WAKEFIELDTHERMAL

VAPOR CHAMBERS

Design Guide 2026

REV1.0



Total Thermal Solution

WAKEFIELDTHERMAL.COM | 603.635.2800

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- VC-140-85-2.5
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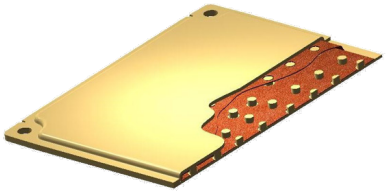
VAPOR CHAMBER INTRODUCTION



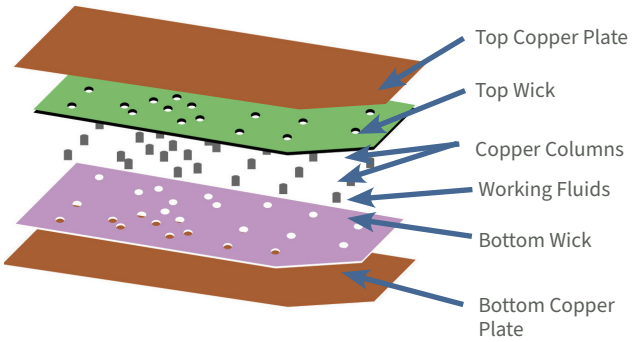
Vapor Chambers are used to transport heat to a large area from a small source or collection of small sources. Vapor chambers are a Fluid Phase Change device, like a heatpipe, that transfer heat quickly using evaporation and condensing within the chamber. Unlike a heatpipe which transports heat down the length, a vapor chamber transports the heat in a plane to achieve a larger area.

Vapor chambers, like heat pipes, do not actually dissipate heat to the environment, but serve to move heat efficiently within a thermal system. A vapor chamber is made from copper plates (top and bottom) with an internal wick structure that is sealed around the perimeter with a small amount of fluid inside. As heat is applied to the chamber, the fluid will boil and turn to a gas, which then travels to the colder section of the vapor chamber, where heat is dissipated through an external heat exchanger. The exchange of heat to the external heat exchanger allows the fluid to condense back to a liquid. It is the evaporating and condensing of the fluid that forms a pumping action to move the fluid (and thus the heat) from the area of the heat source to all other areas of the vapor chamber.

There are a few types of wick structure that can be used within the vapor chamber, but most commercial chambers are classified as mesh or powder. In both cases, the powder or mesh line the copper plate surfaces to allow fluid flow to/from all directions within the area of the vapor chamber. Often, when mesh is used as the wick structure, different sized meshes are used together to promote condensing or transport of liquid depending on the void size. Vapor Chambers are best used in horizontal orientations, but when used above 15° out of horizontal, the effects of gravity can impact the performance and should be considered.



During the manufacturing process copper columns are used throughout the vapor chamber to support the plates that act as the lids and contain the liquid and vapor. The copper wick is oriented within the chamber pressed against the copper plates. The plates are sealed around the perimeter via various methods. These methods ensure the adhesion of the columns and mesh to the copper plates and it designed to meet strength at operating conditions.



WHY USE VAPOR CHAMBERS?

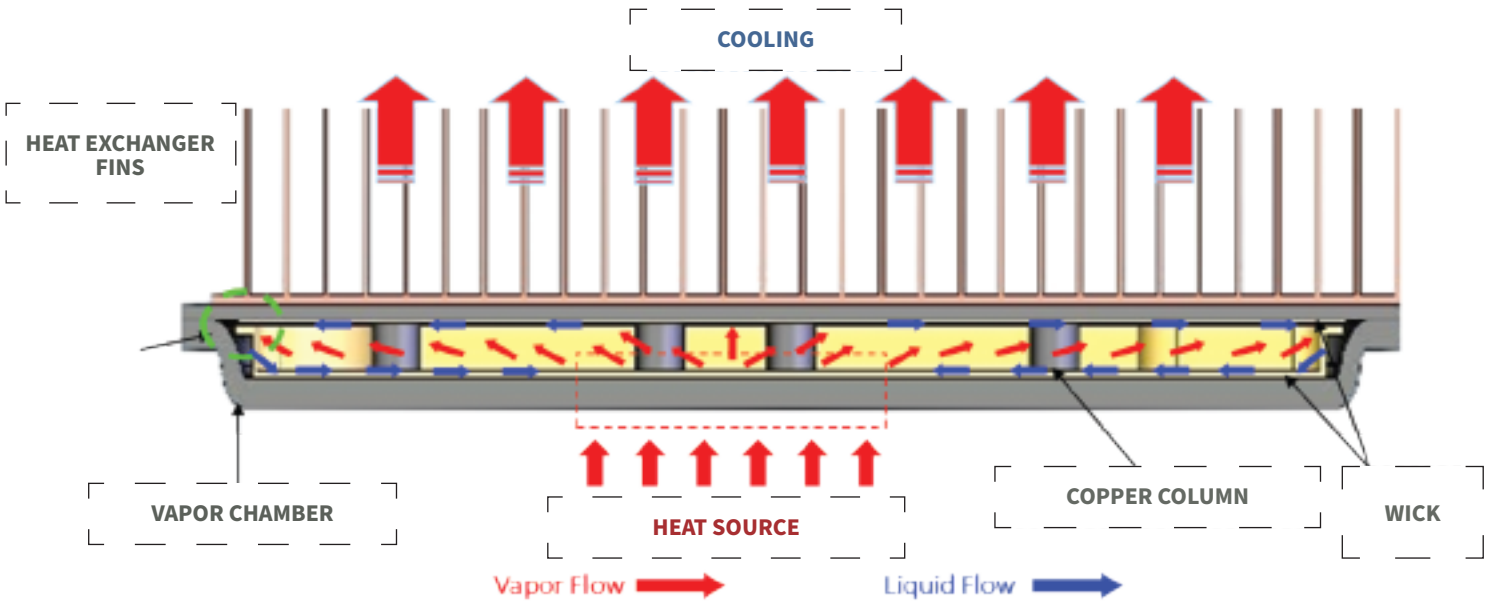
Vapor chambers have proven to be robust and reliable over many years in various types of applications. The next section will give more technical details on the performance of vapor chambers depending on thickness and area. Many thermal systems can benefit from the addition of a vapor chamber, especially when heat sources have high thermal dissipation in a small area. An example of these applications would be processors, graphics cards and other chip sets. Usually, these thermal systems will incorporate fan heatsink or liquid coldplates, but it can still be a battle to spread the heat into a large enough area to make these solutions efficient.

Vapor chambers are used in many harsh environments such as:

- