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Intelligent Power Management System



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Abstract

The paper introduces a project that aims the power factor correction of electrical loads is a problem common to all industrial companies. Earlier the power factor correction was done by adjusting the capacitive bank manually. The automated power factor corrector (APFC) using capacitive load bank is helpful in providing the power factor correction. Proposed automated project involves measuring the power factor value from the load using microcontroller. The design of this auto-adjustable power factor correction is to ensure the entire power system always preserving unity power factor. The software and hardware required to implement the suggested automatic power factor correction scheme are explained and its operation is described. APFC thus helps us to decrease the time taken to correct the power factor which helps to increase the efficiency.

Keywords: ***energy meter, zero crossing detector, potentiometer, zigbee, capacitive bank, relay.***

1. Introduction

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.

The Reactive Power charge on your electricity bill is directly targeted against those companies who do not demonstrate clear energy efficiency use. You will find this charge itemized on electricity bill. Reactive power charges can be made significantly smaller by the introduction of Power Factor Correction Capacitors which is a widely recognized method of reducing an electrical load and minimizing wasted energy, improving the efficiency of a plant and reducing the electricity bill. It is not always necessary to reach a power factor of 1. A cost effective solution can be achieved by increasing your power factor to greater than 0.95

This project uses regulated 5V, 750mA power supply. 7805 three terminal voltage regulator is used for voltage regulation. Bridge type full wave rectifier is

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used to rectify the ac output of secondary of 230/12V step down transformer.

2. LITERATURE SURVEY

Technologies and resources

The work initially involves simulation of basic power electronic circuits and the analysis of the current and voltage waveforms. It starts with simple circuits with a gradual increase in complexity by inclusion of new components and their subsequent effect on the current and voltage waveforms. We focus on the objective of improving the input current waveform i.e. making it sinusoidal by tuning the circuits. The new analytical method simplifies the design of S2PFCs by making it possible to compare a large number of different designs from the same viewpoint in order to identify the best topology. Finally, research has enabled us to reduce the total size of the additional inductors that are used by a factor of two to three with respect to previous implementations.

For rectifier circuits with power Jactor correction, boost converters are generally used, and as a result the output voltage becomes limited. To expand the controlled voltage range, buck-boost or Cook converter types should be utilized. This paper presents a circuit configuration with power factor correction by a third type of' buck boost converter, termed as 'canonical switching cell'. Single-phase power factor correction using a buck boost converter can control the output voltage over a wide range, because it has the ability to step-up and step-down the output voltage. Firstly, this paper compares the mechanisms of the power transmission and the characteristics based on the switching ripple of various converters. Secondly, the canonical switching cell is applied to the single-phase power factor correction. It is proposed that this converter is suitable for power factor correction.(Ms. Kurma Sai Mallika *et al* 2007)

Power factor control is a major role in the improvement of power system stability. Many of the existing systems are expensive and difficult to manufacturer. Nowadays many of the converters have no input power factor correction circuits. The effect of power factor correction circuit is used to eliminate the harmonics present in the system. This type of power factor correction circuit is mostly used in the Switched Reluctance Motor controller drive. Fixed capacitor systems are always leading power factor under at any load conditions. This is unhealthy for installations of power system. The proposed embedded system drive is used to reduce the cost of the equipment and increase the efficiency of the system. Experimental results of the proposed systems are included. It is better choice for effective cost process and energy savings (Kurma Sai Mallika *et al* 2007).

When the input current waveform is chosen properly, power factor reduction leads to a reduction in filter capacitor size (and therefore to reduced system cost) while still meeting power quality requirements. Notice that the choice of waveform is independent of the particular power conversion topology to be used. It applies equally to boost, flyback, buck, and other topologies that have been used in PFC applications. (O. Garcia *et al* 2001)

