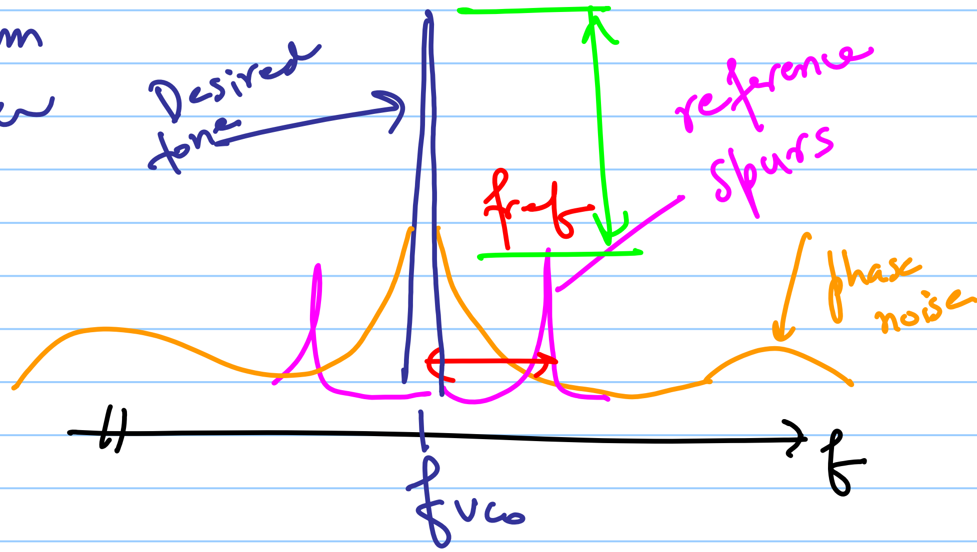
ECE 504 - Lecture 7

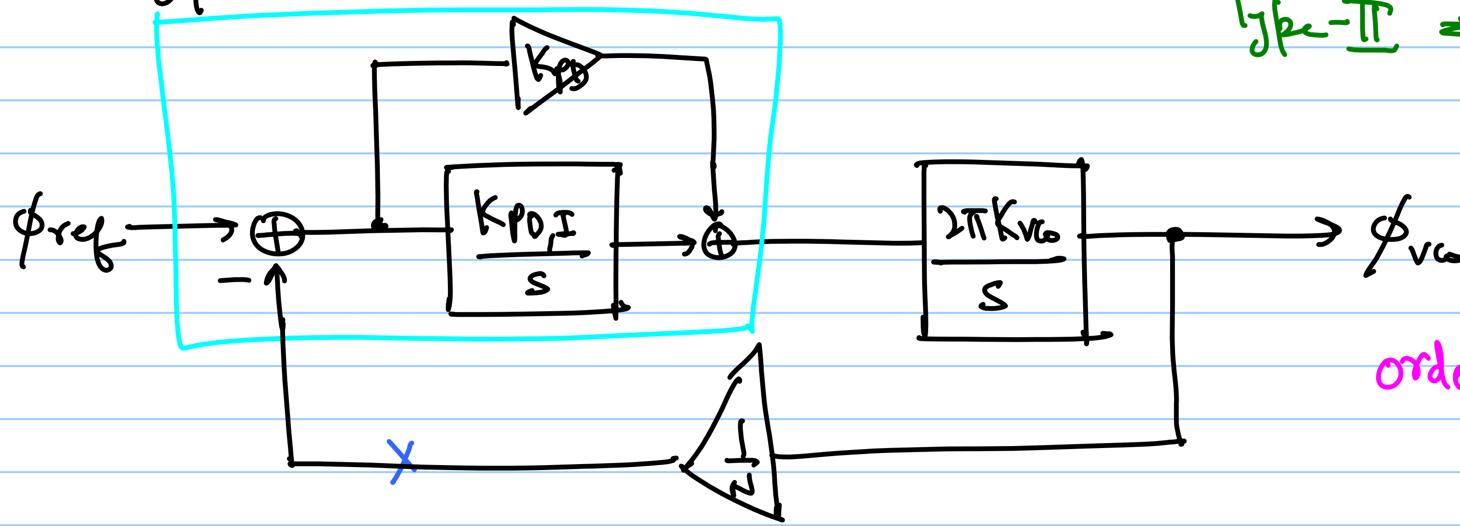
Note Title 9/14/2016

Spectrum Analyzer



HW #2 is posted on the site!

