Stand alone DC nano-grid for a Tiny House with Droop Control

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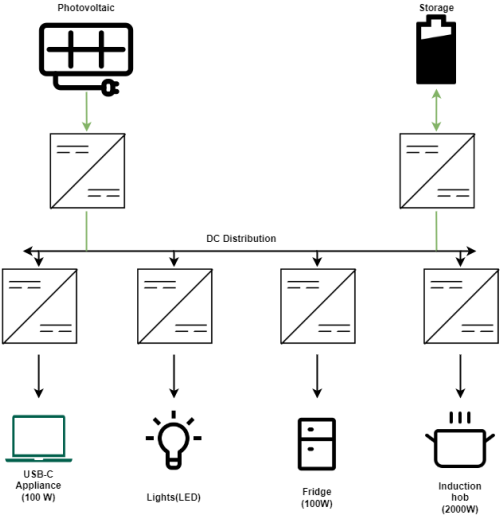
Introduction

Task: Develop a Stand-Alone DC nano-grid for a Tiny House

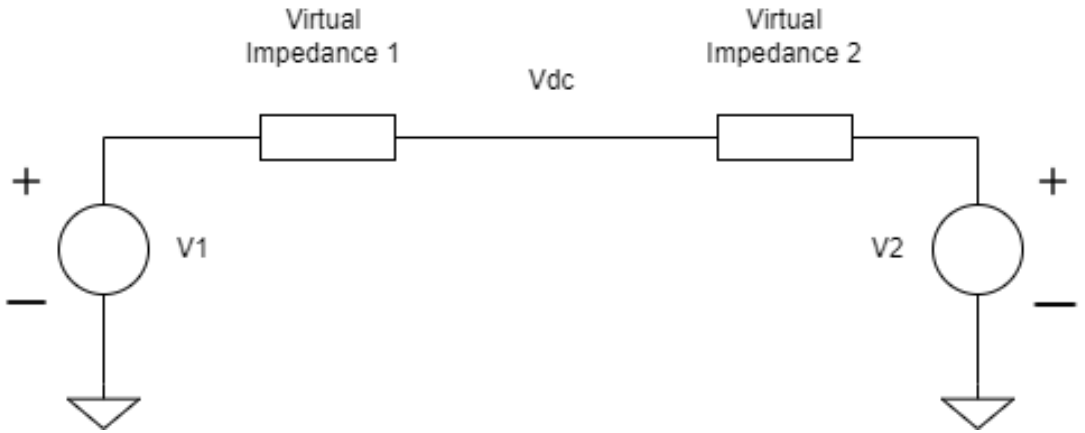
- Solar, Battery and consumers
- Safe for students ($< 48 volt$)
- No Grid connection
- Remote operation and monitoring

