CD - CURS 5

1. $\overset{\circ}{I}_C = \alpha \cdot \overset{\circ}{I}_E + \overset{\circ}{I}_{C0}$ $\qquad \alpha = \frac{\overset{\circ}{I}_C}{\overset{\circ}{I}_E} < 1$

2. $\overset{\circ}{I}_E = \overset{\circ}{I}_C + \overset{\circ}{I}_B \quad / \cdot \overset{\circ}{I}_C$ $\qquad \frac{\overset{\circ}{I}_E}{\overset{\circ}{I}_C} = 1 + \frac{\overset{\circ}{I}_B}{\overset{\circ}{I}_C} \Rightarrow$

$\Rightarrow \frac{1}{\alpha} = 1 + \frac{1}{\beta}$ $\qquad \alpha = \frac{\beta}{1+\beta} < 1$

$\beta = \frac{\alpha}{1-\alpha}$

3. $\overset{\circ}{I}_B \cdot \beta = \overset{\circ}{I}_C$

$\beta = \frac{\overset{\circ}{I}_C}{\overset{\circ}{I}_B} \gg 1$

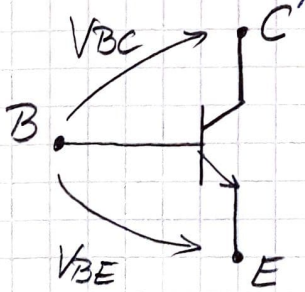
$\alpha = 0,9 \div 0,99$

$\beta = 10 \div 200$

ex: $\alpha = 0,99$

$\beta = \frac{0,99}{1-0,99} \cong 100$

Regimul de funcționare a tranzistorului




(1) $j_{BE}$ inv. $\quad j_{BC}$ inv. $\quad \overset{\circ}{I}_C = \overset{\circ}{I}_{C0}$ (regim blocat)

(2) directă $\quad$ inv. $\quad$ regim activ

a) (BC) $\overset{\circ}{I}_C = \alpha \cdot \overset{\circ}{I}_E + \overset{\circ}{I}_{C0}$

$\Rightarrow$ tranzistorul funcționează ca repetor

b) (EC) $\overset{\circ}{I}_C = \beta \cdot \overset{\circ}{I}_B$

$\Rightarrow$ amplificator

| | $j_{BE}$ | $j_{BC}$ | |
|---|---|---|---|
| (3) | inv. | directă | regimul invers |

$$\underline{I}^{\circ}_{E_i} = \alpha_i \underline{I}^{\circ}_{C_i} + \underline{I}^{\circ}_{E_0}$$

↳ curentul rezidual de emitor

$$\alpha_i = 0{,}01 \div 0{,}5$$

atenuator

| | | | |
|---|---|---|---|
| (4) | directă | directă | regimul saturat |

$$\underline{I}^{\circ}_{C} = ct. = \underline{I}^{\circ}_{CS} \ (max)$$

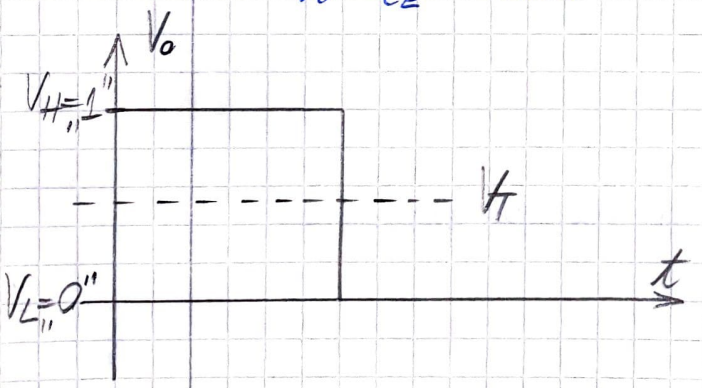
↳ curentul de saturație

$$V_{BE} = V_{BE_S} \approx ct. = 0{,}75\,V$$

$$V_{CE} = V_{CE_S} = ct. = 0{,}1 \div 0{,}2\,V$$

comutator

saturat $\begin{cases} \underline{I}^{\circ}_{C} \ max \\ V_0 = V_{CE} = min \end{cases}$ blocat $\begin{cases} \underline{I}^{\circ}_{C} - min\,(\underline{I}^{\circ}_{C0}) \\ V_0 = V_{CC} = max \end{cases}$




