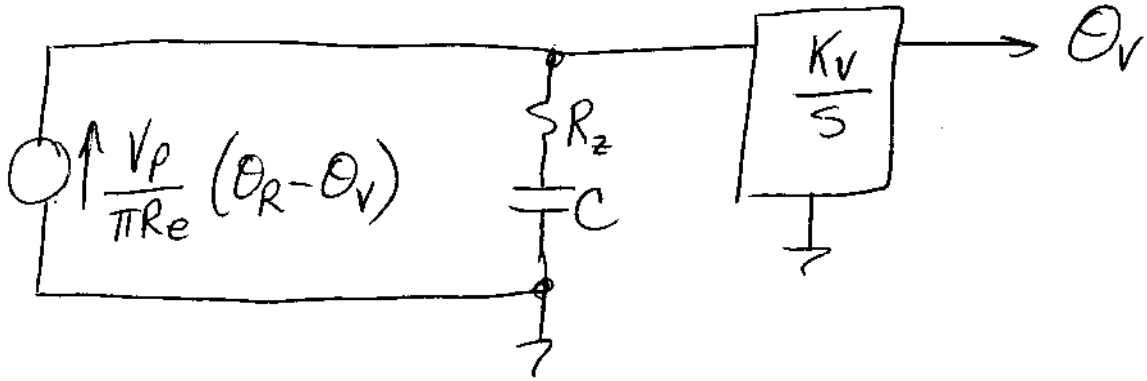


ANALOG PHASE DETECTOR STABILITY



$$\theta_V = \frac{V_p}{\pi R_e} \cdot \frac{R_2 C s + 1}{C s} (\theta_R - \theta_V) \cdot \frac{K_v}{s}$$

$$\theta_V \left[1 + \frac{V_p}{\pi R_e} \cdot \frac{R_2 C s + 1}{C s} \cdot \frac{K_v}{s} \right] = \theta_R \frac{V_p}{\pi R_e} \cdot \frac{R_2 C s + 1}{C s} \cdot \frac{K_v}{s}$$

$$\theta_V \left[\pi R_e C s^2 + V_p K_v R_2 C s + V_p K_v \right] = \theta_R V_p K_v (R_2 C s + 1)$$

$$\frac{\theta_V}{\theta_R} = \frac{V_p K_v}{\pi R_e C} \cdot \frac{R_2 C s + 1}{s^2 + \frac{V_p K_v R_2}{\pi R_e} s + \frac{V_p K_v}{\pi R_e C}}$$

STANDARD FORM $\rightarrow s^2 + 2 \zeta \omega_n s + \omega_n^2$

THUS $2 \zeta \omega_n = \frac{V_p K_v R_2}{\pi R_e} \neq \omega_n^2 = \frac{V_p K_v}{\pi R_e C}$

(2)

D.C. LOOP GAIN (CALLED K_V in GARDNER, p. 29 & 46
HERE CALLED K_D):

$$K_D = \frac{V_p R_{EQ.} K_V}{\pi R_e}$$

$R_{EQ.}$ = EQUIVALENT D.C.
IMPEDANCE AT
FILTER NODE

PULL-IN RANGE FROM p. 46

$$\Delta \omega_p = 2 \sqrt{\zeta \omega_n K_D}$$

BUT $\zeta \omega_n = \frac{V_p K_V R_z}{2 \pi R_e}$

$$\Delta \omega_p = 2 \sqrt{\frac{V_p K_V R_z}{2 \pi R_e} \cdot K_D}$$

OR

$$\Delta \omega_p = \sqrt{\frac{2 V_p K_V R_z}{\pi R_e} \cdot \frac{V_p R_{EQ.} K_V}{\pi R_e}}$$

OR

$$\Delta \omega_p = \frac{V_p K_V}{\pi R_e} \sqrt{2 R_z R_{EQ.}}$$

ALSO, FROM p. 43

$$\Delta \omega_L \cong 2 \zeta \omega_n = \frac{V_p K_V R_z}{\pi R_e}$$

(FAST LOCK-IN RANGE)

3

CONSIDER $V_p = 0.2 \text{ V}$

$$K_V = \frac{2\pi \times 4 \times 10^4}{2} = 2\pi \times 2 \times 10^4 \frac{\text{RAD}}{\text{V-SEC}}$$

$$R_e = 1\text{K}$$

$$R_z = 100\Omega$$

$$R_{eq} \approx 10^5$$

$$\Delta\omega_p = \frac{2 \times 2 \times 10^4 \times 10^3}{10^3} \sqrt{\frac{2 \times 10^2 \times 10^5}{20 \times 10^6}}$$

$$\Delta\omega_p \approx 8 \times 4.47 \times 10^3 = 35.8 \times 10^3 \frac{\text{RAD}}{\text{SEC}}$$

$$\Delta f_p = 5.7 \text{ KC}$$

$$\Delta\omega_L = \frac{0.2 \times 2 \times 10^4 \times 10^3}{10^3} = .8 \times 10^3 \frac{\text{RAD}}{\text{SEC}}$$

$$\Delta f_L = 128 \text{ CPS}$$

THIS NUMBER COMPARES WELL WITH EXPERIMENT WITH 19 KC SYSTEM.