SMART POWER FACTOR CONTROLLER USING MICROCONTROLLER AND WI-FI ENABLED SWITCH

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Abstract: In this proposed system, two zero crossing detectors are used for detecting zero crossing of voltage and current. The project is designed to minimize penalty for industrial units using automatic power factor correction unit. The microcontroller used in this project belongs to 8051 family. The time lag between the zero-voltage pulse and zero-current pulse is duly generated by suitable operational amplifier circuits in comparator mode is fed to two interrupt pins of a microcontroller. The program takes over to actuate appropriate number of relays from its output to bring shunt capacitors into load circuit to get the power factor till it reaches near unity. The capacitor bank and relays are interfaced to the microcontroller using a relay driver. It displays time lag between the current and voltage on an LCD. Furthermore, the project can be enhanced by using thyristor control switches instead of relay control to avoid contact pitting often encountered by switching of capacitors due to high in rush current

Keywords: Zero Crossing Detector, Capacitors, Power Factor Correction.

1. Introduction

The Power factor is the ratio between real power and the apparent power of the equipment. In the present trend, Automatic Power Factor Controller design can be achieved by using programmable devices. As we think about programmable device embedded systems comes forefront. Embedded systems nowadays are very popular and microcontrollers prove to be advantageous with the reduction of cost, extra hardware use such as timer, RAM, ADC are avoided. Only the relays used are disadvantageous as they are too bulky and need regular maintenance. Now the embedded technology has become cheaper with the help of technical revolution so as to apply it in all the fields. Automatic Power Factor Correction device is very useful to improve the transmission of active power efficiently. Power factor must be maintained within a limit. As inductive load is connected, Power factor lags and when Power factor goes below the lagging Power factor, then a penalty is charged by the supplying company. Therefore, it is necessary to maintain Power factor within limit. APFC techniques can be applicable to industries, power systems and also to households to make them stable and also help in improving the efficiency of the system. Poor Power factor can be improved by addition of Power factor correction, but a poor Power factor which is caused due to distortion in current waveform needs to have a change in the design of the equipment APFC is to be developed based on microcontroller (AT89S52\C51) Poor Power factor can be improved by addition of Power factor correction, but a poor Power factor which is caused due to distortion in current waveform needs to have a change in the design of the equipment APFC is to be developed based on microcontroller(AT89S52\C51) . Lesser reactive power flows from the line.

1.2 Objective

To conduct an electrical survey of the existing system in an opencast mine to study the system configuration and load patterns, variation of power factor during the domestic load hours and analyze power factor correction facilities, if any.Design a microcontroller based correction equipment to improve the power factor of the system to desired value of greater than 0.95. Implement the system and monitor different electrical load models and diverse load patterns to verify the result.
To carry out economic analysis for power factor improve

2. Overview

In this proposed system, two zero crossing detectors are used for detecting zero crossing of voltage and current. The project is designed to minimize penalties for industrial units using automatic power factor correction units. The microcontroller used in this project belongs to the 8051 family. The time lag between the zero-voltage pulse and zero-current pulse is duly generated by suitable operational amplifier circuits in comparator mode fed to two interrupt pins of a microcontroller. The program takes over to actuate an 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.

1. Advantages:

The following are the advantages of Smart Power Factor Controller Using Wi-Fi Enabled Switch are:

- Reactive power decreases
- Efficiency of the supply system and apparatus increases.

- The electrical consumption tariffs depend on the power factor.
- Avoid poor voltage regulation
- Overloading is avoided
- Copper loss decreases
- Distribution loss decreases

2. Limitations:

The following are the disadvantages of Smart Power Factor Controller Using Wi-Fi Enabled Switch are:

- Large line losses: Line losses are proportional to the square of current. Therefore, larger the current, greater are the line losses.
- Greater conductor size and cost: At low power factor, current will be increased. To transmit this high current conductor size has to be increased.
- Effect on transformers: For decreased power factor, the KW capacity of the transformer is decreased and voltage is increased.
- Effect on switchgear and busbars: The cross- sectional area of the bus bar, and the contact surface of the switchgears must be enlarged for the same power to be delivered at low power factors.

3. Methodology

Smart Power Factor Controller Using Wi-Fi Enabled Switch is shown in figure 3.1.

