



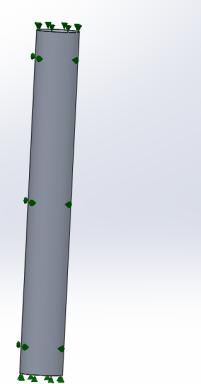
# SolidWorks Thermal Simulations of Cartridge Heater, Heater Block, and Fiber Bundle Mounting Block

Status	Done
Project	② <a href="#">Heat Fiber Bundle Mounting Block</a>
Tags	

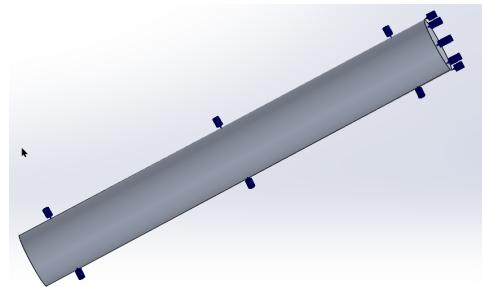
The simulations below are Steady State.

## Cartridge Heater

- **Material:** 6061 Aluminum
- **Thermal Loads: Convection:**  $70 \frac{W}{m^2 K}$  (Taken from → [Estimate Metal to Air HTC in iso320 Full Nipple \(one side open\)](#)) (applied all faces except where Cartridge Heater is inserted.)
  - **Bulk Ambient Temp** = 293.15K



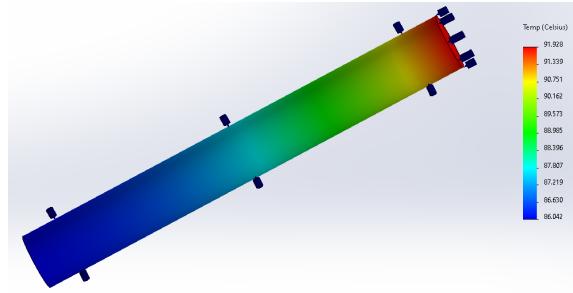
- **Heat Power:** 0.64W (4V @ 0.16A), 1W, 2.56W (8V @0.32A), 5W, 20W (Only applied to diameter and tip)



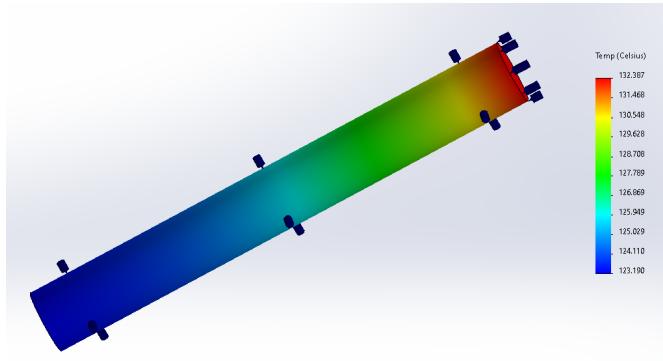
- **Radiation:** Surface to ambient @ 293.15K, Emissivity =1. Same two exposed Faces. View Factor = 0.5

## Results:

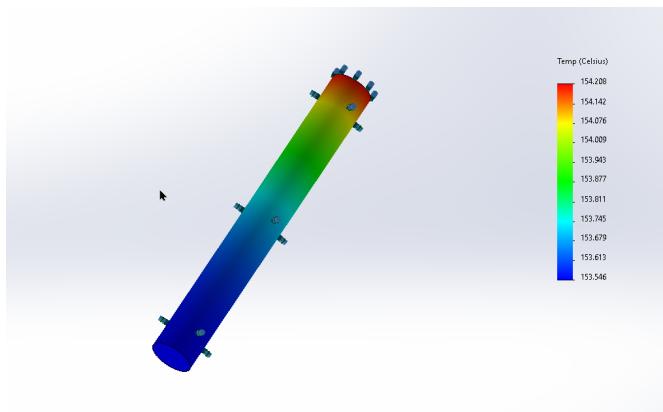
- Heat Power = 0.64W (4V @ 0.16A)
  - = 54C if Heat power is Total with radiation
  - $\approx$  86C if heat power per item and no radiation (Where my thermocouple is located in → [Determine if Adding insulation barrier increases Heat inside chamber with same wattage applied](#)
  - Similar Result as previously measured above.



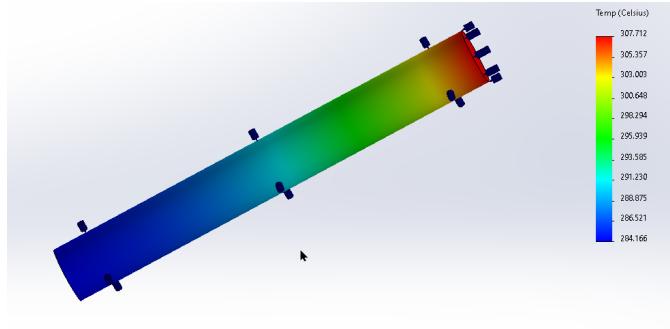
- Heat Power = 1W
  - ≈ 123C if heat power per item and no radiation



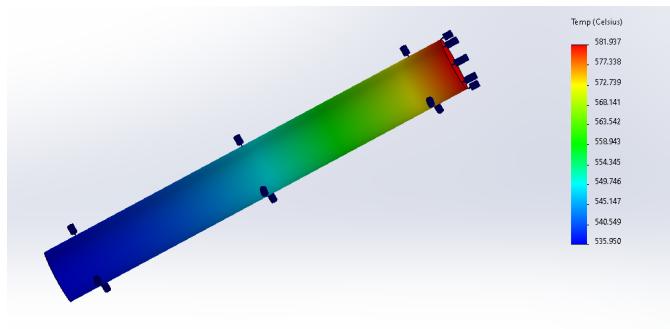
- Heat Power = 2.56W (8V @0.32A)
  - ≈ 153 C if set to total and radiation



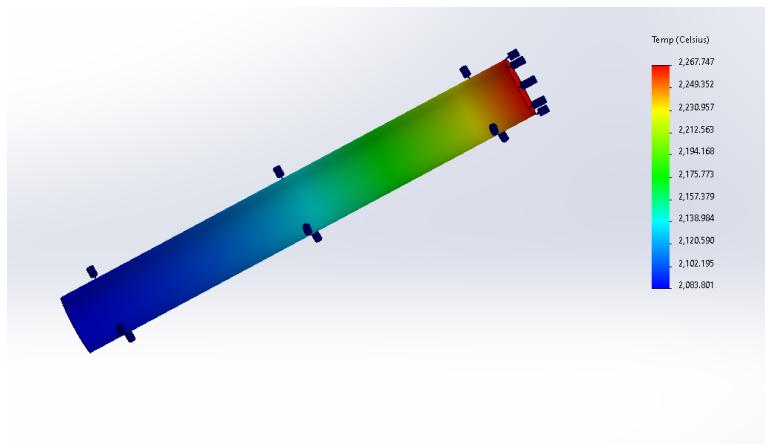
- ≈ 284 C if set to per item and no radiation
- A power of 1.5W gets us closer to what we measured at 188C



- Heater Power = 5W
  - = 269 C if heat power is total with radiation
  - ≈ 535 C if heat power per item and no radiation

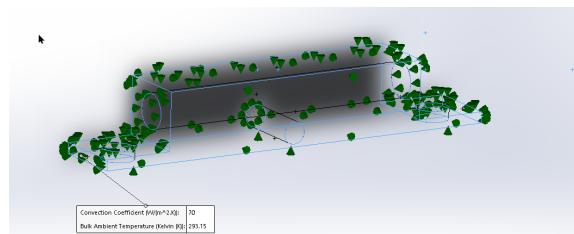


- Heater Power = 20W
  - ≈ 2083 C if heat power per item and no radiation (this sounds like the simulation is breaking down the more power we apply)

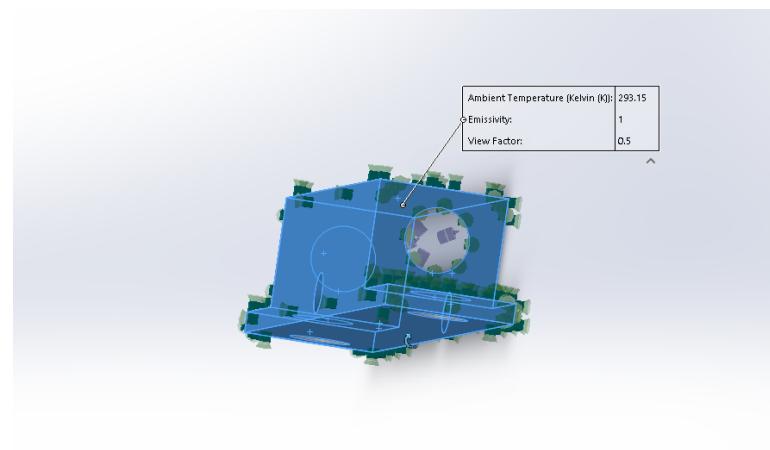


# Heater Block

- **Material:** 6061 Aluminum
- **Thermal Loads:**
  - **Convection:**  $70 \frac{W}{m^2 K}$  (Taken from [Estimate Metal to Air HTC in iso320 Full Nipple \(one side open\)](#)) (applied all faces except where Cartridge Heater is inserted.
    - **Bulk Ambient Temp** = 293.15K



