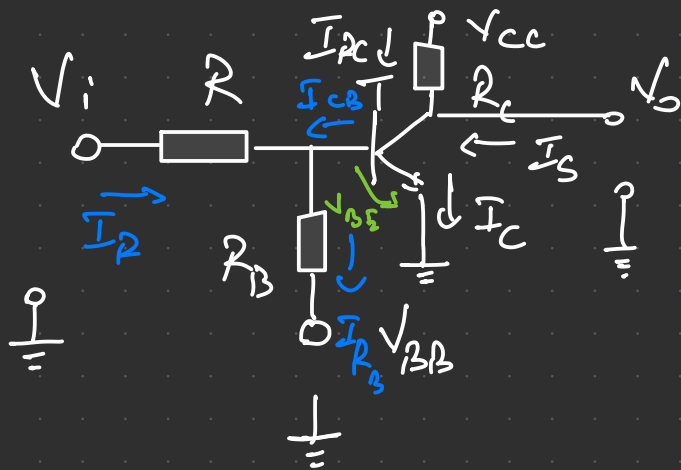


Proiectarea circuitelor numerice



$$V_{CC} > 0$$

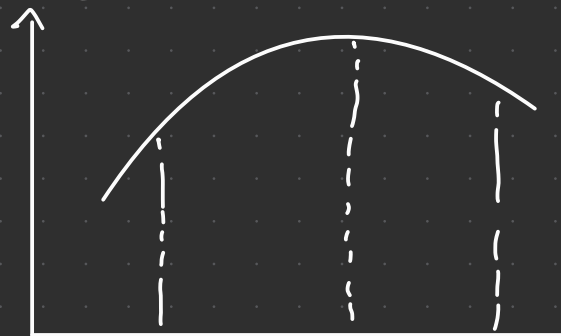
$$V_{BB} < 0$$

a) Dacă $V_i = 0 \rightarrow T \text{ blocat} \rightarrow I_C = I_{CE}$

$$\rightarrow V_o = V_{CC} - I_C R_C \approx V_{CC} = V_H$$

b) Dacă $V_i = V_{CC} \rightarrow T \text{ cond} \Rightarrow \text{saturat} \rightarrow$
 $\rightarrow V_o = V_{CE_{sat}} = 0,1 \approx 0 = V_L$

I_C se alege



$I_{C_{min}}$ $I_{C_{optim}}$ $I_{C_{max}}$

$I_{C_{min}} \rightarrow \text{consum mic}$ $P = I \cdot V$

$I_{C_{max}} \rightarrow \text{încălzire capacități parazitare}$
 + timp de mic



$$I_C = I_{RC} + I_S$$

$$I_{RC} = \frac{1}{2} I_C$$

$$I_S = \frac{1}{2} I_C$$

$$I_{R_B} = I_R + I_{C_0}$$

$$\frac{V_{BE} - V_{BB}}{R_B} = \frac{V_1 - V_{BE}}{R} + I_{C_0}$$

Cond. de bl.

$$V_{BE} \leq 0$$

$$\frac{V_{BE}}{R_B} + \frac{V_{BE}}{R} = \frac{V_{BB}}{R_B} + I_{C_0}$$

$$\frac{V_{BE} (R_B + R)}{R \cdot R_B} = \frac{V_{BB}}{R_B} + I_{C_0}$$

$$\frac{V_{BB}}{R_B} \cdot \frac{R \cdot R_B}{R_B + R} + \frac{I_{C_0} \cdot R \cdot R_B}{R + R_B}$$

