EEO352 Lab 6
Operational Amplifiers

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Copy of Original Assignment

EEO 352 Fall 2023 - Assignment 6 – Operational Amplifiers

Please document each step with snapshots of the built circuit, plots, pictures and your observations. Please include this page.

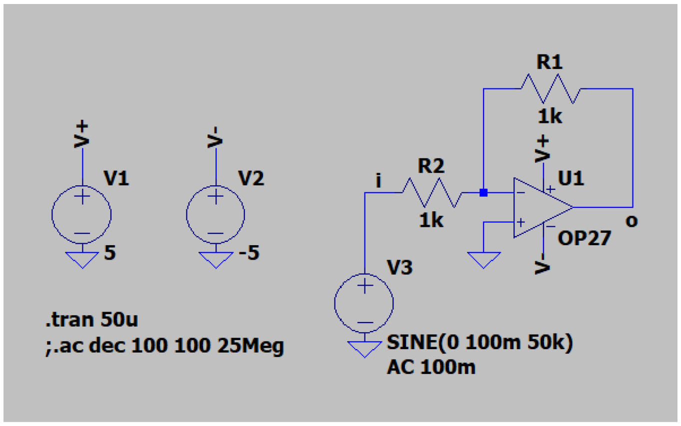

Fig.1

1) Using the OP27 component in the OpAmps library and 1kΩ and 20kΩ resistors, design and simulate the following circuits (**25pts**):

a) Non-inverting buffer

b) Non-inverting amplifier with gain 21

c) Inverting buffer (see example in Fig.1)

d) Inverting amplifier with gain 20

For each circuit:

- plot (input and output) the response to a 50kHz 100mV sinusoidal signal

- plot the frequency response (amplitude and phase) from 100Hz to 25MHz, extrapolate the -3dB frequency and the corresponding phase

- estimate the input resistance of each circuit

2) Using the OP27 part and 1kΩ and 10kΩ resistors, build and measure the following circuits at (1a), (1b), (1c), and (1d) (**75pts**)

For each circuit:

- using the waveform generator measure and plot (input and output) the response to a 50kHz 100mV sinusoidal signal

- using the network analyzer measure and plot (amplitude and phase) the frequency response from 100Hz to 25MHz and extract the -3dB frequency and the corresponding phase, and calculate the gain-bandwidth product

Note: with the network analyzer, use 100 points/decade and a 100mV input amplitude

Summary

In this lab we simulated and built opamp circuits of inverting and non inverting designs and with different gain settings. We measured the -3db frequency point and plotted the input and output signals. We also computed the Gain Bandwidth Product for each circuit assembled and estimated the input resistance.

In my simulation of unity gain opamp designs (1a, 1c) I was unable to measure a -3db point as the Bode plot in LTspice started at around -20db and never really increased. Confusingly, the experiment produced that -3db point for analysis. This could be due to an error in my simulation schematic or just the reality of the physical circuit.

Also, when measuring the frequency response of some circuits I sometimes saw “noisy” signals. This too could be due to the circuit as it is built on the breadboard. I have noticed that the breadboards are of fairly poor quality and sometimes I have had to move my circuit to use a section of the breadboard with better connection properties.

The simulation and actual circuit built showed a strong correlation when comparing the analog behavior. I was able to observe the signal inversion, phase shift and amplitude comparison to verify the gain of the circuit.

1 Design and Simulate

a)

