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An Improved SVPWM based Shunt Active Filter for Compensation of Power System Harmonics

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Abstract —*This paper, a space vector PWM control method for hybrid active power filter is presented. In the proposed control method, the Active Power Filter (APF) reference voltage vector is generated instead of the reference current, and the desired APF output voltage is generated by SVPWM. The entire power system block set model of the proposed scheme has been developed in MATLAB environment. The developed control algorithm is simple. The APF based on the proposed method can eliminate harmonics, compensate reactive power and balance load asymmetry. Simulation results show the feasibility of the APF with the proposed control method.*

Keywords-*SVPWM, shunt APF, VSI***,** *non-harmonic generation, power electronic devices, inverter based shunt active powerfilter*

I. INTRODUCTION

In the last two decades, power system conditioning circuits have known an important development resulted to two groups of circuits, the first group is represented by harmonic generating circuits used in reactive power compensation while the second one consists of non-harmonic generating circuits efficiently used not only in reactive power compensation but also to balance three phase systems and to cancel harmonic

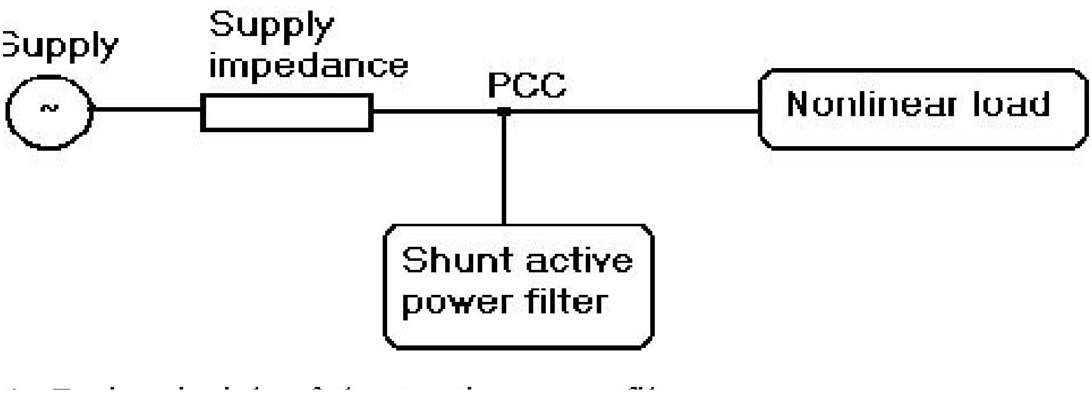


Fig. 1. Basic principle of shunt active power filter

currents . The inverter based shunt active power filter is one of the active power line conditioners (APLC), which is configured by modem power semiconductor switches. In this case the shunt APFs use an inverter and a dc source to produce an equal but opposite compensating current to be injected to the network at the suitable point of common coupling (PCC) as represented in figure 1. This configuration in globes two types namely the voltage source inverter based shunt APFs and the current source inverter based shunts APFs. The continuous improvement of semi conductor device technology, which provides more efficient and more economical components, encourages the interest in nonharmonic generating APFs.

II. SHUNT ACTIVE POWER FILTER

The topologies of the active filters are the shunt, series and hybrid active passive power filter. Parallel or shunt active active power filters have been recognized as a valid solution to current harmonic and reactive power compensation of non linear load.

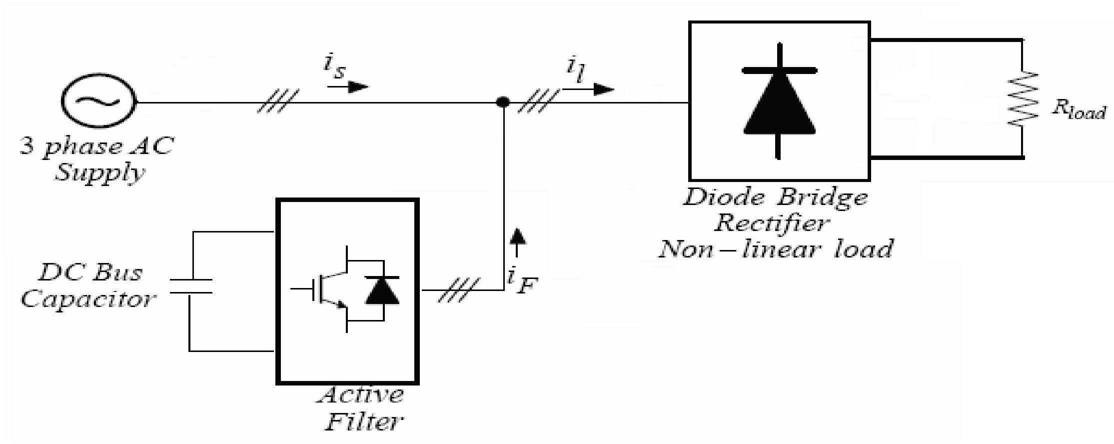


Fig 2.1 SHUNT APF

The shunt active filter shown in Fig.2.1 is the most fundamental system configurations. The shunt APF is controlled to draw and inject compensating current, i_f to the power system and cancel the harmonic currents on the ac side of a general purpose rectifier**.** Besides that, it has the capability of damping harmonic resonance between an existing passive filter and the supply impedance.

