Eclectronics Mini Project 2

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February 11, 2019

1 Design Process

1.1 Hysteretic Oscillator

I wanted to get the circuit designed and the NINJAs hadn't released their hours yet. I grabbed Audrey and Liv so we could work through making a hysteretic oscillator with a frequency of 1 Hz. We chose the resisters that would set where the voltage of the positive rails oscillated to 1MΩ. The equation uses was $V_p = \frac{1M\Omega}{2M\Omega} \times \frac{3.3V}{2} + \frac{1M\Omega}{2M\Omega} \times V_{out}$. This resulted in V_p oscillating between $\frac{1}{4} \times 3.3V$ and $\frac{3}{4} \times 3.3V$ Then we calculated the RC combination that would be necessary to have V_n get from the lower value of V_p to the higher value in 1/2 second. We used the equation $\frac{3.3V}{2} = \frac{3 \times 3.3V}{4} \times (1 - e^{\frac{-0.5s}{RC}})$. Which gave $RC = \frac{1}{2ln(3)} \frac{\Omega}{F}$ We chose to set C = 1uF and that meant R = 455.12KΩ. There is no 455.12KΩresister in the parts list, so we chose to put a 301KΩand 158KΩin series. Together they make a 459KΩwhich keeps the desired frequency in the necessary tolerance.

1.2 Voltage Divider

For this part I was still working with Liv and Audrey. We also asked Paige for help. We knew that we needed a voltage divider of 2 resistors to provide the hysteretic oscillator with a 1.65V input. It is important to make sure that the current draw from the voltage divider into the hysteretic oscillator was very low, or else the voltage in the middle of the divider would be further away from 1.65V. To execute this we made sure the resistors in the hysteretic oscillator were multiple orders of magnitude larger than the resisters in the voltage divider. That is why the resistors in the voltage divider are 1KΩ.

1.3 LED

The resistor selected to be in series with the LED was 1KΩ. I decided on this by reading the documentation on the LED. $3.3V = I \times 1K\Omega$ so I = 3.3mA.

1.4 KiCad

For the design aspects in KiCad, I followed the video tutorial that Brad emailed to us. It can be found at: https://contextualelectronics.com/courses/getting-to-blinky/