Type-II PLL



Type-II ⇒ 2 poles at DC in the loop gain

order ≠ Type

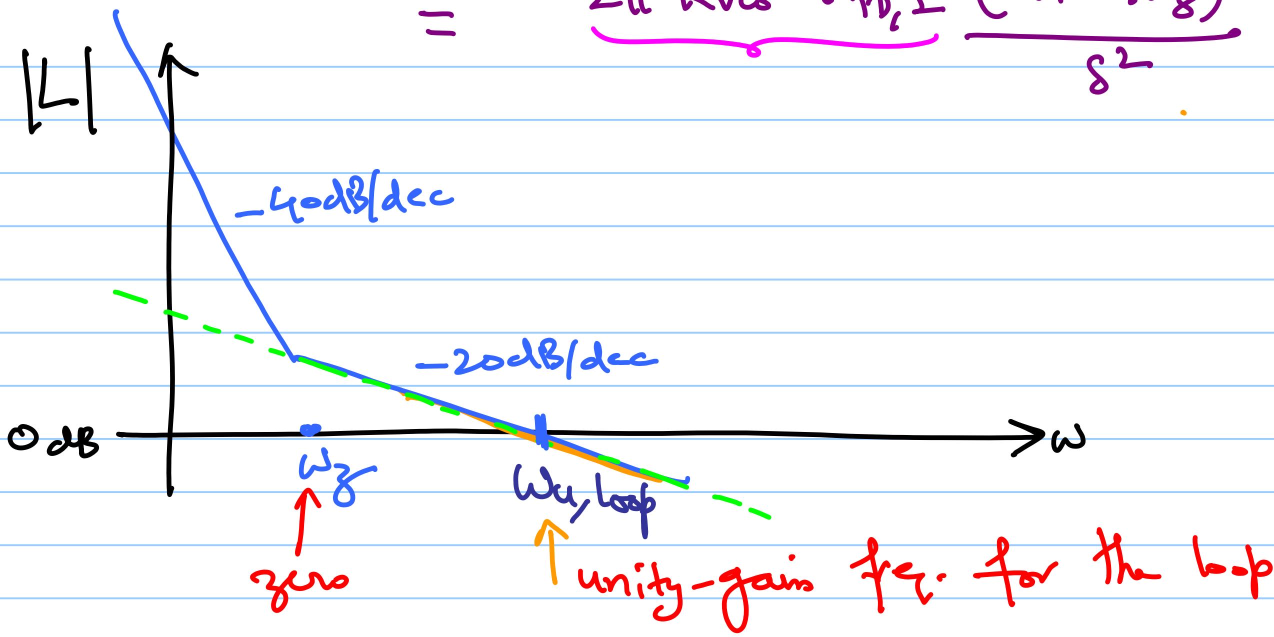
$$L(s) = \left(K_{PD} + \frac{K_{PD,I}}{s}\right) \cdot \frac{2\pi K_{VCO}}{s} \cdot \frac{1}{N}$$

$$= \frac{2\pi K_{VCO} K_{PD,I}\left(1 + \frac{s K_{PD}}{K_{PD,I}}\right)}{N \cdot s^2}$$

$$= \frac{\underbrace{2\pi K_{vco} \cdot K_{PD,I}}\left(1 + s/\omega_z\right)}{s^2}$$

$$z = -\frac{K_{PD,I}}{K_{PD}}$$

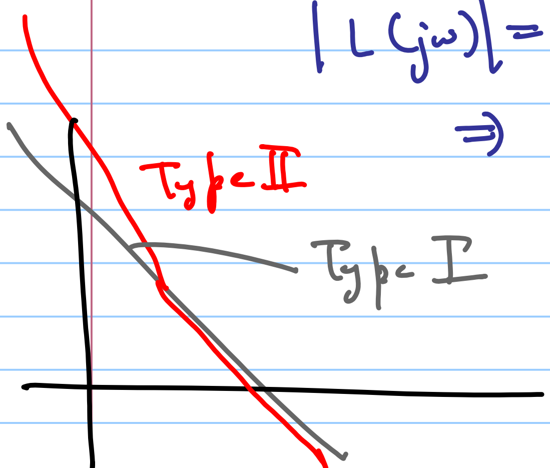
$$\boxed{\omega_z = \frac{K_{PD,I}}{K_{PD}}}$$



