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A REVIEW ON SYSTEM FOR MINIMIZING BILLING PENALTIES BASED ON POWER FACTOR DUE TO APFC UNIT

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ABSTRACT :-In the industrial division, number of motoring loads is running continuously. These motoring loads generate inductive load. Power consumption is increasing day by day at a very high rate. So, because of this inductive receptive force, the force factor gets diminished. The power organization has indicated certain cutoff points, if the force factor gets beneath these predefined limits punishment will be forced to the modern customers. To defeat inductive reactance remuneration is accomplished by the utilization of force capacitors. APFC gadget peruses the force factor from line voltage and current by deciding the delay in arrival of the current signal with respect to voltage signal with high accuracy using internal timer. These values are calibrated as phase angle and corresponding power factor. Then the calculation for the requirement of compensation takes place in the motherboard and accordingly different capacitor banks are switched on.

Key ward: Power factor, Inductive reactance, Penalty, Compensation, Capacitors, Capacitor banks

I. INTRODUCTION

There are many utilities out there that charge commercial and industrial customers a penalty for having a poor PF. Anytime you see demand charges billed in units of kVA, you should know that PF is prepared into the interest charge and any drop in PF under 1 outcomes in extra charged units of interest. As the vast majority of the heaps in current electrical dissemination frameworks are inductive, it is important to further develop power factor. The low force factor of inductive burdens burglarizes framework's ability and may influence the voltage level. Force factor remedy by the utilization of capacitors is broadly practically speaking at all framework voltages. As expansion in utilities brings about punishments, the power organization charge clients for low power factor. The installation of power factor correction capacitors will improve the performance of the system and will save money.

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On AC systems, both the current and voltage are sinusoidal. If loads are reactive, then voltage and current will be out of phase and the Apparent Power (S) will need to be greater to accomplish the same work (in Watts) as a non-reactive load. The graphic above shows this clearly. The hypotenuse shows the total Apparent Power (S) given a certain combination of real (P) and reactive power (Q). The bottom side of the triangle shows the amount of power (P) available to do Work which decreases as reactive power (Q) increases.

If Q was zero, then S and P in the triangle would be equal to each other and the PF would be 1. To put this triangle in real world terms, think of a reactive load like an old heavy-duty electric motor that is just starting up. The motor will dissipate a lot of energy as heat while getting up to speed and the energy dissipated as heat won't result in actual Work (in Watts). This energy lost as heat represents the reactive power (Q). The real power (P) is the kinetic energy that the motor is able to impart to do Work. The apparent power (S) is the total power that must be delivered and is determined based on the amount of the useful real power (P) and the reactive power (Q) that is lost as heat.

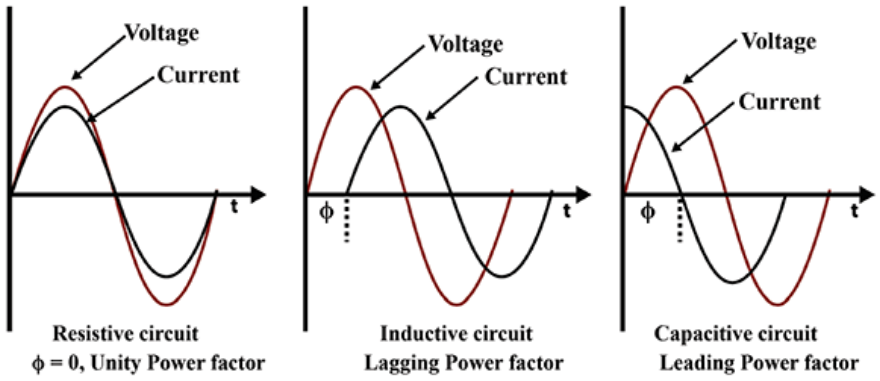

Fig 1.1 – Power factor for different types of loads

II. PENALIZING POOR POWER FACTOR

Reasons for low power factor

- Inductive loading – 90% of the industrial load consists of induction machines. Such machines draw magnetizing current to produce the magnetic field and hence work at low power factor.

- Variations in power loading – When the system is loaded lightly, the voltage increases and the current drawn by the machines also increases. This results in a low power factor.

-Harmonic currents

- A condition known as 3 phase power imbalance occurs, due to improper wiring or electrical accidents. This results in low power factor too.

