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EE313-Electronic Circuit Design

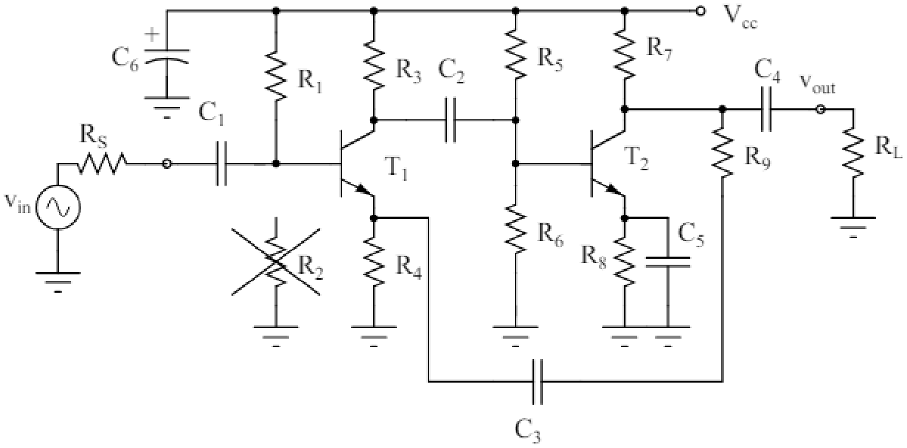
Lab4 Preliminary

Low-Dropout Voltage Regulator

Preliminary Work

This lab explores designing and analyzing a wide-band amplifier with feedback, aiming to meet specific requirements like low output impedance, consistent gain, and minimal distortion. We'll focus on factors such as how much current it uses, how well it boosts signals, distortion levels, and how it handles input and output signals.

There are given 2 possible solutions of this lab, one with BJT's another with NMOS transistors. I picked the BJT solution. So here is the possible circuit we are given:



For this purpose I used BC238 power amplifier. We are asked to analize our circuit first without the feedback loop so that our gain will be much larger than we normally get (about 20dB). However, the current with the feedback circuit doesn't match with the no loop circuit with the appropritе values I picked. Here is my feedback collector current values below:

Specification 1

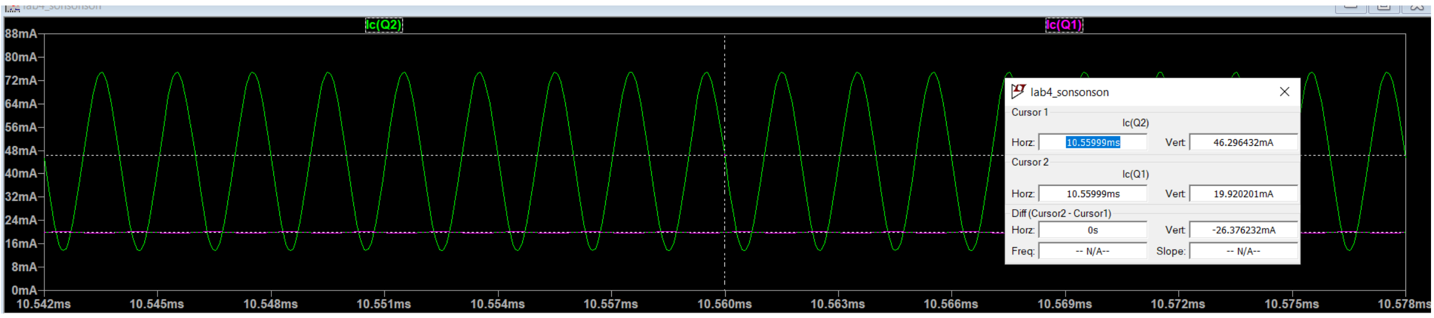


Figure 1: Q1 current= 19.92mA, Q2 current = 46.29mA total= 66.21 mA

After this point I lower my R4 and R8 values so the voltage across them has to be about 1V.

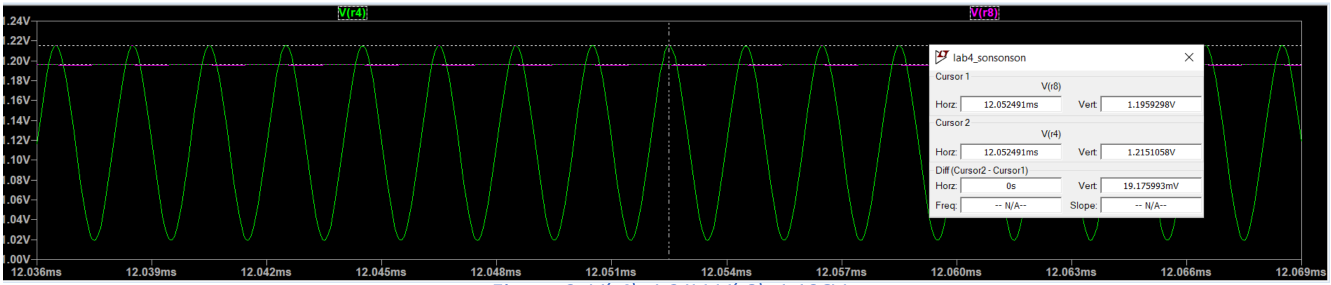


Figure 2: V(r4)=1.21V, V(r8)=1.196V

R5 is chosen so that its current is about 1/20 of T2 collector current. R1, R3, R5, R7 and R6 is picked by trial and error so that gain is high (20dB , vpp=2V) and also, R3 and R7 is arranged carefully so that sinusoidal wave is not clipped and also Vout is not getting lower.

After I arranged 70mA current, I changed R9 at the end of my design to get 20dB gain. After I made sure by transistors working in the ACT region.Here is my overall circuit:

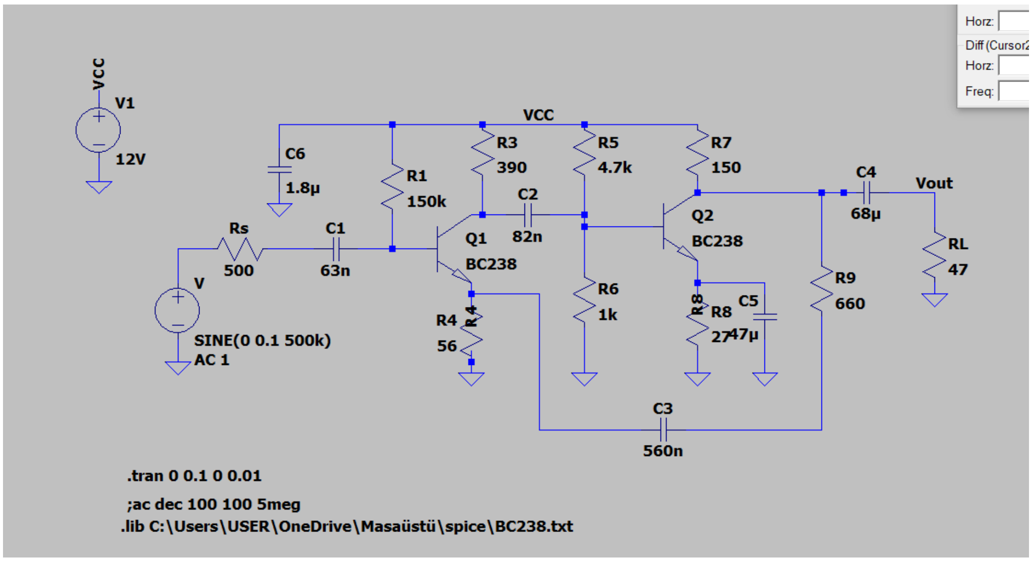


Figure 3: Overall Wideband Amplifier Feedback Circuit

After picking resistors I calculated capacitor values so that they will be RC pairs and pass the lowest frequency of 5KHz. I calculated these values as below so they will resonate:

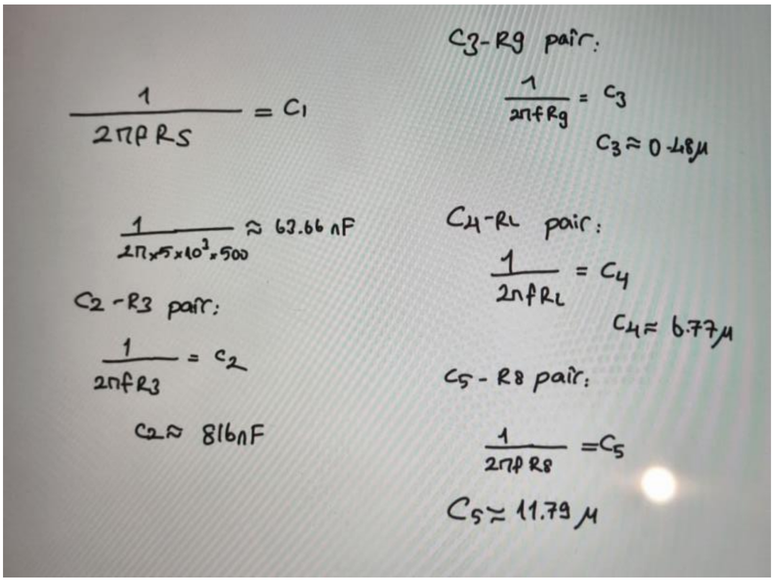


Figure 4: Capacitance Calculaitons

Although these values give me the clue about what should be the capacitor values, I changed them in the simulation by trial and error.

Specification 2

Now, we perform ac analysis (small-signal analysis) to measure the gain at 500kHz and also we will check between 1kHz and 5MHz to ensure the circuit has a wideband gain. Also 1kHz was problematic with my values however, gain decreases from 23dB to 20dB when I increase capacitor value C3.

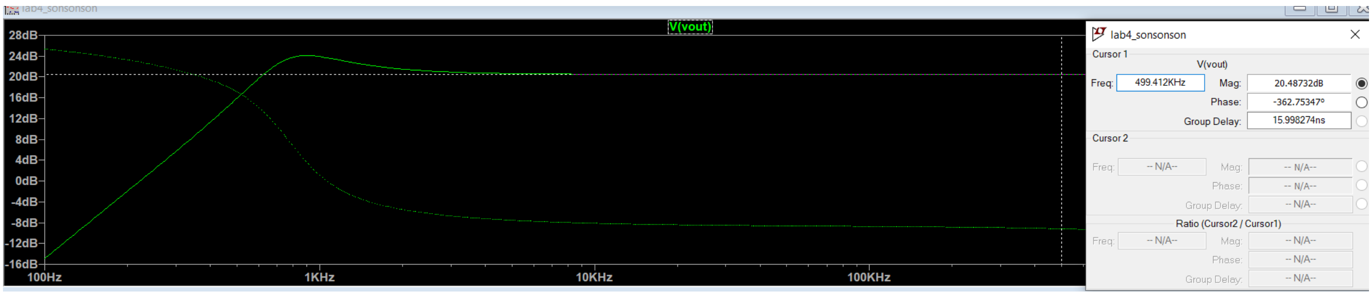


Figure 5: Gain Plot at 500kHz

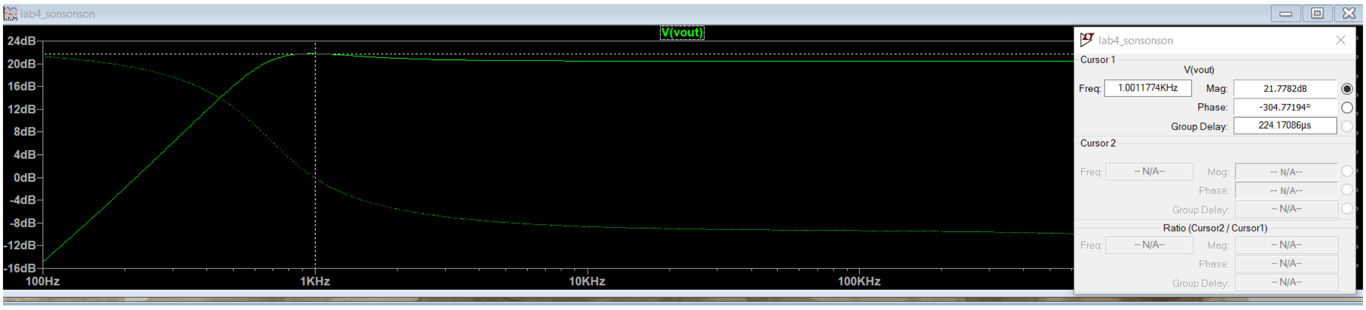


Figure 6: Gain Plot at 1kHz when C3 is 1.5µ instead 560n, gain= 21.78dB

Between 1kHz and 5MHz gain doesn't change drastically.

