Politecnico di Torino

Energy management for IoT
01UDGOV

Master's Degree in Computer Engineering

Lab 03
Energy storage, generation and conversion

Group 08

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CHAPTER 1

Assignment 3 - First analysis

In the following section is described the trace of the simulation obtained with the provided schedule (parallel sensors).

1.1 Main features of the simulation: parallel sensors

Until t = 900s the irradiance incident on the panel is not sufficient to generate a current and the system is entirely powered by the battery. This behavior is shown in 1.1

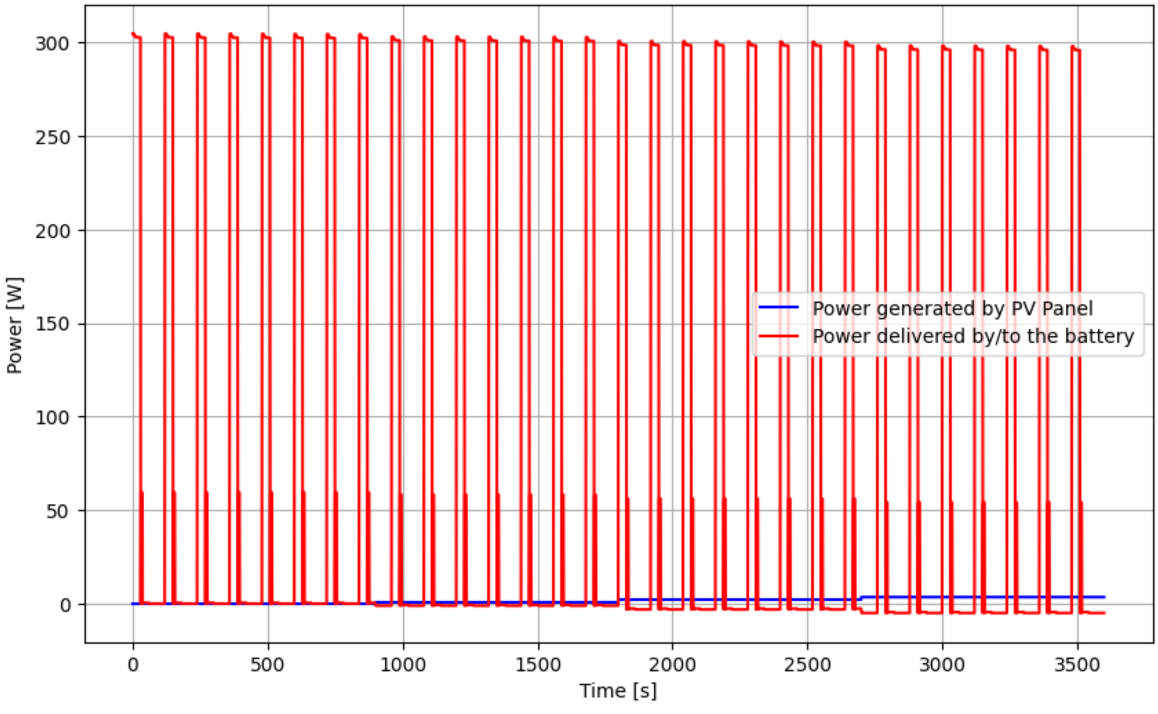


Figure 1.1: Power trace for battery and PV for the first 30T

Zooming into the plot to isolate a single period (T=120s) 1.2 shows that in the parallel execution all the sensors are active at the same time leading to a current draw from the battery of about 66.7 mA during the active state. After t=T+30s memory and controls are activated for 6s and then transmission with the RF ZigBee module takes 0.1mA for 24s. Around t=T+60s the current drawn from the system is nearly zero. A sequential approach could be used to activate the sensors at different t in order to fully utilize the period T and in this case some constraints should be introduced to ensure that memory, control and transmission operations run on the same period T.

