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Designing Oscillators with Low Phase Noise

RF & Protection Devices

Never stop thinking

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1 Designing Oscillators with low phase noise

A key parameter of oscillators is the purity of the signal they produce. Whilst harmonics can be filtered out by a simple lowpass-filter, the spurious levels close the wanted signal can only be minimized by careful oscillator design.

In order to design an oscillator with low phase-noise, the following are required:

- A resonant circuit with a high Q-factor
- Active components with low phase noise

To construct a resonant structure with a high Q-factor low losses are required in all of the constituent parts. The following points should therefore be carefully considered:

- Q of resonator device itself
- Series resistance of capacitors
- Series resistance of tuning diode
- Loss of printed circuit board

Low 1/f noise of the transistor in the oscillator is very important, because the 1/f noise appears as sideband noise around the carrier frequency of the oscillator output signal.

The basic rules to select the right transistor for an optimized design are:

- The best oscillator transistor is a device with the lowest possible f_T. A commonly used criteria is: $f_T \leq 2 \times f_{osz}$.
- The 1/f noise is directly related to the current density in the transistor. Transistors with high I_{cmax} used at low currents have best 1/f performance.However, the f_T of a transitor drops as current decreased. Additionally, the parasitic capacitances of a high current transistor are higher due to the larger transistor structure required.