VOLTAGE MONITORING AND POWER FACTOR CORRECTION USING GSM

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ABSTRACT: *The power factor correction of electrical loads is a problem common to all industries. Earlier the power factor correction was done by adjusting the capacitive banks manually. The automated power factor corrector using capacitive banks is helpful in providing the power factor correction. Proposed automated project involves measuring the power factor value and correcting using microcontroller and the load to be controlled by using GSM.The objective is to improve the power quality by continuously monitoring the load power factor. When the load power factor falls below a certain value it results in increase of line current resulting in more line loss and greater voltage drop. The aim is to build a simple compact and energy efficient system for automatic power factor monitoring and control. It incorporates PIC 16F877 microcontroller kit along with zero crossing detector circuit and relay driver circuit. The voltage and current parameters are detected and controlled by using GSM.*

KEY WORDS: A.C Alternating current, D.C Direct current, P.F Power Factor, Power factor correction, Zero cross detector, Potential Transformer.

1. INTRODUCTION

Power factor is used to evaluate the electric power consumption in a power system.If the power factor is high then the effectiveness of usage of electric power in a power system is more. If the power factor reduces the less effectively electric power is being used in power system.

With the continuous rise in the demand and cost of energy, increased power efficiency and quality is very desirable. Power quality can be increased through power factor correction. A compact and efficient system for power factor control and power management can be very useful in industries with high inductive loads. Its use can be extended to within a building or a single machine or appliances.

Embedded technology is one of the greatest boons to mankind. It reduces the man power, increases the efficiency and saves time. So, embedded technology is incorporated for an efficient power management system.

The effect of low power factor is large copper loss and poor voltage regulations. The main reasons of low power factor are most of the AC motors are of induction type which have low lagging power factor and arc lamps ,electric discharge lamps and industrial heating furnaces operate at lower power factors.

The lower power factor is undesirable from economic point of view.PIC micro controller chip has been used, here for the implementation of the power factor correction. The correction is done by measuring the power factor, evaluating the value of capacitance to be injected and approximating the capacitance obtained with some standard capacitances and the by using the GSM the on/off messages are sent to the load.

Poor power factor costs our community in increased electricity charges and unnecessary green house gasses. While some countries provide incentives for customers to maintain requires power factor, some impose penalties for power factor dropping beyond the limit. Thus, power factor control is the most important part of efficient power management.

2. PROPOSED SYSTEM
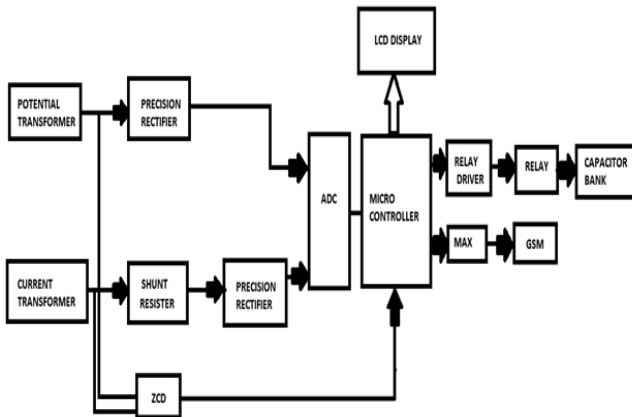
2.1 OVERALL BLOCK DIAGRAM

Fig 2.1 Block Diagram

This project is designed with

- Potential Transformer
- Current transformer
- Shunt register
- Zero crossing detector
- Logic circuit
- Micro controller
- ADC
- LCD display

The voltage mmf is done with the help of potential transformer will give a step down voltage of (0-6V AC) for (230). The AC voltage is rectified to peak voltage with the use of precision rectifier. The precision rectifier O/P is given to ADC is 0-5V the O/P of ADC is in 8-bit data format and the microcontroller will display the voltage in LCD display.

The current mmf is done with the help of current transformers. The current transformer will give a step down current that will be given to shunt resistor and will be converted to voltage. The AC voltage is rectified to peak voltage with the help of precision rectifier. The precision rectifier O/P is given to ADC is 0-5V, the O/P of ADC is in 8-bit data format and the microcontroller will display the current in LCD display.

