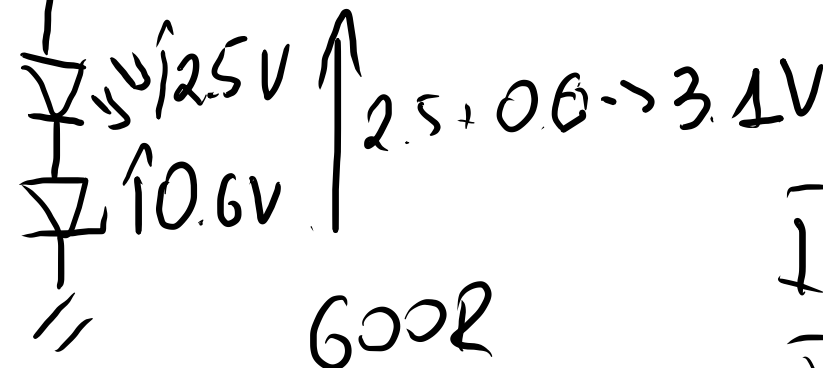


4 ... 20 mA



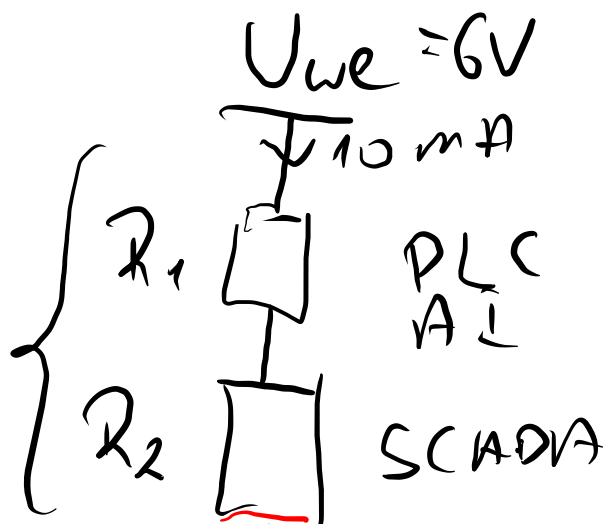
$$R = \frac{U}{I} = \frac{12.1 - 3.1}{I = 10 \text{ mA}} = \frac{9}{10} = 900 \Omega$$

~~$\frac{9}{20} = 450 \Omega$~~



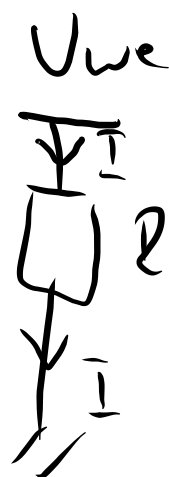
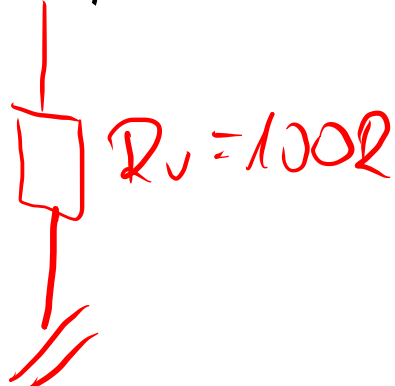
$I \uparrow \quad R \downarrow$   
 $I_{\text{max}} \quad R = 0$

