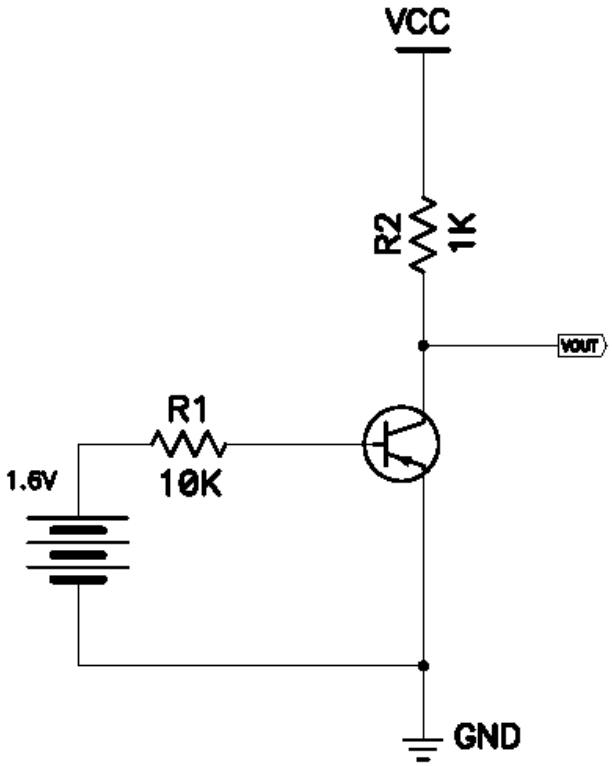
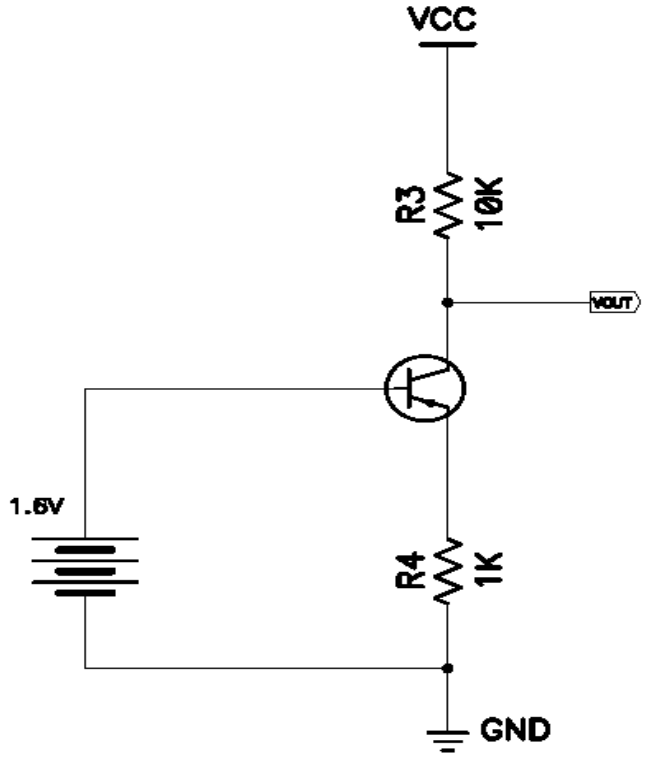
TEST



V_{BE}=0,6V

V_{CES}=0,2V



1)Odrediti struju kroz R2 i Vout ako je hfe=100 a) Vcc=20V;

