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Power Factor Monitoring and Controlling for Industrial Load using IoT

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ABSTRACT: In this environment, to save more energy for the future the power factor correction plays a major role in energy conservation. Therefore, this paper presents the system which monitors different factors of the induction motor and these data are continuously updated onto a webpage using IoT. If any defect occurs, the system sends alert messages to the concerned person and an electronic relay activates. As the inductive load rises there will be a fall in power factor, therefore this system incorporates a power factor improvement mechanism by switching the capacitor banks. The main objective is to build an Automatic Power Factor Correction (APFC) Unit, for variable load which is able to monitor the energy consumption of an induction motor and automatically improve its power factor. It will help to reduce the penalty due to low power factor and the utilities in the protection of induction motor in addition the problems are identified before any failure.

KEYWORDS: Power Factor, Automatic Power Factor Correction, Induction Motor, Capacitor Banks, IoT.

I.INTRODUCTION

Electrical energy efficiency is the major importance of industrial and commercial companies operating in the today's competitive markets. Prime use of plant and equipment is one of the main concerns that industries try to balance with energy efficiency for both economic and environmental reasons. As society becomes more and more conscious of its control of the environment, reduced energy consumption becomes more necessary, which is an achievable goal for everyone. Over the use of measures such as electricity consumption, power factor correctionis optimized, which ultimately leads to reduced energy consumption and reduced CO_2 greenhouse gas emissions. Within a cost conscious market and payback considerations are also essential. The most appropriate application for power factor correction based on energy consumption, cost payback, emission reduction and tariff metering. Power factor correction is an appropriate which is used to improve the power quality of an installation. Its application is dependent though on the size of the installation and the extent that power factor correction needs to be applied.

Automatic power factor correction techniques can be applied in the power systems, industrial unitsand also households to make the system stable. As a result, the system becomes stability and efficiency of the system as well as of the apparatus increases. The use of microcontroller based power factor correction system is used to reduce the overall costs for consumers and the suppliers of electrical energy. Power factor correction is made by capacitor banks it is a very efficient method.it reduces reactive power consumption and also minimize the losses and at the same time increases the electrical system's efficiency. Power saving problems and reactive power management have led to the development of single phase capacitor banks for industrial and domestic applications. The development of the project is to improve and upgrading the operation of single phase capacitor banks by developing a micro-processor based control system. The control unit will be able to control the capacitor bank; it's based on the varying load current. Current transformer is used to measure the load current for sampling purposes current transformer plays a major role in it. Intelligent control using this micro-processor control unit ensures even utilization of capacitor steps, minimizes number of switching operations and optimizes power factor correction.

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II.OBJECTIVE OF THE WORK

- The load power factor is continuously monitored it improves the power quality.
- Design an Arduino based correction equipment to improve the power factor of the system to the desired value of greater than 0.95.
- To reduce the penalty.
- To identify the abnormality before it happens.
- To monitor the parameters of the system through an online server by implementation of the IoT concept.

III.SOFTWARE IMPLEMENTATION

A. INTERNET OF THINGS

The Internet of Things (IoT) is a new revolution for Data Transfer and Storage. Objects that make themselves recognizable and they obtain intelligence by making or enabling context related decisions to the situations. They can transfer information about themselves. They can access information that has been used by other things, or they can be components of other services. The three factors thatmakes IoT look forward are Sensing Nodes, Embedded Processing and Communication. This transformation is accompanied by the emergence of cloud computing capabilities supported by an increased storage capacity and high-end data processing and the Machine-to-Machine communication for data transport with complete security for data. By introducing cloud computing, we can make a full call to the storage resource pool and computing resource pool in the cloud computing architecture, and provide high reliability for IoT cloud storage service and efficient cloud computing services to users. This Machine-to-Machine service layer will provide the needed services like data transport, security, devices, management and device discovery in a harmonized manner across a vertical domain to the application layer.