Around $\omega \simeq \omega_{u,loop}$ if $\frac{s}{\omega_z} \simeq \frac{s}{\omega_z}$, $\because \omega >> \omega_z$

$$L(s) \simeq \frac{2\pi K_{VCO} K_{PD,I}}{N \cancel{s^2}} \times \frac{\cancel{s}}{\omega_z} = \frac{2\pi K_{VCO} K_{PD}}{N} \cdot \frac{1}{s}$$

↳ appx as a first-order system

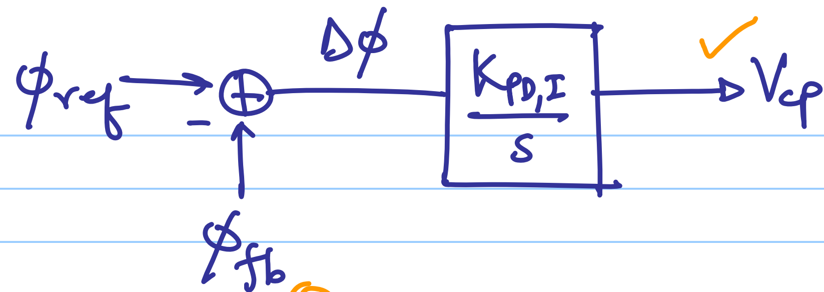


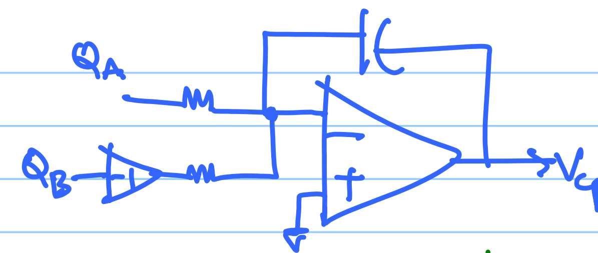
$|L(j\omega)| = 1$

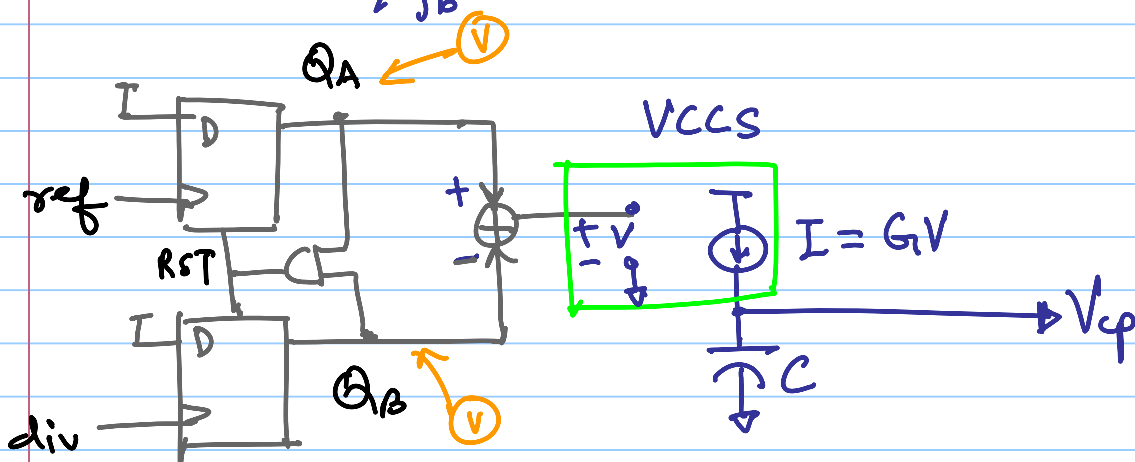
$\Rightarrow$ $\boxed{\omega_{u,loop} \simeq \frac{2\pi K_{VCO} K_{PD}}{N}}$, valid only for $\boxed{\omega_{u,loop} >> \omega_z}$

