Open Solar Powered Irrigation Tool (OSPIT)

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Description

Figure 1: The prototype installation in winter with 6 plant beds. The 40 Watt solar module is mounted to a sturdy pole.

The OSPIT solar irrigation prototype is powered by a small photovoltaic solar panel of 40 Watt peak power in our current setup. The system is currently installed in Berlin-Friedrichshain, Germany at Markgrafendamm 10 and can irrigate 6 planting beds by drip-watering. The current prototype features a water pump to provide water pressure from a water tank at the same height level of the planting beds, but the system can probably also be gravity-fed if the water tank is located higher than the planting beds.

Solar energy is harvested during the day and stored in a 12 Volt AGM type lead acid battery of 18 Ah (Amperehour) capacity. The battery charging and discharging process is managed and monitored by a modified FF-ESP32-OpenMPPT charge controller. The Maximum Power Point Tracking (MPPT) feature of the OpenMPPT charge controller increases the energy yield from the solar panel.

We have modified / extended the Freifunk-ESP32-OpenMPPT open hardware and open software to also work as an irrigation computer besides acting as a solar charge controller and monitoring device.

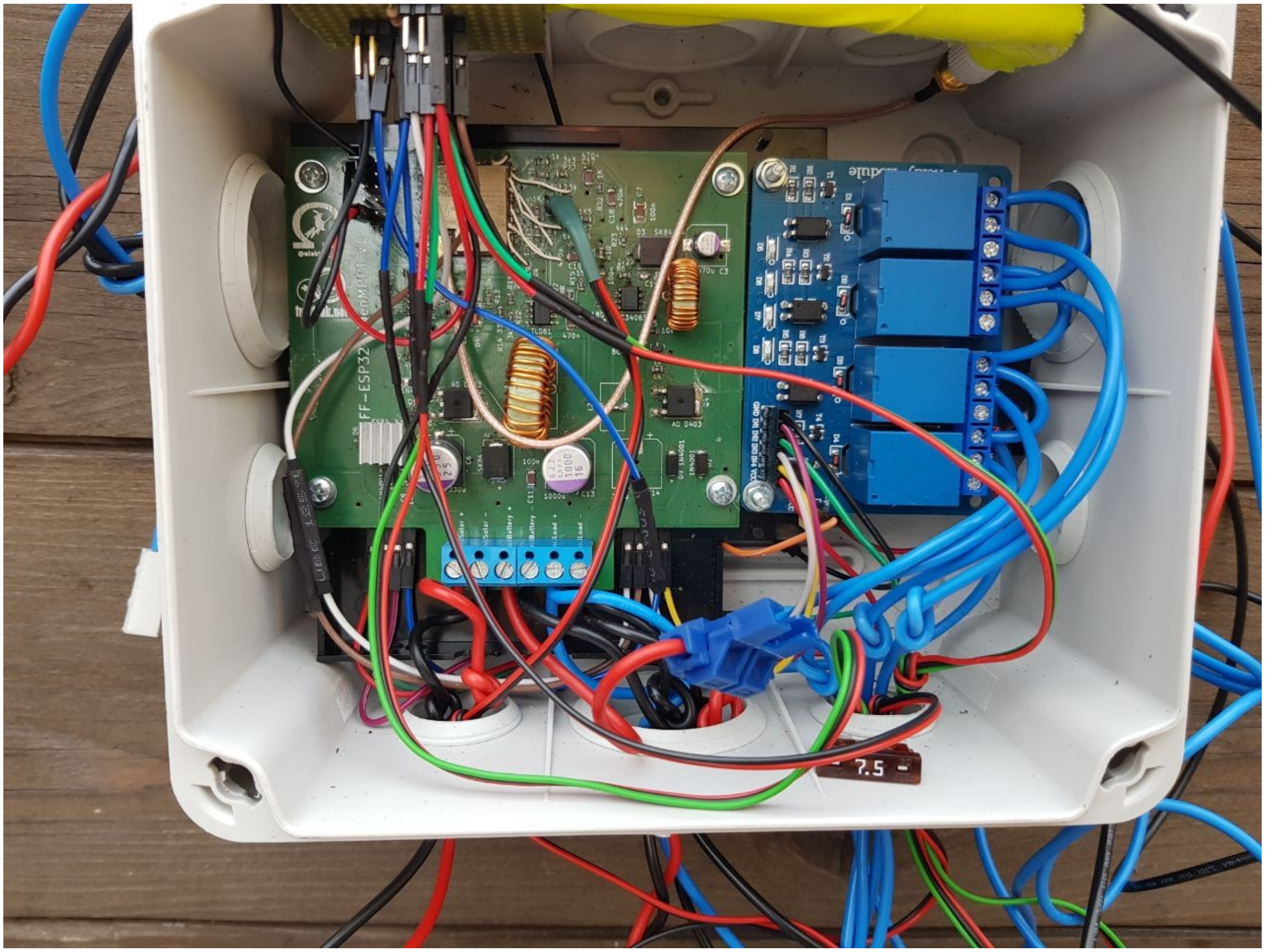

Figure 2: The modified FF-OpenMPPT solar charge controller (green) with a relay board that is controlling the valves (blue). Sensor connectors and tank-gauge series resistor on detachable breadboard (top left). The WiFi antenna is mounted weatherproof inside at the top of the box (behind the yellow tape, top right). The waterproof box is attached with screws to a plant bed wall.

