Politehnica University of Bucharest
Faculty of Electronics, Telecommunications and Information Technology

Project 1 – Electronic devices and circuits

Wien Bridge Oscillator

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Chira Carmen Alexandra

Group: 432G

Prof. coordinator: Teodorescu Laurentiu

Contents

Wien Bridge Oscillator

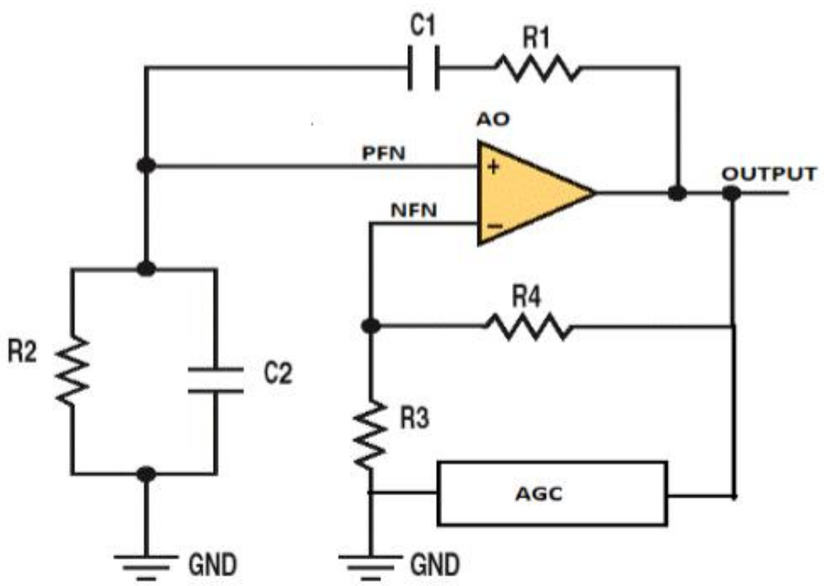
1. Specifications for the components and circuit

It is required to design a Wien Bridge Oscillator with discrete components and the number of identification **N = 5**. We have the following values and specifications:

- Oscillation frequency: programmable in the 5-10 [KHz] range
- Output load impedance: 2kΩ
- The gain of the internal amplifier (AGC) is automatically adjusted by using a J-FET
- The output amplitude may be adjusted in the 0-5Vpp range

2. Theory

The Wien Bridge Oscillator is so called because the circuit is based on a frequency-selective form of the Wheatstone bridge circuit. The Wien Bridge oscillator is a two-stage RC coupled amplifier circuit that has good stability at its resonant frequency, low distortion and is very easy to tune making it a popular circuit as an audio frequency oscillator but the phase shift of the output signal is considerably different from the previous phase shift RC Oscillator.



This oscillator circuit uses the Wien bridge to provide feedback with the desired phase shift. It gives highly stable oscillation frequency and does not vary much with supply or temperature variation. It is basically a two-stage amplifier that consists of an RC bridge circuit or we can say Wien bridge circuit.

The Wien bridge feedback network is used so as to make the oscillator sensitive to signal of only a particular frequency. The RC oscillator is used to generate frequencies ranging from a few Hz to many hundreds of kHz. It is not so efficient for frequencies in the order of MHz, for which LC oscillators are used.

The amplifiers used for these oscillators usually operate in class A, in order to minimize signal distortion.

2.1: Working principle

The working principle of an oscillator is the following: it transforms a DC input (the differential voltage supply VCC-VDD) into an AC output (a waveform). It is a self-sustaining circuit which consists in the following small circuits: an amplifier (which is an operational amplifier - AO), negative feedback network (NFN), positive feedback network (PFN or the Wien Bridge) and an automatic gain control (AGC). The condition for positive feedback network is that a part of the output is combined in phase with the input.

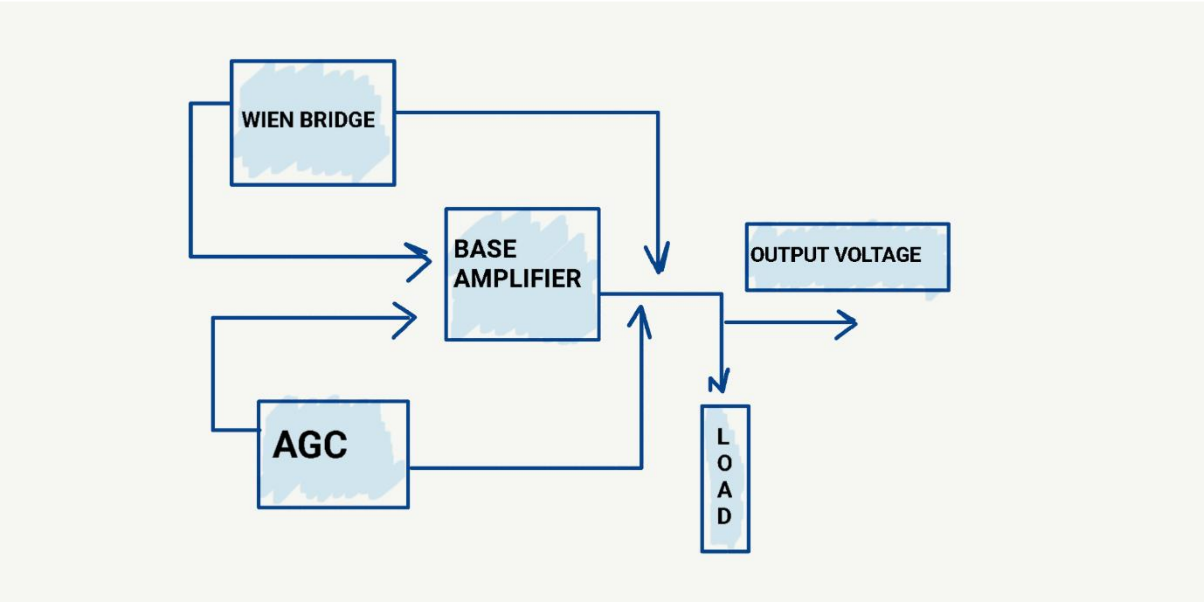


Figure 2. Block diagram of the circuit

The Oscillator has 3 functional blocks, with the load attached to the end:

- The Wien Bridge – generates sine oscillations and modifies the frequency
- AGC (Automatic Gain Control) – maintains the oscillations once they start from previous block
- Base Amplifier – ensures the operations of the two blocks, the control of the amplitude and functioning on the load resistance of the wanted signal

3. : Base amplifier

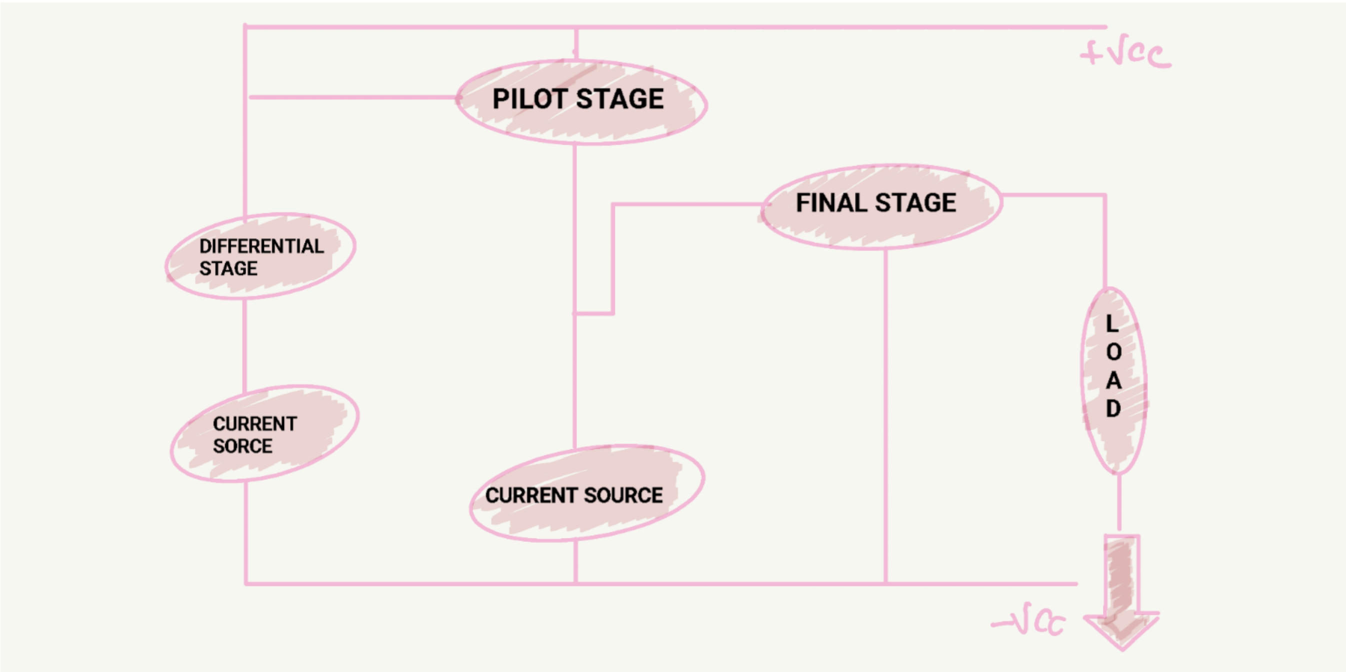
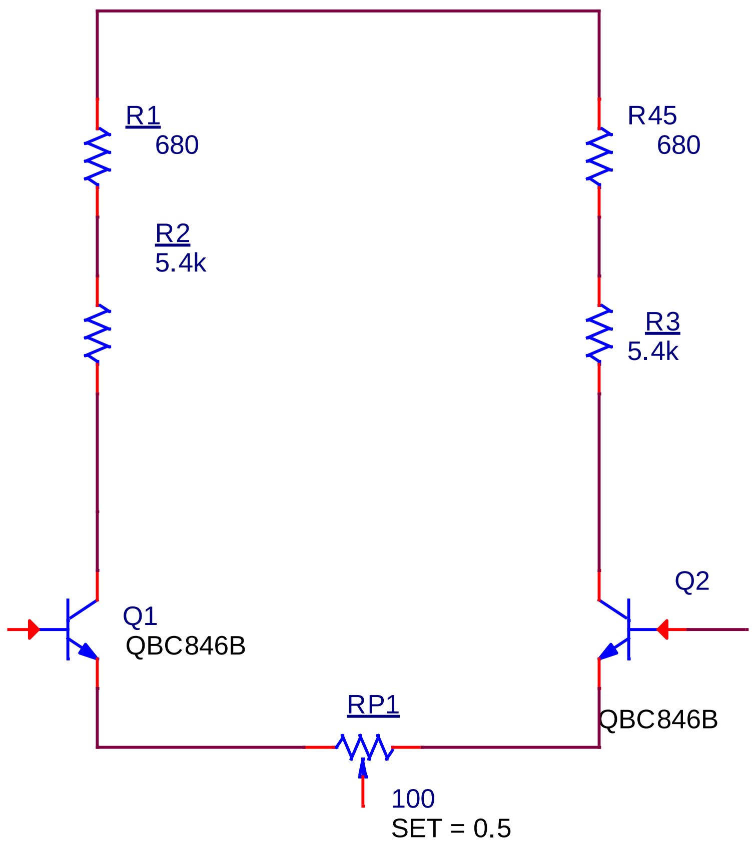


Figure 3. Base amplifier block diagram

To ensure a connection between the positive reaction loop with the negative one, the Voltage Amplifier must be of differential type. The voltage sources are symmetrical and equal with 9V.

3.1. Differential stage



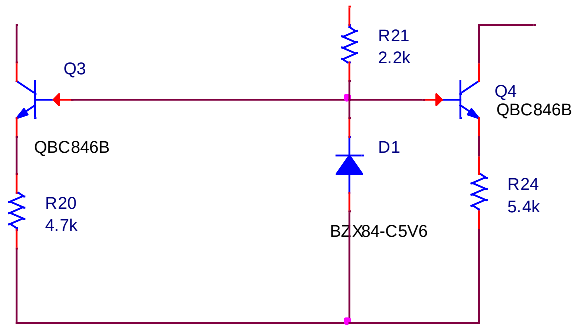
The goal of the project is to design an oscillator, therefore the input stage must allow the connection of two feedback networks: negative and positive.

The chosen solution is the use of the differential amplifier stage. Referencing the classical Operational Amplifier, the non inverting input is the gate of the bipolar transistor Q1 where the Positive Feedback Network is tied and the gate of the bipolar transistor Q2 in the inverting one, where the Negative Feedback Network is connected.

In order to maintain constant drain-source voltages in common mode, we need constant and equal drain currents. This is accomplished by using a series resistance Rs1, formed by the resistors R1 = 910 ohms and R2 = 5.4 kohms on the drain of Q1 and the resistors R3 = 5.4k ohms and R45 = 910 Ohms in the drain of Q2. Ideally, these resistances should have equal values, due to the fact that Q1 and Q2 are identical and have the same working parameters, but since the oscillator requires a slightly higher output amplitude (0-5 Vpp), the values mentioned above have been chosen.

