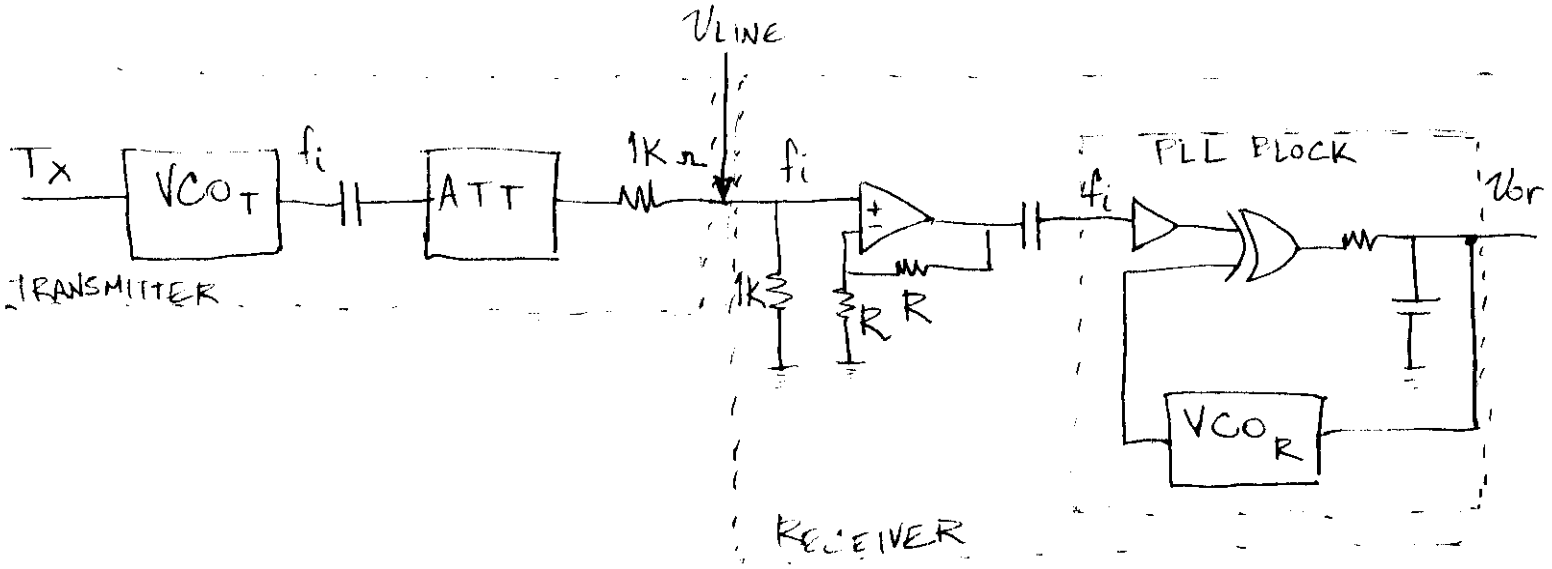
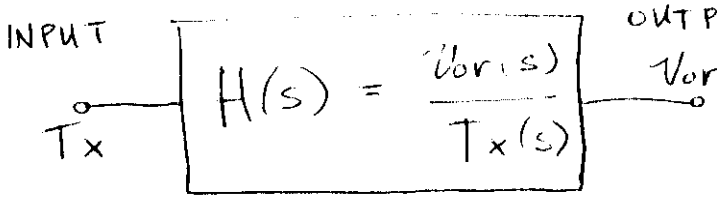
FSK MODEM MODEL

CIRCUIT BLOCK DIAGRAM

3/12/99



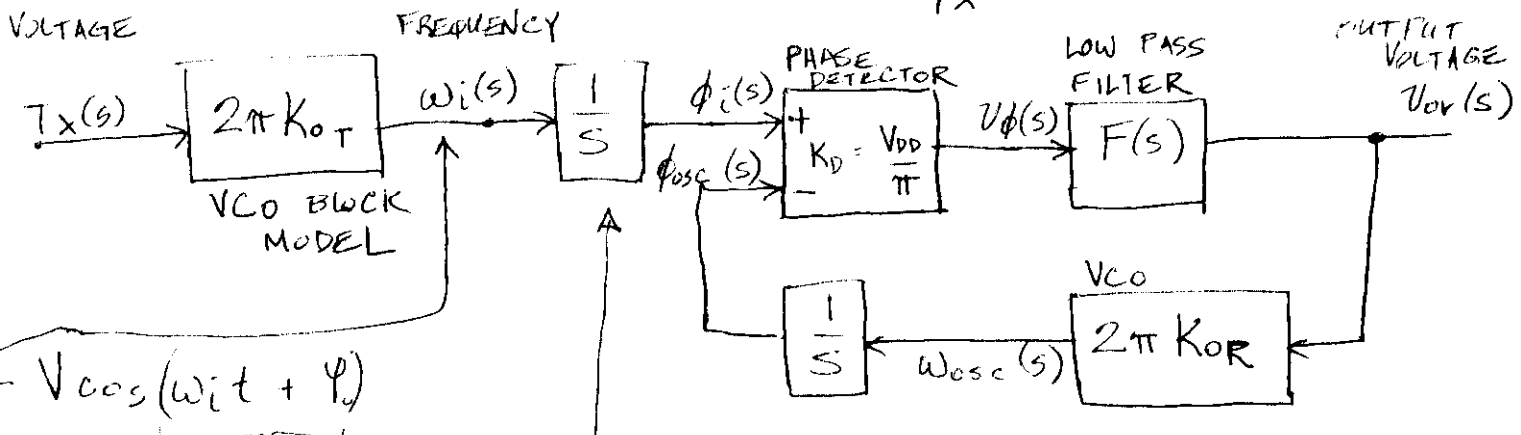
WE WANT THE TRANSFER FUNCTION OF THE MODEM:



→ THE SYSTEM H(s) IS LINEAR IF THE PLL IS ALWAYS LOCKED

MODEL

$\omega_i = 2\pi f_i$, $K_{OT} \triangleq \frac{\Delta f_i}{\Delta T_x}$



$\phi_i = \omega_i t + \varphi_0 \Rightarrow \omega_i = \frac{d\phi_i}{dt}$

$V_\phi(s) = K_D(\phi_i - \phi_{osc})$

$\phi_i(s) = \left(\frac{1}{s}\right)\omega_i(s)$

NOW, SOLVE THE MODEL

$$\phi_i(s) = \left(\frac{2\pi K_{OT}}{s}\right) T_x(s)$$

$$V_{or}(s) = F(s)\, V_\phi(s)$$

$$V_\phi(s) = K_D\left(\phi_i(s) - \phi_{osc}(s)\right)$$

$$V_\phi(s) = K_D\left(\phi_i(s) - \left(\frac{2\pi K_{OR}}{s}\right) V_{or}(s)\right)$$

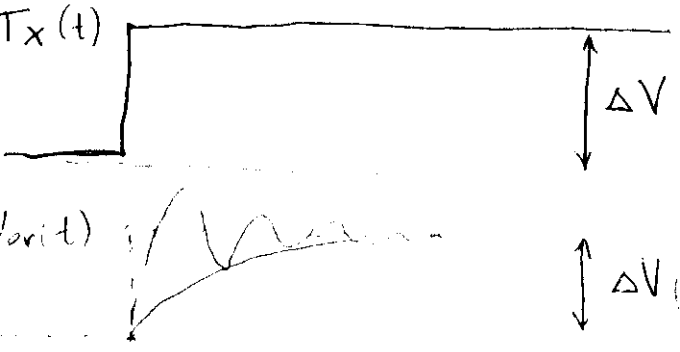
$$\Rightarrow V_{or}(s) = F(s)\, K_D\left[\left(\frac{2\pi K_{OT}}{s}\right) T_x(s) - \left(\frac{2\pi K_{OR}}{s}\right) \cdot V_{or}(s)\right]$$

$$H(s) = \frac{V_{or}(s)}{T_x(s)} = \frac{K_{OT}}{K_{OR}}\left(\frac{1}{1 + \frac{s}{2\pi K_{OR} K_D} + \frac{s^2}{\omega_p 2\pi K_{OR} K_D}}\right)$$

FOR $F(s) = \dfrac{1}{1 + \frac{s}{\omega_p}}$

∴ THE FSK MODEM IS A 2nd ORDER DYNAMIC SYSTEM

LET'S LOOK AT THE STEP RESPONSE:



THE SYSTEM RESPONCE DEPENDS ON THE Q FACTOR OF THE SYSTEM ⟹

SINCE $H(s)\big|_{s\to 0} = \dfrac{K_{OT}}{K_{OR}}$

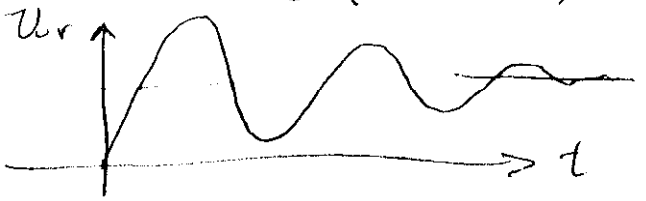
THE TRANSFER FUNCTION CAN BE WRITTEN AS

$$\Longrightarrow \quad H(s) = \frac{K_{OT}}{K_{OR}} \left(\frac{1}{1 + \frac{s}{Q\omega_o} + \left(\frac{s}{\omega_o}\right)^2} \right)$$

WHERE $\omega_o = \sqrt{\omega_p \, 2\pi \, K_D \, K_{OR}}$

$$Q = \sqrt{\frac{K_{OR} \, K_D}{f_p}}$$

A LARGE Q RESULTS IN AN UNDERDAMPED RESPONSE (NOT GOOD)



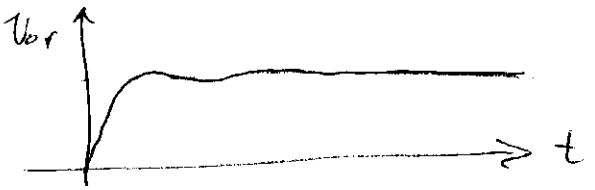
NOW,

$Q < 1/2$ RESULTS IN NO OVERSHOOT OR RINGING

IF f_p GOES DOWN,

$Q \approx 1$ IS ACCEPTABLE

AC RIPPLE GOES DOWN (GOOD)
CAPTURE RANGE GOES DOWN (BAD)
Q GOES UP (BAD)



TRY TO USE THIS RESULT IN YOUR DESIGN!