Analiza regimului blocat

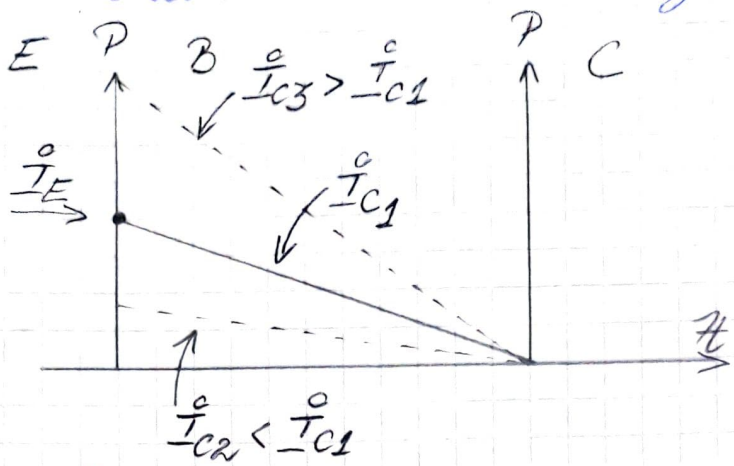
$V_{BE} < 0\,V$

(BC) $\quad \underline{I}^{\circ}_{E} = 0\,V$

(EC) $\quad \underline{I}^{\circ}_{B} = -\underline{I}^{\circ}_{C0}$

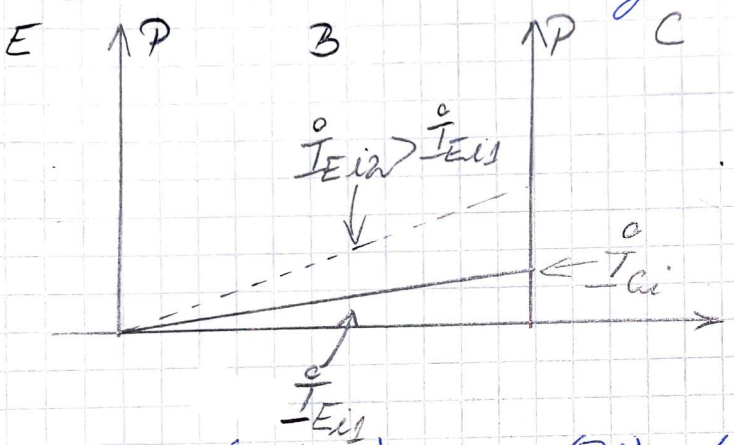
## Analiza regimului saturat

Tranzistorul este în regim activ



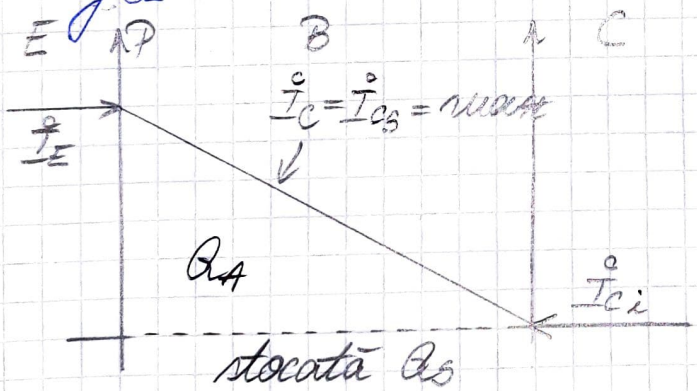

($j_{BE}$ pol. direct
$j_{BC}$ pol. invers)

Tranzistorul este în regim invers




($j_{BE}$ pol. invers
$j_{BC}$ pol. directă)

$j_{BE}$ (direct) (BC) direct




Saturată

$\overset{\circ}{I}_C = \overset{\circ}{I}_{CS}$ ($max \overset{\circ}{I}_C$)

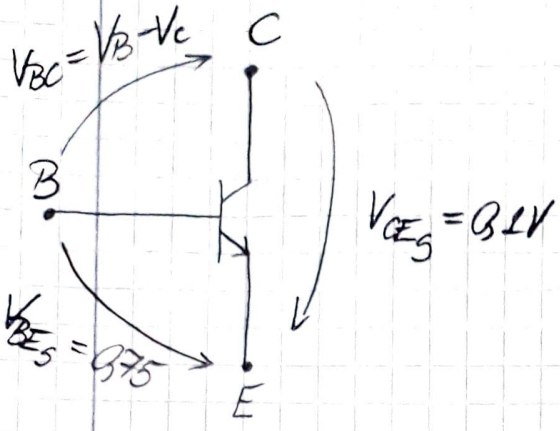
$V_{CE} = ct$ ($V_{CES} \approx 0,1 \div 0,2 V$)

