International Journal of Research (IJR) Vol-1, Issue-11 December 2014 **ISSN 2348-6848**

Study of Thyristorised Based Real Time Power Factor Correction (TRTPFC)

Ravi Khemchandani[1] Ashish Nipane [2] Hitesh Khanna [3]

[1]Student in Dronacharya College of Engineering

Abstract-

Power factor reflects how efficiently industries and organizations use electricity. Power factor compares the amount of useful work that is extracted from the total amount of electric energy supplied. This paper proposes a conceptual design of microcontroller based automatic power correction (APFC Relay) for 1 phase and 3 phase circuit with intension to be used in power factor load applications. As can be seen from power factor definition, if PF is near unity, the apparent power (KVA value approaches near actual power (KW). This is possible if, and only if KVAR (reactive power) is kept to a minimum. In practice, this reactive power KVAR is Inductive in nature (major loads are inductive). This reactive power is compensated by countering it with capacitive KVAR in the circuit and can bring system KVAR value near zero. The designing of the power factor correction is to ensure the entire power system always preserving almost unity power factor and thus optimizing the current consumption.

Keywords-

Energy Saving; Reduction of Harmonics; Power Factor Correction

I. INTRODUCTION

Power factor is related to total power consumed and working power. Essentially, power factor is a measurement of how effectively electrical power is being used. The higher the power factor, the more effectively electrical power is being used. Low power factor means poor electrical efficiency. When low power factor is not corrected, more power is consumed which leads use of larger generators, transformers, bus bars, wires, and other distribution system devices that otherwise would not be necessary. This would lead to increase in the operating cost and this would pass on to users in the form of power factor penalties. One of the new approaches is to use a variable inductor in parallel with a fixed capacitor as a reactive power compensating circuit. The inductor current is controlled by adjusting the firing angle of two anti parallel connected thyristors or using TRIAC. The adjustment of the thyristors' firing angle is made in accordance to the result of a comparison between the measured values of a certain system parameter with its reference value .This paper proposes a real time power factor correction scheme for 1 phase and 3 phase system. The election of the capacitor according to load value and simulation for both systems with harmonics are including in this paper.

II.BLOCK DIAGRAM OF 1 PHASE SYSTEM

The figure shows the block diagram of the 1 phase power factor correction system. There are two references namely Voltage and Current measured from the PT and CT. These two references are compared and their resultant angle is given as firing angle of Thyristor. Before them these references are gone through the band pass filter and zero crossing detector. ZCD converts the sinusoidal waveform into square waveforms for triggering thyristor at every zero crossing.

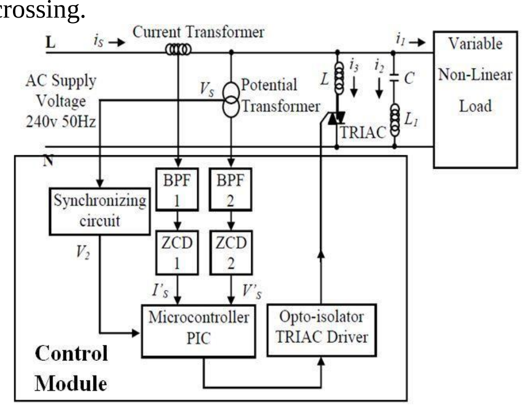

Figure 1. Block Diagram of 1 phase System

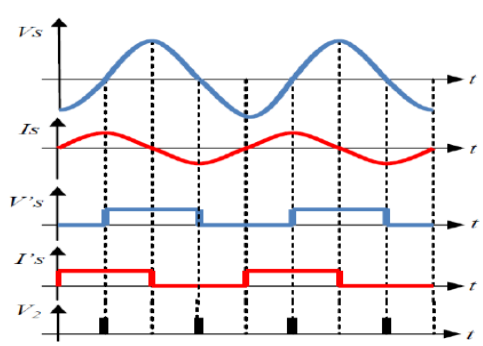

Figure 2.Waveform of leading pf

In figure 1, i_s is the Source current; Vs is the Source voltage; i_1, i_2, i_3 are the load current, Capacitive branch current, Inductive branch current respectively. Figure 2 and 3 are theoretical waveforms of the 1 Phase system. I'_s and V'_s are the output current and voltage of the ZCD respectively.

