UNIFIED POWER FACTOR CONTROL SYSTEM WITH CAPACITIVE BANK

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Abstract

Wasted energy capacity, also known as poor power factor, is often overlooked. It can result in poor reliability, safety problems and higher energy costs. The lower your power factor, the less economically your system operates. The actual amount of power being used, or dissipated, in a circuit is called true power. Reactive loads such as inductors and capacitors make up what is called reactive power. The linear combination of true power and reactive power is called apparent power. Power system loads consist of resistive, inductive, and capacitive loads. Power factor correction (PFC) is usually achieved by adding capacitive load to offset the inductive load present in the power system. The power factor of the power system is constantly changing due to variations in the size and number of the motors being used at one time. This makes it difficult to balance the inductive and capacitive loads continuously.

Keywords:PIC microcontroller, Relay, capacitor bank, LCD, Load, Inductor

1. Introduction.

Power is vital in current circumstances because of specialized transformations. Inductive loads are expanded in view of industrialization, these will impact on the power factor.So the productivity of the framework is diminished. Framework proficiency can be enhanced with the utilization of force element adjustment gadget. This will build the power factor consider closer to unity. This gadget peruses the power factor variable from the line current and line voltage values. Power factor is one of the factors that affect the efficiency of the power supply. Low power factor is one of the losses to the power supply company where supplying consumer with apparent power (voltamperes), but bill them for real power (watt). At the same time, low power factor will cause high current to flow in the line, so the power losses will be increases because of proportional to the square of the current. In order to reduce the losses, the company needs to apply power factor correction.

This project provides continuous power factor correction without manual capacitive bank loading. A PFC controller provides power factor correction and peak current limiting for a switch-mode power converter of any topology (buck, boost or buck-boost), without having to directly sense inductor current.

2. LITERATURE SURVEY

Reactive power is the power consumed in the ac circuit because of the inductive and capacitive field. The unit used for measuring reactive power is KVAR [1]. Apparent power is the combination of the active power and reactive power. It is the product of a circuit voltage and current without reference to phase angle. Apparent power(S) is measured in the unit of volt-amps (VA). A load with a power factor unity is the purely resistive load, because the sinusoidal voltage and sinusoidal current wave form is in phase or the phase angle difference between the voltage and the current is zero [2]. A poor power factor can be the result of a significant phase between the applied voltage and the current at the load terminals or it can be due to a high harmonic content or distorted (discontinuous current wave form). The poor load current phase angle can be generally the result of inductive loads such as induction motor, power transformers and lighting ballasts. A distorted current wave form can be the result of rectifier, variable speed drive, switched mode power supply and other electric loads. Low power factor loads increases losses in power supply and distribution system and it increases the cost in electricity in bills. Circuits containing inductive or capacitive elements such as lamp ballasts and motors often have a power factor below 1.0[3]. The energy price is growing, what force the industry plants and individual customers to minimize energy consumption, including reactive power. Generally, there are solutions that allow handle the problem of reactive power compensation. The first one is reactive power compensator using power factor capacitors. This is very important compensating device, due to economic reasons and they are very cheap comparing with active filters by means of electric motors [4]. If the consumer connect inductive load, then the power factor lags, when the power factor goes below 0.97(lag) then the electric supply company charge penalty to the consumer. So it is essential to maintain the power factor below with in a limit. Automatic power factor correction device reads the power factor from line voltage and line current, calculating the compensation requirement switch on different capacitor banks [5].

