Cross Coupled Oscillator Design

First Pass

1) $P_{DC} = 1mW$, $V_{DD} = 1V$, $V_{TH} = 580mV$, $Q_L = 8$, $C_{out} = 20fF$.

2) $I_{SS} = \frac{P_{DC}}{V_{DD}} = 1mA$;

$$R_p = \frac{\pi V_{DD} V_{TH}}{4 P_{DC}} = \frac{\pi \times 0.58}{4 \times 10^{-3}} = 455\Omega$$

3) $$L_1 = \frac{R_p}{Q_L \omega_0} = \frac{455}{8 \times 2\pi \times 10^{10}} = 0.905\,nH$$

$$C_1 = \frac{1}{\omega_0^2 L_1} = 280fF - \underbrace{10fF}_{C_{out}} = 270fF.$$

4) $\frac{W}{L} = 5\mu m$ with 10 fingers.

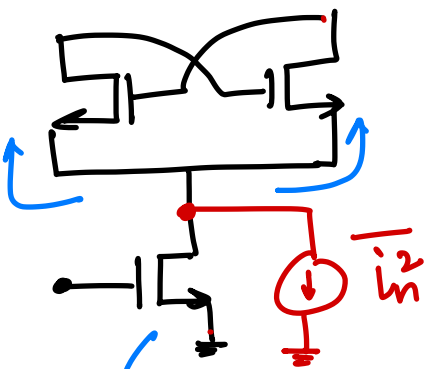
Effect of Tail Current

$\overline{i_n^2} = \overline{i_{n,flicker}^2} + \overline{i_{n,white}^2}$

$\overline{i_{n,flicker}^2}$ → how freq. ($\ll f_0$)

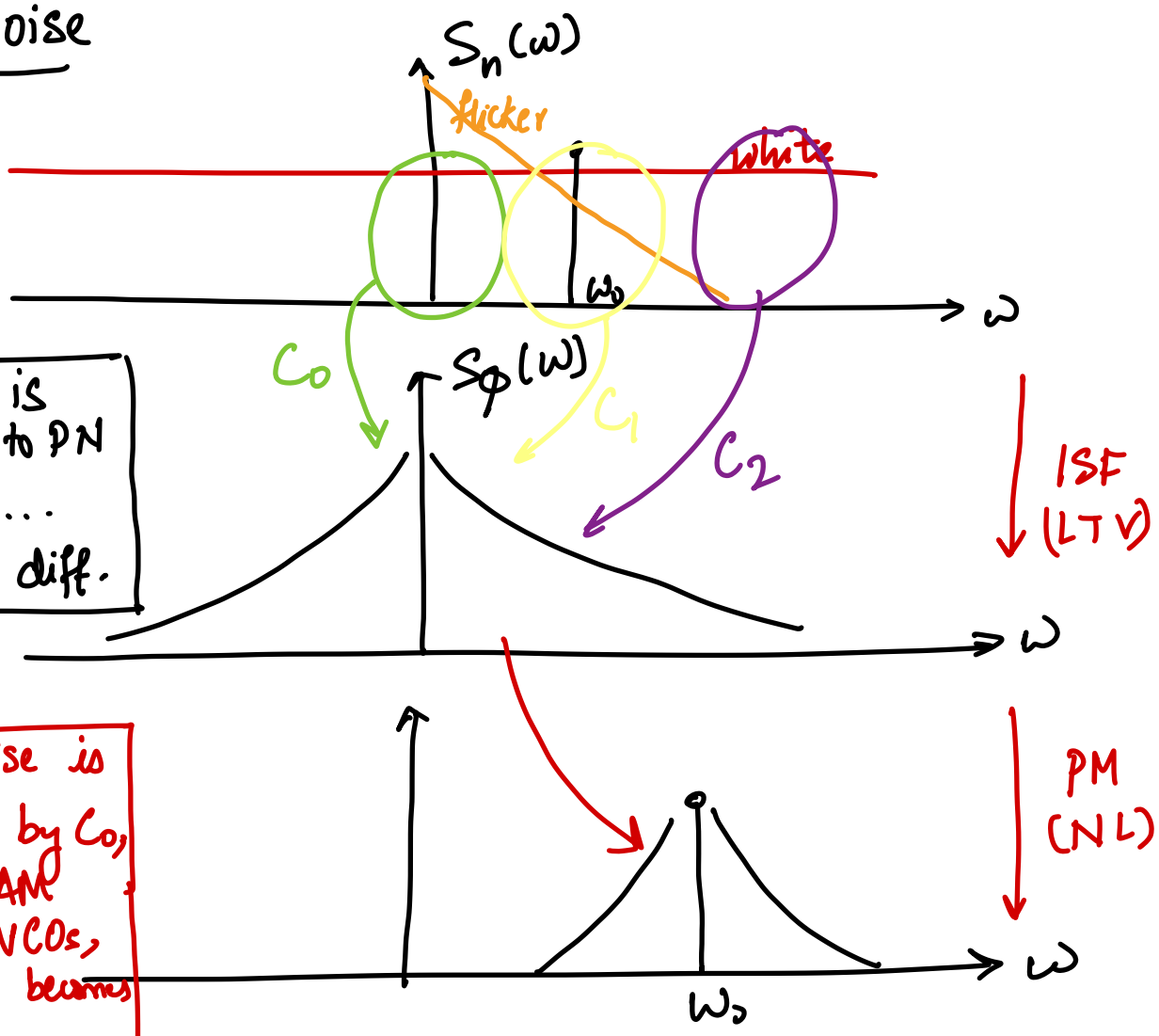
$\overline{i_{n,white}^2}$ → Wideband.

