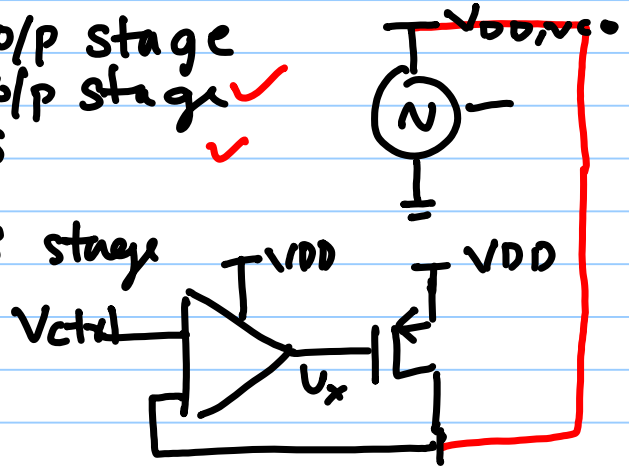
Lecture # 36

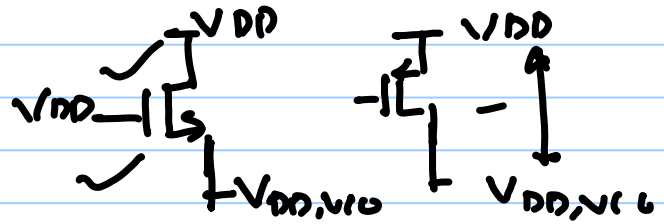
Note Title 11-10-2017

Power supply regulation of VCO (Ring Osc.)