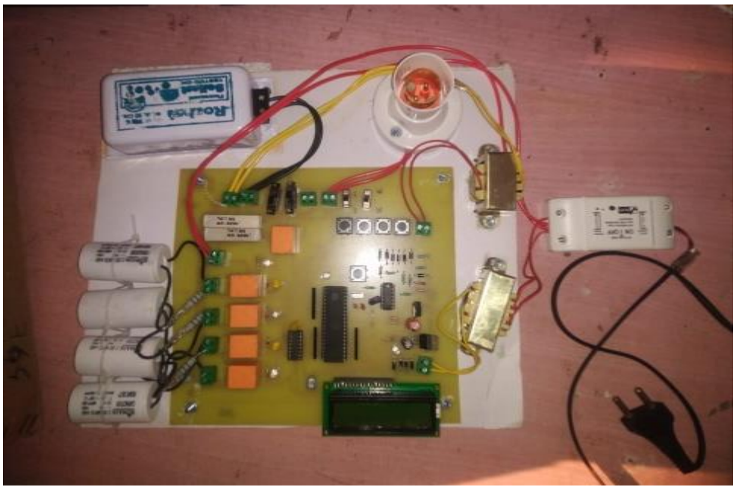

Fig 3.0: Real Time Implementing System

Power factor correction is the process of compensating for the lagging current by creating a leading current by connecting capacitors to the supply. A sufficient capacitance is connected so that the power factor is adjusted to be as close to unity as possible However, using passive power correction method in series with wi-fi switch it operates the circuit remotely.

1. Real -Time Implementation Monitoring:

In this paper we had shown and implemented that the power factor correction at the receiving end near to unity,The output is generated during the process is approximately 1.0. When the supply is connected, based on the load the microcontroller computes the phase shift between the voltage and current by zero crossing detector, which detects every zero magnitude in the power cycle. Then based on the phase angle the respective capacitors are get compensated the lagging power makes the value in the display 1.0.

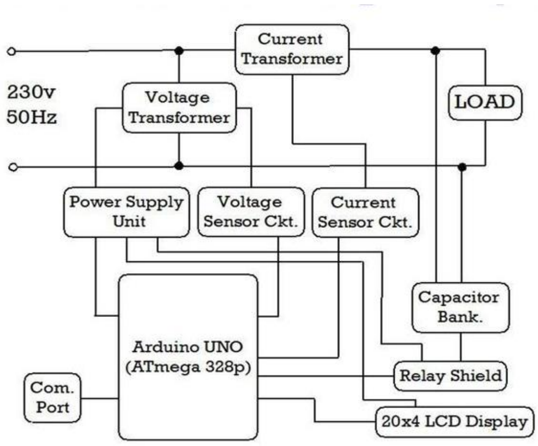

Fig 3.1: Automatic power factor control and monitoring system

2. Applications:

- Power factor enhancements reduce the amount of current flowing through an electrical system
- Cost of energy utilized is decreases, by reducing the wastage current.
- Due to flow of active power, Less heat generation in the loads occur.
- Greater energy efficiency is achieved by consuming active power and less reactive power.
- The installation results in a lowering of your power bill as a result of reducing the maximum supply tariff.

4. Hardware Description

1. Equivalent Circuit Model:

An approximated model of Smart Power Factor Controller Using Wi-Fi Enabled Switch was live monitoring and controlling has been done in live. The electrical equivalent circuit of this model is as shown in the figure 4.1

