

Viktige ligninger INF 5460

Noen typiske tall:

Motstand på chip:

$$30\text{m}\Omega/\text{sq} \cdot (1\text{cm}+1\text{cm})/30\mu\text{m}=2\Omega$$

Induktanser:

Bondetråd: 10nH

Coax 50 Ω : 250nH/m, 100pF/m

Elektrolytt kond.: 25nH

Skive kond.: 4-6nH

OFM kond.: 2nH

$$C = \varepsilon \cdot \frac{A}{t} \quad C = \frac{dQ}{dV}$$

$$V_N = j\omega RC_{12}V_1$$

$$V_N = \left(\frac{C_{12}}{C_{12} + C_{2G}} \right) V_1$$

Mottiltak mot kapasitiv støy:

1. Unngå kryssning
2. Minimaliser lederbredden i kryssningspunktet
3. Øk avstand
4. Bruk skjerm
5. Legg på kapasitiv jordlast
6. Velg isolasjonen med mindre ϵ_r
7. Reduser utgangsmotstanden til linjedriveren
8. Reduser frekvens (unngå steile flanker)
9. Reduser støykildens spenningsving
10. Generer motstøy

$$\phi = LI$$

$$M_{12} = \frac{\phi_{12}}{I_1}$$

$$V_N = j\omega MI_1 = M \frac{di_1}{dt}$$

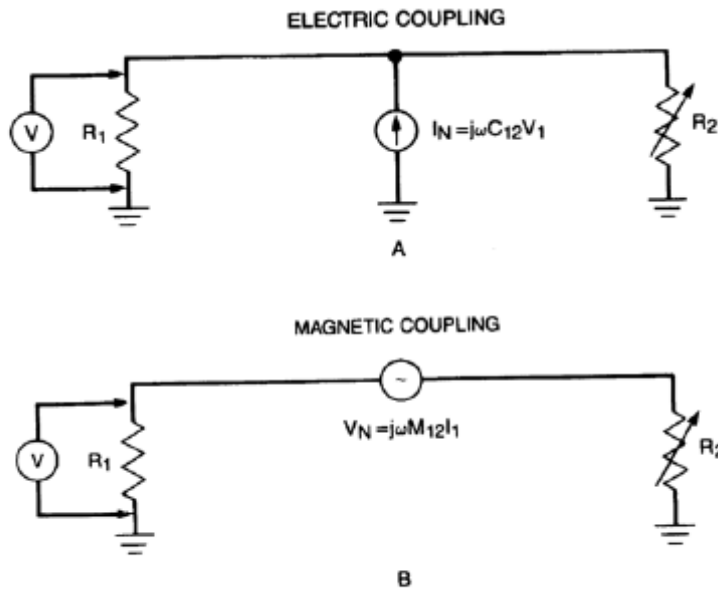
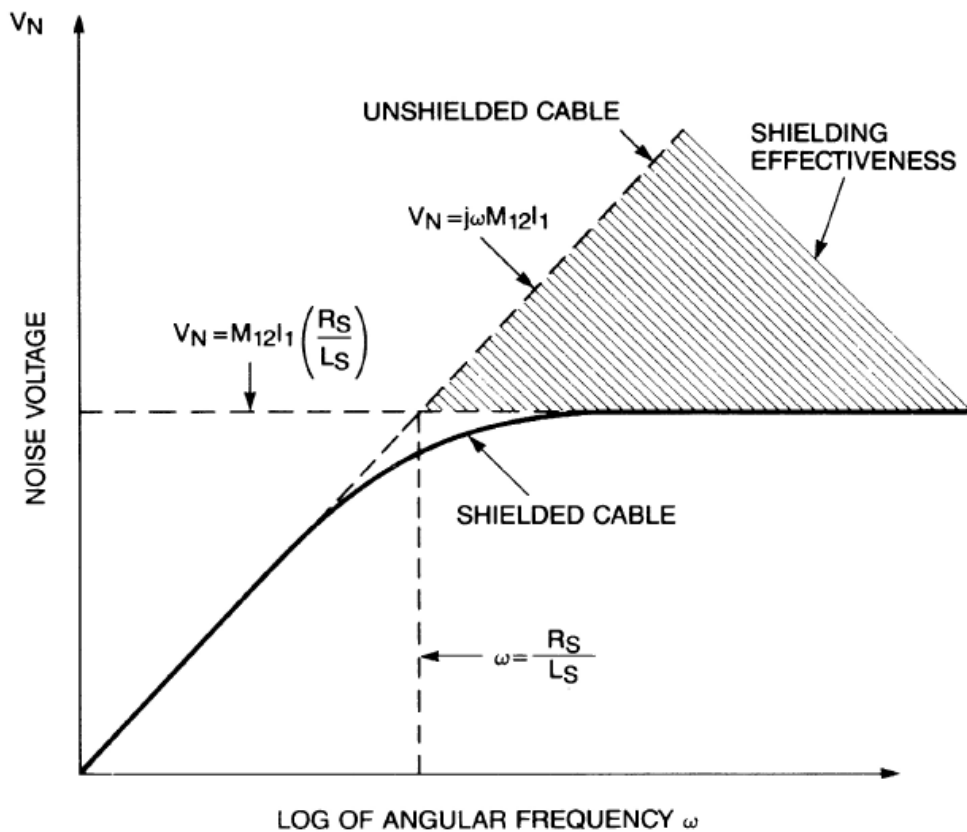


Figure 2-9. (A) Equivalent circuit for electric field coupling; (B) equivalent circuit for magnetic field coupling.

Biot-Savarts lov:

$$B = \frac{\mu I}{2\pi r}$$

Når $\phi_s = \phi_c$ så $M = L_S$

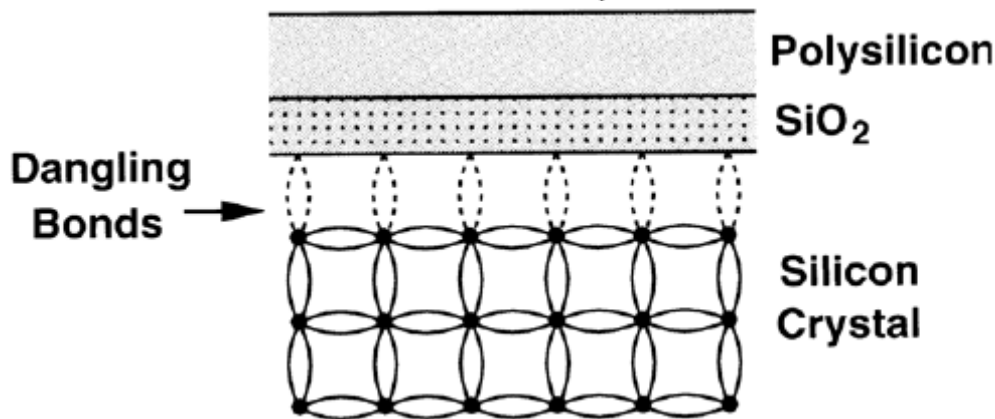


$$V_{IN} = R_S I_S$$

$$E = \sqrt{4kTR\Delta f}$$

$$I_{sh} = \sqrt{2qI_{DC}\Delta f}$$

$$I_f^2(f_1, f_h) = \frac{K_F I_{DS}^{AF}}{Cox \cdot L_{eff}^2} \int_{f_1}^{f_h} \frac{1}{f} = \frac{K_F I_{DS}^{AF}}{Cox \cdot L_{eff}^2} \ln \frac{f_h}{f_1}$$



$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\left[\frac{(x-\mu)^2}{2\sigma^2}\right]}$$

