



DHANALAKSHMI COLLEGE OF ENGINEERING



Smart Weather and Power Consumption Monitoring System with Real-Time Control Using MQTT.

Domain: Internet of Things

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1.INTRODUCTION

- ✓ Due to the increasing demand for energy efficiency and environmental monitoring, smart systems integrating IoT provide a seamless solution.
- ✓ This project focuses on a **Smart Weather and Power Consumption Monitoring System** using an ESP32, MQTT protocol, and various sensors to track environmental conditions and electrical usage in real time.
- ✓ It also enables remote control of appliances, enhancing energy management.

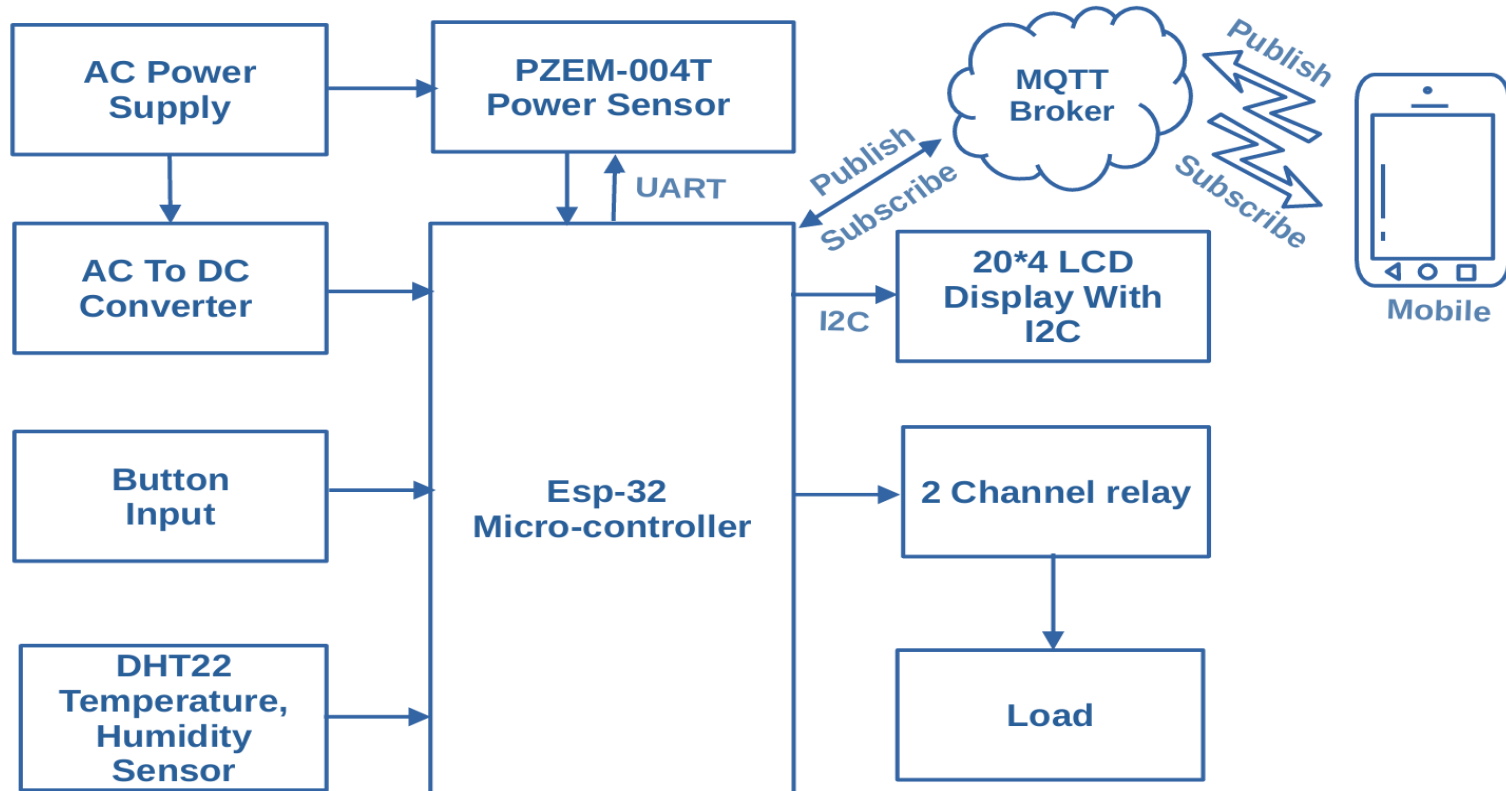
2.OBJECTIVES

- ✓ Monitor temperature, humidity, and power consumption in real time.
- ✓ Provide remote control of electrical appliances via an MQTT-based app.
- ✓ Display real-time data on a 20x4 LCD for local monitoring.
- ✓ Ensure energy efficiency by tracking power consumption trends.
- ✓ Store and transmit data efficiently using ESP32 and MQTT.