The potentiometer RP1's function is to balance even more the voltage drops and equalise the currents.

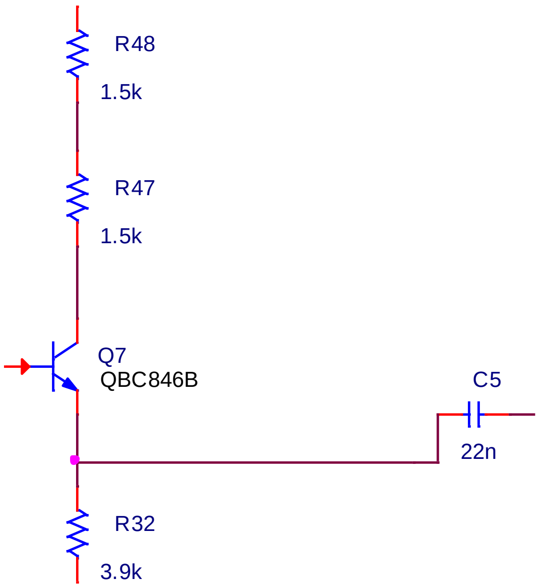
3.2. Current source



In order for the differential stage to work properly, we must place a current source in the conjunction of the Q1 and Q2 amplifiers. For this, we use a BJT whose base-emitter and emitter resistance voltages are fixed using a Zener diode, placed in parallel with them.

When supplied with a minimum current of 5mA, the diode maintains a constant voltage drop of approximatively 5V. This voltage controls the current source made up by the Q3 transistor and R3 resistor. Therefore, the current commanded by the size of R3 is constant.

3.3. Final stage

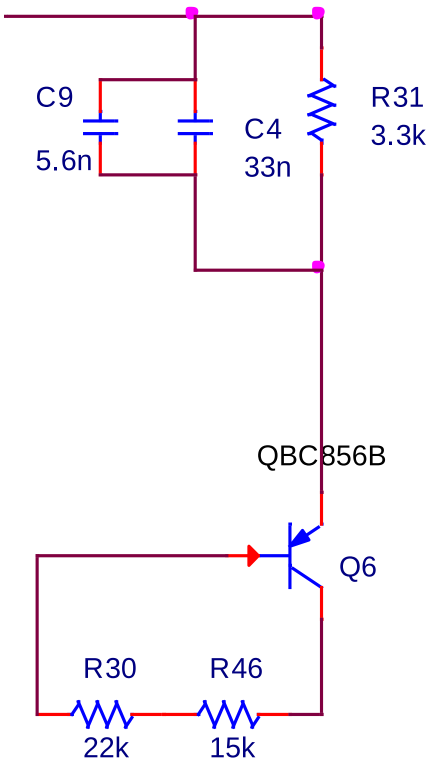


For this stage it has been used a NPN bipolar transistor, Q7, alongside a resistor in the emitter of it, and a decoupling capacitor, Cs.

The resistors controls the amplification, being directly proportional to it, acting at the same time as the amplifier's output impedance. The values of the resistors are as following: Rs4 = R48 + R47 = 1.5k + 1.7 k = 3kOhms and R32 = 3.9 kOhms.

The decoupling capacitor, Cs, is necessary as to ensure a correct voltage drop on the resistor and to prevent a big influence on the negative reaction (AGC block). The value of Cs has been chosen on it's influence on the waveform which has to corresponds to a sinusoidal, so the best suited values is 22nF.

3.4. Pilot stage



It is formed by the NPN bipolar transistor Q6, the resistor R31 and the capacitor Cs2. This ensemble of a capacitor in parallel with a resistors creates a bypass capacitor on the source of Q6. The purpose of this bypass capacitor is to short the AC signals to the ground, so that any AC noise that may be present on a DC signal is removed, producing a much more leaner and pure DC signal.

A capacitor is a device that offers a tremendously high resistance for signals of low frequencies. Therefore, signals at low frequencies will not go through them. This is because signals (current) always takes the path of least resistance.

Therefore, DC signals will go through the resistor, R31, while AC signals will go through the capacitor, getting shunted to ground. So AC signals get shunted to ground. This is how we have a clean DC signal across our circuit, while AC noise imposed on it is bypassed to ground.

In order for it to work properly, we want the resistance of the bypass capacitor to be 1/10th of R31. Considering the chosen value of R31 is 3.3 kOhms, this means that the reactance of the capacitor should be around 390 Ohms. Solving the formula of the reactance, XC= 1/2πfc, we obtain that the value for the bypass capacitor should be around 40nF. Since there is no standard value of 40nF, we use 2 capacitors, C4 and C9, with values of 33nF, respectively 5.6nF; which is approximatively 40nF

There is also a resistor R30 in series with R46 with a total resistance of 37 kOhms between the base and collector of pnp transistor Q6. It is used to considerably improve the stability of the circuit. This produces a negative feedback which reduces the gain of the amplifier, therefore the increased stability of the collector to base bias is obtained at the cost of AC voltage gain.

Base amplifier

$$V_{cc} + V_{ee} = i_{c1}(R_1+R_2) + V_{CE1} + R_{p1}n + I_{c3} R_{20} + V_{CE3}$$

$$V_{cc} + V_{ee} = i_{c2}(R_{45}+R_3) + V_{CE2} + R_{p1}(1-n) + I_{c3} R_{20} + V_{CE3}$$

$$i_{c1}(R_1+R_2) + V_{CE1} + R_{p}n_1 - i_{c2}(R_{45}+R_3) - V_{CE2} - R_{p1}(1-n)$$

for $n = 0.5$ (equal drain currents)

$$\Rightarrow i_{c1}(R_1+R_2) + V_{CE1} + 0.5 R_{p1} - i_{c2}(R_{45}+R_3) - V_{CE2} -$$

$$- 0.5 R_{p1} = 0$$

$$\Rightarrow i_{c1}(R_1+R_2) + V_{CE1} = i_{c2}(R_{45}+R_3) + V_{CE2}$$

— 1 = his means that i_{c3} should be

1

" and BC - NPN $\Rightarrow$ $V_{CE} = 5V$

$Q_1 = Q_2 = \ _3 = Q_4 = Q_7$

$Q_6 = BC856B$ - PNP $\Rightarrow$ $V_{CE6} = 5V$

for Q_1, Q_2: $V_{BE} = 0.66V$, $\beta = 110$ } data sheet

for a desired current of approx. 1mA on Q_3 ($i_{c3} = 1mA$) we'll get on Q_1 and Q_2: $i_{c2} = i_{c1} \cong 560\mu A$

It is desired that Q_1, Q_2 and Q_3 are in active normal regime $\Leftrightarrow$ $V_{CE} > V_{CEsat}$

$\rightarrow$ For a current of $I_C = 10mA$, Q_1 and Q_2 have $V_{CEsat} = 0.3V$, so for a current of $560\mu A$, we get:

$$V_{CEsat} = \frac{560 \cdot 10^{-6} \times 0.3}{10^{-3}} = 560 \cdot 0.3 \cdot 10^{-3} = 168\ mV \Rightarrow \text{limit of } Q_1, Q_2$$

On the Zenner Diode we want to maintain a constant Voltage of $V_Z = 5.6V$, so we need $I_{Z\,min} = 5mA \Rightarrow$ Breakdown region

We write KII on the loop containing the Diode and we get:

$$V_{BE_3} + R_{20} I_{E_3} = V_Z \Rightarrow R_{20} = \frac{5.6 - 0.68}{1 \cdot 10^{-3}} = 4.92 \cdot 10^3 = 4.92\ k\Omega$$

Since there is no standard value resistor, I have chosen the value $R_{20} = 4.7\ k\Omega$

$\rightarrow$ For this project I have chosen a standard value voltage source of $\pm 9V$, so a total of 18V.

$\rightarrow$ R_{P1} is used for real case implementation, to ensure that Q_1 and Q_2 are identical and work at the same parameters. This means that its value should not have a big impact on the circuit, therefore i have chosen $R_{P1} = 100\Omega$

$$\left.\begin{aligned} \rightarrow V_Z &= 5.6V \\ I_Z &= 0.5mA \end{aligned}\right\} \Rightarrow V_{CC} + V_{EE} = I_Z R_{21} + V_Z \Rightarrow R_{21} = \frac{V_{CC} + V_{EE} - V_Z}{I_Z} = \frac{18 - 5.6}{5.1 \cdot 10^{-3}} = 2.4\ K\Omega$$

$\Rightarrow R_{21} = 2.2\ k\Omega$ (chosen value)

$\Rightarrow$ this ensures the maintaining of desired values on the Zenner Diode.

$\rightarrow$ We write KII on the differential stage:

$$V_{CC}+V_{EE} = I_{C1} R_{S1} + V_{CE1} + \frac{R_{P1}}{2} \cdot \frac{I_{C3}}{2} + I_{C3} R_{20} + V_{CE3}$$

$$R_{S1} = \frac{18-5-50\cdot 560\cdot 10^{-6} - 4.7 - 5}{560\cdot 10^{-6}}$$

$$R_{S1} = 5.84\,k\Omega$$

=) Since this value is not standard, I used two resistances to try and recreate it, so: $R_1 = 680\,\Omega$ and $R_2 = 5.4k\Omega$

=) Q_1 and Q_2 are identical and work on same parameters

) $R_{45} = 680\,\Omega$ and $R_3 = 5.4k$

Obs: Since the values in the catalogue are different than the ones resulted from calculus, there might be some sligth changes in the simulation.

Q_4: $\begin{cases} V_{CE} = 5V, & i_E = 920\,\mu A \\ \beta = 110 & i_C = 917\,\mu A \end{cases}$

For a desired current of almost 0.9mA it is obtained:

$$V_{BE4} + R_{S3} I_{C4} = V_Z \Rightarrow R_{S3} = \frac{V_Z - V_{BE4}}{i_{C4}} = \frac{5.5-0.68}{0.9\cdot 10^{-3}} = 5.4\,k\Omega$$

Q_6: $\begin{cases} V_{CE} = 5V & i_E = 789.\ A \\ \beta = 125 & i_C = 787\,\mu A \end{cases}$

For a desired current of 0,7 mA:

$$R_{31} I_{E1} + V_{BE4} = I_{C1} R_{S1} \Rightarrow R_{31} = \frac{0.5\cdot 10^{-3}\cdot 6\cdot 10^{3} - 0.68}{0.7\cdot 10^{-3}} = 3.3\,K\Omega$$

$R_{30} + R_{46} = 37k\Omega \Rightarrow \left.\begin{array}{l} R_{30} = 22k\Omega \\ R_{46} = 15k\Omega \end{array}\right\} \Rightarrow$ the value has been chosen based on simulations

C_S is connected for better amplification, therefore it must have a high capacity and low reactance.

The chosen value is 38.6nF and since there is no standard value C_S is made from $C_3 = 5.6nF$ and $C_4 = 33nF$.

$$f = 5kHz \Rightarrow X_C = \frac{1}{2\cdot\pi\cdot 5\cdot 10^3 \cdot 38.6\cdot 10^{-9}} = 0.82\,k\Omega.$$

$$f = 10kHz \Rightarrow X_C = \frac{1}{2\cdot\pi\cdot 10^4 \cdot 38.6\cdot 10^{-9}} = 0.41\,k\Omega$$

$\Rightarrow$ the value is very low, so it won't change the equivalent value.

$$Q_7 : \begin{cases} V_{CE} = 5V & I_E = 2mA \\ \beta = 110 & I_C = 2mA \end{cases}$$

$\Rightarrow$ For a desired current of 2mA:

$$V_{cc} + V_{ee} = I_{C_7} R_{47} + V_{CE_7} + I_{E_7} R_{32}$$

$$I_{C_7} = I_{E_7} \Rightarrow R_{47} + R_{32} = \frac{18-5}{2} \approx 6.5\,k\Omega$$

But, in order for our signal to reach the desired amplitude we split the two resistors: $R_{47} = 3k\Omega$ goes on the collector of Q_7 and $R_{54} = R_{47} + R_{48} = 1.5k + 1.5k = 3k\Omega$ goes on the emitter

→ The output capacitor has the value $C_5 = 22\,nF$ in order to maintain a desired output waveform.

