

Improving the Stability of a Two Bus System Using Shunt Active Filter

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ABSTRACT: Stability of two bus system is enhanced using the shunt active filter. Here shunt active power filters are connected parallel to the line to reduce the current harmonics present in the system. Nonlinear loads are used to produce the non sinusoidal waveforms. The harmonics presented in the bus system are reduced by injecting the compensating current using shunt active filter. Shunt power filter comprises of a switching device such as IGBTs; power MOSFETs along with DC link capacitor. Synchronous Reference Frame (SRF) algorithm and Hysteresis current control technique are used to produce the reference current and to produce the firing pulses needed for the inverter. This method is simulated using MATLAB/ Simulink and the results are presented.

KEYWORDS: Shunt Active Filter, Synchronous Reference Frame (SRF), stability, Hysteresis current control.

I. INTRODUCTION

The stability of power system is defined as the capacity of power system to conserve its steady stability or improve the initial steady state after any variation occurs in the operation of the system. Now a day's power systems are being operated closer to their stability limits due to economical reasons and environmental changes[1-3]. Stability and operation of a power system is currently becoming a very significant and difficult issue. The stability of the system is affected by faults, transient, harmonics, distortion in the voltage and voltage. The main aim of this paper is to diminish the current and enhance the system stability. AC system mostly uses non linear loads. A load is considered non linear if its impedance changes with the applied voltage. The changing impedance means that the current drawn by the non linear load will not be sinusoidal even when it is connected to a sinusoidal voltage.

At present, most of the system prefers nonlinear loads. But the nonlinear loads generate the harmonic current which produces the non sinusoidal waveforms. This leads to the reduction of power factor, decreasing the efficiency and the system performs is reduced[3-7]. In order to resolve these distortions many types of filters are used. In this paper shunt active filter along with PI controller, Synchronous Reference Frame theory, Hysteresis Current Controller is used to balance the harmonic current and improve the system stability.

II. PROPOSED METHOD

A. Shunt Active Filter

Use of some filters leads to the generation of some resonance problem, provides only fixed compensation and increased in size. To overcome these drawbacks active filter is used. Active filter is used to compensate the harmonic content and decreases the total harmonic distortion. Active filters are implemented using a combination of passive and active (amplifying) components, and require an outside power source.

It uses active components such as MOSFET, IGBT-transistors etc. both the shunt and series active filter is used. Series active filters are used to balance the voltage harmonics[7-10]. But the series active filter contain some drawbacks that, they have to hold high load currents, which boost their current rating and rising I²R losses.

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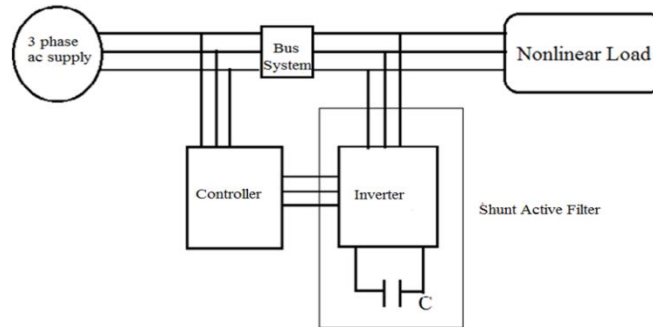


Fig. 1. Block Diagram of Shunt Active Filter

Here shunt active filter is used to balance the harmonic current. The filter is attached in parallel to the line. Shunt active filter compensates the harmonics contain in the current waveform by provide equal but opposite harmonic compensating current. Thus the harmonic component appear in the waveforms is reduced and the current waveforms be sinusoidal. By the use of shunt active filter the losses in the system are reduced and the reactive power is compensated. The DC link capacitor is coupled across the inverter or various switching devices. The DC link capacitor helps to maintain these transients from returning back to the input[10-13]. This also helps to avoid the switching network from oscillating or triggering inadvertently at an improper moment and leads to a short circuit.

III. PROJECTED CONTROLLERS

Many types of control schemes and controllers are used. Here PI controller, synchronous reference frame theory, Hysteresis current control technique is used.

A. PI Controller

The PI controller is the combinations of proportional and integral controller. PI controller is essential to enhance the speed of the response. It also used to abolish the steady state error. The forced oscillations and steady state error occurs in the system is reduced using the PI controller.

