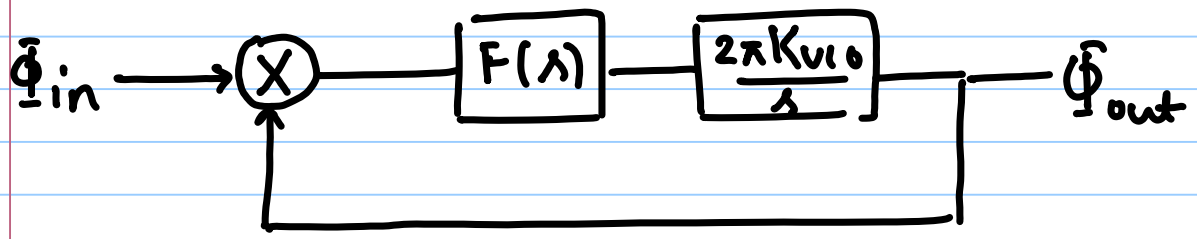
Lecture # 10

Note Title 16-08-2017

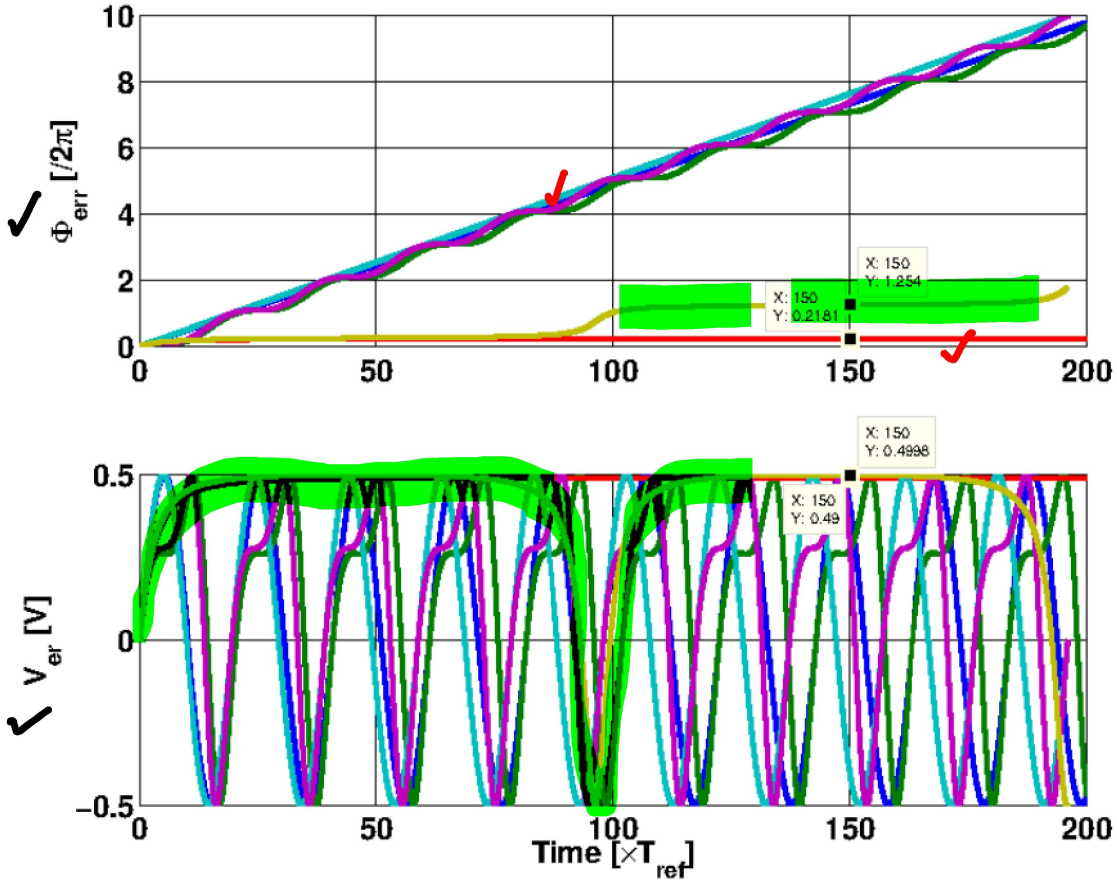


Type-I, Order-II: $F(s) = \frac{1}{1+s\tau}$

Ex: $\omega_{in} = 2\pi \times 1\,GHz$, $0.95 \le f_{free} \le 1.05\,GHz$.

