



BOYD
TRUSTED INNOVATION

Enhanced Air & Liquid Cooling Solutions

Boyd Confidential

Liquid Coldplates - Overview

Core Fabrication Methods:

- Vacuum Brazing
- Controlled Atmospheric Brazing (CAB)
- Friction Stir Welding
- Hi-Contact® Tube
- Machining
- Soldering



Specialization in:

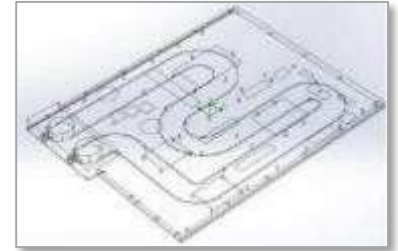
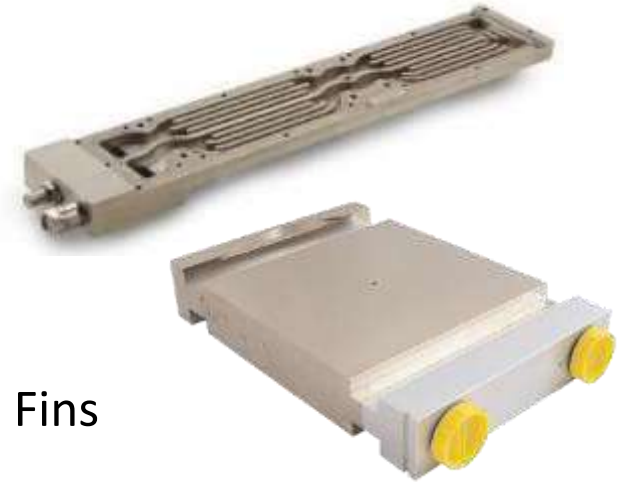
- Ruggedized Cold Plates
- Optimization for Compact Sizes
- Alternative Materials
- High Contact/ High Heat Transfer

Common Materials:

- Aluminum
- Cu or SS Pipe for Corrosive Fluids

Channel/Flow Types:

- Serpentine / Press Fit Tube
- Micro Channel
- Meso-Channel
- Extended Surface
- Integrated High Heat Transfer Fins
- Blister
- Direct Chip Contact



Common Markets

- Telecommunications
- Industrial Drives & Power Conversion
- Traction
- Automotive
- Medical



