Too Hot To Test

February 9 - 11, 2021

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smiths interconnect

Thermal Management for IC System Level Testing

Quynh Nguyen & Tim Wooden 02/11/2021

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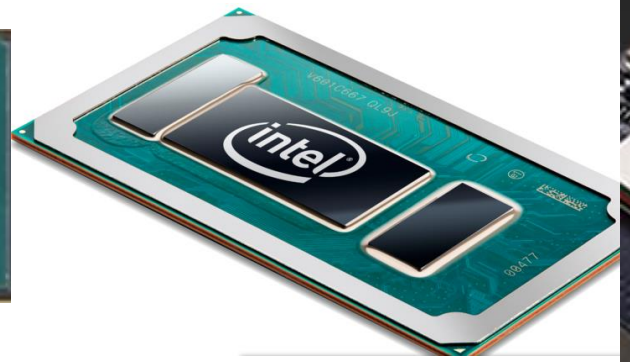
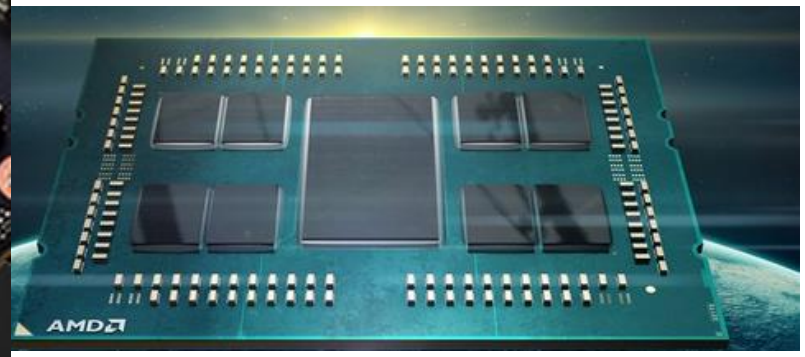




