**Lab – Linear Operational Amplifiers – A Better Amplifier**

**Objectives:**

After performing this experiment, you will be able to:

-Construct and test inverting and noninverting amplifiers using op-amps.

-Determine the difference between these amplifiers

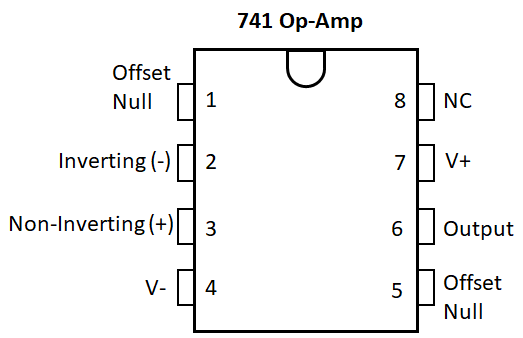
**Equipment and Materials Needed:**

-Equipment: Powered Breadboard; DMM; Function Generator; Oscilloscope

-Resistors: two 1.0 k, one 10 k, one 1.0 M

-Potentiometer: one 1.0 1k

-One 741C op-amp

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*Figure 1 – IC 741 Op Amp pin diagram*

**Introduction**

The *measured* gain of any amplifier is found by taking the ratio of the output voltage signal and the input signal as shown by the equation below, where *A* is defined as the gain.

(1)

Non-Inverting Amplifier Equations

Gain (A)= 1+ (2)

Inverting Amplifier Equations

(3)

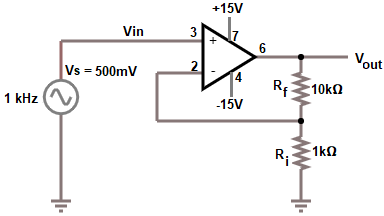
**Activity 1 – Non-Inverting Amplifier**

**Calculations:**

1. Measure a 10 k resistor for *Rf* and a 1.0 k resistor for *Ri.* Record the measured value of resistance in Table 1.
2. Using the measured resistances, compute the gain of the *non-inverting amplifier*. The closed-loop gain equation is given on page 1. Use equation 2.
3. Calculate *Vout* using the computed closed-loop gain.

**Measurements:**

1. Wire up the circuit shown in Figure 2 and set the signal generator for a 500 mVsinusoidal wave (peak-to-peak) at 1.0 kHz. Make sure that the dc offset on the function generator is set to zero. Note that pins 1, 5 and 8 of the op amp are not connected.



*Figure 2 – Non-inverting amplifier[[1]](#endnote-1)*

1. Measure the output voltage, *Vout* by placing the output (red probe) from channel 2 of the oscilloscope to pin 6 of the op amp. The black probe always goes to ground. Record the measured value in table 1 below. Sketch the input voltage (Vin) and output voltage (*Vout)* in your notebook*.*
2. Measure the feedback voltage at pin 2 by placing the output (red probe) from channel 2 to pin 2 of the op amp. Record the measured value in table1.

Table 1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Rf  Measured | Ri  Measured | Vin,pp  Measured | *A*  *(gain)* | Vout,pp  Computed Measured  (pin 6) | | V(-)  Measured  (pin 2) |
|  |  | 500 mV |  |  |  |  |

**Activity 2 – Inverting Amplifier**

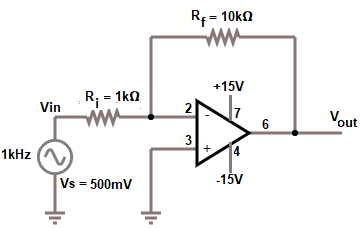
In this activity, you will test an inverting amplifier.

**Calculations:**

1. Using the measured resistances (*Rf* and *Ri )* from activity 1, compute (see page 1) the closed-loop gain (A) of the *inverting* amplifier by using equation 3. Record this value in table 2 below.

**Measurements:**

1. Wire up the circuit shown in Figure 3 and set the signal generator for a 500 mV sine wave (peak to peak) with a frequency of 1 kHz. Make sure that the dc offset on the function generator is set to zero. Note that pins 1, 5, 8 of the op amp are not connected.



*Figure 3 –Inverting amplifier*

1. *Measure* and record the output voltage, Vout.
2. Use the amplifier gain determined in step 1 to *calculate* Vout. Show this calculation in your notebook and record this value in table 2.
3. Measure and record the voltage at pin 2. This point is called a *virtual ground*. It is called a “virtual” ground because it is zero (ideally) even though it is not connected to ground.

Table 2

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Rf  Measured | Ri  Measured | Vin  Measured | A | Vout,pp  Computed Measured  (pin 6) | | V(-)  Measured  (pin 2) |
|  |  | 500 mVpp |  |  |  |  |

**Question:** Compare the output and input signals of a non-inverting amplifier with those of an inverting amplifier. How are these signals different and how are they the same?

**Question:** What is the phase difference between the output and input signals of a non-inverting amplifier? Of an inverting amplifier?

1. All schematic diagrams were created with Falstad circuit simulator (https://falstad.com/circuit/) [↑](#endnote-ref-1)