4.: Wien Bridge

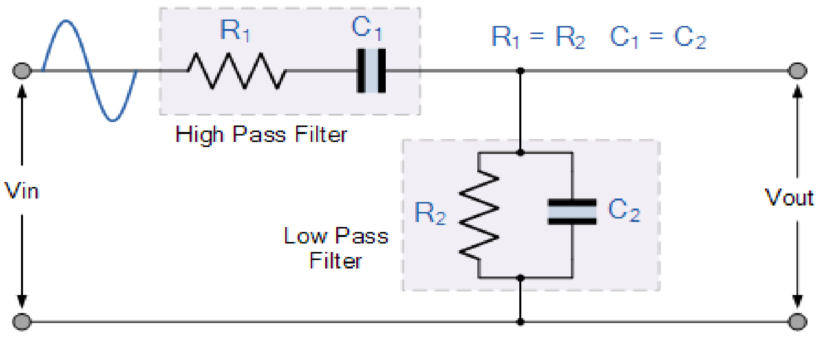
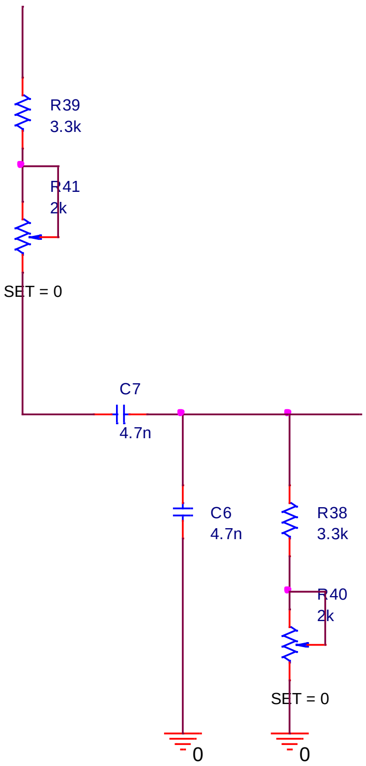


Figure 5. Wien bridge



The Wien Bridge Oscillator uses a feedback circuit consisting of a series RC circuit connected with a parallel RC of the same component values producing a phase delay or phase advance circuit depending upon the frequency. At the resonant frequency *ƒr* the phase shift is 0.

The bridge measures the frequencies from 100Hz to 100kHz. The accuracy of the bridges lies between 0.1 to 0.5 percent. The bridge is used for various other applications like capacitance measurement, harmonic distortion analyser and in the HF frequency oscillator.

The Wien Bridge attenuates with 1/3 the signal, so it must pe compensated through an amplification as to fulfil the oscillation condition.

The PNP consists in two non-polar capacitors and two resistors in a high pass and low pass filter.

Wien Bridge

Range of working frequency

$$f = [5, 10]\ KHz$$

For the positive feedback network the oscillation frequency is $f_{osc} = \frac{1}{2\pi RC}$, since $R_1 = R_2 = R$, $C_1 = C_2 = C$, for which $\beta = \frac{1}{3}$

The values of the capacitors have been chosen at 4.7nF

- for $f_{min} = 5\ KHz$

$$R_{min} = \frac{1}{2\pi f_{max} C} = \frac{1}{2 \cdot \pi \cdot 10 \cdot 10^3 \cdot 4.7 \cdot 10^{-9}} = \frac{1}{2 \cdot \pi \cdot 4.7} \cdot 10^5 = 3.38\ K\Omega$$

- for $f_{max} = 10\ KHz$

$$R_{max} = \frac{1}{2\pi f_{min} C} = \frac{1}{2 \cdot \pi \cdot 5 \cdot 10^3 \cdot 4.7 \cdot 10^{-9}} = \frac{1}{2 \cdot \pi \cdot 5 \cdot 4.7} \cdot 10^6 = 6.77\ K\Omega$$

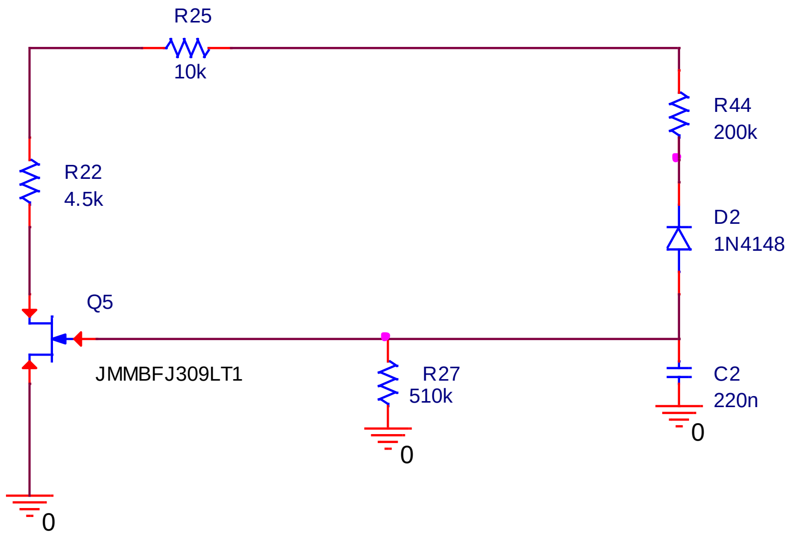
It has been chosen a fix resistance of $3.3K\Omega$

- for the variable resistance we will have a value of: $R_{pot} = 6.77 - 3.38 = 3.3\ K\Omega$, but since there is no standard pot. of such value, we will use potentiometers of value $2K\Omega$ each

- Max. frequency with $R = 3.3K$ is:

$$f = \frac{1}{2 \cdot \pi RC} = \frac{1}{2 \cdot \pi \cdot 3.3 \cdot 10^3 \cdot 4.7 \cdot 10^{-9}} = \frac{1}{2\pi \cdot 3.3 \cdot 4.7} \cdot 10^6 = 10{,}26\ KHz$$ (just a bit over max)

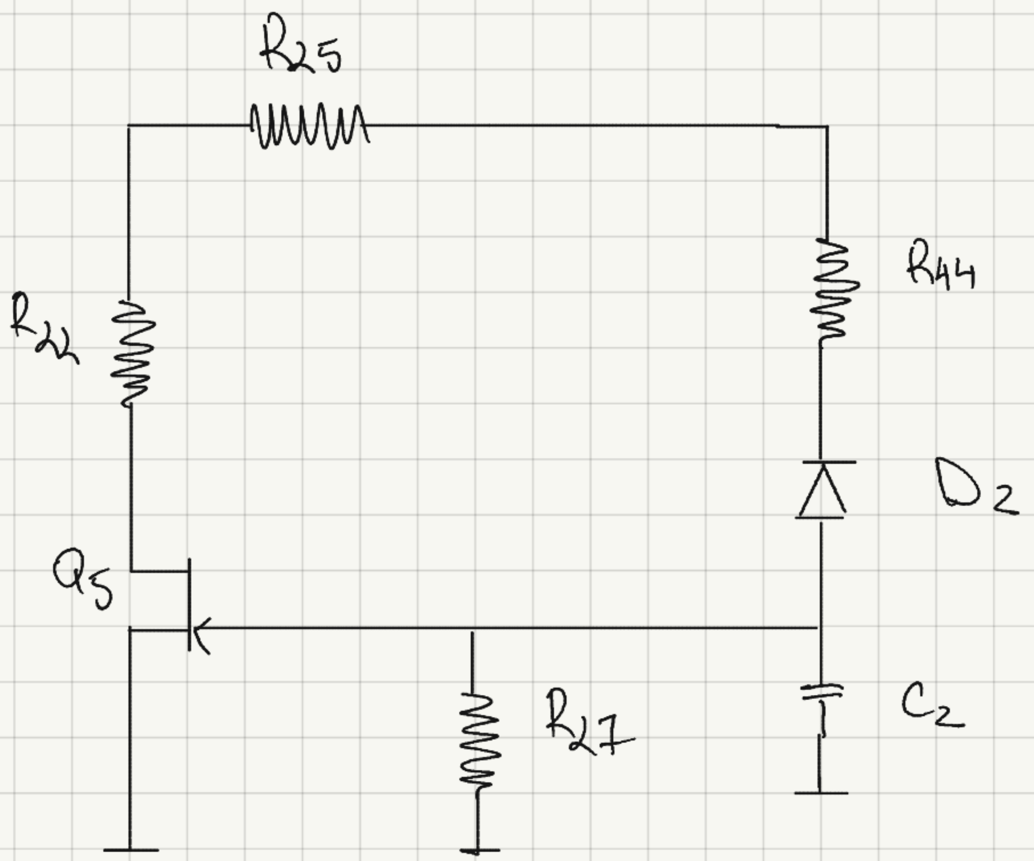
5.: AGC Block



The purpose of the Automatic gain Control Block is to introduce a variable component alongside the Negative Feedback Network, which allows for adjustments to be made to the transfer function, more exactly the amplitude.

The JFET is used as a variable resistance dependant on its gate voltage. Since it's N type, the transistor needs a DC-like negative voltage from a complete AC signal. This is achieved by using the diode 1N4148 in reverse bias, which allows only the negative parts of the sinusoidal shape to pass. The C2 capacitor is used to help filtering the signal, transforming the negative pulses into a constant. The value chosen for the capacitor is 220nF. Although the value is quite big and there is a slight chance of overcharging, the filtering is quite smooth. The resistances R22 and R25 have been chosen as to fulfil the Barkhausen condition, so the ratio is 2.22.

AGC Block



For obtaining oscillations it is considered the Barkhausen condition:

$A_v \cdot \beta = 1$ => A_v - closed loop amp.
β - transfer function

→ Topology of Negative feedback: Series at input
Shunt at output

→ input impedance for base amp. must be high and output impedance must be low.

→ We must have $f_v = \frac{1}{3}$ in order for NF to work. The following resistances have been chosen

$R_{25} = 10k\Omega$

$R_{22} = 4.5k\Omega$

The gain at f_0: $A_v = 1 + \frac{R_{25}}{R_{22} + R_j}$

If $R_j = 0 \Rightarrow A_v = 1 + \frac{10}{4.5} = 3.22.$

→ R_{27} is used to form the input impedance, so it's value should be quite big, therefore I have chosen the value $R_{27} = 510k\Omega$

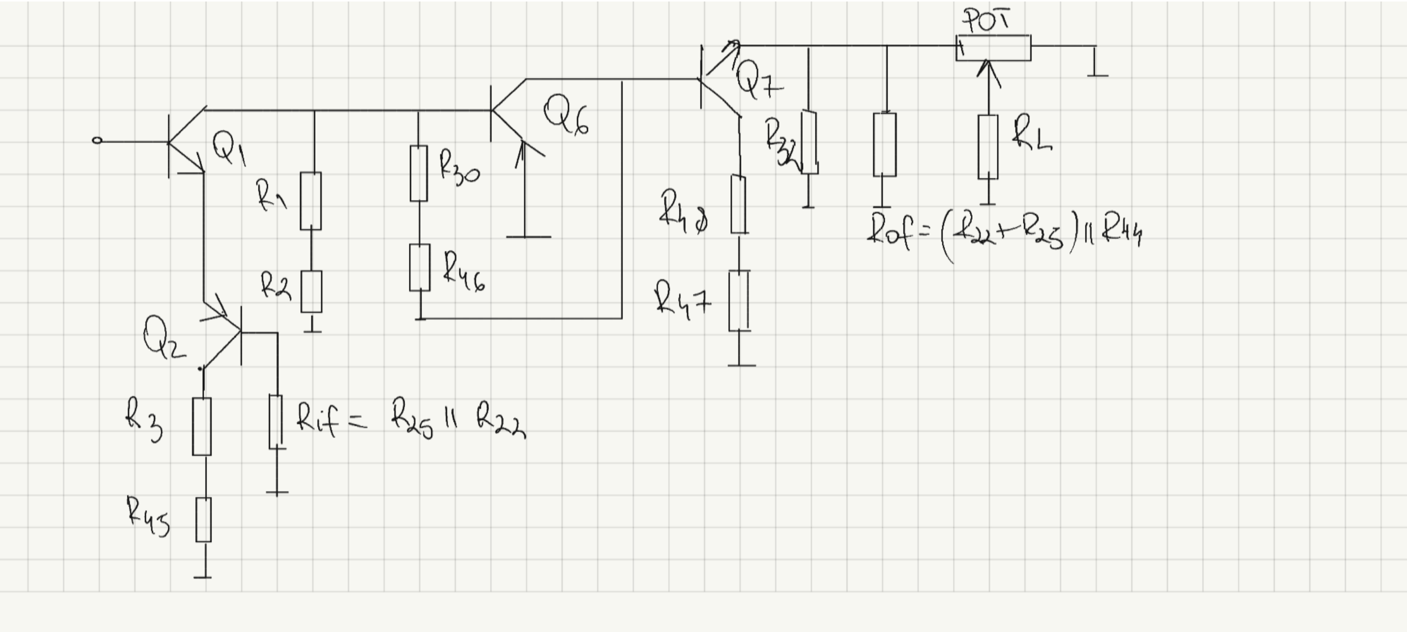
→ For C_2 I have chosen the value $C_2 = 220nF$

$$\cdot f = 5\,KHz \Rightarrow X_C = \frac{1}{2\cdot\pi\cdot 5\cdot 10^3 \cdot 220\cdot 10^{-9}} = \frac{1}{2\pi\, 5\cdot 220}\cdot 10^6 = 0.14\,k\,\Omega$$

$$\cdot f = 10\,KHz \Rightarrow X_C = \frac{1}{2\pi\cdot 10^4\cdot 220\cdot 10^{-9}} = \frac{1}{2\pi\cdot 220}\cdot 10^5 = 0{,}072\,k\Omega$$

