Case Study Osc1: Design of a Reflection Oscillator

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Oscillator type

Colpitts oscillator

f_{osc} = \frac{1}{2\pi\sqrt{LC_T}}

C_T = C_1C_2 = \frac{C_1C_2}{C_1 + C_2}

Common-Gate Colpitts Oscillator
Common gate Colpitts oscillator

- Parasitic capacitances of active device are incorporated in Colpitts feedback elements.
- Avoids multifrequency oscillation.
- Aids stability.
  - Periodic output signal.
  - Output is not chaos.

Oscillator type

$C_R$ and $L_R$ are called a resonator but resonate at a frequency far below the oscillation frequency so the network looks like an effective capacitance.
Reflection oscillator operation

As the amplitude of the oscillation increases, the magnitude of the device conductance, \( |G_d| \), decreases while the conductance of the tank circuit, \( G_r \), is constant.

As the frequency of the oscillation increases the susceptance of the tank circuit, \( B_r \), changes while, \( B_d \) (ideally) does not change.

Active device and resonator admittances

Reflection coefficient of the resonator, \( \Gamma_r \), and of the active device

At oscillation \( \Gamma_d \Gamma_r = 1 \).
i.e. \( \Gamma_d = 1/\Gamma_r \)

\( \Gamma_d \) rotates clockwise with respect to frequency.

\( \Gamma_r \) rotates clockwise with respect to frequency.

\( 1/\Gamma_r \) rotates counterclockwise with respect to frequency.

Intersection is at a single point, thus single frequency oscillation.

Cross over at 17.76 GHz and −6 dBm
Reflection coefficient of the resonator, $\Gamma_r$, and of the active device

Want $\Gamma_d$ and $1/\Gamma_d$ loci to be parallel at oscillation power.
Adjust slope of resonator susceptance to achieve this, also manages tuning range.

Cross over at 17.76 GHz and $-6$ dBm

Phase noise

Oscillation frequency is 17.76 GHz.

Final oscillator

- Common base Colpitts oscillator but sometimes simply called a reflection oscillator with transmission line in base providing feedback.
- Resonator enables slope of the admittance to be set. Leads to lower phase noise and overall improved oscillator performance.
- Resonator is isolated from load. So load has limited effect on resonant frequency.
- Need to follow with an attenuator (usually) and bandpass filter.

Resonant frequency of resonator is 3.188 GHz

Oscillation frequency is 17.76 GHz.