$R_2$



$R_2 = R_1 + R_2$

$R_{2n} = R_2 + R_v$



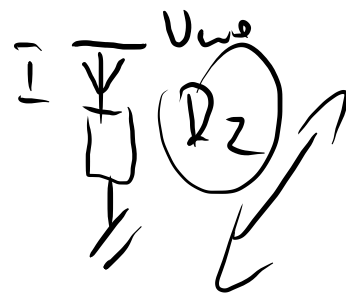
$U_{we} = R_2 \cdot I$

const const 10mA

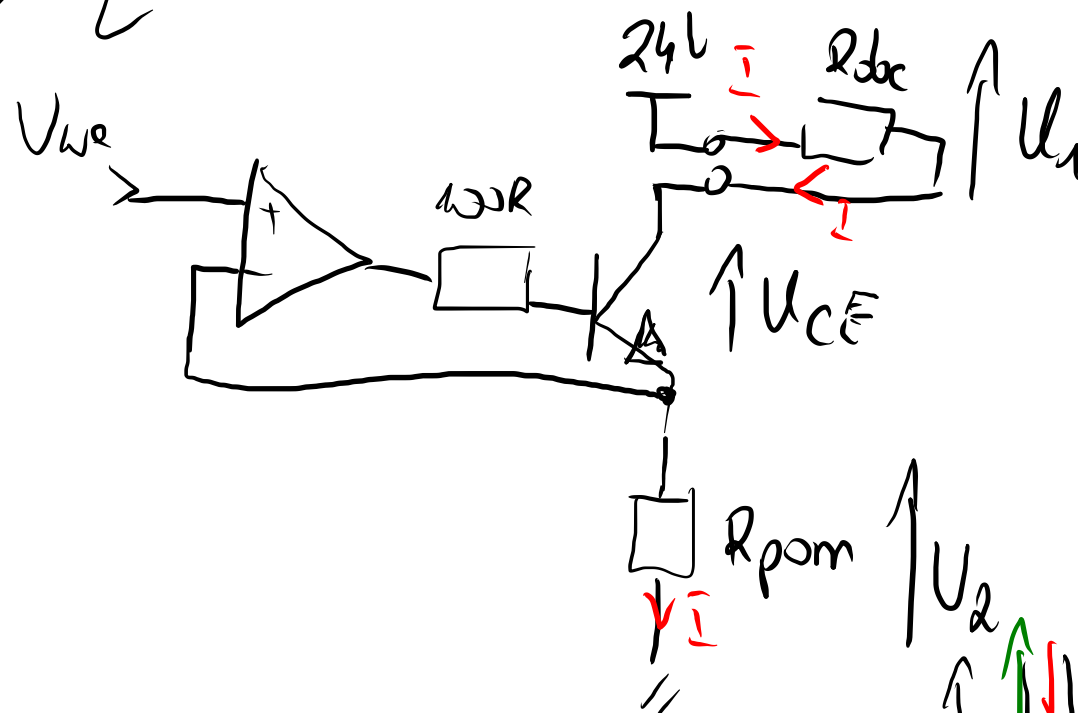
$U_{we} = 600 \cdot 10 \text{ mA} = \underline{6V}$

$6V = R_{2n} \cdot I$   
 $6V = 400 \cdot I \rightarrow \frac{6}{400}$

4 ... 20 mA



1. Ustabilizacja prądu zmiennymi  $R_2$
2. Stabilne wyjściowe prądowe  $I = \text{const}$  mimo zmiany  $U_{st}$



$I = \text{const}$   
 $R_{dcc} \neq \text{const}$

$$U_{\text{const}} = R_{\text{const}} I_{\text{const}}$$

$$U_1 + U_2 + U_{CE} = 24V$$

$\text{const}$

$$R_{max} \begin{cases} 20mA \rightarrow \sim 1100\Omega \\ 4mA \rightarrow \sim 5700\Omega \end{cases}$$

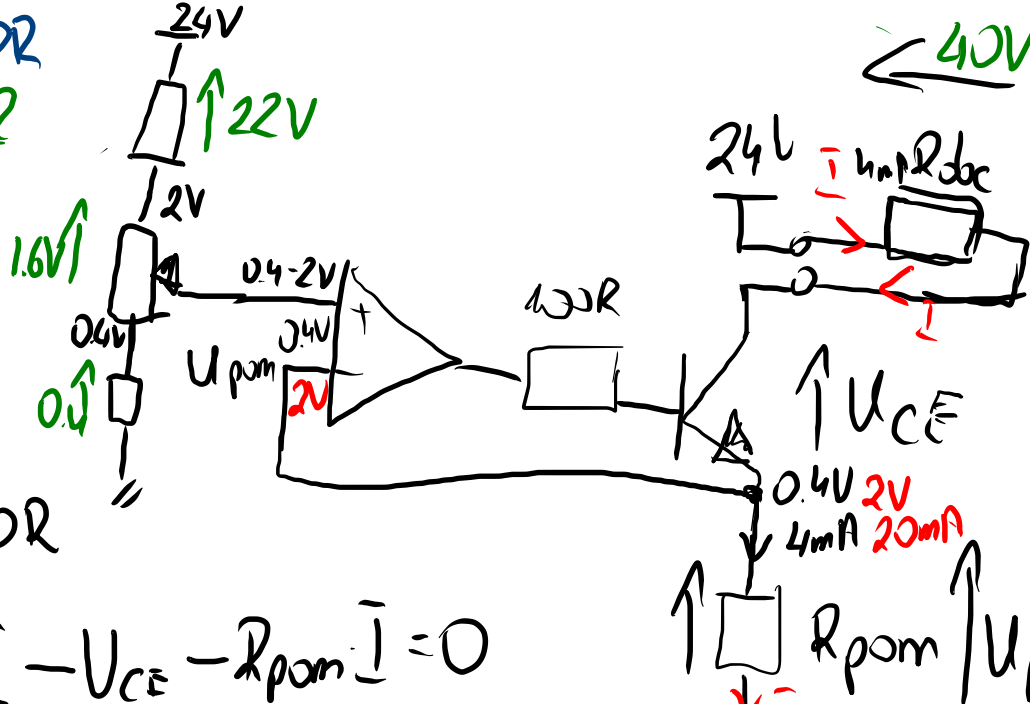
$$\frac{23.5V}{4} \cdot 10^3 \approx 5700\Omega$$

$$\begin{aligned} R_{dbc} &= 2k \\ \bar{I} &= 10mA \\ R_{pom} &= 100\Omega \end{aligned}$$

$$\begin{aligned} 24V - R_{dbc} \cdot \bar{I} - U_{CE} - R_{pom} \cdot \bar{I} &= 0 \\ 24 - 2k \cdot 10mA - U_{CE} - 100 \cdot 10mA &= 0 \\ 24 - 20 - U_{CE} - 1 &= 0 \\ 3 - U_{CE} &= 0 \rightarrow U_{CE} = 3V \end{aligned}$$