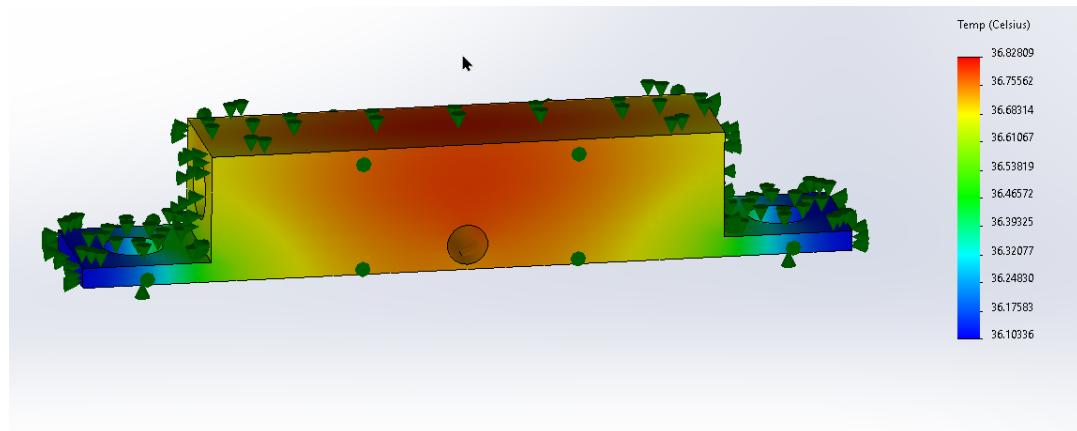
- **Heat Power:** 1W, 5W, 20W (Only applied to inner diameter where Cartridge Heater is inserted.)
- **Radiation:**



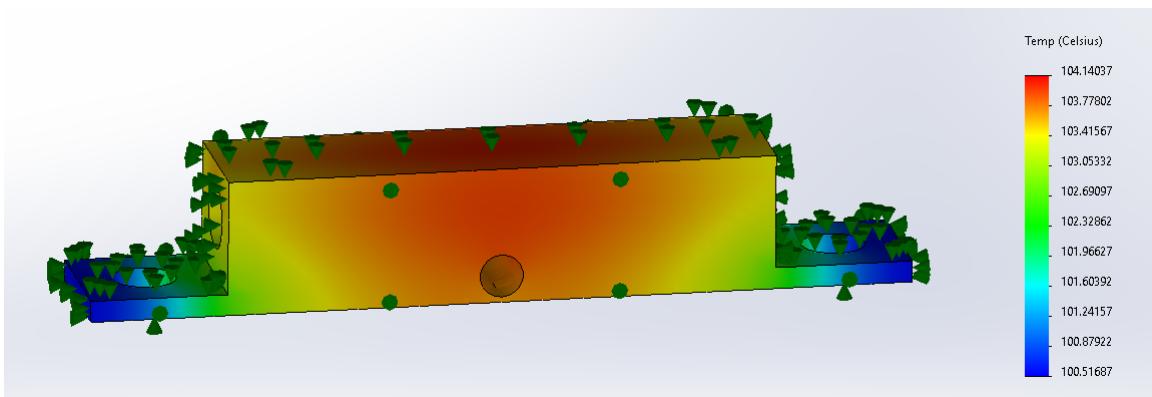
## Results:

- Heat Power = 0.64W (4V @ 0.16A)
  - 30C if radiation
- Heat Power = 1W

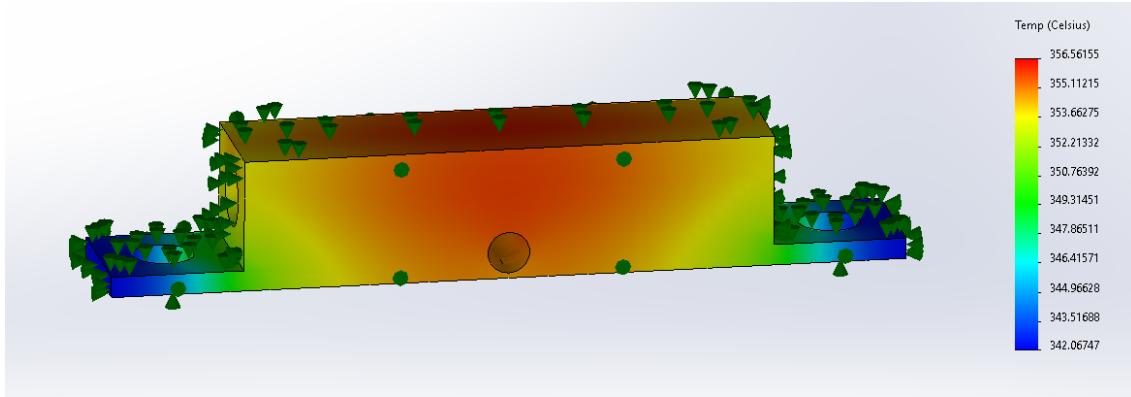
- = 36C if radiation
- ≈ 37 C (Max Temp) if no radiation



- Heater Power = 5W
  - = 99 (max temp if radiation)
  - ≈ 104 C if no radiation

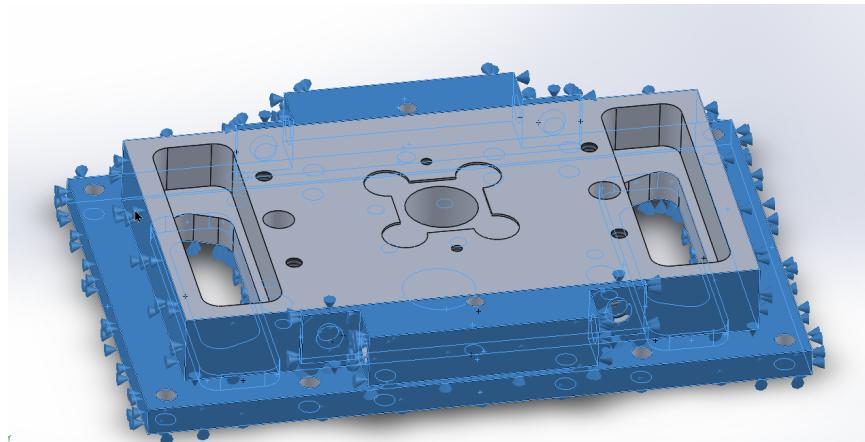


- Heater Power = 20W
  - ≈ 311 if radiation
  - ≈ 357 C if no radiation

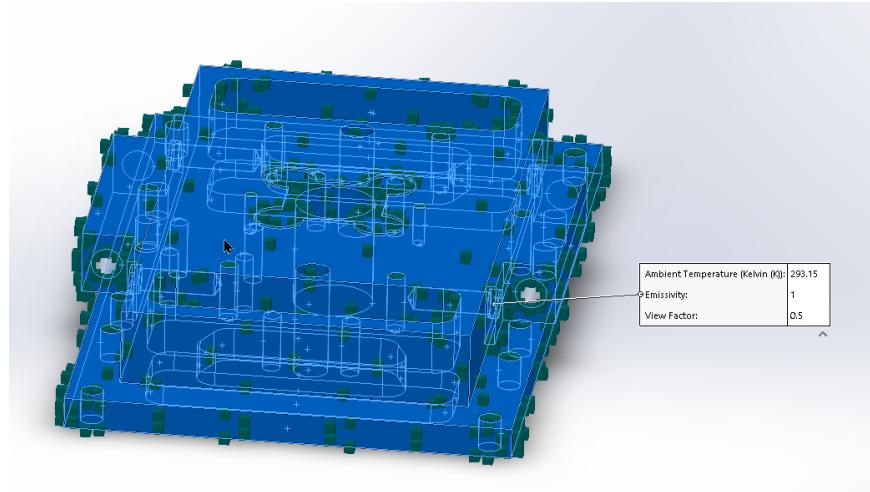


## Heater Block + Mounting Block/Lid

- **Material:** 6061 Aluminum for both items
- **Thermal Loads:**
  - **Convection:**  $70 \frac{W}{m^2 K}$  (Taken from [Estimate Metal to Air HTC in iso320 Full Nipple \(one side open\)](#)) (applied all faces except where Cartridge Heater is inserted and on top of mounting lid. the PCB would be covering the top of the block from moving air.)

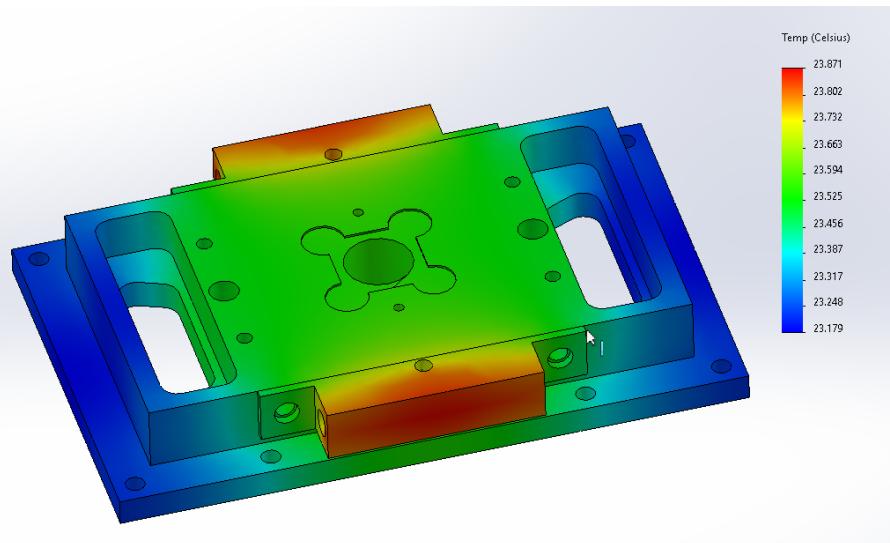


- **Heat Power:** 1W, 25W, 35W, 45W, 50W (Only applied to inner diameter where Cartridge Heater is inserted.)
- **Radiation:** Applied to all exposed surfaces except heater cart insertion hole.

