International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 09 | Sep 2019 www.irjet.net p-ISSN: 2395-0072

Automatic Power Factor Correction

Miss Aaiman S Shaikh[1], Prof. Laxman S Patil[2]

[1]Student of Department of Electrical Engineering, Padmabhooshan Vasantraodada Patil institute technology, Budhgaon, India
[2]Associate Professor of Department of Electrical Engineering, Padmabhooshan Vasantraodada Patil institute technology, Budhgaon, India

---

Abstract - *A low power factor leads to an increase in losses and draws penalty by the utility. Modern industry implementing the mechanized methods can suffers from lower power factor due to the use of different electric equipment which requires more reactive power. Significant savings in utility power costs can be understood by keeping up an average monthly power factor close to unity. The above drawback is overcome by the PFC. Power factor correction (PFC) is a technique of reducing the undesirable effects of electric loads that create a power factor which are less than one. In this paper an Automatic Power Factor Correction (APFC) Unit is build which monitors the power factor and automatically it corrects the power factor. Power factor correction is a method of reducing undesirable adverse effects of electric loads that causes a power factor to be less than one. In this t an Automatic Power Factor Correction Unit is build which monitors the power factor and automatically it corrects the power factor. The phase differences between voltage and current are determined using zero crossing detectors with some basic functions of microcontroller.*

***Key Words*: power factor, capacitor bank, relay, micro controller, rectifier, current transformer, potential transformer**

1. INTRODUCTION

Power quality of an A.C system is much concerned because of the rapidly increasing numbers of electronic equipment's, high voltage power system and power electronics. All commercial and industrial installation in India have a large electrical load that are most probably inductive in nature. This causes lagging power factor that gives high penalties to consumers. The high penalty situation is tackled by the Power Factor Control. Power Factor Control is a method of reducing the disagreeable effect of loads that causes power factor to drop down to lesser than one.

In A.C circuits, the power factor can be described as a proportion of the actual (Real) power that does the work and the Apparent power which is provided to the circuit. Real power is well-characterized as the circuit's capacity for performing work in a specific time. Moreover, apparent power is known as the current and voltage product of the circuit see the Figure no. 1.

$$Power\ Factor = \frac{\text{Real Power}}{Apparent\ Power}$$

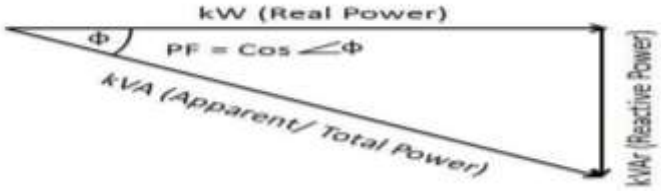

Fig -1: Schematic Diagram for Power Factor

The power factor can attain values in the range from 0 to 1. Power factor tends to zero when all the power present is only reactive power and is commonly known as inductive load. Similarly, P F is one when there is only real power present, and it is known as resistive load. Correcting P F is nothing but adjusting the electrical circuit so that the power factor could be changed near to 1. Improving Power Factor near to 1 compensates the reactive power existing in the circuit and then most of the power existing will be real power. Consequently, this lessens the power lines losses. The application of Power factor correction can be associated with an electrical power source to enhance the efficiency of the system along with stabilising the transmission network. Furthermore, in order to achieve the cost reductions, the improvements can be made through the electricity suppliers charging for single electrical customers. For the improvement of transmission efficiency, power factor correction research is now considered as a hot issue.

2. Various Methods for Improving Power Factor

2.1 By using Capacitors:

Improving P F means decreasing the phase difference of the voltage and the current. Inductive loads require some reactive power for them to work. The reactive power is provided by bank of capacitors that are connected parallel to load. It can be said that capacitors are a source of local reactive power, and hence lesser reactive power flows from the line. They decrease the phase difference in the voltage and current.

When capacitors are used Losses are low and also requires very less maintenance. Installation of capacitors is easy because of lighter weight and do not require foundation.

2.2 By using Synchronous Condenser:

Synchronous Condenser are 3 phase synchronous motor which do not have any load attached to its shaft. The synchronous motor has the feature of working under any power factor which can be leading, lagging or unity that depends on the excitation. In case of inductive type of load, a

synchronous condenser is connected at load side and is then overexcited. They behave as a capacitor when they are over excited. When such machine is connected parallel to supply, it takes leading current which partly neutralizes lagging reactive component of the load thus power factor is improved. By using synchronous condenser high Control on power factor and also have higher thermal stability. The faults can be eliminated easily. Losses occur in the motor. It has high maintenance cost.

2.3 Phase Advancer:

This is an A C exciter which is mainly used for improvement of power Factor of the induction motor. Phase advancers are used suitably when synchronous motor use is not admissible. Phase advancers are uneconomical for motors that are under 200HP

3. Methodology for power factor computation and penalty and incentive sept 2018

Power Factor is computed as:

$$Power\ Factor = \frac{KWH}{\sqrt{(KWH)^2 + (RKVAH\ Lag - RKVAH\ Lead)^2}}$$

If Power Factor Level is less than 0.90 then penalty shall be as per percentage given in MERC order.

