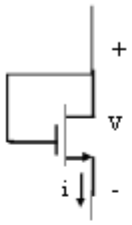
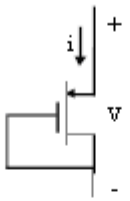
MOS AKTİF DİRENÇ

Gerçekleştirme





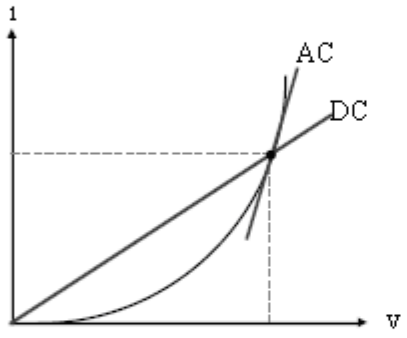
DS kısadevre, eleman doymada

$$v_{DS} \geq v_{GS} - V_T$$

$$v_D - v_S \geq v_G - v_S - V_T$$

$$\therefore \quad v_{DG} \geq -V_T \text{ where } V_T > 0$$

I-V Karakteristiği



Büyük İşaret Davranışı

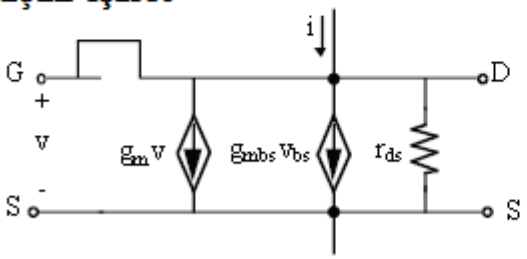
$$i = i_D = \left(\frac{K'W}{2L}\right)[v_{GS} - V_T]^2$$

$$= \frac{\beta}{2}(v_{GS} - V_T)^2, \quad \lambda \text{ ihmal}$$

veya

$$v = v_{DS} = v_{GS} = V_T + \sqrt{\frac{2i_D}{\beta}}$$

Küçük İşaret

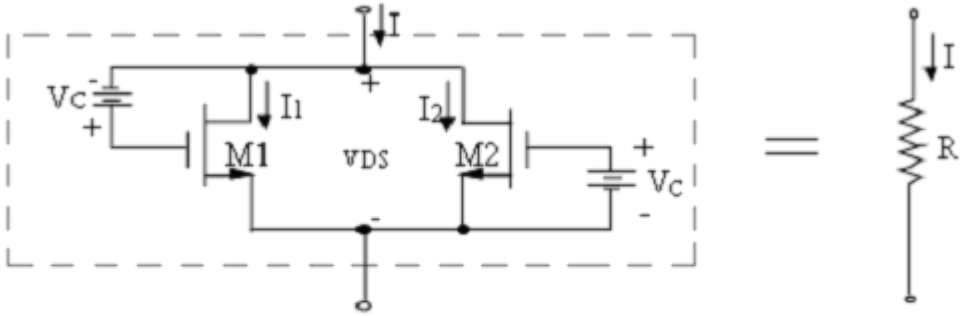


$V_{BS} = 0$, $\quad R_{OUT} = \frac{v}{i} = \frac{1}{g_M + g_{DS}} \approx \frac{1}{g_M}$

$V_{BS} \neq 0$?

genel olarak $\quad g_m \approx 10\, g_{mbs} \approx 100\, g_{ds}$

Aktif Direncin Dinamik Aralığının Genişletilmesi



Her iki elemanın doymasız bölgede çalıştıkları kabul edilirse

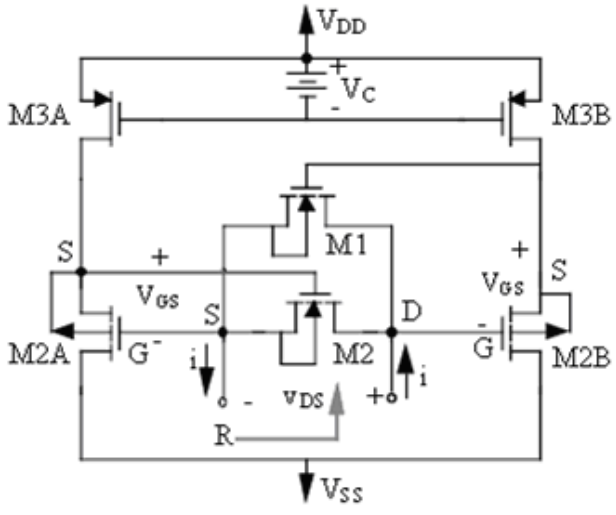
$$I_1 = \beta_1\left[(v_{DS} + V_C - V_T)v_{DS} - \frac{v_{DS}^2}{2}\right]$$

