ISSN: 2248-9622 www.ijera.com
Vol. 2, Issue 3, May-Jun 2012, pp. 360-364

COMPARISION OF PI AND NEURAL CONTROLLER USING UNIVERSAL ACTIVE POWER FILTER

Sangeetha S.P[#] Pradeep R[*]
[#]Student , [#]Assistant professor,
[#]Dept of EEE, SNS College Of Technology , Coimbator

ABSTRACT—
A universal active power filter is used for harmonic and reactive power compensation in single-phase to three- phase systems. This configuration solves a typical problem found in remote (or rural) applications in which only the single-phase grid is available to supply a three-phase load. In this paper two controllers are used to regulate the load voltage, the power factor, and to minimize the voltage and current harmonics. And then finally compare these two results and find out the best one. Simulated and experimental results are also presented.

***Keywords*—. Universal active power filter, reactive power compensation, harmonic compensation, single phase to three phase conversion**

1 INTRODUCTION

Solid state control of ac power using thyristors and other semiconductor switches is widely employed to feed controlled electric power to electrical loads, such as adjustable speed drives ,furnaces, computer power supplies ,etc. Such controllers are also used in HV dc systems and renewable electrical power generation. As nonlinear loads, these solid-state converters draw harmonic and reactive power components of current from ac mains. In three-phase systems, they could also cause unbalance and draw excessive neutral currents.

The injected harmonics, reactive power burden, unbalance, and excessive neutral currents cause low system efficiency and poor power factor. The universal power filter, also known as the active power line conditioner [1]–[3], which is used to compensating harmonics and reactive power in the system. it consists of a combination of a series type and shunt-type active filter topologies, as observed in Fig. 1. The general advantages of the series active filters are related to its capability for compensating harmonic distortion and disturbance of the grid voltages [4]–[5], while the advantages of the shunt active filters are related to their capability for compensating load harmonic currents and reactive power[6]. The series-active filter eliminates supply voltage flicker/imbalance from the load terminal voltage, and forces an existing shunt-passive filter to absorb all the current harmonics produced by a nonlinear load. Elimination of

supply voltage flicker, however, is accompanied by low frequency fluctuation of active power flowing into or out of the series-active filter. The shunt-active filter performs dc-link voltage regulation, thus leading to a significant reduction of capacity of the dc capacitor.

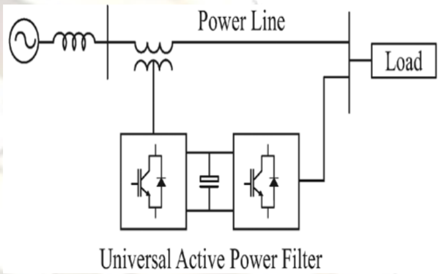


Fig.1.General scheme of the active power filter.

The universal active power filter conceived for harmonic and reactive power compensation in single-phase to three-phase systems. This configuration solves a typical problem found in remote (or rural) applications in which only the single-phase grid is available to supply a three-phase load. Detection and compensation are very important to control an active filter. Detection and compensation are very important to control an active filter. Many techniques have been developed, such as p-q theory , synchronous d–q reference frame, synchronous detection, proportional-integral (PI) controller ,adaptive detection , and selective detection .In this paper the universal active power is controlled by PI and Neural controller and finally compare two results.

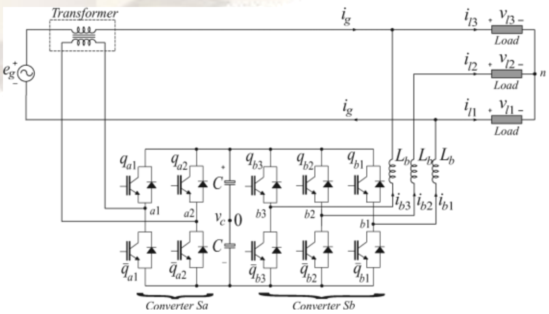


Fig.2. single-phase to three-phase universal active power filter

II. PROPOSED FILTER MODEL

The proposed configuration is presented in Fig. 2. The proposed active power filter can be ideally modeled by a simple circuit, as observed in Fig. 3. From the circuit shown in Fig. 3, the following equation can be written:

$$Eg *= \frac{Va21 *}{\eta} + ZgIg * + Vl31 * \qquad (1)$$

Where Zg is the equivalent impedance composed by the impedance of the transformer plus the impedance of the grid; Eg*,Va21*, and Vl31* are the grid voltage, the series filter voltage , and the load-line voltage , respectively; and is the transformer turns ratio. From the circuit, the following equation can be also written

$$Vl31 *= Vb31 * - Zb\ Ib31 * + Zb\ Ib1 * \qquad (2)$$

where Vb31*,Zb,Ib31*, and are the parallel filter voltage, the impedances connected to phases of the parallel active filter, and the parallel filter currents, respectively.

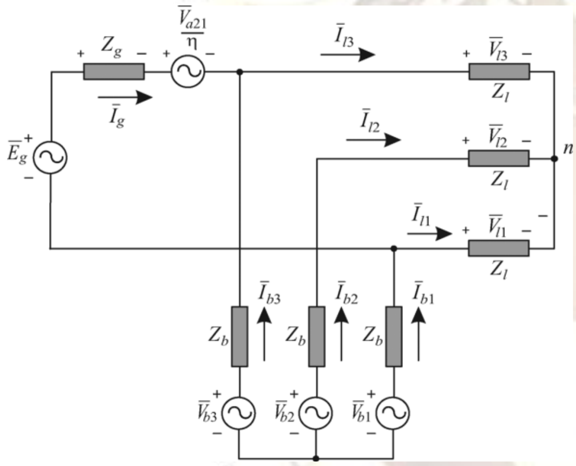


Fig. 3. Single-phase to three-phase ideal active power filter equivalent circuit.

The boundary conditions Ib3*=Il3*−Ig*,Ib1*=Il1*+Ig* and substituting (2) into (1) allows us to obtain the input current as a function of the power filter voltages the grid voltage, and the load currents

$$Ig *= \frac{Eg *}{Zgb} - \frac{Va21 *}{\eta Zgb} - \frac{Vb31 *}{Zgb} + \frac{Zb}{Zgb} Il3 * - \frac{Zb}{Zgb} Il1* \qquad (3)$$

Where Zgb = (Zg + 2Zb) Equation (3) shows that Ig* is a function of Vb31* and Va21* with the same level of importance when η=1. The other terms Eg*,Il3* and Il1* can be considered as a disturbance for the control system; therefore, they can be compensated. Since the control of Vl31* should be performed by using Va21*, the current Ig* is controlled by Vb31* . Considering (1), we can obtain

$$Vl31 *= Eg * - \frac{Va21 *}{\eta} - Zg\ Ig * \qquad (4)$$

In this case, Vl31* must be controlled by Va21* . From Fig. 3, the voltage Vl21* can be easily obtained as follows:

$$Vl21 *= Vb21 * - ZbIb21 * + Zb\ Ib1 * \qquad (5)$$

Then, Vl21* should be controlled by Vb21*. The model of the topology shown in Fig. 3 is only valid for the following assumptions: only the fundamental component of voltages and currents is considered and the single-phase transformer and inductor are ideals. Note that the balanced three-phase voltages Vl1*, Vl21*, and Vl31* can be obtained from the phase diagram in Fig. 4 even in the case of the single-phase grid. The voltage phase angle δl is an important parameter of system, used for optimization proposes.

III. STEADY-STATE ANALYSIS OF THE PROPOSED SYSTEM

Steady-state analysis permits determining the behavior of currents and voltages of the proposed system. With that, it is possible to manipulate its parameters to minimize the converter currents and voltages and, consequently, to minimize the converter losses.

