Example of linear op-amp report

Art & Culture, Symbolism

Abstract

An operational amplifier – OP-AMP is a circuit device that amplifies buffers or attenuates the input signal depending on the configuration. Amplified signal means that the output is greater than the input. This means the gain is larger than one. A buffered output means that the magnitude of input is equal to the output; only that the input has been delayed. An attenuated signal implies that the gain magnitude is less than unity. In this paper, amplification using an op-amp will be investigated. Inverting and non-inverting configurations will be connected and tested. Input waveforms and output waveforms will be compared. It will be noted that the inverting configuration gives an output that is out of phase with the input while a non-inverting configuration gives an output signal that is in phase with the input.

Objective

The aim of this lab was to observe the inverting and non-inverting configurations of a linear op-amp and compare the results with theoretical expectations.

Theory

An op-amp is an electronic circuit that is capable of controlling both current and voltage of electrical circuits. The LM741 is a common op-amp chip that is available for several applications. It is used in strain gauges, thermostats and accelerometers among other applications.

The inside of an op-amp is composed of transistors. The first stage of an op amp is a differential amplifier. However, these complex circuits can be treated like a black box and analyzed from a terminal behavior as will be done in this lab.

Figure 1. 0 below shows the circuit symbol of an operational amplifier.

Figure 1. 0: circuit symbol of an OP-AMP

As shown in figure 1. 0, the op-amp has the inverting input (V-), non-inverting input (V+), positive and negative power supplies (Vs+ and Vs-) and the output (V-). Practically, the output cannot be greater than the magnitude of the supplies.

For an ideal op-amp, current can flow from the output but there is no current flow into the inputs. Also, for an ideal op-amp, there is no voltage difference between the inputs. If voltage changes in one of the inputs, voltage on the other input decreases or increases so as to match. This makes the amplifier to operate linearly thus keeping the output voltage constant. The equilibrium is made possible by a negative feedback within the circuitry of the op-amp. For a non-ideal op-amp, there is a voltage difference between the inputs causing non-linearity, i. e. output does not return to initial value. However, the negative feedback in the op-amp circuitry limits the differences so that linearlity can be safely assumed.

The inverting and non-inverting configurations are shown in figure 2a and 2b.

Figure 2a: Inverting op-amp configuration

Assuming that no current enters the inputs, then the junction between R1 and Rf is a virtual ground. The following analysis can be made.

Vin= IR1 and Vout=-IRf

Therefore;

VoutVin=-IRfIR1=-RfR1

Figure 2b: Non-inverting op-amp configuration

Once more, assuming that no current enters the input nodes, then the junction between R1 and Rf can be assumed to be a virtual short. This makes, R1 and Rf parallel with respect to Vin. Therefore;

Vin= IR1RfR1+Rf and Vout= IRf

VoutVin= IRfIR1RfR1+Rf= R1+RfRfR1Rf= R1+RfR1= 1+RfR1

Procedure

The inverting and non-inverting configurations were connected as detailed in the lab manual.

A 1 kHz, 1 V sinusoidal voltage was fed into the input for each configuration. Both input and output were observed from an oscilloscope and compared.

Results

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Analysis

Theoretical expectations from each configuration were calculated so that the results would be compared to the experimental findings.

[calculations..]

[for theoretical results, use the resistance values to obtain gain]

[for practical results, use peak values observed in the electroscope to compute gain..]

[perform error analysis]

error= Gaintheory-GainpracticalGaintheory×100%

Discussion

For both configurations, it was observed that the measured gain was close to the theoretical gain. Most measurements were found to be within an error margin of 2% showing that our results were precise and accurate. These errors arise from observation errors, rounding off and slight distortion introduced by the oscilloscope. This is assuming that the op-amp is linear. In addition, resistors have marginal tolerance; this could be a reason why discrepancy between observed value and theoretical value was obtained.

Conclusion and Recommendation

The objective of the experiment was achieved. The results obtained showed that the experimental errors were negligible. The operation of inverting and non-inverting amplifier was thus verified. To minimize errors, a more accurate oscilloscope and resistors could be used. However, in the scope of this laboratory and its objectives, using more precise devices is simply expensive and unnecessary.