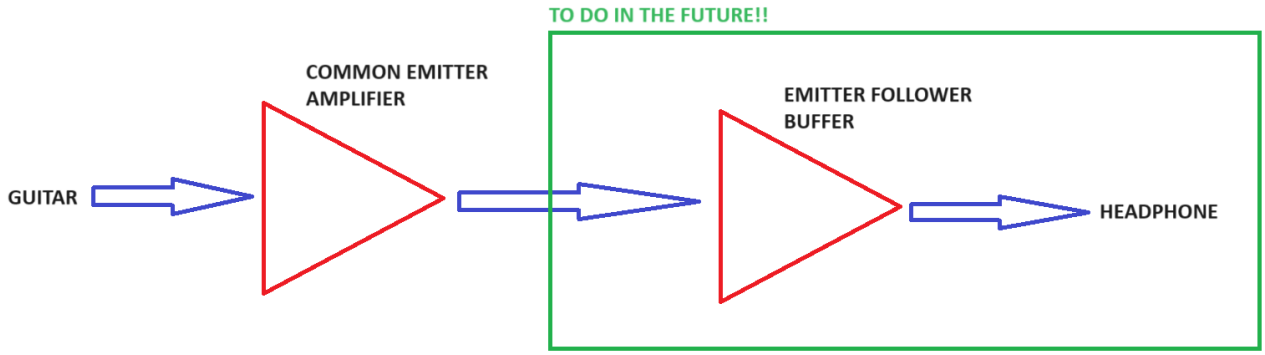
Target: build a pre-amplifier with discrete components, in order to learn something. Eventually, insert an emitter follower to drive headphone (DC impedance more or less 80 ohms).

Top view scheme.



CE amplifier scheme.

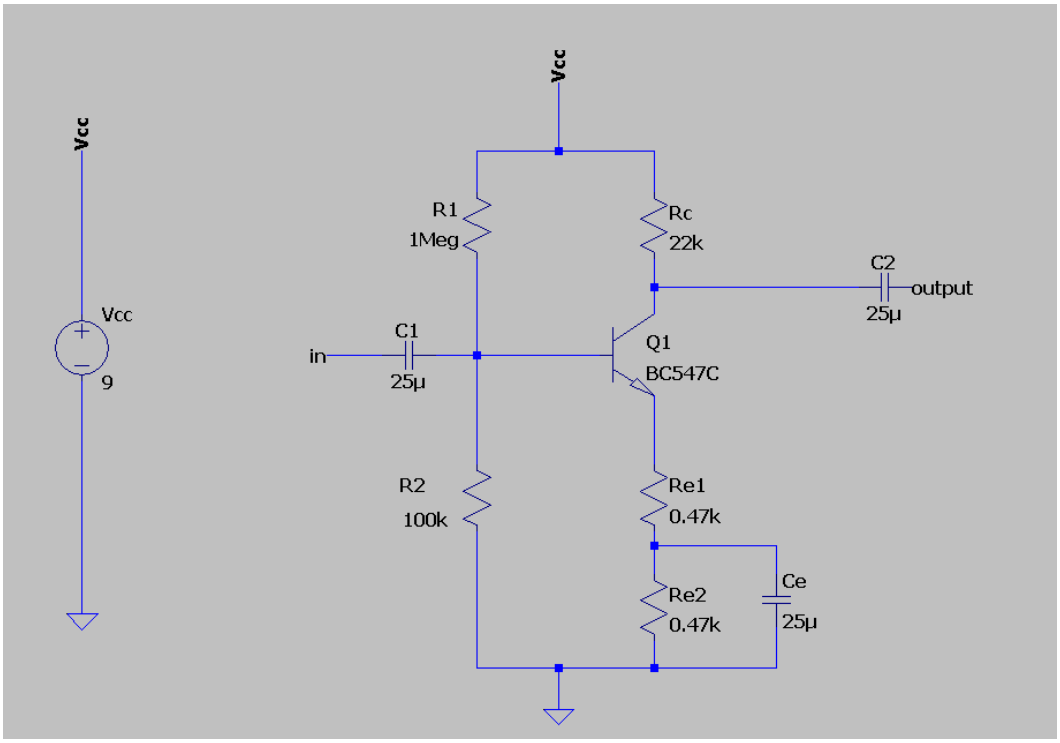


Figure 1

DC Biasing: emitter resistance Re is split in two parts, 470ohm with 22uF bypass capacitor and 470ohm without capacitor. Vcc = 9V, I assumed 0.65V for Vbe.

