

APRIL 2010

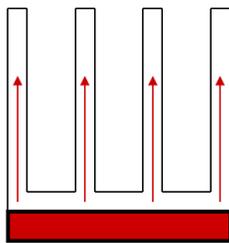


# App News

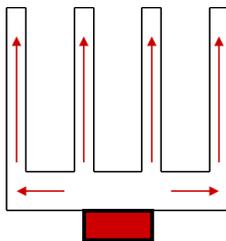


## Higher Performance Heat Sink Design Base Spreading Technologies

The best “bang for the buck” in heat sinks are aluminum extrusions. They are the most cost effective solution, but as with all products/technologies, they have limitations. In a simple extrusion as shown below, where the



Heat Sink = Heat Source



Heat Sink &gt; Heat Source

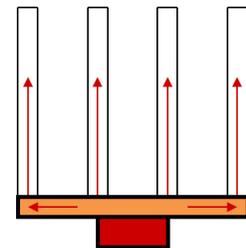
footprint of the heat sink is the same size as the heat source, the base of the heat sink needs only to be thick enough to hold the fins and keep the mating surface flat. A short distance from the base to the fins means that the fins are maximized in height and therefore surface area. The second example shows a similar part, but now the heat source is much smaller than the heat sink footprint. This means that the heat must now travel along the base to get to the fins, so for optimal heat flow, the base must now be thick enough to carry the heat to the outer fins. This is analogous to electrical current flow in a wire, the more the current, the larger the wire needs to be to carry the current. Likewise, the base must be thick enough to carry the heat to the outer fins, rather than just be a base to hold the fins. We call this “base heat spreading”.

Whilst the 6063 aluminum extrusion alloy is a good thermal conductor at 203 W/mK, it does have some thermal resistance. This thermal resistance can limit heat sink performance, especially as we increase the amount of heat to be dissipated. Initially, we can start to increase the base thickness to carry the heat load, but that reduces the height of the fins, which reduces the surface area of the fins and starts to limit the performance of the heat sink. We now need to find a way to increase the base spreading without reducing the height of the fins.

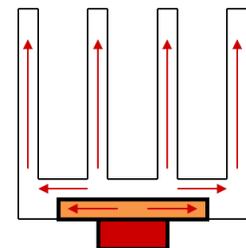
One option is to add a copper insert in the base or make the entire base out of copper. Copper has a thermal conductivity of around 380 W/mK, almost double that of aluminum, which means that a copper base would base spread twice the heat of a same thickness aluminum base. This works well for many applications, the main drawback of a copper base or insert is that it is heavy and copper is several times more expensive than aluminum. The copper insert is a partial copper base which permits good heat transfer where it is needed, but uses aluminum for the outer edges where less conductivity is needed and weight can be saved.

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Full Copper Base



Copper Base Insert

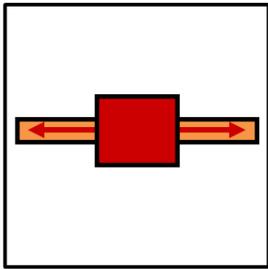


## Base Spreading, Copper Inserts and Heat Pipes

Copper inserts can be costly as now we need to attach the two metals and do extra machining. Some applications can use just a copper pedestal. A nice feature of solid aluminum and copper bases is that they conduct heat well and evenly in all directions, length, width and height.

As the total power and the power density (power/area) increases, even copper bases cannot conduct all the heat needed, plus large copper parts start to get very heavy and expensive. As the distance that the heat needs to travel from the heat source to the cooling fins increases, despite the high thermal conductivity of copper, it does have some thermal resistance which starts to add up over the longer heat path. This is where heat pipes come into play.