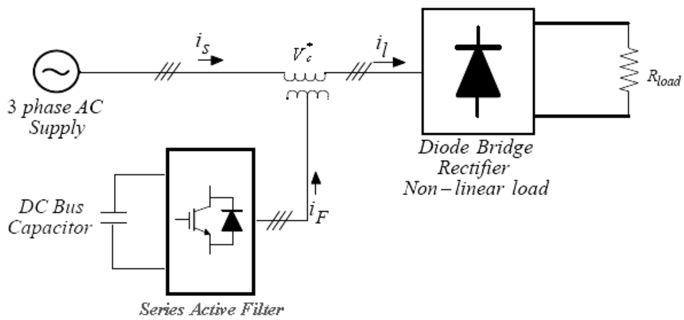
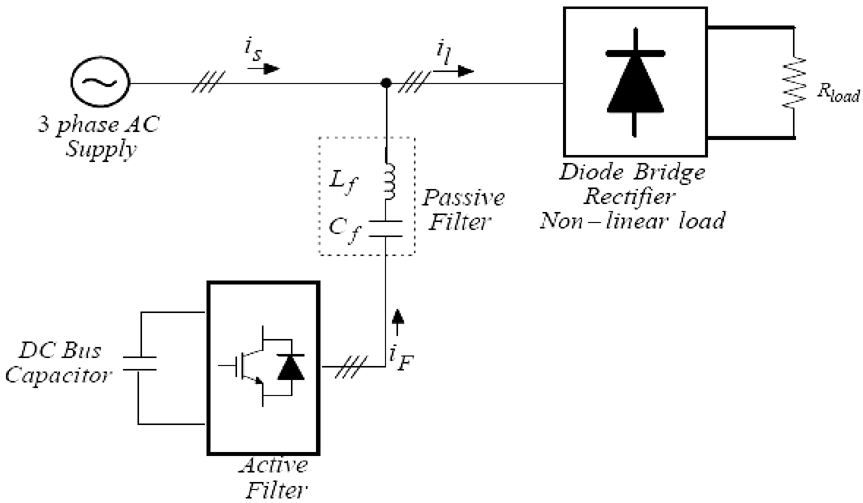


Fig.2.2 Series APF

The difference of the shunt and series active filter is the compensating harmonic injection method and the type of compensating harmonic. The compensating voltage, V_C* of the series power filter is added into the phase supply voltage to cancel the harmonic voltage in each phase. Both shunt and series active power filter carry different role for the harmonic compensation. The shunt and series active filters act as a current

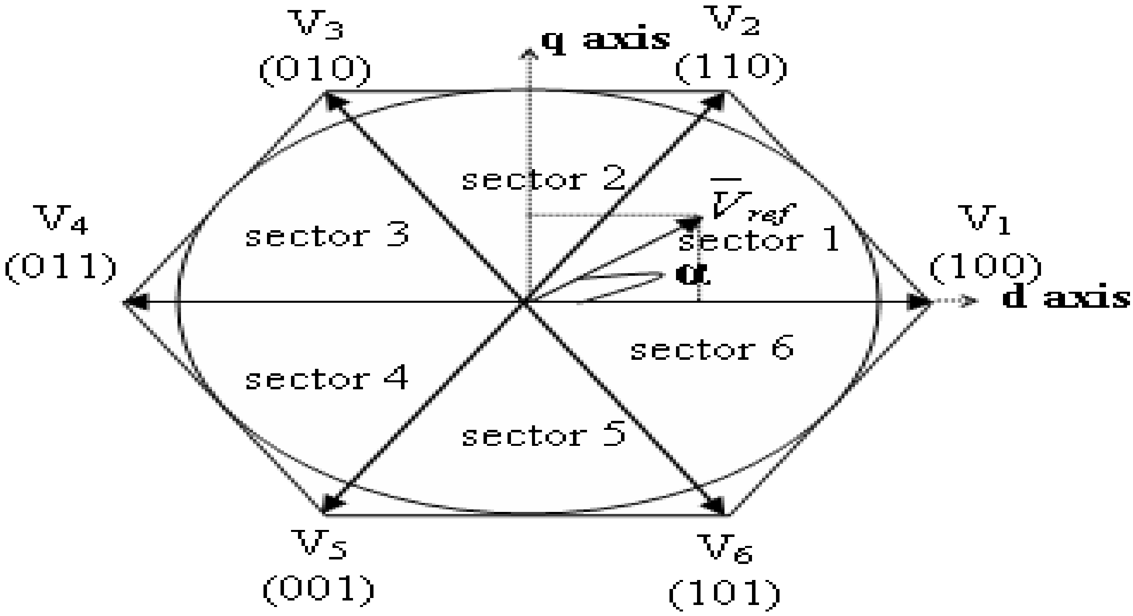


III. SPACE VECTOR MODULATION

3.1. Second-order headings

- **It is a more sophisticated, advanced, computation intensive technique for generating sine wave that provides a higher voltage with lower total harmonic distortion and is possibly the best among all the pulse width modulation techniques.**
- **The main aim of any modulation technique is to obtain variable output voltage having a maximum fundamental component with minimum harmonics.**

3.1.1. Basic switching sectors & vectors



The SVPWM technique is more popular than conventional technique because of its excellent features.