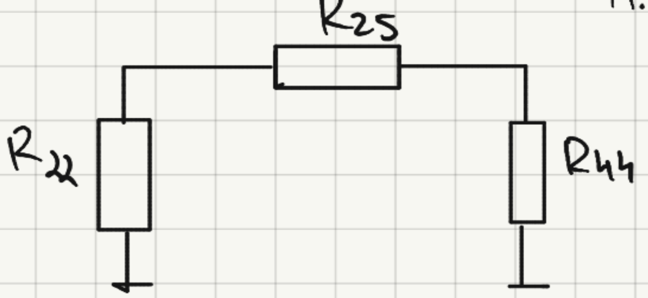
→ Reactance of the capacitor is not very high; this means that the value chosen for it is good

6. Open Loop Amplification (AC Current)



$$R_{if} = R_{25} \parallel R_{22} = \frac{10 \cdot 4.5}{10+4.5} = 3.1\,k\Omega$$

$$R_{of} = (R_{25} + R_{22}) \parallel R_{44} = \frac{14.5 \cdot 200}{14.5+200} = 13.5\,k\Omega$$



$$\begin{cases} R_{if} = \left.\frac{V_{if}}{I_{if}}\right|_{V_{of}=0} \\ R_{of} = \left.\frac{V_{of}}{I_{of}}\right|_{V_{if}=0} \end{cases}$$

$$A_v = A_{Q1} \cdot A_{Q6} = (-g_{m1} \cdot r_{if})(-g_{m6} \cdot R_{oQ6})$$

$$R_{oQ6} = (R_{30} + R_{40}) \parallel h_{ie6}$$

$$h_{ie6} = \frac{h_{fe}}{g_{m6}} = \frac{\beta_6}{g_{m6}} = \frac{125}{40 \cdot 0.7} = 4.4\,k\Omega$$

$$R_{oQ6} = \frac{37 \cdot 4.4}{37+4.4} = 3.9\,k\Omega$$

$$A_v = -40\, I_{C1} \cdot R_{if} \cdot (-40\, I_{C6} \cdot 3.9) =$$

$$= -40 \cdot 0.5 \cdot 3.1\,(-40 \cdot 0.7 \cdot 3.9) = 6770$$

For closed loop amplification should be:

$$A = \frac{a}{1+af} = 3$$

→ Output impedance is $R_{34} = 2\,k\Omega$

Due to the fact that output voltage should be variable, a potentiometer is used at output $R_{33} = 100k\,\Omega$

We consider that R_{34} doesn't affect the output amplitude, we have: $POT = 0 \Rightarrow V_{out} \simeq 0$

$POT = 100 \Rightarrow V_{out} = max\ val = 5V_{pp}$

C_{15} has a very low reactance ($X_C \in [0.72; 1.44]$ so it's value doesn't affect the output value

All used components work at voltages, currents and dissipated powers lower than the max. values from data sheet.

- NPN BJT: Q_1, Q_2, Q_3, Q_4 Q_7 (BC 846B)

Max values: $\begin{cases} V_{CE} = 65V \\ I_C = 100mA \end{cases}$

$Q_1, Q_2: \begin{cases} i_{C_1} \simeq I_{C_2} = 0.5mA < I_{C\,max} \\ V_{CE_1} \simeq V_{CE_2} = 5V < 65V \end{cases} \Rightarrow$

$\Rightarrow$ Q_1 and Q_2 are working in RAN, at values smaller than max. ones

$Q_3: \begin{cases} I_{C_3} = 1mA < I_{C\,max} \\ V_{CE_3} = 4V < V_{CE\,max} \end{cases}$

$Q_4: \begin{cases} I_{C_4} = 0.9mA < I_{C\,max} \\ V_{CE} = 4V < V_{CE\,max} \end{cases}$

$Q_7: \begin{cases} I_{C_7} = 2.3mA < I_{C\,max} \\ V_{CE} = 9V < V_{CE\,max} \end{cases}$

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We consider that R_{34} doesn't affect the output amplitude, we have: $POT = 0 \Rightarrow V_{out} \simeq 0$
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All used components work at voltages, currents and dissipated powers lower than the max. values from data sheet.

- NPN BJT: Q_1, Q_2, Q_3, Q_4 Q_7 (BC846B)

Max values: $\begin{cases} V_{CE} = 65V \\ I_C = 100mA \end{cases}$

$Q_1, Q_2: \begin{cases} I_{C_1} \simeq I_{C_2} = 0.5mA < I_{Cmax} \\ V_{CE_1} \simeq V_{CE_2} = 5V < 65V \end{cases} \Rightarrow$

$\Rightarrow$ Q_1 and Q_2 are working in RAN, at values smaller than max. ones

$Q_3: \begin{cases} I_{C_3} = 1mA < I_{Cmax} \\ V_{CE_3} = 4V < V_{CEmax} \end{cases}$

$Q_4: \begin{cases} I_{C_4} = 0.9mA < I_{Cmax} \\ V_{CE} = 4V < V_{CEmax} \end{cases}$

$Q_7: \begin{cases} I_{C_7} = 2.3mA < I_{Cmax} \\ V_{CE} = 9V < V_{CEmax} \end{cases}$

- PNP BJT: Q_4 (BC 856B)

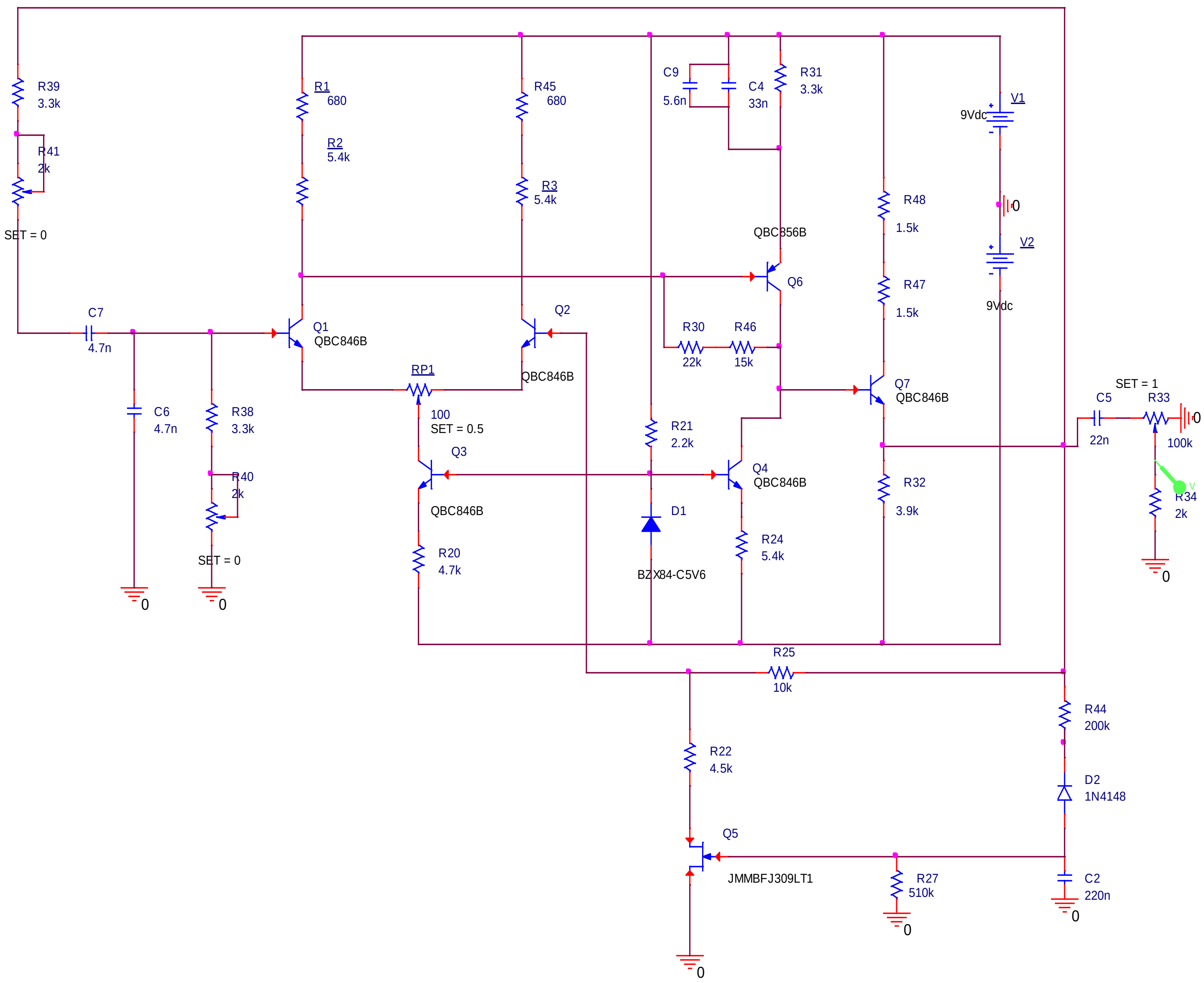
Q_6: $\begin{cases} I_{C_6} = 0.8mA < I_{Cmax} \\ V_{CE_6} = 6.3V < V_{CEmax} \end{cases}$ $\begin{cases} I_{Cmax} = 100\ mA \\ V_{CE} = 65V \end{cases}$

J_1: JFET N-Type (must be in saturation)

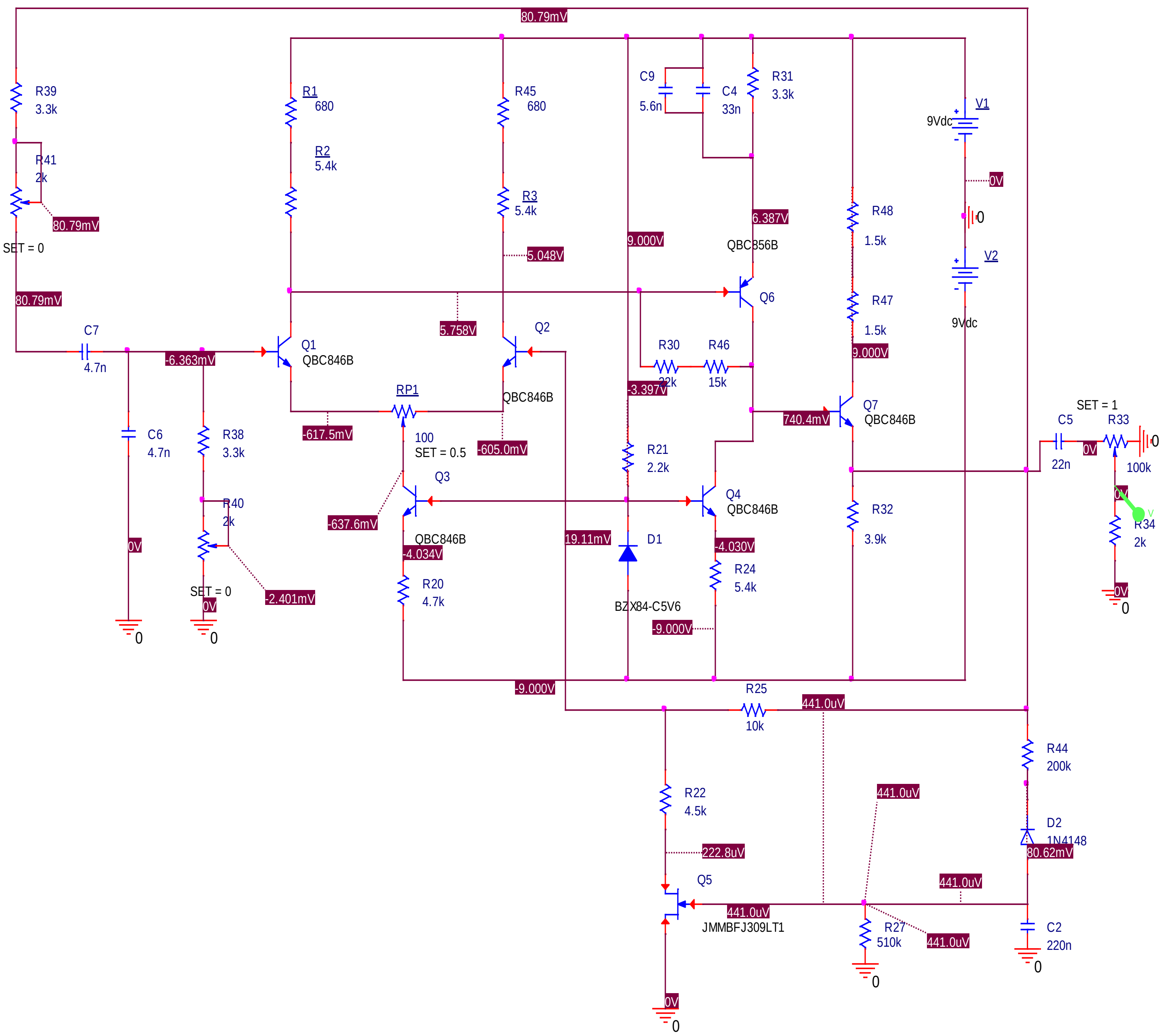
$V_{DS} < V_{DSsat}$; $V_{DSsat} = 2.5V$

$V_{DS} = 0.4V < V_{DSsat}$.

