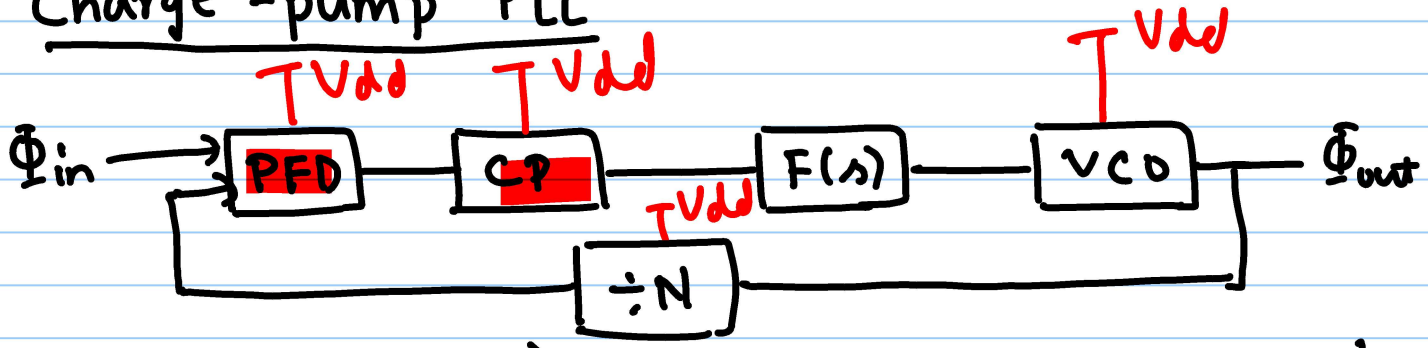
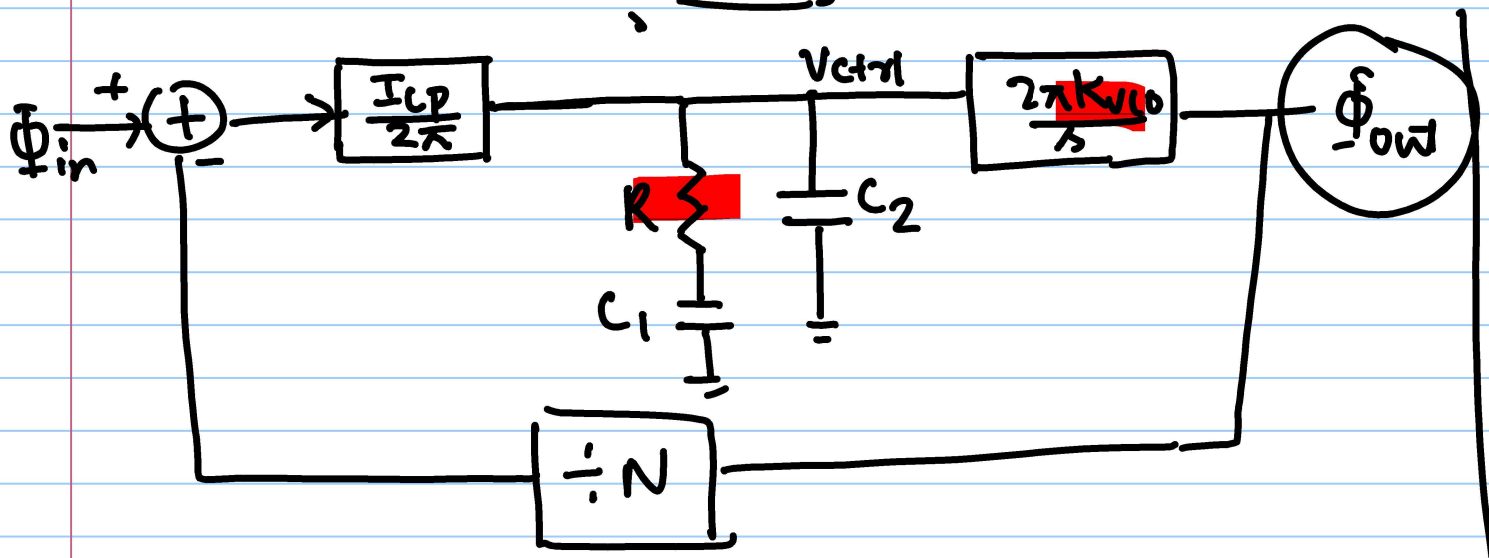
Lecture # 20