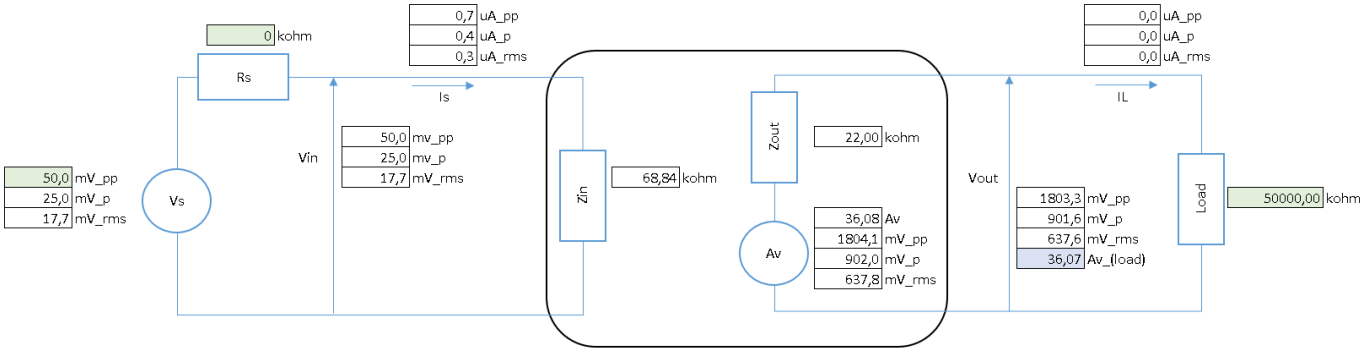
Rc	22	kohm
Re	0,94	kohm
R1	1000	kohm
R2	100	kohm

Bias voltage measured vs expected: some differences, I am happy anyway ($V_{ce} = 4.4V$ which is more or less half of V_{cc}).

	Expected (V)	Measured (V)	Delta
Vc	5,064	4,557	-10,0%
Ve	0,168	0,188	11,8%
Vb	0,818	0,771	-5,8%

Expected Input/Output impedances. With a very high impedance load (such as a tester and/or oscilloscope) I expect a maximum voltage gain of $Av_{max} = 36$. The maximum input voltage without occurring in distortion should be:

$$V_{in_{pp}}^{max} = \frac{0.8\, V_{cc}}{Av_{max}} \approx 200\, mV_{pp}$$



Building the circuit on breadboard: I tried to keep everything as closer as possible, cutting extra connections from parts and keeping the reference ground ("-" of battery) very close to each component. See Figure 2. I built the circuit in this way since in other attempts I was able to capture the TV signal of my neighbor (wires acted as antenna I suspect).

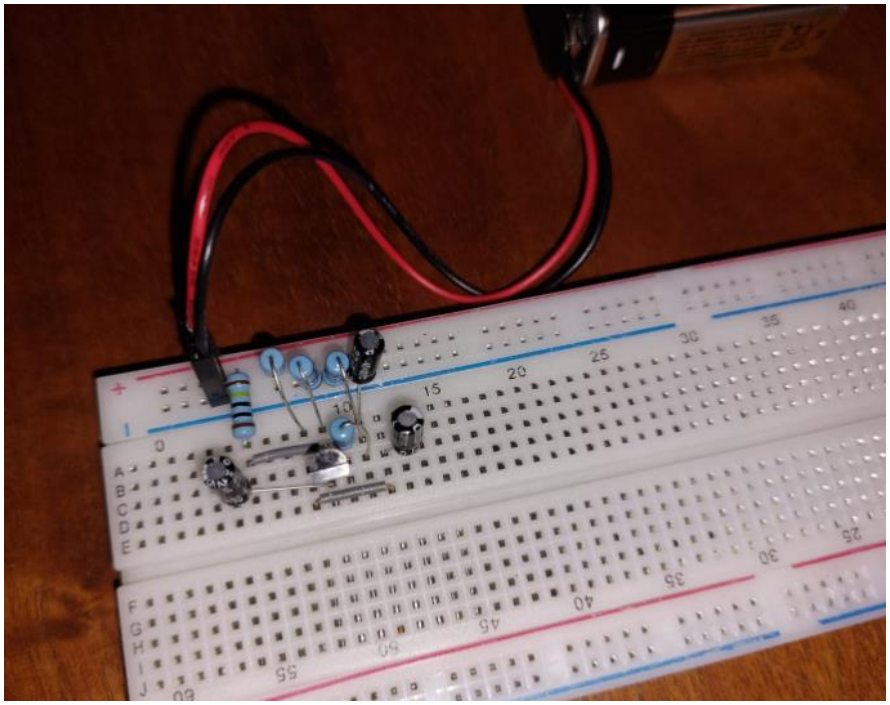


Figure 2: my CE amplifier circuit

AC test: The test was made with Focusrite solo 2nd generation 2-in/2-out USB soundcard, using Soundscope as scope and signal generator. See Figure 4 and Figure 5 for my set-up. The Input is recorded by Channel 2 of

the Focusrite keeping the Gain at minimum level. Of course, I calibrated it times ago and it works 😊. As follow, I report the scheme of my test (Figure 3 and Figure 4).

