

ΒΑΣΙΚΕΣ ΕΙΣΩΣΕΙΣ ΗΛΕΚΤΡΟΝΙΚΗΣ ΙΙΙ

Ζεύγος κοινού συλλέκτη - κοινής βάσης:

$$\frac{V_o}{V_{sig}} = \frac{1}{2} \left(\frac{R_{in}}{R_{in} + R_{sig}} \right) (g_m R_L) \quad R_{in} = 2r_\pi$$

$$f_{P1} = \frac{1}{2\pi \left(\frac{C_\pi}{2} + C_\mu \right) (R_{sig} \parallel 2r_\pi)} \quad f_{P2} = \frac{1}{2\pi C_\mu R_L} \quad f_H \cong \sqrt[3]{\frac{1}{f_{P1}^2} + \frac{1}{f_{P2}^2}}$$

Ζεύγος κοινής πηγής - κοινής πύλης (κασκοδική συνδεσμολογία):

$$R_{out} = r_{o2} + [1 + (g_{m2} + g_{mb2}) r_{o2}] r_{o1} \quad A_v = -A_0^2 \frac{R_L}{R_L + A_0 r_0} \quad f_H \cong \frac{1}{2\pi \tau_H}$$

$$R_{gd1} = (1 + g_{m1} R_{d1}) R_{sig} + R_{d1} \quad \tau_H = R_{sig} [C_{gs1} + C_{gd1} (1 + g_{m1} R_{d1})] + R_{d1} (C_{gd1} + C_{db1} + C_{gs2}) + (R_L \parallel R_{out}) (C_L + C_{gd2})$$

Ζεύγος κοινού εκπομπού - κοινής βάσης (κασκοδική συνδεσμολογία):

$$A_M = -\frac{r_\pi}{r_\pi + r_x + R_{sig}} g_m (\beta r_0 \parallel R_L) \quad R_{c1} = r_{o1} \parallel \left[r_{e2} \left(\frac{r_{o2} + R_L}{r_{o2} + R_L / (\beta_2 + 1)} \right) \right]$$

$$R'_{sig} = r_{\pi1} \parallel (r_{x1} + R_{sig}) \quad \tau_H = C_{\pi1} R_{\pi1} + C_{\mu1} R_{\mu1} + (C_{cs1} + C_{\pi2}) R_{c1} + (C_L + C_{cs2} + C_{\mu2}) (R_L \parallel R_{out})$$

$$R_{\mu1} = R'_{sig} (1 + g_{m1} R_{c1}) + R_{c1} \quad f_H \cong \frac{1}{2\pi \tau_H}$$

Τελεστικός ενισχυτής MOS δύο βαθμίδων:

$$A_v = -g_{m1} (r_{ds2} \parallel r_{ds4}) \quad g_{m1} = \sqrt{2\mu_p C_{ox} \left(\frac{W}{L} \right)_1 I_{D1}} = \sqrt{2\mu_p C_{ox} \left(\frac{W}{L} \right)_1 \frac{I_{bias}}{2}}$$

$$R_B = \frac{2}{\sqrt{2\mu_n C_{ox} (W/L)_{12} I_B}} \left(\sqrt{\frac{(W/L)_{12}}{(W/L)_{13}}} - 1 \right)$$

$$g_{m12} = \frac{2}{R_B} \left(\sqrt{\frac{(W/L)_{12}}{(W/L)_{13}}} - 1 \right) \quad g_{mi} = g_{m12} \sqrt{\frac{I_{Di} (W/L)_i}{I_B (W/L)_{12}}} \quad g_{mi} = g_{m12} \sqrt{\frac{\mu_p I_{Di} (W/L)_i}{\mu_n I_B (W/L)_{12}}}$$

$$C_1 = C_{gd4} + C_{db4} + C_{gd2} + C_{gs6} \quad C_2 = C_{db6} + C_{db7} + C_{gd7} + C_L$$

