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Instructions:

- ***Submission must contain only original, individual, and current work.***
- ***After completion, save as PDF before submitting.***

Task 8.10: AC vs DC Input to an Op-Amp

Objective:

The objective of this task is to understand the difference of AC and DC input into an Op-amp, and the limitations of an op-amp in real circuits.

Circuit Schematic:

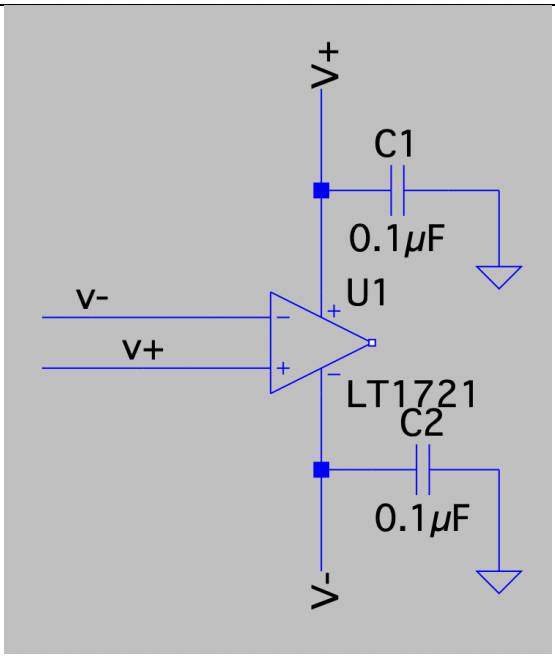

Figure I: Circuit Diagram

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Step 2:

V_{in} (V)	V_{out} (V)	Gain	Percent Error
5	-4.3189	-0.8638	42.41
2.5	-3.7364	-1.4946	0.36
1	-1.4980	-1.4980	0.13
0	0.0067	NA	NA
-1	1.4859	-1.4859	0.94
-2.5	3.5859	-1.4344	4.38
5	3.571	-0.7142	52.39

Table I: Gain and Vout

Around lower voltages, the gain of the op-amp matched the gain we calculated, however, at higher voltages the percent error got higher, specifically around 5V. at higher voltages, the op-amp cannot output a voltage higher than the voltage given, in our case 5V. additionally, the op-amp consumes some voltage in the internal components.

Step 3:

V_{in} (Vp)	V_{out} (Vp)	Gain	Percent Error
0	0	0	0
0.987	-0.735	-0.7447	50.35%
1.9625	-1.45	-0.7388	50.75%
3	-3.5	-1.167	22.20%
4	-3.5	-0.875	41.67
5	-3.487	-0.6974	53.51

Table III: Input voltage and output voltage with gain

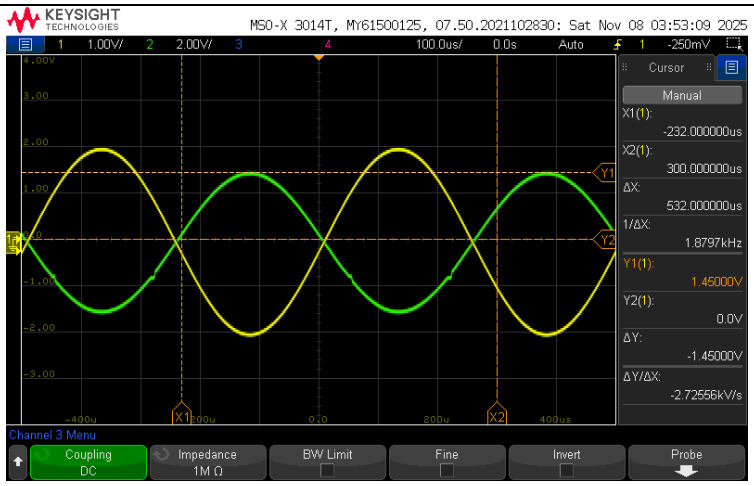

Figure II: Output voltage (green) and input voltage

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Increasing the input voltage made the output more accurate. Similar to how we saw the voltage cut off in the DC input, the op-amp cannot supply more voltage that its supplied and the op-amp itself takes some voltage in its operation.

Step 5:

Op-amps cannot supply more voltage than their given. This is true for both AC and DC inputs, and the op-amp depending on the input voltage will attempt to drive the output to either the V- or V+, depending on the circuit its set up in with voltage dividers or adjustable resistors.

Conclusion:

In this task we explored the use op-amps with both AC and DC input and used experimental data to understand their limitations and real-world use.

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Task 8.11: The Adjustable Gain Amplifier

Objective:

The objective of this task is to explore the use an adjustable gain amplifier with the use of op-amps and potentiometers.

Circuit Schematic:

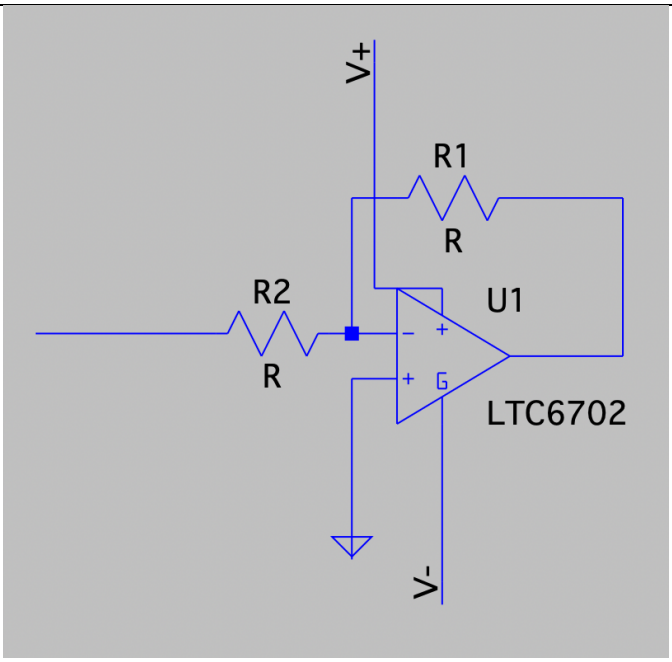

Figure V: Adjustable gain amplifier diagram

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Step 2:

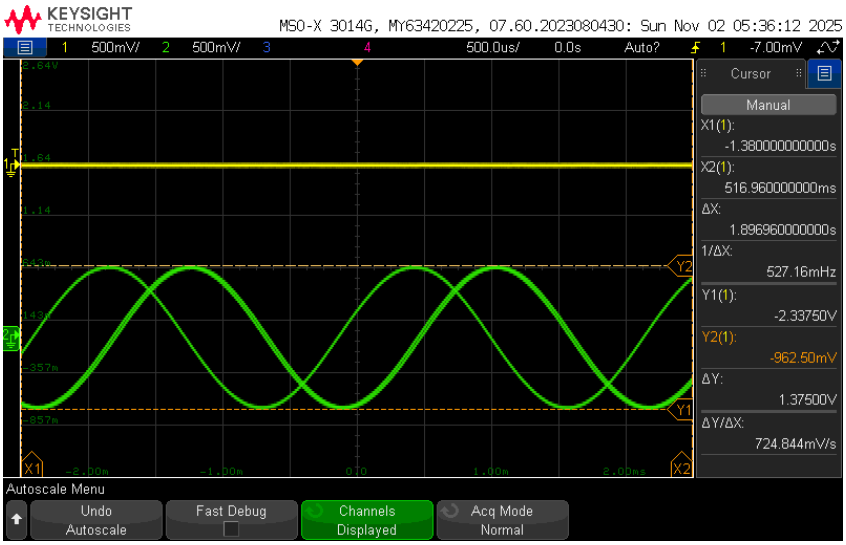

Figure VI: Op-amp output at 0 gain

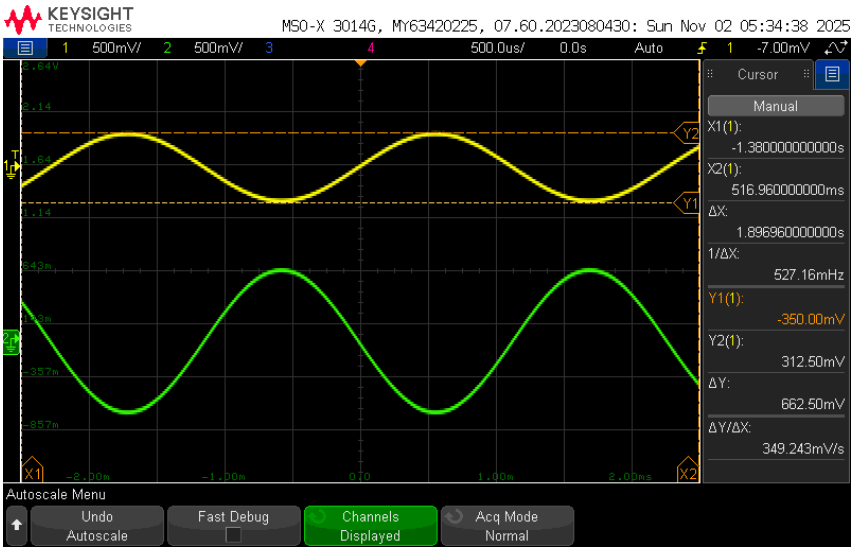

Figure VII: op-amp output at around medium gain

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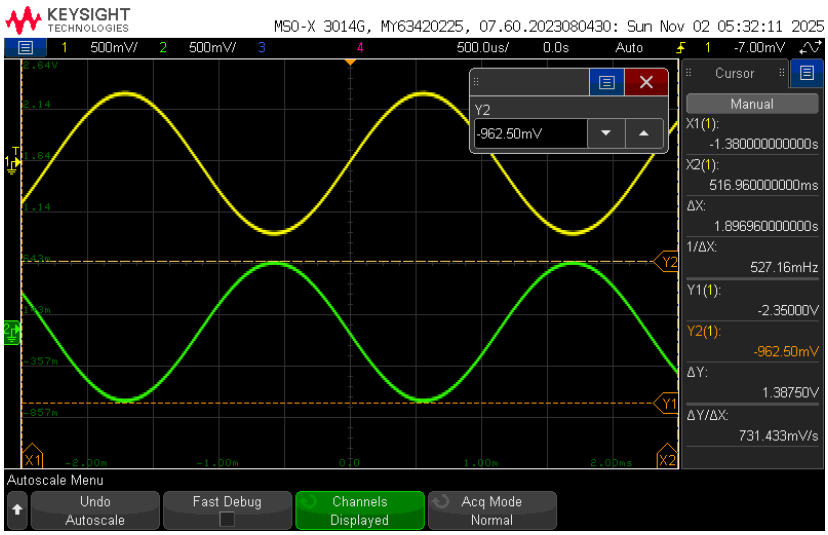

Figure VIII: op-amp output at max gain

Step 3:

Plugging it into the speakers as I turned the potentiometer the volume increased and at the extreme the speaker went silent.

Step 5:

The output of the op-amp at higher gains causes the speaker to go loud and then go silent.

Conclusion:

In this task we used voltage dividers and potentiometers to construct an adjustable gain amplifier and used a speaker to understand its real world applications.

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Task 8.12: Characteristics of Op-Amps and Comparators

Objective:

The objective of this task is to understand and use comparators using potentiometers.

