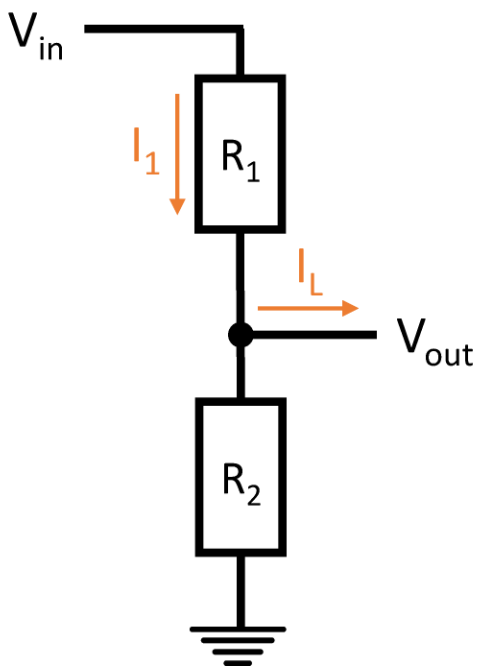
Voltage Divider

Electrical Engineering

Wolfgang Neff

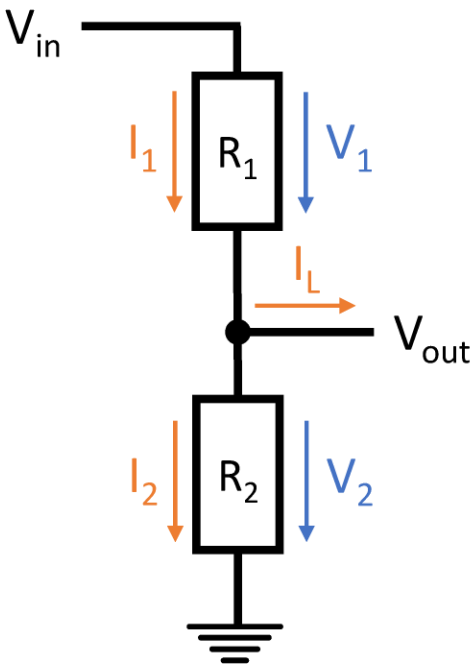
Voltage Divider (1)

- Mode of Operation
  - Reduce voltage with the aid of resistors
  - Two resistors in series
  - Two modes
    - Unloaded voltage divider
      - $I_L = 0$ A ($I_L \leq 0.1 \cdot I_1$)
      - There is no load on V_{out}
    - Loaded voltage divider
      - $I_L > 0$ A ($I_L > 0.1 \cdot I_1$)
      - There is a load on V_{out}



Voltage Divider (2)

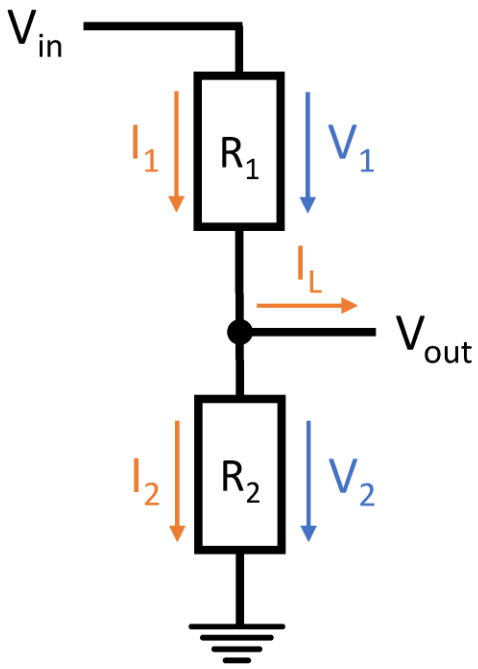
- Unloaded voltage divider
  - Given values
    - R_1, R_2, V_{in}
  - Required values
    - V_{out}, I_V, P_{tot}
  - Relations
    - $I_L = 0\ A$
    - $V_{out} = V_2$
    - $I_V = I_1 = I_2$
    - $R_{tot} = R_1 + R_2$
    - $P_{tot} = V_{in} \cdot I_V$



V_{in}: Input Voltage
V_{out}: Output Voltage
I_L: Load Current
I_V: Vertical Current
R_{tot}: Total Resistance
P_{tot}: Total Power Loss

Voltage Divider (3)

- Unloaded voltage divider (continued)
  - Relations
    - $I_2 = \frac{V_2}{R_2}$
    - $\frac{V_2}{V_{in}} = \frac{R_2}{R_{tot}}$
  - Formulas
    - $V_{out} = \frac{R_2}{R_1+R_2} \cdot V_{in}$
    - $I_V = \frac{V_{out}}{R_2}$
    - $P_{tot} = \frac{V_{in} \cdot V_{out}}{R_2}$