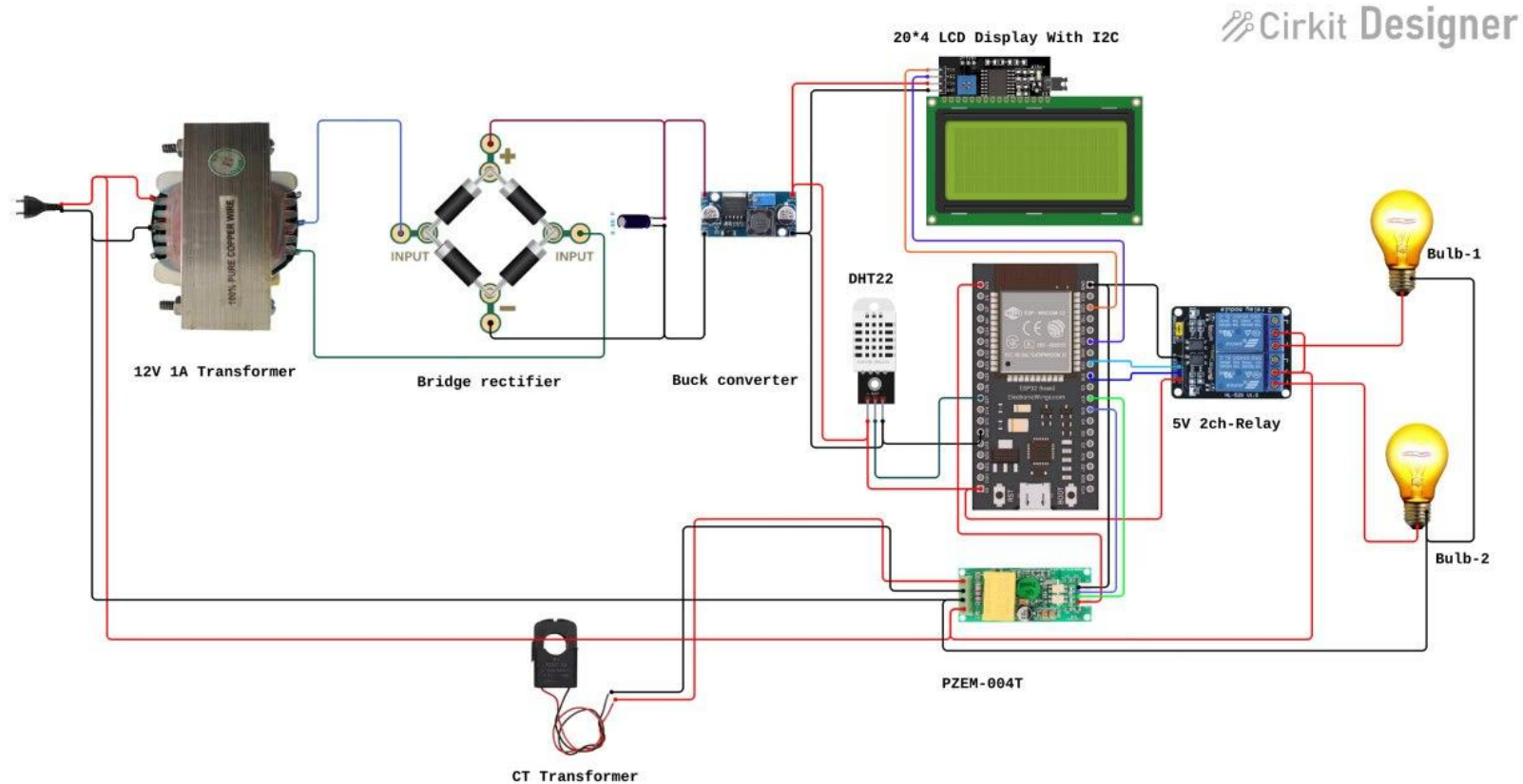
3.ABSTRACT

- ✓ This project integrates ESP32, DHT22, PZEM-004T, and an MQTT-based control system to create a smart monitoring system. The DHT22 sensor measures environmental conditions, while the PZEM-004T module tracks voltage, current, power, and energy consumption. A 2-channel relay allows remote control of connected appliances. The system continuously updates the data to an MQTT server, enabling real-time monitoring via a mobile or web application. The 20x4 LCD provides local display for quick insights.

4.BLOCK DIAGRAM



5 CIRCUIT DIAGRAM



6.COMPONENTS & BRIEF INTRODUCTION

- ✓ ESP32 – Microcontroller with Wi-Fi & Bluetooth for IoT applications.
- ✓ PZEM-004T – Measures voltage, current, power, and energy.
- ✓ DHT22 – Digital temperature and humidity sensor.
- ✓ 2-Channel Relay Module – Controls electrical loads remotely.