b) Vcc=5V

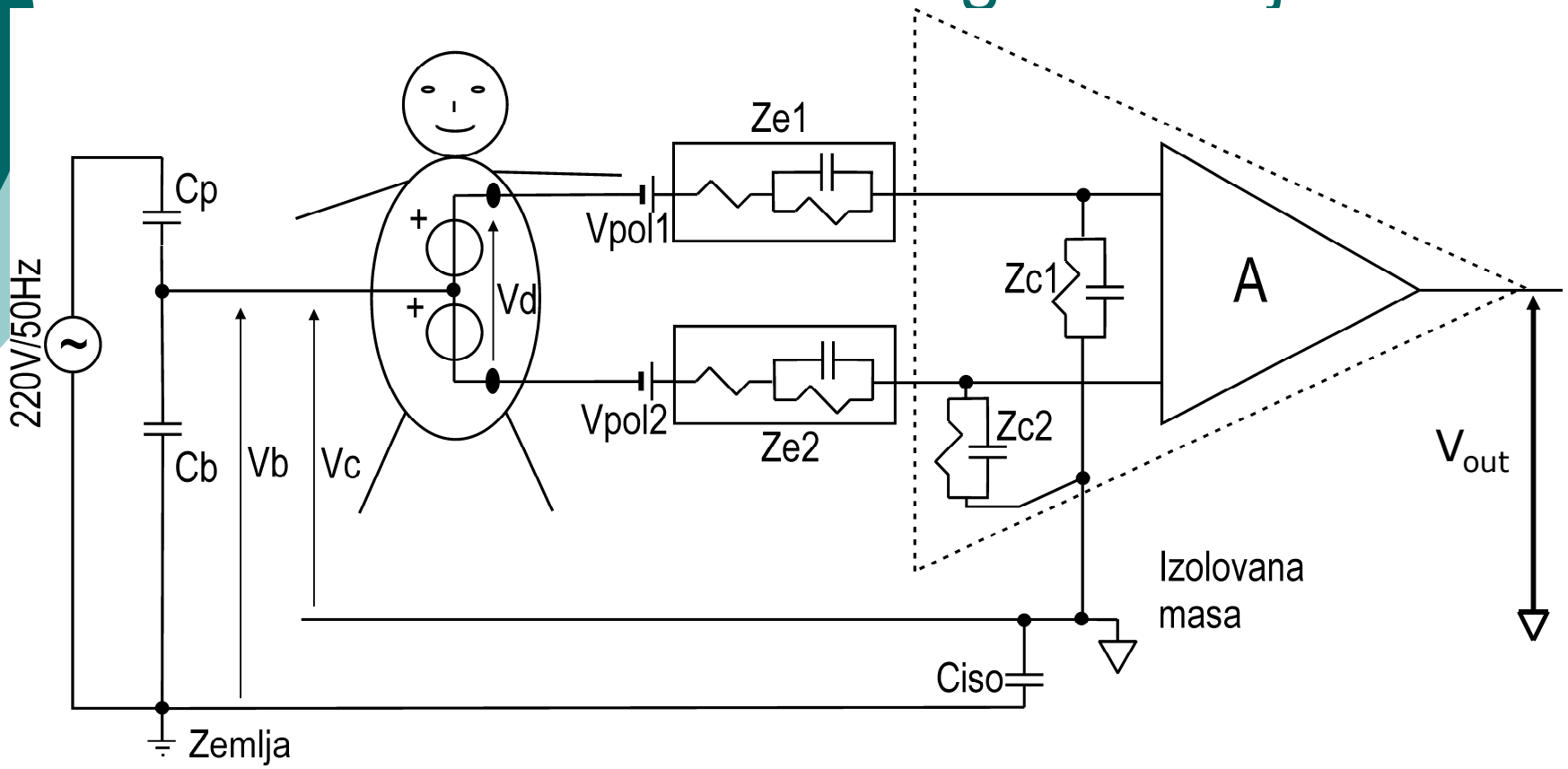
2)Odrediti struju kroz R3 i Vout ako je hfe=100-300 a) Vcc=20V;

b) Vcc=5V

INSTRUMENTACIONI POJAČAVAČ

Tehnologije biomedicinskog inženjeringa

Model elektrofiziološkog snimanja



$$V_b = V_m \frac{C_p}{C_p + C_b}$$

$$Z_i = \frac{1}{j\omega\left(C_p + C_b\right)}$$

Faktor potiskivanja signala zajedničkog moda CMRR

Izlazni signal pojačavača:

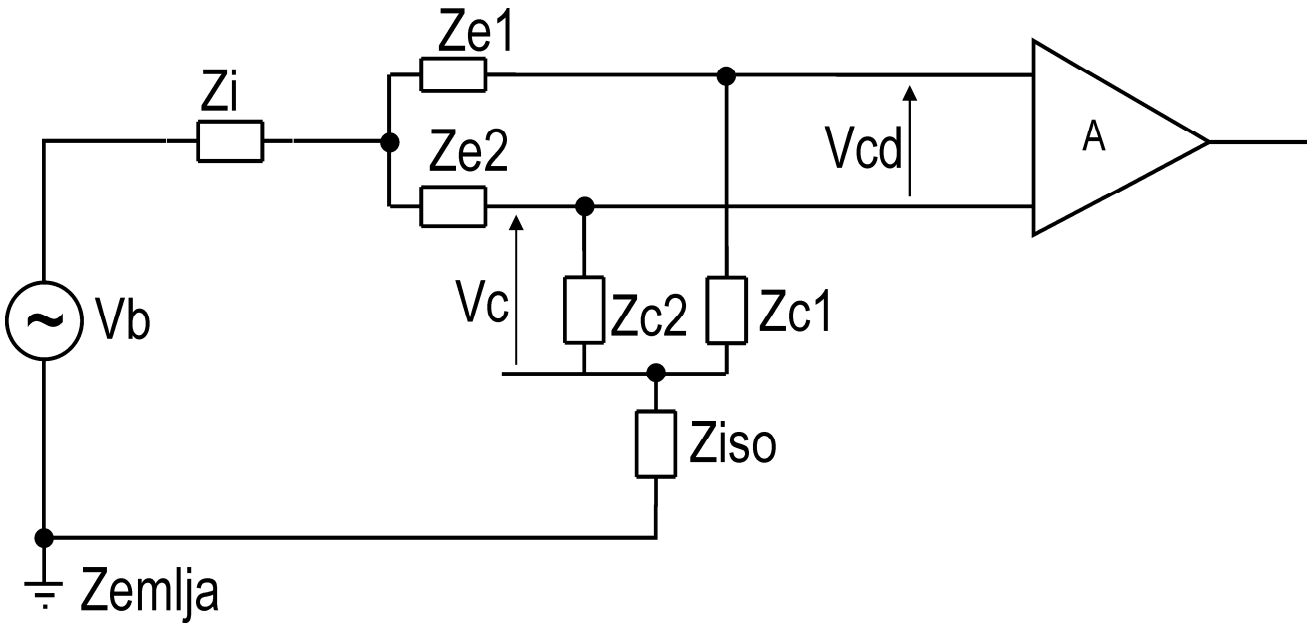
$$V_{out} = A_d \cdot V_d + A_c \cdot V_c$$

