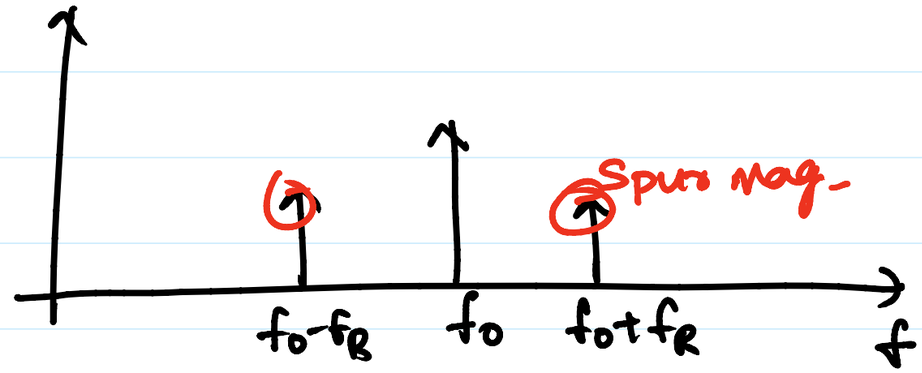
Lecture 18

Tuesday, February 14, 2017 8:58 AM

PLL building blocks. – CP

$$\text{Spur magnitude} = \frac{F_{BW}}{2F_R}\,\Delta\phi_{os}$$



F_{BW} : unity gain bandwidth

F_R : ref. frequency

$\Delta\phi_{os} = \frac{2\pi T_{os}}{T_R}$: phase offset due to current mismatch ($I_{up} \neq I_{dn}$)

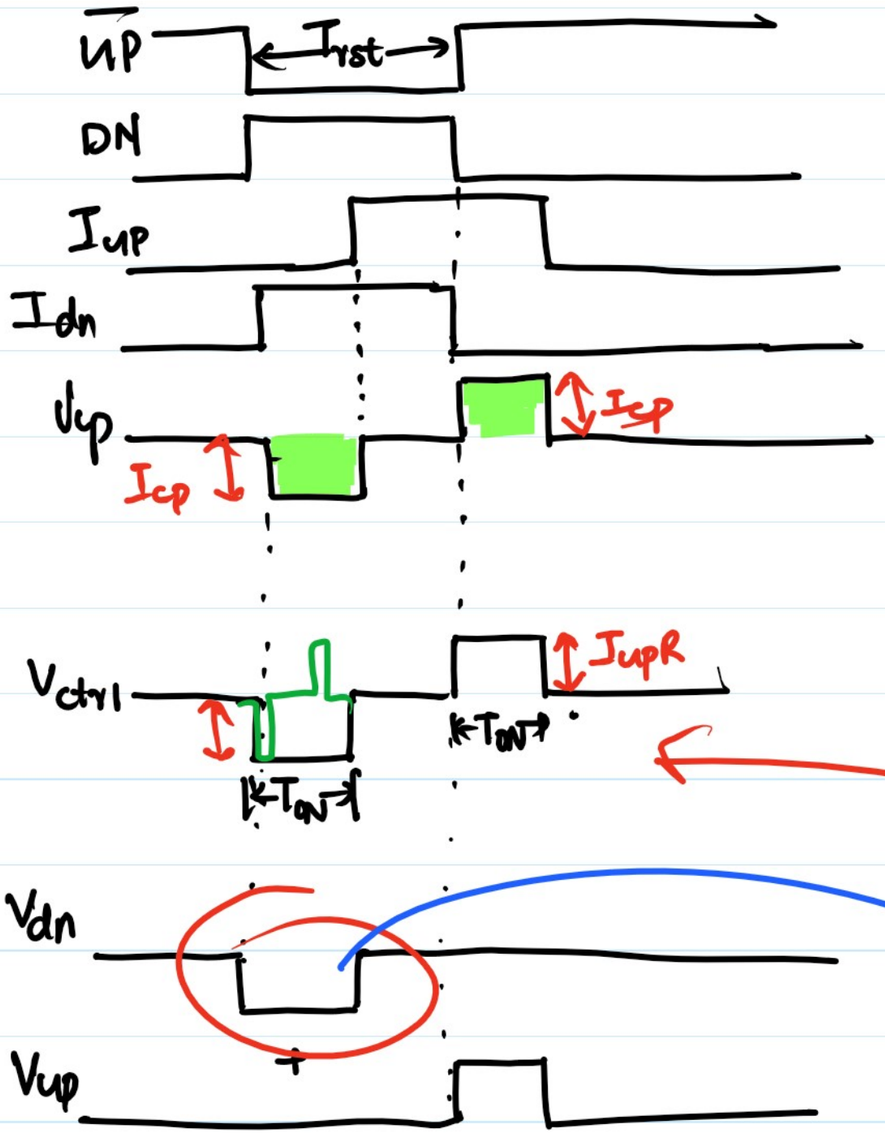
$$\text{Spur mag. (in dB)} = 20\log\left(\frac{F_{BW}}{2F_R}\cdot\Delta\phi_{os}\right) \underbrace{- 20\log\left(\frac{\omega_R}{\omega_{p3}}\right)}_{\text{Ref. spur suppression}}$$