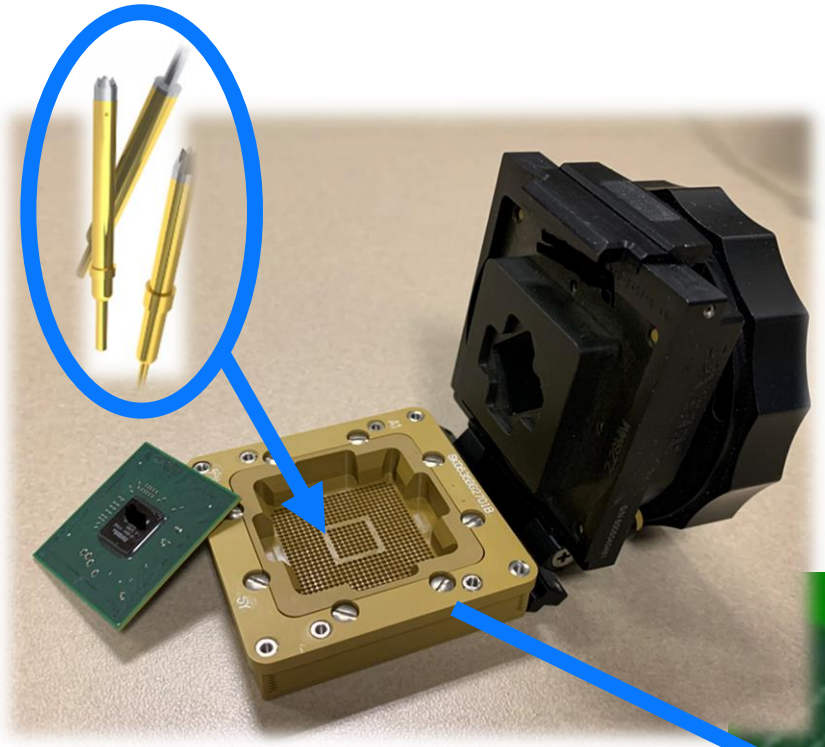
~50W

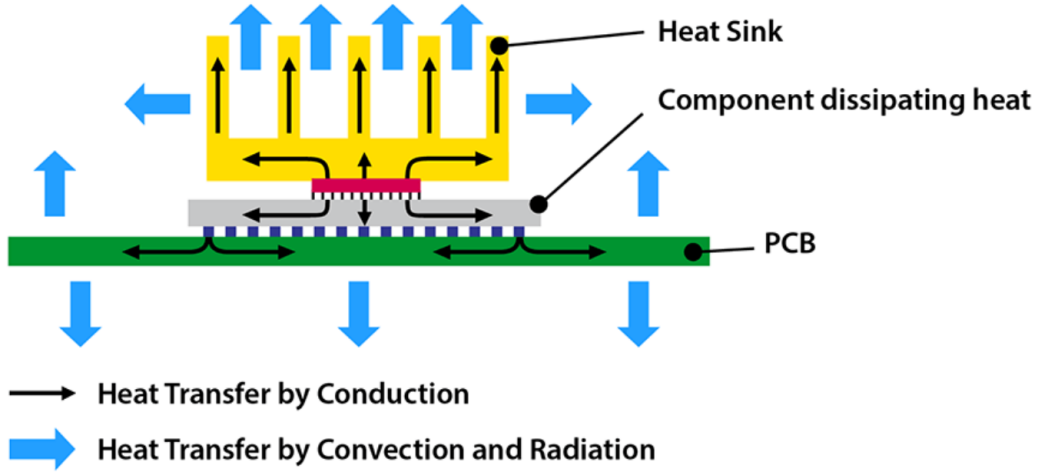
~150W

~250W

≥350W

The Setup (System Level or Functional/Bench test)

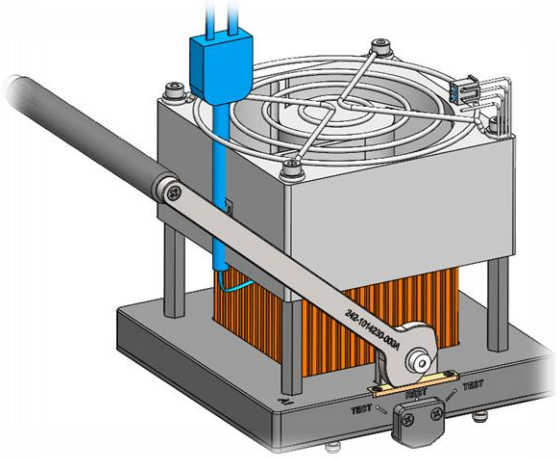


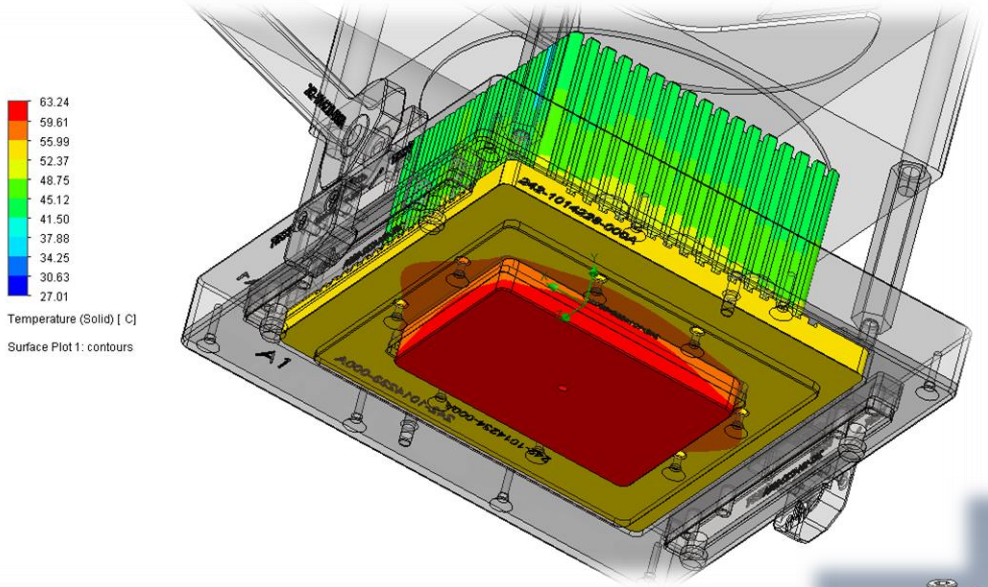


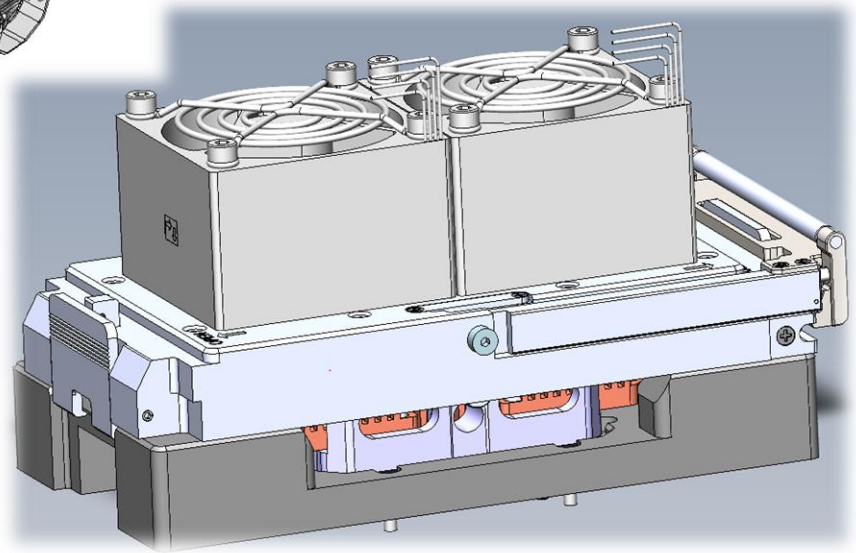
Source: Electronics Cooling

- **Mode of Cooling**
  - Conduction
  - Convection
    - Natural
    - Force
  - Radiation is mostly negligible