3. IMPLEMENTATION:

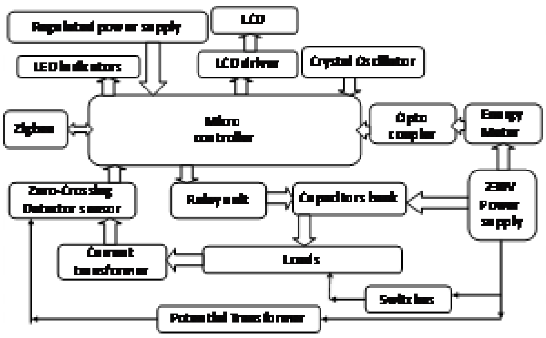

Fig: 3.1 transmitter section

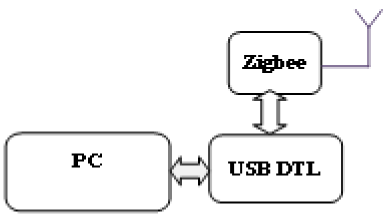

Fig: 3.2 receiving section

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Given below is the block diagram of automatic power factor correction system. The input to the circuit is applied from the regulated power supply. The AC input i.e., 230V from the mains supply is step down by the transformer to 12V and is fed to a rectifier. The output obtained from the rectifier is a pulsating DC voltage. So in order to get a pure DC voltage, the output voltage from the rectifier is fed to a filter to remove any AC components present even after rectification. The supplied voltage and current signals, taken through a potential transformer and a current transformer. The two sinusoidal waveforms are being changed to square waves through two zero-crossing detectors. These digital square waves are used by microcontroller to calculate phase difference and thus power factor.

4. RELATED WORK:

The brief introduction of different modules used in this project is discussed below:

Microcontroller

Microcontroller is the main heart of the project the total work was controlled by the controller the energy meter readings are calculates and given to the output values the more of the components are intrudes below.

ENERGY METER:

An electricity meter, electric meter, or energy meter is a device that measures the amount of electric energy consumed by a residence, business, or an electrically powered device.. The most common unit of measurement on the electricity meter is the kilowatt hour [kWh], which is equal to the amount of energy used by a load of one kilowatt over a period of one hour, or 3,600,000 joules. In an induction type meter, creep is a phenomenon that can adversely affect accuracy that occurs when the meter disc rotates continuously with potential applied and the load terminals open circuited. A test for error due to creep is called a creep test. Time of Day metering (TOD), also known as Time of Usage (TOU) or Seasonal Time of Day (SToD), metering involves dividing the day, month and year into tariff slots and with higher rates at peak load periods and low tariff rates at off-peak load periods.

Zero crossing circuit:

Zero-Crossing Detectors Circuits and Applications. by Lewis Loflin. A zero-crossing detector is used to generate a sync pulse related to the AC voltage phase angle often used in power control circuits. Fig. 1 shows the relationship of a zero-crossing pulse to a sine wave. The pulse occurs at 0, 180, and 360 degrees.

The zero crossing detector circuit is an important application of the op-amp comparator circuit. It can also be called as the sine to square wave converter. Anyone of the inverting or non-inverting comparators can be used as a zero-crossing detector. The only change to be brought in is the reference voltage with which the input voltage is to be compared, must be made zero (Vref = 0V). An input sine wave is given as Vin. These are shown in the circuit diagram and input and output waveforms of an inverting comparator with a 0V reference voltage.

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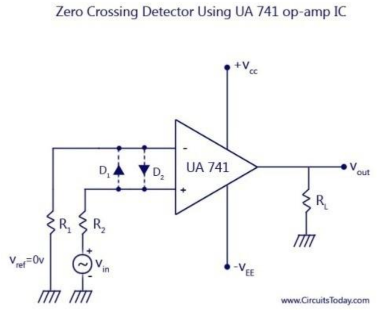
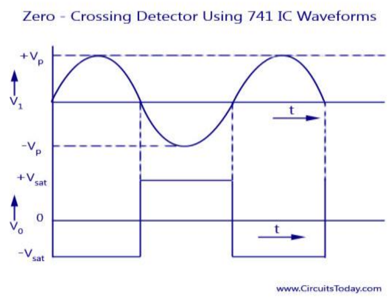


As shown in the waveform, for a reference voltage 0V, when the input sine wave passes through zero and goes in positive direction, the output voltage Vout is driven into negative saturation. Similarly, when the input voltage passes through zero and goes in the negative direction, the output voltage is driven to positive saturation. The diodes D1 and D2 are also called clamp diodes. They are used to protect the op-amp from damage due to increase in input voltage. They clamp the differential input voltages to either +0.7V or -0.7V.

