$P_{out} := 200\ mW$ $R_{load} := 16\ \Omega$ $R_{in\_min} := 10\ k\Omega$ $R_{out\_max} := 5\ \Omega$

$BW_{min} := 20\ kHz$ $V_{in} := 20\ mV$ amplitude

$V_T := 25\ mV$

$V_{out} := \sqrt{P_{out} \cdot R_{load}} = 1.789\ V$

$I_{out} := \sqrt{\frac{P_{out}}{R_{load}}} = 111.803\ mA$

$A_{CE} := 3$

$A_{diff} := 42$

$\frac{V_{out}}{\frac{V_{in}}{\sqrt{2}}} = 126.491$

$\beta_{AB} := 90$

$\beta := 325$

$V_{CC} := 15\ V$ $V_{EE} := -15\ V$

$\frac{I_{out}}{\beta_{AB}} = 1.242\ mA$

$f_c := 20\ kHz$

Class AB

$V_{BN} := 0.7\ V$ $V_{BP} := -0.7\ V$ $A_{AB} := 1.5$

$V_{BB} := V_{BN} - V_{BP} = 1.4\ V$

$i_{L\_max} := \sqrt{\frac{P_{out}}{R_{load}}} = 111.803\ mA$

$V_{BEQ1} := 0.7\ V$

$fA := 10^{-15}\ A$

$i_{B\_max\_AB} := \frac{i_{L\_max}}{\beta_{AB}} = 1.242\ mA$

$I_{bias} := 3\ mA$

$\frac{V_T}{\frac{i_{L\_max}}{2}} = 0.447\ \Omega$

$I_R := 1\ mA$

$I_{C1} := I_{bias} - I_R = 2\ mA$

$I_S := \frac{I_{C1}}{e^{\frac{V_{BB}}{2 \cdot V_T}}} = 1.383\ fA$

$R_{eq} := \frac{V_{BB}}{I_R} = 1.4\ k\Omega$

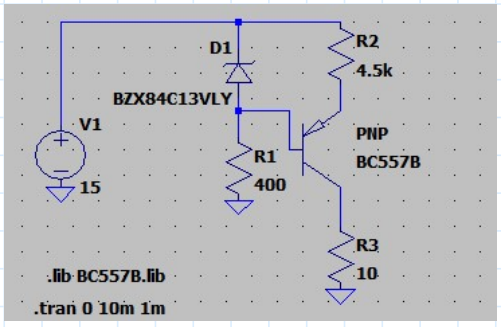
$R_1 := \frac{V_{BEQ1}}{I_R} = 700\ \Omega$

$R_2 := R_{eq} - R_1 = 700\ \Omega$

$V_{CC} = 15\ V$

Constant current source Zener diode (bruges ikke)

$V_{zener} := 13\ V$ $V_{diode} := 0.7\ V$



$V_{Eset} := V_{CC} - V_{zener} + V_{diode} = 2.7\ V$

$R_{set} := \frac{V_{CC} - V_{Eset}}{I_{bias}} = 4.1\ k\Omega$

$I_{zener} := 5\ mA$

$R_Z := \frac{V_{CC} - V_{zener}}{I_{zener}} = 400\ \Omega$

$V_{Cset} := V_{Eset} - 0.3\ V = 2.4\ V$

$V_{Cset} := V_{CC}$

$V_{B\_AB1} := 0.6\ V$

$R_{1\_AB} := \frac{V_{Cset} - V_{B\_AB1}}{I_{bias}} = 4.8\ k\Omega$

$V_{B\_AB1} := V_{Cset} - R_{1\_AB} \cdot I_{bias} = 0.6\ V$ $\quad V_{BE} := 0.7\ V$

$V_{B\_AB2} := V_{B\_AB1} - V_{BB} = -0.8\ V$

$R_{2\_AB} := \frac{V_{B\_AB2} - V_{EE} - V_{BE}}{I_{bias}} = 4.5\ k\Omega$

Strøm spejl

$I_{C\_SP} := I_{bias} = 3\ mA$

$I_{B\_SP} := \frac{I_{C\_SP}}{\beta} = 9.231\ \mu A$

$I_{R\_SP} := I_{B\_SP} \cdot 2 + I_{C\_SP} = 3.018\ mA$

Output modstand

$V_{CC} - R_{SP} \cdot I_{R\_SP} - V_{BE} - V_{EE} = 0$

$V_B := 1.4\ V$

$R_{SP} := \frac{V_{CC} - V_{EE} - V_{BE}}{I_{R\_SP}} = 9.707\ k\Omega$

$V_E := V_B - V_{BE} = 0.7\ V$

$R_{SP} := 10\ k\Omega$

$I_E := \frac{V_E}{R_{load}} = 43.75\ mA$

$I_{R\_SP} := \frac{V_{CC} - V_{EE} - V_{BE}}{R_{SP}} = 2.93\ mA$

$R_{out} := \frac{V_T}{I_E} = 0.571\ \Omega$

CC AMP

$R_{E\_CC} := 500\ \Omega$ $\quad V_{E\_CC} := V_{B\_AB2} = -0.8\ V$ $\quad \alpha := \frac{\beta}{\beta + 1} = 0.997$