DC Nano Grid



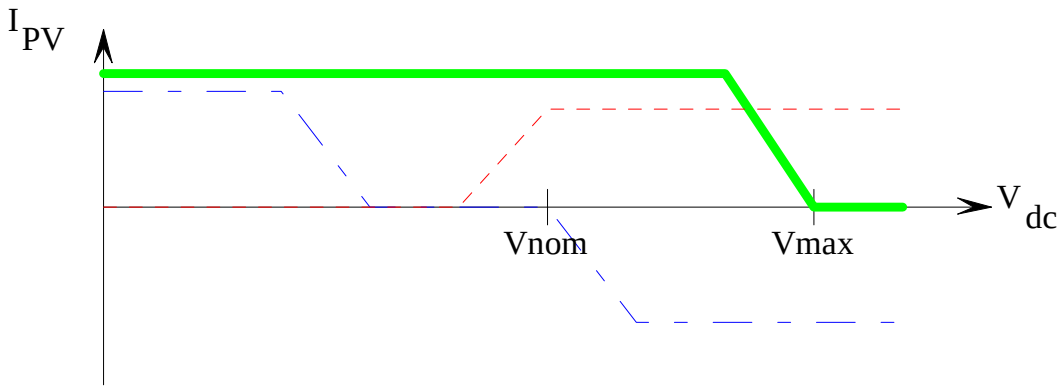
Schematic of the DC nano grid

Droop Control



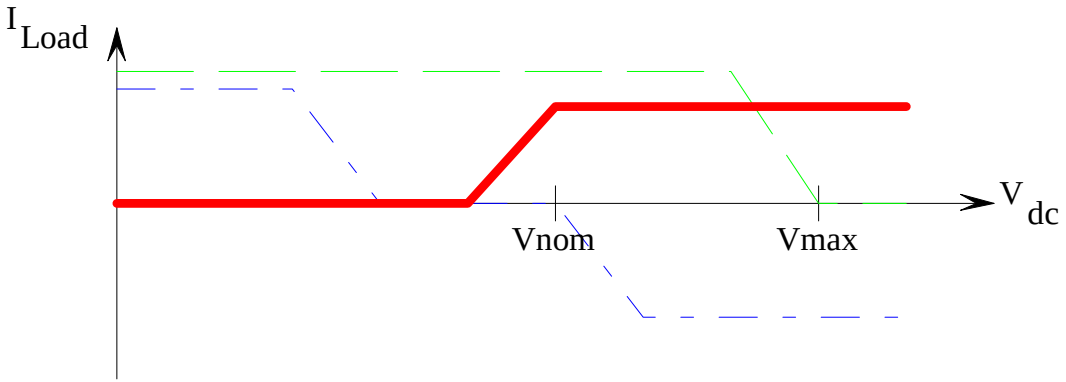
Simplified version of droop control

Droop Control



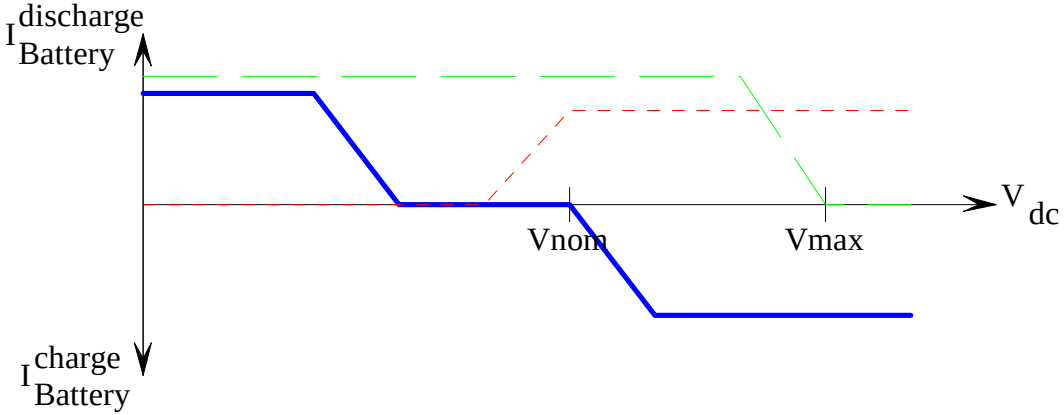
Droop curves for the PV

Droop Control

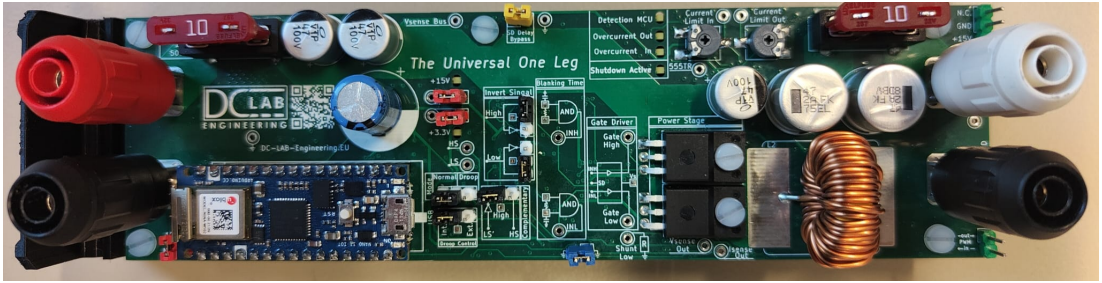


Droop curves for the appliance

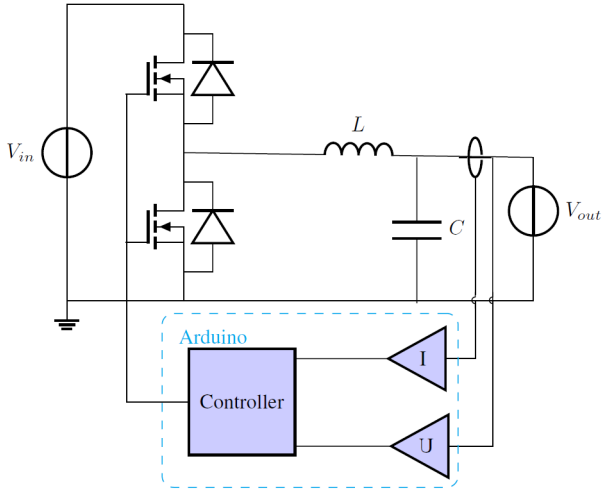
Droop Control



Droop curve for the battery

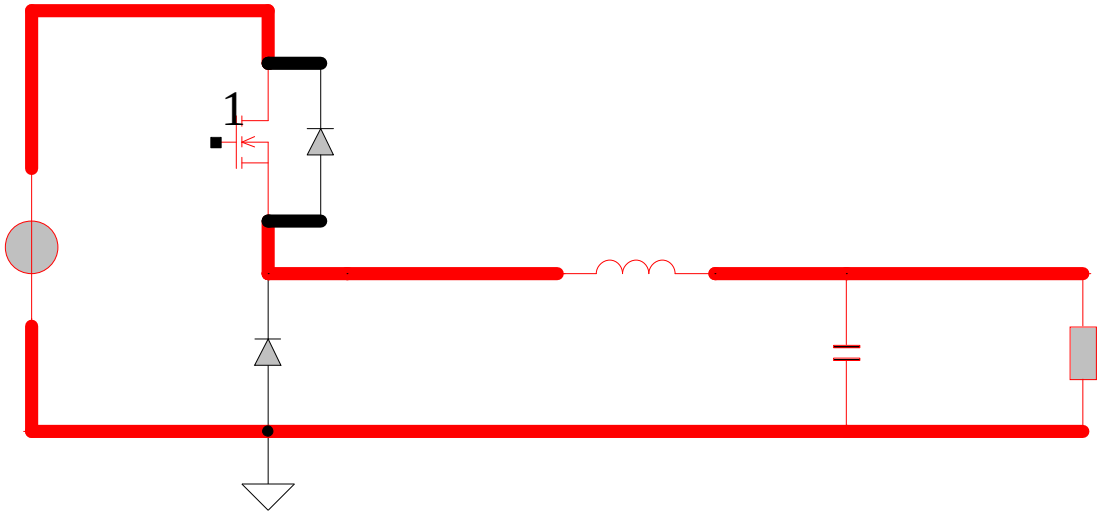


Universal One Leg



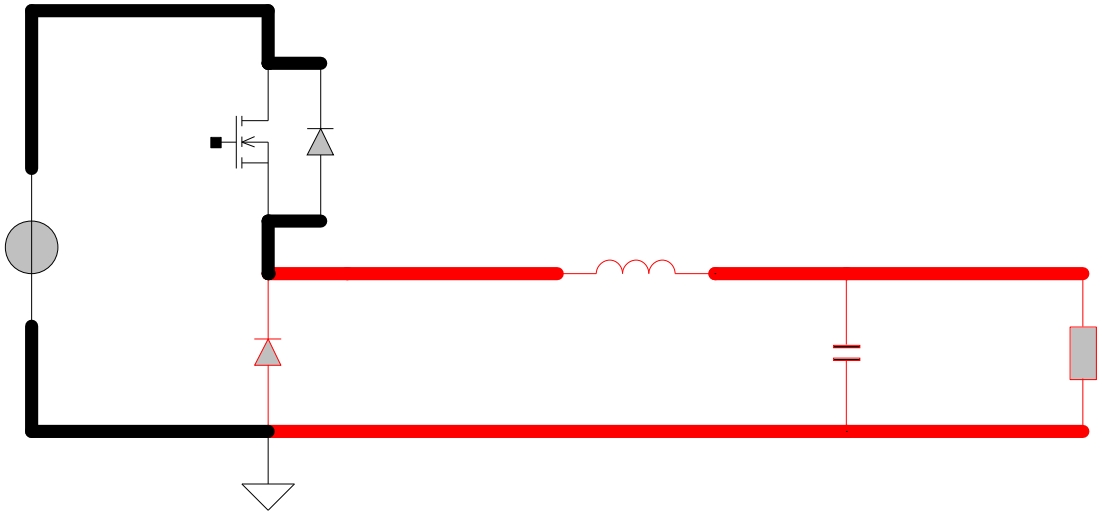
Schematic of the Universal One Leg

Control

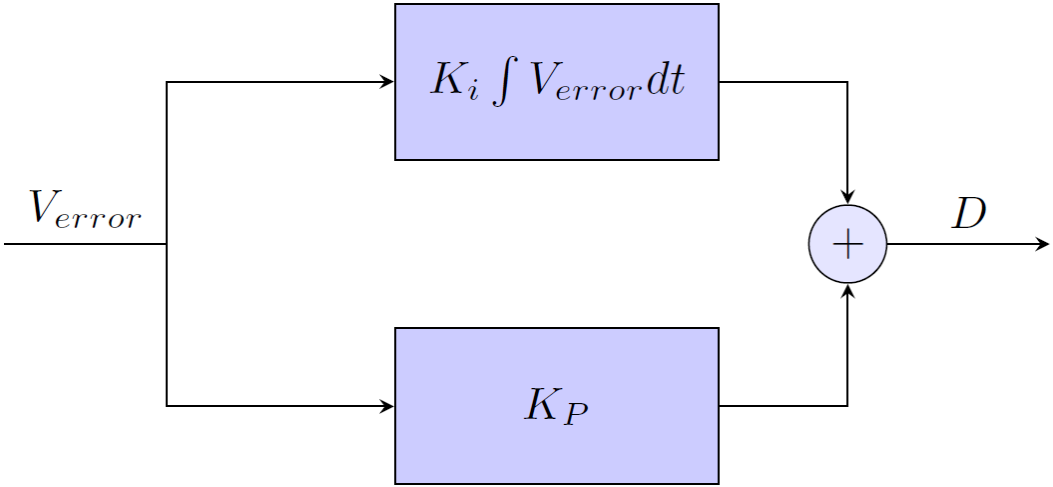


Inductor charging state

Control



Inductor discharging state



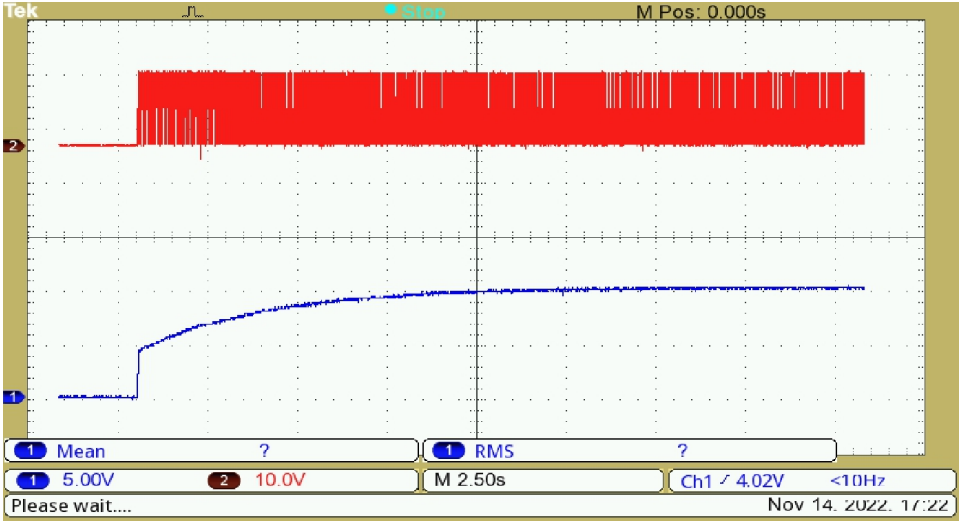
Schematic of the PI controller

Control

```
1  void PIcontrol_buck(float goal,
       float duty, float vbus, float
       vsense){
2
3    static float error=0;
4    static float K= -;
5    static float tau= -;
6    static float pwm_pi=duty;
7    static float integral=0;
8    static float output=0;
9
10   error= (goal-vsense);
11   integral += (K*tau)*(error);
12   output = (K*error) + integral;
13
14   pwm_pi=  output;
15   }
```

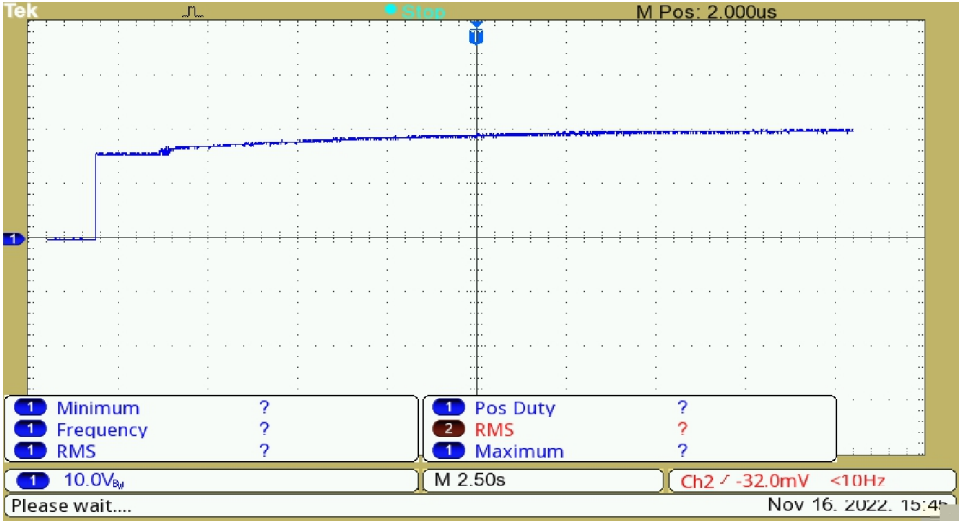
PI controller code

Control



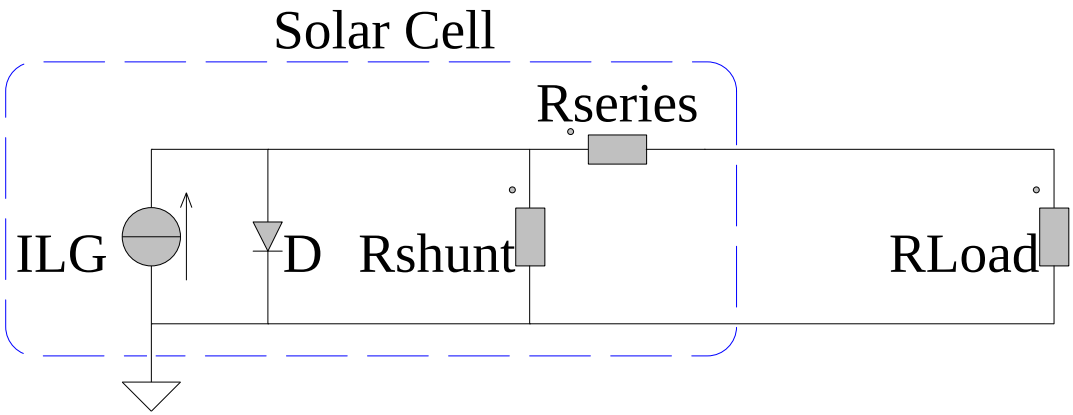
PI Buck

Control



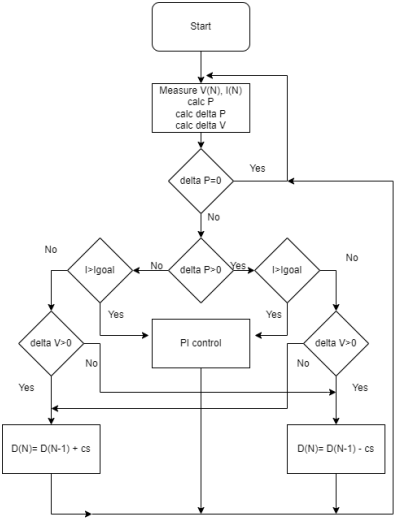
PI Boost

Solar Panel model



Electronic representation of the PV

MPP Control



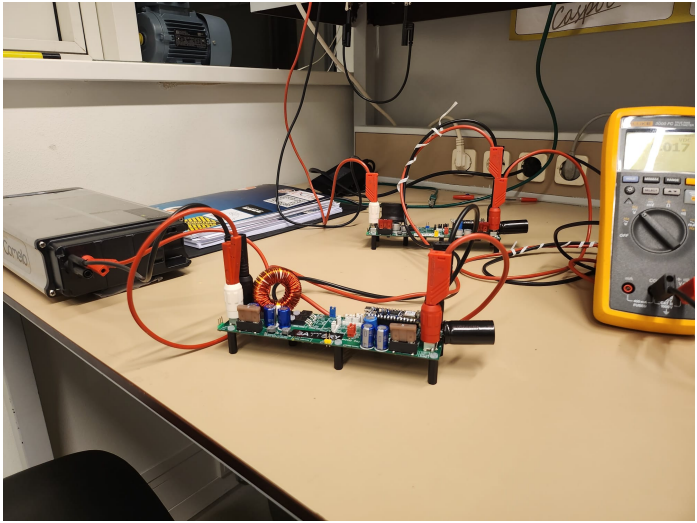
MPP control Algorithm

$$\left.\begin{array}{rl} CS3 = \alpha \times \Delta P(K) & \text{if } (\Delta V(K) \times \Delta I(K)), \\ CS2 = \beta & \text{if } (\dfrac{\Delta P(K)}{\Delta V(K)}) >= \gamma, \\ CS1 = \lambda & \text{otherwise} \end{array}\right\} \text{=CS(K)}$$

$$\alpha, \beta, \gamma \quad \text{and} \quad \lambda \quad \text{are defined empirically.}$$

