Automatic power factor control using Arduino UNO

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ABSTRACT

This study shows how to construct automated the power factor correction (APFC) system for single phase home loads in simple and low-cost manner. To adjust the power factor of inductive loads, the suggested a system employs a relay to swap the capacitor banks. An Arduino board is used to control Relay's switching. By detecting the signal from CT, PT, and Zero Cross Detectors (ZCDs), the Arduino is programmed to continuously monitor and calculate the power factor of the attaching the load, and to maintain the power factor of the load well above reference value (0.9) by properly energizing the capacitors in parallel to the attaching a load via Relay switching. Also on LCD, the power factor numbers, as well as the current before and after an improvement, are presented. The suggested APFC a design's a hardware prototype is also being built in order to test its functionality. The APFC system testing is verified that the proposed a design produces a dependable output and may be utilized in any single phase a practical application to assure a power factor near to one.

Keyword : - *Capacitors Banking; ATmega328P; Arduino Uno; Power Factor; Reactive Components; Auto Switch.*

1. INTRODUCTION

The power factor of an AC electrical system is the measure of how closely a particular load equals the resistance of a pure resistance. It's a proportion of a load's an average power to a resistive load's an average power for much the same voltage and the current scale, with a value between 0 and 1. An active power is the actual quantity of the power utilized or lost in a circuit, and it is measured in watts. The product of the sine voltage and current waveforms called an active power. The energy consumption in the ac circuit due to the inductive and capacitive fields is known as the reactive power. KVAR is the unit for measuring the reactive power. The sum of the active and reactive power is known as an apparent power. It's the sum of a circuit's voltage and current without taking the phase angle into the account. The volt-amps unit is used to measure the apparent power(S) (VA). It is more powerful than both active and reactive power. Because of the reactive power, which is the electric charge in the circuit and is negative, or because the current lags the voltage by a phase angle and returns to the supply, or because of a misaligned load, the produced a wave from the power source is distorted. The perfectly resistive load has a power factor of one Because the sine voltage and current waveforms are in the phase, or the phase angle variation between both the voltage and current is 0.

The power factor is expressed in kilowatts. Reactive power doesn't quite produce beneficial “work,” but rather flows between both the generator and the load during times when the system is required to function properly. In kilovolt-amperes, reactive power is measured (kVA). It is visible power when active and reactive power are combined. In kilovolt-amperes, the perceived power is measured (kVA).