- ✓ 20x4 LCD Display (I2C) – Displays real-time sensor readings.
- ✓ MQTT Protocol – Facilitates real-time communication between devices and the cloud.

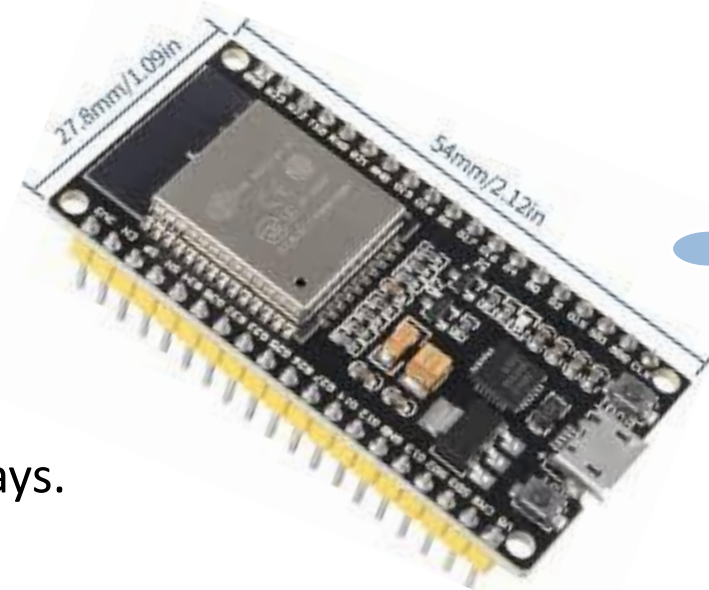
7.ESP32-WROOM

ESP32 – Wi-Fi & Bluetooth Microcontroller

ESP32 is a powerful microcontroller with built-in **Wi-Fi and Bluetooth** capabilities, making it ideal for IoT applications. It supports multiple sensors, low-power operation, and real-time data processing.

Features:

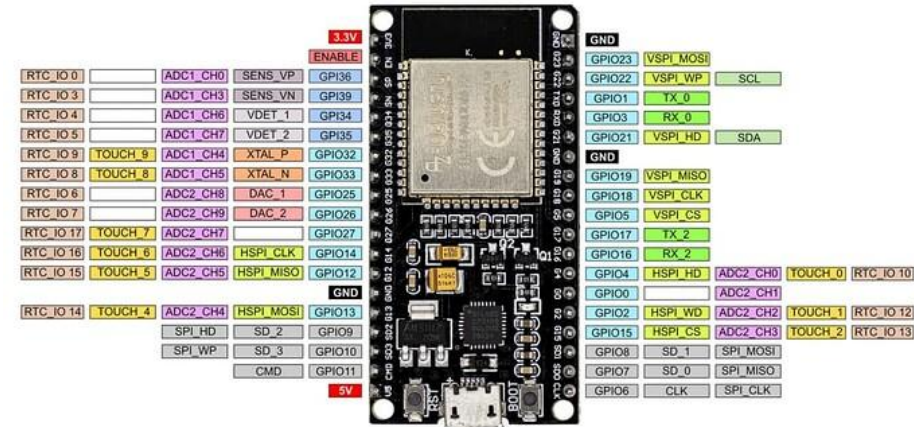
- ✓ **Dual-core processor** for efficient multitasking.
- ✓ **Wi-Fi and Bluetooth** connectivity for remote communication.
- ✓ **Low power consumption** with deep sleep mode.
- ✓ **Multiple GPIOs** to connect sensors, relays, and displays.
- ✓ **Supports MQTT, HTTP, and WebSockets** for cloud communication.



