Wzmacniacz tranzystorowy w układzie WK (OC)

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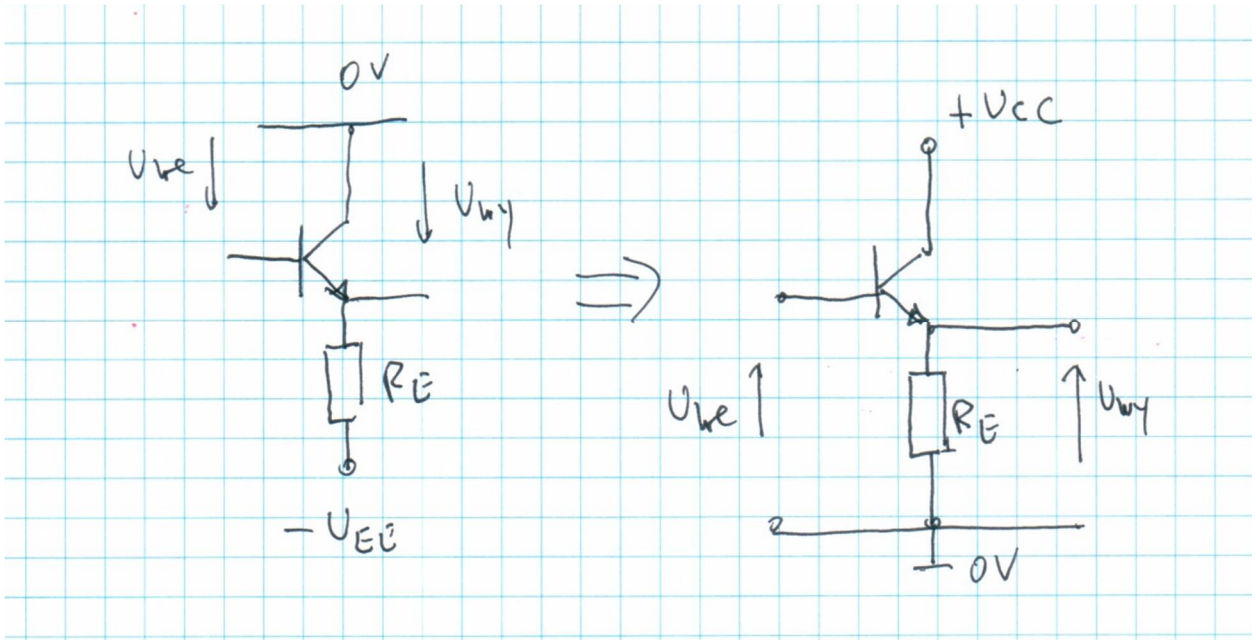

