ELECTRONICS (ETEN1000)

STUDENT NUMBER: **22663281**

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GROUP: **12 pm to 2pm Thursday**

LABORATORY: 6: Amplifier Design to Drive a Speaker

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I hereby declare that the calculation, results, discussion and conclusions submitted in this report is entirely my own work and have not copied from any other student or past student.

Student Signature: Troyee

Amplifier Design to Drive a Speaker

Introduction

The primary objective of this mini-project is to designing and implementing an amplifier circuit that can power a low-power .Specific requirements must be met by the amplifier, such as a maximum gain of 12 dB, an input impedance of more than 30 kΩ, and a load impedance of 8–16 Ω. Peak-to-peak, the input signal range is set at 0 to 1 V. To accomplish the desired amplification, this project needs the use of operational amplifier concepts, together with component selection and circuit analysis to guarantee that the output can successfully deliver an audio signal to the speaker.

Aim

The goal of this project is to design and build an operational amplifier circuit that satisfies the technical specifications and can amplify audio signals to drive a speaker. The amplifier should be set up to handle load and input impedance as needed and to reach a gain of up to 12 dB. This involves selecting appropriate resistor values, building the circuit on a breadboard and Vero board, then using an oscilloscope and a speaker to test the output performance.

Summery

An operational amplifier was used in the amplifier's design, and resistors were chosen to provide the necessary gain. In order to view waveform outputs, the amplifier was first tested on a breadboard by connecting it to a signal generator with a 1 kHz input frequency and a 1 kΩ load resistor. Using oscilloscope measurements, the amplifier's gain was verified, and performance was optimized by adjustments.

Circuit

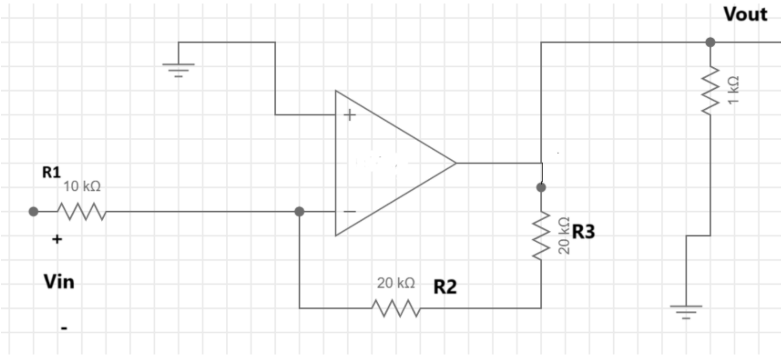

figure1 – Inverting amplifier

This circuit is an inverting amplifier that amplifies an input signal applied through a **10 kΩ** resistor $\boldsymbol{R_1}$ using an operational amplifier. The signal is received by the inverting input (pin2) and for stability, the non-inverting input(pin3) is grounded.

Two resistors R_3 and R_2 each 20 kΩ, together form a feedback network that is connected in series from the output back to the inverting input and will work as R_2 and value is 40 **k** $\boldsymbol{\Omega}$.

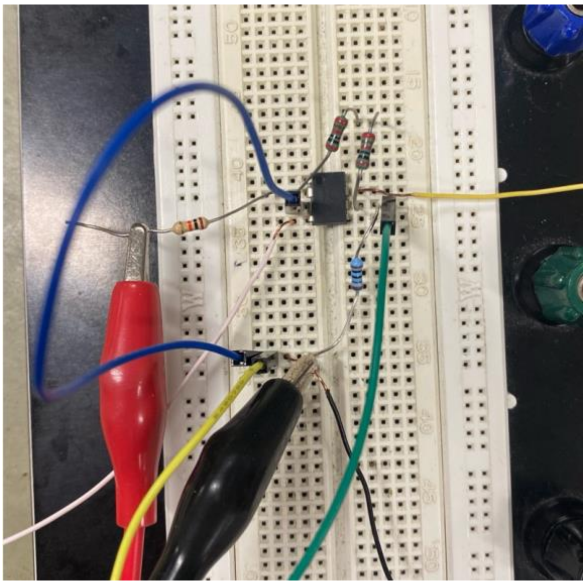

Figure2 – Set up of the circuit on a breadboard

The actual circuit that was built from the circuit diagram is shown in the photo above.

