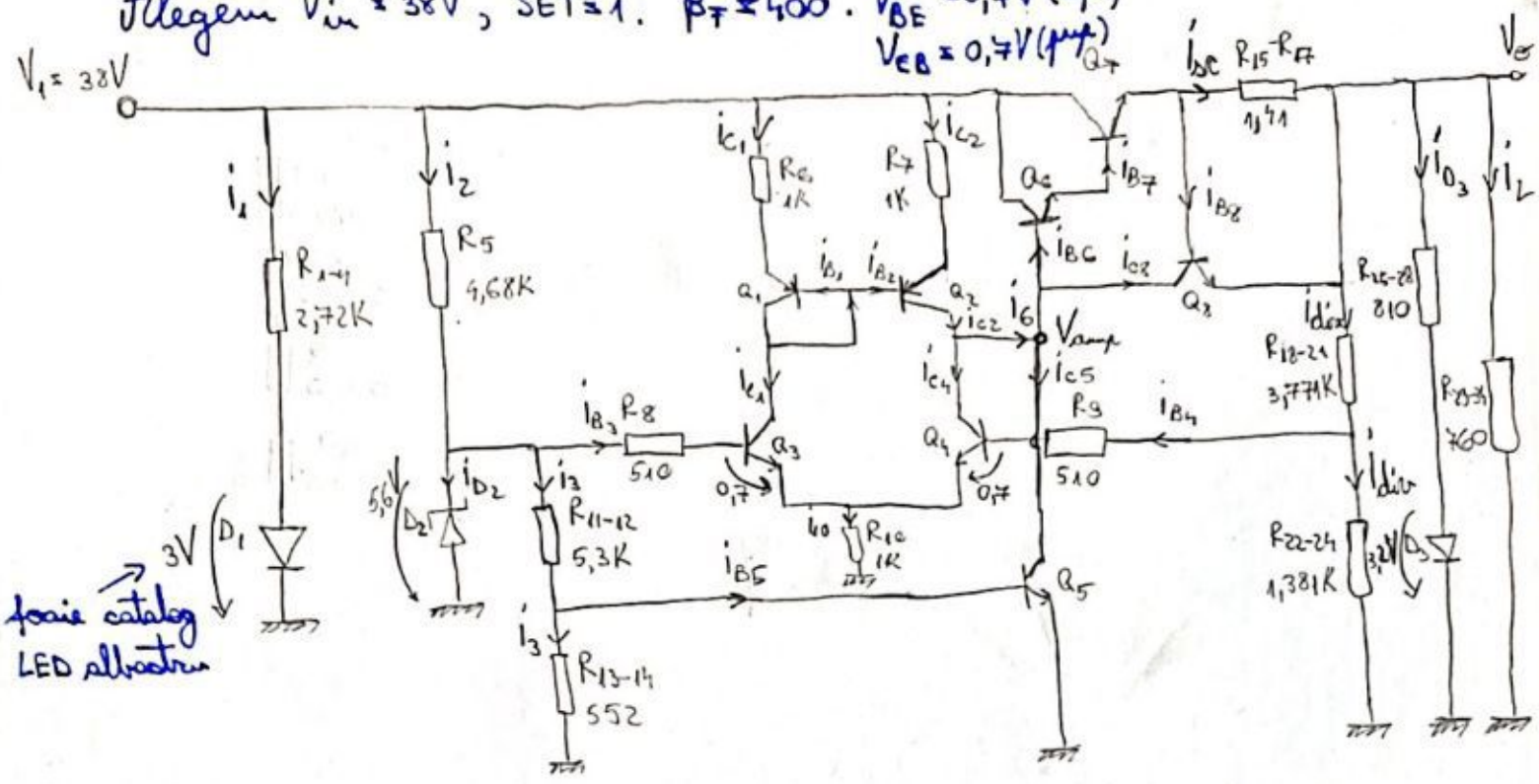
Alegem $V_{in} = 38V$, SET = 1. $\beta_T = 400$. $V_{BE} = 0,7V$ (npn)
$V_{EB} = 0,7V$ (pnp)



foaie catalog LED albastru

TK II: $i_1 = \frac{V_1 - V_{D1}}{R_{1-4}} = \frac{35}{2,72} = 12,86$ mA $\in [10,20]$ mA (catalog - LED)

TK II: $i_2 = \frac{V_1 - V_{D2}}{R_5} = \frac{38-5,6}{4,68} = 6,92$ mA

$\#. i_{D3} << i_3 \Rightarrow i_2 \simeq i_{D2} + i_3$

$\#. i_{B5} << i_3 \Rightarrow i_{R_{13-14}} \simeq i_3$

TK II: $V_{D2} = i_3 (R_{11-12} + R_{13-14}) \; (\Leftarrow) \; i_3 = \frac{5,6}{5,852} = 0,957$ mA $\Rightarrow i_{D2} = 6,92 - 0,957 = 5,963$ mA > 5 mA

TK II: $V_{D2} = i_{B3} \cdot R_8 + 0,7 + i_{10} R_{10} \; (\Rightarrow) \; i_{10} = \frac{5,6 - 0,7}{1} = 4,9$ mA

Q_1, Q_2 formează o oglindă de curent; $Q_{1,2}$ - de aceeași tip; $R_6 = R_7 \Rightarrow$

$\Rightarrow i_{C1} = i_{C2}$; $i_{B1} = i_{B2} << i_{C1}, i_{C2} \Rightarrow i_{C3} = i_{C1}$

$i_{C4} = i_{C2} - i_6$

$i_6 = i_{B6} + i_{C8} + i_{C5}$ (*); i_{BC} - ft mic; i_{C8} și i_{C5} sunt curenți mici, până când acționează protecțiile la temperatură, respectiv supratensiune, tranzistoarele „deschizându-se". $\Rightarrow i_C << i_{C2} \Rightarrow i_{C4} \simeq i_{C2}$ $\Rightarrow i_{B1} = \dots = i_{B4} \simeq 6,125$ μA

$i_{B4} << i_{C4}$, $i_{B3} << i_{C3}$ $\Rightarrow \begin{cases} i_{C1} = i_{E3} \\ i_{C4} = i_{E4} \end{cases} \Rightarrow i_{C1} = i_{C2} = i_{C3} = i_{C4}$

$i_{B6} = i_{C3} + i_{C4} \Rightarrow I_{C1} = i_{C2} = i_{C3} = i_{C4} = \frac{4,9}{2} = 2,45$ mA $\Rightarrow$

~~$TK\text{II}: i_2R_5 + i_{B_3}R_8 = i_{C_1}R_6 + V_{EC_1} \Rightarrow V_{EC_1} = 3,24 \cdot 10 - 2,45 =$~~

$V_{EC_1} = V_{EB_1} = \underline{0,7V}$

$TK\text{II}: i_2R_5 + i_{B_3}R_8 = i_{C_1}R_6 + V_{EC_1} + V_{CB_3} \Leftrightarrow V_{CB_3} = 32,4 - 2,45 - 0,7 = 29,25V \Rightarrow$

$\Rightarrow V_{CE_3} = 29,25 + 0,7 = \underline{29,95V}$

$\Downarrow i_{B_3} \ll i_{divr}$

$TK\text{II}: R_9 i_{B_3} + R_{10}i_{10}^{+0,7} = i_{divr} \cdot R_{22-24} \Rightarrow i_{divr} = \frac{R_{10}i_{10}^{+0,7}}{R_{22-24}} = \frac{5,6}{1,381} = \underline{4,05mA} >> i_{B_3} \checkmark$

$(i_3 = 957\mu A >> i_{B_3} = 6,125\mu A \checkmark)$

$V_o = i_{divr}(R_{18-21} + R_{22-24}) = 4,05 \cdot (3,771 + 1,381) = \underline{20,87V}$

$TK\text{II}: V_o = i_{D_3} \cdot R_{25-28} + V_{D_3} \Leftrightarrow i_{D_3} = \frac{17,87}{0,81} = \underline{21,89mV}$

($V_{D_3} = 3,2V$, la curenți mari (>20mA))

$TK\text{II}: V_o = i_L \cdot R_{29-34} \Leftrightarrow i_L = \frac{20,87}{0,76} = \underline{27,46mA}$

$V_{BE_6} = V_{BE_7} = 0,7V \overset{TK\text{II}}{\Rightarrow} V_{CB_8} = 1,4V$

$TK\text{I}: i_{sc} = i_{divr} + i_{D_3} + i_L = \underline{53,32mA} \Rightarrow V_{R_{15-17}} = 53,32 \cdot 0,00141 = \underline{0,07V} \Rightarrow$

$\overset{TK\text{II}}{\Rightarrow} V_{BE_8} = \underline{0,07V}$ (tranzistorul nu este deschis) $\Rightarrow$

$\Rightarrow V_{CE_8} = \underline{1,47V}$ ~~$\Rightarrow V_{amp} = V_{CE_8} + V_o$~~ $\Rightarrow V_{amp} = V_{CE_8} + V_o = 20,87 + 1,47 = \underline{22,34V}$

$V_{amp} = V_{CE_5} = \underline{22,34V}$

$TK\text{II}: V_1 - V_{amp} = R_{17}i_{C_2} + V_{EC_2} \Leftrightarrow V_{EC_2} = \underline{13,21V}$

$TK\text{II}: 38 - 20,87 = V_{CE_7} + 0,07 \Rightarrow V_{CE_7} = \underline{17,06V}$

$TK\text{II}: V_{amp} = V_{CE_4} + R_{10}i_o \Leftrightarrow V_{CE_4} = 22,34 - 4,9 = \underline{17,44V}$

$V_{CB_7} = 17,06 - 0,7 = \underline{16,36V} \overset{TK\text{II}}{=} V_{CE_6}$ $\frac{i_{C_7}}{400} =$

$\Downarrow i_{B_8} \ll i_{sc} \Rightarrow i_{C_7} \simeq i_{sc} = \underline{53,32mA} \Rightarrow i_{B_7} = \underline{133\mu A} = i_{C_6} \Rightarrow i_{B_6} = \underline{333mA}$

