

3 Phase Power Meter

Personal Project

[#4]



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Overview

I developed a 3-phase home power meter utilizing an ESP32, which connects to an MQTT broker for seamless integration with my Home Assistant setup. The hardware comprises non-intrusive current clamps and voltage transformers to accurately monitor multiple phases. I programmed the ESP32 with PlatformIO for board management to sample signals using the 12-bit ADC on the ESP32, ensuring high-enough-resolution readings while adhering to the Nyquist theorem to prevent aliasing.

Data Acquisition

To enhance measurement accuracy, I implemented a rolling average technique to reduce noise, prioritising data quality over quantity for stable readings in residential applications.

The system calculates key parameters such as voltage (RMS and peak), current (RMS and peak), and various power metrics: active, reactive, and apparent, enabling effective monitoring of energy consumption and identification of inefficiencies.

I used an HTTP client together with the MQTT connection to fetch real-time electricity prices from a local energy provider's website. This feature enables dynamic energy management, based on pricing data. The MQTT broker transmits this information to Home Assistant, for built in visualization and ZeroTier connectivity so the data can be shown worldwide with the virtual network.

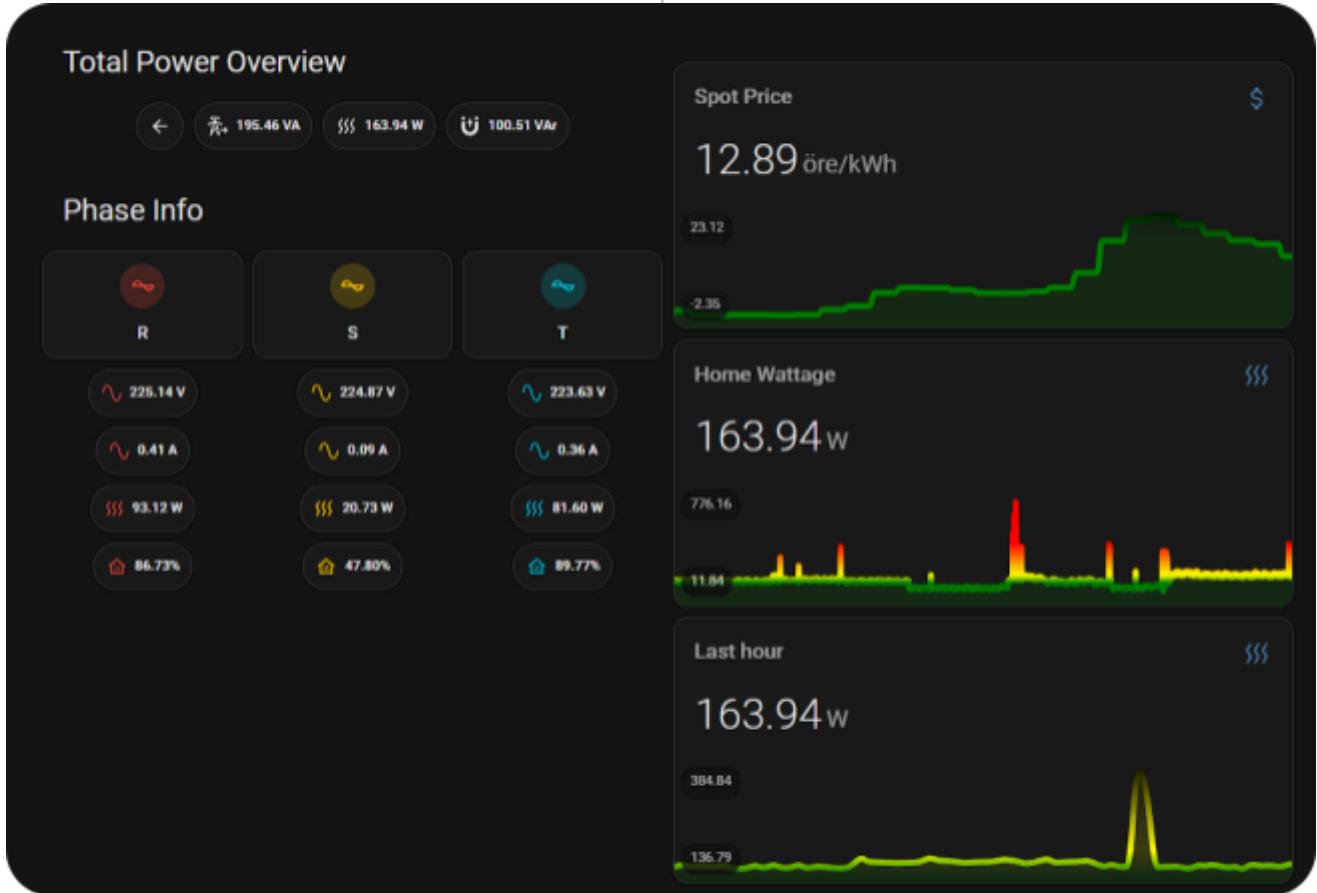


fig 1: custom dashboard in Home Assistant

Status & Future Improvements

Currently, the project is still a work in progress, and I'm addressing some phase shift issues, particularly with Phase 2, which has resulted in an unexpectedly low power factor. While this was intended as a proof of concept, it highlights the potential for future refinements. My ultimate goal is to achieve better phase balance and develop advanced control strategies to optimize energy consumption during low-cost electricity periods. This will be implemented using AppDaemon to run full Python scripts on the Raspberry Pi 4, which currently hosts the Home Assistant instance on an external SSD. This setup will enable automations to run continuously in the background, allowing for parallel processing and opening up numerous possibilities for enhanced energy management and control.

Educational Relevance

This project aligns closely with my course Electrical Power (EEK565) i had at the time. The hands-on experience allowed me to apply theoretical concepts to a practical scenario, significantly deepening my understanding of energy management, 3-Phase systems, circuit theory and Power. Integrating hardware and software systems provided valuable insights into real-time data's role in making informed energy consumption decisions.

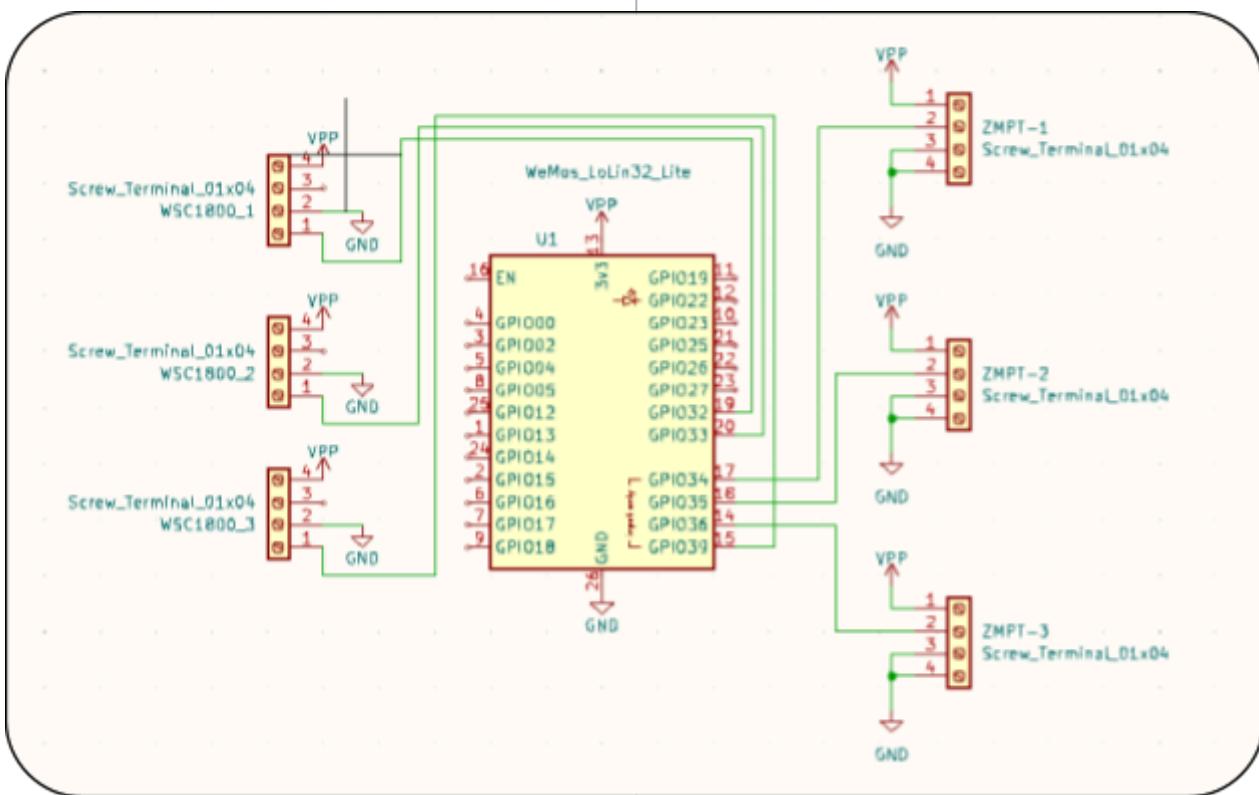


fig 2: KiCad basic connections