2. BLOCK DIAGRAM

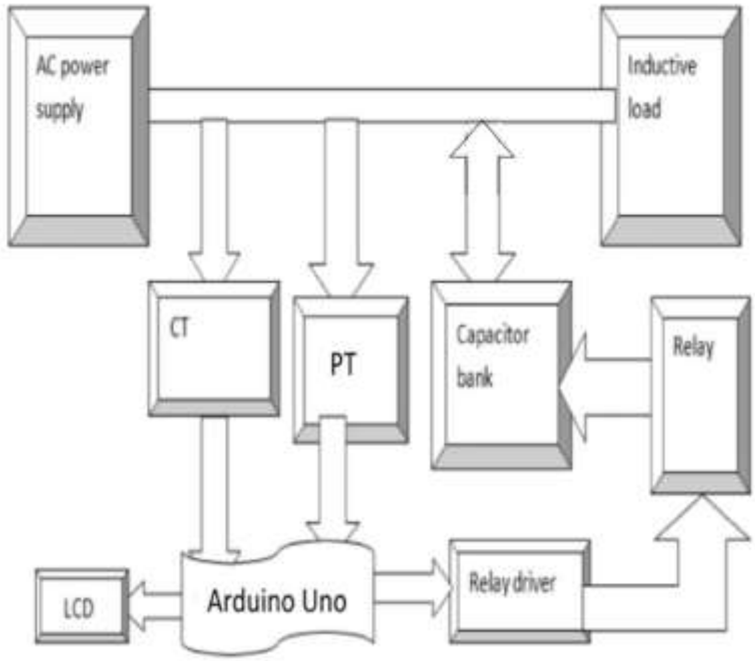

Fig- 1

The planned APFC system's the schematic representation. The Arduino board, which is developed to measure and adjust the power factor of the attached a load, is the system's brain. Using a potential transformer (PT) and a current transformer (CT), the voltage and current signals from a single phase wire are scaled down to a low power level appropriate for Arduino computing. These signals are supplied to Arduino through sensor circuits and zero cross detectors (ZCDs) for detecting current and the voltage, as well as the phase difference, in order to compute the power factor and an active power of the connecting the load. In the event of a lagging power factor, the Arduino sends a control signal to the circuit, which energises the capacitor bank parallel to the load using TIAC switching. This procedure is repeated until the necessary adjustment of the power factor is achieved, i.e. the power factor value after and before the repair for attached the load is displayed on LCD with a pause.

3. THEORY OF VOLTAGE CIRCUIT DIVIDER

Ohm's theorem and the voltage divider concept has utilized for the voltage sensor The present value was converted to voltage value using Ohm's law. Signals from both measuring systems are conditioned so that the Arduino can read them. Arduino is in a charge of digitizing analogue signals. The digital signal was transferred to a computer for the additional processing, which resulted in a graph of the voltage, current, energy usage, and utilized energy, as well as the RMS and average measured values. A voltage divider is a linear circuit that dividing an input voltage by a particular ratio to produce an output voltage. They had created a circuit by connecting two impedance.

The electricity supply on the microcontroller utilized in this study delivers a consistent output voltage of 5 V. This electrical power is then used to move the sensor output voltage till it can be spelled it correctly by the Arduino; the voltage source is scaled and then shifted by 2.5V, and the voltage sensor goes from the 340v to about 2.5V. The voltage is determined by multiplying the current by the 0.5 ohms resistance in the current sensor circuit. The current sensor's a voltage signal is then shifted by 2.5V. It can be observed in the current sensor circuit that the current sensor can read up to 5 Ampere current. As a result, the current will generate 2.5V. Because the microcontroller can only accept an analogue voltage signal between 0 and 5V, a voltage shifting is required. The resistors are then linked to the microcontroller's the 5v power supply, giving the final output signal a range of 0 to 5V. For current and voltage sensors, voltage value of 2.5V represents zero, whereas 5V and 0V show the highest and low values of the corresponding sensors. These are used to convert analogue signals to digital data so that the microcontroller can execute them.

