

# **Smart Energy Monitoring System**

## **Introduction**

Smart energy monitoring systems are an essential step towards creating energy-efficient and sustainable solutions. By leveraging sensors, IoT technology, and user-friendly interfaces, such systems enable real-time monitoring and analysis of power consumption. This report outlines the development and functionality of a smart energy monitoring system using a ZMT101 voltage sensor, SCT-013 current sensor, and an IoT Blank app for data visualization.

## **Components Used**

### **1. Voltage Sensor (ZMT101):**

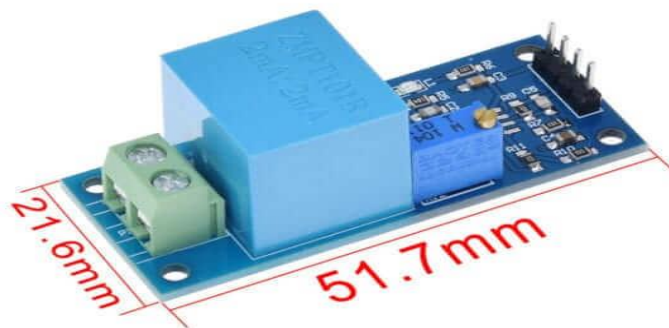
- a. The ZMT101 voltage sensor measures the electrical potential difference (voltage) across a circuit.

#### **b. Working Principle:**

It operates by converting the high voltage levels of an AC system into a proportional low-voltage signal, safe for microcontrollers or data acquisition systems to process.

#### **c. Features:**

- i. High accuracy in voltage measurements.
- ii. Simple integration with microcontroller platforms.
- iii. Compact and robust design.



### **2. Current Sensor (SCT-013):**

- a. The SCT-013 is a non-invasive, clip-on current transformer used to measure AC current.

- b. **Working Principle:**

This sensor detects the magnetic field around a conductor carrying current, inducing a proportional voltage in its winding. This induced voltage can be processed to determine the current.

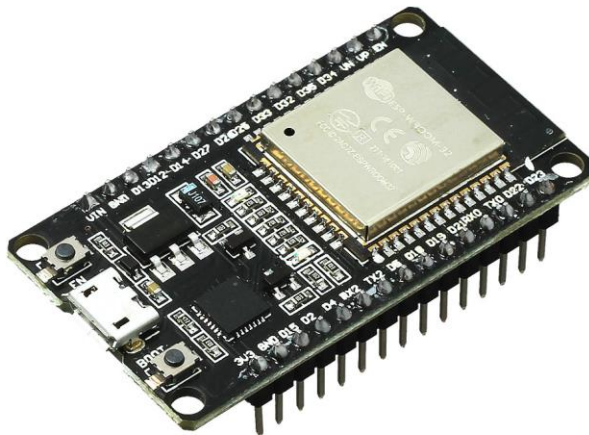
- c. **Features:**

- i. Non-invasive and safe.
- ii. Suitable for AC current up to 100A.
- iii. High precision and durability.



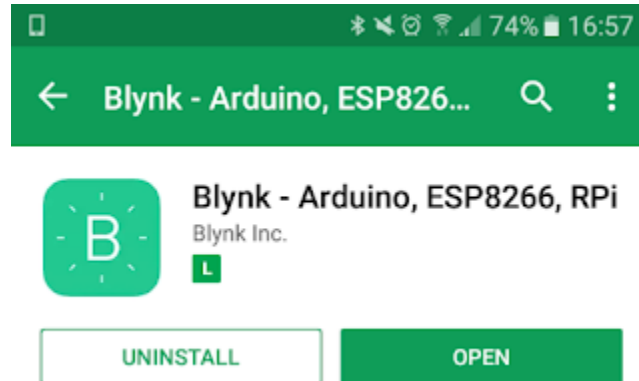
### 3. **Microcontroller (e.g., ESP32 or Arduino):**

- a. Used for data acquisition and processing from sensors.
- b. Supports wireless communication for IoT applications.