The two branches are correlated



"Common Mode" noise

Phase Noise



White noise is carried up to PN by C_2, C_4 ... since osc is diff.

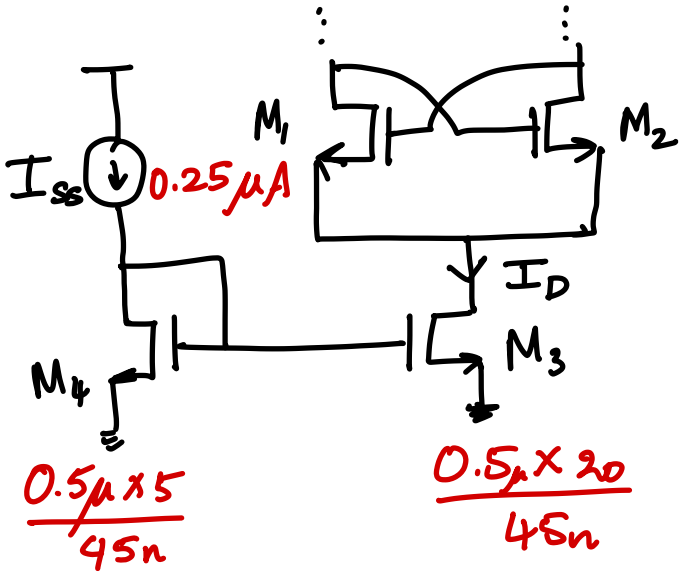
Flicker noise is carried up by C_0, mostly as AM noise. In VCOs, AM → PM & becomes significant.

Current mirror

$$I_D = \left(\frac{W}{L}\right)_3 \cdot \frac{1+\lambda V_{DS_3}}{1+\lambda V_{DS_4}} \cdot I_{SS}$$

CLM coeff.

$1+\lambda V_{DS_4}$: significant when $L \to$ min.



Noise: (Flicker) Noise of M_4 is amplified by the current mirror's gain.

Suppressing the Flicker Noise of M4

$$S_f(f) = \frac{K}{C_{ox}} \frac{1}{WL} \frac{1}{f}$$ } Flicker Noise Spectrum.

WL → Larger area "averages out" the impact of Flicker Noise.