

Calvin Passmore

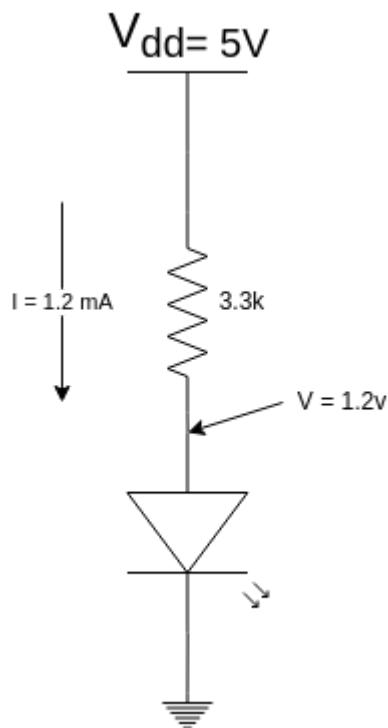
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# Optoelectronics Pre Lab

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## DC Operating Point: Transmit Side

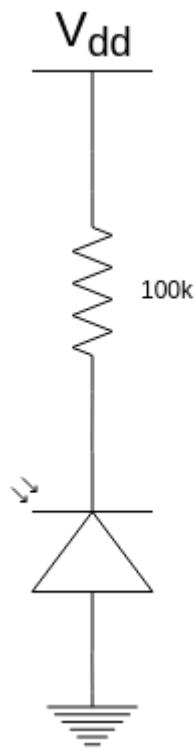


$$\begin{aligned} I_{\text{LED}} &= 1 \text{ mA} \\ V_F &= 1.2 \text{ V} \end{aligned}$$

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## DC Operating Point: Receive Side



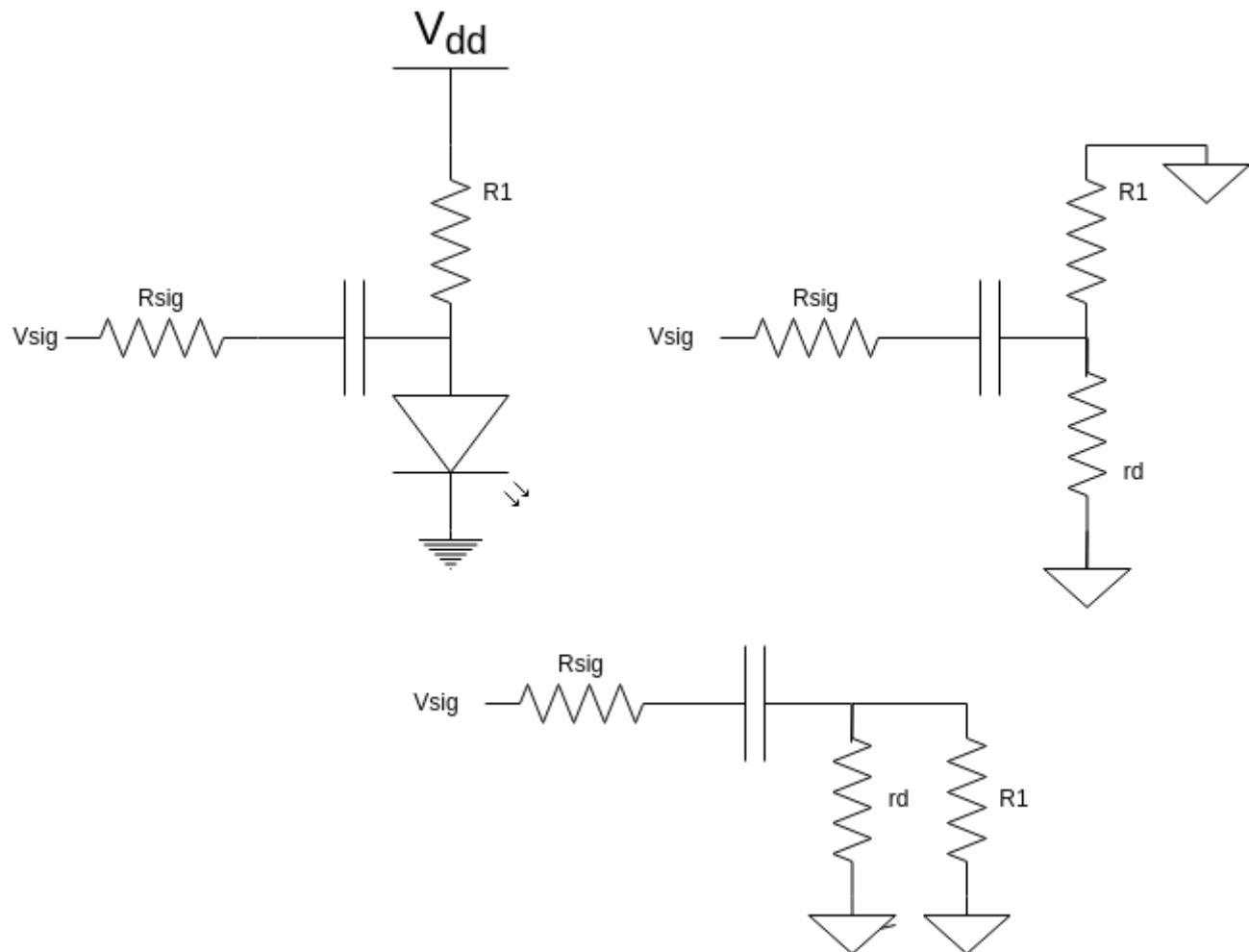
$I_{PH} = 12 \mu A$   
 $V_y = 3.7 v$

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## Minimum Signal Frequency

### Transformation

Showing the transformation of the circuit to small signal.



## High-pass filter

$$\$ H(s) = sRC / (1 + sRC) \$\$$$

$$\text{where } R = \$ R_{\text{sig}}(R_1 + r_d) + R_1 r_d \over R_1 + r_d \$$$

$$\$ H(s) = \{sC(R_1 || r_d) \over 1 + sC(\{R_{\text{sig}}R_1 + R_{\text{sig}}r_d + R_1 r_d\} \over R_1 + r_d)\} \$\$$$


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## Low-Frequency Cutoff

$$\$ f_L = \{1 \over 2\pi RC\} \$\$$$

$$\text{where } R = \$ R_{\text{sig}}(R_1 + r_d) + R_1 r_d \over R_1 + r_d \$$$

$$\$ f_L = \{1 \over 2\pi C \{(R_{\text{sig}}(R_1 + r_d) + R_1 r_d) \over R_1 + r_d\}\} \$\$$$

$$\$ R_1 \gg r_d \$, so \$ R_1 + r_d \approx R_1 \$$$

$$\$ f_L \approx \{1 \over 2\pi C(R_{\text{sig}} + r_d)\} \$\$$$

$$\$ C = 1/\mu F \$$$

$$\$ R_{\text{sig}} = 100k\Omega \$$$

$$r_d = 25 \Omega$$

$$f_L = 1.6 \text{ Hz}$$

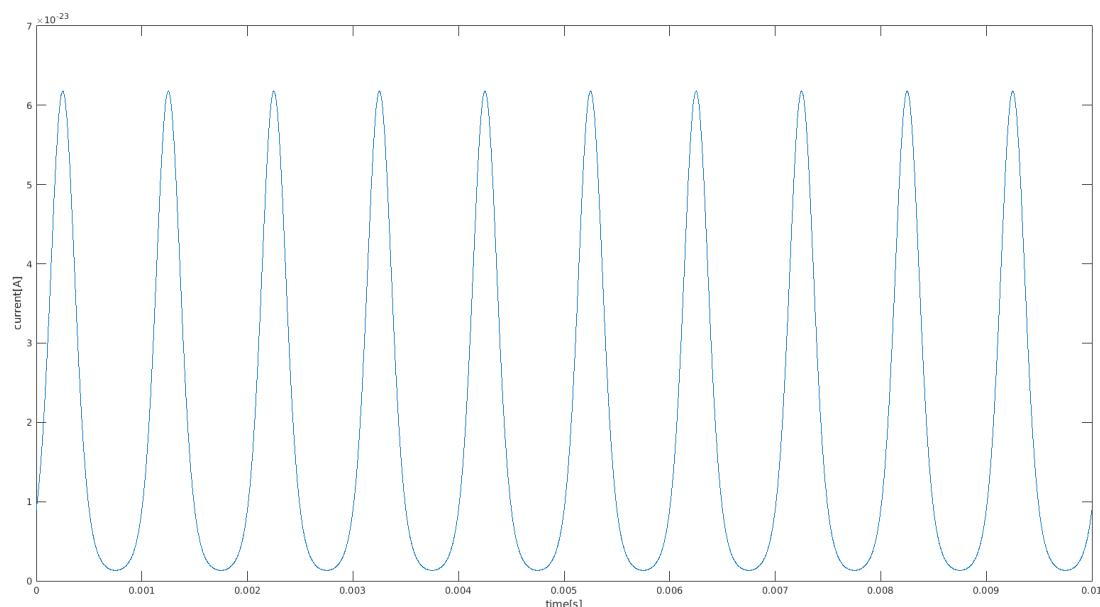
## Maximum Signal Frequency

$$V_R = 3.7 \text{ V} \therefore C_j = 26 \text{ pF}$$

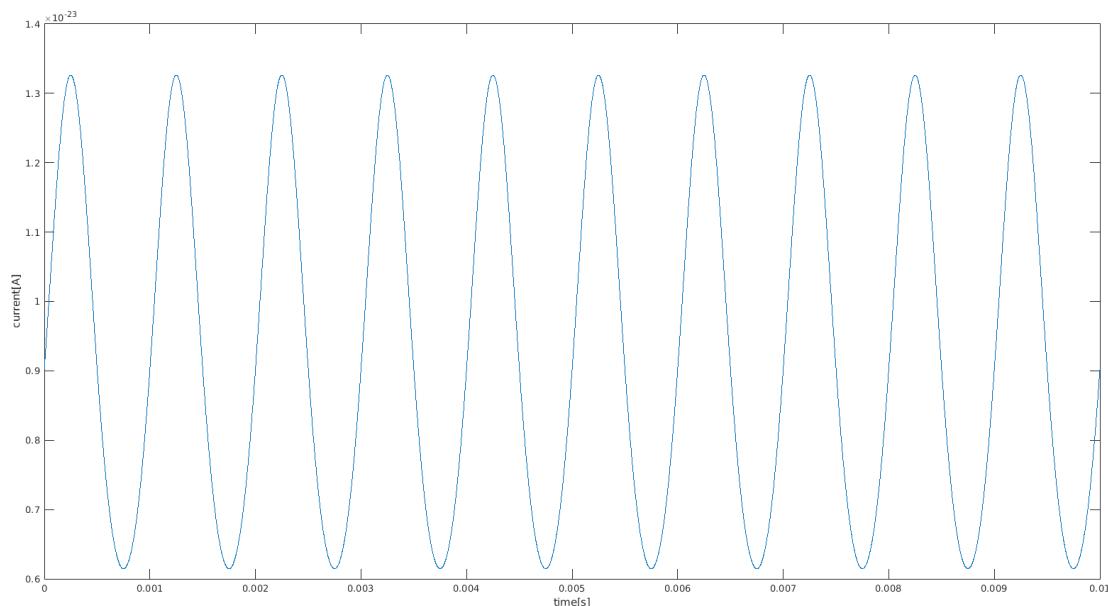
$$f_H = \frac{1}{2\pi RC} \quad f_H = \frac{1}{2\pi C(R_{sig} + r_d)} = 1.84 \text{ Hz}$$

## Signal Distortion: Forward Bias LED

Forward Bias current at 0.05 v



Forward Bias current at 0.05 v

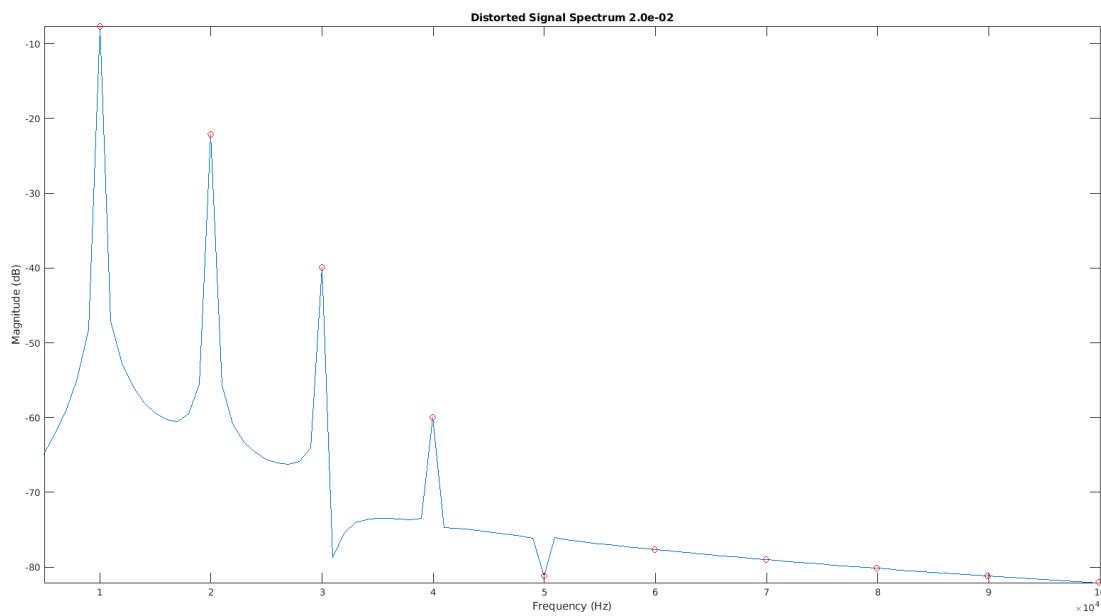


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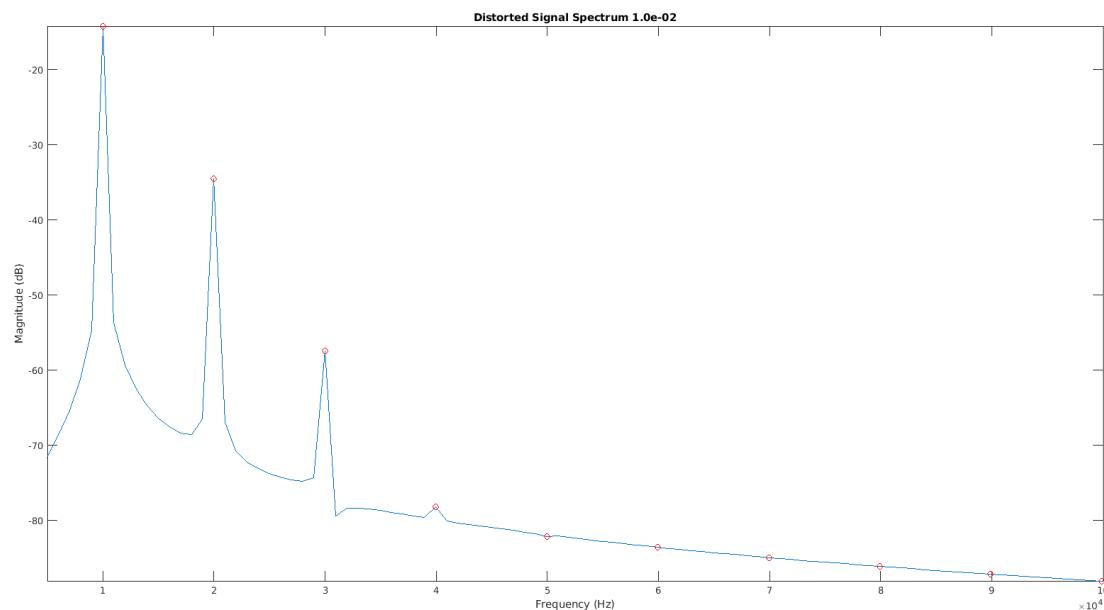
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## MatLab Data

