Supervisory Control and Data Acquisition System

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Objective

This project aims to investigate and develop SCADA (Supervisory Control and Data Acquisition) software designed for integration with hardware to showcase its capabilities. It focuses on measuring current, voltage, power factor, real power, reactive power, and apparent power. It also allows users to control connected loads based on the collected data

Motivation

As electrical engineers, we recognize the need for efficient, real-time monitoring and control in power systems. SCADA plays a crucial role in optimizing energy management, improving reliability, and enabling remote operation. This project aims to develop a cost-effective SCADA system to measure key electrical parameters and control loads based on real-time data. By integrating modern microcontrollers and communication protocols, we enhance automation, support smart grid development, and contribute to sustainable energy management.

Approach

- **Power Conversion and Supply:** A step-down transformer and rectifier convert 120V AC to stable 5V DC, securing a safe and reliable power supply.
- **Safety Mechanism:** A relay ensures rapid power disconnection during faults, enhancing system safety.
- **Power Monitoring and Data Handling:** The PZEM-004T meter and ESP32 microcontroller manage real-time data analysis and load control, ensuring precise power monitoring.
- **Software Integration:** SCADA software offers real-time visualization and control, providing essential insights and effective load management via interactive graphs.

Webserver

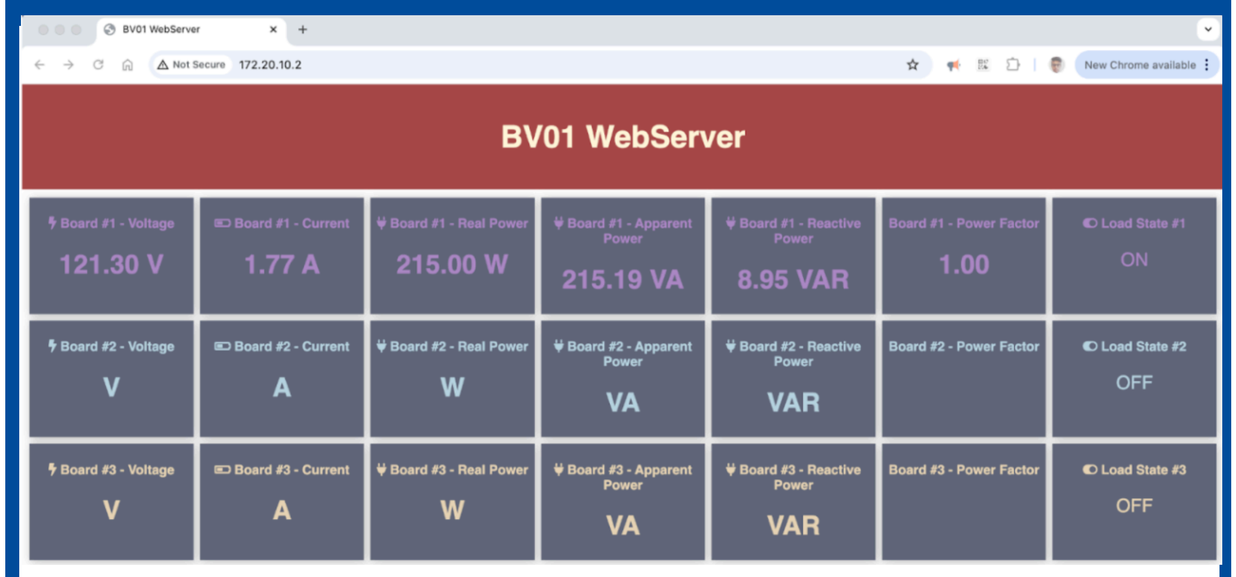

Fig 1. *Webserver Interface*

A central device gathers all of the wireless load data and hosts a web page. This page is organized into a JSON (JavaScript Object Notation) format. By making HTTP requests to the URL the python application can retrieve, parse, and manipulate the JSON data according to the needs of the SCADA system.

Hardware

Hardware setup was designed for optimal energy measurement and reliability. Allowing for measurement and control of loads.

