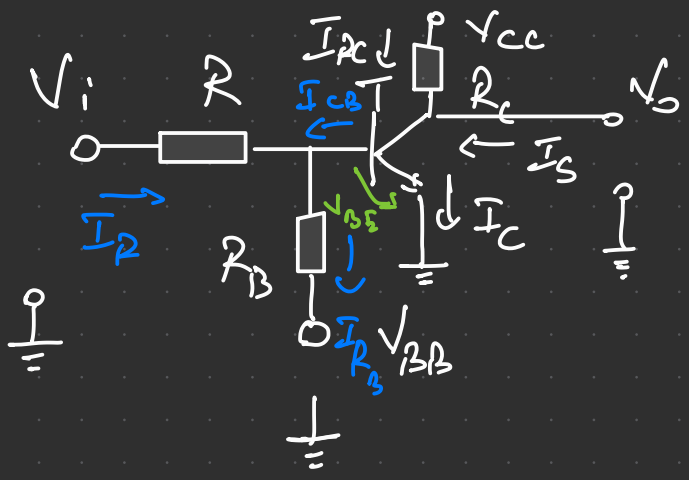
Proiectarea circuitelor numerice



$V_{CC} > 0$

$V_{BB} < 0$

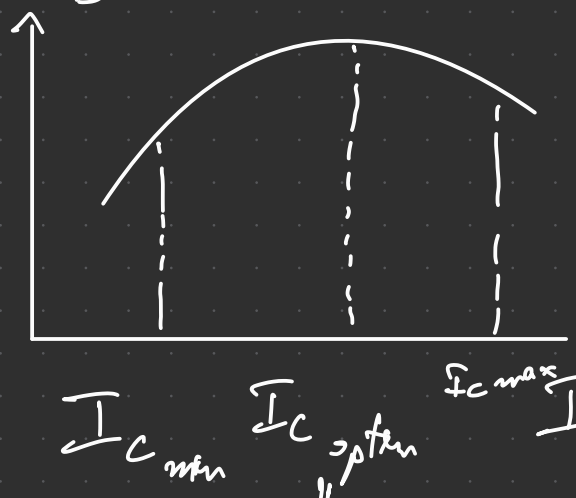
a) Dacă $V_i = 0^V \rightarrow$ T blo. $\rightarrow I_C = I_{CC}$

$\rightarrow V_0 = V_{CC} - I_C R_C \approx V_{CC} = V_H$

b) Dacă $V_i = V_{CC} \rightarrow$ T cond $\Rightarrow$ saturat $\rightarrow$

$\rightarrow V_0 = V_{CE_S} = 0{,}1^V \approx 0^V = V_L$

I_C se alege



$I_{C_{min}}$ → consum mic

I_C ↑ $P = I \cdot V$

$I_{C_{max}}$ → încărcare capacitate parazită
↓ timp blo. mic

$I_C \rightarrow I_{RC}$, I_S

$I_C = I_{RC} + I_S$

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

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

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

Cond. di bl. $\quad V_{BE} \leq 0$

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

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

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

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

b) T saturat

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

$I_R = I_B + I_{R_B}$

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

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

$V_i = V_{CC}$

$V_{BE} = V_{BE_S}$ (aprox)

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

functionalitate logică

a) Dacă $V_i = V_L$ ($\sim 0^V$) -> T blocat -> $V_o = V_{CC} = V_H$

b) Dacă $V_i = V_H$ ($\sim V_{CC}$) -> T saturat -> $V_o = V_{CE_S} = V_L$

V_i	V_o
V_H	V_L
V_L	V_H

-> $F = \overline{A}$ (inversor)

Fie $V_{CC} = 5V$ alegem $I_C = 10\,mA$

$V_{BB} = -1\,V$

$V_{BES} = 0{,}7\,V$ $\beta = 100$ $\rightarrow I_{R_C} = \frac{1}{2} I_C = 5\,mA$