Faktor CMRR:

$$CMRR = \frac{A_d}{A_c}$$

$$CMRR_{dB} = 20\log\left(\frac{A_d}{A_c}\right)$$

Ekvivalentna šema signala zajedničkog moda



$$V_c = V_b \frac{Z_c}{Z_e + Z_c + 2(Z_i + Z_{iso})}$$

Ze1=Ze2=Ze

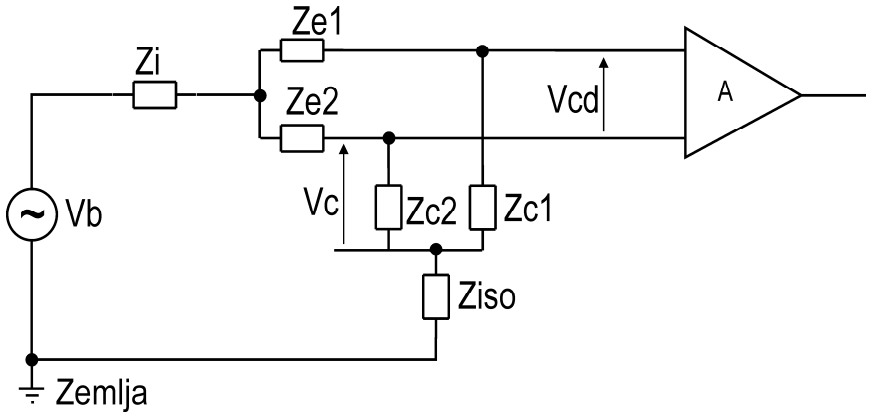
Zc1=Zc2=Zc

Pretvaranje zajedničkog u diferencijalni mod

Ze1=Ze+ΔeZe; Ze2=Ze-ΔeZe; Zc1=Zc-ΔcZc; Zc2=Zc+ΔcZc

$Z_{iso} = Z_i = 0$

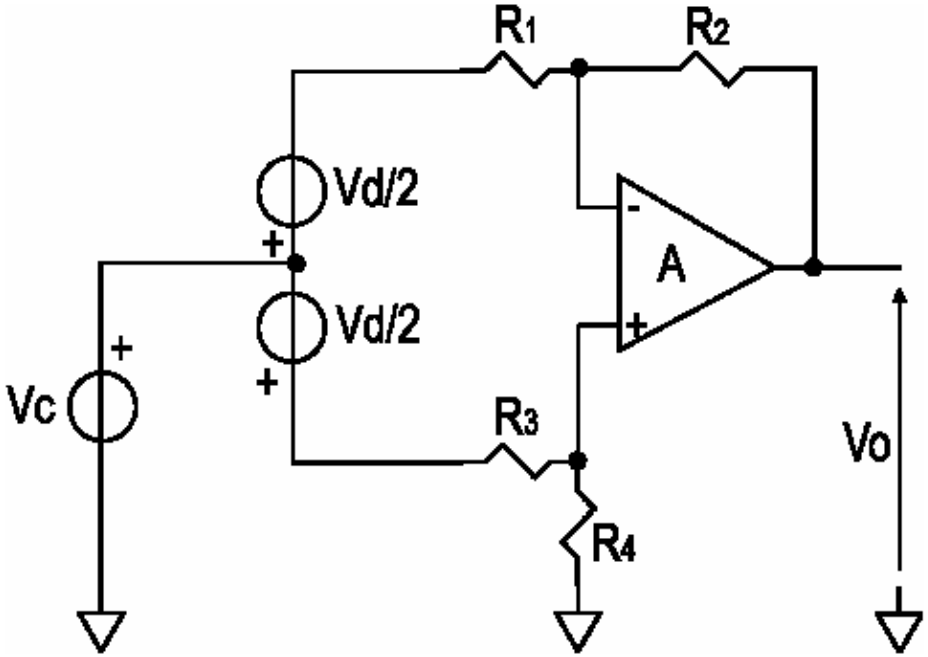
$$V_{cd} = V_b \left[\frac{Z_c + \Delta c Z_c}{Z_c + \Delta c Z_c + Z_e - \Delta e Z_e} - \frac{Z_c - \Delta c Z_c}{Z_c - \Delta c Z_c + Z_e + \Delta e Z_e} \right]$$



$$CMR_{\Delta Z} = \frac{Ad}{Ac_{\Delta Z}} = \frac{Ad}{Ad\dfrac{V_{cd}}{V_b}} = \frac{V_b}{V_{cd}}$$

$$CMR_{\Delta Z} = \frac{Z_c}{Z_e} \cdot \frac{1 - \Delta c^2}{2(\Delta c + \Delta e)}$$

Diferencijalni pojačavač



$$\frac{V_o}{V_d} = \frac{R_2}{R_1}$$

Karakteristike pojačanja diferencijalnog pojačavača

$$V_o = \left(V_c + \frac{V_d}{2}\right)\frac{R_4}{R_3+R_4}\frac{R_1+R_2}{R_1} - \left(V_c - \frac{V_d}{2}\right)\frac{R_2}{R_1}$$

$$V_o = V_c\left[\frac{R_4}{R_3+R_4}\frac{R_1+R_2}{R_1} - \frac{R_2}{R_1}\right] + V_d\left[\frac{R_4}{R_3+R_4}\frac{R_1+R_2}{R_1} + \frac{R_2}{R_1}\right]$$

$$A_c = \frac{V_o}{V_c}\Big|_{V_d=0} = \left[\frac{R_4}{R_3+R_4}\frac{R_1+R_2}{R_1} - \frac{R_2}{R_1}\right]$$

$$A_d = \frac{V_o}{V_d}\Big|_{V_c=0} = \frac{1}{2}\left[\frac{R_4}{R_3+R_4}\frac{R_1+R_2}{R_1} + \frac{R_2}{R_1}\right]$$

$$CMRR = \frac{R_4(R_1+R_2)+R_2(R_3+R_4)}{2\left[R_4(R_1+R_2)-R_2(R_3+R_4)\right]}$$

$za\ R_1 = R_2 = R_3$

$i\ R_4 = 1.001R_1$

$CMRR_{dB} = 66dB$

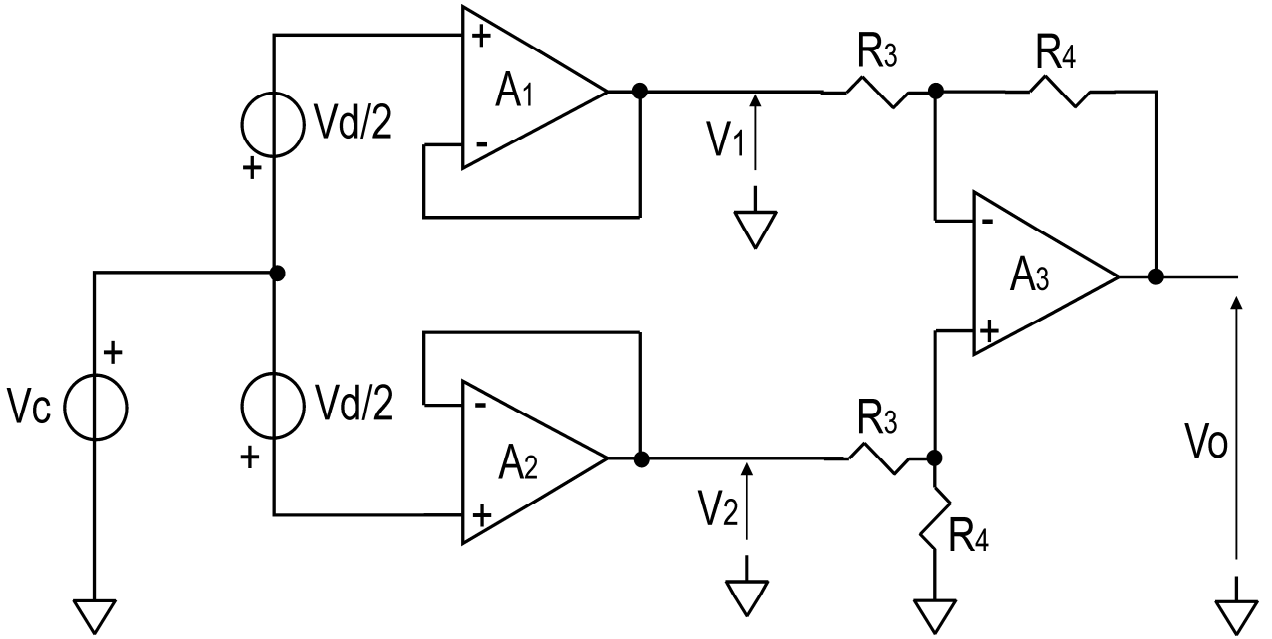
Ulazna impedansa diferencijalnog pojačavača

