Designing &Testing a Lightweight Heatsink for a PV Converter

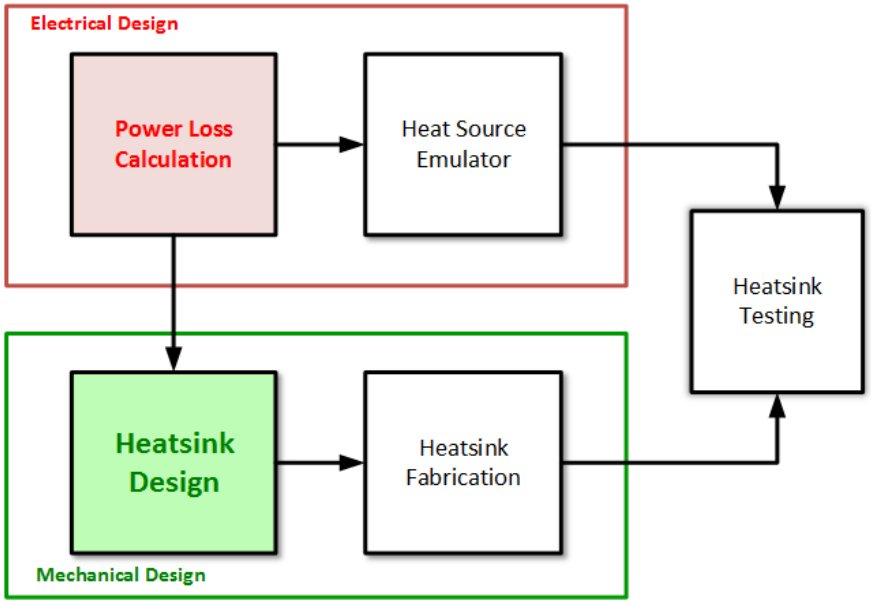
Team 13

Electrical Engineering
Melanie Gonzalez
Tianna Lentino

Mechanical Engineering
Leslie Dunn
James Hutchinson
Colleen Kidder

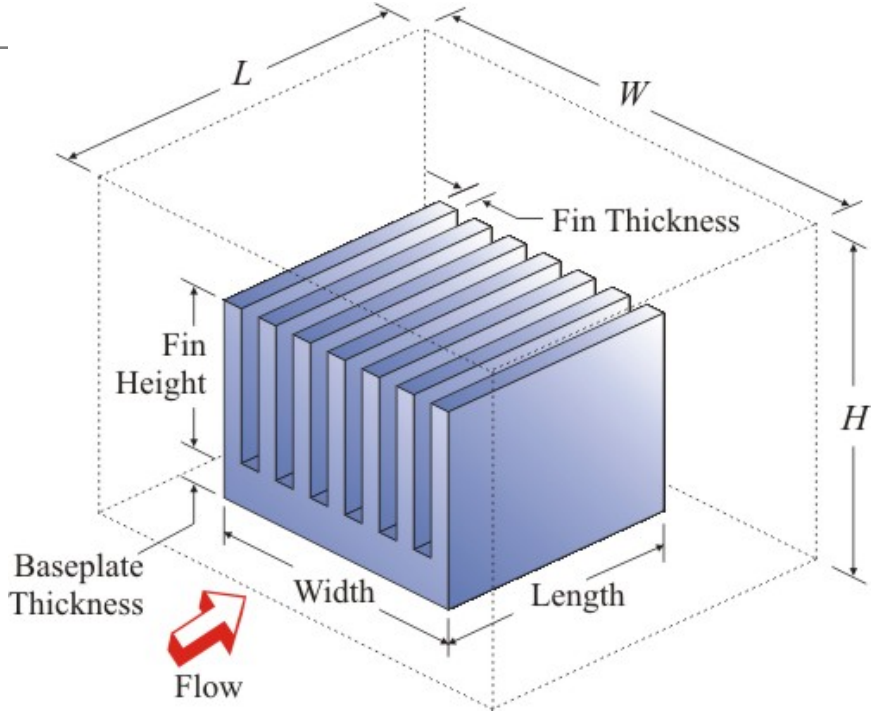
Project Scope

- Design, build, and test a thermal system for power converters that increases the power density
- Increase power density to 5 kW/kg
- Implement modular heatsink design to advance current system



