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

The hardware setup for this project was designed to efficiently monitor, control and manage power. A step-down transformer with a rectifier was used to convert 120V AC to 5V DC, providing the necessary low-voltage power supply. A 3.3V DC relay was implemented to regulate power flow to the receptacle while also serving as an isolation device, enabling disconnection in case of emergencies or faults. A PZEM-004T power meter was integrated to measure voltage and current from the receptacle and to compute key power parameters. An ESP32 microcontroller, equipped with a heatsink for improved heat dissipation, was implemented for data transmission and load control. A current transformer was employed to step down the current to a suitable level for analysis by the PZEM-004T. To maintain optimal operating conditions, a cooling fan was installed to facilitate airflow and prevent overheating of components. Additionally, a reset button was included to restore the system to its original state in response to faults or malfunctions.

Webserver

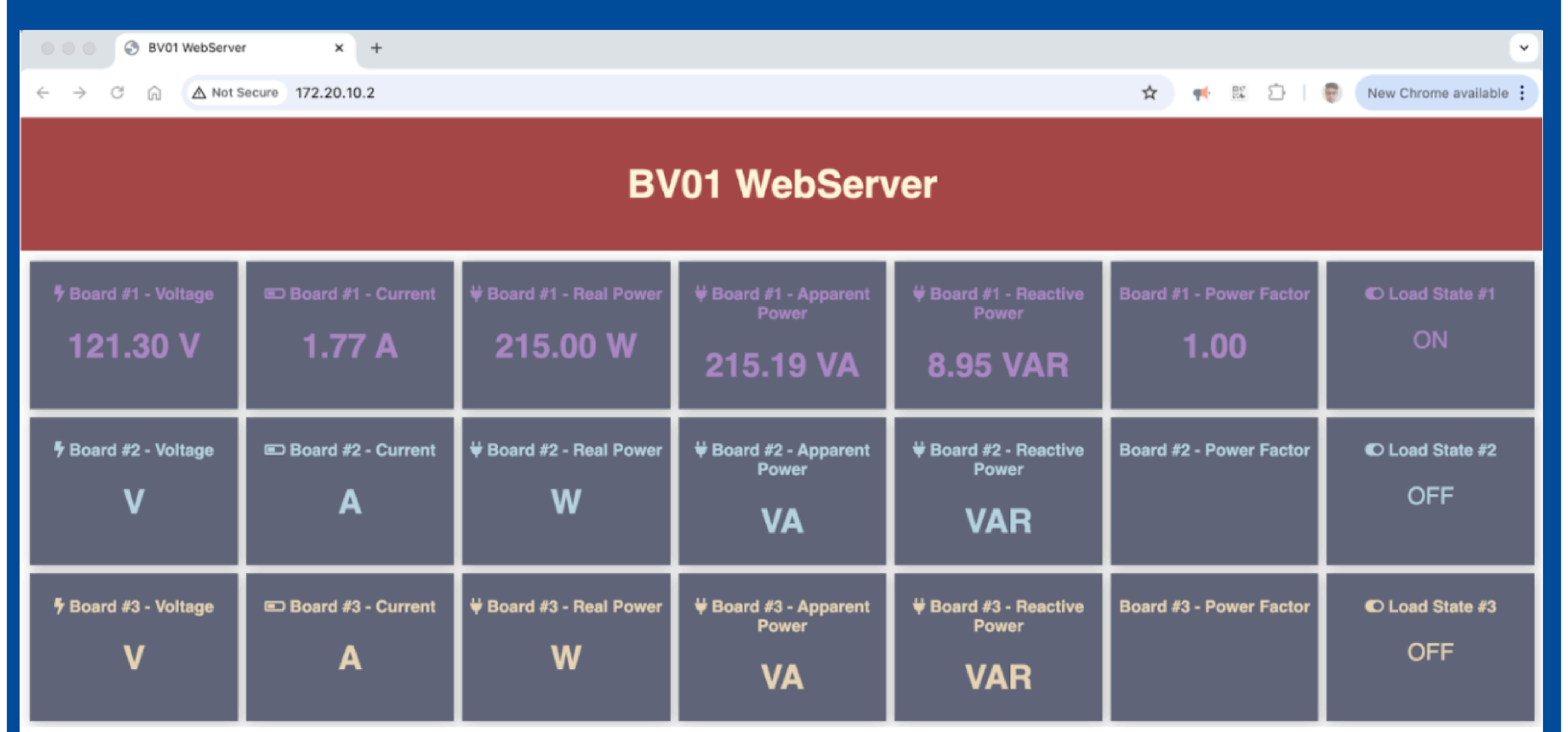

Fig 1. *Webserver Interface*

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.

Software

Software enabling seamless data integration and real-time analytics.