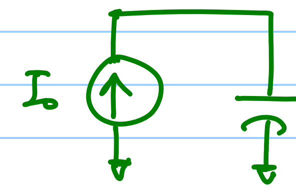
↳ same as the Type-I PLL

↳ but more gain at DC $\Rightarrow \Delta\phi \rightarrow 0$



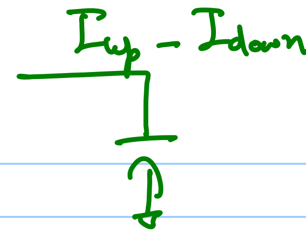


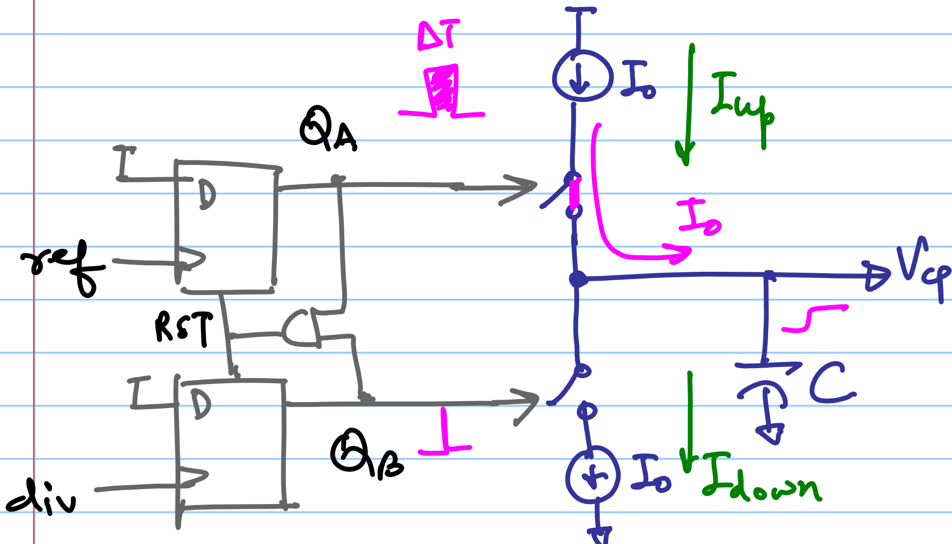


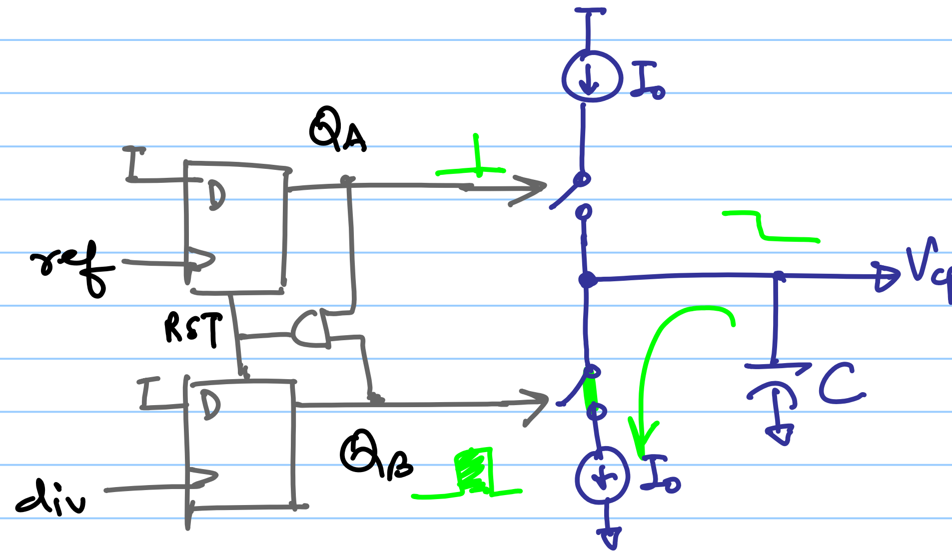


$$v_c = \frac{1}{C}\int_{-\infty}^{t} i\,dt$$

charge pump PLL

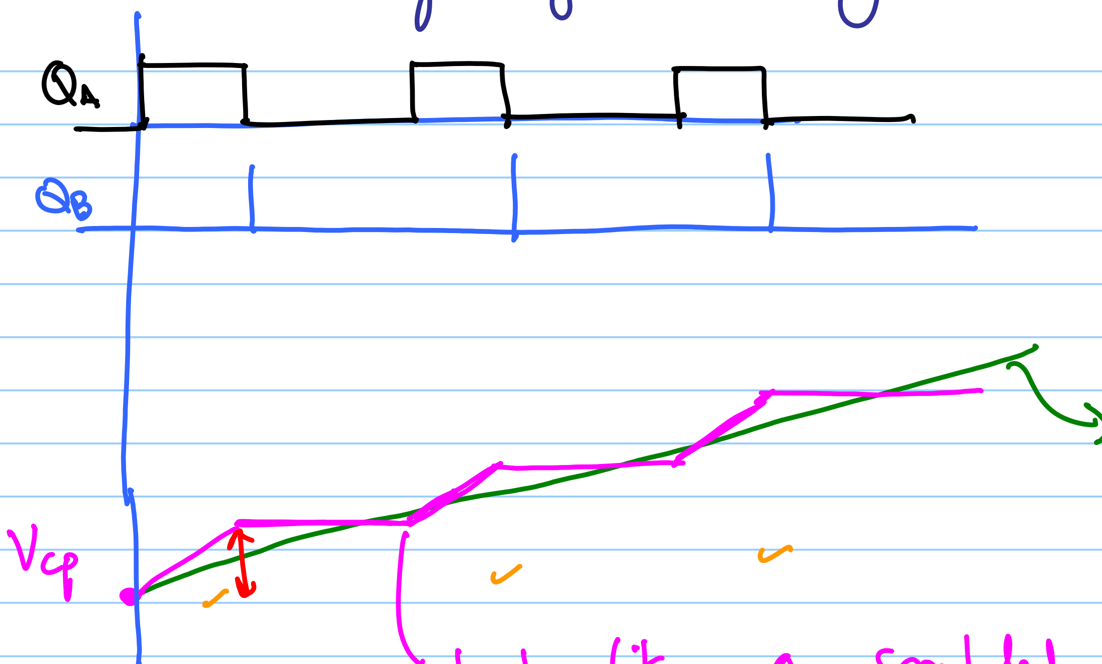






* push current when $Q_A > 0$