Heatsink Background

- Form of heat exchanger that uses fins to dissipate heat generated by electronic device
- Ensures power modules remain cool and therefore function properly
- Fans typically added to heatsink to increase heat transfer



Heatsink Design

Important Parameters

- Weight
- Pressure Drop
- Thermal Resistance

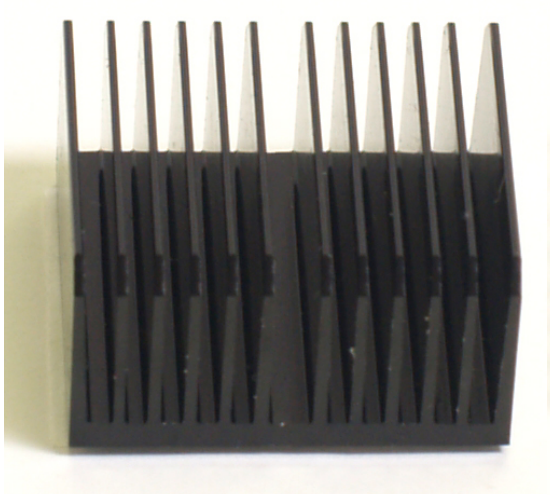
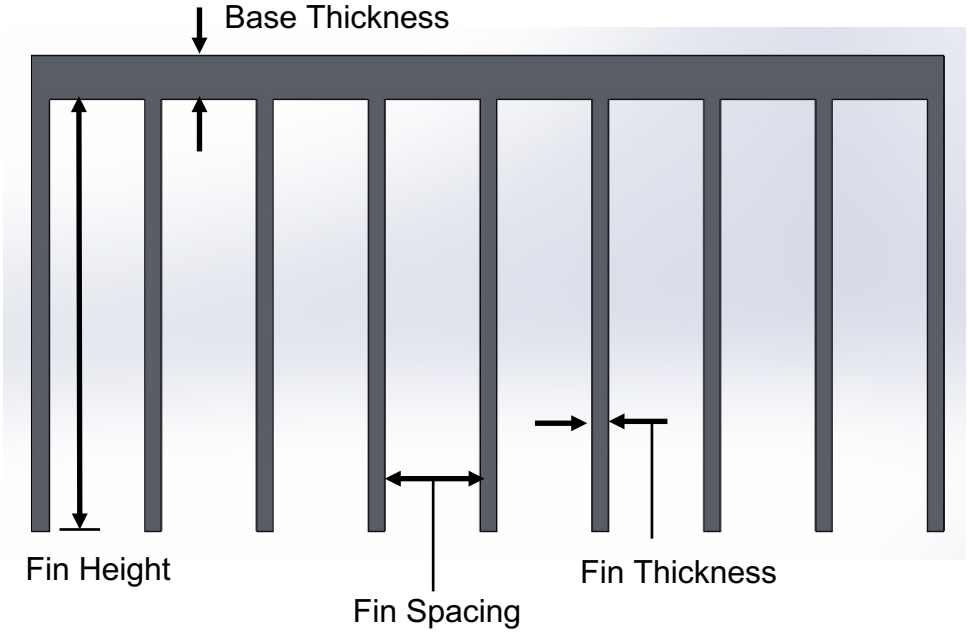


Plate Fin

Pin Fin

Bi-Modular Plate Fin Heatsink

Length	127 mm
Depth	127 mm
Height	69.2 mm
Base Thickness	6.4 mm
Fin Height	62.8 mm
# Fins	9
Fin Thickness	2.5 mm
Fin Spacing	13.2 mm



Bi-Modular Plate Fin Heatsink

Assumptions

- Material: Al 6063 T-5
- Steady-state heat transfer
- Environment at T_{∞}=20°C and P=1atm
- Incompressible air flow → 1.73 m^3/min
- Power loss = 200 W