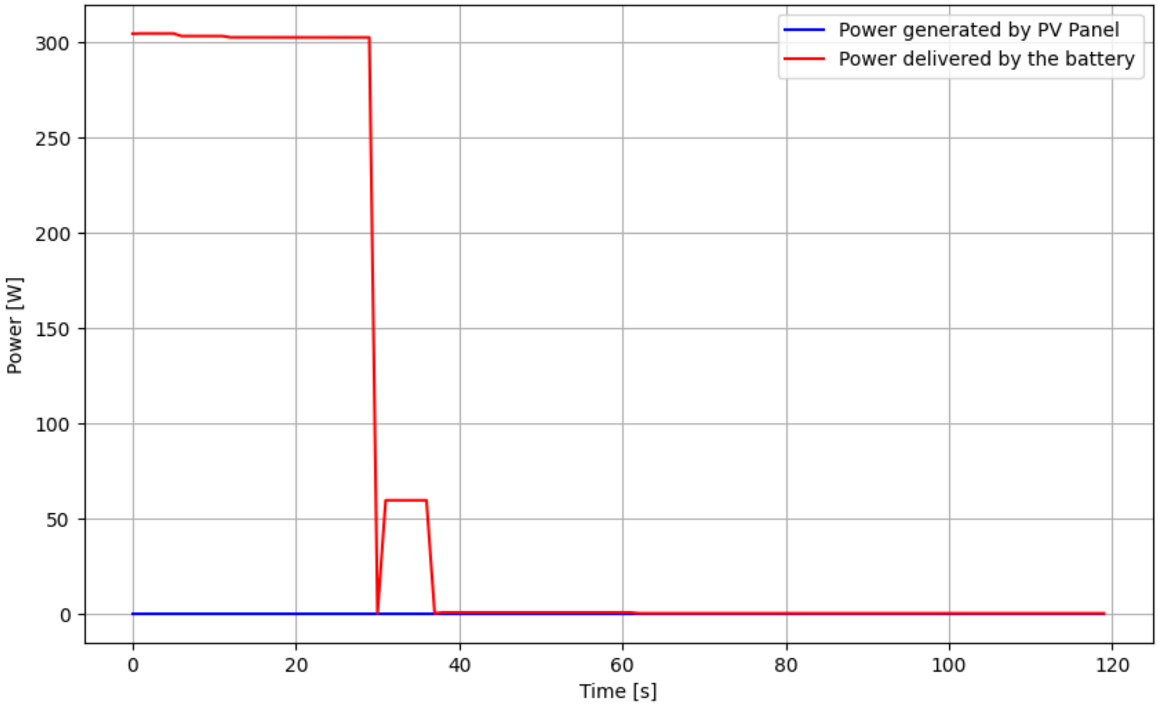


Figure 1.2: Power trace for battery and PV for the first T

By shifting the plot between 40T and 80T 1.3, we observe an increase in the power generated by the PV panel, which reduces the power requested to the battery powering the sensors during execution. Additionally, during idle periods, the battery is recharged by this power supplied by the panel.