The modified FF-ESP32-OpenMPPT can turn the flow in up to 4 water pipes on and off individually for drip-watering and reads analog data from the water tank gauge sensor, an analog temperature sensor and 2 analog capacitive soil humidity level sensors.

Water is pumped into the system with 12 Volt DC power from the solar battery. The water pump is only powered on during the irrigation process. The OpenMPPT irrigation prototype monitors soil humidity and tank gauge level.

Function of the irrigation program

The best time for irrigation is not too long before dawn, when the soil has cooled down over night and the plants can make best use of a minimal amount of water for irrigation, thus avoiding water vaporing away as much as possible.

Via a WiFi configuration interface the user can set the irrigation time, targeted soil humidity level for each set of valves and associated humiditiy sensor. A maximum irrigation time for each set of valves can also be set from a web browser.

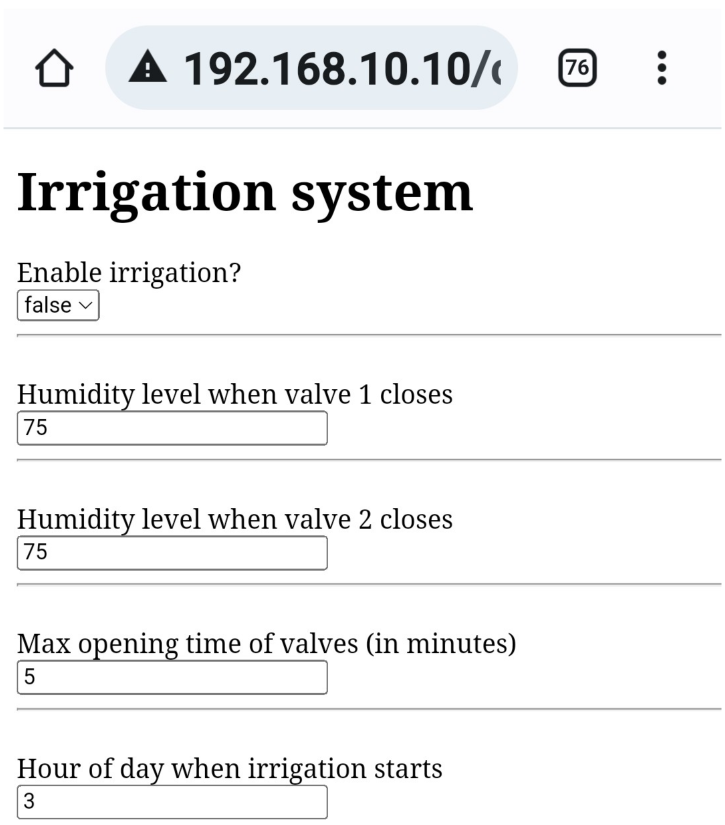

Figure 3: Irrigation section of the configuration web interface.

In this configuration example, the irrigation system will start watering at 3:00 am. The computer stops watering the planting beds behind valve 1 when soil humidity reaches 75% or after five minutes – whatever comes first. Then it will go through the same procedure for the beds behind valve 2 (in our prototype valves 2, 3 and 4 are configured to act together). If the water tank runs dry, the irrigation process will also stop.