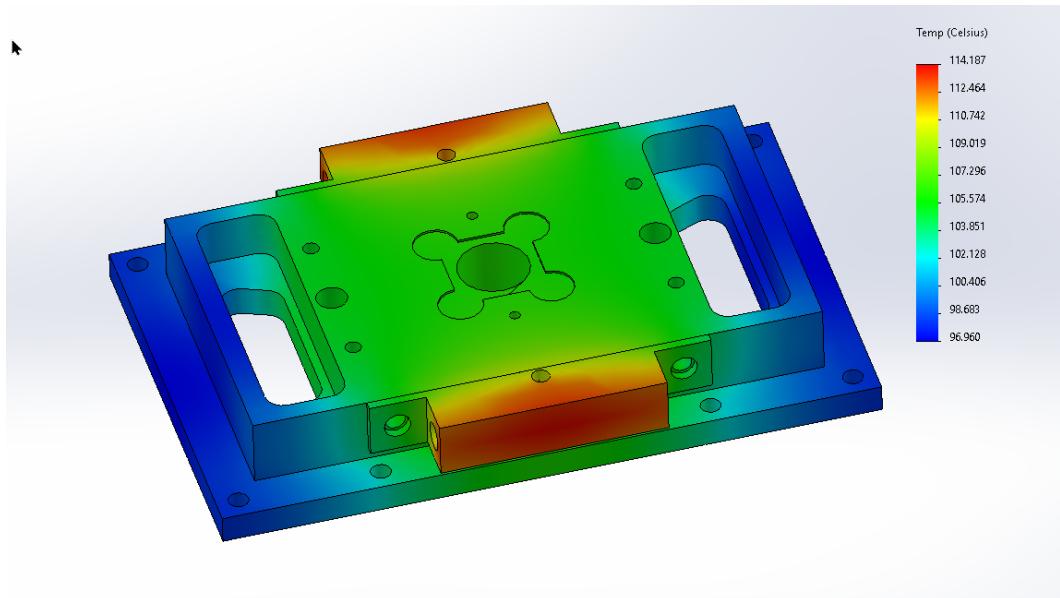


## Results:

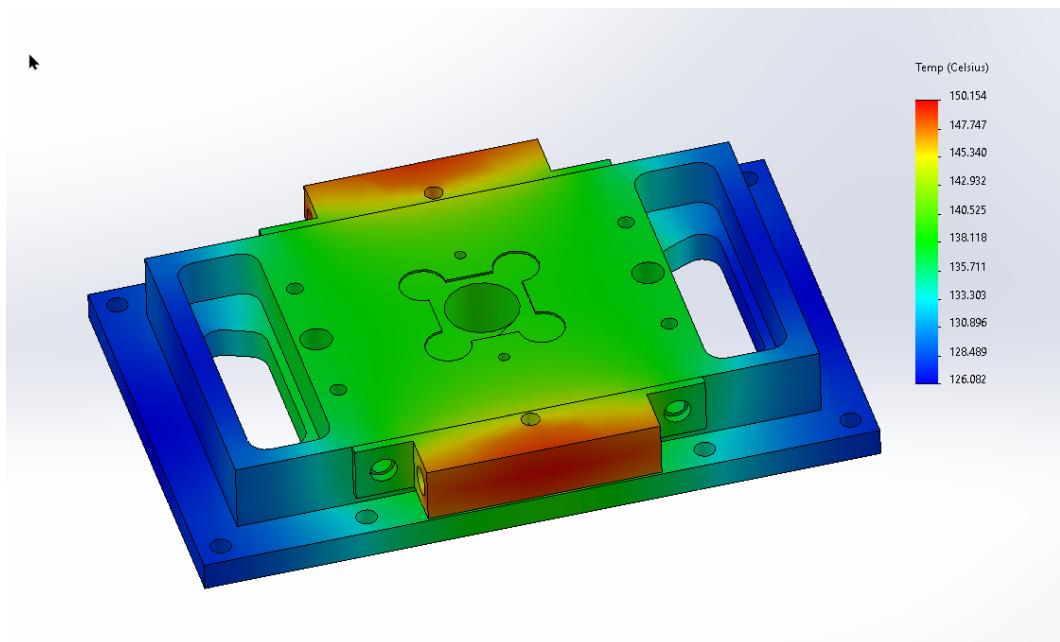
- Heat Power = 1W
  - = 23C



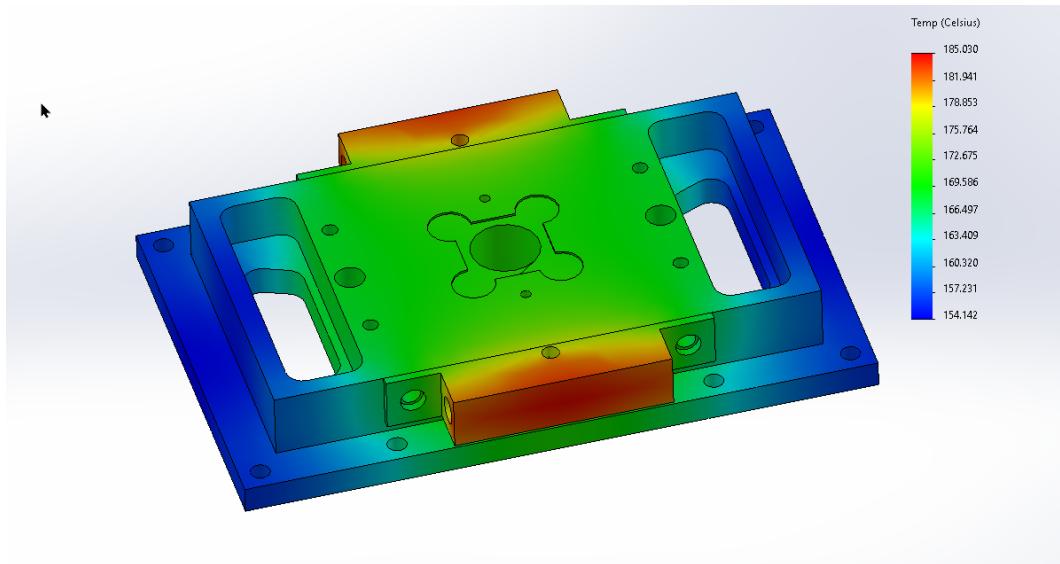
- Heat Power = 25 W
  - 105C



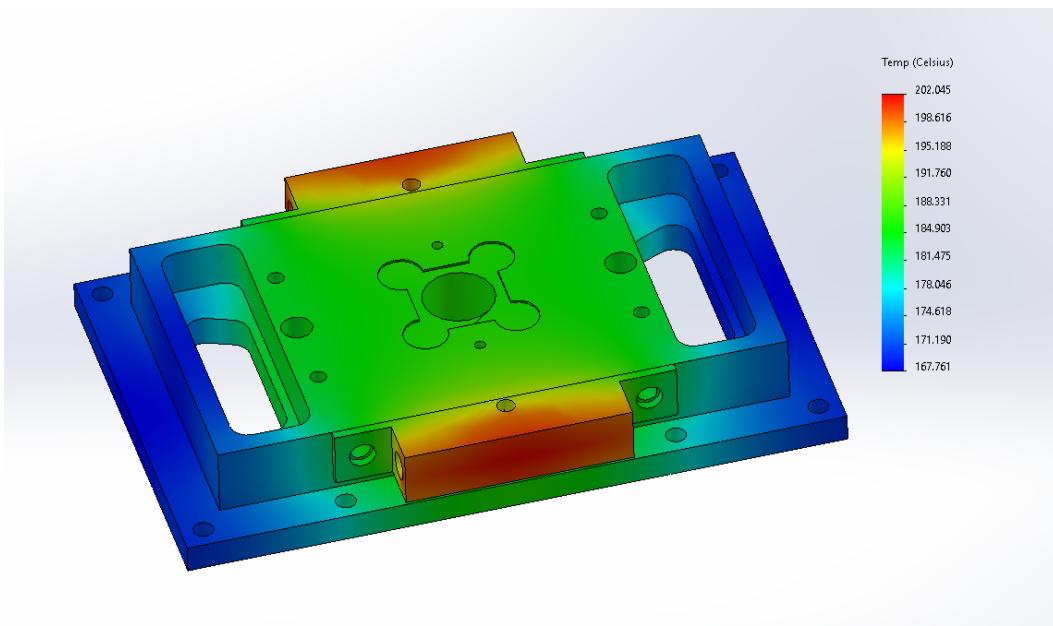
- Heat Power = 35W
  - 138C



- Heat Power = 45W
  - 169C



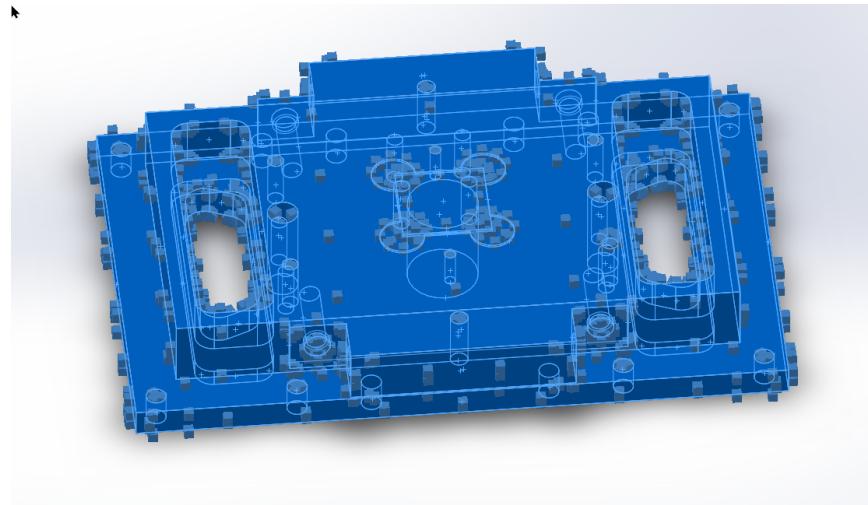
- Heat Power = 50W
  - 184C



## **Heater Block + Mounting Block/Lid + Silicon Chip**

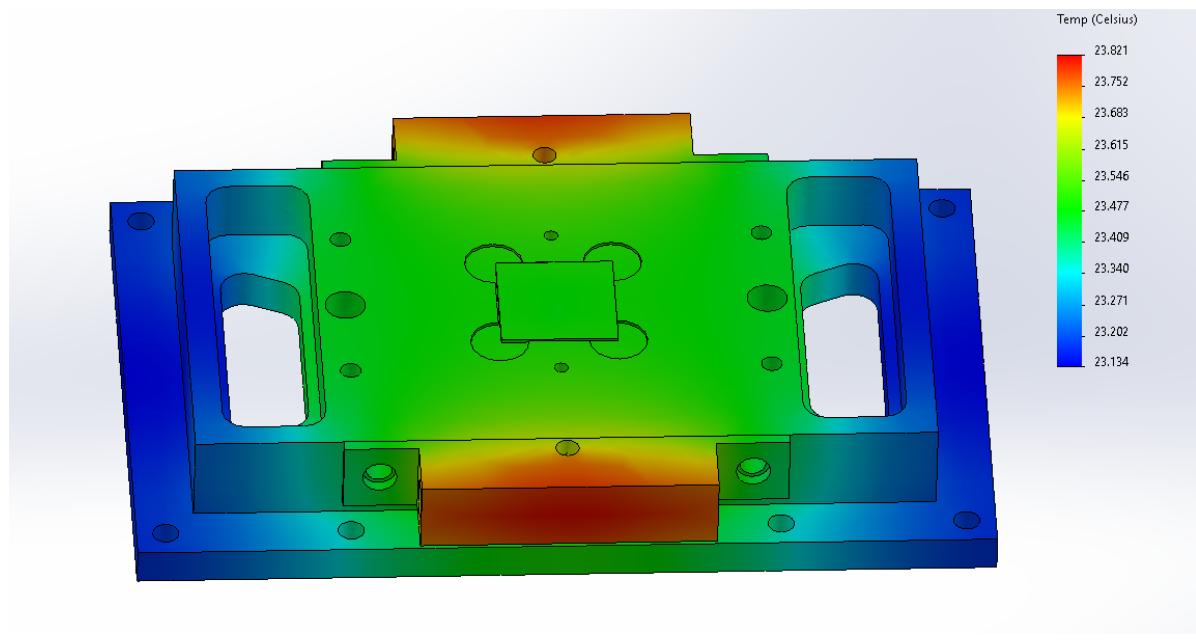
- **Material:** 6061 Aluminum for blocks/lid, Silicon for the Chip
- **Thermal Loads:**

- **Convection:**  $70 \frac{W}{m^2 K}$  (Taken from [Estimate Metal to Air HTC in iso320 Full Nipple \(one side open\)](#)) (applied all faces except where Cartridge Heater is inserted and on top of mounting lid. the PCB would be covering the top of the block from moving air. )
  - **Bulk Ambient Temp** = 293.15K
- **Heat Power:** 1W, 25W, 35W, 45W, 50W (Only applied to inner diameter where Cartridge Heater is inserted.
- **Radiation:** Applied to all exposed surfaces except heater cart insertion hole.

