Fergusson College (Autonomous), Pune.

Department of Electronic Science

Report

on

"Smart Energy Meter Using ESP32 and Blynk App"

By

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Content

- ## Aim:

  The aim of the project is to design and implement a **smart energy meter** using the **ESP32 microcontroller** and the **Blynk app**. The goal is to provide users with a real-time, user-friendly, and remote way to monitor and manage their energy consumption, which can help in reducing electricity costs, improving energy efficiency, and promoting energy conservation.

- ## Objectives:

  1. To measure and monitor the energy consumption (voltage, current, and power) of connected devices in real-time using the ESP32.
  2. To transmit energy consumption data wirelessly to a mobile app using **Wi-Fi** through the ESP32.
  3. Enable remote monitoring and data visualization through the **Blynk app** on a smartphone or tablet.
  4. To ensure the system is cost-effective and accessible to a wide range of users.

- **Bill of Material:**

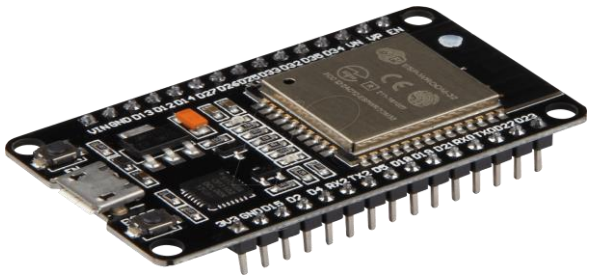
Sr.no	Component	Quantity
1.	ESP32 Board	1
2.	AC Voltage Sensor (ZMPT101B)	1
3.	Current Sensor (SCT-013-030,30A Non - invasive)	1
4.	Capcitor 10uf	1
5.	Resister 100ohm,10K	1
6.	Breadboard	1

- # Introduction:

In this project, we will learn how to make our own **IoT Based Electricity Energy Meter** using **ESP32** & monitor data on the **Blynk Application**. Earlier we built **IoT DC Energy Meter** and **GSM Prepaid Energy Meter**. With the current technology, you need to go to the **meter reading** room and take down readings. Thus monitoring and keeping track records of your **electricity consumption** is a tedious task. To automate this, we can use the Internet of Things. The Internet of Things saves time and money by automating **remote data collection**. Smart **Energy Meter** has received quite a lot of acclaim across the globe in recent years. We need to select the **current sensor** as well as the **voltage sensor** so that the current & voltage can be measured and thus we can know about the power consumption & total power consumed. The best current sensor available in the market is SCT-013. This is **SCT-013 Non-Invasive AC Current Sensor** Split Core Type Clamp Meter Sensor which can be used to measure AC current up to **100 amperes**. Similarly, the best voltage sensor is the AC Voltage Sensor Module ZMPT101B. The **ZMPT101B AC Voltage Sensor** is the best where we need to measure the accurate AC voltage with a voltage transformer.Using the **SCT-013 Current Sensor & ZMPT101B Voltage Sensor**, we can measure the all required parameters needed for Electricity Energy Meter. We will interface the SCT-013 Current Sensor & ZMPT101B Voltage Sensor with **ESP32 Wifi Module** & Send the data to Blynk Application. The **Blynk Application** Dashboard will display the Voltage, Current, Power & total unit consumed in kWh.