7.1.ESP32-WROOM

Specifications:

- ✓ Processor: Dual-core Xtensa LX6 @ 240 MHz
- ✓ Flash Memory: 4MB (varies by model)
- ✓ GPIO Pins: 34 (Capable of PWM, ADC, I2C, SPI, UART)
- ✓ Wi-Fi: 802.11 b/g/n (Station & AP mode)
- ✓ Bluetooth: BLE & Classic
- ✓ Operating Voltage: 3.3V
- ✓ Current Consumption: ~160mA (active), ~10μA (deep sleep)



8.PZEM-004T

PZEM-004T – Power Monitoring Module

The PZEM-004T is an energy metering module designed to measure voltage, current, power, and energy consumption in AC circuits. It communicates via UART and is widely used for energy monitoring applications.

Features:

- ✓ Measures voltage (80-260V AC), current (0-100A), power, and energy.
- ✓ High accuracy measurement with minimal error.
- ✓ UART communication for easy integration with microcontrollers.
- ✓ Supports data storage to retain values after power loss.



8.1.PZEM-004T

Specifications:

- ✓ Operating Voltage: 80-260V AC
- ✓ Current Range: 0-100A (via external CT sensor)
- ✓ Power Measurement: 0-22kW
- ✓ Energy Measurement: 0-9999kWh
- ✓ Baud Rate: 9600bps (UART)
- ✓ Accuracy: $\pm 1\%$



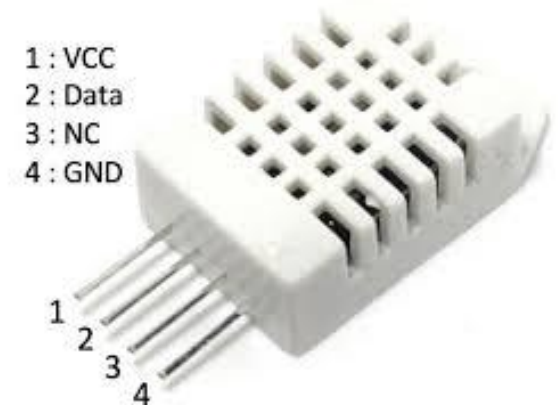
9.DHT22

DHT22 – Temperature & Humidity Sensor

The DHT22 is a digital sensor that provides precise temperature and humidity measurements, commonly used in weather monitoring and automation projects.

Features:

- ✓ Measures temperature (-40°C to 80°C) and humidity (0-100%).
- ✓ Calibrated output for high accuracy and stability.
- ✓ Single-wire communication for easy microcontroller integration.
- ✓ Low power consumption (ideal for battery-operated systems).



9.1.DHT22

Specifications:

- ✓ Operating Voltage: 3.3V – 5V
- ✓ Temperature Range: -40°C to 80°C ($\pm 0.5^\circ\text{C}$ accuracy)
- ✓ Humidity Range: 0-100% RH ($\pm 2\%$ accuracy)
- ✓ Response Time: 2 seconds
- ✓ Output Signal: Digital (1-wire protocol)



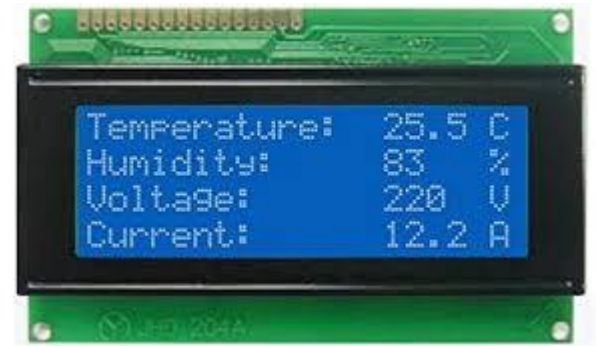
10.LCD Display (I2C)

20x4 LCD Display (I2C) – Real-time Data Display

This LCD screen provides clear, real-time data visualization, reducing the need for external displays like mobile or PC screens. The I2C module reduces wiring complexity.