	Innenfor	Utenfor
$[-\sigma, \sigma]$	68%	32%
$[-2\sigma, 2\sigma]$	95%	5%
$[-3\sigma, 3\sigma]$	99.7%	0.3%
$[-4\sigma, 4\sigma]$	99.994%	0.006%

$$V_{rms} = \sqrt{\frac{1}{T} \int_0^T v^2(t) dt}$$

$$N_t = kT\Delta f$$

$$N_t = \frac{E_0^2}{R_L} = \frac{E_t^2}{4R_L} = \frac{E_t^2}{4R_S} = kT\Delta f$$

$$\Delta f = \frac{1}{G_0} \int_0^\infty G(f) df$$

$$\Delta f = \frac{1}{A_{vo}^2} \int_0^\infty |A_v(f)|^2 df$$

$$E_{no}^2 = kT / C$$

Fremgangsmåte:

1. Først finner vi systems spenningsforsterkning
2. Så finner vi støyen på utgangen
3. Så deler vi utgangsstøyen på systems spenningsforsterkning og får da ekvivalent støy på inngangen.

$$E_{ni}^2 = \frac{E_{no}^2}{K_t^2} = E_t^2 + E_n^2 + I_n^2 R_s^2$$

$$E_{ni}^2 = E_t^2 + E_n^2 + I_n^2 R_s^2 + 2CE_n I_n R_s$$

$$F = \frac{S_i/N_i}{S_o/N_o} = \frac{N_o/S_o}{N_i/S_i} = \frac{N_o/N_i}{S_o/S_i}$$

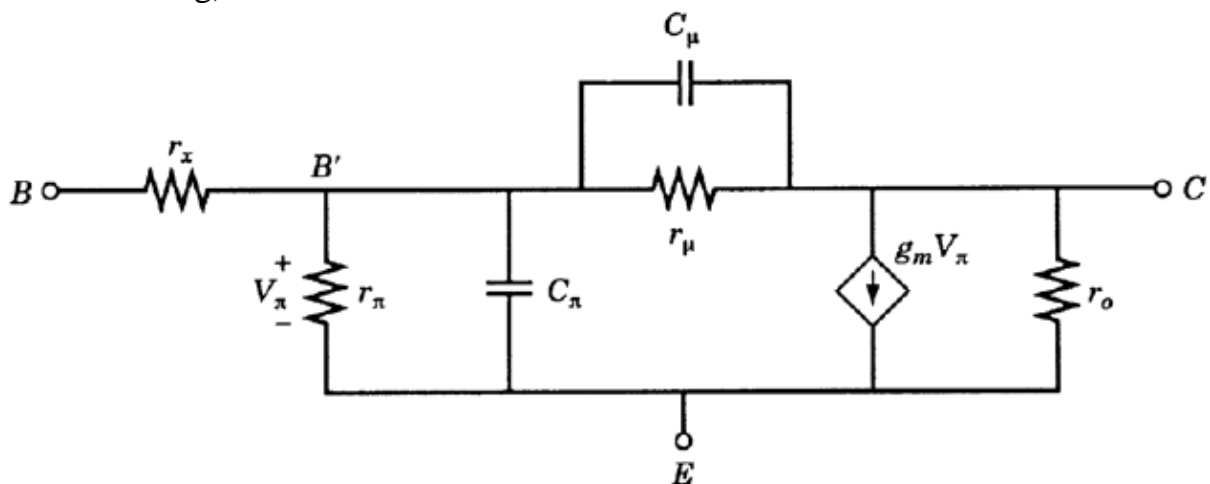
$$F_{1\dots j} = F_1 + \frac{(F_2 - 1)}{G_1} + \dots + \frac{(F_j - 1)}{G_1 G_2 \dots G_{j-1}}$$

$$V_O = \left(\frac{R_4}{R_3 + R_4} \right) \left(\frac{R_1 + R_2}{R_1} \right) V_{in2} - \left(\frac{R_2}{R_1} \right) V_{in1}$$