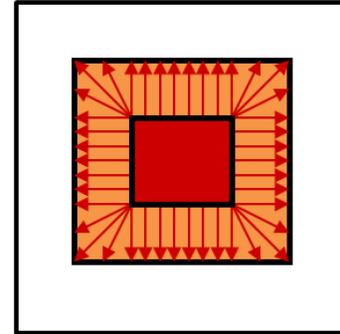
A heat pipe is simply a copper pipe containing a few drops of water in a partially evacuated atmosphere. As the water in the tube heats up, it eventually boils (or vaporizes) and now low pressure steam can move within the pipe. The reason for the partial evacuation is so that the liquid will boil below 100C, similar to why water boils at lower temperatures in the mountains. This is engineered so that the water boils at temperatures below that needed to protect modern electronics. It takes a great deal of energy (heat) to convert the liquid to vapor. It takes 1 calorie of heat to raise the temperature of 1 gram of water by 1 degree Centigrade, but it takes 540 calories of heat to convert 1 gram of water at 100C to steam at 100C, this is called the Latent Heat of Vaporization. This law of physics allows heat pipes to absorb lots of heat and move it as steam to another area where it can be cooled and condense back to liquid. Heat pipes in of themselves do not dissipate heat, they just allow easy transfer of heat to another area where it can be cooled.



Heat Pipe excellent heat transfer but in one axis only

Heat pipes have minimum and maximum length limitations, so as with all technologies they must be designed for their sweet spot.

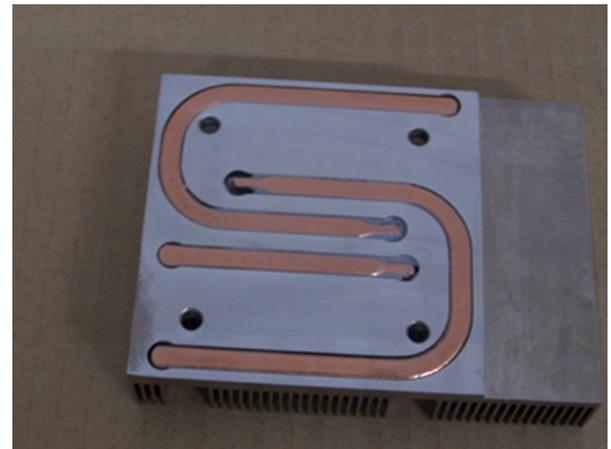
The 6 mm diameter heat pipe is the most commonly used and the most inexpensive, typically this part will be between 100 and 300 mm in length for best performance.



Copper base or insert equal heat transfer in all 3 axis

Since heat pipes are basically hollow thin walled copper tubes they are very light in weight compared to copper bases.

Heat pipes have high thermal conductivity in the longitudinal axis (typically 5-10,000 W/mK) but only 50 W/mK in the Y and Z axes. So they offer superb heat transfer in the pipe itself but not the rest of the base. It is for this reason that you will often see formed heat pipes, to move the heat to cooler areas of the heat sink to improve



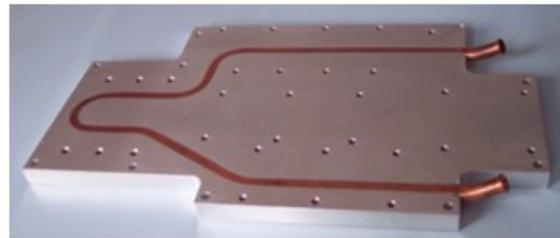


## Base Spreading, Heat Pipes and Vapor Chambers

Heat pipes are now commonly used in many applications including laptops and desktops as they are versatile, low weight and inexpensive. For higher power applications, some customers are now looking at Vapor Chambers. A vapor chamber is based on heat pipe technology, but rather than being the shape of a pencil with good thermal conductivity along the main axis only, it is now in the form of a flat plate. Thermal conductivity is now around 1,000 W/mK in the X and Y axes but around 100 in the Z axis. Vapor chambers look like a solid copper plate, but contain similar inside structure to a heat pipe and offer much lower weight. They do need additional internal support to prevent the vapor chambers themselves from oil-canning. Extreme care must also be taken as they have a large peripheral seal, any leaks would cause the product to fail in short order. Vapor chambers offer slightly higher performance over heat pipes, but have high unit cost, high tooling cost and quality/life of the product can vary substantially. Vapor chambers are an exciting technology but have limited use due to cost, tooling and lifetime/reliability concerns.



