POWER FACTOR MONITORING AND CONTROLLING FOR INDUSTRIAL LOAD USING IOT

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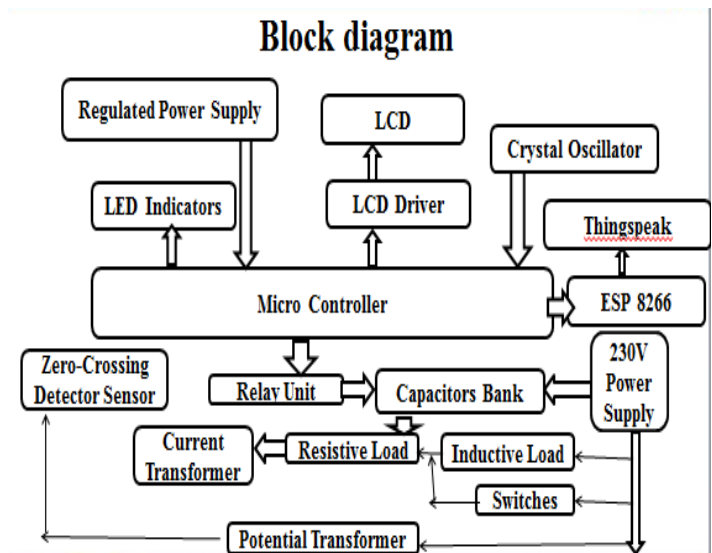
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Abstract - *This paper describes In this environment, to save more energy for the future the power factor correction plays a major role in energy conservation. Therefore, this paper presents the system which monitors different factors of the induction 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.*

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

1. 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 correction is 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.

1.1 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.

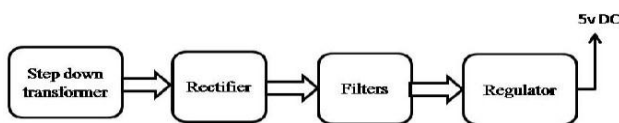## 2. HARDWARE COMPONENETS

2.1 PIC MICROCONTROLLER

Fig 2.1 Microcontroller

RAM	192
Memory Type	Flash
Program Memory K Bytes	7
I/O Pins	22
Pin count	28
Max. CPU Speed MHz	20
Timers :	2 - 8-bit & 1 - 16-bit
Temperature Range	-40 to 125

Below are the specifications of PIC Microcontroller Microcontroller based systems are designed to perform a specified task.

2.2 REGULATED POWER SUPPLY

Fig 2.2 Regulated power supply

The process of conversion is shown above. PIC Microcontroller requires a 5V DC for its operation.

The aim of this block is to convert battery voltage to 5V DC

2.3 CRYSTAL OSCILLATOR :

Fig 2.3 Crystal Oscillator

Crystal oscillator is used in the project because of the fact that crystal is more stable to temperature than other types of oscillators.   An oscillator is an electronic circuit that produces a repetitive electronic signal.
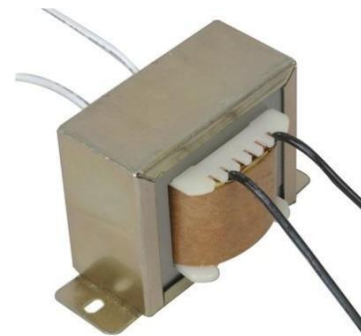
2.4 LED INDICATORS

Fig 2.4 LED Indicators

In this project we are using LED indicators for checking Microcontroller working status and various status indications. This usually works on 2 volts, 10 mA.

2.5 POTENTIAL TRANSFORMER

Fig 2.5 Potential Transformer

We are making use of PT (potential transformer) for capturing the zero-crossing point of voltage wave form.
PT converts the high voltage AC to a low voltage measurable quantity. PT of type step-down transformer.

2.6 CURRENT TRANSFORMER

Fig 2.6 Current Transformer

CT are used for current measurements. We are making use of CT (current transformer) for capturing the zero-crossing point of current wave form. CT is of type step-up transformer.
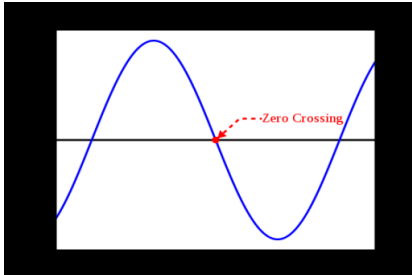
2.7 ZERO CROSSING DETECTOR

Fig 2.7 Zero Crossing Detector

Zero crossing detection is the process of finding the variation of waveform from zero as reference point. In this project this is used to find out whether both current and voltage wave forms are leading or laggingor in phase with each other.

2.8 RELAY UNIT

Fig 2.8 Relay Unit

A relay operation depends upon the electromagnetic effectsof current flowing in an energizing winding. Relay is used for controlling high voltage device using low voltage signal. This works on electromagnetic principle.

2.9 LCD DISPLAY

Fig 2.9 LCD Display

A liquid crystal display (LCD) is a thin, flat electronic visual display that uses the light modulating properties of liquid crystals. The LCD display used in the project is 16X2. We use this display to show the power factor.