2 Final Design

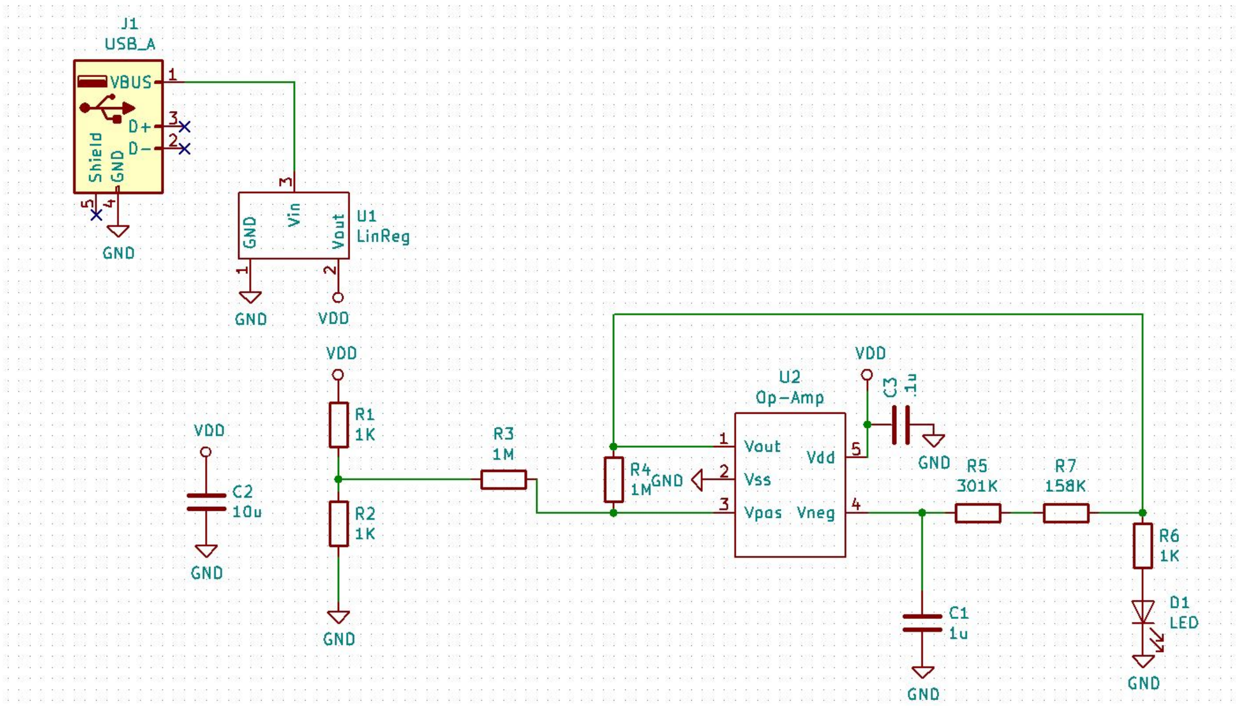

Figure 1: This is a screenshot of the KiCad schematic. I made schematic symbols for the linear regulator and the op-amp.

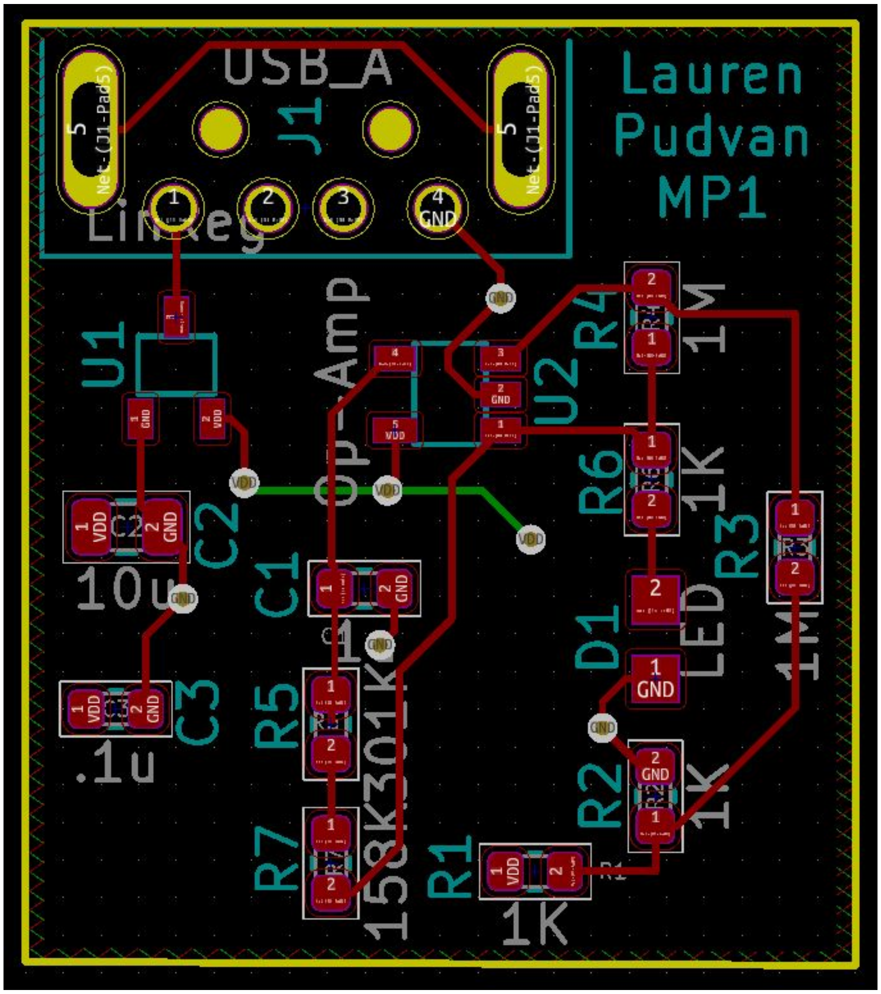

Figure 2: This is a screenshot of the KiCad layout. I made footprints for the linear regulator, op-amp, LED, and USB. This image has the copper plating on the layers invisible. This makes the layout a little easier to view.