- $-3\,\text{dB}$ frequency: N/A
- Input impedance: $\infty\Omega$

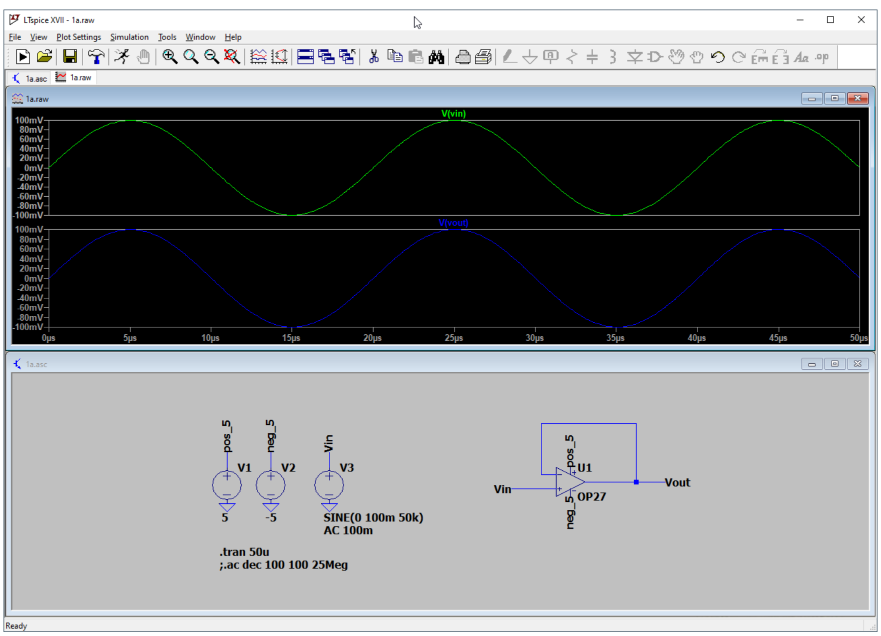

Figure 1: Non-inverting Buffer; Analog response

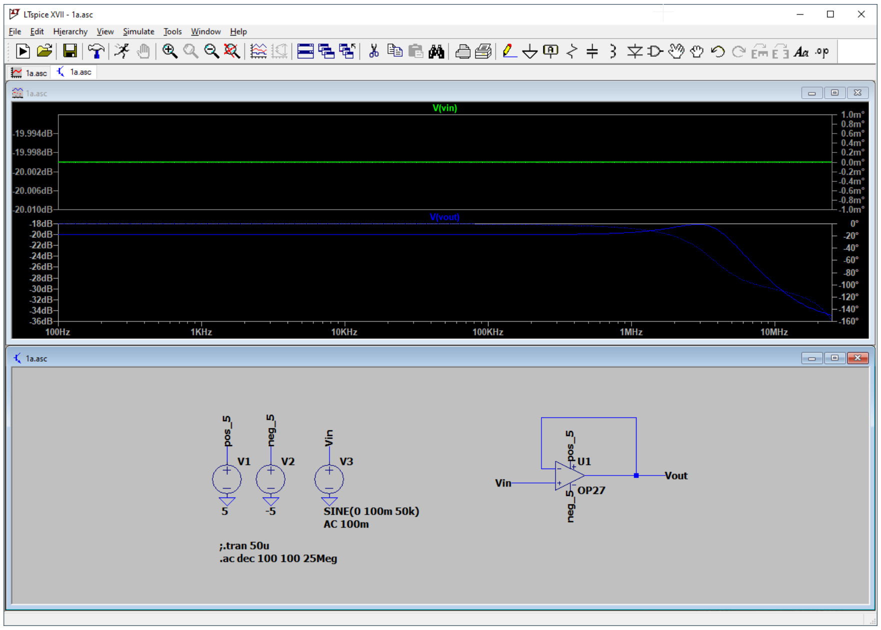

Figure 2: Non-inverting Buffer; Frequency response

b)

- $-3\,\mathrm{dB}$ frequency: $1.08\,\mathrm{MHz}$, phase $-97.0°$
- Input impedance: $\infty\Omega$

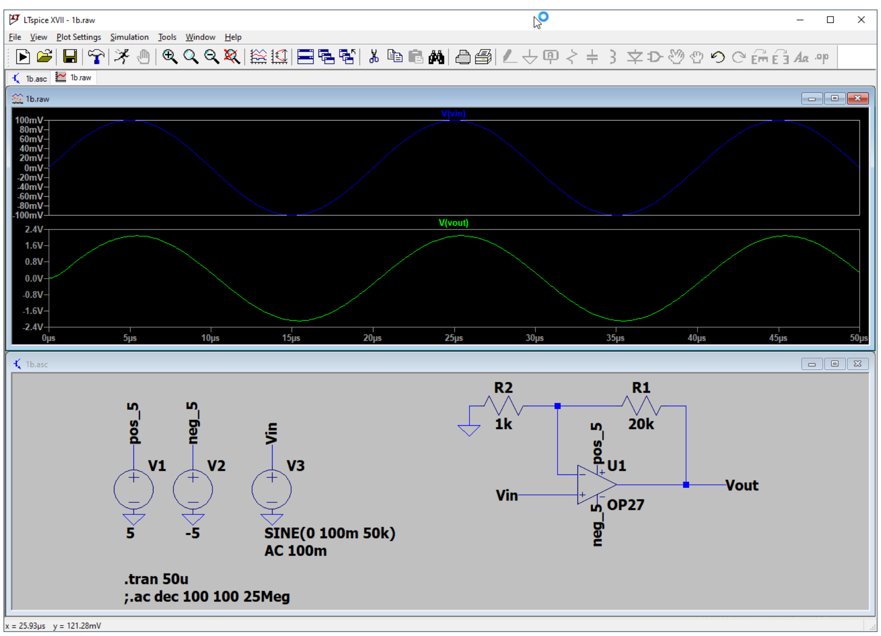

Figure 3: Non-inverting amp with gain 21; Analog Response

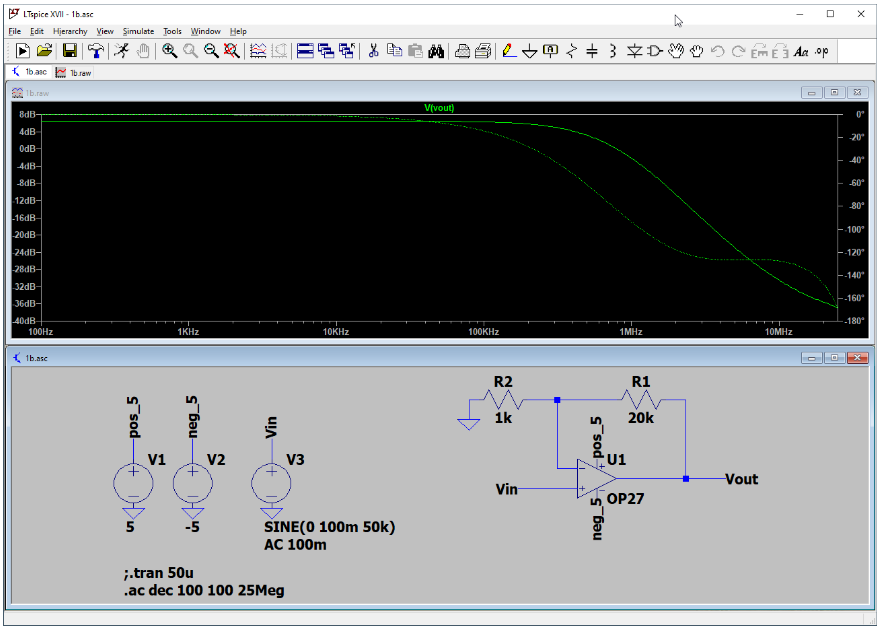

Figure 4: Non-inverting amp with gain 21; Frequency Response

c)

