Equivalent noise source

U_{Nin}

Steady−state oscillation

$U_{Nout} = U_{Nin} + H(\omega) \cdot \sqrt{\overline{G}} \cdot U_{Nout}$

$H(\omega_0) \cdot \sqrt{\overline{G}} = 1$

P_0

Valid at $P_{Nout} \ll P_0$

Resonator T_R

R_{Cu}

L C

$H(\omega)$

Amplifier

G

R_{out} R_{in} F

T_G

$T_R \approx T_0 = 290K$

$T_R + T_G \approx T_0 \cdot F$

$U_{Nout} = \dfrac{U_{Nin}}{1 - H(\omega) \cdot \sqrt{\overline{G}}}$

$\Sigma R = R_{out} + R_{Cu} + R_{in}$

Spectrum $\log |\mathbf{F}(\omega)|$

Carrier $P_0(\omega_0)$

Phase noise

Phase noise

Thermal noise

Thermal noise

$\Delta \omega$

ω

$\omega_0 = 1/\sqrt{\overline{LC}}$

$H(\omega) \cdot \sqrt{\overline{G}} = \dfrac{\Sigma R}{\Sigma R + j\omega L + \dfrac{1}{j\omega C}} \approx \dfrac{1}{1 + j2Q_L \dfrac{\Delta\omega}{\omega_0}}$

$Q_L = \dfrac{\omega_0 L}{\Sigma R}$

$U_{Nout} \approx U_{Nin} \cdot \left(1 + \dfrac{\omega_0}{j2Q_L \Delta\omega}\right)$

$P_{Nout} \approx P_{Nin} \cdot \left[1 + \left(\dfrac{\omega_0}{2Q_L \Delta\omega}\right)^2\right]$

Amplitude and phase noise

$P_{Nout} \approx P_{Nin} \cdot \left[1 + \left(\dfrac{f_0}{2Q_L \Delta f}\right)^2\right]$