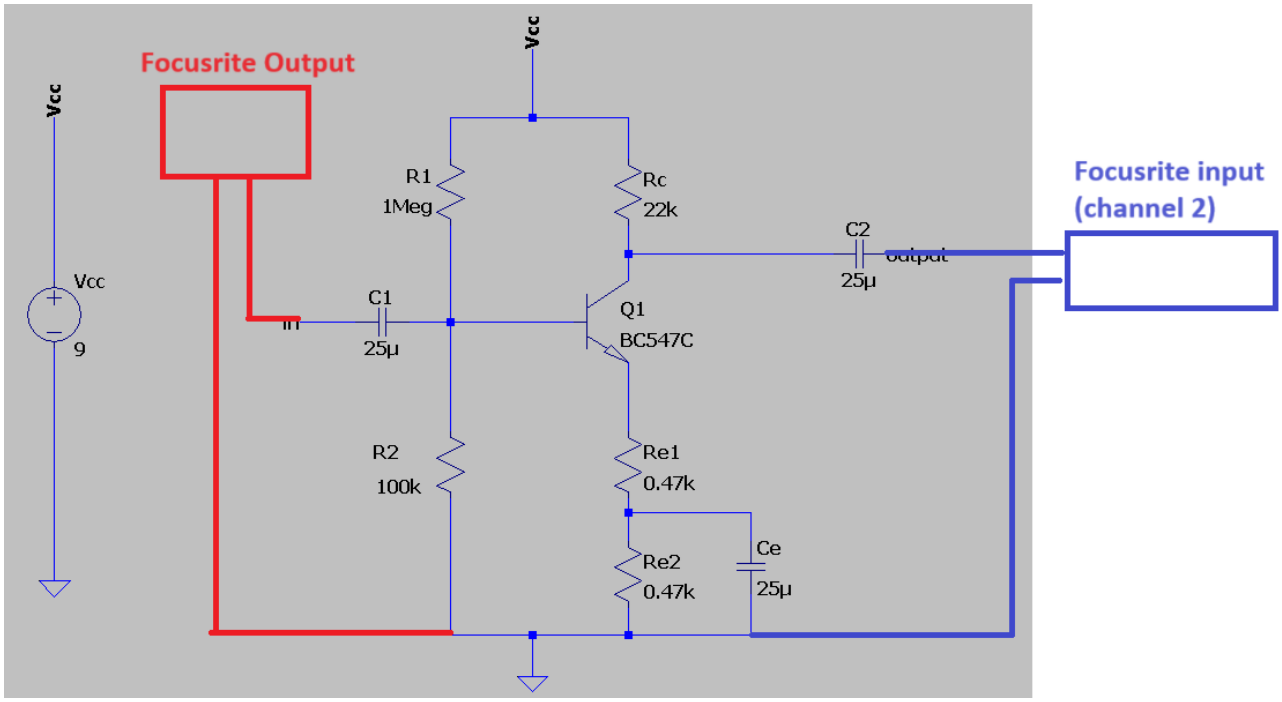


Figure 3: AC test set-up

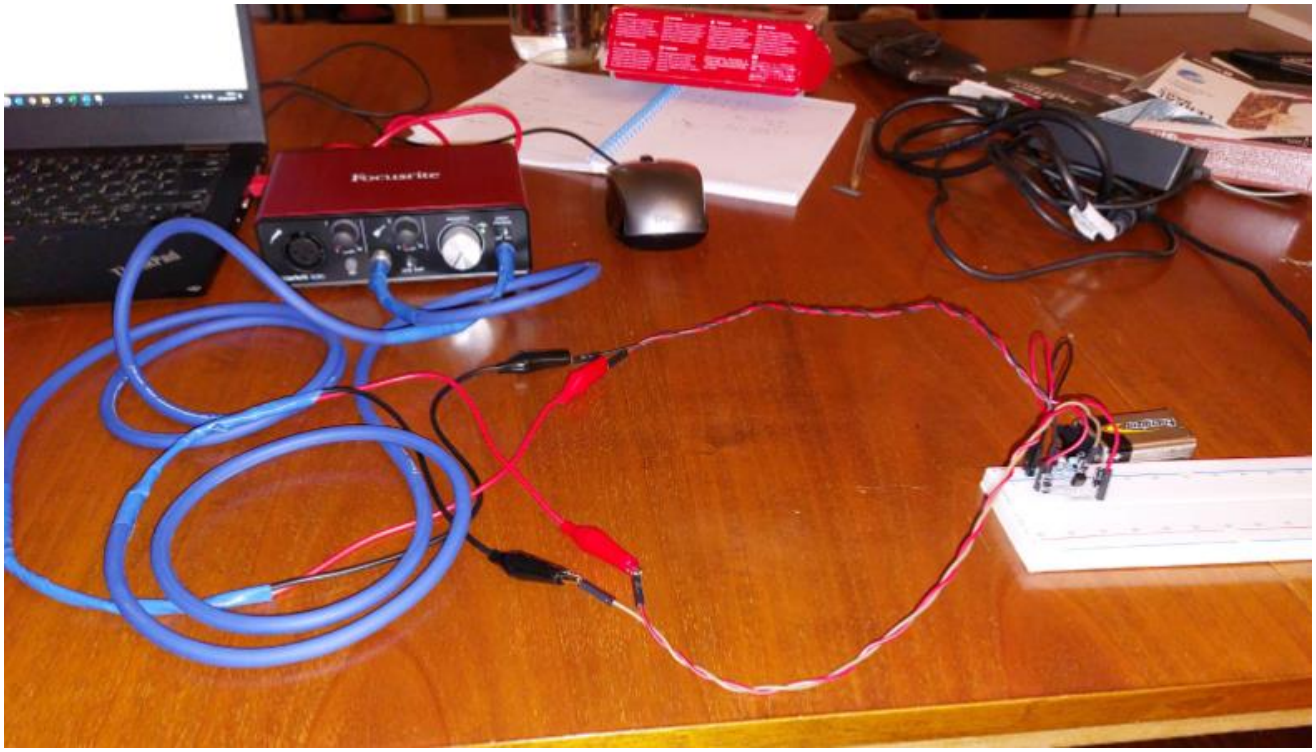


Figure 4: AC test set-up

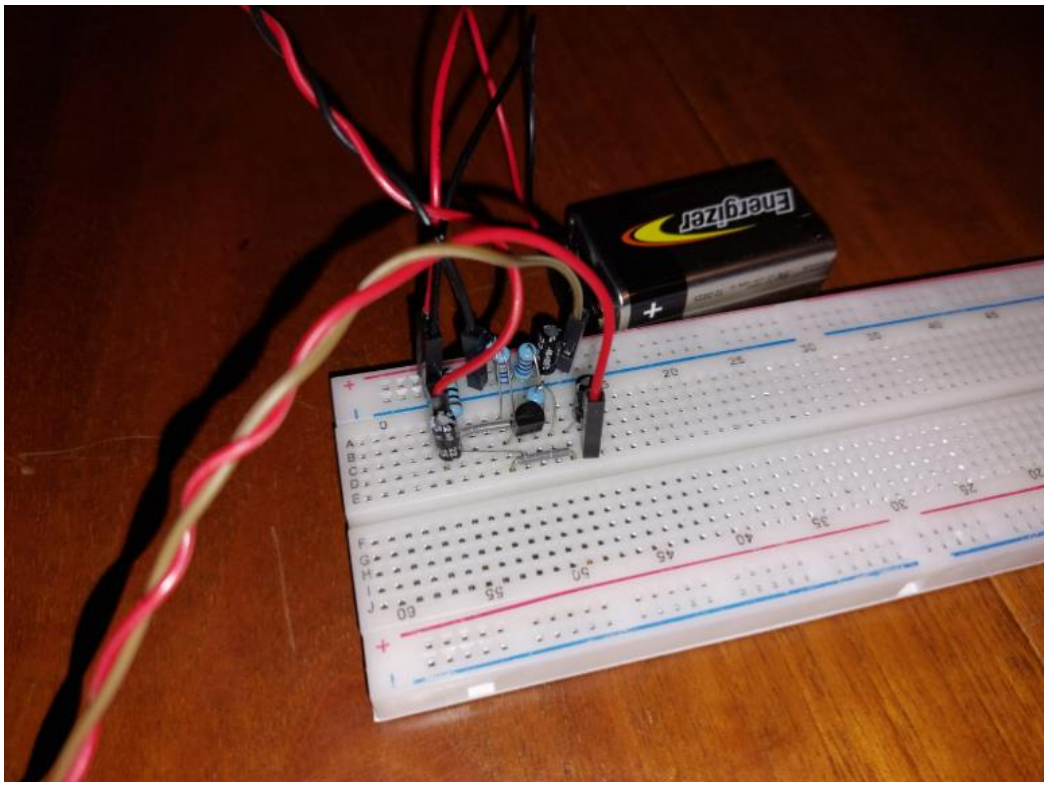


Figure 5: detail of IN/OUT pins during the AC test

I generate an input signal of 50mVpp (Figure 6), output signal of 1.71Vpp (Figure 7). The voltage gain is equal to $A_V = 34.2$, more or less equal to the one expected by design calculations. THD calculated by the Scope Software equal to 1.1%. With an input of 200mVpp, the output is 6.6Vpp ($A_V = 33$) with a THD of 5.52%.

I recorded signal at various frequency with $V_{in} = 50mV_{pp}$ with audacity and no buzz or hum is present. I attached the file "Audio_1" for proving that. The first part of the audio is without signal just for proving that no hum/buzz is actually amplified.

