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## INDUSTRIAL ENERGY MONITORING SYSTEM

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### ABSTRACT

The increasing demand for electrical energy and the decreasing supply of fossil fuels in recent years have increased the cost of electrical energy. So that the culture of saving electrical energy is a habit that must be cultivated in the community. Energy-saving behavior cannot be realized massively without a support system that can control energy use. This system is an electric power monitoring system that is integrated with a smart electrical panel that continuously monitors the use of electricity

**Keywords:** Smart Electrical Panel.

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### I. INTRODUCTION

Electricity has become one of the basic requirements of humans. It is used in domestic, industrial, and agricultural purposes. Existing system is a time consuming system. IoT based smart energy meters can overcome the existing problems like reducing man power, energy monitoring, load management, power theft etc. Smart meters are same as normal meters. It is an advanced technology for reading, billing, Smart meters are referred as smart because it includes a two way communication system. It monitors the system very quickly and provides real time data to the user. The main advantage of smart meter is that we don't require many components to take readings as smart meter sensor itself will give different parameter readings. It takes the reading and sends the detailed information to the user remotely.

In this paper, user monitors the 3-phase electrical energy using Node MCU and pzem-004t sensor module. The objective of our proposed system is to monitor the Industrial energy consumption for safety purpose Pzem-004t module can measure voltage, current, power, power factor, energy consumption and frequency. The collected data gets send to server by Node MCU. Data from the Node MCU can be monitored by the web in real time basis. An intelligent energy monitoring system can flag any faults in real time, and indicate with alarm

### II. LITERATURE REVIEW

In 2017, C. Choi, et al. proposes an effective energy monitoring system based on IoT. It will forecast users, energy demands. It mainly focuses on LoRa technology, renewable energy generations etc. But its main drawback is, it does not discuss how the data is taken and how power is calculated. Hiremath et al. in 2017 made his research on IoT-based energy control and managing devices. They designed and implemented an energy meter which uses Arduino as its microcontroller. This system is used to measure the power consumed by electrical devices. Power consumption is monitored and is send to the server via Wi-Fi module. Web based application is used so that the user can monitor the consumption anywhere in the world. The researcher mainly focuses only on the tools used in the experiment. Measurement data and their details are not discussed in it.

Other scholars like Medina et al. in 2018 conducted a study on IoT-based electrical energy consumption using Raspberry pi. This study was made in order to know how energy consumption can be controlled and monitored. An android application was used for displaying the data obtained. According to their studies analog input from the current sensor is connected to Arduino and is controlled by Raspberry pi. This data is then processed and stored in the database. Based on their results some systems are having high accuracy while some other devices are having low accuracy.

In 2019, Prasetyo et al. researched Smart Home for monitoring and control of electrical energy. The research was taken place in Indonesia. The research aims to conduct the effectiveness of electricity usage by monitoring and controlling power using cloud-based IoT. The Smart Home design was built using several devices such as an Arduino microcontroller, Internet module, AC Voltmeter, Relay, LDR Sensor, and PIR Motion Sensor. The output of the research is still in the form of design, not yet at the stage of developing and implementing the tool.

### III. HARDWARE COMPONENTS

#### A. PZEM-004t



**Figure 1.** PZEM 004T, (source: PZEM-004T V3.0 User Manual)

PZEM 004T multifunction AC power monitor is a very popular smart meter used in electrical consumption measurement projects. It is great for measuring voltage, current, power, and energy. It comes with serial TTL interface. It has overload detection function. The main part of PZEM 004T module is of SD3004 chip.

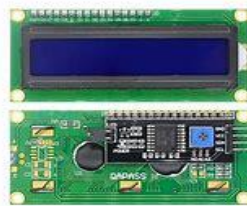
#### B. ESP32



**Figure 2.** ESP 32 Node

Arduino doesn't have built-in support to wireless network. Therefore developers need to add a WiFi module to the board and write code to access the wireless network. Node MCU is a microcontroller which has built-in support for wifi connectivity and hence makes IoT applications developments much easier. It is an open-Source Software & hardware development environment which is built-in an inexpensive chip ESP32. It provides low-level control for the specific hardware. Node MCU can be programmed using Arduino IDE.

#### C. Display



**Figure 3.** 16\*2 LCD Display

This is a 16\*2 LCD display screen. It have i2c communication interface. It only needs 4 pins for the display; VCC, GND, SDA, SCL.

