Simulation Study of Active Shunt Power Filter Using Pi Controller

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Abstract: ***In This paper we study the simulation of shunt active power filter using PI controller for improve the power quality using shunt active power filter. When it connected non-linear. Make a simulation of shunt active power filter in MATLAB.***

Keywords: Active power filter, PI controller, MATLAB,non- linear, load,IGBT.

1. Introduction

The application of power electronics devices such as arc furnaces, adjustable speed drives, Computer power supplies etc. are some typical non-linear characteristic loads used in most of the industrial applications and are increasing rapidly due to technical improvements of semiconductor devices, digital controller and flexibility in controlling the power usage. The use of the above power electronic devices in power distribution system gives rise to harmonics and reactive power disturbances.

The harmonics and reactive power cause a number of undesirable effects like heating, equipment damage and Electromagnetic Interference effects in the power system. The conventional method to mitigate the harmonics and reactive power compensation is by using passive LC filters but this method has drawbacks like large size, resonance problem and fixed compensation behavior. The solution of these problem is the active power filter (APF).

1.1 Passive Filters

Passive filters are the conventional filters used for filtering harmonics in low power levels. They comprise of an inductor and a capacitor, thus forming a second order filter.

1.2 Active Power Filters

Active filters have been recognized as a valid solution to harmonic and reactive power compensation due to the presence of non-linear loads. The principle of operation of active filters is based on the injection of the harmonics required by the load.

2. Power Quality Issue &Solution

2.1 Power Quality Issue:

The Power Quality (PQ) problem can be detected from one of the following several symptoms depending on the type of issue involved.

- Lamp flicker
- Frequent blackouts
- Sensitive-equipment frequent dropouts
- Voltage to ground in unexpected
- Locations
- Communications interference
- Overheated elements and equipment

2.2 Power Quality Solution:

Active power filters have proved to be an important and flexible alternative to compensate for current and voltage disturbances in power distribution systems. The idea of active filters is relatively old, but their practical development was made possible with the new improvements in power electronics and microcomputer control strategies as well as with cost reduction in electronic components.

3. Power Filter Topology

Depending on the particular application or electrical problem to be solved, active power filters can be implemented As :

- hunt type
- eries type
- combination of shunt and series active filters (shunt-series type)

The shunt-connected active power filter, with a self-controlled dc bus, has a topology similar to that of a static compensator (STATCOM) used for reactive power compensation in power transmission systems. Shunt active power filters compensate load current harmonics by injecting equal-but opposite harmonic compensating current. In this case the shunt active power filter operates as a current source injecting the harmonic components generated by the load but phase-shifted by 180°.

Series active power filters were introduced by the end of the 1980s and operate mainly as a voltage regulator and as a harmonic isolator between the nonlinear load and the utility system. The series-connected filter protects the consumer from an inadequate supply-voltage quality.

4. Principle of Shunt Active Power Filter (APF)

Fig.4.1 shows the components of a typical active-power-filter system and their interconnections. The information regarding the harmonic current, generated by a nonlinear load, for example, is supplied to the reference current/voltage estimator together with information about other system variables. The reference signal from the current estimator, as well as other signals, drives the overall system controller. This in turn provides the control for the PWM switching pattern generator. The output of the PWM pattern generator controls the power circuit via a suitable interface. Thus the voltage or current generated by the power circuit will be coupled to the power system through a connection transformer.

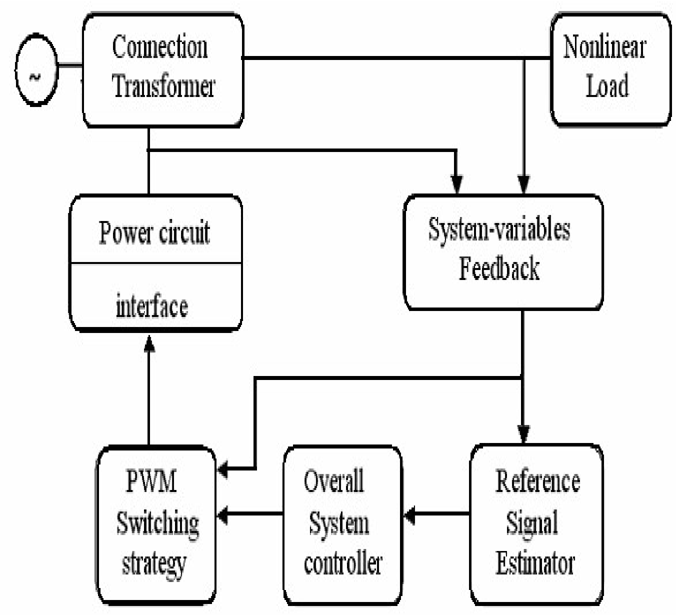

Figure 4.1. Generalized block diagram for active power

4.1 Classification Based on the Supply System:

1) Two-wire APFs

2) Three-wire APFs

3) Four-wire APFs

This fig. shows the basic compensation principle of a shunt active power filter. It is controlled to draw / supply a compensating current ic from / to the utility, so that it cancels current harmonics on the AC side, and makes the source current in phase with the source voltage