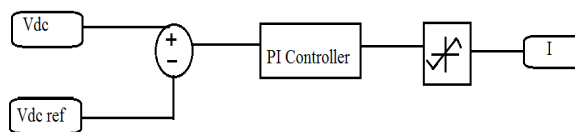


Fig. 2. Block diagram of PI Controller

PI controllers are used to obtain the maximum value of the reference current. This figure represents the PI controller compares the reference voltage and the actual voltage present in the system. Here the DC side capacitor voltage is sensed and compared with a required reference voltage.

B. Synchronous Reference Frame Theory

The most familiar and probably used method is Synchronous Reference Frame method (SRF). Synchronous reference frame theory is appropriate to a three phase system[13-16]. It is used to produce the reference current based on time domain. Synchronous Reference theory is also recognized as dq theory. This theory is chosen for its simplicity and it uses only the algebraic calculation.

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The source current is detected and is transformed into two instantaneous active and reactive components using dqo transformation. The output has some harmonics present in it and low pass filter is used to reduce the harmonics.

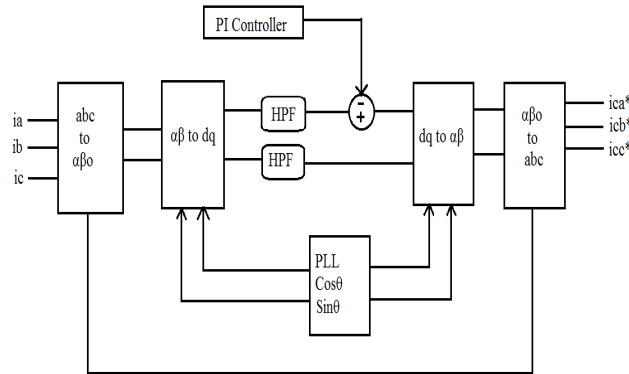


Fig. 3.Synchronous Reference Frame Theory

Phase locked loop gives the $\cos\theta$ and $\sin\theta$ for synchronism. The axes current and the PI controller output was compared and once more transformed into reference current by the technique inverse transformation. This reference current produced is fed to the hysteresis current control.

C. Hysteresis Current Control

The filter current is compared with the reference current to acquire the switching pulse for the inverters. This is done using hysteresis current control. The hysteresis current control method is used because of its good stability, a very fast response, good accuracy and simple operation. The reference current is obtained from the synchronous reference frame theory is I_{abc}^* . The actual filter current is represented as I_{fabc} . The error signal is then given to the hysteresis band to achieve the switching pulses for the inverter.

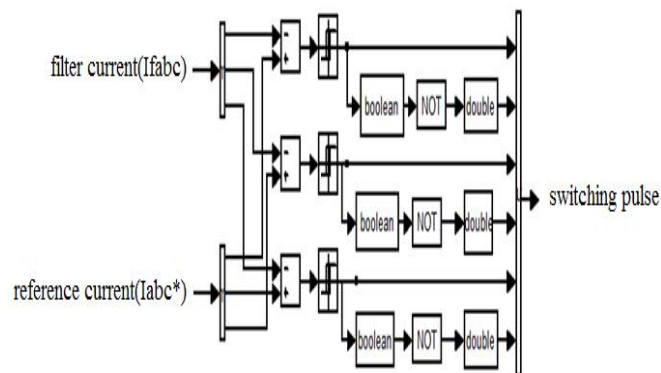


Fig. 4.Hysteresis Current Control

The operation of APF depends on the sequence of pulse generated by the controller. A hysteresis band is position between the generated error signals. When the error signal crosses the upper band, the output voltage changes with decreasing the input current and when the signal crosses the lower band, the output voltage changes with increase the input current. As the result, switching signals are generated.

The switching pulses thus generated are given to the power circuit which consists of switching devices with a DC link capacitor[16-17]. According to the switching pulse given to the inverter, it generates the compensating current

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signal. The compensating current is given back into the power line and thus suppressing the current harmonics present in the line.

IV. SIMULATION STUDY

A. Simulation without Filter

The simulink model of the two bus system without a filter is shown in the figure 5. The total harmonic distortion of the system is 10.23%. The waveform of various current such as I_a , I_b , I_c is shown in the figure 7, 8, 9.