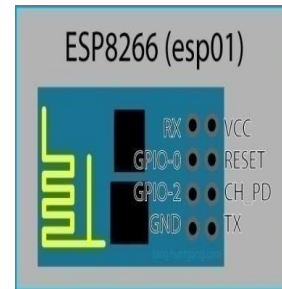### 2.10 WI-FI MODULE ESP8266

Fig 2.10 Wi-Fi Module ESP8266

The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. The ESP8266 module is an extremely cost effective board with a huge, and ever growing, community.
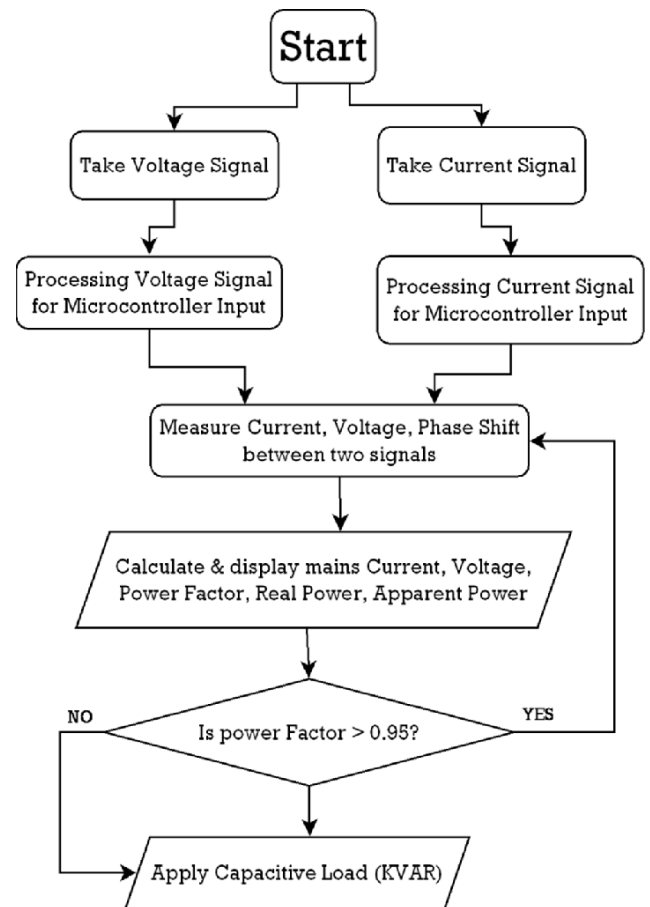
3. FLOWCHART

Fig 3. Flow Chart

4. PROTOTYPE

Fig 4 Prototype

5. RESULT AND DISCUSSION

Fig 5.1 R -Load

Fig 6.1 depicts that when R-load switch is ON the powerfactor will be in 0.96 which is near to 1 lagging.

Fig 5.2 R-L Load

Fig 6.2 depicts that when R-Load is connected in series with L-Load and L-Load then power factor will be in lagging statei.e., 0.75.
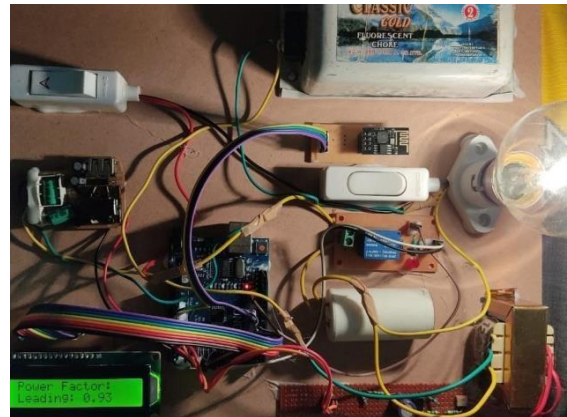

Fig 5.3 R –C Load

When we isolate the inductive choke coil then the relay operates and it shows the 0.93 leading as shown Fig 6.3
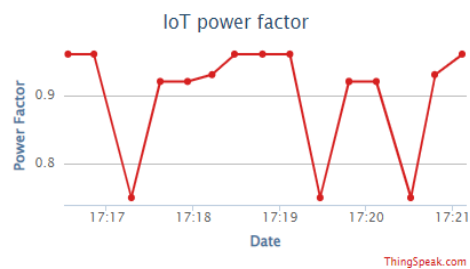

Fig 5.4 IoT power factor graph using ThingSpeak

	A	B	C	D	E	F	G
1	created_a	entry_id	field1	latitude	longitude	elevation	status
2	2022-05-1	1	0.96				
3	2022-05-1	2	0.96				
4	2022-05-1	3	0.75				
5	2022-05-1	4	0.92				
6	2022-05-1	5	0.92				
7	2022-05-1	6	0.93				
8	2022-05-1	7	0.96				
9	2022-05-1	8	0.96				
10	2022-05-1	9	0.96				
11	2022-05-1	10	0.75				
12	2022-05-1	11	0.92				
13	2022-05-1	12	0.92				
14	2022-05-1	13	0.75				
15	2022-05-1	14	0.93				
16	2022-05-1	15	0.96				
17							
18							
19							
20							

Fig 5.5 Values of power factor at different date and time

6. 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.

7. 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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