Bi-Modular Plate Fin Heatsink

Analysis Results

Weight: 0.954 kg

Pressure Drop: 7.406 Pa

Thermal Resistance: 0.335 K/W

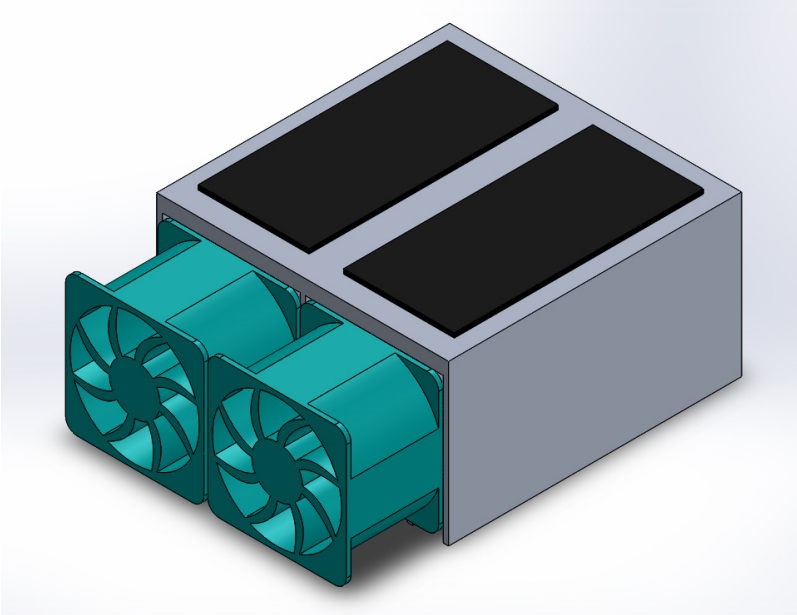
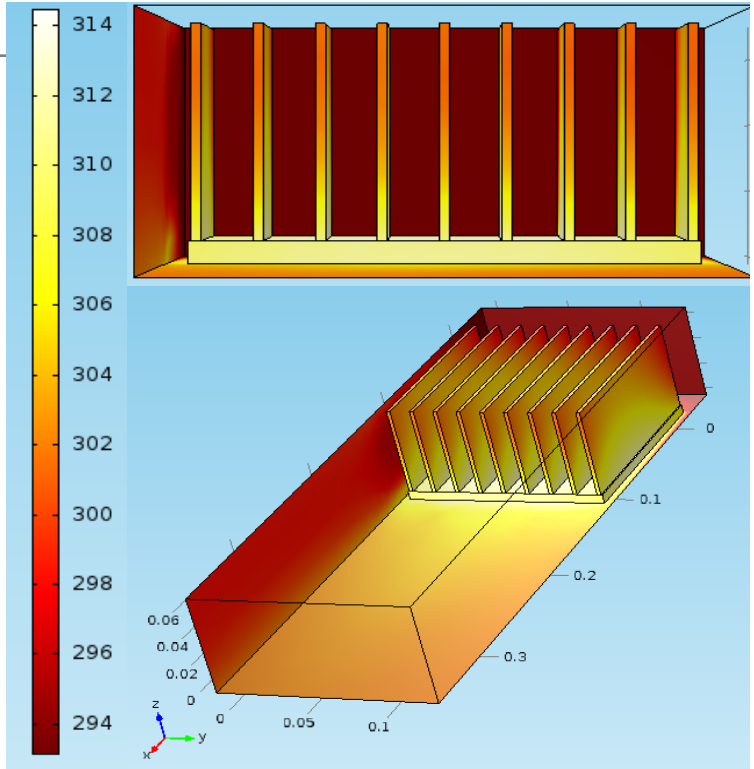