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Power factor correction: Consumers can avoid power factor penalties by installing devices for power factor correction,

- Install capacitors in the appropriation framework. While capacitor banks further develop the general framework's force factor, the individual machines which caused a drop in power factor would in any case continue as before. These machines can be adjusted or improved into more energy effective variants, to keep a healthy electrical system.
- Minimize operation of idling or lightly loaded motors
- Install variable frequency drive (VFD) systems to lightly loaded induction motors
- Install new motors that will be operated near their rated capacity
- Replace lightly loaded motors with motors sized to be operated near their rated capacity
- Avoid operation of equipment above its rated voltage.

Thus, it is important to pay attention to the power factor of your machines and your system as a whole, and utilize most of the power bought from the utilities to perform actual work. Maintain a healthy electrical system and avoid power factor penalties by staying informed about the electrical parameters of your place, with the help of energy monitoring devices.

III. SYSTEM DESCRIPTION OF APFC

The power factor compensating devices essentially supplies the required reactive power of the system to improve the power factor and system voltage profile. Shunt capacitors are the most commonly utilized pay gadget in the business. Shunt capacitors are in effect broadly utilized in modern appropriation frameworks. They supply responsive ability to balance the out-of-stage segment of current needed by an inductive burden. The utilization of shunt capacitor banks brings about a lessening in the greatness of the source-current, further develops the force factor and subsequently further develops voltage guideline all through the framework. Nonetheless, shunt capacitor banks don't influence current or force factor past their place of use. Capacitor banks can be fixed, exchanged, or a mix of both. The switching process can be manual or automatic. Capacitor banks are rugged and simple to configure and install.

The system is designed to minimize penalty for industrial units by using automatic power factor correction unit. 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.

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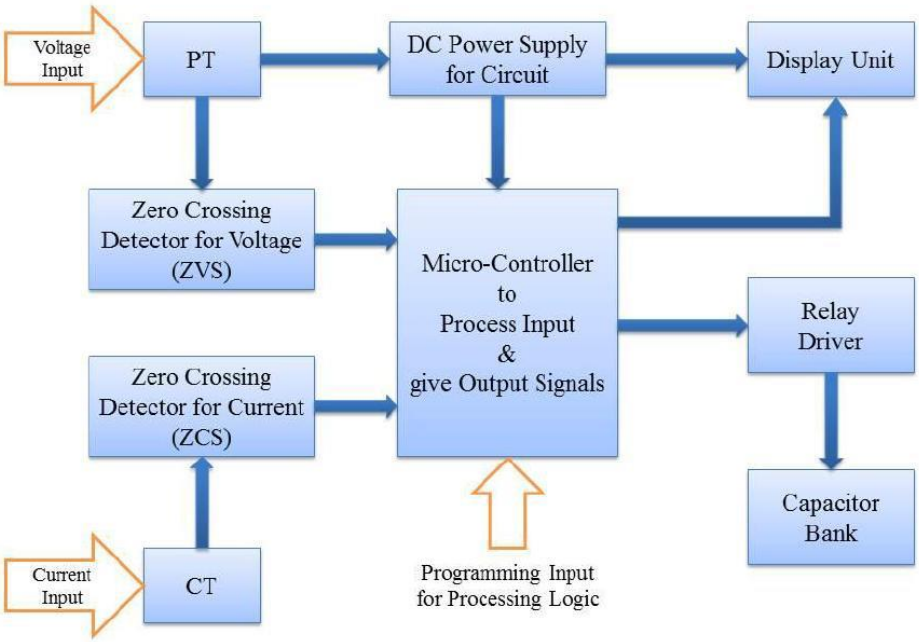

Fig 3.1 – Process flow diagram for APFC

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 duty generated by suitable operational amplifier circuits in comparator mode are fed to two interrupt pins of the microcontroller. It displays the time lag between the current and voltage on an LCD. 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.

IV. HARDWARE AND COMPONENTS

Automatic Power Factor correction device is developed basing on a micro controller 8051. The voltage and current sampled is converted in to square wave using a zero cross detector. The V and I sample signals are feed to the micro controller at INT0andINT1andthedifferencebetweenthe arrival of wave forms indicate the phase angle difference. The difference is measured with high accuracy by using internal timer. This time value is calibrated as phase angle and corresponding power factor. The values are displayed in the 2x16 LCD modules after converting suitably. The capacitor banks are switched as per the calibration insteps.

