AUTOMATIC POWER FACTOR CORRECTION UNIT

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ABSTRACT

Due to the modern civilization the growth of industry has been increased as thus the usage of energy has been raised. So ,every industry needs to implement power factor correction to limit power wastage and to avoid penalty due to the same. Lower power factor means that higher current is flowing through it, Higher current results in greater voltage drop. There are many methods to solve this problem so the aim of our project is to correct the power factor of a single phase electricity by switching capacitor. The utility that delivers the power to you will likely charge you if your power factor is to low.GSM module is used to alert the user about the power factor of loads and give the error indication in the system.

Keyword : - *Active power, Power factor, Atmega 328, Relay, Zero crossing detector, Power supply, capacitor bank, GSM module, voltage drop, load .*

1. INTRODUCTION

The project is designed to minimize penalty for industrial units by using automatic power factor correction unit. In simple words, power factor basically states how far the energy provided has been utilized. The maximum value of power factor is unity. So the closer the value of power factor to unity, better is the utility of energy or lesser is the wastage. Power factor is defined as the ratio of real power to apparent power. This definition is often mathematically represented as KW/KVA, where the numerator is the active (real) power and the denominator is the (active + reactive) or apparent power. Reactive power is the non working power generated by the magnetic and inductive loads, to generate magnetic flux. The increase in reactive power increases the apparent power, so the power factor also decreases. Having low power factor, the industry needs more energy to meet its demand, so the efficiency decreases. In this proposed system the time lag between the zero voltage pulse and zero current pulse duly generated by suitable operational amplifier circuits in comparator mode are fed to the microcontroller. The program takes over to actuate appropriate number of relays from its output to bring shunt capacitors into the load circuit to get the power factor till it reaches near unity.Further we are also using the GSM module to send the message to thr user when extensive amount of Indusctor load is used in the industry.The hardware implementation was developed by using Arduino Uno board, which uses the ATmega328 as the Microcontroller, The power factor from the load is measured by using zero crossing circuit and phase shift detector, and then calculated the power factor according to the program and LCD will be used for display. This project provides implementation done on Arduino UNO microcontroller using C language software to program the microcontroller, the proposed design has the skill to sense power factor efficiently and by using proper procedure enough capacitors are switched on in order to compensate the reactive power, thus withdraw PF near to unity as a result acquires higher efficiency and better quality AC output. Current transformer and a Voltage transformer are used for sampling of the circuit current and voltage, so as to determine the power factor. The intelligent control using this micro-processor control system ensures even utilization of capacitor steps, minimizes number of switching operations and optimizes power factor correction**.**

1.1 WHAT IS POWER FACTOR ?

The Power factor is defined as the ratio of a real power to the apparent power. And also, it is the cosine angle between the voltage and current. The real power 'P' it is the average of instantaneous voltage and current product over a cycle during which some useful work in the equipments is done. Whereas the apparent power 'S' is the RMS value of the voltage and currents product, which is a total power available, as shown in the figure below fig.1.1.
The below equation tells that over an apparent power how much is the true power accounts. The power factor measures the amount of energy used for a given supply from the utility company. Imagine ,if the power factor is 0.6,which means, only 60% of the power is utilised for given 100% power, and the remaining power is considered as waste or lost.

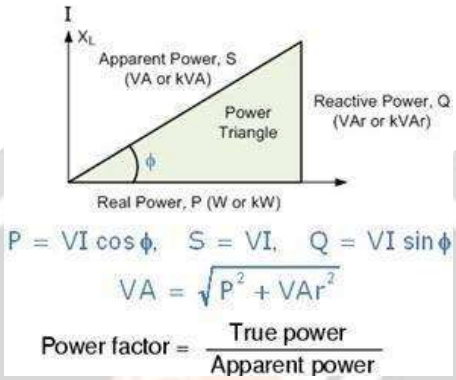


Fig.1.1 Power factor Triangle

2. WORKING

2.1 Block diagram

As shown in block diagram, system starts from the main core of the system. First system checks with all available sources and select it according to the priority in the code.
When a particular source is selected the system will then allocate a track to the load in parallel with the capacitor bank. Whenever the supply connects with the load, CT and PT is used to calculate the overall voltage and current consumption with the load.