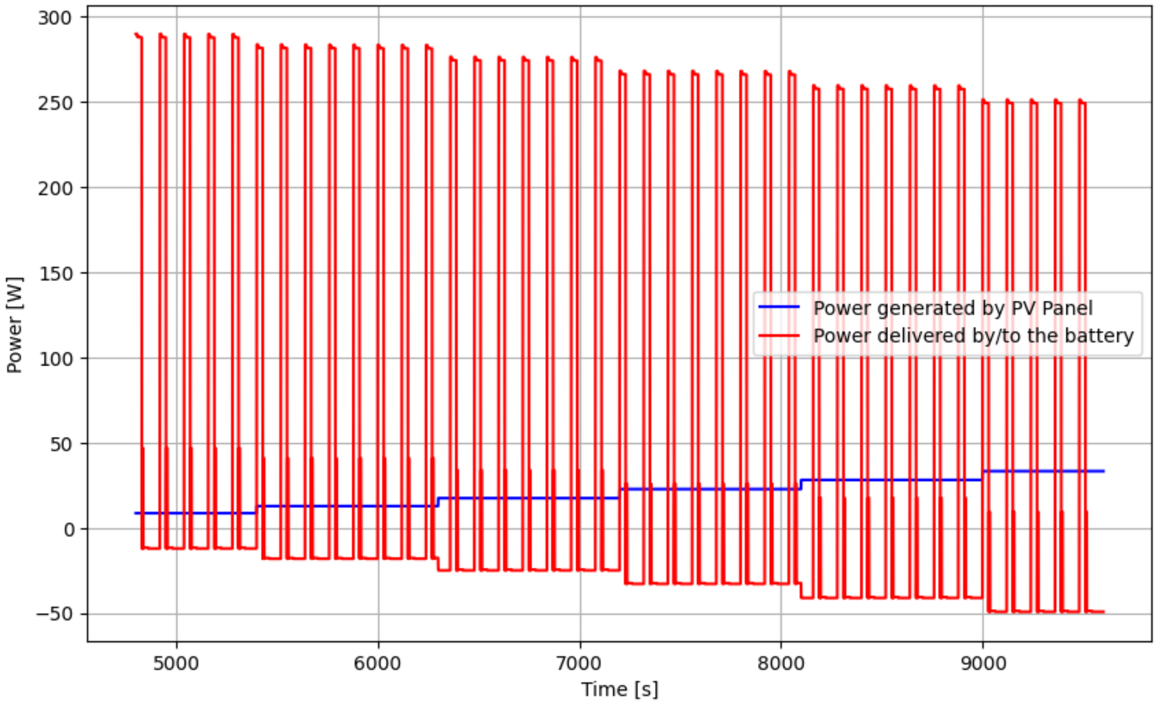


Figure 1.3: Power trace for battery and PV between 40T and 80T

As the simulation progresses toward its conclusion, we observe the battery's state of charge (SoC) 1.5 gradually approaching zero. During the inactive state when some power is provided by the PV 1.4, the SoC increases, followed by a gradual discharge during the sensors' active periods.

In a parallel execution the battery is always used because the panel does not provide enough energy to power alone the system, but it is useful to recharge the battery during sensors' inactive states.