B. ARDUINO SOFTWARE (IDE)

The Arduino Integrated Development Environment (IDE) contains message area, the text console, text editor for writing code, a toolbar with buttons for common functions and a series of menus. It connects to Arduino and Genuine hardware upload programs written using the Arduino software (IDE) are called sketches. The programs are written in the text editor and are saved with the file extension of‘. ino’. The editor has features for cutting/pasting and for saving/replacing text. The message area gives feedback and displays errors. The console displays text output by the Arduino software (IDE), including complete error message and other information.The configured board and serial port are displayed in the right hand corner of the window. The toolbar buttons permit to verify and upload programs, create, open, and save sketches, and open the serial monitor.

IV.BLOCK DIAGRAM

Arduino is programmed to read the parameters of variable load. Real time voltage, current is uploaded to a webpage and checked whether these values are within the range or not. If the data are not within the specified range, then the corresponding action takes place. If the real time voltage or current is not in the specified range relay will be switched off and message will be sent to the concerned person using IoT module. If the power factor is not within the specified range, then capacitor banks are switched accordingly to correct it. When the power factor is increased or decreased it causes the penalty.so the power factor monitoring and control using IoT. It is used to avoid this problem. By using IoT things that connected to the internet can be accessed from anywhere. The data monitored can be used to store in a cloud environment and view the details when needed. The capacitor can be connected to the system for compensating the power factor whether power factor lags or leads.

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The block diagram of power factor monitoring and control using IoT system is shown in Figure 1

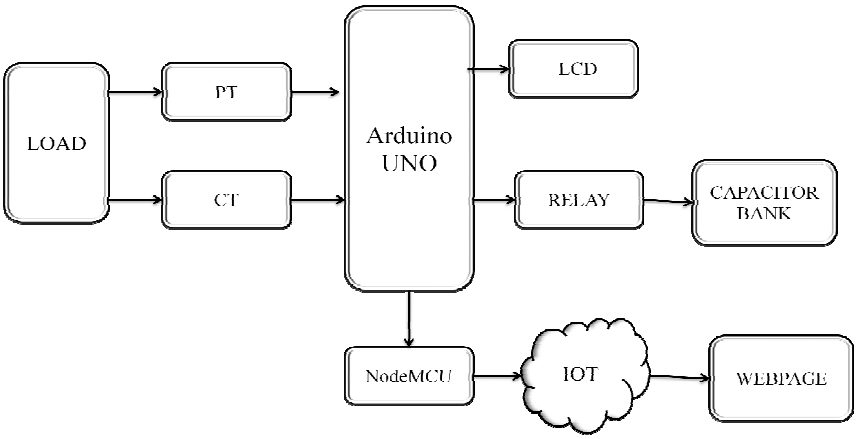

Figure 1

A. POTENTIAL TRANSFORMER

Potential Transformer is used to stepdown the input voltage because the maximum rating of Arduino is very less compared to the input voltage. So, the PT is used to stepdown the voltage. The rating of PT used to step down the supply voltage of 230 Volts to 12 Volts as required by the circuit to operate. The ratio of the number of turns on each coil, called the turn's ratio, determines the ratio of the voltages. A step down transformer has a large number of turns on its primary (input) coil which is connected to the high voltage mains supply, and a small number of turns on its secondary (output) coil to give a low output voltage.

B. CURRENT TRANSFORMER

Current Transformer is used to stepdown the input current because the maximum rating of Arduino is very less compared to the input current. So, the CT is used to stepdown the current. The CT is used to step down the supply current of 2A to 40mA as required by the circuit to operate. When current in a circuit is very high it directly applies the measuring instruments, a current transformer produces a condensed current perfectly proportional to the current in the circuit, which can be appropriately connected to recording andmeasuring instruments. It also isolates the measuring instruments from what may be very high voltage in the monitored circuit. They are frequently used in metering and protective relays in the electrical power industry.

C. ARDUINO UNO

Arduino is an open-source platform. It is easy-to-use hardware and software. Arduino boards are able to read input from light on a sensor, a finger on a button, or a Twitter message and turn it into an output activating a motor, turningan LED on. You can tell your board what to be done by sending a set of instructions to the microcontroller on the board. There are many other microcontrollers and microcontroller platforms are available for computing. Parallax Basic Stamp, Netmedia's BX-24, Phidgets, MIT's Handyboard, and many others offer similar functionality as the same. Arduino looks simple process of working than with microcontroller, but it offers some advantage for students, and interested amateurs over other systems. It will fetch input from source module and process them and decide the required action for them. Arduino is programmed to read the parameters the load. Real time voltage, current and power are uploaded to a webpage and checked whether these values are within the range. If the values are not within the specified range, then corresponding actions to be taken place. Arduino boards are inexpensive compared to the other microcontroller.

