Operational Amplifiers

Daniel Lucero[1]

[1]California State University, Chico

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Purpose:

To give you the chance in experimenting with basic op-amp circuits like inverting and non-inverting amplifiers, difference and adder circuits. The use of the LF411 will be the primary used op-amp for these exercises, in which are necessary for basic circuitry.

Procedure:

1) Build an inverting amplifier with a theoretical gain of -20 dB. Measure its frequency with a bode plot and compare with expected values. Find the corner frequency. Now replace the LF411 with its pin equivalent op-amp, the TL061, and repeat previous measurements.

2) Build a non-inverting amplifier and repeat measurements as done in part 1 of the procedure.

3) Build an adder circuit and take measurements using two different DC voltages, then verify that it works properly with the following relationship.

- $V_{out} = -\left(V_1 - \frac{1}{2}V_2\right)$

4) Build a difference amplifier as shown in fig. 6.7 of your textbook, and verify that is operates as to be expected.

Data:

1) The materials used for the inverting amplifier circuit as shown in Fig. (1), included R_1=10 kOhms, R_f=200 kOhms, and a gain B.W. = 3 MHz. The expected corner frequency was calculated by dividing the wide gain bandwidth by the expected gain.

- $f_c = \frac{3x10^6\ Hz}{20\ dB} = 150\ kHz$
- $f_{mc} = 149871\ Hz$

The measured corner frequency is very close to the expected calculations. Data was collected using LabVIEW and plotted with Python.

Now repeating the same measurements, but with the TL061 op-amp.

- $f_c = \frac{1x10^6\ Hz}{20\ dB}\ =\ 50\ kHz$

- $f_{mc} = \ 30\ kHz$

The difference in measured and expected corner frequencies for the TL061 op-amp is quite large, proving the LF411 to be of higher quality, and a prettier penny.

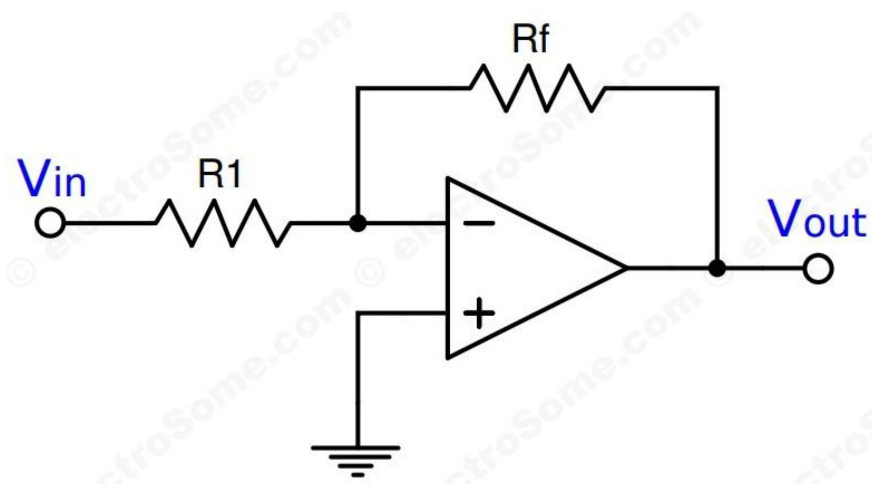

Figure 1: Inverting Amplifier.

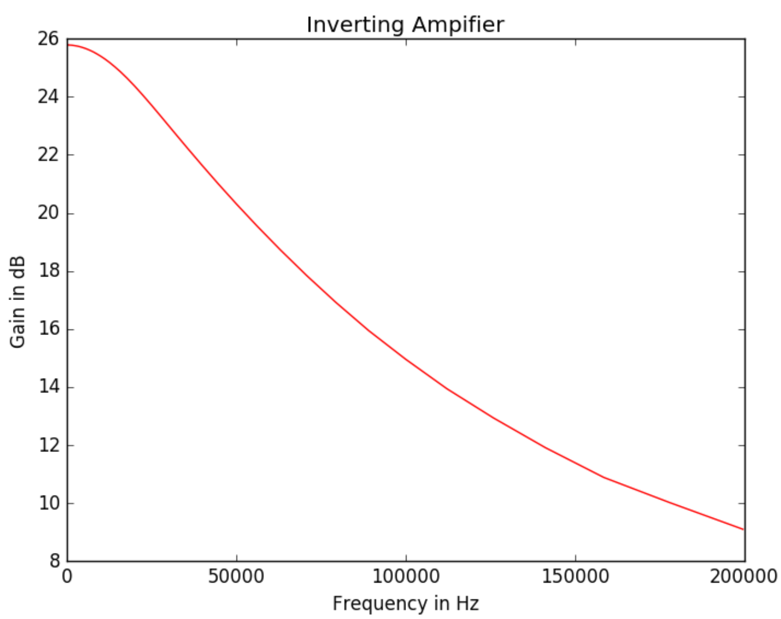

Figure 2: Bode Plot Gain/Freq.