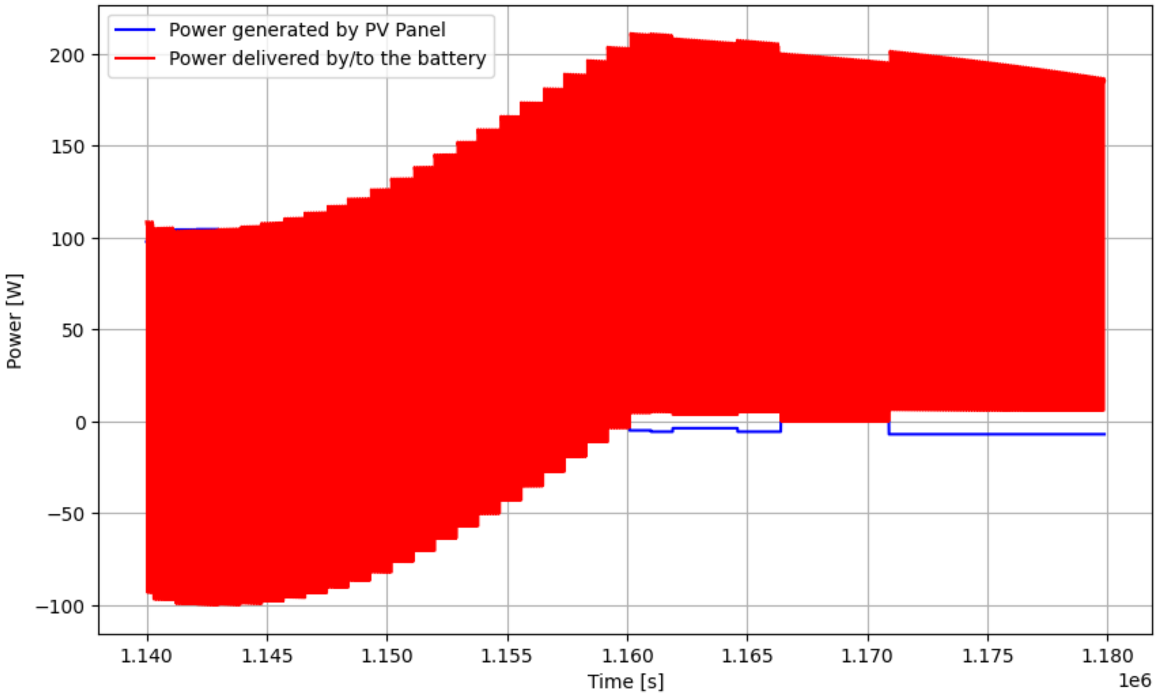


Figure 1.4: Power trace for battery and PV end of the execution

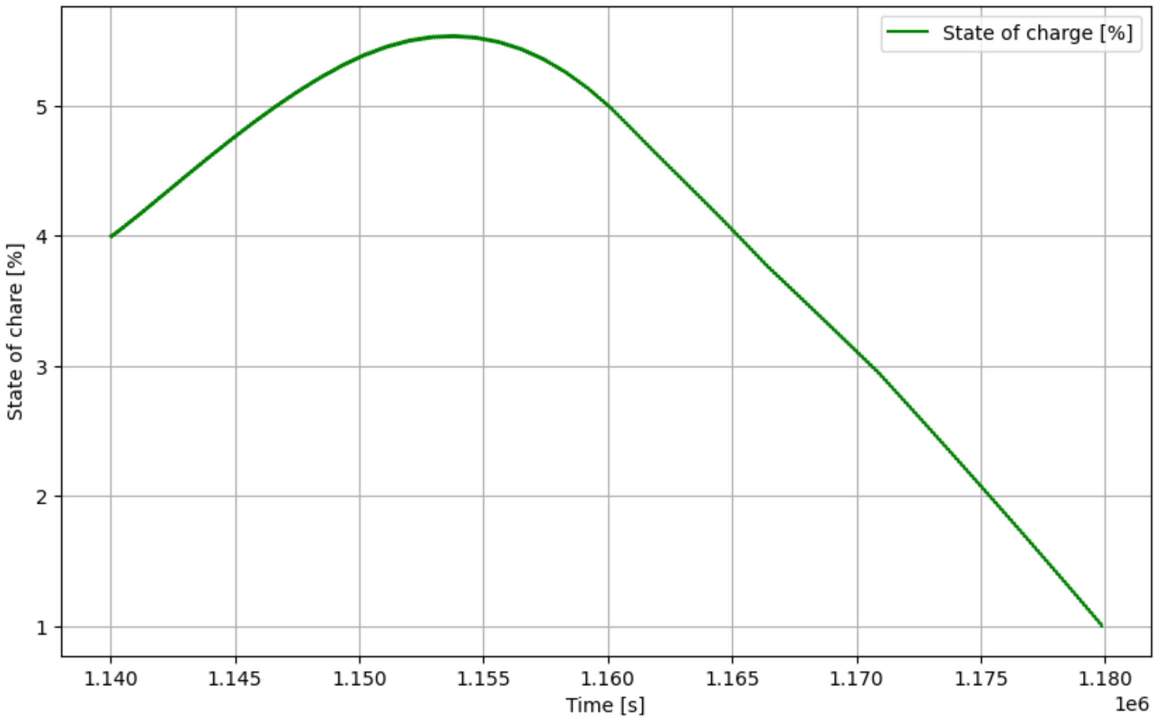


Figure 1.5: State of Charge at the end of the execution

CHAPTER 2

Assignment 3 - Second analysis

In this chapter a sequential scheduling of the sensors is used.

2.1 Sequential scheduling

From the slides

Sensor	Active Time (s)
Air quality sensor	30
Methane sensor	30
Temperature sensor	6
Mic click sensor	12
ZigBee transmission	24
Memory and control	6

Table 2.1: Sensor Active Times

If a fully sequential schedule is used, the worst case execution took 108s, that is still lower than a period T=120s. So the first hypothesis is to schedule the loads as described in 2.2

Memory, control and transmission are not controlled by the configuration but are executed by the simulator after the execution of the sensors is completed.

Sensor	Active Time (s)	Start Time (s)
Air quality sensor	30	0
Methane sensor	30	30
Temperature sensor	6	60
Mic click sensor	12	66
Memory and control	6	78
ZigBee transmission	24	84

Table 2.2: Sequential schedule

The scheduling is better shown in 2.1 As expected, the total peak current requested from the loads during the active time is lower compared to the parallel execution (48.2mA vs. 66.6mA), as shown in figure 2.2. This kind of scheduling allows in some periods both to power the loads and charge the battery with the power provided by the PV panel, as shown in 2.3 and 2.4. In doing so,

