

## Thermal Circuit to determine heat flux difference inside Heated Plate from different heat paths

Assume Base temperature of  $T_{\text{base}} := 413.15\text{K}$  (140 C)

and Surface temperature of  $T_s := 410.15\text{K}$  (137 C)

### Define Thicknesses and Thermal Conductivities

Surface plate, Aluminum 2024	$t_{\text{surface}} := 0.125\text{in}$	$k_{\text{surface}} := 141 \frac{\text{W}}{\text{m}\cdot\text{K}}$	
Total thickness of adhesive in combination with HFS or Cirlex	$t_{\text{total}} := 0.05\text{in}$		
Heat Flux Sensor	$t_{\text{HFS}} := 0.013\text{in}$	$k_{\text{HFS}} := 0.156 \frac{\text{W}}{\text{m}\cdot\text{K}}$	
Cirlex	$t_{\text{Cirlex}} := 0.010\text{in}$	$k_{\text{Cirlex}} := 0.12 \frac{\text{W}}{\text{m}\cdot\text{K}}$	
Adhesive layer over HFS	$t_{\text{ad\_HFS}} := t_{\text{total}} - t_{\text{HFS}} = 0.037\text{in}$		$k_{\text{ad}} := 1.0 \frac{\text{W}}{\text{m}\cdot\text{K}}$
Adhesive layer over Cirlex	$t_{\text{ad\_Cirlex}} := t_{\text{total}} - t_{\text{Cirlex}} = 0.04\text{in}$		
Base Metal, Aluminum 6061	$t_{\text{base}} := 0.25\text{in}$	$k_{\text{base}} := 167 \frac{\text{W}}{\text{m}\cdot\text{K}}$	

### Thermal Circuit Analysis

$$V = I \cdot R \quad T_1 - T_2 = q'' \cdot R'' \quad q'' = \frac{T_1 - T_2}{R''}$$

Consider two parallel paths and compare thermal resistance and heat flux

$$R''_{\text{HFS}} := \frac{t_{\text{base}}}{k_{\text{base}}} + \frac{t_{\text{HFS}}}{k_{\text{HFS}}} + \frac{t_{\text{ad\_HFS}}}{k_{\text{ad}}} + \frac{t_{\text{surface}}}{k_{\text{surface}}} = 3.117 \times 10^{-3} \cdot \frac{\text{m}^2 \cdot \text{K}}{\text{W}}$$

$$R''_{\text{Cirlex}} := \frac{t_{\text{base}}}{k_{\text{base}}} + \frac{t_{\text{Cirlex}}}{k_{\text{Cirlex}}} + \frac{t_{\text{ad\_Cirlex}}}{k_{\text{ad}}} + \frac{t_{\text{surface}}}{k_{\text{surface}}} = 3.193 \times 10^{-3} \cdot \frac{\text{m}^2 \cdot \text{K}}{\text{W}}$$

$$q''_{\text{HFS}} := \frac{T_{\text{base}} - T_s}{R''_{\text{HFS}}} = 962.461 \frac{\text{W}}{\text{m}^2}$$

$$q''_{\text{Cirlex}} := \frac{T_{\text{base}} - T_s}{R''_{\text{Cirlex}}} = 939.494 \frac{\text{W}}{\text{m}^2}$$

$$\frac{q''_{\text{HFS}}}{q''_{\text{Cirlex}}} = 1.024$$