

Observation of the Behavior of an Operational Amplifier

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March 30, 2016

Abstract

In this lab, we will explore the behavior of a Operational Amplifier as an inverting amplifier. We will measure the frequency response of the output and how the amplifier influences differentiation and integration of the input. We also observed the behavior of a summing amplifier with two function generators.

1 Preperation

We know that an op-amp has two inputs an inverting and non-inverting. These inputs influence how our input signal will be given as an output. The amp also has power supply connections which are not usually visible on op-amp schematics. Op-amps typically always use feedback loops since they have a large voltage gain. For an inverting amplifier we know that the input impedance is

$$Z_{in} = R_1$$

and the gain

$$G_V = -\frac{R_2}{R_1}$$

If we use a non-inverting the gain would have been

$$G_V = 1 + \frac{R_2}{R_1}$$

which would put the signal well beyond the scope of the oscilloscope.

2 Lab work

2.1 Apparatus

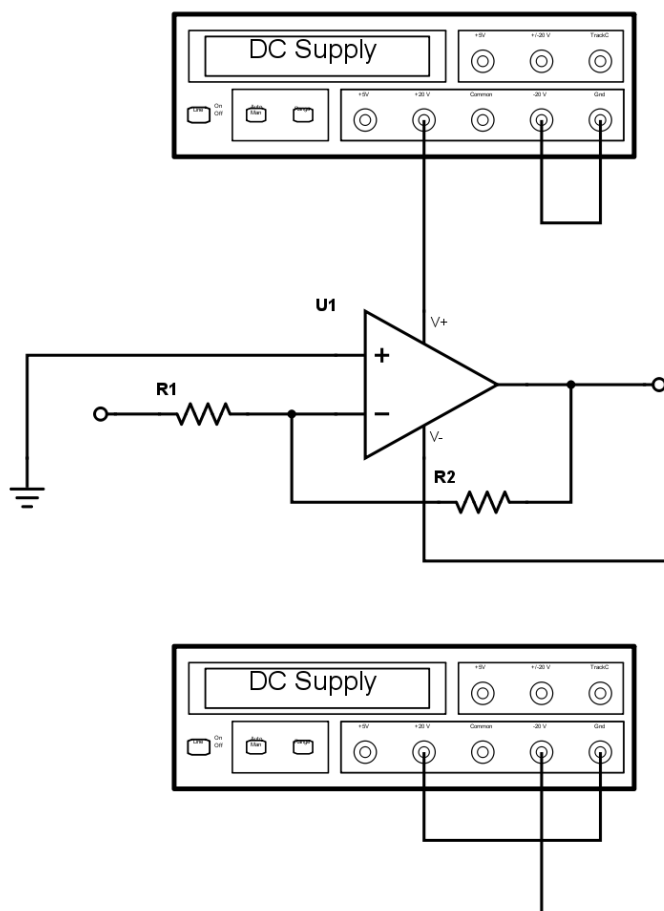


Figure 1: Our Op-amp amplifying circuit. R_2 will vary between 102.7 k Ω or 529 k Ω resistors.

This lab will use a signal generator, an oscilloscope, two DC voltage source, an op-amp, a 10 k Ω , 102.7 k Ω , and 529 k Ω . A Tee connector will connect

the input AC signal with channel 1 on the oscilloscope. The non-inverting input will be grounded. The AC signal generator will be in series with the $10\text{ k}\Omega$ resistor and inverting input of the amp. It will also form a feedback loop with the output using the $102.7\text{ k}\Omega$ or $529\text{ k}\Omega$ resistors. The two DC supplies will each be given a specific voltage. One will give $+15\text{ V}$ with the negative lead grounded and the other -15 V with the positive lead grounded. The two grounded leads will be connected and behave as our ground. A representation of our circuit can be seen in Figure 1.