• If Power Factor is more than 0.95 and RKVAH Lag consumption >= RKVAH Lead consumption, then incentive is as per percentage given in MERC order.

• If Power Factor is more than 0.95 and RKVAH Lag consumption < RKVAH Lead Consumption, then incentive is not applicable.

• If the RKVAH Lead reading is not available, then the old procedure of power factor consumption will be followed.

There is Change in percentage of Power Factor penalty and incentive as follows:

Power Factor Incentive:

Table -1: Power Factor incentives

Power Factor	Old %	New %
0.95	0	0
0.96	1	0.5
0.97	2	1
0.98	3	1.5
0.99	5	2.5
1	7	3.5

Table-2: Power Factor Penalty (For Lead as well as Lag):

Power Factor	Old %	New %
0.90	0	0
0.89	2	1
0.88	3	1.5
0.87	4	2
0.86	5	2.5
0.85	6	3

4. PROPOSED SYSTEM

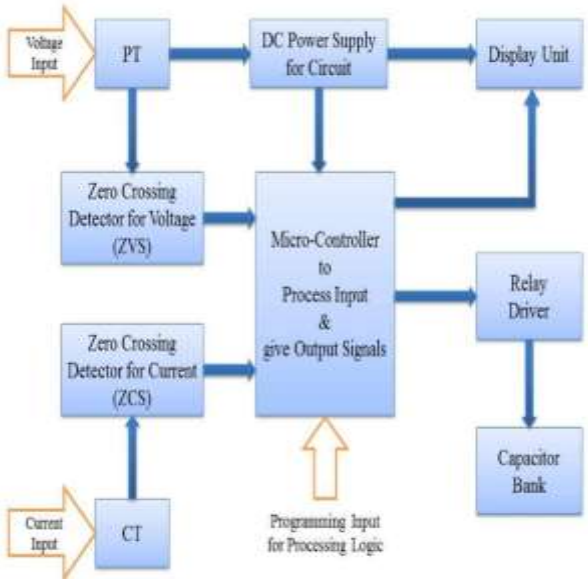

Fig -2: Block Diagram of Automatic Power Factor Correction unit

The complete automatic power factor correction unit consist of following parts

4.1 Power supply

Most of time embedded system circuit uses 12 volts. 5-volt DC is used as its operating voltage. It's necessary to change the 230 Volt A C supply to the essential D C supply. Firstly 12 volts ac supply is obtained by using stepdown transformer by reducing the 230 Volt supply to 12 volts. In this project the potential transformer (PT) outputs can be used in its place rather than going for another different step-down transformer. By rectification process, the 12 Volts A C is converted in to a 12 Volts pulsating DC voltage. The pulsating D C is then sent to a capacitive filter for smoothening and a standard 12 Volt DC is obtained as a output.

4.2 Potential transformer

They convert A.C from one level to another voltage level along with some loss of power. The P T utilizes a step-down transformer to lessen hazardously higher voltage to a more secure lower voltage in any substation. Potential Transformer used in automatic power factor correction project steps-down the supply voltage from 230 V to 12 V as needed by circuit to work. Potential Transformers output is usually used for measuring and also various monitoring purposes.

4.3 Current transformer

In an electrical circuit, currents is measured by using a C T.At point when current is exceptionally high to straightforwardly apply to measuring instruments, the C T creates a decreased

current, that can be suitably connected with measuring and recording instruments. C T that are used in the circuit also protects the measuring instruments from an exceptionally higher voltage. C T are mostly used in metering devices. and also, in protective relays

4.4 Capacitor bank

Shunt capacitor banks basically is utilized for the improvement of the P F in electrical network. Capacitor banks are also used for the improvement of the voltage stability and decrease network losses. Shunt capacitor banks are not expensive. Shunt capacitors installation can be done easily anywhere on the network. Depending on the necessity of reactive power, capacitor bank which consist of shunt capacitors are made ON or OFF. With the usage of relays the switching can be done by manual way or automatically.

4.5 Microcontroller

An embedded system is not effective without logical processing. The microcontrollers take the responsibility of logical processing hence can be seen as a heat of an embedded system. They do majority of the work starting from taking the data or instructions in, processing it according the programme written and finally provide the output to complete the required function. It is worthy to mention another positive characteristic of the embedded system such as chip memory. This allows the system to store some temporarily variables during the processing procedures to smoothen the process. The PIC microcontroller PIC16f877a is one of the most well-known microcontrollers. This microcontroller is very suitable to use. The main benefit is that it can be write or can be erased as many times as possible because it uses FLASH memory technology.

4.6 Relay unit

Relay unit contains a relay driver and some relays. The relay unit controls the high-power circuit from a low power circuit because microcontroller's output cannot control direct switching of capacitors. Relay is defined as an electrically operated switch. When there is a need to control in a circuit by a low power signal in such cases relays are used. Current that passes from coil of relay generates a magnetic field that gets attracted towards lever and then the switch contacts are changed. Connections of relay's switch are Common, Normally Open (NO), normally closed (NC).