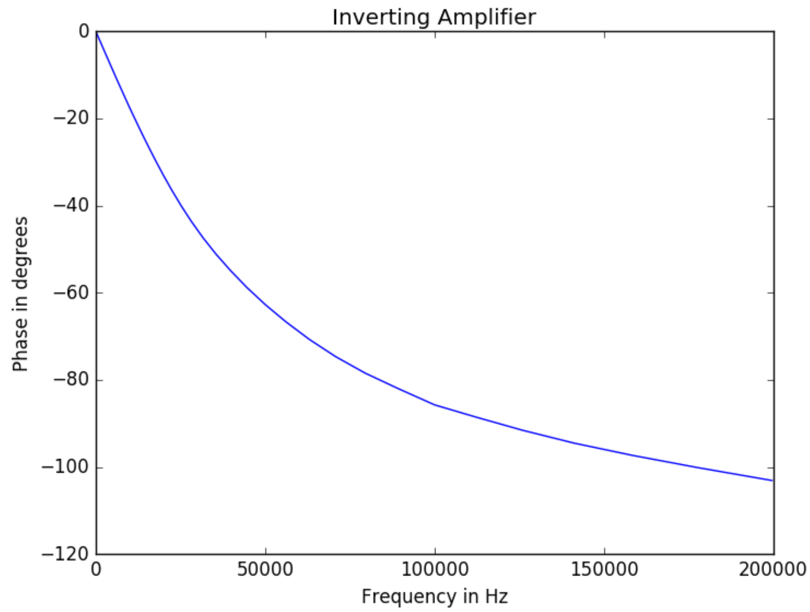

Figure 3: Bode Plot Phase/Freq.

2) A non-inverting amplifier was built with theoretical gain of 20 dB using the LF411 op-amp as shown in Fig. (4). The very same expected corner frequency was calculated, along with the same corner frequency measured as in part 1, except this time the voltage is no longer inverted. The same expected corner frequency was also calculated for the TL061 op-amp, however a measure corner frequency was unavailable. The TL061 is insubordinate in working properly with the Elvis II board variable voltage for non-inverting cases while measuring Bode plots, however the function generator and oscilliscope render fruitful evidence that the TL061 is operating to its expected degree of value/accuracy ratio.

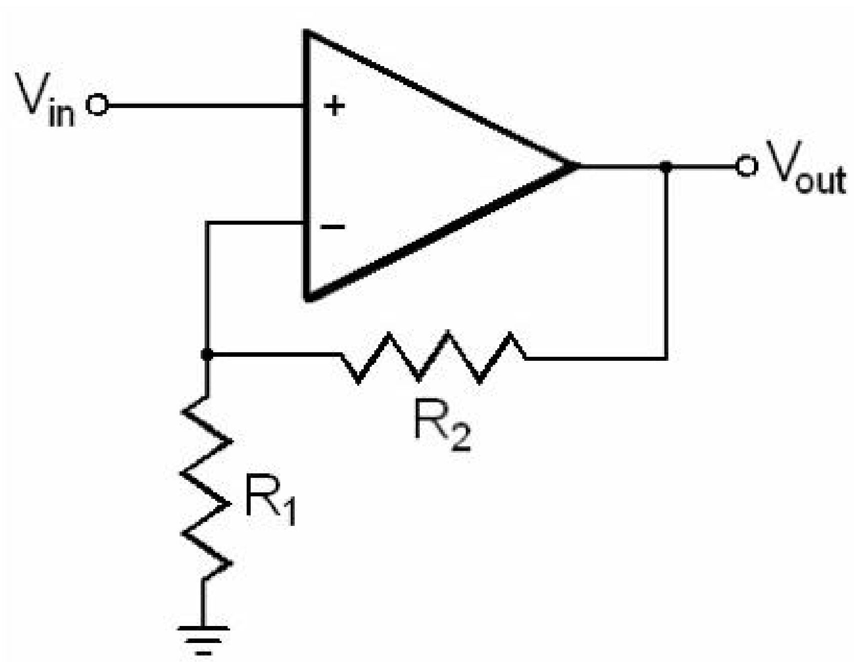

Figure 4: Non-Inverting Amplifier.