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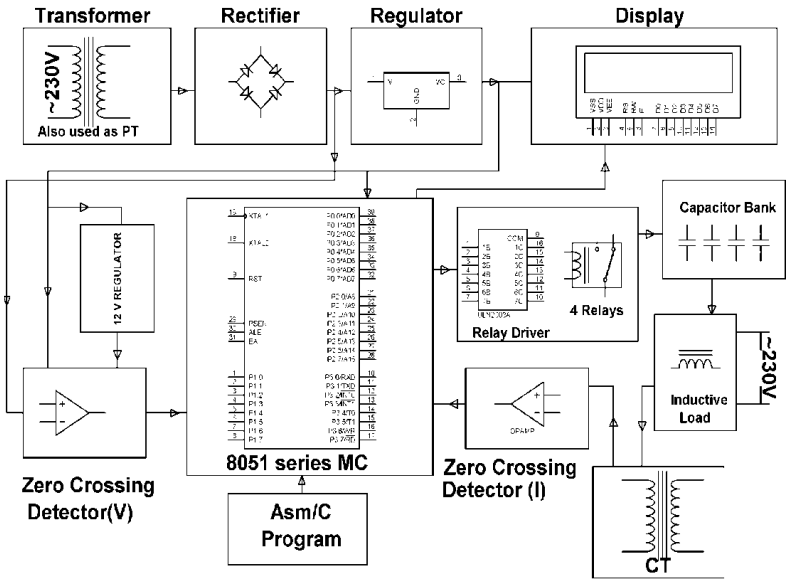

Fig 4.1- Block Diagram of Power Factor Improvement

The materials and systems used in the project include: Hardware: -

-8051 Microcontroller, switches, slide switches, relays, relay drive, resistor, capacitor, Op-amp, diodes voltage regulator (Zener diode) , crystal lamp, choke, transformers, shunt capacitors

- Software: Keil compiler

-Languages: Embedded 'C' or assembly

1. Voltage and current estimation unit: Current transformer (CT) associated with line and the potential transformer (PT) is associated parallel with the supply line.

2. Comparator unit: It takes the values of voltage and current from PT and CT respectively and gives this information to the microcontroller.

3. Transformer: Transformers convert AC electricity from one voltage to another with little loss of power. Transformers work only with AC.

4. Relays: A relay is usually an electromechanical device that is actuated by an electrical current. The current flowing in one circuit causes the opening or closing of another circuit. Relays are like remote control switches and are used in many applications because of their relative simplicity, long life, and proven high reliability.

5. Choke coil: A coil is a series of loops. A coiled coil is a structure where the coil itself is in turn also looping. A coil is made up of materials, usually rigid, which can be fashioned into a spiral or helical shape.

6. Capacitor Bank: The collection of capacitors of different values is known as capacitor bank. Series and parallel combination of different capacitors provide various ranges of capacitance required for the compensation of low power factor.

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7. Calibration process: Few factors are necessary to be determined based on the components used in the voltage and current sensor circuits. These factors are considered in the calculation of accurate power. Voltage and current calibration constants are determined based on the step-down and voltage divider ratios of PT and CT.

Fig 4.2– Hardware model developed for the system demo

Algorithm of the Project: -

(a) Altering phase of two Signals

1. Timer0 set and run till Timer1 is set or vice-versa.
2. Two signals (current & voltage) are introduced.
3. Phase angle between the two signals altered by incrementing or Decrementing delay .
4. Delay of 0.1 ms is given while incrementing or decrementing.
5. Accumulator stores the number of incrementing or decrementing operations. Step-6:- Delay is called according to the number stored in the accumulator.
6. The signals, altered in phase are sent to the motherboard for power factor detection.

(b) Phase angle Detection:-

1. Microcontroller started on interrupt mode
2. INTX0 & INTX1 are enabled.
3. INTX0 given VOLTAGE (V), INTX1 given CURRENT (I) from sampling circuit
4. Timer measures time interval between two interrupts.
5. Time interval calibrated
6. Calibrated data is converted from HEX to BCD, then to ASCII for display on LCD.

V. CONCLUSION

It can be concluded that power factor correction procedures can be connected to industries, power system and furthermore households to make them stable and because of that the framework winds up stable productivity of the framework and furthermore mechanical gathering increments. It apportions the procedure used to beat the punishment forced and power misfortune because of low influence factor endless with same private and little mechanical unit. The static capacitor is utilized in ventures to work on the force factor in industry and distribution lines. Thus, it not only improves power factor but also increases line efficiency. It can be concluded that power factor correction techniques can be applied to the industries, power systems and also households to make them stable and due to that the system becomes stable and efficiency of the system as well as the apparatus increases.

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