$$I_2 = \beta_2\left[(V_C - V_T)v_{DS} - \frac{v_{DS}^2}{2}\right]$$

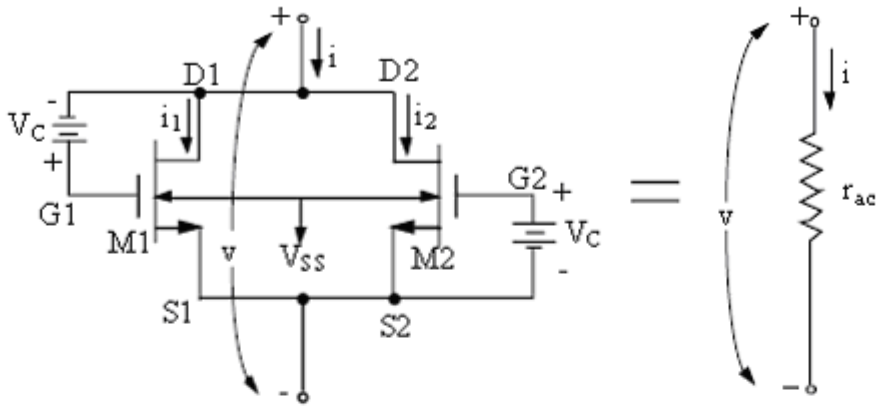
$$I = I_1 + I_2 = \beta\left[v_{DS}^2 + (V_C - V_T)v_{DS} - \frac{v_{DS}^2}{2} + (V_C - V_T)v_{DS} - \frac{v_{DS}^2}{2}\right]$$

$$I = 2\beta(V_C - V_T)v_{DS} \qquad \boxed{R = \frac{1}{2\beta(V_C - V_T)}}$$

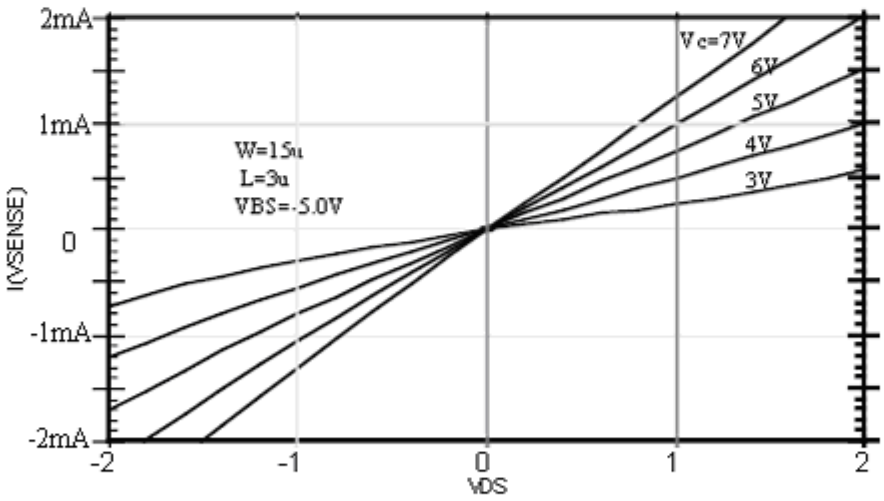
Gerçekleştirme



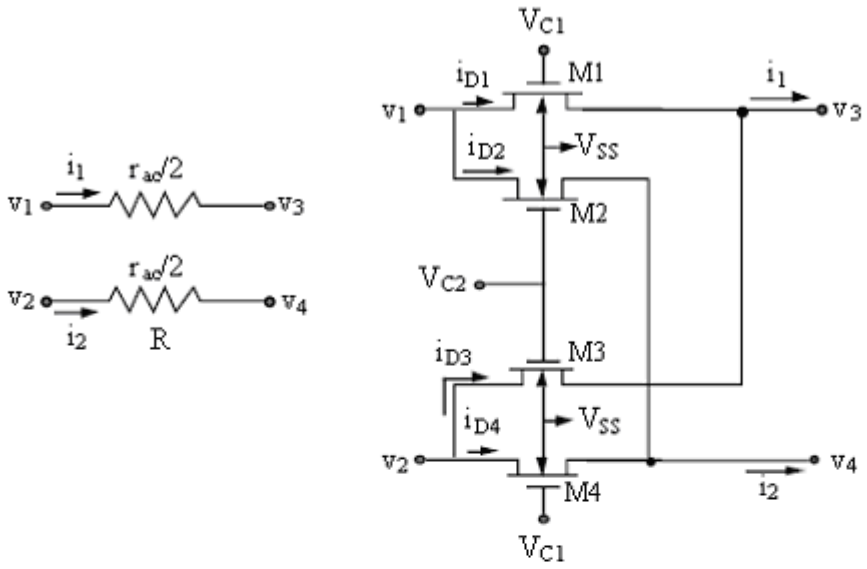
NMOS paralel tranzistorlarla gerçekleştirme