$$R_B \leq - \frac{V_{BB}}{I_{C_0}}$$

b) T saturat

$$V_{BE} \geq V_{CE} ; \beta I_B \geq I_C$$

$$I_R = I_B + I_{R_B}$$

$$I_B = I_R - I_{R_B} \geq \frac{I_C}{\beta}$$

$$I = \frac{V_i - V_{BE}}{R}$$

$$V_i = V_{CC}$$

$$V_{BE} = V_{BE_S} \text{ (approx)}$$

$$R \leq \frac{V_{CC} - V_{BE_S}}{\frac{I_C}{\beta} + \frac{V_{BE_S}}{R_B}}$$

funcționalitate logică

a) Dacă $V_i = V_L (\sim 0^V) \rightarrow T_{bl} \rightarrow V_o = V_{CC} = V_H$

b) Dacă $V_i = V_H (\sim V_{CC}) \rightarrow T_{saturat} \rightarrow V_o = V_{CE_S} = V_L$

$$\begin{array}{cc} V_i & V_o \\ V_H & V_L \\ V_L & V_H \end{array} \rightarrow F = \overline{A} \text{ (inverter)}$$

$V_{CC} = 5V$
 $V_{BB} = -1V$
 $V_{BEs} = 0,75V$
 $\beta = 100$
 $I_{C0} = 1\mu A$

a) $I_C = 10mA$
 $\rightarrow I_{R_C} = \frac{1}{2} I_C = 5mA$
 $I_S = \frac{1}{2} I_C = 5mA$

a) $R_C = \frac{V_{CC} - V_{CEs}}{I_{R_C}} = \frac{5 - 0,1}{5 \cdot 10^{-3}} \sim 1k\Omega$

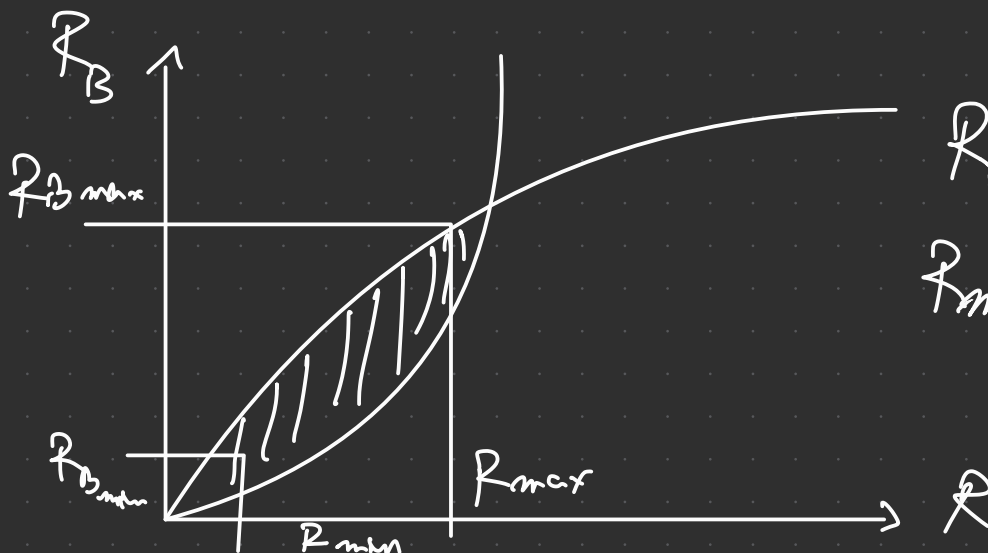
b) $R_B \leq -\frac{V_{BB}}{I_{C0}} = -\frac{-1V}{10^{-6}} = 10^6 = 1M\Omega$

a) $R_B = 100k\Omega$

$R \leq \frac{V_{CC} - V_{BEs}}{\frac{I_C}{\beta} + \frac{V_{BEs} - V_{BB}}{R_B}} = \frac{5 - 0,75}{\frac{10 \cdot 10^{-3}}{100} + \frac{0,75 - (-1)}{100 \cdot 10^3}}$