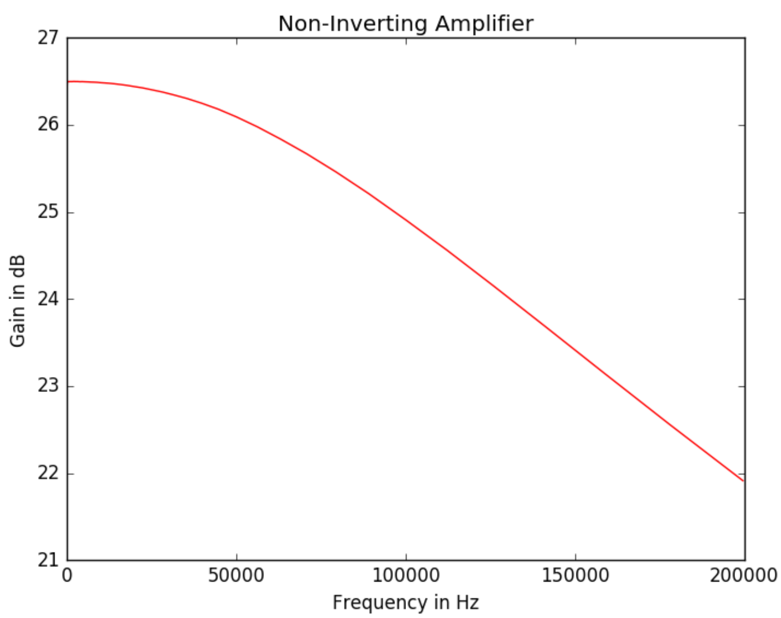

Figure 5: Bode Plot Gain/Freq.

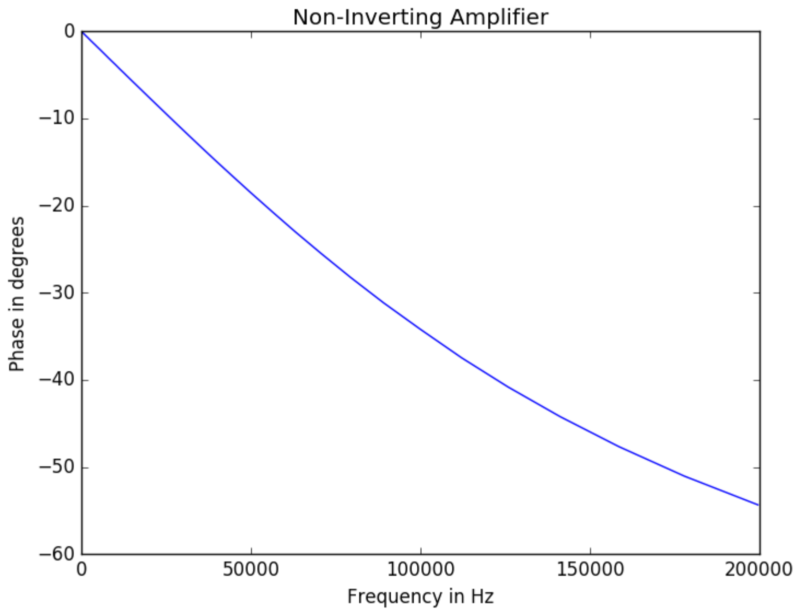

Figure 6: Bode Plot Phase/Freq.

3) After building the adder circuit (Fig. (7)) using just two V_{in}, V_0 = -5.00 V, V_1= 5.00 V, and the resistors R_0 = R_f = 1 kOhms, and R_1 = 2 kOhms, the circuit out voltage was calculated using the following relationship,

- $V_{out} = -\left(\frac{R_f}{R_{in}} (V_1) \; + \; \frac{R_f}{R_{in}} (V_2) \right) = -7.5 \; V$

and the voltage measured came to,

- $V_{out \; measured} = \; -7.465 \; V$

verifying that the circuit is working properly.

Figure 7: General Form of an Adding Circuit.

4) The difference amplifier as shown in Fig. (8) was built using R_1 = R_3 = 1 kOhms, R_2 = R_4 = 2 kOhms, V_1 = -3.00 V, and V_2 = 2.00 V. The theoretical V_{out} was calculated using the following relationship,

- $V_{out} \; = \; \frac{R_2}{R_1} (V_2 - V_1) \; = \; -10 \; V$

and the voltage measured came to,

- $V_{out} \; = \; -10.11 \; V$

verifying that the circuit works as to be expected.

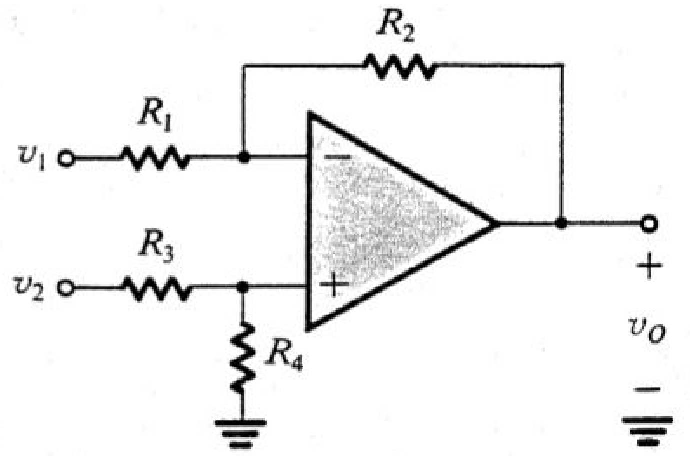

Figure 8: Difference Amplifier.