$$\omega_Z = \frac{G_{m2}}{C_C} \quad \omega_{P1} = \frac{1}{C_1 R_1 + C_2 R_2 + C_C (G_{m2} R_2 R_1 + R_1 + R_2)} \cong \frac{1}{R_1 C_C G_{m2} R_2}$$

$$\omega_{P2} = \frac{G_{m2} C_C}{C_1 C_2 + C_C (C_1 + C_2)} \quad \omega_t = (G_{m1} R_1 G_{m2} R_2) \omega_{P1} \quad \text{Επιλογή } C_C \text{ ώστε } \omega_t < \omega_Z < \omega_{P2}$$

$$PSRR = g_{mN} (r_{oP} \parallel r_{oN}) \quad SR \equiv \left. \frac{dV_{out}}{dt} \right|_{\max} = \frac{I_{SS}}{C_L}$$

$$GB = A_v(0) \cdot |p_1| = (g_{m1} g_{m2} R_I R_{II}) \cdot \left(\frac{1}{g_{m2} R_I R_{II} C_C} \right) = \frac{g_{m1}}{C_C}$$

$$PM = \text{Arg}[AB] = \pm 180^\circ - \arctan\left(\frac{\omega}{|p_1|}\right) - \arctan\left(\frac{\omega}{|p_2|}\right) - \arctan\left(\frac{\omega}{Z}\right)$$

Για περιθώριο φάσης (PM) 45° και $Z \geq 10 \cdot GB$: $|p_2| \geq 1.22 \cdot GB$

Για περιθώριο φάσης (PM) 60° και $Z \geq 10 \cdot GB$: $|p_2| \geq 2.22 \cdot GB$

$$Z = \frac{1}{C_C \left(\frac{1}{g_{m2}} - R_Z \right)}$$

Τελεστικός ενισχυτής με είσοδο n-MOS

$$\max(V_{in}) = V_{DD} - \sqrt{\frac{I_5}{\beta_3}} - \max(|V_{T03}|) + \min(V_{T01}) \quad \min(V_{in}) = V_{SS} + \sqrt{\frac{I_5}{\beta_1}} + \max(V_{T01}) + V_{DSsat} \quad V_{DSsat} = \sqrt{\frac{2I_{DS}}{\beta}}$$

Τελεστικός ενισχυτής με είσοδο p-MOS

$$\max(V_{in}) = V_{DD} - \sqrt{\frac{I_5}{\beta_1}} - V_{DSsat} - \max(|V_{T01}|) \quad \min(V_{in}) = V_{SS} + \sqrt{\frac{I_5}{\beta_3}} + \max(V_{T03}) - \min(|V_{T01}|)$$

Σχεδίαση τελεστικού ενισχυτή με είσοδο n-MOS

$SR = \frac{I_5}{C_C}$	$A_{v1} = \frac{-g_{m1}}{g_{ds2} + g_{ds4}} = \frac{-2g_{m1}}{I_5 \cdot (\lambda_2 + \lambda_4)}$	$A_{v2} = \frac{-g_{m6}}{g_{ds6} + g_{ds7}} = \frac{-g_{m6}}{I_6 \cdot (\lambda_6 + \lambda_7)}$
$GB = \frac{g_{m1}}{C_C}$	$p_2 = \frac{-g_{m6}}{C_L}$	$Z = \frac{g_{m6}}{C_C}$
		$\beta = k' \frac{W}{L} \cong \mu_0 C_{ox} \frac{W}{L} \text{ (A/V}^2\text{)}$
$C_C > 0.22C_L$	$I_5 = SR \cdot C_C$	$S_3 = \left(\frac{W}{L}\right)_3 = \frac{I_5}{k'_3 [V_{DD} - \max(V_{in}) - \max(V_{T03}) + \min(V_{T01})]^2}$
$\frac{g_{m3}}{2C_{gs3}} > 10 \cdot GB$	$g_{m1} = GB \cdot C_C \implies S_1 = S_2 = \frac{g_{m2}^2}{k'_2 I_5}$	