- More efficient use of DC supply voltage.
- 15% more output voltage then conventional modulation.
- Low total Harmonic distortion.
- Redundant combinations are available.
- To implement SVPWM, the voltage equations in the abc reference frame can be transformed into the stationary d-q reference frame that consists of the horizontal (d) and vertical (q) axes.
- Step 1. Determination of V_d, V_q, V_{ref} and angle(α)
- Step 2. Determination of time duration T_1, T_2, T_0
- Step 3. Determination of the switching time of each switch(s_1 to s_6)
- The transformation from abc to d-q is given by

$$\therefore \begin{bmatrix} V_d \\ V_q \end{bmatrix} = \frac{2}{3} \begin{bmatrix} 1 & -\frac{1}{2} & -\frac{1}{2} \\ 0 & \frac{\sqrt{3}}{2} & -\frac{\sqrt{3}}{2} \end{bmatrix} \begin{bmatrix} V_{an} \\ V_{bn} \\ V_{cn} \end{bmatrix}$$

$$\therefore T_1 = T_z \cdot a \cdot \frac{\sin(\pi/3 - \alpha)}{\sin(\pi/3)}$$

$$\therefore T_2 = T_z \cdot a \cdot \frac{\sin(\alpha)}{\sin(\pi/3)}$$

$$\therefore T_0 = T_z - (T_1 + T_2) \qquad \left(where \;\; T_z = \frac{1}{f_z} \;\; and \;\; a = \frac{|\bar{V}_{ref}|}{\frac{2}{3} V_{dc}} \right)$$

III. SIMULATION

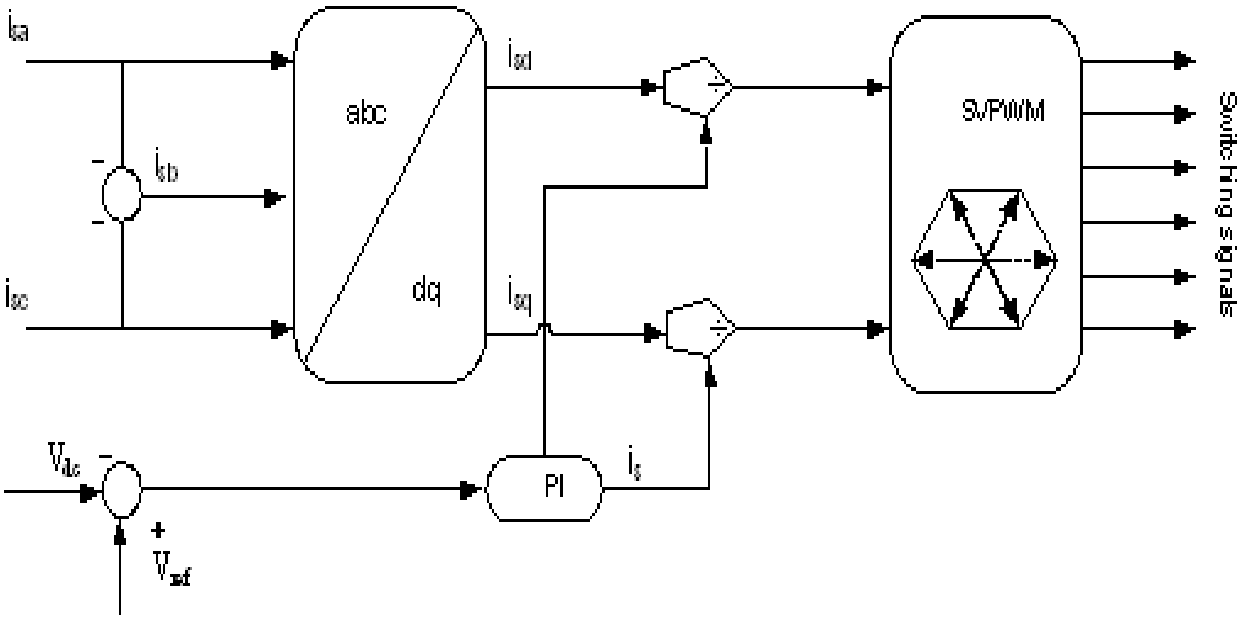


Fig 4. Control Block Diagram of Proposed System

shows the block diagram of active filter controller implemented for reducing the harmonics with hybrid active filter system. In each switching cycle, the controller samples the supply currents i_{sa} ,i_{sc} and the supply current i_{sc} is calculated with the equation of -(i_{sa}+i_{sc}), as the summation of three supply current is equal to zero. These three-phase supply currents are measured and transformed into synchronous reference frame (d-q axis). The fundamental component of the supply current is transformed into dc quantities in the (d-q) axis and the supply current amplitude I_s generated by the PI controller with V_{dc} and V_{ref}, the reference value of the dc bus voltage. The obtained d-q axis components generate voltage command signal. By using Fourier magnitude block, voltage magnitude and angle is calculated from the obtained signal. These values are fed to the developed code and compared with the repeating sequence. Then the time durations T_1, T_2 and T_0, the on-time of V_1, V_2 and V_0 are calculated. The generated switching actions are applied to the APF and power balancing of the filter takes place.

For nonlinear load

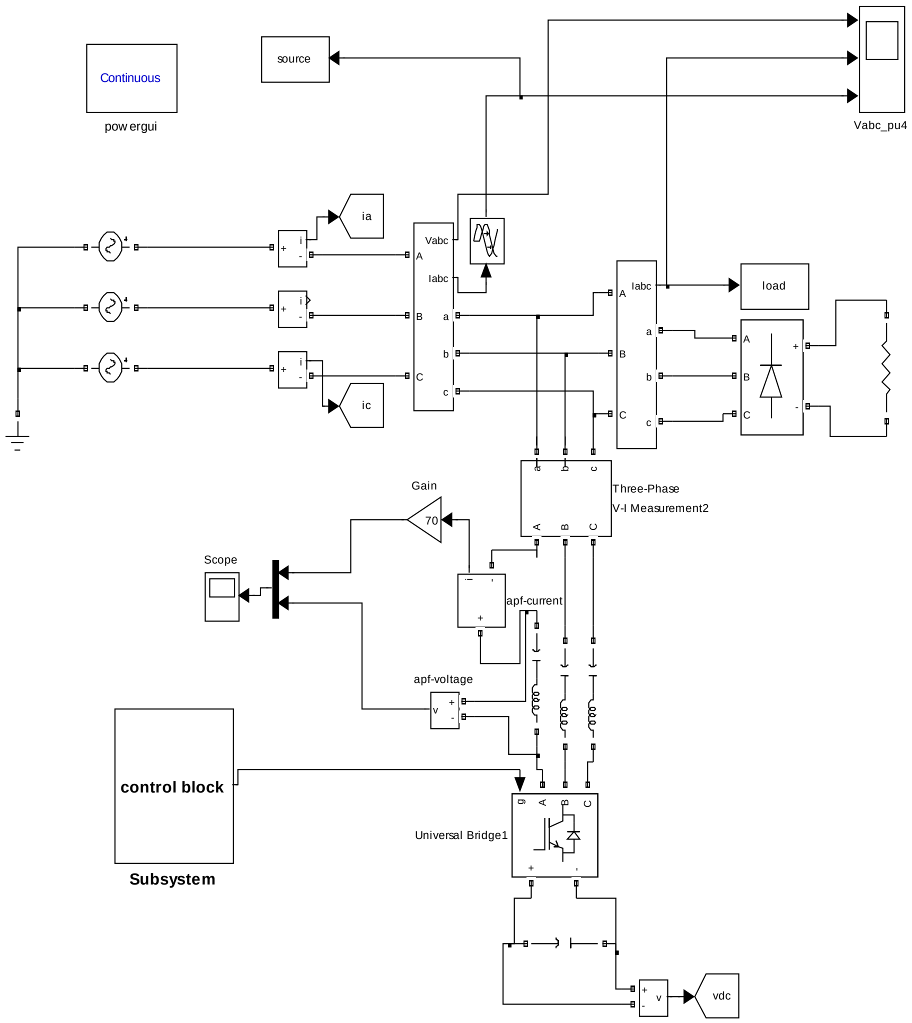


Fig 4.1 simulink diagram for SVPWM based shunt Active Filter for non linear load

The developed control method for three-phase shunt APF is simulated in MATLAB/Simulink. Firstly, the three-phase supply currents are sensed and transformed into synchronous reference frame (d-q) axis. The fundamental component of the supply current is transformed into dc quantities in the (d-q) axis and the supply current amplitude I_s generated by the PI controller. The obtained d-q axis components generate voltage command signal. By using Fourier magnitude block, voltage magnitude and angle is calculated from the obtained signal. These values are fed to the developed code and generated switching actions are applied to the APF. Thus, power balancing of the filter takes place. Further, the performance with different type of loads is presented.