Plate Fin FEA

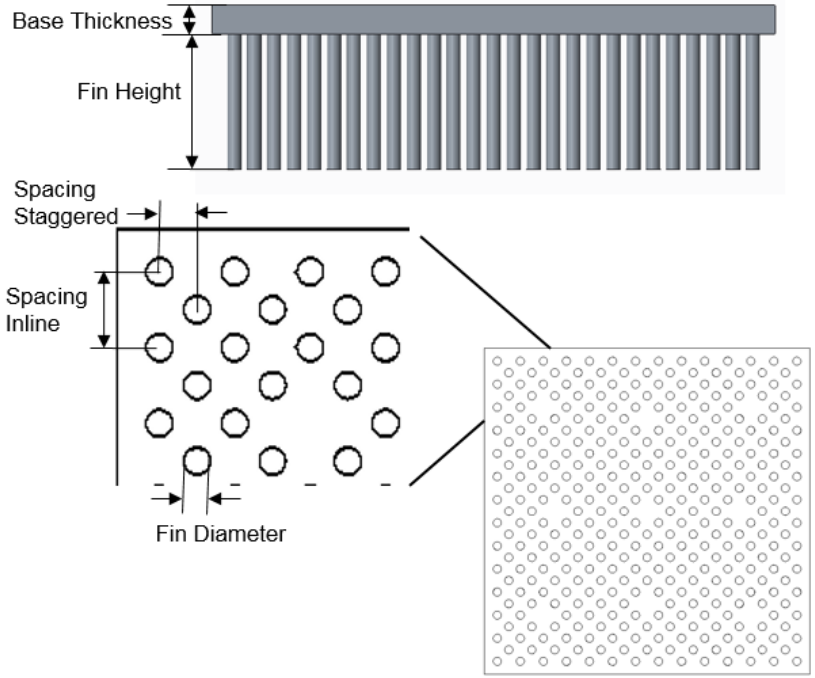
- Temperature distribution in Kelvin [K]
- Fan assumed to operating at maximum flow rate
- Average max temperature of heatsink base

  T ≈ 314K = 41°C



Bi-Modular Pin Fin Heatsink

Length	127 mm
Depth	127 mm
Height	30.5 mm
Base Thickness	6.4 mm
Fin Height	24.1 mm
# Fins	356
Fin Diameter	3.2 mm
Fin Spacing Inline	9 mm
Fin Spacing Staggered	4.5 mm