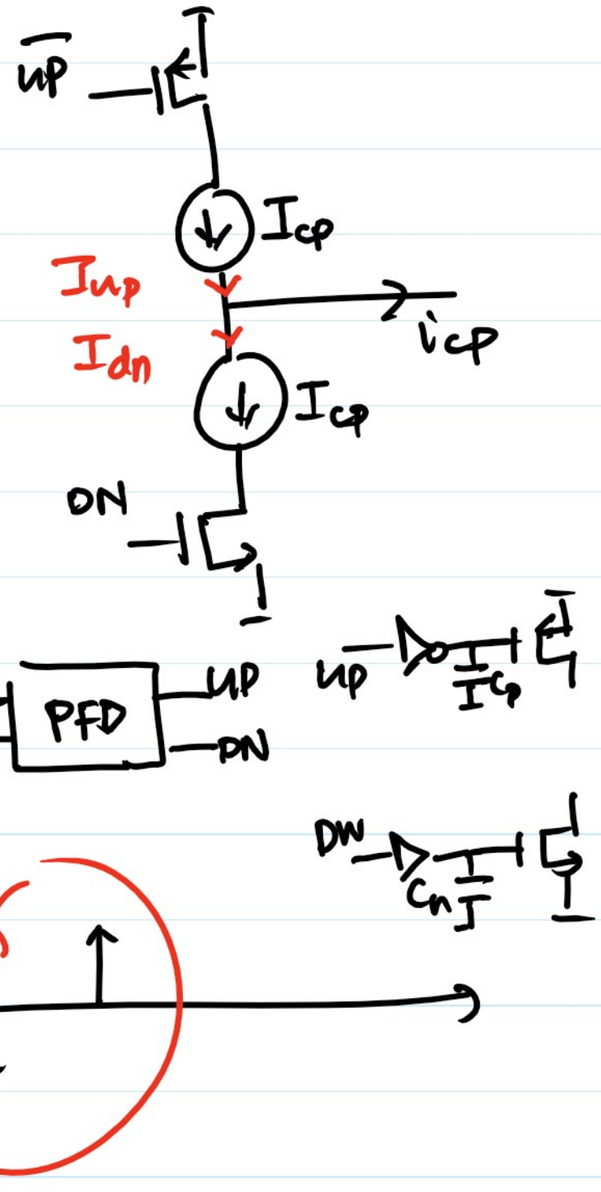
Spur suppression: $F_{BW}\downarrow$, $\omega_{p3}\downarrow$, $F_R\uparrow$