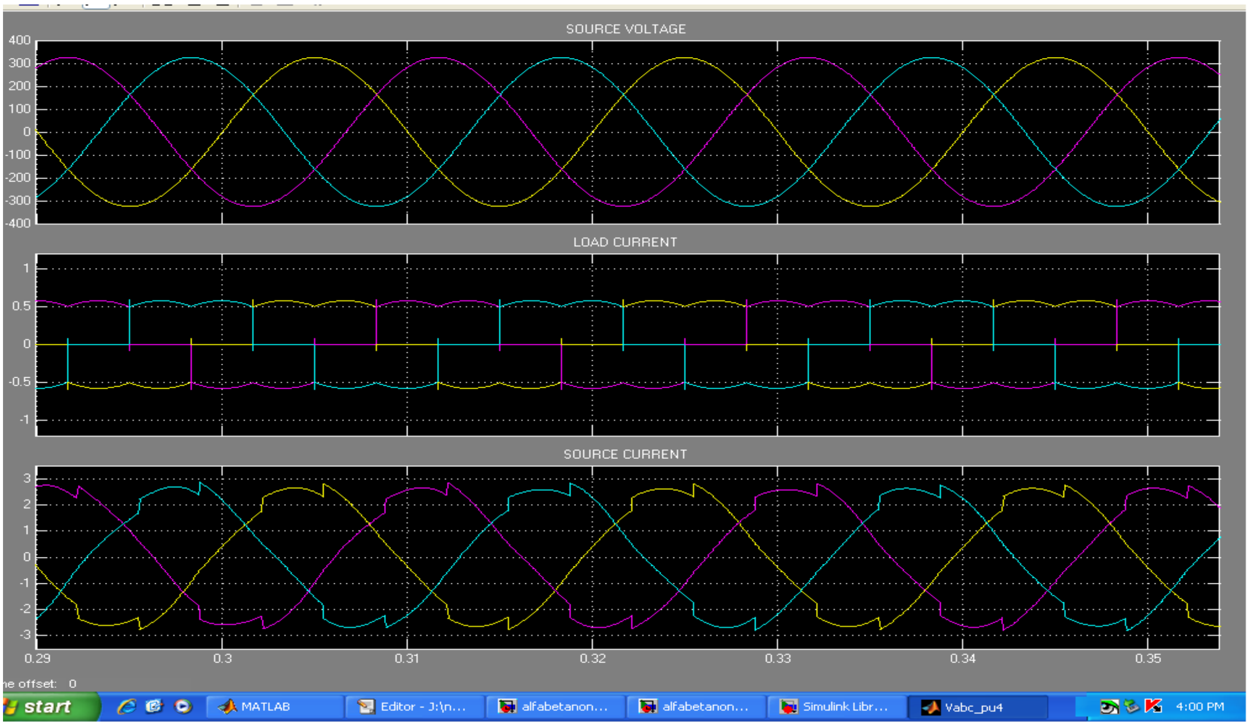


Fig 4.3 Wave-forms of source voltage, load current and source current for Non-linear load