1. NMOS i/p amp + NMOS o/p stage
2. NMOS i/p Amp + PMOS o/p stage ✓
3. PMOS i/p + NMOS ✓
4. PMOS i/p + PMOS stage



$$\frac{V_{DD,VCO}}{V_{DD}} =$$

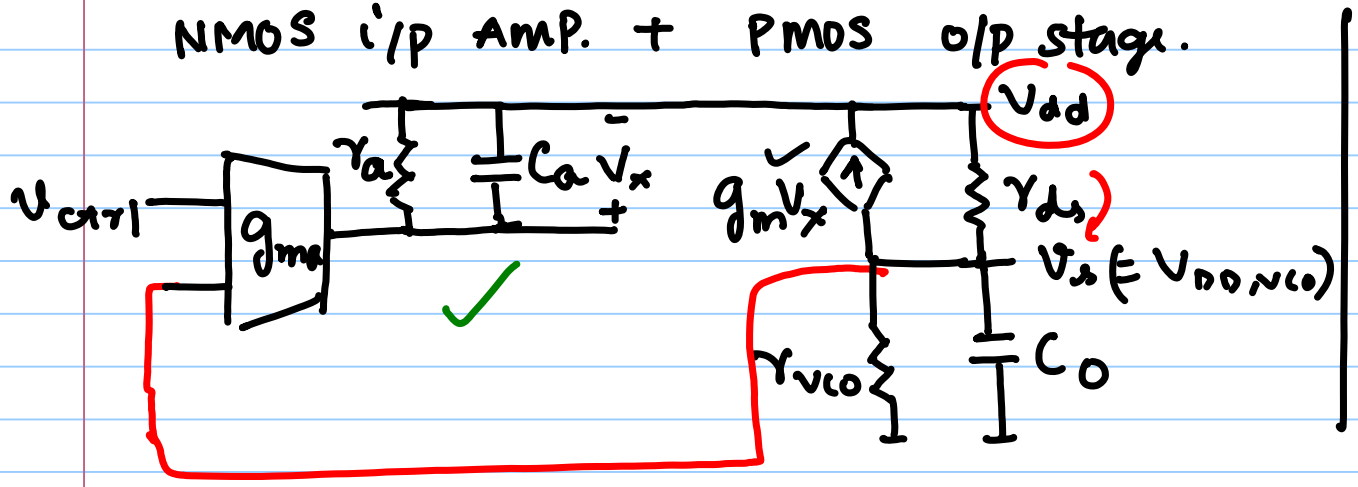


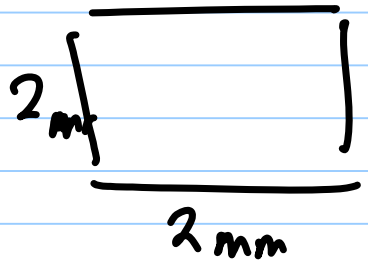
* Max. supply $\leq V_{DD}$

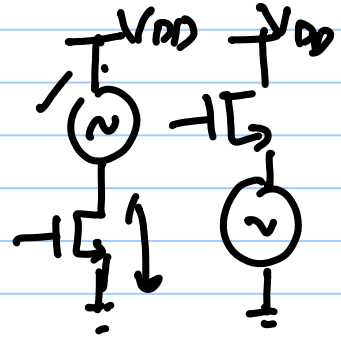
$V_{DD,VCO}$ for NMOS

$< V_{DD,VCO}$ for PMOS

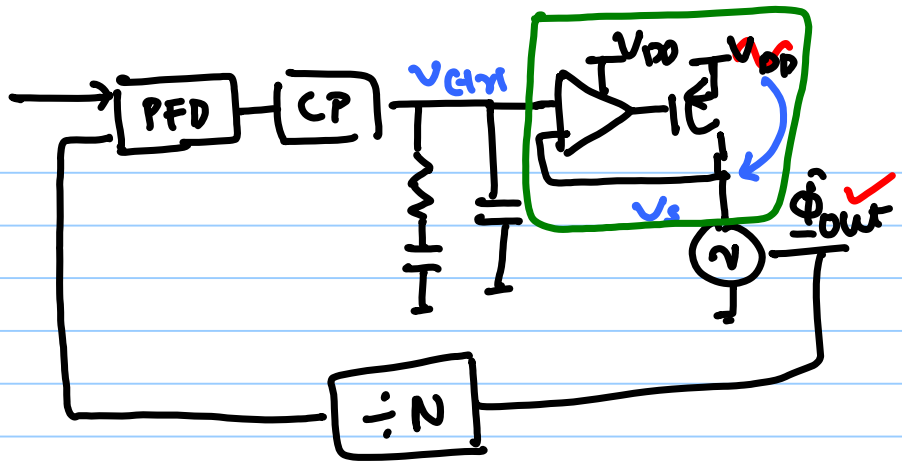
NMOS i/p Amp. + PMOS o/p stage.







$$\frac{\Phi_{out}(s)}{v_{dd}(s)} = \frac{\Phi_{out}(s)}{v_s(s)} \cdot \frac{v_s(s)}{v_{dd}(s)}$$

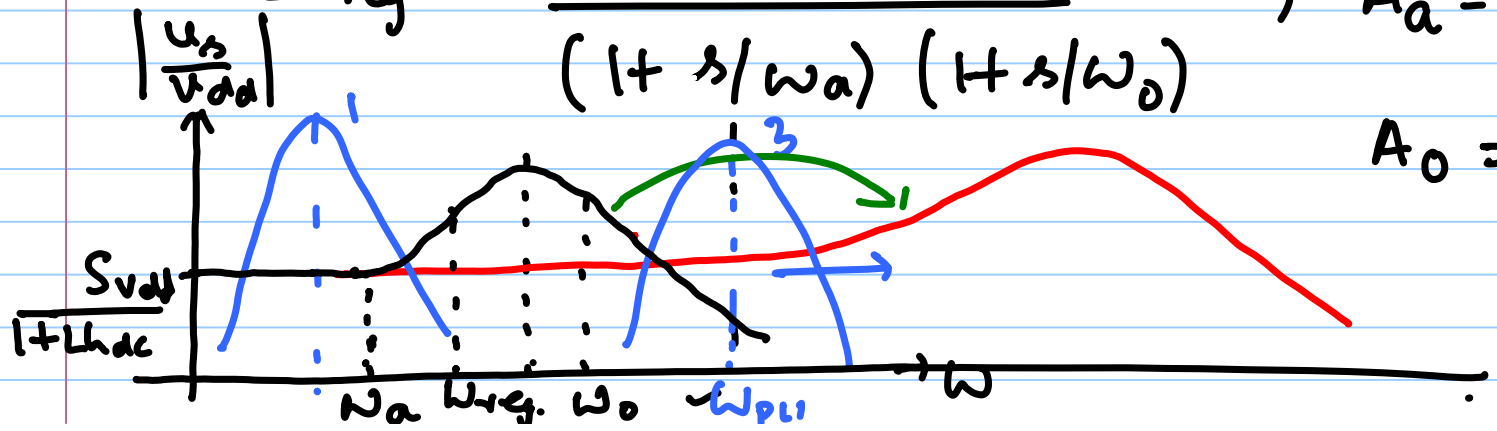


$$\frac{v_s(s)}{v_{dd}(s)} = \frac{S_{vdd}}{(1+s/\omega_0)(1+L_{Lreg})}$$

$$S_{vdd} = \frac{r_{vco}}{r_{vco}+r_{ds}}, \quad \omega_0 = \frac{1}{(r_{ds}\|r_{vco})C_0}, \quad \omega_a = \frac{1}{r_a C_a}$$

$$L_{Lreg} = \frac{A_a \cdot A_0}{(1+s/\omega_a)(1+s/\omega_0)}, \quad A_a = g_{ma} r_a$$