$$\bar{I} = 20mA$$

$$\begin{aligned} R_{pom} &= 100\Omega \\ R_{max} \cdot 20mA &= 24 - R_{max} \cdot 20mA - 0.1V - 2V = 0 \\ 21.3 &= R_{max} \cdot 20mA \\ R_{max} &= \frac{21.3}{20} \cdot 10^3 \approx 1100\Omega \\ \bar{I}_{max} &= 20mA \end{aligned}$$



$$\begin{aligned} &\leftarrow 40V \quad 2k \rightarrow 20mA \\ &40V \end{aligned}$$

$$U_{CE} > 0.1$$

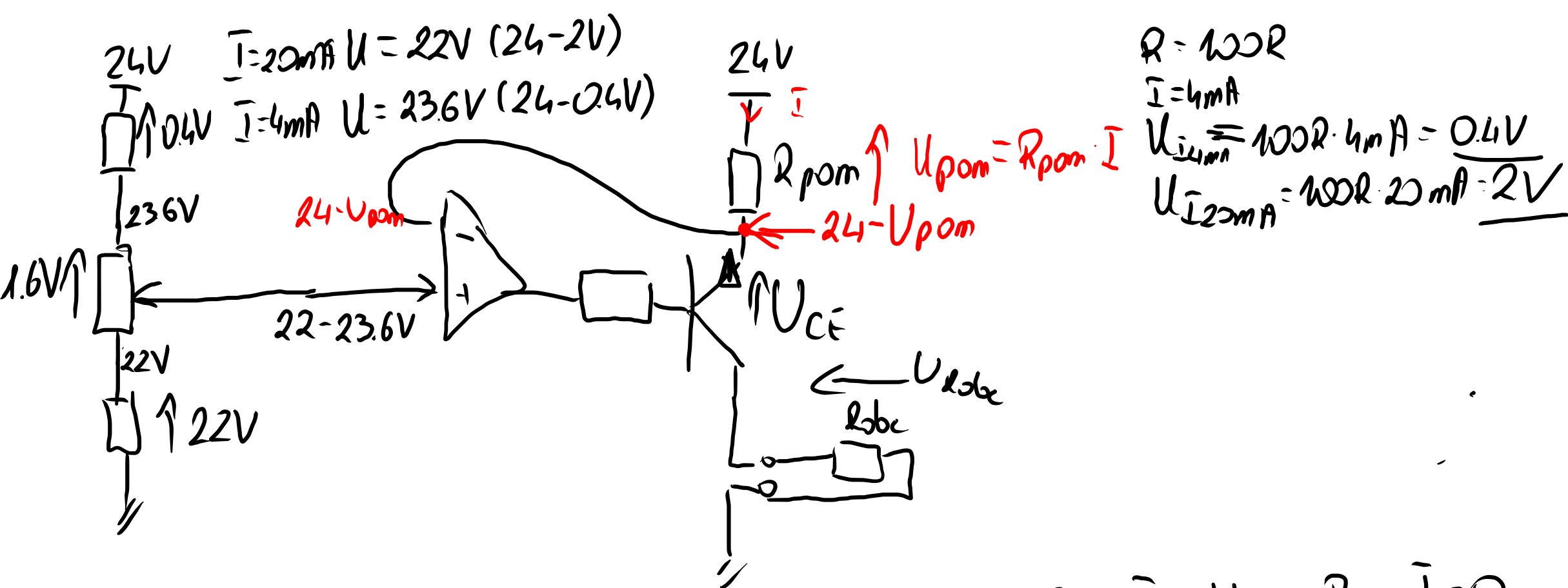
$$R_{pom} = 100\Omega \quad 200\Omega$$

$$U_{pom} = \bar{I} \cdot R_{pom}$$

$$\begin{aligned} \bar{I}_{min} &= 4mA \rightarrow U_{4mA} = 4mA \cdot 100\Omega = 0.4V \\ \bar{I}_{max} &= 20mA \rightarrow U_{20mA} = 20mA \cdot 100\Omega = 2V \end{aligned}$$

$$\begin{aligned} 24V - R_{dbc} \cdot \bar{I} - U_{CE} - R_{pom} \cdot \bar{I} &= 0 \\ 24 - 2k \cdot 20mA - U_{CE} - 2V &= 0 \\ 24 - 40 - 2 - U_{CE} &= 0 \end{aligned}$$

$$\begin{aligned} -18 - U_{CE} &= 0 \\ U_{CE} &= -18V \end{aligned}$$



$$R = 100\Omega$$

$$\bar{I} = 4mA$$

$$U_{I_{4mA}} = 100\Omega \cdot 4mA = 0.4V$$

$$U_{I_{20mA}} = 100\Omega \cdot 20mA = 2V$$

$$24 - U_{pom} - U_{CE} - U_{L_{BCE}} = 0$$

$$24V - \frac{R_{L_{BCE}} \cdot \bar{I}}{U_{L_{BCE}}} - U_{CE} - R_{pom} \cdot \bar{I} = 0$$