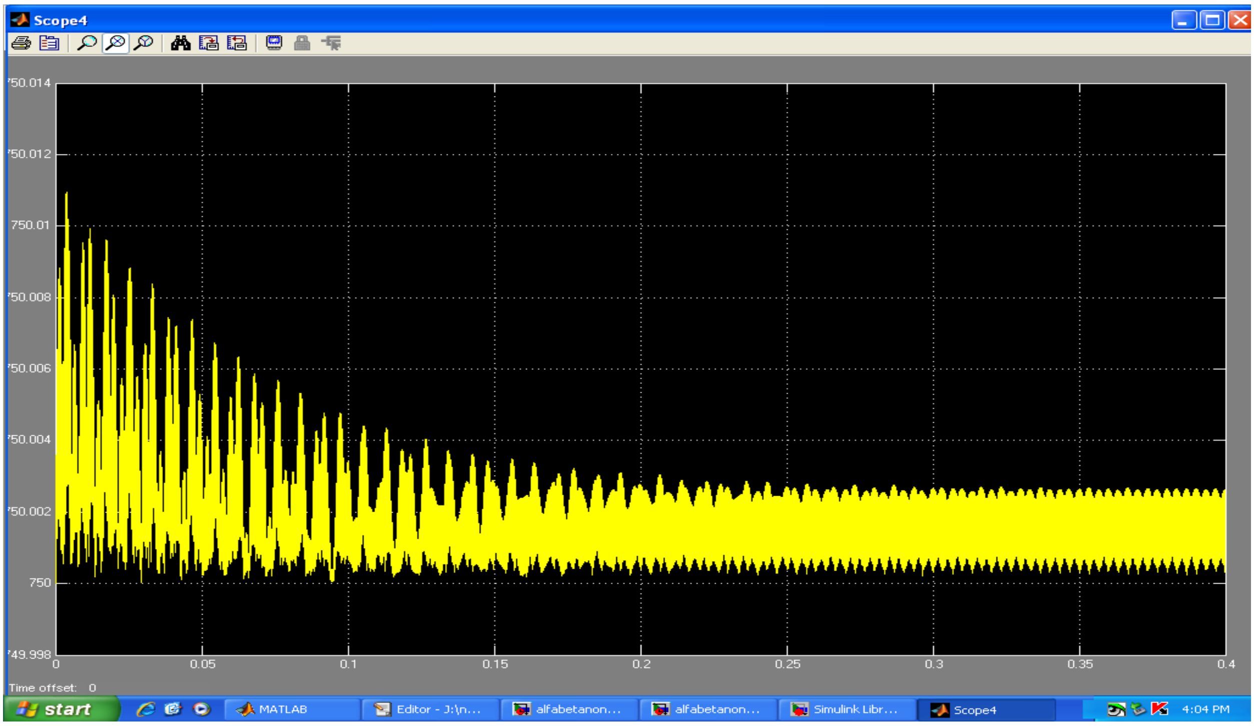


Fig 4.4 VSI Capacitor Voltage

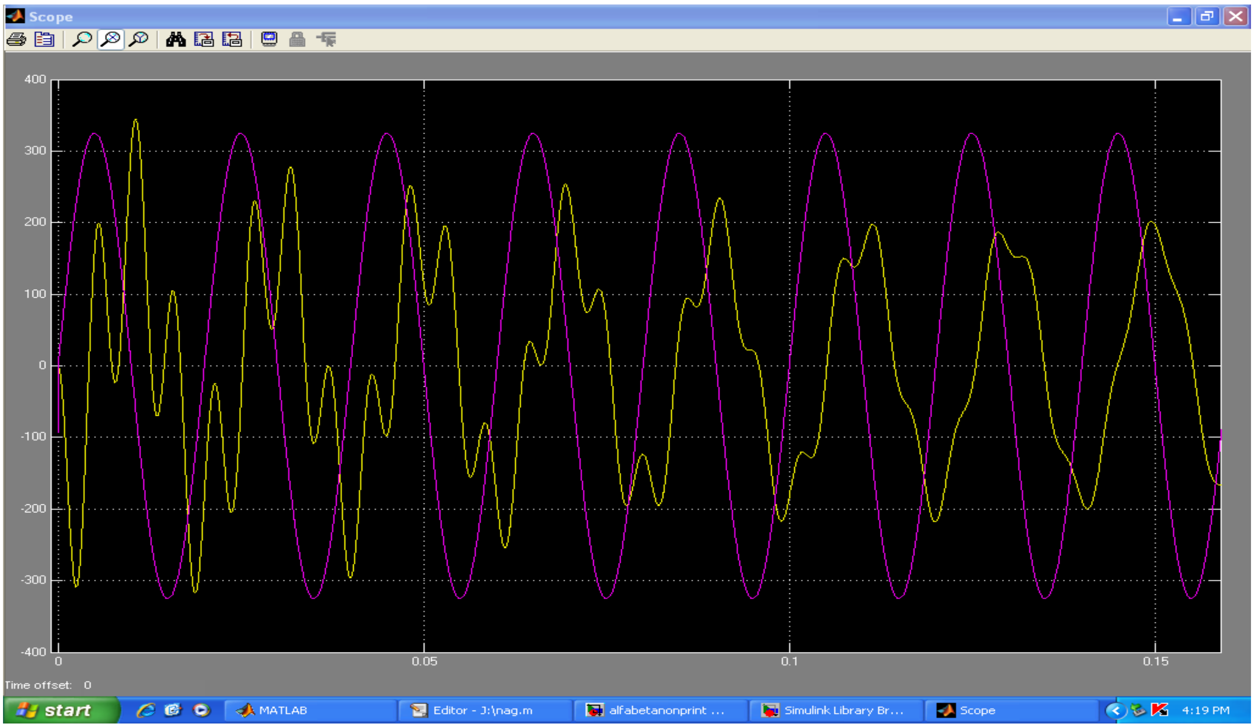


Fig. 4.5 Compensated voltage from APF

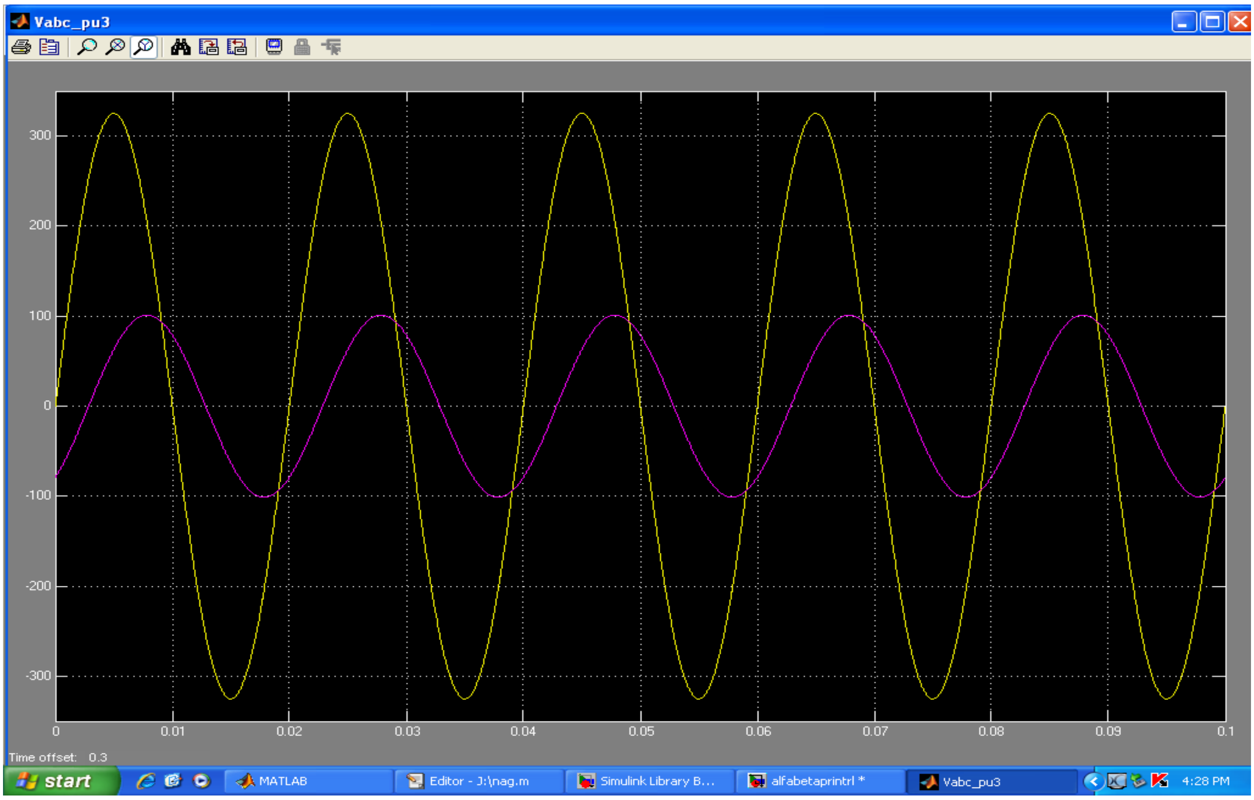


Fig4.6 Voltage and Current waveforms for balanced linear load without compensation