Traditional Heatsink and Fan

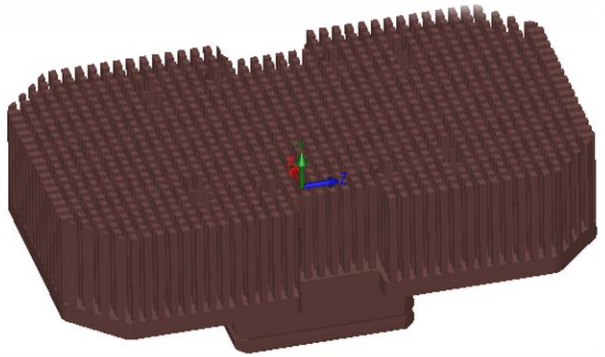




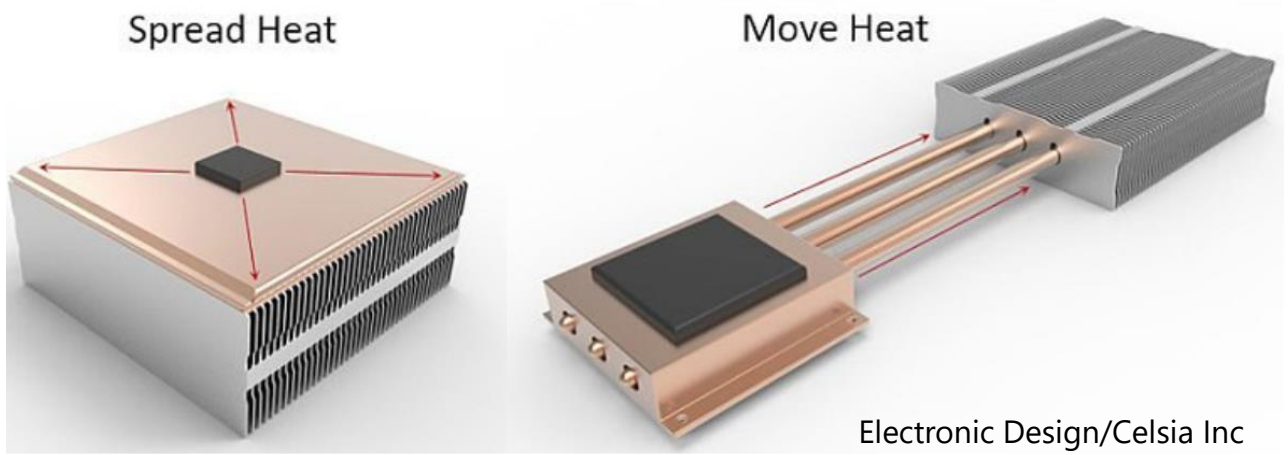


- **Pros:**
  - Capable up to 250W
  - Lead time ~3wks
  - Lowest cost

- **Cons:**
  - Limited dissipation capability up to 250W
  - Space limitation
  - Weight / Ergonomics
  - Fan noise > 63dBA