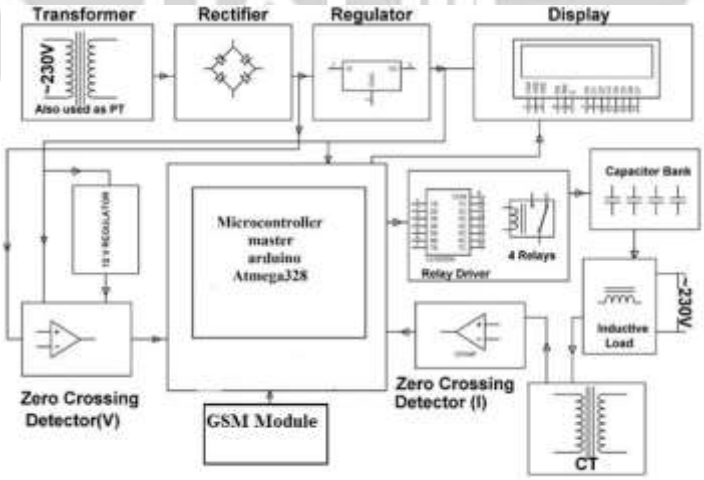


Fig2.1.Block diagram

The microcontroller is responsible for complete activity of the system current sensor is used for real time current measurement.Voltage sensor s used for measurement of potential diffenrence.

When a sinosouidal value crosses 0 point system will raise and interupt which stsrts the counter.If the counting overflows power factor value is less than maximum limit system iwill calculate the time difference between zero crossing of current waveform as well as volatge waveform.This Power factor value is compared with the pre-defined set values and if the power factor is less than threshold then 1st capaciotr is swithed ON .
If Power factor is less than 2nd threshold then both capacitors will be turn ON. LCD display will show current status of the system.And further Gsm module is also added to send the sms to the user when extensive amount of inductors are used in the industry.

2.2.ALGORITHM

1) Algorithm for determining power factor:
Step 1- Check for zero line crossover of voltage signal from negative to positive.

Step 2- Timer _t' starts (t).

Step 3- Timer _T' starts (T).

Step 4- Check for zero line crossover of voltage signal from positive to negative.

Step 5- Timer _t' stops.

Step 6- Check again for zero line crossover of voltage signal from negative to positive.

Step 7- Timer _T' stops.

Step 8- Phase φ = (t / T) * 360.

Step 9- Calculate _cos φ

2)Algorithm for switching of the capacitor bank:

Step 1- Calculate the Power Factor (cos φ).

Step 2- Check whether the power factor is less than or greater the 0.98.

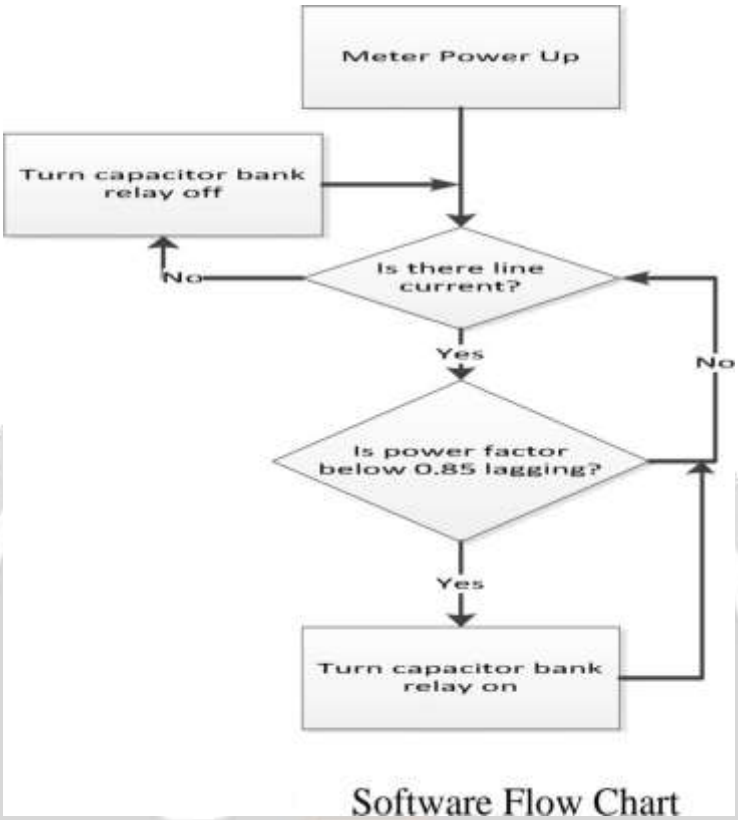
Step 3- If the power factor is greater (_>') than or equal to (_='), the load is resistive in nature.

Step 4- If the power factor is less than 0.98, then switch ON' a capacitor from the capacitor bank and again check the corrected power factor.