* Slow response
* Noise
* Reduced Φ_M

* More power

- Delay between I_{up} & I_{dn}



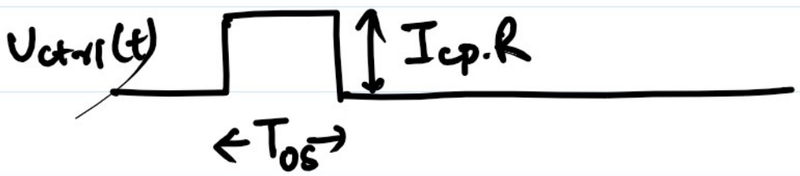


$$V_{ctrl}(s) = V_{dn}(s) - e^{-sT_{rst}} V_{dn}(s)$$

$$= \left(1 - e^{-sT_{rst}}\right) V_{dn}(s)$$

$$= \left[1 - (1 - s T_{rst})\right] V_{dn}(s) \quad ; \quad |s T_{rst}| \ll 1$$

$$= (s T_{rst})\, V_{dn}(s)$$



$$V_{ctrl} = \sum \frac{2 I_{cp}.R}{n\pi} \sin\left(n\pi \frac{T_{os}}{T_R}\right) \cos(n\omega_R t) + a_0$$

For mismatch between I_{up} & I_{dn} delays

I_{up} delay : Delay from UP signal to I_{up} o/p.

$$V_{Ctrl}(t) = \frac{2 I_{cp}.R}{\pi} \sin\left(\pi \frac{T_{ON}}{T_R}\right) \left(\frac{2\pi}{T_R}.T_{rst}\right)$$

$$V_{ctrl}(t) = \frac{2 I_{cp} R}{\pi} \sin\left(\pi \frac{T_{ON}}{T_R}\right) \cos(\omega_R t)$$

$$\frac{d(V_{ctrl}(t))}{dt} = \frac{2 I_{cp} R}{\pi} \sin\left(\frac{\pi T_{ON}}{T_R}\right) \left(-\omega_R \sin(\omega_R t)\right)$$

$$V_{ctrl}(t) = \frac{2 I_{cp}.R}{1} \frac{T_{ON}}{T_R} 2\pi \frac{T_{rst}}{T_R}$$

$$V_{out} = A\cos\left(K_{VCO}\int V_0 + \frac{2I_{cp}\cdot R}{T_R}\cdot 2\pi\frac{T_{rst}}{T_R}\cdot\cos(\omega_R t)\cdot dt\right)$$

$$= A\cos\left(\omega_0 t + \frac{2I_{cp}\cdot R\cdot K_{VCO}}{\omega_R}\cdot\frac{T_{ON}}{T_R}\cdot 2\pi\frac{T_{rst}}{T_R}\sin(\omega_R t)\right)$$

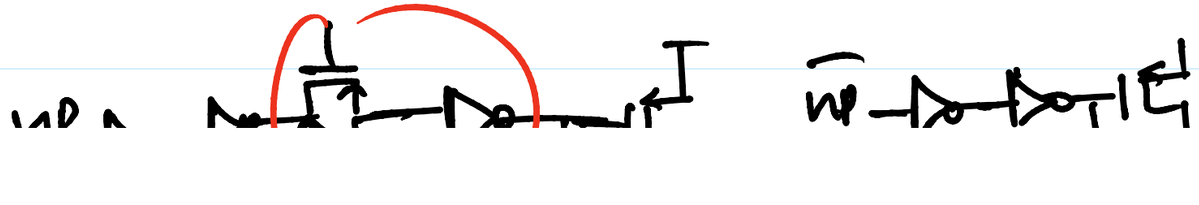
$$= A\cos\left(\omega_0 t + \underbrace{2I_{cp}\cdot R\cdot K_{VCO}\,\frac{T_{ON}}{T_R}\cdot T_{rst}}_{\beta'}\sin(\omega_R t)\right)$$