2.2 Data Collection

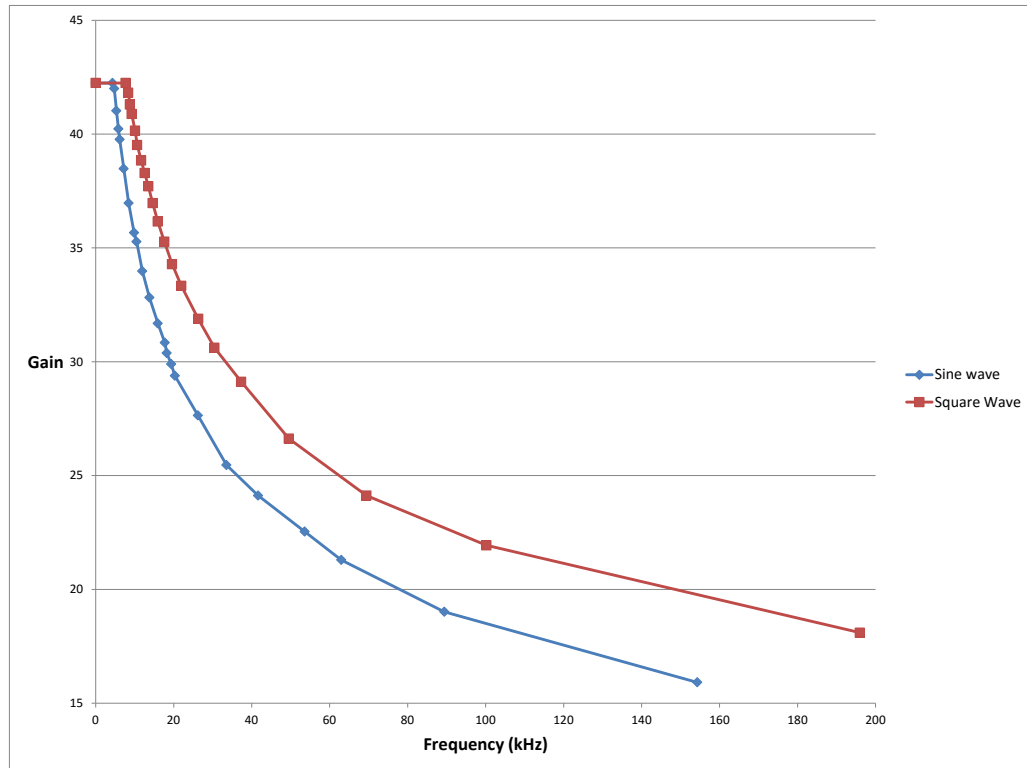


Figure 2: The Gain vs Frequency for a square and sine wave.

For an inverting amplifier as we can see from Figure 2, that from 0 to 4kHz the sine input has a flat gain and until 5 kHz the gain begins to decrease as frequency increases. For the square wave the gain is stable from 0 to 8 kHz

where it then begins to fall off. The input that was used was 224 mV since an input any higher would yield an output that would exceed the limits of the oscilloscope.

