5.4.2: Summing 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 summing two voltages.

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:

DEMO — Demonstrate circuit operation to teaching assistant; teaching assistant should initial lab notebook and grade sheet, indicating that circuit operation is acceptable.

ANALYSIS — Analysis; include principle results of analysis in laboratory report.

SIM — Numerical simulation (using PSPICE or MATLAB as indicated); include results of MATLAB numerical analysis and/or simulation in laboratory report.

DATA — Record data in your lab notebook.

General Discussion:

The circuit shown in Figure 1 is a summing amplifier circuit. Appropriate pin numbers for the OP27 operational amplifier are provided on Figure 1. The output voltage, v_{out}, is an inverted and scaled version of the sum of the input voltages, v_a and v_b. If $R_1 = R_2$, the input voltages are not individually scaled and the output voltage is:

$$v_{out} = -\frac{R_3}{R_1}(v_a + v_b)$$

Note that if, in addition, $R_3 = R_1$, the output voltage is simply the sum of the two input voltages.

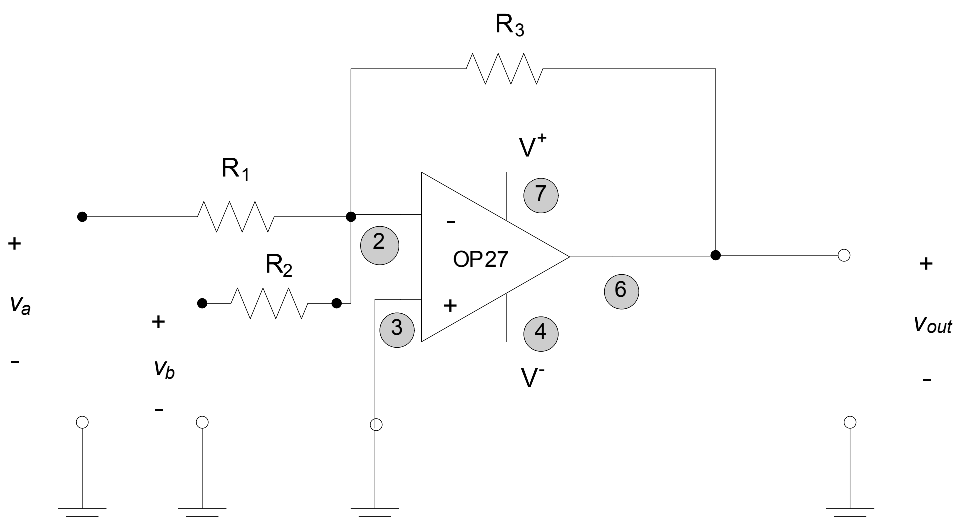

Figure 1. Summing amplifier circuit.

Pre-lab:

ANALYSIS

Design an inverting summing circuit which performs an addition of two signals. The input resistance seen by the two voltage sources (v_a and v_b) should be at least 1kΩ. (The input resistance of a circuit is defined as the input voltage divided by the input current. Since the inverting input terminal of the operational amplifier in Figure 1 is a "virtual" ground, the input resistance seen by v_a and v_b are R_1 and R_2, respectively.)

Lab Procedures:

DATA

1. Implement the 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- on the Analog Discovery to set the negative op-amp supply V^- to -5V; set the positive op-amp supply V^+ to 5V using V+ on the Analog Discovery.
    - Use one waveform generator channel to provide the input voltage v_a to your circuit, and use the other waveform generator channel to set v_b = 1V.
    - Measure the output voltage, v_{out}.

DATA

2. Test your design with v_a = -4V, -2V, -1V, 0V, 1V, 2V, 3V, and 5V. Tabulate your results (v_a, v_b and v_{out}) in your lab notebook (you may assume that the values you set for v_a and v_b are correct – you do not need to measure these). Also in your lab notebook, comment on your results (make sure that you compare your results with your expectations based on your pre-lab.

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.