The P.T. & C.T. O/P will be given to zero crossing detectors and two O/P of zero crossing detectors will be given to P.F. mmf circuit and that will be given to a microcontroller directly.

By the above methods we can calculate voltage, current, power factor separately. By using these three parameters we can calculate active power, reactive power and energy with respect to time period we can easily calculate the maximum demand in an industry.

For power factor controller, after measuring the power factor we have to write a microcontroller program to switch on some relays along with capacitor bank. By switching the capacitor bank we will try to get the unity power factor.

If the monitored power factor is less then unit, then the microcontroller activates the relay driver circuit. The capacitor bank is connected across the relay output terminal. The relay output terminal is shorted through the capacitor so the lagging angle is compensated through leading angle due to the capacitor. Here the key pad is used to set the desired power factor.

By using these three parameters we can calculate active power, reactive power and energy with respect to time period we can easily calculate the maximum demand in an industry.

All the parameters are monitored and control via GSM. If we need to ON the LOAD using GSM send SMS to Control the Load ON/OFF.

2.2. CIRCUIT DIAGRAM DESCRIPTION

*POWER SUPPLY:*The power supply is of two ranges, +5V for micro controller and +12 V for the relay switch. It was constructed using 7805 and 7812 IC's respectively. They are provided with a 9-0-9 Volt and 15-0-15 Volt step down transformer after filter circuits they are given to the re Power supply is a reference to a source of electrical power. The device which supplies electrical energy to an output load is known as power supply unit. This term is often applied only to   electrical energy supplies rather than others.

It involves converting 240 volt AC supply to a well-regulated lower voltage (+5V) DC for electronic devices.

- ➢ Potential transformer
- ➢ Rectifier
- ➢ Filter
- ➢ Regulator

All electronic circuits need DC power supply either from battery or power packs units. It is not convenient to depend upon battery power supply. Hence, much electronic equipment contains circuit which converts AC supply voltage into DC voltage at the required level. Transformer converts 240 volt AC supply into step down AC voltage. Rectifier is an electronic device which converts AC voltage into unidirectional voltage. The rectifier utilizes unidirectional conduction device like a vacuum diode. It also consists of filter to remove the pulsating AC component.

Then it will feed into regulator. The regulation of power supplies is to control the output voltage or current to a specific value. The specific value is maintained in the load presented to the power supply's output, or any reasonable voltage variation at power supply's input. We can add more than one regulator according to our needed voltage to get the different output voltages. From this, we can get the regulated +5V and +/-12V DC supply.

CURRENT TRANSFORMER: A transformer transfers electrical energy from one circuit to another by the transformer's coils. A varying current is produced in primary winding. It creates a varying magnetic flux in the secondary winding. This varying magnetic field induces a varying emf or voltage in the secondary winding. The varing emf is called mutual induction.

If a load is connected to the secondary, an electric current will flow in the secondary winding then electrical energy will be transferred from the primary circuit to the load by tranformer. In an ideal transformer, the induced voltage in the secondary winding is in proportion to the primary voltage and given by the ratio of number of turns in the secondary (NS) to the number of turns in the primary (NP).

A current transformer is used for the measurement of electric currents. Current transformer with potential transformer are known as instrument transformers.

The current is too high when apply to measuring instruments, a current transformer produces a low current proportional to the current in the circuit, which can be conveniently connected to measuring and recording instruments. A current transformer identifies the measuring instruments from what may be very high voltage in the primary circuit. Current transformer used in metering and protective relays in the electrical power industry

POTENTIAL TRANSFORMER: It is used to step down or step up the ac voltage levels. Here we use the potential

transformer to measure the voltage level of the ac lin e. These type potential and current transformers are working with the concept of mutual inductance.

We have the AC voltages from the current and potential transformers. Now we have to measure them. We can't measure that AC quantities as they are. So we should convert them into DC and then into Digital format. Then we need to calibrate the digital value with the line voltage and sets the minimum and maximum values. The following circuit diagram shows the circuit of precision rectifier.

*ZERO CROSSING DETECTORS:*Zero crossing detector (ZCD) is a voltage comparator that switches the output between +V sat and –V sat when the input crosses zero reference voltage.

Comparators are basic operational amplifier circuits that compare two voltages simultaneously and switch the output according to the comparison.

