ECE 205: Lab 4

NE555 Timer and RC Circuits

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1 Statement of Purpose

The purpose of this lab was to characterize the NE555 integrated circuit and determine how it works. We accomplished this goal utilizing the ubiquitous program LTspice.

2 PreLab Deliverables

For the first prelab deliverable, we created the NE555 circuit with operating parameters of $R_1 = R_2 = 1\ k\Omega$, $C = 0.5\ \mu F$, and $V_{cc} = 9\ V$. By using the following equations given in the Texas Instruments 555 manual, we were able to calculate the period to be 1.03972 ms.

$$t_H = ln(2) \cdot (R_1 + R_2)\, C = 0.69315ms \tag{1}$$

$$t_L = ln(2) \cdot (R_2)\, C = 0.34657ms \tag{2}$$

$$period = T = t_H + t_L = ln(2) \cdot (R_1 + 2R_2)\, C \tag{3}$$

Equipped with the period, we then sketched the waveform for the output voltage and the capacitor voltage, which is given as follow:

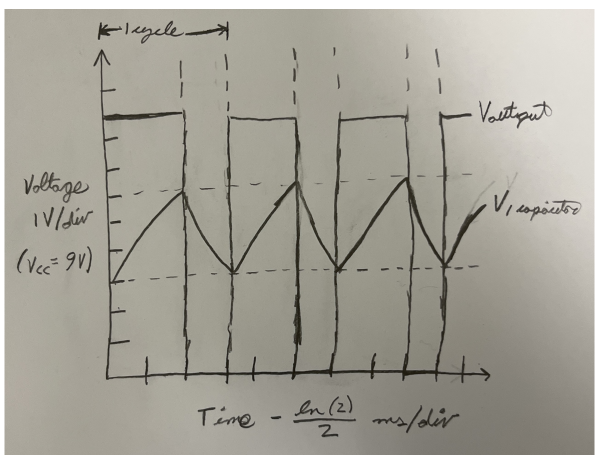

Figure 1: Voltage Waveform Sketch for NE555 Integrated Circuit

For the second pre-lab deliverable, we assumed a "full cycle" refers to a period. Under this *modus operandi*, if we want at least two full cycles displayed on the oscilloscope, we know two periods $2T = 2.07944\ ms$ will be fully pictured with a timebase of 0.5 ms.

3 Procedure

To begin, we constructed a circuit with the NE555 timer as the centerpiece. We then added 2 resistors, R_1 and R_2, and two capacitors, C_1 and C_2. Further we added a voltage source. R_2 had a constant resistivity of 1 $k\Omega$, while R_1 had a resistivity of 1 $k\Omega$ for the first trial and 2 $k\Omega$ for the second. The two capacitors, C_1 and C_2, had capacitances of .5 and .01 μF capacitance, respectively. Finally the voltage source had a strength of 9 V. The schematic we used to complete this lab is presented below in Fig. 2.

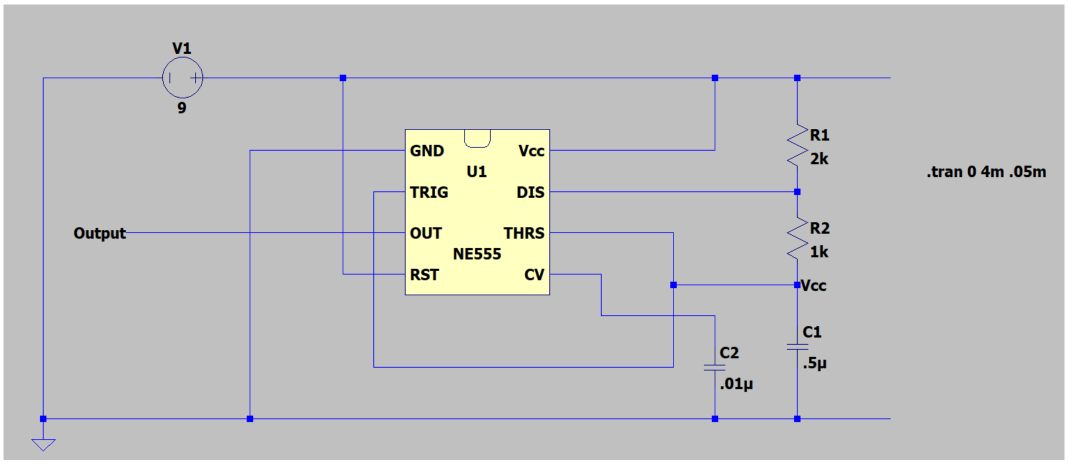

Figure 2: Schematic of circuit modeled in LTspice

We conducted two trials, the first with R_1 set to 1 $k\Omega$ and then 2 $k\Omega$ for the second. For both trials we ran a transient simulation spanning 4 ms, with 0.05 ms time-steps. From these simulations we output the voltage at node V_{cc} and at node $Output$.

