Technical University of Cluj-Napoca
Faculty of Automation and Computer Science

Project:

DC STABILIZED SWITCHED MODE POWER SUPPLY

C.

The Controllers design

2023-2024

C.1. Controller design

For the project we had to use two different kinds of controllers:

- **Proportional**
- **Proportional-Integral**

The transfer function of the fixed part:

$$H_f(s) = \frac{1}{2A} \cdot \sqrt{2} \cdot k_u \cdot \widetilde{U}_2 \cdot \frac{1}{LCs^2 + \frac{L}{R_s}s + 1} = \frac{0.6894}{6.49 \cdot 10^{-7} \cdot s^2 + 0.002596\, s + 1}$$

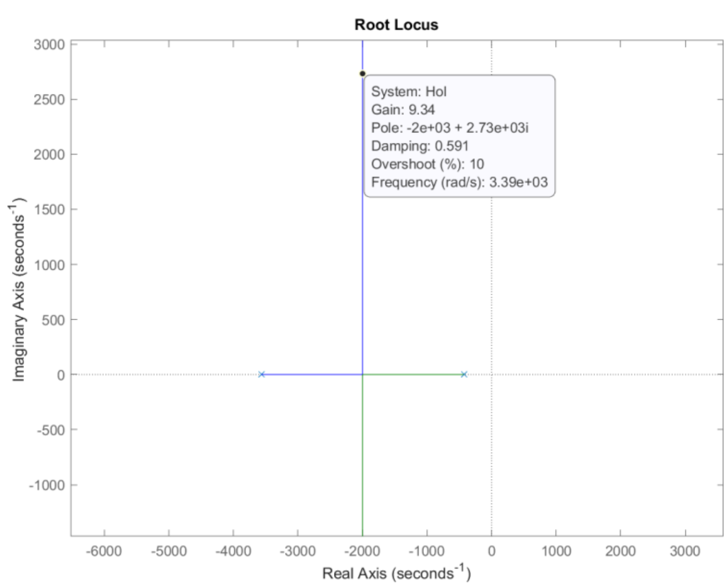
C.1.1 Proportional Controller Design

Because H_f has two real negative a P controller will not ensure a steady state error $\varepsilon_{ss} = 0$.

We will impose the following performance characteristic for the overshoot σ:

$$\sigma = 10\%$$

We can use the root locus of the fixed transfer function to tune our controller:



Therefore the value for $kp = 9.34$

C.1.2 Proportional-Integral Controller Design

We will impose the following performance characteristic for the overshoot σ:

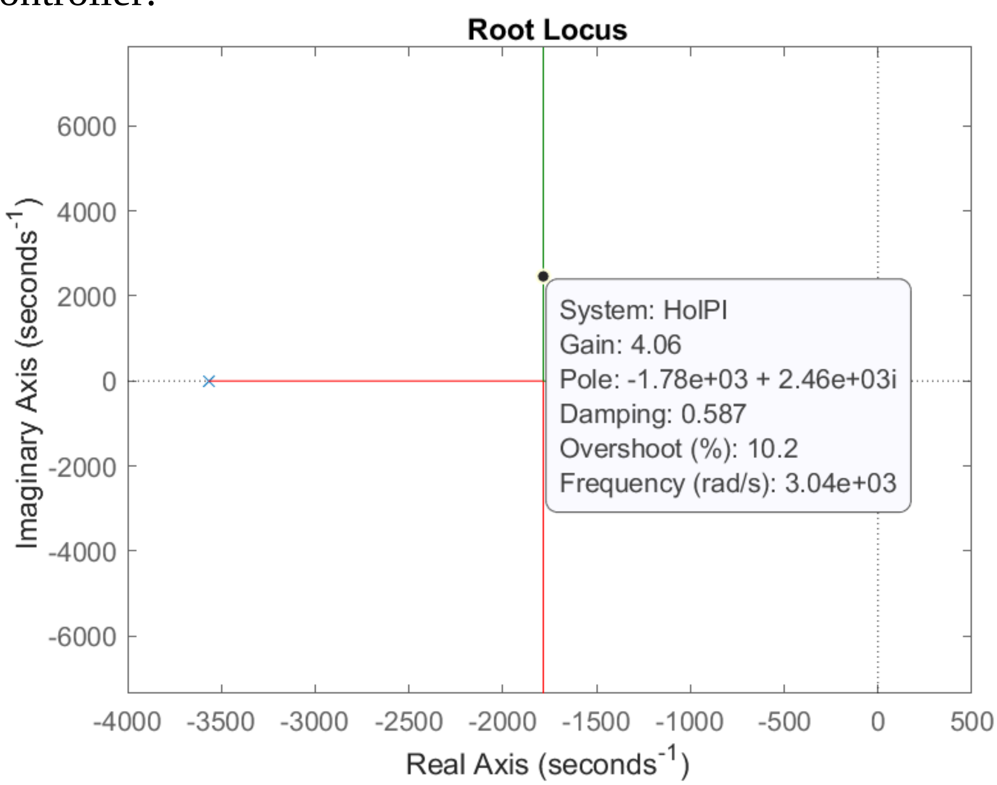
$$\sigma = 10\%$$

The controller transfer function will be:

$$H_c(s) = k_p \cdot \frac{1 + T_i \cdot s}{T_i \cdot s}$$

We will take $T_i = {}^{1}/_{432}$ witch is the dominant time constant in our process and we will cancel it.

We can again use the root locus of the fixed transfer function to tune our controller:



Therefore the value for $kp = 4.06$ and $T_i = {}^{1}/_{432}$.

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D.

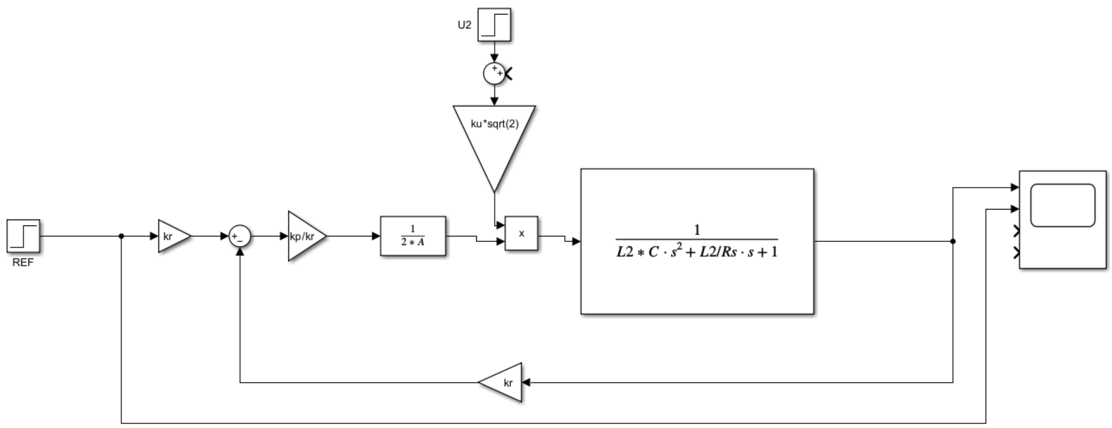
The simulation of the stabilized DC power supply

