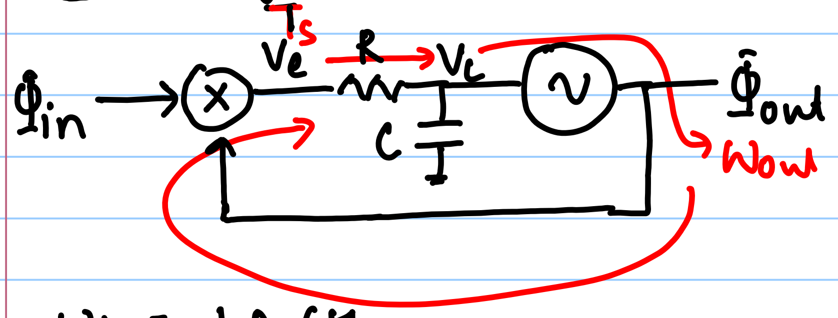
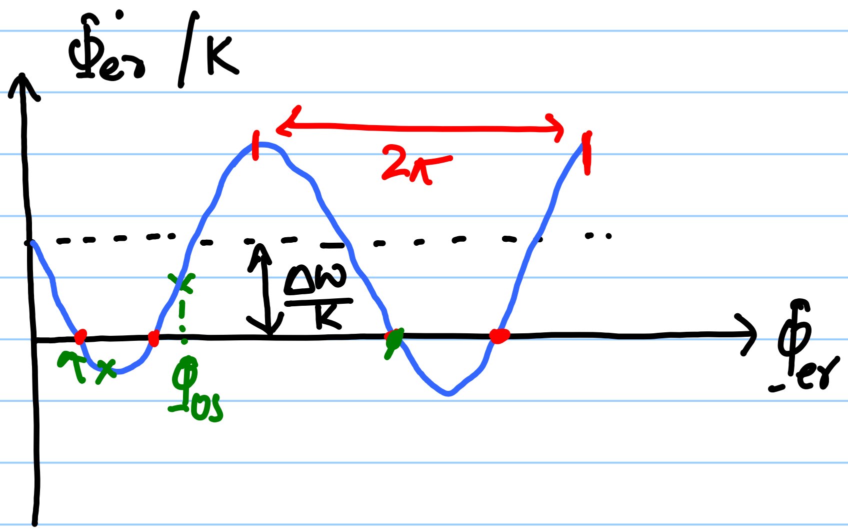
Note Title 28-05-2020

lecture #7

Frequency Acquisition for Type-I PLL





$W_{in} = 1.0\ GHz.$

$W_{out} = W_{free} + K_{VCO} \cdot V_c$

$\Delta W = W_{in} - W_{free}$

$$\hat{\Phi}_{er} = \hat{\Phi}_{in} - \hat{\Phi}_{out}$$

$$= \Delta\omega \cdot t - \int K_{VCO} \cdot K_{PD} \sin(\hat{\Phi}_{er})\, dt$$

$$\frac{d\hat{\Phi}_{er}}{dt} = 0 \Rightarrow \dot{\hat{\Phi}}_{er} = \Delta\omega - \underbrace{K_{VCO} \cdot K_{PD}}_{K} \sin(\hat{\Phi}_{er}) = 0$$

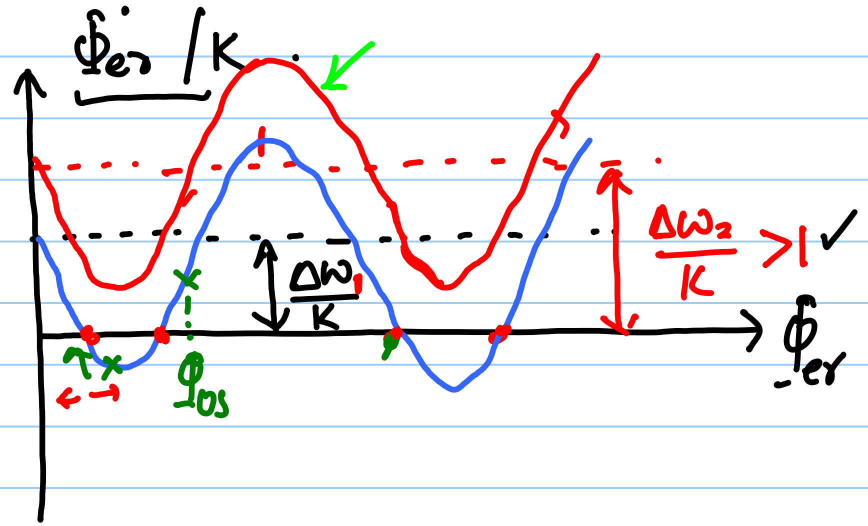
$$= K\left(\frac{\Delta\omega}{K} - \sin(\hat{\Phi}_{er})\right)$$

- There is a locking point $\dot{\hat{\Phi}}_{er} = 0$ for $\hat{\Phi}_{er} \in [0, 2\pi]$.