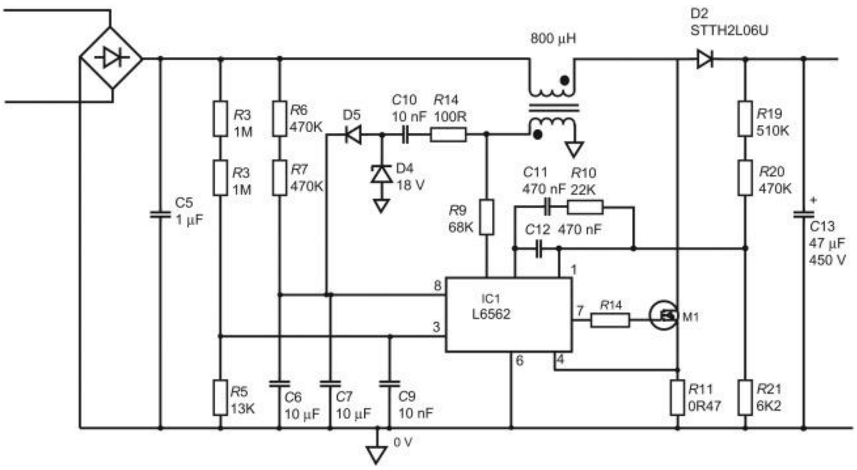

Fig 4.1: Equivalent Circuit Model

Power Factor Correction improves the phase angle between the supply voltage and current while the real power consumption in watts remains the same, because as we have seen a pure reactance does not consume any real power. Adding an impedance in the form of capacitve reactance in parallel with the coil above will decrease Θ and thus increases the power factor which in turn reduces the circuits rms current drawn from the supply.

The power factor of an AC circuit can vary from between 0 and 1 depending on the strength of the inductive load but in reality it can never be less than about 0.2 for the heaviest of inductive loads. As we have seen above, a power factor of less than 1 means that there is reactive power consumption which increases the closer it gets to 0 (fully inductive). Clearly then a power factor of exactly "1" means the circuit consumes zero reactive power (fully resistive) resulting in a power factor angle of 0°. This is referred to as "unity power factor".

2. Working Principle

The below figure 4.2 shows the Working Principle.

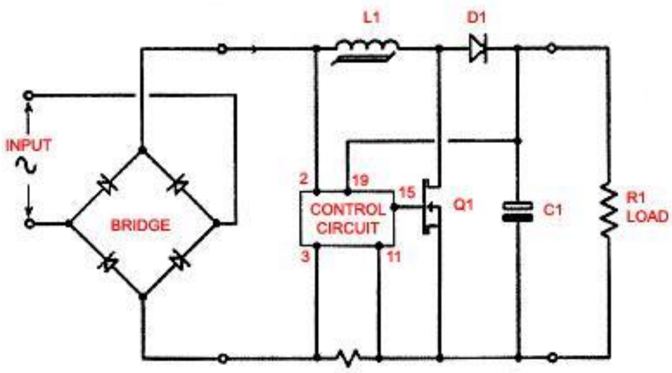

Fig 4.2: Working Principle

Power factor is a measure of the efficiency with which electrical loads convert electrical power into useful work. It is a ratio of useful power (working power) to the total power (apparent power) supplied. A high power factor is an indicator that the electrical loads are utilising power efficiently, while a low power factor indicates that the connected electrical loads are utilising power inefficiently. A poor power factor results in significant energy wastage, and decreases the capacity of the electrical system. It can be caused by a phase difference between current and voltage at the terminals of an electrical load, or a distorted current waveform.

5. Types of Power Factor Correction Capacitors

Capacitors for power factor correction are manufactured in a variety of types, sizes and designs. The most commonly used types are constructed using a metallized polypropylene film while a few employ metallized polyester film or paper. Bi-metallized paper capacitors are commonly used in applications that demand robust power factor correction solutions. The special paper used for constructing these capacitors contains a thin layer of metal alloy. Sheets of paper are separated by a polypropylene film. These capacitors are constructed to withstand high temperatures and high harmonic content. Bi-metallized paper capacitors find many applications in power electronics. Metallized polyester film capacitors are compact, light and offer excellent capacitance stability. Although these capacitors are used primarily for DC applications, they are alos suitable for AC line filtering and power factor correction.

6. Conclusion:

Power factor correction techniques can be applied to the domestic and industries, power systems and 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. The use of microcontroller reduces the costs. Due to use of microcontroller multiple parameters can be controlled and the use of extra hard wares such as timer, RAM, ROM and input output ports reduces. Care should be taken for overcorrection otherwise the voltage and current becomes more due to which the power system or machine becomes unstable and the life of capacitor banks reduces.

7. Future Scope:

- Electricity compensation at domestic side will reduce unwanted power.
- It will decrease the pollution. In future, every individual had their own power generation which connected to grid. So it helps in Automatic power factor correction (PFC).
- In the Present days the loads are day by day increase, by this it reduces the burden on the distribution side

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