Liquid Coldplates - Overview

- Water + Ethylene Glycol Solutions

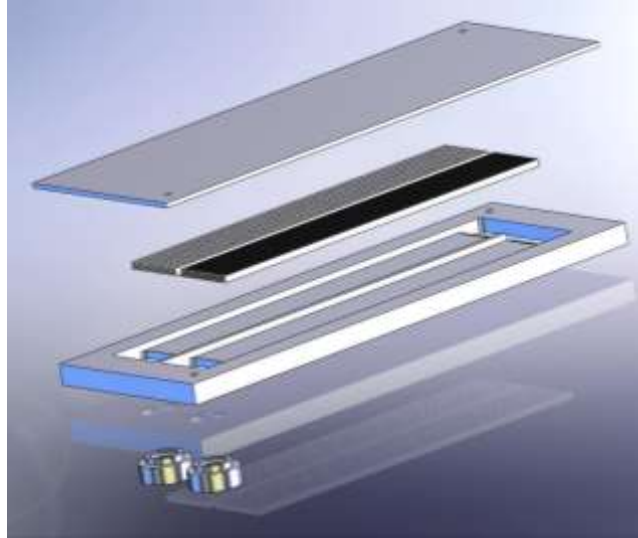
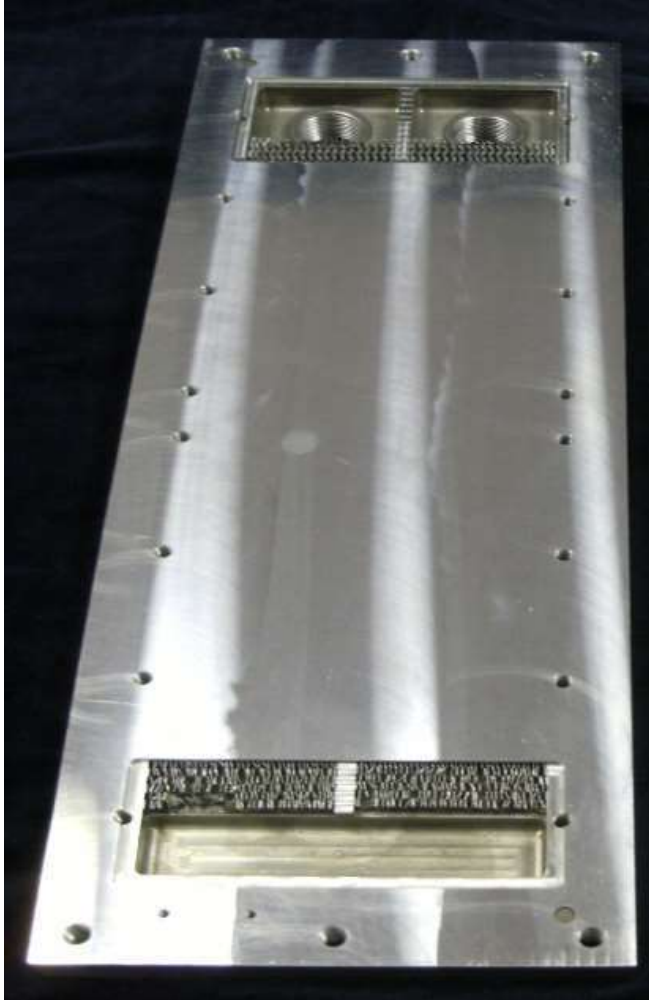
- Glycol provides freeze protection during use & shipping
- Glycols with proper inhibitors are highly recommended over non-inhibited glycols
- Experts recommend minimum concentration of 25-30% ethylene glycol, serving as a freeze protector, bactericide & fungicide
- Water quality is important to maximize performance
- Ions in water can cause channel clogging or corrosion
- CAB brazed cold plates are not suitable with de-ionized water

Minimum Requirements for Good Quality LCP Water

Mineral	Limit
Calcium	< 50 ppm
Magnesium	< 50 ppm
Total Hardness	< 100 ppm (5 grains)
Chloride	< 80 ppm
Sulfate	< 25 ppm

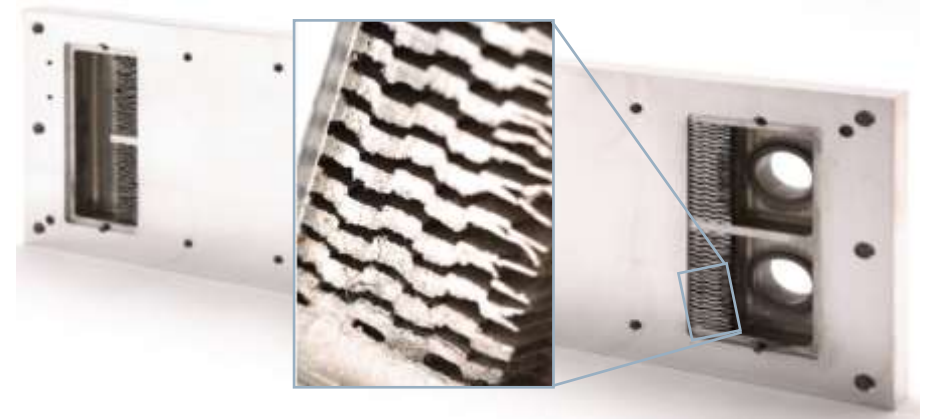
Coolant Compatibility	Water	Glycol / Water	De-ionized Water	Oil	Dielectric Fluids
Cu Tube Cold Plates	X	X	X	X	X
SS Tube Cold Plates	X	X	X	X	X
Fin Insert Cold Plates		X		X	X
Milled Cold Plates		X			
Blister Cold Plates		X		X	X