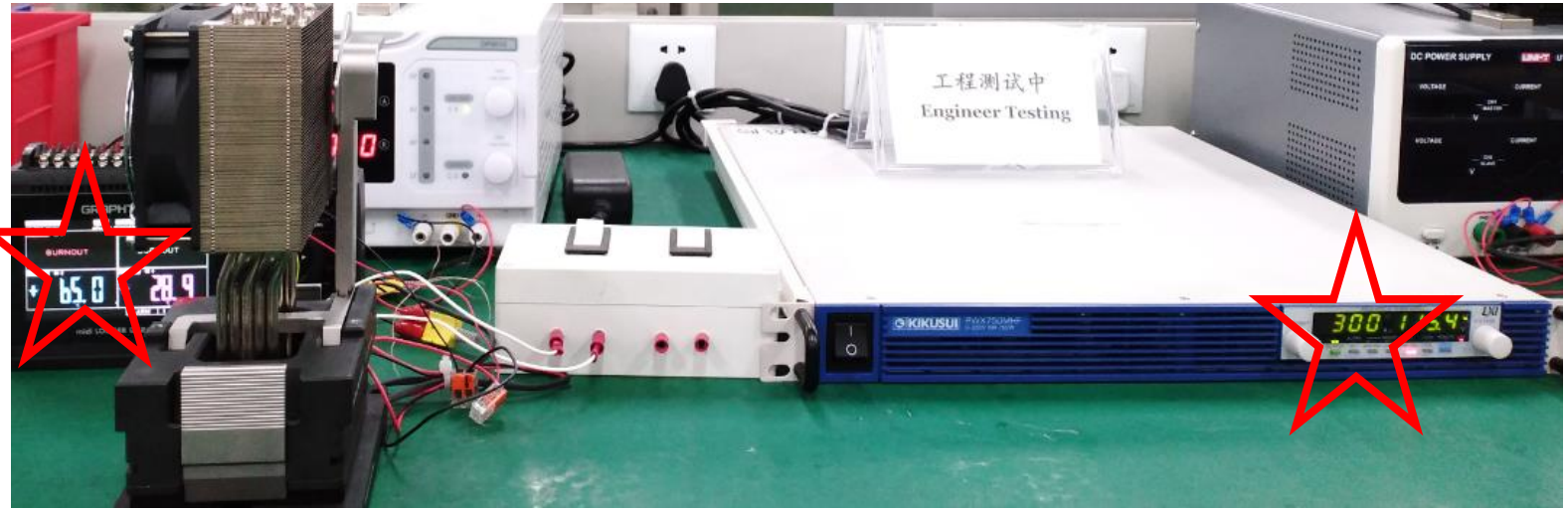
Heatsink with Heatpipe or Vapor Chamber

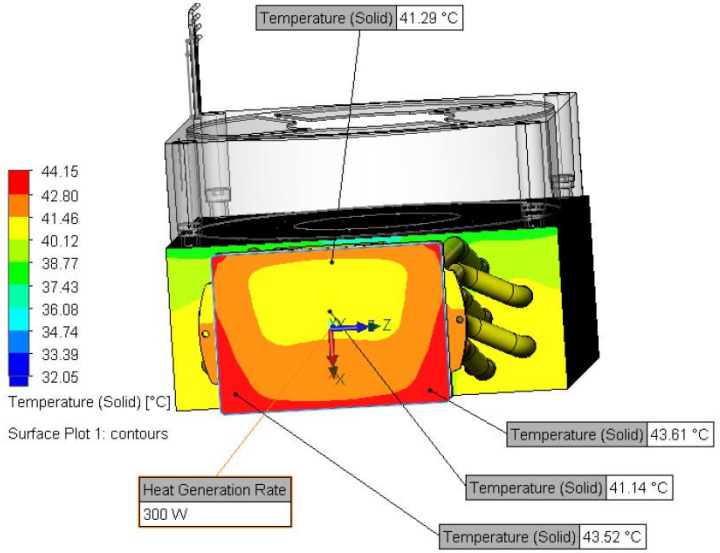


Electronic Design/Celsia Inc

Heatpipe heatsink:

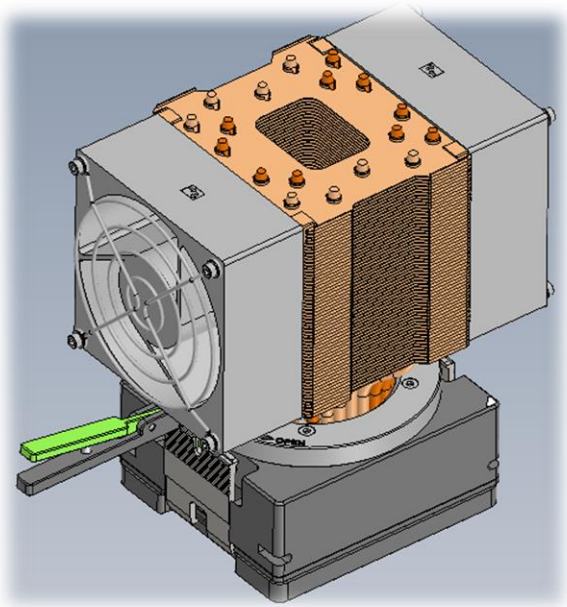
- 300W
- Rca 0.1, Rjc 0.03
- Simulation: ~77°C
- Measured: 65°C