Features:

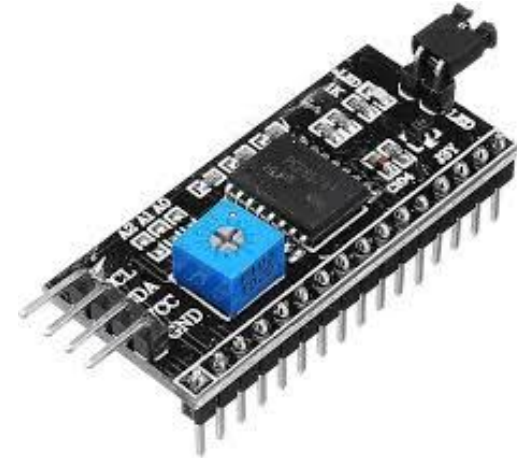
- ✓ Displays up to 4 lines of 20 characters each.
- ✓ Uses I2C communication to reduce wiring.
- ✓ Compatible with 3.3V & 5V systems.
- ✓ Backlight for visibility in low-light environments.



10.1.LCD Display (I2C)

Specifications:

- ✓ Display Size: 20x4 characters
- ✓ Interface: I2C (SDA, SCL)
- ✓ Operating Voltage: 5V
- ✓ Character Size: 2.95mm x 4.75mm
- ✓ Backlight: LED



11. Relay Module

2-Channel Relay Module – Remote Load Control

This module is used to switch high-voltage electrical devices on or off using a low-voltage microcontroller signal, allowing remote automation.

Features:

- ✓ Controls AC (110V/220V) or DC loads up to 10A.
- ✓ Optocoupler isolation for safety and reliability.
- ✓ LED indicators for relay status.
- ✓ Low power consumption with a 5V trigger voltage



11.1. Relay Module

Specifications:

- ✓ Operating Voltage: 5V
- ✓ Trigger Voltage: 3.3V – 5V (compatible with ESP32)
- ✓ Relay Switching Capacity: AC 250V/10A, DC 30V/10A
- ✓ Number of Relays: 2
- ✓ Optocoupler Isolation: Yes



12.MQTT

MQTT Protocol – IoT Communication

MQTT (Message Queuing Telemetry Transport) is a lightweight protocol used for real-time messaging between devices over the Internet or local networks.



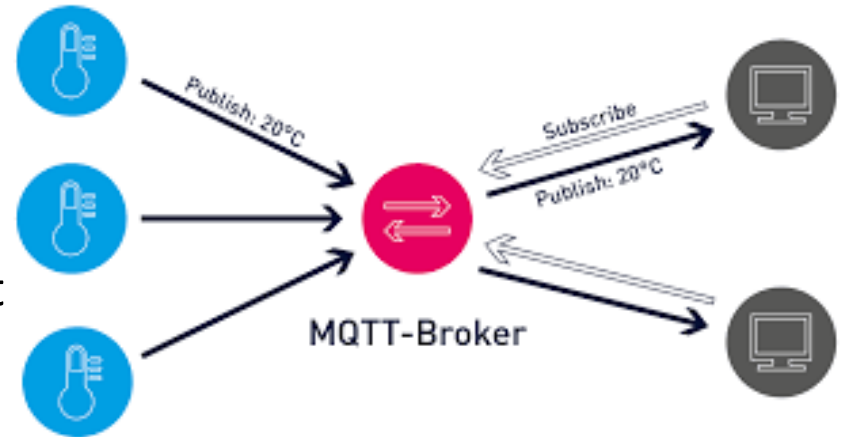
Features:

- ✓ Low bandwidth consumption, ideal for IoT applications.
- ✓ Supports multiple devices via Publish/Subscribe architecture.
- ✓ Real-time data transmission with minimal latency.
- ✓ Secure communication using authentication and encryption.