$R \leq 42,5k\Omega$

$R = 40k\Omega$



$R_{max} \rightarrow I_{min} \rightarrow \text{consum. min.}$

$R_{min} \rightarrow I_{max} \rightarrow \text{cons. max.}$

$\rightarrow \text{temp. minimum}$

Parametri de bază ai circuitelor integrate numerice

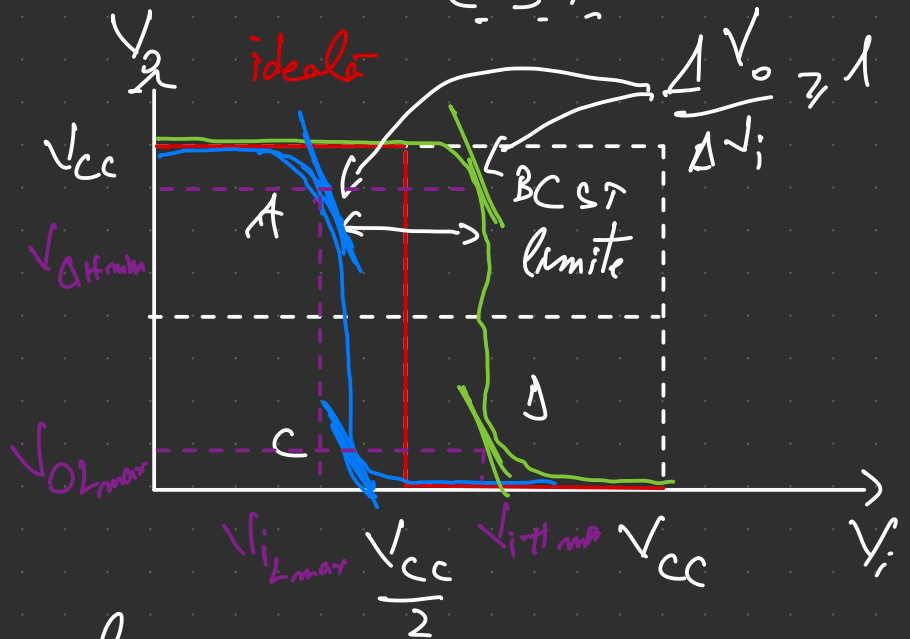
(A) nivel de tensiune

se definesc pe Caract. statică de transfer C.S.T.

$$V_o = f(V_i)$$

C.S.T. ideală

pt. un C.I.N.
cu inversare



factori → temp. lucru

→ tensiunea de alimentare

→ încălzirea C.I.N.

→ param. comp. elec.

→ zgomot electro-mag.

A și B → cel mai defavorabil

def. min

$$\left. \begin{array}{l} V_{OH_{min}} ; V_{OL_{min}} \\ V_{IL_{max}} ; V_{IH_{min}} \end{array} \right\} \rightarrow \text{zone de fct. a cin}$$

a) zona delimitată de $V_{CC} \div V_{OH_{min}} \rightarrow$
 \rightarrow zona garantată la ieşire V_H

b) zona delur. de $[0 \div V_{OL_{min}}]$, nivel logic inf.

c) $[0 \div V_{IL_{max}}]$ \rightarrow zonă admisă la intrare pt. nivelul logic inf.