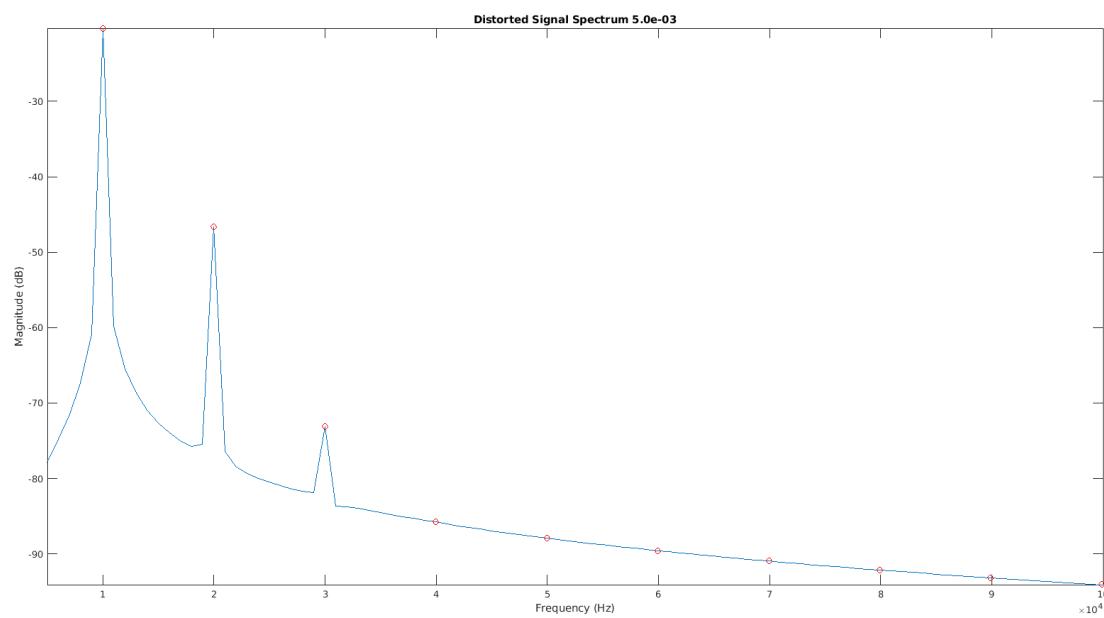
```
>> plot_signal_spectrum(0.02)
THD: 17.776924%
SNDR: 14.524570 dB
```



```
>> plot_signal_spectrum(0.01)
THD: 9.486085%
SNDR: 20.388633 dB
```



```
>> plot_signal_spectrum(0.005)  
THD: 4.997734%  
SNDR: 26.366854 dB
```



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First output:

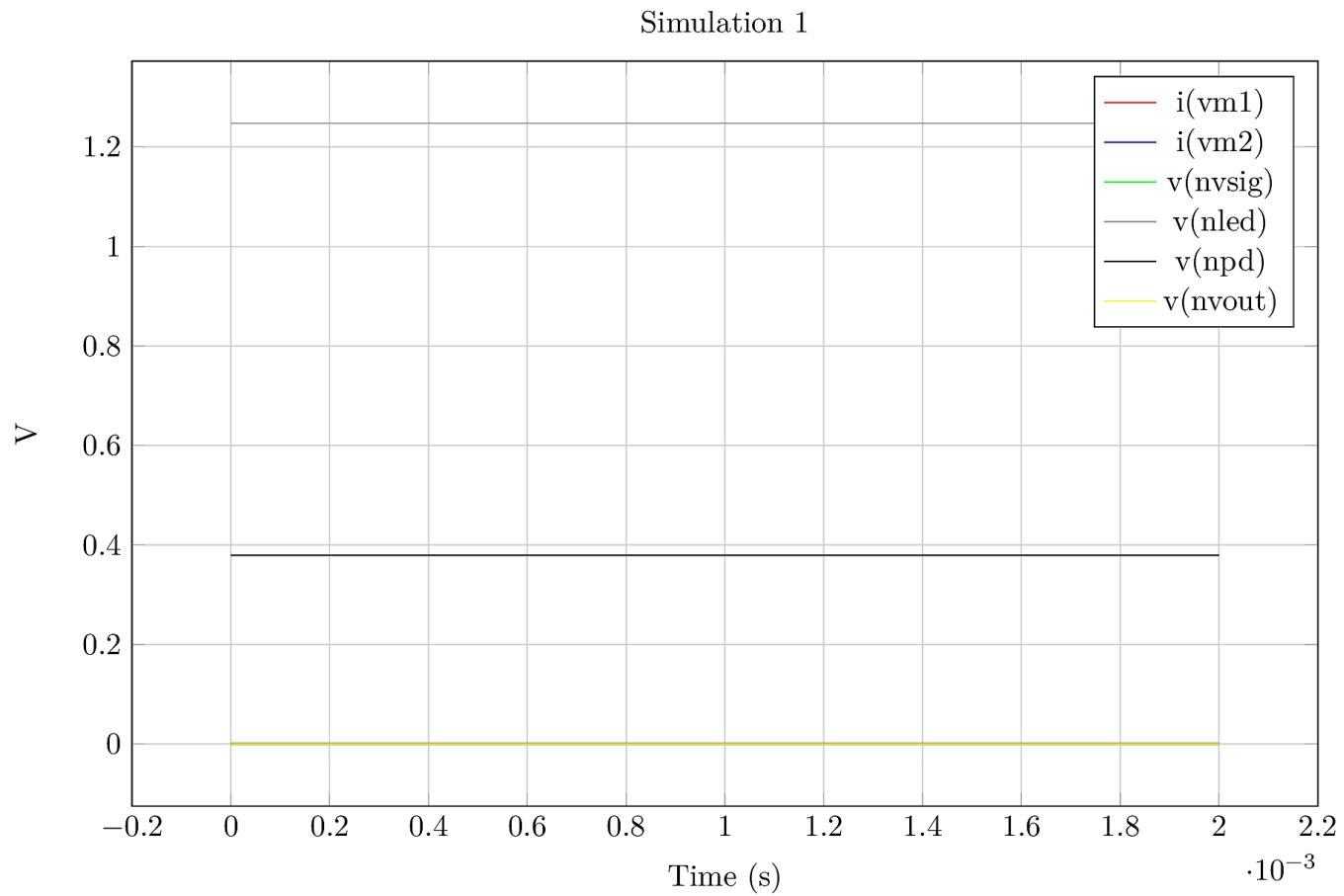
```
nvx = 1.247910e+00
nvy = 3.788906e-01
i(vm1) = 1.136997e-03
i(vm2) = 3.332524e-05
```

This was close to the expected values.

Transient Solution

```
Initial Transient Solution
```

Node	Voltage
nvdd	5
nsig	0
nvx	1.24791
nled	1.24791
nvy	0.378891
npd	0.378891
nvsig	1.24791
nc	1.24791
nvout	0.378887
vm1#branch	0.001137
vm2#branch	3.33252e-05
vsig#branch	0
vdd#branch	-0.00118321

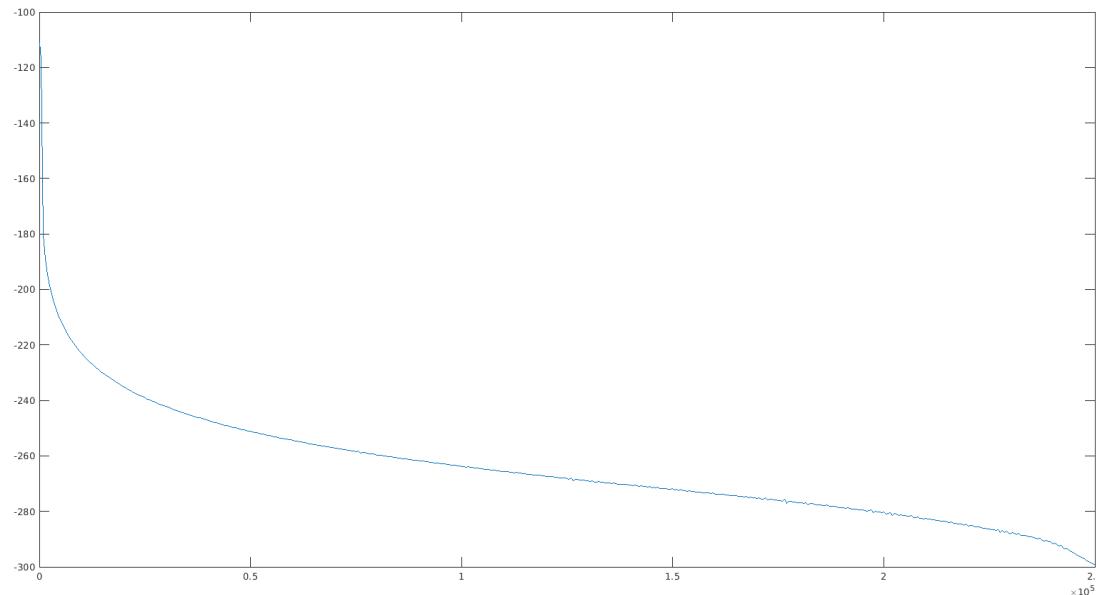
**sim1 png output****MATLAB STUFF TODO**

Fourier analysis for  $v(nvout)$ :

No. Harmonics: 10, THD: 73.5045 %, Gridsize: 200, Interpolation Degree: 1

Harmonic	Frequency	Magnitude	Phase	Norm. Mag	Norm. Phase
0	0	-1.4001e-06	0	0	0
1	5000	8.90459e-11	-179.1	1	0
2	10000	4.45281e-11	-178.2	0.500058	0.901387
3	15000	2.96904e-11	-177.3	0.333428	1.80209
4	20000	2.22746e-11	-176.4	0.250147	2.70049
5	25000	1.78105e-11	-175.48	0.200014	3.62102
6	30000	1.48622e-11	-174.6	0.166904	4.50241
7	35000	1.27466e-11	-173.7	0.143147	5.39605
8	40000	1.11597e-11	-172.81	0.125325	6.28972
9	45000	9.92586e-12	-171.91	0.111469	7.18534

## Matlab FFT



```
maxdb          = -inf at= 1.000000e+06
Error(checkvalid): vector inf is not available or has zero length.
Error: RHS "-inf" invalid
Error(checkvalid): vector maxdb is not available or has zero length.
Error: RHS "maxdb - 3.0" invalid

Error: measure fl find(AT) : out of interval
meas ac fl find frequency when vdb(nvout)=cutoffmag failed!

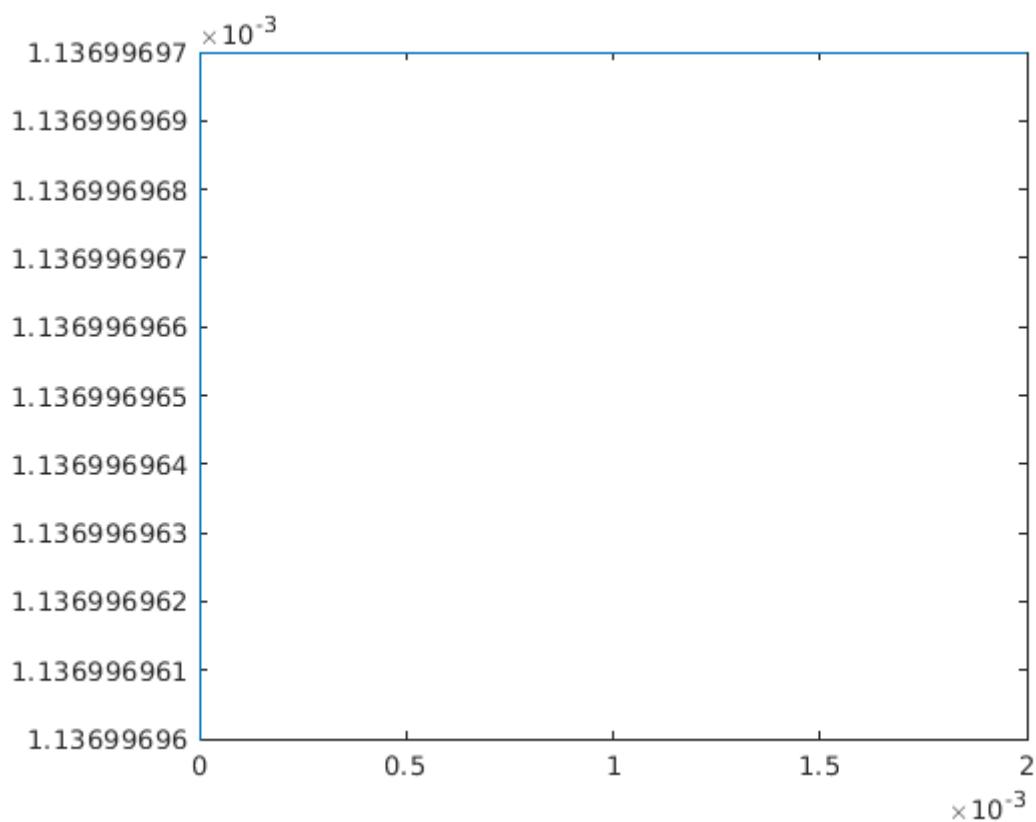
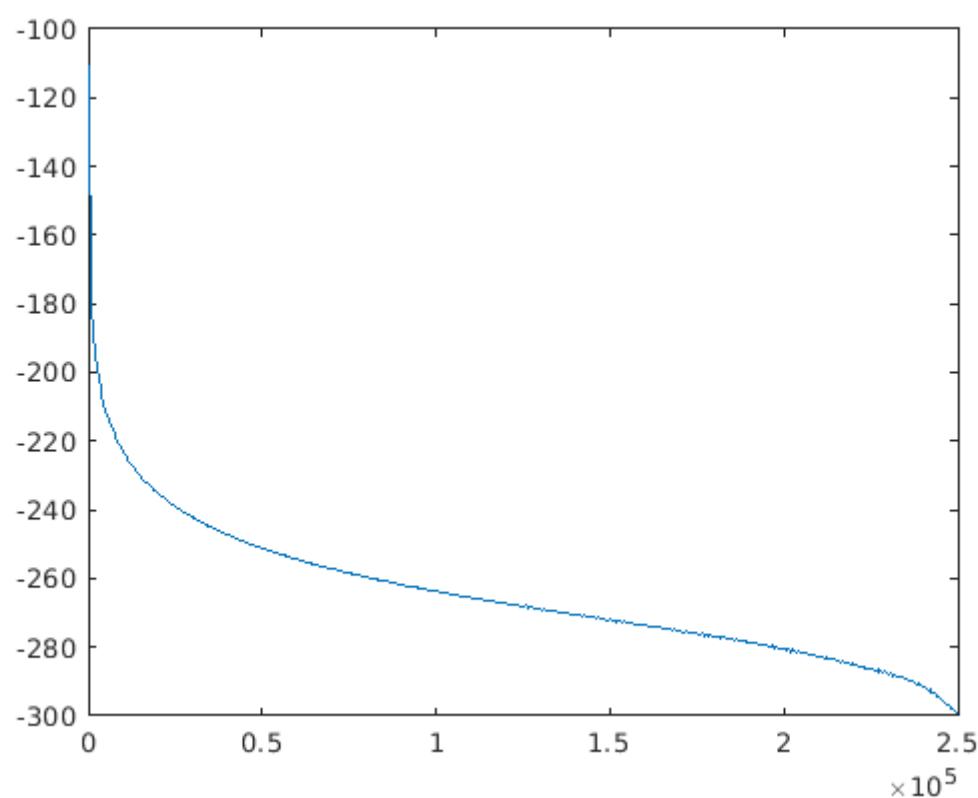
Error: measure f2 find(AT) : out of interval
meas ac f2 find frequency when vdb(nvout)=cutoffmag cross=last failed!

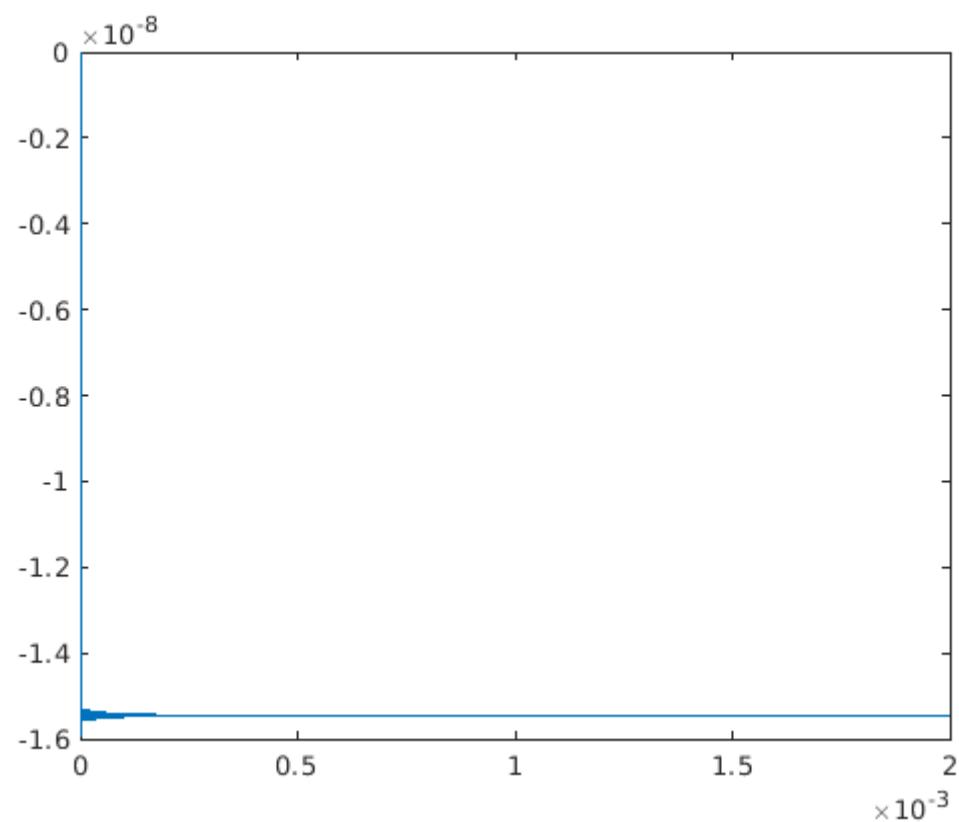
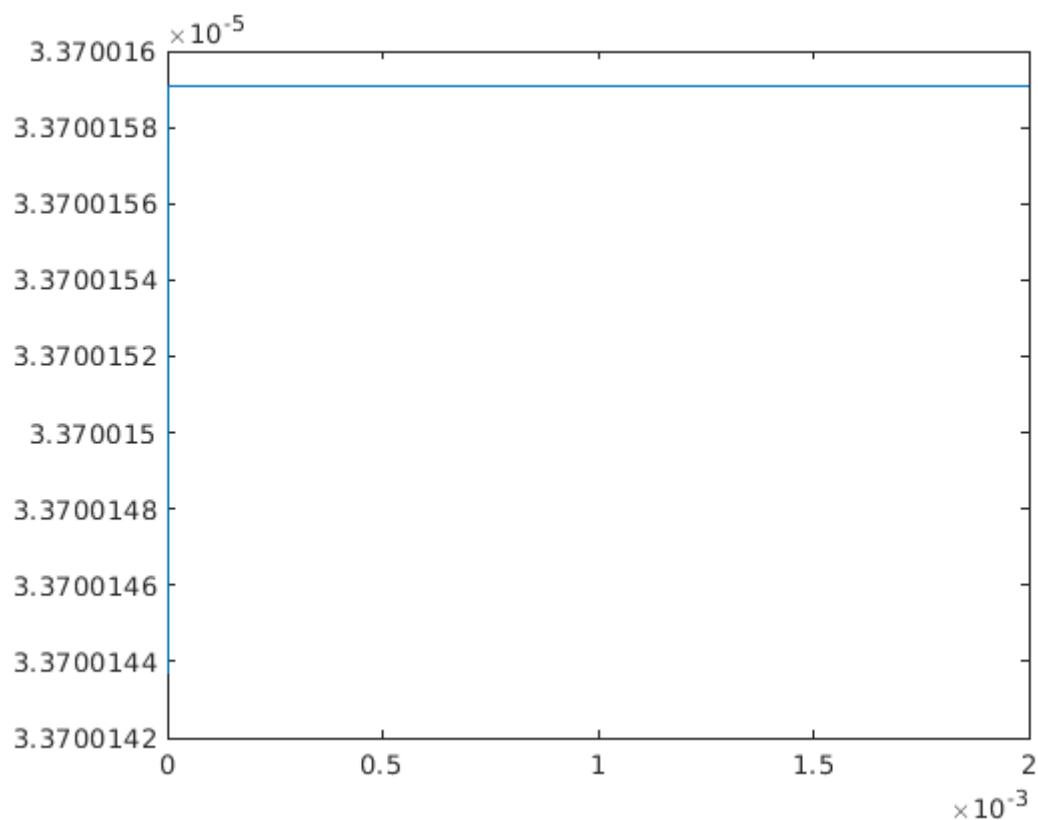
Error: &maxdb: no such variable.
Max dB =
Error: &fl: no such variable.
Lower Cutoff Frequency =
Error: &f2: no such variable.
Higher Cutoff Frequency =
```

