Executive Summary

Operational Amplifiers (Op-Amps) are devices that can perform a number of actions including adding, subtracting, multiplying, integrating, and differentiating voltage signals. This report shows the 741 Op-Amp’s ability to multiply and compare signals. We set up multiple circuits in configurations that would allow the Op-Amp to perform these actions and used various instruments for measurement. Our results showed that the 741 Op-Amp could indeed perform these operations on electrical signals that are between -10 volts and 10 volts (with some head room). This Op-Amp can be very useful in low voltage, low power situations.

University of Rochester

Electrical and Computer Engineering

Laboratory #5

Simple 741 Op-Amp Circuits

Purpose

The purpose of this lab was to test different functionalities of the 741 Op-Amp. We used it as an inverting amplifier, a non-inverting amplifier, and as a comparator.

Procedure

Set Up

One of the most important aspects of this lab was setting up the power supply so that we were able to get a negative and positive voltage out of the power supply. Although the voltage was really ranging from 0 - 24V when grounded to Earth, we were able to use a reference ground that let the Op-Amp act just the same as though there was a range of -12 - 12V. This was important for the supplying the power to the Op-Amp and for allowing an inverting signal invert past 0V.

For the resistors, we chose to use 2.2kΩ and 22kΩ because they met the requirements of having a larger value then the potentiometer and they would not allow more than 1A of current through.

Inverting Amplifier

We used a breadboard, a DIP 741 Op-Amp, two 2.2kΩ and 22kΩ resistors for Rf and Ri respectively, and a 20k potentiometer. We set the set up the circuit as shown below:lab5

Then, we made predictions as to what the Op-Amp would output depending on our input. Finally, we tested this experimentally by using our power supply and a potentiometer to input any voltage we wanted in between the two rails.

Results

|  |  |  |  |
| --- | --- | --- | --- |
| Predicted Vin | Measured Vin | Predicted Vout | Measured Vout |
| 0V | .003 | 0 | -.034 |
| 0.1V | .1 | -1 | -1.013 |
| 0.2V | .202 | -2 | -2.04 |
| 0.5V | .502 | -5 | -5.08 |
| 1.0V | 1.001 | -10 | -10.21 |
| 2.0V | 2.001 | -12 | -10.66 |
| -0.1V | -.101 | 1 | 1.019 |
| -0.2V | -.204 | 2 | 2.036 |
| -0.5V | -.501 | 5 | 5.008 |
| -1.0V | -1.002 | 10 | 10.025 |
| -2.0V | -2.000 | 12 | 10.67 |

Discussion and Conclusion

Our measurements matched our predictions rather well. The set up of this Op-Amp would allow for the input signal to be inverted and have a gain of 10. We even made predictions that the Op-Amp would not be able to invert a 2V signal to -20V or a -2V signal to 20V and instead would max out at the -12V and 12V rail. Although this wasn’t exactly correct, our Op-Amp exhibited saturation, which was what we were basing our predictions off of.

Non-Inverting Amplifier

We used a breadboard, a DIP 741 Op-Amp, two 2.2kΩ and 22kΩ resistors for Ri and Rf respectively, and a 20k potentiometer. We set the set up the circuit as shown below:

lab5b

Then, we made predictions as to what the Op-Amp would output depending on our input. Finally, we tested this experimentally by using our power supply and a potentiometer to input any voltage we wanted in between the two rails.

Results

|  |  |  |  |
| --- | --- | --- | --- |
| Predicted Vin | Measured Vin | Predicted Vout | Measured Vout |
| 0V | .003 | 0 | .033 |
| 0.1V | .102 | 1 | 1.019 |
| 0.2V | .201 | 2 | 2.021 |
| 0.5V | .503 | 5 | 5.045 |
| 1.0V | 1.005 | 10 | 10.01 |
| 2.0V | 2.003 | 12 | 10.66 |
| -0.1V | -.101 | -1 | -1.014 |
| -0.2V | -.202 | -2 | -2.023 |
| -0.5V | -.504 | -5 | -5.039 |
| -1.0V | -1.002 | -10 | -10.04 |
| -2.0V | -2.002 | -12 | -10.67 |

Discussion and Conclusion

Our measurements matched our predictions once again. We made predictions on what our output results should be based on our input. Then, we measured the input (the node in between Ri and Rf on the non-inverting input) and the output while trying to match the input with our theoretical values. The values we got were congruent with our predictions. Our results also displayed the same saturation that the Inverting Op-Amp showed. The Non-Inverting Op-Amp can take a signal between -1V and 1V as the input and output a voltage gain of 10.

Comparator

This part of the lab used the Op-Amp as a comparator. An Op-Amp can often to described as a device that tries to make both its inverting and non-inverting terminals equal the same voltage. It usually does this by negative feedback, a design aspect integral to many Op-Amp circuits to allow the output to adjust to the inputs. In this case, we see the Op-Amp in a state were there is no negative feedback, as shown below:

lab5c

This makes the Op-Amp saturate to its negative or positive rail when the inverting or non-inverting input exceeds the other. This was meant to make a sort of switch when the input of the non-inverting input was larger then the inverting input to then light up the LED on the output.

Results

The LED turned on at 9.46V

Discussion and Conclusion

Due to the nature of the voltage divider on the inverting input, the critical voltage value for turning the LED on and off was 9.46V. This was very apparent because as soon as the voltage of the non-inverting input past the inverting input, the LED flipped on without brightness or flickering issues.