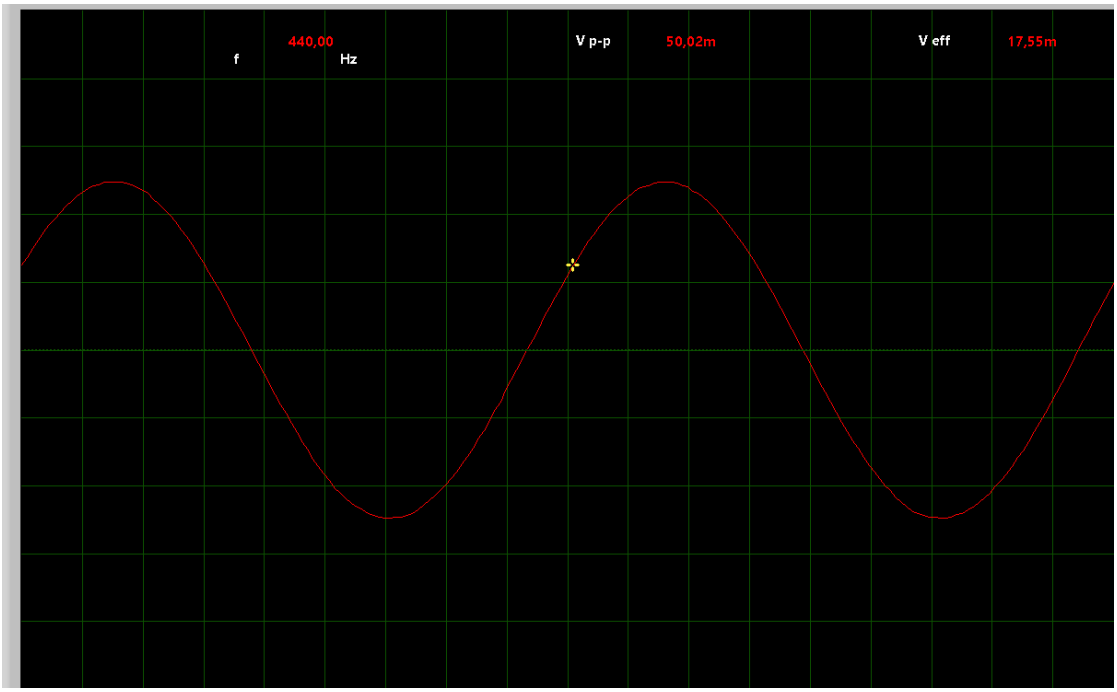


Figure 6: Input signal 50mVpp

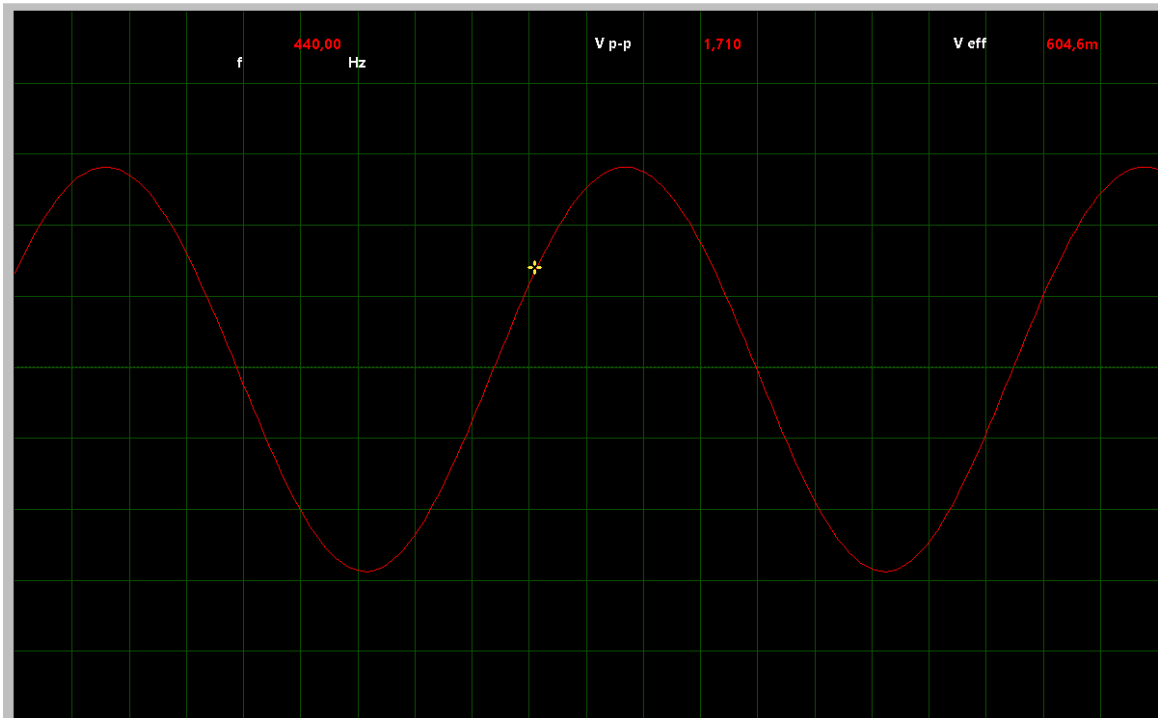


Figure 7: output signal using Vin = 50mVpp

Now it is time to **record a guitar**! I used an acoustic guitar with Shadow removable pick-up. See Figure 8.

Figure 8

The test was made in this way (see Figure 10 and Figure 9).