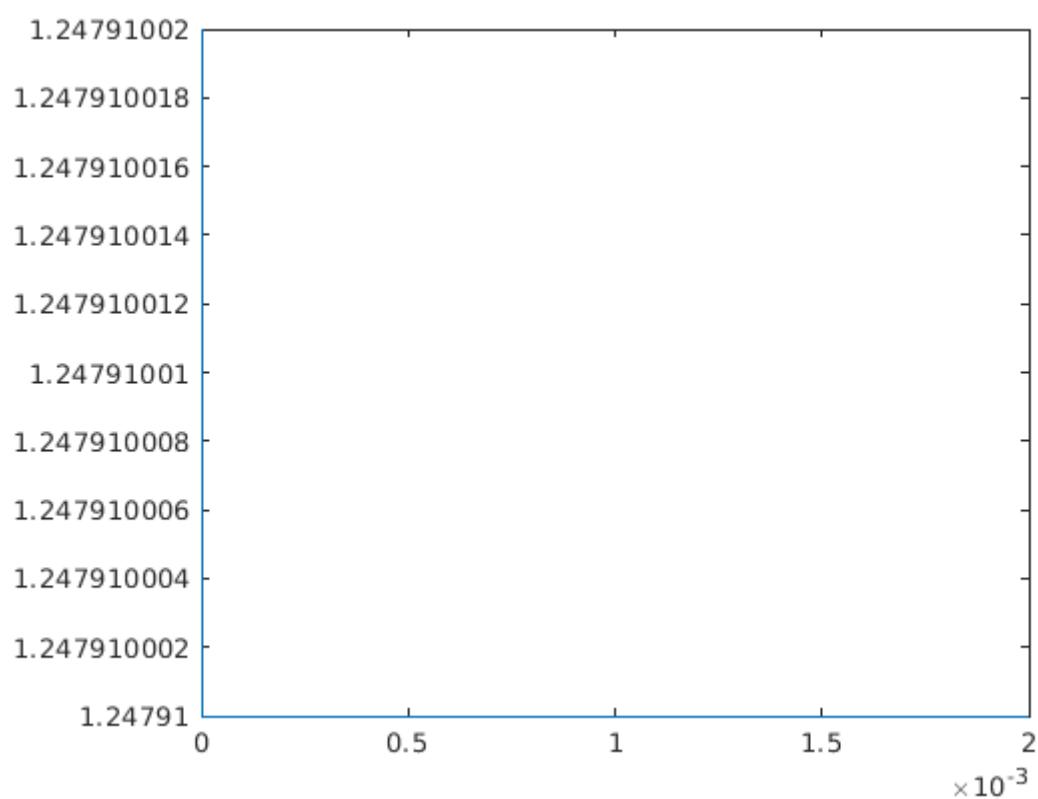
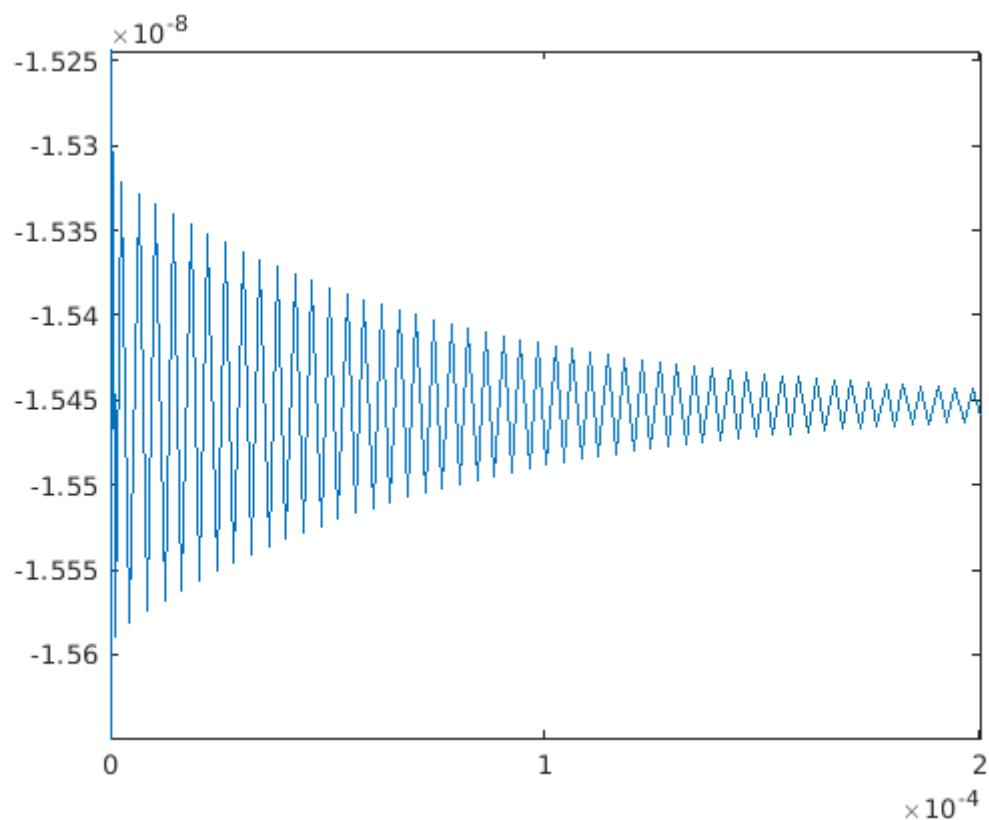
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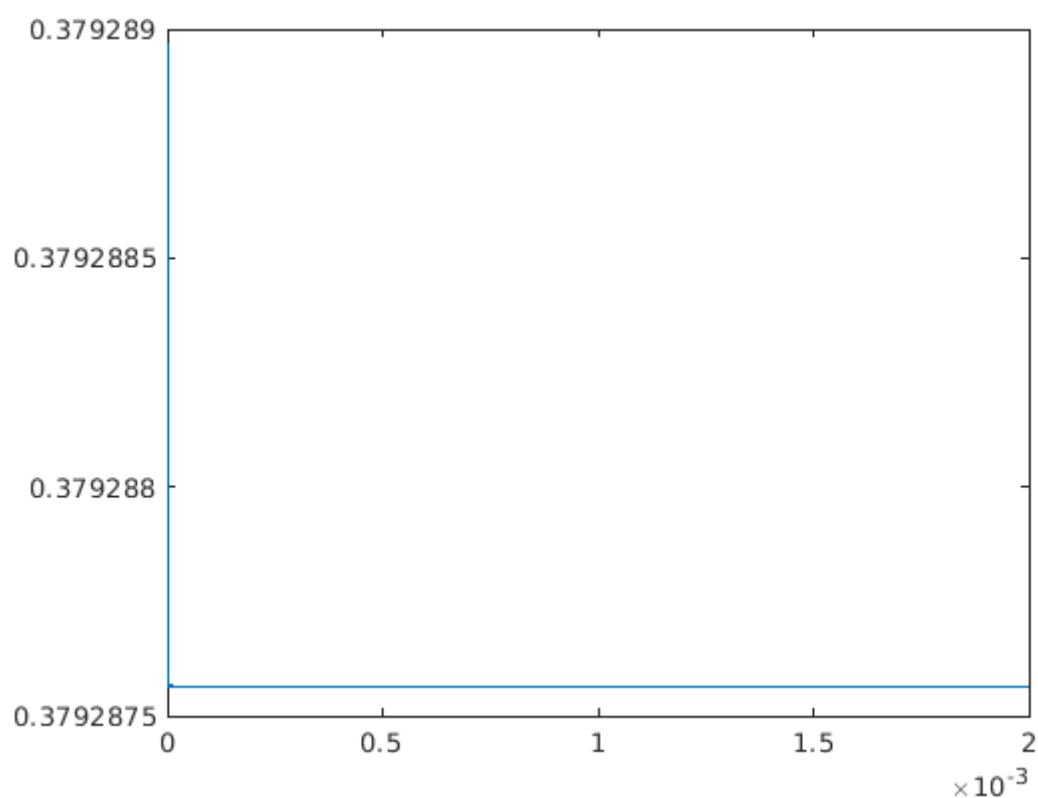
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A = 0.02





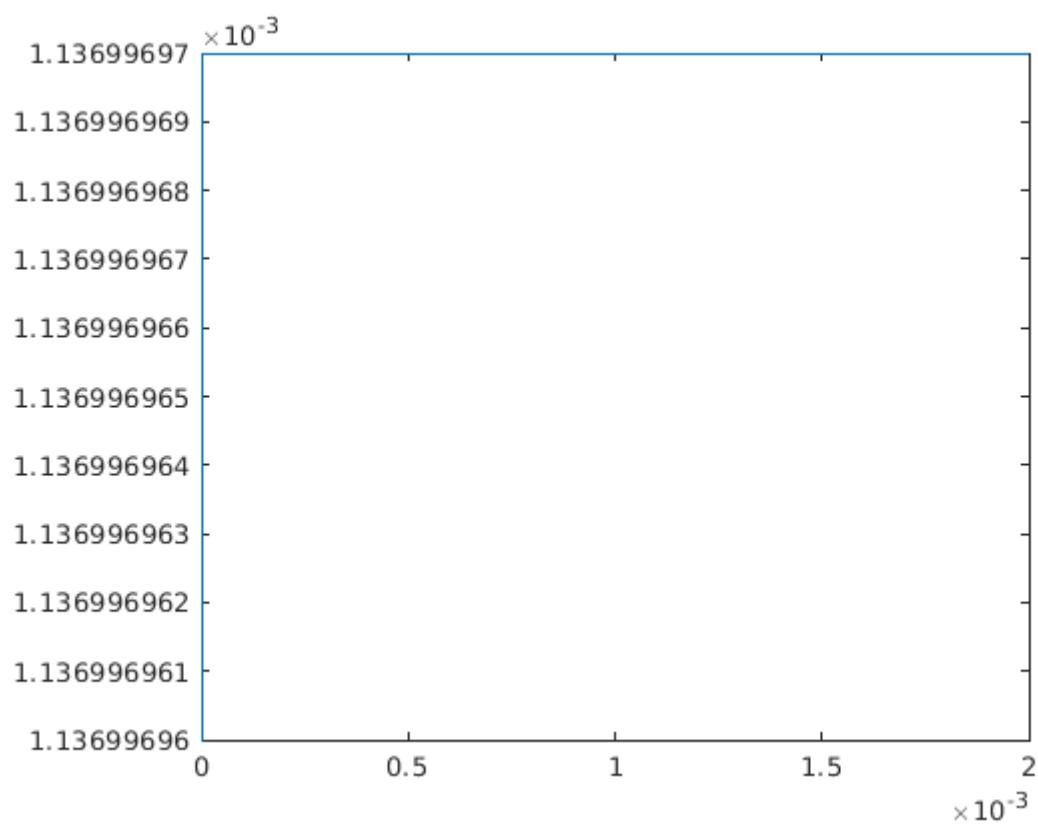
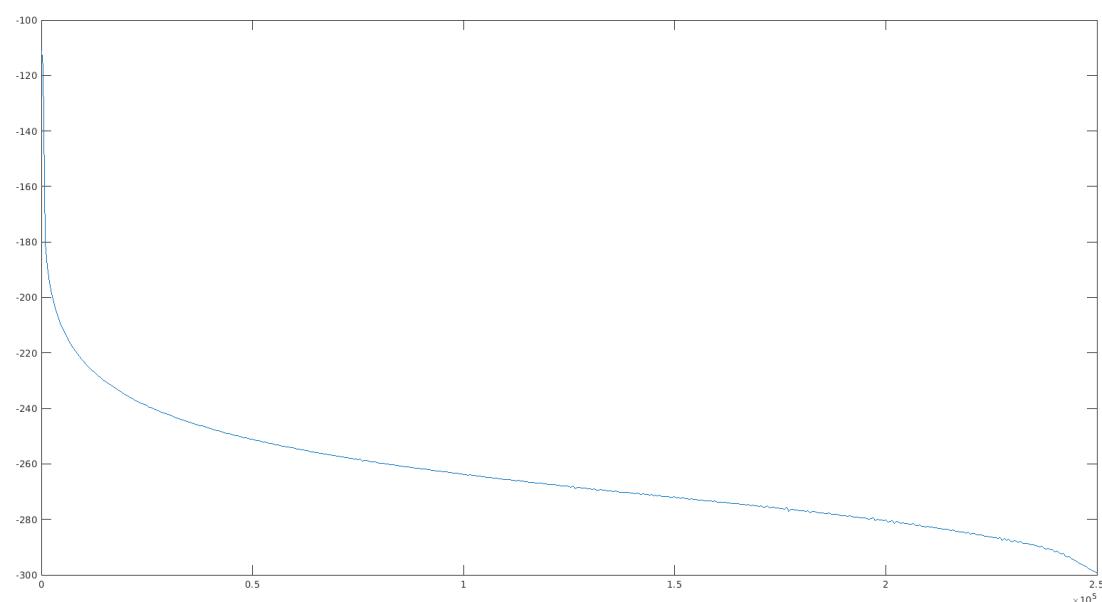