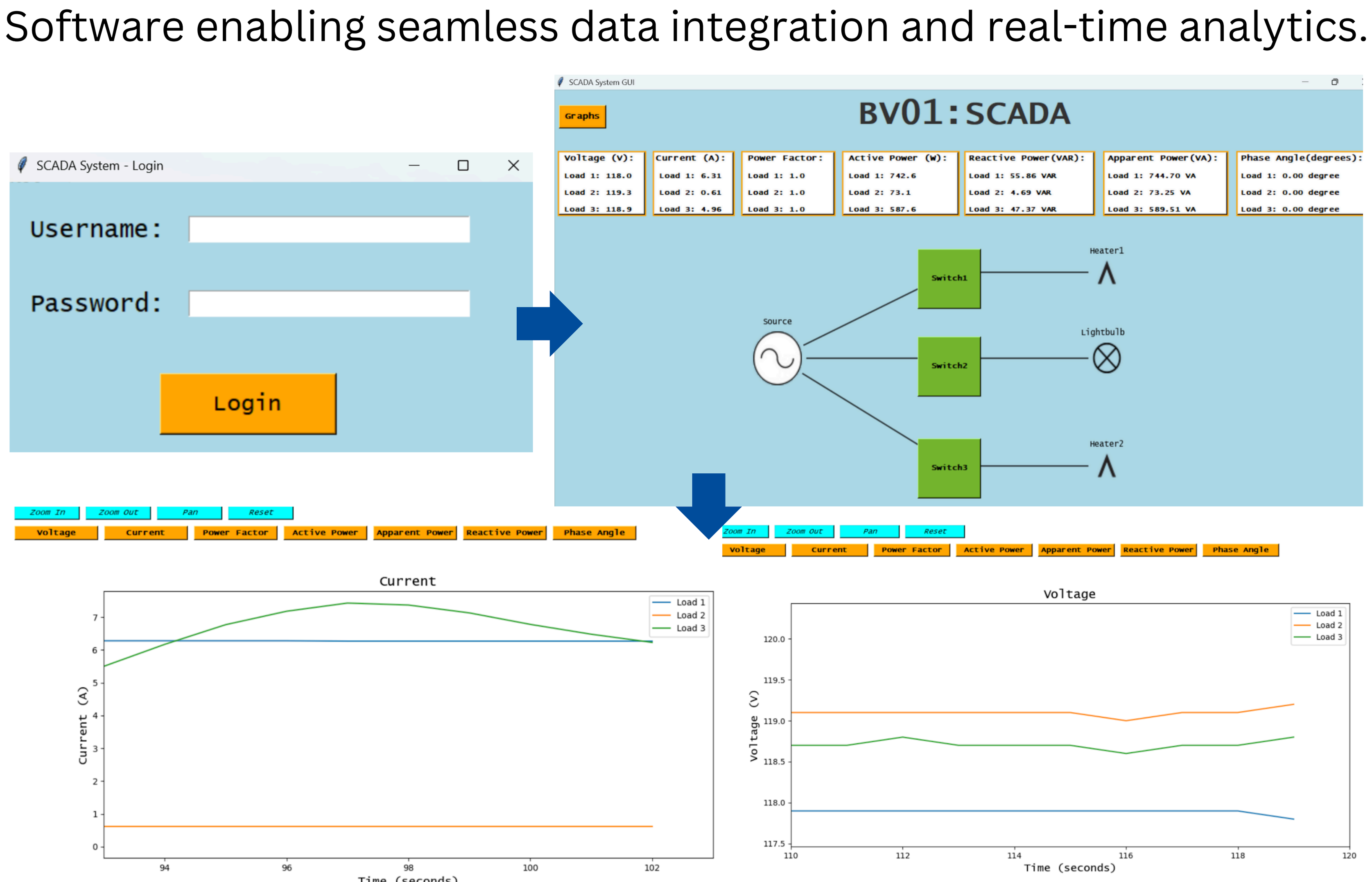

Fig 4. *Overview of the SCADA System's Main Interface.*

Hardware

Robust hardware setup designed for optimal energy measurement and reliability.