3. Proposed system:

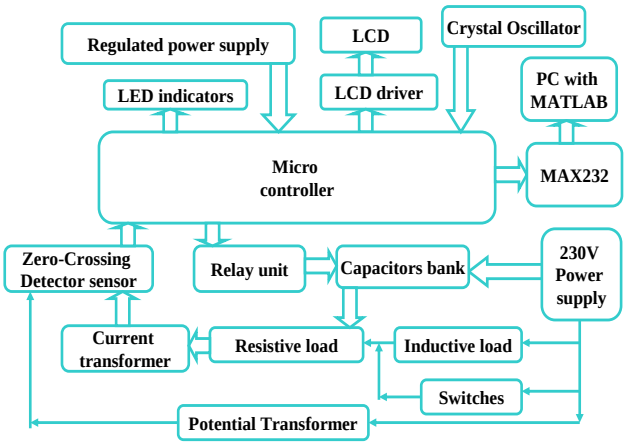

Figure 1: Block diagram

Working:

This project provides continuous power factor correction without manual capacitive bank loading. A PFC controller provides power factor correction and peak current limiting for a switch-mode power converter of any topology (buck, boost or buck-boost), without having to directly sense inductor current. The PFC control technique involves using a piecewise-polynomial analog computer (AC) to compute power transistor on-times in accordance with separate polynomial transfer functions for power-factor control and peak-current-linking using as inputs current representations of line input voltage (VLN), load output voltage (VLD), and long-term current demand (VCD). A conduction cycle is initiated by sensing when the rate of change in the inductor current reaches zero using an auxiliary winding on the current storage inductor, and terminated after the computed on-time to implement either power-factor control or peak-current-limiting.

PIC microcontroller:

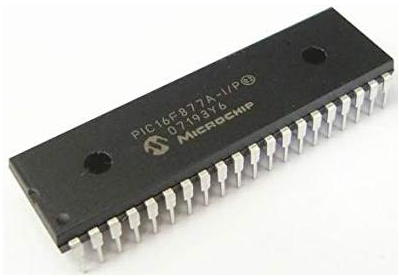

Figure 2: PIC microcontroller

The PIC16F877A CMOS FLASH-based 8-bit microcontroller is upward compatible with PIC16C72B/74B/76/77,PIC16F873/874/876/877devices. It features 200 ns instruction execution, self-programming, an ICD, 2 Comparators, 8 channels of 8-bit Analog-to-Digital (A/D) converter, 2 capture/compare/PWM functions, a synchronous serial port that can be configured as either 3-wire SPI or 2-wire I2C bus, a USART, and a Parallel Slave Port. PIC16F877A is a RISC microcontroller, that means that it has a reduced set of instructions, more precisely 35 instructions.

Relay:

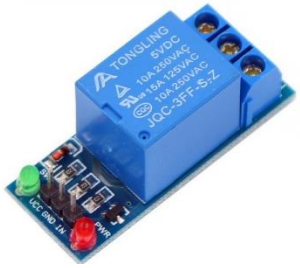

Figure 3: Relay

A **relay** is an electrically operated switch. Many relays use an electromagnet to operate a switching mechanism, but other operating principles are also used. Relays find applications where it is necessary to control a circuit by a low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits, repeating the signal coming in from one circuit and re-transmitting it to another. A type of relay that can handle the high power required to directly drive an electric motor is called a contactor. Solid-state relays control power circuits with no moving parts, instead using a semiconductor device triggered by light to perform switching.

LCD display:

One of the most common devices attached to a micro controller is an LCD display. Some of the most common LCD's connected to the many microcontrollers are 16x2 and 20x2 displays. This means 16 characters per line by 2 lines and 20 characters per line by 2 lines, respectively.

Basic 16x 2 Characters LCD

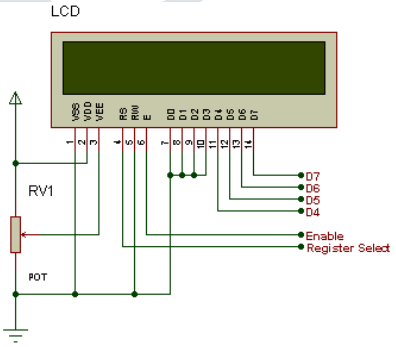

Figure 4: LCD display

Switch:

Figure 5: Switch

A switch is an electrical component which can break an electrical circuit, interrupting the current or diverting it from one conductor to another. The most

familiar form of switch is a manually operated electromechanical device with one or more sets of electrical contacts. Each set of contacts can be in one of two states: either 'closed' meaning the contacts are touching and electricity can flow between them, or 'open', meaning the contacts are separated and none conducting.