- $-3\,\text{dB}$ frequency: N/A
- Input impedance: $1k\Omega$

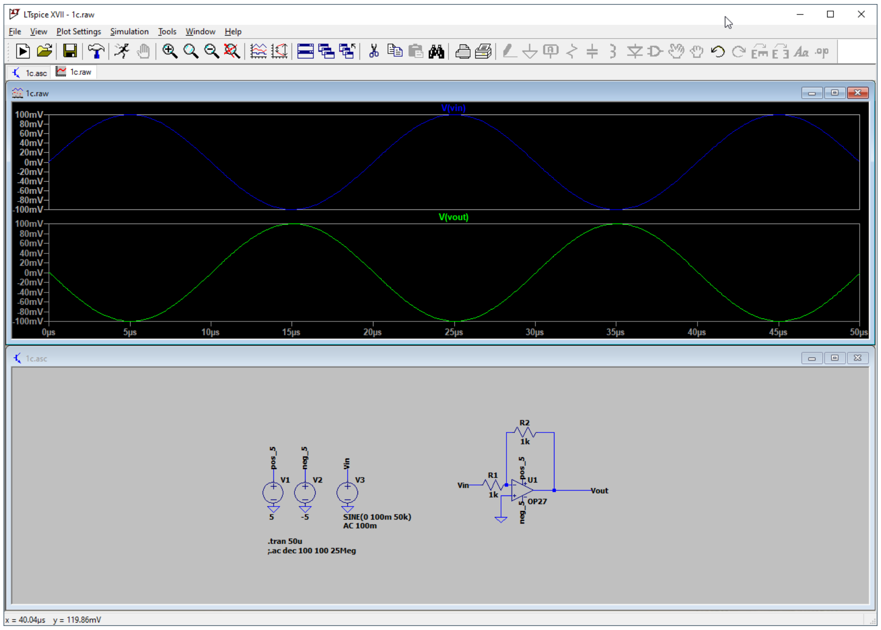

Figure 5: Inverting buffer; Analog Response

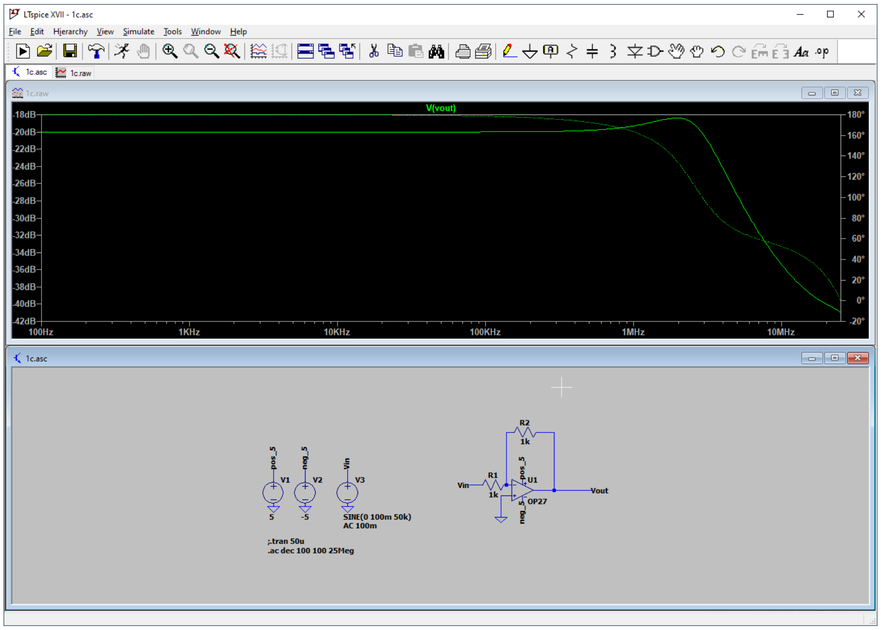

Figure 6: Inverting buffer; Frequency Response

d)

- $-3\,\text{dB}$ frequency: $1.04\,\text{MHz}$, phase $83.8°$
- Input impedance: $1k\Omega$

