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Date: 01.05.2024

EE313-Electronic Circuit Design
Lab4 Experimental Work
Wide-Band Amplifier with Feedback

Experimental Work

In the experimental part, our aim is to lower the output gain and a flat gain via feedback connection and made sure that our design in spice working properly and consider what could be the errors in real life and solve these real life problems.

My overall circuit on breadboard as below:

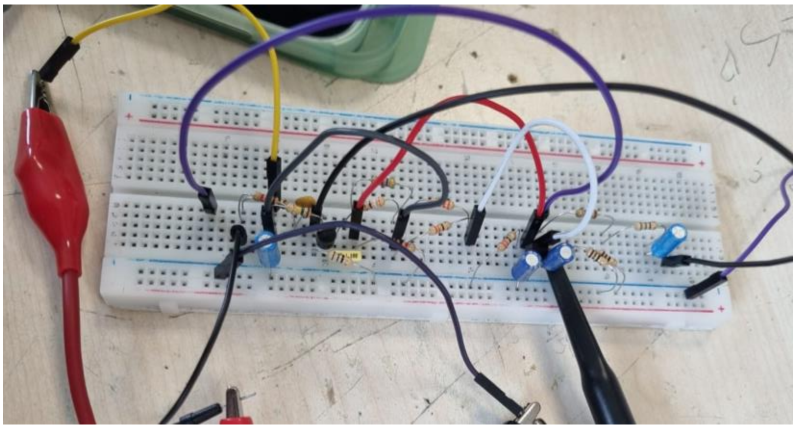

Figure 1: Breadboard Implementation of Wide-Band Amplifier with Feedback

At first I tested my circuit without feedback, as expected I observed a very high gain. Results are below:

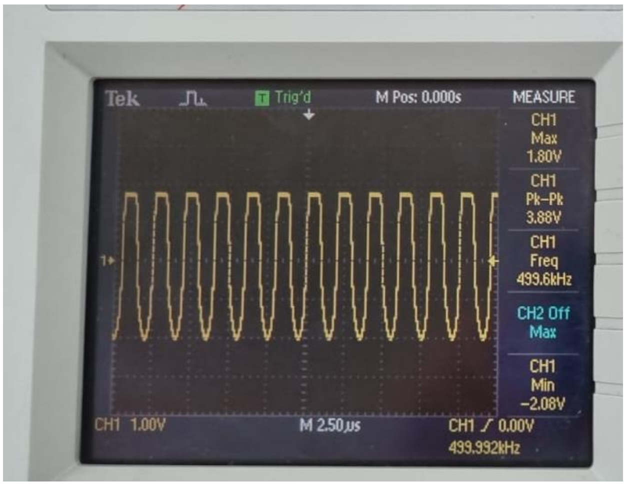

Figure 2: Voltage Gain Without the Feedback, 25.8dB gain

The clipping occurs when the input signal exceeds the maximum or minimum limits of the transistor's linear operating range which is totally normal because we designed our circuit as it should work properly with the feedback connection. But we can eliminate clipping when we lower the input voltage so that we get a higher gain.

We are expected to get 40dB gain without the feedback however in spice I got about 35dB at 500kHz.

