Real-Time IoT Enabled Electricity Consumption Monitoring for Individual Devices Using Node MCU ESP-32 Through LCD and Android Application

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Abstract— In this work, Node MCU ESP-32 and IoT enabled real time electricity measurement monitor for individual electrical appliances is proposed. An android application and LCD are used to display the amount of real-time consumed electricity of individual device. An AC voltage sensor and SCT current sensor are used to measure the flowing voltage and current in the device. Also, the mathematical formula to find the KWh value is used to find how much electricity is consumed. The main focus of this work is making awareness on electricity consumption of each device so that total billing amount can be reduced. The electricity consumption of tungsten bulb of 100 watt is displayed in LCD and also in an Android mobile phone through IoT.

Keywords— Node MCU ESP-32, electricity consumption, IoT, voltage sensor, SCT current sensor, KWh.

I. INTRODUCTION

Smart energy meters are the replacement for standard meters; A technology created decades ago to track consumers consumed power to pay the accurate bill to suppliers. Unlike the automatic meter reading (AMR), smart meter utilizes advance metering infrastructure (AMI) that enables high accuracy, through wireless or wired system and makes the user aware of consumed power in daily or hourly basis.

In the domain of smart energy meter lots of advanced system is ready by worldwide researchers. Integration of an advance metering infrastructure (AMI) to perform energy management operation and power quality monitoring by using commercial AMI that was implemented in laboratory.

In India to-be smart cities are inclined with smart technology to ensure comfortable life for human being, implementing smart meters is one of the first footsteps and for this, implementation surveys are also done to discover the energy perspective of smart cities.

In today's world IoT runs a big role, therefore it is required to make a new generation smart meter that uses Wi-Fi to track energy consumption data. In our work a Wi-Fi based Node MCU ESP-32 controlled smart metering system is proposed. It is a mobile monitoring system that will work via Wi-Fi synced with an android application. Consumer will get the benefits by knowing the information of reading energy uses and prices so that consumer can manage their activities and energy expenditure accordingly. Generally, in India electricity is priced on tariff basis for the most household customers. This system is an incentive to support effectiveness in production of electricity uses. Here smart metering technology comes up with the solution that helps electricity saving.

II. METHODOLOGY AND COMPONENTS

In our work we made a prototype of Smart energy meter using Node MCU ESP-32, here we used 1 tungsten bulb of 100W as load. We made it as IoT enabled to monitor the electricity consumption data from mobile using android application and also, we attached LCD display for an immediate monitoring.

A. Current Measuring with SCT013-030

The SCT013-030 is a type of AC current sensor commonly used for non-invasive current sensing applications. It is designed to measure alternating currents (AC) flowing through a conductor without the need for direct electrical connections.

This sensor operates on the principle of electromagnetic induction, where a magnetic field generated by the current induces a proportional voltage in the sensor's coil. The SCT013-030 specifically is optimized for measuring currents up to 30A. It features a split-core design, allowing it to be easily clamped around the conductor carrying the current, making it suitable for installation in existing electrical systems without the need for interruption. The output of the SCT013-030 is typically an analog voltage signal proportional to the measured current, making it compatible with various microcontrollers and data acquisition systems for further processing and analysis. This sensor finds applications in energy monitoring, power management, and various industrial and home automation systems where non-invasive current sensing is required the output in serial monitor of Arduino software.

B. Voltage Measuring with ZMPT101B.

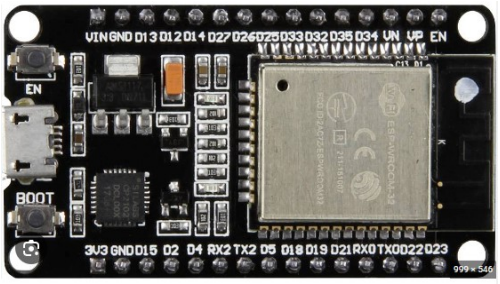
The ZMPT101B is an AC voltage sensor module commonly used for non-invasive voltage measurement applications. It is designed to measure alternating voltages (AC) without the need for direct electrical connections.

This sensor operates based on the principle of electromagnetic induction, where the alternating voltage induces a proportional voltage in the sensor's coil. The ZMPT101B module typically contains a step-down transformer to scale down the input voltage to a level suitable for measurement, as well as additional circuitry for signal conditioning and isolation.

It is optimized for measuring low to moderate AC voltages, often within the range of 0-250V AC. The output of the ZMPT101B is typically an analog voltage signal proportional to the measured voltage, making it compatible with various microcontrollers and data acquisition systems for further processing and analysis. This sensor finds applications in energy monitoring, power quality analysis, and various industrial and home automation systems where non-invasive voltage measurement is required.