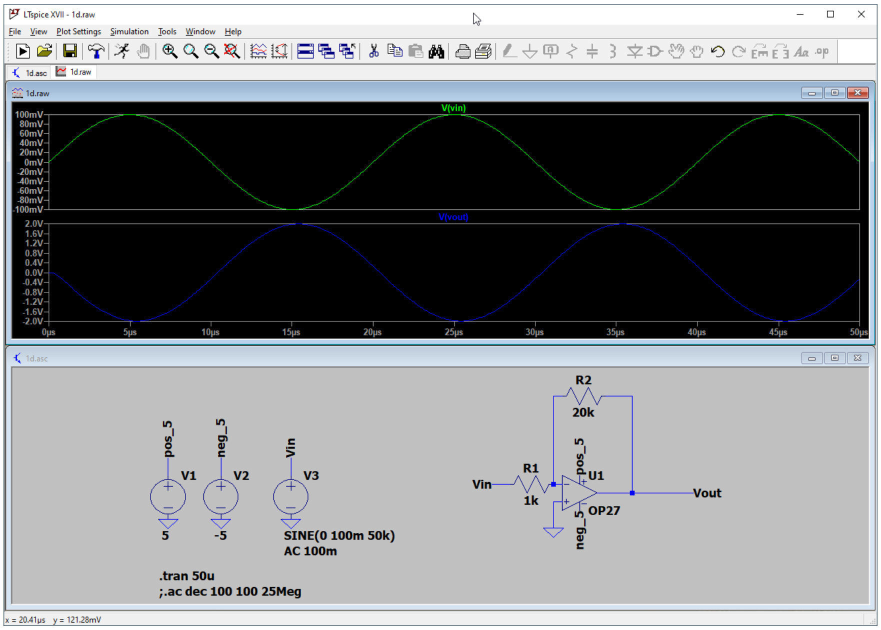

Figure 7: Inverting amp with gain 20; Analog Response

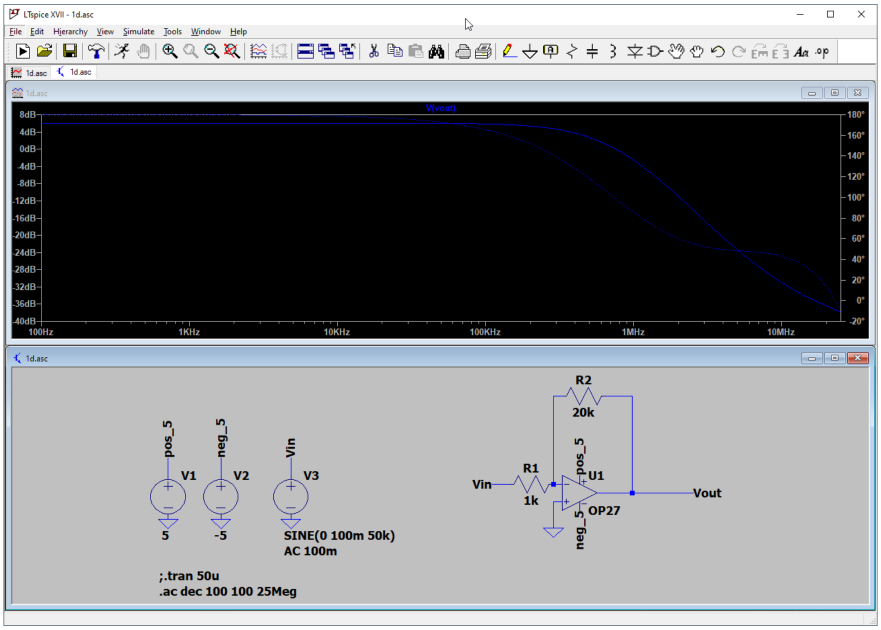

Figure 8: Inverting amp with gain 20; Frequency Response

2 Build and Measure

a)

- $-3\,\text{dB}$ frequency: $3.17\,\text{MHz}$, phase $-75.3°$
- GBWP $= 1 * 3.17\,\text{MHz} = 3.17\,\text{MHz}$

