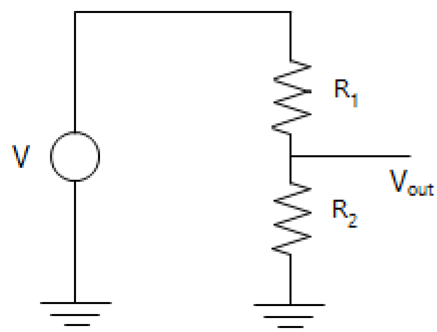
Extreme Value Analysis of a Voltage Divider

This application performs an extreme value analysis of a voltage circuit.



Parameter Values

Number of components $N := 3$

Nominal values for V, R_1 and R_2 $nom := \begin{bmatrix} 5\,\mathbf{V} \\ 86.7\,\mathbf{k} \\ 11\,\mathbf{k} \end{bmatrix}$

Upper and lower % tolerances for V, R_1 and R_2 $upper\_tol := \begin{bmatrix} 0.1 \\ 0.05 \\ 0.01 \end{bmatrix}$ $lower\_tol := \begin{bmatrix} 0.1 \\ 0.05 \\ 0.01 \end{bmatrix}$

Voltage equation $V_{out} := (V, R_1, R_2) \to \dfrac{V \cdot R_2}{R_1 + R_2}$

Voltage at the nominal component values $V_{out}(nom[1], nom[2], nom[3]) = 0.563\,\mathbf{V}$

Extreme Value Analysis

Calculate every combination of tolerance values

zeta ≔ Vector(2^N, i   subs(0 = -1, Bits:-Split(i, bits = N)))

$$
\text{zeta} = \begin{bmatrix} [1,\ -1,\ -1] \\ [-1,\ 1,\ -1] \\ [1,\ 1,\ -1] \\ [-1,\ -1,\ 1] \\ [1,\ -1,\ 1] \\ [-1,\ 1,\ 1] \\ [1,\ 1,\ 1] \\ [-1,\ -1,\ -1] \end{bmatrix}
$$

zeta2 ≔ Vector(2^N, i 1+~ zeta[i] ·~ [seq(ifelse(zeta[i][j] = 1, upper_tol[j], lower_tol[j]), j = 1 ..N)])

$$
\text{zeta2} = \begin{bmatrix} [1.100,\ 0.950,\ 0.990] \\ [0.900,\ 1.050,\ 0.990] \\ [1.100,\ 1.050,\ 0.990] \\ [0.900,\ 0.950,\ 1.010] \\ [1.100,\ 0.950,\ 1.010] \\ [0.900,\ 1.050,\ 1.010] \\ [1.100,\ 1.050,\ 1.010] \\ [0.900,\ 0.950,\ 0.990] \end{bmatrix}
$$

Calculate the voltage at every combination of extreme tolerance values

V ≔ Vector(2^N, i V_{out}(seq(nom[j] · zeta2[i][j], j = 1 ..N)))

$$V = \begin{bmatrix} 0.642\ \mathbf{V} \\ 0.481\ \mathbf{V} \\ 0.588\ \mathbf{V} \\ 0.535\ \mathbf{V} \\ 0.654\ \mathbf{V} \\ 0.489\ \mathbf{V} \\ 0.598\ \mathbf{V} \\ 0.525\ \mathbf{V} \end{bmatrix}$$

Extreme values of voltage

$$\min(V) = 0.481\ \mathbf{V}$$

$$\max(V) = 0.654\ \mathbf{V}$$