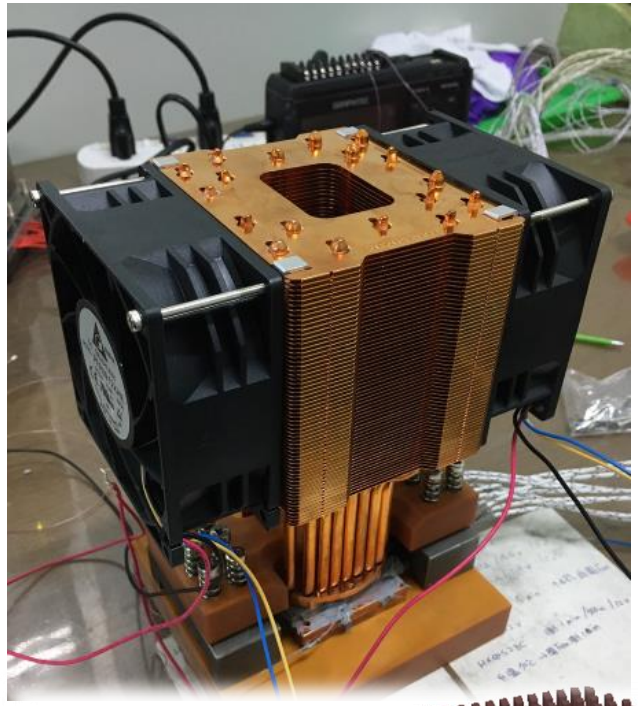




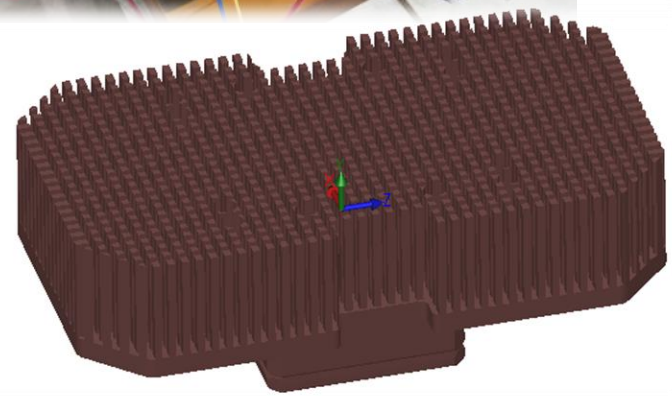
Heatsink with Heatpipe

- **Heatpipe heatsink:**
  - 600W
  - Rca: 0.08,
  - Simulation: ~74°C
  - Measured: ~58°C
- **Pros:**
  - Capability up to 600W
  - Long Lead Time ~5 to 7 wks
  - High thermal conductivity
  - Design flexibility due to bendability
  - Lowest cost for high volume
  - Weight / Ergonomics
- **Cons:**
  - Space limitation (more Z, than X,Y)
  - Lead time is longer for Heatpipe tooling
  - High cost for low volume

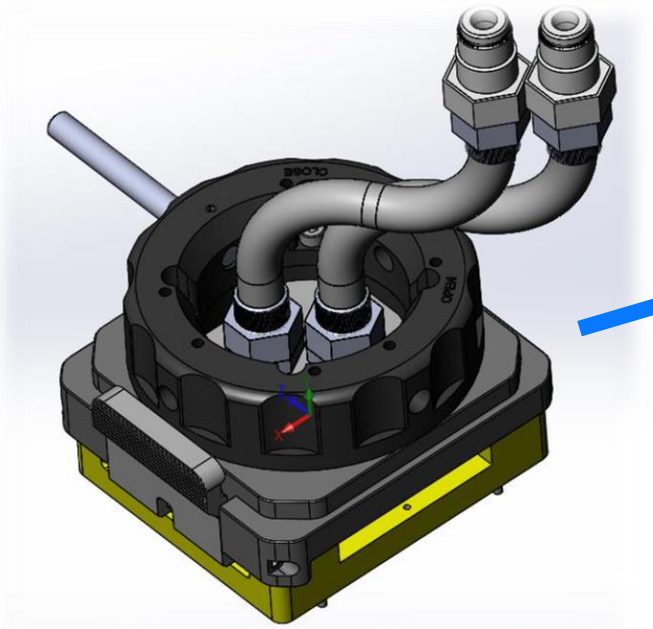




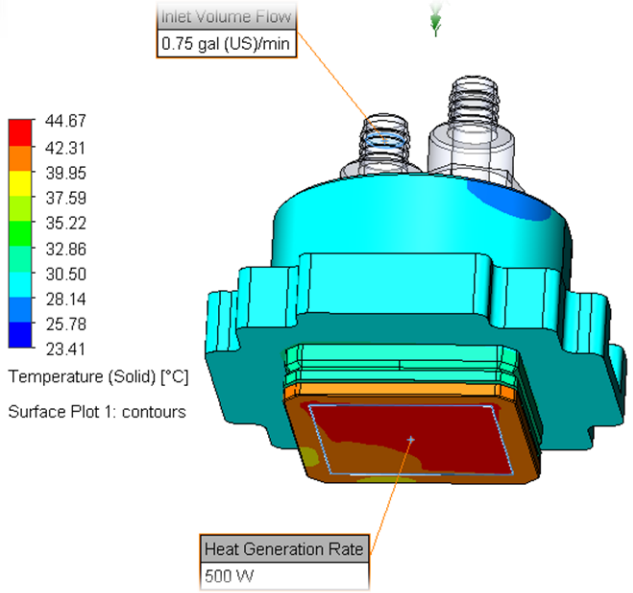
Tc (°C)	Ta (°C)	Power (W)	△T(a) (°C)	Rca
52.6	22.6	600	30.0	0.0500
53.3	22.5	600	30.8	0.0513
52.1	22.4	600	29.7	0.0495
57.8	22.5	600	35.3	0.0588
52.4	22.4	600	30.0	0.0500
52.3	22.5	600	29.8	0.0497
52.3	22.5	600	29.8	0.0497