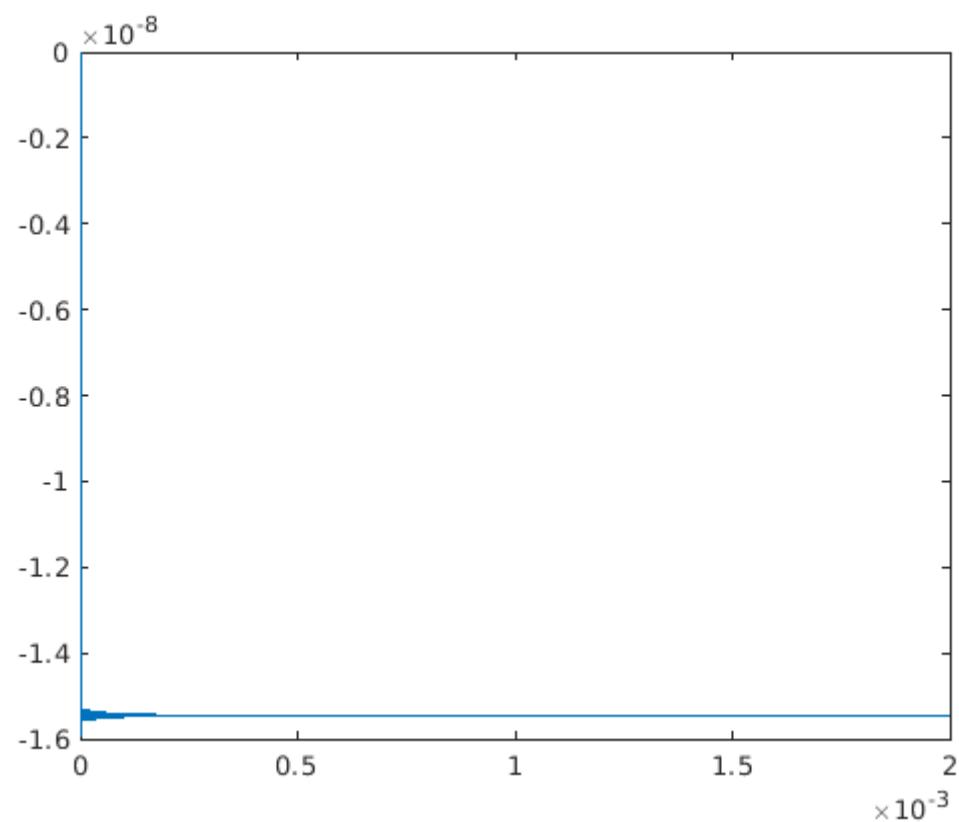
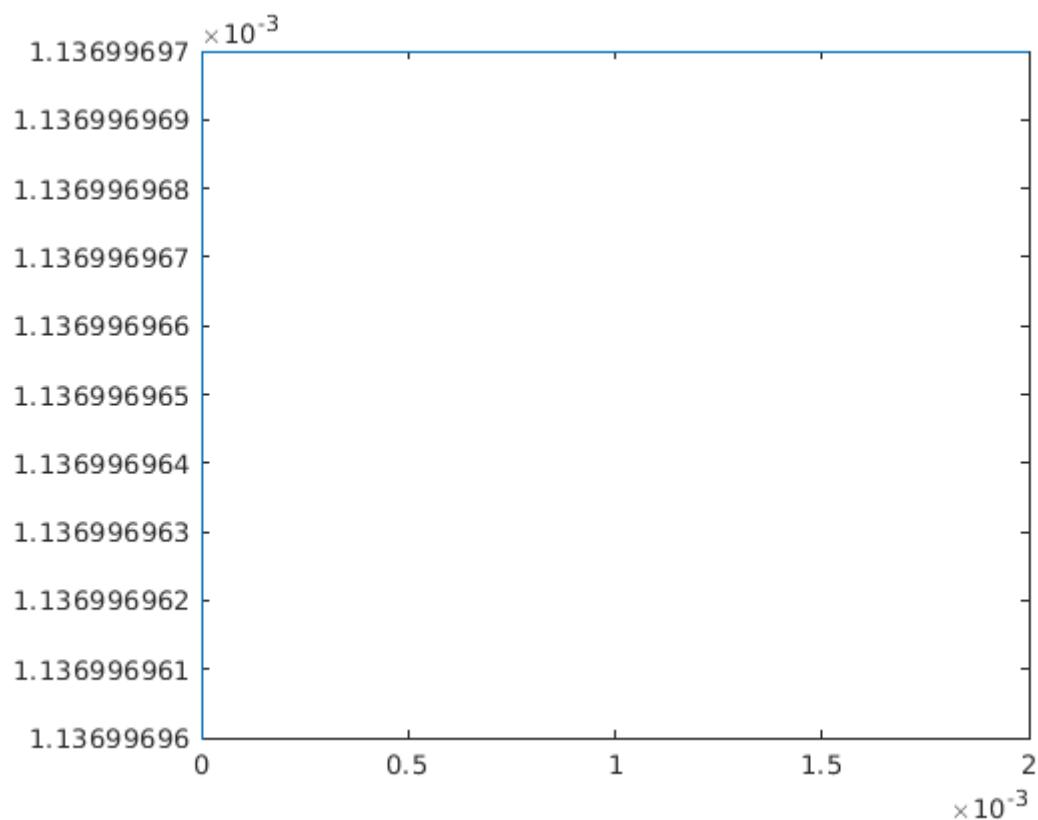


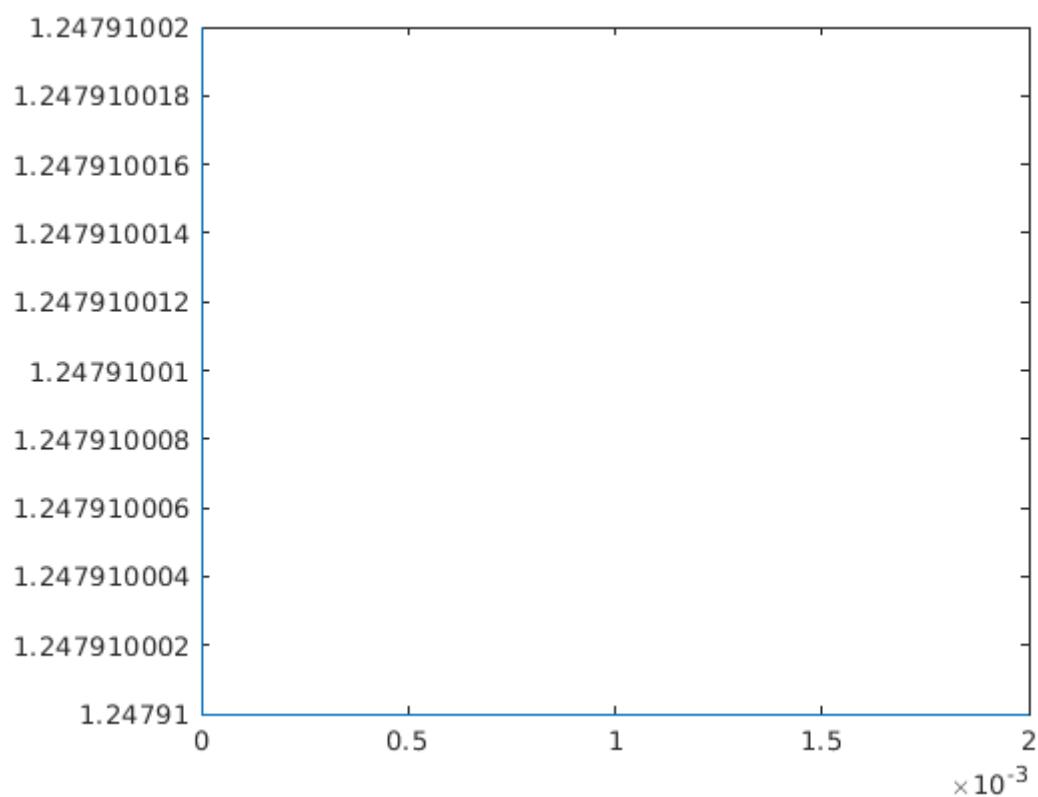
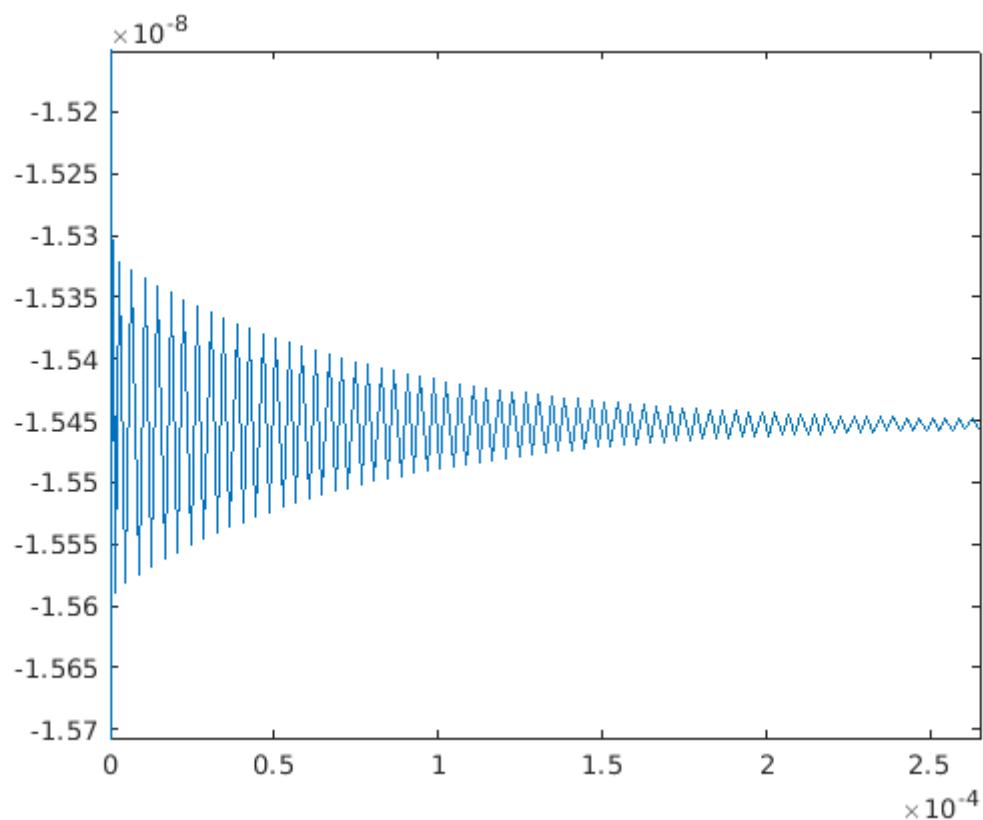
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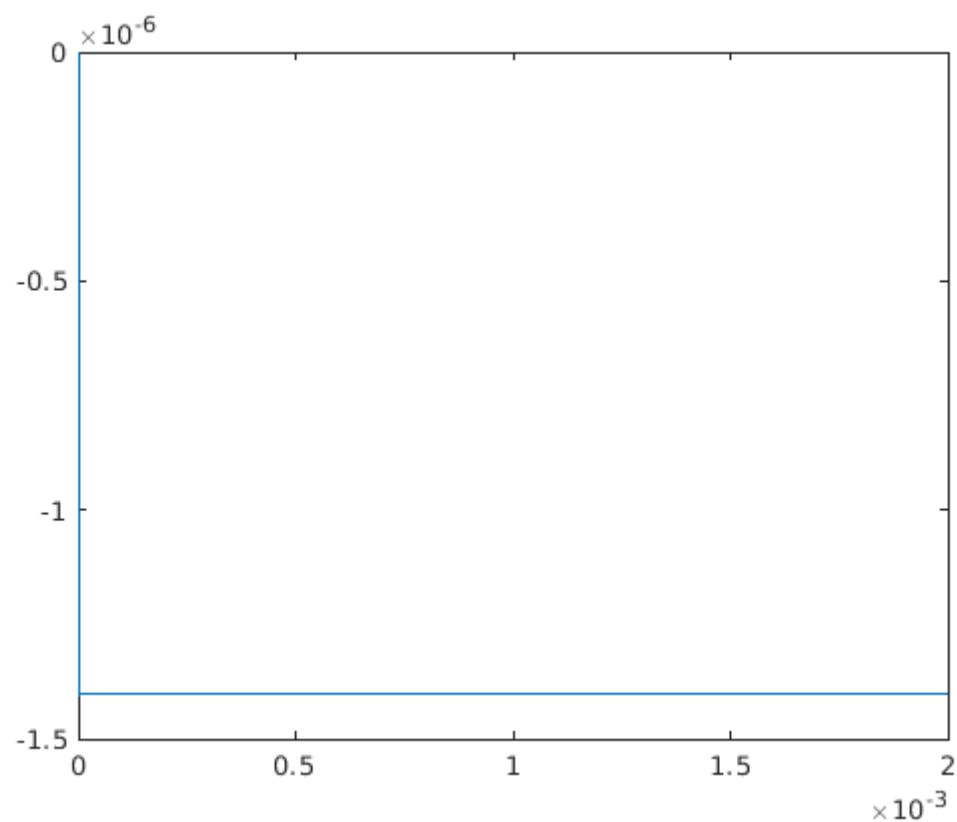
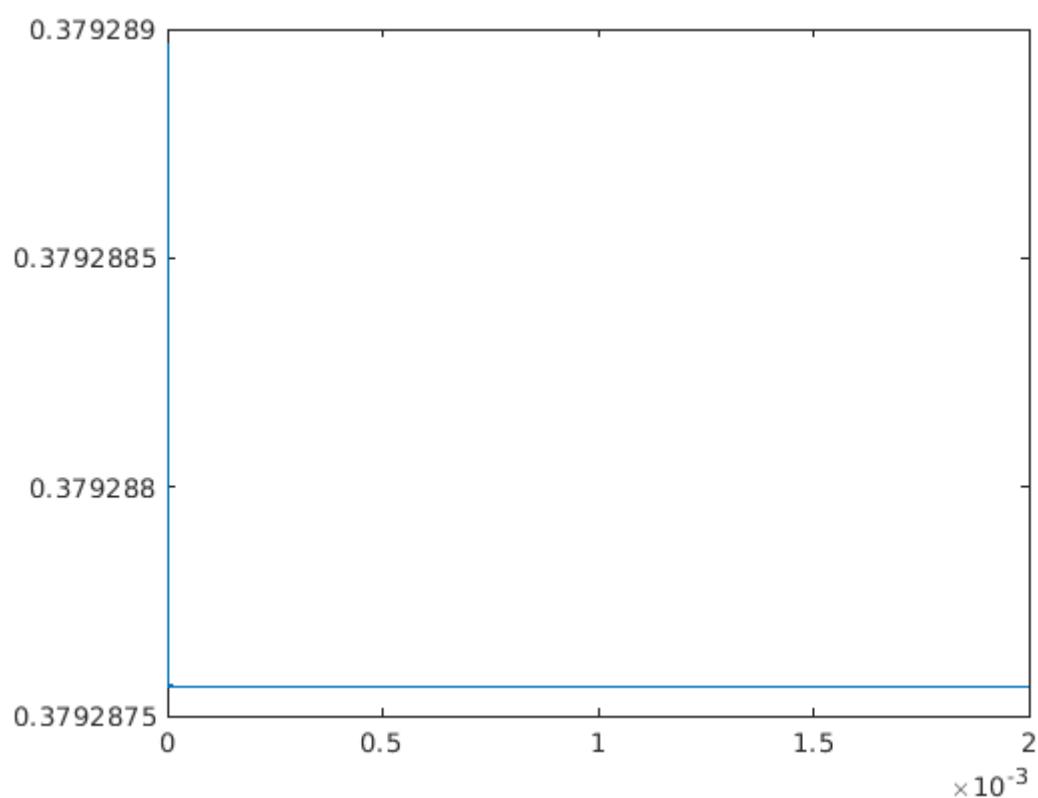
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A = 0.01