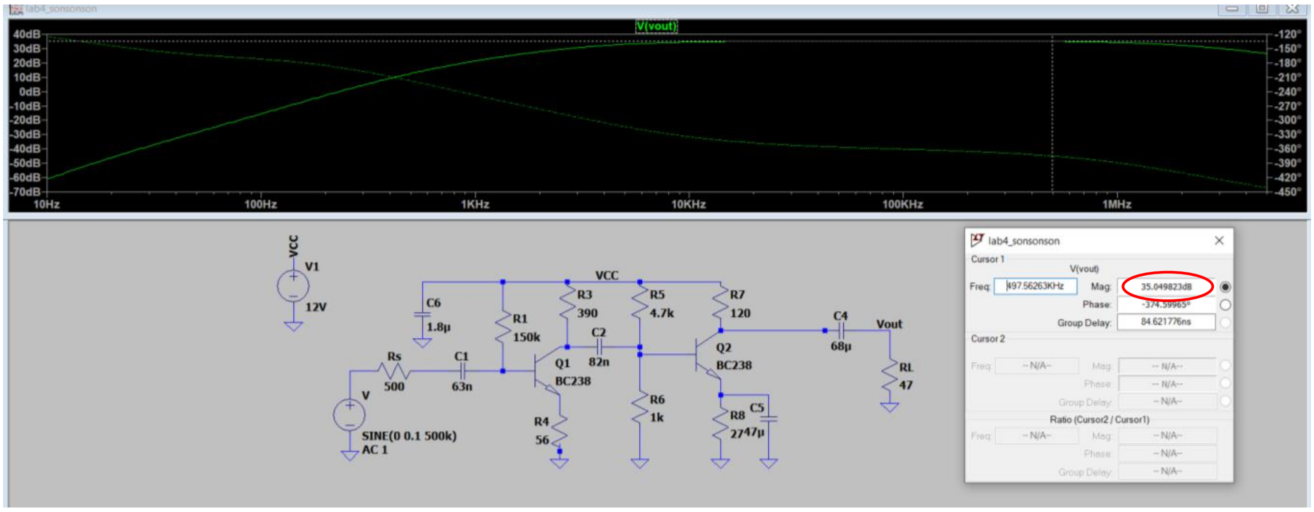

Figure 3: Output gain without feedback at 500kHz ≈ 35dB, in spice

Considering that I changed my component values while implementing the circuit for example to lower the supply current, I changed R8 and R4 values and some of my capacitors beacause of some other reasons. My circuit could not give exactly 35dB, but rather 25.8dB because we also have clipping, without clipping we could reach about 4V as an output which gave us 26dB. This gave us 25% error which is acceptable considering I played with my component values in the lab.

After observing output gain, I connected the feedback connection again and continued.

Specification 1

The current consumption is less than 70mA. However, when I first connect my circuit to the supply I got slightly higher than 70mA. Like about 74mA. To decrease the current consumption. I played with R4 and R8 because these are the resistor decreasing the current consumption of the transistors and affecting minimum the mechanism of the circuit. Changing any other resistor will cause gain change or will be problematic fort he operating region of the transistors.

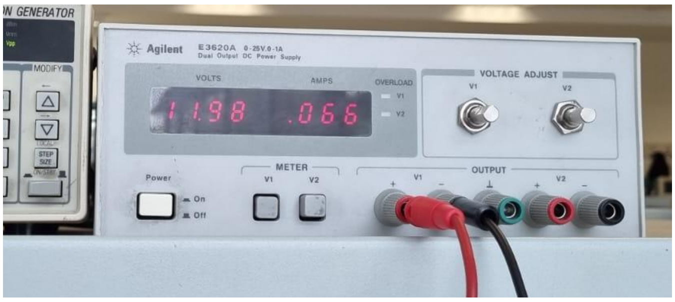

Figure 4: Current Consumption of Power Supply

Specification 2

The bandwidth is at least 5KHz-5MHz while the mid-band gain is 20dB±0.5dB. The output voltage should be 2Vpp because of the gain calculation below:

$$20\log\left(\frac{2}{0.2}\right) = 20$$

Here is the output voltages of different frequencies, so that I observed a flat gain after about 5kHz:

Figure 5: Output voltage at 5kHz, 2.12V

Figure 6: Output voltage at 100kHz, 2.16V

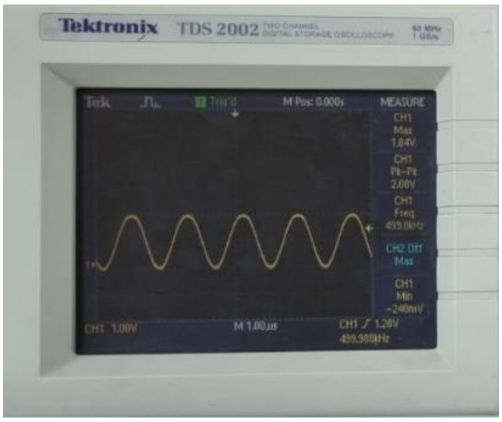

Figure 7: Output voltage at 500kHz, 2.08V

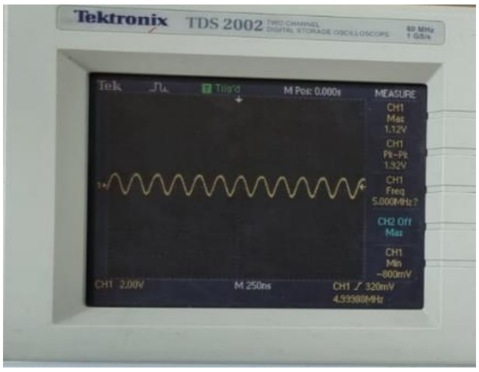

Figure 8: Output voltage at 5MHz, 1.92V

	Voltage (V)	Gain (dB)
5kHz	*2.12*	*20.51*
100kHz	*2.16*	*20.67*
500kHz	*2.08*	*20.34*
5MHz	*1.92*	*19.65*

Table 1: Gain at Different Frequencies

Specification 3

At this part, the harmonic content of the output voltage should be better than −30dBc at 500KHz. So we will observe FFT of the given signal in our output from the MATH MENU of our oscilloscope. We observe the dB difference between the harmonic via cursor.

