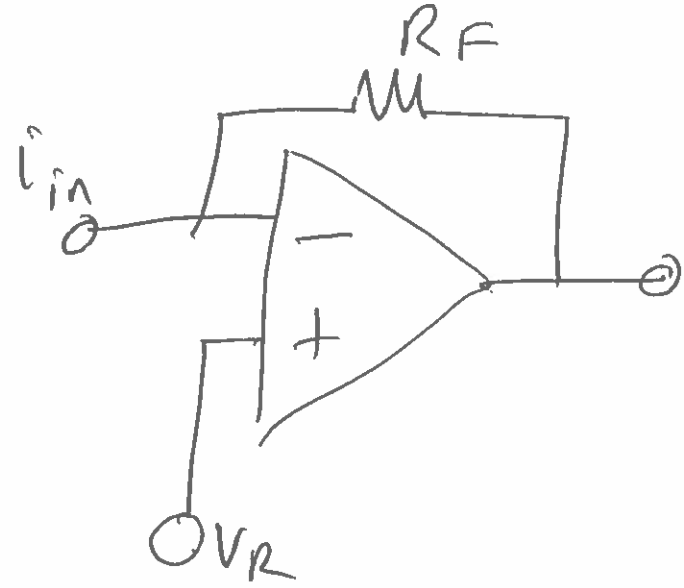


Current → Voltage converter

$$V_{OUT} = V_R - i_{in} R_F$$

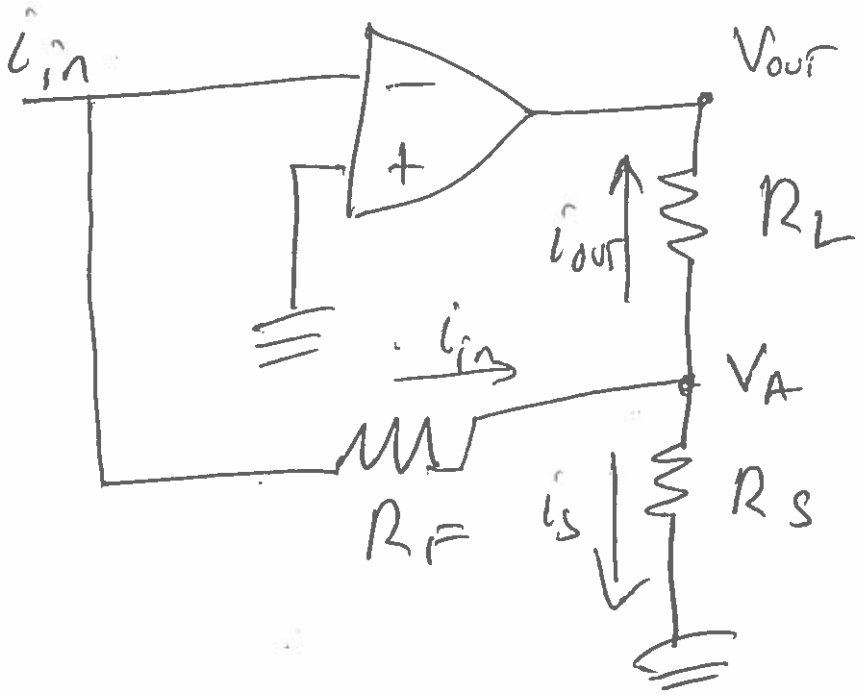
Converts current to voltage

Let $i_{in} = \underline{1\ \mu A}$ Use $R_F = 10\ M\Omega$

$V_R = 0$

$$V_{OUT} = -i_{in} R_F = -(1 \times 10^{-6}\ A)(10 \times 10^{6}\ \Omega)$$