Circuit Schematic:

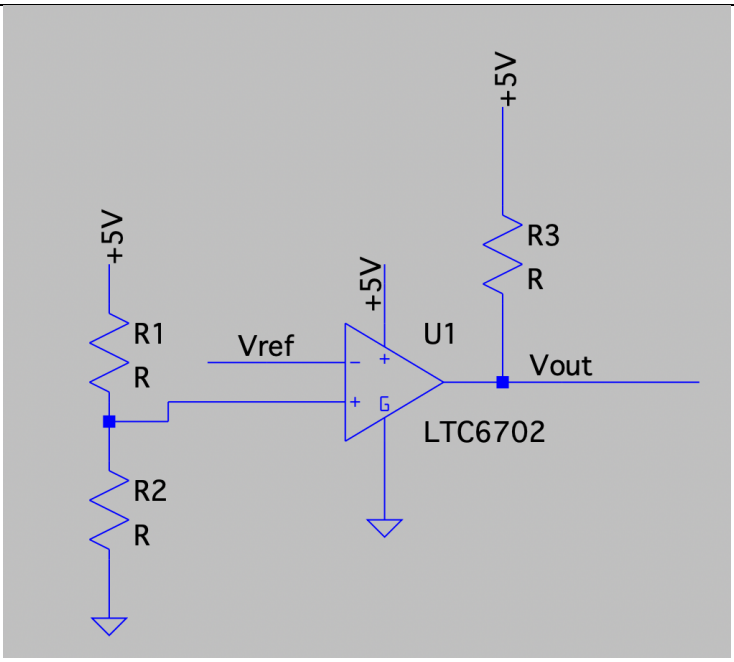

Figure XII: Comparator circuit diagram

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Step 2:

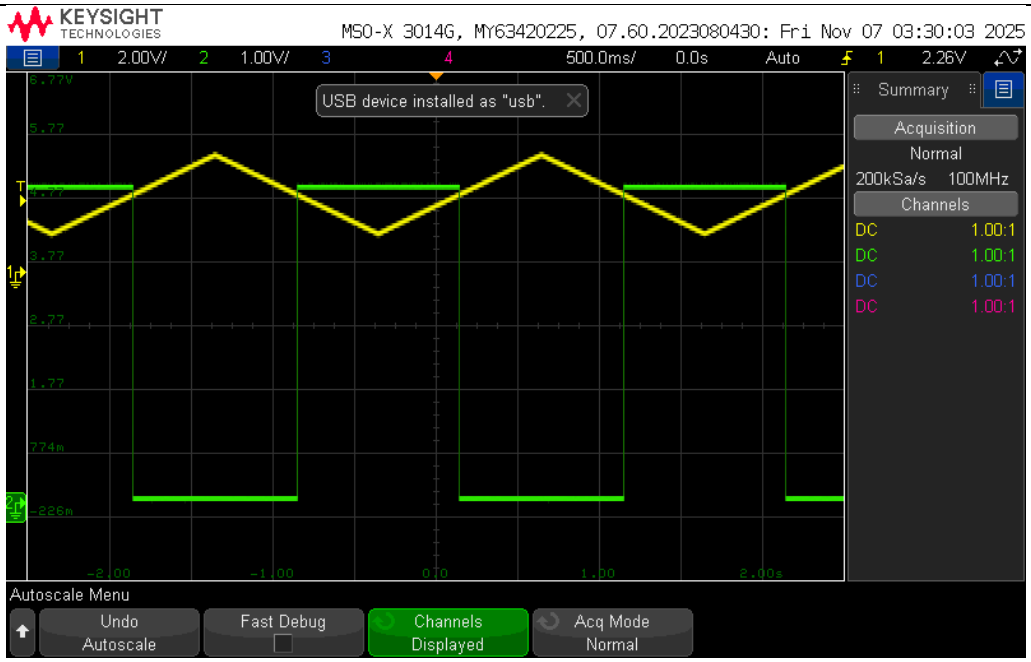

Figure XIII: Comparator circuit output

Step 3:

The pull up resistor causes the output voltage to stay constantly low or constantly high, removing the switching effect.