Note Title 05-09-2017

Charge-pump PLL





1. ω_u : unity gain freq.
   ϕ_m : Phase Margin
2. $\frac{C_1}{C_2} = f(\tan(\phi_m)) = K_C$
   $\omega_u^2 = \omega_z \cdot \omega_{p3}$
3. Choose R.
   $C_1 = \frac{1}{\omega_z \cdot R}$
   $C_2 = C_1 / K_C$

$\omega_{p1} = \omega_{p2} = 0$, $\omega_{p3} = \frac{1}{RC_1C_2/C_1+C_2}$

$\omega_z = 1/RC_1$

4. $|L_h(\omega_u)| = 1 \Rightarrow I_{cp}$.
For given K_{VCO}

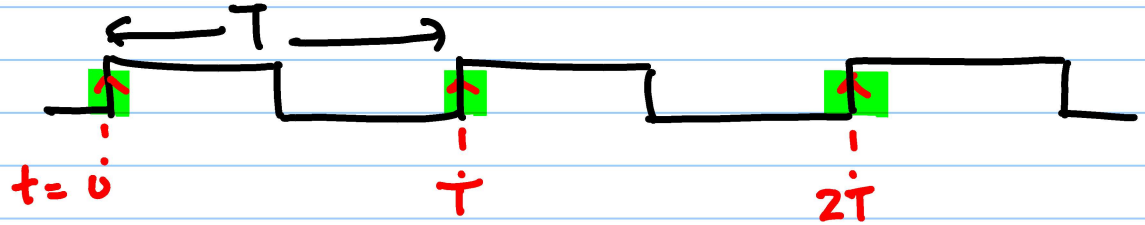
Noise Analysis of CP-PLL

Extrinsic Noise Source

1. Supply Noise
2. Substrate Noise.
3. Ref. Noise.

Intrinsic Noise Sources.

1. Thermal Noise
2. Flicker Noise.

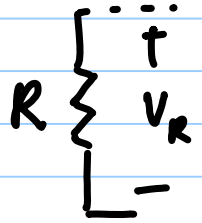


Jitter : any deviation in clocking events w.r.t absolute time.

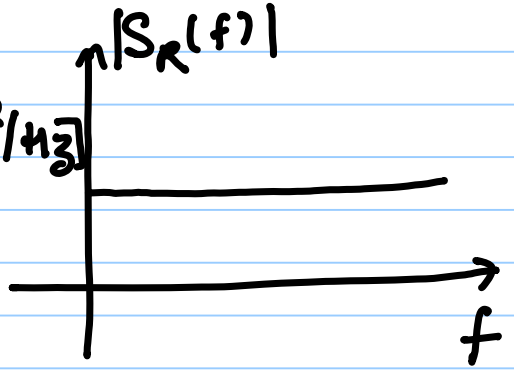
$(\Delta t) \longrightarrow \Delta\phi$

Noise Source

1. Resistor

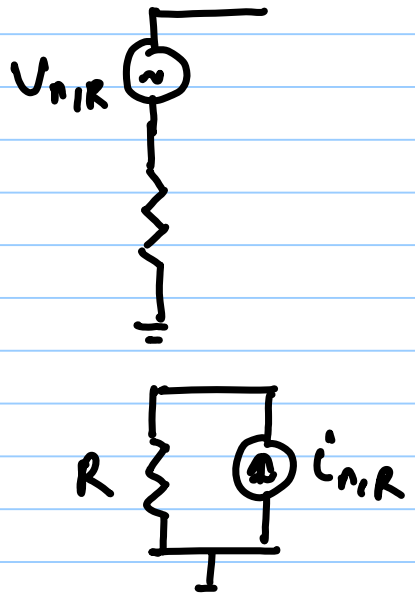


$$|S_R(f)| = 4KTR \ [V^2/Hz]$$



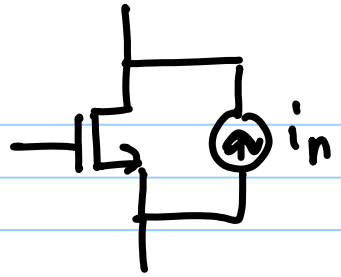
K: 1.38×10^{-23} J/K

T: Temp. in Kelvin.



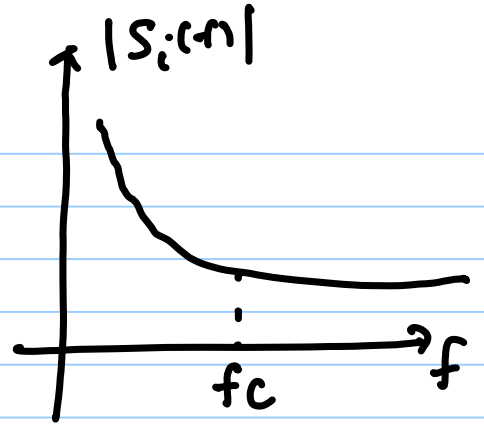
$$|S_{R,i}(f)| = \frac{4KT}{R}$$

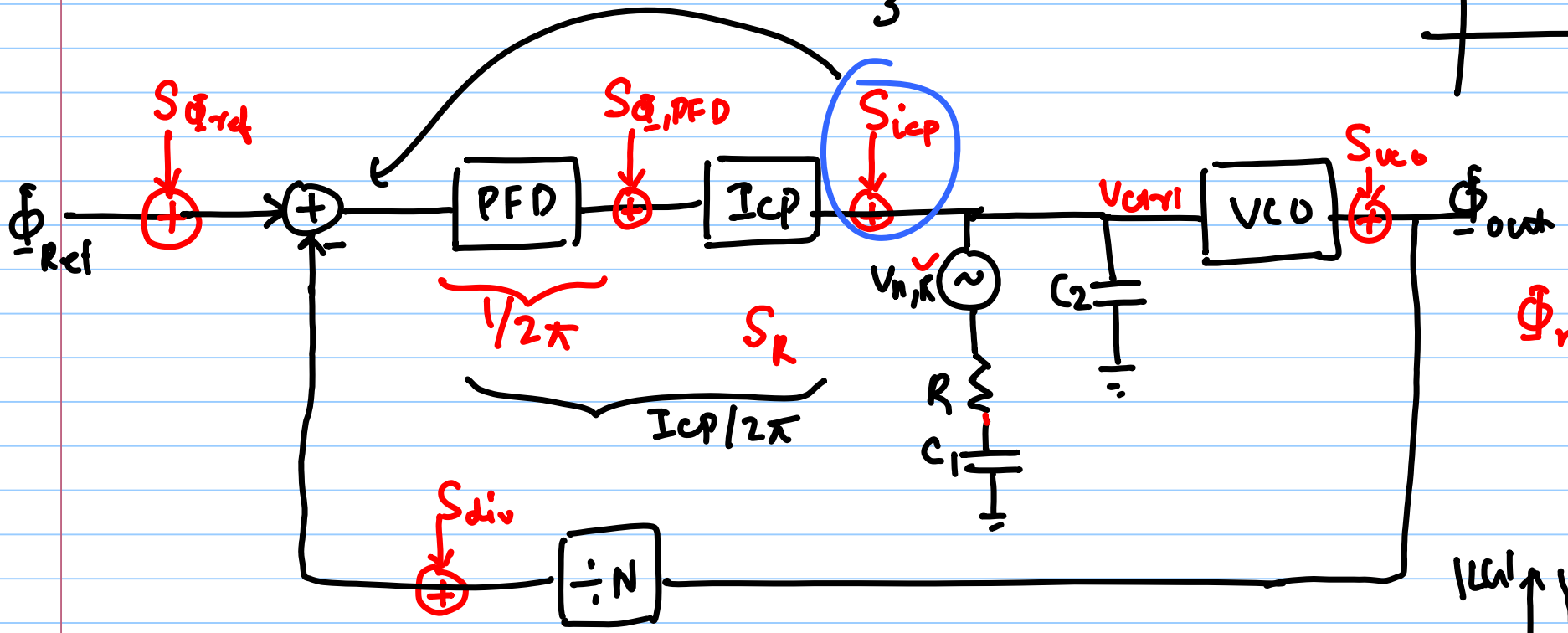
2.1



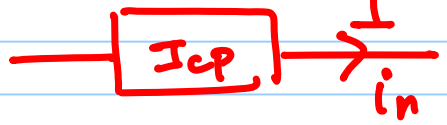
$$S_{in}(f) = 4kT\gamma g_m \quad [A^2/Hz]$$

$$\gamma : \frac{2}{3} - 2$$





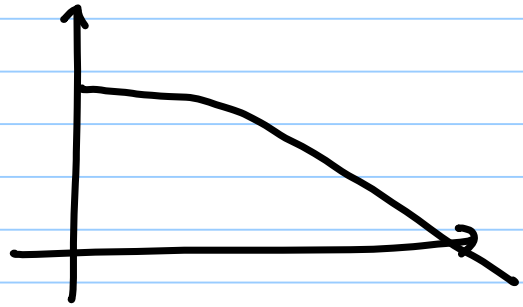
$\Phi_{n,out}$.



$$S_{icp} \propto \frac{8kT}{3} g_m$$

Noise Transfer Function (NTF)

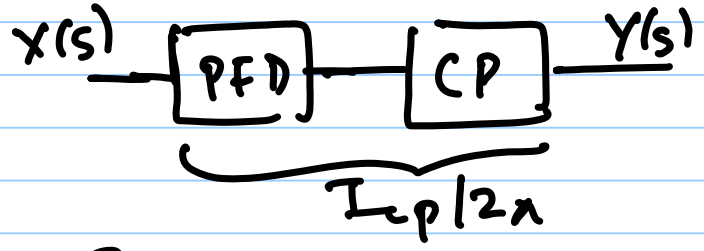
$LG(s) =$



1. $\Phi_{n,ref}$: $NTF_{ref} = \dfrac{\Phi_{n,out}}{\Phi_{n,ref}} = \dfrac{N \times LG}{1 + LG}$

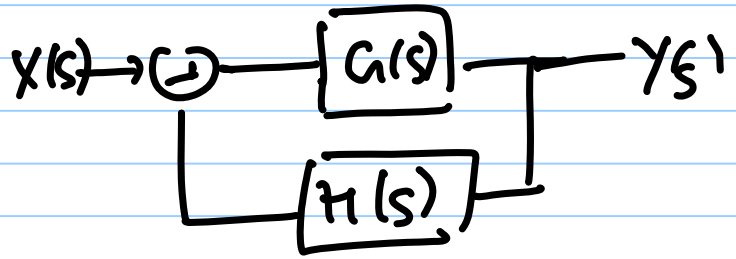
2. $S_{n,PFD}$: $NTF_{PFD} =$

3. $S_{n,Icp}$: $NTF_{Icp} = \dfrac{2\pi}{I_{cp}} NTF_{ref}.$



$$\frac{I_{cp}}{2\pi} \cdot X(s) = Y(s)$$

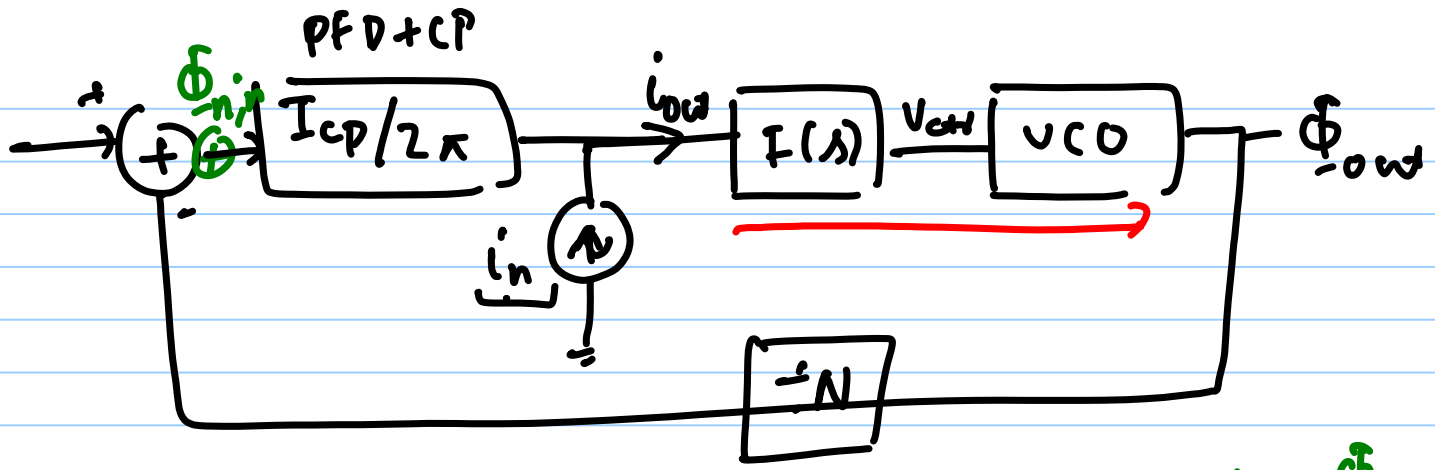
$$\underline{\frac{X(s)}{Y(s)} = \frac{2\pi}{I_{cp}}}$$



