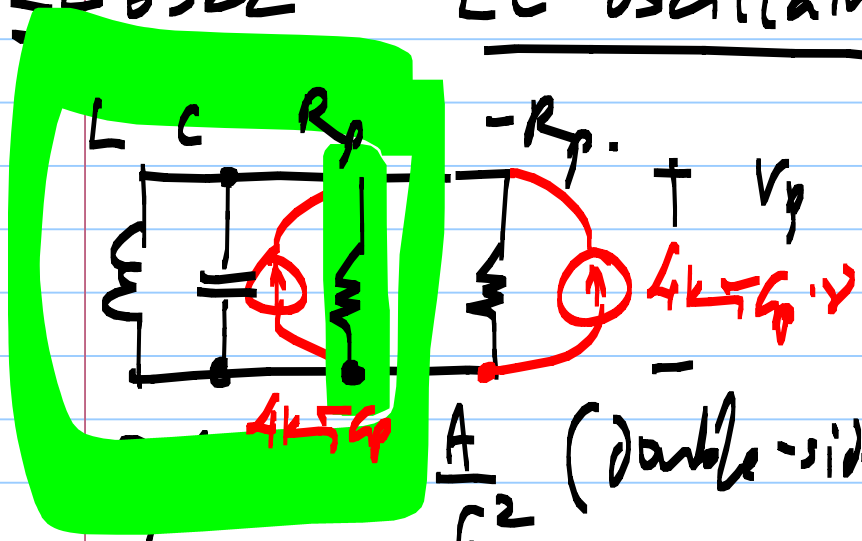
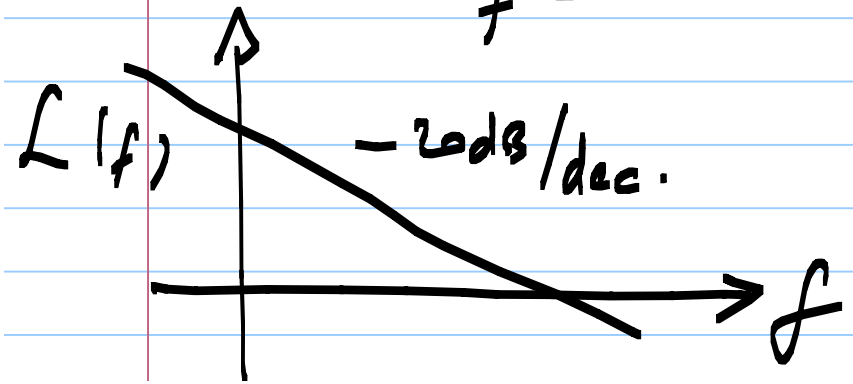
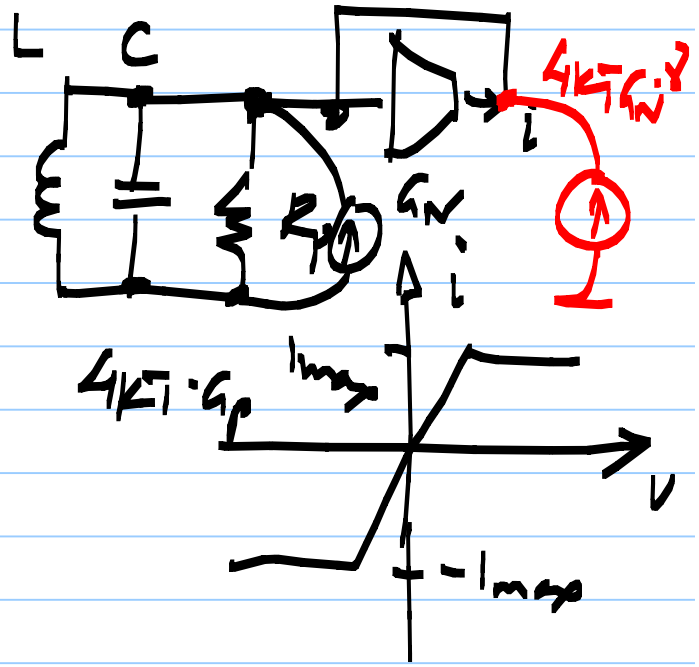
EE6322 LC oscillators 13/3/2018

