EE 473/538 Project 2 Winter 2022

Title: Design a High-Output Impedance Current Source.

Due Date: Friday, March 4th at 5pm. Please submit your report online. Note, for this project, *you can have a project partner if you want*.

Description: As discussed in class, a particularly challenging aspect of neural stimulation driver electronics is the high-impedance of an implantable neural electrode. This is illustrated in the below figure, where the electrode is modeled as a resistor in series with a capacitor which is in parallel with a resistor. To ensure an accurate delivery of charge to a cluster of nerves, the output impedance of the current source driver must be extremely high. In this project, you are to design a PTAT current source driver with as high an output impedance as possible. The output impedance should have a bandwidth of at least 1kHz. You will be graded on the value of your output impedance as determined through simulation. Your output impedance should be simulated using three methods:

1) You should run a small-signal AC analysis and simulate the output resistance. You can also run a PAC analysis with the stimulator running in the time domain.
2) You should run your stimulator as a pulse, in the time domain. You should see a sawtooth waveform at the output, this is mainly due to the capacitance of the electrode. In simulation, you need to measure the current going into the electrode and compare this current, with the current supplied by your current driver when the output is an AC short to ground. For this simulation, to create an AC ground at the output, simply connect the current source to a DC supply (AC short) that is $\frac{V_{DD}}{2}$.
3) Since the source current is coming from an ideal current source, you can check the accuracy of your current source by integrating the positive and negative current pulse to see if the charge indeed balances in both directions.

You are actually designing a current sink, and for the current source, you may use an ideal current source from AnalogLib in Cadence. Your circuit should look like what is shown in the below figure. We will discuss this more in class.

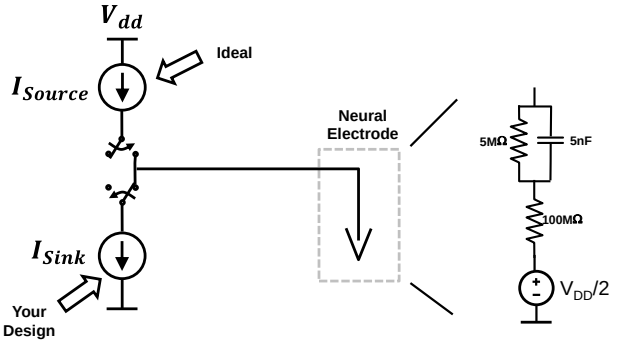

Figure 1: High-Level Diagram of the current sink driver stage for neural stimulators. Sink and Source currents should be designed for 100μA.

Design the current driver to both source and sink 100μA. Your output impedance should be no less than 1GΩ.

You should write a two-page report that contains the following content:

- **Introduction:** which describes the challenges of building your circuit and what alternative solutions have been published.
- **Design:** a detailed description of your design, please emphasize any novelty in your design.
- **Results:** please use clear figures to show your Cadence simulation results with a clear discussion of the results.
- **Conclusions:** Type up a brief paragraph of concluding comments. You may add another paragraph to describe what you would have done differently if you had more time to design this circuit.
- **Appendix:** You may use an additional page for figures.