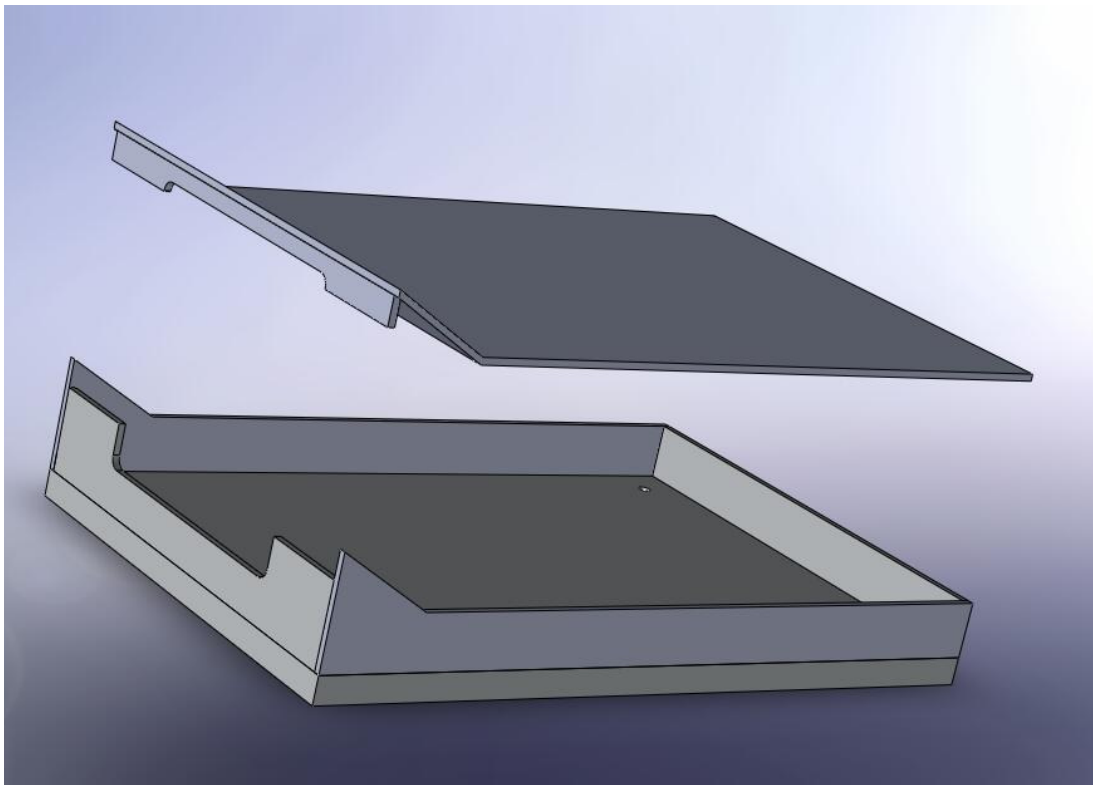


## P09222 | SAE Formula Team ECU | Mechanical Design



This platform is designed to not only maximize heat dissipation, but to also provide a watertight enclosure for the PCB to be housed. Complex thermal analysis, coupled with the fundamental mechanical design principles are strategically implemented to develop a useful product for future generations. Our end goal in this design is to land sole propriety to the SAE formula team – RIT development on all facets.

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- 3 Thermal Analysis
- 4 Analysis Results
- 5 ANSYS Model
- 6 Waterproofing
- 7 – 9 Case Design

## Appendix A: Bill of Materials

# Agenda

- 1 Heat and Vibration analysis
  - 2 Waterproofing
- 3 Design considerations
  - 4 Materials