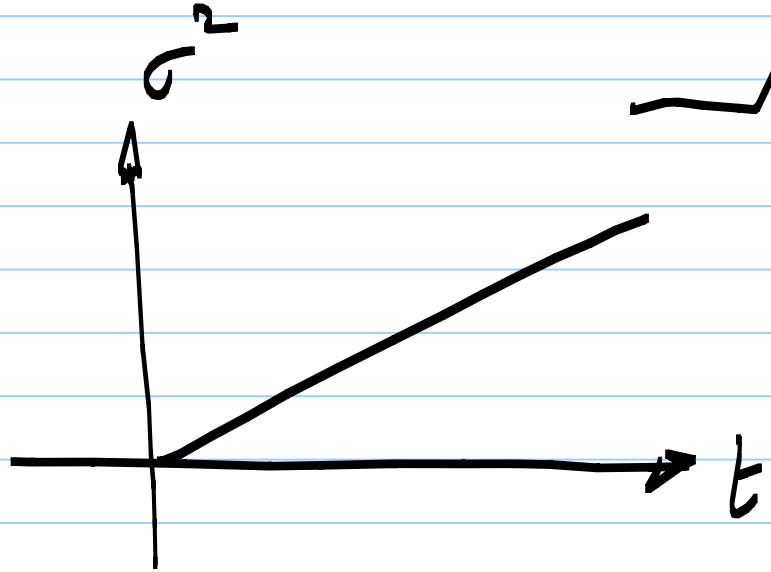


$\frac{A}{f^2}$ (double-sided)

$\mathcal{L}(f) = \frac{A}{f^2}$ $(f > 0)$







offset freq. · Loss resistance · osc. freq. · the tank which has to be compensated

$$\mathcal{L}(\Delta f) = \frac{kT}{} \frac{(1+\gamma)}{Q^2} \frac{f_0^2}{\Delta f^2}$$

$$P_d = \frac{V_p^2}{2R_p}$$

Power dissipated in the tank

$$\text{FoM} = \frac{1}{\mathcal{L}(\Delta f) P_{d,\text{mW}}} \frac{f_0^2}{\Delta f^2}$$

$$= \frac{2}{kT} \frac{Q^2}{1+\gamma} 10^{-3}$$

$$\mathcal{L}(\Delta f) = \frac{kT}{2} \cdot \frac{(1+\gamma)}{Q^2 \cdot P_d} \cdot \frac{f_0^2}{\Delta f^2}$$

$$\mathcal{L}(\Delta f) = \frac{8}{3} \frac{kT \cdot V_{DD}}{(V_{GS} - V_t) \cdot I_D \cdot V_{DD}} \cdot \frac{f_0^2}{\Delta f^2}$$

LC oscillator: $\frac{1}{2} \cdot kT \cdot \frac{(1+\gamma)}{P_d} \cdot \frac{1}{Q^2} \cdot \frac{f_0^2}{\Delta f^2}$ $\frac{2}{4 \cdot 10^{-21}} \cdot \frac{10^2}{\gamma} \cdot 10^{-3}$

$\frac{1}{4} \cdot 10^{20}$ ✓

Ring oscillator: $\frac{8}{3} kT \cdot \frac{1}{P_d} \cdot \frac{V_{dd}}{V_{GS} - V_T} \cdot \frac{f_0^2}{\Delta f^2}$

$Q = 10$ $\gamma = 1$

$10 \log$

$$FoM\,(LC) = \frac{2}{kT} \frac{Q^2}{1+\gamma} 10^{-3}$$

194 dB

$$FoM\,(Ring) = \frac{3}{8} \cdot \frac{1}{kT} \cdot \frac{V_{GS} - V_T}{V_{dd}} \cdot 10^{-3}$$

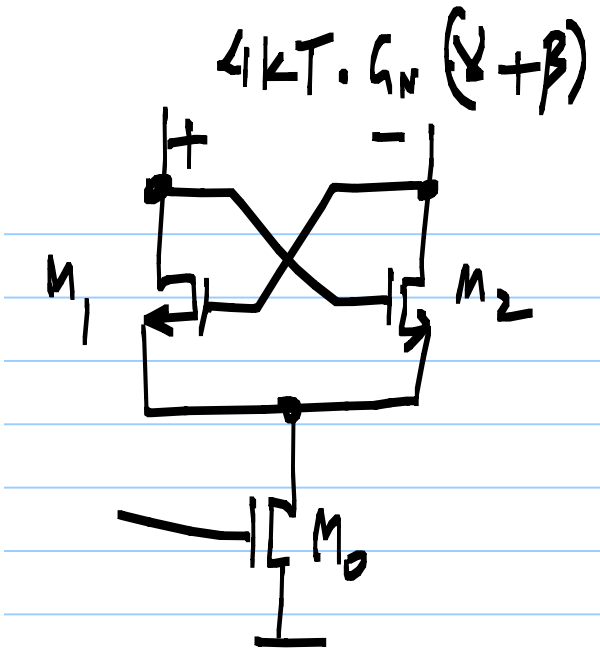
$$\mathcal{L}(\Delta f) = \frac{kTR_P(1+\gamma+\beta)}{V_P^2 Q^2}\frac{f_0^2}{\Delta f^2}$$