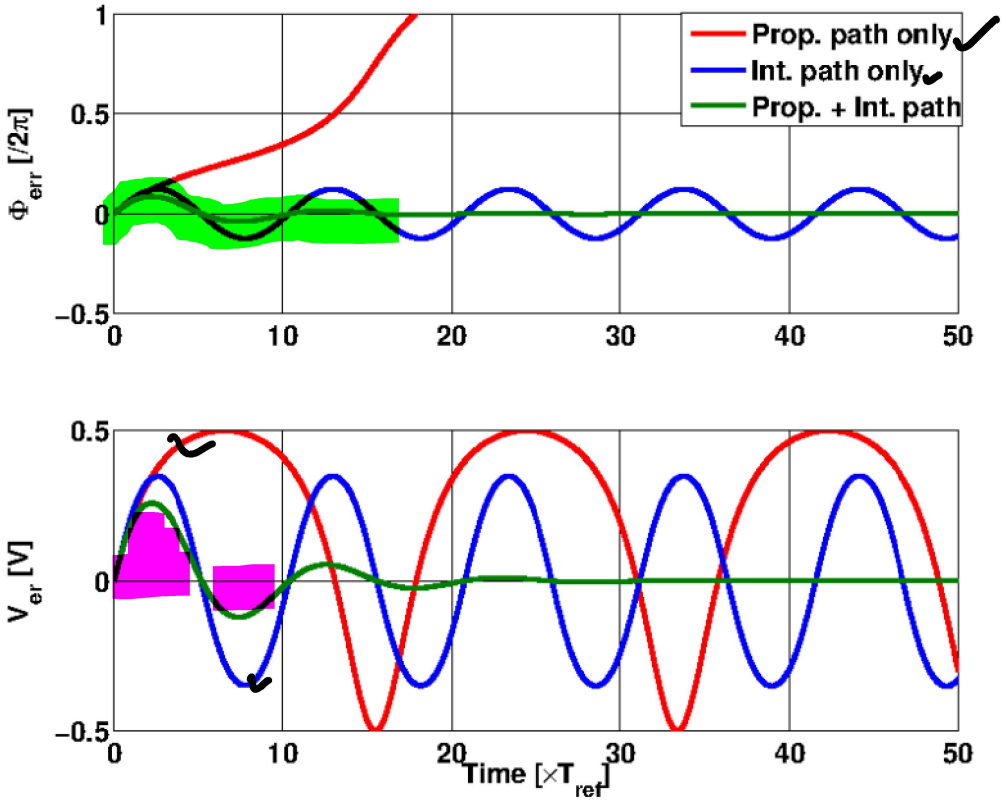
$K_{VCO} = 100\,MHz/V$, $K_{pd} = \frac{1}{2}$

$\frac{\Delta\omega}{K} \le 1 \Rightarrow \Delta f \le 50\,MHz$.



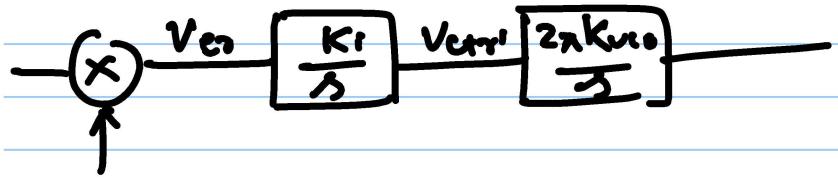
$V_{er} = \sin(\phi_{er})$

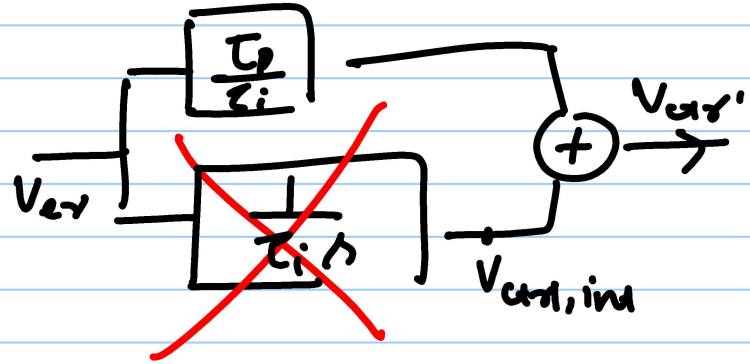
$\Delta f = 75$ MHz.