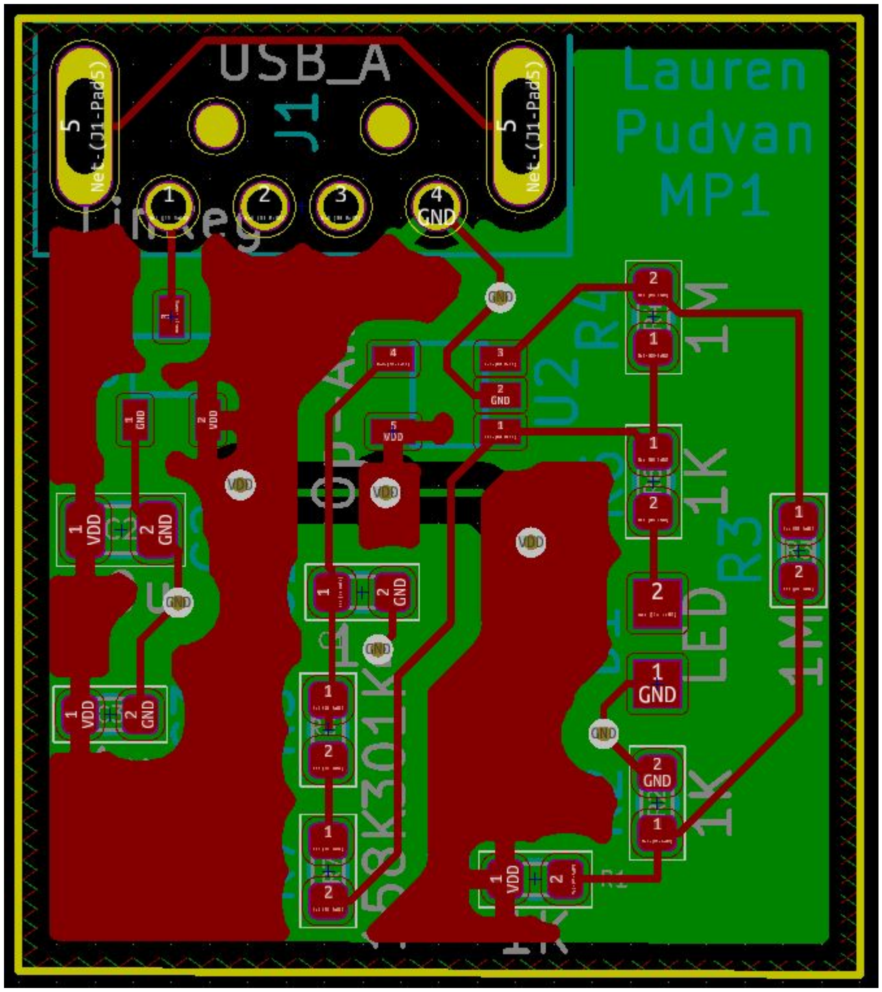

Figure 3: This is a screenshot of the KiCad layout. I made footprints for the linear regulator, op-amp, LED, and USB. This image has the copper plating on the layers visible.

3 Bill of Materials

Below are two versions of my bill of materials. One has the Digikey Catalog # and the other has the Manufacturer Part #. I tried to make them into one table but it was running off of the paper. So I split it into two seporate tables. The first, with the Digikey Catalog #, is more helpful to me if I were ordering the parts today. The second, with the Manufacturer Part #, is more helpful to another person trying to make this PCP.

Part Description	Digikey Catalog #	Quantity
CONN PLUG USB 4POS RT ANG PCB	WM17117-ND	1
IC REG LIN 3.3V 250MA SOT23A-3	MCP1702T-3302E/CBCT-ND	1
IC OPAMP GP 10MHZ RRO SOT23-5	MCP6021T-E/OTCT-ND	1
LED GREEN CLEAR 0805 SMD	160-1887-1-ND	1
CAP CER 10UF 16V X7R 0805	1276-2872-1-ND	1
CAP CER 1UF 25V X7R 0603	399-7376-1-ND	1
CAP CER 0.1UF 50V X7R 0603	311-1779-1-ND	1
RES SMD 1K OHM 1% 1/10W 0603	311-1.00KHRCT-ND	3
RES SMD 158K OHM 1% 1/10W 0603	311-158KHRCT-ND	1
RES SMD 301K OHM 1% 1/10W 0603	311-301KHRCT-ND	1
RES SMD 1M OHM 1% 1/10W 0603	311-1.00MHRCT-ND	2