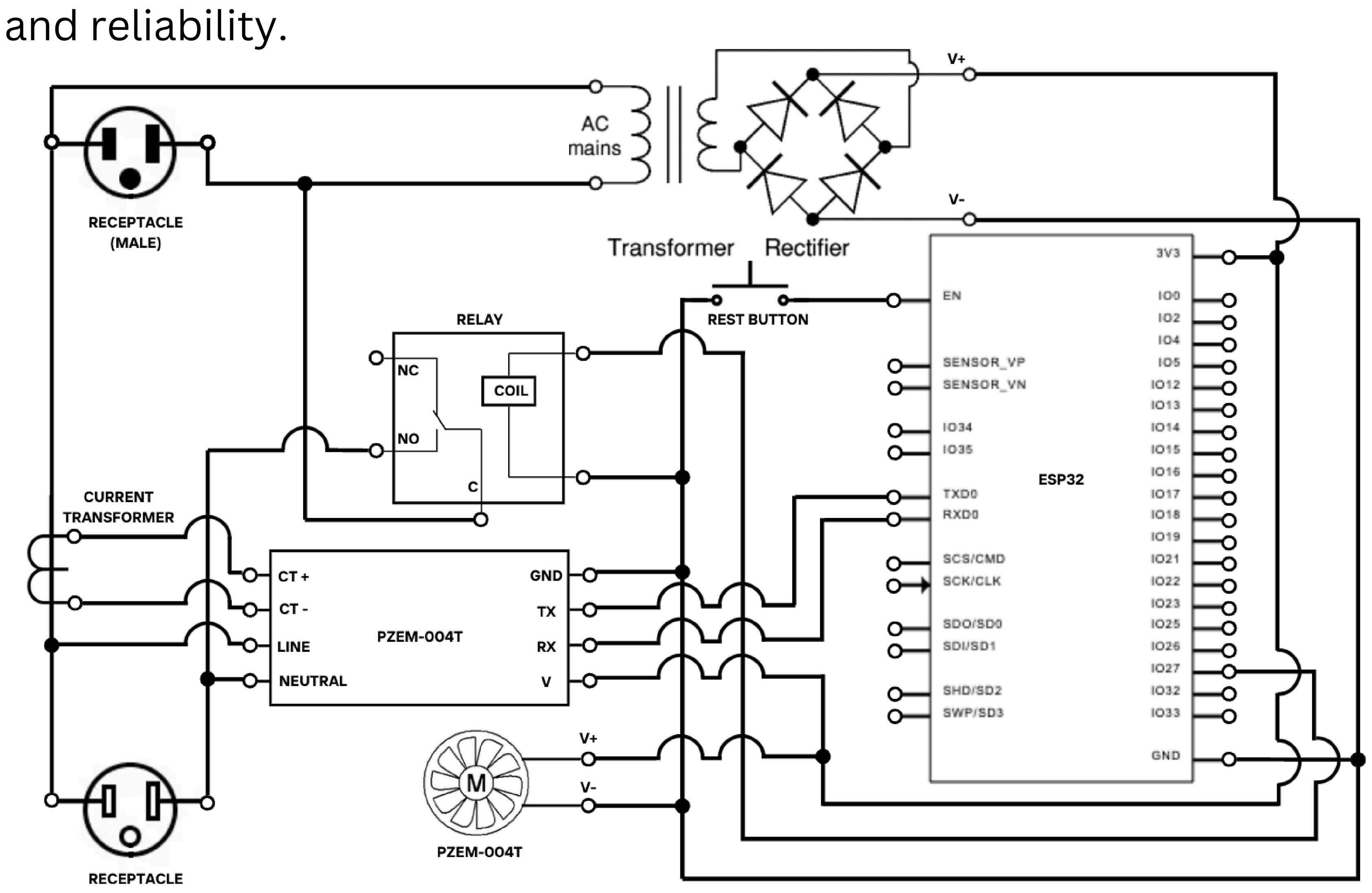

Fig 2. *Schematic of the hardware configuration*

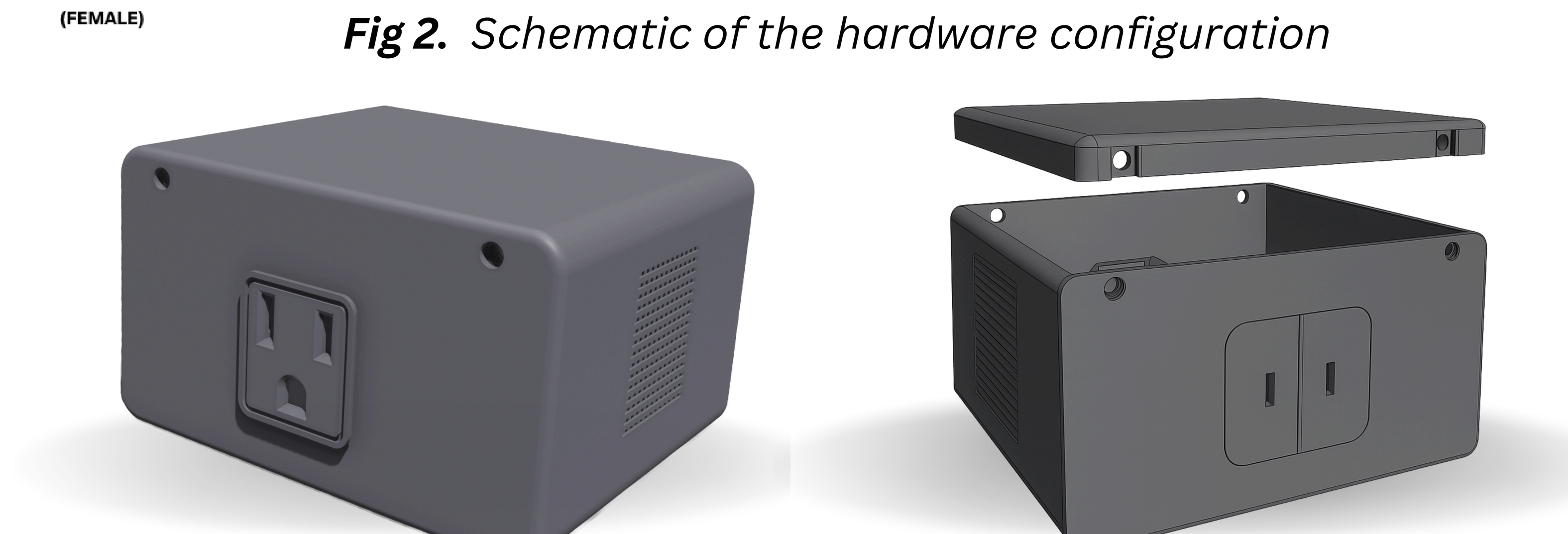

Fig 3. *Hardware Enclosure 3D Print Design*

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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