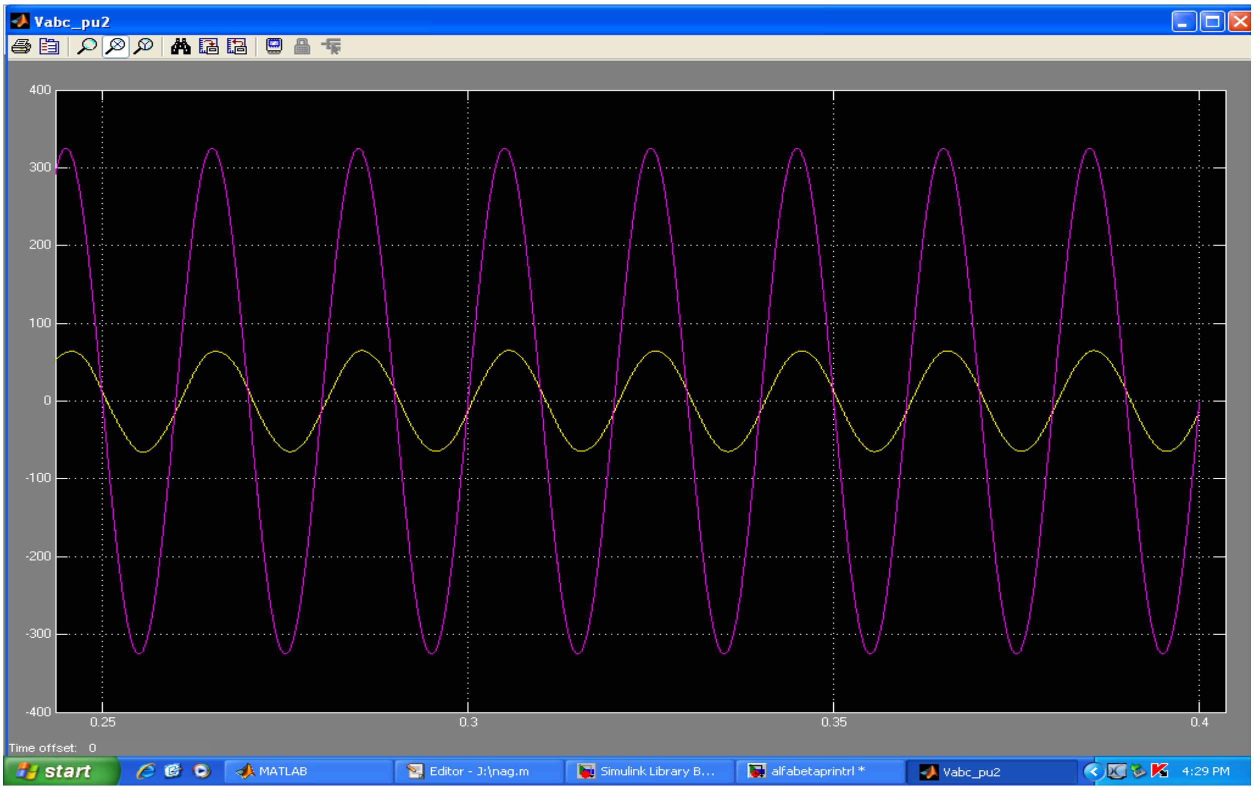
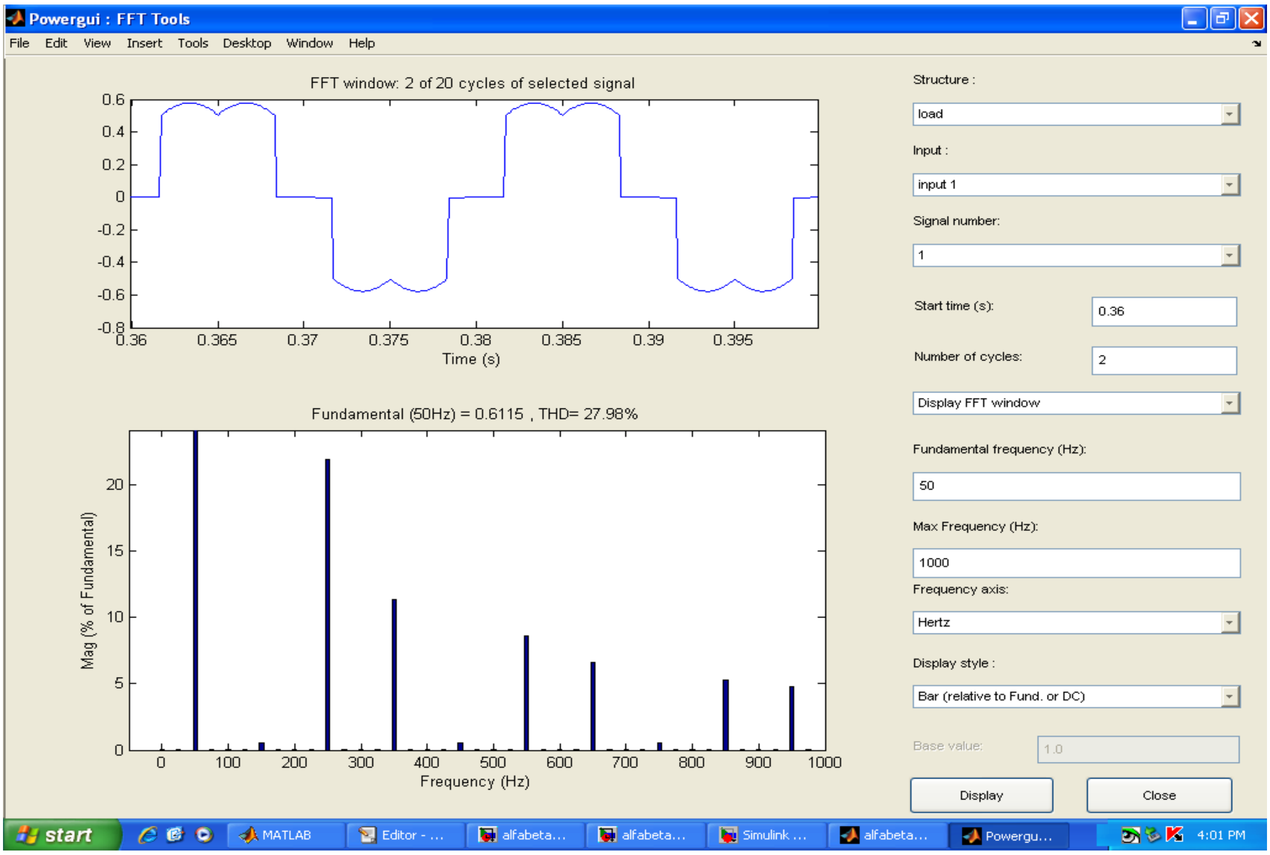
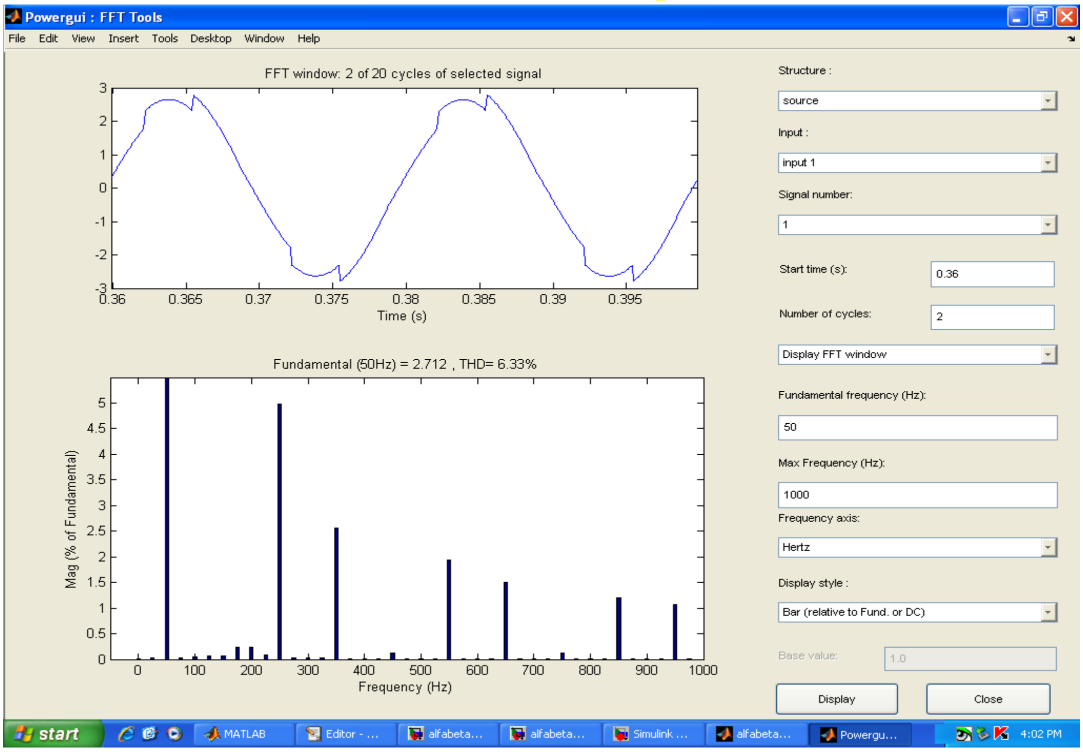