2023-2024

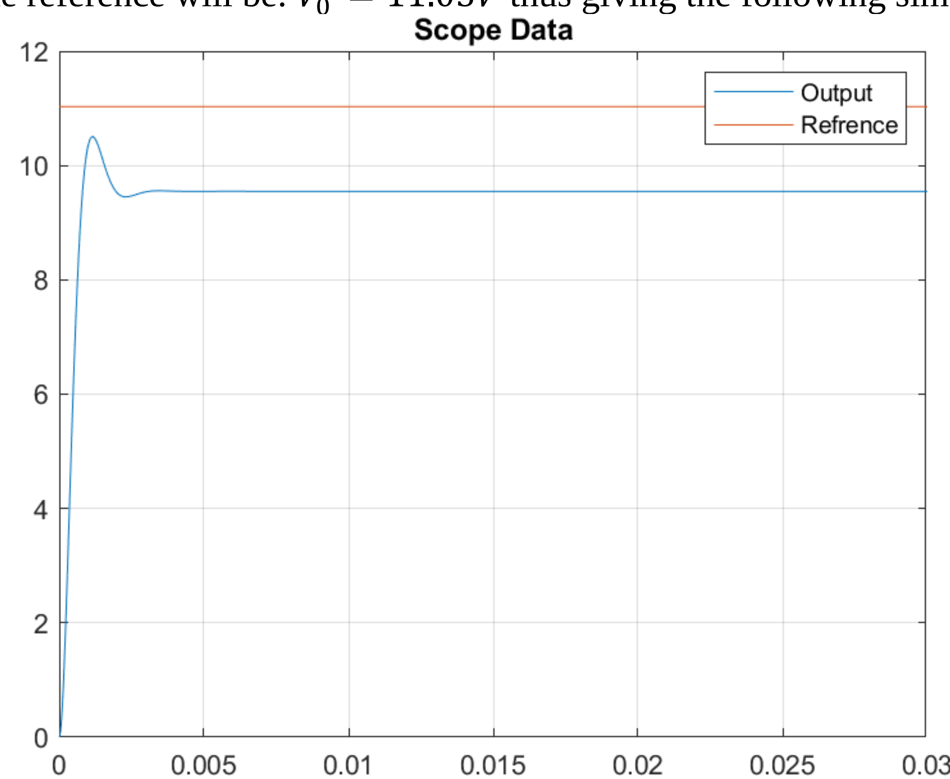
D.1. Step response

D.1.1 Step response on the P controller:

We have the following simplified mathematical model of the DC power supply:



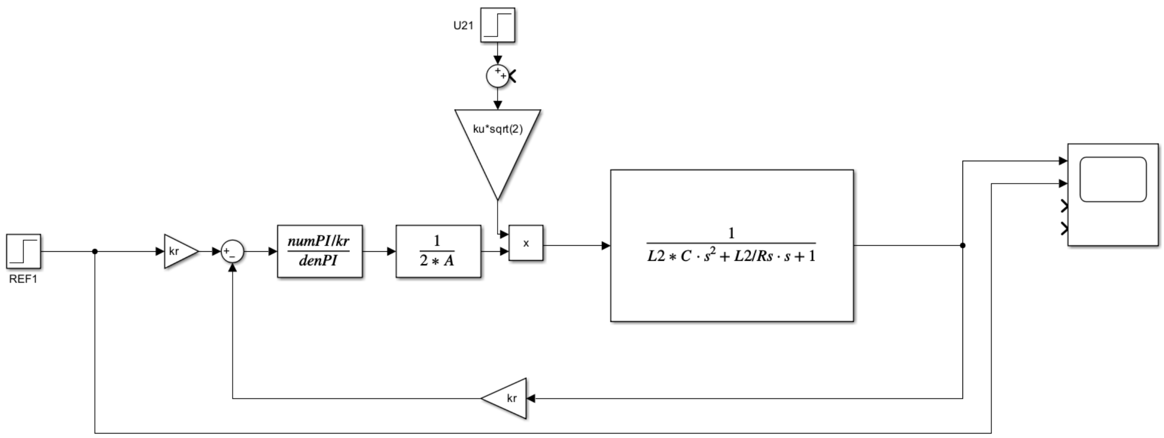
The reference will be: $V_0^* = 11.03V$ thus giving the following simulation:



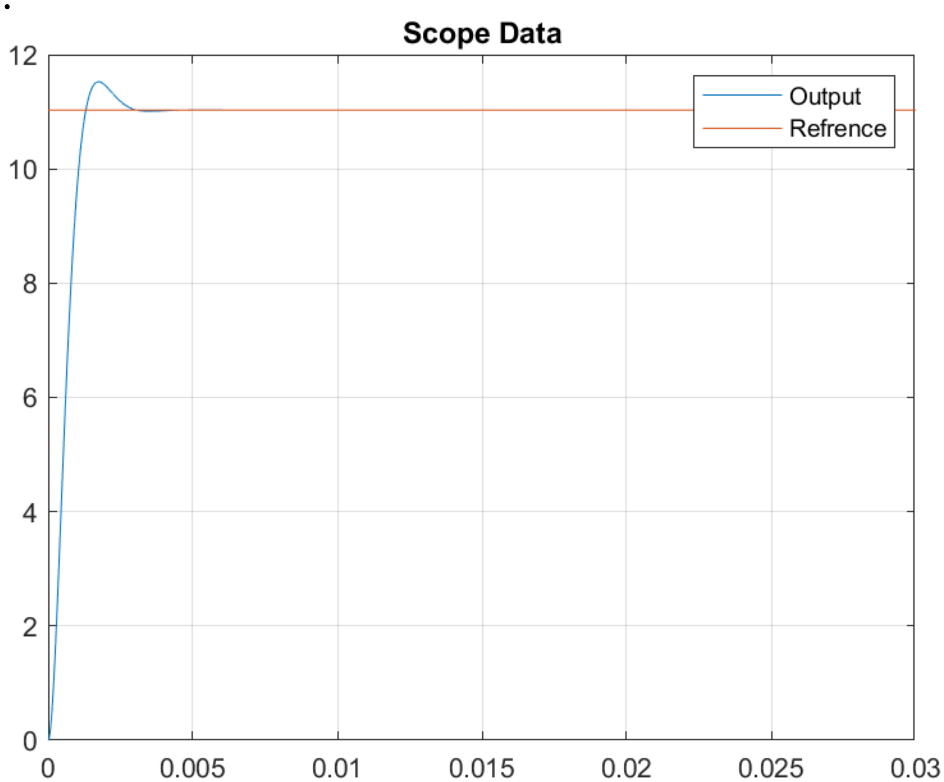
The output has an overshoot of: $\sigma = 10\%$ and a steady state error of: $\varepsilon_{ssp} = 15{,}71\%$.

