AUTOMATIC POWER FACTOR CORRECTION

PROJECT SYNOPSIS

OF MINI PROJECT

BACHELOR OF TECHNOLOGY

ELECTRICAL ENGINEERING

SUBMITTED BY

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CHAPTER 1

INTRODUCTION

In the present scenario of technological revolution, from the whole over observation it can be said that the power is very precious and becoming more and more complex with passing days. The increase in usage of inductive loads in industry will give impact to the power factor value of the system and thus due to that will give impact to the power factor value of the system and thus the efficiency of the power system decreases.

The efficiency of the power system decreases. Nonlinear loads will lead to a poor power factor which can disrupts the AC voltage and give poor performance to other equipment connected to the same source. The main objective of this project is an improvement of the existing AC power factor output by adding capacitance. The ideal power factor controller should produce unity power factor output.

This project mainly aims the attention on the arrangement and development of power factor correction using Arduino as microcontroller. The power factor controller method and device are useful in improvement of the efficient transmission of active power. This PFC are popular because of their advantages such as high-power factor, fast dynamic response, and low cost.

Digital PFC converters are more desirable because digital controllers have many advantages over the analogy controllers due to their programmability, flexibility, no temperature and aging effect, and more resistance to the input voltage distortion. Power factor correction using capacitor banks reduces reactive power consumption which will lead to minimization of losses and at the same time increases the electrical system's efficiency. Power saving issues and reactive power management has led to the development of single-phase capacitor banks for domestic and industrial applications. The development of this project is to enhance and upgrade the operation of single-phase capacitor banks by developing a micro-processor-based control system.

The output of this device which obtains from the simulation result and hardware implementation will be analysed to see the effect of controlling and correcting activity. This paper proposed the controlling and correction of power factor automatically due to that efficiency of the power system.

Automatic power factor controller project is designed to improve power factor automatically whenever power factor falls below a certain level. More and more inductive loads are being used in industry and domestic applications. Automatic power factor controller project provides solutions to these problems. Low power factor includes unnecessary burden on power system and transmission lines. By improving power factor of power system automatically, power system efficiency can be improved. In this project, power factor correction prototype is developed using Arduino, microcontroller, relays, potential transformer and current transformer.

CHAPTER 2

THE NEED AND SIGNIFICANCE OF THE PROJECT

Power factor correction is a technique of counteracting the undesirable effects of electric loads that create a power factor less than one. Power factor correction may be applied either by an electrical power transmission utility to improve the stability and efficiency of the transmission network or correction may be installed by individual electrical customers to reduce the costs charged to them by their electricity supplier. An electrical load that operates on alternating current requires apparent power, which consists of real power plus reactive power. Peal power is the power actually consumed by the load. Reactive power is repeatedly demanded by the load and returned to the power source, and it is the cyclic effect that occurs when alternating current passes through a load that contains a reactive component. The presence of reactive power causes the real power to be less than the apparent power, and so, the electrical load has a power factor of less than unity.

The reactive power increases the current flowing between the power source and the load, which increases the power losses through transmission and distribution lines. This results in operational and financial losses for the power companies. Therefore, power companies require their customers, especially those with large loads, to maintain their power factors above a specified value (usually 0.90 0r higher) or be subjected to additional charges. Electrical engineers involved with the generation, transmission and consumption of electrical power have an interest in the power facto of loads because power factors affect efficiency and costs for both the electrical power industry and the consumers. In addition to the increase operating costs, reactive power can require the use of wiring, switches, circuit breakers, transformers and transmission lines with higher current carrying capacities. Power factor correction attempts to adjust the power factor of an AC load or an AC power transmission system to unity (1.0) through various methods. Simple methods include switching in or out banks of capacitors or inductors which act to cancel the inductive or capacitive effects of the load, respectively. For example, the inductive effect of motor loads may be offset by locally connected capacitors. It is also possible to effect power factor correction with an unloaded synchronous motor connected across the supply. The power factor of the motor is varied by adjusting the field excitation and can be made to behave like a capacitor when over excited.

Non-linear loads create harmonic currents in additional to the original AC current. The simple correction techniques described above do not cancel out the reactive power at harmonic frequencies, so more sophisticated techniques must be used to correct for non-linear loads.

