Experiment 4 – Operational Amplifier Circuits I: Inverting and Non-Inverting Amplifiers

Physics 242 - Electronics

Introduction

Op amps are highly versatile integrated circuits used in many applications. In this initial lab, we will explore the properties of the inverting and non-inverting amplifier configurations.

Procedure and Questions

1. Adjust the variable voltage supplies on your breadboard to provide +15 V and -15 V. Test the supply voltages with your multimeter. Then turn off power to your breadboard before setting up the circuit.
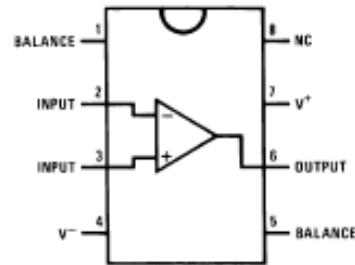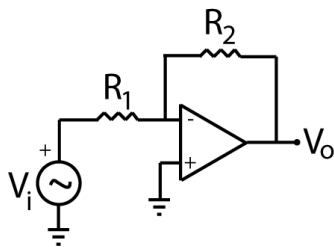
2. Build the inverting amplifier circuit circuit shown above left (with breadboard powered off). Refer to the pinout diagram above right to determine where to connect power connections, inputs, and output. We will not use pins 1, 5, and 8; they should be left unconnected. The positive supply (+15 V) is connected at pin 7 and the negative supply at pin 4. Use a 1 kHz sine wave from the function generator as your input signal, and measure the input and output signals with the 'scope. Use $R_1 = 1$ kΩ and $R_2 = 5.1$ kΩ, 10 kΩ, 51 kΩ, 100 kΩ, 200 kΩ, one at a time. Measure each resistance value. For each value of R_2, measure the gain of your inverting amplifier, which is the ratio of the output amplitude to the input amplitude. Note that you may have to adjust the amplitude of your input waveform so that it is small enough that the amplitude of the output waveform is ~13 V or less; otherwise, the output waveform will be clipped since the op amp cannot produce a larger voltage.

Plot measured gain vs. theoretically predicted gain. Are the results in accord with your expectations? Explain briefly.
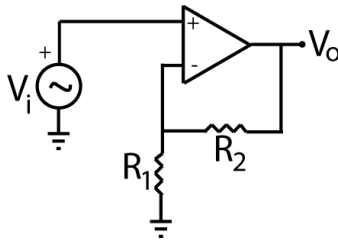
3. Next build the non-inverting amplifier circuit shown above, with $R_1 = 1$ kΩ and $R_2 = 1$ kΩ, 2 kΩ, 5.1 kΩ, 10 kΩ, one at a time. Measure each resistance value. Measure the gain of your amplifier for each value of R_2.

Plot gain vs. R_2. Is the shape, slope, and y-intercept of the plot in accord with your expectations? Explain.

4. In this Procedure, you will measure the output impedance of the picoscope's waveform generator, which is its Thevenin equivalent resistance. Using any convenient amplitude from your function generator (which must not be changed during this procedure), use the 'scope to measure the output of your function generator across the following loads: open circuit, 390 Ω, 510 Ω, 1 kΩ, and 1.5 kΩ. (For the "open circuit" load, the 'scope is still connected across the function generator's output.) As usual, you should measure each resistance value with the multimeter.
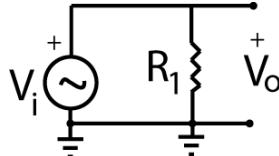
Make a plot from which you can determine the output impedance of your function generator. Explain clearly how you determined output impedance from your plot, and show any relevant derivations.
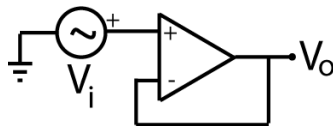
Next, connect your op amp as a voltage follower, shown above. Use the picoscope's waveform generator output as the input to the follower. Then, using the same set of loads as before (connected between the op amp output and ground), try to measure the output impedance of your function generator+follower combo. Determine the output impedance if you can. If the output impedance is too low to measure, can you provide an estimate for an upper bound on its value?