ω_{in} : i/p freq, $\omega_{out} = \omega_{free}$, $\underline{\Delta\omega} = \omega_{in} - \omega_{free}$

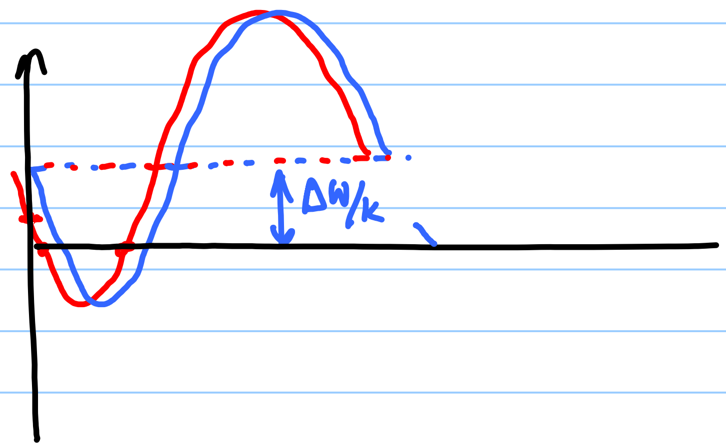
- <u>Lock-in range</u>: $\underline{\Delta\omega_L}$

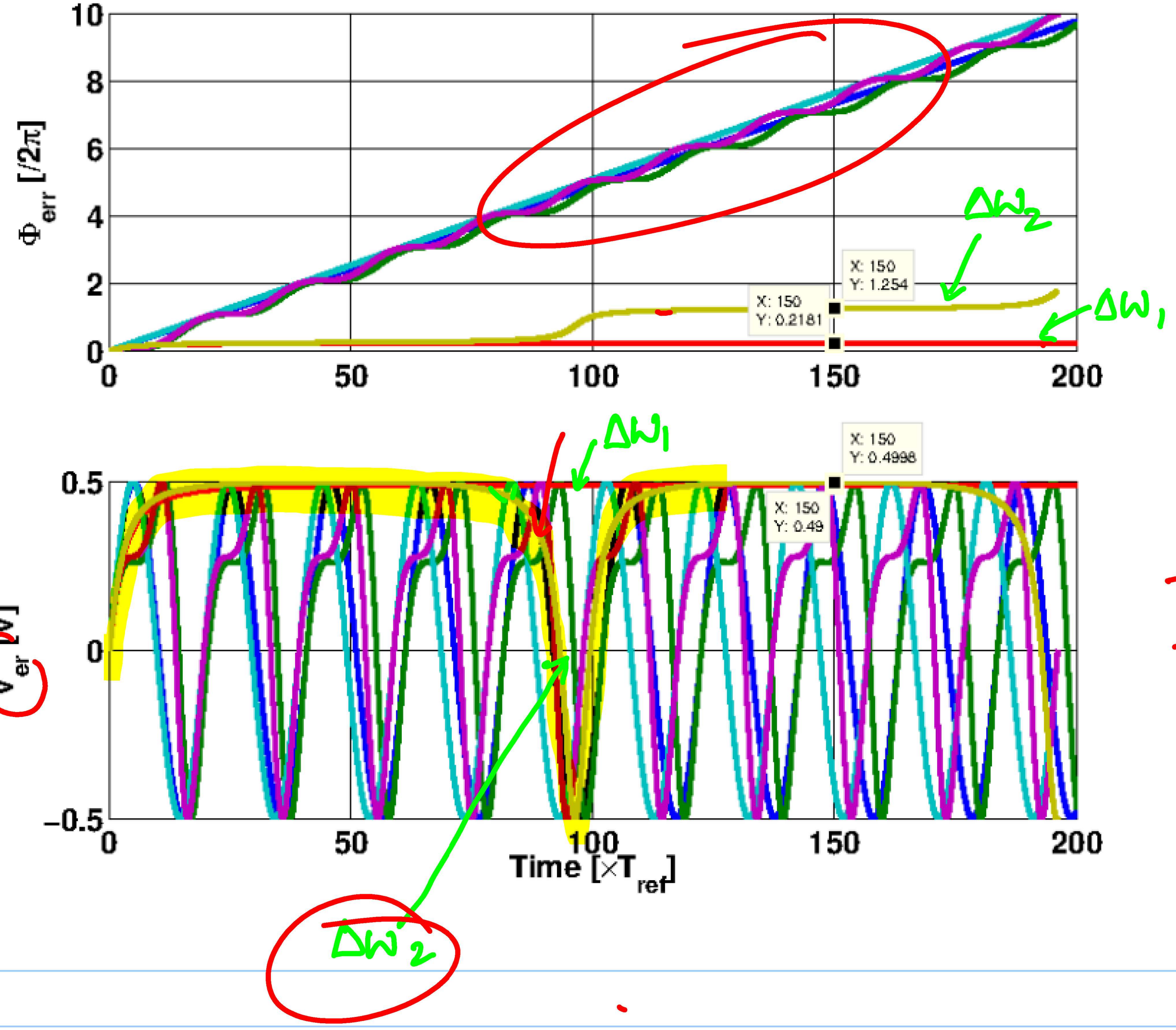
Frequency range the PLL locks without the phase error exceeding 2π.



$\Delta\omega_L = K$

$\{\Phi_{os}, \Phi_{os} + 2\pi\}$

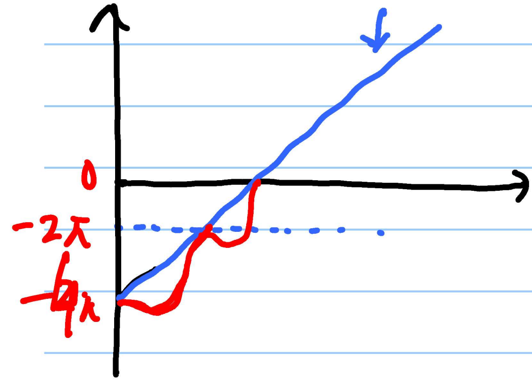




$\Delta\omega_L = K_{VCO} \cdot K_{PD}$
≈ 50 MHz.

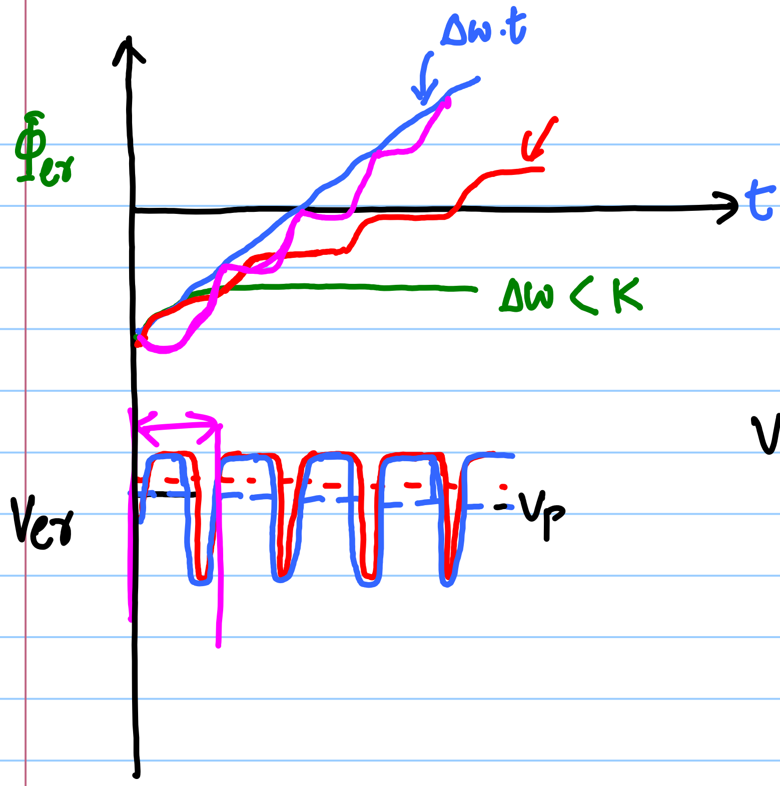
$\Delta\omega_1(0) = 49$ M

$\Delta\omega_2(0) = 51$ M



$V_e = \sin(\Phi_e)$

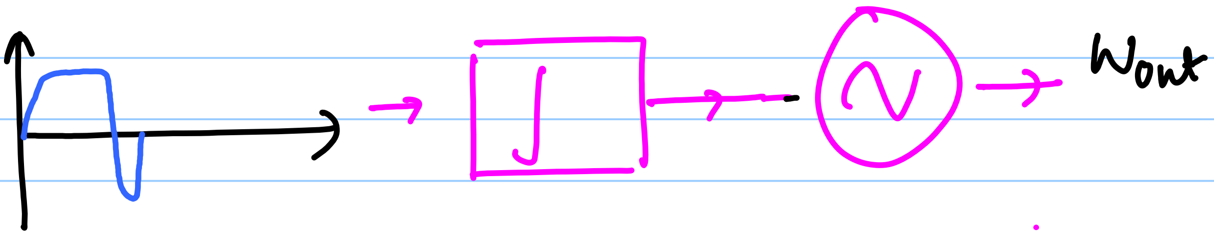
$= \sin(\Delta\omega \cdot t)$



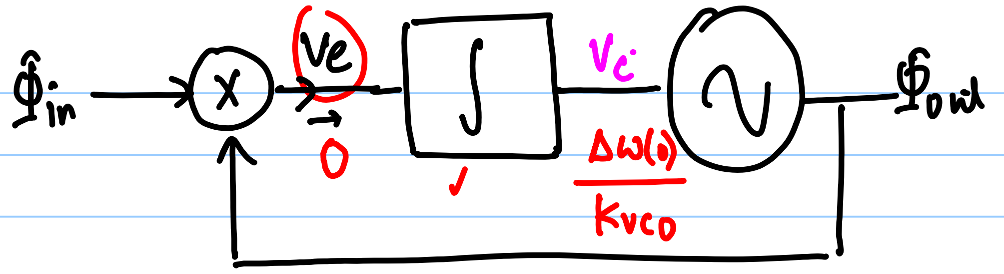
$$V_p = K_{PD}\left[\frac{\Delta\Omega}{K} - \sqrt{\left(\frac{\Delta\Omega}{K}\right)^2 - 1}\,\right]$$

$$\Delta\Omega = \omega_{in} - \Omega_{out}$$

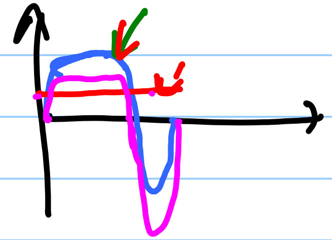
- For $\Delta\omega > K$, $\dot{\Phi}_{er} \neq 0$, V_p ($\bar{V_e}$ during one $\underbrace{\text{beat period}}_{0 \to 2\pi}$) is proportional to frequency error.