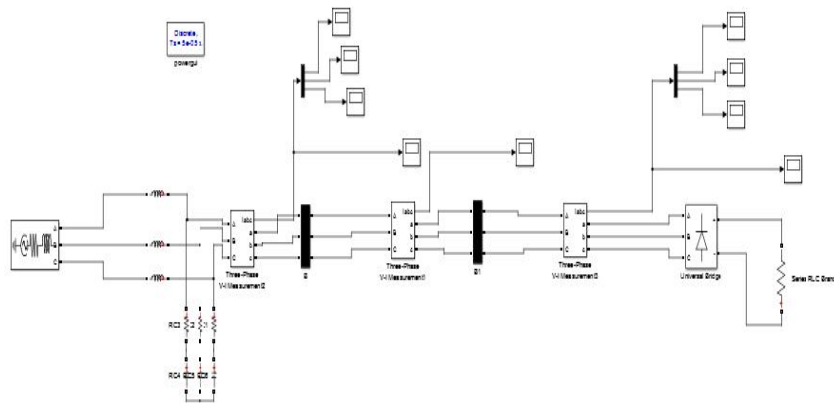


Fig. 5. Simulink diagram

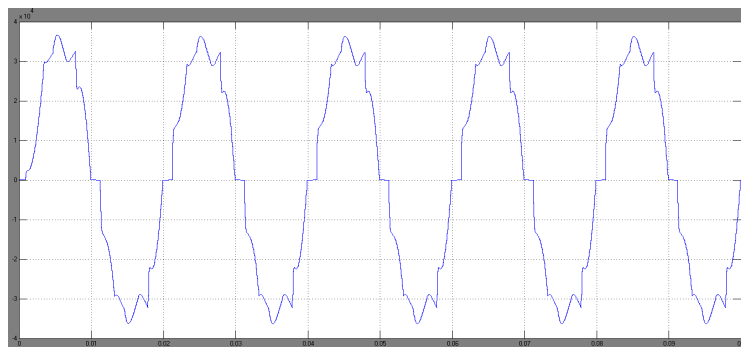


Fig. 6. Analysis of I_a current.

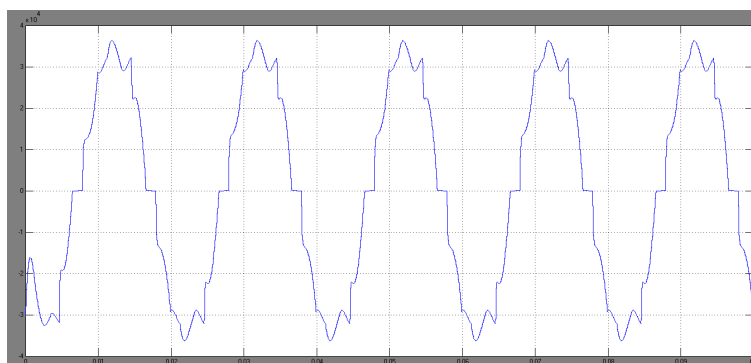


Fig. 7. Analysis of I_b current.

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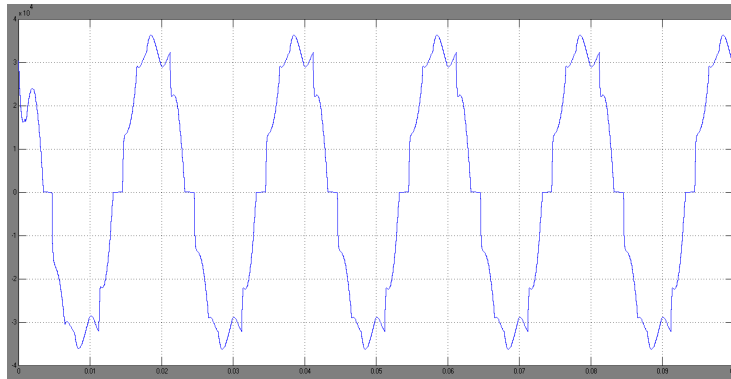


Fig. 8. Analysis of Ic current.