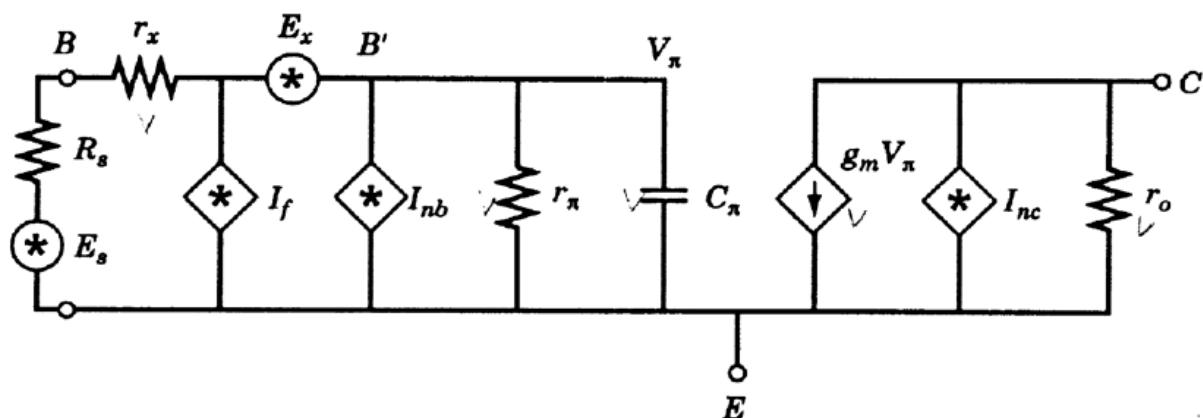
$$V_O = (R_2/R_1)(V_{in2} - V_{in1}) \text{ n\u00e5r } R_2/R_1 = R_4/R_3$$

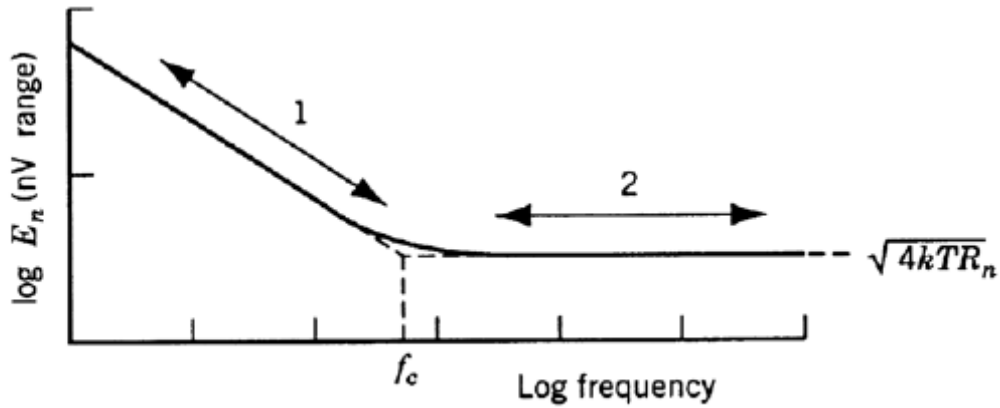
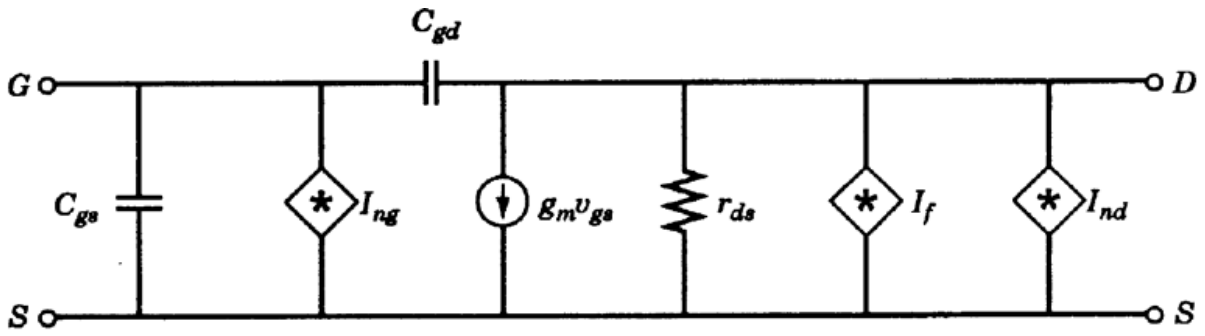
$$E_{ni}^2 = E_{ts}^2 + E_{na}^2 + I_n^2 R_s^2 \text{ (Invertert negativ tilbakekobling)}$$