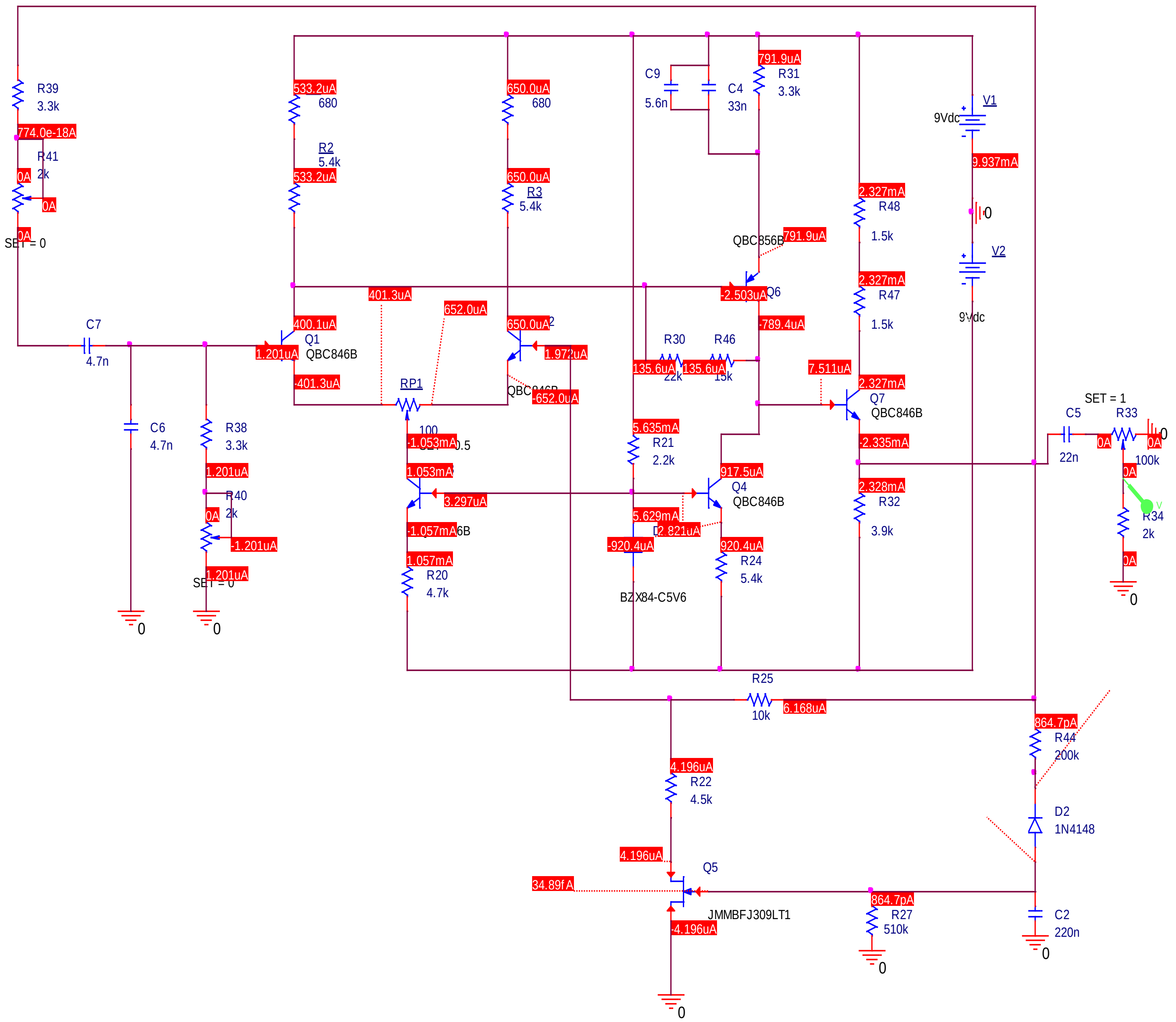
7. Final scheme and simulations



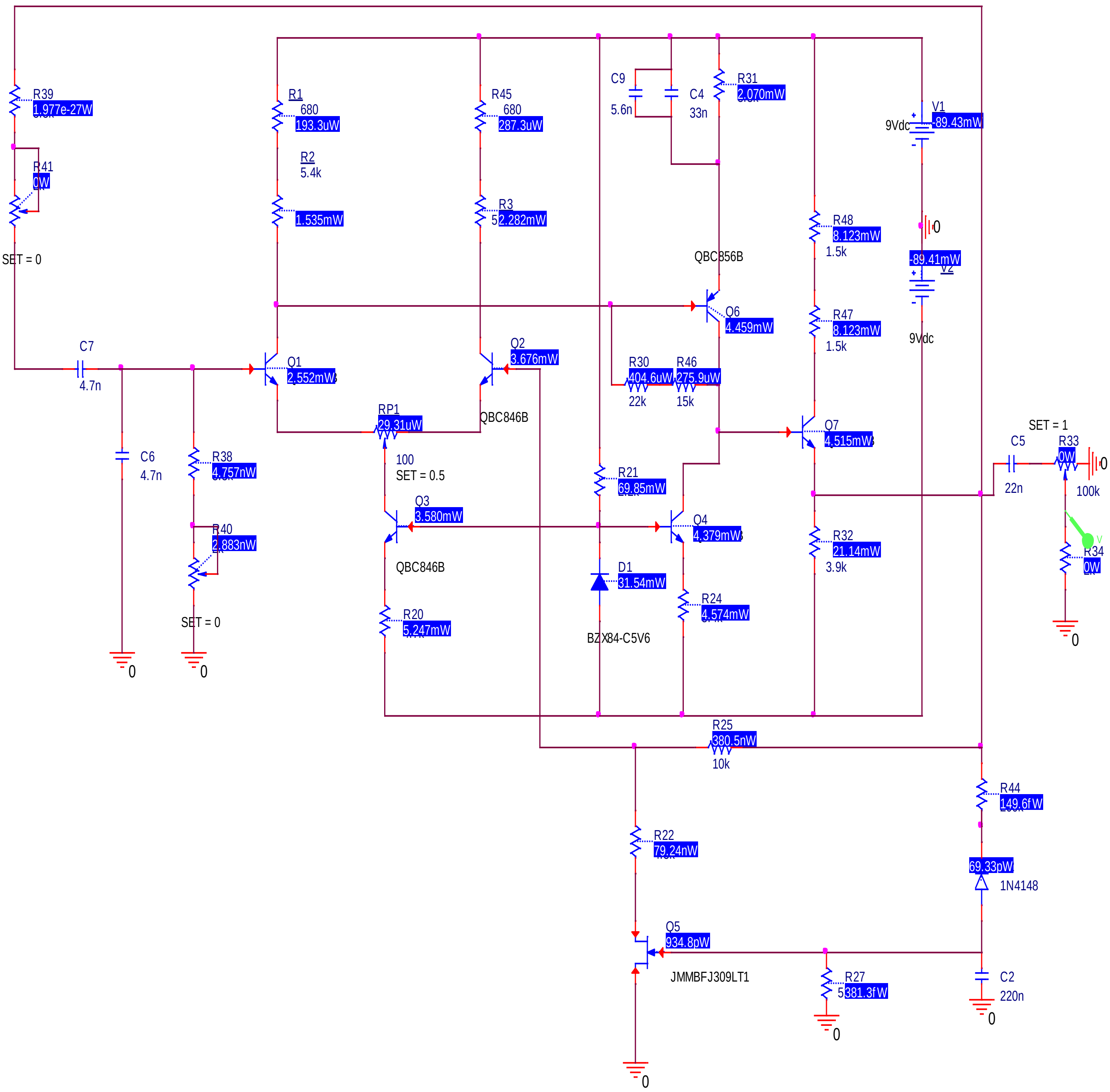
7.1. Voltages


80.79mV
R39
3.3k
R1
680
R45
680
C9
5.6n
C4
33n
R31
3.3k
V1
9Vdc
R41
2k
R2
5.4k
R3
5.4k
80.79mV
SET = 0
5.048V
6.387V
9.000V
QBC856B
0V
0
R48
1.5k
V2
9Vdc
Q6
80.79mV
C7
4.7n
5.758V
Q2
R47
1.5k
-6.363mV
Q1
QBC846B
R30
22k
R46
15k
9.000V
-3.397V
RP1
QBC846B
Q7
QBC846B
740.4mV
SET = 1
C5
22n
R33
100k
0V
0
C6
4.7n
R38
3.3k
-617.5mV
100
SET = 0.5
-605.0mV
R21
2.2k
Q3
Q4
QBC846B
R32
3.9k
R40
2k
-637.6mV
0V
R34
2k
0V
QBC846B
-4.034V
19.11mV
D1
-4.030V
R20
4.7k
R24
5.4k
SET = 0
0V
-2.401mV
BZX84-C5V6
-9.000V
0
0
-9.000V
R25
10k
441.0uV
R44
200k
R22
4.5k
441.0uV
D2
1N4148
80.62mV
222.8uV
Q5
441.0uV
441.0uV
JMMBFJ309LT1
R27
510k
441.0uV
C2
220n
0
0
0V
0