Vacuum Brazed Coldplates



Technology Description

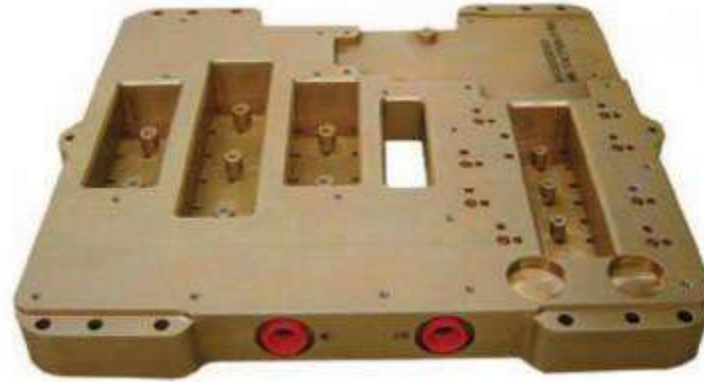
- Best thermal performance out of all cold plate types presented.
- High surface area in flow channels and complex fluid flow geometries can be realised to route coolant across the hotspots.
- Very clean components in absence of any fluxes, but longer lead time and higher processing costs.



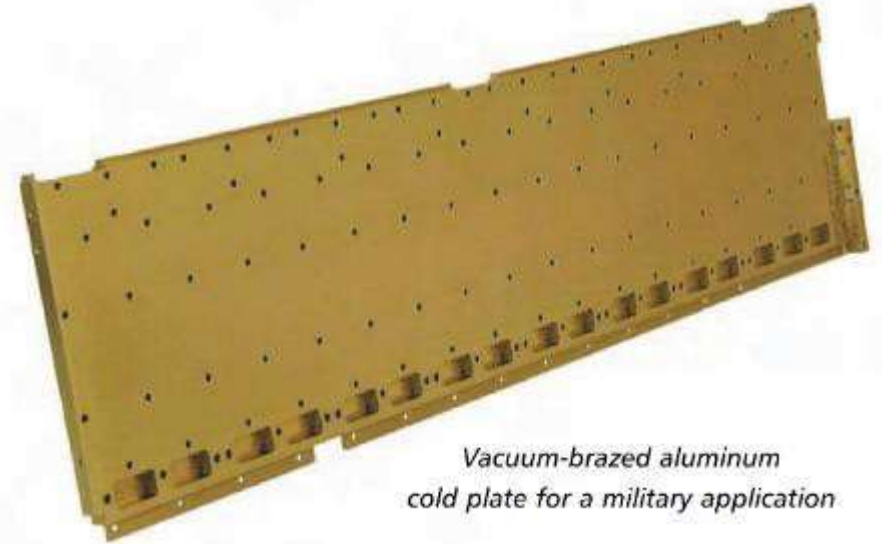
Vacuum Brazed Coldplates



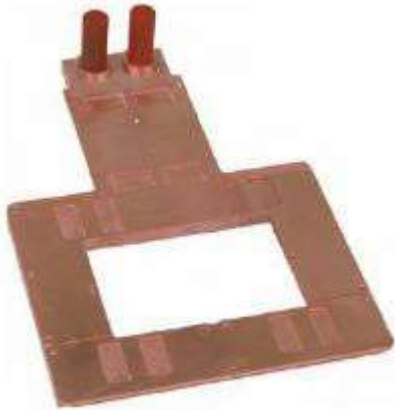
Vacuum brazed aluminum cold plate with extensive machining for Semiconductor Application



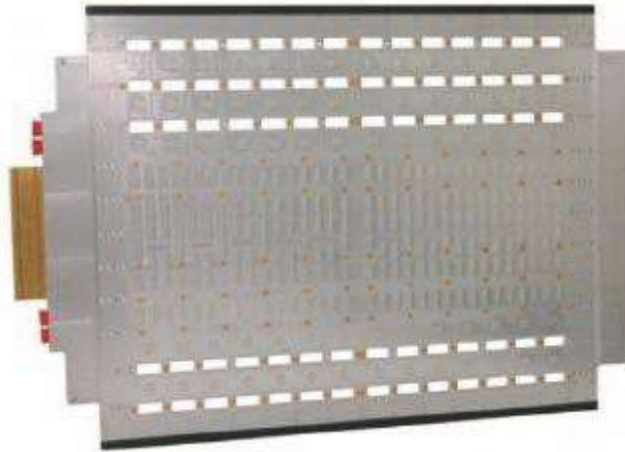
Vacuum brazed aluminum cold plate for Power Electronics Cooling