Irrigation system diagram:

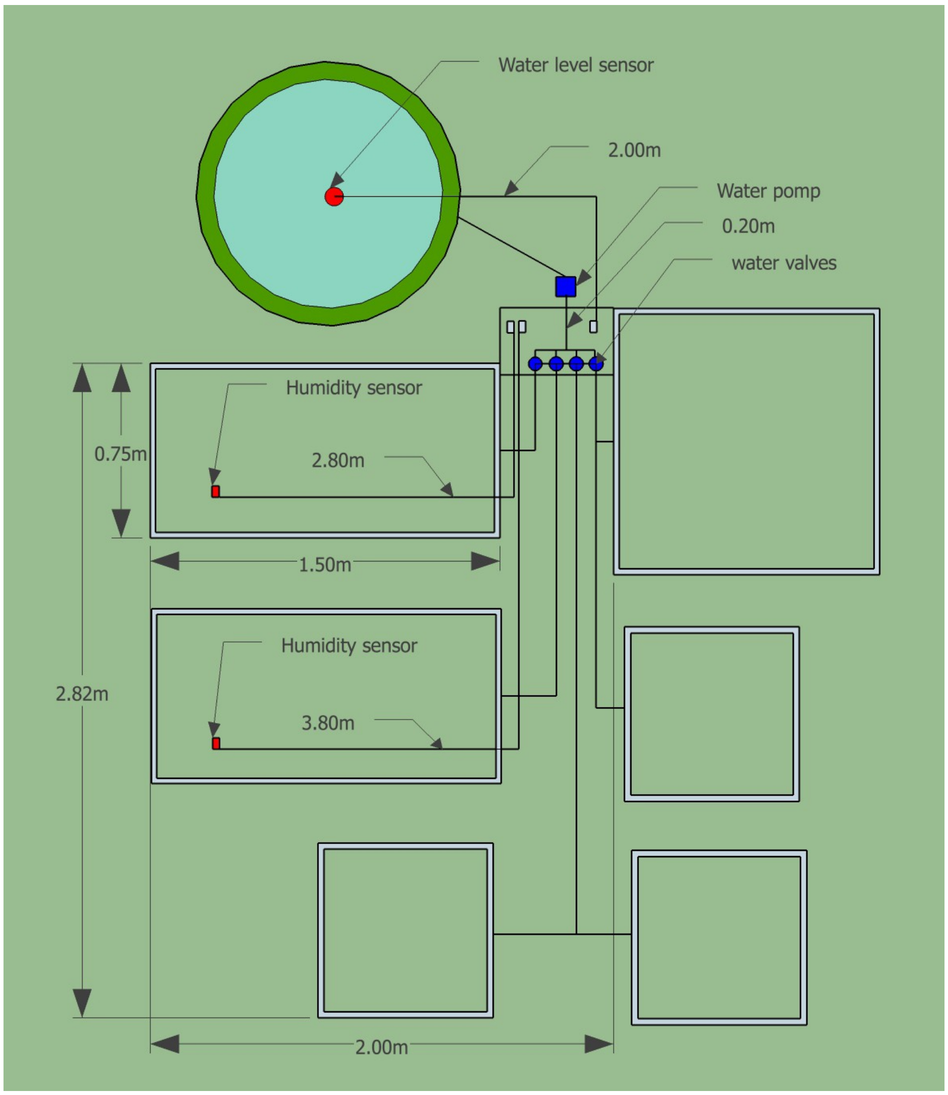

Figure 4: The drip watering outlets.