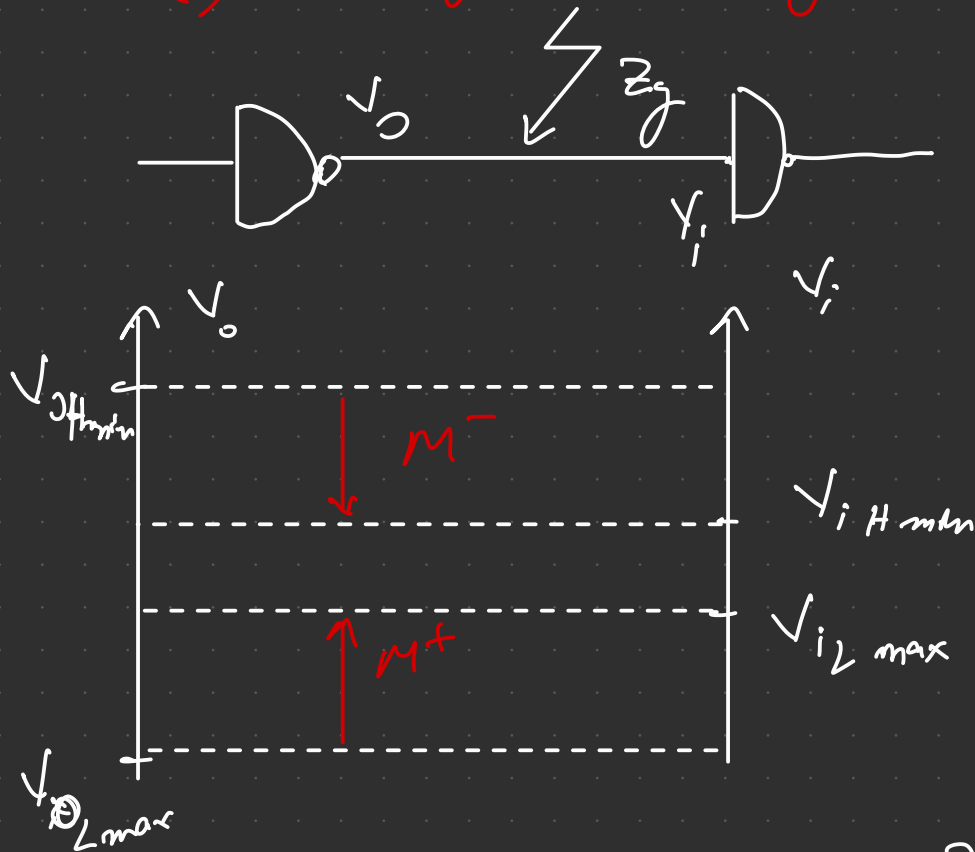
d) $[V_{IH_{min}} \div V_{CC}] \rightarrow$ nivel logic superior

e) zona $\in [V_{IH_{min}} ; V_{IL_{max}}] \rightarrow$ zonă de tranziție, producătorul nu garantează fct. logică, nedefinit

$$V_{IL_{max}} \leq 0$$

$$V_{IH_{max}} \geq V_{CC}$$

(B) Marginea de zgomot



$$M^- = V_{oHmin} - V_{iHmin} [V]$$

$$M^+ = V_{iLmax} - V_{oLmax} [V]$$

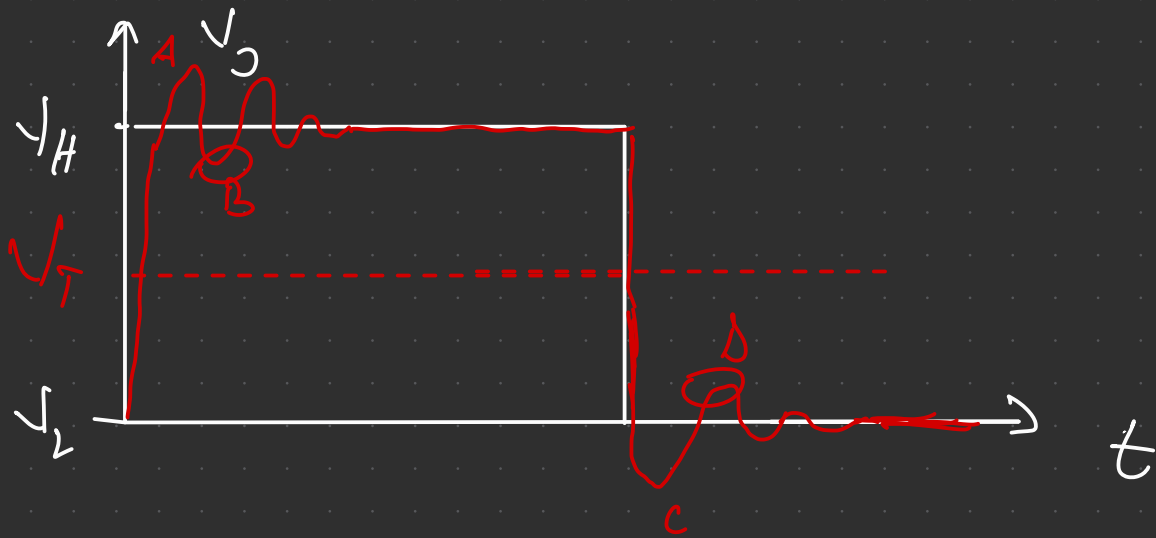
ex. min TTL $\rightarrow V_{oHmin} = 2,4V$