$V_{BE} = ct.$ ($V_{BES} \approx 0,75 V$)

Sat.

$$\overset{\circ}{I}_B \cdot \beta \geq \overset{\circ}{I}_{CS}$$

$$V_{BES} \geq V_{CES}$$

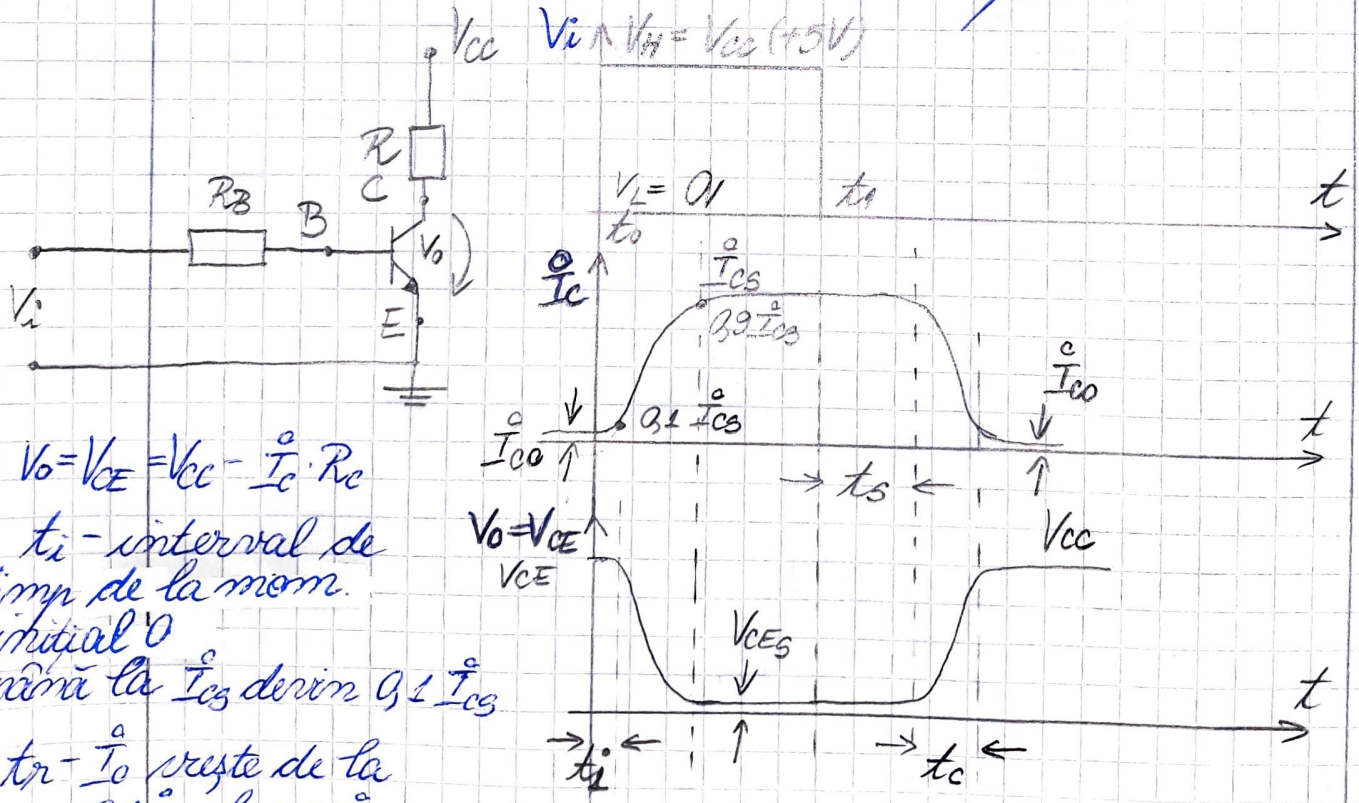



$V_{BC}=V_B-V_C=V_{BE_S}-V_{CE_S}$
$=0,75-0,1$
$=0,65V$

| $V_{BE}$ (blocare) | $V_{BE}$ (activ) | $V_{BE}$ (prag) | $V_{BE}$ (saturat) |
|---|---|---|---|
| $\approx 0V$ | $0,5V$ | $0,65V$ | $0,75V$ |

| $V_{CE}$ (blocare) | $V_{CE}$ (activ) | $V_{CE}$ (saturat) |
|---|---|---|
| $\approx V_{CC}$ | ? | $0,1V-0,2V$ |