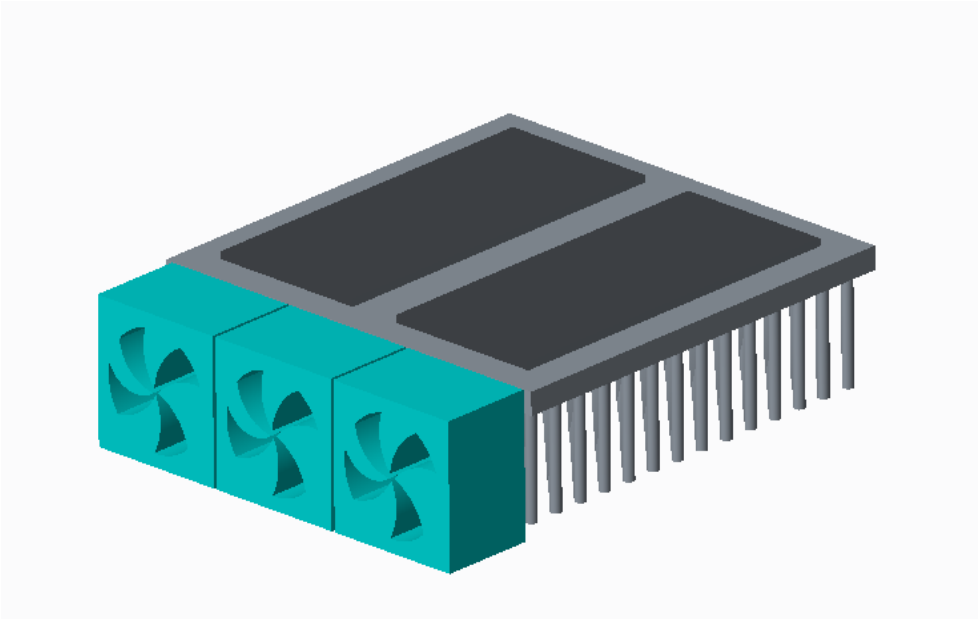
Bi-Modular Pin Fin Heatsink

Analysis Results

Weight: 0.521 kg

Pressure Drop: 106.6 Pa

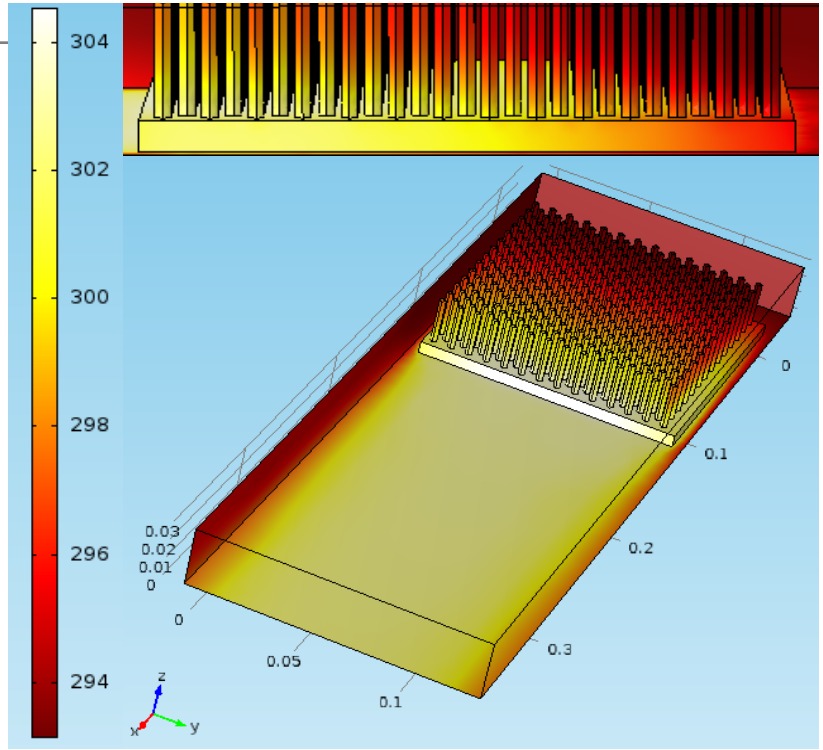
Thermal Resistance: 0.2081 K/W



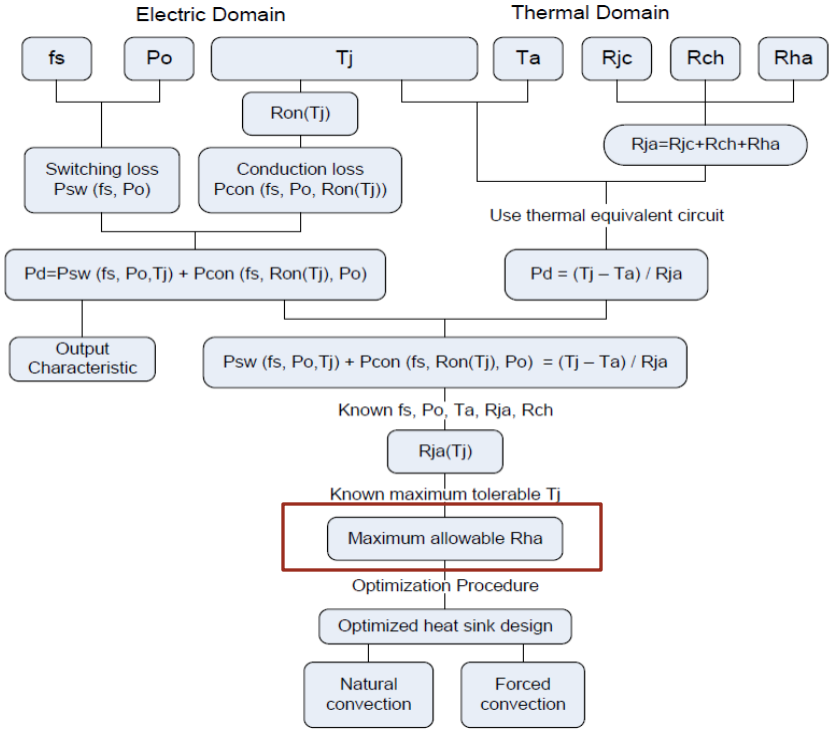
Pin Fin FEA

- Temperature distribution in Kelvin [K]
- Fan assumed to operating at maximum flow rate
- Average max temperature of heatsink base