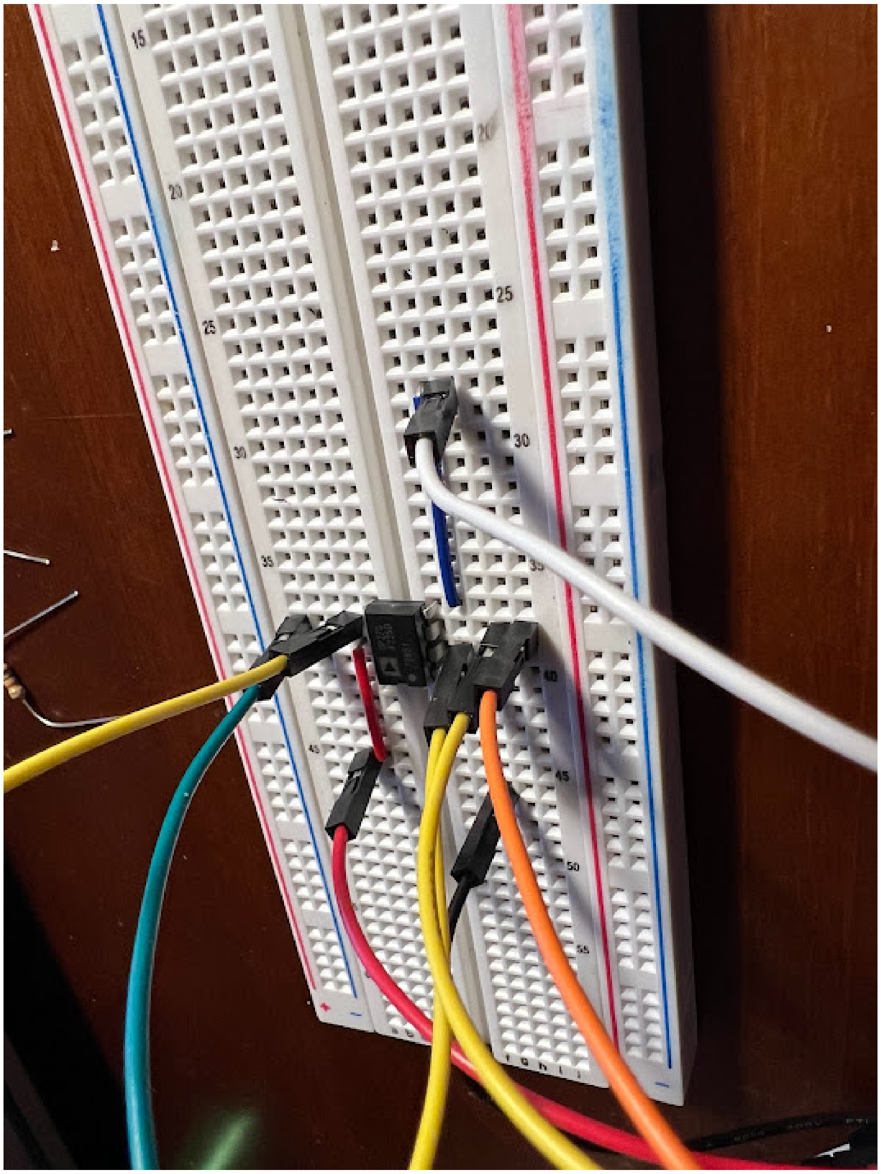

Figure 9: Setup photo

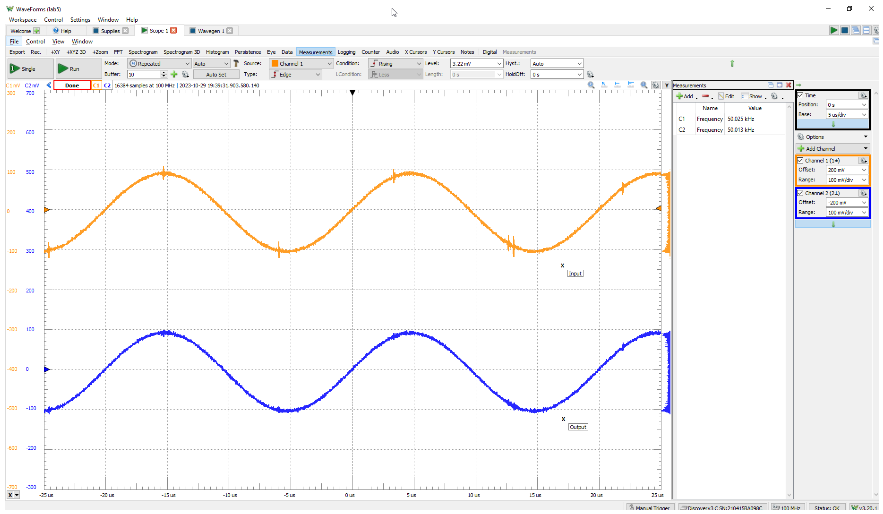

Figure 10: Non-inverting Buffer; Analog response

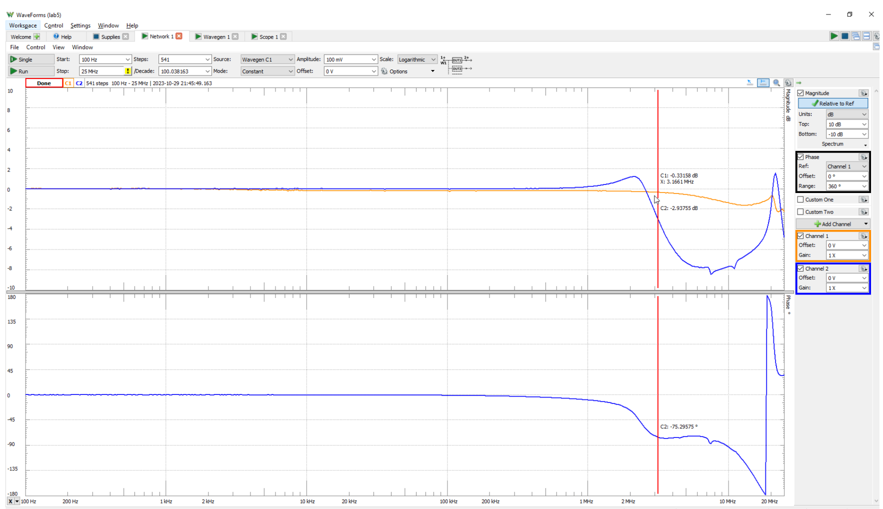

Figure 11: Non-inverting Buffer; Frequency response

b)

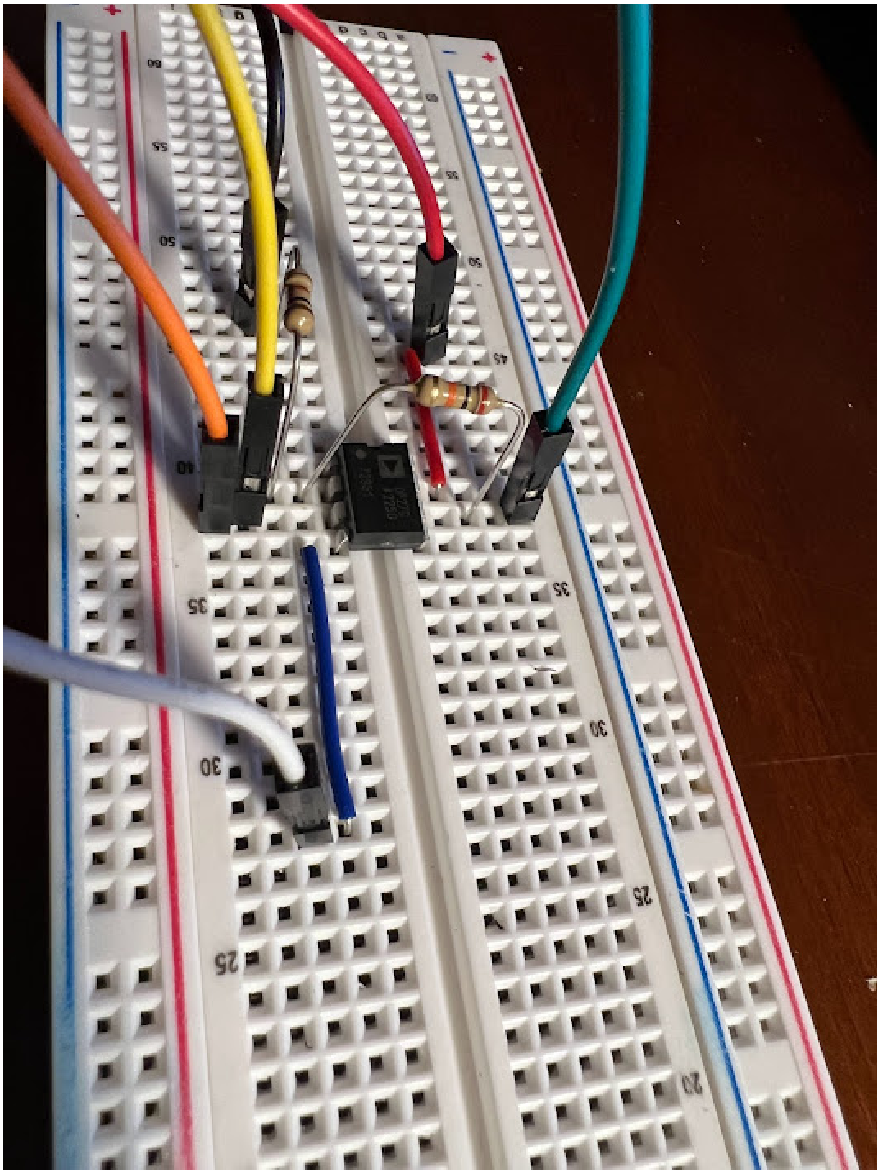

Figure 12: Setup photo

- $-3\,\mathrm{dB}$ frequency: 3.14 MHz, phase $-122.9°$
- GBWP = 21 * 3.14 MHz = 65.94 MHz