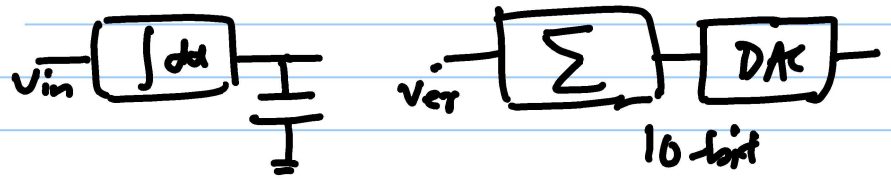


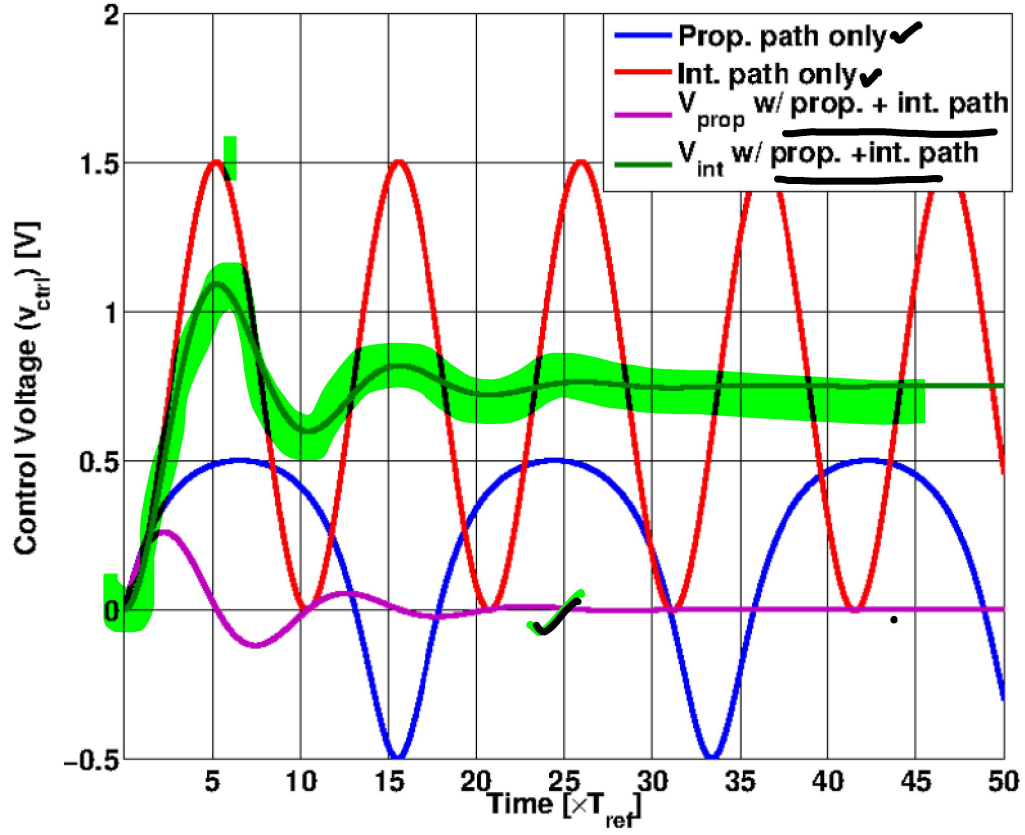
$$F(s) = \frac{1}{1+s\tau} \longrightarrow \frac{1+s\tau_p}{s\tau_i}$$