Step 5- If the corrected power factor is still less than 0.98, switch _ON' another capacitor and again check for the power factor.

Step 6- Repeat steps 3 and 4 until the corrected power factor is greater (_>') than or equal to (_=') i.e., as close to unity as in can get

2.3 FLOWCHART



Measurement techniques have initially been design and further simulation takes place by using proteus ISIS and embedded C language is used for software coding using Arduino software.

3. EQUATIONS AND CALCULATION

3.1EQUATIONS

If θ is the phase angle between the current and voltage, then the **power factor** is equal to the cosine of the angle, When the **power factor** is 1, all the energy supplied by the source is consumed by the load. **Power factors** are usually stated as "leading" or "lagging" to show the sign of the phase angle.

Power factor is the ratio of real power (KW) to total power (KVA) dissipated in load.

Power factor=cosØ = P/S=Active power/Apparent power

ACTIVE POWER
The power which is actually consumed or utilized in an Ac circuit is called Active power or true power(KW).

Active power= P=V.I.cosØ

REACTIVE POWER
The power which flows back and froth that means it flows in both the direction in the ciruit or react upon itself is called reactive power(kVAR).

Reactive Power=Q=V.I.sinØ

APPARENT POWER
The product od root mean square(RMS) value of voltage an current is known as apparent power(kVA).

Apparent power=S=V.I

3.2 CALCULATIONS
The survey of an under construction building is shown below table:

Sr.no.	RealPower(kw)	Reactive Power(VA)	Total power(kva)	P.F
1	4110	19.6	5205	0.78
2	7408	33.7	8699	0.85
3	1752	37.5	2080	0.84
4	8864	7.46	8810	0.9

Table I Construction site table

The average power factor of the unit is 0.84.which can be improved using appropriate capacitor bank.

4.RESULT

A High power factor benefits both the customer and utility,While a low power factor indicates poor utilization of electric power.When the inductive load is connected to the system,Power factor becomes low,So to improve the P.f switching of capaciotor takes place .

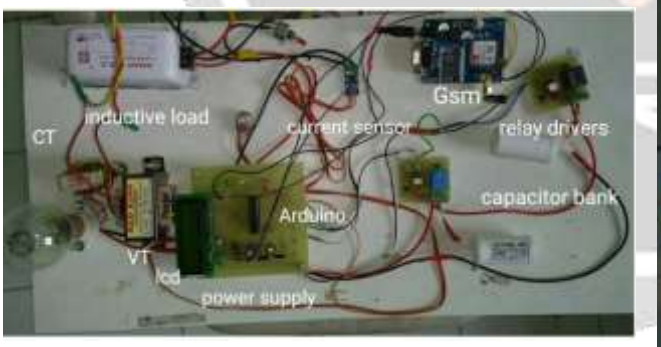


Fig.4.1Basic Test bench

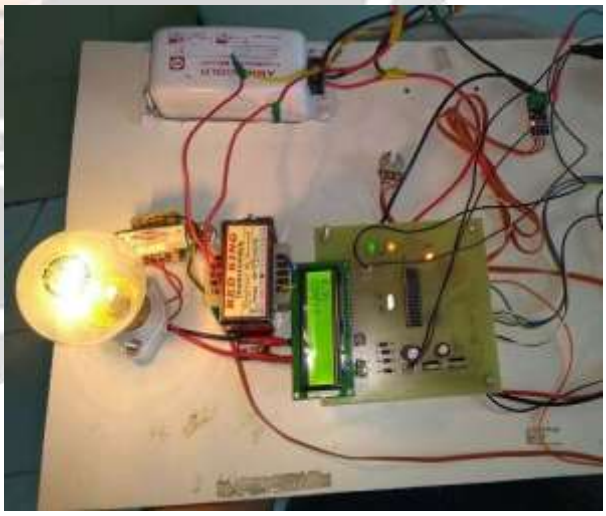


Fig.4.2.Improved P.F output

The Fig.4.1, shows the complete implementation of the project.
The 2nd fig shows the improved power factor .This makes the utility transmission/distribution system more efficient,reducing cost for the utility and their customers.

5.CONCLUSION

The Automatic power factor correction unit is the cheapest way to implement the power factor compensation for the lagging loads which are continually varying. It brings the power factor near to unity. Also we can define the power factor range which should be maintained for a particular system using this unit. It also monitors the lagging and leading power factor and takes the necessary control action. The real time data for the power factor can also be stored using this unit. The consumers using power near unity power factor is also provided incentives to encourage the efficient use of electricity.

6.ACKNOWLEDGEMENT

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