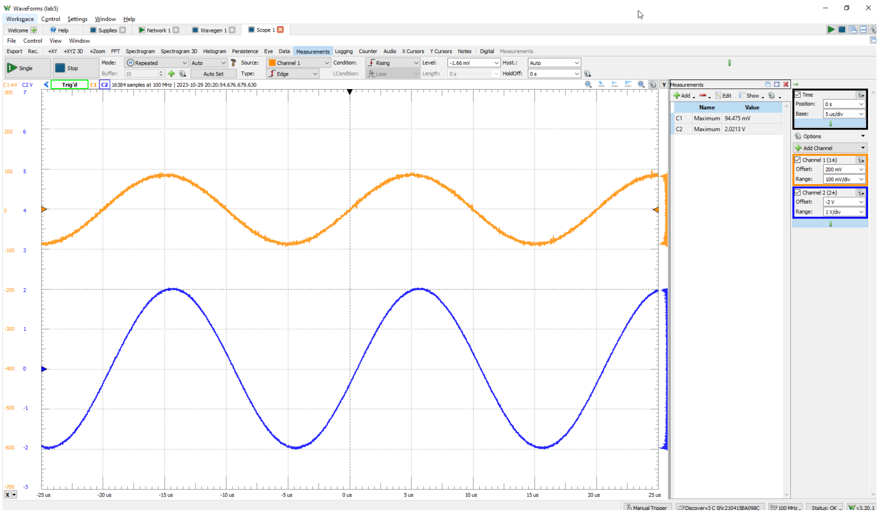

Figure 13: Non-inverting amp with gain 21; Analog Response

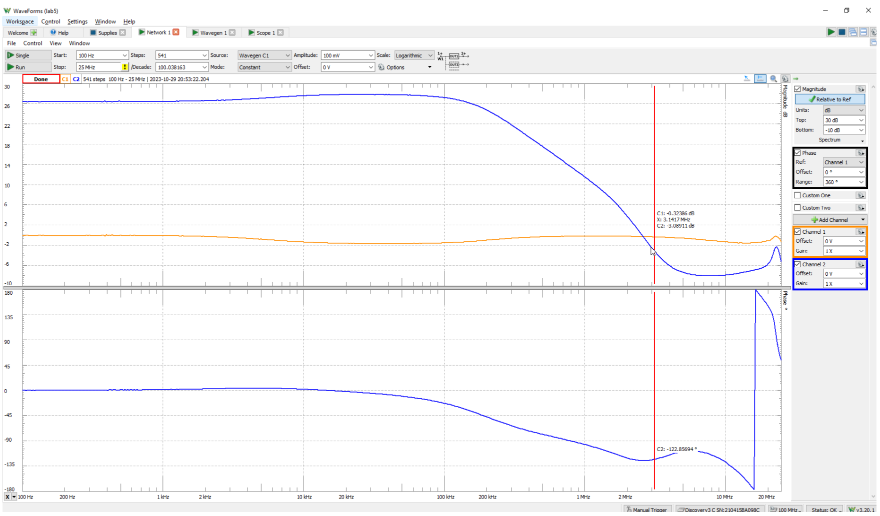

Figure 14: Non-inverting amp with gain 21; Frequency Response

c)