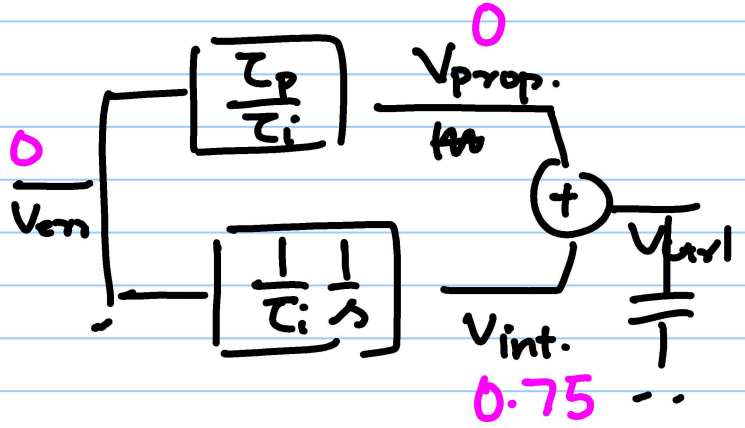
$$F(s) = \frac{K_i}{s}$$









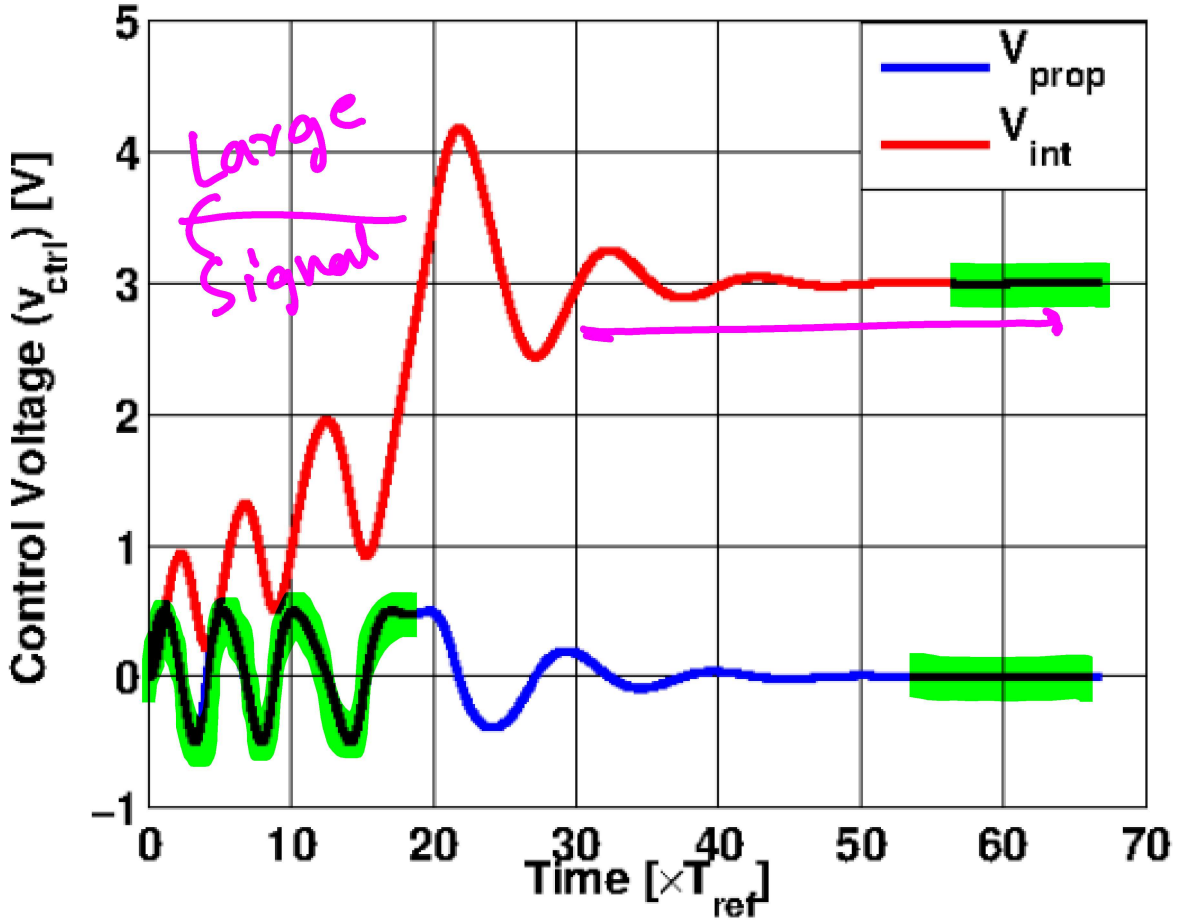


$$V_{err} = \frac{1}{2}\left[\sin(2\omega t) + \sin(\phi_e)\right]$$

$$V_{ctrl} = \frac{1}{2}\sin(2\omega t) \quad \left| \frac{\tau_p}{\tau_i} = 1 \right.$$

$$\omega_{out} = \omega_{free} + 2\pi K_{VCO} \cdot V_{int} + 2\pi K_{VCO} \cdot \frac{1}{2}\sin(2\omega t)$$

$$\phi_{out} = \int \underbrace{\omega_{free} + 2\pi K_{VCO} \cdot V_{int}}_{\omega_{des}} dt + 2\pi K_{VCO} \frac{1}{2} \int \sin(2\omega t)\, dt$$