- Ulazna impedansa relativno mala
- Različita ulazna impedansa na invertujućem i neinvertujućem ulazu

$$Z_{inv} = R_1$$

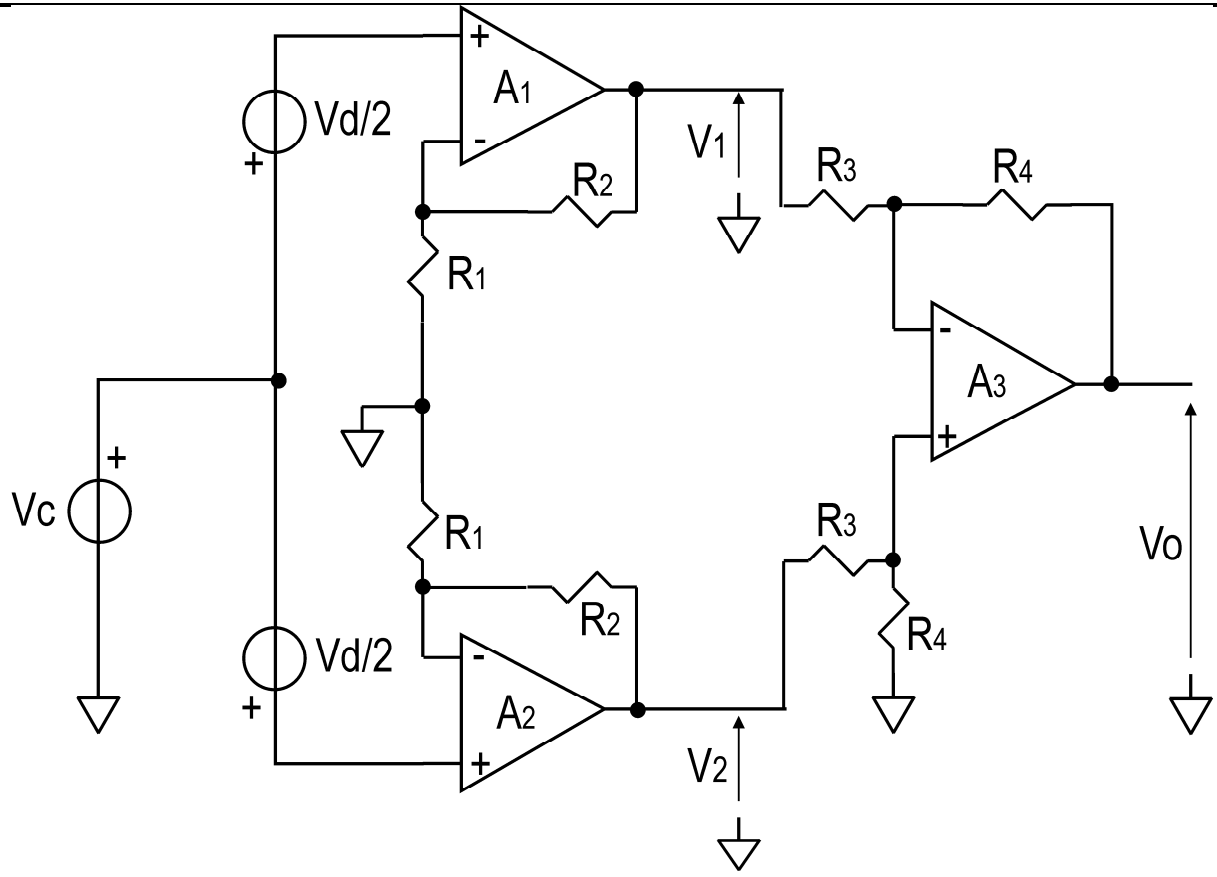
$$Z_{ninv} = R_3 + R_4$$

Baferovan diferencijalni pojačavač



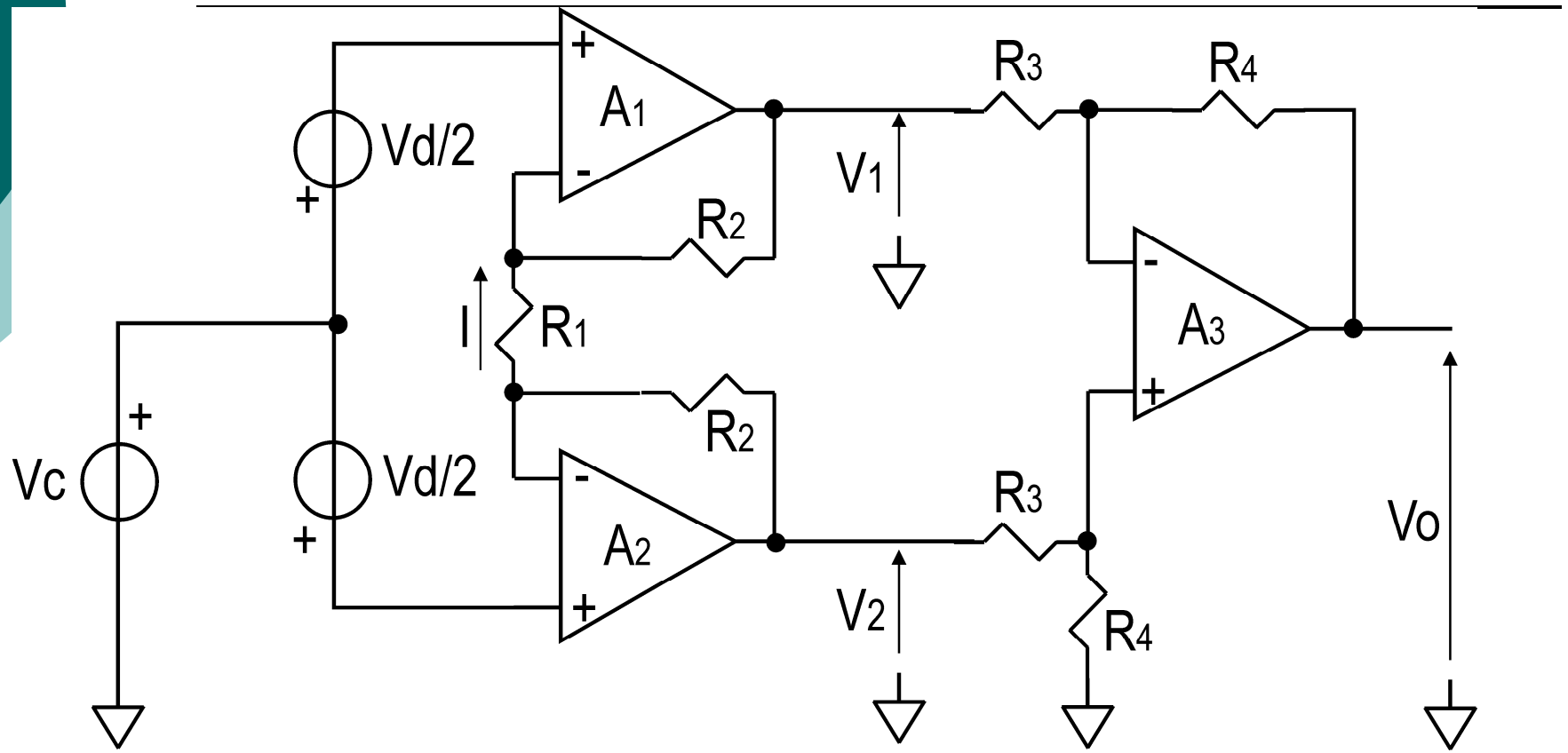
$$V_1 = V_c - \frac{V_d}{2} \quad V_2 = V_c + \frac{V_d}{2} \quad V_o = \frac{R_4}{R_3}(V_2 - V_1)$$