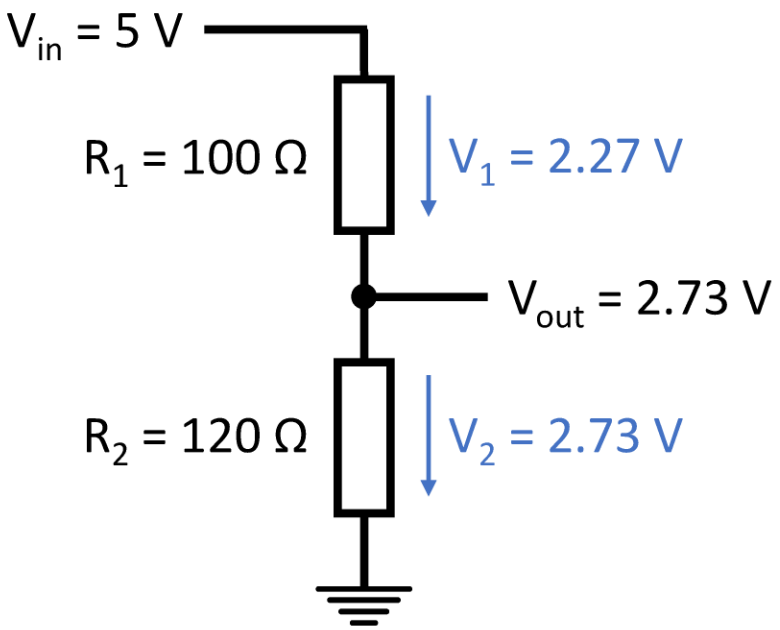


Voltage Divider (4)

- Unloaded voltage divider (example)
  - Given values
    - V_{in} = 5 V
    - R_1 = 100 Ω
    - R_2 = 120 Ω
  - Calculation
    - $V_{out} = \frac{R_2}{R_1+R_2} \cdot V_{in}$

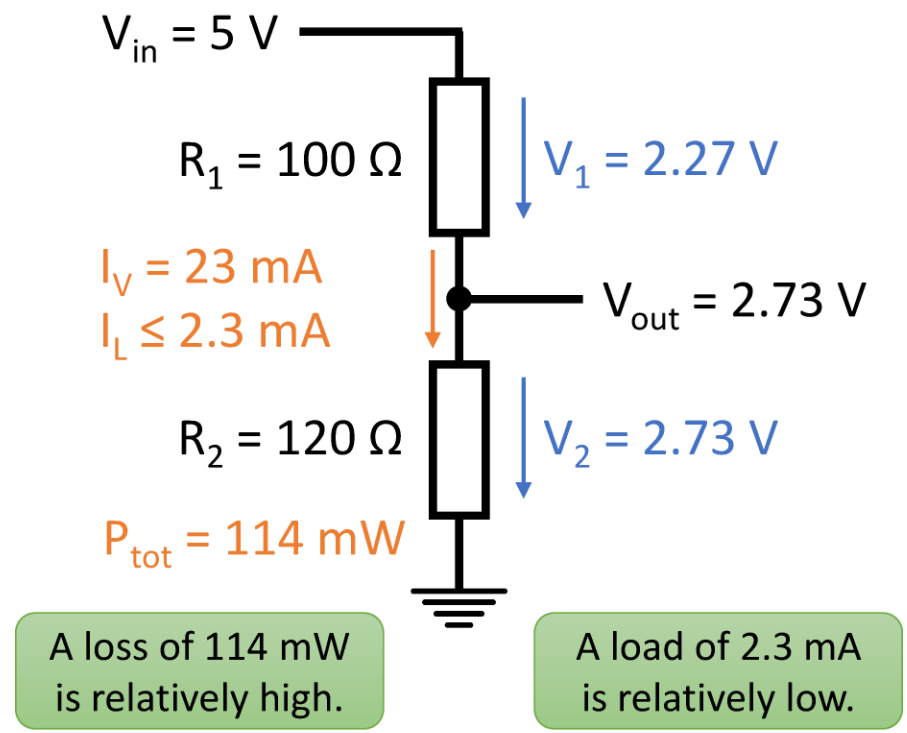
$$= \frac{120\ \Omega}{100\ \Omega+120\ \Omega} \cdot 5\ \text{V}$$

$$= 2.73\ V$$



Voltage Divider (5)

- Unloaded voltage divider (example continued)
  - Calculation
    - $I_V = \frac{V_{out}}{R_2}$
      $= \frac{2.73\ V}{120\ \Omega}$
      $= 23\ mA$
    - $P_{tot} = \frac{V_{in} \cdot V_{out}}{R_2}$
      $= \frac{5\ V \cdot 2.73\ V}{120\ \Omega}$
      $= 114\ mW$



Voltage Divider (6)

- Voltage Divider with Amplifier
  - Loaded voltage divider are difficult to handle
    - Current load may be unknown
    - Current load may vary
  - An amplifier can eliminate the load current