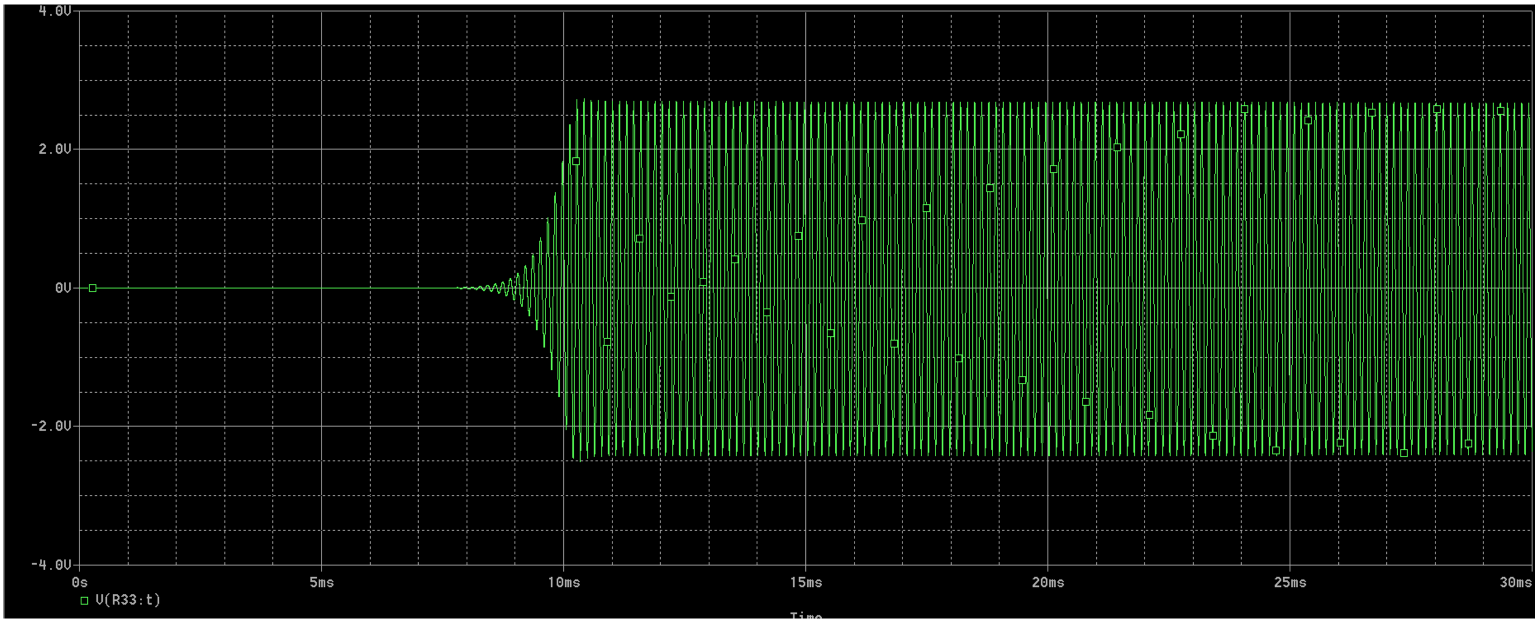
7.2. Currents



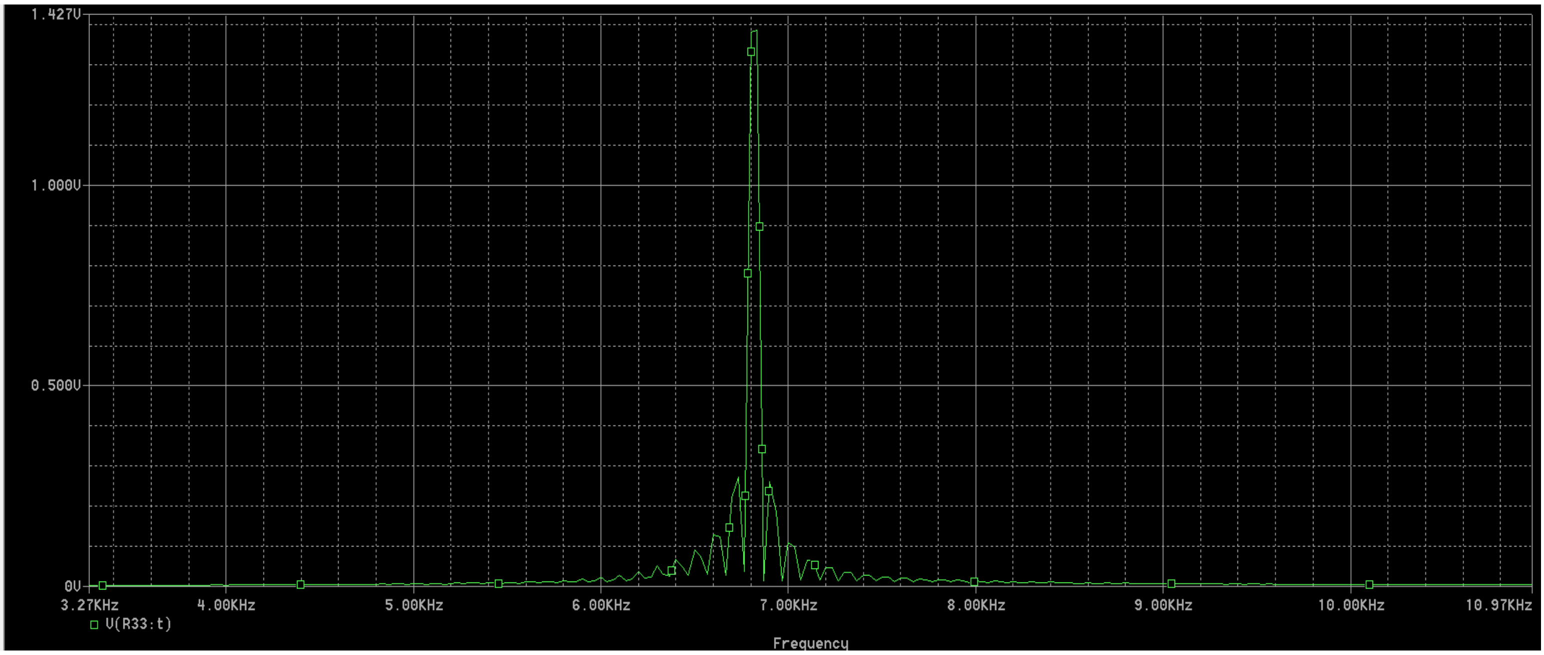
7.3. Power dissipation



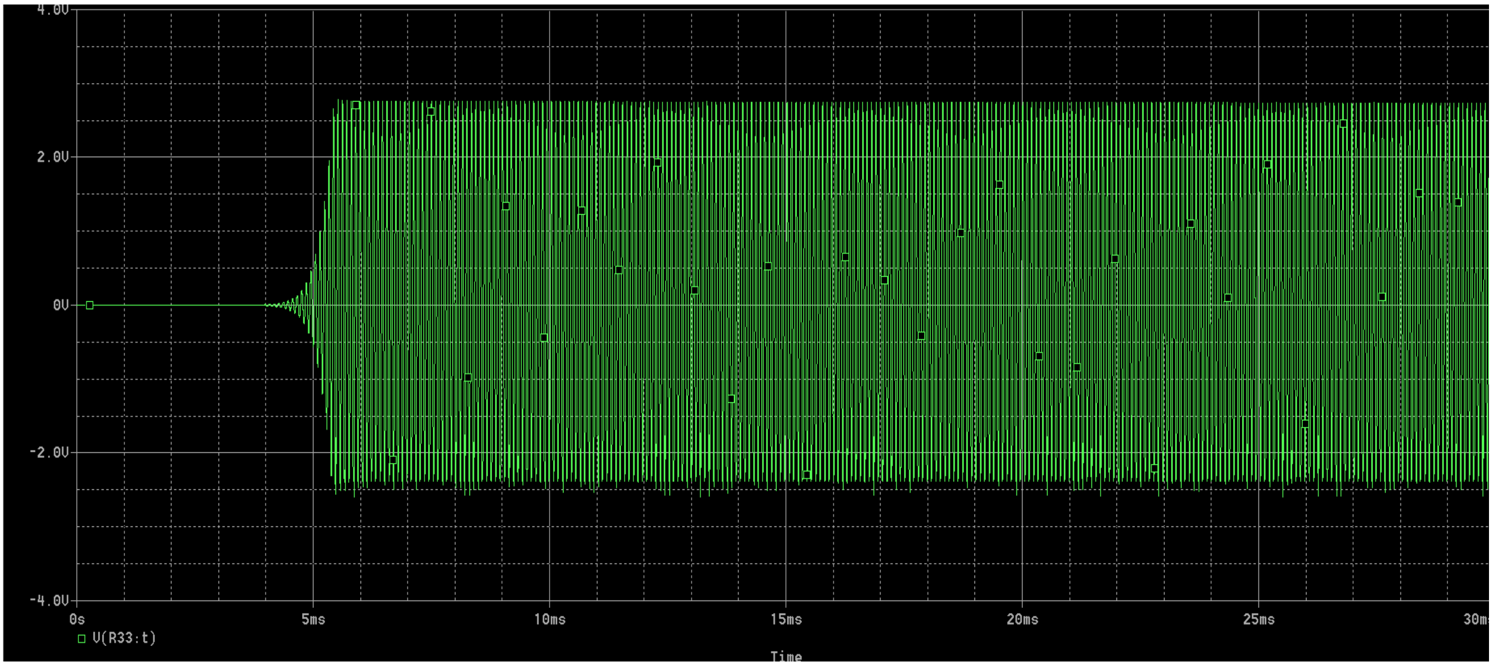
7.4. Output voltage at 5 kHz frequency (inferior limit)



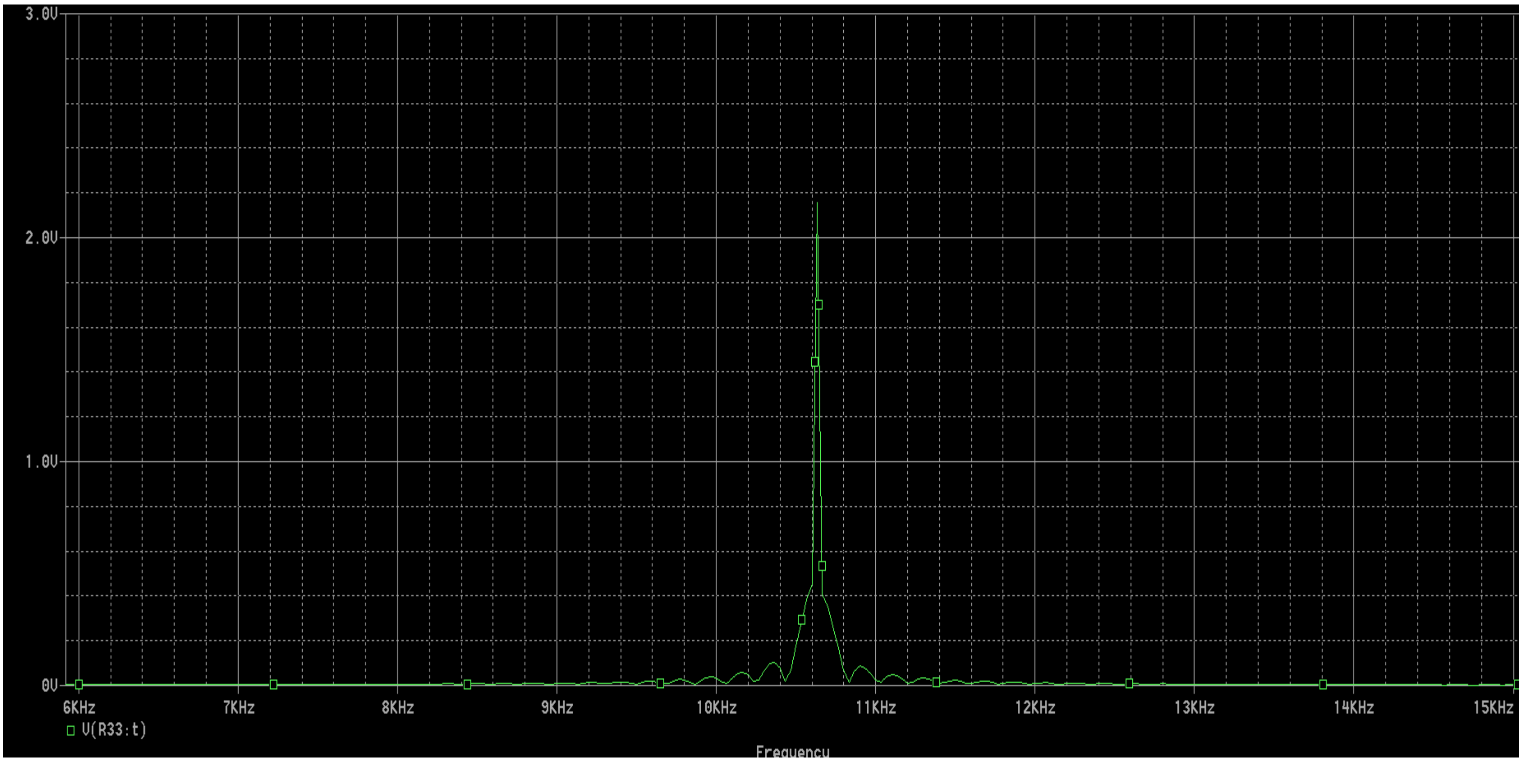
7.5. FTF for the wave at 5 kHz



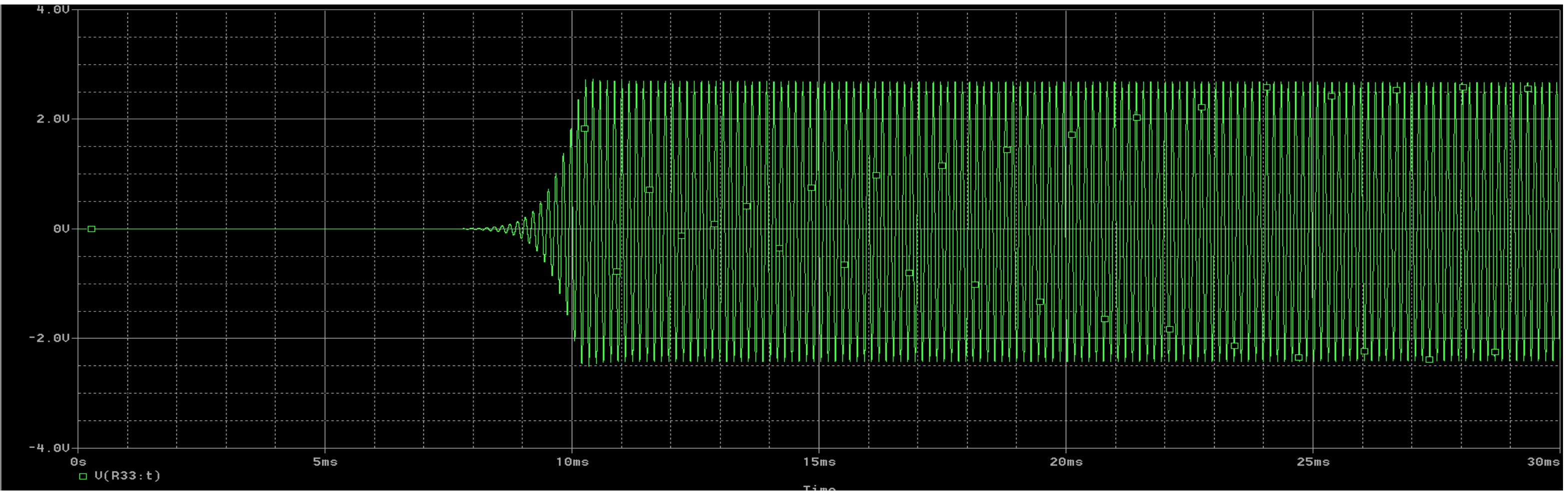
7.6. Output voltage at 10 kHz (superior limit)

