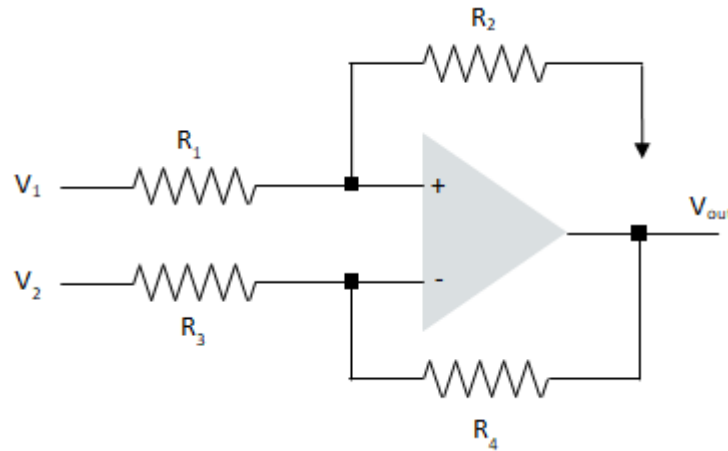


# Differential Amplifier Design

A differential amplifier is to be used to design a unipolar to bipolar converter. The input and output voltage ranges are known. Given a voltage reference, the resistances are to be calculated



Reference voltage  $V_2 := 2.5 \text{ V}$

Known resistances  $R_2 := 3 \cdot 10^3 \Omega$        $R_3 := 10^3 \Omega$

Approach 1:  
Define two expressions  
evaluated at different  
parameter values

$$\text{circuit} := V_{\text{out}} = V_1 \cdot \frac{1}{1 + \frac{R_2}{R_1}} \cdot \left( 1 + \frac{R_4}{R_3} \right) - V_2 \cdot \frac{R_4}{R_3}$$

$$\text{eq1} := \text{eval}(\text{circuit}, [V_1 = 0 \text{ V}, V_{\text{out}} = -1 \text{ V}])$$

$$\text{eq2} := \text{eval}(\text{circuit}, [V_1 = 2.5 \text{ V}, V_{\text{out}} = 1 \text{ V}])$$

$$\text{fsolve}(\{\text{eq1}, \text{eq2}\}) = \{R_1 = 2.250 \times 10^3 \Omega, R_4 = 400.000 \Omega\}$$

Approach 2:  
Define a function using  
arrow operators

$$V_{\text{out}} := (V_1, R_1, R_4) \rightarrow V_1 \cdot \frac{1}{1 + \frac{R_2}{R_1}} \cdot \left( 1 + \frac{R_4}{R_3} \right) - V_2 \cdot \frac{R_4}{R_3}$$

$$\text{sol} := \text{fsolve}(\{V_{\text{out}}(0 \text{ V}, R_1, R_4) = -1 \text{ V}, V_{\text{out}}(2.5 \text{ V}, R_1, R_4) = 1 \text{ V}\})$$

$$\text{sol} = \{R_1 = 2.250 \times 10^3 \Omega, R_4 = 400.000 \Omega\}$$