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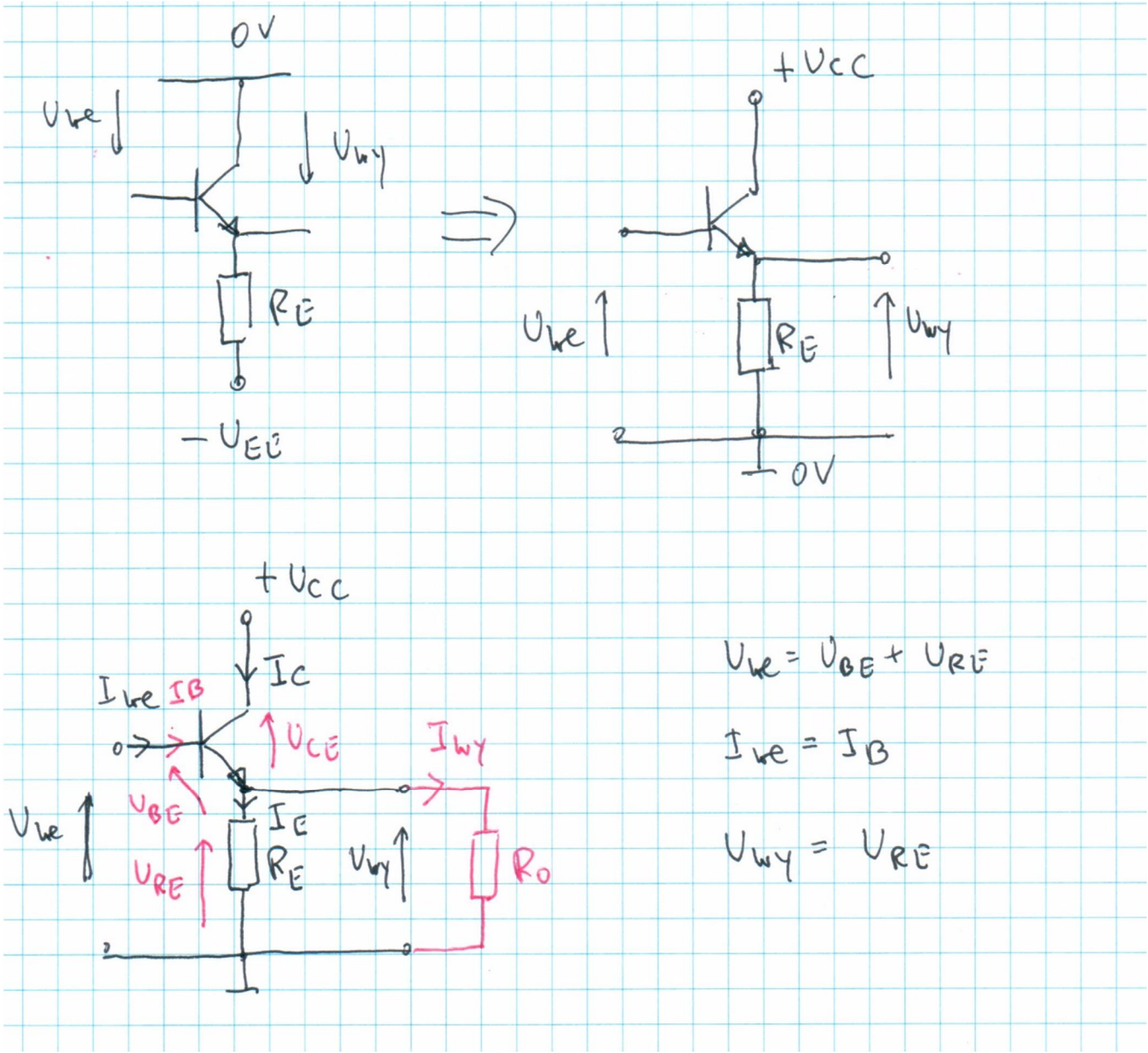

Wzmacniacz tranzystorowy w układzie WK (OC)

$$K_{U0} = \frac{\Delta U_{wy}}{\Delta U_{we}}\bigg|_{I_{wy}=0} = \frac{\Delta U_{RE}}{\Delta U_{BE} + \Delta U_{RE}} \;/\Delta U_{RE} = \frac{1}{\frac{\Delta U_{BE}}{\Delta U_{RE}} + 1} \approx 1$$

$$\frac{\Delta U_{BE}}{\Delta U_{RE}} \to 0$$

Wzmacniacz tranzystorowy w układzie WK (OC)

$$K_{U0} = \frac{\Delta U_{wy}}{\Delta U_{we}}\bigg|_{I_{wy}=0} = \frac{\Delta U_{RE}}{\Delta U_{BE} + \Delta U_{RE}} = \frac{1}{\frac{\Delta U_{BE}}{\Delta U_{RE}} + 1} \approx 1$$

$$\frac{\Delta U_{BE}}{\Delta U_{RE}} \to 0$$

Dokładniej

$$\Delta U_{wy} = \Delta U_{RE} = R_E \cdot \Delta I_E \approx R_E \cdot \Delta I_C$$

$$\Delta U_{we} = \Delta U_{BE} + \Delta U_{RE}$$

$$I_E = I_C + I_B = \left(1 + \frac{1}{\beta}\right) \cdot I_C \simeq I_C$$

$$I_C = \beta \cdot I_B$$

$$I_B = \frac{1}{\beta} \cdot I_C \qquad \beta > 100$$

Wzmacniacz tranzystorowy w układzie WK (OC)

$$\Delta I_C = g_m \cdot \Delta U_{BE} + \frac{1}{r_{CE}} \Delta U_{CE}$$

$$\Delta U_{BE} = \frac{1}{g_m} \cdot \Delta I_C - \frac{1}{g_m \cdot r_{CE}} \Delta U_{CE}$$

$$U_{CC} = U_{CE} + U_{wy}$$

$$\Delta U_{CC} = \Delta U_{CE} + \Delta U_{wy} = 0 \qquad \Delta U_{CE} = -\Delta U_{wy} = -R_E \cdot \Delta I_E \approx -R_E \cdot \Delta I_C$$

$$\Delta U_{BE} = \frac{1}{g_m} \cdot \Delta I_C + \frac{R_E}{g_m \cdot r_{CE}} \cdot \Delta I_C = \frac{1}{g_m} \left(1 + \frac{R_E}{r_{CE}}\right) \cdot \Delta I_C$$

Wzmacniacz tranzystorowy w układzie WK (OC)

$$\Delta I_C = g_m \cdot \Delta U_{BE} + \frac{1}{r_{CE}} \Delta U_{CE}$$

$$\Delta U_{BE} = \frac{1}{g_m} \cdot \Delta I_C - \frac{1}{g_m \cdot r_{CE}} \Delta U_{CE}$$

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$$\Delta U_{BE} = \frac{1}{g_m} \cdot \Delta I_C + \frac{R_E}{g_m \cdot r_{CE}} \cdot \Delta I_C = \frac{1}{g_m} \left(1 + \frac{R_E}{r_{CE}}\right) \cdot \Delta I_C$$

$$K_{U_0} \approx \frac{R_E \cdot \Delta I_C}{\frac{1}{g_m}\left(1 + \frac{R_E}{r_{CE}}\right) \cdot \Delta I_C + R_E \cdot \Delta I_C} = \frac{R_E}{\frac{1}{g_m}\left(1 + \frac{R_E}{r_{CE}}\right) + R_E}$$

$R_E \approx 1k \quad r_{CE} \simeq 100k$

Wzmacniacz tranzystorowy w układzie WK (OC)

$$K_{U_0} \approx \frac{R_E \cdot \Delta I_C}{\frac{1}{g_m}\left(1 + \frac{R_E}{r_{CE}}\right)\cdot \Delta I_C + R_E \cdot \Delta I_C} = \frac{R_E}{\frac{1}{g_m}\left(1+\frac{R_E}{r_{CE}}\right) + R_E}$$

$R_E \approx 1k \quad r_{CE} \simeq 100k$

$$\frac{1}{g_m}\left(1+\frac{R_E}{r_{CE}}\right) \simeq \frac{1}{g_m} \approx 1$$

$$\frac{R_E}{r_{CE}} << 1 \qquad g_m \approx 1$$

$$K_{U_0} \approx \frac{R_E}{1 + R_E} = \frac{1}{\frac{1}{R_E} + 1} \approx 1$$

$R_E = 1k = 1000 \quad \frac{1}{1000} << 1$

$K_{U_0} = 1$ wtórnik napięciowy (wtórnik emiterowy)

Wzmacniacz tranzystorowy w układzie WK (OC) - wtórnik emiterowy

$$r_{we} = \frac{\Delta U_{we}}{\Delta I_{we}} = \frac{\Delta U_{BE} + R_E \cdot \Delta I_E}{\Delta I_B} = \frac{\Delta U_{BE}}{\Delta I_B} + \frac{R_E \cdot \Delta I_E}{\Delta I_B}$$

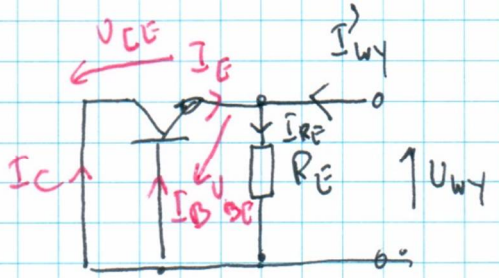
$$r_{we} = r_{BE} + R_E (1+\beta)$$

Wzmacniacz tranzystorowy w układzie WK (OC) - wtórnik emiterowy

$$r_{we} = \frac{\Delta U_{we}}{\Delta I_{we}} = \frac{\Delta U_{BE} + R_E \cdot \Delta I_E}{\Delta I_B} = \frac{\Delta U_{BE}}{\Delta I_B} + \frac{R_E \cdot \Delta I_E}{\Delta I_B}$$

$$r_{we} = r_{BE} + R_E (1+\beta)$$

$r_{wy} = ?$



$$r_{wy} = \frac{\Delta U_{wy}}{\Delta I'_{wy}}$$

$$\Delta I'_{wy} = \Delta I_{RE} - \Delta I_E \simeq \Delta I_{RE} - \Delta I_C$$