The steady-state analysis is accomplished by writing the variables on the complex form. For example, Ig* = Igd + jIgq (i.e., the subscript d stands for the real component and q stands for the imaginary component of the complex variable). Assuming that , the equations for the boundary conditions are

$$Ig *= Igd = Ig \qquad (6)$$
$$Pa + Pb + Pg = Pl \qquad (7)$$
$$Pa + Pb + Ploss = 0 \qquad (8)$$

Where Pg is the net active power furnished by the grid; Pa and Pb are the active power through the series and parallel power filter, respectively,

Ploss is the filter power losses; and Pl is the active power received by the load.Condition 6) indicates the unit input-power factor and conditions (7) and (8) indicate that the active power filter does not furnish active power in steady state.

IV. TRANSFORMER INDUCTORS AND DC-LINK CAPACITOR SPECIFICATIONS

A. Transformer Specification

The power of the single-phase transformer can be determined by the characteristics shown in Fig. 4. These characteristics are determined from the steady-state model, and the value of the transformer power is defined as a function of the load power.

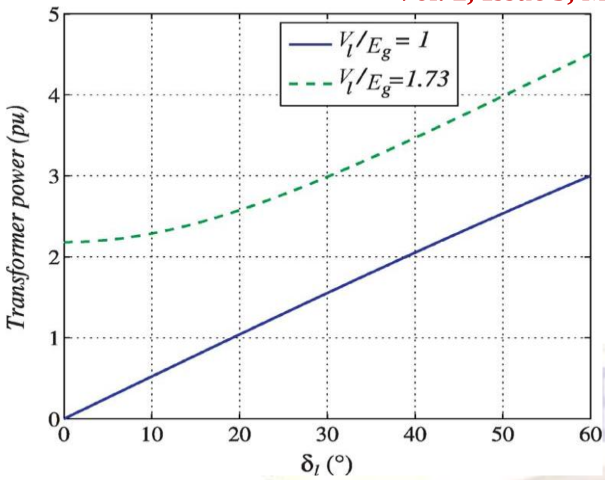


Fig.4.Transormer power versus angle δl.

B. Inductor Specification

The design of the inductors (Lb) is an important issue in the parallel active power filter, since this type of filter must have source current characteristics. The inductors specification affects the dc-link voltage and the THD of the grid current.

In fact, an increase in the value of this inductor will increase the dc-link voltage and will decrease the total harmonic distortion voltage. On the other hand, a decrease in the inductor value will decrease the dc-link voltage while increasing the THD value.. the specification of filter Lb is a critical parameter associated with the total harmonic distortion (THD) of the filter variables.

C.DC-Link Capacitor Specification

When the converter provides only reactive current, the minimum capacitance on the dc link may be calculated from maximum dc-voltage ripple constraint, caused by the switching frequency [7]. The specification of the capacitor value is determined by [7]

$$C = \frac{ic,ripple\,\sqrt{2}}{2fch\ \Delta vcmax} \qquad (9)$$

where ic,ripple is the rms current in the capacitor, fch is the switching frequency, and Δvcmax is the allowable dc-link voltage ripple.

V.CONTROL STRATEGY

The control block diagram of the proposed system as shown in fig.. The capacitor dc-link voltage Vc is adjusted to a reference value by using the controller Rc , which is a standard PI-type controller. This controller provides the amplitude of the reference current Ig*. For the power factor and harmonic control, the instantaneous reference current ig* must be synchronized with voltage This is obtained via block GEN-g; this block indicates the instantaneous phase δg of voltage eg and generates the current ig* from Ig* and δg.

The current controller is implemented by using the controller indicated by block Ri . This current controller defines the reference voltage Vb31*, which has been used for the power factor control, operating as a shunt filter.