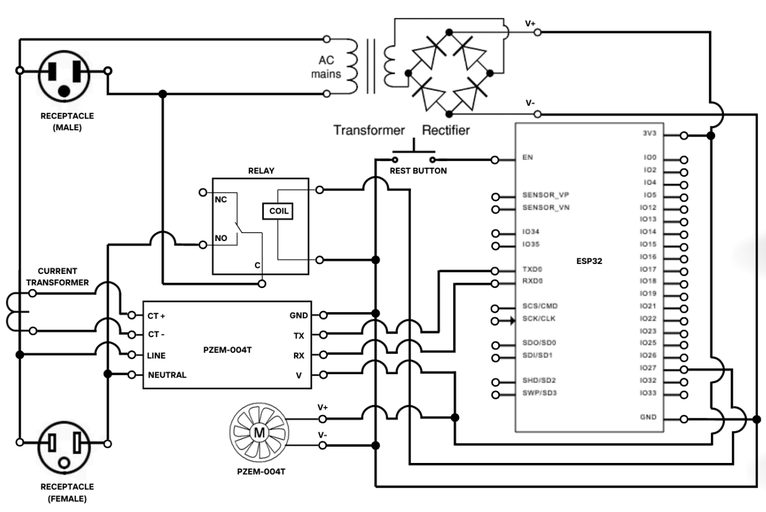

Fig 2. *Schematic of the hardware configuration*

Fig 3. *Hardware Enclosure 3D Print Design*

Software

The SCADA software offers real-time data visualization with interactive graphs and dynamic updates of electrical parameters, giving users control and insight into system performance. Features like zoom, pan, reset, and adjustable data points allow users to analyze trends in detail. An interactive network representation enables easy system interaction, including toggling switches for three loads and automatic overcurrent protection.