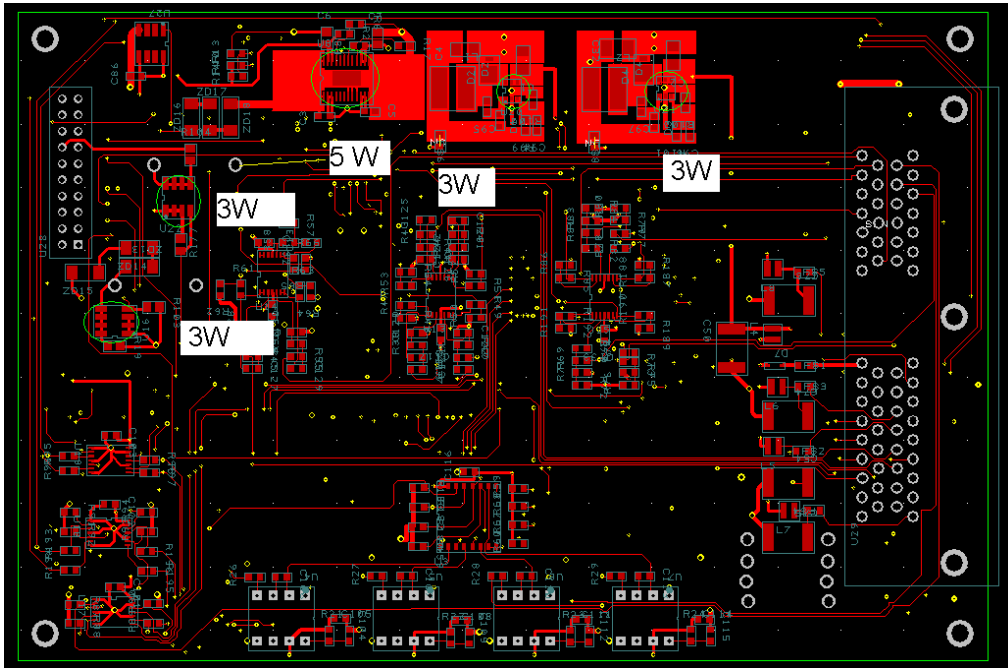


Figure 1 – ECU PCB Top View

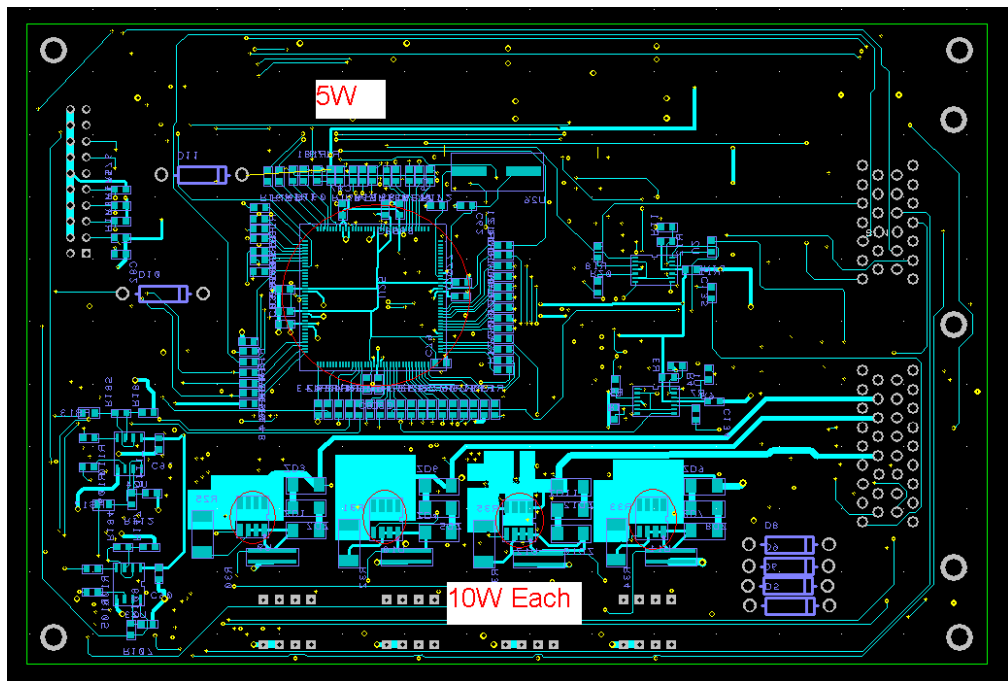
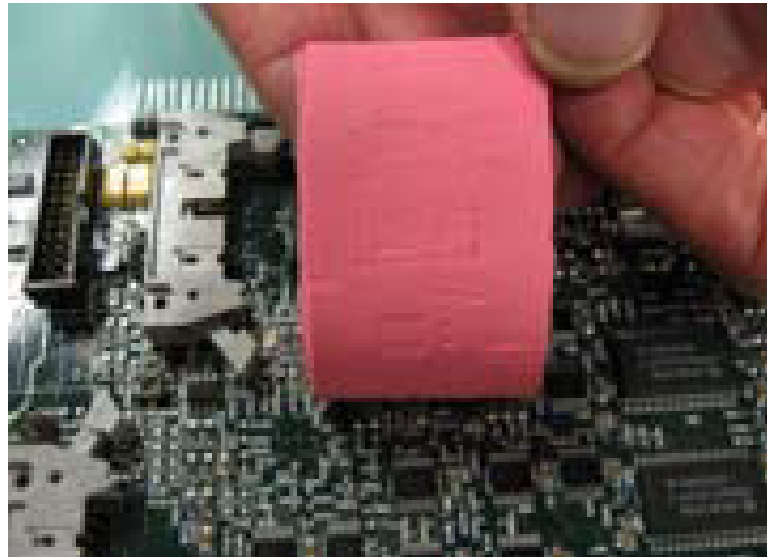