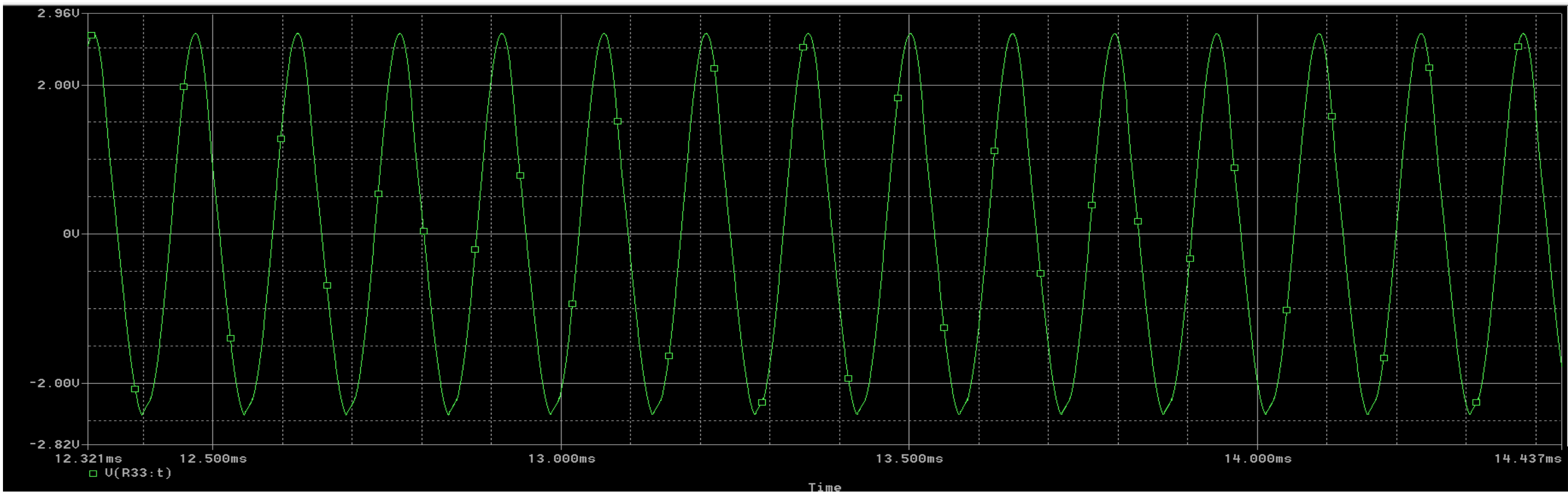


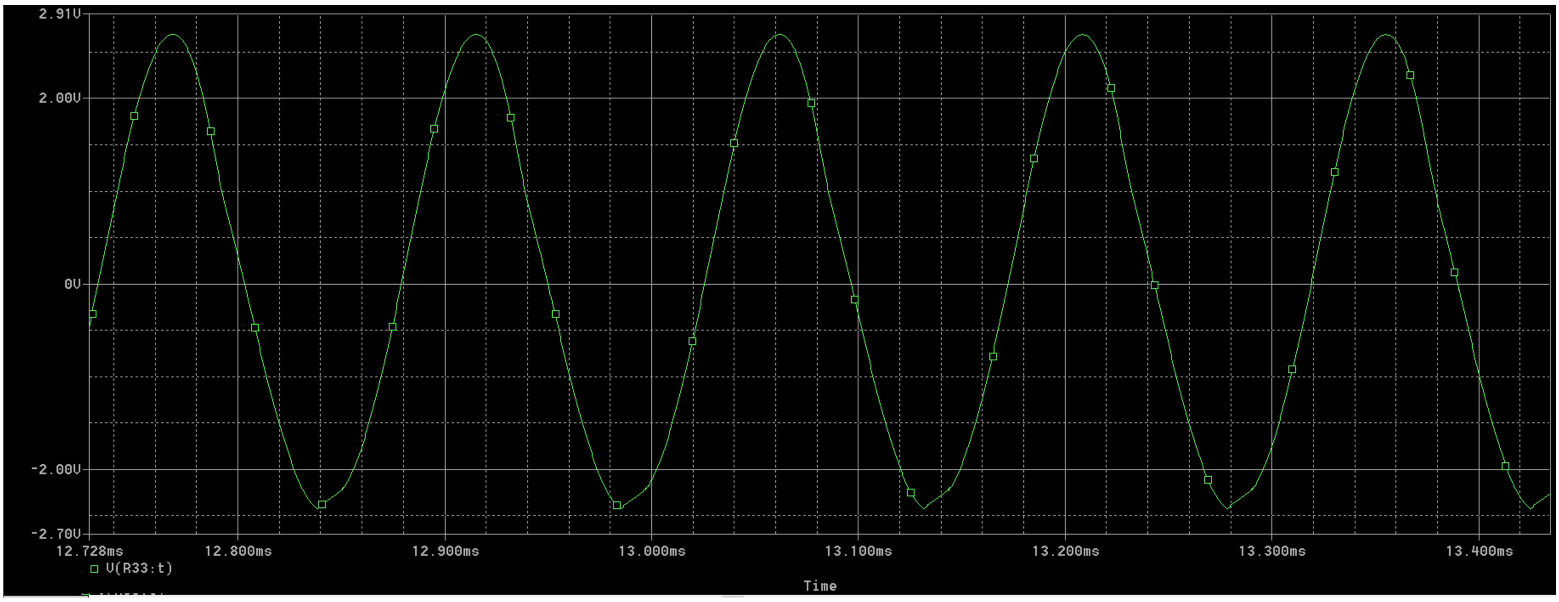
7.7. FTF of the wave at 10 kHz



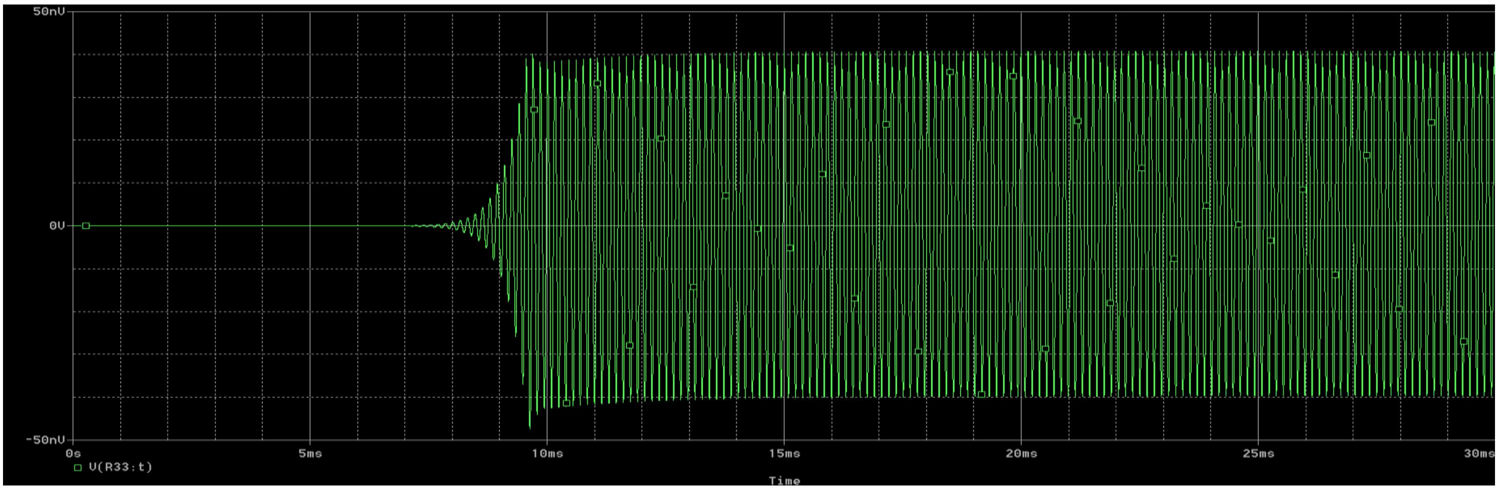
7.8. Output voltage maximum amplitude (R33 = 100k set 1): 5Vpp

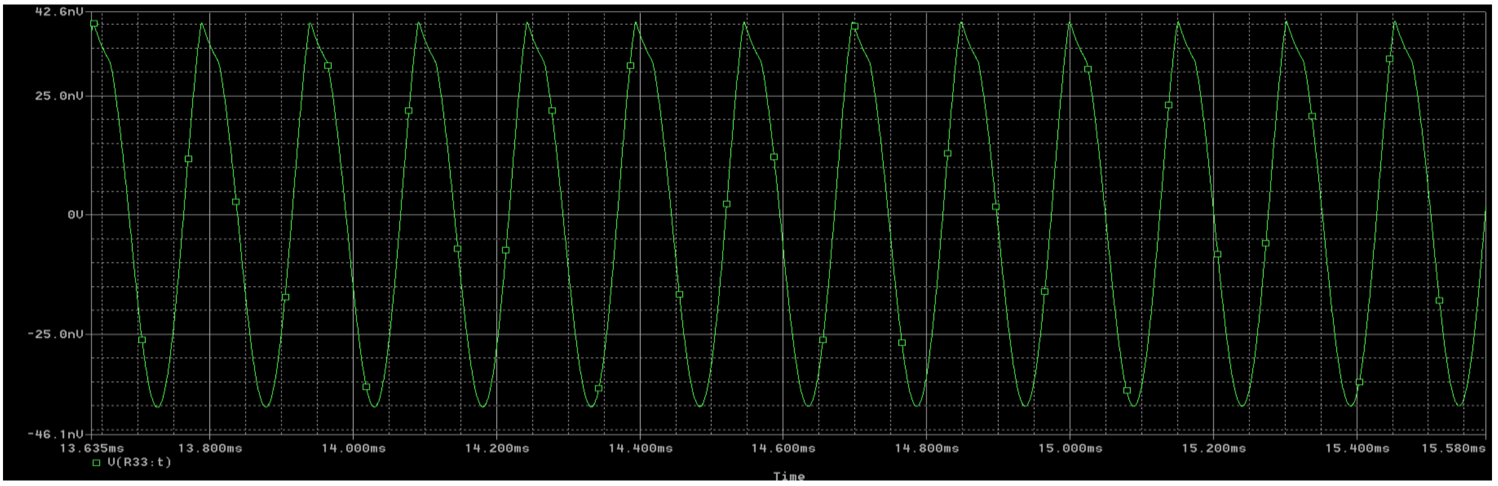


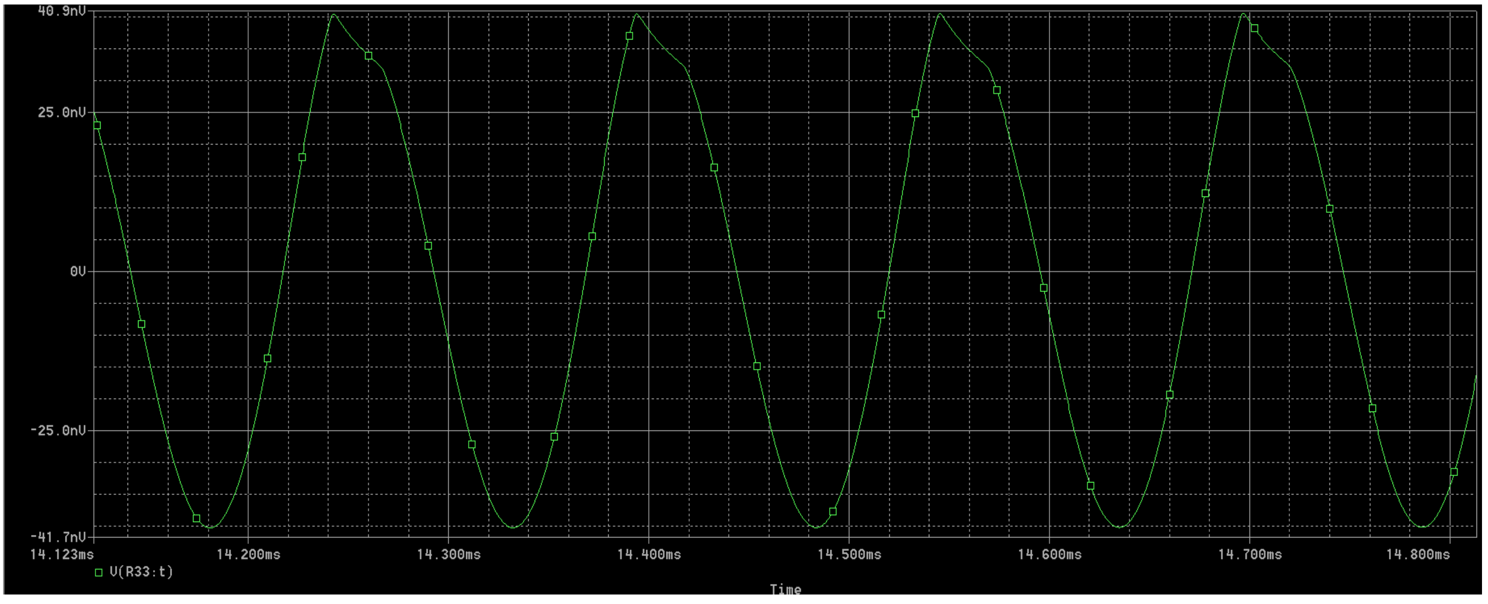




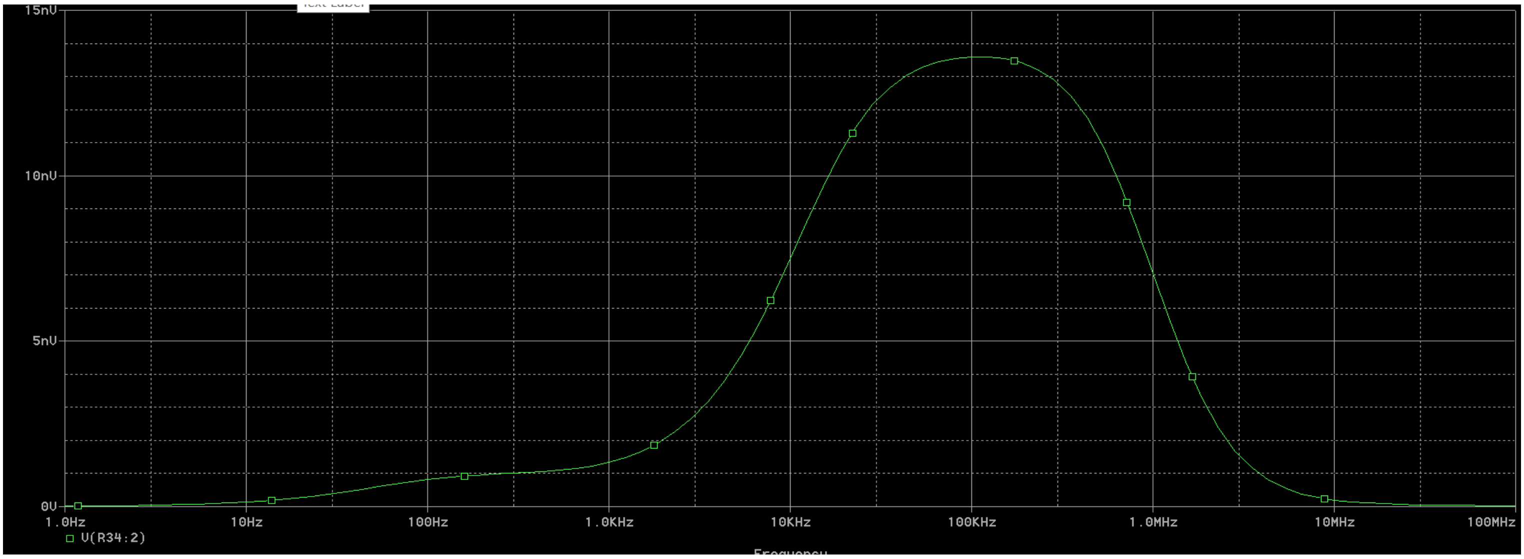
7.9. Output voltage minimum amplitude (R33 = 100l set 0): 5Vpp

