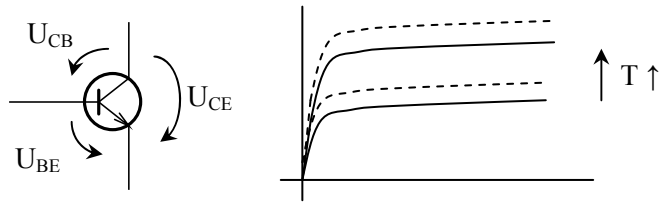
Teplotní závislost tranzistoru

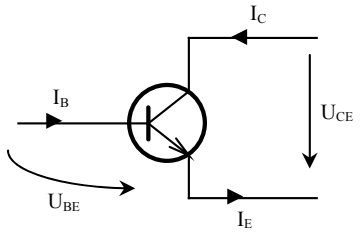


$$U_{CB} + U_{BE} = U_{CE}$$

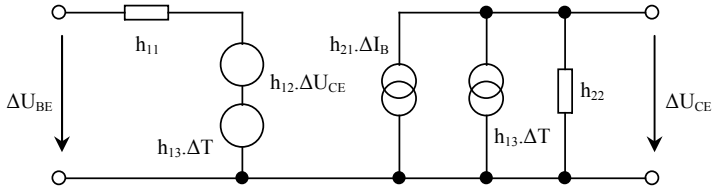
$$P_{C_{max}} = U_{CE_{max}}.I_{CE\,max} = \frac{\vartheta_{j_{max}} - \vartheta_C}{R_{th}}$$

$$I_{CE_0} = I_{CB_0}(1 + h_{21E})$$

Poloha pracovního bodu při teplotě T=25°C a T=50°C



$$\Delta U_{BE} = h_{11}.\Delta I_B + h_{12}.\Delta U_{CE} + h_{13}.\Delta T$$
$$\Delta I_C = h_{21}.\Delta I_B + h_{22}.\Delta U_{CE} + h_{13}.\Delta T$$



Teplotní koeficient:

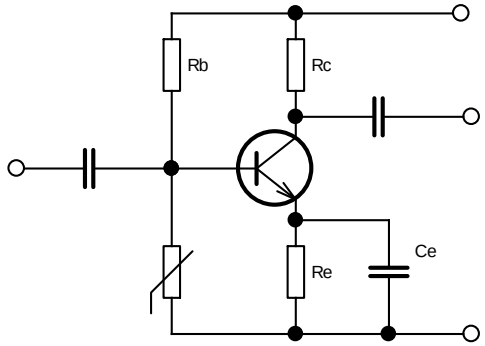
$$T_k = \frac{\Delta U_{BE}}{\Delta T} < 0$$

- Pro Ge 1,8 – 2,2 mV/°C
- Pro Si 3,3 mV/°C

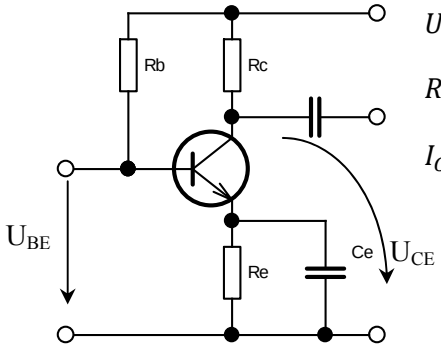
T 10°C I_{CB0} zvětší 100%, zmenšení I_C, U_{CE} maximální

Stabilizace tranzistoru

Teplotně závislý prvek



Zapojení zpětnovazebního odporu



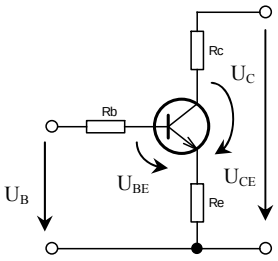
$$U_C = R_C.I_C + U_{CE}$$

$$U_C = R_B.I_B + U_{BE}$$

$$R_B = \frac{U_C - U_{BE}}{I_B} = \langle 400 \div 600 \rangle$$

$$I_C = \langle 2 \div 10 \rangle . I_B$$

<u>Stabilizace pomocí zpětné vazby u germaniového tranzistoru</u>



$$U_C = R_C.I_C + U_{CE}$$

$$U_B = R_B.I_B + U_{BE} + R_E.I_E$$

$$I_C = h_{21E}.I_B + I_{CE_0} \Rightarrow I_B = \frac{I_C - I_{CE_0}}{h_{21E}}$$

$$U_B = R_B.\frac{I_C - I_{CE_0}}{h_{21E}} + U_{BE} + R_E.\left(I_C + \frac{I_C - I_{CE_0}}{h_{21E}}\right) \quad |.h_{21E}$$

$$U_B.h21_E = R_B.\left(I_C - I_{CE_0}\right) + U_{BE}.h_{21E} + R_E.I_C.h_{21E} + R_E.I_C - R_E.I_{CE_0}$$

$$I_C.[R_B + R_E.(1 + h_{21E})] = -U_{BE}.h_{21E} + U_B.h_{21E} + I_{CE_0}.(R_B + R_E)$$

$$I_C = \frac{-U_{BE}.h_{21E} + U_B.h_{21E} + I_{CE_0}.(R_B + R_E)}{R_B + R_E.(1 + h_{21E})}$$