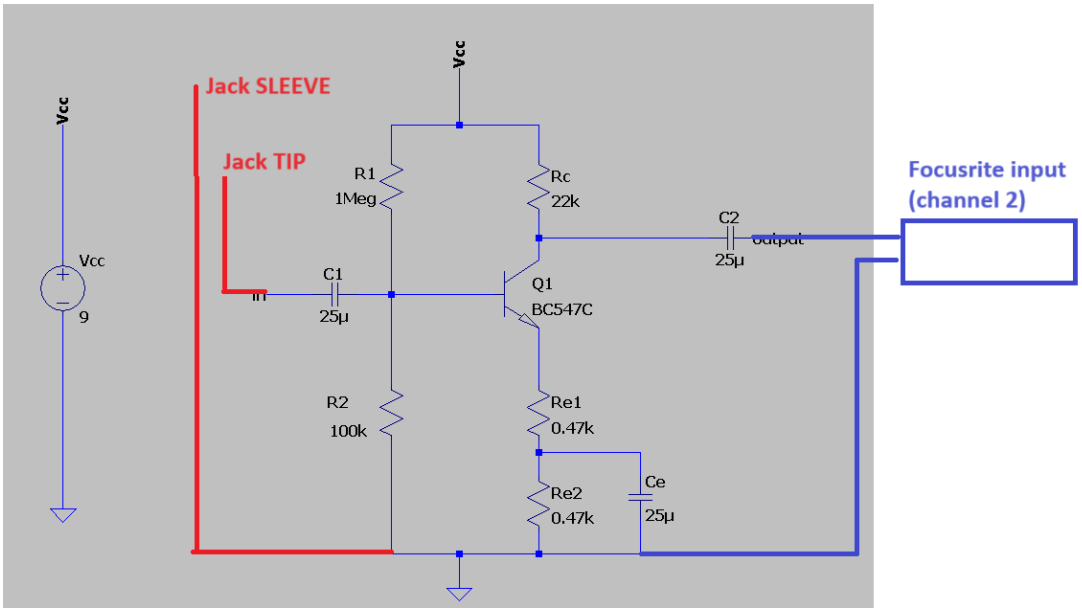


Figure 9: testing Guitar schematic

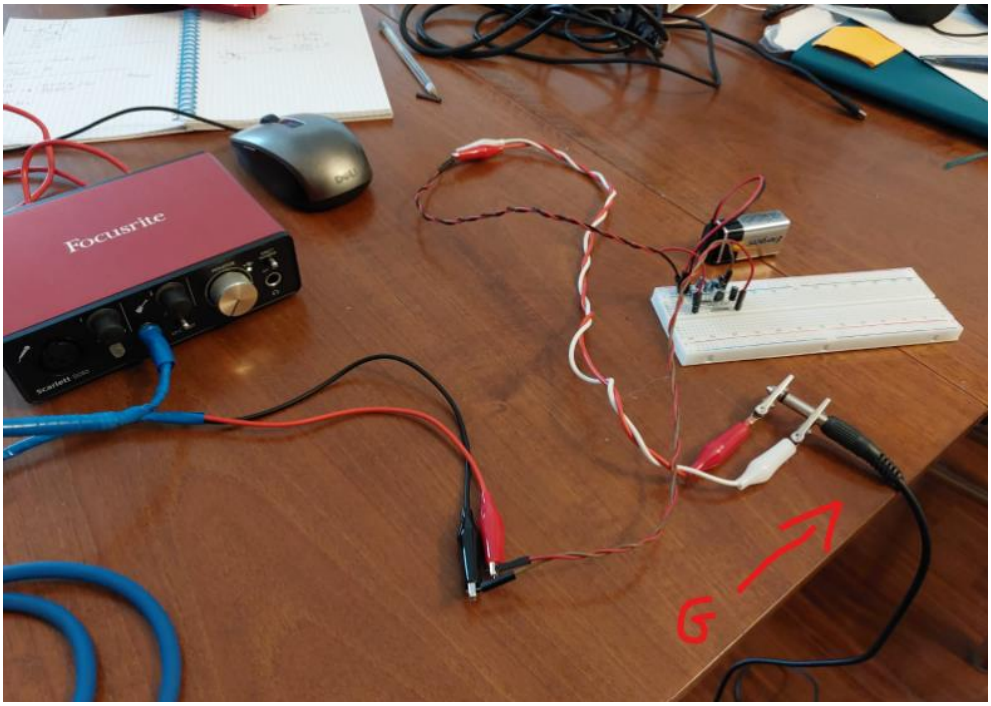


Figure 10: "G" stands for Guitar

Here I have some troubles with hum and buzz (I don't know the differences between these two terms, it will be helpful to explain 😊). Even without playing nothing, I get at the output of the amplifier the following signal (see Figure 11 and Figure 12). Note that my PC was not plugged into the grid during my tests.