## Parametrii dinamici ai tranzistorului bipolar




$V_0=V_{CE}=V_{CC}-\overset{\circ}{I}_C\cdot R_C$

$t_i$ - interval de timp de la mom. inițial 0 până la $\overset{\circ}{I}_{CS}$ devin $0,1\,\overset{\circ}{I}_{CS}$

$t_r$ - $\overset{\circ}{I}_C$ crește de la $0,1\,\overset{\circ}{I}_{CS}$ la $0,9\,\overset{\circ}{I}_{CS}$

$t_1$ - momentul de blocare a tranzistorului

$t_S$ - $\overset{\circ}{I}_{CS}$ = st. $t_1$ - la $0,9\,\overset{\circ}{I}_{CS}$

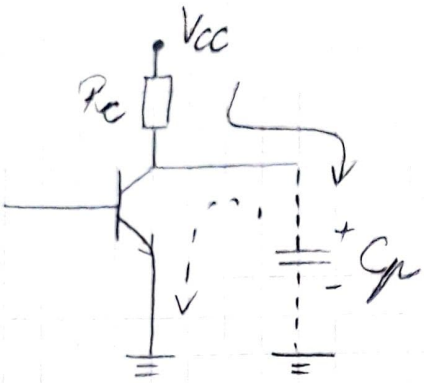
$t_c$ - $\overset{\circ}{I}_{CS}$ scade de la $0,9$ la $0,1\,\overset{\circ}{I}_{CS}$

$t_{deblocare}=t_i+t_r$

$t_{blocare}=t_S+t_c$

$t_d$ - t. m. mic

$t_s$ - t. m. mari

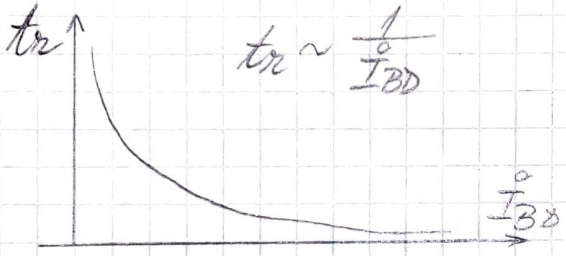


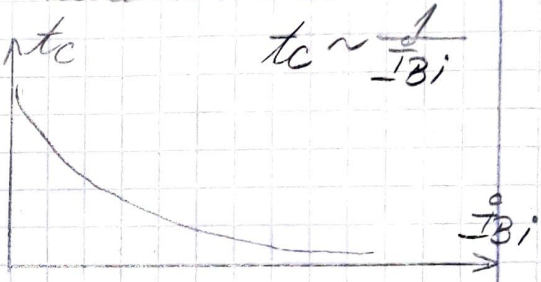

1. $t_i \to 0$

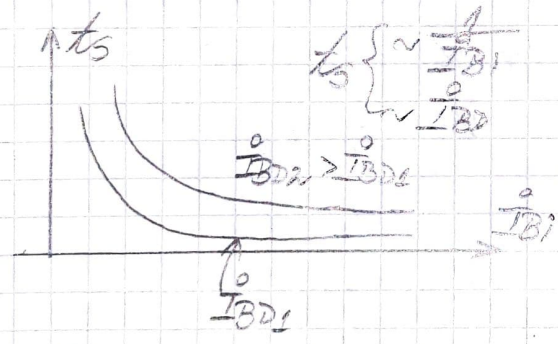
$V_{BEsat} \approx V_{BET}$

(0,65 V)

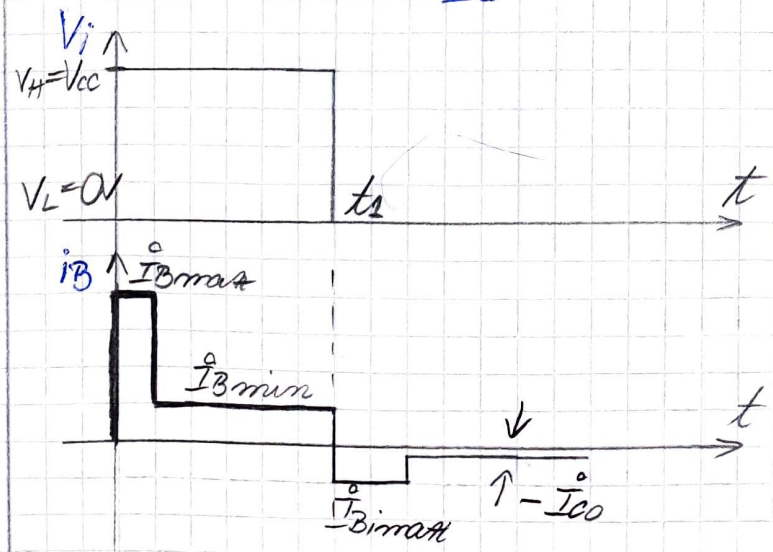
2. $t_r \overset{\text{depinde}}{\to} I_{BD}$ (deblocare tr.) - curent direct de bază