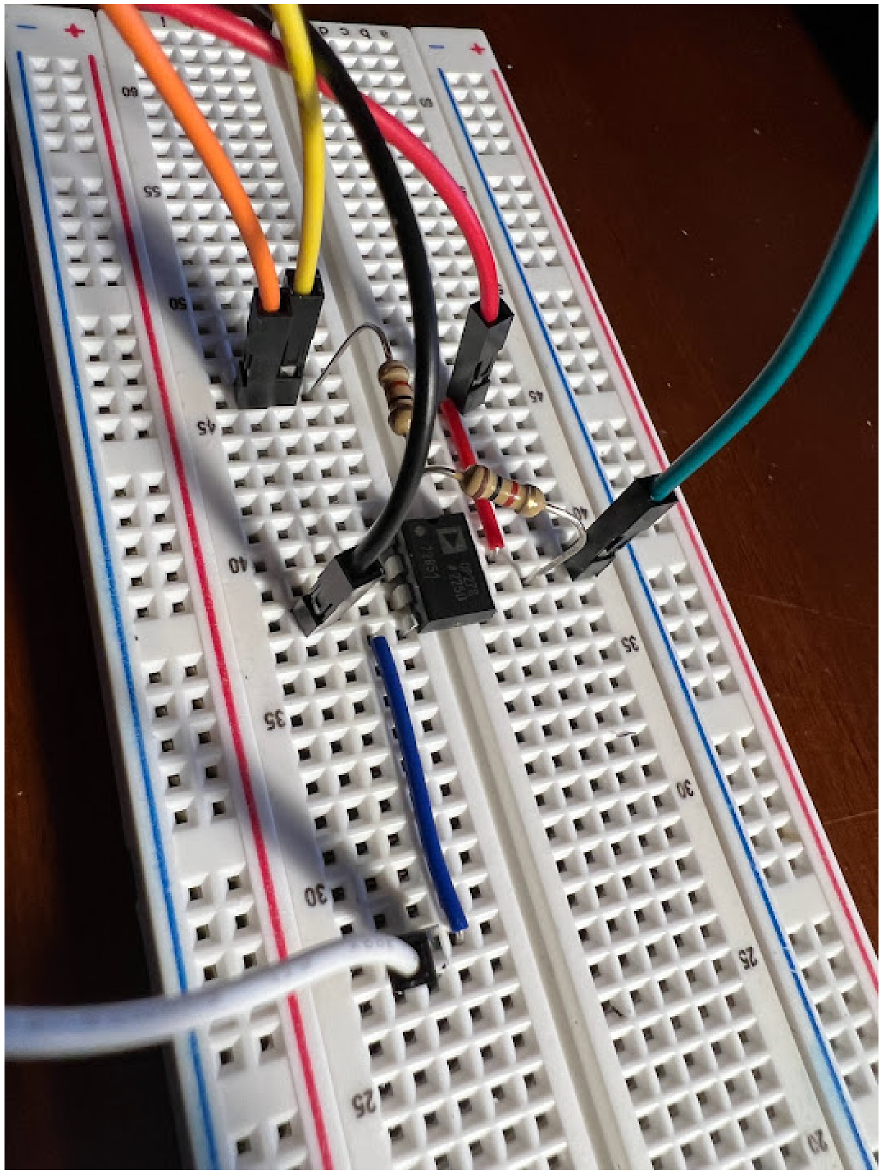

Figure 15: Setup photo

- $-3\,\text{dB}$ frequency: $2.78\,\text{MHz}$, phase $85.93°$
- GBWP $= 1 * 2.78\,\text{MHz} = 2.78\,\text{MHz}$

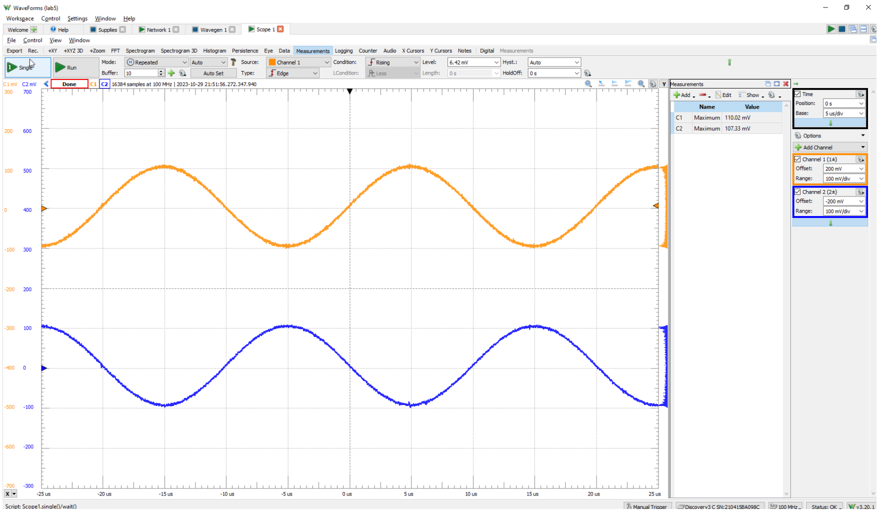

Figure 16: Inverting buffer; Analog Response

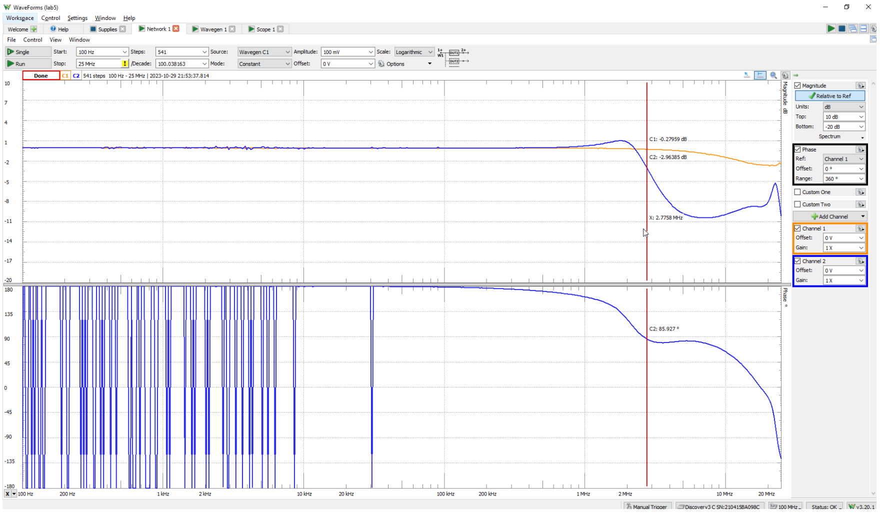

Figure 17: Inverting buffer; Frequency Response

d)