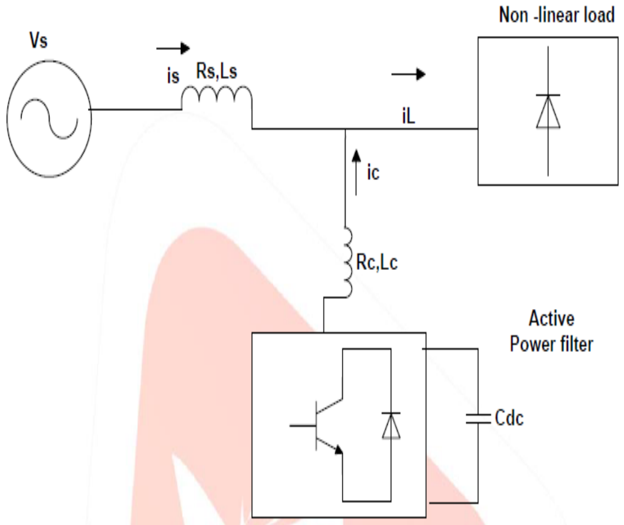

Figure 4.2 Shunt active power filters Basic compensation . principle

4.2 PI Control Scheme:

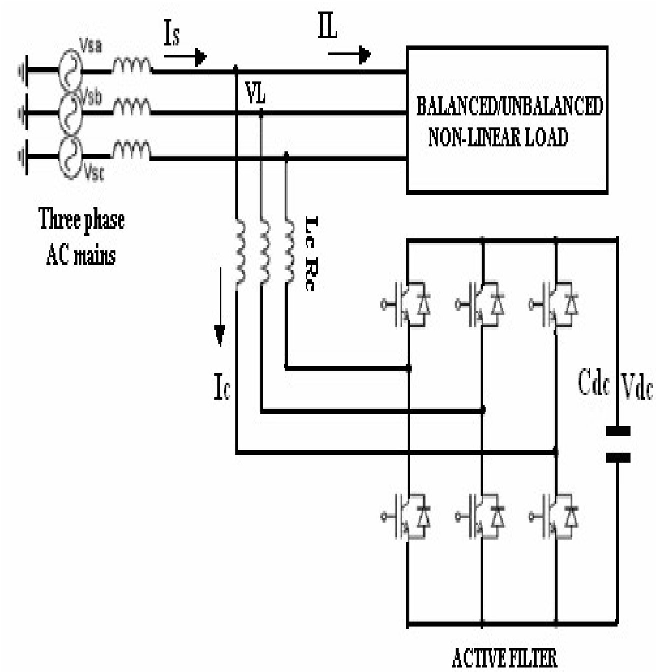

Figure 4.3.Configuaration of three-phase shunt active power filter

The complete schematic diagram of the shunt active power filter is shown in figure 4.3 gives the control scheme realization. The actual capacitor voltage is compared with a set reference value.

The basic configuration of a three -phase three-wire active power filter is shown in Fig 4.3. The diode bridge rectifier is used as an ideal harmonic generator to study the performance of the Active filter. The current-controlled voltage-source inverter (VSI) is shown connected at the load end. This PWM inverter consists of six switches with anti- parallel diode across each switch. The voltage which must be supported by one switch is uni-polar and limited by the DC voltage Vdc. The peak value of the current which is bi-directional is imposed by the active filter current. Thus the appropriate semiconductor device may be an IGBT or a MOSFET with an anti-parallel diode and must be protected against over current. The capacitor is designed in order to provide DC voltage with acceptable ripples. In order to assure the filter current at any instant, the DC voltage. Vdc must be equal to 3/2 of the peak value of the line AC mains voltage.

5. Simulation Model Result

Table 1: Simulation System Parameters

System Parameters	*Value*
Source voltage(Vs)	100 v
System frequency(f)	50Hz
Source impedance(Rs,Ls)	0.1Ω,0.15mH