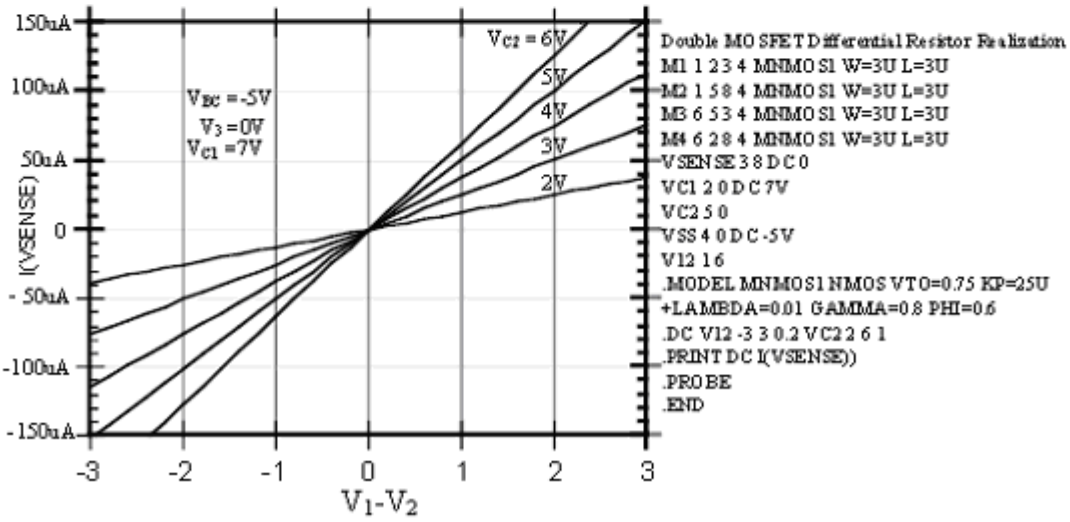
Gerilim-Akım Karakteristiği



Çift MOSFET ile Farksal Direnç Gerçekleştirme



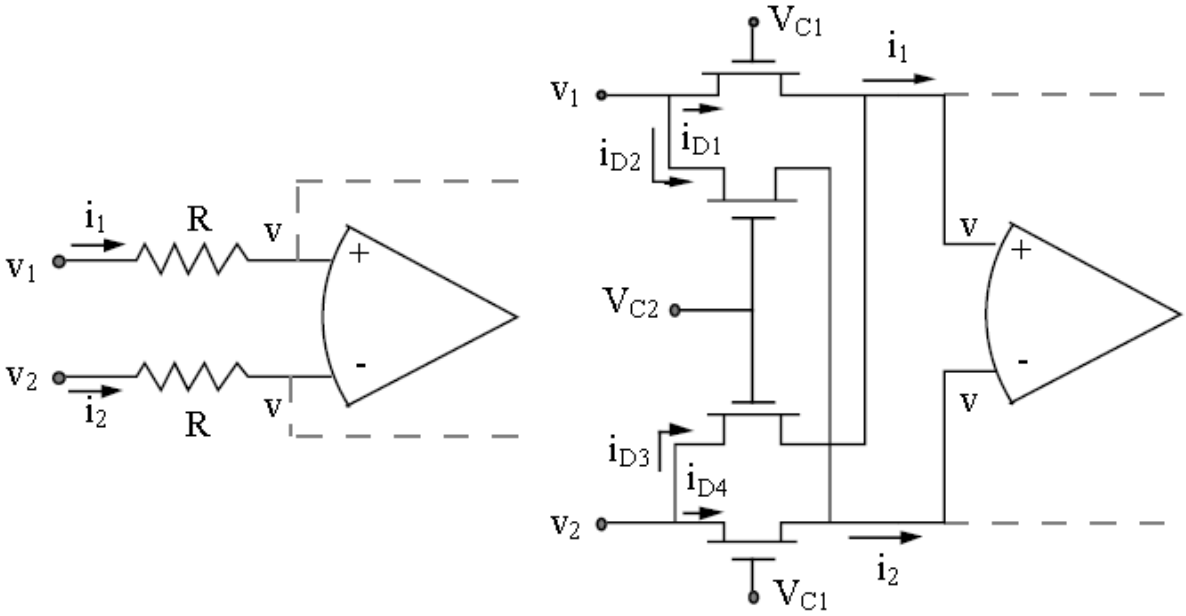
Gerilim-Akım Karakteristiği



*

$$R_{in} = \frac{v_1 - v_2}{i_1 - i_2} = \frac{v_1 - v_2}{\beta(V_{C1} - V_{C2})(v_1 - v_2)} = \frac{1}{\frac{KW}{L}(V_{C1} - V_{C2})}$$

$$\boxed{R_{in} = \frac{1}{\frac{KW}{L}(V_{C1} - V_{C2})}} \qquad v_1, v_2 \leq \min\left[(V_{C1} - V_T), (V_{C2} - V_T)\right]$$



$$i_{D1} = \beta\left[(V_{C1}\text{-}v\text{-}V_T)(v_1\text{-}v) - \frac{1}{2}(v_1\text{-}v)^2\right]$$

$$i_{D2} = \beta\left[(V_{C2}\text{-}v\text{-}V_T)(v_1\text{-}v) - \frac{1}{2}(v_1\text{-}v)^2\right]$$

$$i_{D3} = \beta\left[(V_{C1}\text{-}v\text{-}V_T)(v_2\text{-}v) - \frac{1}{2}(v_2\text{-}v)^2\right]$$

$$i_{D4} = \beta\left[(V_{C2}\text{-}v\text{-}V_T)(v_2\text{-}v) - \frac{1}{2}(v_2\text{-}v)^2\right]$$

$$i_1 = i_{D1} + i_{D3} = \beta\left[(V_{C1}\text{-}v\text{-}V_T)(v_1\text{-}v) - \frac{1}{2}(v_1\text{-}v)^2 + (V_{C2}\text{-}v\text{-}V_T)(v_2\text{-}v) - \frac{1}{2}(v_2\text{-}v)^2\right]$$