#### D. SMPS



**Figure 4.** SMPS

SMPS stands for switch mode power supply. It is mainly used to achieve regulated DC output voltage from unregulated AC voltage. It provides supply from source to loads. It is very important for power consumption. They are efficient than liner regulators. Power loss will be much less than transformer based power supplies. In our project we had used 5Volt 1Ampere power supply.

**E. Buzzer**



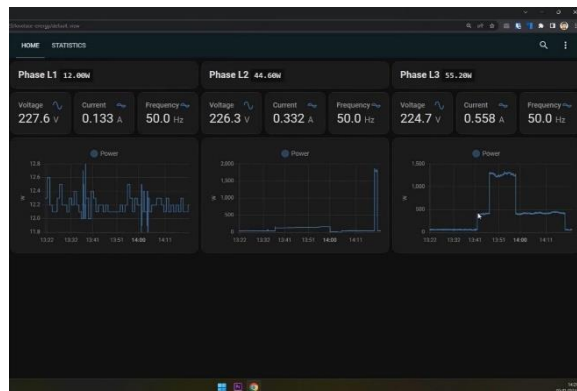
**Figure 5. Buzzer**

There are many ways to communicate between the user and a product. One of the best ways is audio communication using a buzzer. A buzzer or beeper is an audio signaling device

**IV. WORKING**

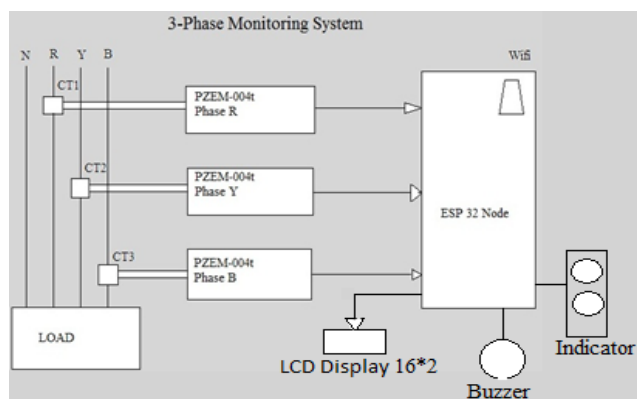
PZEM 004T device read the electricity consumption in real time. This device have pair of 2 port for read the electrical unit like voltage and current so first pair is connected with phase and neutral, second pair is connected with ct coil this ct coil placed in phase wire after this connection PZEM 004t device read the data . one microprocessor present inside the PZEM 004t this micro processor calculate the data give the result in different electrical units like active power, reactive power, voltage, current .

The pzem 004t have 2 port for serial communication (tx) and (rx) this port connected with esp32 node module the esp32 node module has 3 serial port for communication. ESP32 node receives the data form pzem 004t and send the data to our accessable device like mobile laptop the different server help to connect with esp 32 to our accessable decive. If any trouble or fault occur, esp 32 show the indicator and blow alarm, send the data to our device .



**Figure 6. Dashboard in device**

**V. BLOCK DIAGRAM**



**Fig 7. Block Daigram of 3-phase monitoring system**

Fig 3 represent the block diagram of 3 phase energy monitoring system In this 3 PZEM 004t are use for 3 phase energy monitoring system each PZEM 004t connected with separate phase, neutral is common. All three PZEM

004t connected with esp 32 node module. That means every module send the data of each phase and hence we can easily calculate the 3 phase energy consumption.