#### 4. IoT Blank App:

- a. A customizable IoT platform for visualizing and analyzing energy data.
- b. **Purpose:** Provides real-time access to voltage, current, and power readings on laptops and mobile devices.
- c. **Features:**
  - i. User-friendly interface.
  - ii. Compatibility with various IoT devices.
  - iii. Secure data storage and visualization.



#### 5. Additional Components:

- a. Resistors and capacitors for signal conditioning.
- b. Breadboard and jumper wires for prototyping.
- c. Power supply for sensors and microcontroller.

### System Design and Workflow

#### 1. Data Acquisition:

- a. The ZMT101 voltage sensor measures the AC voltage of the circuit.
- b. The SCT-013 current sensor captures the AC current flowing through the load.

#### 2. Signal Processing:

- a. The analog signals from both sensors are conditioned and fed into the microcontroller's ADC (Analog-to-Digital Converter).
- b. The microcontroller calculates real-time power ( $P = V \times I$ ) and energy consumption.

#### 3. Data Transmission:

- a. The processed data is sent wirelessly to the IoT Blank app via Wi-Fi or Bluetooth.

#### 4. Data Visualization:

- a. The IoT Blank app displays voltage, current, and power readings in real time on connected devices like laptops and mobile phones.
- b. Historical data is stored for trend analysis and energy optimization.

## Methodology

The smart energy monitoring system follows a systematic methodology to ensure accurate and real-time energy tracking:

### 1. Sensor Calibration:

- a. Proper calibration of ZMT101 and SCT-013 is performed to eliminate errors.
- b. Calibration involves comparing sensor readings against standard measurement tools.

### 2. Data Logging:

- a. Continuous logging of voltage, current, and power values is implemented.
- b. Logged data is stored locally or on cloud platforms for further analysis.

### 3. Energy Analytics:

- a. The IoT Blank app provides insights into energy consumption patterns.
- b. Users can identify peak usage periods and optimize their energy usage accordingly.

### 4. Alerts and Notifications:

- a. The system can be configured to send alerts for abnormal energy usage or faults.
- b. Notifications help in preventing potential electrical hazards and reducing energy waste.

## Purpose

### 1. Energy Efficiency:

Identifies areas of energy wastage and suggests optimization strategies.

### 2. Cost Reduction:

Helps reduce electricity bills by monitoring and managing consumption effectively.

### 3. Sustainability:

Encourages responsible energy usage, contributing to environmental conservation.

#### **4. Real-Time Monitoring:**

Provides instantaneous access to energy data, enhancing user awareness and control.

#### **5. Fault Detection:**

- a. Early detection of electrical issues to ensure safety and reduce maintenance costs.

### **Advantages of the SCT-013 Current Sensor**

1. Non-invasive and easy to install.
2. High accuracy in AC current measurement.
3. Cost-effective and durable.
4. Compatibility with various microcontroller platforms.

### **Advantages of the ZMT101 Voltage Sensor**

1. Simple integration with digital systems.
2. Accurate voltage measurements for AC systems.
3. Safe and reliable operation.

## **Applications**

#### **1. Residential:**

- a. Monitoring household energy usage to reduce electricity bills.

#### **2. Commercial:**

- a. Managing energy consumption in offices and industrial facilities.

#### **3. Renewable Energy Systems:**

- a. Monitoring solar panel output and battery storage performance.

#### **4. Smart Grids:**

- a. Contributing to the development of efficient and sustainable power distribution networks.

## **Conclusion**

The smart energy monitoring system developed using the ZMT101 voltage sensor, SCT-013 current sensor, and IoT Blank app demonstrates a robust solution for energy management. By offering real-time insights and analytics, this system empowers users to optimize energy usage, reduce costs, and contribute to a sustainable future. Such technologies are

pivotal in addressing the growing global demand for energy efficiency and environmental responsibility.

