

# uebung\_3.5.3

## Student Group

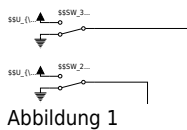
First Name	Surname	Matrikel Nr.

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### Exercise 3.5.3. R-2R conductor



You work in the company “HHN Mechatronics & Robotics”, which is supposed to build a battery model for a customer. This model is intended to replicate a real battery. For this purpose, a voltage is to be output which is specified by a software model of the battery. A digital-to-analog converter (DAC) is therefore required.

You have found the DAC7741 for this. On [page 12](#) of the datasheet you can see an image of the internal structure - this is similar to the illustration on the right. For an error analysis, you now want to understand this structure in more detail.

In the drawing on the right, the current switch position stands for 000b, so all switches  $\text{SW}_1 \dots \text{SW}_3$  are switched to ground. It is advisable to recreate the circuit in the [Falstad-Circuit](#) for a better understanding. In this case, it is advisable to measure the individual node voltages  $\text{K}_1 \dots \text{K}_3$  as well.

1.  $\text{SW}_3 = 1$ ,  $\text{SW}_2 = 0$  and  $\text{SW}_1 = 0$  should now apply initially - that is, only switch  $\text{SW}_3$  is switched to  $U_{\text{logic}}$ .
  1. To do this, draw the equivalent circuit diagram without a switch.
  2. Simplify this equivalent circuit using an equivalent resistor.
  3. The result is a resistance that lies between the inverting and non-inverting input. The operational amplifier always tries to feed so much current into the resistor network surrounding it that a small differential voltage  $U_{\text{D}}$  results. This is also possible with a (not too small) resistance between the inverting and non-inverting input.  
So what is the gain?
2.  $\text{SW}_3 = 0$ ,  $\text{SW}_2 = 1$  und  $\text{SW}_1 = 0$  should now apply initially - that is, only switch  $\text{SW}_2$  is switched to  $U_{\text{logic}}$ .
  1. Here, too, draw the equivalent circuit diagram without a switch.
  2. Simplify this equivalent circuit using equivalent resistors.
  3. The statement about the above-mentioned resistance between the inverting and non-inverting input also applies here. You should also be aware of the voltage of node  $\text{K}_3$ .

Now draw an equivalent circuit diagram of the left, taking the voltage at the node  $K_3$  of the ideal amplifier.

4. Now determine the voltage at node  $K_2$ .
  5. This voltage at node  $K_2$  is the output voltage of an inverting amplifier, which starts from node  $K_2$  to the right. Now calculate the gain of the resulting network.
3. The concept should be understood by now. Now specify which input / which switch specifies the **LSB**.

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