$$V_{OUT} = \underline{10\ V}$$



$$i_{OUT} = i_{in} - i_S$$

$$i_{in} = \frac{0 - V_A}{R_F}$$

$$i_S = \frac{V_A}{R_S}$$

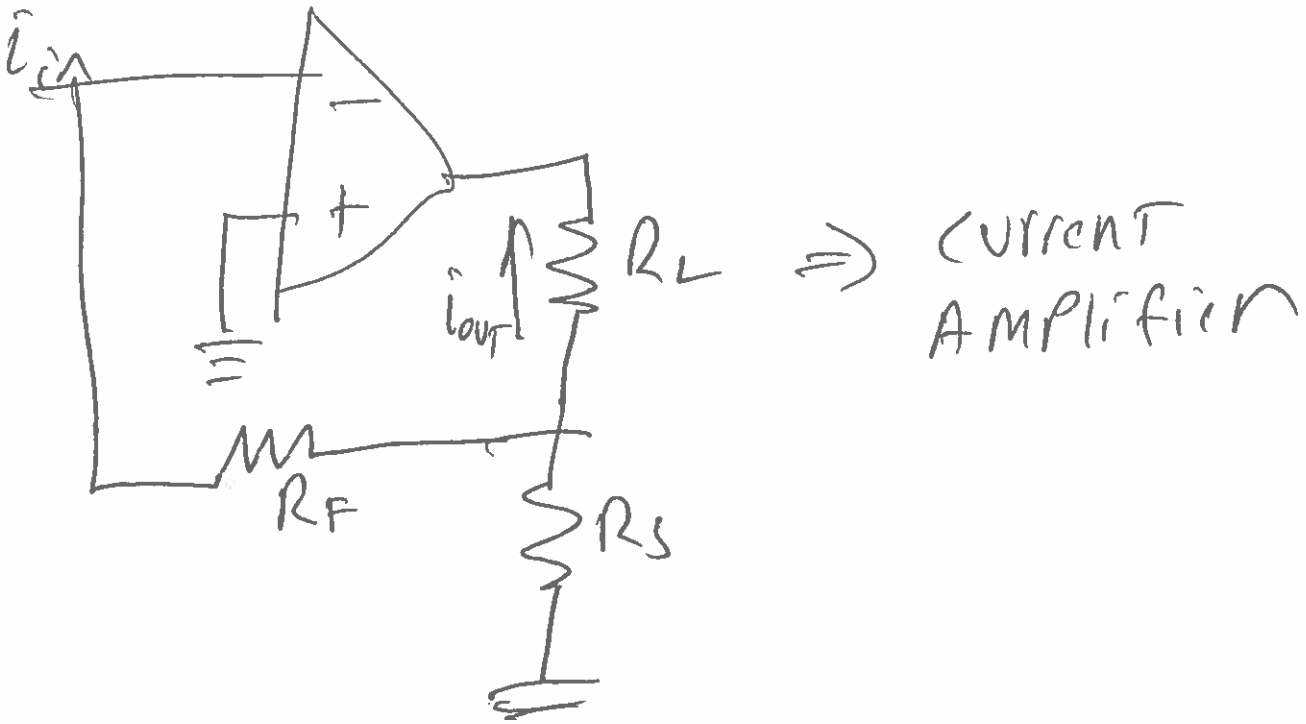
$$i_{OUT} = \frac{0 - V_A}{R_F} - \frac{V_A}{R_S} = -\frac{V_A}{R_F}\left(1 + \frac{R_F}{R_S}\right)$$