Step 4:

The pull up resistor allows the comparator to ‘pull’ the output up to a full 5V. a pull-up resistor could be useful when you need to pull an output to high when the IC or circuit itself cannot do that.

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Step 5:

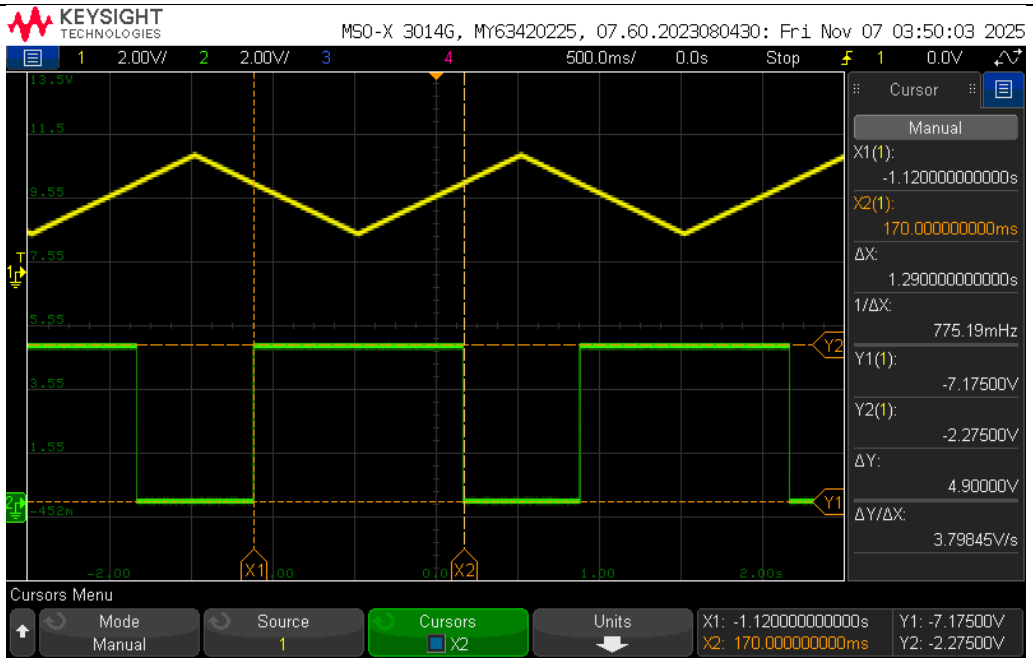

Figure XIV: output of the circuit with a different voltage.

The difference of the output is that the period at which the voltage is high is much lower, instead of encompassing a whole rising/falling period it shortens significantly.

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Step 7:

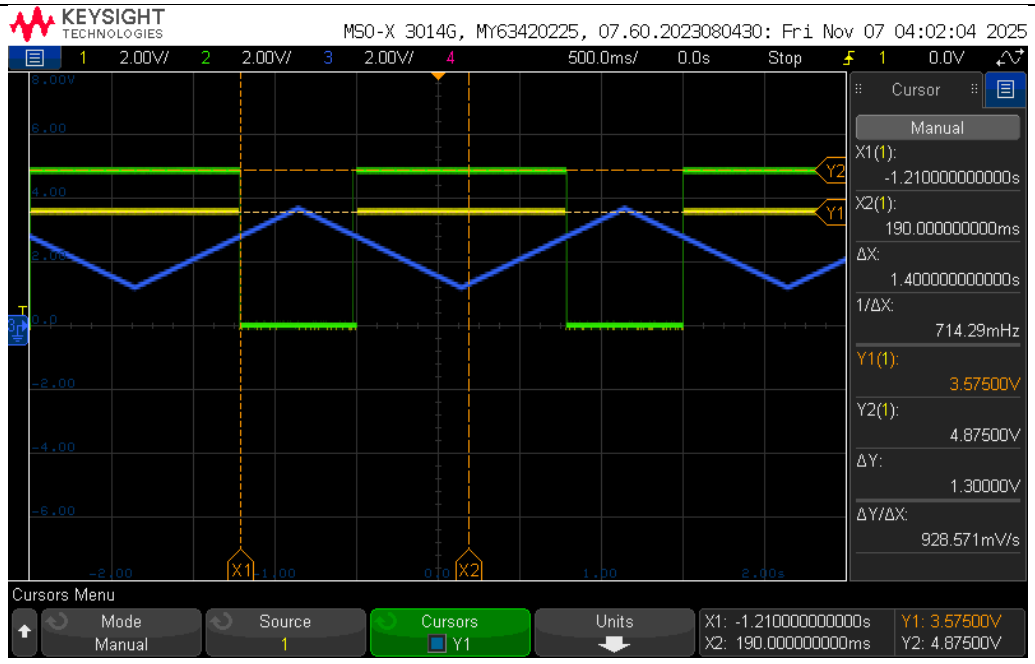

Figure XVI: input, op-amp, and comparator output.

Step 8:

the slew rate of the op-amp is lower than the comparator. We can use the higher slew rate of the comparator output to allow circuits to switch following a condition, which would allow the op-amp to go high shortly after.

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Step 9:

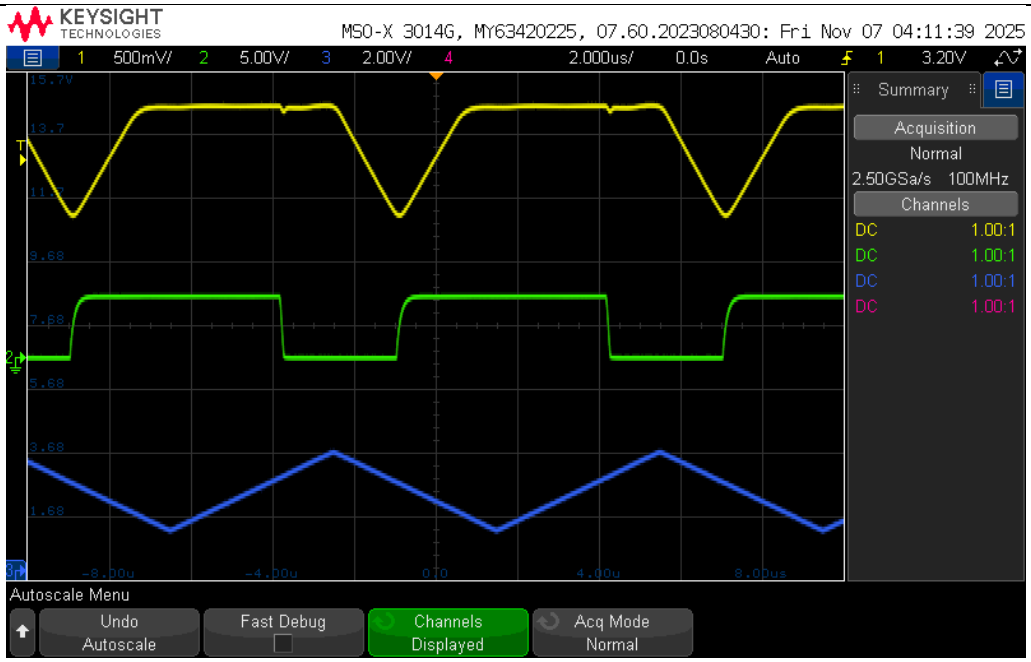

Figure XVII: Unusual op-amp output

What could be happening here is the op-amp not being able to constantly switch following the alternating current. With a higher frequency the op-amp struggles to keep up with trying to pull the output to either to v- or v+.

Conclusion:

Throughout this task we explored the use of comparators and the effectiveness of pull-up resistors. We also compared them to op-amps and the differences in the two ICs.