Vacuum-brazed aluminum cold plate for a military application



Copper cold plate for cooling Diodes in High Power Applications



Vacuum brazed cold plate with machining & gold inserts for Compute Module Cooling



Insert fin aluminum vacuum brazed cold plate for Power Electronics Cooling in Traction Application

Common Design Options



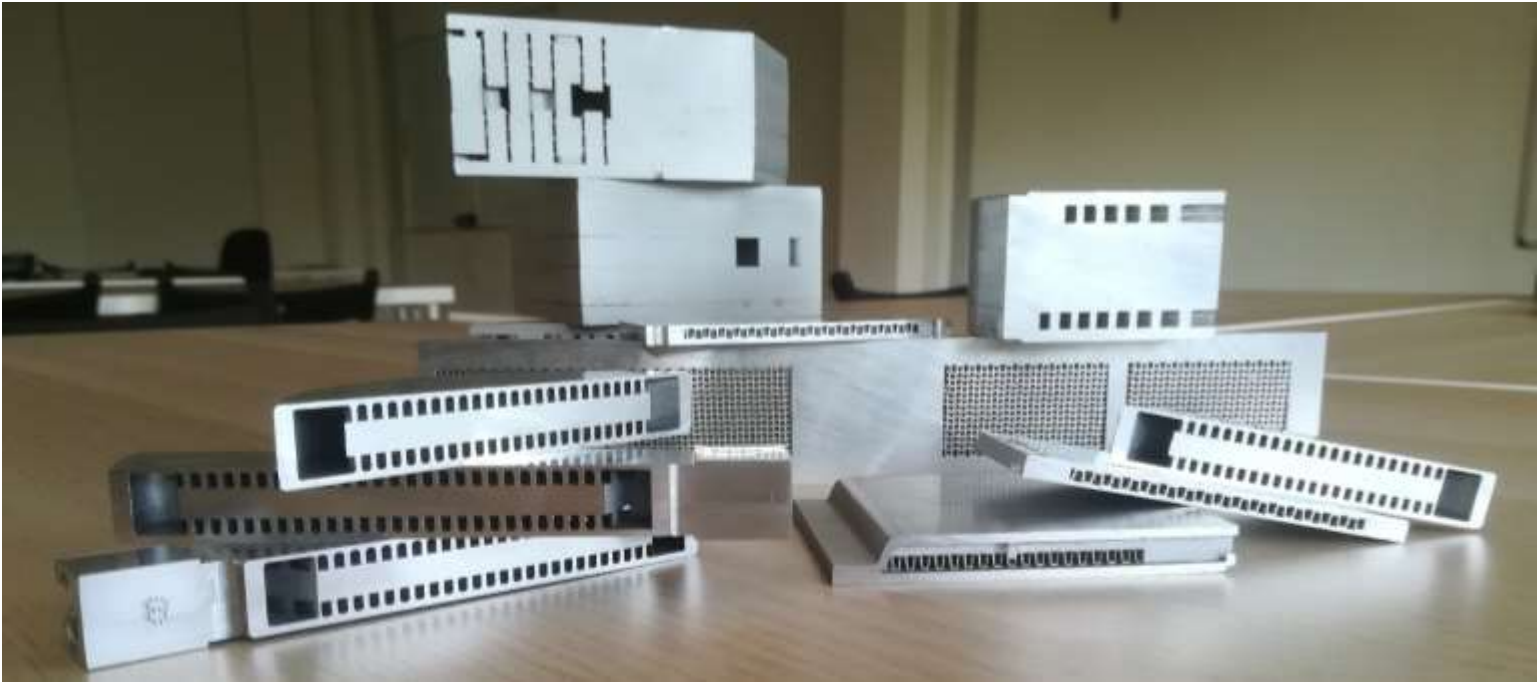
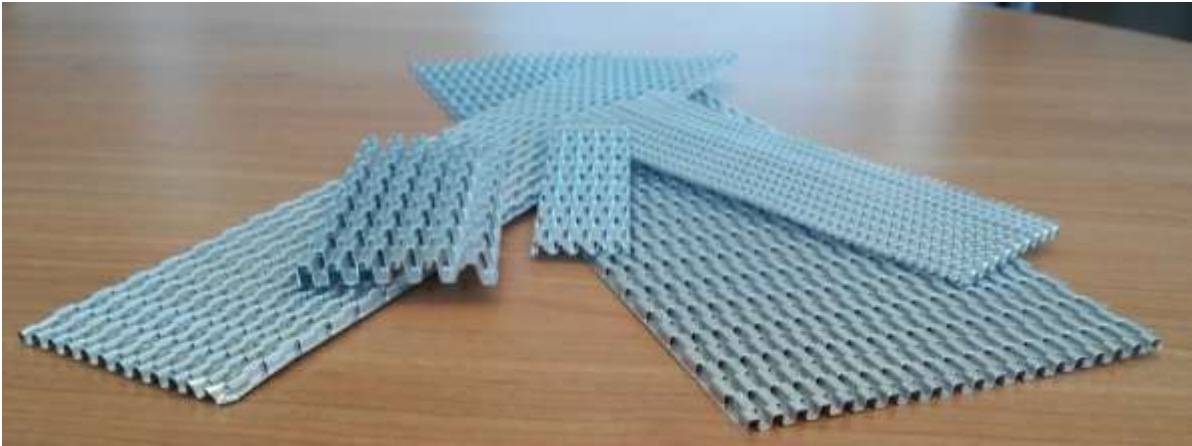
3 Layers



