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Automatic Power Factor Correction For Industries

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Abstract-*The power factor correction of electrical loads is a problem common to all industrial companies. Earlier the power factor correction was done by adjusting the capacitive bank manually. The automated power factor corrector (APFC) using capacitive load bank is helpful in providing the power factor correction. Proposed automated project involves measuring the power factor value from the load using microcontroller. The design of this auto-adjustable power factor correction is to ensure the entire power system always preserving unity power factor. The software and hardware required to implement the suggested automatic power factor correction scheme are explained and its operation is described. APFC thus helps us to decrease the time taken to correct the power factor which helps to increase the efficiency***.**

Keywords— ***APFC, Apparent power, Capacitor bank, Power factor.***

INTRODUCTION

The electrical energy is almost exclusively generated, transmitted and distributed in the form of alternating current. Therefore, the question of power factor immediately comes into picture. The power factor of an electrical system gives the idea about the efficiency of the system to do useful work out of the supplied electric power. A low power factor leads to increase in losses and also draws penalty by the utility. Utilizing shunt capacitor banks for Automatic Power Factor Correction (APFC) is an exceptionally established methodology. The recent trend is to automate the switching procedure of capacitors to get greatest advantage in real time basis. Embedded systems based on microcontrollers can be used to monitor and control the switching of correction devices because of its dependability and execution.Net industrial load is highly inductive causing a very poor lagging power factor. If this poor power factor is left uncorrected, the industry will require a high maximum demand from Electricity Board and also will suffer a penalty for poor power factor. Standard practice is to connect power capacitors in the power system at appropriate places to compensate the inductive nature of the load.

The cosine of the angle blow is also equal to KW per KVA so you can think of the power factor as the ratio of real power to what you measure with a volt and amp meter (apparent power). If they are equal, then your power factor is one. [1]

Reactive power is not a problem for a motor and is required for its operation. It is a problem for the electric utility company when they charge for KW only. If two customers both use the same amount of real energy but one has a power factor of 0.5, then that customer also draws double the current [3-5].

The main objective of the proposed system is design of automatic power factor correction using microcontroller software. Specifically;

- To design an automatic power factor correction using an arduino micro-controller in Clanguage for improving the poor power factor by adding parallel capacitors to the inductive load.
- To develop an automatically corrected power factor to establish design parameters.
- To simulate the established control concepts relative to its corresponding input and output relationship and control frame work.

This study significantly provides an important study results for cost effective, reliable and faster power factor corrector. Thus the result of designing power factor corrector for small industrial enterprises will have the following significances.

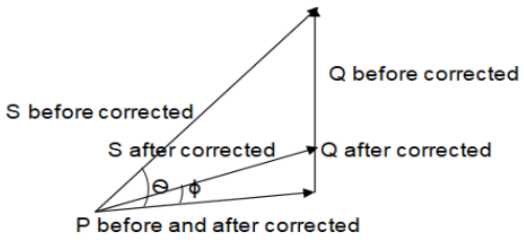

Figure 1: Power angle circuit

- It minimizes value of reactive power in the power triangle by connecting the capacitance of the capacitor to the inductive load to make the apparent and real power to become in phase.
- It minimizes the reactive power and phase angle difference between the sinusoidal voltages and current wave shapes. This can result to decrease the power consumption and power losses, the cost will also be less than the recent.
- It improve low power factor by using power factor correction and this method is important in minimizing the wasted energy.
- It improves efficiency of a plant and reducing the electricity bill but not necessary to reach power factor unity.

DESIGN AND METHODOLOGY

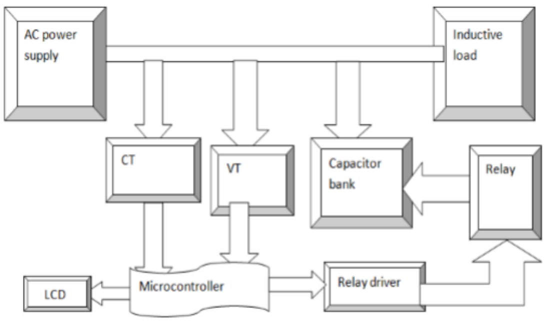

Fig1: block diagram[6-7]

POTENTIAL TRANSFORMER

Transformers convert AC electricity from one voltage to another with a little loss of power. The potential transformer (PT) essentially uses a step-down transformer to reduce the dangerously high voltage to a safer low voltage in any substation. The PT used here is steps-down the supply voltage of 230 Volts to 12 Volts as required by the circuit to operate.

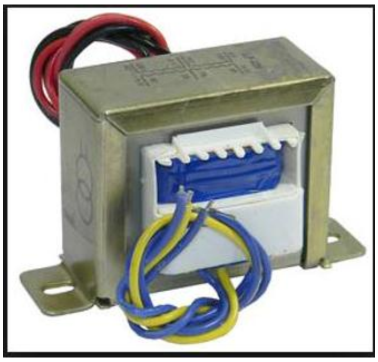

Fig 2;A230/12 Volt Transformer[8]

The output of a PT is used for all measurement and monitoring purposes in conjunction with relay operation. The ratio of the number of turns on each coil, called the turn's ratio, determines the ratio of the voltages. A step-down transformer has a large number of turns on its primary (input) coil which is connected to the high voltage mains supply, and a small number of turns on its secondary (output) coil to give a low output voltage.