Liquid-Cooled Heatsink



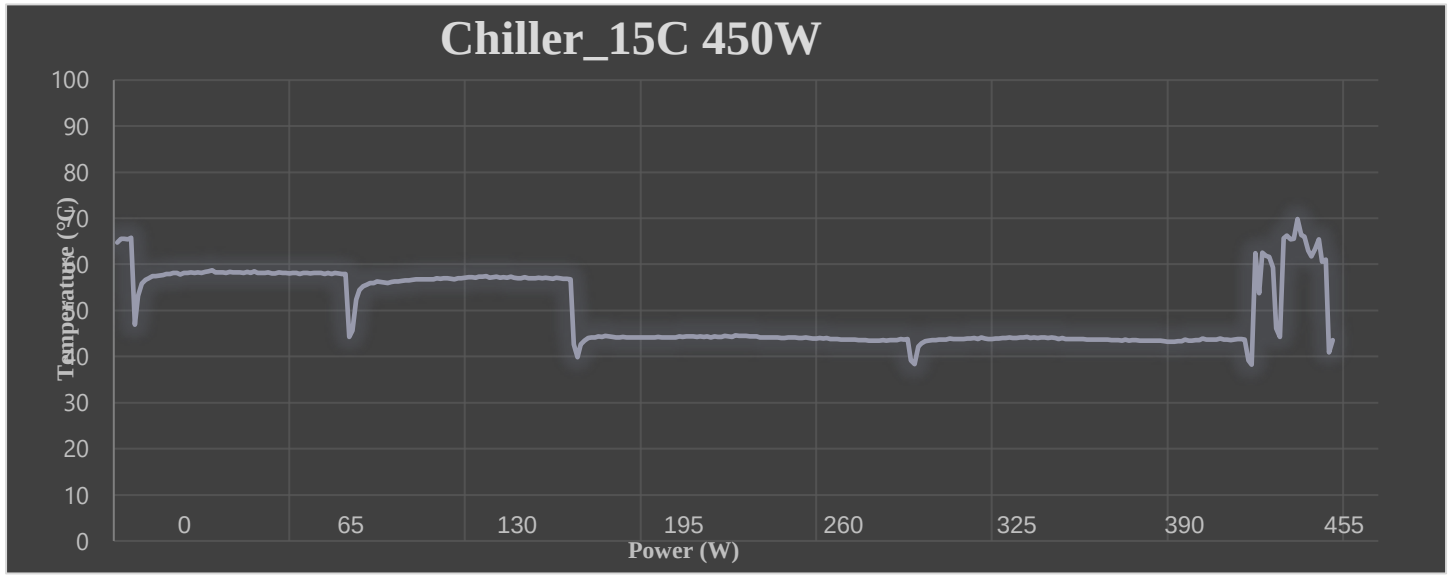
Liquid-Cooled heatsink connects to waterline in lab



