Technical University of Cluj-Napoca

Faculty of Automation and Computer Science

**Project:**

DC STABILIZED SWITCHED MODE POWER SUPPLY

C.

Controllers design

Student Name: Brezae Tudor

Group: 30331

2023-2024

**C1. Representation of the Step-Down (Buck) converter as a plant in Simulink**

**C1.1 Recreating the Circuit**

In section B, we have calculated the parameters of the circuit elements comprising the Step-Down Converter. Those parameters are used in the digital reconstruction of the converter into the app named SimuLink as in Figure 11.

A diagram of a circuit

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*Figure 11*

We provide the necessary parameters to the components, in order to produce a simulation that is as faithfully as possible with the one that we would be provided with in the real world. We also make use of a Scope and Display to see the results of the simulation.

**C1.2 Discretizing the circuit into a plant**

The next step is to create the plant that is equivalent to the circuit. This step is done in 2 ways:

* The first way to discretize is to select the whole circuit and then tell Simulink to create a subsystem, which will then allow us to use in the whole system later. (Figure 12a)
* The second way is to use an equivalent plant by using the formula (Figure 12b):

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Ways to represent the circuit as a plant:

A close-up of a circuit

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*Figure 12 a) Figure 12 b)*

**C2. Constructing the Closed Loop Circuit**

To complete the design of a normal system we need to place a controller block before the plant, a scope to see what our output will be, alongside a Display to see where the signal stabilizes with ease. We also need a reference that tells the controller what our desired output should be, and a feedback that helps the controller make adjustments depending on the error. Because the application does not let us tune the controller based on the subsystem created from the circuit, we will use the approximated plant. (Figure 13)

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*Figure 13*

**C3. Tuning the controllers**

Arriving at the most important part of the section, we start to tune the Controllers. We select the controller block and double click it which allows us to select the type of controller that we wish. For this project, the P and PI type controllers were chosen.

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Afterwards we click on the Tune Button and a menu will open up which will provide us with the best possible combinations of P (Figure 14a) or P and I (Figure 14b)values to get the best possible performance.

A screen shot of a graph

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*Figure 14a (P Tuner for best possible performance)*

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*Figure 14a (PI Tuner for best possible performance)*

**C4. The P/PI Controlled Systems**

To conclude the section, we take the tuned controllers and put them into a P Controlled System (Figure 15a) and a PI Controlled System (Figure 15b) that has the discretized circuit as it’s plant.

A diagram of a computer component

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*Figure 15a*

A computer screen shot of a computer

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*Figure 15b*

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D.

Simulation Related to DC Stabilized

Power Supply

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**D1. The Output of the Step-Down Circuit Simulation**

The following section will mostly be comprised of graphs and responses to the different Controllers and Loads which are chosen:

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*Figure 16a (The input (Blue) and Output (Magenta) of the Buck Circuit)*

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*Figure 16b (The Steady state value of the Output)*

**D2. The Output of the P Controlled System**

**D2.1 The Load of the System coincides with the Load of the Circuit**

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*Figure 17a (The value of the Load Rs)*

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*Figure 17b (The Input of the Circuit (blue) and the Output (Magenta) when we use a P controller with a reference of 17.67 V)*

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*Figure 17c (The Steady State value of the output)*

*It can be observed that the value cannot reach 17.67 V with our best tuning possible of a P controller)*

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*Figure 17d (The Performance and Robustness of the System)*

**D2.2 The Load of the System reduced with 20% of the circuit Load**

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*Figure 18a (The value of the Load Rs)*

A screenshot of a video game

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*Figure 18b (The Input of the Circuit (blue) and the Output (Magenta) when we use a P controller with a reference of 17.67 V)*

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*Figure 18c (The Steady State value of the output)*

*It can be observed that the value cannot reach 17.67 V with our best tuning possible of a P controller)*

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*Figure 18d (The Performance and Robustness of the System)*

**D2.3 The Load of the System increased with 20% of the circuit Load**

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*Figure 19a (The value of the Load Rs)*

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*Figure 19b (The Input of the Circuit (blue) and the Output (Magenta) when we use a P controller with a reference of 17.67 V)*

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*Figure 19c (The Steady State value of the output)*

*It can be observed that the value cannot reach 17.67 V with our best tuning possible of a P controller)*

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*Figure 19d (The Performance and Robustness of the System)*

**D2.4 The Source of the System decreased with 20% of the circuit source**

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*Figure 20a (The value of the Source Uh)*

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*Figure 20b (The Input of the Circuit (blue) and the Output (Magenta) when we use a P controller with a reference of 17.67 V)*

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*Figure 20c (The Steady State value of the output)*

*It can be observed that the value cannot reach 17.67 V with our best tuning possible of a P controller)*

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*Figure 20d (The Performance and Robustness of the System)*

**D3. The Output of the PI Controlled System**

**D3.1 The Load of the System coincides with the Load of the Circuit**

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*Figure 21a (The value of the Load Rs)*

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*Figure 21b (The Input of the Circuit (blue) and the Output (Magenta) when we use a PI controller with a reference of 17.67 V)*

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*Figure 21c (The Steady State value of the output)*

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*Figure 21d (The Performance and Robustness of the System)*

**D3.2 The Load of the System reduced with 20% of the circuit Load**

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*Figure 22a (The value of the Load Rs)*

A screenshot of a video game

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*Figure 22b (The Input of the Circuit (blue) and the Output (Magenta) when we use a PI controller with a reference of 17.67 V)*

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*Figure 22c (The Steady State value of the output)*

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*Figure 22d (The Performance and Robustness of the System)*

**D3.3 The Load of the System increased with 20% of the circuit Load**

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*Figure 23a (The value of the Load Rs)*

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*Figure 23b (The Input of the Circuit (blue) and the Output (Magenta) when we use a PI controller with a reference of 17.67 V)*

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*Figure 23c (The Steady State value of the output)*

A screenshot of a computer

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*Figure 23d (The Performance and Robustness of the System)*

**D3.4 The Source of the System increased with 20% of the circuit Source**

**A screenshot of a computer

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*Figure 24a (The value of the Load Rs)*

**A screenshot of a computer

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*Figure 24b (The Input of the Circuit (blue) and the Output (Magenta) when we use a PI controller with a reference of 17.67 V)*

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*Figure 24c (The Steady State value of the output)*

A screenshot of a data

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*Figure 24d (The Performance and Robustness of the System)*