4 Observation and Data

From our first trial, with the resistivity of R_1 set to 1 $k\Omega$, we produced the plot presented in Fig 3.

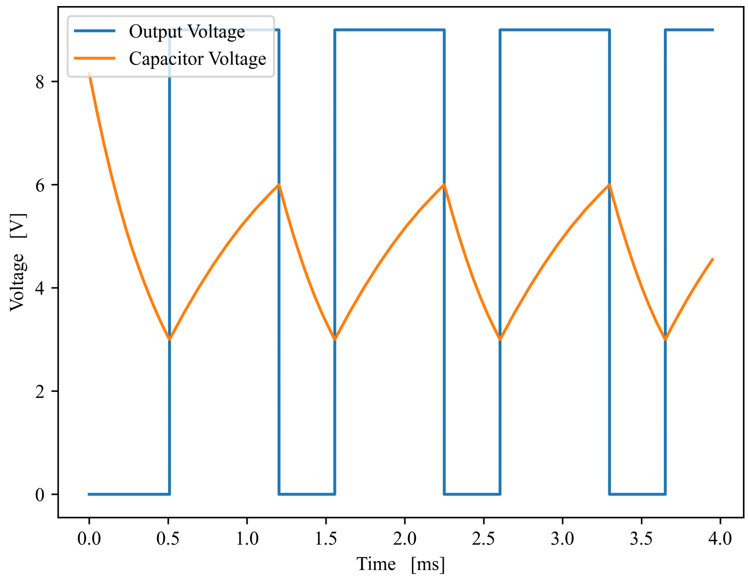

Figure 3: *Output* and V_{cc} voltage, R_1 set to 1 $k\Omega$

Next, from our second trial, where the resistivity of R_1 was set to 2 $k\Omega$, we constructed Fig. 4.

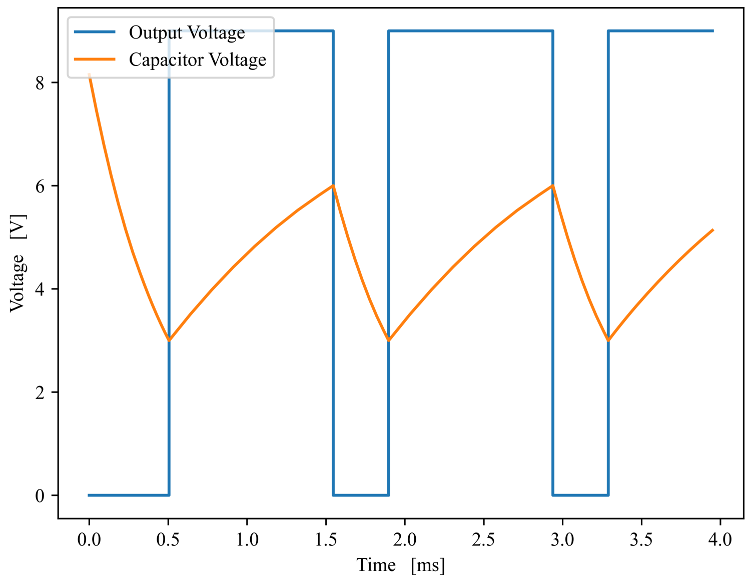

Figure 4: *Output* and V_{cc} voltage, R_1 set to 2 $k\Omega$

5 Analysis

From Figs. 3 and 4, the dependencies of the the charging and discharging regions can be ascertained as follows: the discharging period **is not** dependent on the resistivity of R_1, while the charging period **is** dependent on the resistivity of R_1. The discharge time in the first trial is 0.35362, and the discharge time of the second trial is 0.35131; a negligible difference. The charging time of the first trial is 0.69377, where the charging time of the second trial was 1.04065.

6 Conclusions

In conclusion, the charging time depends only on R_2 and the discharging time depends on both R_1 and R_2.

7 Appendix

All output files and schematic screenshots are in this Google Drive folder. r1k refers to the output file of the first trial, and r2k is that of the second trial.