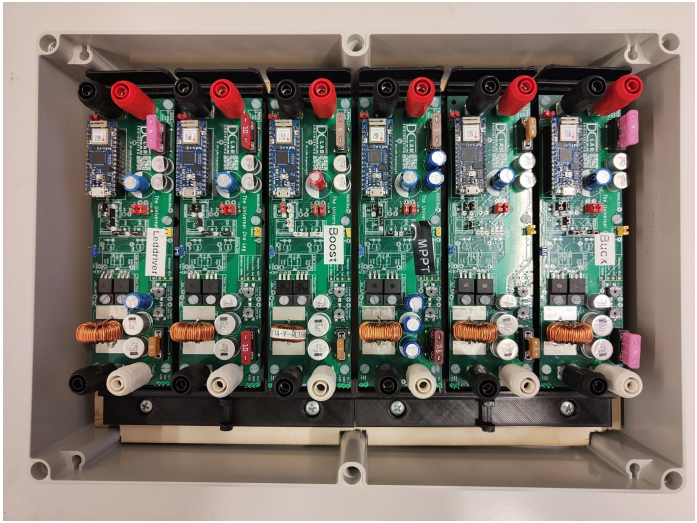
Current Step Size in the MPP control

Test Setup



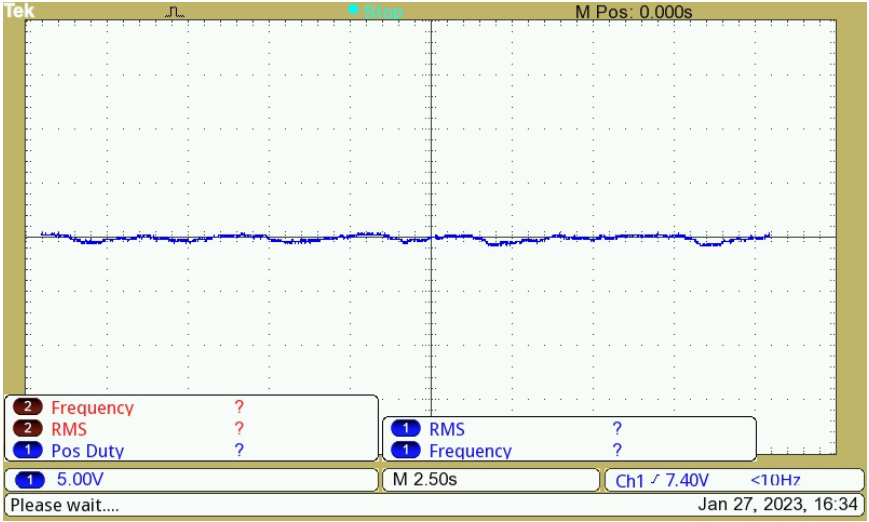
Battery and PV test setup

Implementation



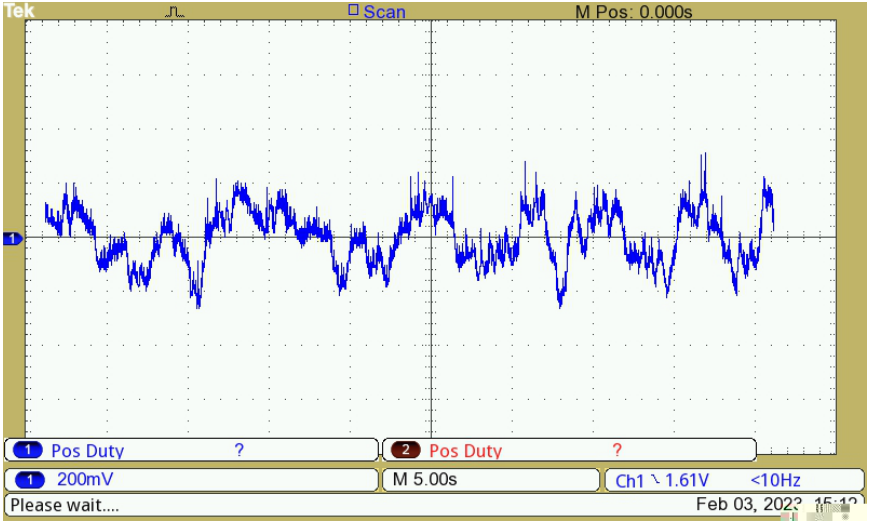
Grid Manager

Experimental Result



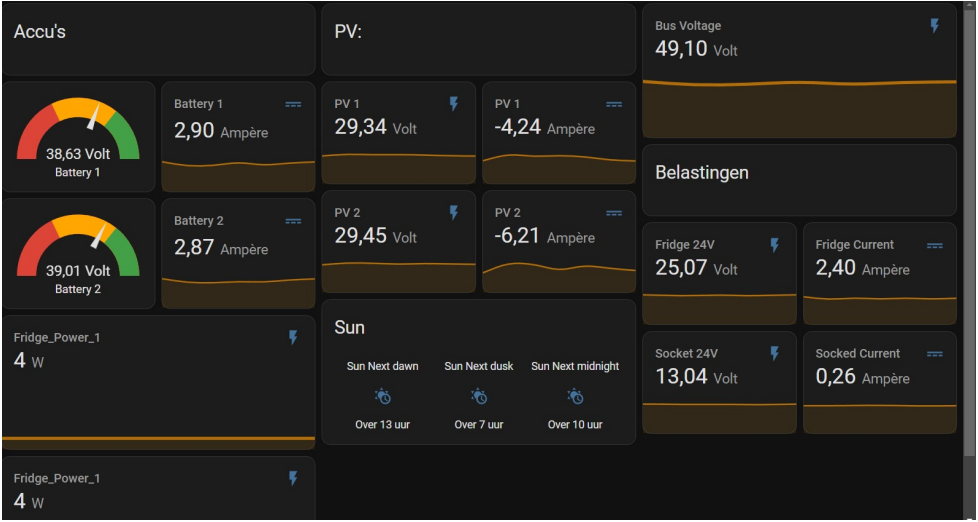
DC coupled measurement of the dc grid voltage

Experimental Result



AC coupled measurement of the dc grid voltage

Outlook



Remote operation and Monitoring(2024)

Conclusion

- DC nano Grid (Grid Manager)
- Especially designed for droop control using power electronics
- Stand Alone Operation

Thank you!
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