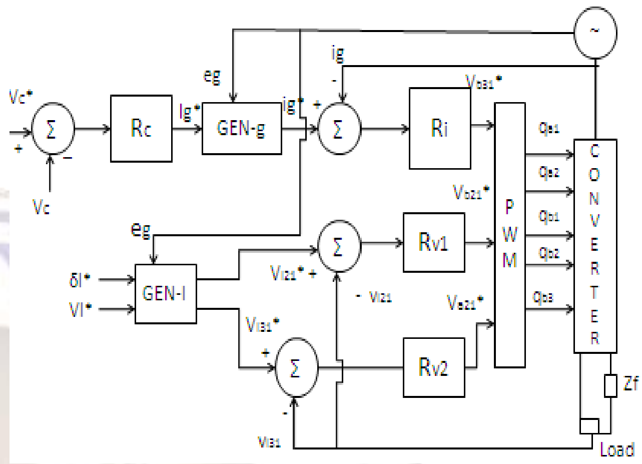


Fig .5. Control block diagram of the system

The line voltage Vl31 has been defined by the series filter; the controller Rv2 defines Va21*. The line voltage Vl21 has been regulated by controller Rv1, which defines. Vb21* Once the reference voltages are defined the PWM strategy can be directly applied.

The block GEN-l is similar to that of GEN-g It generates the reference line voltages (Vl31* and Vl21*) from Vl*, δl*,and δg.

$Vl31* = \sqrt{3}Vl * \cos(\omega g\ t + \delta g + \delta l *)$ and
$Vl21* = \sqrt{3}Vl * \cos(\omega g\ t + \delta g + \delta l * + 60°)$.

the same control strategy also used for neural controller for reduce THD.

TABLE I

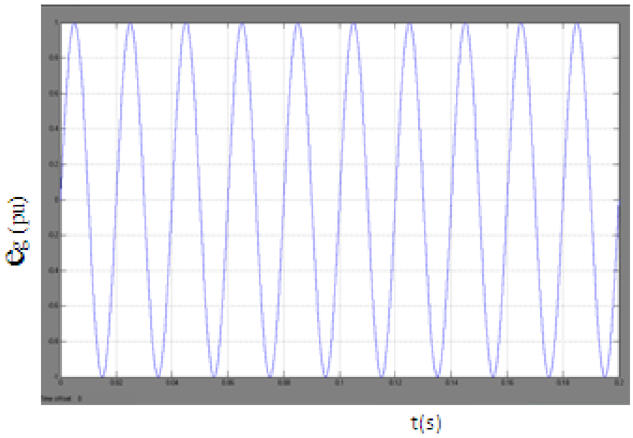
Comparison Between The PI And Neural Controller THD Value

PI CONTROLLER	NEURAL CONTROLLER
THD FOR LINE-1 1.65	THD FOR LINE 1 = 0.86
THD FOR LINE 2 = 4.01	THD FOR LINE 2 = 2.70
THD FOR LINE 3 = 2.84	THD FOR LINE 3 = 1.31

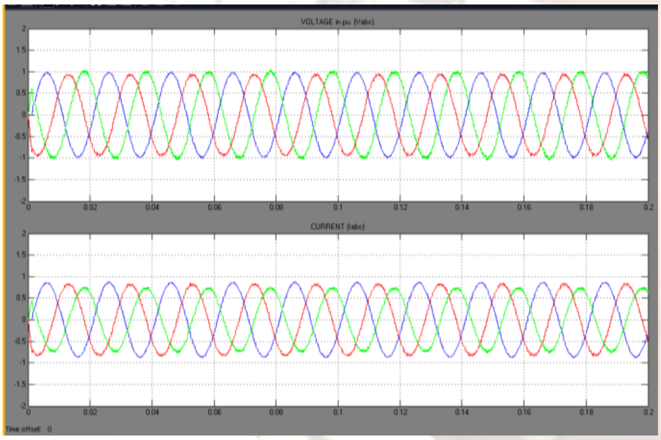
ISSN: 2248-9622 www.ijera.com
Vol. 2, Issue 3, May-Jun 2012, pp. 360-364

*VI.*SIMULATED *RESULTS*

Fig 6.shows a set of simulated results of single phase grid voltage(e.g.), three phase output voltage and current wave form. and the THD measured for all three phase line.