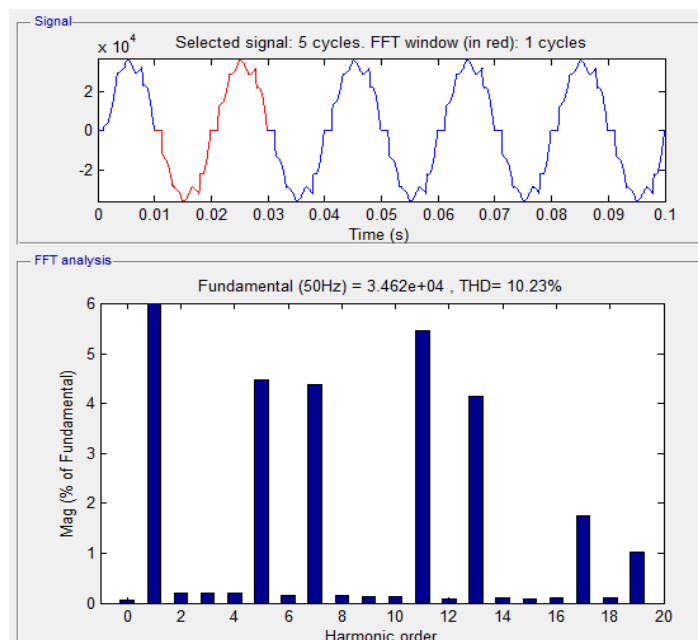


Fig. 9. THD analysis.

B. Simulation with Filter

The simulink model of the two bus system with shunt active filter is shown in the figure 10. The total harmonic distortion of the system is 5.76%. The waveform of various current such as Ia, Ib, Ic is shown in the figure 11, 12, 13.

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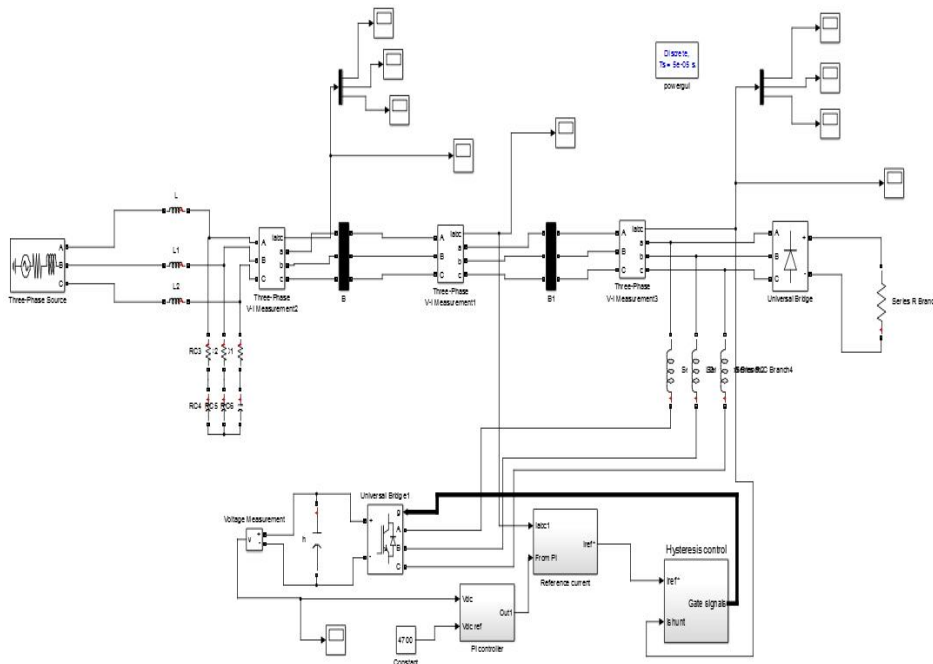


Fig. 10. Simulink diagram

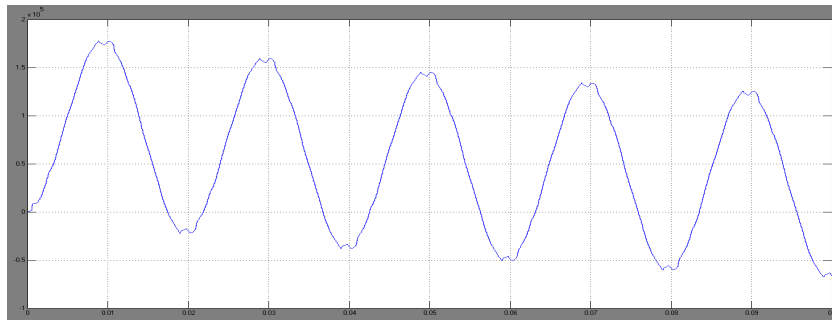


Fig. 11 . Analysis of I_a current.