$I_{C_0} = 1\,\mu A$ $I_S = \frac{1}{2} I_C = 5\,mA$

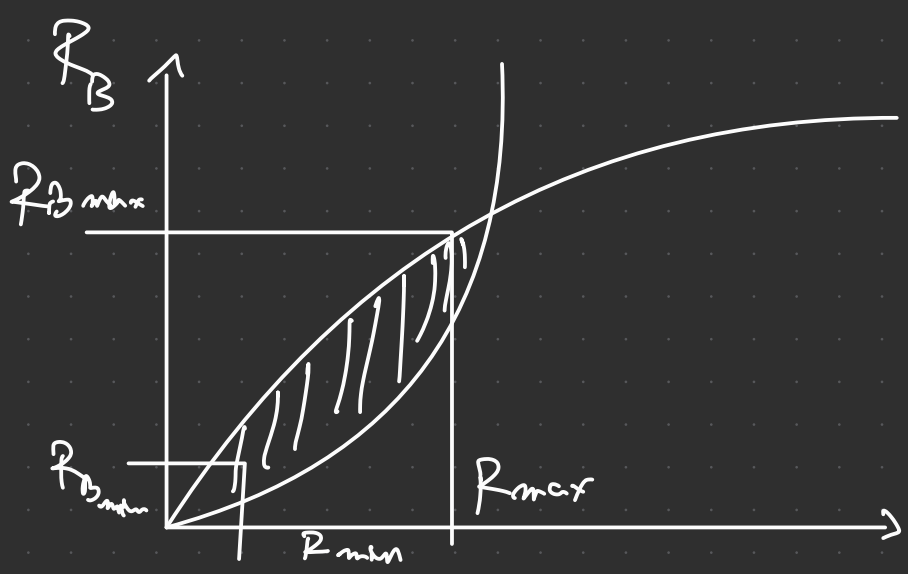
a) $R_C = \frac{V_{CC} - V_{CES}}{I_{R_C}} = \frac{5 - 0{,}1}{5 \cdot 10^{-3}} \sim 1\,k\Omega$

b) $R_B \leq -\frac{V_{BB}}{I_{C_0}} = -\frac{-1}{10^{-6}} = 10^6 = 1\,M\Omega$

alegem $R_B = 100\,k\Omega$

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

$R \leq 42{,}5\,k\Omega$ $R = 40\,k\Omega$



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

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

$\rightarrow$ temp min

Parametrii de bază ai circuitelor integrate numerice

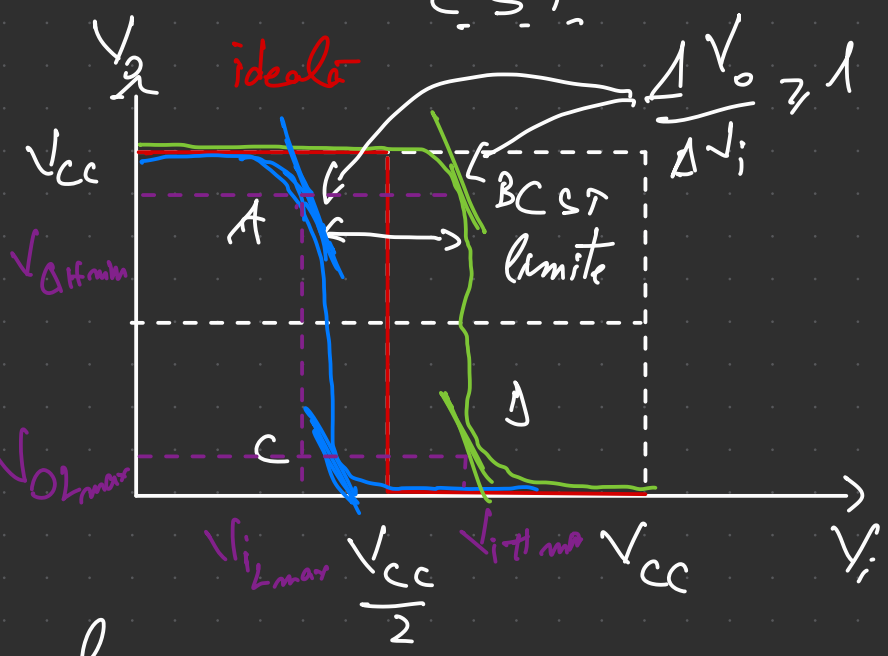
(A) nivel de tensiune

se definesc pe Caract. statică de transfer

$V_o = f(V_i)$

C.S.T. ideală

pt. un CIN cu inversare



factori → temp. lucru
→ tensiunea de alimentare
→ încărcarea CIN
→ param. comp. elec.
→ zgomot electro-mag.