(a)

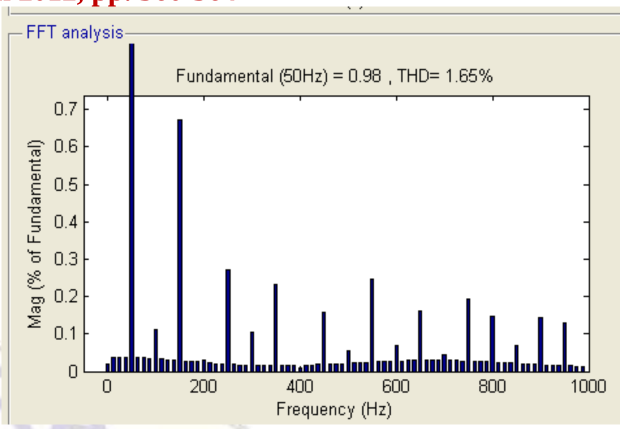


(b)

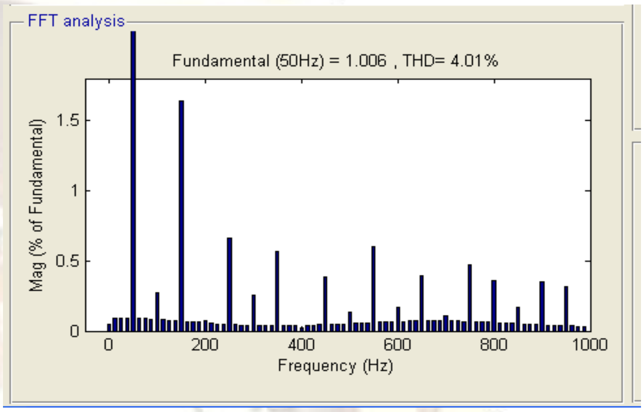
Fig.6. Experimental results. (a) Grid voltage.
(b) Load voltage(top) and load current(bottom)

A. Case I

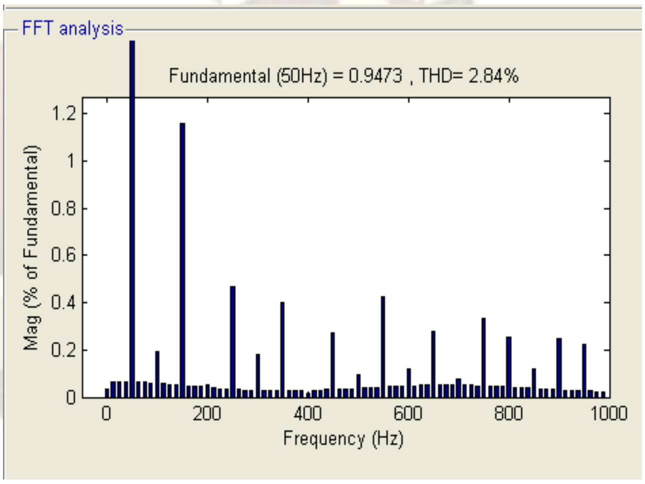
The THD measurement for three phase line by using PI controller.



(a)



(b)

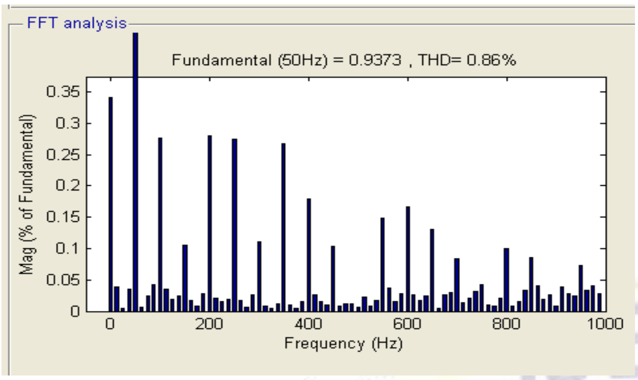


(c)