* pull current when $Q_B > 0$

Lets say ref is leading div in every cycle



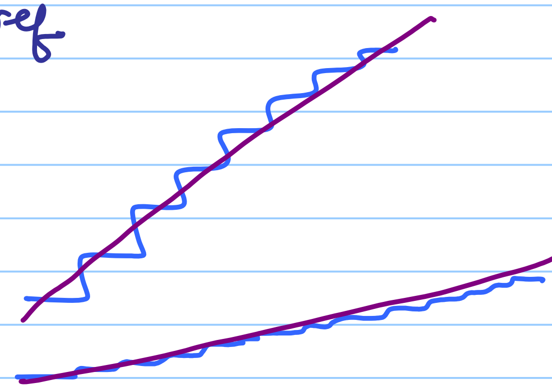
Hybrid DT–CT system
↳ precise analysis is very challenging

continuous-time approximation

looks like a sampled system
↳ V_{cp} is not CT in nature

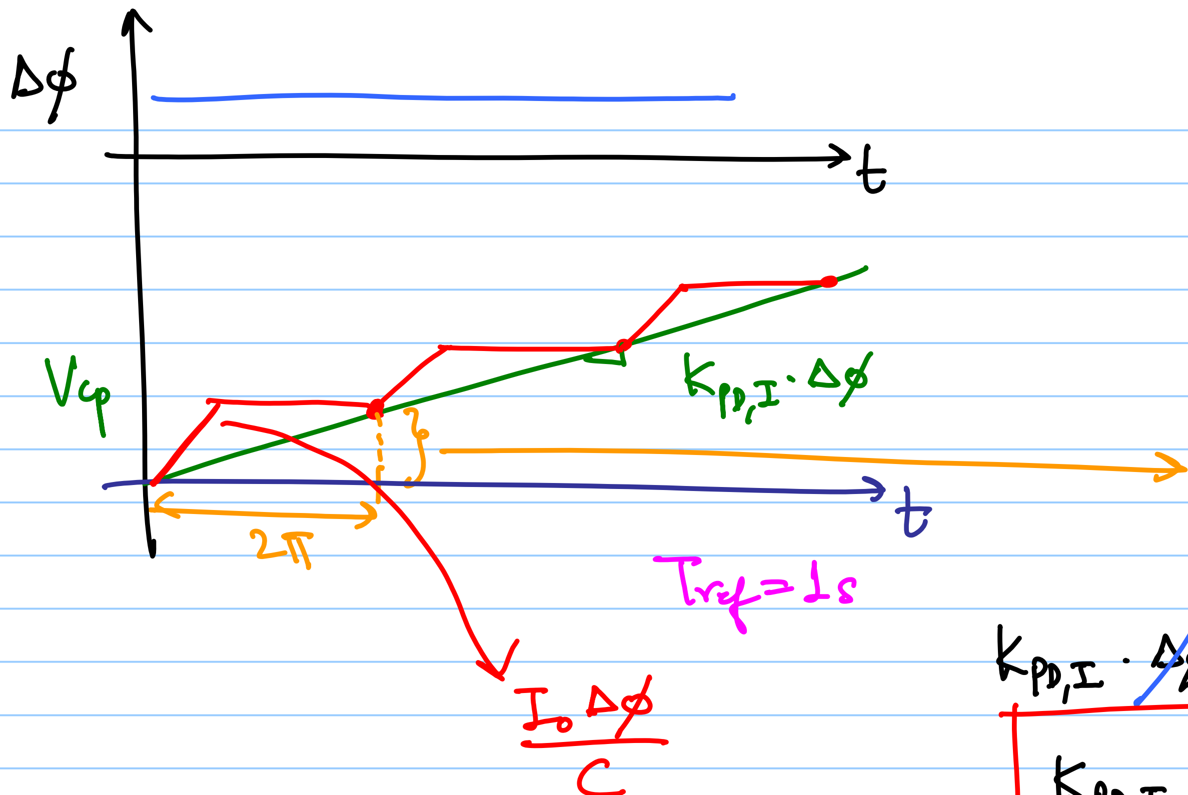
We can approximate this system as CT for analysis as long as $\omega_{u,loop} \ll \omega_{ref}$