12.1.MQTT

Specifications:

- ✓ Protocol Type: Publish-Subscribe
- ✓ Transport: TCP/IP
- ✓ Message Format: JSON, Binary, or Plain Text
- ✓ Security: TLS/SSL support
- ✓ QoS Levels: 0 (At most once), 1 (At least once), 2 (Exactly once)



13.PROBLEM STATEMENT & SOLUTION

Problem:

- ✓ Lack of efficient monitoring leads to **energy wastage and high electricity bills.**
- ✓ Manual tracking of power usage is **inconvenient and inaccurate.**
- ✓ No remote-control system to **optimize appliance usage.**

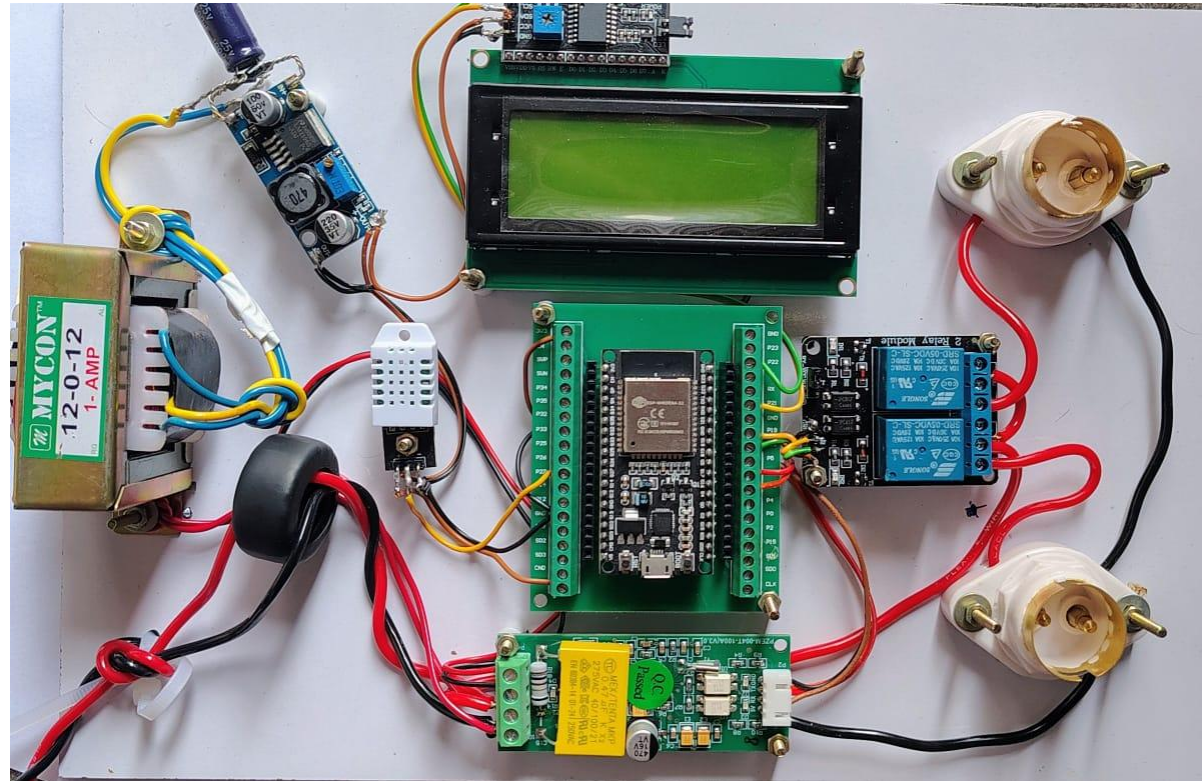
Solution:

- ✓ A **real-time power monitoring system** that logs and analyzes energy consumption.
- ✓ **Wireless control of appliances** using an MQTT-based mobile app.
- ✓ A **user-friendly LCD display** for local insights.

14.FEATURES

- ✓ **Real-time monitoring** of weather and power parameters.
- ✓ **Remote appliance control** via MQTT.
- ✓ **Energy consumption tracking** to optimize power usage.
- ✓ **Live data display** on LCD for quick insights.
- ✓ **MQTT-based notifications and alerts** for power fluctuations.

15 PROJECT LAYOUT



WORKING

System Initialization

- ESP32 connects to Wi-Fi network on boot.
- Sensors (DHT22 and PZEM-004T) and LCD are initialized.
- MQTT broker connection is established.