Ulazni stepen sa neinv. pojačavačima



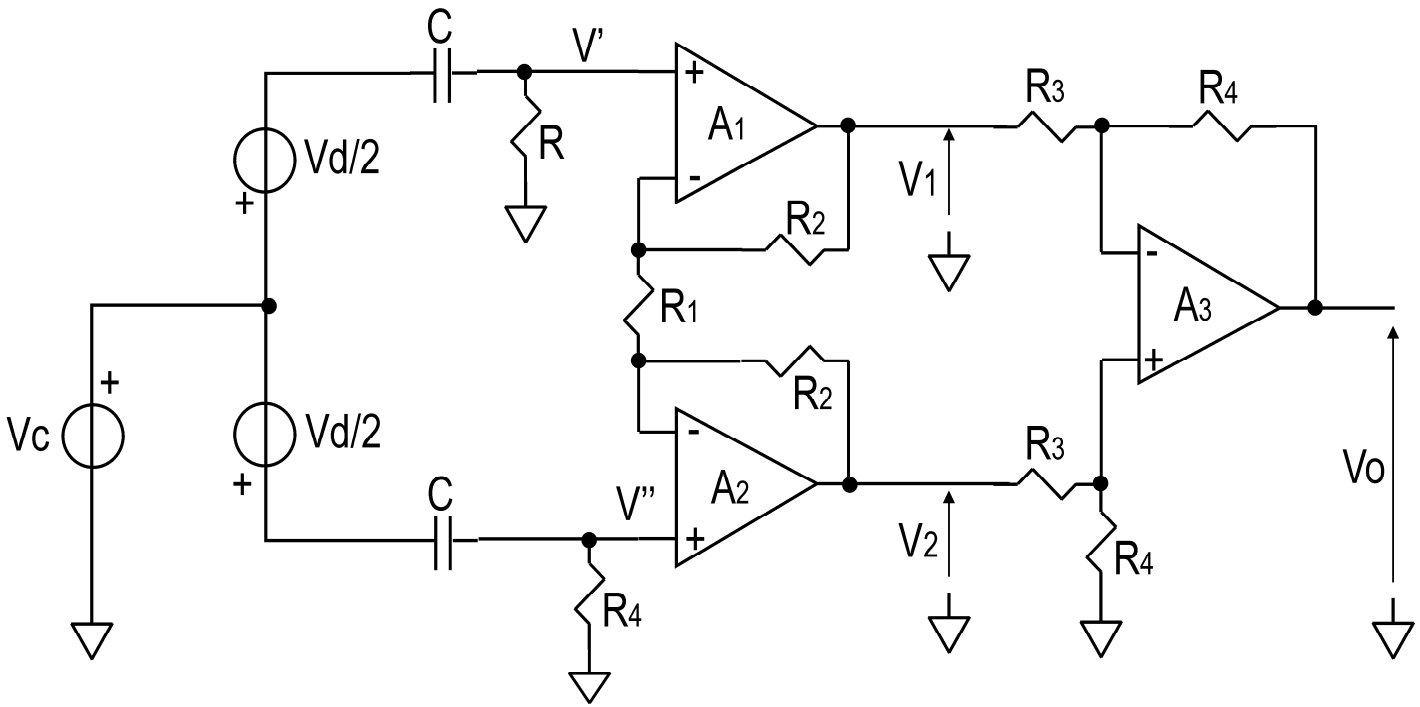
$$V_1 = \left(1 + \frac{R_2}{R_1}\right)\left(V_c - \frac{V_d}{2}\right) \quad V_2 = \left(1 + \frac{R_2}{R_1}\right)\left(V_c + \frac{V_d}{2}\right) \quad V_o = \frac{R_4}{R_3}\left(V_2 - V_1\right)$$