Figure 11

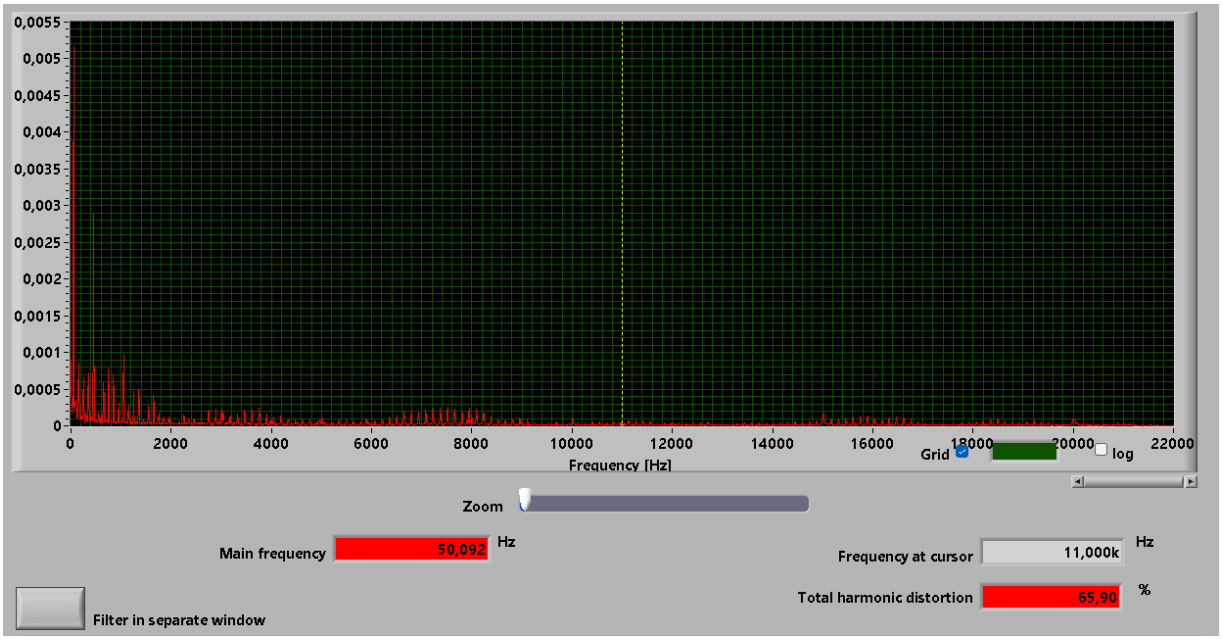


Figure 12

<u>Recording the guitar and of course the buzz/hum remains</u> (anyway, I was happy with the sound). The strange thing (I mean…strange because I don't know what is going on) is that if I directly plug the guitar jack on the input of Focusrite the buzz/hum is always present! I attach "Audio_2" where:

- First part: recording with my amplifier (Focusrite Gain set to minimum).
- Second part: <u>recording directly with Focusrite (Focusrite Gain set to a certain level) with guitar jack directly plugged into Focusrite input</u>.

You should note the buzz/hum, where buzz-peaks are my hand touching my PC…

Last thing…I measured the output of the amplifier using as input the Focusrite output without generating any signal. The buzz/hum