Data Collection

DHT22 measures:

- Temperature
- Humidity

PZEM-004T measures:

- Voltage
- Current
- Power
- Energy consumption

WORKING

. Data Display & Transmission

- Sensor data is:
 - Shown in real-time on **20x4 I2C LCD**
 - Published to MQTT broker under specific topics

Mobile Monitoring

- **MQTT Panel App** subscribes to the same topics.
- Displays real-time sensor data.
- Uses toggle switches for appliance control.

WORKING

Real-Time Control

- MQTT commands (ON/OFF) sent from the app.
- ESP32 receives commands via subscribed topics.
- **2-Channel Relay** triggers the respective appliances.

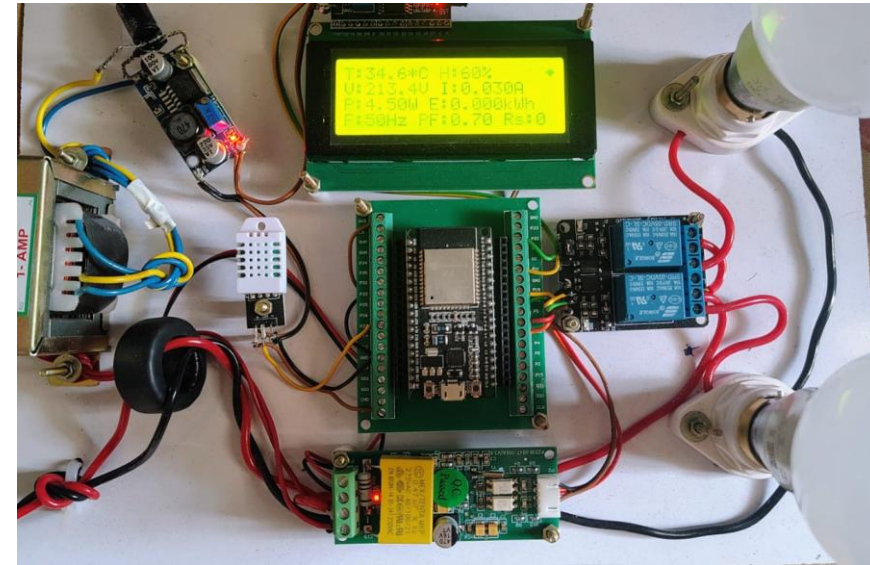
Continuous Monitoring & Control

- Loop continues:
 - Data updates every 2–5 seconds.
 - Appliances can be remotely turned ON/OFF anytime.
- Enables smart control and energy optimization.

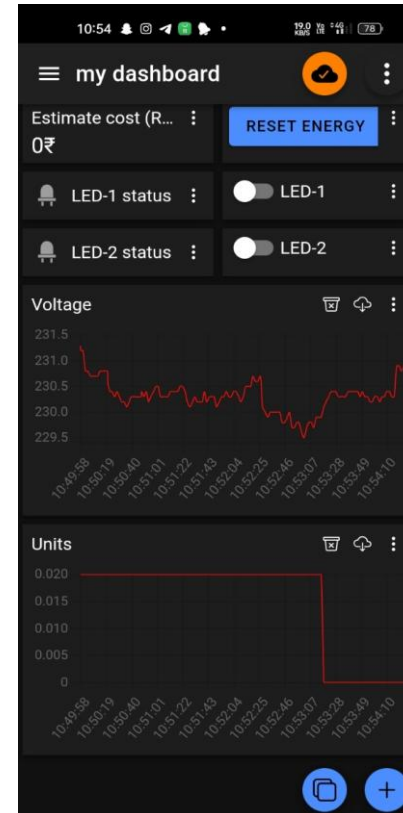
WORKING

✓ Outcome

- Seamless integration of monitoring + control.
- Real-time, wireless, low-latency communication.
- Suitable for energy-aware smart home environments.



MQTT PANNEL INTERFACE



15.CONCLUSION

- ✓ This system provides an **accurate, efficient, real-time, and remote monitoring solution** for power and weather parameters. By integrating IoT, MQTT, and ESP32, users can track electricity usage, automate control, and reduce wastage, leading to cost savings and smarter energy management.

16. REFERENCES & ACKNOWLEDGMENTS

Thank You...

Acknowledgments

➤ Project Guide.

- Mrs Esther Gandhimathi S

➤ Batch members.

- Yuvaraj E
- Hemath Kumar Nidhi R
- Bharath J

References

- Research papers, articles, and documentation.
- Websites used for coding & circuit design.