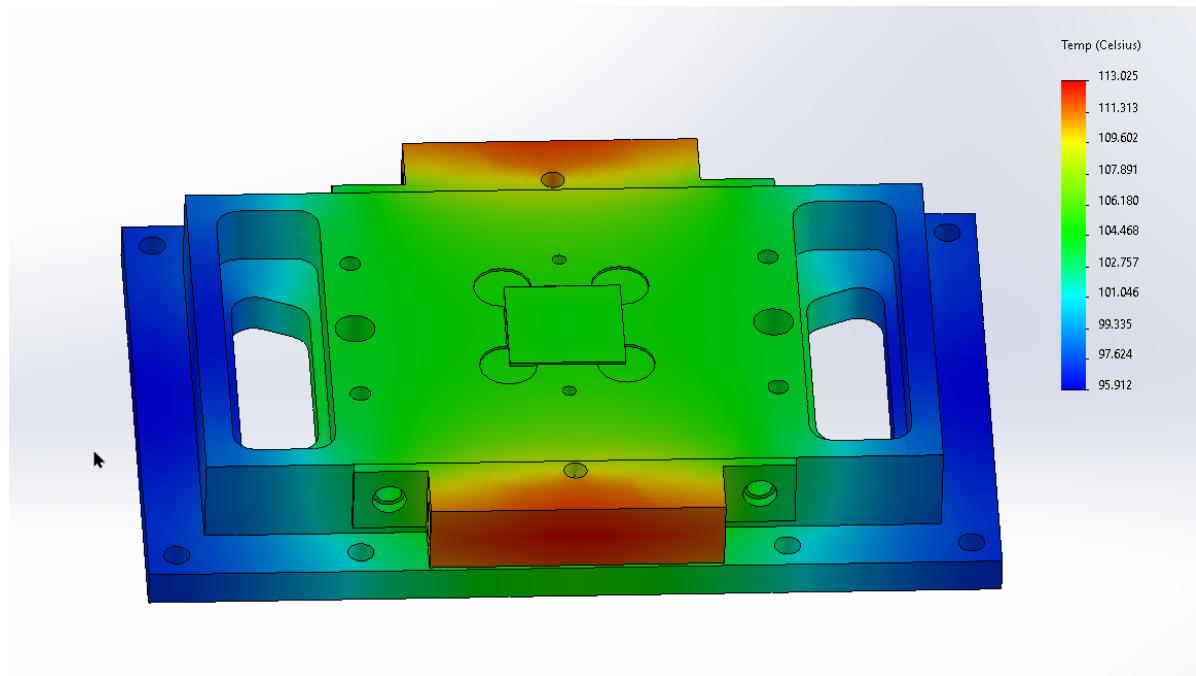


## Results

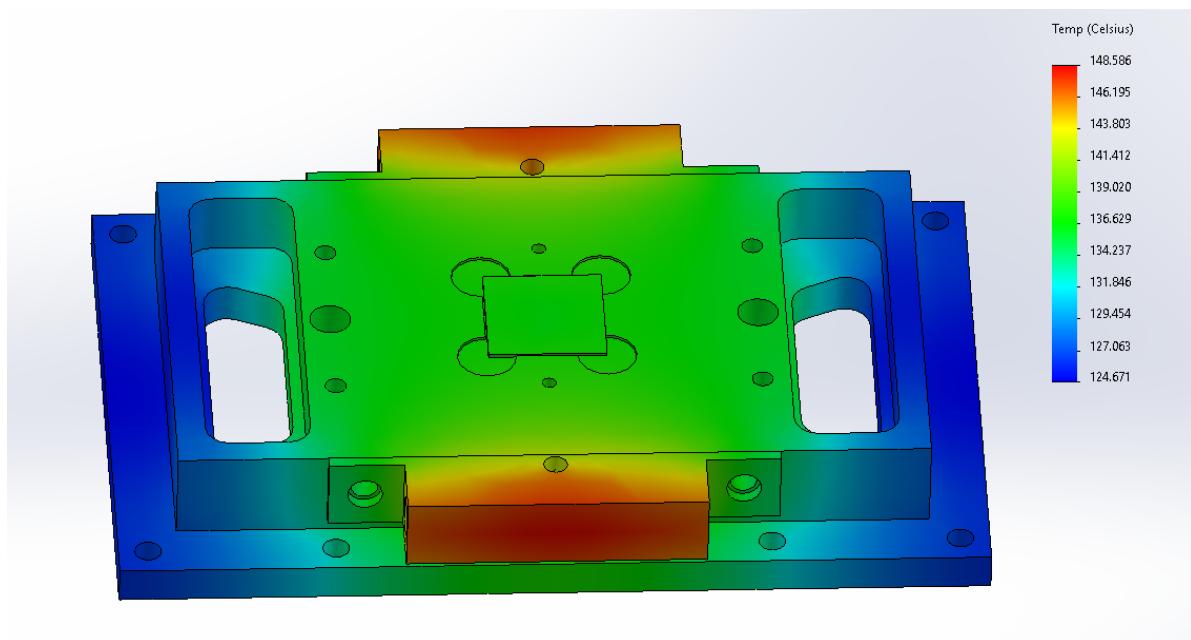
- Heat Power = 1W
  - 23C
  -



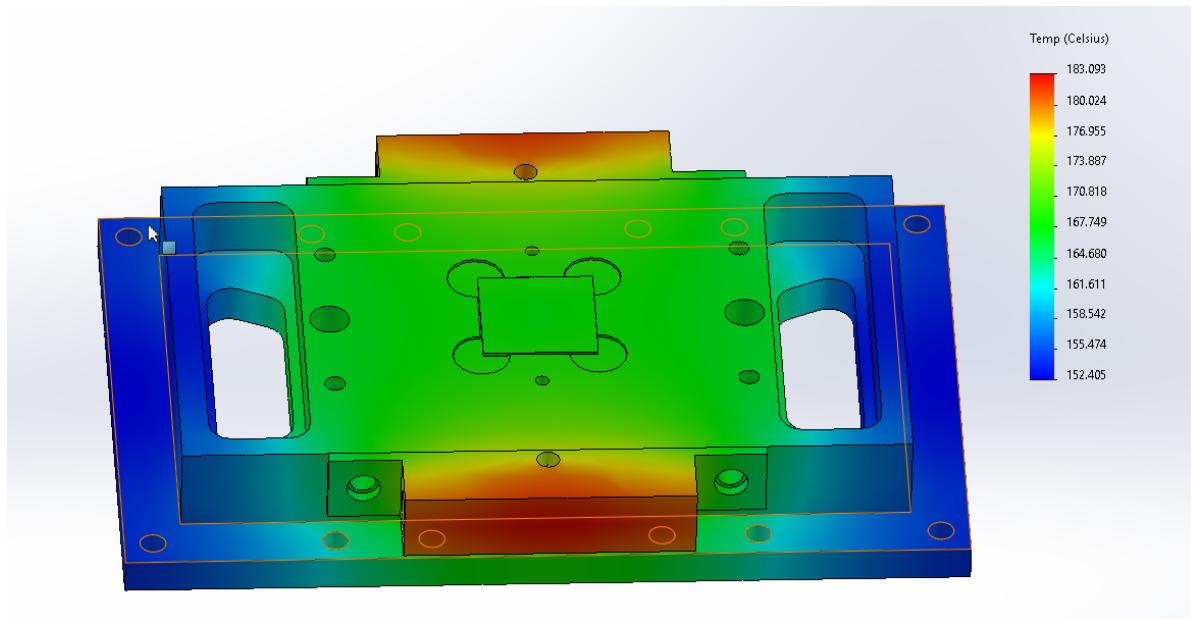
- Heat Power = 25W
  - 104C



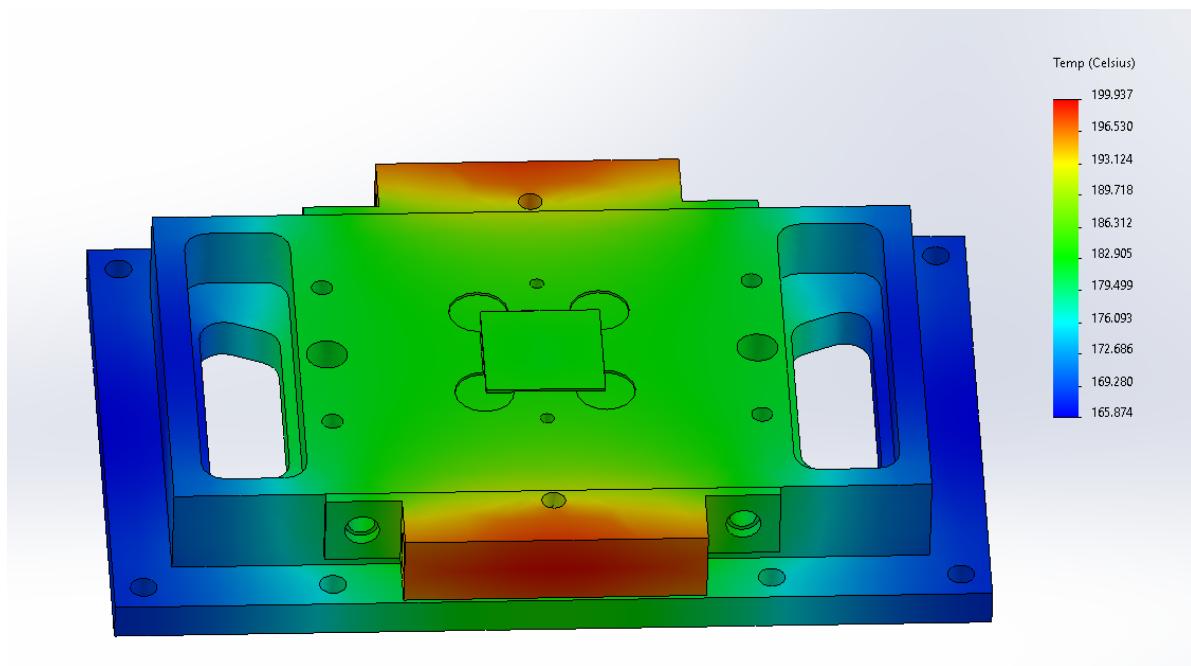
- Heat Power = 35W
  - 136C



- Heat Power = 45W
  - 167C

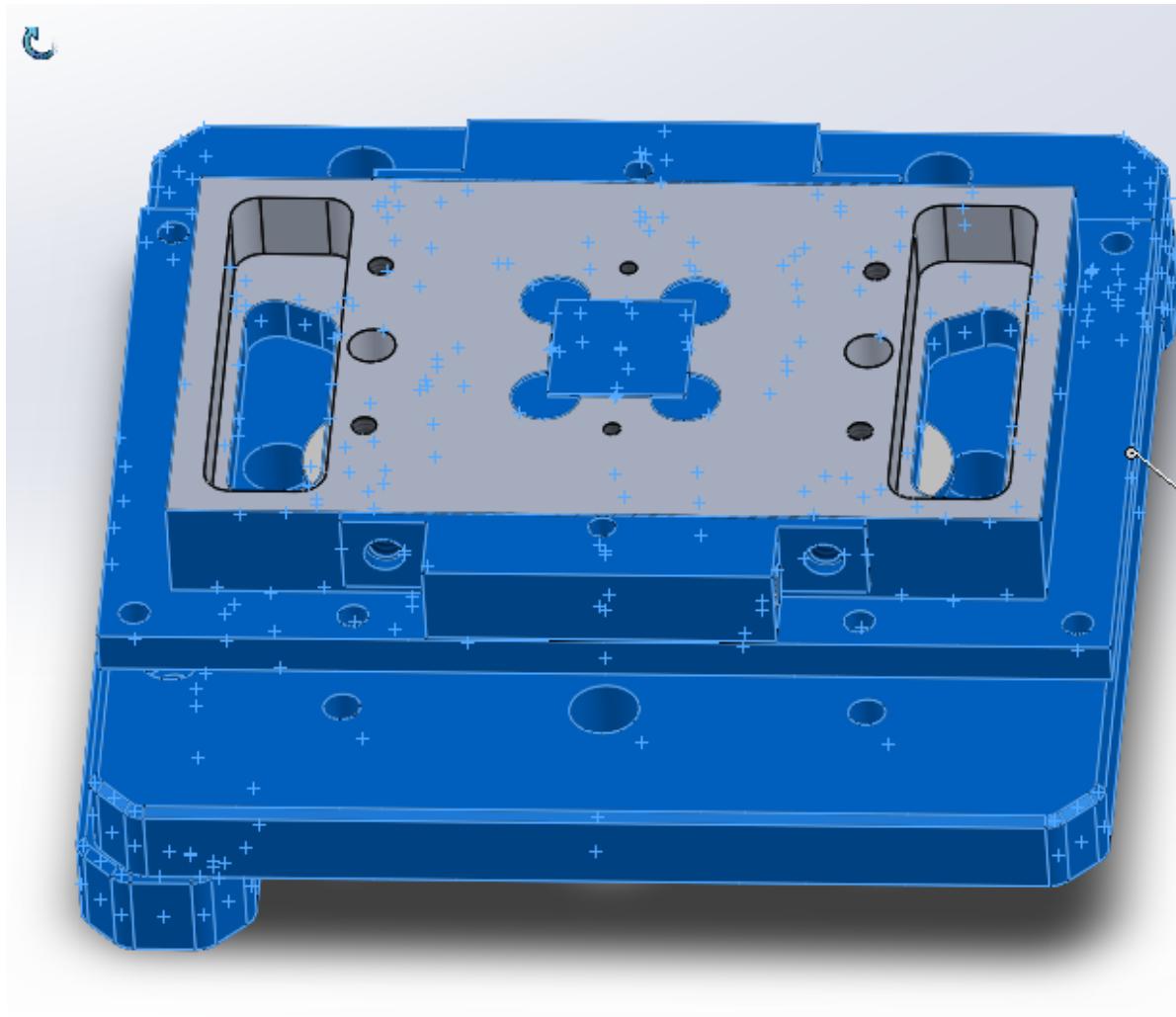


- Heat Power = 50W
  - 182C

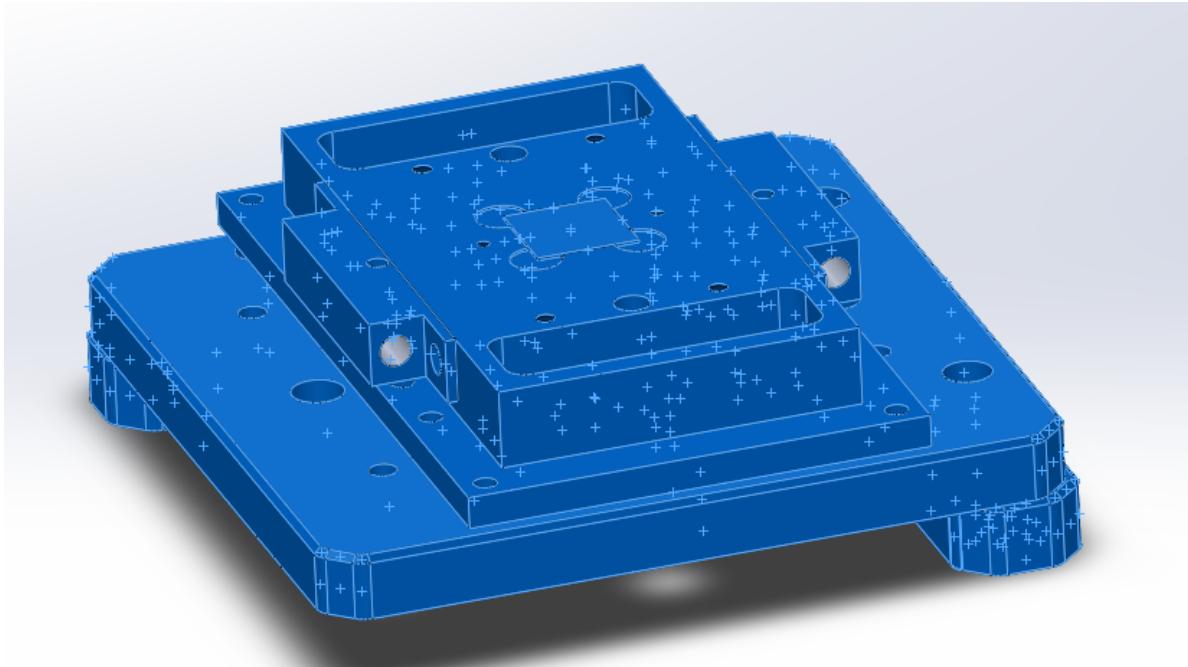


## Heater Block + Mounting Block/Lid + Silicon Chip + PEEK Spacer + Optical Stage

- **Material:** 6061 Aluminum for blocks/lid/Optical Stage, Silicon for the Chip, PEEK for Spacer
- **Thermal Loads:**
  - **Convection:**  $70 \frac{W}{m^2 K}$  (Taken from [Estimate Metal to Air HTC in iso320 Full Nipple \(one side open\)](#)) (applied all faces except where Cartridge Heater is inserted and on top of mounting lid. the PCB would be covering the top of the block from moving air. Excluding Top/bottom face fo spacer)
  -