2 Layers (Blister)



Brazing Junction Design



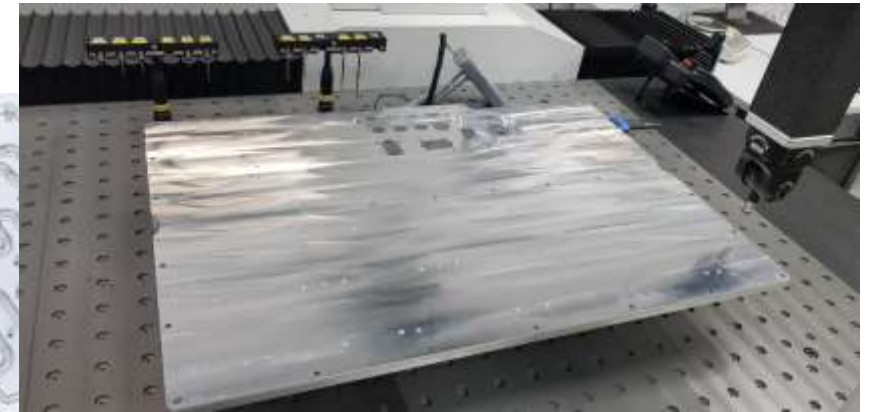
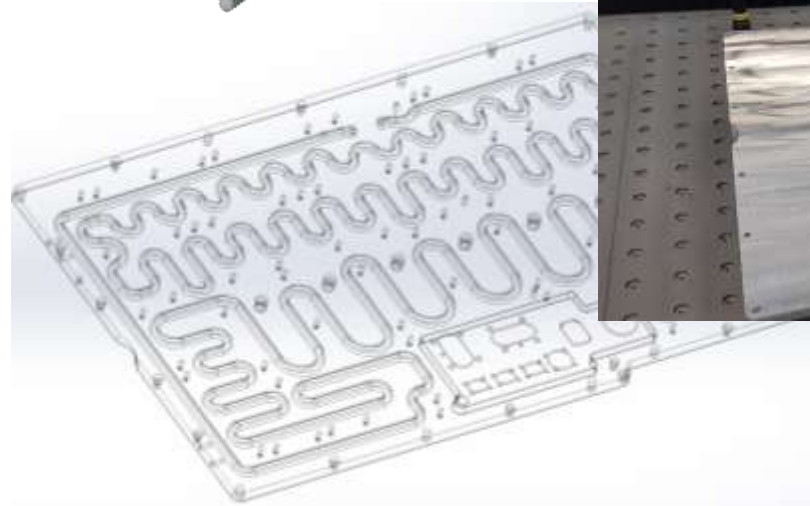
Fully Customized Coldplate Solutions