Liquid-Cooled Heatsink connects to radiator

CorSair

Liquid-Cooled with Chiller



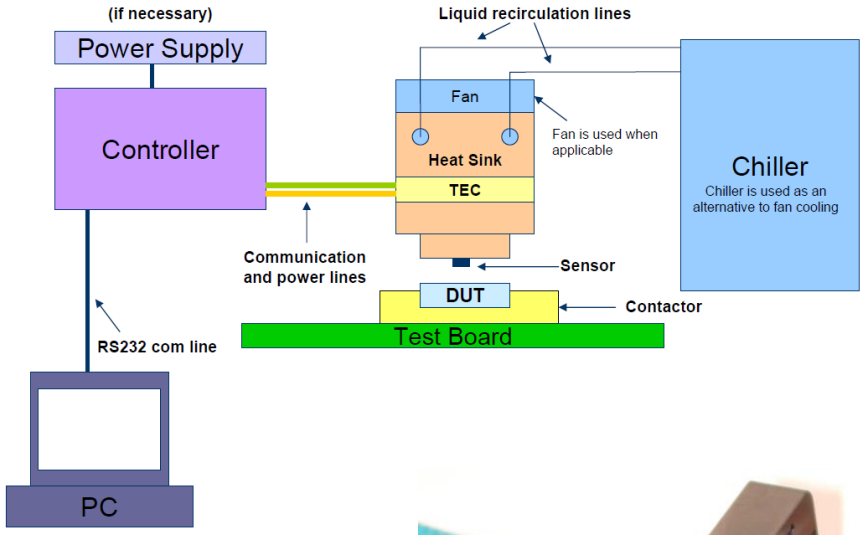
- **Liquid-cooled heatsink connects to chiller**
  - Set point
- **Insulated hoses for low set point**
- **One chiller can support multiple heatsinks**
- **Pros:**
  - Capability > 500W
  - Chiller: Set Point
  - Lower cost than heatpipe heatsink at low volume
  - Ease of maintenance
  - Lid portion has lower weight then conventional heatsink
  - Low/No noise
- **Cons:**
  - Water/Coolant Source
  - Fix Flow rate
  - Fix Fluid temperature
  - Radiator: Fluid temperature is higher than ambient
  - Potential Leaks

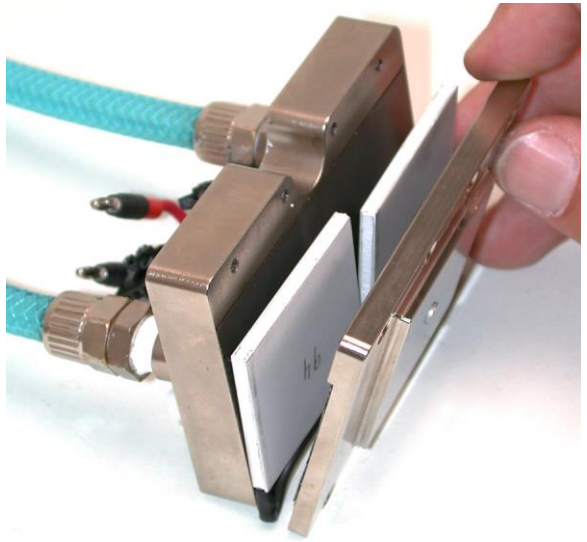
Temperature Control Unit

- **Heatsink connects to fan/fluid/Chiller For Cooling**
- **Thermoelectric cooler or Heater Cartridge for heating.**
- **Resistance temperature detector/ Thermocouple and thermostat for temperature feedback**
- **Controller**

- **Pros:**
  - Capability > 600W
  - Chiller: Set Point
  - Ease of maintenance
  - Lid portion has lower weight then conventional heatsink
  - Low/No noise

- **Cons:**
  - Highest Cost
  - Space/Set up
  - High Maintenance if use TEC
  - Potential Leaks



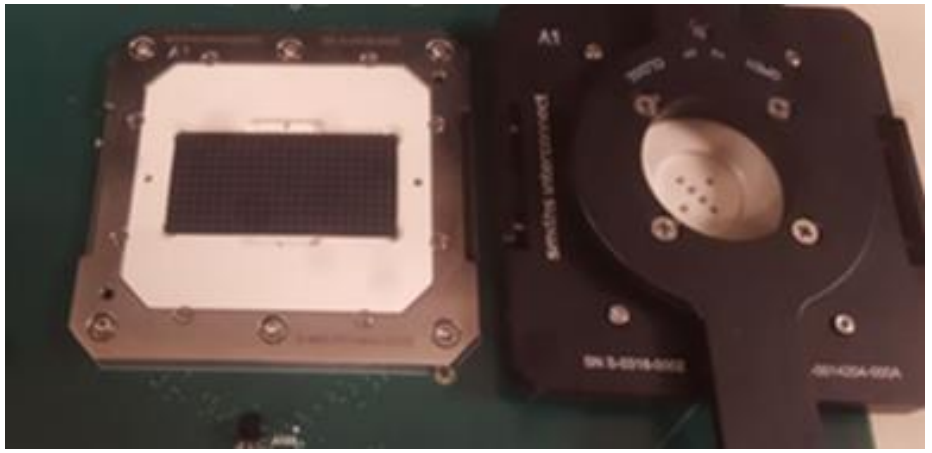


Immersion Cooling

- **Non-Conductive Fluid**
  - 3M Novec 7500 Engineering Fluid
  - Enclosed system
  - Vapor is condensed by Facility Water.