D.1.2 Step response on the PI controller:

The simplified mathematical model of the DC power supply is:



With the same reference voltage as before we have the following response:

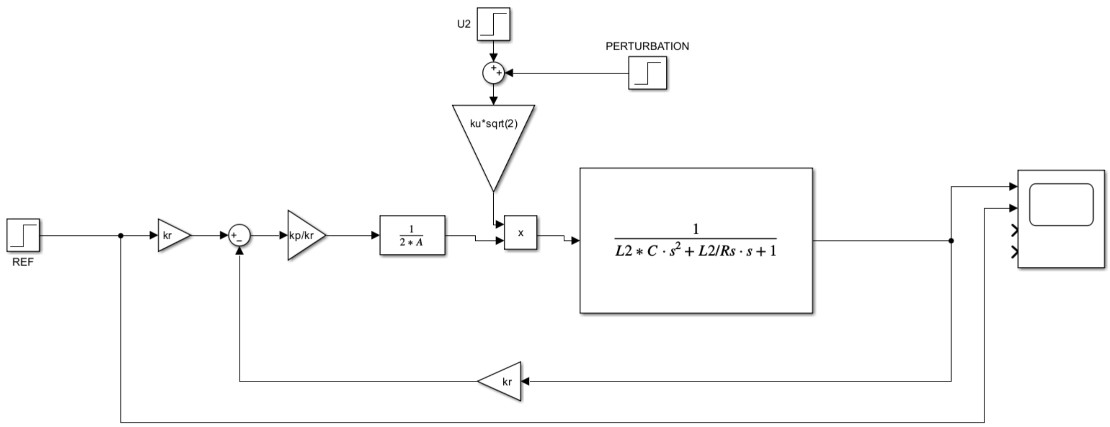


We see that the overshoot is no more than $\sigma = 10\%$ and the steady state error $\varepsilon_{ssp} = 0$.

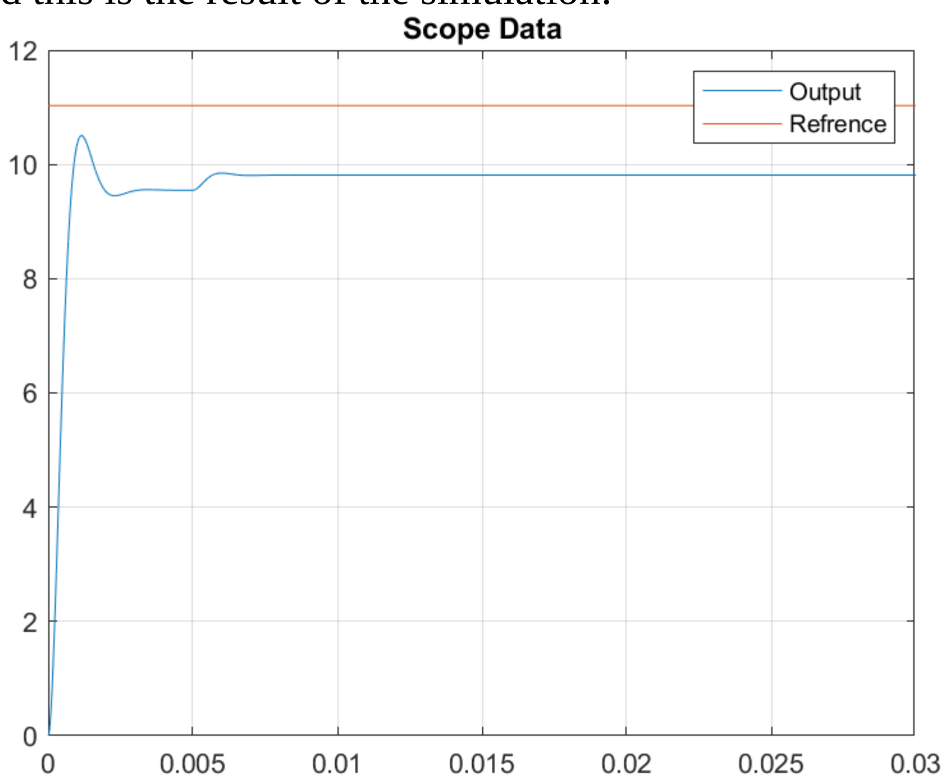
D.2. Step response with disturbance to the input