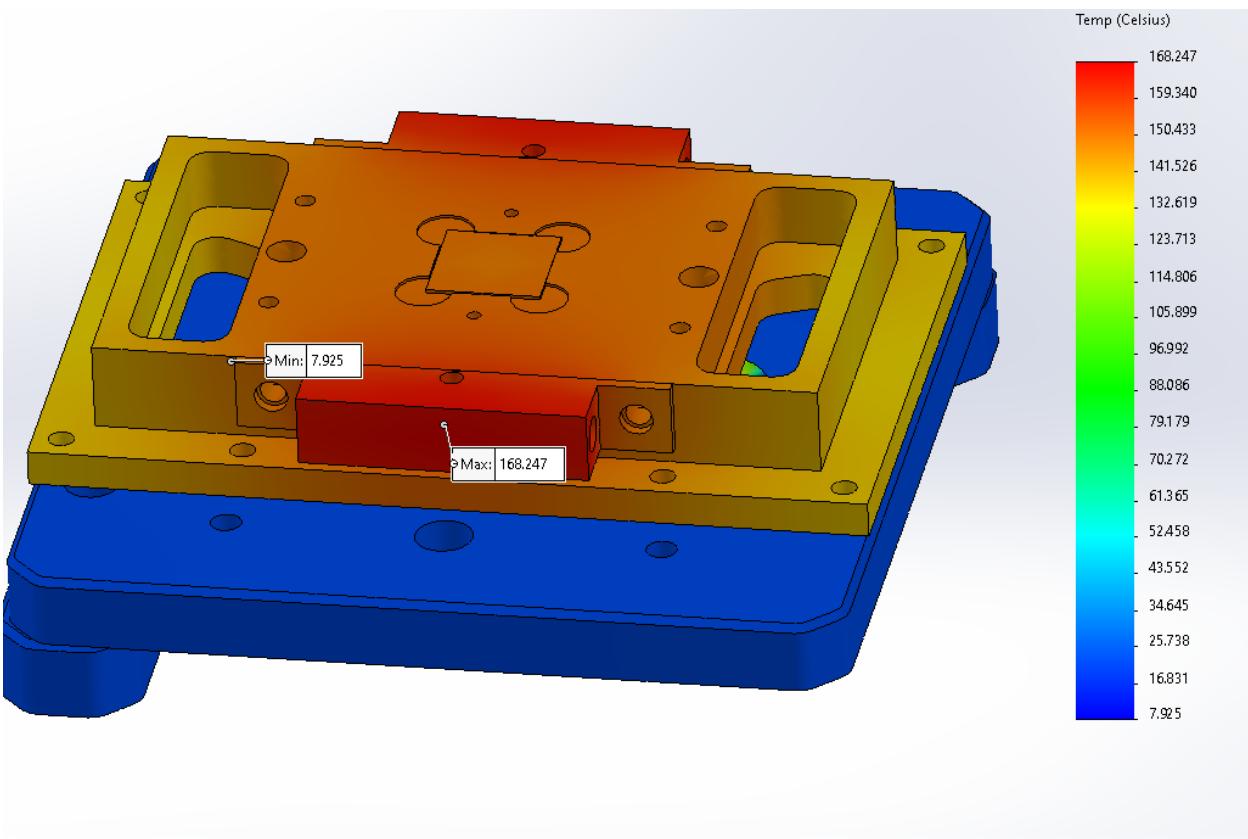


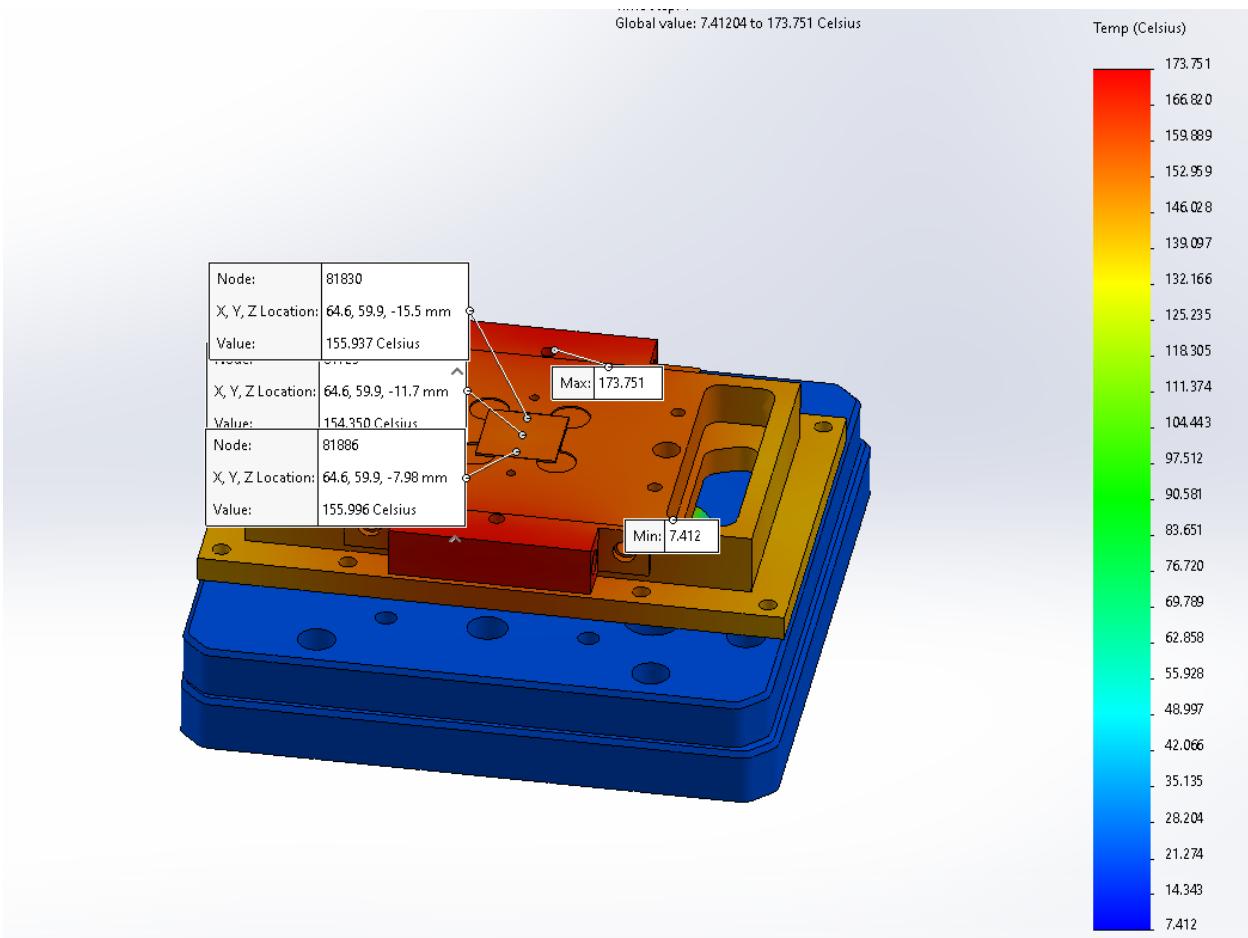
- **Heat Power:** 50W (Only applied to inner diameter where Cartridge Heater is inserted.)
- **Radiation:** Applied to all exposed surfaces except heater cart insertion hole.



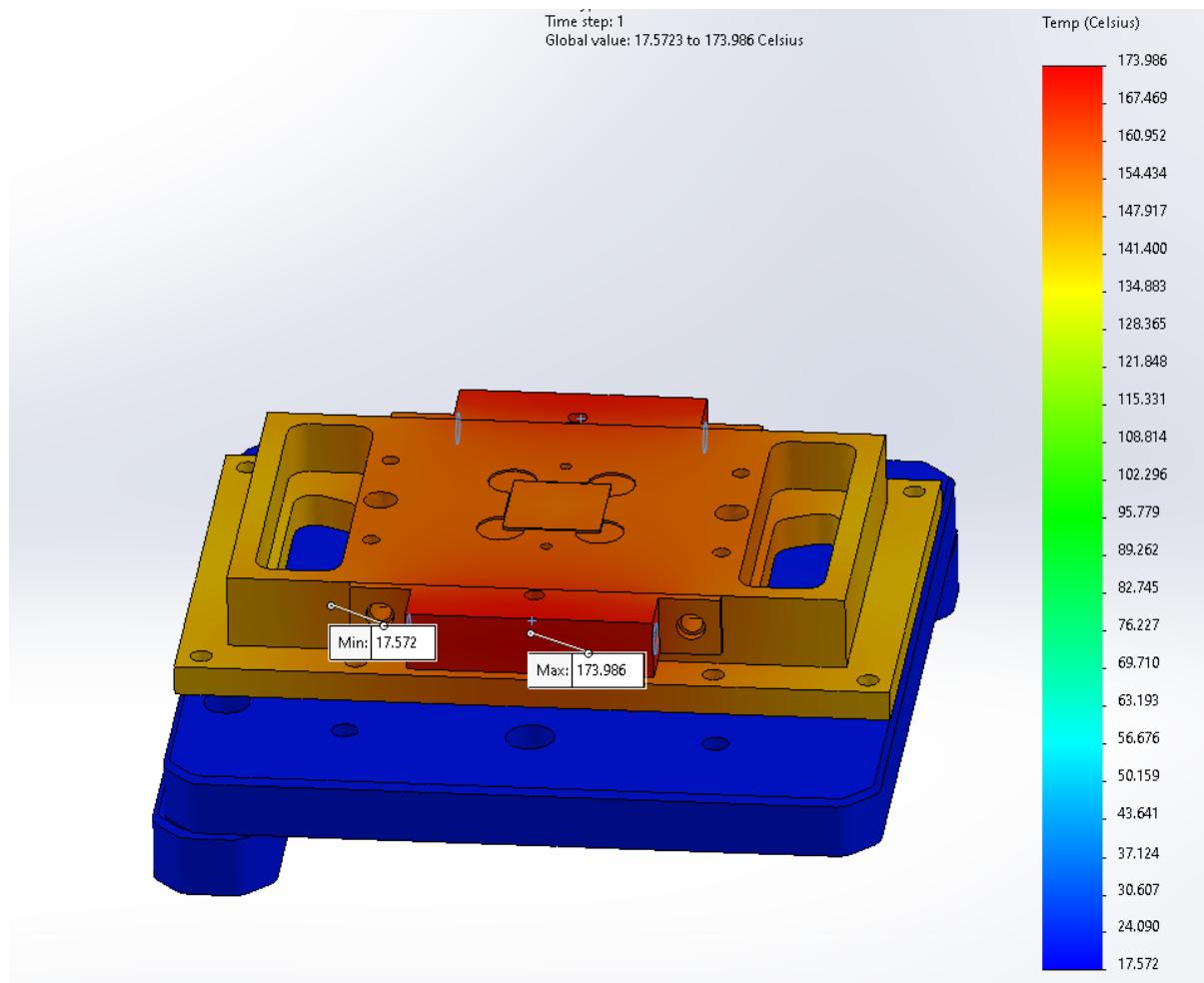
## Result

- Heat Power = 50W
  - Between 141-150C Too low for 50W. **Also doesn't make sense the optical stage is at 7C so it seems to be cooling below ambient. It's as if 70W/m^2K is a fan blowing on the stage cooling it below ambient temps.**  
**Going to add a second PEEK Washer**