- **Pros:**
  - 1000x better than air cooled
  - Less Noise
  - No Hose Routing
  - Low maintenance cost

- **Cons:**
  - Mainly used for Data Center, Crypto Mining
  - High cost for setup/hardware
  - Spillage / Safety



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Summary

	Heatsink Air Cooled	Heatpipe	Liquid-Cooled	Liquid-Cooled (Chiller)	Temperature Control Unit
Cost	Lowest	Higher	Lower	High	Highest
Wattage	≤ 250W	≤ 600W	≤ 500W	≤ 650W	≥ 650W
Leadtime	Shortest	Long	Short	Short	Long
Noise Level	Up to ~76dBA	Up to ~53dBA	No noise/Low	45 dBA	45 dBA
Fluid Medium	Air	Air	DI water/Coolant*	Coolant	Coolant
Maintenance	No	No	No/Coolant	Coolant	Coolant & Heater
Stand Alone	Yes	Yes	Water line/Radiator	Chiller	Chiller, Controller
Space Limitation	Heatsink Size	Heatsink Size	No/Radiator Size	Chiller Size	Chiller Size
Ergonomic	Heatsink Weight	Heatsink Size	No	No	Weight of hoses, cables

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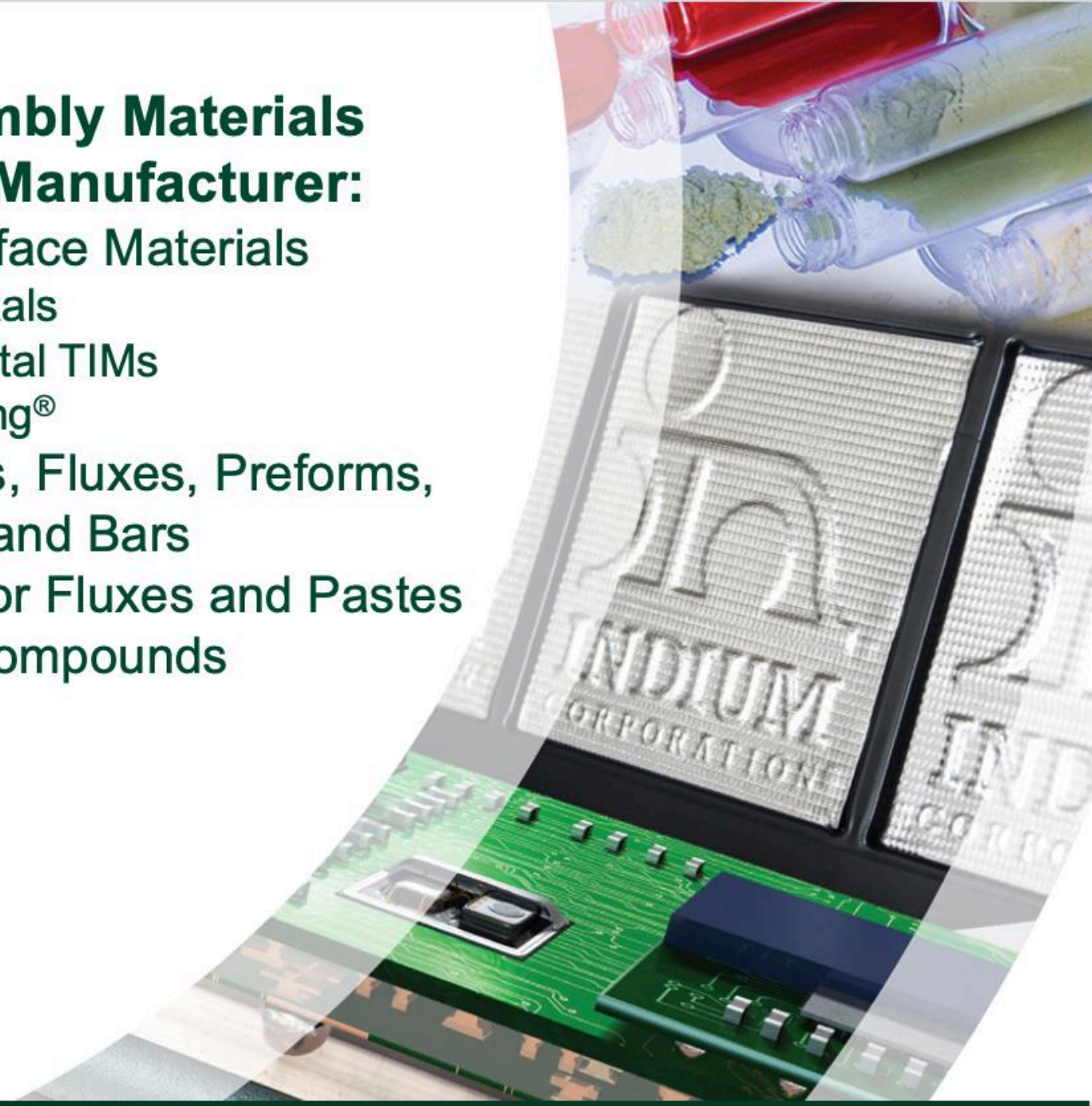

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