D.2.1 Input disturbance on the P controller:

I added a perturbation of $10\% \cdot U2\ [V]$ at the moment in time 0.005 seconds.

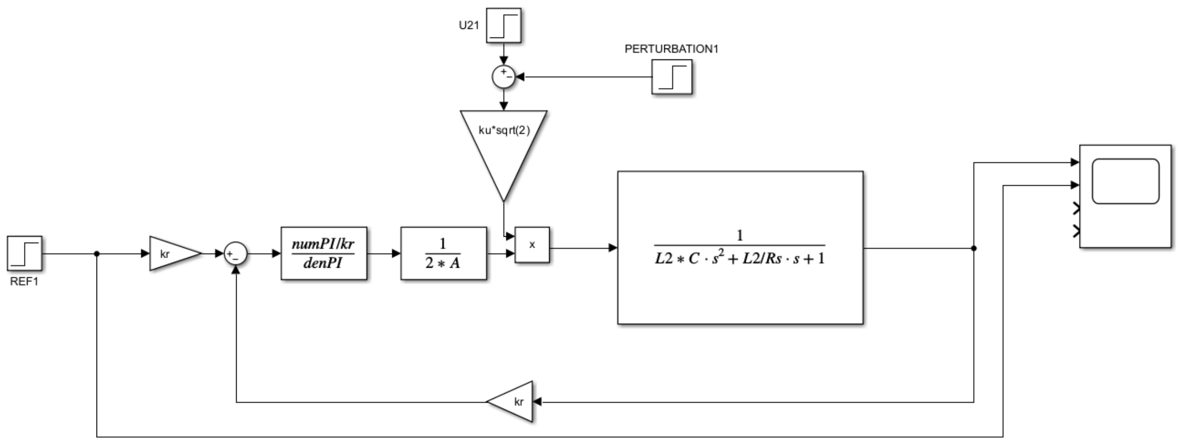


And this is the result of the simulation:

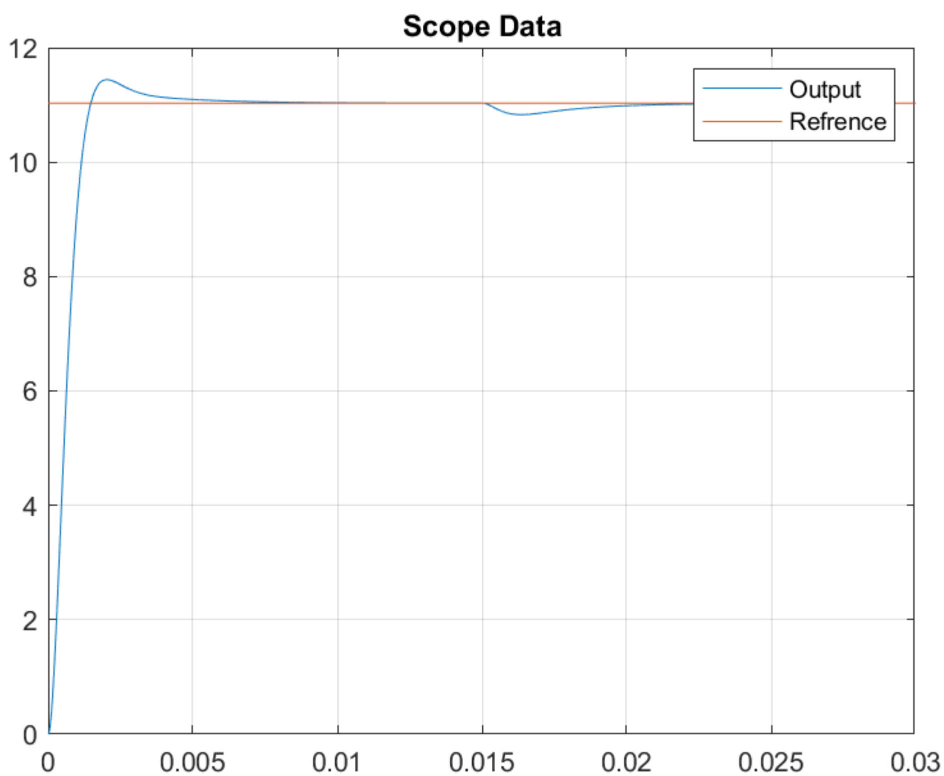


D.2.2 Input disturbance on the PI controller:

I added a perturbation of $-10\% \cdot U2\ [V]$ at the moment in time 0.015 seconds.



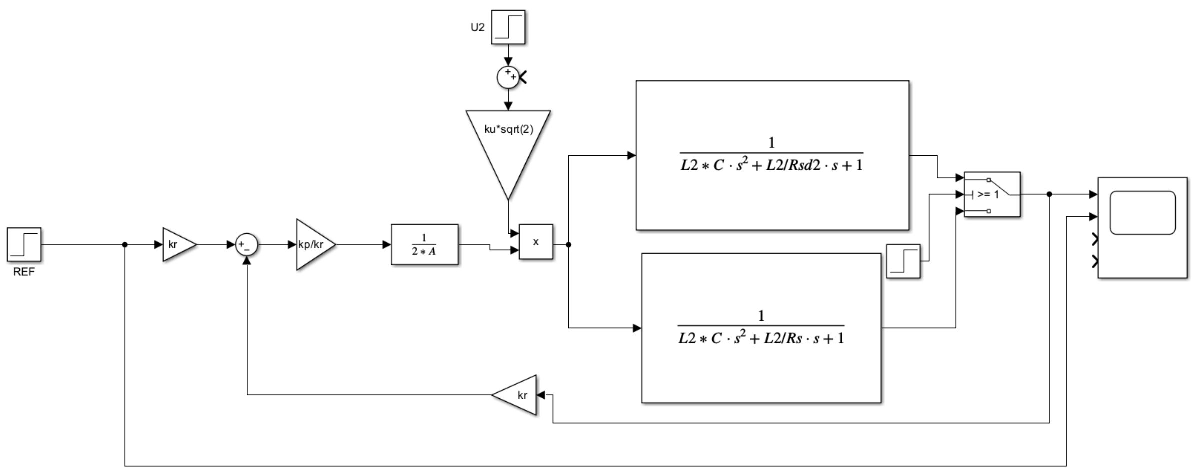
And this is the result of the simulation:

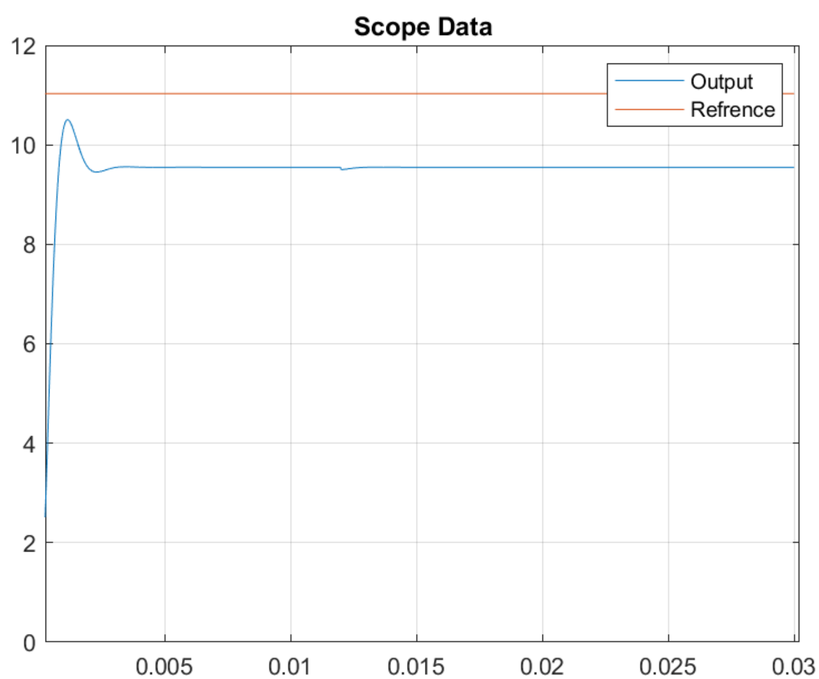


D.3. Step response with disturbance to the output

D.3.1 Output disturbance on the P controller:

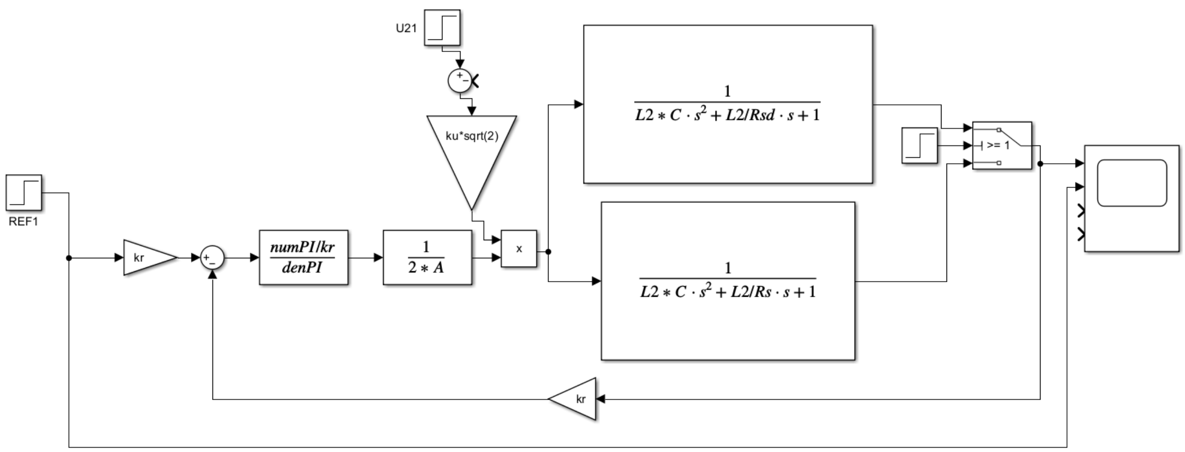
I added a perturbation of $-20\% \cdot Rs$ at the moment in time 0.012 seconds.