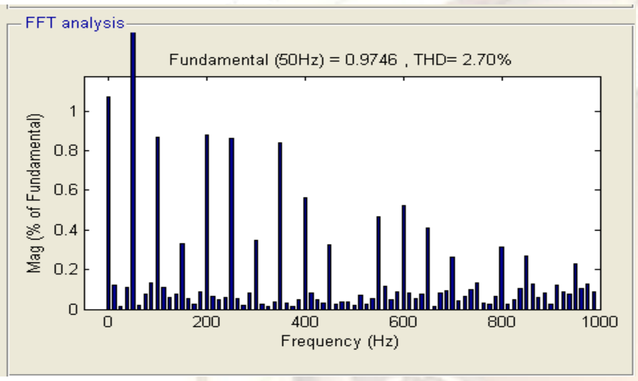
Fig.7. Experimental result (a) Line-1 (b) Line-(2) (c) Line-3

B.Case II

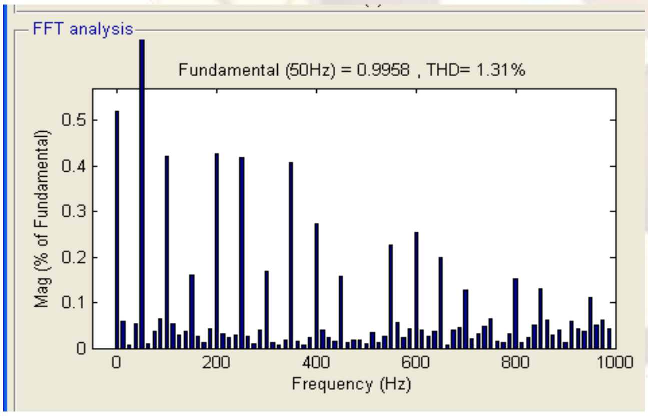
The THD measurement for three phase line by using Neural controller.



(a)



(b)



(c)

Fig.8. Experimental result (a) Line-1 (b) Line-2 (c) Line-3

VII CONCLUSION

A universal active power filter for harmonic and reactive power compensation in single-phase to three-phase systems was presented. A suitable control strategy, has been developed as well. The model of the system was derived, and comparing PI and Neural controller. The experimental results demonstrate the Neural controller reduced the THD, switching losses, and switches power ratings compare then PI.

REFERENCES

[1] B. Singh, K. Al-Haddad, and A. Chandra, “A review of active filters or power quality improvement,” *IEEE Trans. Ind. Electron.*, vol. 46, no. 5, pp. 960–971, Oct. 1999.

[2] M. Aredes, K. Heumann, and E. H. Watanabe, “An universal active power line conditioner,” *IEEE Trans. Power Del.*, vol. 13, no. 2, pp. 545–551, Apr. 1998.

[3] H. Fujita and H. Akagi, “The unified power quality conditioner: The integration of series and shunt-active filters,” *IEEE Trans. Power Electron.*, vol. 13, no. 2, pp. 315–322, Mar. 1998.

[4] E. Ribeiro and I. Barbi, “Harmonic voltage reduction using a series active filter under different load conditions,” *IEEE Trans. Power Electron.*, vol. 21, no. 5, pp. 1394–1402, Sep. 2006.

[5] S. Inoue, T. Shimizu, and K. Wada, “Control methods and compensation characteristics of a series active filter for a neutral conductor,” *IEEE Trans. Ind. Electron.*, vol. 54, no. 1, pp. 433–440, Feb. 2007

[6] H. Fujita and H. Akagi, “Voltage-regulation performance of a shunt active filter intended for installation on a power distribution system,” *IEEE Trans. Power Electron.*, vol. 22, no. 3, pp. 1046–1053, May 2007.

[7] L. Asiminoaei, E. Aeloiza, P. N. Enjeti, F. Blaabjerg, and G. Danfoss, “Shunt active-power-filter topology based on parallel interleaved inverters,” *IEEE Trans. Ind. Electron.*, vol. 55, no. 3, pp. 1175–1189, Mar. 2008.