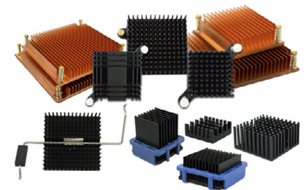
Thermal Management Solutions

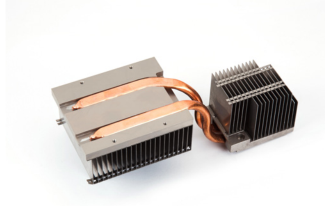
Two-Phase Cooling

Nearly all electronic components require a thermal solution to dissipate waste heat and keep them from overheating. Boyd provides optimized, cost-efficient thermal solutions and systems utilizing the largest range of traditional and advanced cooling technologies.

Heat Sinks



Heat sinks are the most fundamental thermal solution constructed of a base and fins. They are fabricated using materials such as aluminum and copper. Parts may be fabricated using die casting, stamping, extrusion, and skiving processes or as assemblies by bonding, soldering, or brazing fins to bases to optimize conduction and convection.

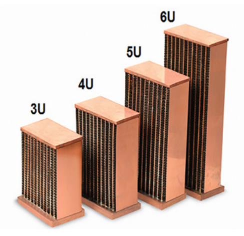


Heat Pipes

Heat Pipes are passive, two-phase components that are integrated into heat sinks. They enable rapid heat transport that is more than 100X as efficient vs copper. Heat pipes are long tubes typically made of copper with a few grams of water inside present as both liquid and vapor (two phase) while under vacuum at room temperature. With the use of a capillary wick structure, the condensed fluid returns back to the heat source similar to how a sponge soaks up water. They are found in nearly every laptop, server, gaming console and many A&D applications.

Vapor Chambers

Vapor Chambers are typically used in applications where the main concern is spreading heat quickly and evenly in every direction over a base plate. Vapor Chambers are similar to heat pipes but the fluid is contained in a flat, typically rectangular chamber. They are integrated into or used as heat sink bases to transport heat quickly over that plane. When space is limited, they themselves are a very effective thermal spreader commonly found in mobile phones and tablets or with fins attached for cooling in servers, gaming consoles, routers, and larger industrial or A&D applications.



3D Vapor Chambers

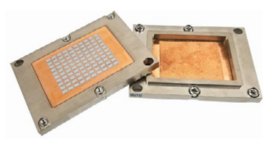
3D Vapor Chambers are typically used where extreme performance is required within a local heat sink volume over the component being cooled. 3D VC's are enhanced where the flat base chamber includes added vertical hollow tubes protruding from one surface to conduct heat evenly to the fins above. They allow heat to be collected from one or more sources on the base and distributed through the entire 3D volume for maximum performance. Common applications are in cooling high-power enterprise chips such as GPU and AI devices in excess of 500W.

Thermosiphons

Thermosiphons differ from heat pipes in that they are commonly made of all aluminum or a combination of aluminum and copper, use a refrigerant as the working fluid, and do not have a wick thus requiring gravity to return the liquid back for evaporation. Thermosiphons are used where their orientation is fixed, the condenser is elevated above the evaporator and much higher powers than heat pipes must be transported. They are used in servers (1U+), industrial, and telecom applications where high performance within a local or remote heat sink volume is needed.

Oscillating, Pulsating, and Loop Heat Pipes

This category of two-phase device uses several different methods to move the working fluid within the device and may be made from a variety of materials depending on the fluid type. These technologies also offer varying degrees performance independent of gravity. Rather than utilizing a wick along the entire surface like a traditional heat pipe the fluid moves as slug flow pushed by bubbles or using independent liquid and vapor lines. These highly custom thermal solutions are used in specialty A&D applications such as cooling within satellites as well as government and corporate R&D studies.



Immersion Cooling

Immersion cooling utilizes fluid, in a single or two-phase form (boiling), to cool the entire PCB and electronic components by immersing them in a fluid-filled tank. For two-phase immersion, a boiler plate that includes a boiling enhancement coating (BEC) is used as the heat sink on high-power components. This boiler is mounted to devices such as CPUs and GPUs that enhance the boiling of the fluid. Boiler plates are often made from solid copper or a copper vapor chamber with mounting hardware as required. Immersion cooling requires a completely new architecture from what most customers are using today. There is currently activity for cooling servers in data centers using this method where the entire server is immersed in a large tank in place of a traditional rack.

Performance comparison of Two Phase Cooling Technologies

	Extruded, Skived, Bonded Zipper Fin Heat Sinks	Heat Pipes	Vapor Chambers	3D Vapor Chambers	Thermosiphons	Oscillating Pulsat-ing, and Loop Heat Pipes	Immersion Cooling
Thermal resistance	4	3	2	2	2	3	1
Power Handling	5	4	3	2	2	2	2
Heat Transport Distance	5	3	4	4	2	2	1
System level Power Consumption	5	2	3	2	2	2	1
Weight (Item)	4	2	3	4	1	2	1
System Dependency	1	2	1	1	2	3	5
Cost (Item)	$	$$	$$	$$$	$$	$$$$$	$$
Considerations	Passive (sold conduction)	Passive, <0C considerations	Passive, <0C considerations	Passive, <0C considerations	Gravity required, dielectric fluid	Startup transient considerations	Facility + rack (tank) design

***Above rankings are on a scale from 1 to 5 where 1 = Excellent and 5 = Fair

Have questions? We're ready to help!

If you are ready to improve or retrofit your cooling solutions or are looking to tackle new challenges for the next generation, start by contacting Boyd Corporation to learn more about two phase solutions, customizations, and other possibilities for better optimized cooling. To receive more information regarding Thermosiphons, please visit us at www.boydcorp.com.