Instrumentacioni pojačavač sa tri operaciona pojačavača



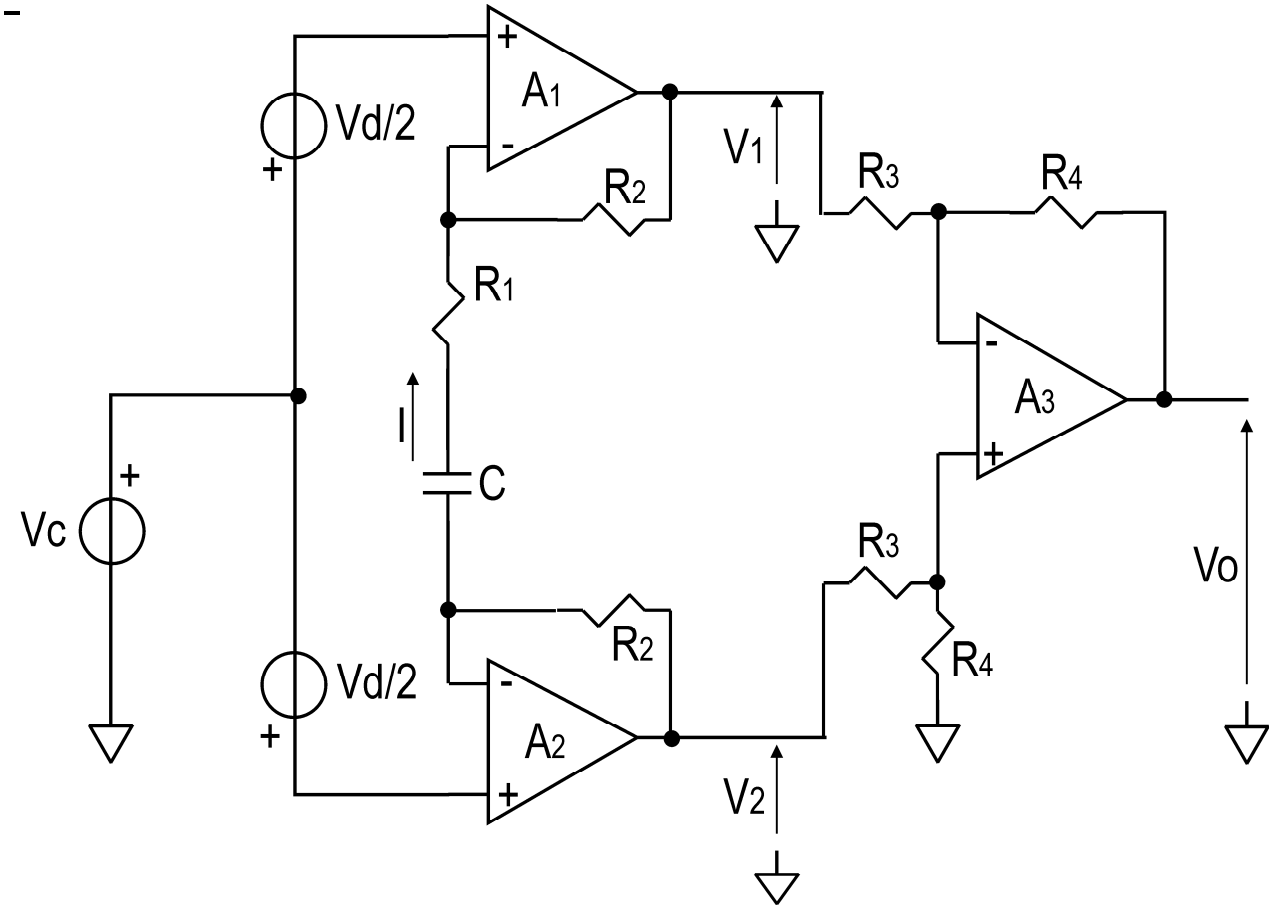
$$I = \frac{V_d}{R_1} \quad V_1 = V_c - (1 + \frac{2R_2}{R_1})\frac{V_d}{2} \quad V_2 = V_c + (1 + \frac{2R_2}{R_1})\frac{V_d}{2} \quad V_o = \frac{R_4}{R_3}(V_2 - V_1)$$