Part Description	Manufacturer Part #	Quantity
CONN PLUG USB 4POS RT ANG PCB	480370001	1
IC REG LIN 3.3V 250MA SOT23A-3	MCP1702T-3302E/CB	1
IC OPAMP GP 10MHZ RRO SOT23-5	MCP6021T-E/OT	1
LED GREEN CLEAR 0805 SMD	LTST-C170TGKT	1
CAP CER 10UF 16V X7R 0805	CL21B106KOQNNNE	1
CAP CER 1UF 25V X7R 0603	C0603C105K3RACTU	1
CAP CER 0.1UF 50V X7R 0603	CC0603JRX7R9BB104	1
RES SMD 1K OHM 1% 1/10W 0603	RC0603FR-071KL	3
RES SMD 158K OHM 1% 1/10W 0603	RC0603FR-07158KL	1
RES SMD 301K OHM 1% 1/10W 0603	RC0603FR-07301KL	1
RES SMD 1M OHM 1% 1/10W 0603	RC0603FR-071ML	2

4 Frequency Analysis

For the frequency analysis, I did a monte carlo simulation in LTspice of 100 runs. I did this over Coleman's and Paige's NINJA hours. The following figures show how the simulation was run.

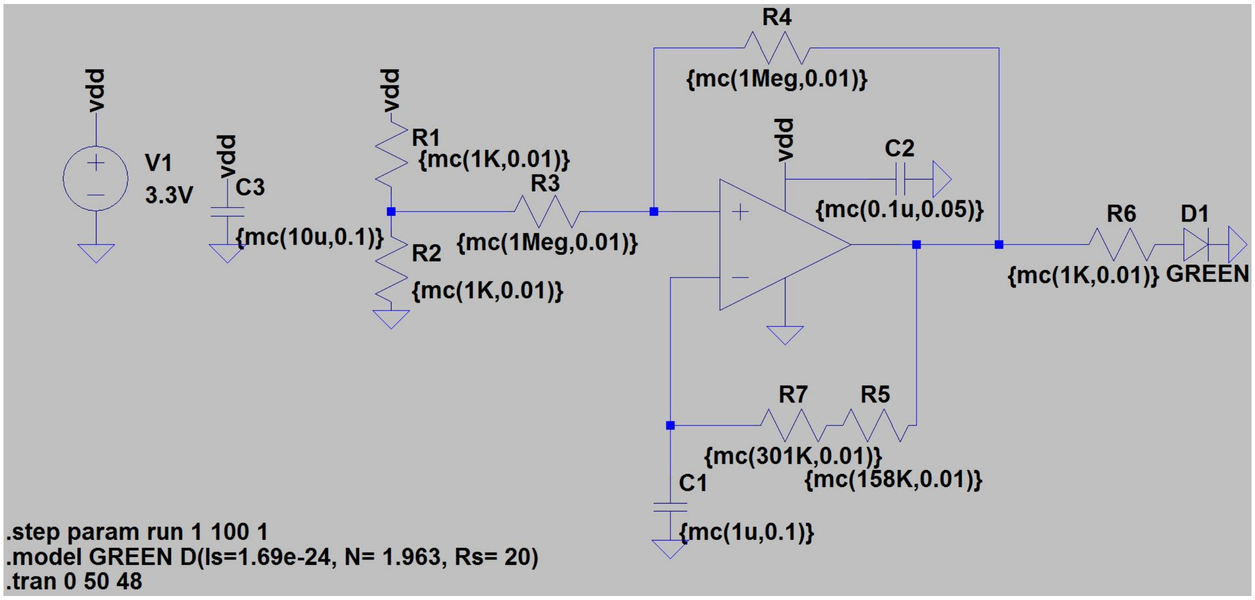

Figure 4: This is a screenshot of my LTspice schematic.