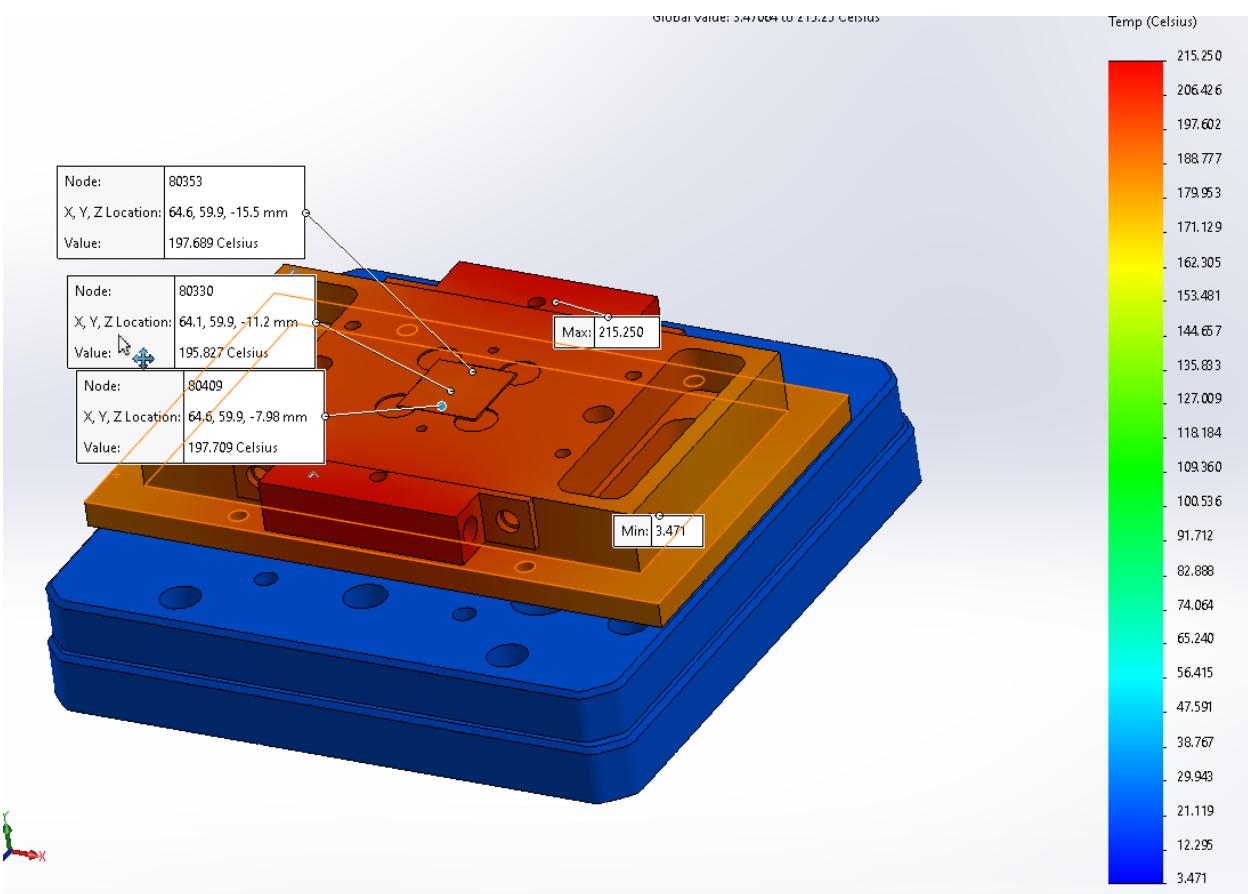
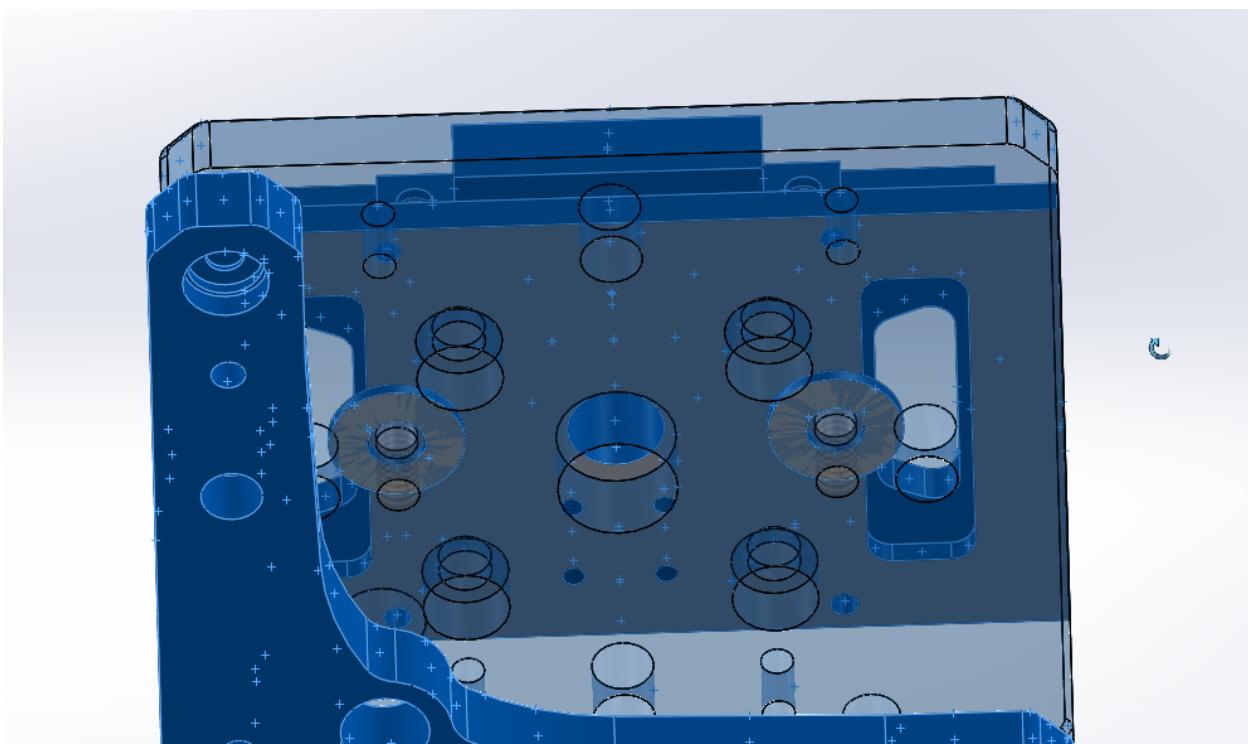




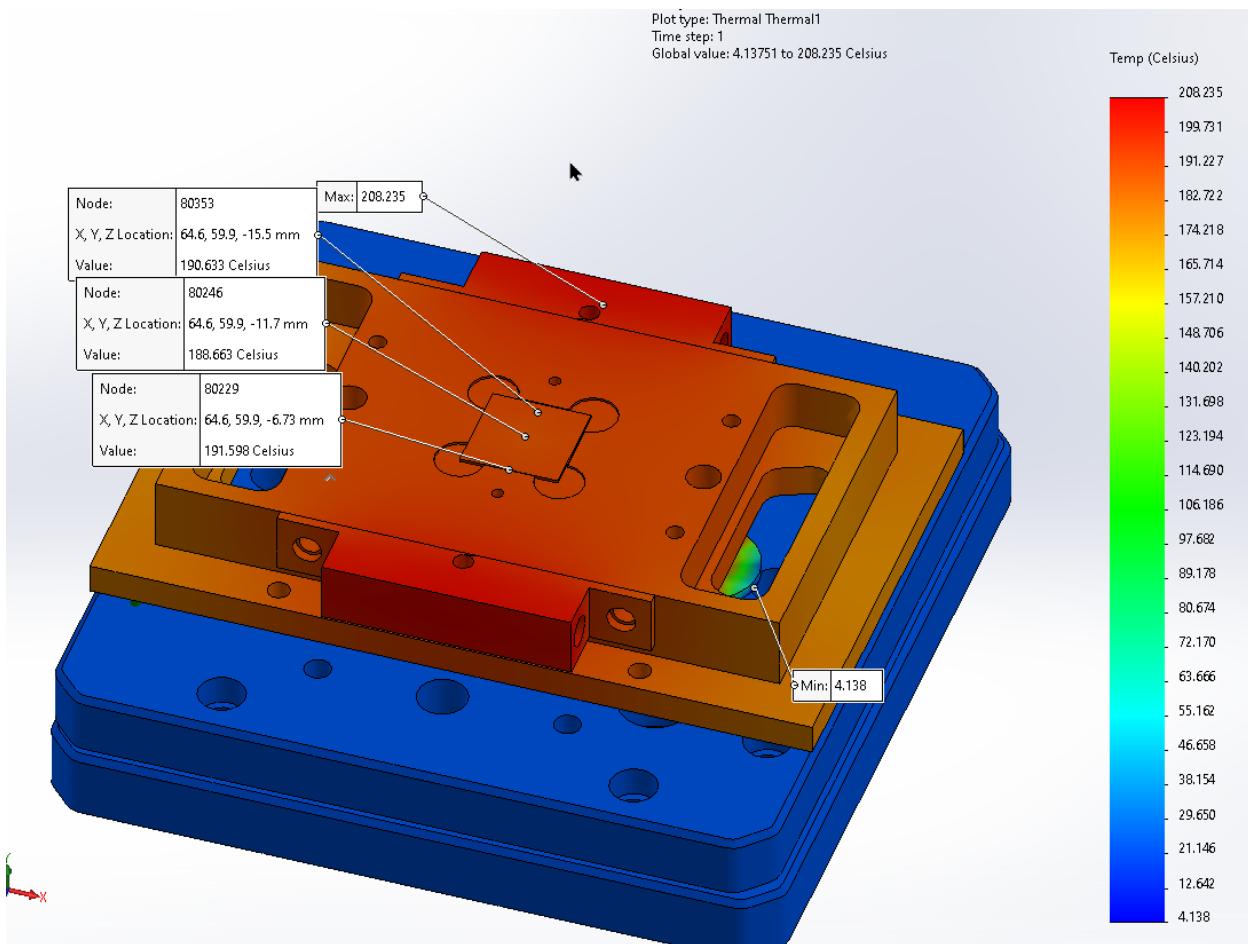
- Added Second set of PEEK Washers
  - 147-155C. As expected it increased the temperature of the chip by doubling the thermal resistance to the optical stage.