Aerospace/ Space & Automotive

- High Performance Power Trains
- Battery Cooling
- Power Electronics/Inverter Cooling
- MPU/PSU Cooling

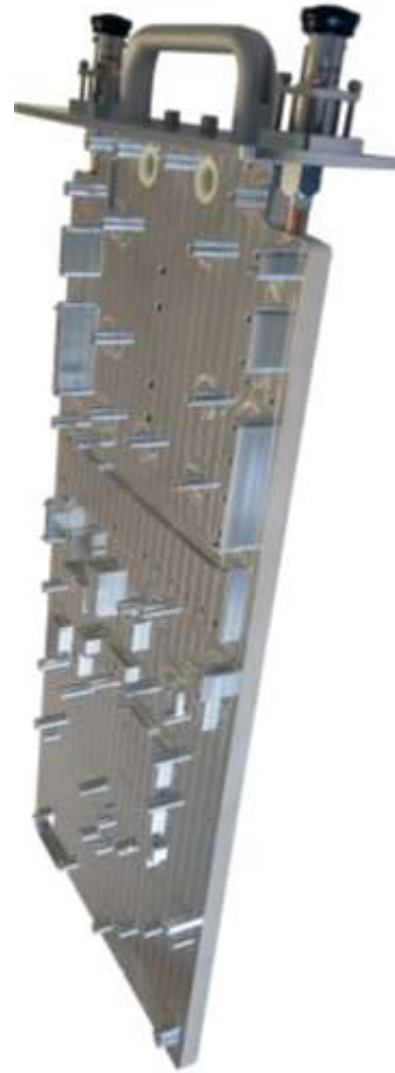
Technology

- Vacuum Brazed



Power Supply Units

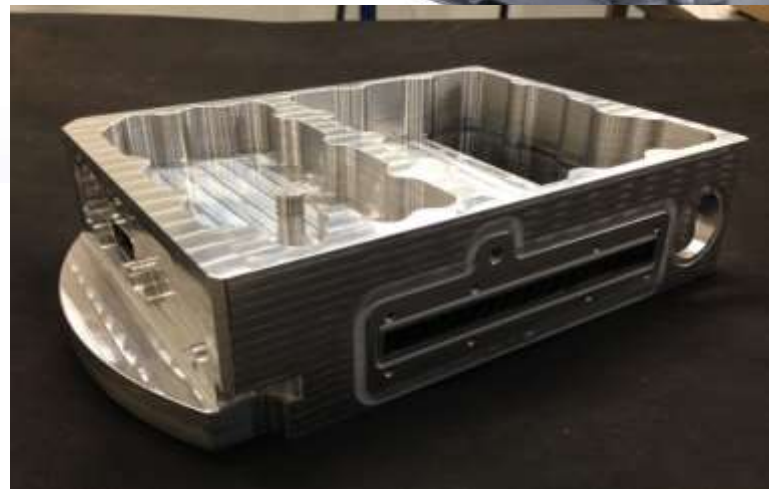
- **Liquid Cooling**
- Sub-Assembly
- **Technology**
- Serpentine Cold Plate



Naval & Airborne Radar

Liquid Cooling Modular Design

Technology
Vacuum Brazed; Liquid
Cold Plates and Heat
Exchangers and K-Core
Assemblies.



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Contact:

Mark Small – Area Sales Manager

Email: mark.small@boydcorp.com

Mobile: +44 (0) 779 378 0533

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