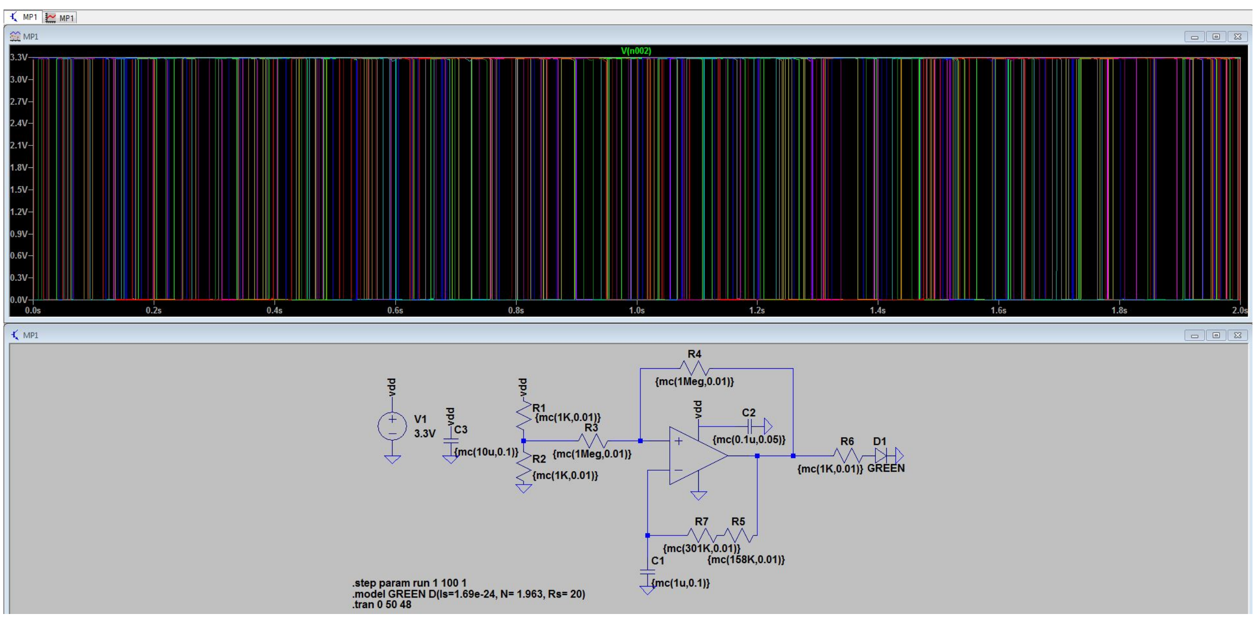

Figure 5: This is a screenshot of my LTspice simulation.

To know if the frequency is within 15% of 1Hz, I made a matlab script that found the period of each simulation and plotted the period in a scatter plot.

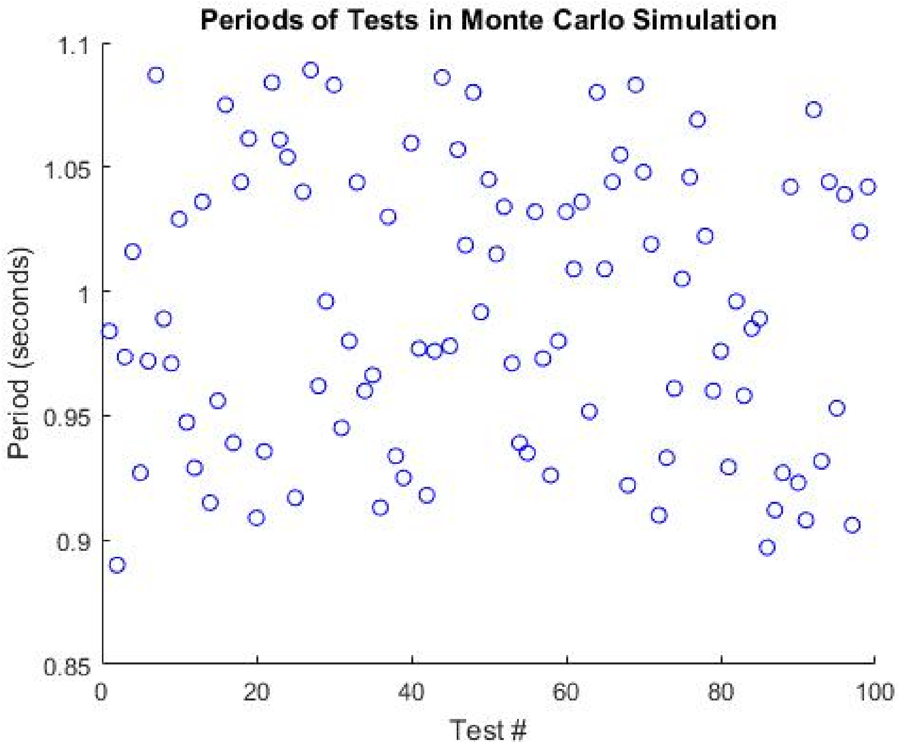

Figure 6: This is the plot of all the periods for each simulation. None of the periods were over 1.15 seconds and none were under 0.85 seconds.