### VI. CIRCUIT DIAGRAM

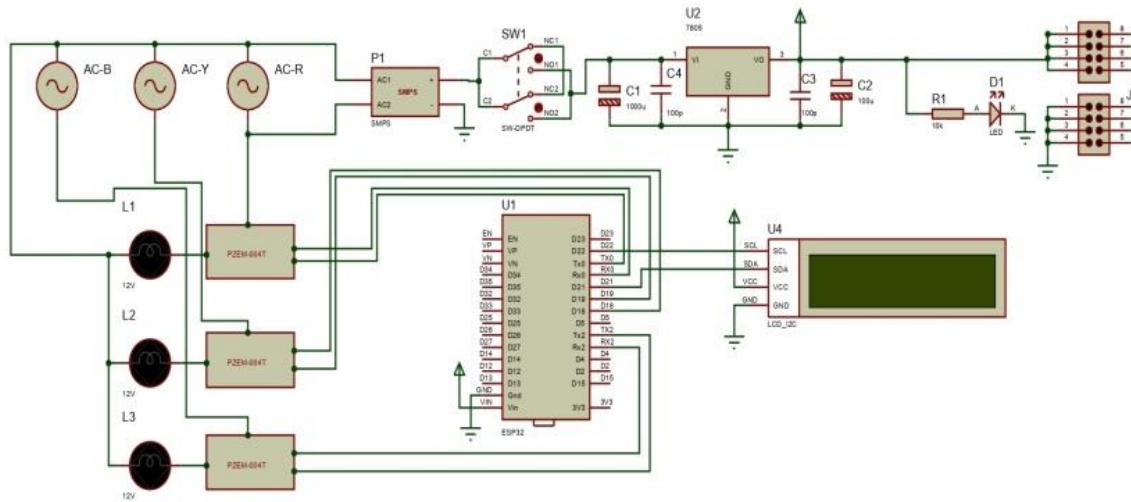


Figure 8. Circuit diagram

In circuit diagram show the arrangement of all components and connectors pins in the proper position in circuit diagram. There are many software available in internet. Protous 8 software we use for design a circuit diagram. First select all components and add which are required for circuit and arrange in proper form connect with each other

#### Programming Software

Arduino IDE The project uses arduino IDE as software to program microcontroller. The program is written in arduino IDE and compiled and fed into microcontroller. The following step are involved into programming a microcontroller using arduino.

Before you can start doing anything with the Arduino, you need to download and install the Arduino IDE (integrated development environment). From this point on we will be referring to the Arduino IDE as the Arduino Programmer. The Arduino Programmer is based on the Processing IDE and uses a variation of the C and C++ programming languages Plug your Arduino to your computer using the programmer as shown before.

Before compiling the programmer and feeding it onto the Arduino board you need to select the appropriate board into which you are feeding the program. To set the board, go to the following: Tools --> Boards Since we are using ESP32 in our project we selected ESP32 To set the serial port, go to the following: Tools --> Serial Port.

### VII. RESULT

The prototype is test on 3-phase single motor

The motor specification is

Hp/kw:- 3/2.2 , RPM:- 2880

Ampere rating :- 8 amp,Voltage:- 415vac

Phase:- 3 phase

The prototype is placed near the motor starter and connected with each other then after first, Switch on the power supply of starter and second switch on the power supply of prototype. The esp32 module is connect with wifi and the prototype starts monitoring the 3-phase energy consumption and the monitored data send to user device

First we monitor the energy consumption of 3-phase motor. The observation table is given below

**Table no 1:- Normal Condition**

Condition	Voltage			Current			Alert	
	Phase R	Phase Y	Phase B	Phase R	Phase Y	Phase B	Indicator	Buzzer
Motor Off	242v	240v	241v	0A	0A	0A	GREEN	off
Motor ON	241v	240v	242v	7.5A	7.4A	7.6A	GREEN	off

After sometime we connect the external single phase load. The is connected with R-phase and monitor the variation in energy consumption. The table is given below

**Table no 2- Abnormal condition (other load connected with supply)**

Condition	Voltage			Current			Alert	
	Phase R	Phase Y	Phase B	Phase R	Phase Y	Phase B	Indicator	Buzzer
Motor ON	241v	240v	242v	7.5A	7.4A	7.6A	GREEN	off
Other load connected	242v	239v	241v	9.5A	7.2A	7.4A	YELLOW	OFF

After monitoring the result switch off the power supply of starter. We remove R-phase fuse from fuse holder and switch ON the Main switch that means only 2 phase is given to the starter and start the monitoring the incoming supply from main switch. The observation table given below.

**Table no 3:- R-phase cut-off**

Condition	Voltage			Current			Alert	
	Phase R	Phase Y	Phase B	Phase R	Phase Y	Phase B	Indicator	Buzzer
One Phase cut	0v	240v	238v	0A	0A	0A	RED	ON

### VIII. CONCLUSION

The system uses to analyze the 3-phase energy consumption in real time. This system help to show all electrical parameter like, voltage, current, power, frequency etc all electrical parameter show on user device using blynk server. It is observed that the system work accurately and fast.

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