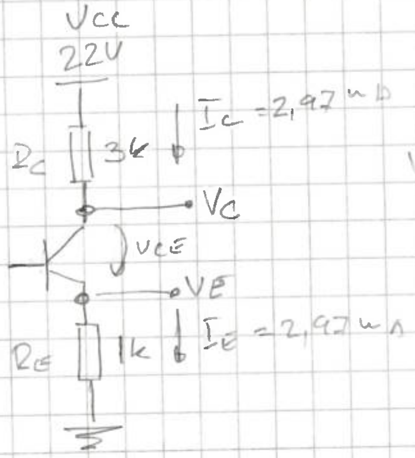


Analys DC (Extra förklaring)

$I_C \approx I_E$

$V_C = V_{CC} - I_C \cdot 3k$

$= 22 - (2{,}97 \cdot 3) = 13.1V$

$V_E = I_E \cdot 1k = 2{,}97V$

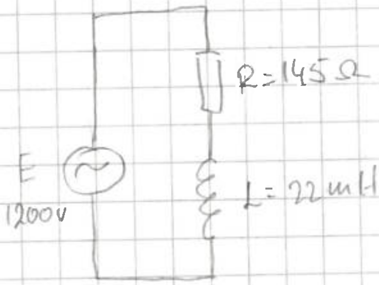
$V_{CE} = V_{CC} - V_C - V_E = 10.13V$

↳ $V_{CC} - I_C \cdot R_C - V_{CE} - I_E R_E = 0$

$I_C \approx I_E$

$V_{CE} = V_{CC} - I_C(R_C + R_E)$

RL Circuit



ⓐ At $f = 1250$ Hz

$\omega L = 2\pi f L$

$V_L = I_{max} \cdot X_L$ → V amplitud över L

$V_R = I_{max} \cdot R$ → V amplitud över R

$$\underline{I_{max}} = \frac{E_{max}}{Z} = \frac{E_{max}}{\sqrt{R^2 + X_L^2}} =$$

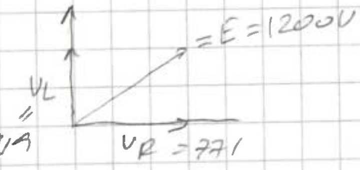
$$= \frac{1200V}{\sqrt{(145)^2 + \underbrace{4\pi^2(1250)^2(22\cdot 10^{-3})^2}_{\underbrace{(2\pi f L)^2}_{X_L}}}} =$$

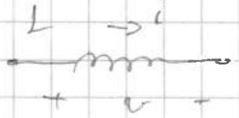
$= \underline{5.32\,A}$ (I_{max})

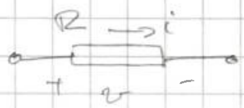
$V_L = I_{max} \cdot X_L = I_{max}(\omega L) = \underbrace{I_{max}}_{5.32A}(2\pi f L) = 919V$

$V_R = I_{max} \cdot R = 5{,}32 \cdot 145 = 771V$

$E_{max} = 1200V \neq V_L + V_R$





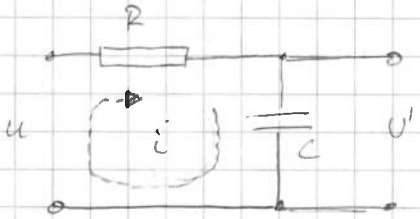


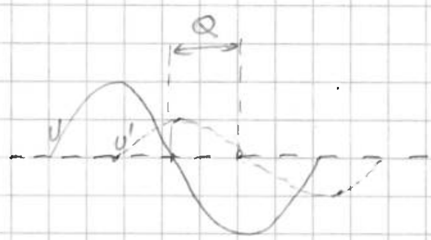
$$v = L\frac{di}{dt} \qquad v = i \cdot R$$