D. NODEMCU

NodeMCU is an open source development board and firmware based on the widely used ESP8266 -12E Wi-Fi module. It agrees to program the ESP8266 Wi-Fi section with the simple and powerful LUA programming language or

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Arduino IDE. NodeMCU is a combination of Wi-Fi access point and microcontroller. These features make the NodeMCU very powerful device for Wi-Fi networking. It can be used as an access point and station, host a webserver, connect to the internet to fetch or upload data. Which is used to send and receive the data to the cloud.

E. LCD

LCD (Liquid Crystal Display) is an electronic display module. A 16x2 LCD display is a very basic module and is frequently used in various devices and circuits. These modules are chosen over seven segments and other multi segment LEDs. The advantages are: LCDs are very economical, easyto program, have no limitation of displaying special & even custom characters, animations and so on. The image of 16*2 LCD display is used here. A 16*2 means display 16 characters per line and there are 2 such lines. On this 16*2 LCD display each character is displayed in 5*7-pixel matrix. This LCD has two registers that are Command and Data registers.LCD display is a most common device to attach the microcontroller. Some of the most common LCDs connected to the microcontroller are 16x2 and 20x4 displays. In this project a 16x2 LCD, model JHD 162A which shows the power factor and the phase lag between voltage and current in milliseconds.

F. RELAY

The Relay is an electrically operated switch. Relays are used to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits need to be controlled by single signal. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the contact of the switch. The rating of relay is 12V/5A.

V. RESULT & ANALYSIS

The hardware setup shows the value of Current, Voltage, Real Power, Reactive power and Power Factor. This is a real time power factor monitoring and correction. The Liquid Crystal Display shows the result of the power factor, Voltage and Current before and after the power factor correction in all occasions. The values will be updated for every 2 minutes.

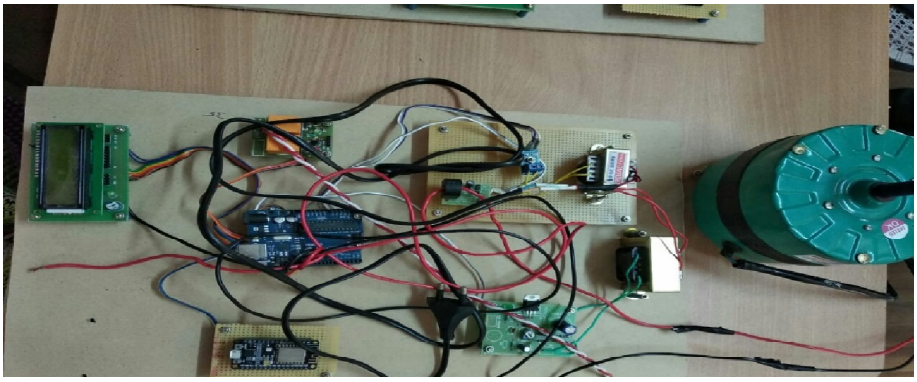

Figure 2

VI. CONCLUSION

Power factor correction equipment designed based on microcontroller and capacitor banks using IoT was used for measurement and monitoring of modelled electrical load and the following deductions were obtained: The power factor correction device was able to improve the power factor from 0.76 to 0.97 under the test load conditions. The average savings in energy consumption were about 1.7% of the designed load and different load patterns. With the proper amount of reactive power compensation, the system capacity is released as there is a reduction in current drawn. The economic analysis suggested the payback period to be around 9 months with a significant amount of savings in energy cost.

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VII. FUTURE SCOPE

In future this method will be implemented in most of the organization and industry. It can be implemented even in the small-scale industries because energy conservation and paying penalty cause a major issue in all scale industry and this method rectifies all the problem and so this will be a compulsion to minimize their expenses. This will be the best solution in future because man power will be eradicated completely and will be automated. This will play a major role in it.

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