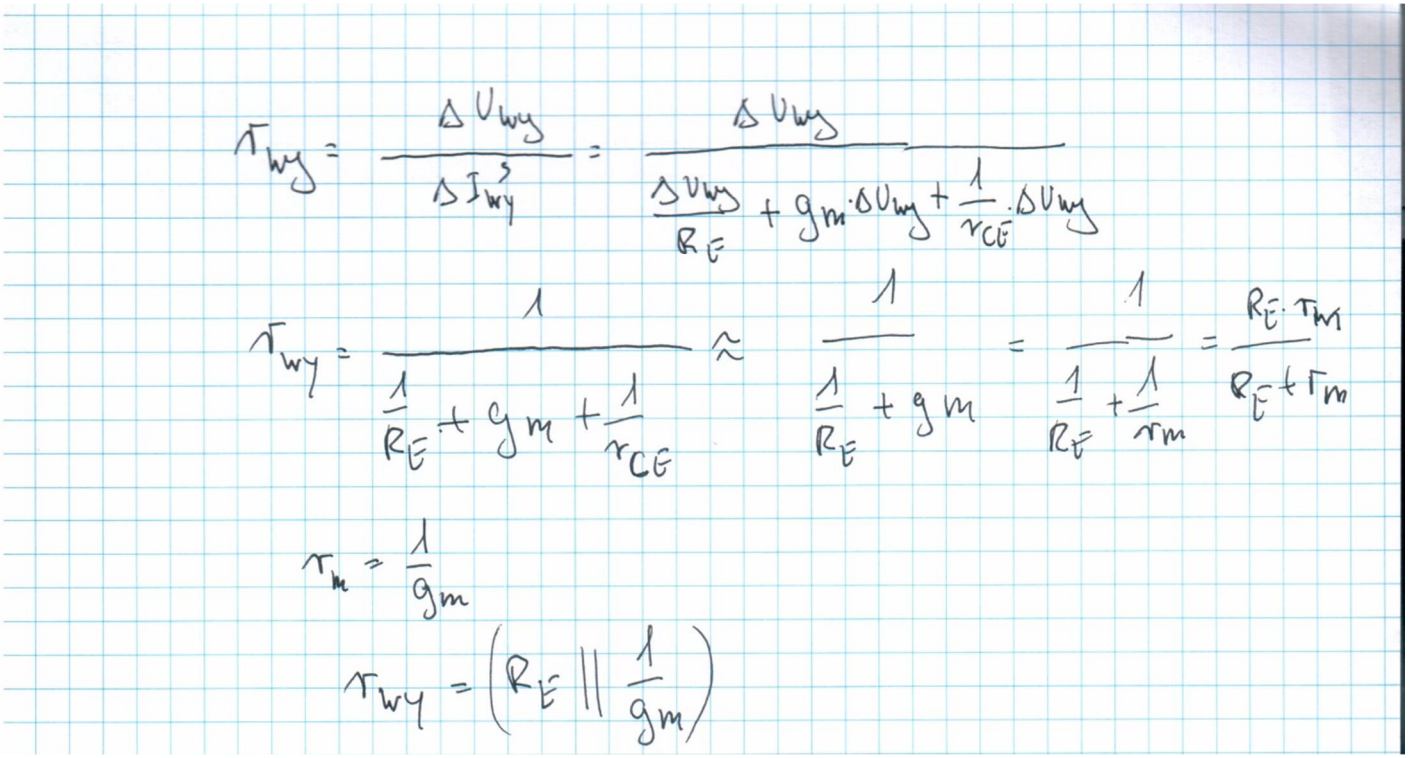
$$\Delta I_C = g_m \cdot \Delta U_{BE} + \frac{1}{r_{CE}} \cdot \Delta U_{CE}$$

$$U_{BE} = -U_{wy}$$

$$U_{CE} = -U_{wy}$$

$$\Delta I_{RE} = \frac{\Delta U_{wy}}{R_E}$$

Wzmacniacz tranzystorowy w układzie WK (OC) - wtórnik emiterowy



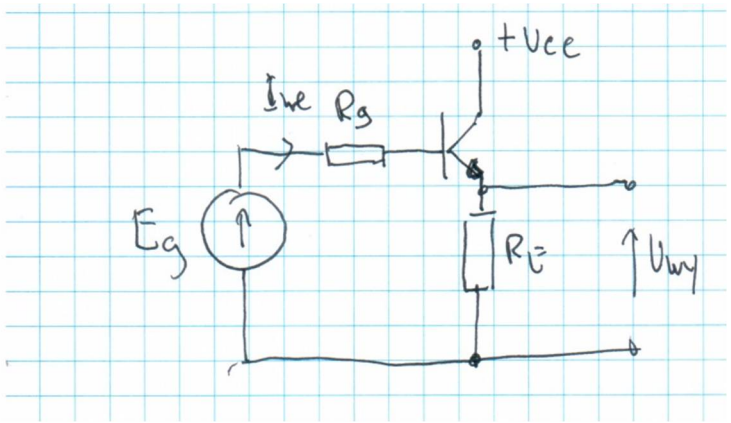
Wzmacniacz tranzystorowy w układzie WK (OC) - wtórnik emiterowy

$$r_{wy} = \frac{\Delta U_{wy}}{\Delta I_{wy}} = \frac{\Delta U_{wy}}{\frac{\Delta U_{wy}}{R_E} + g_m \cdot \Delta U_{wy} + \frac{1}{r_{CE}} \cdot \Delta U_{wy}}$$