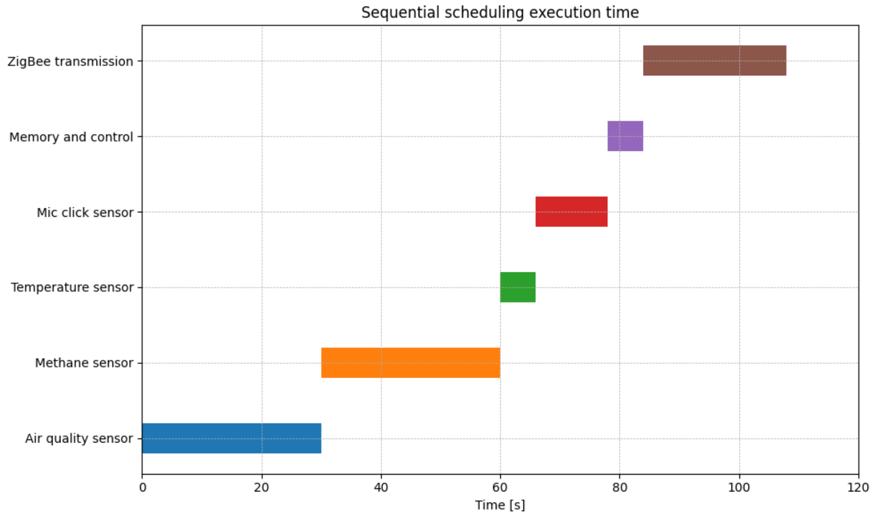
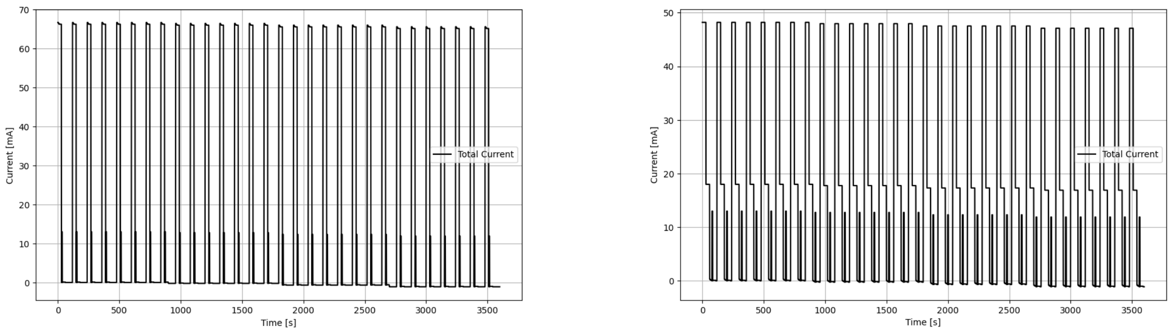


Figure 2.1: Sequential scheduling

the battery lifetime is extended, and the simulation runs for 1180252s compared to 1179869s of the parallel schedule.