Capacitor bank:

Figure 6: Capacitor bank

Capacitor banks work on the same theory that a single capacitor does; they are designed to store electrical energy, just at a greater capacity than a single device. An individual capacitor consists of two conductors which are separated by a dielectric or insulating material. When current is sent through the conductors, an electric field that is static in nature then develops in the dielectric which acts as stored energy.

Inductive load:

Inductive Loads, also called Lagging Loads or Inductive Load Banks or Inductive Reactive Loads or Power Factor Loads, are AC loads that are predominantly inductive in nature so that the alternating current lags behind the alternating voltage when the current flows into the load.

High power LED:

Figure 7: High power LED

A **light-emitting diode** (**LED**) is a semiconductor light source. LEDs are used as indicator lamps in many devices. Like a normal diode, the LED consists of a chip of semiconducting material impregnated, or doped, with impurities to create a p-n junction. As in other diodes, current flows easily from the p-side, or anode, to the n-side, or cathode, but not in the reverse direction. Charge-carriers—electrons and holes—flow into the junction from electrodes with different voltages. When an electron meets a hole, it falls into a lower energy level, and releases energy in the form of a photon.

Crystal oscillator:

Figure 8: Crystal oscillator

An oscillator is an electronic circuit that produces a repetitive electronic signal. The maximum operating frequency of PIC Microcontrollers is 20 MHz Crystal oscillator is used in the project because of the fact that crystal is more stable to temperature than other types of oscillators.

MAX232:

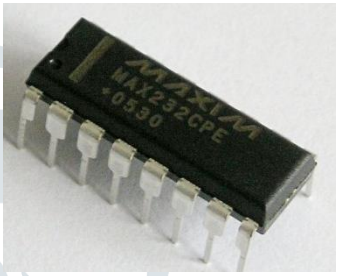

Figure 9: MAX232

The MAX232 is an integrated circuit first created in 1987 by Maxim Integrated Products that converts signals from a TIA-232 (RS-232) serial port to signals suitable for use in TTL-compatible digital logic circuits. The MAX232 is a dual transmitter / dual receiver that typically is used to convert the RX, TX, CTS, RTS signals.

The drivers provide TIA-232 voltage level outputs (about ±7.5 volts) from a single 5-volt supply by on-chip charge pumps and external capacitors. This makes it useful for implementing TIA-232 in devices that otherwise do not need any other voltages.

MATLAB

The name MATLAB stands for matrix laboratory. MATLAB (matrix laboratory) is a numerical computing environment and fourth-generation programming language. Developed by MathWorks, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, Java, and Fortran.

MATLAB can be used in a wide range of applications, including signal and image processing, communications, control design, test and measurement, financial modeling and analysis, and computational biology. For a million engineers and scientists in industry and academia, MATLAB is the language of technical computing.

Power factor:

Electric power is defined as the rate at which electrical energy is transferred by an electric circuit. The SI unit of power is the watt.

In alternating current circuits, energy storage elements such as inductance and capacitance may result in periodic reversals of the direction of energy flow. The portion of power flow that, averaged over a complete cycle of the AC waveform, results in net transfer of energy in one direction is known as real power (also referred to as active power). That portion of power flow due to stored energy, which returns to the source in each cycle, is known as reactive power.

Loads will absorb energy during part of the AC cycle, which is stored in the device's electric field, only to return this energy back to the source during the rest of the cycle. For example, to get 1 kW of real power, if the power factor is unity, 1 kVA of apparent power needs to be transferred (1 kW ÷ 1 = 1 kVA).

5. CONCLUSION

The existing model presents an Integrating feature of all the hardware components. The presence of each and every module has been reasoned out and placed very carefully. Hence the contributing to the best working unit for "**Unified power factor control system with capacitive bank**" has been designed perfectly. Thus, the project has been successfully designed and tested.

6. ACKNOWLEDGEMENT

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