A și D → cel mai defavorabil

def. mai

$V_{OH\,min}$; $V_{OL\,max}$
$V_{iL\,max}$; $V_{iH\,min}$
} → zone de fct. a CIN

a) zona delimitată de $V_{CC} \div V_{OH\,min}$ →
→ zona garantată la ieșire V_H

b) zona delim. de $[0 \div V_{OL\,max}]$ → nivel logic inf.

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

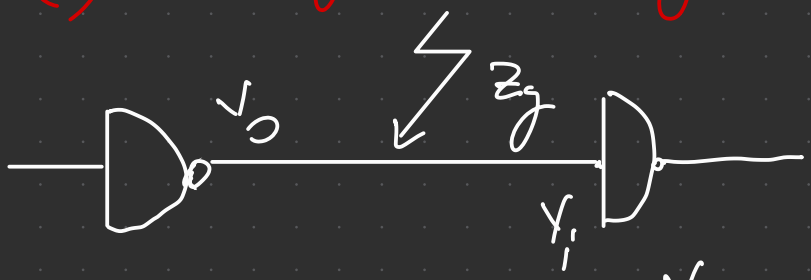
d) $[V_{iH\,min} \div V_{CC}]$ → nivel logic superior

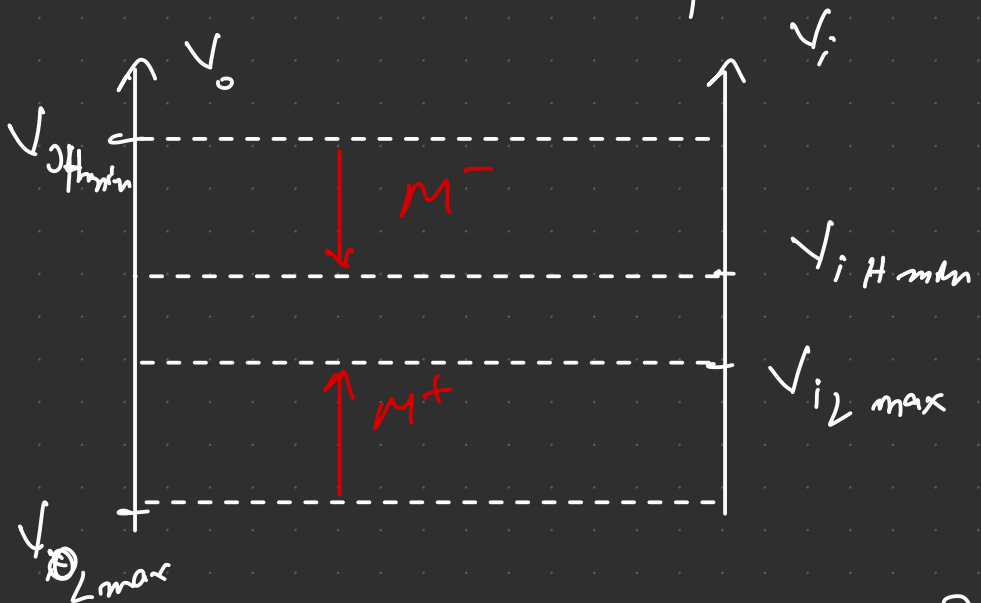
e) zona $\in [V_{iH\,min}, V_{iL\,max}]$ → zonă de tranziție, producătorul nu garantează fct. logice → nedefinit