Components required:

> ➢ OP AMP
> ➢ Power supplies
> ➢ Function generator

*PRECISION RECTIFIER:*The precision rectifier is called as super diode, this is obtained with an operational amplifier in order to have a circuit behave like an ideal diode and rectifier.

The basic circuit implementing such a feature is shown on the figure below, where can be any load. When the input voltage is negative, there is a negative voltage on the diode, so it works like an open circuit, no current flows through the load, and the output voltage is zero

if the input is positive, it is amplified by the operational amplifier which switches the diode on. Because of the feedback Current flows through the load and the output voltage is equal to the input voltage. The threshold of the super diode is very close to zero, but is not zero. It equals the threshold of the diode, divided by the gain of the operational amplifier.

This basic configuration has a problem so it is not commonly used. When the input becomes negative, the operational amplifier runs open loop, due to there is no feedback signal through the diode. With a high open loop gain operational amplifier, the output saturates. when the input becomes positive again, it has to get out of the saturated state before positive amplification can take place

again. This change generates some ring and takes some time which greatly cause the frequency response of the circuit

ADC (ANALOG TO DIGITAL CONVERTER) An Analog-Digital Converter (ADC) is used in electronic component that converts an analog electric signal (usually a voltage) into a digital representation. The ADCs are at the front-end of any digital circuit that needs to process signals coming from the exterior world Many ways have been developed to convert an analog signal, each with its strengths and weaknesses. The application of ADC is defined by the requirements we have: if we need speed, use a fast ADC; if we need precision, use an accurate ADC; if we are constrained in space, use a compact ADC.

All ADCs work under the same principle: they need to convert a signal to a certain number of bits N. The sequence of bits represents the number and each bit has the double of the weight of the next, starting from the Most Significant Bit (MSB) up to the Least Significant Bit (LSB). In a nutshell, we want to find the sequence of bits b_{N-1}, b_{N-2}, ..., b_0 that represents the analog value Vin as tpes:

1. Flash
2. Pipelined
3. Successive-Approximations Register (SAR)
4. Integrating or Dual-slope
5. Sigma Delta

3. MICROCONTROLLER

Microcontrollers are scheduled to play an increasingly important role in various industries and influencing our day to day life more strongly than one can imagine. the microcontroller has been accepted as a general purpose building block for intelligent digital systems. It is used in different area, starting from simple children's toys to highly complex spacecraft,due to its flexibility and many advantages.

A microcontroller is a microprocessor system built on a single IC. Microcontrollers were bulid to meet a need for microprocessors to be put into low cost products. Building a complete microprocessor system on a single chip substantially reduces the cost of making simple products, which use the microprocessor's power to implement their function, because the microprocessor is a natural way to implement many products. the idea of using a microprocessor for low cost products growing up. But the 8-bit microprocessor system, such as Z80 and 8085 is expensive. 8085 and Z80 system need extra additional circuits to make a microprocessor system. that circuit costs more money. Even though a product design may

requires only very simple system, the parts needed to make this system as a low cost product

Microcontroller is a general purpose device, which integrates a number of the components of a microprocessor on to single chip. It has CPU, memory and peripherals to make it as a mini computer. A microcontroller combines on to the single microchip:

> ➢ The CPU core
> ➢ Memory(both ROM and RAM)
> ➢ Some parallel digital i/o

Microcontrollers will combine other devices such as:

> ➢ A timer module allows the microcontroller to perform tasks for certain time periods.
> ➢ A serial i/o port to allow data to flow between the controller and other devices such as a PIC or another microcontroller.
> ➢ An Analog to Digital converter allows the microcontroller to accept analogue input data for processing.

Microcontrollers features :

> ➢ Smaller in size
> ➢ Consumes less power
> ➢ Inexpensive

Micro controller is a standalone unit ,which can perform functions on its own without any requirement for additional hardware like i/o ports and external memory.

The heart of the microcontroller is the CPU core. In the past, this has traditionally been based on a 8-bit microprocessor unit. For example Motorola uses a basic 6800 microprocessor core in their 6805/6808 microcontroller devices.