Figure 2 – ECU PCB Bottom View

# Thermal Analysis

In the course of my thermal analysis, I decided to use a thermal interface material known as Therm-A-Gap™ to act as a heat sink and vibration dampener between the PCB and the case. Therm-A-Gap™ is an industry standard product used in a wide variety of applications. Its thermal



properties suit it ideal for creating an excellent thermocouple between two normally unconnected objects. In the end, our thermocouple will take the heat generated by the power consuming ICs on the PCB and route it to the aluminum chassis as well as dampen the vibration within the case and protect the components.

<b>Therm-A-Gap™ A580 Specifications</b>	
Standard Thickness (mm)	5
Operating Temperature Range (°C)	-55 to 200
Thermal Conductivity (W/m*K)	3
Flammability Rating	V-0

<b>Aluminum 2024 T-3 Specifications</b>	
Standard Thickness (mm)	1
Thermal Conductivity (W/m*K)	121

<b>Standing Air Specifications</b>	
Convection Thermal Coefficient (W/m <sup>2</sup> *K)	28.1
Assumed Ambient Temperature (°C)	51.7

<b>Thermal Analysis Results</b>	
Maximum Chip Temperature (°C)	85
Heat Generation (W/m <sup>3</sup> )	1.334*10 <sup>6</sup>
PCB Temperature (°C)	76.8

1 MODAL SOLUTION  
STEP=1  
SUB =1  
TIME=1  
TEMP (AVG)  
RSYS=0  
SMN =53.608  
SMX =53.786

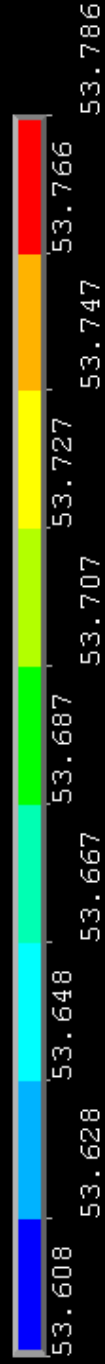
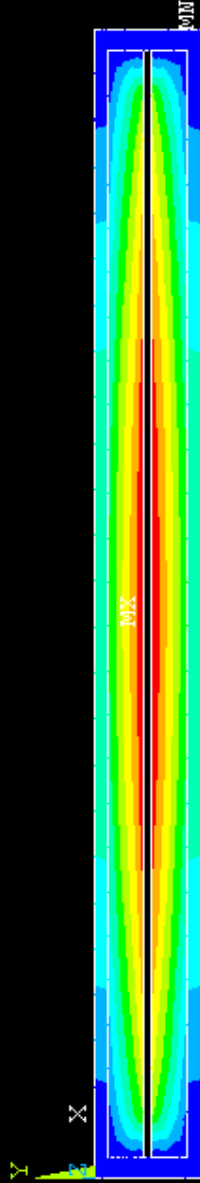