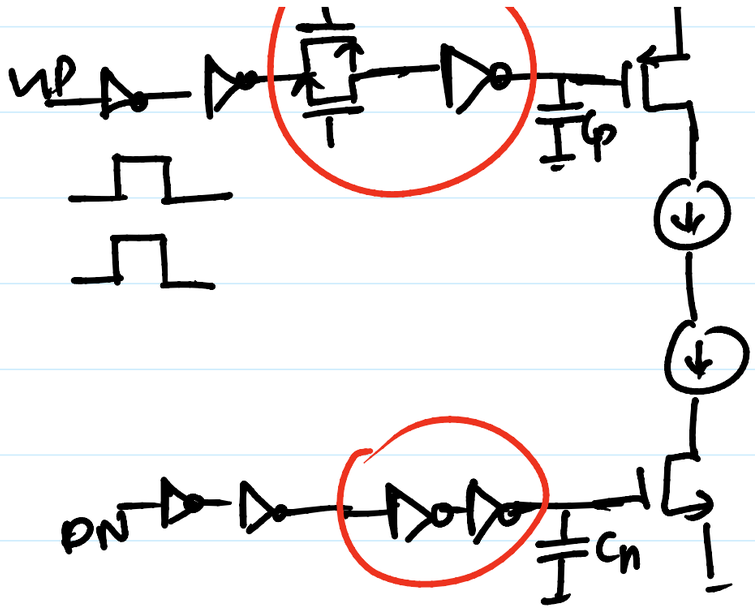
$$\text{Spur mag.} = \frac{\beta'}{2} = \frac{2I_{cp}R K_{VCO}}{T_R}\cdot T_{ON}\cdot T_{rst}\times\frac{1}{2}$$

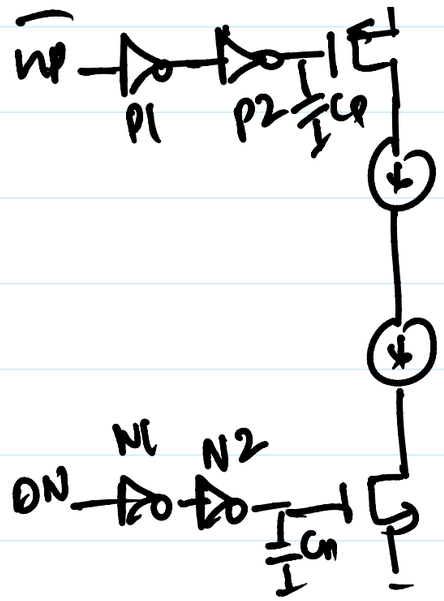
$$= \frac{F_{BW}}{2}\cdot\left(2\pi\frac{T_{ON}}{T_R}\right)\cdot T_{rst}$$

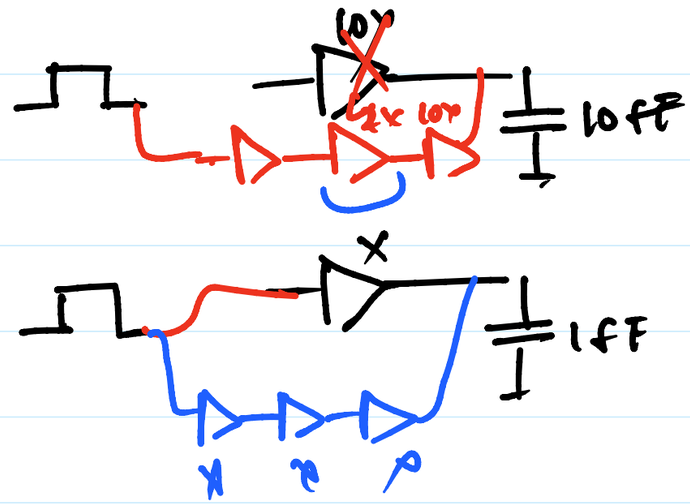
$$= \frac{F_{BW}}{2}\cdot\Delta\phi_{ON}\cdot T_{rst}$$

$$\text{Spur mag.} = 20\log\left(\frac{F_{BW}}{2}\cdot\Delta\phi_{ON}\cdot T_{rst}\right) - \underbrace{20\log\left(\frac{\omega_R}{\omega_{p3}}\right)}_{\text{Spur Suppression due to 3rd pole}}$$




UP
DN
Cp
Cn


UP
P1
P2
Cp
N1
N2
DN
Cn


10x
4x 10x
10fF
X
1fF