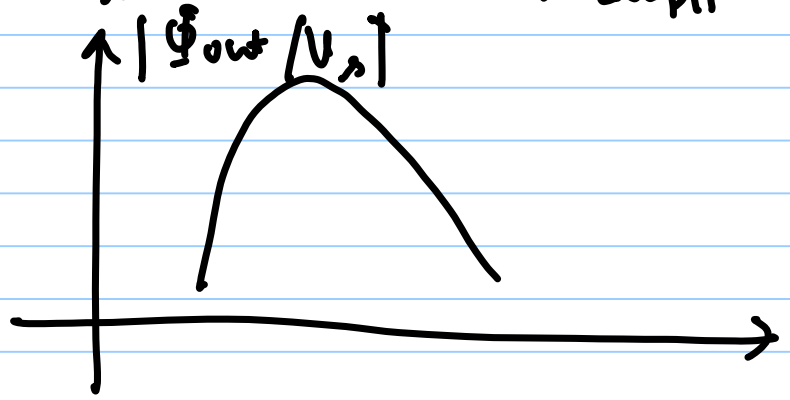
$$A_0 = g_m (r_{ds}\|r_{vco})$$



$$\frac{v_o(s)}{v_{dd}(s)} = \frac{S_{vdd}\ (1+s/\omega_a)}{A_a A_0 + (1+s/\omega_a)(1+s/\omega_0)}$$ ✓ f(ω_reg)

$$\frac{v_o}{v_{dd}} = \frac{S_{vdd}}{A_a A_0 + 1}$$

$$\frac{\Phi_{out}(s)}{v_o(s)} = \frac{2\pi K_{VCO}}{s} \cdot \frac{1}{1+L(s)_{PLL}}$$



$$\frac{v_o(s)}{v_{ctrl}(s)} = \frac{L(s)_{reg}}{1+L(s)_{reg}}$$

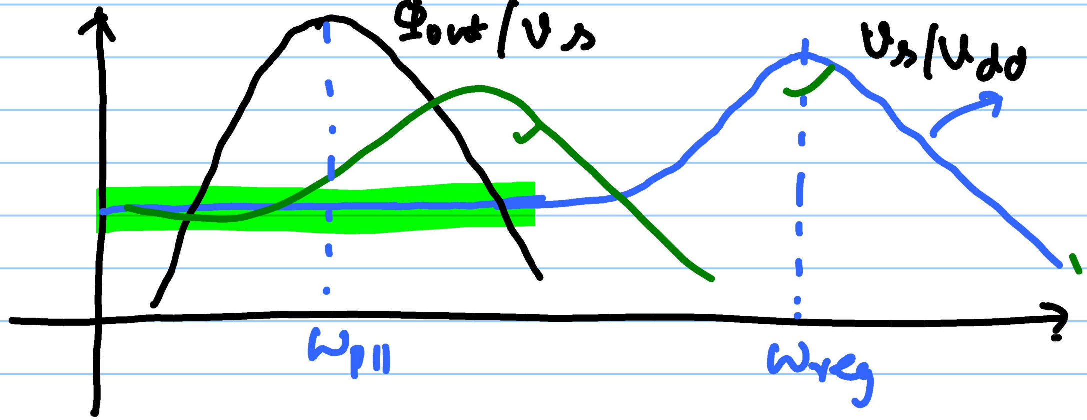
$$L(s)_{PLL} = \frac{I_{cp}}{2\pi N} \cdot \frac{1+sRC_1}{s^2 C_1 \left(1+s\frac{C_1+C_2}{C_1 C_2}\right)} \times 2\pi K_{VCO} \times \left(\frac{L(s)_{reg}}{1+L(s)_{reg}} \approx \frac{1}{1+s/\omega_{reg}}\right)$$ ✓

* $\omega_{reg} < \omega_{PLL0}$

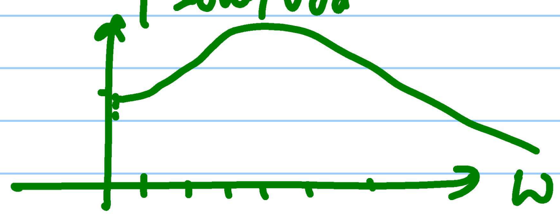
– $\hat{\Phi}_n$

– Noise contribution. – VCO noise

* $\omega_{reg} > \omega_{pll}$



$\omega_{reg} = 10 \times \omega_{pll0}$



$$\frac{\hat{\Phi}_{out}}{v_{dd}} =$$