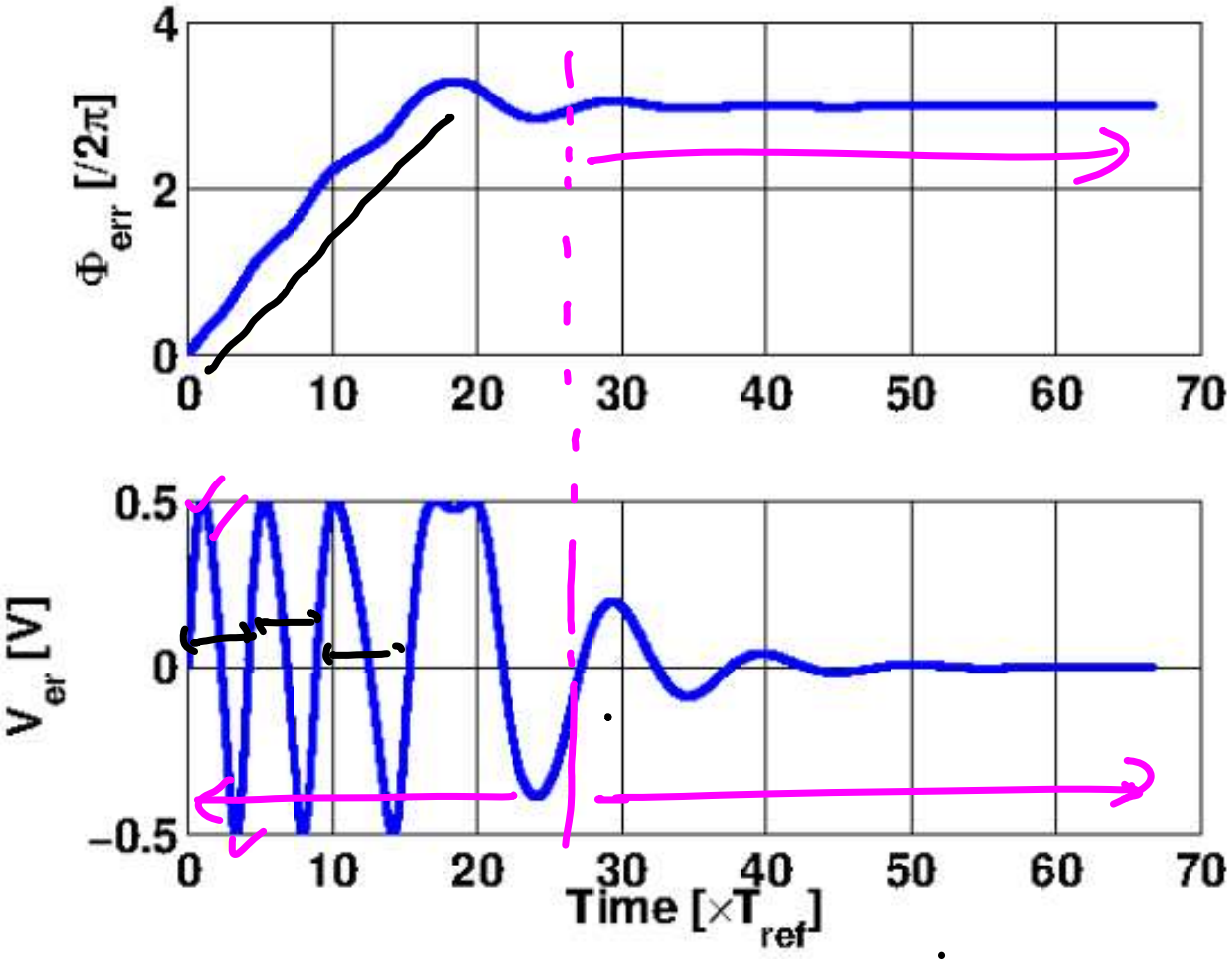


$\Delta f = 300\ MHz.$

$$V_e = \frac{1}{2}\sin(\phi_e)$$

$$V_{out} = \sin\left(\omega_{free}t + 2\pi K_{vco}\int\left(\frac{\tau_p}{\tau_i}K_{pd}\sin(\Delta\omega\cdot t) + \frac{1}{\tau_i}\int K_{pd}\sin(\Delta\omega t')dt'\right)\right.$$