4. HARDWARE IMPLIMENTATION

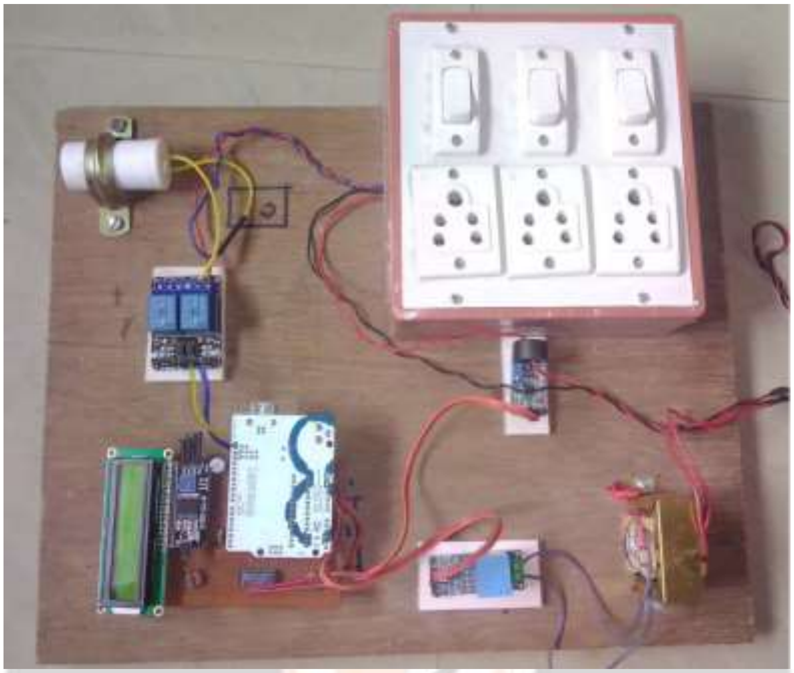

Fig- 2 : Hardware implementation

The figure 2 shows the whole hardware deployment of the planned APFC system. In the same board of the APFC, two loads of inductive nature (i.e. the fan and choke) and one load of resistive nature (i.e. an incandescent light) with various phase ratings for testing their working processes is also provided.

5. CIRCUIT DIAGRAM

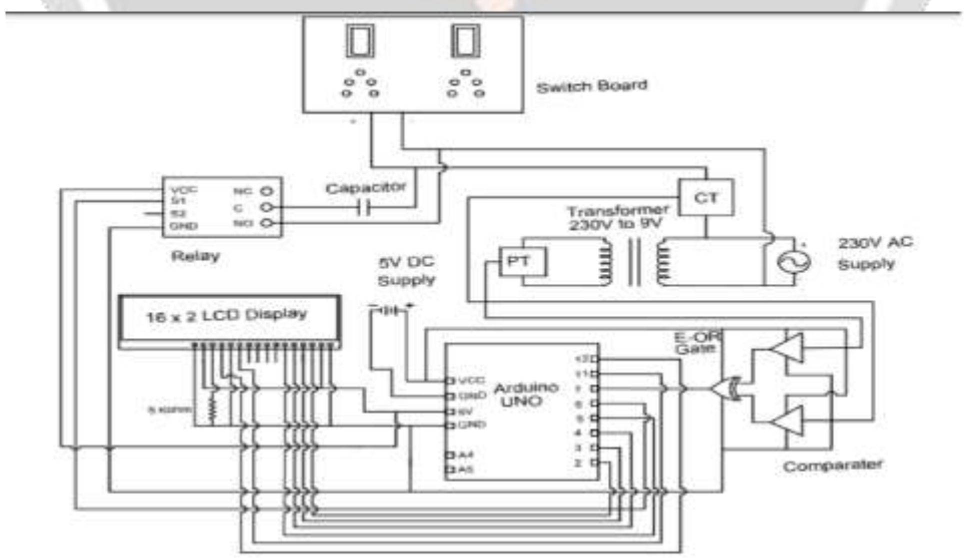

Fig -3: Circuit diagram

The suggested APFC system has a circuit design. The key elements of the circuit are as follow. The voltage, current, a power factor, and the power of the connected load are measured in the following a manner using these signals provided to the analogue pins of the Arduino board through sensor circuits and ZCDs. The signal from a PT is sent to arduino board through a half-wave rectifier circuit for a voltage monitoring.A 5V DC a power source is used to deliver the needed power for the Arduino board and other peripherals in the planned APFC system. Showed that the proposed APFC system uses PT and CT to take the voltage and current signals from the associated the load.

They send the signal that enables the optocoupler by turning on the transistor. By adding the gate current, the optocoupler's output is used to operate the relay. The gate current from the optocoupler's output turns on the relay, which connects the capacitor bank to the load. The Arduino evaluates the increased a power factor by detecting the signals from PT and CT after energizing the static capacitor parallel to load an adjustment of the connected load. If the enhanced the power factor value is less than the set point, the microcontroller compares it to the reference value and repeats the power factor correction procedure. This power factor adjustment is done until the desired a power factor correction is achieved. Finally, after correcting the needed a power factor value, the microcontroller shows the power factor value after and before an adjustment on the LCD with 5sec time gap between them.

6. SIMULATION

The simulation was created using a design Suite. It is possible to see the diagram. The display of various state vectors related to the power factor is aided by programming code. Potential transformers (PT) and current transformers (CT) are used to sense single-phase voltages and currents.