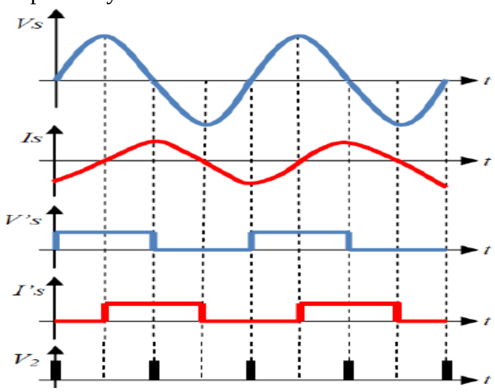

Figure 3. Waveform of lagging pf

III .CIRCUIT DIAGRAM OF 3 PHASE SYSTEM

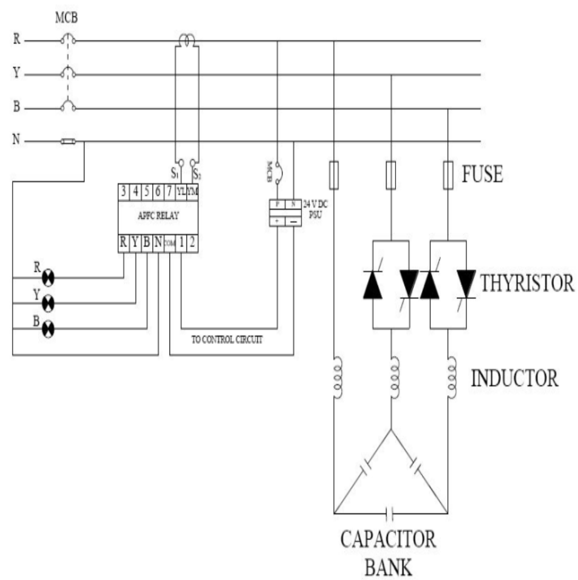

Figure 4. Block Diagram of 3 phase System

This figure 4 seems that power circuit diagram of RTPFC panel. This control circuit will control the load power factor by sensing various parameters like –switching device thyristor, inductors, capacitor banks etc. And generally this will have one incoming switch like MCB. In this figure 4 3 phase supply is given through MCB and C.T is connected to the line which is measured the current, And secondary terminal of C.T is connected in terminal (s1 and s2) of APFC relay's terminal (YL and YM).Phase angle will be measured by pick controller in APFC relay which is given to the zero crossing device. And this thyristor switched devise TRTPFC is switch at zero crossing device. Power factor correction is the process of compensating for the lagging current by creating a leading current by connecting capacitor in parallel to the supply.

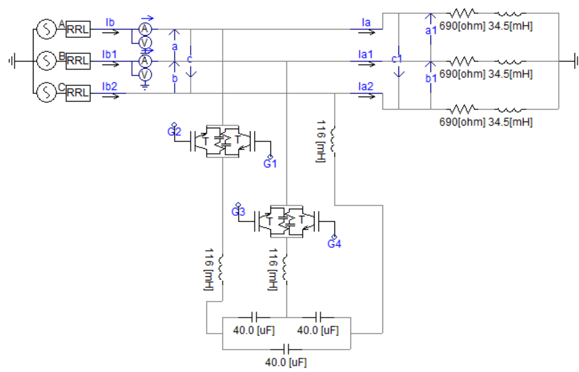

Figure 5. Power Circuit of 3 phase System

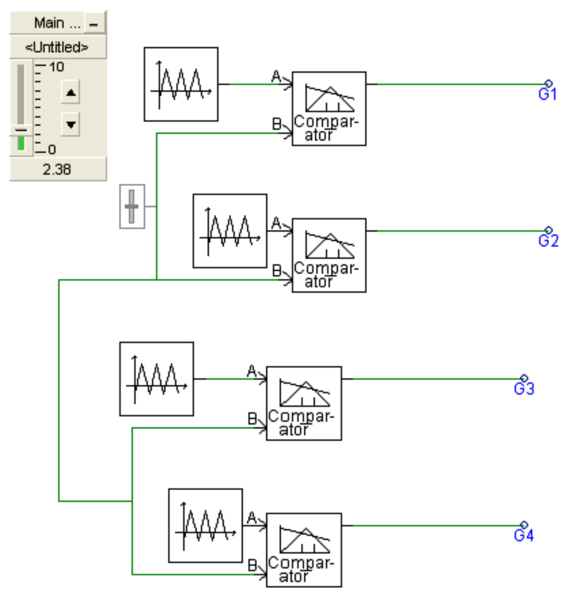

Figure 6. Control circuit of 3 phase System

The following figure shows the control circuit diagram for 3 phase system. In 3 phase system, phase angle for each phase is given at 0^0 , 120^0 and 240^0. The value of capacitor is depending on the value of load. So, election of the capacitor value is based upon following relation.

KVAR of Capacitor = P x (Tan Φ1 - Tan Φ2)

Where P is value of load in kW

Φ1 is actual angle between Voltage and current

Φ2 is required angle between voltage and current

Per phase capacitance KVAR = $KVAR/3$

Icph =$Vp\,h\,/Xc$= $Vp\,h/1/\,2\pi fC$= Vph X $2\pi fC$

KVAR/ Ph = $Vp\,h\,Ip\,h$ 1000

After simulating 3 phase circuit as shown in figure-10. Following results are obtained.As in figure-7. 3 phase input voltage, input current, output voltage, output current and voltage is nearly same as input voltage and current.