. dt



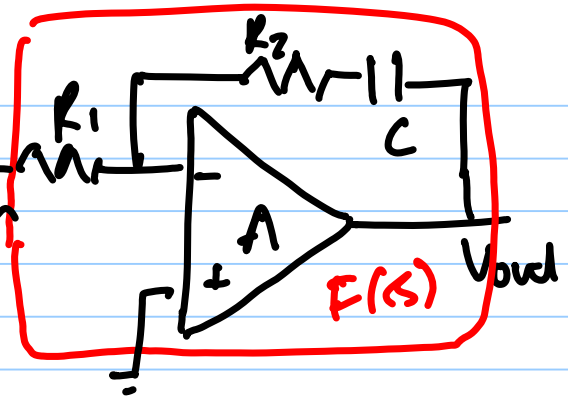
$$F(s) = \left(\frac{\tau_p}{\tau_i} + \frac{1}{s\tau_i}\right)$$

Lock-in range $\leq \frac{2\pi K_{VCO} K_{pd}}{\frac{\tau_p}{\tau_i}}$

Pull-in range $\leq \infty$

Hold-in range $\leq \infty$.

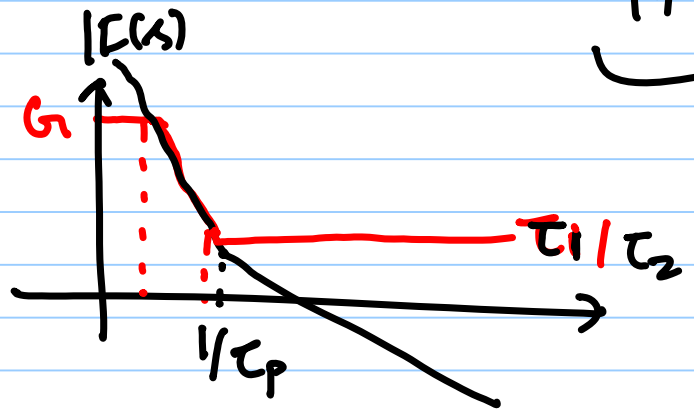
$$F(s) = \frac{\tau_p}{\tau_i} + \frac{1}{s\tau_i}$$

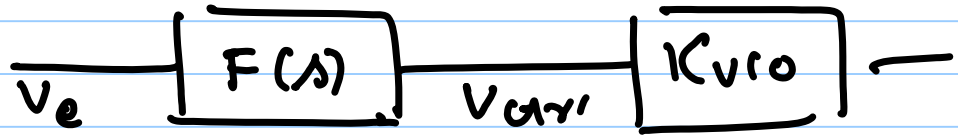


$A \to \infty \Rightarrow \quad \frac{V_{in}}{R_1} = -\frac{V_{out}}{R_2 + 1/sC} \Rightarrow \frac{V_{out}}{V_{in}} = -\frac{1+sR_2C}{sCR_1} = \frac{1+s\tau_p}{s\tau_i}$

$A \neq \infty \quad \frac{V_{out}}{V_{in}} = \frac{1+s\tau_1}{1+s\tau_2} \times G_1$

$= \underbrace{\frac{1}{sCR_1}}_{1/\tau_i} + \underbrace{\frac{R_2}{R_1}}_{\tau_p/\tau_i}$





$\Delta f = K_{vco} \cdot V_{ctrl} = K_{vco} \cdot F(\ )\, V_{er}$

$$\Delta f = K_{VCO} \cdot F(0) \cdot v_{er} = K_{VCO} \cdot F(0) \cdot K_{pd} \cdot \sin(\phi_e)$$

$$\sin(\phi_e) \leq 1 \Rightarrow \frac{\Delta f}{K_{VCO} \cdot K_{pd} F(0)} \leq 1$$

Hold-in range. $\Delta\omega_{H}$.