Removing Convection term on underside of mount to see difference (As if applying kapton tape to under side of mount)



Added a Convection term of  $10 \frac{W}{m^2 K}$  @ 293.15K ambient temperature for the underside of the mounting block so simulation non-zero Kapton tape convection term.



Adding Teflon cover to simulate chip from semi-forced air convection to free air convection

Estimating Heat Transfer Coefficient: [https://quickfield.com/natural\\_convection.htm](https://quickfield.com/natural_convection.htm)

This calculator provides the natural convection coefficient. Calculation algorithms and formulas are

Surface type:

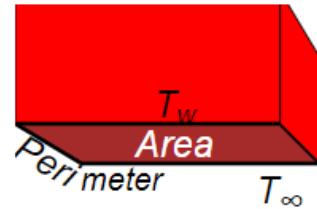
Plane area  $A = 0.00150 \text{ m}^2$ ,

plane perimeter  $P = 0.475 \text{ m}$

Surface temperature  $T_w = 20 \text{ }^\circ\text{C}$

Surrounding media temperature  $T_\infty = 26 \text{ }^\circ\text{C}$

Surrounding media:

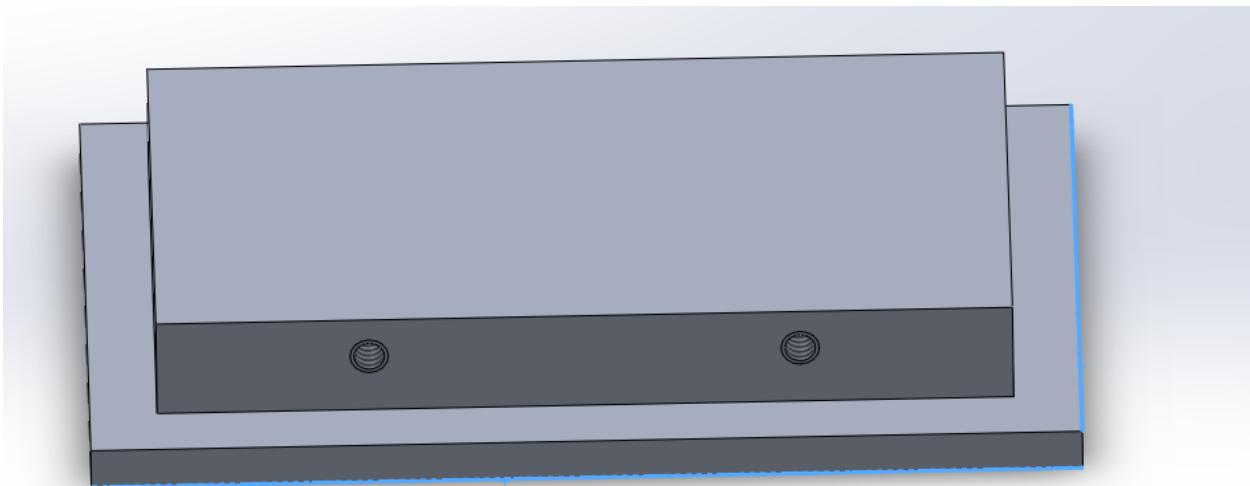


convection coefficient  $h = 4.6 \text{ W/m}^2\text{K}$

[Show the intermediate results](#)

## Cost to make a test block

Basic vs normal:



Our team needs to review this quote before you can place an order

Parts & specifications	CNC machining	Change technology
<input type="checkbox"/> Select all parts	Specifications	Quantity
	CNC machining Aluminum 6061-T6   3.3211  65028  AlMg1SiCu As machined (Ra 3.2µm / Ra 126µin) No part markings General tolerance: ISO 2768 Fine No tighter tolerances Sharp internal corners rounded to 2 mm No fits Contains threads <a href="#">lid_nopocket_92701.pdf</a>	1 <b>US\$140.91</b> US\$140.91p/part
<b>Lid_ACT_SIMPLE.SLDprt</b>	73.5 x 11.0 x 46.5 mm 28,283.835 mm <sup>3</sup>	
<a href="#">View DFM analysis</a>		
	CNC machining Aluminum 6061-T6   3.3211  65028  AlMg1SiCu As machined (Ra 3.2µm / Ra 126µin) No part markings General tolerance: ISO 2768 Fine No tighter tolerances Sharp internal corners rounded to 2 mm No fits Contains threads <a href="#">lid_nopocket_101a5.pdf</a>	1 <b>US\$211.57</b> US\$211.57p/part
<b>Lid.SLDPRT</b>	73.5 x 11.0 x 46.5 mm 22,672.179 mm <sup>3</sup>	
<a href="#">View DFM analysis</a>		
 <b>Drag and drop or select files</b>		

Delivery Method	Delivery Time	Cost
Rapid	5 business days	Unavailable
Expedited	9 business days	<b>US\$857.47</b>
Standard	13 business days	<b>US\$759.48</b>
Economy	20 business days	<b>US\$710.47</b>
<b>Manufactured globally</b>		
Expedited	9 business days	<b>US\$520.79</b>
Standard	13 business days	<b>US\$456.73</b>
Economy	23 business days	<b>US\$352.48</b>

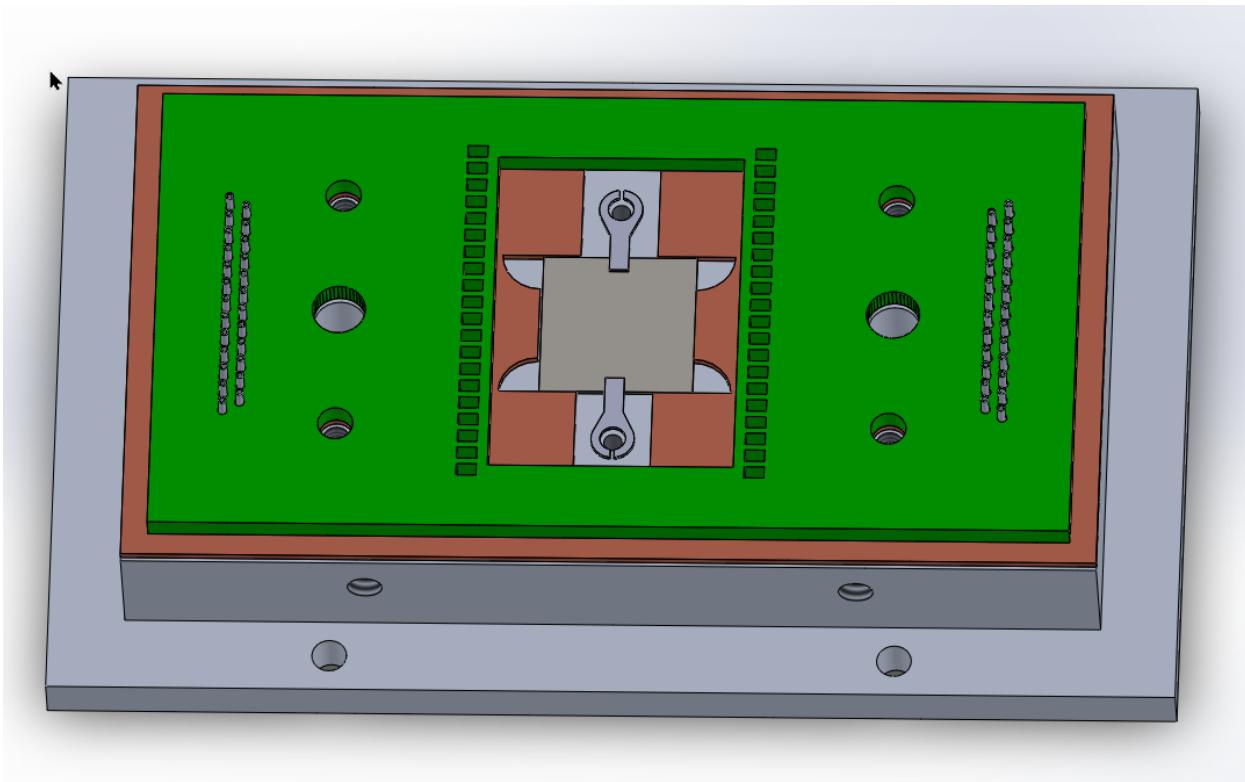
**Shipping** including customs costs

<b>1-2 business days</b>	<b>US\$17.00</b>
Estimated delivery <b>13 July 2023</b>	

 Shipping Address <b>Pasadena, 91125</b>
 Billing Address <b>Boulder, 80305</b>
 Quality documentation <b>Not required</b>

Estimated Subtotal **US\$369.48**

## Checking spacer Cost:



Current Order    Material Catalog    Sign In

Upload Did you know? Pricing is best on larger orders. Add parts or increase quantity for better prices.

	Price	Quantity	Total
<input checked="" type="checkbox"/> Sheet_Space.DXF Design check: <span style="color: orange;">⚠ Found 1 warning</span> <a href="#">Review</a>	\$8.14	1 <a href="#">remove</a>	\$8.14

**Order Subtotal**

Setup:	\$18.59
Parts:	\$8.14
<b>Subtotal:</b>	<b>\$26.73*</b>

\* Prices may decrease after we nest your parts. Please login or register to obtain final prices

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