CURRENT TRANSFORMER

In an electrical circuit, a current transformer (CT) is used for measurement of electric currents. Current transformers, together with voltage transformers (VT) (potential transformers (PT)), are known as instrument transformers. When current in a circuit is too high to directly apply to measuring instruments, a current transformer produces a reduced current accurately proportional to the current in the circuit, which can be conveniently connected to measuring and recording instruments. It also isolates the measuring instruments from what may be very high voltage in the monitored circuit. They are commonly used in metering and protective relays in the electrical power industry.

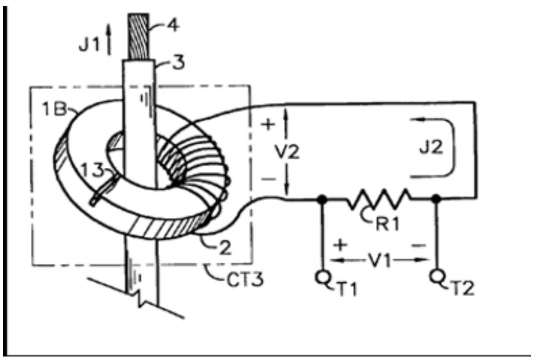

Fig 3;Schematic working of CT [9]

FILTER

Capacitive filter is used in this project. It removes the ripples from the output of rectifier and smoothens the D.C. Output received from this filter is constant until the mains voltage and load is maintained constant. The simple capacitor filter is the most basic type of power supply filter.

VOLTAGE REGULATOR

The LM78XX/LM78XXA series of three-terminal positive regulators are available in the TO-220/D-PAK package and with several fixed output voltages, making them useful in a wide range of applications. Each type employs internal current limiting, thermal shutdown and safe operating area protection, making it essentially indestructible. If adequate heat sinking is provided, they can deliver over 1A output Current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltages and currents. In the LM78XX, the output voltage is specified by the last 2 digits XX. The output of LM7805 will be 5 Volts and the same for 7812 will be 12 volts.[10]

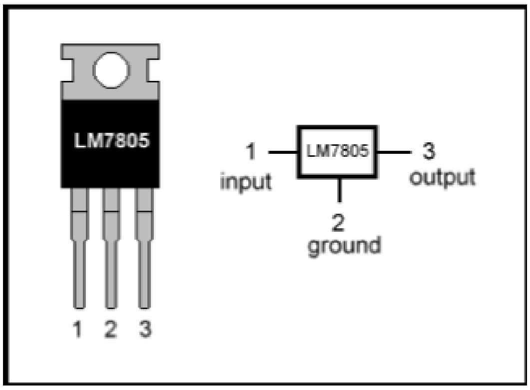

Fig 4;LM7805 and its connection diagram

DISPLAY UNIT

In an embedded system, the microcontroller interacts with the outside world using input and output devices that communicate directly with a human being. One of the most common devices attached to the microcontroller is an LCD display. Some of the most common LCDs connected to the microcontroller are 16x2 and 20x4 displays. This means there will be 16 characters per line by 2 lines and 20 characters per line by 4 lines, respectively available to use. In this project a 16x2 LCD, model JHD 162A which shows the power factor and the phase lag between voltage and current in milliseconds.

Fig 5;A 16x2 LCD Display

RELAY UNIT

This unit consists of a relay driver and some relays. As the output of the microcontroller cannot control the switching of capacitors directly, this unit is responsible for controlling the high power circuit from a low power circuit.[11]

4.9 CAPACITOR BANK

Shunt capacitor banks are used to improve the quality of the electrical supply and the efficient operation of the power system. Studies show that a flat voltage profile on the system can significantly reduce line losses. Shunt capacitor banks are relatively inexpensive and can be easily installed anywhere on the network. The capacitor bank consists of number of shunt capacitors which are switched ON or OFF depending on the reactive power requirement. The switching of capacitors can be done manually or automatically by using relays.

Figure 4.11: Shunt Capacitors [12]

Shunt capacitors, either at the customer location for power factor correction or on the distribution system for voltage control, dramatically alter the system impedance variation with frequency. Capacitors do not create harmonics, but severe harmonic distortion can sometimes be attributed to their presence.

A shunt capacitor at the end of a feeder results in a gradual change in voltage along the feeder. Ideally, the percent voltage rise at the capacitor would be zero at no load and rise to maximum at full load. However, with shunt capacitors, percent voltage rise is essentially independent of load. Thus, automatic switching is often employed in order to deliver the desired regulation at high loads, but prevent excessive voltage at low loads. Moreover, capacitor switching may result in transient overvoltage inside customer facilities.

RESULTS AND CONCLUSIONS

By observing all aspects of the power factor it is clear that power factor is the most significant part for the utility company as well as for the consumer. Utility companies get rid from the power losses while the consumers are free from low power factor penalty charges.By installing suitably sized power capacitors into the circuit the Power Factor is improved and the value becomes nearer to 0.9 to 0.95 thus minimizing line losses and improving the efficiency of a plant. By using this APFC system the efficiency of the system is highly increased. The cost of consumer bill is reduced.

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