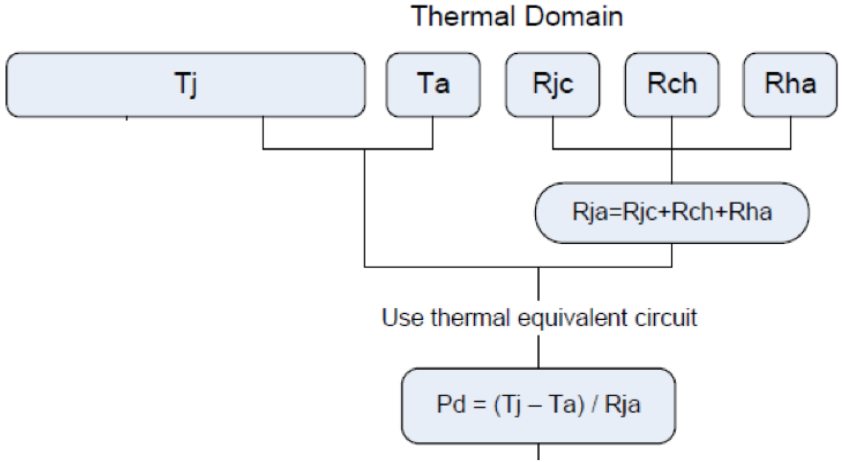
  T ≈ 304K = 31°C

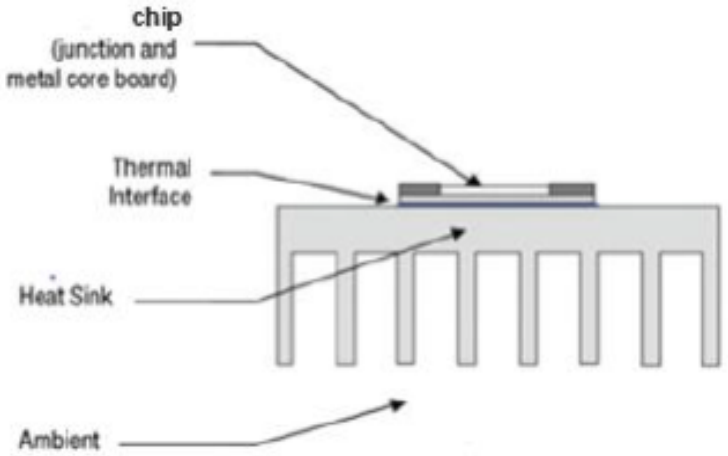


Power Loss Calculations



Theoretical Thermal Model

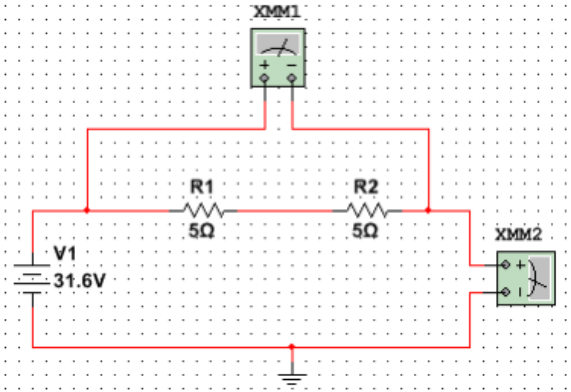




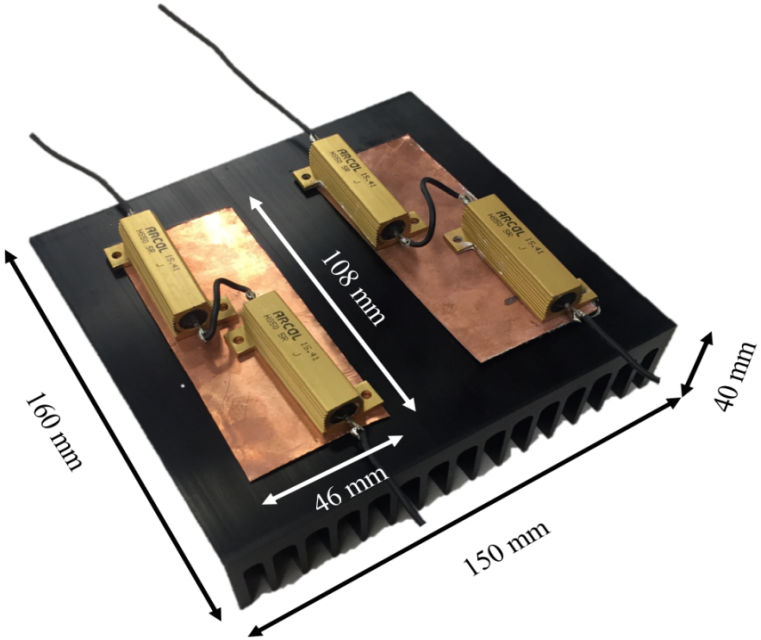
$$\frac{T_j - T_a}{P_d} - R_{jc} - R_{ch} = R_{ha}$$

Heat Source Emulator

- Power dissipation per module 100W
