The Iby and Aladar Fleischman Faculty of Engineering
Tel Aviv University

Designing Oscillator for an Antenna at $\sim$3.5 GHz

2896

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Milestones completed so far

List of Milestones completed

- Created test schematic for oscillator using an ideal transistor
- Ran LTSpice Simulations for the ideal version
- Selected an RF transistor with a required performance at the interested frequency
- Ran PSpice Simulations for the same schematic but with non-ideal transistor
- Collected useful data like S-parameters, Z-parameters, Z_{in} and Z_{out} in order to build matching network
- Built matching network for Z_{out} and $Z_{load} = 50[\Omega]$ at $\sim 3.5[GHz]$
- Tested the power output of the circuit for the matching and adjusted the values to maximize power transfer between the DC sources and Z_{load}

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Topology of Ideal Transistor Circuit

Collpit's Oscillator

- The non-feedback Collpit's version was used for better performance at high frequencies
- The circuit was tested with no load attached
- Values of L_p, C_1 and C_2 were computed using the operating frequency formula

$$f_c \approx \frac{1}{2\pi\sqrt{L_p \frac{C_1 C_2}{C_1 + C_2}}}$$

[a]

[a] Full Derivation in the Appendix

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Ouput Waveform

Choosing the BJT

Reqired characteristics

- The transistor needs high-frequency performance, including f_{max} and f_t, well above 3.5 GHz.
- Low parasitic capacitance at collector, base, and emitter terminals is crucial.
- Low noise figure is essential.
- High gain, especially at the operating frequency, is necessary for stable oscillation.
- Ensure appropriate biasing for Colpitts oscillator operation, including DC voltages and currents.

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Choise of Transistor

Testing with Load and Choosing a Matching Network

Next Steps

Appendix

Proof of operating frequency

BFP520 Spice File

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*$
.SUBCKT BFP520/INF 200 100 300
L1     1    10     0.47nH
L2     2    20     0.56nH
L3     3    30     0.23nH
C1    10    20     6.9fF
C2    20    30     134fF
C3    30    10     136fF
L4    10   100     0.53nH
L5    20   200     0.58nH
L6    30   300     0.05nH
Q1    2 1 3 BFP520
.ENDS
.MODEL BFP520 NPN(
+ IS =1.5E-17        NF =1              NR =1
+ ISE=2.5E-14        NE =2              ISC=2E-14
+ NC =2              BF =235            BR =1.5
+ VAF=25             VAR=2              IKF=0.4
+ IKR=0.01           RB =11             RBM=7.5
+ RE =0.6            RC =7.6            CJE=2.35E-13
+ VJE=0.958          MJE=0.335          CJC=9.3E-14
+ VJC=0.661          MJC=0.236          CJS=0
+ VJS=0.75           MJS=0.333          FC=0.5
+ XCJC=1             TF=1.7E-12         TR=5E-08
+ XTF=10             ITF=0.7            VTF=5
+ PTF=50             XTB=-0.25          XTI=0.035
+ EG=1.11)
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*$
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Calculation of matching network

Bibliography