For those applications with very high heat loads and/or very dense heat flux (power divided by area), many customers turn to liquid cooling systems. To put this in perspective, remember that water can carry 3,400 more heat efficient in than air. Liquid cooling often becomes the best option for power levels over 150W. In the pictures shown we have a simple cold plate with a buried copper tube routed under the heat sources (right), the Apple Computer CPU micro channel cold plate (below) and a large server cold plate that today has over 1,000 heat sources (bottom right).



Liquid cooling is being heavily used in modern servers and data centers where power density levels are high, cooling/operating expenses are vital and acoustic levels are a problem. IBM's latest family of high end servers are all liquid cooled, including the power supplies. The elimination of primary air cooling also allows tremendous operating savings for

inefficient computer room air conditioning units (CRAC's). Liquid cooled systems can cost up to 10 times less to operate than air systems. The IDC states that annual energy costs for data centers are projected to exceed acquisition costs by 2012.



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## COOLCENTRIC OPENS NEW BRIEFING & DEMONSTRATION CENTER

### *New Center Showcases Cost Saving Benefits of LiquiCool Data Center Cooling Solutions*

**MARLBOROUGH, Mass.,—April 21, 2010**—Coolcentric™, a new division of Vette Corp®, today announced the opening of a new state-of-the-art Briefing and Demonstration Center (BDC) in Marlborough, Massachusetts, USA. The BDC will be used to host customers, prospects and business partners to showcase how Coolcentric's LiquiCool® solutions can be used in a variety of visitor-selected architectures and operating conditions. Based on Vette patents, LiquiCool data center cooling solutions can help data center owners and operators reduce data center cooling costs by 90 percent, reduce white space requirements by 80 percent while allowing a 5X increase in rack compute power.

"We recognized that it is challenging to visualize how a new cooling solution can be integrated into an existing data center environment," said Joe Capes, general manager of Coolcentric. "With that in mind, we designed our new Briefing and Demonstration Center to help visitors see how Coolcentric's solutions can be easily applied in a variety of typical operating environments. This innovative facility will help us educate others on the full energy and cost saving benefits that our solutions provide."

The Coolcentric BDC has the following operational equipment:

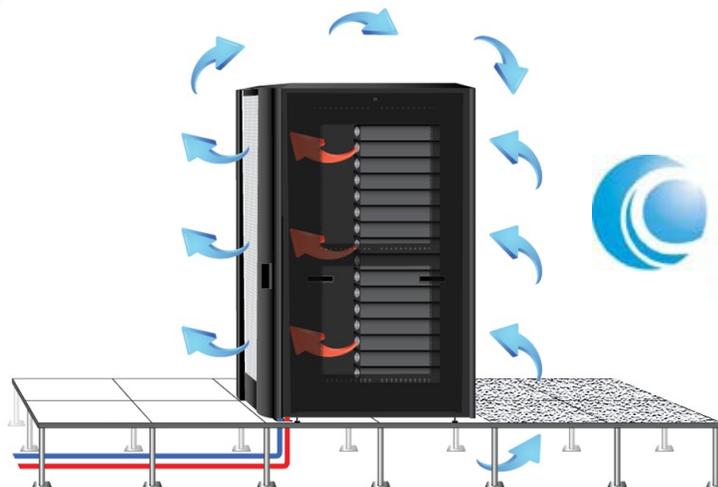
A bottom-fed Rear Door Heat Exchanger (RDHx) on a 23.6"/600mm wide rack and a top-fed RDHx mounted on a 30"/750mm wide rack

120kW floor-mount Coolant Distribution Unit (CDU) with glass panels for viewing of internal components

20kW rack-mount Coolant Distribution Unit (CDU)

Load banks to simulate a maximum IT load of 18kW for demonstration of cooling effectiveness and performance

12-inch raised floor with glass tiles to demonstrate chilled water piping and hose kit connection/routing between the bottom-fed RDHx and the floor-mount CDU



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