- Emulator: Two power resistors in series
  - Placed on a thin copper sheet



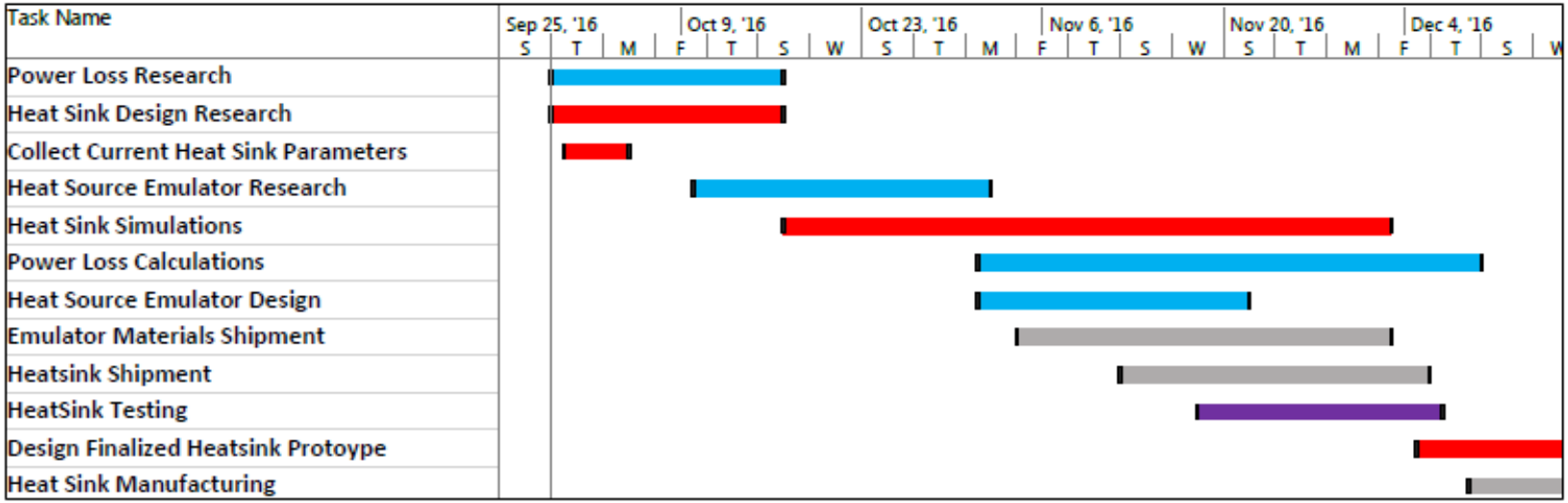
Schematic per module



Moving Forward

- Finish assembling heat source emulator
- Once thermal domain heatsink thermal resistance is measured, move on to electric domain

Gantt Chart



	Mechanical Engineers
	Electrical Engineers
	Other
	Mechanical & Electrical

Questions?