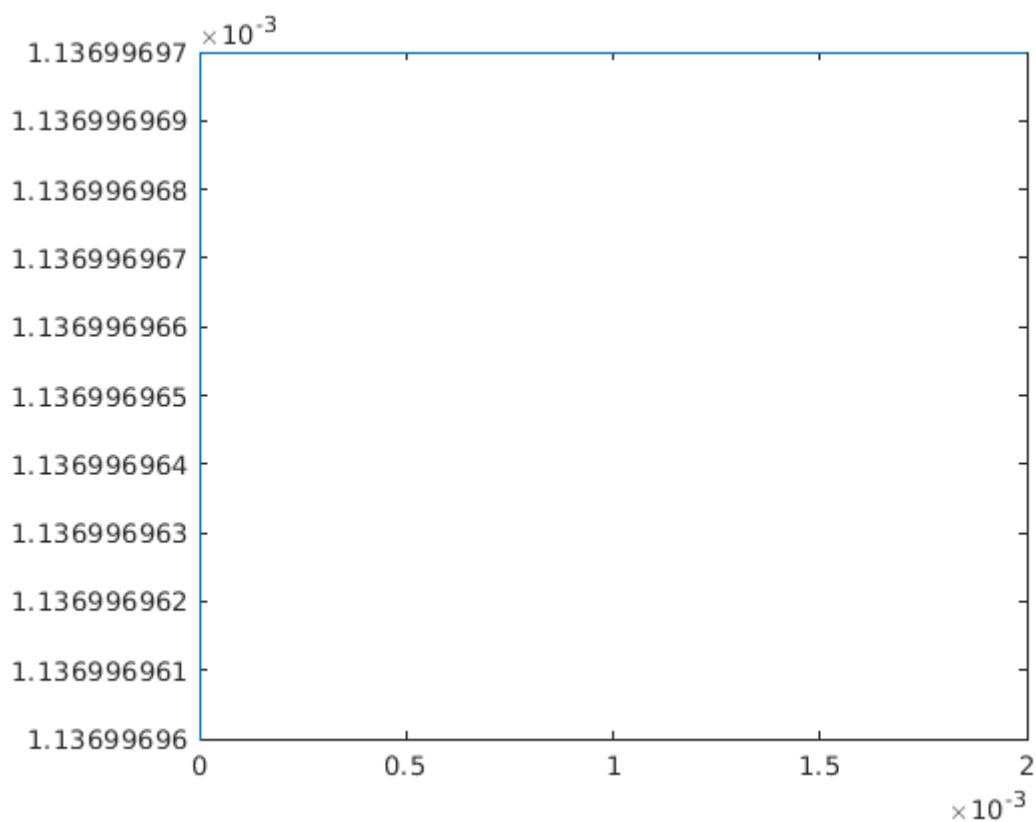
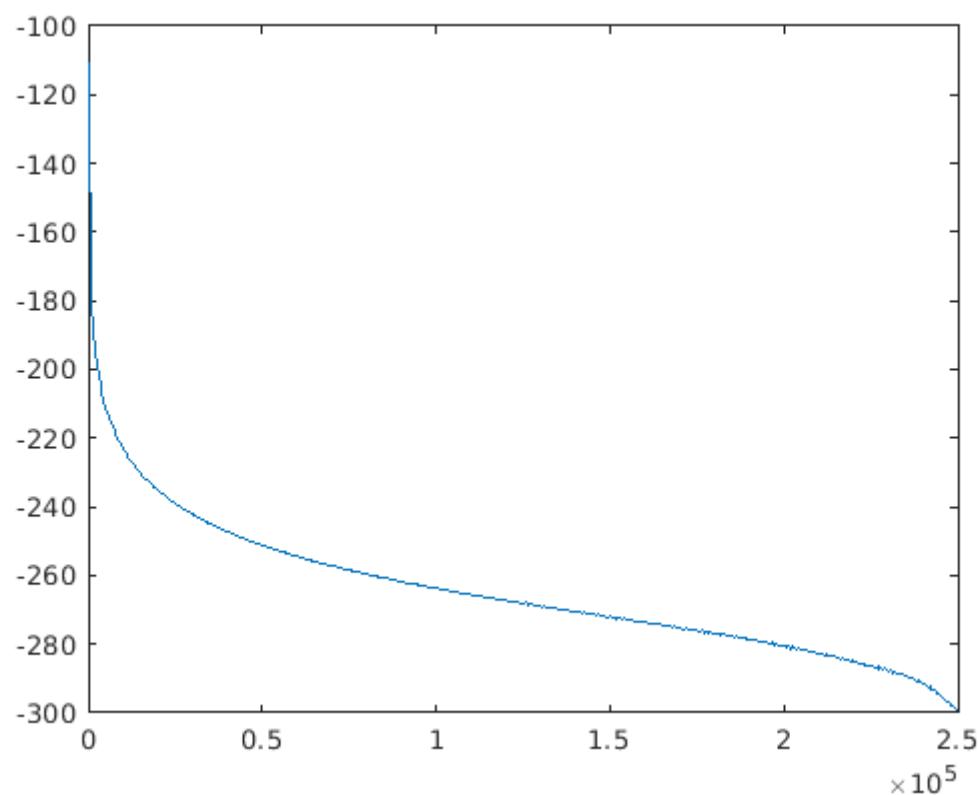


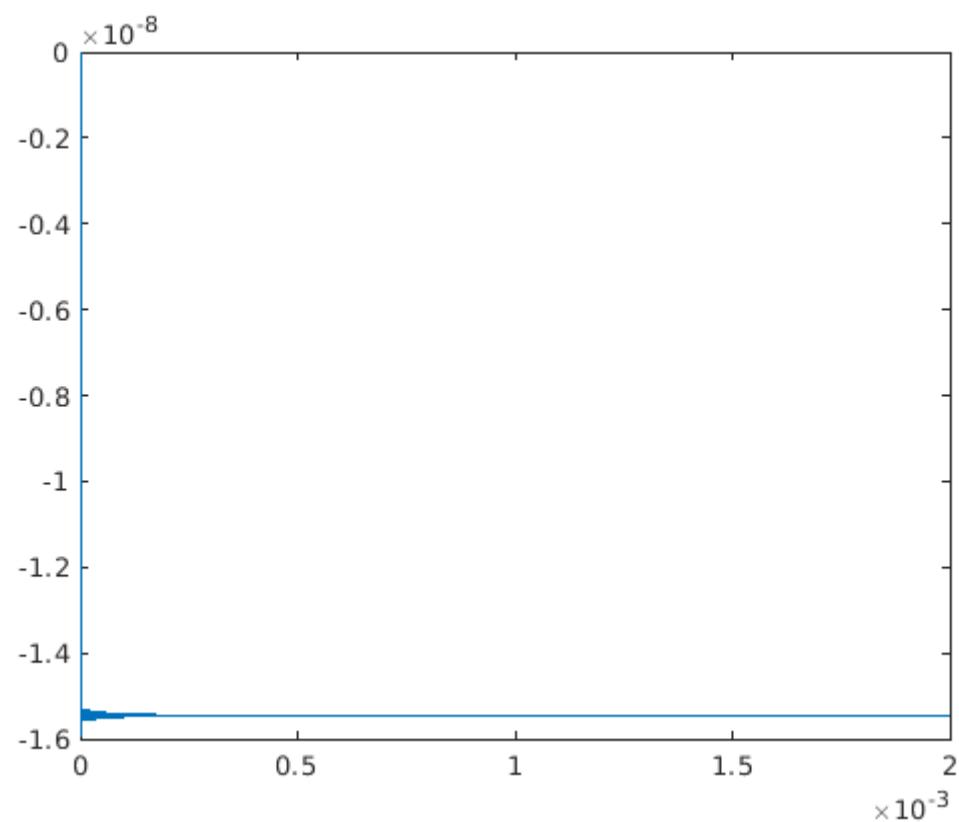
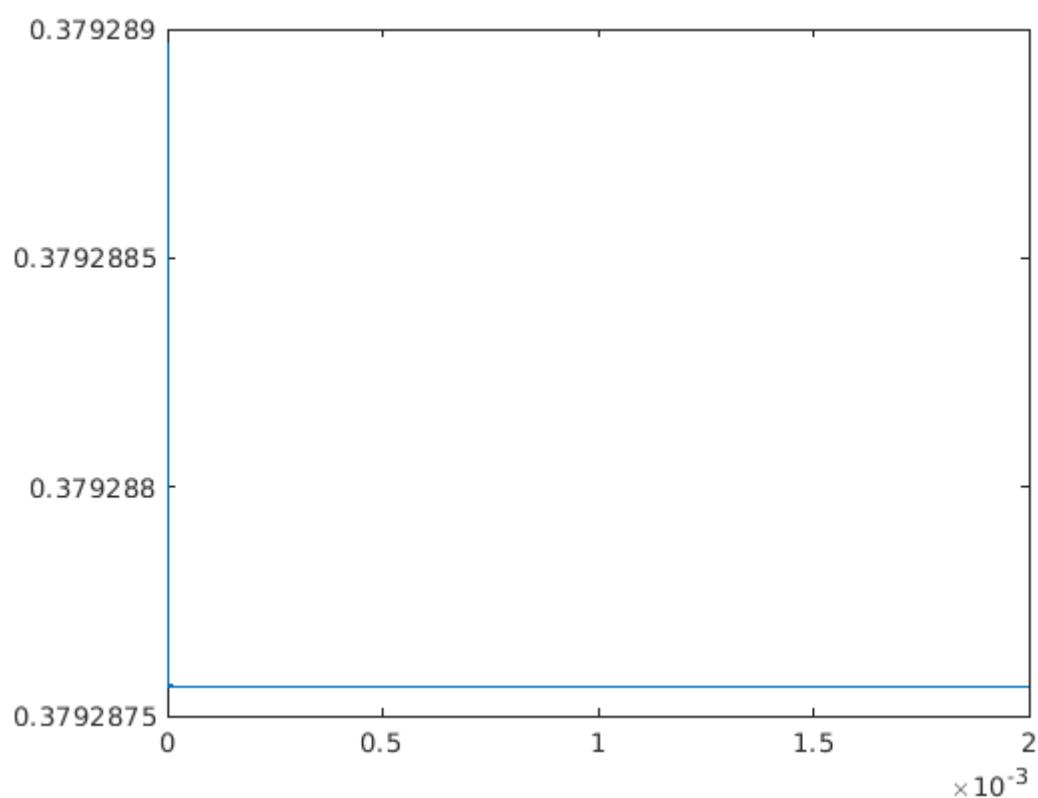


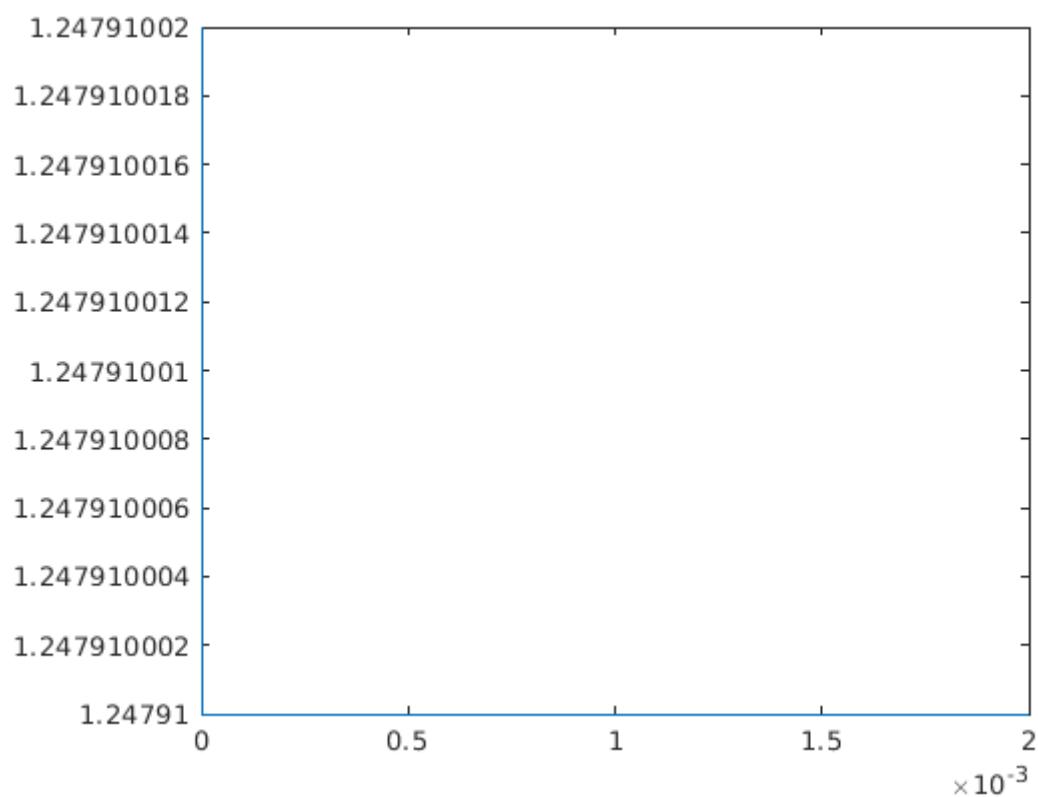
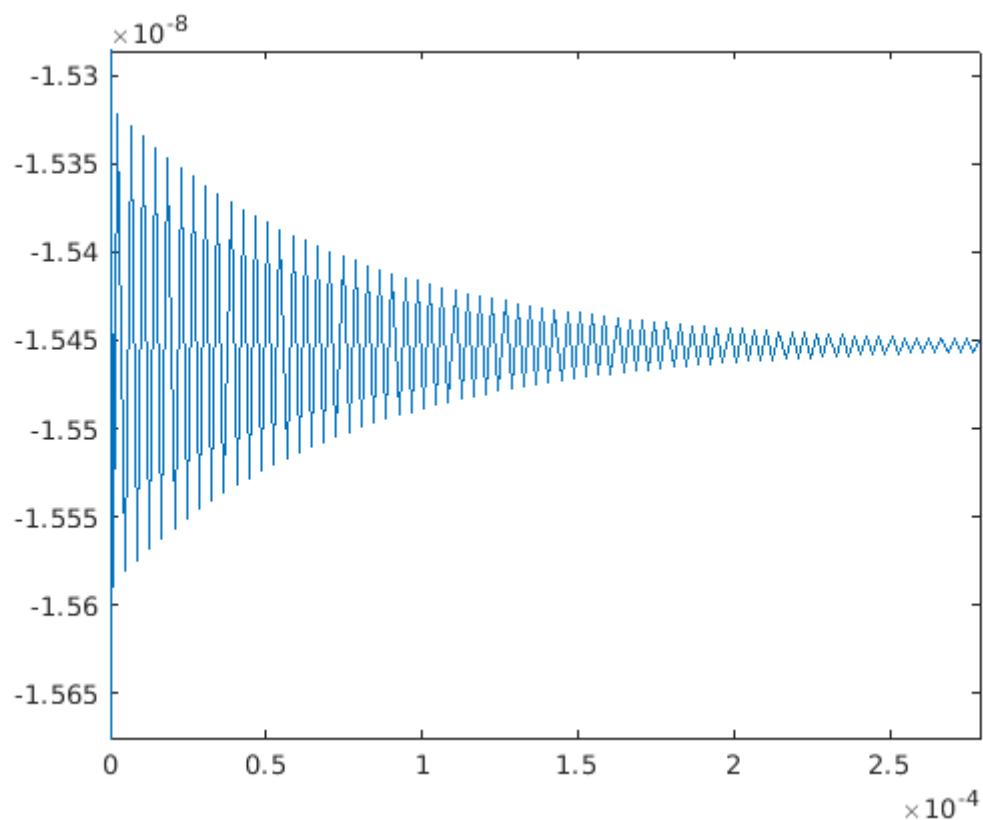
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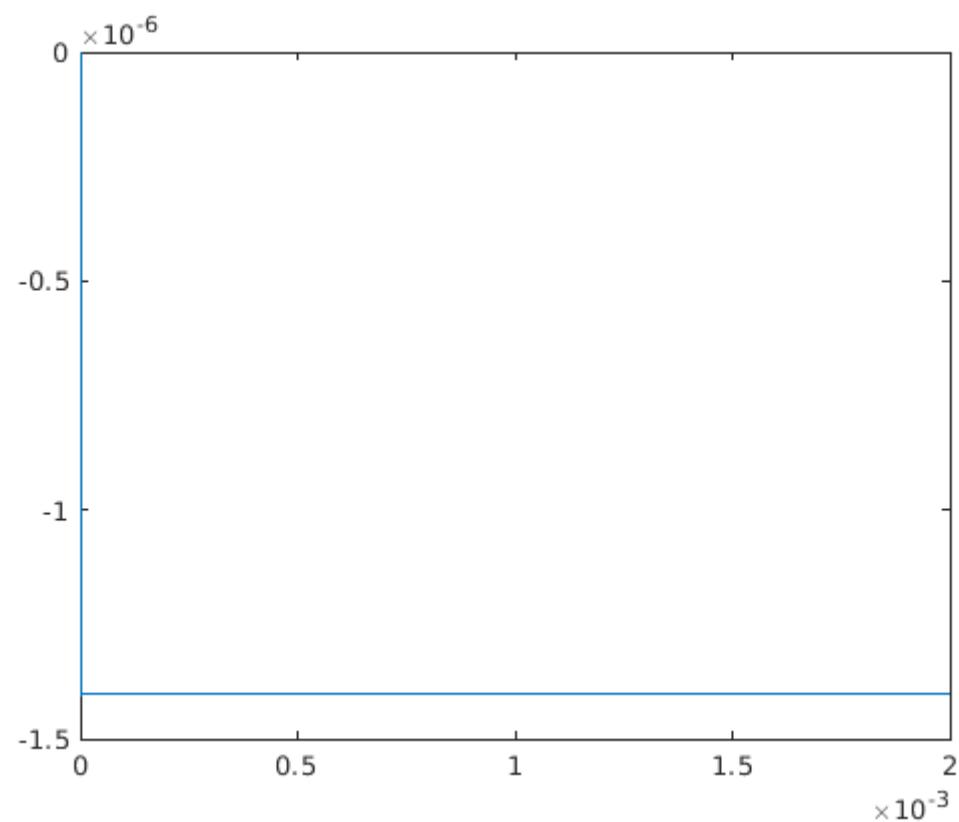
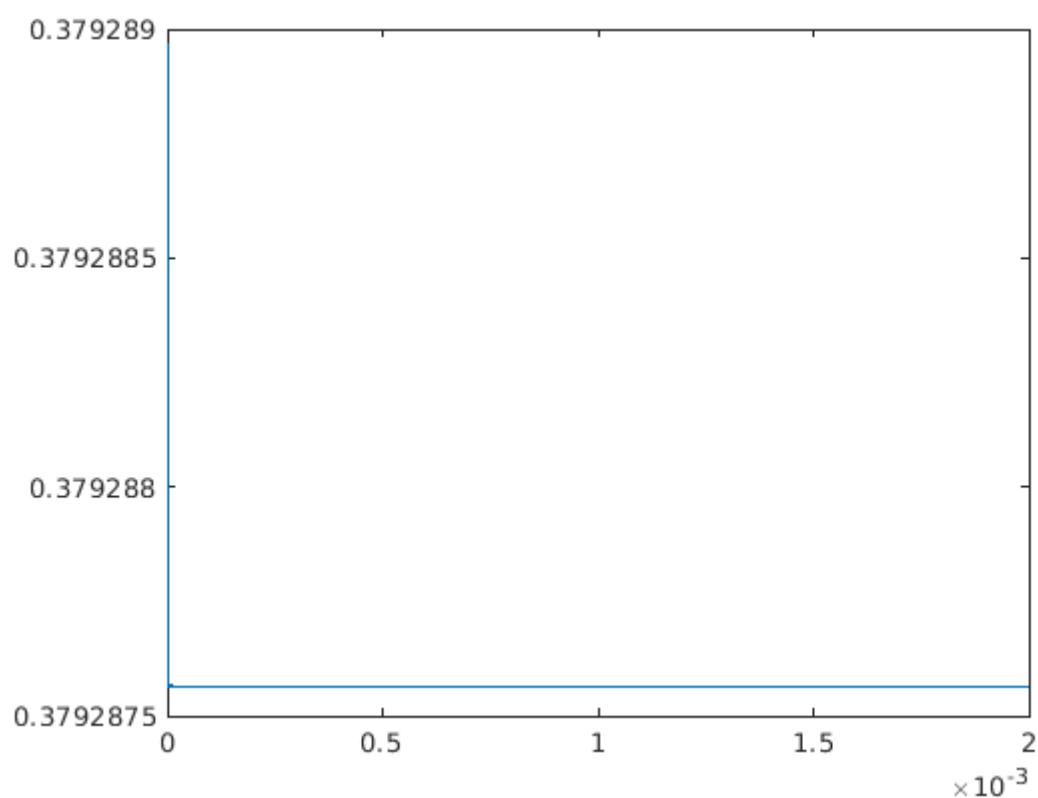
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A = 0.005