$$V_{iHmin} = 2V$$

$$V_{oLmax} = 0,4V$$

$$V_{iLmax} = 0,8V$$

$$M^+ = M^- = 0,4$$



B, C → periculoase din pct. de vedere logic

A, D → periculoase din pct. vedere electronic

$$M_T \text{ normale} \rightarrow M_{\text{Tipic}}^- = V_H - V_T$$

$$M_{\text{Tipic}}^+ = V_T - V_L$$

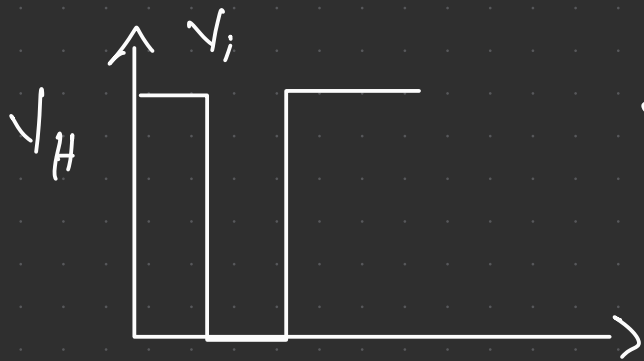
ex. TTL $V_H = 3,5V$ $V_T = 1,5V$

$$V_L = 0,2V$$

$$M^- = 2V$$

$$M^+ = 1,3V$$

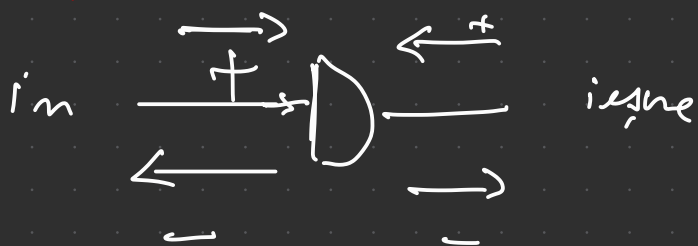
semnale de comandă



→ probabilitatea de disfuncț. → dacă V_i

$$\left(\begin{array}{l} M_T^+ = 1,3V, \quad M_T^- = 2V \\ M_T^+ < M_T^- \end{array} \right)$$

C) Factor de încărcare



Factor de încărcare → $F_{iL} = 1 \mid F_{iH} = 1$

ex TTL $I_{iL} = -1,6 \text{ mA}$

$$I_{iH} = 40 \mu A$$

$$F_{EH} = \left| \frac{I_{OH}}{I_{iH}} \right| = \text{m. întreg. poz}$$

Ex. TTL

$$I_{OH} = -0,8 \text{ mA}$$

$$F_{EL} = \left| \frac{I_{OL}}{I_{iL}} \right| = \text{m. întreg. poz}$$

$$\left(= \frac{1,6}{-1,6} = 10 \right)$$

$$I_{OL} = 16 \text{ mA}$$

$$F_E = \min(F_{E_H}, F_{E_L}) \geq 10 \text{ (parti)}$$

cu o parte TTL \rightarrow pot comanda max 10
partii