C. Node MCU ESP-32 Module

The NodeMCU ESP32 is a compact and versatile development board based on the ESP32 microcontroller.



It combines the power of the ESP32 chip with the convenience of the NodeMCU platform, making it ideal for Internet of Things (IoT) projects. With built-in Wi-Fi and Bluetooth capabilities, digital and analog input/output pins, and support for various programming languages including Arduino and Micro Python, the NodeMCU ESP32 is widely used for prototyping and building IoT devices in applications such as home automation, remote monitoring, and industrial automation.

Specification	Value
Working Voltage	3.3V
Input Voltage Range	5V
Digital I/O Pins	36
Analog Input Pins	18
DC Current per I/O Pin	12mA
DC Current for 3.3V Pin	40mA
Flash Memory	4MB
SRAM	520KB
Clock Speed	80MHz

D. Monitoring with LCD Display

An LCD (Liquid Crystal Display) is a flat-panel display technology that uses the light-modulating properties of liquid crystals to produce images, text, or other visual content. LCD displays are widely used in various electronic devices, from smartphones and televisions to digital clocks and industrial equipment.

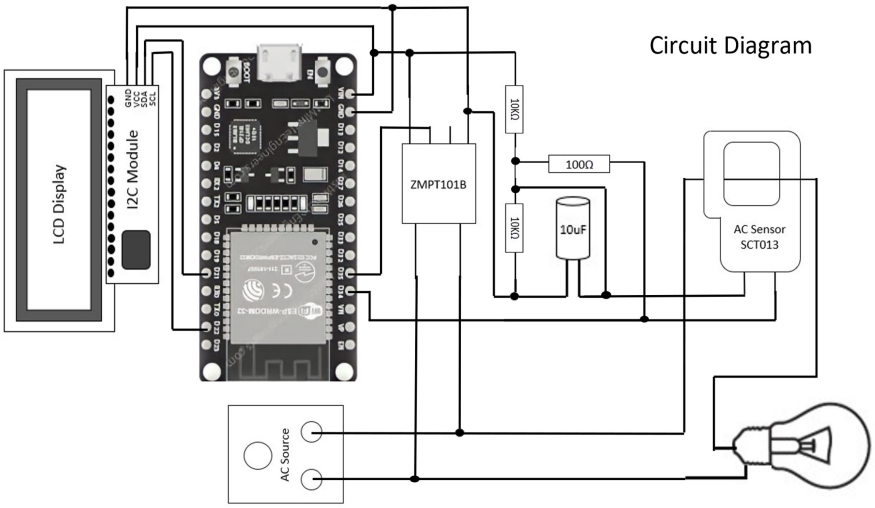
The basic principle behind LCD operation involves applying an electric current to liquid crystal molecules sandwiched between two transparent electrodes. These liquid crystals can align themselves in response to the applied electric field, altering the polarization of light passing through them. By controlling the alignment of the liquid crystals, the amount of light passing through individual pixels can be

controlled, allowing for the display of images and text.

Here, LCD is used just for immediate monitoring of electricity consumption.

I2C CommunicationAn I2C module used with an LCD display is a hardware interface that facilitates communication between a microcontroller or other master device and an LCD (Liquid Crystal Display) module using the I2C (Inter-Integrated Circuit) protocol. This setup allows for the easy integration of LCD displays into projects, providing a simplified and efficient means of controlling the display.

The I2C module acts as the master device on the I2C bus, controlling communication with one or more slave devices, such as the LCD display module. It handles the transmission of data and commands to the LCD display, as well as receiving status or acknowledgment responses from the display



II. RESULT AND DISCUSSION

The main aim of this work is to make awareness on electricity consumption of each device so that the usage of such devices can be controlled / reduced. The design is successfully implemented and the amount of electricity consumption of a single tungsten bulb of 100W is displayed both in LCD screen and mobile application through IoT.

IV. CONCLUSION

We know that the growing of consumption of energy in any country has resulted becoming increasingly dependent on fossil fuels. The security of energy supply in future already raised uncertainties because of price rise of oil and gas and their potential shortage, which has serious repercussions on growth of the national economy. Increasing use of fossil fuels also causes adverse effect on environment. In this work the main object was to justify using of electrical appliances so that energy can be saved and nature will be abstaining from adverse effects. Our work will give benefits to the consumer by informing the information of energy usage of each device so that consumer can control its usage so that the electricity usage can be controlled.

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