(a) Total current in parallel execution

(b) Total current in sequential execution

Figure 2.2: Comparison of total current in parallel and sequential execution

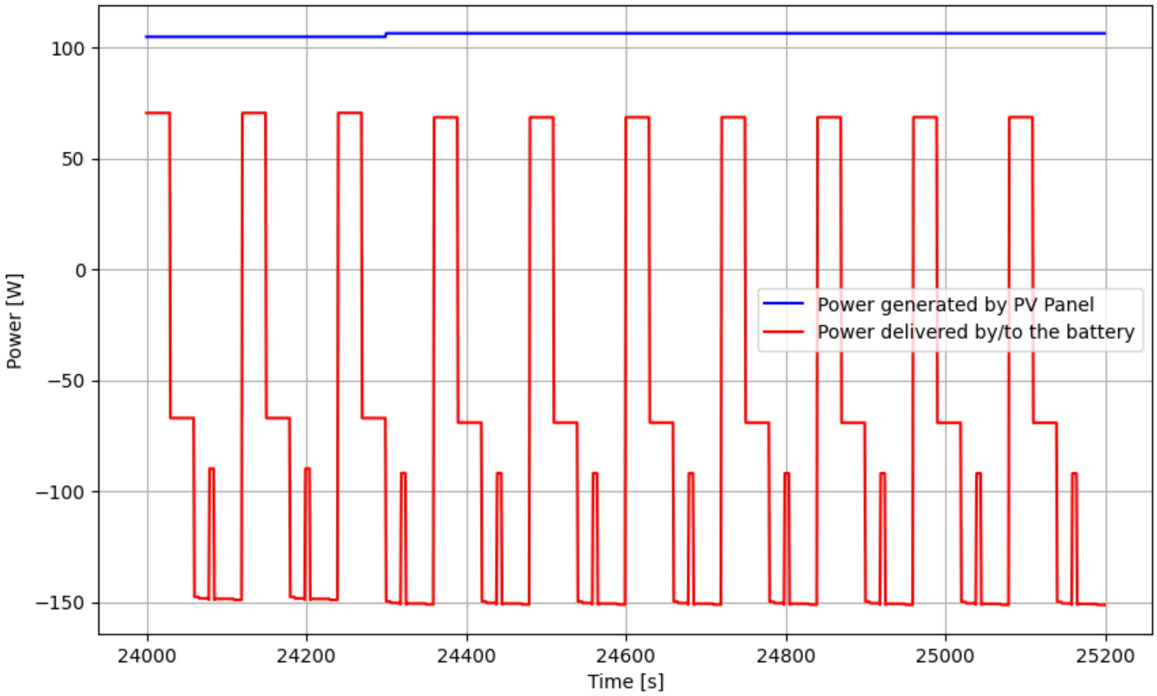


Figure 2.3: PV and battery powers between 200T and 210T in sequential scheduling

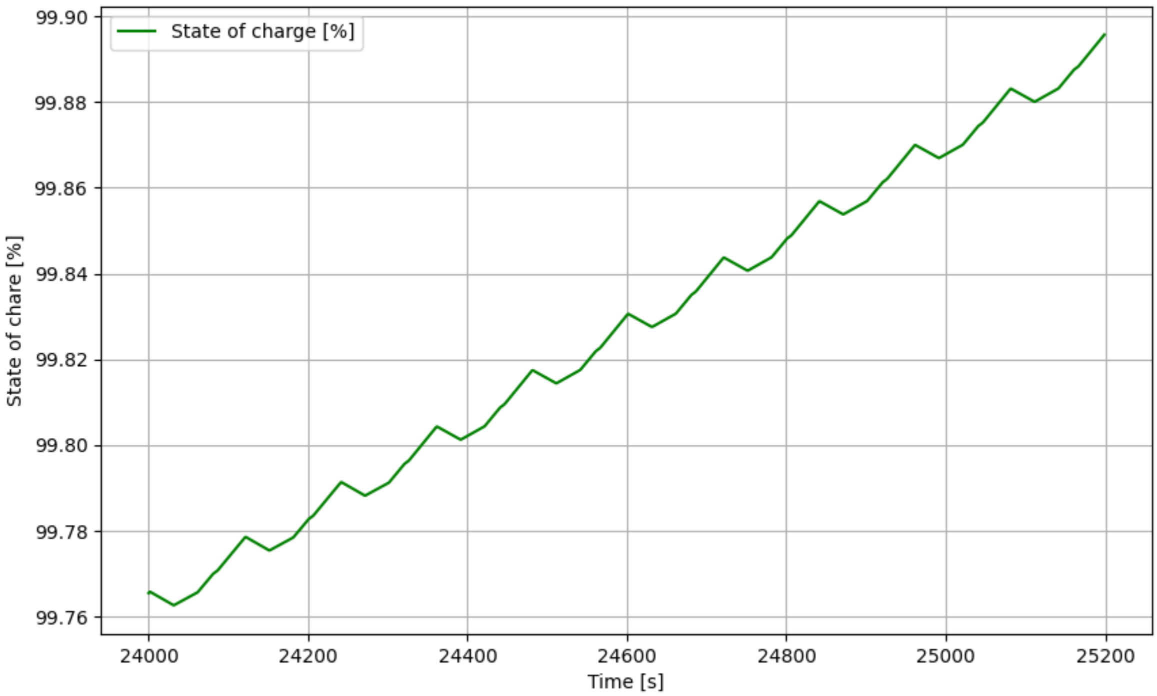


Figure 2.4: State of charge between 200T and 210T in sequential scheduling

CHAPTER 3

Assignment 3 - Third analysis

CHAPTER 4

Appendix

4.1 Sequential execution


```
{
"sim_step" : 1,
"sim_len": 7736400,
"period" : 120,
"vref_bus" : 3.3,
"soc_init" : 1.0,
"selfdisch_factor" : 0.0,
"sensors" : [
    {
        "name": "air_quality_sensor",
        "current_on": "48.2",
        "current_idle": "0.002",
        "activation_time": "0",
        "time_on": "30"
    },
    {
        "name": "methane_sensor",
        "current_on": "18",
        "current_idle": "0.002",
        "activation_time": "30",
        "time_on": "30"
    },
    {
        "name": "temperature_sensor",
        "current_on": "0.3",
        "current_idle": "0.002",
        "activation_time": "60",
        "time_on": "6"
    },
    {
        "name": "mic_click_sensor",
        "current_on": "0.15",
```

```
        "current_idle": "0.002",
        "activation_time": "66",
        "time_on": "12"
    }
],
"mcu" : {
    "states":[
        {
        "name": "ON",
        "current": "13",
        "time_on": "6"
        }
    ],
    "current_idle": "0.002"
},
"rf" : {
    "states":[
            {
        "name": "ON",
        "current": "0.1",
        "time_on": "24"
        }
    ],
    "current_idle": "0.001"
    }
}
```