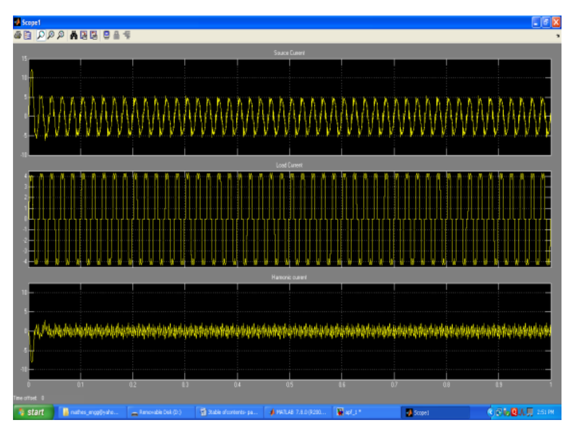

Fig.4.Comparison between Source Current and Load Current, Harmonic Current

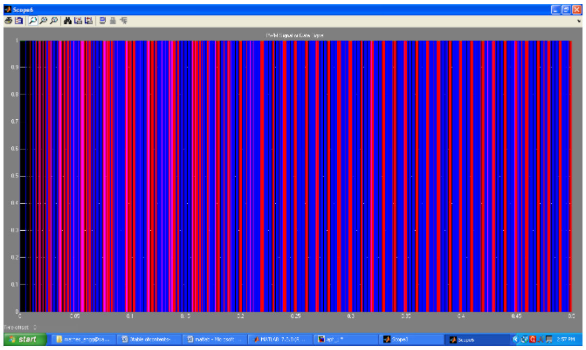

Fig.5.Pulse Width Modulated Gate Signal to Inverter Circuit

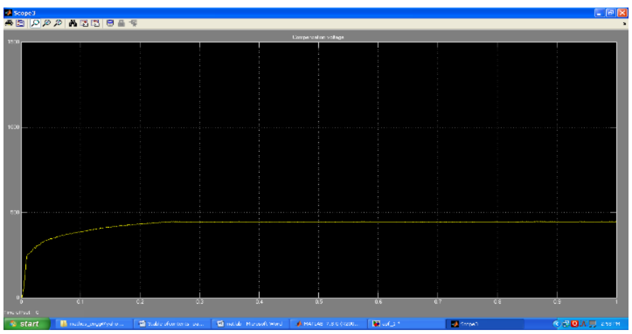

Fig.6.Compensation Voltage

6. CONCLUSION

In this project, the causes due to power quality deteriation, different types of filters, the use and advantages of applying active power filters to compensation power distribution systems has been presented. The principles of operation of shunt active power filters have been presented. The harmonic detection and reactive power performance under fault power distribution system was discussed. Active power filters, based on the proposed theory, give satisfactory operation even when the system phase voltages are unsymmetrical and distorted, because no distortion appears in the line currents. In non-ideal mains voltage condition, the source currents by the instantaneous power (*pq*) theory are distorted, but the source currents by the proposed method have no distortion.

REFERENCES

[1] M. I. Marei, E. F. El-Saadany, and M. M. A. Salama, "A Novel Control Scheme for STATCOM Using Space Vector Modulation Based Hysteresis Current Controller", University of Waterloo, Department of Electrical and Computer Engineering, Waterloo, Ontario, CanadaN2L 3G1.

[2] Moinuddin K Syed and BV Sanker Ram, "A Fuzzy Logic Model for Harmonic Reduction in Three Phase Shunt Active Filter", 1.Dept. of Elec. & Elex.Engg.,BVC Institute of Technology & Science,Amalapuram, India, 2.Dept. of Elec. & Elex. Engg., Jawaharlal Nehru Technological University,Hyderabad, India.

[3] Hemant Barot, Student Member, IEEE and Kankar Bhattacharya, Senior Member, IEEE "Optimal Reactive Power Planning and Compensation Effects on Transmission Loss Components".

[4] Hongliang, LiuYupeng Tang, "Research on a Hybrid System for Dynamic Reactive Power and Harmonic Compensation", School of Electrical Engineering Beijing Jiaotong University, Haidian District, and Beijing, China.

[5] Heinz K. Tyll, SM, IEEE, and Dr. Frank Schettler1, "Historical overview on dynamic reactive power compensation solutions from the begin of AC power transmission towards present applications".

[6] Chen Huai-zhong,ZheJiang, "Research and Application in Substation Reactive Power Dynamic Compensation Based on Fuzzy Control", Industry Polytechnic College, ShaoXing 312000,

[7] mílio F. Couto, Júlio S. Martins, João L. Afonso "Simulation Results of a Shunt Active Power Filter with Control Based On PQ theory",Department of Industrial Electronic University of Minho Campus,deAzurém – 4800-058,Guimarães(Portugal),email:assel.couto@clix.pt,jmartins@dei.uminho.pt, jla@dei.uminho.pt.

[8] Moleykutty George and Kartik Prasad Basu1,"Three-Phase Shunt Active Power Filte" Faculty of Engineering and Technology, Multimedia University, 75450 Melaka, Malaysia.2.Faculty of Engineering, Cyberjaya, Malaysia.

[9] Murat Kale, Engin O¨ zdemir ,"Harmonic and reactive power compensation with shunt active power filter under non-ideal mains voltage", Kocaeli University, Technical Education Faculty, Electrical Education Department, 41100 Izmit, Turkey.

[10] O. Ucak, I. Kocabas, A. Terciyanli ,"Design and implementation of Shunt power filter with reduced DC link voltage",TUBITAK- Space Technologies Research Institute, Power Electronics Group METU Campus, TR 06531, Ankara, TURKEY.

Authors

S.Menaka was born in Erode District,Tamilnadu in 1983. This author has completed M.E degree on Power Electronics and drives in Anna University of Technology,Coimbatore. She is working as an Assistant professor in Coimbatore Institute of Engineering and Technology,Coimbatore. Mrs.S.Menaka is a life time member of ISTE Society.

R.Mahendiran was born in Erode District,Tamilnadu in 1977.This author has got Ph.D degree on Bio-Energy in Tamilnadu Agricultural University,Coimbatore. He is working as an Assistant Professor in Tamilnadu Agricultural University,Coimbatore and also a research engineer of solar energy Technology(ICAR).He is a certified Energy Auditor of Bureau of Energy Efficiency,Accredited by MNRE