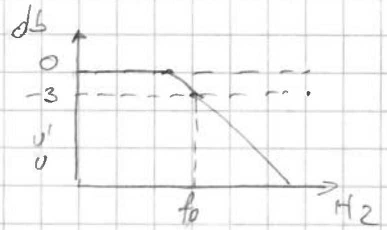
↳ How fast current "i" change thru inductor $\underline{\underline{L}}$

Note: Constant Current 0V accross L
Current Rises : positiv voltage
Current Falls : negativ voltage

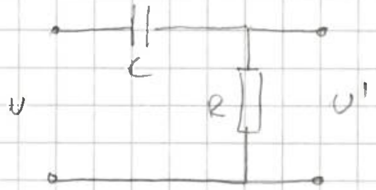
Lågpassfilter

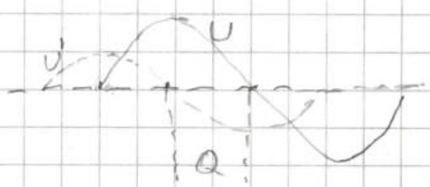


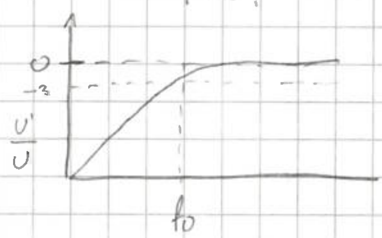




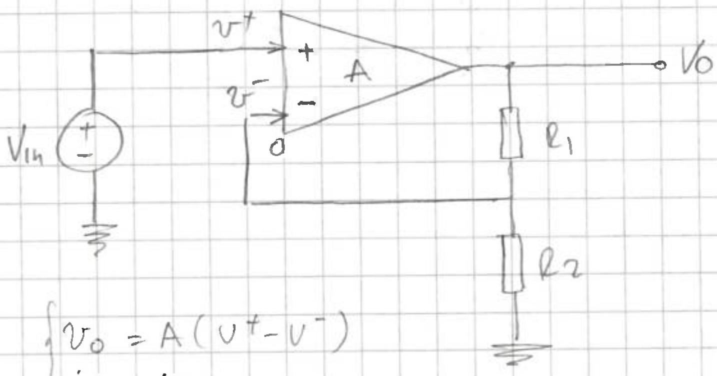
Högpassfilter





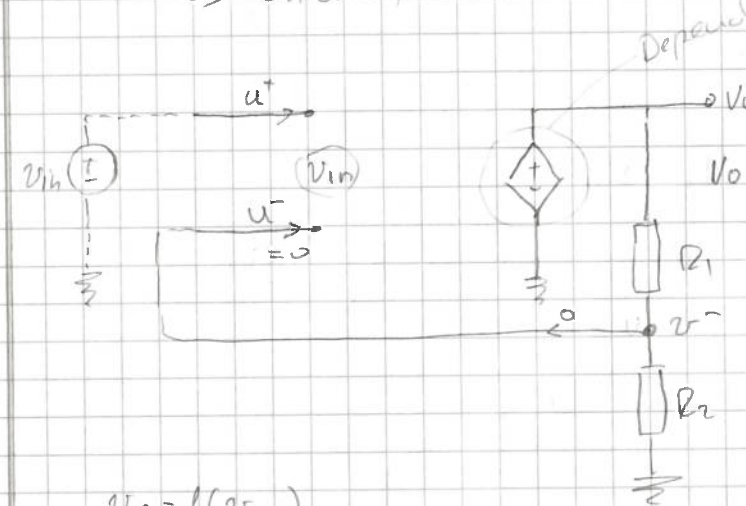


Non-Inverting OP



$$\begin{cases} v_o = A(v^+ - v^-) \\ i^+ = i^- = 0 \end{cases}$$

=> circuit model:



$V_o = A(v^+ - v^-)$

voltage devider

$$v^- = v_o \frac{R_2}{R_1 + R_2}$$

$$v_o = f(v_{in})$$

$$v_o = A(v^+ - v^-)$$

$$v_o = A\left(v^+ - v_o \frac{R_2}{R_1 + R_2}\right)$$

$$v_o = A v^+ - A v_o \frac{R_2}{R_1 + R_2}$$

$$v_o + A v_o \frac{R_2}{R_1 + R_2} = A v^+$$ -> change to v_{in}

$$v_o \left(1 + \frac{A R_2}{R_1 + R_2}\right) = A v_{in}$$

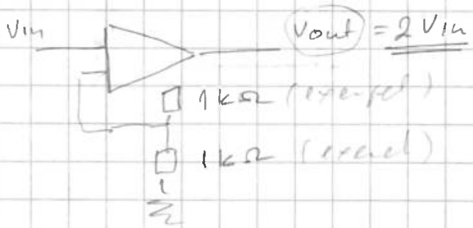
$$v_o = \frac{A v_{in}}{1 + A \frac{R_2}{R_1 + R_2}} \Bigg\} \; v_o = f(v_{in}) \quad \Rightarrow \quad v_o = \frac{R_1 + R_2}{R_2} V_{in}$$

A = stort tal => ta bort 1

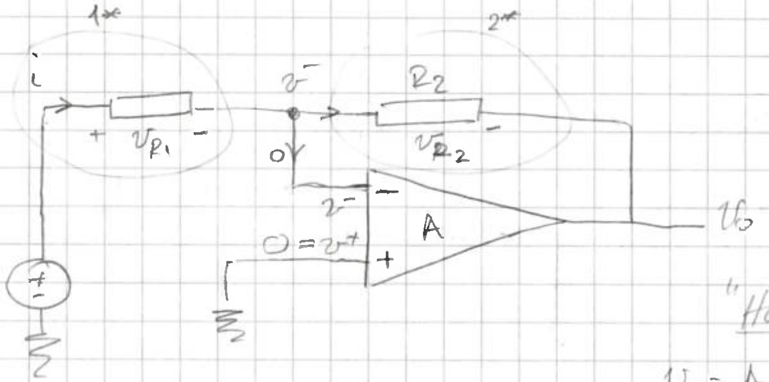
$$\frac{V_o}{V_{in}} = 1 + \frac{R_1}{R_2}$$

if $R_1 = R_2 \Rightarrow \frac{v_o}{v_{in}} = \left(1 + \frac{1}{1}\right) = 2$

$v_o = 2 V_{in}$



$\boxed{\text{INVERTING OP}}$ Hard way



"Hard way"

$v_o = f(v_{in})$

"Hard way"

$V_o = A(\underbrace{V^+}_{=0} - V^-)$

$V_o = A(-v^-) \Rightarrow v^- = \frac{-V_o}{A}$

1* $i = \frac{v_{R_1}}{R_1} = \frac{(v_{in} - v^-)}{R_1}$

2* $i = \frac{v_{R_2}}{R_2} = \frac{v^- - v_o}{R_2}$

$=$

* $\frac{(v_{in} - v^-)}{R_1} = \frac{(v^- - v_o)}{R_2}$

$\frac{v_{in} + \frac{v_o}{A}}{R_1} = \frac{-\frac{v_o}{A} - v_o}{R_2}$

$\frac{A V_{in} + V_o}{R_1} = \frac{-V_o - AV_o}{R_2}$

$\frac{A v_{in}}{R_1} + \frac{V_o}{R_1} = \frac{-V_o}{R_2} - \frac{AV_o}{R_2}$

$\frac{A v_{in}}{R_1} = \frac{-V_o}{R_2} - \frac{AV_o}{R_2} - \frac{V_o}{R_1} \quad / R_1$

$A v_{in} = -\frac{R_1}{R_2} V_o - \frac{R_1}{R_2} AV_o - V_o$

Fortsättning:

$AV_{in} = \frac{-R_1}{R_2} V_o (1 + A) - \cancel{V_o}$

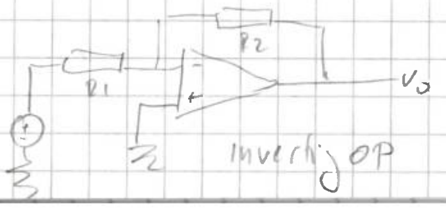
$A >>>> V_o$ så ignorera V_o

$V_{in} = -\frac{R_1}{R_2} V_o \cancel{\frac{(1+A)}{A}}$

ignorera pga det är nära 1

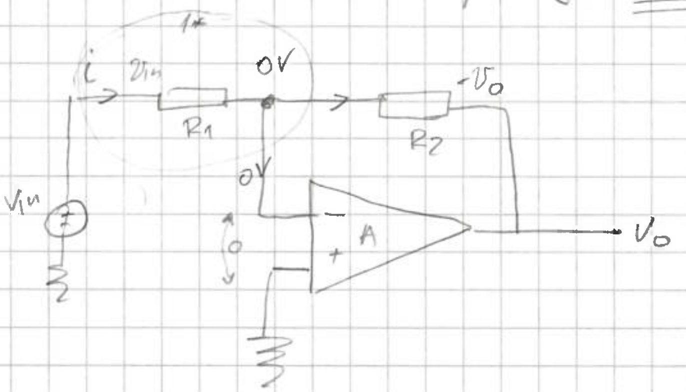
$v_{in} = -\frac{R_1}{R_2} v_o$

$v_o = -\frac{R_2}{R_1} v_{in}$



inverting OP

INVERTIN OP (easy way) virtual ground ($v^+ \approx v^- \approx 0$)



$$1*)\ i = \frac{v_{in} - 0}{R_1}$$

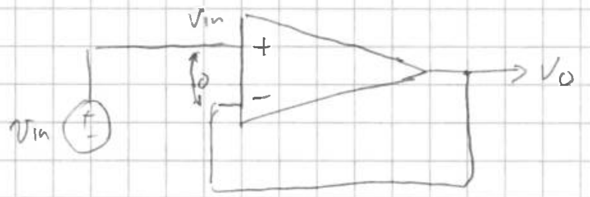
$$2*)\ i = \frac{0 - v_{in}}{R_2}$$

$$=$$

$$\frac{v_{in}}{R_1} = -\frac{v_o}{R_2}$$

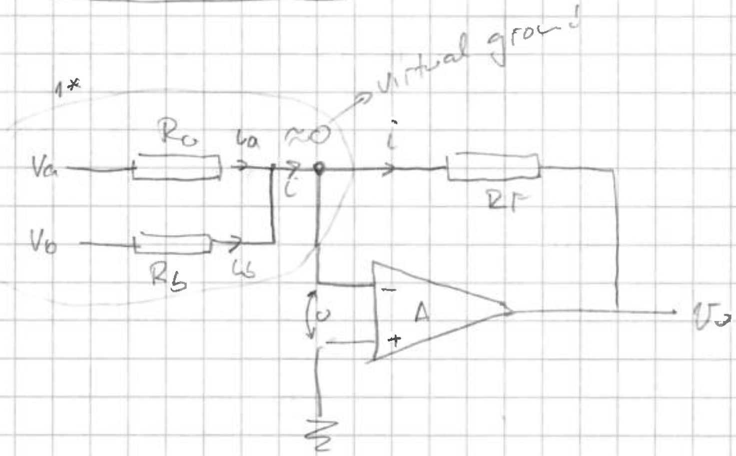
$$v_o = -\frac{R_2}{R_1} v_{in}$$

Följare (Buffer) unity-gain buffer



$\boxed{v_o = v_{in}}$

SUMMING OP



$v_o = f(V_a, V_b)$

1*: $i = i_a + i_b$

$$i = \frac{V_a - 0}{R_a} + \frac{V_b - 0}{R_b}$$

$$i = \frac{V_a}{R_a} + \frac{V_b}{R_b}$$

$$2*\quad i = \frac{-V_o}{R_f}$$

$$*\quad \frac{-V_o}{R_f} = \frac{V_a}{R_a} + \frac{V_b}{R_b}$$

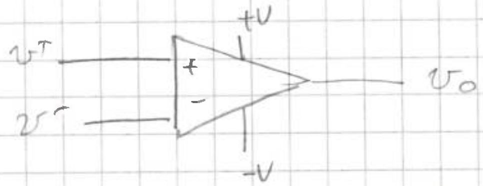
$$V_o = -\left(\frac{R_f}{R_a} V_a + \frac{R_f}{R_b} V_b\right)$$