In the recent years, microcontrollers have been developed around specifically designed CPU cores, for example the microchip PIC range of microcontrollers

3.1. PIC MICROCONTROLLER

In the RISC based microcontroller fabrication PIC microcontroller is the first in CMOS that uses separate bus for instruction and data allowing simultaneous access of program and data memory.

The main advantage of CMOS and RISC combination have low power consumption and resulting in a very small chip size with a small pin count this is the main advantage of this combination. advantage of CMOS is that it has immunity to noise.

PIC 16F877:

Various microcontrollers have different kinds of memories. EEPROM, EPROM, FLASH etc. are some of the memories, from this FLASH is the most recently developed .it is used in pic16F877, so that data is regained even when the power is switched off. Easy Programming and Erasing are one of the features of PIC 16F877.

4.LCD:

Liquid crystal displays (LCD's) are those that have the properties of both liquids and crystals.they have a temperature range but not the melting point in which the molecules behave as mobile and are grouped to crystals

The liquid crystal is kept in between two glass panels. Transparent electrods are being coated in inner surface,they define the character, symbols or patterns to be displayed.there is also a polymeric layer present in between the electrodes and the liquid crystal molecules to maintain a definite orientation angle.

A polarizer is kept on each sides of two glass panel. They rotate the light rays to a definite angle in a particular direction. during off state the light rays are rotated such that the light rays come out of the lcd without deviation,and so it appears to be transparent..

They are light weight and consume only less power,for this reason they are compatible and applied for low powr electronic devices and can withstand for longer duration.as it doesnot generate light,we need to generate light for display.we can also change the display size or layout size which make the consumers easy to use. They are used in watches, calculators and measuring instruments are the seven-segment displays, having a limited amount of numeric data. The recent advances had made it more legible increase in information display and also have wider temperature range. Also extensively used in telecommunications systems. They also find their application in TV by replacing the CRT tubes.now even Crystalloids dot–matrix (alphanumeric) liquid crystal displays are available in TN, STN types. The use of C-MOS and driver ICs result in low power consumption. These modules can be interfaced with a 4-bit or 8-bit microprocessor /Micro controller.

The ic has the following feautures:

- high speed MPU interface (2MHz)
- RAM which has 80*8 display.
- 9,920-bit character generator ROM
- 64 x 8 bit character generator RAM 8 character generator RAM 8 character fonts (5 x 8 dots) 4 characters fonts (5 x 10 dots)
- Programmable duty cycles
- 1/8 – for one line of 5 x 8 dots with cursor
- 1/11 – for one line of 5 x 10 dots with cursor
- 1/16 – for one line of 5 x 8 dots with cursor
- Wide range of instruction functions display clear, cursor home, display on/off, cursor on/off, display character blink, cursor shift, display shift.
- Automatic reset circuit, which initializes the controller / driver ICs after power on.

5. RELAY

A relay is a electromagnet switch. It is useful if we want a small current in one circuit to control another circuit such as a lamp or electric motor which requires a large current, or if we wish several different switch contacts to be operated simultaneously.

When the current flows through the coil, the soft iron core is magnetized and attracts the L-shaped soft iron armature. the electrical contacts in the circuit is being controlled by when it closes the contacts.

The current that operate a relay is called the pull-in current and the dropout current in the coil when the relay just stops working.

Relay driver circuit is used for on / off control of relay, it acts as a switch, normally open relay is used. Relay function is derived by controller unit. Relay working current is 40 ma.

When the controller unit output is low relay should be in off condition. When the controller unit output is high, relay should be ready for doing specified function.

The coil of a relay passes a relatively large current, typically 30mA for a 12V relay, but it can also operate at 100mA for relays designed to operate from lower voltages. Most ICs cannot provide this current and a transistor which is usually used to amplify the small IC current to the larger value required for the relay coil. The maximum output current for the 555 timer IC is 200mA so these devices can supply relay coils directly without amplification.