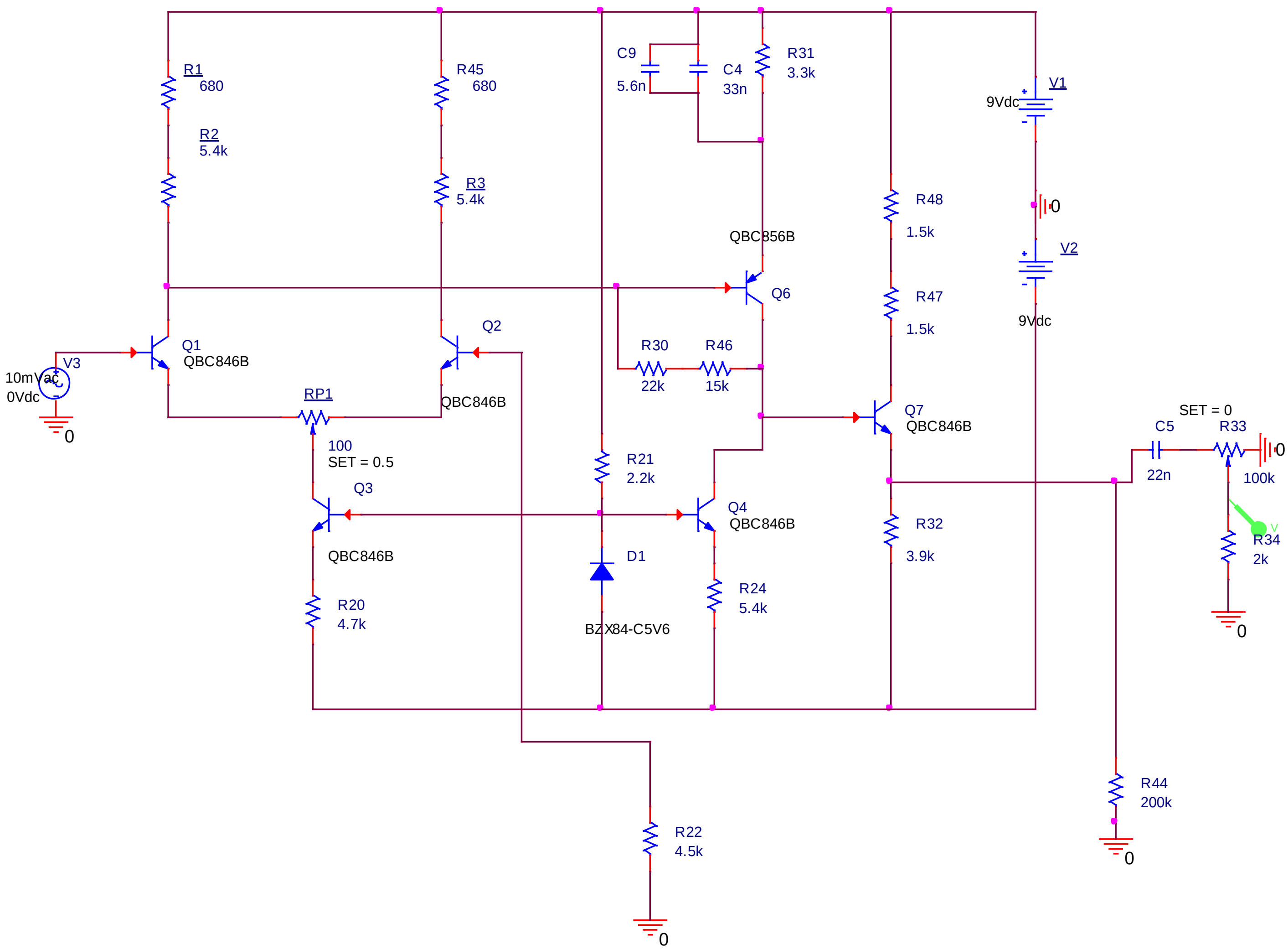




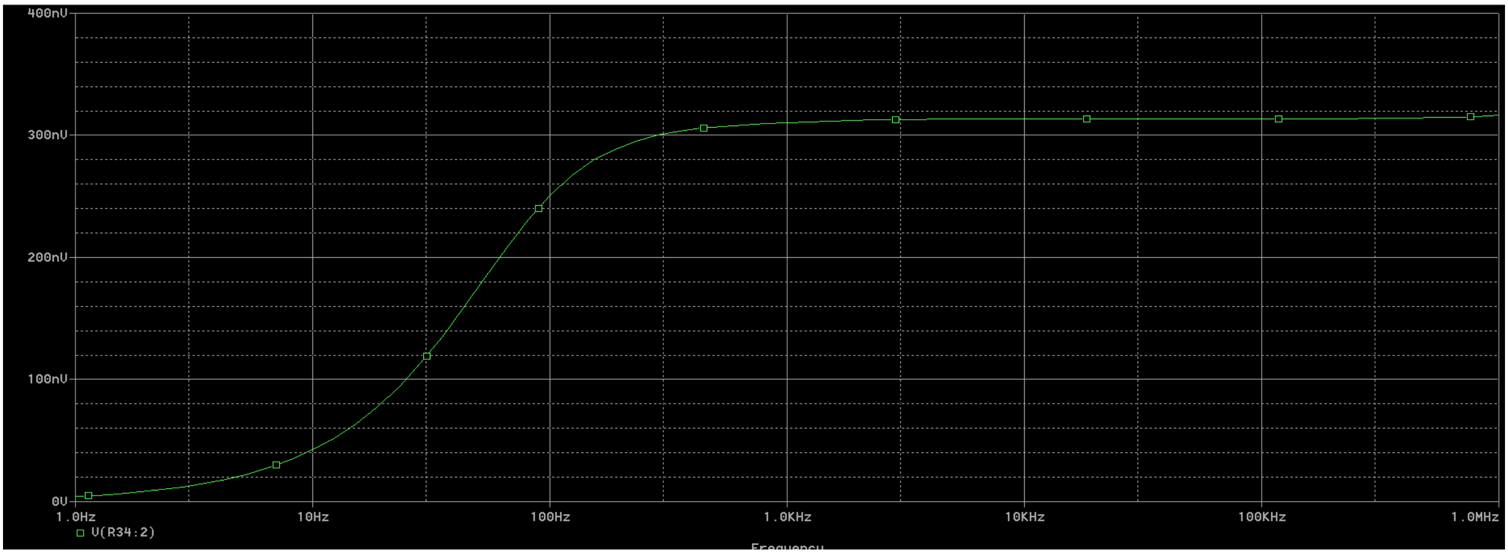


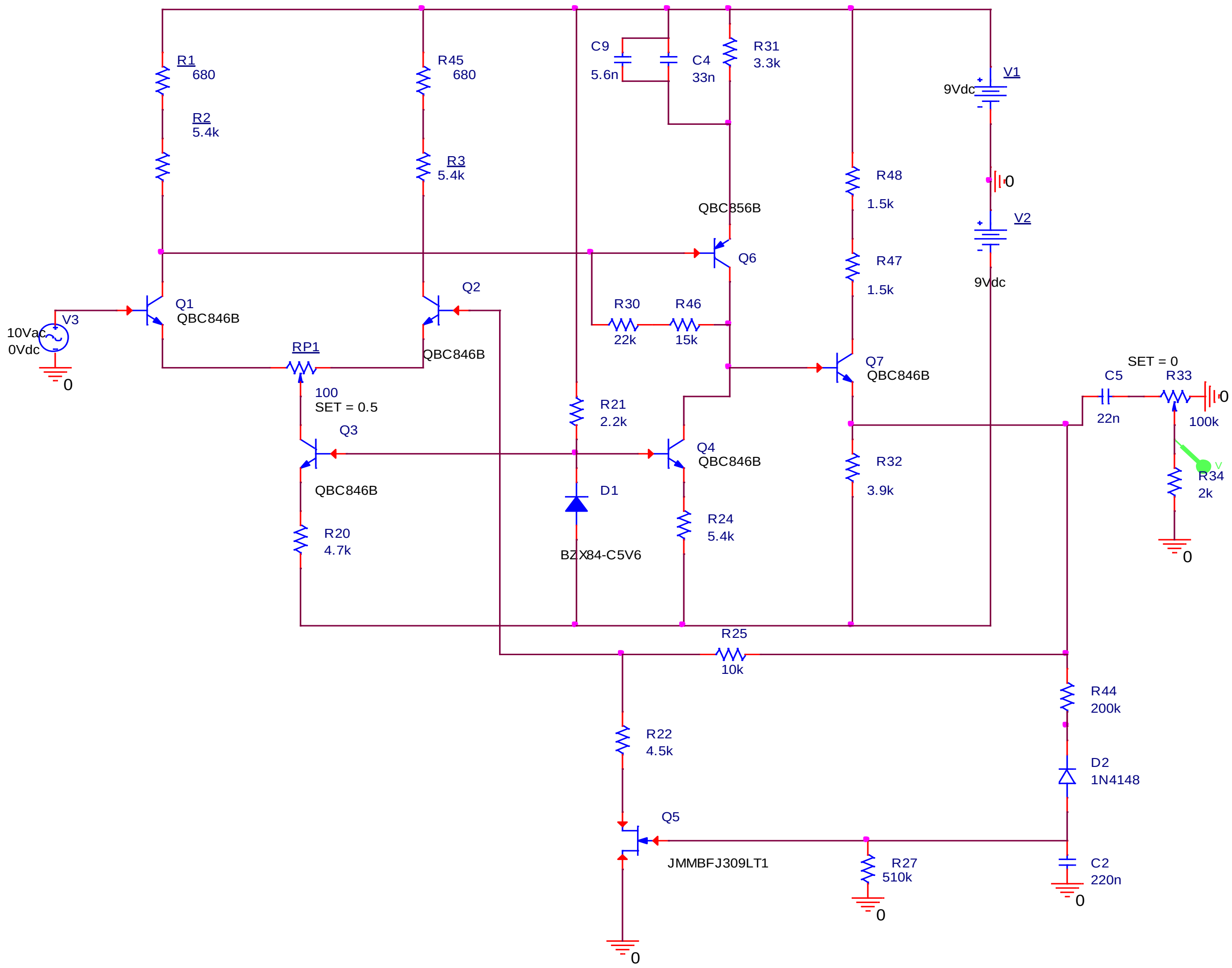
7.10. Open loop amplification





7.11.Negative feedback Amplifier





8. Conclusion

This project was a first for me because I have never designed an oscillation amplifier before. I learned a lot from doing this and, after all, I can say that I enjoyed it. My personal contribution is reflected through my design which started from a sinusoidal oscillator, the descriptions in this pdf file and the many hours of work put into accomplishing this.

Bibliografie:

https://wiki.dcae.pub.ro/images/e/e4/MCM6_Vol1.pdf

https://www.electronics-tutorials.ws/oscillator/wien_bridge.html

https://circuitglobe.com/wiens-bridge.html

http://www.learningaboutelectronics.com/Articles/What-is-a-bypass-capacitor.html

https://www.tutorialspoint.com/amplifiers/methods_of_transistor_biasing.htm

https://www.tme.eu/

https://www.electronics-tutorials.ws/transistor/tran_1.html

https://www.electronicshub.org/wein-bridge-oscillator/