Power factor correction is desirable because the source of electrical energy must be capable of supplying real power as well as any reactive power demanded by the load. This can require large, more expensive power plant equipment, transmission lines, transformers, switches, etc. than would be necessary for only real power delivered. Also, resistive losses in the transmission lines mean that some of the generated power is wasted because the extra current needed to supply reactive power only serves to heat up the power lines. The electric utilities therefore put a limit on the power factor of the loads that they will supply. The ideal figure for load power factor is unity (1), that's a pure resistive load, because it requires the smallest current to transmit a given amount of real power. Real loads deviate from this ideal condition. Electric motor loads are phase lagging (inductive), therefore requiring capacitor banks to counter their inductance. Sometimes, when the power factor is leading due to capacitive loading, inductors (also known as reactors in this context) are used to correct the power factor. In the electric industry, inductors are said to consume reactive power and capacitors are said to supply it, even though the reactive power is actually just moving back and forth between each AC cycle.

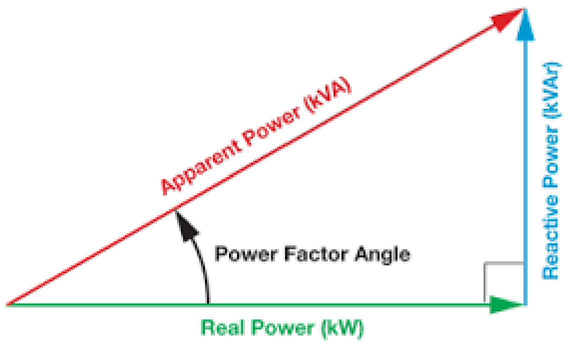
Electric utilities measure reactive power used by high demand customers and charge higher rates accordingly. Some consumers install power factor correction schemes at their factories to cut down on these higher costs.

CHAPTER 3

METHODOLOGY/ PLANNING OF WORK

Power factor correction is the capacity of absorbing the reactive power produced by a load. It determines the phase angle lag (ø) between the voltage and current signals and then determines the corresponding power factor (cos ø).Then the microcontroller calculates the compensation requirement and accordingly switches on the required number of capacitors from the capacitor bank until the power factor is normalized to about unity.

Power Triangle:



For phase angle calculation,

$\phi = \Delta t \times f \times 360^{\circ}$

Where Δt = Time difference (s)

F = Frequency (50 hz)

Power factor = cos ϕ

Power Factor Correction:

Power factor correction is the process of compensating for the lagging current by creating a leading current by connecting capacitor to the supply. A sufficient capacitance can be connected so that the power factor is adjusted to be as close to unity as possible. Power factor correction (PFC) is a system of counteracting the undesirable effects of electric loads that create a power factor that is less than one (1).