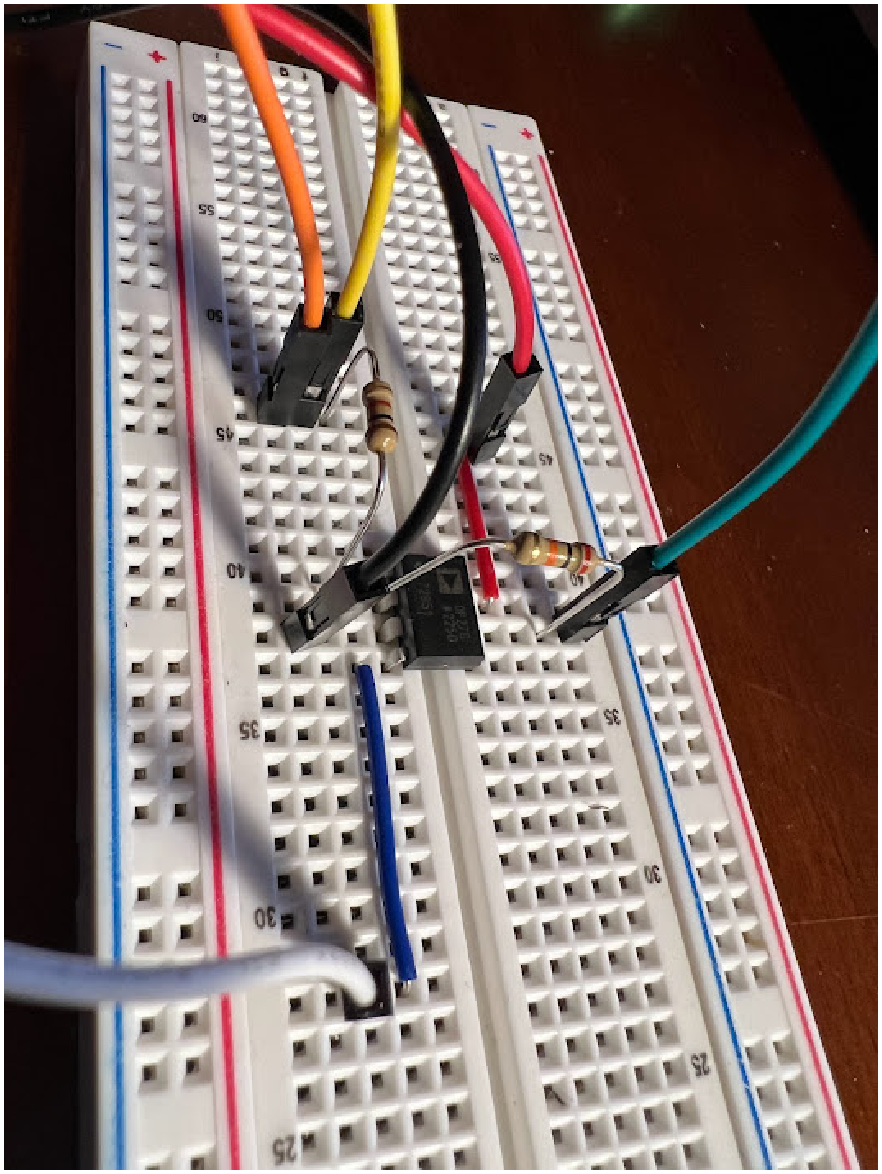

Figure 18: Setup photo

- $-3\,\mathrm{dB}$ frequency: $3.12\,\mathrm{MHz}$, phase $52.45°$
- GBWP $= 20 * 3.12\,\mathrm{MHz} = 62.40\,\mathrm{MHz}$

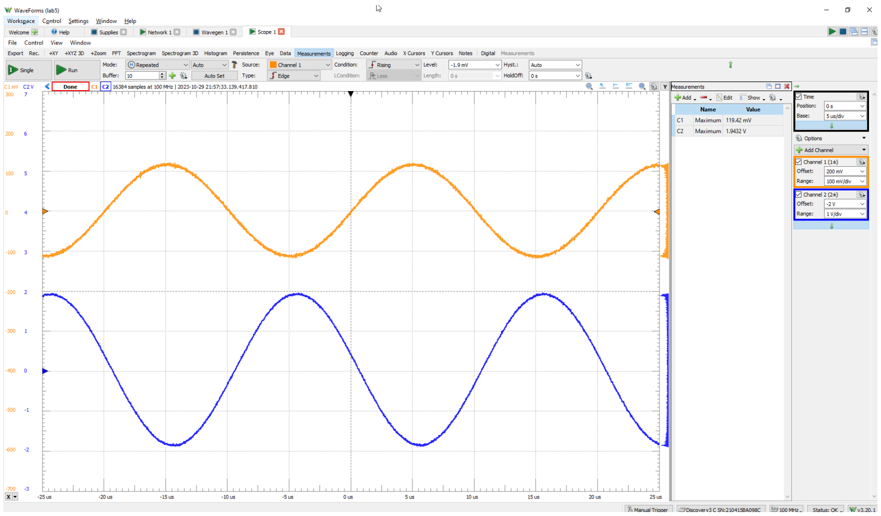

Figure 19: Inverting amp with gain 20; Analog Response

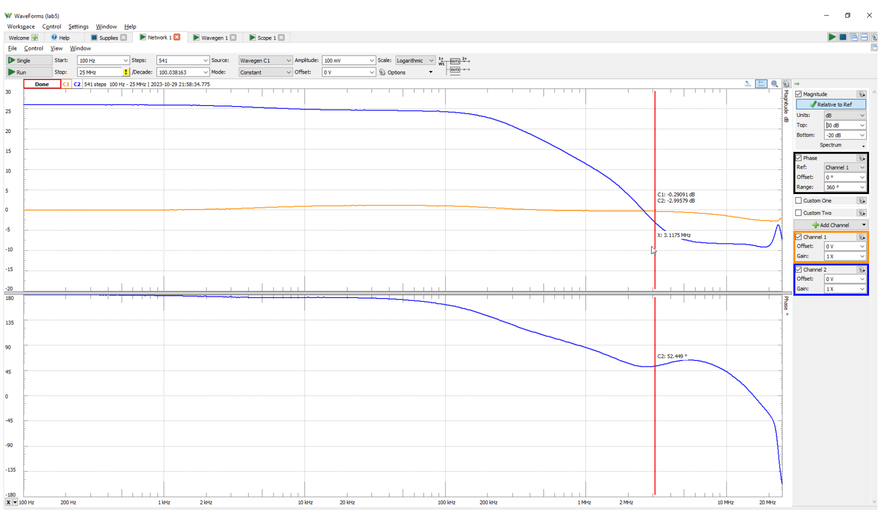

Figure 20: Inverting amp with gain 20; Frequency Response