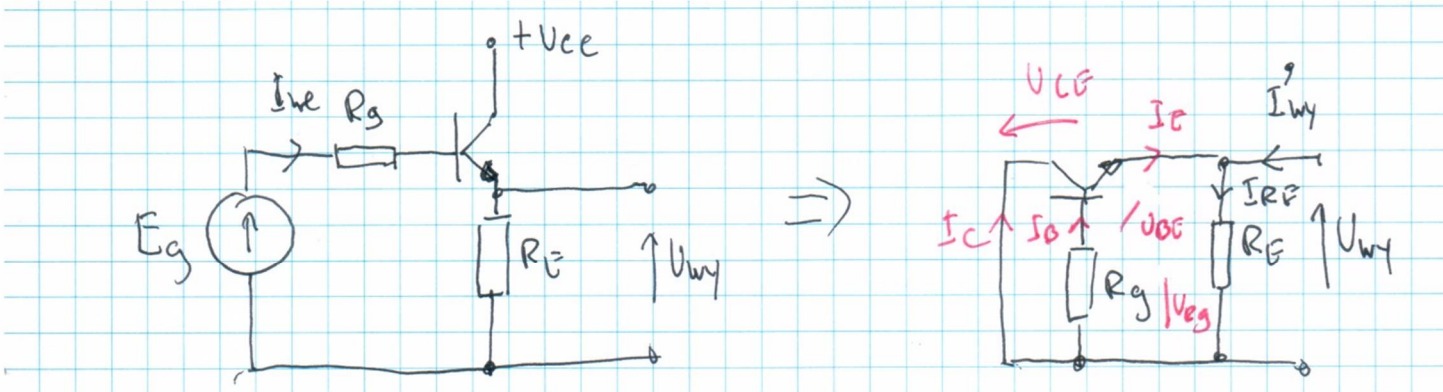
$$r_{wy} = \frac{1}{\frac{1}{R_E} + g_m + \frac{1}{r_{CE}}} \approx \frac{1}{\frac{1}{R_E} + g_m} = \frac{1}{\frac{1}{R_E} + \frac{1}{r_m}} = \frac{R_E \cdot r_m}{R_E + r_m}$$

$$r_m = \frac{1}{g_m}$$

$$r_{wy} = \left(R_E \parallel \frac{1}{g_m}\right)$$



Wzmacniacz tranzystorowy w układzie WK (OC) - wtórnik emiterowy



3 równoległe gałęzie

$$r_{wy} = \left(\frac{\Delta U_{wy}}{\Delta I_{RE}}\right) \| \left(\frac{\Delta U_{wy}}{-\Delta I_C}\right) \| \left(\frac{\Delta U_{wy}}{\Delta I_E}\right)$$

$$\frac{\Delta U_{wy}}{\Delta I_{RE}} = R_E \qquad \frac{\Delta U_{wy}}{-\Delta I_C} = \frac{-\Delta U_{CE}}{-\Delta I_C} = r_{CE}$$

$$\frac{\Delta U_{wy}}{-\Delta I_E} = \frac{-\Delta U_{BE} - \Delta U_{Rg}}{-\Delta I_E} \approx \frac{\Delta U_{BE} + R_g \cdot \Delta I_B}{\Delta I_C} = \frac{1}{g_m} + \frac{R_g}{\beta}$$

$$\Delta I_C = g_m \Delta U_{BE} + \frac{1}{r_{CE}} \cdot \Delta U_{CE}$$

$$r_{wy} = R_E \| \left(\frac{1}{g_m} + \frac{R_g}{\beta}\right) \| r_{CE}$$

$$r_{wy} \approx R_E \| \left(\frac{1}{g_m} + \frac{R_g}{\beta}\right)$$

Wzmacniacz tranzystorowy w układzie WK (OC) - wtórnik emiterowy

$K_{V_0} \approx 1$ – wtórnik napięciowy
wtórnik emiterowy

$$r_{we} = r_{BE} + R_E(1+\beta)$$

$$r_{wy} \approx R_E \| \left(\frac{1}{g_m} + \frac{R_g}{\beta} \right)$$