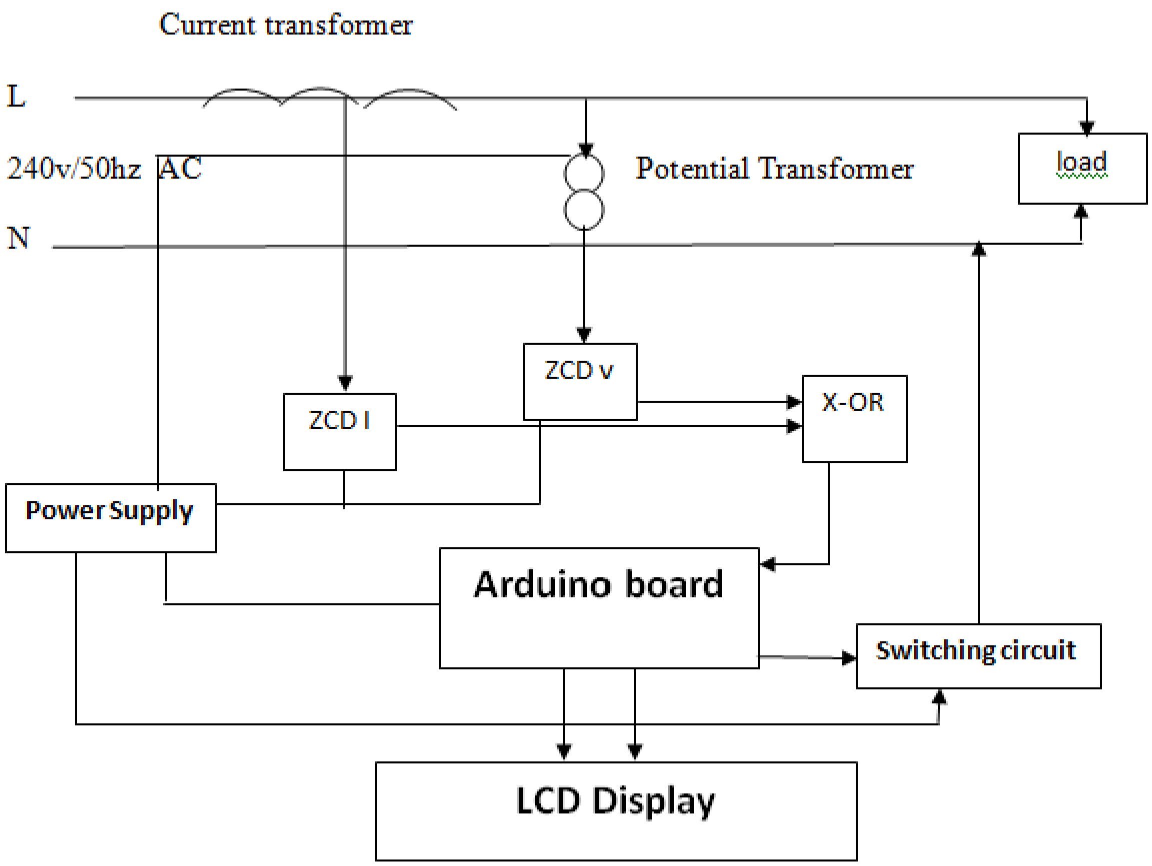
In Power factor correction, System scans the current and voltage waveforms of Load connected to Supply OUT at every 10 Seconds. If load having PF less than 0.95 or greater than -0.95, then it considered as Inductive load. As soon as Inductive load detected, Correction Capacitor get added in parallel to Inductive load. (At ideal condition, PF value -1 or +1 considered as Resistive load.)

PROJECT IMPLEMENTATION:

The current and voltage signal are acquired from the main AC line by using Current Transformer and Potential Transformer. These acquired signals are then pass on the Zero crossing detectors. Bridge Rectifier for both current and voltage signals transpose the analog signals to the digital signal.

Microcontroller read the RMS value for voltage and current used in its algorithm to select the value of in demand capacitor for the load to correct the power factor and monitors the behaviour of the enduring load on the basis of current depleted by the load.

In case of low power factor Microcontroller send out the signal to switching unit that will switch on the in-demand value of capacitor. The tasks executed by the microcontroller for correcting the low power factor by selecting the in-demand value of capacitor and load monitoring are shown in LCD.



CHAPTER 4

SOFTWARE AND HARDWARE OF THE PROJECT

WORK BEFORE MID-TERM

1. **SIMULATION OF THE PROJECT:**
   REQUIRED SOFTWARE- PROTEUS

PROTEUS:

CIRCUIT DIAGRAM:

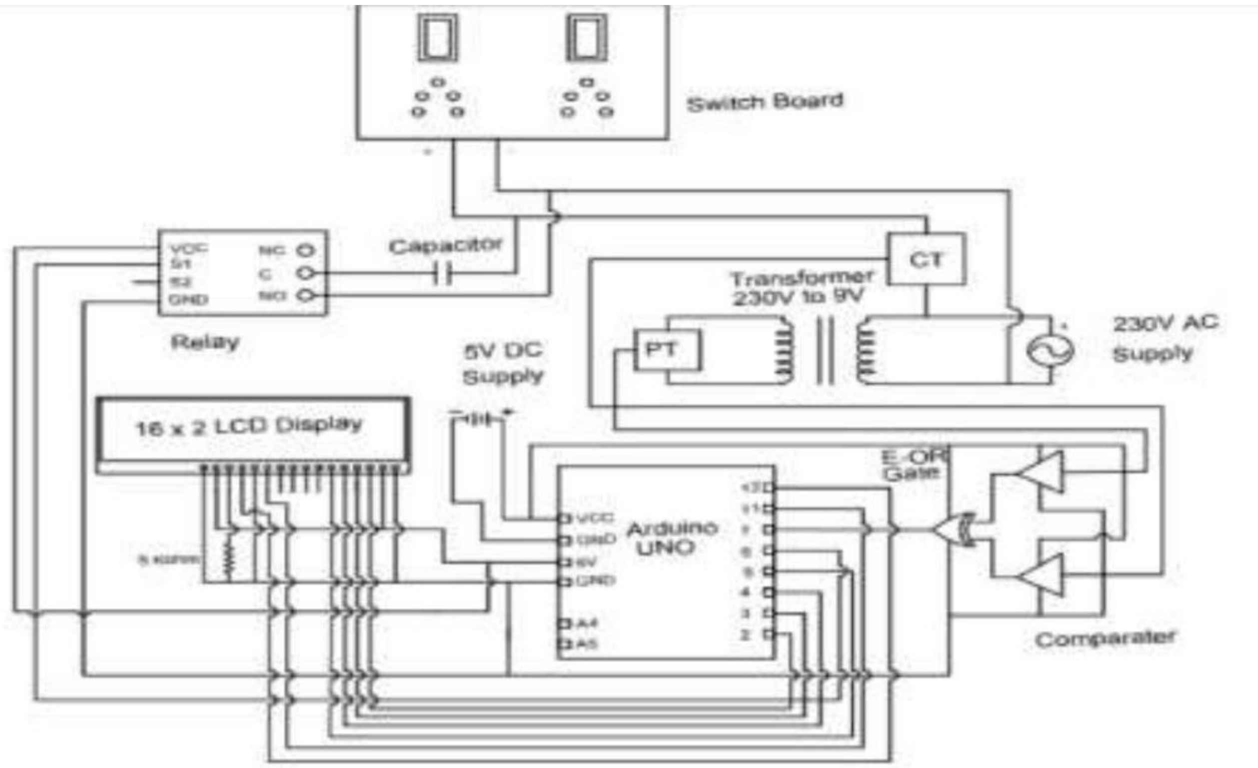


Fig -3: Circuit diagram

These two digitized signals i.e., voltage and currents are sent to the microcontroller as the inputs. According to the program written microcontroller calculates the time difference between the zero crossings of these two signals. This time difference is indirectly proportional to the system power factor. The information about this power factor and the power loss is displayed on the LCD display. And according to the range calculated by the microcontroller program; this drives the relays which switches the shunt capacitors across the load.

WORK AFTER MID-TERM-

HARDWARE IMPLEMENTATION OF THE PROJECT

Sr. No.	Component	Specification	Quantity
1	Ardino UNO	-	1
2	Step down transformer	230V-12V	2
3	16x2 LCD display	-	1
4	Current transformer	20A/20mA	1
5	Euro style connector	-	2
6	shunt capacitor/power capacitor	-	5
7	choak ballast	-	1
8	AC capacitor	2uF,230VAC	1
9	Sugar cube relay	12VDC	10
10	General purpose PCB	-	2
11	LM 740	op-amp	5
12	IN4007	-	20
13	ULN2003	Relay driver IC	2
14	Incandencent lamp	230VAC/100W	2
15	Resistors	1K ohm	1
		10M ohm	1
		47K ohm	1
16	Green connector	2 pin	5
17	LED	-	10
18	Lamp holder	-	2
19	teflon wire	-	1 role
20	striker tie	-	24
21	Ele. Capacitor	460uF/25V	6
		1000uF/25V	10

		100uF/25V	10
22	IC7486		2
23	IC7805	Voltage regulator 5V	3
24	IC7809	Voltage regulator 9V	3
25	IC7812	Voltage regulator 12V	3
26	Soldering Wire	-	1 Role
27	Multistrand Wire	2sq.mm	3 meter
28	screw nut	3mm	30
29	Ply board	5mm	1

CHAPTER 5

FUTURE SCOPE AND CONCLUSION

FUTURE SCOPE

The automatic power factor correction using capacitive load banks is very efficient as it reduces the cost by decreasing the power drawn from the supply. As it operates automatically, manpower is not required also this automated power factor correction using capacitive load banks can be used for the industries purpose in the future.

CONCLUSION

The automatic power factor detection and correction provides a efficient technique to improve the power factor of a power system by an economical way. Static capacitors are invariably used for power factor improvement in factories or distribution line. However, this system makes use of capacitors only when power factor is low otherwise, they are cut off from line. Thus, it not only improves the power factor but also increases the life time of static capacitors. The power factor of any distribution line can also be improved easily by low-cost small rating capacitor. The role of an automatic power factor corrector to reduce cost, reduce development time, a low power supply and low data rate.

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