Figure 3 – ANSYS Model

# Waterproofing

In order to ensure the case is watertight, I decided to use a silicon-based sealant known as Permatex®. The Permatex® Clear RTV Silicone Adhesive Sealant is designed to seal and secure a variety of materials including metal, glass, weather stripping and wiring. It can be applied to both horizontal and vertical surfaces.

<b>Permatex® Specifications</b>	
Temperature Range (°C)	-55 to 204
Resistance	Oil, Water, Weather, Vibration, Grease

I also decided to use Vibratite® on the fasteners to ensure they do not loosen during operation and stay watertight. Vibratite® is comprised of a mixture of acrylic resins which is directly applied to threaded fasteners in order to make them self-sealing.



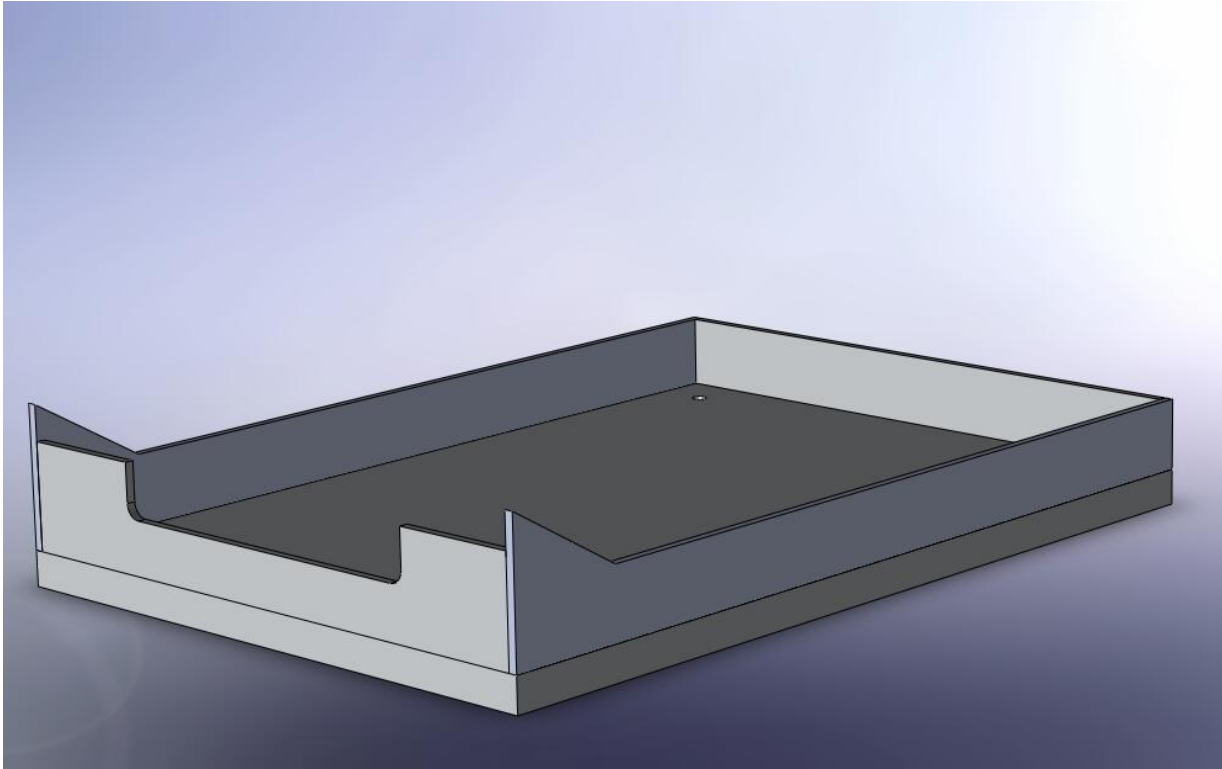


Figure 4 - Base

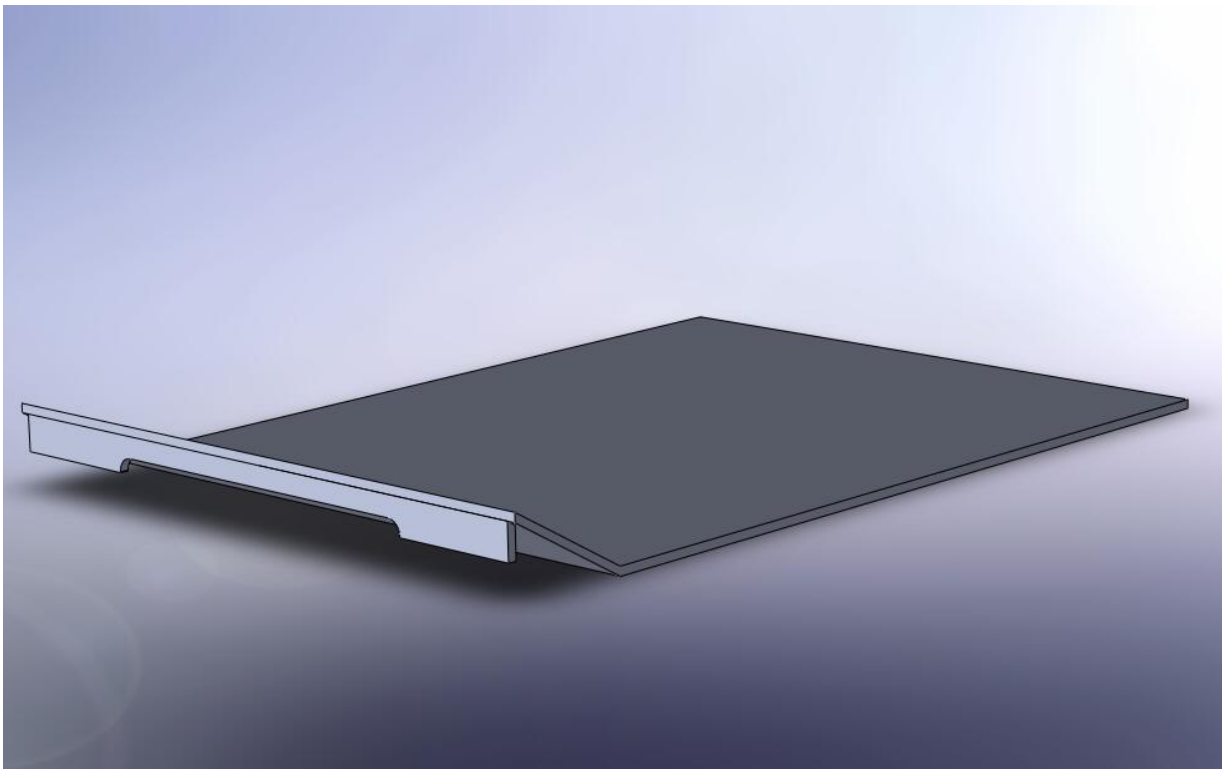


Figure 5 - Lid

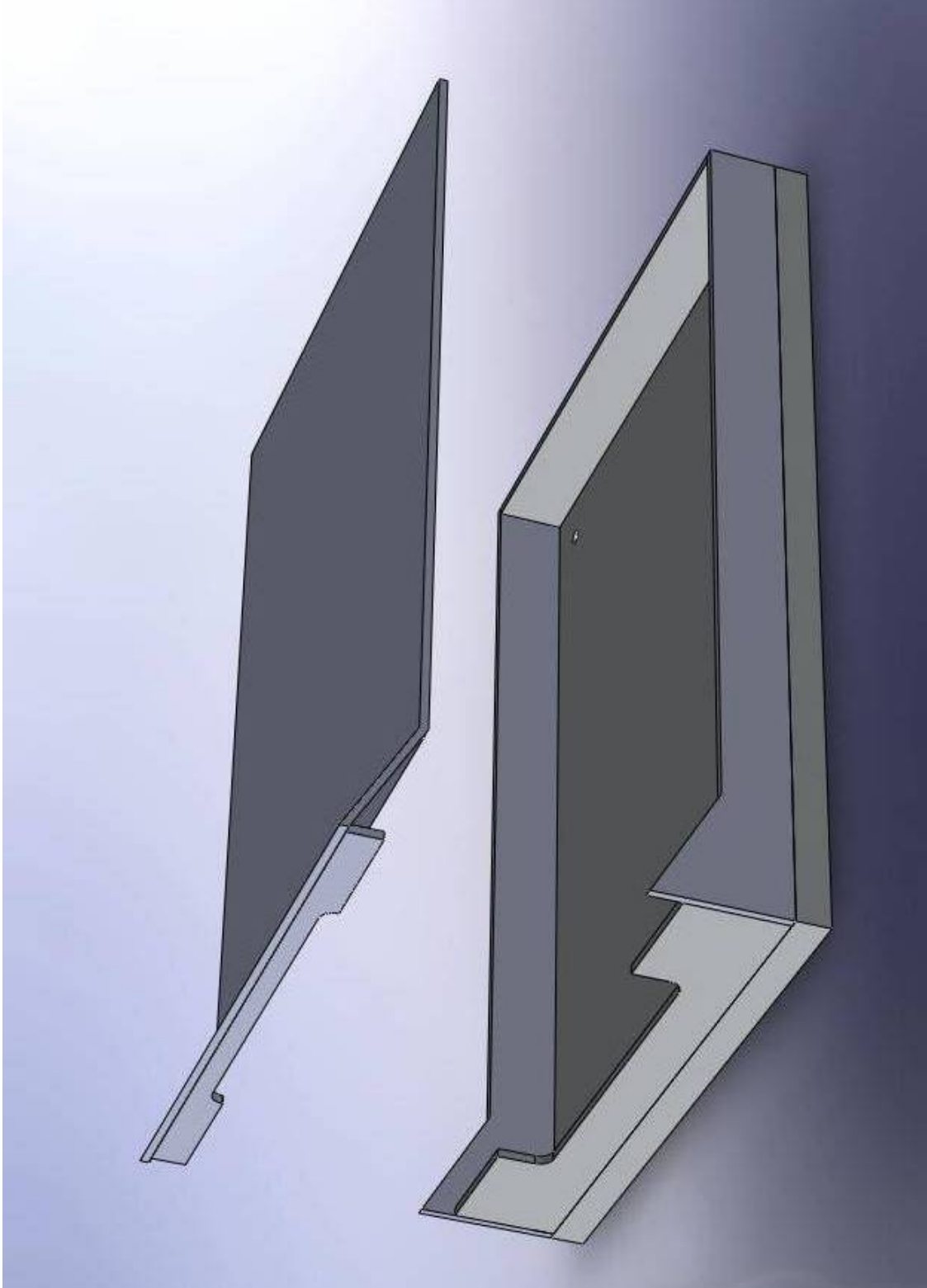


Figure 6 – Exploded View

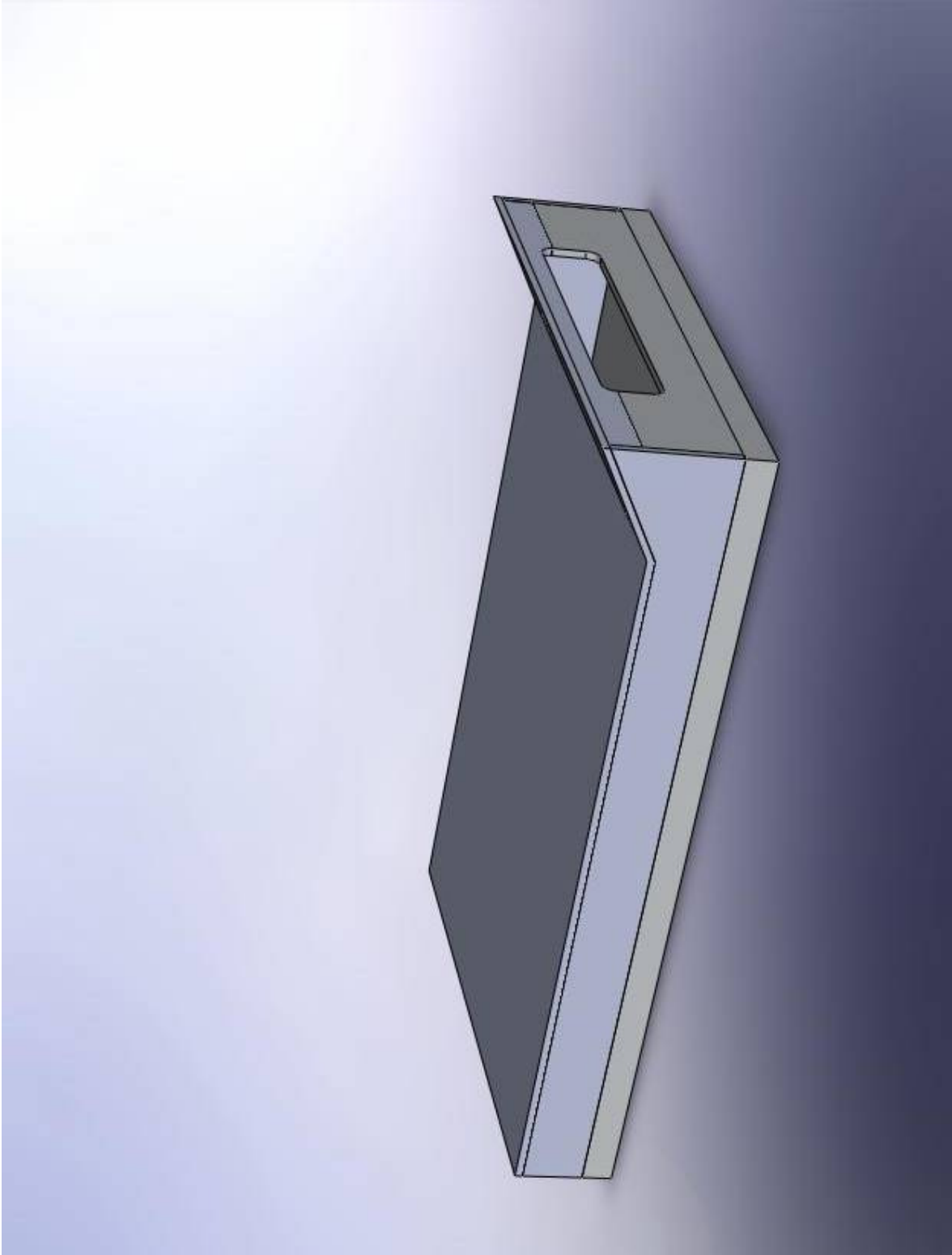


Figure 7 – Case Assembly

# Appendix A: Mechanical Bill of Materials

Material	Size	Quantity	Cost (\$) plus s&h
Aluminum Sheet Stock 2024-T3	12 X 12 X .04"	1	20.40
Aluminum Rod Stock	3/32" diameter	1	2.09
Therm-A-Gap A580 (best for vibration dampening)	custom	1	dependent on size
Silicon based waterproofing sealant (Permatex)	3 oz	1	6.00
Vibra-tite	30 cc	1	18.00
#4 Screws-SS100 degree	TBD	8	2.00
Antivibration Washers	-	4	-