$I_{E\_CC} := \frac{V_{E\_CC} - V_{EE}}{R_{E\_CC}} = 28.4\ mA$

$I_{B\_CC} := \frac{I_{E\_CC}}{\beta + 1} = 87.117\ \mu A$ $\quad I_{C\_CC} := \alpha \cdot I_{E\_CC} = 28.313\ mA$

$V_{B\_CC} := V_{E\_CC} + 0.7\ V = -0.1\ V$

$R_{B\_CC} := \frac{V_{CC} - V_{B\_CC}}{I_{B\_CC}} = 173.331\ k\Omega$ $\quad V_{CE\_CC} := 0.5\ V$

$V_{C\_CC} := V_{E\_CC} + V_{CE\_CC} = -0.3\ V$

$R_{C\_CC} := \frac{V_{CC} - V_{C\_CC}}{I_{C\_CC}} = 540.39\ \Omega$

WAS trin

$i_{C\_max\_WAS} := i_{B\_max\_AB} = 1.242\ mA$

$A_{CE} = 3$

$R_{IN} = (\beta + 1) \cdot (r_e \cdot R_E)$

$i_B = \frac{v_{in}}{R_{IN}}$

$v_o = -R_C \cdot i_b \cdot \beta$

$v_o = -R_C \cdot \frac{v_i}{R_{IN}} \cdot \beta$

$\frac{v_o}{v_i} = -\frac{R_C}{(r_e + R_E)} \cdot \frac{\beta}{\beta + 1}$

$\frac{v_o}{v_i} = -\alpha \cdot \frac{R_C}{r_e + R_E} = -\alpha \frac{R_C}{R_E}$ $\alpha := \frac{\beta}{\beta + 1} = 0.997$

$R_C := 3\ k\Omega$

$A_{CE} = -\alpha \cdot \frac{R_C}{R_E}$ $R_E := \alpha \cdot \frac{R_C}{A_{CE}} = 0.997\ k\Omega$

$R_{E\_AC} := 1\ k\Omega$

DC

$V_{CE} := 7.5\ V$ $I_E := 5\ mA$

$0\ V = V_{CC} - R_C \cdot I_E \cdot \alpha - R_{E\_DC} \cdot I_E - V_{CE} - V_{EE}$ $R_{E\_DC} \cdot I_E = V_{CC} - R_C \cdot I_E \cdot \alpha - V_{CE} - V_{EE}$

$R_{E\_DC} := \frac{V_{CC} - R_C \cdot I_E \cdot \alpha - V_{CE} - V_{EE}}{I_E} = 1.509\ k\Omega$

$R_{E\_DC} := 1.5\ k\Omega$

$R_{E\_AC} = \frac{R_{E\_DC} \cdot R_{E\_comp}}{R_{E\_DC} + R_{E\_comp}}$ $R_{E\_comp} := \frac{-(R_{E\_DC} \cdot R_{E\_AC})}{R_{E\_AC} - R_{E\_DC}} = 3\ k\Omega$

$V_C := V_{CC} - R_C \cdot I_E \cdot \alpha = 0.046\ V$ $V_E - I_E \cdot R_E - V_{EE} = 0$

$V_E := I_E \cdot R_{E\_DC} + V_{EE} = -7.5\ V$ $V_B := V_E + V_{BE} = -6.8\ V$

DC

$V_B = \frac{R_{B1} - R_{B2}}{R_{B1} + R_{B2}} \cdot V_{CC}$ $V_{CE} := V_C - V_E = 7.546\ V$

$R_{B1} := 10\ k\Omega$

$V_B = \frac{R_{B1} - R_{B2}}{R_{B1} + R_{B2}} \cdot V_{CC}$

$R_{B2} := \frac{R_{B1} \cdot V_{CC} + R_{B1} \cdot V_B}{V_{CC} - V_B} = 3.761\ k\Omega$

$R_{B2} := 3.6\ k\Omega$

$V_B := \frac{R_{B2} - R_{B1}}{R_{B2} + R_{B1}} \cdot V_{CC} = -7.059\ V$ $\frac{15\ V - (-6.8\ V)}{15.3\ \mu A} = 1.425\ M\Omega$

$I_E := \frac{V_E - V_{EE}}{R_{E\_DC}} = 5\ mA$ $15\ V - 15.3\ \mu A \cdot 1.5\ M\Omega = -7.95\ V$