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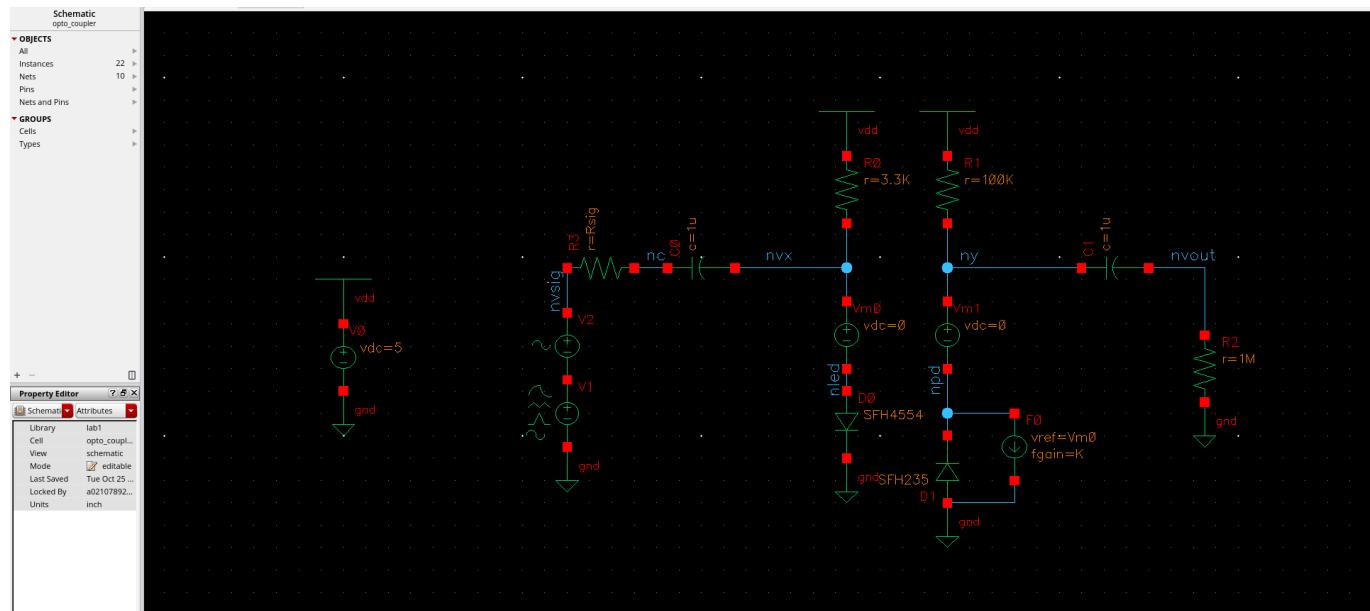
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# Optoelectronics Cadence

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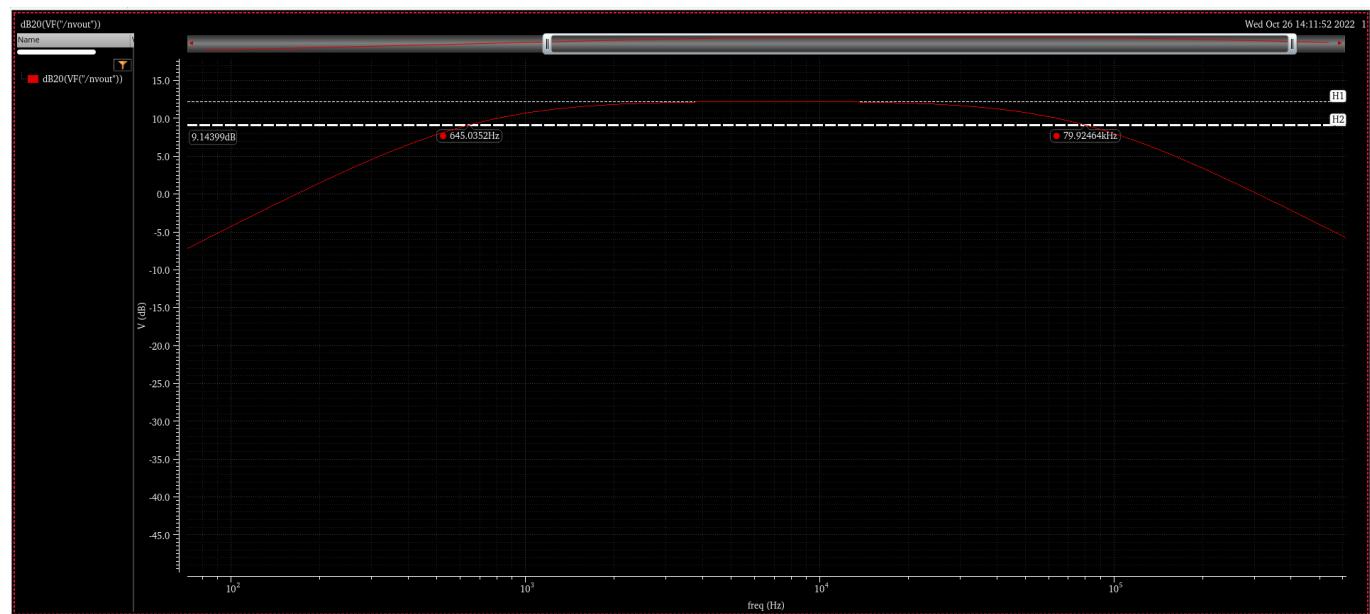
I followed the tutorial videos for going through the Cadence software and outputting the waveforms.

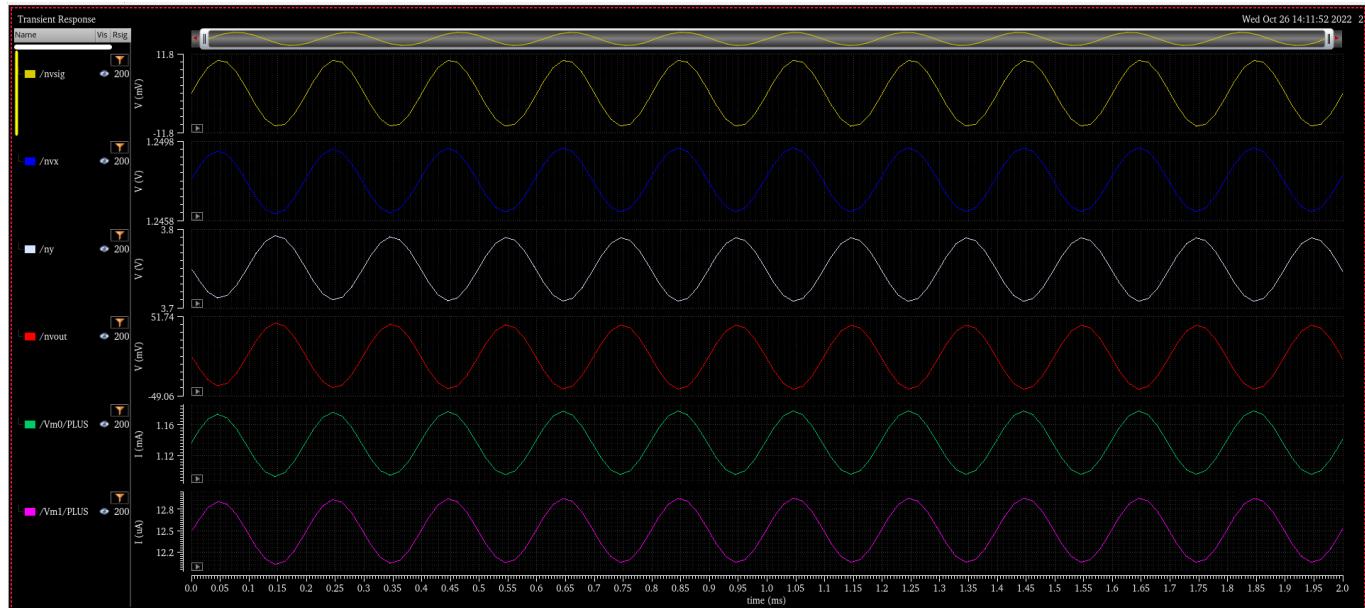
Here is the circuit modeled:



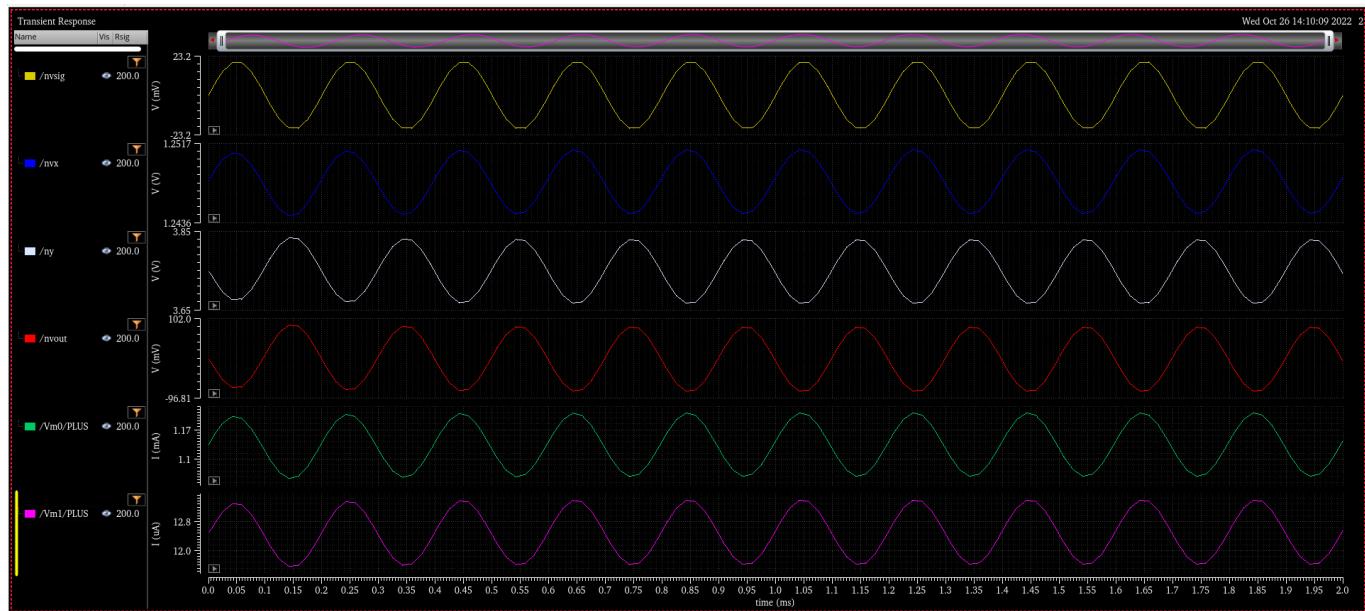
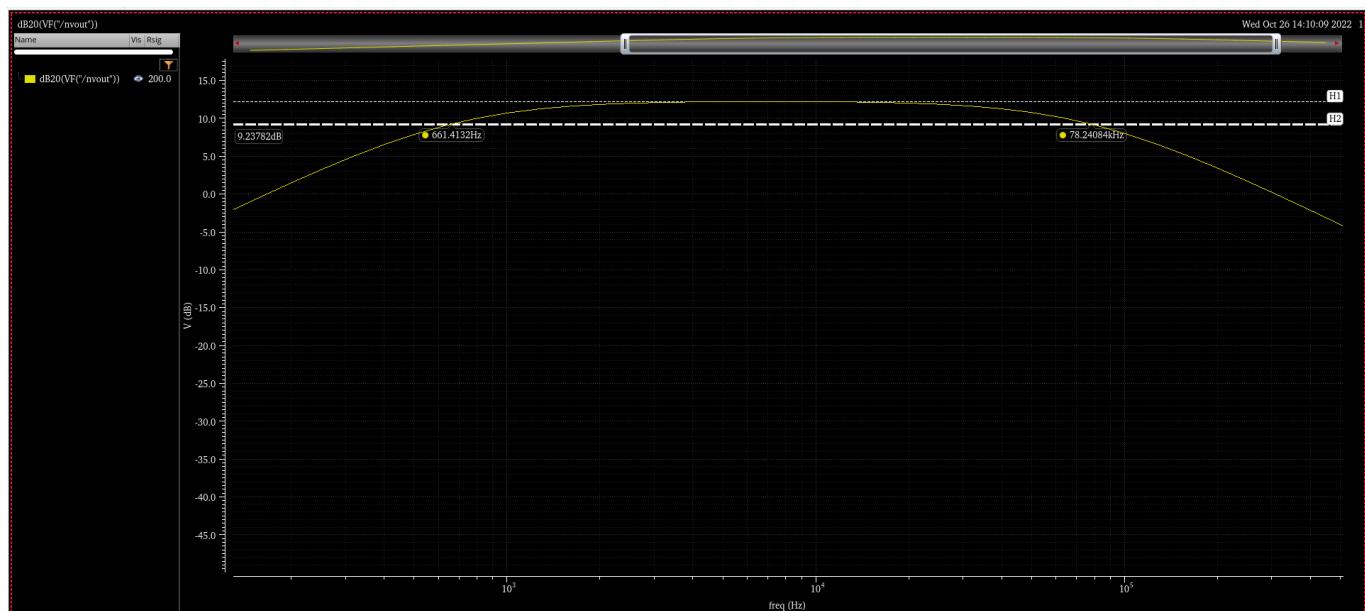
Here are the AC and transient response waveforms for the various amplitudes:

$A = 0.01$

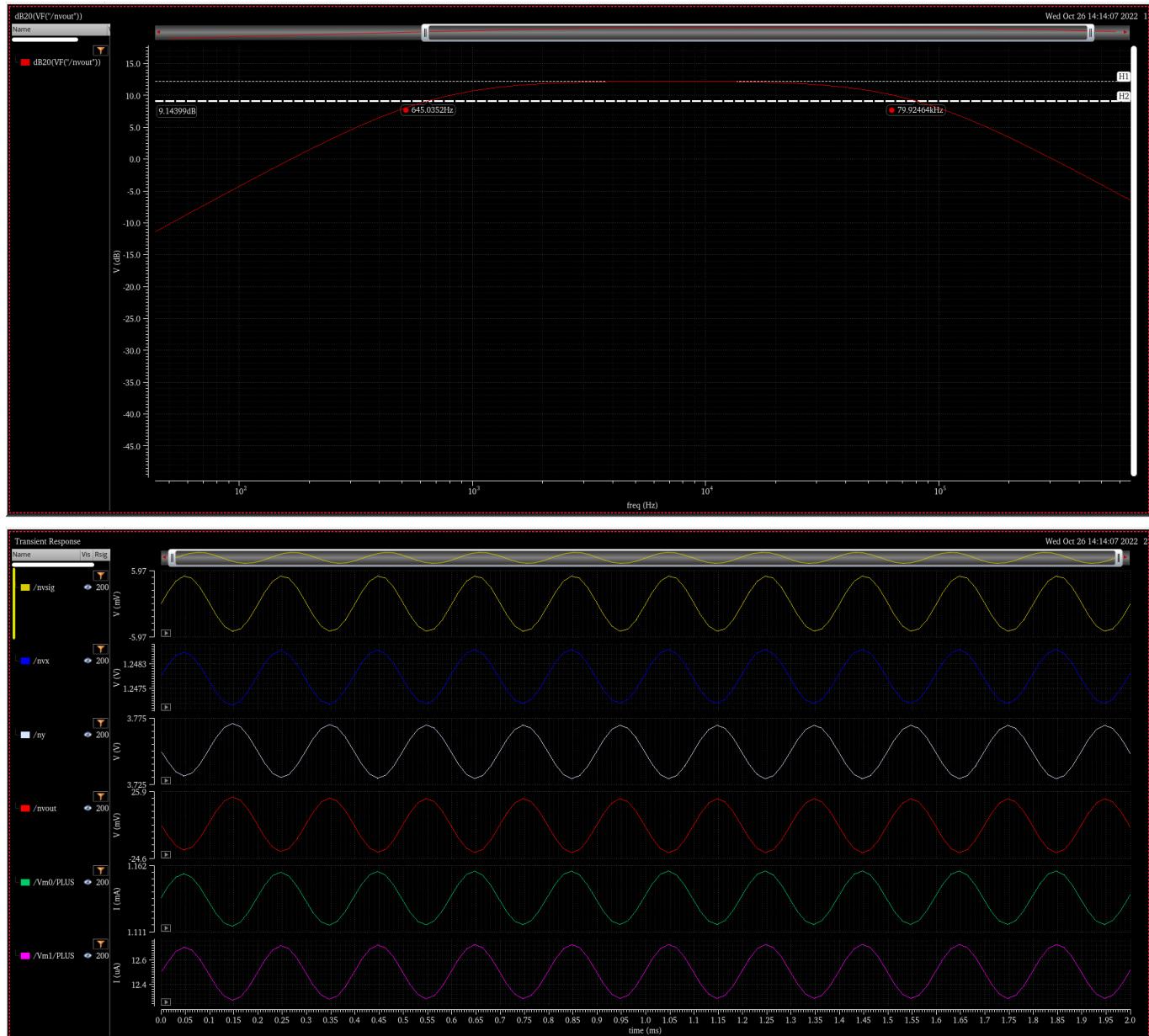




**A = 0.02**



A = 0.005



## 3dB Points

A	Low 3dB [Hz]	High 3dB [Hz]
0.01	645.0352	79.92464 k
0.02	661.4132	78.24084 k
0.005	645.0352	79.92464 k

