Oscillator Design HOMEWORK , autumn 2018, Heikki Valmu

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Use the same transistor as in your amplifier design project (first step) at the same frequency and do the following steps using MWO.

1 - Import the S-parameter file and create the schematic and drag the S-parameter file there (remember this is the S-parameter file for CE configuration and unconditionally stable).

2 - Double click the component and change the ground to explicit ground node.

3 - Change the symbol of the transistor to represent an npn-transistor.

4 - Turn the transistor to a common base configuration. In CB configuration the small signal ground is at base, the input is at the emitter and the output at the collector. Thus rotate/flip your component and add port 1 (input) to the emitter, port 2 (output) to the collector and ground at the base.

5 - Add a Smith chart and draw the output stability circle. You should definitely see that now it's potentially unstable. Thus CB configuration is more unstable than CE and therefore better in oscillator design.

6 - You may still increase the instability by adding a small inductor between the base and the ground. Add the inductor and tune its value and try to maximize the size of the unstable area.

7 - Finally create another schematic in which you have exactly the same circuit, but replace the port 2 at the output with the ZFREQ component. Try to tune the ZFREQ values until the real part of the input impedance is as negative as possible. You may analyze the input impedance through port parameters => Z-parameters => Z11 (and select the real part in the analysis). Analyze simultaneously as well the imaginary part of Z11. The best way to see the effect of your tuning is probably by having the real and imaginary parts at one single frequency on a rectangular graph.

8. Add either a serial capacitor or a serial inductor to the resonator side to compensate the imaginary part of the Z11.

Now quit MWO and continue on paper. Notice: this time you do not have to show the matching circuit of the output. I'm happy with the resonator side as well as the biasing circuit.

10. Design the bias circuit for the transistor.

11. Add an LRC resonator to the input of the transistor. The resistor value should be one third of the magnitude of your Z11 (Z11 negative and resistor positive). Select the L and C values in order to have a resonance at the frequency of the oscillator.

Draw the whole circuit on paper and submit as your result together with the .emp file. In the circuit schematic just replace the output matching circuit with a box.

According to center frequency formula:

$$f_0 = \frac{1}{\sqrt{2\pi \times L \times C}} = 3.8 \times 10^9$$

Assume C = 200pF, then according to the above formula:

$$\mathrm{L} = \frac{1}{2\pi \times {f_0}^2 \times C} = \frac{1}{2\pi \times (3.8 \times 10^9)^2 \times 2 \times 10^{-10}} \approx 55.1pH$$

$$R_C = \frac{5-3}{I_C} = \frac{2}{15 \times 10^{-3}} \approx 133\Omega$$

$$I_B = \frac{I_C}{\beta} = \frac{15 \times 10^{-3}}{95} \approx 157\mu A$$

$$R_B = \frac{5-0.7}{I_B} = \frac{4.3}{157 \times 10^{-6}} \approx 27.39k\Omega$$