$I_B := \frac{I_E}{(\beta + 1)} = 15.337\ \mu A$ S.429

Commen mode amplifier

DC analyse del 1

$V_{B\_CM} := 0\ V$ $V_{E\_CM} := V_{B\_CM} - V_{BE} = -0.7\ V$ $V_{CE} := 0.2\ V$

Vi antager 0.2V over
collector emitter

$V_{C\_CM} := V_{E\_CM} + V_{CE} = -0.5\ V$

$I_{EE\_CM} := 4\ mA$ $\alpha = 0.997$

$I_{E\_CM} := \frac{I_{EE\_CM}}{2} = 2\ mA$ $\frac{15\ V - 1.8\ V}{7.5\ k\Omega} = 1.76\ mA$

$V_{C\_CM} = V_{CC} - R_{C\_CM} \cdot I_{E\_CM} \cdot \alpha$ $V_{BE} = 0.7\ V$

$R_{C\_CM} := \frac{V_{CC} - V_{C\_CM}}{I_{E\_CM} \cdot \alpha} = 7.774\ k\Omega$

$R_{C\_CM} := 7.5\ k\Omega$

AC diff

$r_e := \frac{V_T}{I_{E\_CM}} = 12.5\ \Omega$ $A_{diff} = 42$

$\frac{v_d}{2} = i_b \cdot r_\pi + i_e \cdot R_{E\_CM} = i_b \cdot (\beta+1) \cdot r_e + i_b \cdot (\beta+1) \cdot R_{E\_CM} = i_b \cdot (\beta+1)\ (r_e + R_{E\_CM})$

$v_d = 2 \cdot i_b \cdot (\beta+1)\ (r_e + R_{E\_CM})$

$v_{o1\_cm} = -\beta \cdot i_{b\_cm} \cdot R_{C\_CM}$

$A = \frac{X}{2 \cdot (Y+B)}$

$\frac{v_{o1\_cm}}{v_d} = \frac{-\beta \cdot i_b \cdot R_{C\_CM}}{2 \cdot i_b \cdot (\beta+1) \cdot (r_e + R_{E\_CM})} = -\frac{\beta \cdot R_{C\_CM}}{2 \cdot (\beta+1) \cdot (r_e + R_{E\_CM})}$

$R_{E\_CM} := \frac{(-(2 \cdot A_{diff} \cdot r_e) + R_{C\_CM}) \cdot \beta - 2 \cdot A_{diff} \cdot r_e}{2 \cdot A_{diff} \cdot \beta + 2 \cdot A_{diff}} = 76.512\ \Omega$

$R_{E\_CM} := 75\ \Omega$

$R_{IN} := 2 \cdot (\beta+1)\ (r_e + R_{E\_CM}) = 57.05\ k\Omega$

$A_{diff} := -\frac{\beta \cdot R_{C\_CM}}{2 \cdot (\beta+1) \cdot (r_e + R_{E\_CM})} = -42.726$

DC del 2

$0\ V - V_{BE} - R_{E\_CM} \cdot I_{E\_CM} - R_{EE\_CM} \cdot I_{EE\_CM} - V_{CE} - V_{EE} = 0\ V$

$R_{EE\_CM} := \frac{V_{BE} - R_{E\_CM} \cdot I_{E\_CM} - V_{CE} - V_{EE}}{I_{EE\_CM}} = 3.838\ k\Omega$

$R_{EE\_CM} := 3.9\ k\Omega$

AC commen mode

$$v_{CM} = i_b \cdot (\beta+1) \cdot r_e + (\beta+1) \cdot R_{E\_CM} + 2 \cdot i_b \cdot (\beta+1) \cdot R_{EE\_CM}$$

$$v_{o1\_cm} = -\beta \cdot i_{b\_cm} \cdot R_{C\_CM}$$

$$A_{CM} = \frac{v_{o1\_cm}}{v_{CM}} = \frac{-\beta \cdot i_{b\_cm} \cdot R_{C\_CM}}{i_b \cdot (\beta+1) \cdot r_e + i_b \cdot (\beta+1) \cdot R_{E\_CM} + 2 \cdot i_b \cdot (\beta+1) \cdot R_{EE\_CM}}$$

$$\frac{-\beta \cdot R_{C\_CM}}{(\beta+1) \cdot r_e + (\beta+1) \cdot R_{E\_CM} + 2 \cdot (\beta+1) \cdot R_{EE\_CM}}$$

$$A_{CM} := \frac{-\beta \cdot R_{C\_CM}}{(\beta+1) \cdot (r_e + R_{E\_CM} + 2 \cdot R_{EE\_CM})} = -0.948$$

$$CMRR := 20 \cdot \log\left(\frac{A_{diff}}{A_{CM}}\right) = 33.078$$

Strøm spejl

$I_{C\_SP} := I_{EE\_CM} = 4\ mA$

$I_{B\_SP} := \frac{I_{C\_SP}}{\beta} = 12.308\ \mu A$

$I_{R\_SP} := I_{B\_SP} \cdot 2 + I_{C\_SP} = 4.025\ mA$

$V_{CC} - R_{SP} \cdot I_{R\_SP} - V_{BE} - V_{EE} = 0$

$R_{SP} := \frac{V_{CC} - V_{EE} + V_{BE}}{I_{R\_SP}} = 7.628\ k\Omega$