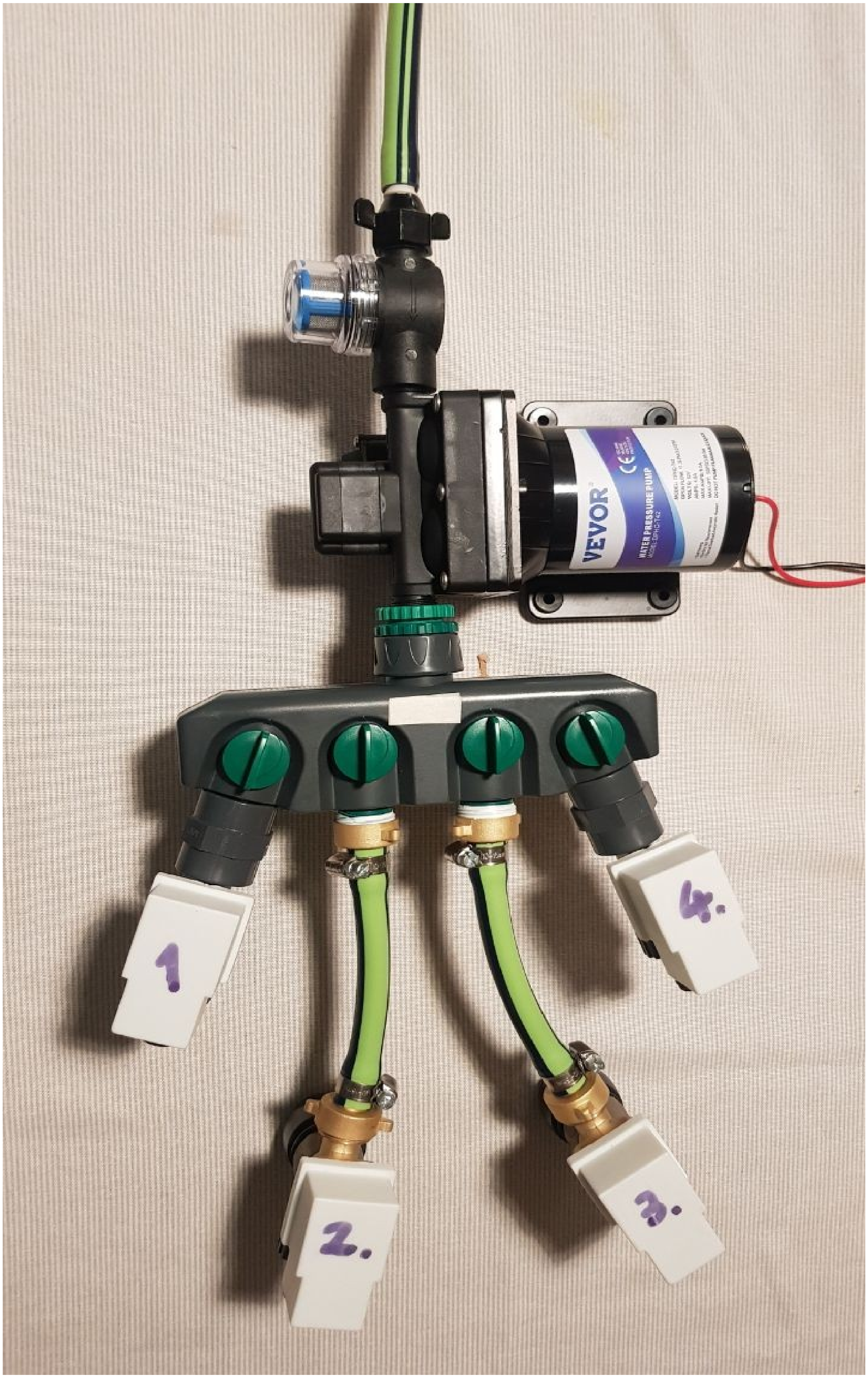

Figure 5: Water pump with pre-filter (top). Manifold 4 x with manual valves (center) and electromagnetic water valves 1 to 4 (bottom).

Figure 6: The electric/electronic part of irrigation computer system before installation. The tank fluid gauge sensor can be seen at the top (black ring = float).