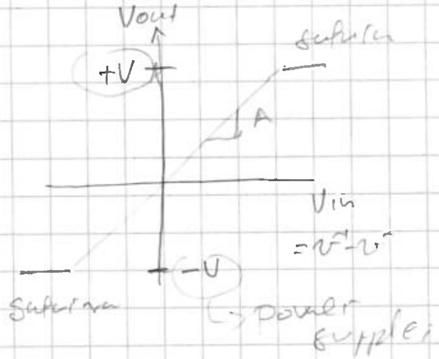
$R_f = R_a = R_b = 10\,k\Omega$ (exemp

$\boxed{V_o = -(V_a + V_b)}$ summing

OP-amp What is it?

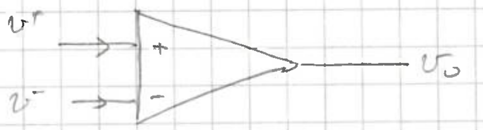
$$x \longrightarrow \boxed{A} \longrightarrow Ax$$





- high gain $A = 10^5 - 10^6$
- feedback
- differential input

$v_o = A(v^+ - v^-)$

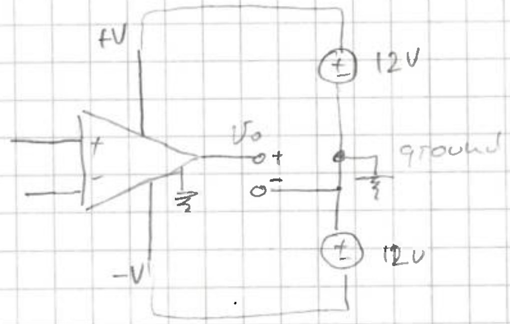


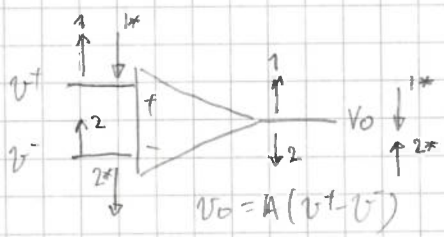
$i = 0$

$v_o = A(v^+ - v^-)$

$\rightarrow v_o = A\, v_{in}$

$v_{in} = v^+ - v^-$



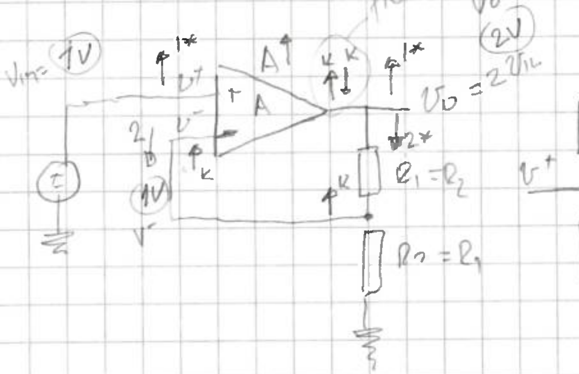


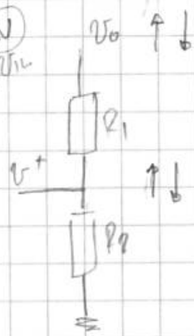
$v_o = A(v^+ - v^-)$

Feedback

feedback effect — (Negative feedback)

Voltage divider





$$v_o = \frac{R_1 + R_2}{R_2} v_{in} \qquad v^- = v_o \frac{R}{R+R} = \frac{1}{2} v_o \quad (R_1 = R_2)$$

$$v_o = 2\, v_{in}$$