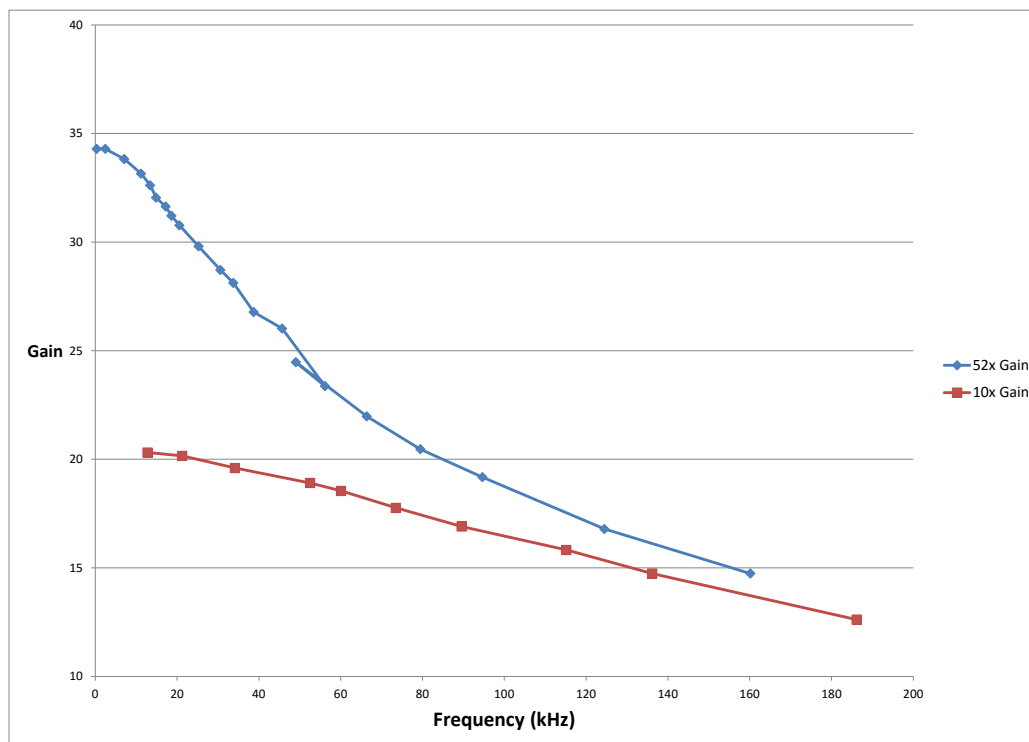


Figure 3: The Gain vs Frequency for a gain of 52 and a gain of 10

From Figure 3 we can see that the higher the gain the faster the gain decreases as the frequency increases. The circuit used to find this plot is seen in Fig 1. The blue line in Fig 3 uses an R_2 of 529 k Ω while the red line uses the 102.7 k Ω resistor. Both use an R_1 of 10 k Ω .

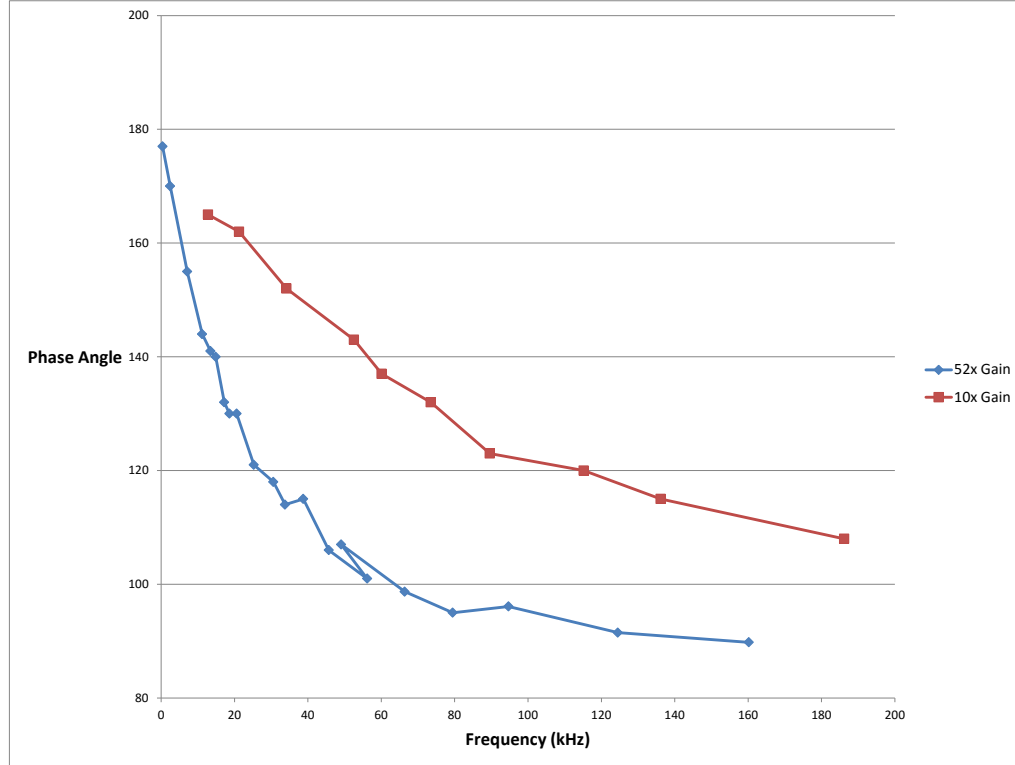


Figure 4: The Phase difference vs Frequency for a gain of 52 and a gain of 10

The phase difference followed a similar pattern as the gain behavior for both gains. At a higher maximum gain the rate at which the gain and phase fall increases as frequency increases. This effect is seen but not as drastically in the 10x gain compared to the 52x gain.

3 Summary and conclusions

In this lab, we have seen how an operational amplifier can amplify signal and how the amplification varies with frequency. From Fig 3, we can see how gain increases as frequency decreases and from Fig 4 the same relationship can be seen with the phase. Both graphs also demonstrated that at a higher maximum gain the rate of decreasing increases relative to frequency.