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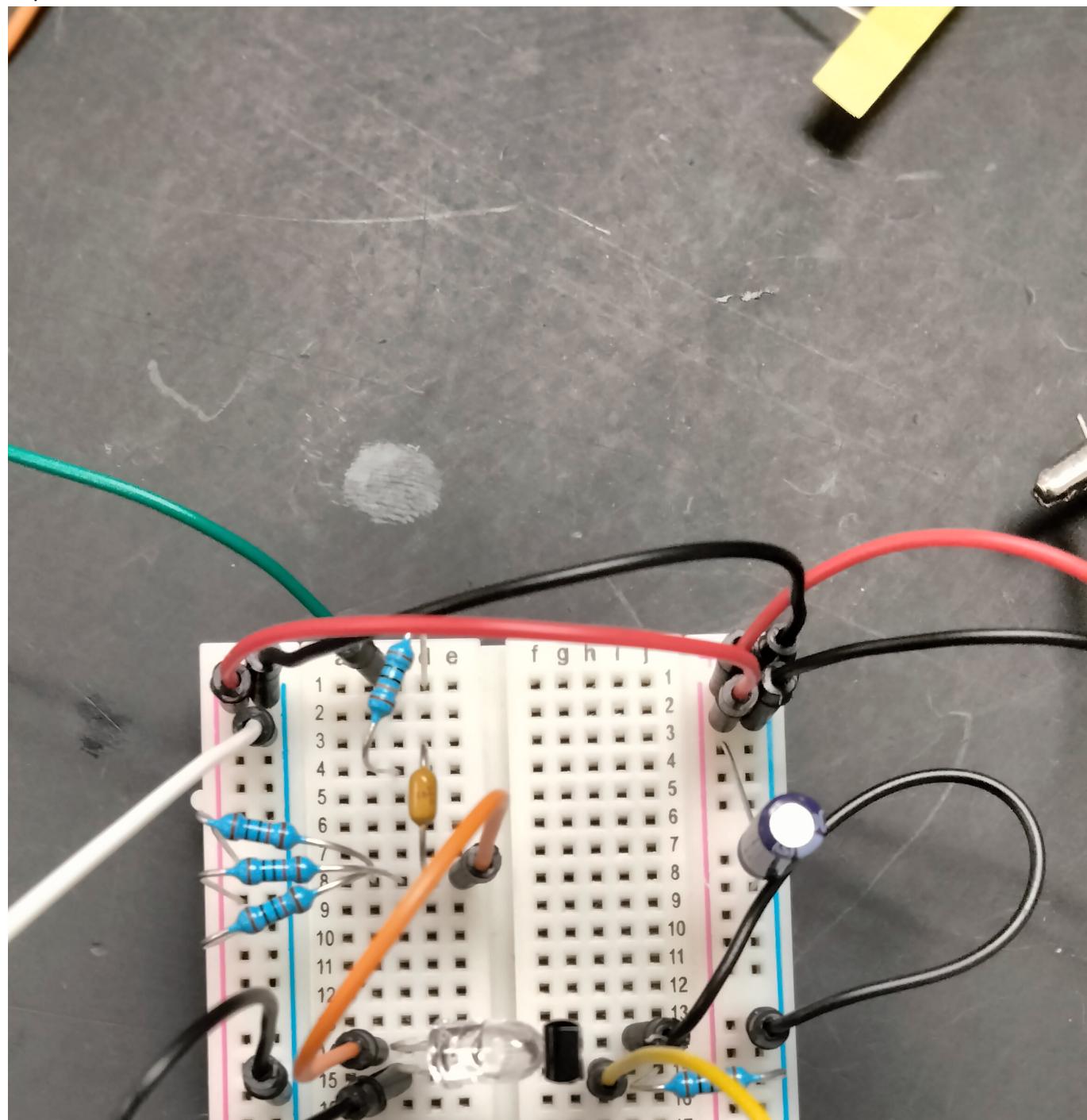
# Optoelectronics Physical Lab

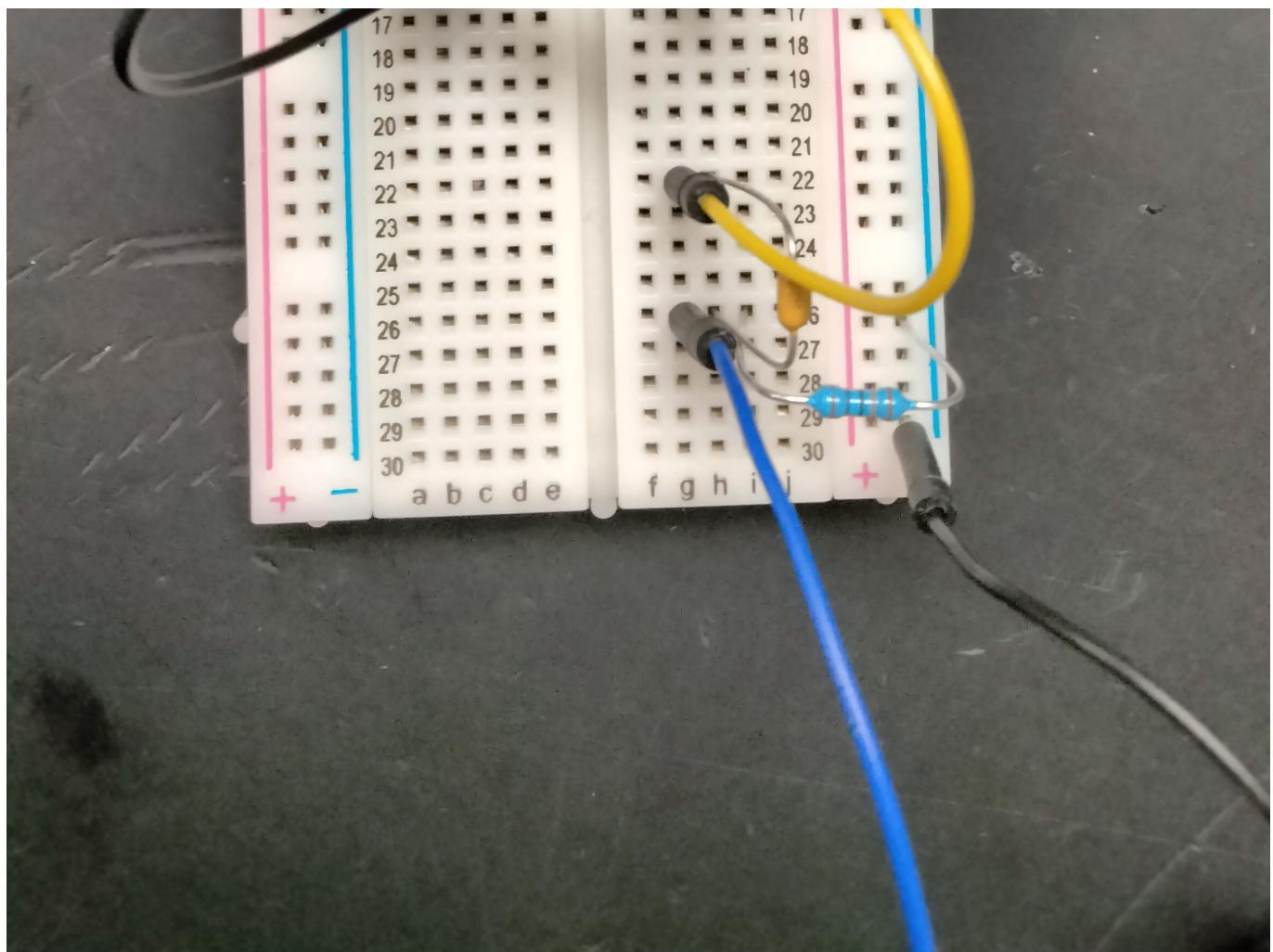
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I did setup the physical circuit, but due to lab equipment limitations in EL104, I wasn't able to get precise measurements. I also wasn't able to get a sin wave to show on the oscilloscope, but I think it's due to the signal loss across the circuit.

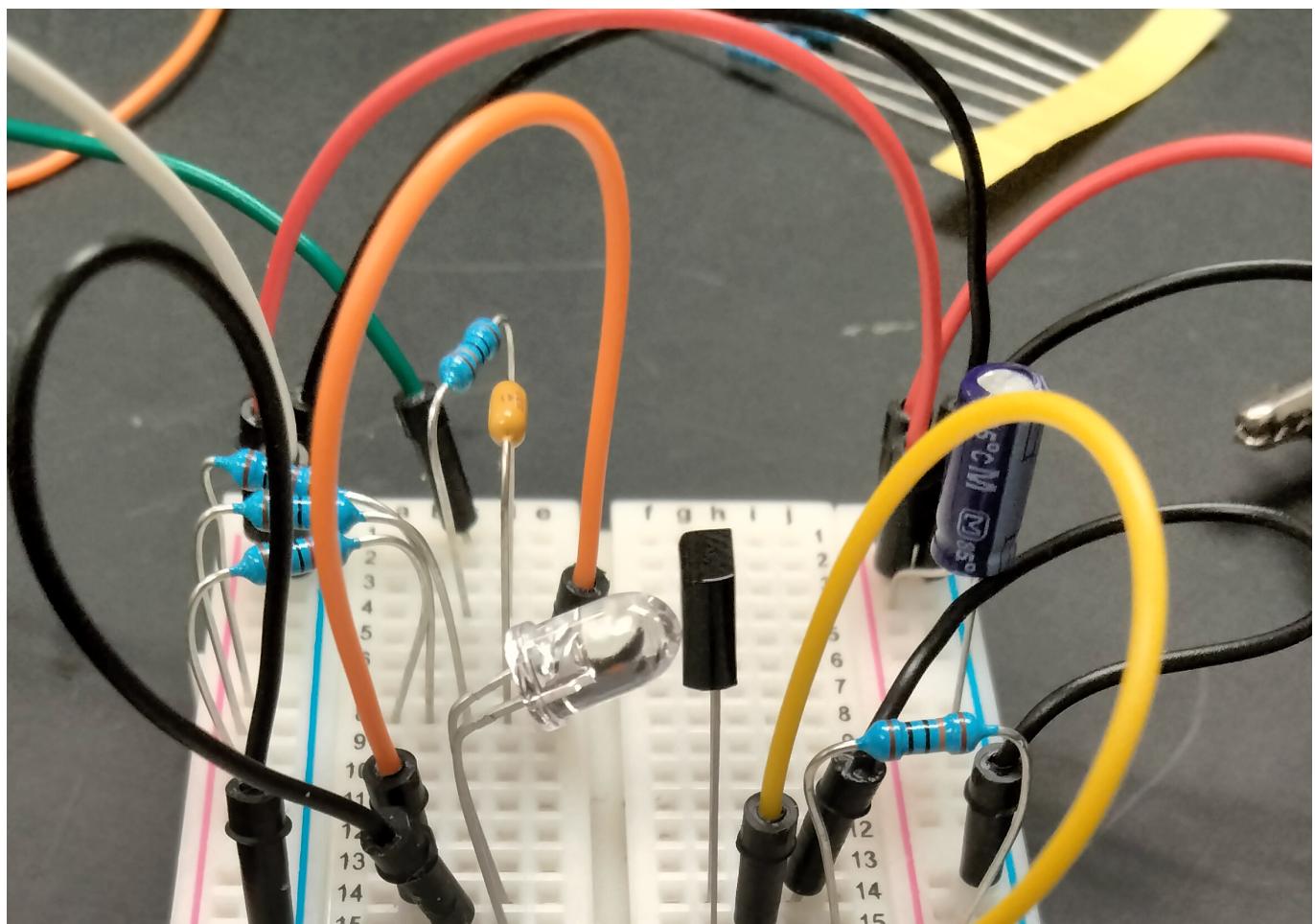
Here are the images of the circuit that I set up:

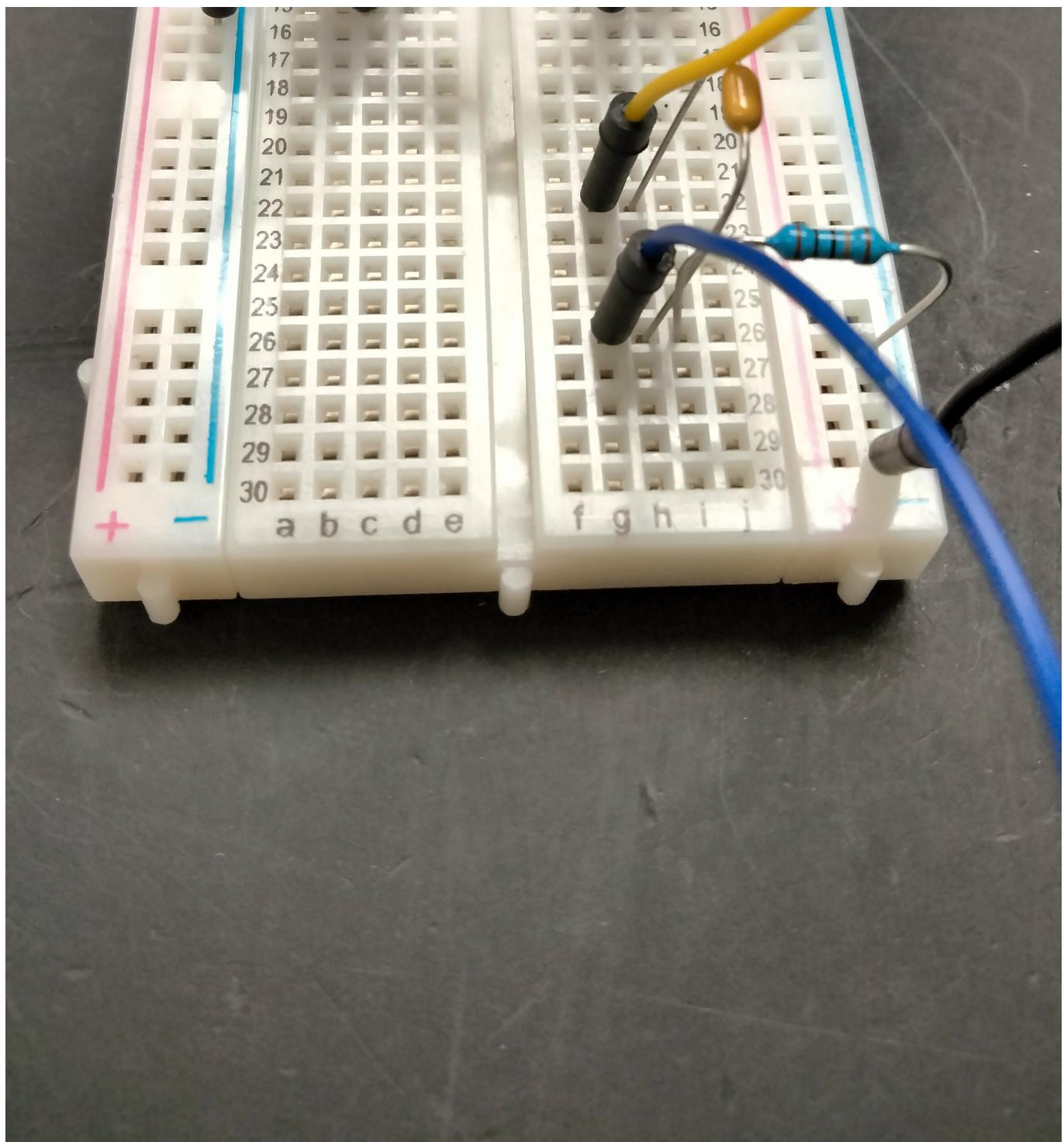
Top:



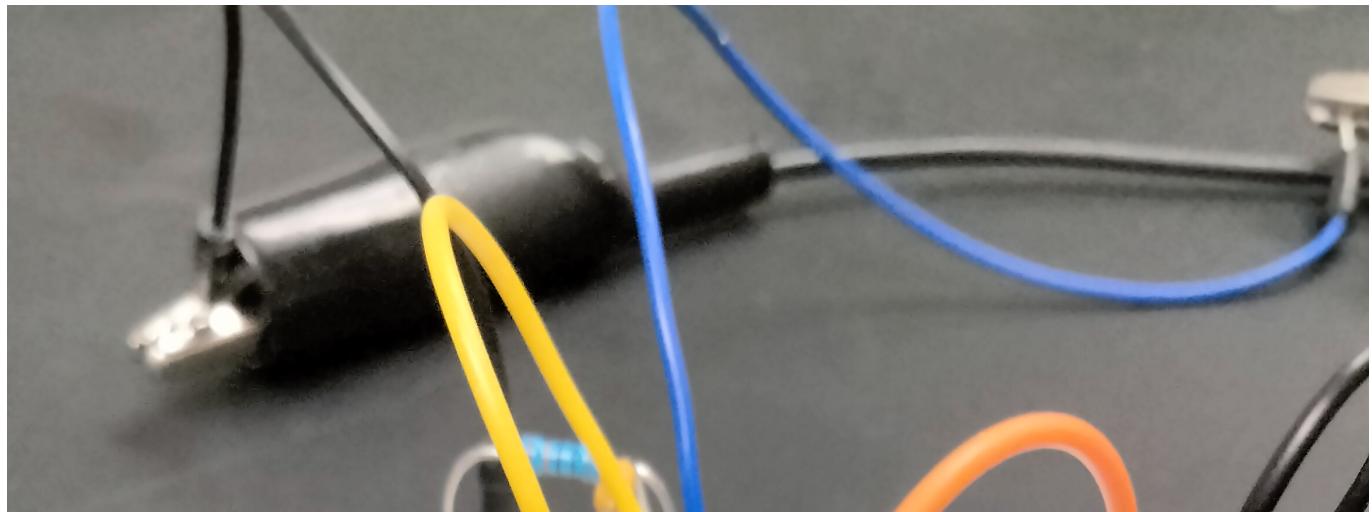


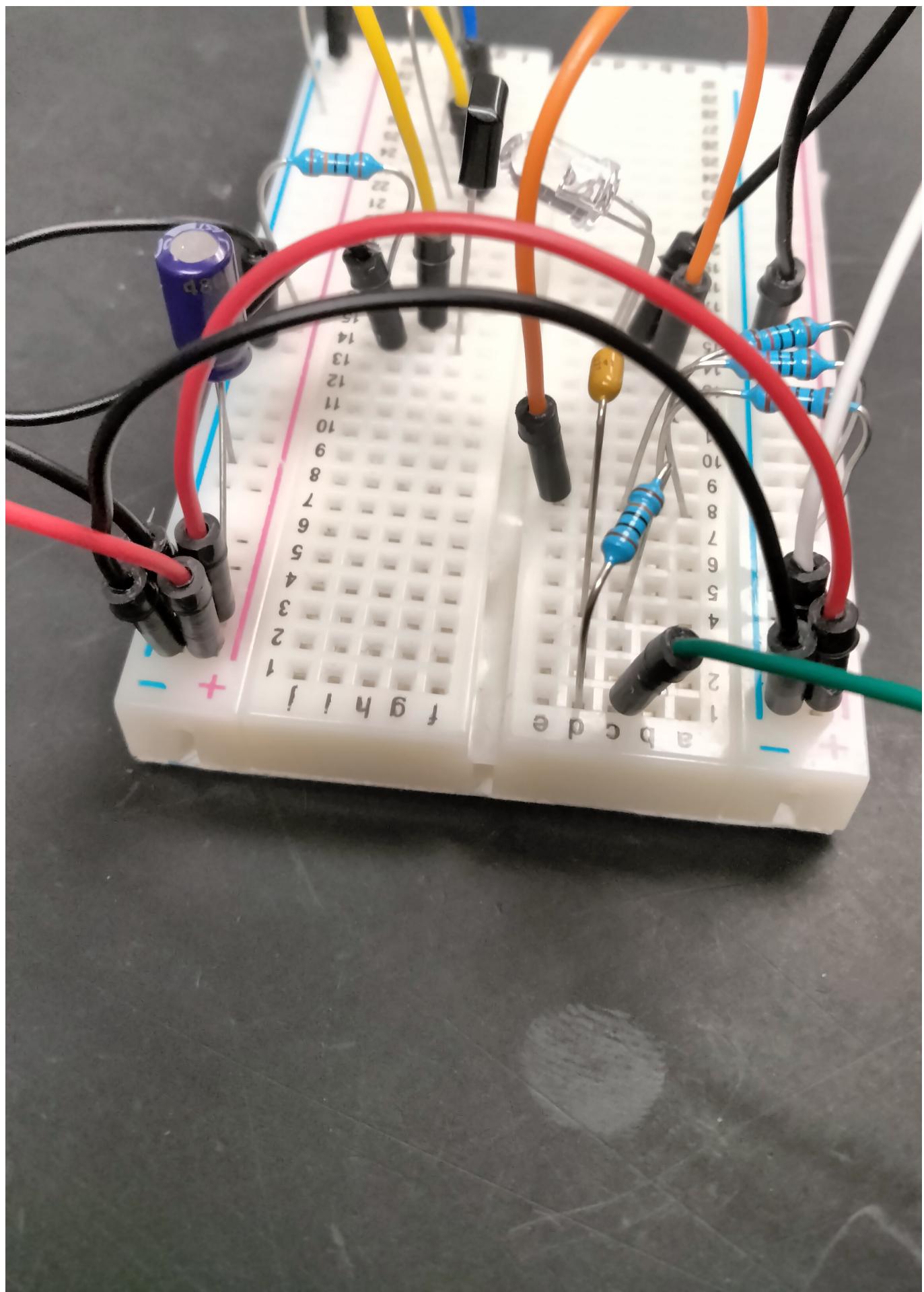
Front:





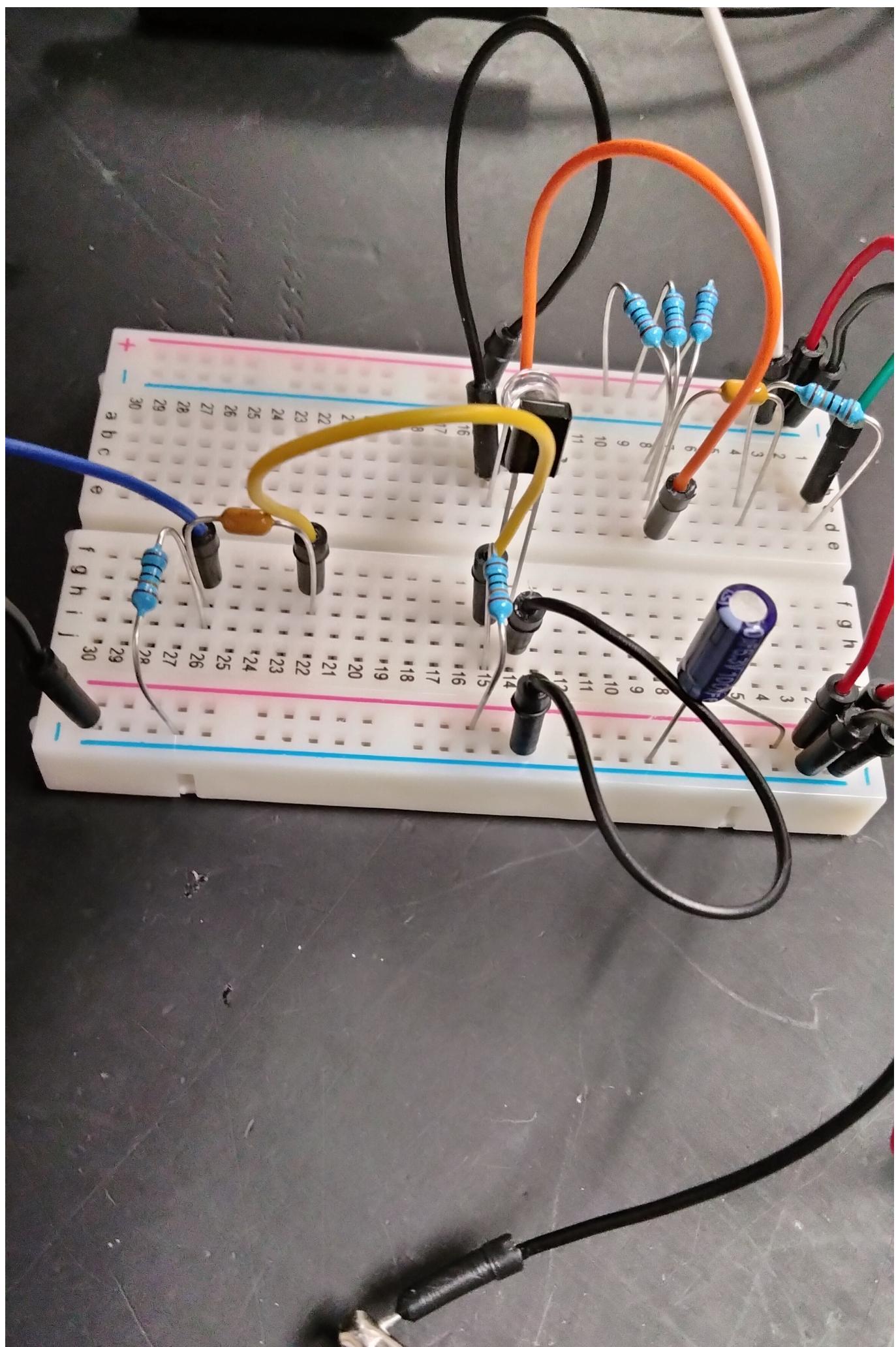
Back:





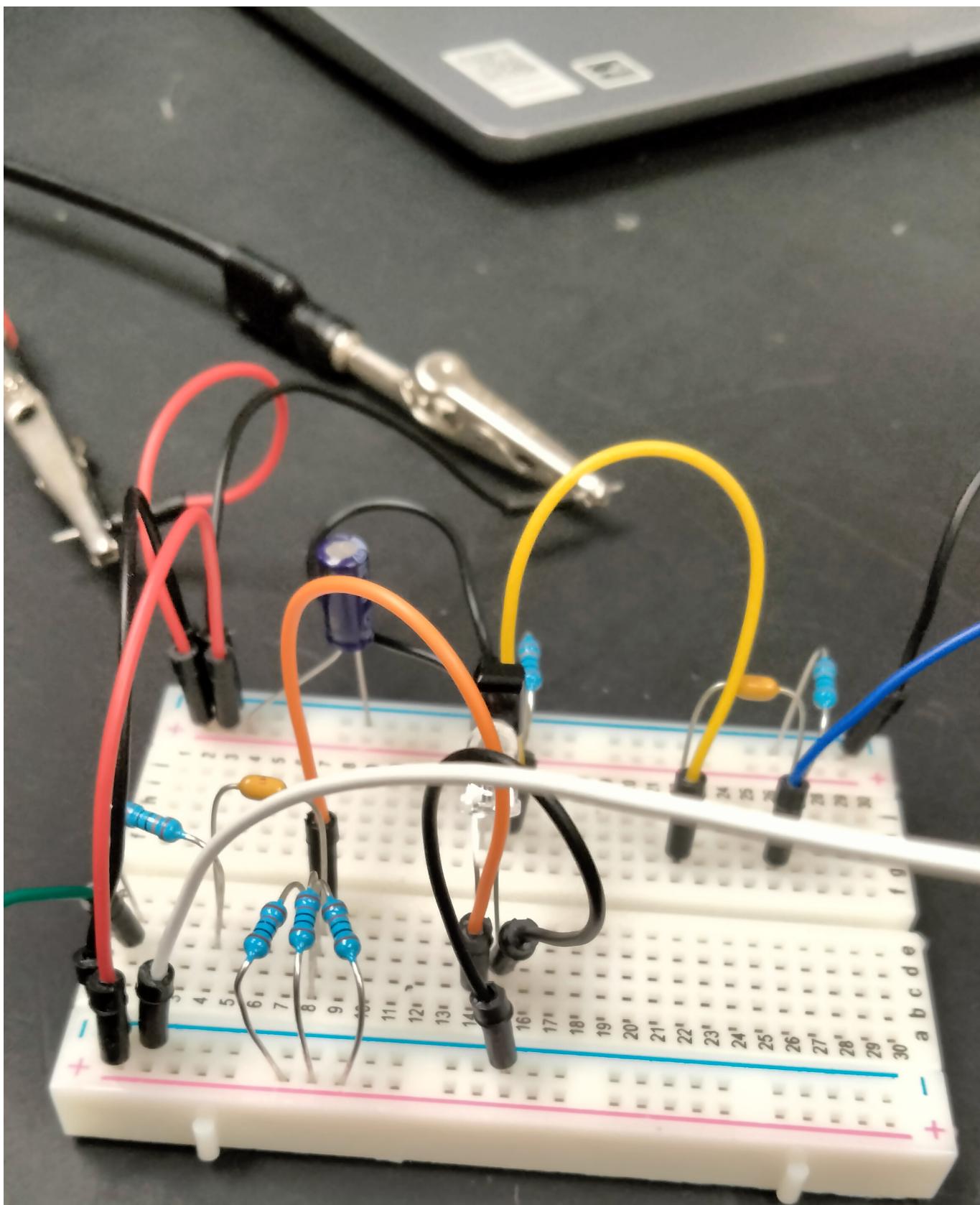
Right:

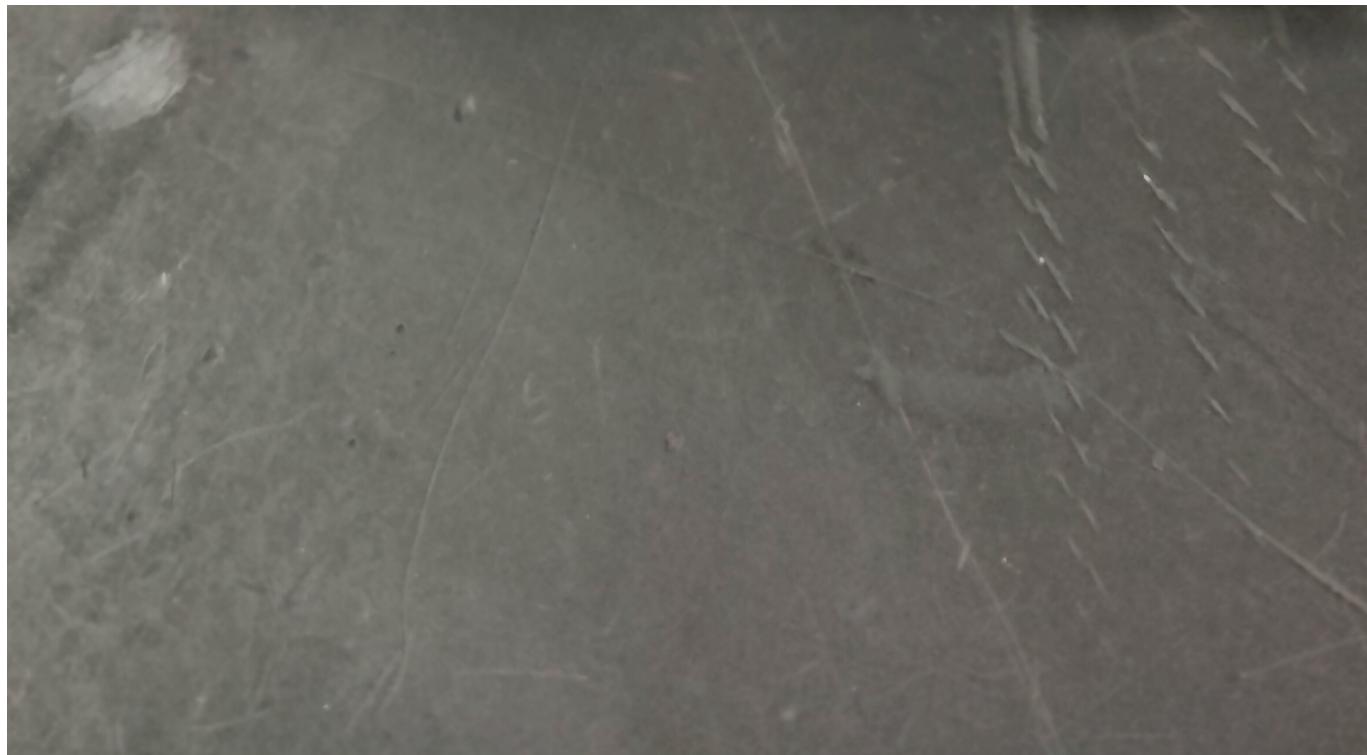






Left:





And these are what I was reading out of the oscilloscope:

