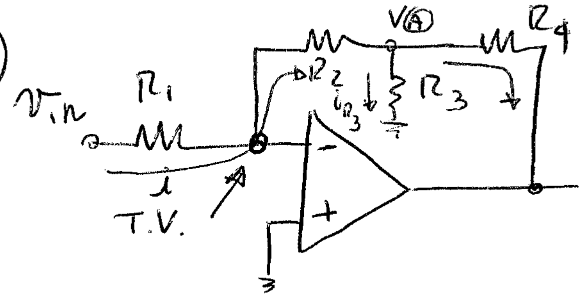
$$-\frac{R_2}{R_1}\left(1+\frac{R_4}{R_2}+\frac{R_4}{R_3}\right)$$

$$-A_0\left(\frac{R_1}{R_1+R_2+R_3/\!/R_4}\cdot\frac{R_3}{R_3+R_4}\right.$$

(1)



$$i_{R_3}=\frac{v_{(A)}}{R_3}\ ;\quad v_{(A)}=-i\ast R_2=-\frac{v_{in}}{R_1}\ast R_2$$

⇓

bilancio di correnti in (A): $i_{R_4}=i-i_{R_3}=\frac{v_{in}}{R_1}+\frac{v_{in}R_2}{R_1R_3}$

$$V_{out}=V_{(A)}-i_{R_4}\ast R_4=-v_{in}\frac{R_2}{R_1}-\frac{R_4}{R_3}v_{in}\frac{R_2}{R_1}-v_{in}\frac{R_4}{R_1}=$$

$$=-v_{in}\left[\frac{R_2}{R_1}+\frac{R_4}{R_3}\frac{R_2}{R_1}+\frac{R_4}{R_1}\right]=-v_{in}\frac{R_2}{R_1}\left[1+\frac{R_4}{R_3}+\frac{R_4}{R_2}\right]$$

⇓

$$G_{id}=-\frac{R_2}{R_1}\left[1+\frac{R_4}{R_3}+\frac{R_4}{R_2}\right]=-\frac{1M\Omega}{1M\Omega}\cdot\left[1+\frac{1M\Omega}{200k}+\frac{1M\Omega}{1M\Omega}\right]=$$

$$=-7$$

$$G_{rede}=\frac{G_{id}}{1-1/G_{loop}}=\frac{-7}{1+\frac{1}{7700}}=-6.999$$

Calcolo G_{loop}: $$G_{loop}=-\frac{R_3/\!/(R_2+R_1)}{R_4+[R_3/\!/(R_2+R_1)]}\cdot\frac{R_1}{R_1+R_2}A_0=$$

$$=-A_0\frac{\frac{(R_2+R_1)\cdot R_3}{R_2+R_1+R_3}}{R_4+\frac{(R_2+R_1)\cdot R_3}{R_2+R_1+R_3}}\cdot\frac{R_1}{R_1+R_2}=-A_0\frac{R_1R_3}{R_4(R_2+R_1+R_3)+(R_2+R_1)}$$

$$=-\frac{A_0\quad R_1R_3}{(R_2+R_1)(R_3+R_4)+R_3R_4}=-A_0\frac{R_1}{R_1+R_2+R_3/\!/R_4}\cdot\frac{R_3}{R_3+R_4}=$$

$$=-10^5\ast\frac{1M\Omega}{1M\Omega+1M\Omega+\underbrace{1M\Omega/\!/200k}_{167k}}\cdot\frac{200k}{200k+1M\Omega}=-10^5\ast0.46\ast0.167$$

$$=-0.077\ 10^5=$$

$$=-7.7\ 10^3$$

(2) $R_{in}\big|_{id}=R_1+0\Rightarrow R_{in}=R_1+\frac{R_{eq}}{1-G_{loop}^{\ast}}$

$R_{eq}=(R_2+R_3/\!/R_4)/\!/R_D=1.167M\Omega/\!/500k\Omega=350k\Omega$

$$G^*_{loop} = -A_0 \frac{R_{in}}{R_{in}+R_2+R_3 \| R_4} \cdot \frac{R_3}{R_3+R_4} =$$

$$= -10^5 \underbrace{\frac{500k}{500k+1M\Omega+167k}}_{0.3} \cdot \underbrace{\frac{200k}{1.2M\Omega}}_{0.167} = -0.05\ 10^{-5} = -5000$$

⇓

$$R_{in} = R_1 + \frac{350k\Omega}{1+5000} = 1M\Omega + 70\Omega \simeq 1M\Omega$$

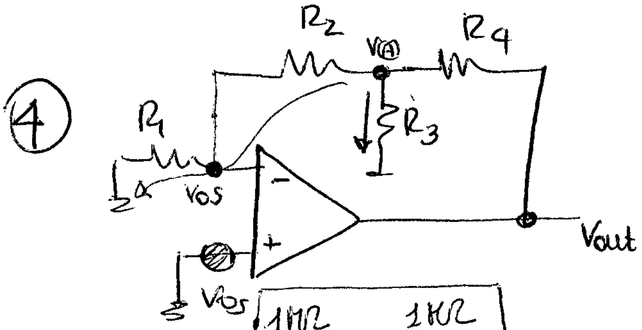
Rispetto ad una configurazione invertente standard posso avere elevata impedenza di ingresso, senza compro messi sul guadagno.

(3)

$$R_{comp} = R_1 \| \left[R_2 + R_3 \| R_4\right] = 1M\Omega \| \left[1M\Omega + \underbrace{200k \| 1M\Omega}_{167k}\right] =$$

$$= 538.5k\Omega$$

(4)



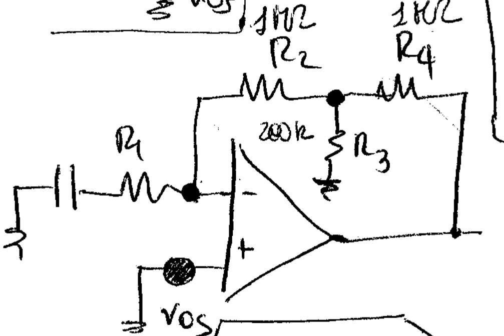
$$V_A = \pm V_{os} + \frac{\pm V_{os}}{R_1} \cdot R_2$$

$$i_{R_3} = \frac{V_A}{R_3} = \pm \frac{V_{os}}{R_3}\left(1+\frac{R_2}{R_1}\right)$$

$$i_{R_4} = i_{R_3} + \frac{\pm V_{os}}{R_1} = \pm \frac{V_{os}}{R_3}\left(1+\frac{R_2}{R_1}\right) \pm \frac{V_{os}}{R_1}$$

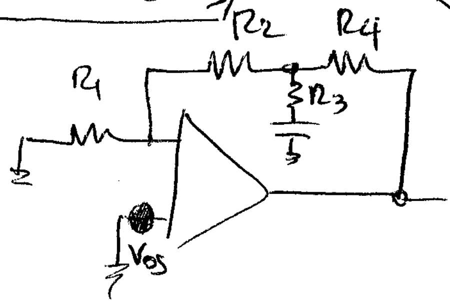
$$V_{out}\Big|_{os} = V_A + i_{R_4} * R_4 = \pm V_{os}\left[\left(1+\frac{R_2}{R_1}\right) + \frac{R_4}{R_3}\left(1+\frac{R_2}{R_1}\right) + \frac{R_4}{R_1}\right] = \pm V_{os}\left[\left(1+\frac{R_2}{R_1}\right)\left(1+\frac{R_4}{R_3}\right)+\frac{R_4}{R_1}\right] =$$

$$= \pm 5mV * 13 = \pm 65mV$$ ✓



$$V_{out}\Big|_{os} = \pm V_{os} * \left[\frac{R_4+R_3}{R_3}\right] =$$

$$= \pm 5mV * \left[\frac{1.2M\Omega}{200k}\right] = \pm 30mV$$ ✓



$$V_{out}\Big|_{os} = \pm V_{os}\left[1+\frac{R_2+R_4}{R_1}\right] =$$

$$= \pm 5mV\left[1+\frac{2M\Omega}{1M\Omega}\right] = \pm 15mV$$