UM–SJTU Joint Institute

Physics Laboratory
(VE215)

Laboratory Report

Exercise 2

Op Amp Lab

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Date: 20 Oct 2016

[rev. 1.0]

1 Goal

Learn how to build and test a variety of circuits based on LM 741 Op Amp chip: non-inverting and inverting amplifiers with fixed gain.

Measure the gain of the amplifier and compare it with theoretical calculations.

Determine the saturated output voltage of the amplifier.

2 Introduction

2.1 The gain of amplifier circuits

The amplifier circuits are characterized by their gain values. The voltage gain is the ratio of output voltage to the input voltage in the circuit:

$$Voltage\ Gain = \frac{Output\ Voltage}{Input\ Voltage}$$

In the lab, you can use oscilloscope to measure the input and output peak-to-peak (ppk) amplitudes of the signals through two channels at the same time.

2.2 Apparatus

Apart from the DC source you are already familiar with in Lab 1, we are going to use function generator and oscilloscope this time.

2.2.1 Function generator

1. Parameter: to change the amplitude, frequency of wave to generate
   *Note: The amplitude here equals to half of the pp value. (i.e. If you set a wave whose amplitude is 100mV, the measured pp value would be 200 Vpp.) pp means peak to peak value.
2. 1/ 2: to switch on the channel.

2.2.2 Oscilloscope

1. Auto scale: to automatically achieve an output on the screen with proper scale
2. Meas: to turn on the measurement of the wave
3. 1/2: to show or hide the wave you detecting through channel 1 or 2

2.3 Procedure

2.3.1 Non-inverting amplifier

You are going to build a non-inverting amplifier in this part.

1. Build the circuit according to the figure below. $R_F = 100\Omega$, $R_A = 50\Omega$.
   Note:
   (a) Use the power supply to provide $+V_{cc}$=+5V and $-V_{cc}$=-5V to the op amp.
   (b) Use the COM port on the power supply as the ground in the schematic.
2. Use the function generator to generate a sine wave, and use it as the input voltage (v_i in the figure above). Set the initial amplitude of the sine wave to $0.1V_{pp}$. Use the oscilloscope to measure the output voltage (v_o in the figure above).
3. Increase the input voltage by $0.1V_{pp}$ each time and record the corresponding output until the output voltage is saturate, which means the output voltage is not increasing any more as the input voltage increases.

2.3.2 Inverting amplifier

You are going to build an inverting amplifier in this part.

1. Build the circuit according to the figure below. $R_F = 100\Omega$, $R_A = 50\Omega$.
   Note:
   (a) Use the power supply to provide $+V_{cc}$=+5V and $-V_{cc}$=-5V to the op amp.
   (b) Use the COM port on the power supply as the ground in the schematic.
2. Use the function generator to generate a sine wave, and use it as the input voltage (v_i in the figure above). Set the initial amplitude of the sine wave to $0.1V_{pp}$. Use the oscilloscope to measure the output voltage (v_o in the figure above).
3. Increase the input voltage by $0.1V_{pp}$ each time and record the corresponding output until the output voltage is saturate, which means the output voltage is not increasing any more as the input voltage increases.

3 Results and Discussion

3.1 Resistances and Voltage Supply

$R_1[\Omega]$	99.5
$R_2[\Omega]$	51.2

Table 1: The resistances of the two resistors we use to build the circuit.

$+V_{cc}[V]$	5.00
$-V_{cc}[V]$	-5.00

Table 2: The voltage supplied to the op amp.

$+V_{pp(in)}[V]$	$V_{pp(out)}[V]$
0.100	0.302
0.200	0.600
0.300	0.904
0.400	1.200
0.500	1.500
0.600	1.800
0.700	2.100
0.800	2.400
0.900	2.700
1.000	3.000

Table 3: Non-inverting amplifier.

3.2 Non-inverting Amplifier

Use MATLAB to plot the figure.

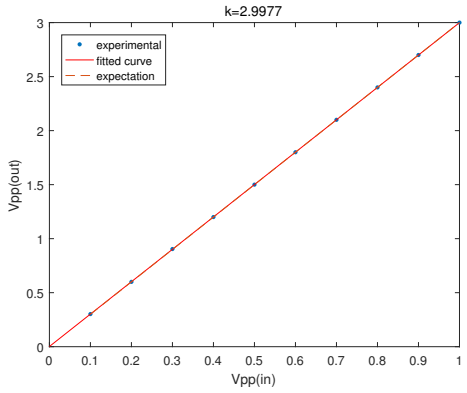

Figure 1: Non-inverting amplifier.

We can find that

$$\frac{V_{out}}{V_{in}} = 2.9977$$

By directly calculating,

$$\frac{V_{out}}{V_{in}} = 1 + \frac{99.5}{51.2} = 2.943$$

They are very similar.

3.3 Inverting Amplifier

$+V_{pp(in)}[V]$	$V_{pp(out)}[V]$
0.100	0.187
0.200	0.353
0.300	0.520
0.400	0.686
0.500	0.860
0.600	1.020
0.700	1.193
0.800	1.346
0.900	1.533
1.000	1.717

Table 4: Inverting amplifier.

Use MATLAB to plot the figure.

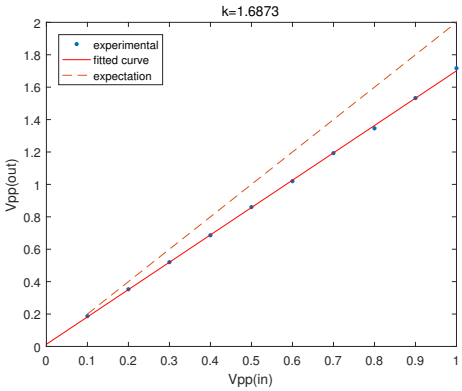

Figure 2: Inverting amplifier.

We can find that

$$\frac{V_{out}}{V_{in}} = 1.6873$$

By directly calculating,

$$\frac{V_{out}}{V_{in}} = -\frac{99.5}{51.2} = -1.943$$

They are not similar, probably because of the resistance in the amplifier can't be neglected when it is connected as an inverting amplifier.

4 Conclusion

In the lab, we learned how to build and test a variety of circuits based on LM 741 Op Amp chip: non-inverting and inverting amplifiers with fixed gain.We measured the gain of the amplifier and compared it with theoretical calculations and determinef the saturated output voltage of the amplifier.

5 Reference

Circuits Make Sense, Alexander Ganago, Department of Electrical Engineering and Computer Science, University of Michigan, Ann Arbor.

6 Pre-lab and Data sheet