$i_{OUT} = i_1$

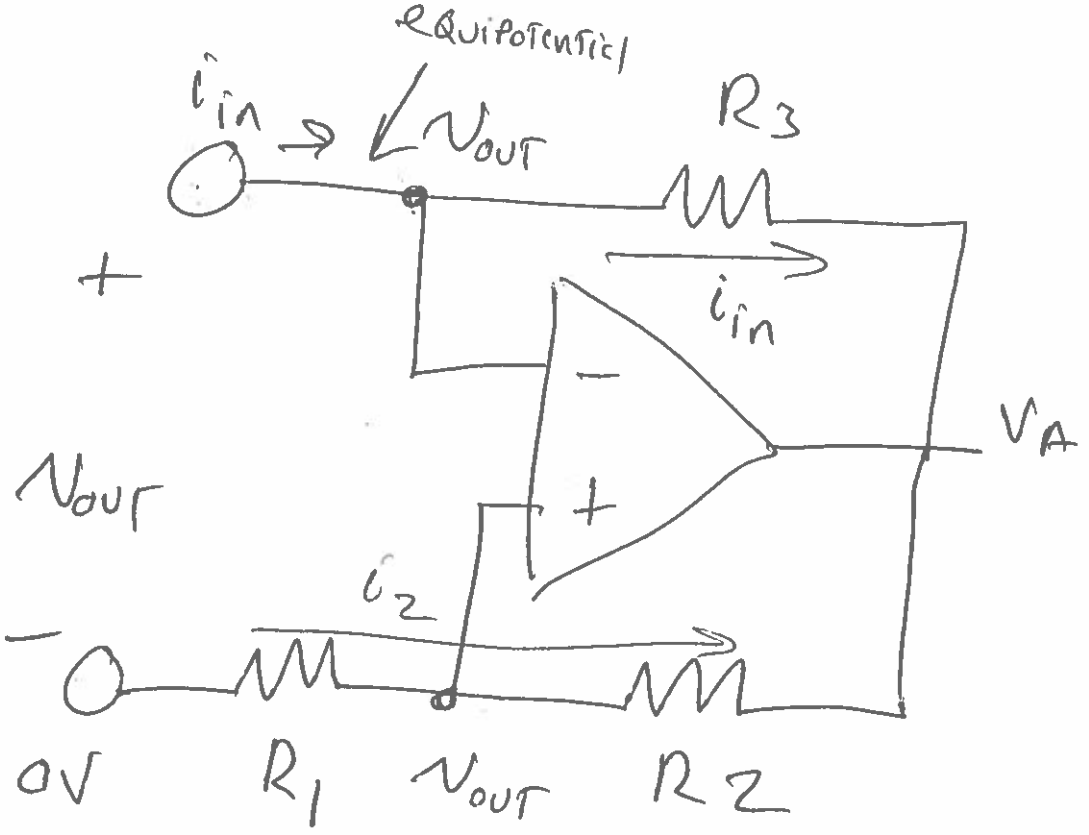
Using $i_{in} = -\frac{V_A}{R_F}$

$$i_{OUT} = i_{in}\left(1 + \frac{R_F}{R_S}\right)$$

$$\frac{i_{OUT}}{i_{in}} = 1 + \frac{R_F}{R_S} = \text{Current Gain}$$



$\Rightarrow$ Current Amplifier



because $V_- = V_+$

$$i_{in} = \frac{V_{OUT} - V_A}{R_3}$$

$$i_2 = \frac{0 - V_{OUT}}{R_1} = \frac{V_{OUT} - V_A}{R_2}$$

$$-V_{OUT} = \frac{R_1}{R_2} V_{OUT} - \frac{R_1}{R_2} V_A$$

$$V_{OUT}\left(1 - \frac{R_1}{R_2}\right) = \frac{R_1}{R_2} V_A$$ can do, not useful

$$V_{OUT} - V_A = -V_{OUT}\frac{R_2}{R_1}$$

$$i_{in} = \frac{V_{OUT} - V_A}{R_3} = \frac{-V_{OUT}\,R_2/R_1}{R_3} = \frac{-V_{OUT}\,R_2}{R_1 R_3}$$

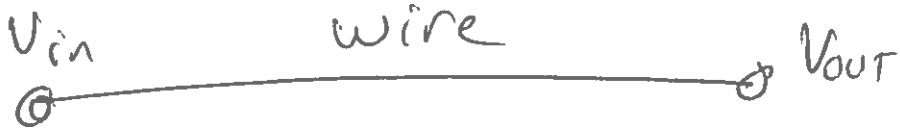
$$\boxed{V_{OUT} = -i_{in}\frac{R_1 R_3}{R_2}}$$