In certain applications, the input voltage may be a low frequency waveform. This means that the waveform only changes slowly. This causes a delay in time for the input voltage to cross the zero-level. This causes further delay for the output voltage to switch between the upper and lower saturation levels. At the same time, the input noises in the op-amp may cause the output voltage to switch between the saturation levels. Thus zero crossing are detected for noise voltages in addition to the input voltage. These difficulties can be removed by using a regenerative feedback circuit with a positive feedback that causes the output voltage to change faster thereby eliminating the possibility of any false zero crossing due to noise voltages at the op-amp input.



Opto coupler:

In electronics, an opto-isolator, also called an optocoupler, photocoupler, or optical isolator, is a component that transfers electrical signals between two isolated circuits by using light. Opto-isolators prevent high voltages from affecting the system receiving the signal. Commercially available opto-isolators withstand input-to-output voltages up to 10 kV[3] and voltage transients with speeds up to 10 kV/μs.[4]

A common type of opto-isolator consists of an LED and a phototransistor in the same opaque package. Other types of source-sensor combinations include LED-photodiode, LED-LASCR, and lamp-photoresistor pairs. Usually opto-isolators transfer digital (on-off) signals, but some techniques allow them to be used with analog signals.

An opto-isolator contains a source (emitter) of light, almost always a near infrared light-emitting diode(LED), that converts electrical input signal into light, a closed optical channel (also called dielectrical channel[7]), and a photo sensor, which detects incoming light and either generates electric energy directly, or modulates electric current flowing from an external power supply. The sensor can be a photo resistor, a photodiode, a phototransistor, a silicon-controlled rectifier (SCR) or a triac. Because LEDs can sense light in addition to emitting it, construction of symmetrical, bidirectionalopto-isolators is possible. An opto coupled solid state relay contains a photodiode opto-isolator which drives a power switch, usually a complementary pair of MOSFETs. A slotted optical switch contains a source of light and a sensor, but its optical channel is open, allowing modulation of light by external objects obstructing the path of light or reflecting light into the sensor.

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Potentiometer:

Typical voltage-divider configurations For each of these circuits, assume that V_{IN} represents a low-impedance voltage source, and that V_{OUT} represents a high-impedance input node. Figure 1a depicts a simple voltage-divider with a transfer function of $V_{OUT} = V_{IN}(R_B/R_{POT})$, where $R_{POT} = R_A + R_B$. R_A and R_B represent the resistances from V_{IN} to the wiper, and from the wiper to ground, respectively. Stepping the wiper from the bottom of the pot to the top, with V_{IN} at a constant 5V level, generates a linear transfer function. This is shown in the linear-response plot in Figure 1b. A link to an Excel® spreadsheet is provided at the end of this article, to help you calculate V_{OUT} versus tap-position data.

Adding a series resistor to the circuit (R1 in yields an entirely different result. Now this circuit's transfer function more closely resembles a logarithmic curve and is characterized by the equation $V_{OUT} = V_{IN}(R_B/(R1 + R_B))$. By varying the value of R1, which in this case is 10kΩ, the "pseudologarithmic" transfer function can be customized to meet the actual needs of the circuit. A graph of the transfer function. One possible drawback to this circuit, as compared to a log-taper digital pot, is that V_{OUT} can only *approach* the full-scale value of V_{IN}. V_{OUT} cannot reach V_{IN}. Therefore, there is some loss of the output's dynamic range; the magnitude of that loss depends on the value chosen for R1. Using a log-taper digital pot, however, limits the response to that particular pot's specifications (1dB/step, 2dB/step, etc). There are trade-offs for both topologies, depending on the specifications needed.
Lastly, swapping the positions of R1 and the MAX5160 yields the. This configuration alters the response of the output to form more of an inverse-logarithmic function. The transfer function for this circuit is given as $V_{OUT} = V_{IN}(R1/(R1 + R_B))$. As in the previous example, the value chosen for R1 affects the dynamic range of the output. This circuit's output does not extend to the ground rail.

