Lab analog electronics: 1

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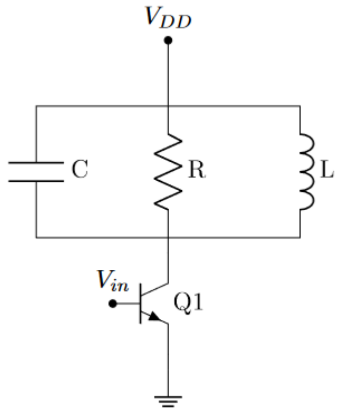
1 Introduction

A class c amplifier is an amplifier which amplifies a signal with a constant frequency and has applications in various fields. The layout of a class C amplifier is rather simple: a network of a capacitor, a inductor, and a resistor in parallel with a transistor in series. This is then put between a voltage and an input signal is applied to the base of the transistor. The values of the C, L and R components needs to be calculated in order to achieve the desired resonant frequency. Furthermore there are a few other parameters that need to be taken into account such as the quality factor and the maximum power consumption and are calculated using the following formulas.



$$\mathrm{P}_{\mathrm{max}} = \frac{(V_{DD})^2}{2R}$$

$$f = \frac{1}{2\pi} \cdot \sqrt{\frac{1}{LC}}$$

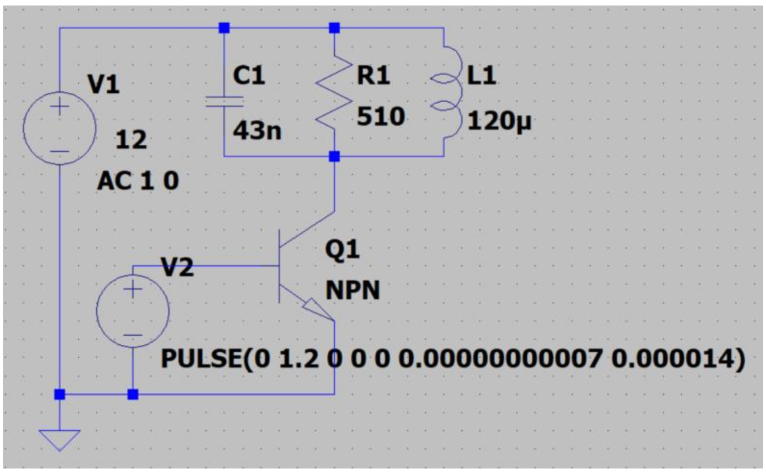
$$Q = R \cdot \sqrt{\frac{C}{L}}$$

2 methodology

This amplifier was build around the following parameters:

- VDD = 12V
- f = 70kHz
- Pmax = 0.15W
- Q = 10

Furthermore we used a ti-nspire calculator for the calculations and used LTspice for the simulations. The above mentioned formulas were used. The following schematic was used for the simulations:



3 Simulation detail and results

3.1 Design of the components & quality factor Q

The Q factor is a factor which is a trade-off between energy efficiency and bandwidth, therefore a high Q factor would be more efficient but it would mean the operational bandwidth is lower and the component cost would increase to exactly match the desired frequency. We assumed the given value of 10 is satisfactory.

Using this information the following values were calculated:

Pmax = VDD^2 / 2 R = 0.15> ➔ R = 480 ohm

Here the resistance value is chosen higher as to not go over the maximum value while taking into account the accuracy of 5% for a realistic component which will be further discussed in the next section.

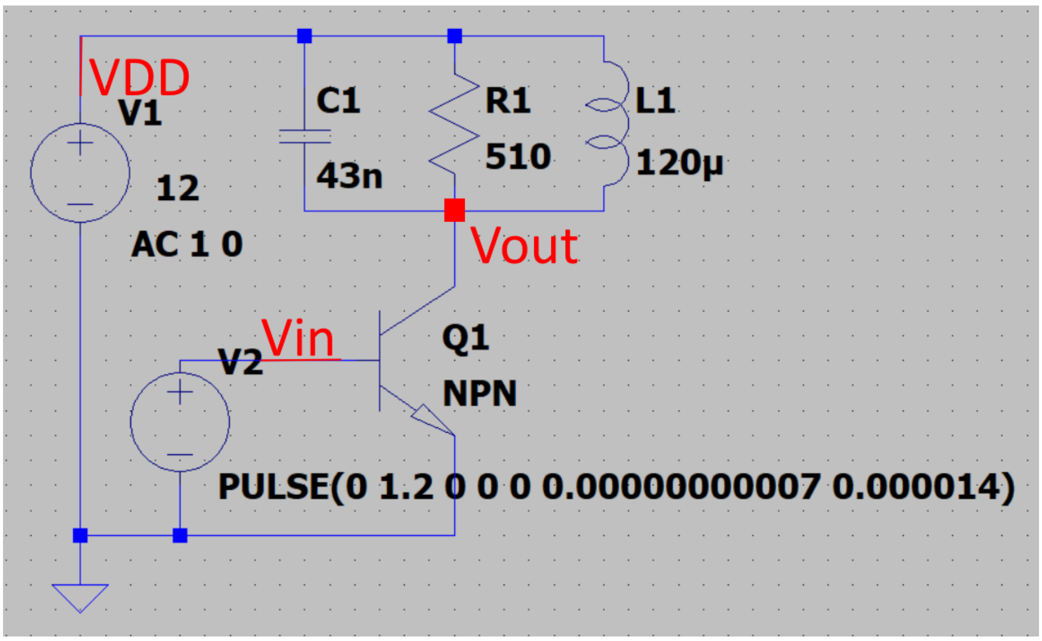
This was the calculation done using the calculator, this formula is a combination of two to extract the L and C value for a frequency of 70kHz and a quality factor of 10.

$$\text{solve}\left(\left\{\begin{array}{l}\dfrac{1}{2\cdot\pi}\cdot\sqrt{\dfrac{1}{l\cdot c}}=70000\\ 510\cdot\sqrt{\dfrac{c}{l}}=10\end{array}\right.,c,l\right)$$

The results are: C = 44.58nF and L = 116µF

These values however are not realistic and should be replaced. Therefore the following standard values were chosen: C = 43nF and L = 120µF. To preserve the frequency, one value was chosen to be higher (L) and one value was chosen to be lower (C). The resulting resonant frequency: 70064Hz and Q: 9.65.

Resulting schematic:



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