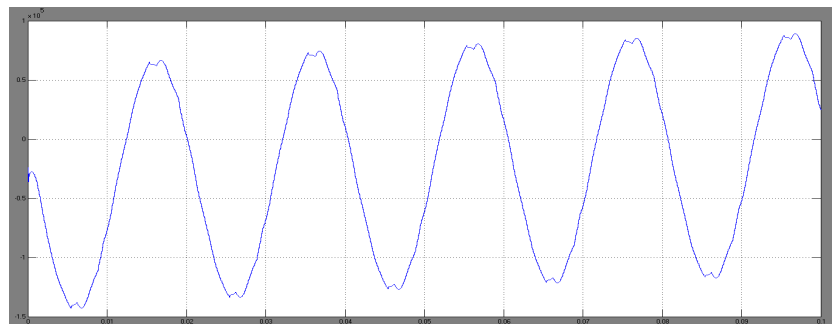


Fig. 12 . Analysis of I_b current.

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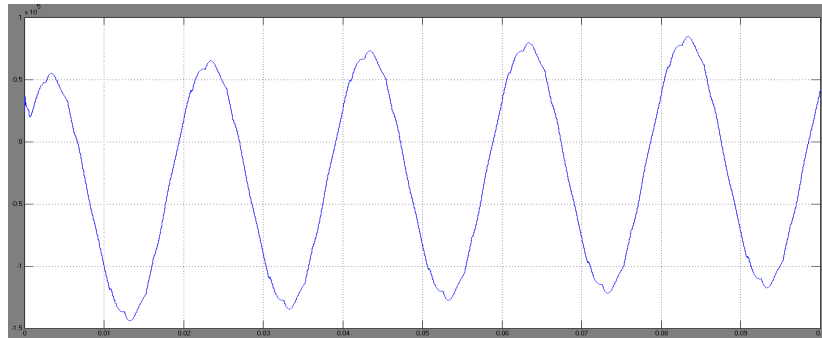


Fig. 13 . Analysis of Ic current.

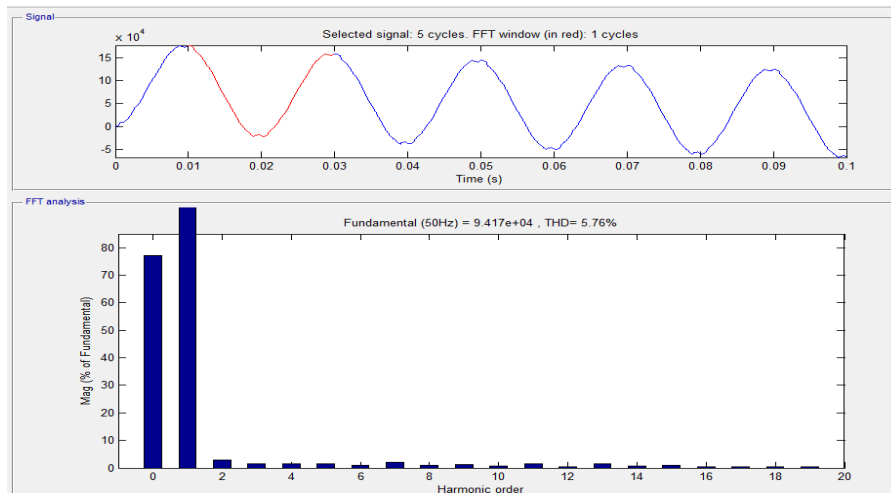


Fig. 14. THD analysis.

C. Performance assessment

The table shows the assessment of THD with filter and without filter.

NON LINEAR LOADS	WITHOUT FILTER(THD)	WITH FLTER(THD)
	10.23%	5.76%

By using shunt active filter, Total Harmonic Distortion is reduced to 5.76% from 10.23% and is more efficient.

V. CONCLUSION

To eliminate the harmonic content produced by the nonlinear load, shunt active filter is used. It also produces the sinusoidal waveforms. The control techniques such as synchronous reference frame theory and the hysteresis current control techniques were establish to be very efficient. The total harmonic distortion was compared without filter and with filter. The active filter with the control techniques are simulated using MATLAB. The system performance, system stability and reduction of harmonic components were achieved.

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