Designing of the circuit

This circuit design's primary goal was to attain a gain of 4, which was determined using the following relationship:

$$\text{db(gain)} = \left| \frac{\boldsymbol{V_{OUT}}}{\boldsymbol{V_{IN}}} \right| \quad \mathbf{= 4}$$

We chose a 10 kΩ resistor for $\boldsymbol{R_1}$ and a combined 40 kΩ resistor for $\boldsymbol{R_2}$ in order to satisfy this gain requirement. Two 20 kΩ resistors ($\boldsymbol{R_2}$, $\boldsymbol{R_3}$)were connected in series to obtain the required resistance value because a single 40 kΩ resistor was not available, so designing $\boldsymbol{R_2}$= 40 kΩ. Here, $\boldsymbol{R_2}$, $\boldsymbol{R_3}$ will work as R_2.

So, $\boldsymbol{R_2}$ will be calculated as follow:

$$\boldsymbol{R_2} = \boldsymbol{R_2} + \boldsymbol{R_3}$$

$$= 20\ \text{k}\Omega + 20\ \text{k}\Omega$$

$$= 40\ \text{k}\Omega$$

Using these values, the amplifier circuit receive gain of:

$$\text{gain} = \frac{40{,}000\Omega}{\mathbf{10{,}000\Omega}} = 4$$

With this arrangement, the output signal is both amplified and phase-inverted in comparison to the input signal, creating an inverting amplifier system. Inverting amplifiers contain this phase inversion, which can be expressed mathematically as:

$$\boldsymbol{A_v} = -\frac{\boldsymbol{V_{OUT}}}{\boldsymbol{V_{IN}}}$$

Test results

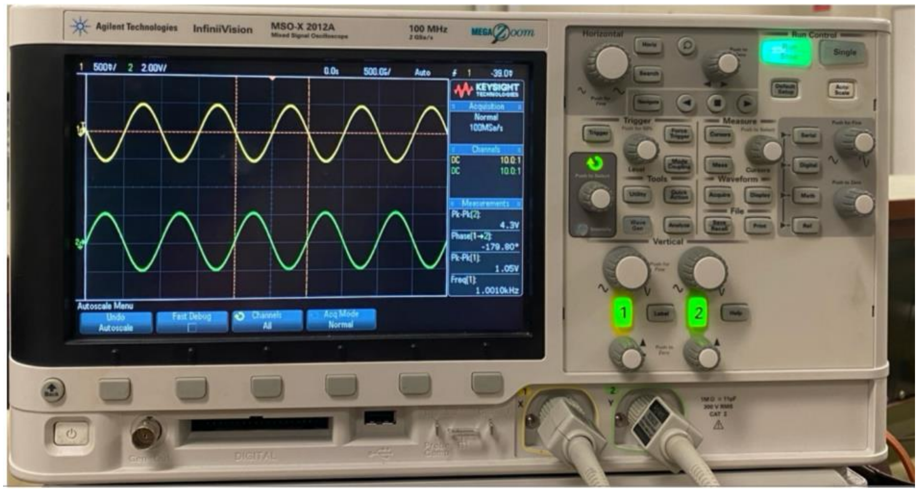

Figure 3: Inverting Amplifier input and output waveform

The output signal is represented by the **green waveform** on the oscilloscope display, and the input signal is displayed by the **yellow waveform**. The observed voltage levels from the waveforms can be used to calculate the amplifier's gain (or dB). The gain is calculated using the following formula, where the input voltage is $\boldsymbol{V_{in}}$ = 0.5 V and the output voltage is $\boldsymbol{V_{out}}$ = 2V. The gain is calculated as follows:

$$\text{Gain(dB)} = \left| \frac{V_{OUT}}{V_{IN}} \right|$$

$$= \left| \frac{2}{0.5} \right|$$

$$= 4$$

This analysis verifies that the amplifier meets the design requirement by achieving a gain of 4.

Reflection

In order to generate sound, the last step was to connect the amplifier's output to a speaker. The pitch of the speaker changed significantly when the signal generator's input frequency was changed. In order to show how well the amplifier controls audio output, lowering the frequency generated a lower pitch and raising the frequency produced a higher pitch.

The speaker was connected via one terminal to the output voltage and the other to the circuit's common ground. Although the speaker terminals have polarity, connecting the ground to either terminal did not affect the sound quality. The performance was not affected by the polarity arrangement, which was flexible.

The biggest difficulty was getting the required gain (dB) using the resistor values that were available. Since individual resistors with the precise resistance values needed were not available, calculations were necessary to combine resistors in a way that closely matched the required resistance values. These alterations made sure the circuit met its design requirements.

References

lecture notes

Appendices

Nil