[redacted]

$$P_d = \frac{P_{tank}}{\eta}$$

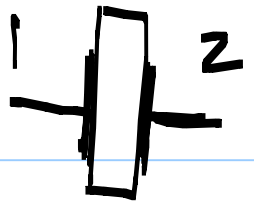
η : Efficiency

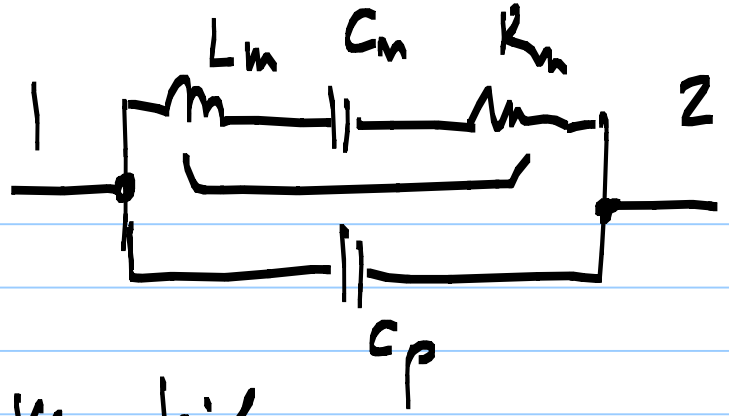
$$\text{FoM} = \frac{2}{kT}\frac{\eta Q^2}{1+\gamma+\beta}10^{-3}$$



$G_N = g_{m1}/2$

Quartz crystal :





Piezoelectric :

Q : Very high

Low temp. coefficient

Quartz crystal oscillator:

Low phase noise

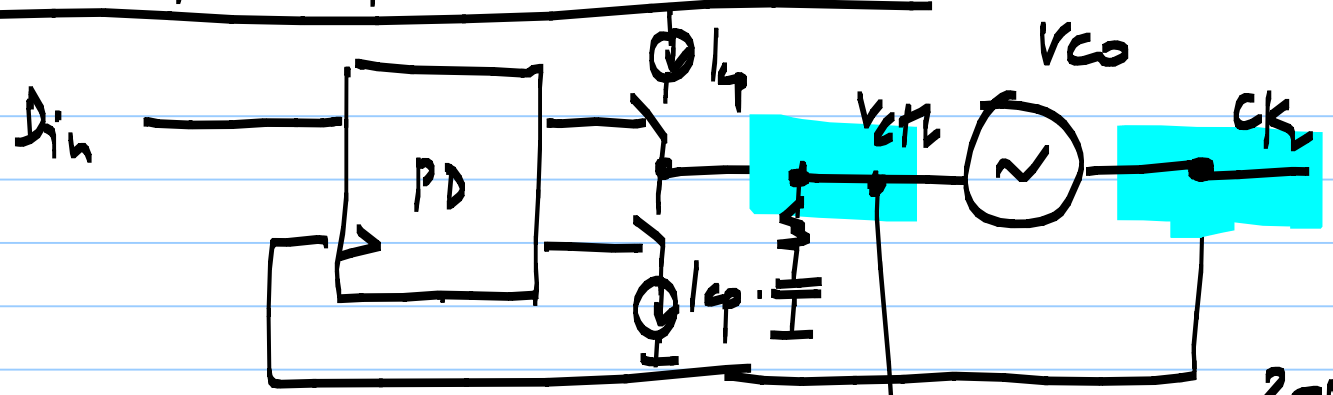
Accurate freq. with low temp. coefficient