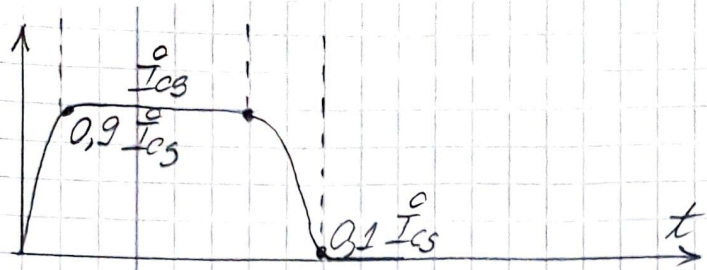


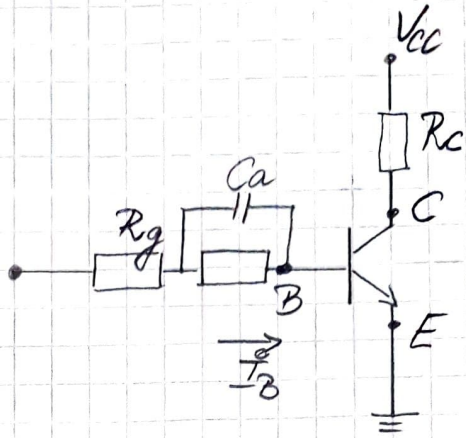



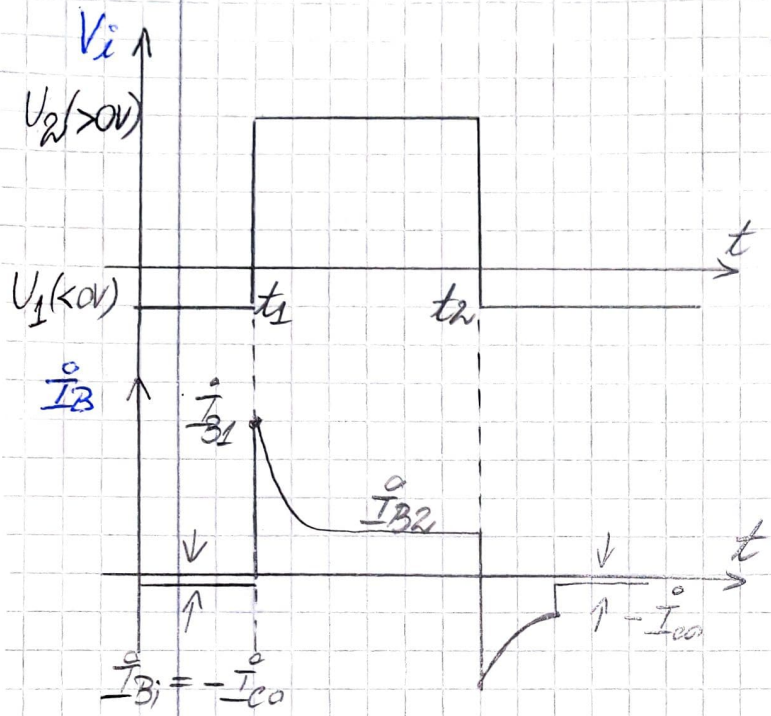




Forma ideală a $i_B$



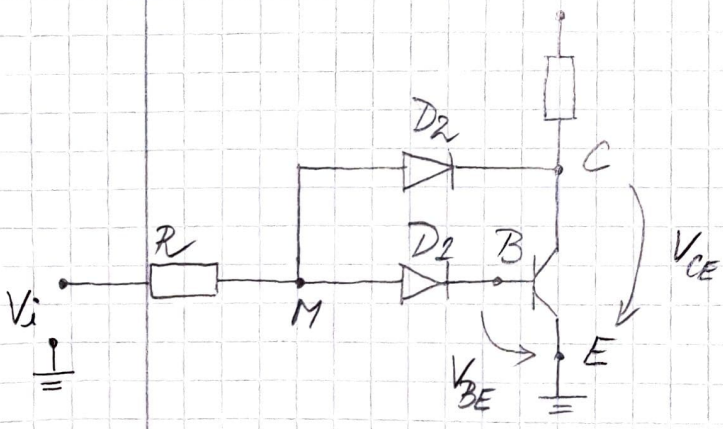



*Metode de micșorare a timpului de saturare*

→ *Utilizarea a două diode cu reacție negativă*




$V_M = V_{D1} + V_{BE}$ } ⇒

$V_M = V_{D2} + V_{CE}$ }

$\Rightarrow V_{D1} + V_{BE} = V_{D2} + V_{CE}$

$V_{BE} - V_{CE} = V_{D2} - V_{D1}$

Deci $V_{CE} > V_{BE}$

$V_{BE\,sat} \geq V_{CE\,sat}$.

$D_1$ - Si $V_{D1} = 0,75V$

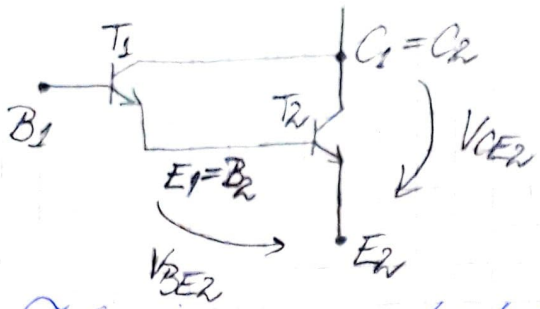
$D_2$ - Ge $V_{D2} = 0,35V$

$V_M = V_{BE_S} + V_{D1} = 0,75 + 0,75 = 1,5V$