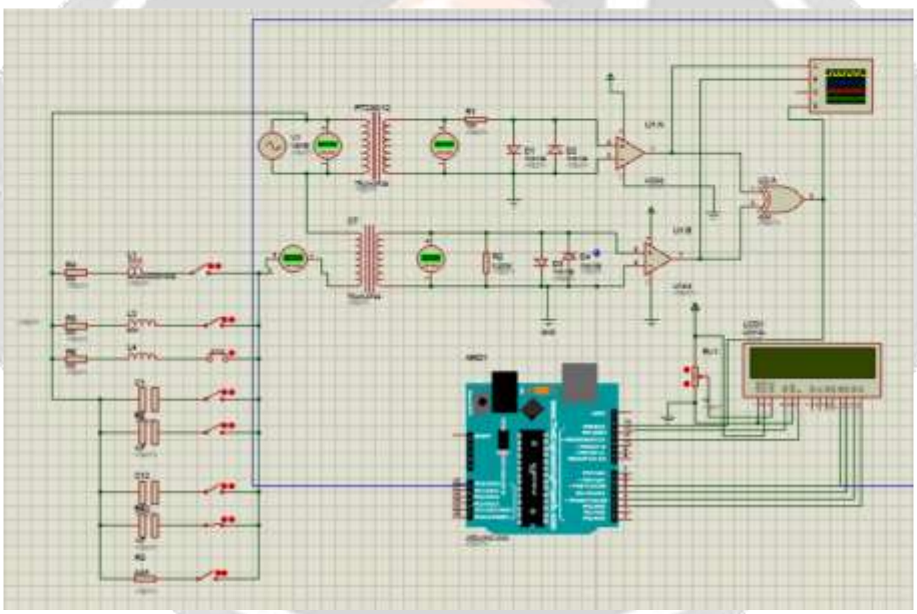

Fig -4:Simulation

These signals are sent to the controller to calculate the active and reactive powers by measuring currents and voltages, measuring the angle between the voltage and current, and measuring the sine and cosine values. magnetic relay couples the 5v DC signal from the microcontroller to the 220v AC, with certain capacitors switched on or off for the optimum power factor. The turn ratio of the Potential Transformer (PT) is set to 230:5 to make the voltage on the secondary side compatible with the microcontroller's an analogue input. The secondary voltage on the current transformer is 5 volts.

7. RESULT

7.1 No load connected in circuit :-

7.2 Inductive load is connected in circuit :-

When the load is switched on, the LCD result displays the power factor of the load before the rectification. Because its power factor 0alue is smaller than the reference Value, the APFC system immediately inserts the capacitor(s) in a parallel with this load to rectify the power factor. The LCD shows the adjusted power factor value.

7.3 Power factor correcting by system :-

The data of a power factor adjustment before and after corrections for the mixed load example are shown on the LCD in a fig. E. A 68W incandescent light, a 36W choke, and a 68W fan motor make up the combined load. When this load is turned on, the APFC system rapidly detects and corrects the power factor by connecting the capacitor(s) in parallel.

8. ADVANTAGES:-

1) Increased efficiency through lowering power usage.
2) A reduction in energy usage results in a reduction in greenhouse gas emissions.
3) Lowering the cost of power.
4) Extra KVA is available from the same current supply.
5) I2R losses in transformers and distribution equipment are reduced.

9.DISADVANTAGES:-

1) Service life is short, ranging from 6 to 8 years.
2) If the voltage exceeds the rated value, it is easily destroyed.
3) It is critical to restore the capacitor after it has been destroyed.

10. APPLICATION:-

1) This system is implemented in industries.
2) It is use full of industrial automation.

3) Save the light bill.

11. CONCLUSIONS

The automatic power factor a very useful device for improving an efficient transmission of an active power. It can be concluded that a power factor correction technique has applied to the industries, a power system, and the also household to serve them with a stable way and due to that the system has become stable. an efficiency of the system as well as increases. The role of an automatic power factor corrector to reduce cost, reduce development time, a low power supply and low data rate. This paper accomplishes an aim of the design as it has shown on the simulated diagram of corrected an output of the power factor.

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