$$E_{ni}^2 = E_{ts}^2 + E_{nb}^2 + I_n^2 R_s^2 \text{ (Ikke-invertert negativ tilbakekobling)}$$

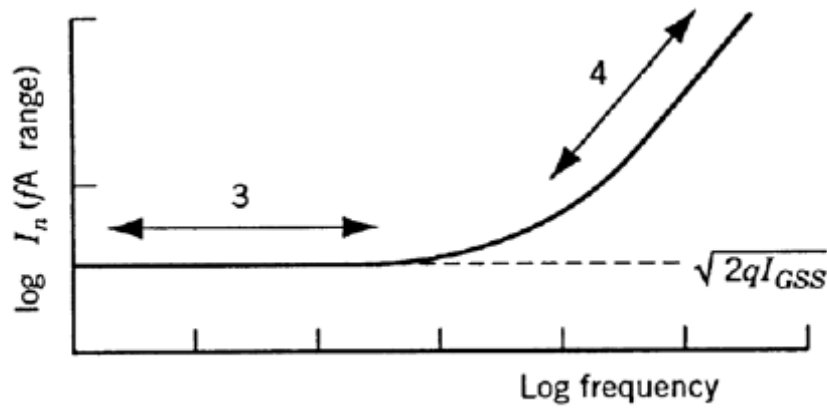


$$\beta_0 = \frac{I_C}{I_{BE}}$$

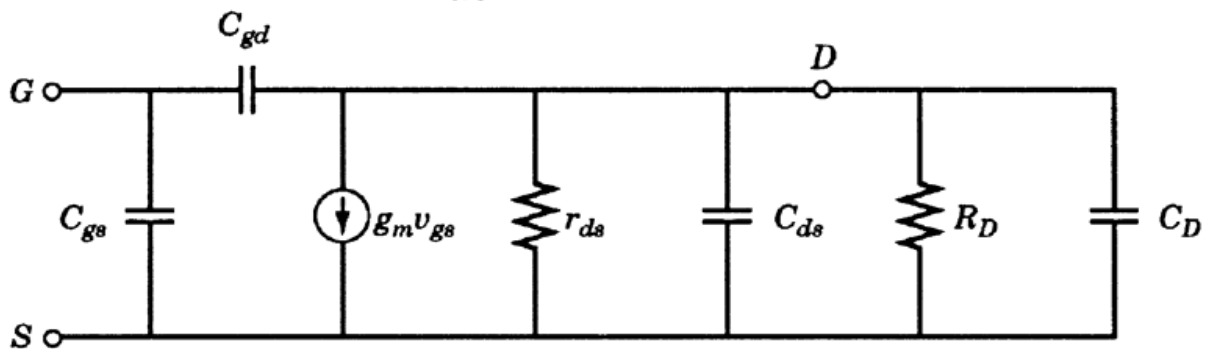




(a)