↳ $$\boxed{\omega_{u,loop} \le \frac{\omega_{ref}}{10}}$$



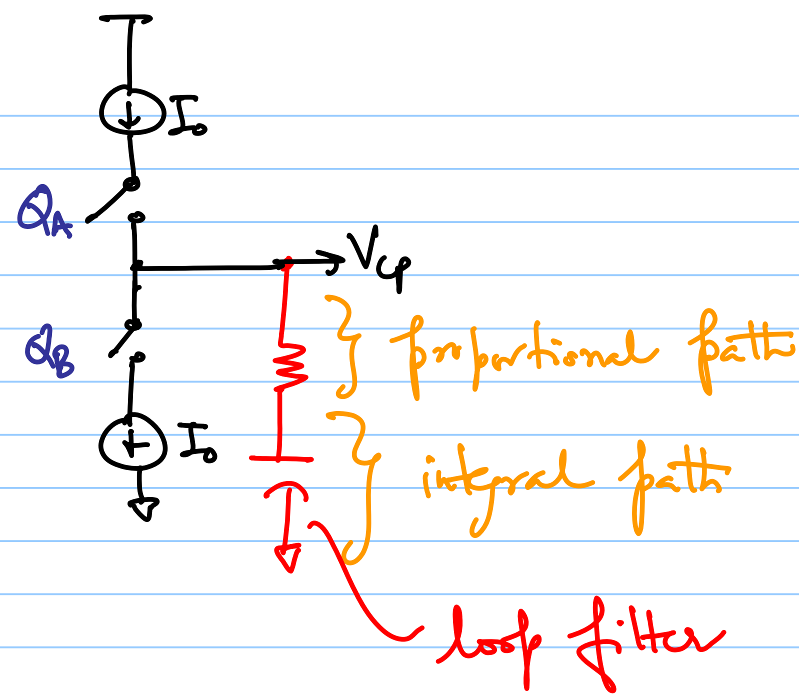
Rule of thumb so that PLL has appx CT dynamics

↳ PLL response is much slower than the frequency of phase detection (ω_{ref})



$$K_{PD,I} \cdot \cancel{\Delta\phi} \cdot 2\pi = \frac{I_o}{C} \cancel{\Delta\phi}$$