f_o < 100MHz

freq. multiplier → N

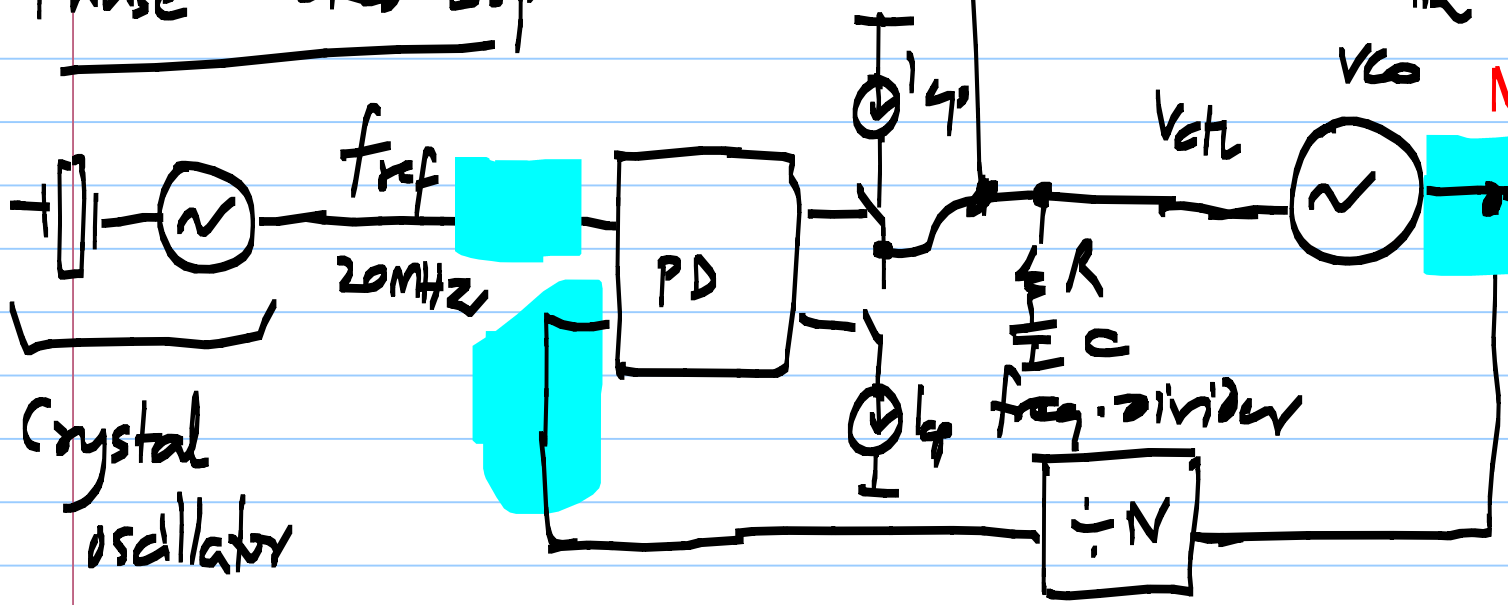
$N \cdot f_{crystal}$ Phase locked loop

CDR w/o forwarded clock:



Track Din & recover its value

Phase-Locked Loop



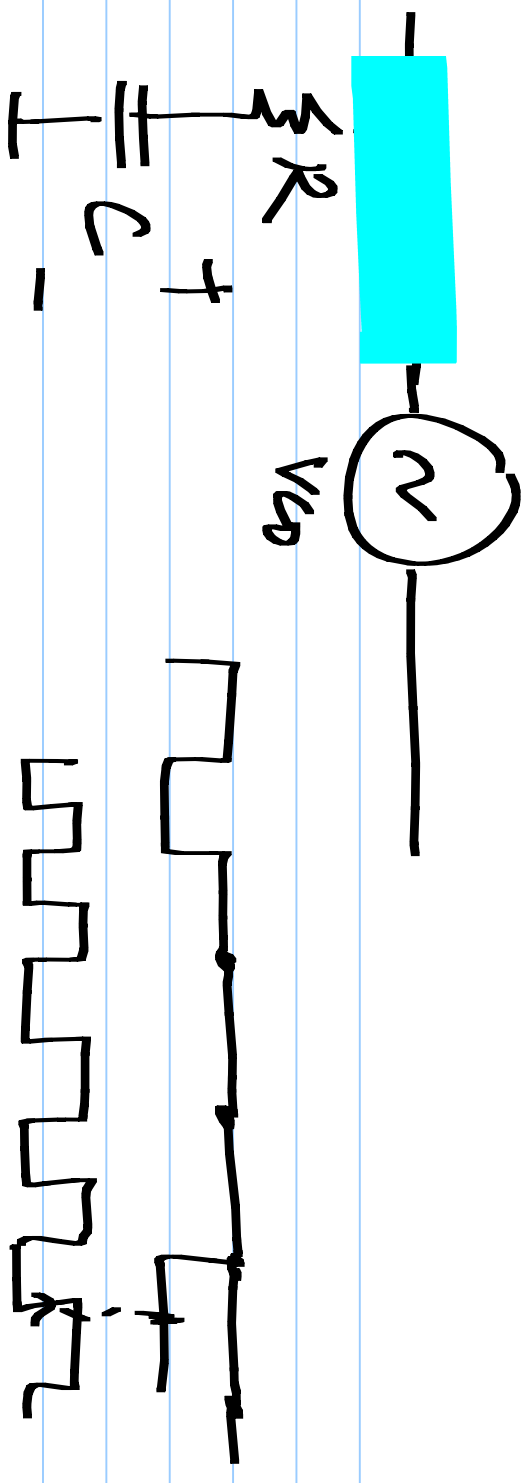
Crystal oscillator

20MHz X500
10GHz

Nfreq

In steady state

Generate a periodic signal


R
C
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