(b)



$$I_D = K_P \left(\frac{W}{L} \right) (V_{GS} - V_T)^2 (1 + \lambda V_{DS})$$

$$g_m = \left. \frac{\partial I_D}{\partial V_{GS}} \right|_{Q\text{-point}}$$

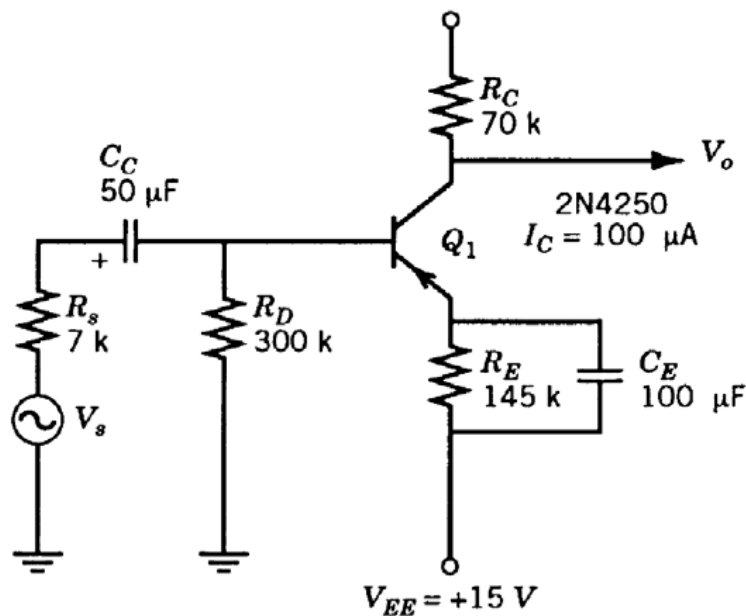
$$g_{ds} = \left. \frac{\partial I_D}{\partial V_{DS}} = \frac{1}{r_{ds}} \right|_{Q\text{-point}}$$

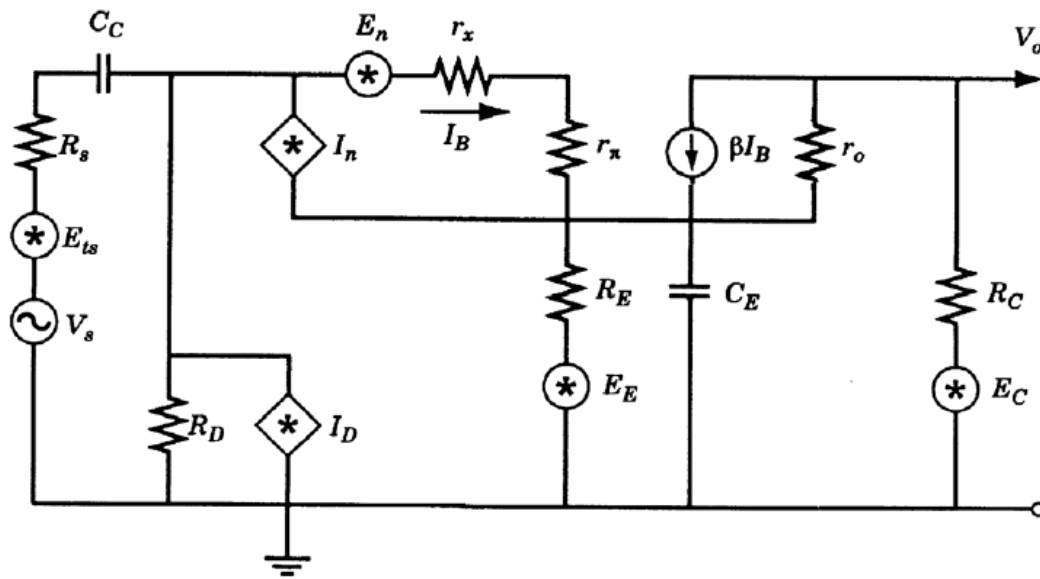
$$E_{ni}^2 = \frac{E_{no}^2}{K_t^2} = E_S^2 + \left(\frac{R_S + R_p}{R_p} \right)^2 E_n^2 + (I_n^2 + I_{np}^2) R_S^2$$

$$E_{ni}^2 = E_S^2 + \left(\frac{R_S + X_S}{X_p} + 1 \right)^2 E_n^2 + (R_S + X_S)^2 I_n^2$$