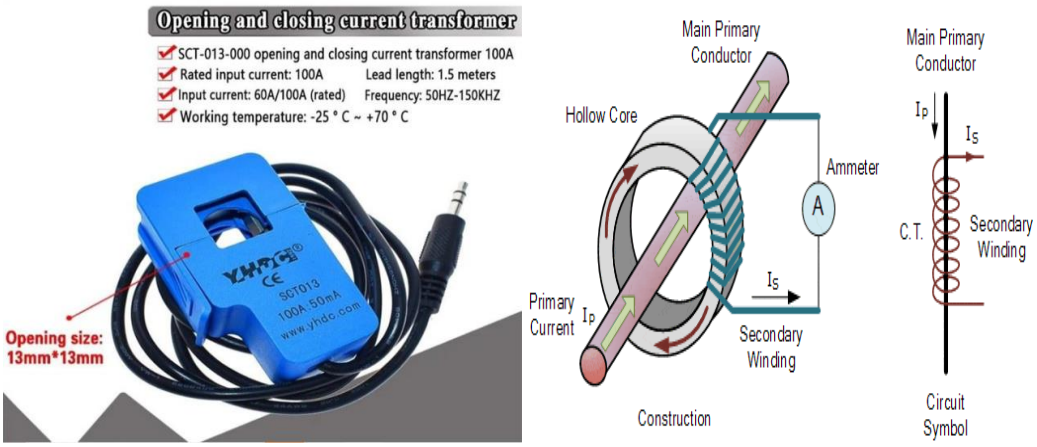
- **Component**

1. ESP32:



This is ESP WROOM 32 MCU Module. ESP WROOM 32 is a powerful, generic WiFi-BT-BLE MCU module that targets a wide variety of applications, ranging from low-power sensor networks to the most demanding tasks, such as voice encoding, music streaming, and MP3 decoding. it is a powerful and versatile microcontroller developed by Espressif Systems, widely used in the core of this module is the ESP32s chip, which is designed to be scalable and adaptive. ESP-WROOM-32 development board containing Tensilica Xtensa Dual-Core 32-bit LX6 microprocessor operates at 80 to 240 MHz adjustable clock frequency. It comes with 448 KB of ROM, 520 KB of on-chip SRAM, and 4MB of Flash Memory. The **ESP32-WROOM** is a versatile and powerful microcontroller module that combines **Wi-Fi, Bluetooth, and extensive peripheral support**, making it ideal for IoT, automation, and embedded systems. Its low power consumption and security features make it a preferred choice for developers worldwide.

2. Current Sensor sct-013 000:

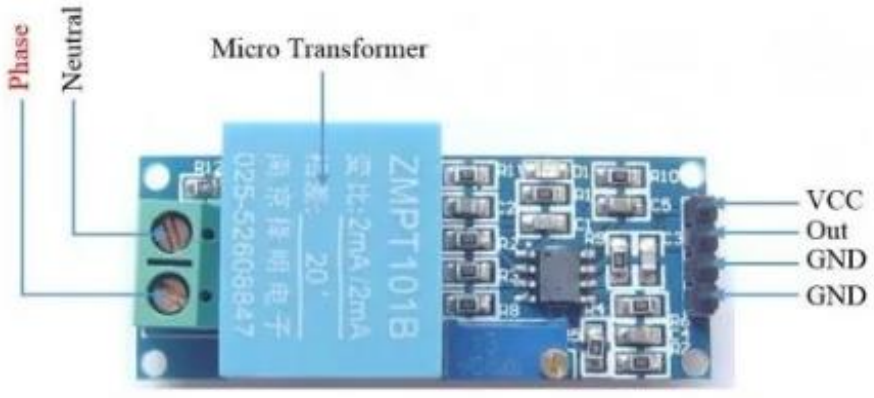


SCT-013-000 is a Non-Invasive AC current sensor i.e. it is a current transformer that can be used to measure AC current up to 100 amperes. Current transformers (CTs) are sensors are for measuring alternating current. A current sensor detects and measure the electric current passing through a conductor . it turns the current into a quantifiable output, such as a voltage, current, or digital signal, which may be utilised in a variety of applications for monitoring, control, or protection. SCT-013-000 100A Non-invasive AC current sensor Split Core Type is a current transformer which can be used to measure AC current up to 100 amperes. It has no internal burden resistor, but a transient voltage suppressor limits the output voltage in the event of accidental disconnection from the burden.

Specifications

- Output Signal:- **DC 0-1 V**
- Input Signal:- **0-30A Ac**
- Work Temperature :- **-25c to 70c**
- Resistance Grade:- **Grade B**
- Turn Ratio:- **1800:1**
- Non-linearity:- **2-3%**
- Build-in Sampling resistance:- **63 ohm**

3. Voltage Sensor zmpt101b:

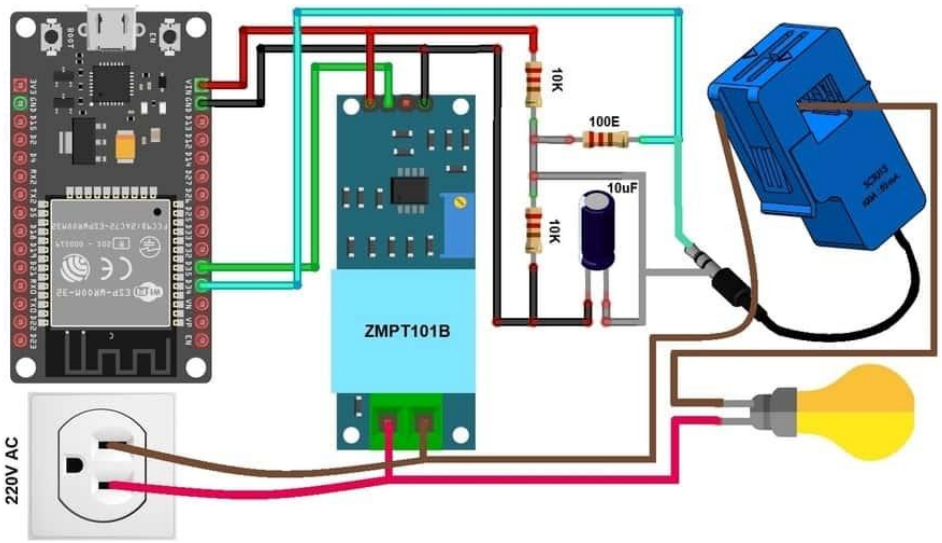


The ZMPT101B is a voltage sensor commonly used in electronic projects to measure alternating current (AC) voltages. It is a compact size and easily accessible module that provides a simple way to monitor AC voltages in various Projects. The ZMPT101B is a voltage transformer used to measure AC voltage. You can measure AC voltages up to 250 volts by using this module. The output of this sensor is analog. If you change input voltage, the output voltage will change as well.