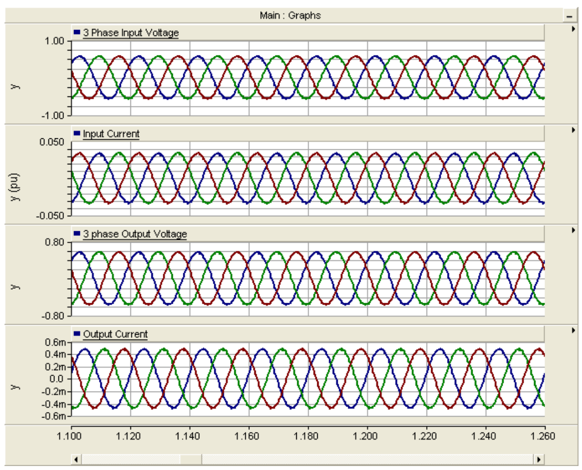

Figure 7. Control circuit of 3 phase System

The following figure shows the gating signals for 3 – phase system.

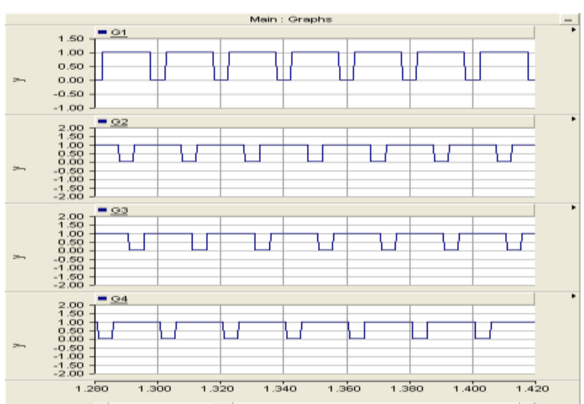

Figure 8. Waveforms of Gate signals of 3 phase

The figure -9 shows the control circuit for 3 phase system for Harmonics Analysis.

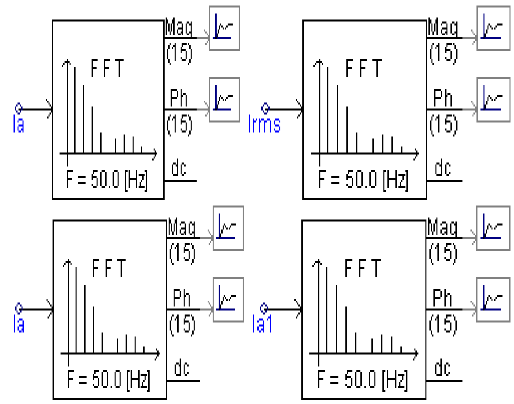

Figure 9. Control circuit of 3 phase System with Harmonics

The following figure shows the harmonics waveforms for 3 phase system.

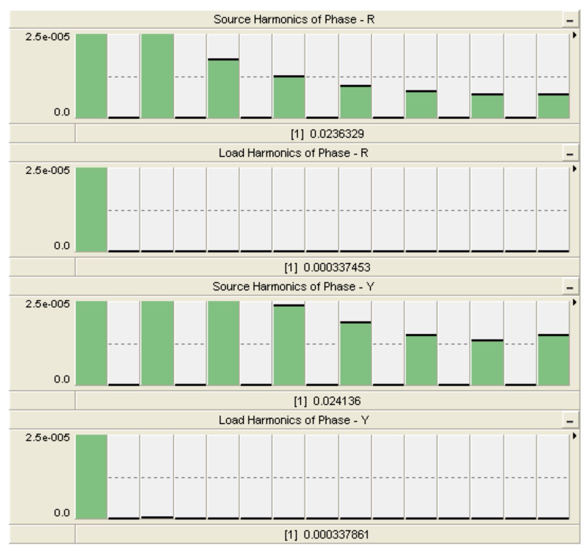

Figure 10. Waveforms of 3 Phase System with Harmonics

Figure-10 shows the harmonics are present and load harmonics are effectively eliminated by applying TRTPFC control technique.

IV. Conclusion

PFC preregulators are needed to improve output voltage dynamics. In under load condition, voltage leads the current due to capacitive effect and in overload condition; system draws more current due to inductive effect that produces the harmonics. By using TRTPFC technique, that improve output voltage and eliminates the harmonics. TRTPFC also improves the power factor almost to unity which saves the energy. TRTPFC technique is easily implemented in practical system.

REFERENCES

[1]Alexander.C.K and Sadiku, .N.O.(2000).” Fundamentals of Electric Circuit “United States of America: McGraw-Hill Companies.inc.

[2] Stephen, J.C.(1999).”Electric Machinery and Power System Fundamental. ”3rd .ed. United State of America: McGraw-Hill Companies, Inc.

[3] John J. Grainger, William D. Stevenson (1994). ”Power System Analysis.”New York: McGraw-Hill.

[4]Jos Arrillaga, NevilleR.Watson (2003). ” Power System Harmonics” 2nd.ed. Chichester: John Wiley.

[5]J.E.Miller (1982). ”Reactive Power Control in Electric System.” New York: Wiley

[6] H.M. El-Bolok, M.E.Masoud .and M.M.Mahmoud(1990). “A Microprocessor –Based Adaptive Power Factor Corrector for Nonlinear Loads” Faculty of Engineering and Technology, University of Helwan, Cairo, Egypt.

[7] “Electrical Power System”,V.K. Mehta and Rohit Mehta.

[8]www.google.com