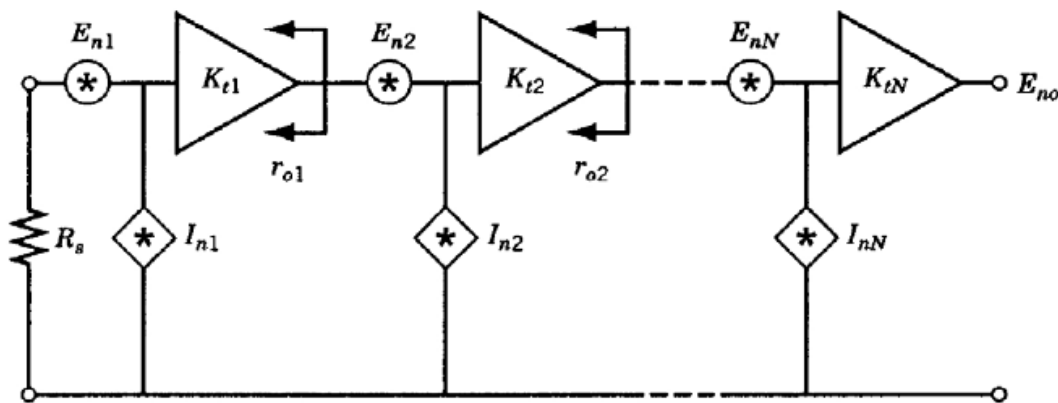
$$R'_0 = \frac{E'_n}{I'_n} = \frac{E_n}{T^2 I_n} = \frac{R_0}{T^2} = R_0 \frac{N_S^2}{N_P^2}$$

$$E_{ni}^2 = E_t^2 + E_n^2 + I_n^2 |Z_s|^2$$





$$E_E'^2 = I_E^2 \cdot (C_E \parallel R_E) = \frac{E_E^2}{R_E^2} \left| \frac{R_E}{j\omega R_E C_E + 1} \right|^2 = \frac{E_E^2}{1 + (\omega R_E C_E)^2}$$



$$E_{ni}^2 = E_{ns}^2 + E_{n1}^2 + I_{n1}^2 R_S^2 + \frac{E_{n2}^2 + I_{n2}^2 r_{o1}^2}{K_{t1}^2} + \frac{E_{n3}^2 + I_{n3}^2 r_{o2}^2}{K_{t1}^2 K_{t2}^2} + \dots$$

$$K_{dm} = \frac{V_{o2} - V_{o1}}{V_{s2} - V_{s1}}$$

$$K_{cm} = \frac{V_{o2} + V_{o1}}{V_{s2} + V_{s1}}$$

$$K_{dc} = \frac{V_{o2} - V_{o1}}{2V_S}$$

$$E'_n = \frac{E_n}{\sqrt{N}} \quad \text{og} \quad I'_n = I_n \sqrt{N}$$

Fra Razavi:

$$\overline{I_n^2} = 4kT\gamma g_m$$

$$\overline{V_n^2} = \overline{I_n^2} r_O^2 = 4kT \left(\frac{2}{3} g_m \right) r_O^2$$

$$\overline{V_n^2} = 4kT \left(\frac{2}{3} g_{m1} + \frac{2}{3} g_{m2} \right) \frac{1}{g_{m1}^2} = 4kT \left(\frac{2}{3g_{m1}} + \frac{2}{3} \frac{g_{m2}}{g_{m1}^2} \right)$$

$$\overline{V_{n,in}^2} = \overline{V_{n1}^2} + \frac{\overline{V_{n,out}^2 |_{M2}}}{A_v^2} = 4kT \frac{2}{3} \left(\frac{1}{g_{m1}} + \frac{g_{m2}}{g_{m1}^2} \right) \quad (\text{Samme for CS og CD})$$

$$SNR_{Max} = \frac{S_{Max}}{N_{Max}}$$

$$SNR_{Min} = \frac{S_{Min}}{N_{Min}}$$

$$DR = \frac{S_{Max}}{N_{Min}}$$