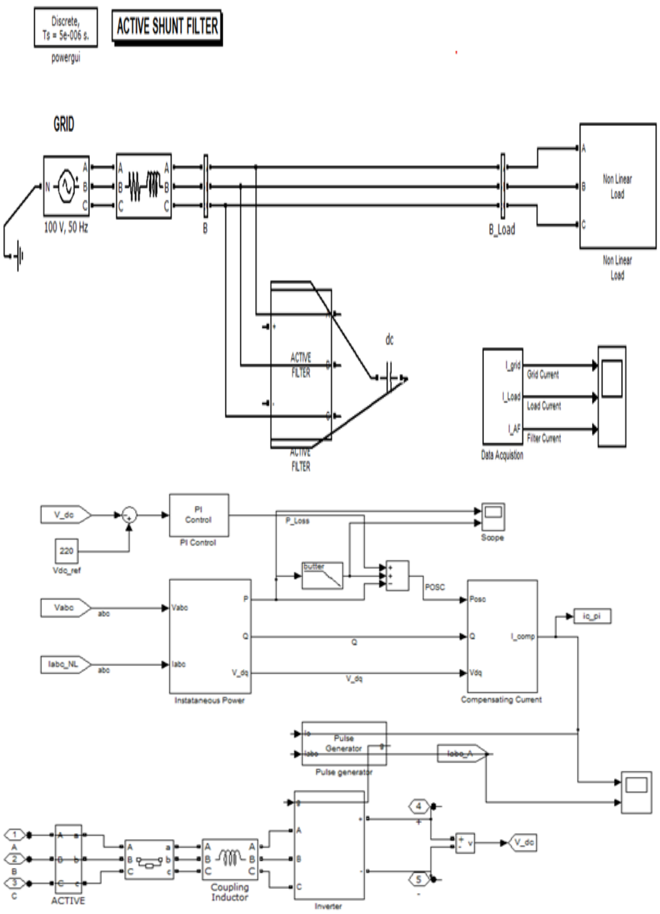

Figure 5.1&5.2: simulation of Active Shunt Filter

5.1 Result

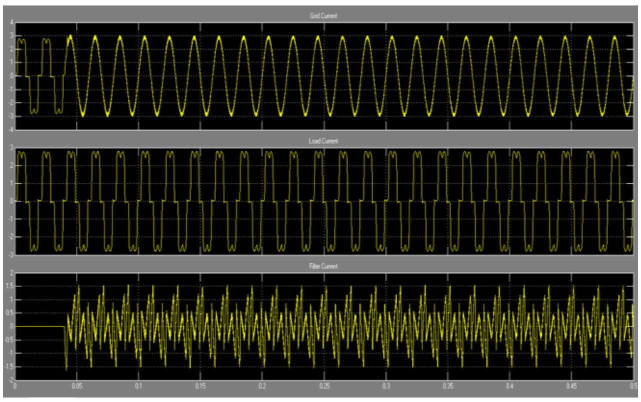

Figure 5.1: waveform of 1) grid current, 2) load current, 3) filter current

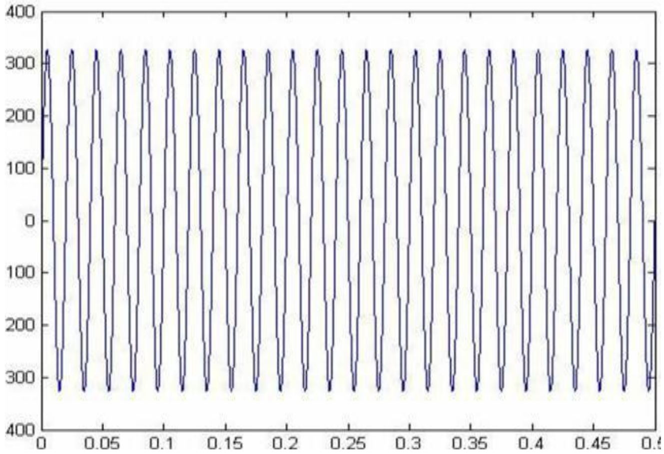

Figure5.2: source voltage

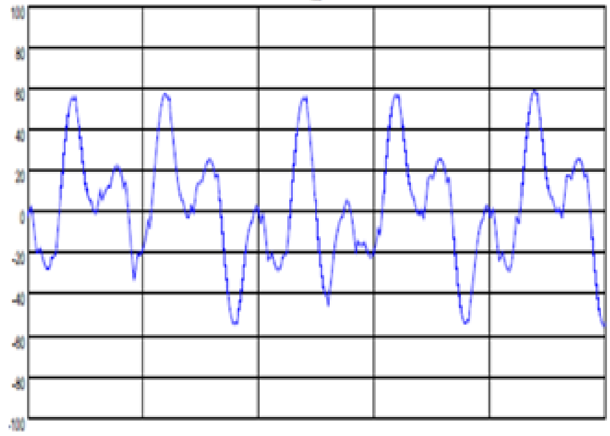

Figure 5.3: compensating current using pi controller

6. Conclusion

This paper has presented a simulation study of PI based hysteresis current controlled active shunt power filter for harmonic in MATLAB and reactive power compensation of the non –linear load. We found from simulation results that shunt active power filter improves power quality of the power system which makes the load current sinusoidal and in phase with the source voltage.

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