$$i_2 = i_{D2} + i_{D4} = \beta\left[(V_{C2}\text{-}v\text{-}V_T)(v_1\text{-}v) - \frac{1}{2}(v_1\text{-}v)^2 + (V_{C1}\text{-}v\text{-}V_T)(v_2\text{-}V) - \frac{1}{2}(v_2\text{-}v)^2\right]$$

$$\begin{aligned} i_1 - i_2 = {} & \beta[(V_{C1}\text{-}v\text{-}V_T)(v_1\text{-}v) + (V_{C2}\text{-}v\text{-}V_T)(v_2\text{-}v) \\ & - (V_{C2}\text{-}v\text{-}V_T)(v_1\text{-}v) - (V_{C1}\text{-}v\text{-}V_T)(v_2\text{-}v)] \\ = {} & \beta[v_1(V_{C1}\text{-}V_{C2}) + v_2(V_{C2}\text{-}V_{C1})] = \beta(V_{C1}\text{-}V_{C2})(v_1\text{-}v_2) \end{aligned}$$

$$R_{in} = \frac{v_1\text{-}v_2}{i_1\text{-}i_2} = \frac{v_1\text{-}v_2}{\beta(V_{C1}\text{-}V_{C2})(v_1\text{-}v_2)} = \frac{1}{\frac{KW}{L}(V_{C1}\text{-}V_{C2})}$$

$$R_{in} = \frac{v_1 - v_2}{i_1 - i_2} = \frac{v_1 - v_2}{\beta(V_{C1} - V_{C2})(v_1 - v_2)} = \frac{1}{\frac{KW}{L}(V_{C1} - V_{C2})}$$

$$\boxed{R_{in} = \frac{1}{\frac{KW}{L}(V_{C1} - V_{C2})}} \qquad v_1, v_2 \leq \min\left[(V_{C1} - V_T), (V_{C2} - V_T)\right]$$

Kaynaklar:

P.E. Allen and D.R. Holberg, CMOS analog circuit design (Second Edition), Oxford University Press, New York Oxford, 2002.