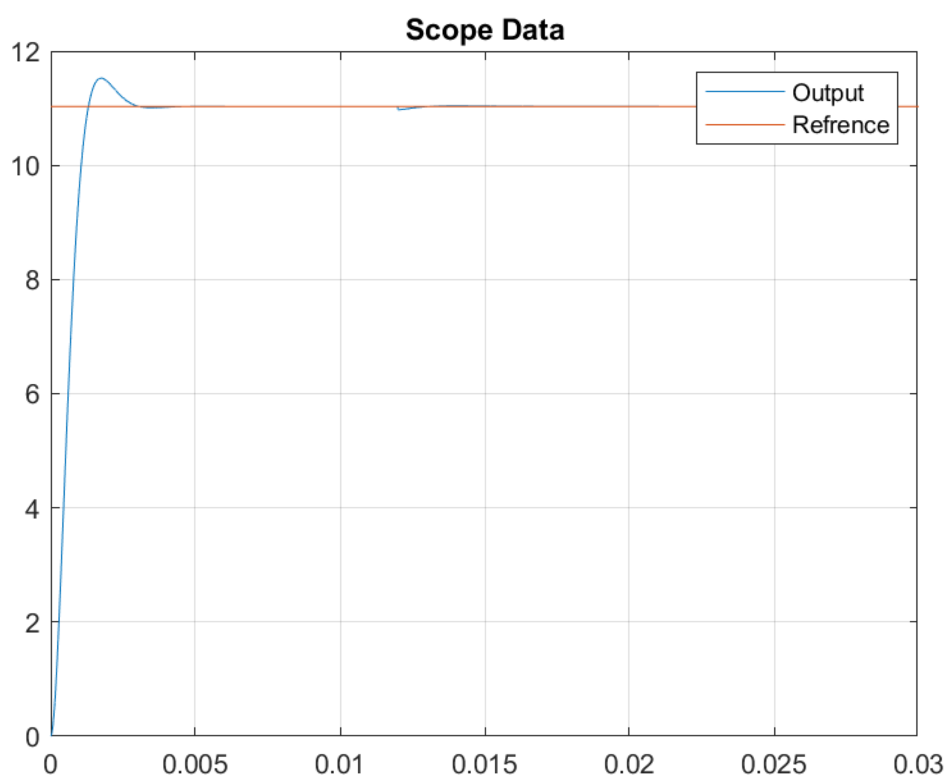


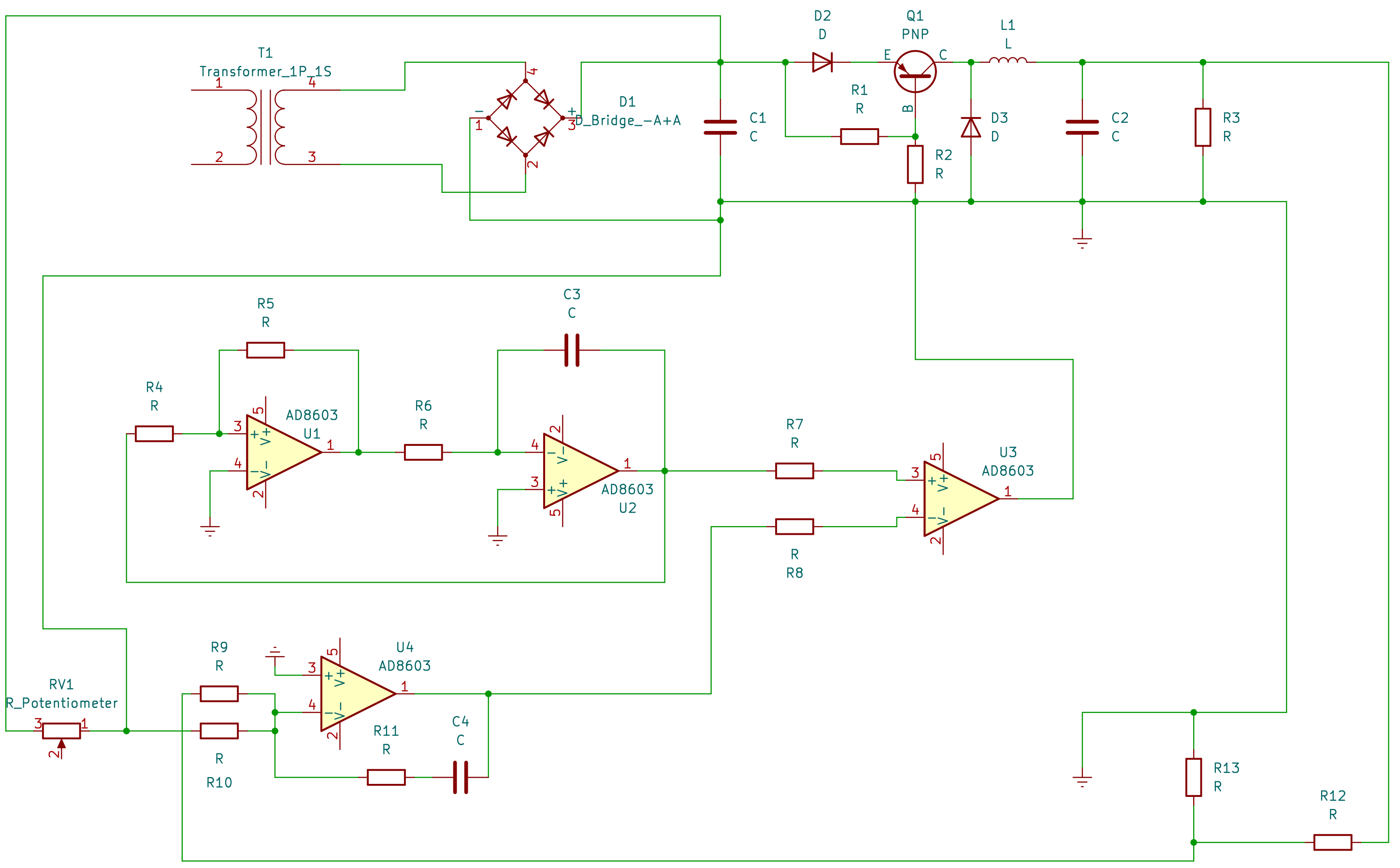


D.3.2 Output disturbance on the PI controller:

I added a perturbation of $-20\% \cdot Rs$ at the moment in time 0.012 seconds.







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