at 50Hz is still present (see Figure 13) but is much lower than the one I get when plugging the guitar cable (see Figure 11 for comparison). In fact, in Audio_1 there isn't any hum/buzz even when the signal is not present.

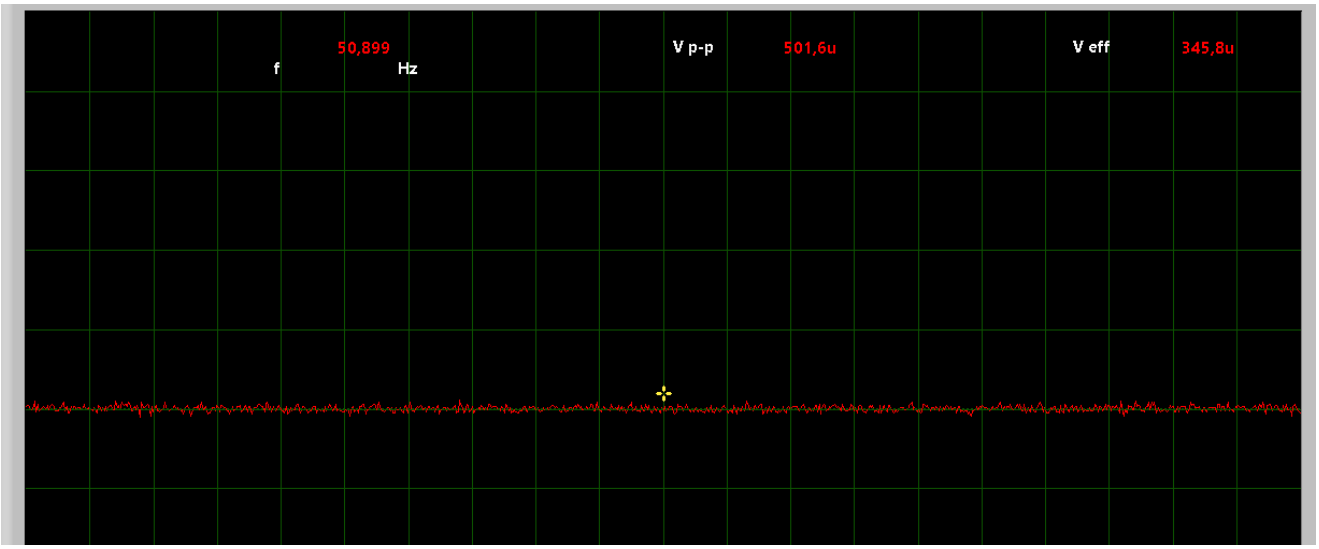


Figure 13

My questions are:

- Why don't I get any appreciable buzz/hum when recording signals generated by Focusrite+Soundcard scope (Audio_1)?? In other words, why the noise in Figure 13 is much lower that the noise in Figure 11?
- Is there any way to reduce this buzz/hum when I use my guiatr? Why is it present? I read somewhere that putting a resistor between guitar signal input and "-" reference reduce the buzz. I tried, but with a 1K resistor the input impedance lowers too much, so I don't think is a beautiful idea…