Figure 9: 54.4 dB Gain Difference

Specification 4 and 5

The smallsignal input impedance of the amplifier at 500KHz (with RL=47Ω, adjusted value of RS until the voltage gain drops to half its value compared to RS=0).

I found the input impdence at the point when output voltge halves (about 1V). Similarly output impedance is found 5Ω in simulation, I tried this value in the lab and satisfied the simulation value, but the reason why sinus wave started to clip I lower Vin and find the half value that way. The reason why it halves is input gets the same impedence with the right side of the circuit and in parallel voltage drops its half value.

However, as the input impedence I observed 1Vpp at 47kΩ in spice, but I got that voltage with 56kΩ.

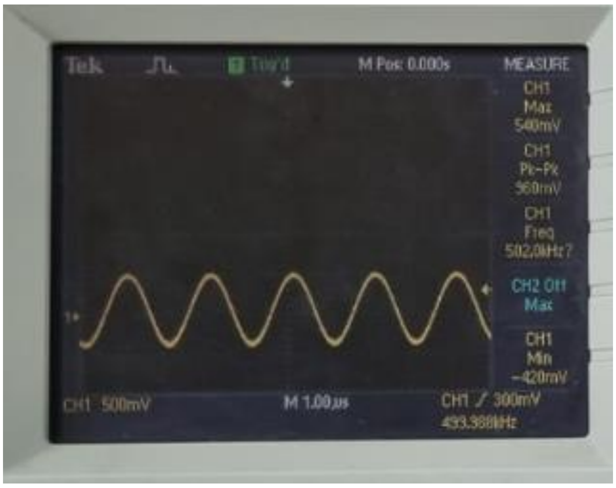

Figure 10: 960 mV when Rs = 56kΩ

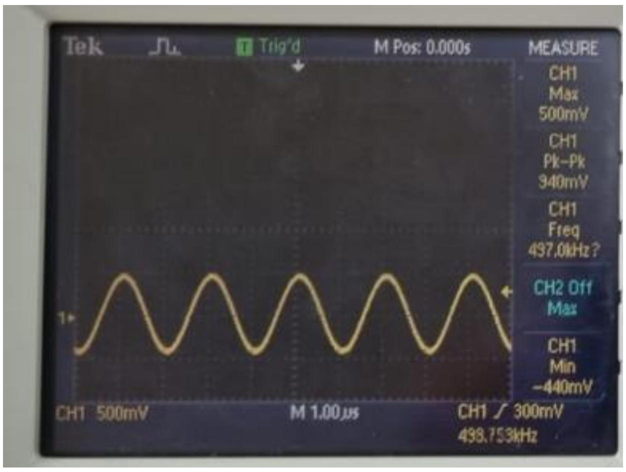

Figure 11: 940 mV when RL = 5Ω

At 500kHz, I observed 2.08Vpp so that, as halved value I should get 1.04Vpp when I give *5Ω for* RL and *56kΩ* Rs. I got a small error because I tried to use standard resistor values.

	Expected Voltage (Vpp)	Experimental Voltage (Vpp)	Error (%)
When RL= 5Ω	1.04	*0.94*	*9.62*
When RS= 56KΩ	1.04	*0.96*	*7.69*

Table 2: Error in Vpp for Input and Output Impedence Values

They are below 10%, so in a acceptale range.

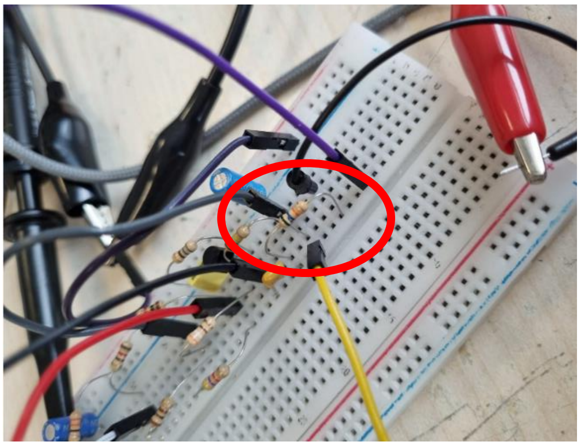

Figure 12: when Rs = 56kΩ

Conclusion

In summary, our experiment focused on designing and testing a Wide-Band Amplifier with Feedback. We aimed to achieve lower output gain and flat gain characteristics through feedback connection. Initial evaluation without feedback yielded a high gain, with observed clipping. Despite minor deviations from simulated values, our adjustments to component values ensured compliance with specified requirements for current consumption, bandwidth, and harmonic content. Overall, our experimental results demonstrate successful implementation of the amplifier design, highlighting considerations for real-world circuit performance.

References

https://moodle.bilkent.edu.tr/2023-2024-spring/pluginfile.php/102573/mod_resource/content/4/Lab4.pdf

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