Relay coil is not operated by the current provided by the output of microcontroller as current is insufficient. Relay driver ULN2003 is used for the operation of the relay. ULN2003 is a mono-lithic higher voltage and higher current Darlington transistor array.

4.7 DISPLAY UNIT

An embedded system communicates directly to a human being by use of input and output devices. It should be noticed that in an embedded system, the interaction is instigated by the microcontrollers. The system uses input and output devices those generate direct communications with human being. LCD display can be considered as the most common devices that is connected to the microcontroller. Specifying the types of LCD displays, 16x2 and 20x4 are the most common ones connected to the microcontrollers. These digits indicate the numbers of the characters and the numbers of the lines. For example, a 16x2 LCD display contains 16 characters and 2 lines made available to use. Similarly, 20x4 LCD display indicates 20 characters and 4 lines made accessible for use. In this project a 16x2 LCD display, is considered.

5. HARDWARE IMPLEMENTATION

The P C B was made-up as per the diagram and then all the components were soldered. The Potential transformer, Current Transformer, capacitor bank were soldered properly at their respective places. microcontroller was programmed by using a burner. The C T is connected in series with load and capacitor bank. Microcontroller determines both magnitudes and phase difference of AC voltage and current . Based on the measured values using formula P F of load is calculated. The liquid crystal display is used to display the improved P.F.

Fig -3: Hardware of Automatic Power Factor Control

6. Results

Figure 3 shows the whole hardware of Automatic Power Factor Control Unit used for improving power factor. One of the results is discussed below. Figure 3, when inductive load was applied i.e. Choke is used in this case the measured P.F was found to be 0.85 Lagging (refer the figure 4) and In Figure 5, the P F is increased to 0.99 by adding capacitor in parallel. The result shows the working and idea of Automatic Power Factor Correction by using capacitors.

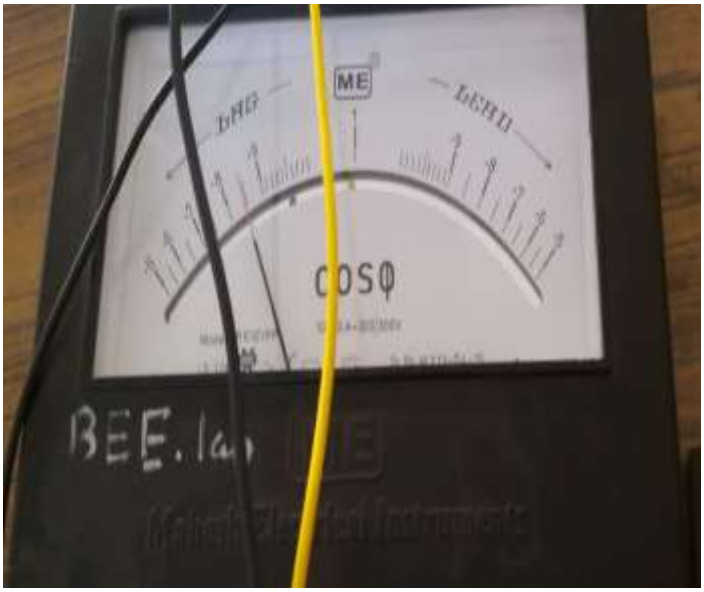

Fig 4 Measured power factor

Fig 5. Showing corrected power factor on LCD

7. CONCLUSION

This project is implemented to automatically correct power factor. Microcontroller used helps to sense the Power Factor by monitoring the load of the system, and according to the lagging behavior of P F because of type of load it will perform the control action by switching capacitor bank through different relays and improves the Power Factor of the load. By improving Power Factor electricity bill can be reduced.

REFERENCES

[1] The 8051 Microcontroller and Embedded Systems" by Muhammad Ali Mazidi and Janice Gillispie Mazidi.

[2] Ware, John. "POWER FACTOR CORRECTION."IET Electrical. IEE Wiring Matters, spring 2006. Web. 14 July 2016. Available at [www.electrical.theiet.org/wiring-matters/18/powerfactor. cfm?type=pdf] .

[3] "POWER FACTOR CORRECTION."www.nhp.com.au. NHP Catalogue - PFCSFC, Nov. 2007. Web. 14 July 2016. Available at[https://portal.nhp.com.au/power-quality]

[4] "Power Factor Correction: A Guide for the Plant Engineer."www.eaton.com/. Eaton Corporation, Aug. 2014. Web. 14 July 2016. Available at [www.eaton.com/ecm/groups/public/@pub/.../sa02607001e.pdf]

[5] Mehta, V. K., and Rohit Mehta. Principles of Power System: (including Generation, Transmission, Distribution, Switchgear and Protection). 4th ed. Chapter 9, New Delhi: S. Chand, 2005.

[6] Kulkarni Kaumudi, Kumbhar Pooja, Patil Priyanka, Prof. Madhuri International Namjoshi, "Automatic power factor correction using PIC microcontroller",Engineering Research Journal (IERJ) Volume 2 Issue 1 Page 13-16, ISSN 2395-1621, February 2016.