

5.4.1: Inverting Voltage Amplifier

Overview:

In this assignment, we implement a simple operational amplifier-based circuit. Since operational amplifiers are used commonly in circuits used to implement mathematical operations, we implement the processes of multiplication by a negative constant.

Before beginning this lab, you should be able to:

- Analyze operational amplifier-based circuits

After completing this lab, you should be able to:

- Design and build an operational amplifier-based inverting voltage amplifier

This lab exercise requires:

- Analog Discovery module
- Digilent Analog Parts Kit
- Digital multimeter (optional)

Symbol Key:

	Demonstrate circuit operation to teaching assistant; teaching assistant should initial lab notebook and grade sheet, indicating that circuit operation is acceptable.
	Analysis; include principle results of analysis in laboratory report.
	Numerical simulation (using PSPICE or MATLAB as indicated); include results of MATLAB numerical analysis and/or simulation in laboratory report.
	Record data in your lab notebook.

General Discussion:

The circuit shown in Figure 1 is called an inverting amplifier. Appropriate pin numbers for the OP27 operational amplifier are provided on Figure 1. v_{in} is the applied (input) voltage to the circuit. v_{out} is the output voltage from the circuit. The relationship between v_{in} and v_{out} for this circuit is:

$$v_{out} = -\frac{R_2}{R_1} v_{in}$$

Thus, the output voltage is an *inverted* (due to the sign change) and *amplified* or *scaled* (due to the multiplicative factor $\frac{R_2}{R_1}$) version of the input voltage. The scaling factor $\frac{R_2}{R_1}$ is sometimes called the *gain* of the amplifier. The ground symbol, $\downarrow$, is used to denote the reference voltage from which all other voltages are measured. Note that if R_1 and R_2 are the same, the output voltage is simply the negative of the input voltage.

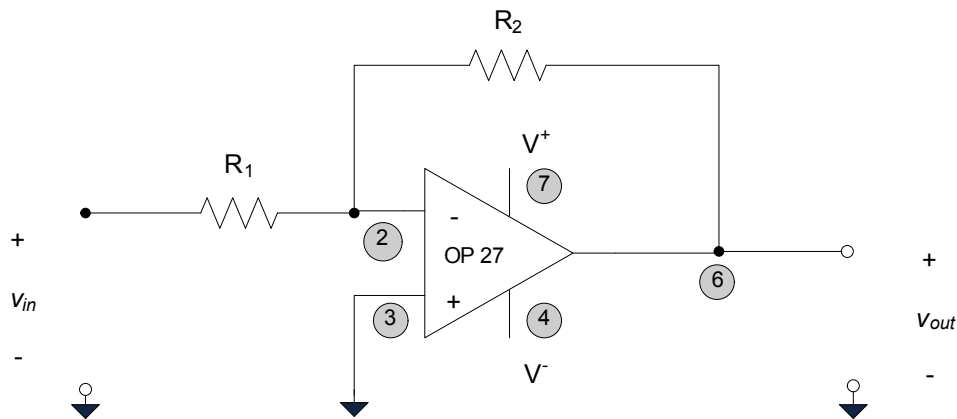


Figure 1. Inverting amplifier circuit.

Pre-lab:

ANALYSIS

Design an inverting amplifier which provides a gain of approximately 2 and an input resistance, R_1 , of approximately $2\text{k}\Omega$. (The input resistance is defined as the input voltage divided by the input current. Since pin 2 provides a “virtual” ground, the input resistance is simply R_1 .)

Lab Procedures:

DATA

1. Implement the amplifier design you generated in the pre-lab. Create a schematic of the circuit in your lab notebook, record actual resistance values, and label supply voltages on your schematic. Recommended connections are as follows:
 - Use $V+$ as positive supply rail to the op-amp and $V-$ as the negative supply rail to the op-amp.
 - Use one of the waveform generator channels on your Analog Discovery to provide the input voltage v_{in} to your circuit.
 - Measure both the input voltage, v_{in} and the output voltage, v_{out} , using your DMM and/or the scope channels on your Analog Discovery.

DATA

2. Test your design with input voltages of approximately -3V to +4V by step sizes of .5V. Tabulate your results (v_{in} and v_{out}) in your lab notebook. Also in your lab notebook, create a plot of v_{in} vs. v_{out} and comment on your results (make sure that you calculate a circuit gain – the rate of change of output to input – and compare it to your expectations based on your pre-lab). Note in your lab notebook the range of output voltages over which the circuit response is linear.

DEMO

3. Demonstrate operation of your circuit to the Teaching Assistant. Have the TA initial the appropriate page(s) of your lab notebook and the lab checklist.