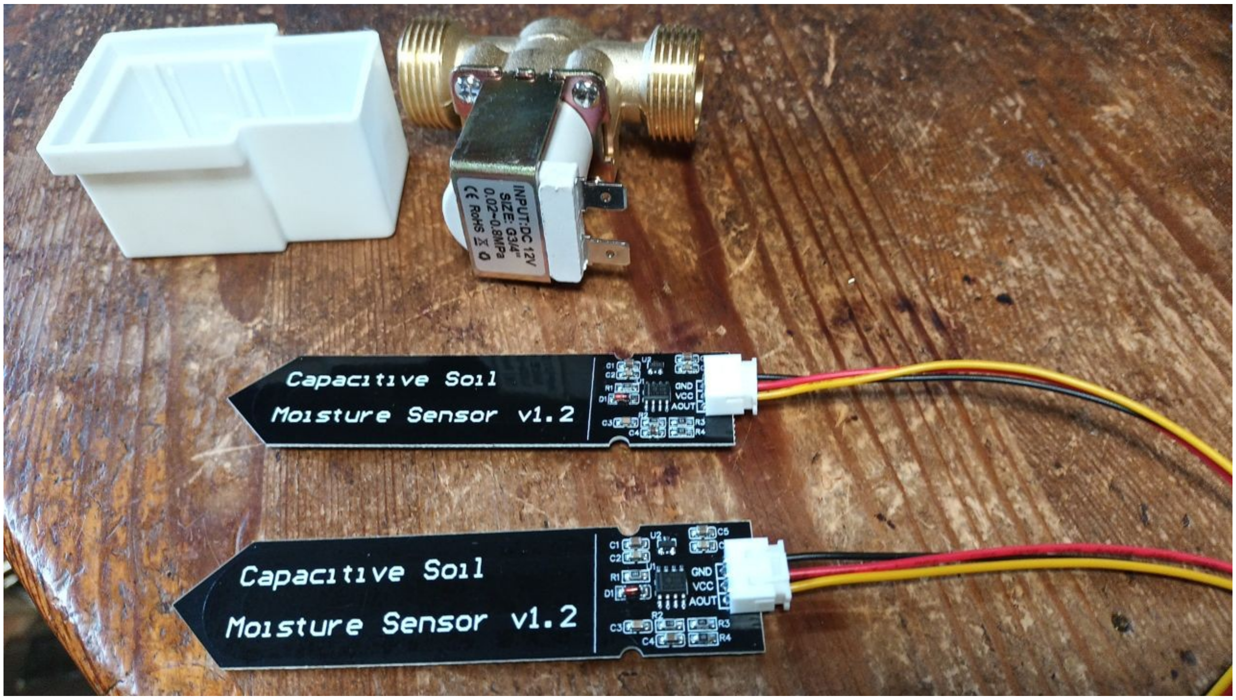

Figure 7: Top: One of the water valves with the plastic cover removed. Bottom: Two capacitive soil moisture sensors. These had to be modified electrically and sealed (water proofed the on board electronics and the edges of the pcb) before deploying them.

Local monitoring and telemetry

The FF-ESP32-OpenMPPT features a local web-interface for configuration, updates and local monitoring. If a local WiFi Internet accesspoint is not available, the OpenMPPT will operate as a local WiFi accesspoint at a fixed IP address (default: 192.168.10.10), but it will not offer Internet access, of course.