$V_C = V_M - V_{D2} = 1,5 - 0,35 = 1,15V$

$(V_C = 1,15V > V_B = 0,75V)$ ⇒ Tranzistorul nu se saturează

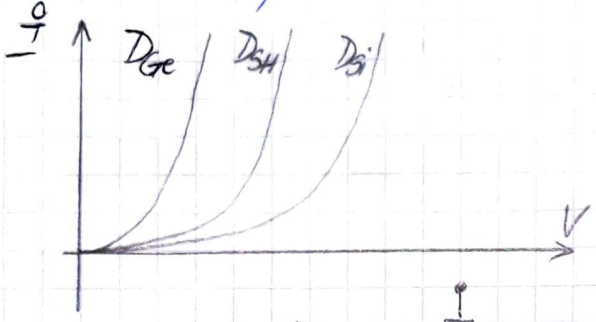
→ Utilizarea tranzistorului compus




$T_2$ nu se mai saturează

→ Folosirea unei diode Schottky

• are timpi de comutare foarte foarte mici

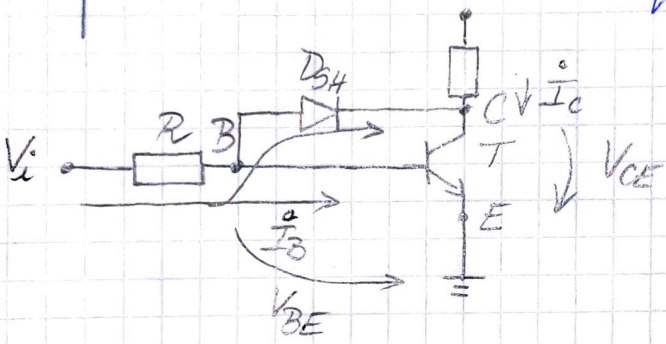



$V_{DSH} = 0,5V$

$V_{DSi} = 0,75V$

$V_{BES} = 0,75V$

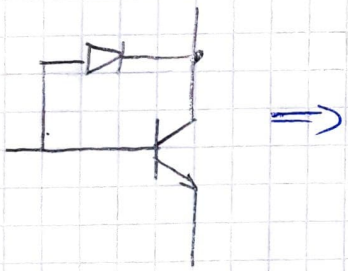
$V_{CE} = V_{BE} - V_{DS} = 0,75 - 0,5 = 0,25V$




$\overset{o}{I_B} \cdot \beta \geq \overset{o}{I_C}$

$\overset{o}{I_B} \downarrow$ și $\overset{o}{I_C} \uparrow$

T să nu se satureze



⇒ Tranzistorul Schottky