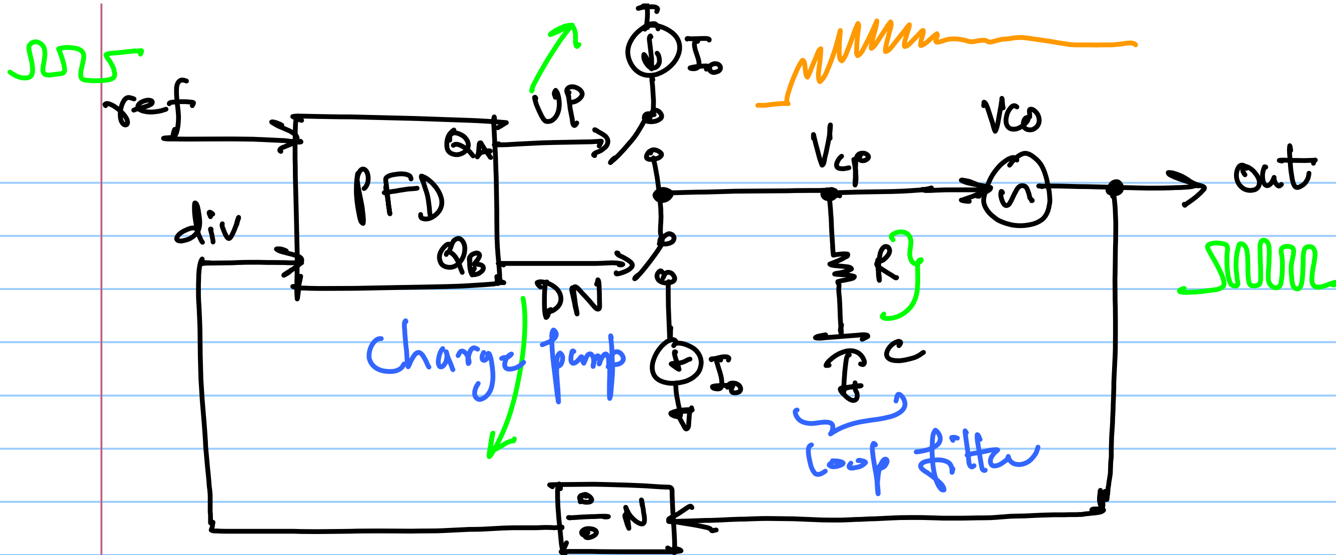
$$\boxed{K_{PD,I} = \frac{I_o}{2\pi C}}$$



By the same logic as $K_{PD,I} = \frac{I_o}{2\pi C}$

$$\boxed{K_{PD} = \frac{I_o R}{2\pi}}$$

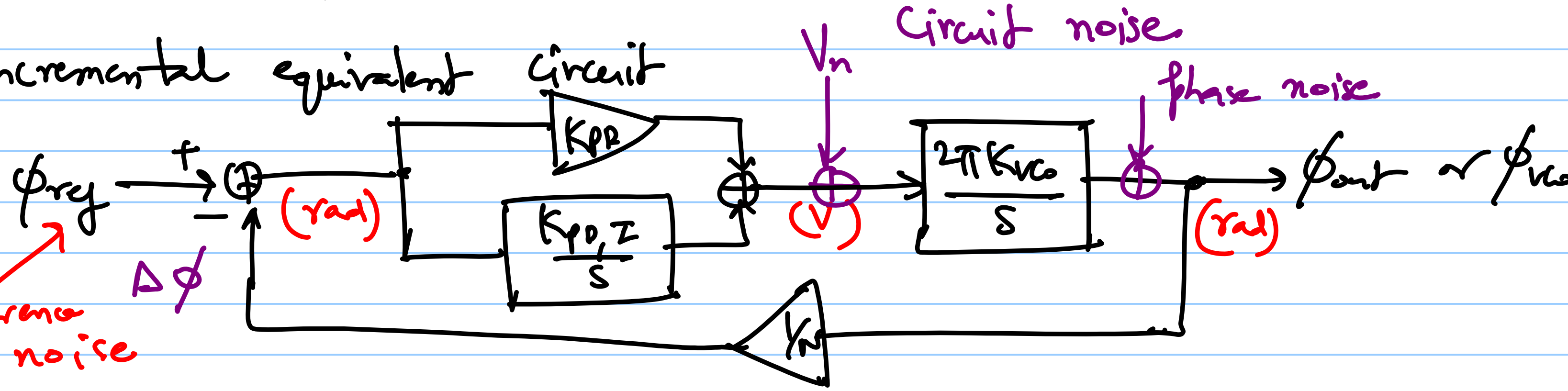
Type-II PLL



UP ⇒ increment VCO frequency

DN ⇒ decrement VCO frequency

Incremental equivalent circuit



$$L(s) = \left(\frac{I_0 R}{2\pi} + \frac{I_0}{2\pi s C}\right)\frac{2\pi K_{vco}}{s}$$

$$\boxed{\omega_z = \frac{1}{RC}}$$

$$\boxed{\omega_{u,loop} \simeq \left(\frac{K_{vco} I_0 R}{N}\right.}\ ,$$

$\omega_{u,loop} \gg \omega_z$