Instrumentacioni pojačavač za naizmenične signale



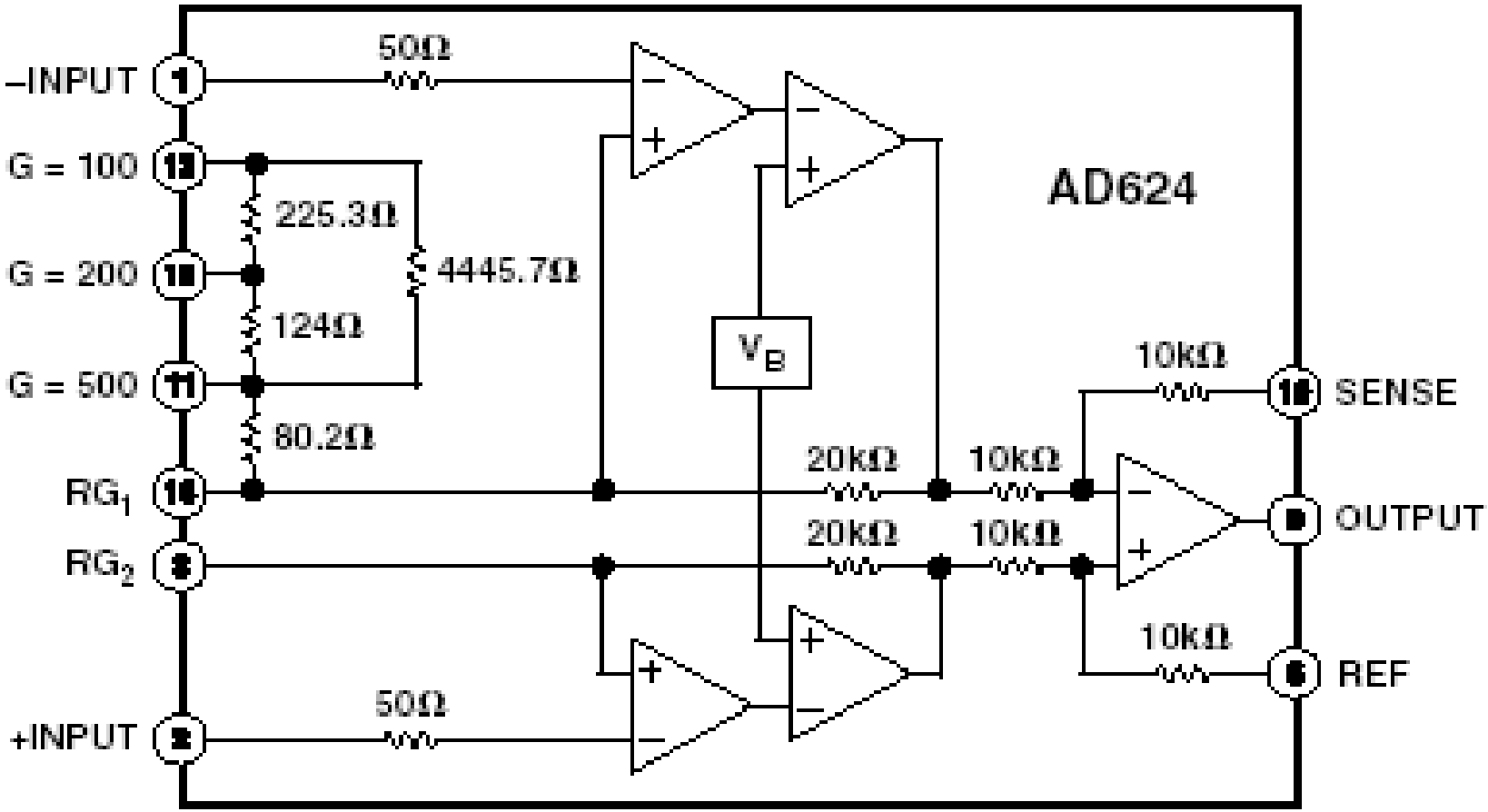
$$V' = \left(V_c - \frac{V_d}{2}\right)\frac{sCR}{1+sCR} \qquad V'' = \left(V_c + \frac{V_d}{2}\right)\frac{sCR}{1+sCR} \qquad V_o = \frac{R_4}{R_3}\left(1+\frac{2R_2}{R_1}\right)\frac{sCR}{1+sCR}V_d$$

Instrumentacioni pojačavač za naizmenične signale



$$I = \frac{V_d}{R_1 + \frac{1}{sC}} \quad V_1 = V_c - (1 + \frac{2R_2}{R_1 + \frac{1}{sC}})\frac{V_d}{2} \quad V_2 = V_c + (1 + \frac{2R_2}{R_1 + \frac{1}{sC}})\frac{V_d}{2} \quad V_o = \frac{R_4}{R_3}\frac{1 + sC(R_1 + 2R_2)}{1 + sCR_1}V_d$$

Monolitni instrumentacioni pojačavači



Operacioni pojačavači u nelinearnom režimu rada

- Komparator
- Komparator sa histerezisom