Assignment 10

1 Design Exercises

Feel free to use Multisim to test and confirm your derivations. However, Multisim by itself does not prove anything! We need to see derivations.

1.1 (10 points) Can be done after the lab

In the lecture about a relaxation oscillator shown in Figure 1, we saw the equation connecting its period to $V_{ref_{high}}$, $V_{ref_{high}}$, and V_{neg}.

$$T = 2RC \ln \frac{V_{ref_{high}} - V_{neg}}{V_{ref_{low}} - V_{neg}}$$

This equation was derived with an assumption that the capacitor discharging time is equal to charging time (i.e. the times for hi and low outputs are the same). As we saw in the lab, this assumption is not always incorrect.

Derive the equations for the capacitor charging time in the relaxation oscillator and show the correct expression for its period. Assume that you know $V_{ref_{high}}$, $V_{ref_{high}}$, V_{neg}, and V_{pos}.

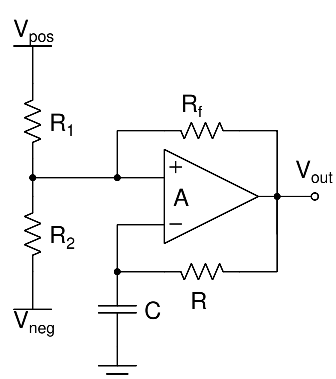

Figure 1: A relaxation oscillator with bipolar power supply.

1.2 (10 points) Can be done after the lab

To charge your phone you need a DC power supply with output voltage of 5V. To make charging fast your phone can consume current of about 2A, i.e. the phone will appear as a very small resitor with value 5V/2A=2.5Ω. High quality chargers have pulsation less than 1% of its output voltage.

Find the value of the filtering capacitor to achieve this requirement, recall that AC power line has the oscillation frequency of 60 Hz.

You will see that the required capactior is quite large (recall the largest capacitor you saw in the lab), this is why modern chargers use a special circuit to have much faster internal oscillation frequency. This allows much smaller physical component sizes.

2 Lab 10: Diodes

Always start with a circuit diagram and only then build it in hardware.

Your notebooks must be complete, understandable, and address all activities, design exercises, observations, and questions noted in the laboratory's procedures. Remember to use your notebook as a laboratory journal and record your data, design calculations, notes and scratch work. *Make sure to write a conclusion for each exercise and each week.*

Task 0

Demand

- a tutorial about a diode check with a multimeter:
  - what does it show, i.e. diode voltage drop
  - how to find the anode and cathode of the diode with a multimeter

Do not connect an LED without a current limiting resistor of at least 100 Ω, better yet limit the current to 10 mA or less

Task 1 (10 points) LEDs

Grab an LED of you choice. Unmodified LEDs have one leg longer than the other. Which one is the anode, and which one is the cathode? Hint: the LED lights up when current is flowing (the LED is forward biased).

Task 2 (15 points) LED's IV curve

Grab an LED of you choice. Measure an LED IV curve. You can assume that current is very-very small (almost 0) when it is reversed biased. Remember about current limiting resistor, if you need a higher current to flow through an LED, reduce this resistor but never go above 100 mA of total current.

Task 3 (10 points) Half-wave rectifier

Grab an LED of you choice. Built a half-wave rectifier (with a resistor of several kΩ). Confirm that it works according to the specification. Why the output half-wave is lower than the input half wave?

Task 4 (15 points) Low pulsation half-wave rectifier

Switch the function generator to the frequency of 10 kHz, add use an appropriate filtering capacitor to reduce output voltage pulsation below 10%.

Note: unlike a full-wave rectifier, your half-wave rectifier discharges for a twice longer time (at the same input frequency).

Switch the generator to 10 Hz, how big are the pulsations? Is it what predicted by the formula? What is wrong with the formula?