- 

$V_e = \underline{V_{dc}} + \underline{V_{ac}}$



at $t=0$, $\Delta\omega = \Delta\omega(0) > K$



#2: $\Delta\omega(1) < \Delta\omega(0)$

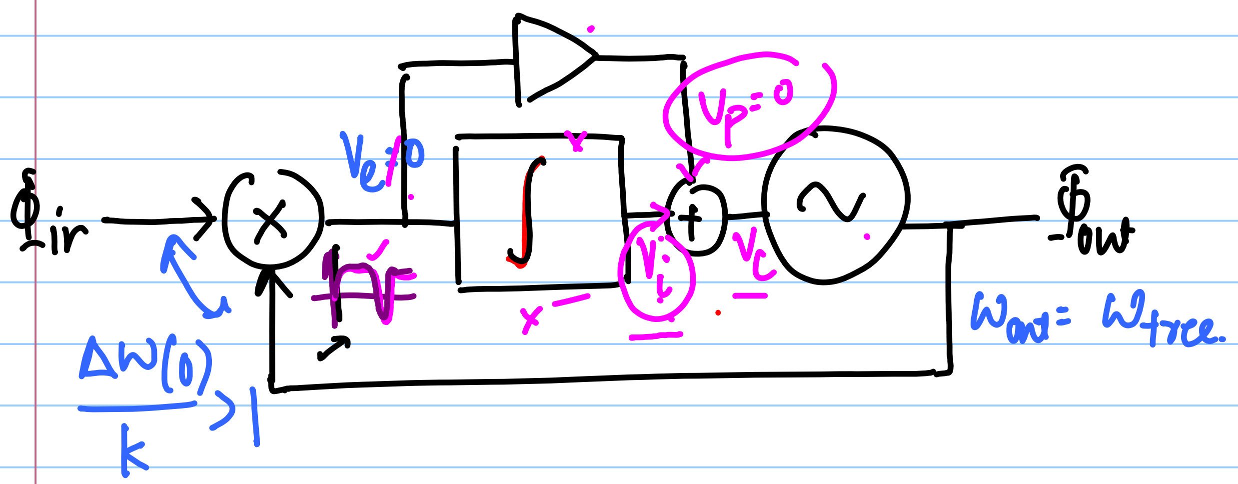
$\Delta\omega(1) > K$

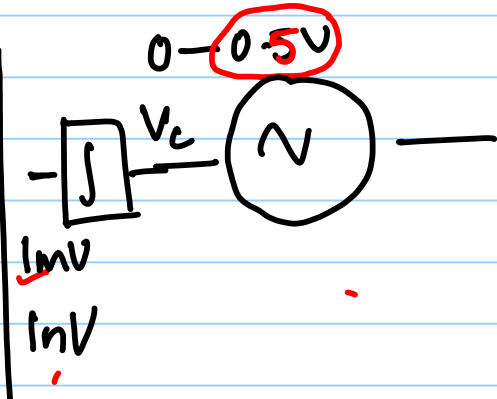
$\boxed{\Delta\omega(n) < K}$

$$V_c = \int V_{dc} + V_{ac} \cdot dt$$

Pull-in range: $(\Delta\omega_p)$

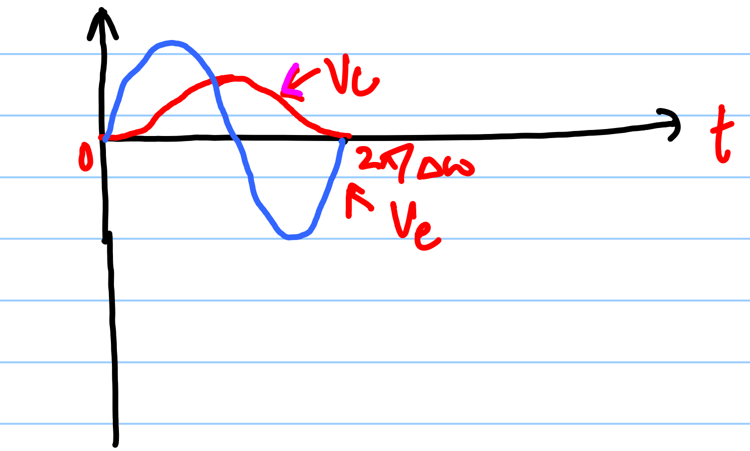