Činitel stabilizace tranzistoru

Pro Si tranzistory:

$$\frac{\Delta I_C}{\Delta U_{BE}} = \frac{dI_C}{dU_{BE}} = \frac{1}{R_B + R_E.(1 + h_{21E})}.(-1).h_{21E}$$

Pro Ge tranzistory:

$$\frac{\Delta I_C}{\Delta I_{CE_0}} = \frac{dI_C}{dI_{CE_0}} = \frac{1}{R_B + R_E.(1 + h_{21E})}.(R_E + R_B)$$

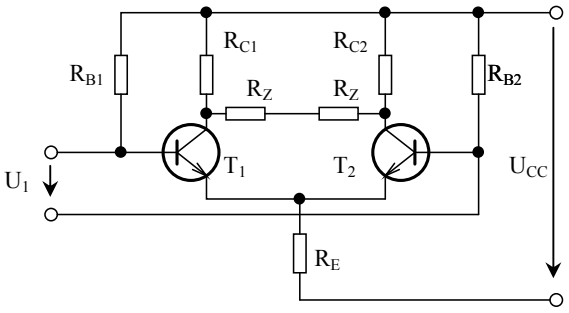
- co nejmenší

$U_B = U_{BE} + R_B.I_B + R_E.I_E = \text{konst.}$
T ↑ ⇒ I_E ↑

$$C_E = \frac{h_{21E}}{2\pi f.(h_{11E} + R_i)}$$

- **Stabilizace je kompromis mezi I_{CE} a činitelem stabilizace**

Diferenční zesilovač



$$U_1 = U_{B1} - U_{B2} = U_{BE1} + U_E - (U_{BE2} + U_E) = \\ = U_{BE1} - U_{BE2}$$
$$U_2 = U_{CC} - R_{C1}.I_{C1} - (U_{CC} - R_{C2}.I_{C2}) = \\ = -R_{C1}.I_{C1} + R_{C2}.I_{C2}$$

- R_{C1} a R_{C2} jsou stejné
  $U_2 = -R_C.(I_{C1} - I_{C2})$

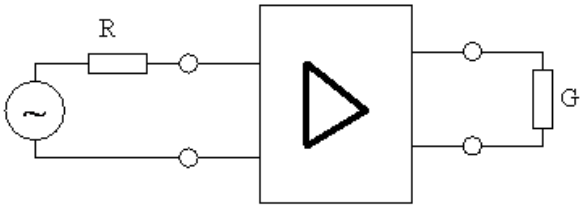
- Pro tranzistor jako dvojbran platí *y* parametry

$I_1 = I_B = y_{11}.U_1 + y_{12}.U_2$
$I_2 = y_{21}.U_1 + y_{22}.U_2 \quad y_{22} \ll 1$
$I_2 = I_C = y_{21}.U_1$
$U_2 = -R_C.(I_{C1} - I_{C2}) = -R_C.y_{21}.U_1 = -R_C.y_{21}.(U_{BE1} - U_{BE2})$

$$A_U = \frac{U_2}{U_1} = \frac{-R_C.y_{21}.U_1}{U_1} = \frac{-R_C.y_{21}.(U_{BE1} - U_{BE2})}{U_{BE1} - U_{BE2}} = -R_C.y_{21}$$

Potlačení CCMR

- Pro potlačení CCMR použijeme zdroj proudu



$$u_1 = h_{11}.i_1 + h_{12}.u_2$$
$$i_2 = h_{21}.i_2 + h_{22}.u_2$$

$$u_1 = U_G - R.i_1$$
$$u_2 = -R_Z.i_z$$

$$A_i = \frac{i_2}{i_1} = h_{21} + h_{22}$$
$i_2 = h_{21}.i_1 + h_{22}.(-R_Z.i_Z)$
$i_2.(1 + h_{21}.R_Z) = h_{21}.i_1$
$$A_i = \frac{i_2}{i_1} = \frac{h_{21}}{1 + h_{22}.R_Z}$$

1. $R_Z = 0 \Rightarrow A_i = h_{21}$
2. $R_Z = \infty \Rightarrow A_i = 0$