6. FLOWCHART:

The flowchart of intelligent power management is shown in the figure

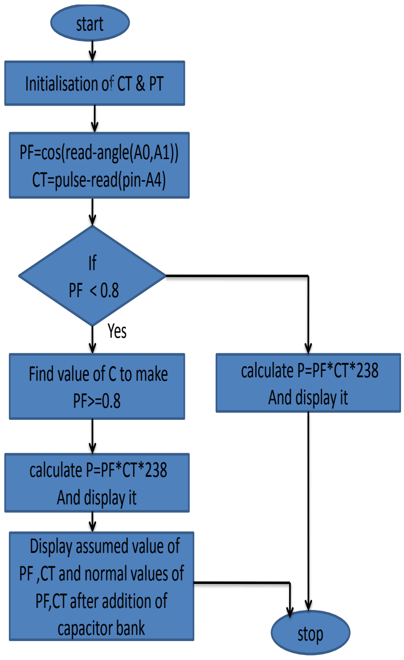

Fig Flow chart of Intelligent Power Management System

7. Result:

The image of the project intelligent power management is shown in the fig 7.1

Fig 7.1: Image of project setup

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PROJECT OUTPUT:

The image of final output of the project intelligent power management is shown in the fig 7.2.

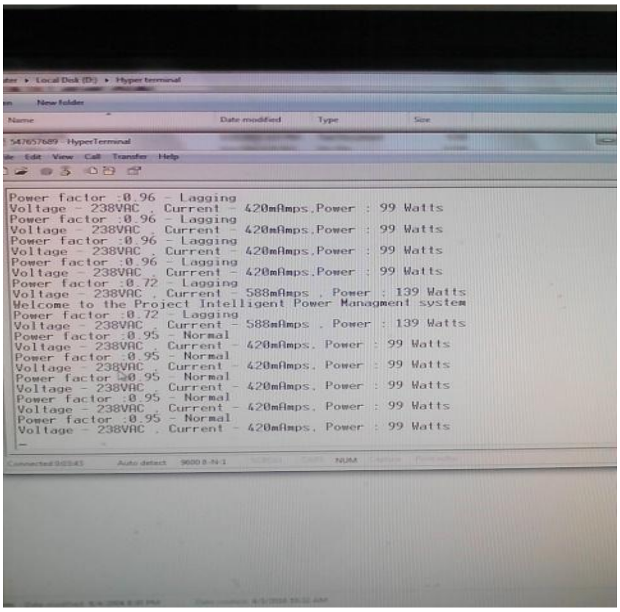

Fig 7.2: Image of project output

8. CONCLUSION:

Integrating features of all the hardware components used have been developed in it. Presence of every module has been reasoned out and placed carefully, thus contributing to the best working of the unit. Secondly, using highly advanced IC's with the help of growing technology, the project has been successfully implemented. Thus the project has been successfully designed and tested. So, by using the Automatic Power Factor Improvement module we can efficiently improve the power factor for variable inductive loads, improving the life span of equipment and reducing power bills.

9. ACKNOWLEDGEMENT

We would like to thank all the authors of different research papers referred during writing this paper. It was very knowledge gaining and helpful for the further research to be done in future.

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Mr . Bhogadi Lokeswara Rao was born on Jan 4, 1968.He received his Bachelor's degree in Electronics & Communication Engineering from Andhra University, Master's degree in Microwave & Radar Engineering from Osmania University and Ph.D in ECE from Andhra University. He is currently working as Professor & HOD in the Department of Electronics & Communication Engineering, CMR College of Engineering & Technology, Hyderabad. He has 26 years of experience in Teaching, R&D, and Industry. He is working in the area of GPS/INS Integration using Kalman filtering. He is a Fellow of IETE and also a Fellow of IE (India).

Mr.Y.Chitti Babu working as an Assistant Professor in CMRCET. He has done his post-graduation in embedded systems and graduation in ECE. He has 8 to 9 years of teaching experience.