Max. Frequency to which the PLL can lock while the Φ_{er} exceeds 2π.





$$V_e = \frac{1}{2} \sin(\Delta\omega(0) \cdot t + x)$$

$\bar{V}_e = 0$



$$\int \sin(\Delta\omega \cdot t)\, dt$$

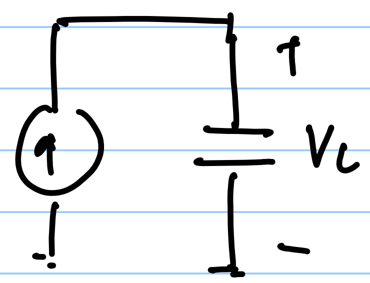
$$= \left. \frac{-\cos(\Delta\omega \cdot t)}{\Delta\omega} \right|_0^t$$

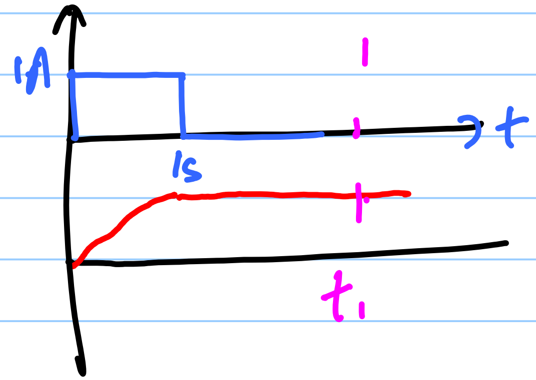
$$= \frac{1}{\Delta\omega}\left(1 - \cos(\Delta\omega \cdot t)\right)$$