Relays are SPDT or DPDT but they can also have many sets of switch contacts, for example relays with 4 sets of changeover contacts are readily available. Most relays are designed for PCB mounting but we can solder wires directly to the pins by take care to avoid melting the plastic case of the relay. The diagram shows a working relay with its coil and switch contacts.there is a lever on the left being attracted by magnetism when the coil is switched on. It moves the switch contacts. one set of contacts (SPDT) in the grounded and another behind them, making the relay DPDT.
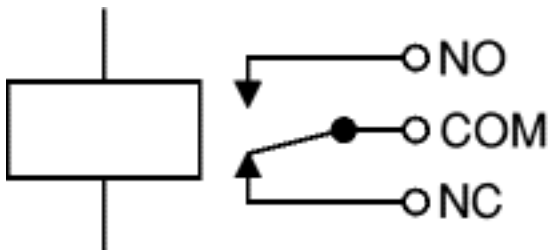
The relay's switch connections are usually labeled COM, NC and NO:

- COM = Common, always connect to this, it is the moving part of the switch.
- NC = Normally Closed, COM is connected to this when the relay coil is off.
- NO = Normally Open, COM is connected to this when the relay coil is on.

6. CAPACITOR BANK:

Capacitor bank is an interconnection of such capacitors either in series or parallel based on requirement. Capacitor banks are commonly used to

1.Power Factor Correction

2. Reactive Power Compensation.

NEED FOR CAPACITOR BANK:

The demand of active power is expressed in Kilo watt (kw) or mega watt (mw). This power is supplied from electrical generating station. All the arrangements in electrical pomes system are done to meet up this basic requirement. Although in alternating power system, reactive power always comes in the consideration. The reactive power is expressed in Kilo VAR or Mega VAR.. The demand of this reactive power is mainly from inductive

load connected to the system. These inductive loads are electromagnetic circuit of electric motors, electrical transformers, inductance of transmission and distribution networks, induction furnaces, fluorescent lightings etc.

This reactive power should be compensated otherwise, the ratio of actual power consumed by the load, to the total power. This ratio is known as electrical power factor, and fewer ratios indicates poor power factor of the system. If the power factor of the system is poor, the ampere burden of the transmission, distribution network, transformers, alternators and other equipments connected to the system, becomes high for required active power. reactive power compensation becomes very important. This is usually done by capacitor bank. active power is expressed $=vIcos\theta$ where,$cos\theta$ is the power factor of the system.if this power factor has got less valve, the corresponding current (I) increases for same active power P.when the current increases, the ohmic loss also increases. Ohmic loss is the generated electrical power is lost as unwanted heat emerged in the system. The diameter of the conducting parts of the system may also have to be increased for carrying ampere burden, which is not economical in the commercial point of view. the major disadvantage, is poor voltage regulation of the system, which mainly caused due to poor power factor.

There are mainly two equipments used for reactive power compensation purpose are

(1) synchronous condensers

(2) Static capacitors or Capacitor Bank

7.GSM (GLOBAL SYSTEM FOR MOBILE COMMUNICATION):

GSM (Global System for Mobile communication) is a digital mobile telephony system that is widely used in Europe and other parts of the world. GSM uses a variation of time division multiple access (TDMA) and is the most widely used of the three digital wireless telephony technologies (TDMA, GSM, and CDMA). GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at either the 900 MHz or 1800 MHz frequency band.

8. CONCLUSION:

The low power factor is highly undesirable as it causes an increase in current resulting in additional losses of active power in all the elements of power system. In this project, the design of control and monitoring of voltage and

current can be performed by using the micro controller and the power factor of the system is maintained. The conversion process of difference between the current and voltage signals of the load to degree and time, and process can be achieved by PIC 16F877. Dynamic compensation can be made by adding the relay and capacitor to the design circuit. The micro controller based compensation process is also carried out by switching capacitance

9.REFERENCE

1.Mr. A Kumar Tiwari ,Mrs.Durga Sharma, Mr.Vijay Kumar Sharma, "Automatic Power Factor Correction Using Capacitive Bank" ISSN:2248-9622, Vol:4, February 2014,pp.392-395

2.Barsoum, Nader (2007) "Programming of PIC Micro- Controller For power factor correction" IEEE Conference on Modeling And Simulation, Pages: 19-25

3. Nagarajan M, Kandasamy K.V (2012) "Automatic power factor correction for inductive load using PIC" International Conference on Modelling, Optimization and Computing. (ICMOC-2012)

4. IEEE Transactions on "Automatic Power Factor Improvement Using Micro Controller" , Dr.Satadal Mal, and Reetam Sen Biswas, 2015.

5.Wikipedia.org/wiki/Power_Factor_Correction