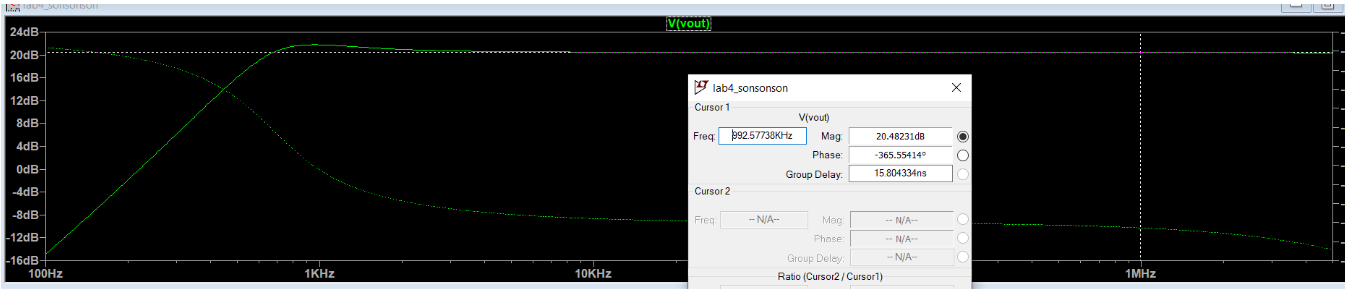


Figure 7: Gain Plot at 1MHz , gain = 20.48dB

Specification 3

With 0.1V peak input signal at 500KHz we should observe more than 3dB difference at the harmonic content of the output voltage. We measured this value via FFT analysis of Ltspice.

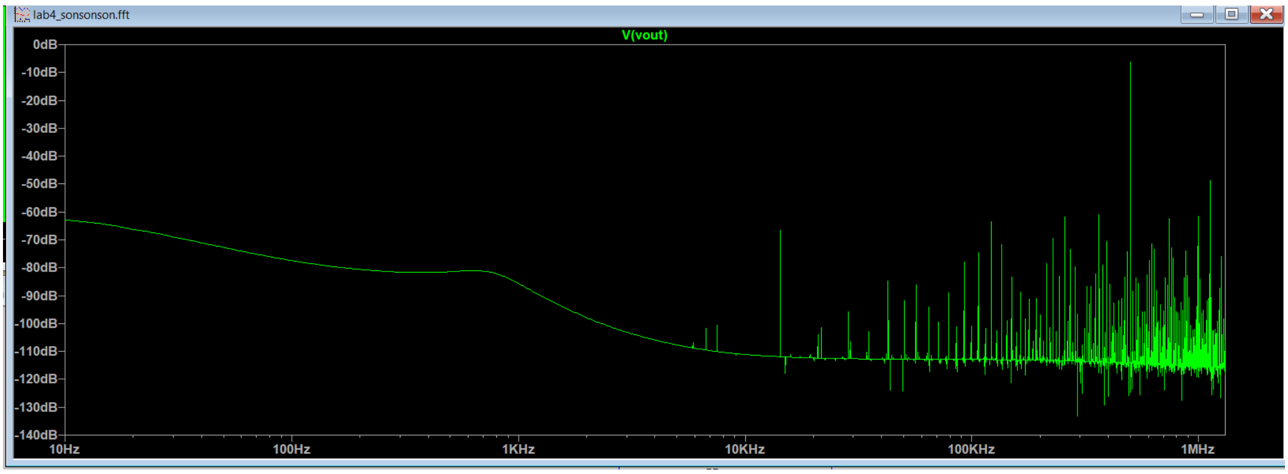


Figure 8: FFT analysis (check 500kHz)

I calculated the difference between the harmonics with the cursor as given below, calculated as 42.20dB:

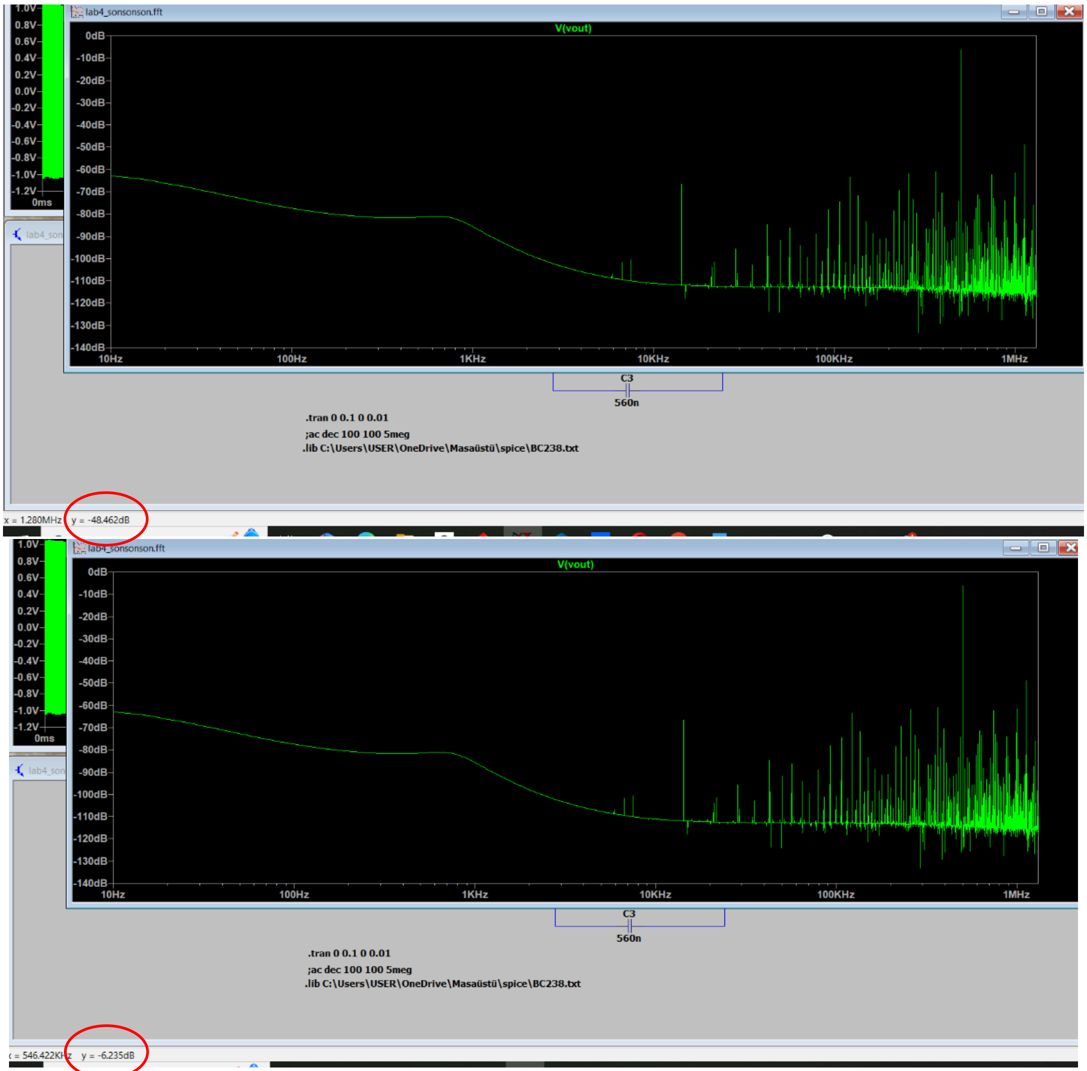


Figure 9 and 10 : 48.46dB-6.26 dB =42.20 dB

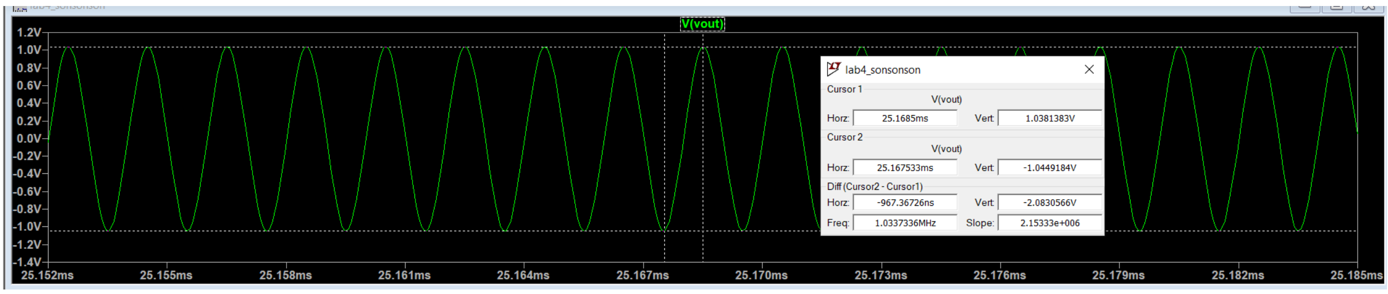


Figure 11: Vpp measured 2.08V with the cursors

Specification 4 and 5

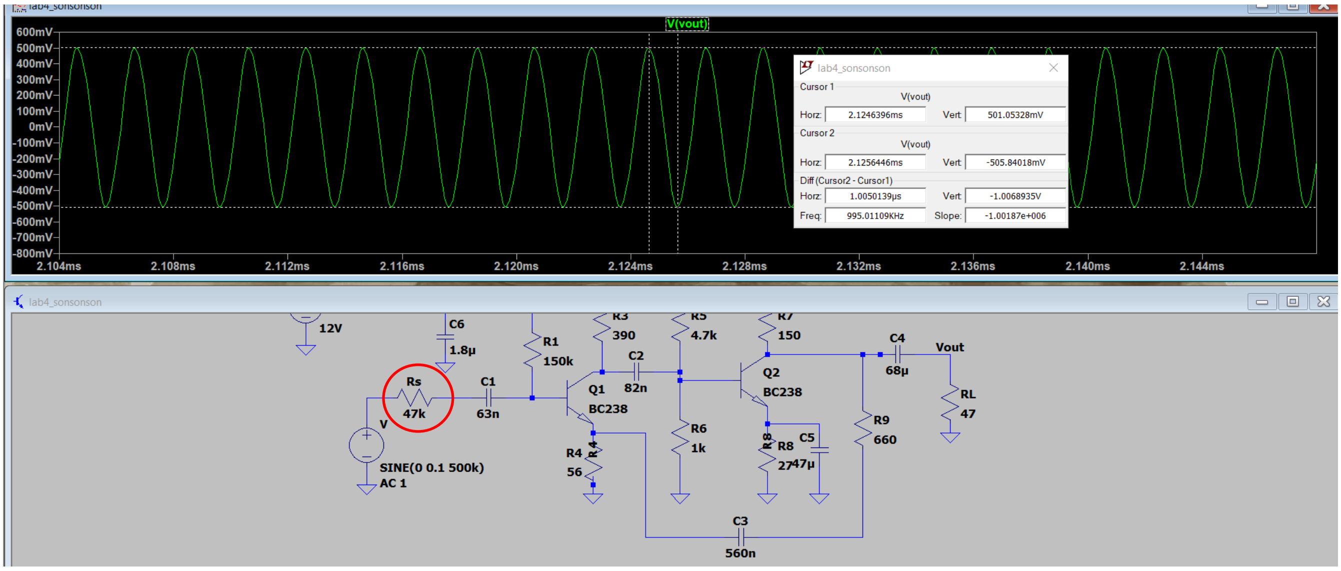


Figure 12: input impedance found 47kΩ

I found the input impdence at the point when output voltge halves (about 1V). Similarly output impedance is found 5Ω, but the reason why sinüs wave strated 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.