Fig 4.5 Voltage and current waveforms after compensation



FFT analysis of source current for non linear load after compensation



Conclusion

control methodology for the APF using SVPWM is proposed. This method requires few sensors, simple in algorithm and able to compensate harmonics and unbalanced loads. The performance of APF with this method is done in MATLAB/Simulink. The harmonic spectrum under non linear load conditions shows that reduction of harmonics is better. Under unbalanced linear load, the magnitude of three phase source currents are made equal and also with balanced linear load the voltage and current are made in phase with each other. The simulation study of two level inverter is carried out using SVPWM because of its better utilization of dc bus voltage more efficiently and generates less harmonic distortion in three-phase voltage source inverter

REFERENCES

[1] H. Akagi, “New trends in active filters for power conditioning,” *IEEE Trans. Ind. Appl.*, vol. 32, no. 2, pp. 1312–1332, Nov./Dec. 1996.

[2] El-Habrouk. M, Darwish. M. K, Mehta. P, “Active power filters—A review,” IEE—Elect. Power Applicat., Proc. vol. 147, no. 5, pp. 403– 413, Sept. 2000.

[3] F. Z. Peng, “Application issues of active power filters,” *IEEE Ind. Appl.Mag.*, vol. 4, no. 5, pp. 21--30, Sep./Oct. 1998.

[4] J. O.Pinto, B. K.Bose, L.B.da Silva, and M. P.Kazmierkowski, “A neural-network-based space-vector PWM controller for voltage-fed inverter induction motor drive” *IEEE Trans. Ind. Appl*, vol.36, no.6, pp.1628-1636, Nov/Dec 2000.