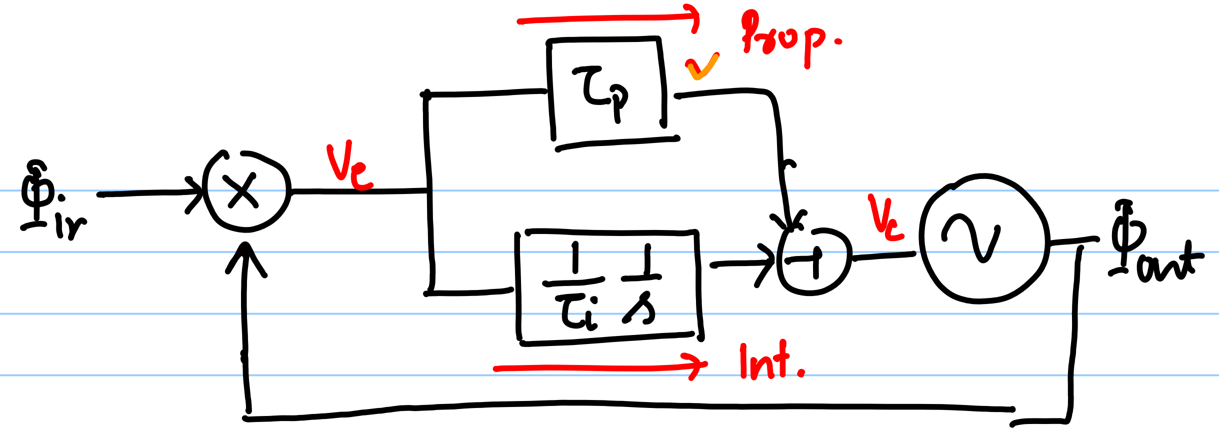
$$V_e = \frac{1}{2}\sin\left(\Delta\omega \cdot t - K_{VCO}\int V_c \cdot dt\right) \checkmark$$

$$V_c = \int V_e\, dt$$

$$V_c = \int \frac{1}{2}\sin\left(\Delta\omega \cdot t - K_{VCO}\int V_c \cdot dt\right) dt$$





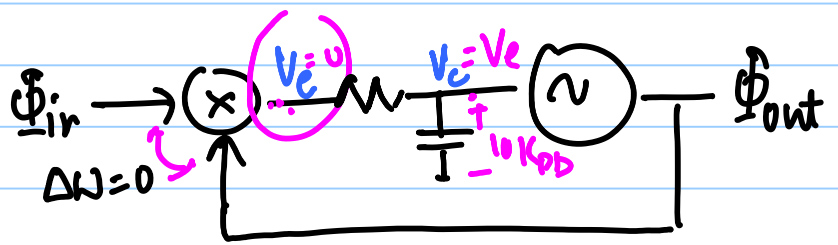


Lock-in Range ($\Delta\omega_L$) w/o Φ_e exceeding 2π (w/o cycle slipping)

Pull-in Range ($\Delta\omega_p$) w or w/o Φ_e exceeding 2π

Hold-in Range ($\Delta\omega_H$) Range of frequencies where the PLL will remain in lock.

$$\Delta\omega_H \geq \Delta\omega_p \geq \Delta\omega_L$$



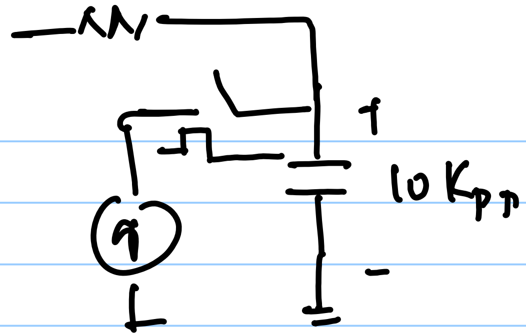
$\Delta\omega_L = K_{VCO} \cdot K_{PD}$

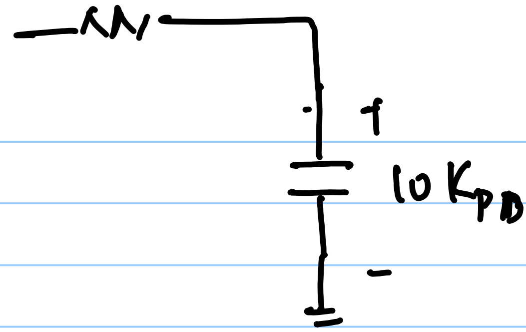
$\Delta\omega_p = K_{VCO} \cdot K_{PD}$

$$\dot{\Phi}_e = \Delta\omega - K_{VCO} \cdot K_{PD} \sin(\Phi_e) = 0$$

$$\frac{\Delta\omega}{K} = 10$$

$$V_c = \frac{10K}{K_{VCO}} = \frac{10 \cdot K_{PD} K_{VCO}}{K_{VCO}} = 10K_{PD}$$


+
10 Kpn
−


+
10 KpD
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