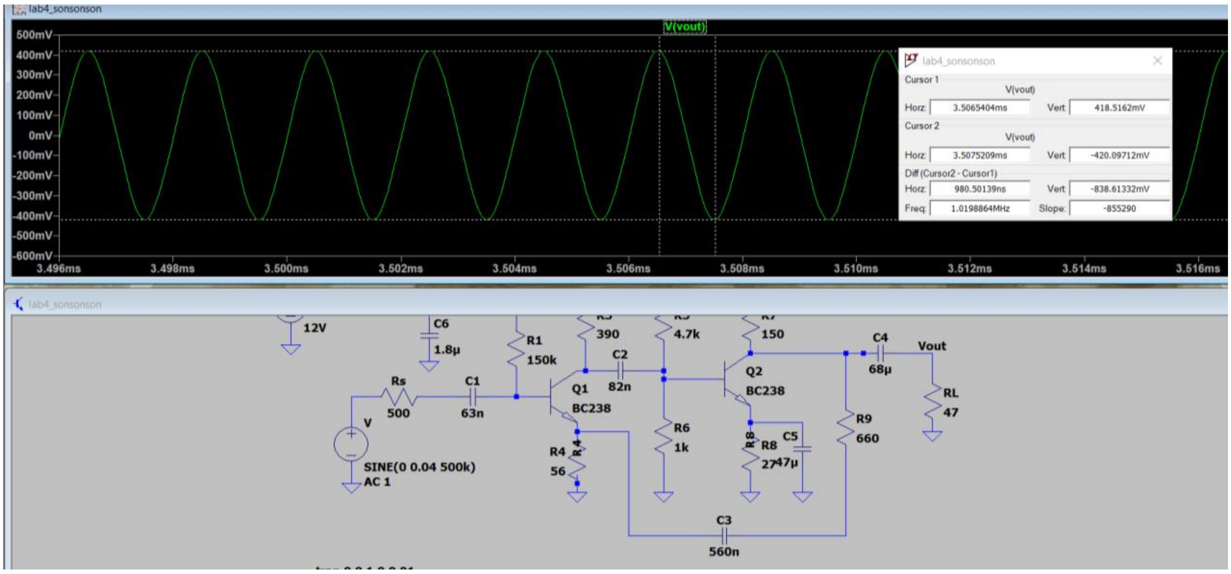


Figure 13: When we get rid of clipping in 0.04V input amplitude, Vpp=838mV

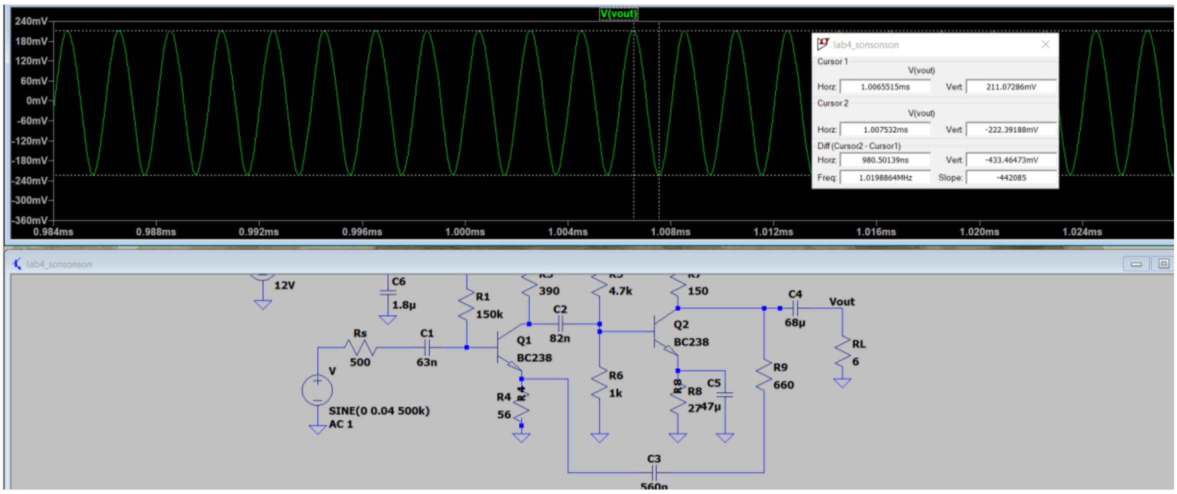


Figure 14: When we get rid of clipping in 0.04V input amplitude, Vpp=433mV

It's nearly the half value, output impedence found 6 (RL).

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