Specifications:

- Voltage Range:- **250 volts**
- Operating Temperature :- **40c to 70c**
- Input Supply Voltage:- **5V**
- small size and lightweight
- on-board op-amp circuit

- **Circuit Diagram**



- The connection diagram is simple. Both the Sensor, i.e. SCT-013 Current Sensor & ZMPT101B Voltage Sensor VCC is connected to **Vin** of ESP32 which is a **5V Supply**.
- The GND pin of both the modules is connected to the **GND** of ESP32. The output analog pin of the ZMPT101B Voltage Sensor is connected to **GPIO35** of ESP32.
- Similarly, the output analog pin of SCT-013 Current Sensor is connected to **GPIO34** of ESP32.
- Need a two resistor of **10K** & a single resistor of **100 ohms** connected along with a **10uF** Capacitor.
- Apart from the circuit part, the AC wires where the current and voltage needs to measured are connected to the **input AC Terminal** of Voltage Sensor.
- Similarly, the **current sensor clip** doesn't have any connection and a single live wire or neutral wire is inserted inside the clip part as shown in the above circuit.

- ## Working:

1. The **SCT-013** is a **current transformer** sensor that measures the **AC current** passing through a conductor (such as a power line). It is a non-invasive sensor, meaning it can measure the current without directly connecting to the circuit.
2. The sensor generates an analog output proportional to the current passing through the conductor. This analog signal is then sent to the **ESP32 microcontroller** for processing.
3. The **ZMPT101B** is used to measure the **AC voltage** applied to the connected load. This sensor provides an analog output proportional to the AC voltage being supplied to the device.
4. The sensor converts the AC voltage to a measurable output (usually 0–5V) and sends it to the **ESP32** for further processing.
5. Once the analog signals from the current and voltage sensors are received by the **ESP32**, the microcontroller processes the data and calculates the **real power consumption**.

   Here's how the power is calculated:

   Power (W) = Voltage (V) × Current (I)

6. After calculating the energy consumption data (current, voltage, and power), the **ESP32** sends this information to the **Blynk app** through a **Wi-Fi connection**.

- # Procedure:

Step 1: Circuit Design

Connect the Voltage Sensor (ZMPT101B) to ESP32:

VCC → 3.3V (ESP32)

GND → GND (ESP32)

Analog Output (VOUT) → ESP32 Analog Pin (A0 or A34/A35, etc.)

Connect the Current Sensor (SCT-013):

VCC → 5V

GND → GND

OUT → ESP32 Analog Pin (A36, A39, etc.)

Step 2: Install Required Libraries in Arduino IDE

Install the following libraries:

Blynk (BlynkSimpleEsp32.h)

WiFi (WiFi.h)

LiquidCrystal_I2C.h` (For LCD, optional)

Filters (for smoothing sensor values)

Step 3: Blynk App Setup

Download the Blynk App .

Create a new project and select ESP32 as the board.

Add Gauge and Value Display widgets for Voltage, Current, Power, and Energy.

Copy the Auth Token provided by Blynk.

Step 4: Write the Arduino Code

Step 5: Upload and Test

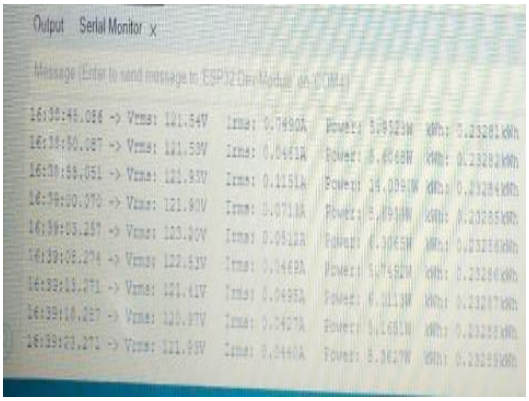
Connect ESP32 to PC and Upload Code via Arduino IDE.

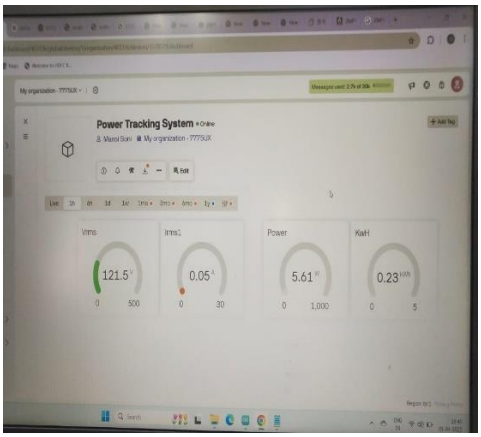
Open Serial Monitor to check sensor values.

Open the Blynk App to see real-time voltage, current, power, and energy readings.

- **Source Code:**

- **Output:**


Output Serial Monitor x


Power Tracking System
Vrms
Irms
Power
KwH
121.5
0.05
5.61
0.23