$TK\text{II}: V_{BE_5} = i_3 \cdot R_{13-14} = \underline{0,53V}$

$i_{C_8} \simeq i_{S_8}$ (descrește $V_{BE_8} \to 0 = V_{th}\ln\left(\frac{i_C}{i_S}\right)$); $i_{S_8} \overset{\text{Spice model}}{=} \underline{10fA} \simeq i_{C_8} \Rightarrow$

$V_{BE_5} = 0,025 \cdot \ln\left(\frac{i_{C_5}}{135}\right) \Rightarrow$

$\Rightarrow \frac{i_{C_5}}{i_{S_5}} = e^{21,2} \Rightarrow i_{C_5} = e^{21,2} \cdot 10^{-11} =$

$\Rightarrow i_{B_5} = \underline{40,2mA}$ $= \underline{16,1\mu A} \Rightarrow$

$\Rightarrow i_6 \simeq i_{C_5} = \underline{16,1\mu A}$

$i_{C_6} = 400$

- $P_{R_{1-4}} = R_{1-4} \cdot i_1'^2 = 12,86^2 \cdot 2,72 = 450\,mW \Rightarrow P_{R_1,\dots,R_4} = \frac{450}{4} = 112,5\,mW$
- $P_{R_{5,35}} = 2 \cdot 6,92^2 = 95,77\,mW$
- $P_{R_6} = P_{R_7} = 1 \cdot 2,45^2 = 6\,mW$
- $P_{R_8} = P_{R_9} = 0,51 \cdot 6,125^2 \cdot 10^{-6} = 19,13\,mW$
- $P_{R_{10}} = 1 \cdot 4,9^2 = 24\,mW$
- $P_{R_{11}} = 2 \cdot 0,957^2 = 1,83\,mW$
- $P_{R_{12}} = 3,022\,mW$
- $P_{R_{13}} = 0,43\,mW$
- $P_{R_{14}} = 0,048\,mW$
- $P_{R_{36}} = 0,68 \cdot 6,92^2 = 32,58\,mW$
- $P_{R_{15-17}} = 0,00141 \cdot 53,32^2 = 4\,mW \Rightarrow$
- $\Rightarrow P_{R_{15},\dots,17} = 1,33\,mW$
- $P_{R_{18}} = 4,05^2 \cdot 1,5 = 24,5\,mW$
- $P_{R_{19}} = 4,05^2 \cdot 0,22 = 3,61\,mW$
- $P_{R_{20}} = 0,836\,mW$
- $P_{R_{21}} = 4,05^2 \cdot 2 = 32,8\,mW$
- $P_{R_{22}} = 16,4\,mW$
- $P_{R_{23}} = 0,33 \cdot 4,05^2 = 5,41\,mW$
- $P_{R_{24}} = 0,051 \cdot 4,05^2 = 0,836\,mW$
- $P_{R_{25}} = 0,22 \cdot 21,81^2 = 104,65\,mW = P_{R_{26}} = P_{R_{27}}$
- $P_{R_{28}} = 0,15 \cdot 21,81^2 = 71,35\,mW$
- $P_{R_{29}} = P_{R_{30}} = P_{R_{31}} = P_{R_{32}} = P_{R_{33}} = 0,15 \cdot 27,46^2 = 113,1\,mW$
- $P_{R_{34}} = 0,01 \cdot 27,46^2 = 7,54\,mW$

- $P_{D_1} = U_{D_1} \cdot i_1 = 3 \cdot 12,86 = 38,58\,mW$
- $P_{D_2} = U_{D_2} \cdot i_{D_2} = 5,6 \cdot 5,963 = 33,4\,mW$
- $P_{D_3} = U_{D_3} \cdot i_{D_3} = 3,2 \cdot 21,81 = 69,8\,mW$

- $P_{Q_1} = V_{EC_1} \cdot i_{C_1} = 0,7 \cdot 2,45 = 1,72\,mW$
- $P_{Q_2} = V_{EC_2} \cdot i_{C_2} = 13,21 \cdot 2,45 = 32,36\,mW$
- $P_{Q_3} = V_{CE_3} \cdot i_{C_1} = 29,95 \cdot 2,45 = 73,38\,mW$
- $P_{Q_4} = V_{CE_4} \cdot i_{C_2} = 17,44 \cdot 2,45 = 42,73\,mW$
- $P_{Q_5} = V_{CE_5} \cdot i_{C_5} = 22,34 \cdot 0,016 = 0,357\,mW$
- $P_{Q_6} = V_{CE_6} \cdot i_{C_6} = 16,36 \cdot 0,133 = 2,176\,mW$
- $P_{Q_7} = V_{CE_7} \cdot i_{C_7} = 17,06 \cdot 53,32 = 909,6\,mW$ (tranzistor de putere)
- $P_{Q_8} = V_{CE_8} \cdot i_{C_8} = 1,47 \cdot 10\,\mu A = 14,7\,\mu W$