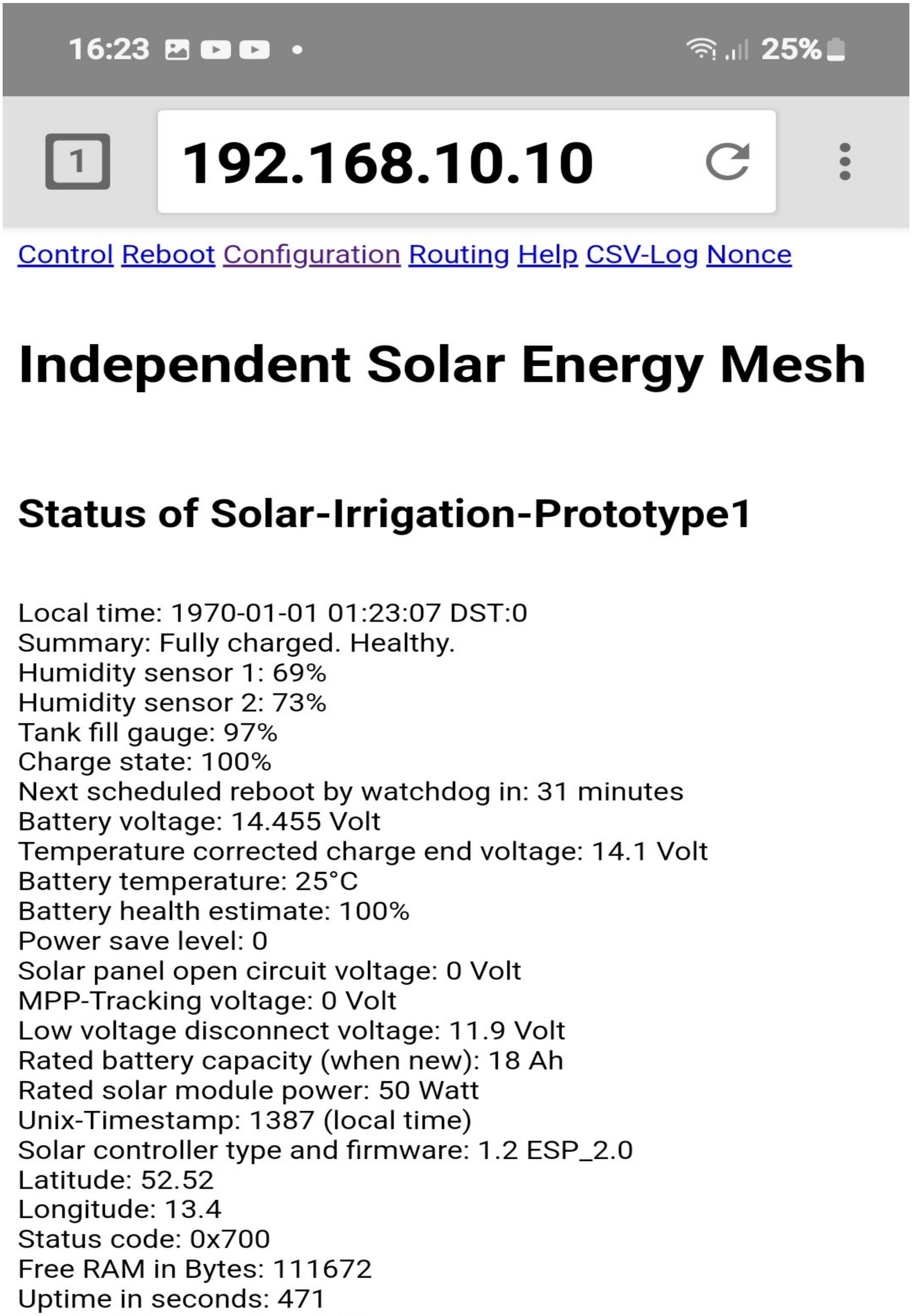

Figure 8: The OpenMPPT status page in offline mode. Note that in offline mode, date and time have to be set manually. In online mode date/time is synced automatically using the NTP protocol.

If a WiFi accesspoint is available, the system will set time and date automatically using the NTP protocol it can be set up to send telemetry data using the MQTT protocol to servers like https://isems.mqtthub.net

If the MQTT telemetry system is enabled, many system parameters can be monitored via the Internet:

Figure 9: Humidity Sensor 1 data graph, recorded during lab testing.

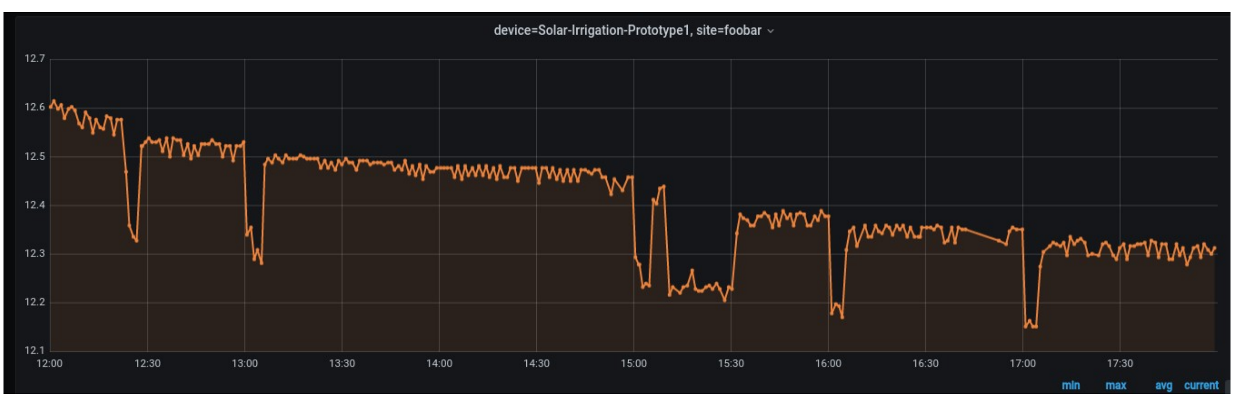

Figure 10: Graph of battery voltage while discharging the battery. The voltage drops in the graph show the time periods when the irrigation valves were turned on. They consume about 4 Watt each.