$V_{IL\,max} \leq 0^{V}$

$V_{IH\,max} \geq V_{CC}$

(B) Marginea de zgomot





$$M^- = V_{O\,H\,min} - V_{I\,H\,min}\ [V]$$

$$M^+ = V_{I\,L\,max} - V_{O\,L\,max}\ [V]$$

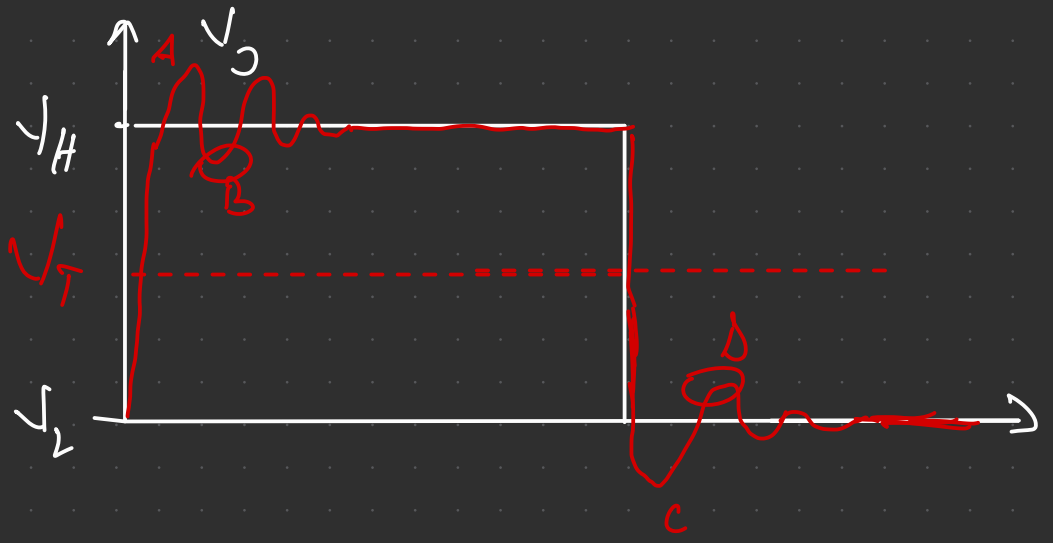
ex. min TTL $\Rightarrow V_{O\,H\,min} = 2{,}4\,V$

$V_{I\,H\,min} = 2\,V$

$V_{O\,L\,max} = 0{,}4\,V$

$V_{I\,L\,max} = 0{,}8\,V$

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



B, C → perturbare din pct. de vedere logic

A, D → perturbare din pct. vedere electronic

M_Z normale → $M^-_{Tipic} = V_H - V_T$

$M^+_{Tipic} = V_T - V_L$

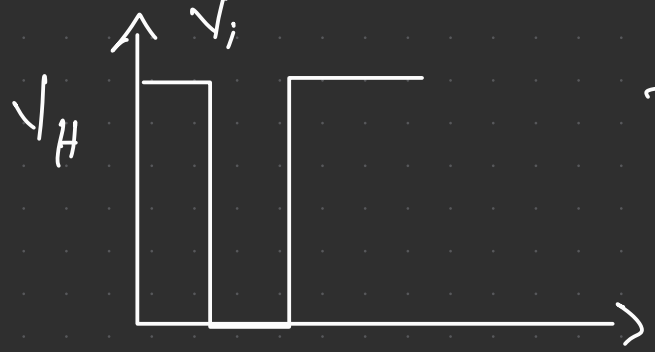
ex. TTL $V_H = 3,5V$ $V_T = 1,5$

$V_L = 0,2V$

$M^- = 2V$

$M^+ = 1,3V$

semnale de comandă

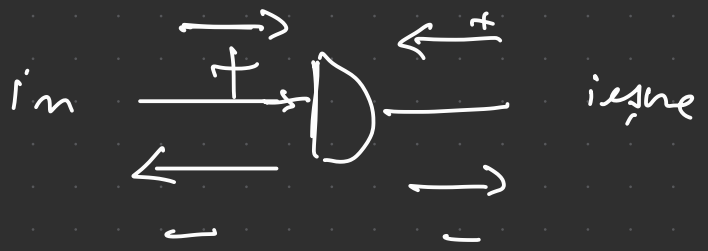


→ probabilitatea de disfunct. → dacă V_L

($M_T^+ = 1,3V$; $M_T^- = 2V$

$M_T^+ < M_T^-$)

(c) Factor de încărcare



Factor de încărcare → $F_{i_L} = 1$ | $F_{i_H} = 1$

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

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

$F_{E_H} = \left| \frac{I_{OH}}{I_{iH}} \right|$ = nr. întreg. pt. $\frac{-0,8}{0,04}$ (= 20)

$F_{E_L} = \left| \frac{I_{OL}}{I_{iL}} \right|$ = nr. întreg pt. $\left(= \frac{16}{-1,6} = 10\right)$

Ex. TTL

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

$I_{OL} = 16\ mA$

I

$$F_E = \min\left(F_{E\,H}\, i\, F_{E\,L}\right) \geq 10 \text{ (puncte)}$$

cu o poartă TTL → pot comanda max 10 porți