$$\frac{V_{OUT}}{i_n} = R_{eff} = -\frac{R_1 R_3}{R_2}$$ Negative resistance

Passive resistors can never be negative

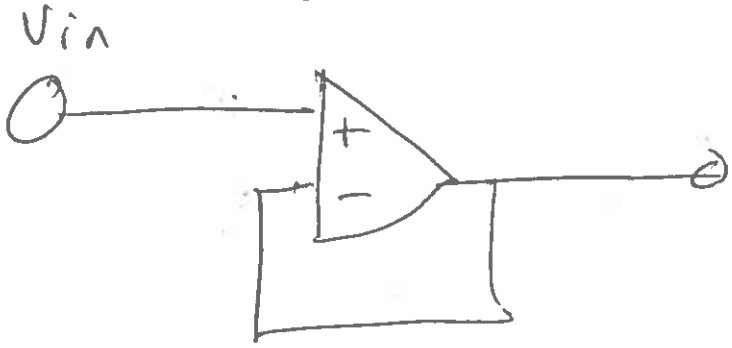
Active resistor (has seperate power source)

Therefore can act as increasing current rather than decreasing current.



$V_{OUT} = V_{in}$

Voltage follower



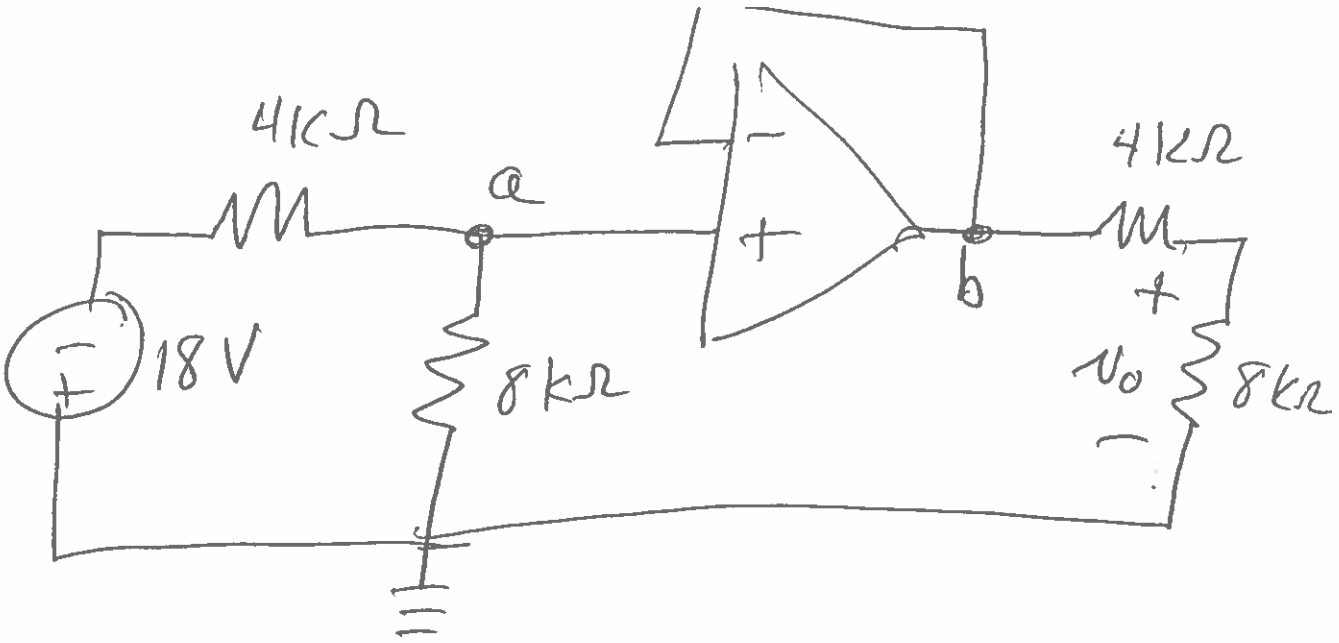
$V_{OUT} = V_{in}$

This draws more energy

Use Voltage follower to protect @

by limiting Voltage Allowed

limiting current Allowed



$V_{OUT} = ?$ $\quad V_{OUT} = V_b \dfrac{8\,k\Omega}{4k\Omega + 8k\Omega}$

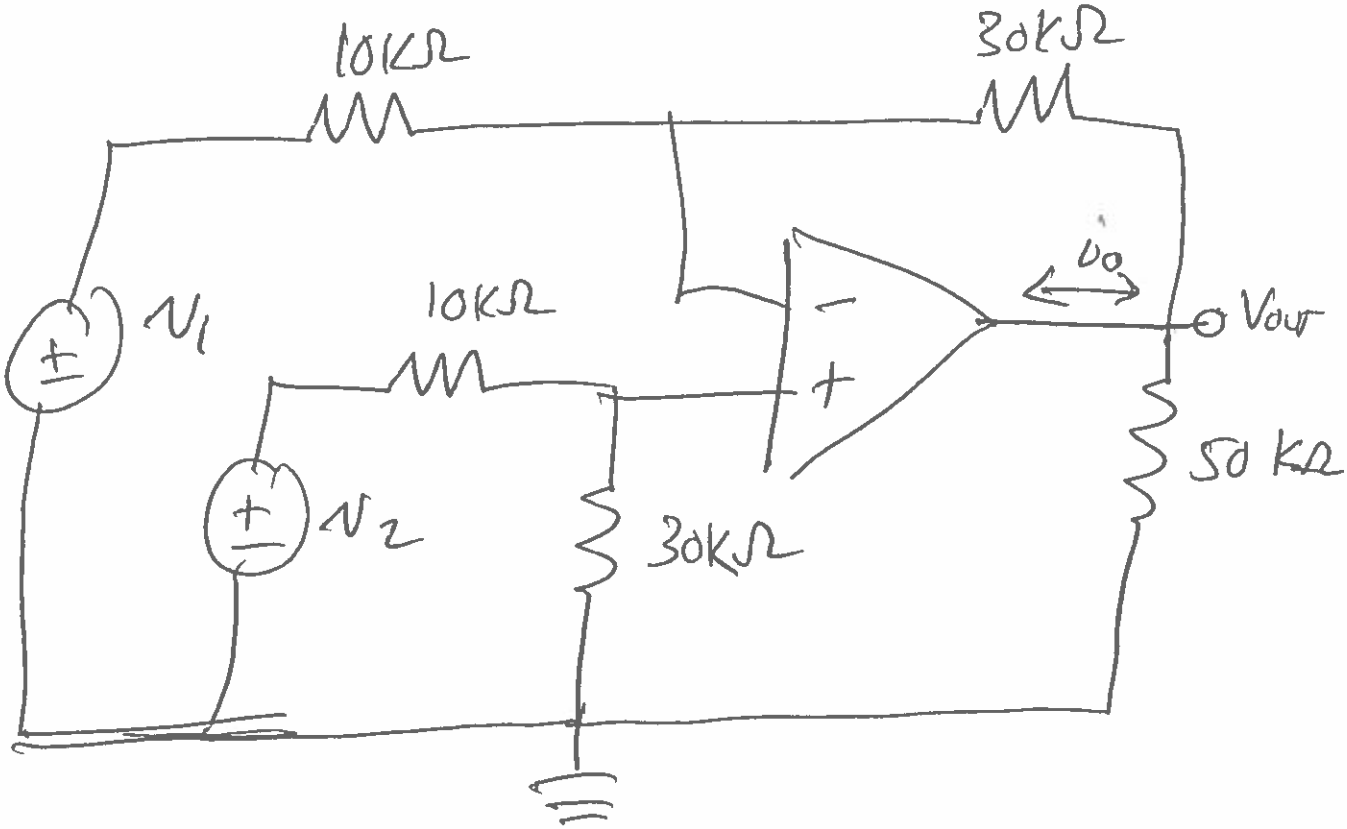
$$V_a = (-18V)\frac{8k\Omega}{4k\Omega + 8k\Omega} = (-18V)\frac{8}{12} = (-18V)\frac{4}{6}$$

$$V_a = -12V$$

$V_b = V_a$ $\quad$ So $V_{OUT} = (-12V)\dfrac{8}{12}$

$$\boxed{V_{OUT} = -8V}$$

Node Analysis with OP-AMPS



OP-AMP is either a current source or sink to V_{out}. So you cannot write V_{out} as a primary node equation.