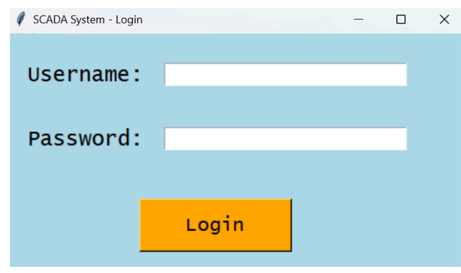

Fig 4. *Login Screen*

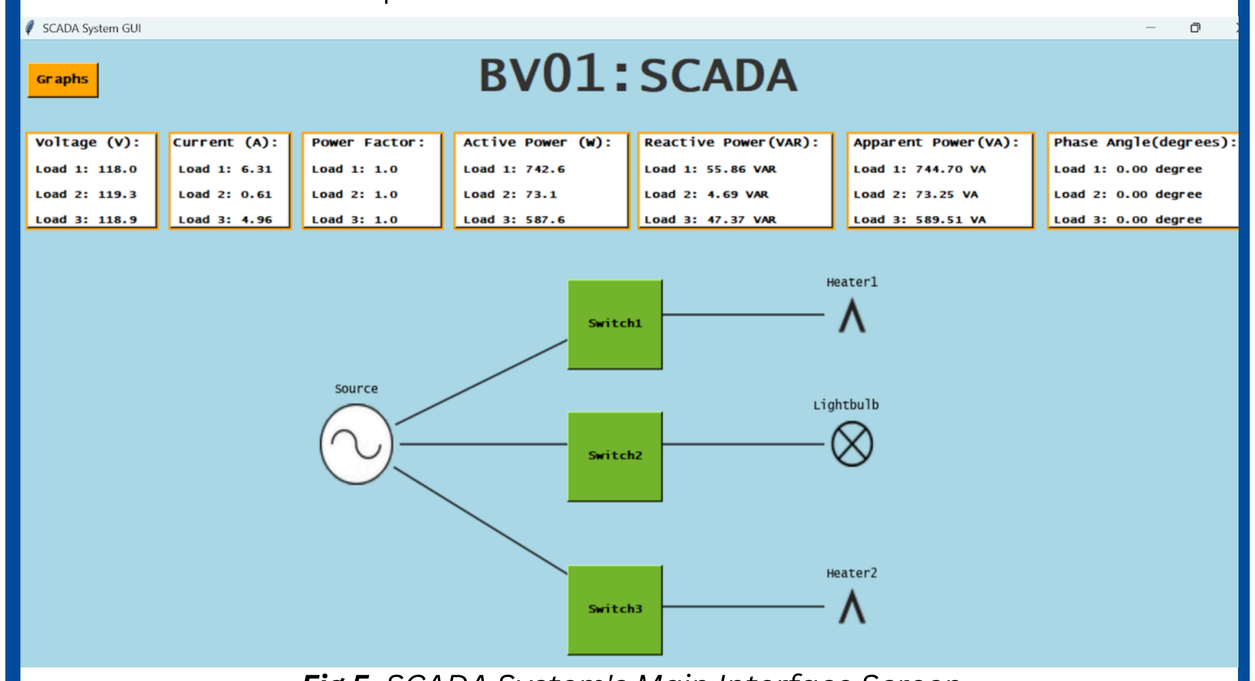

Fig 5. *SCADA System's Main Interface Screen*

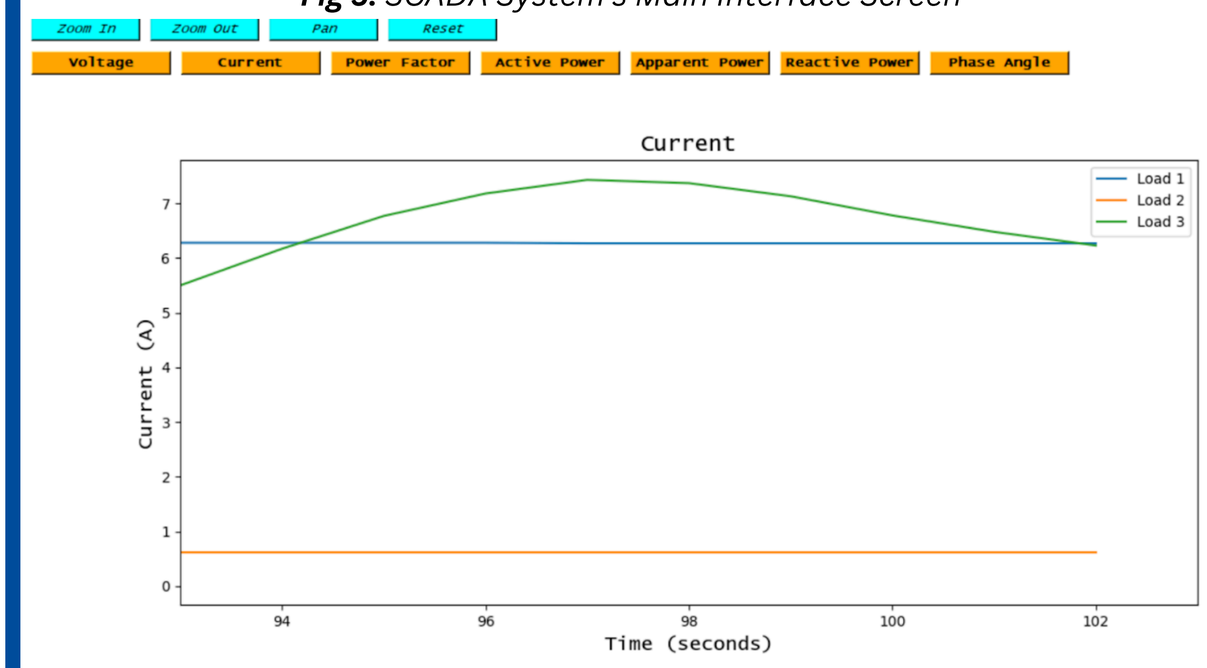

Fig 6. *SCADA System's Graphical Interface*

Conlusion

The developed SCADA device enables real-time monitoring of an electrical network, providing critical data for system operation. It facilitates both electrical measurements and load control within the network. The SCADA system is visualized through a graphical user interface (GUI), which incorporates a login system to ensure access is restricted to authorized users. The GUI displays electrical measurements over time and allows users to control load operations efficiently.

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