$$\frac{Y(s)}{X(s)} = \frac{G(s)}{1 + G(s)H(s)}$$

$$LG = G(s)H(s)$$

$$\frac{Y(s)}{X(s)} = \frac{LG/H(s)}{1 + LG}$$



$$\frac{\Phi_{out}}{i_n} = \frac{F(s)\,\frac{2\pi K_{VCO}}{s}}{1+LG}$$

$$\Phi_{n,in} \times \frac{I_{cp}}{2\pi} = i_n$$

$$\Phi_{n,in} = \frac{2\pi}{I_{cp}}\, i_n$$

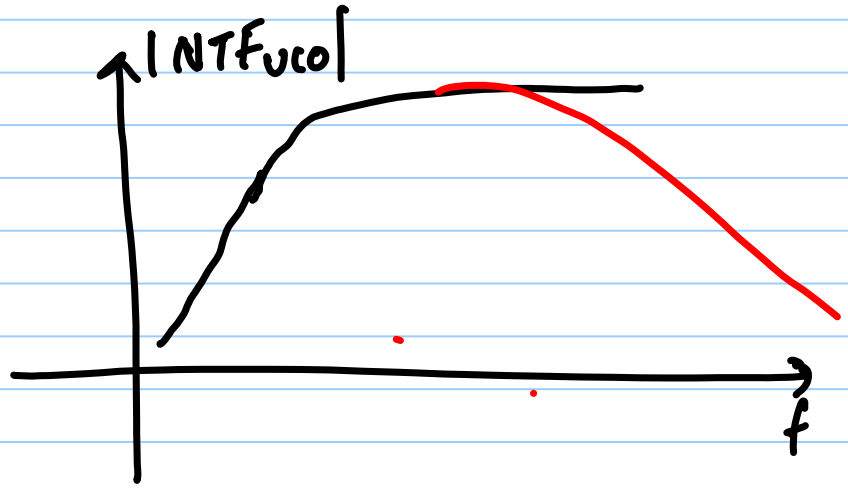
$$\frac{\Phi_{out}}{i_n} = \frac{\Phi_{out}}{\Phi_{n,in} \times \frac{I_{cp}}{2\pi}} = \frac{2\pi}{I_{cp}} \times \frac{\Phi_{out}}{\Phi_{n,in}} = \frac{2\pi}{I_{cp}}\,\frac{N \times LG}{1+LG}$$

$$= \frac{2\pi}{I_{cp}} \times N \quad \frac{I_{cp}}{2\pi} \times \frac{1}{N}\, F(s)\,\frac{2\pi K_{VCO}}{s}$$

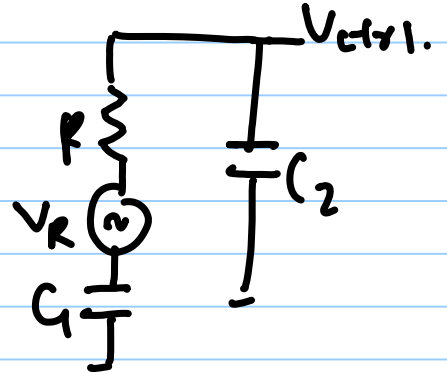
4. VCO Noise

$$NTF_{VCO} = \frac{\Phi_{n,out}}{\Phi_{n,vco}} = \frac{1}{1+LG}$$

$$\frac{1}{1+\frac{\alpha(1+s/\omega_2)}{s^3}}$$



5. Resistor Noise



$$\frac{V_{ctrl}}{V_{n,R}} = \frac{1/sC_2}{R+1/sC_1+1/sC_2} = H_R$$

$$NTF_R = \frac{\Phi_{out}}{V_{n,R}} = \frac{\Phi_{out}}{V_{ctrl.}/H_R} = H_R \cdot \frac{\Phi_{out}}{V_{ctrl.}}$$

$$NTF_R = H_R \cdot \frac{2\pi K_{VCO}}{s} \cdot \frac{1}{1+LG}$$

$$= H_R \cdot \frac{2\pi K_{VCO}}{s} \cdot NTF_{VCO}$$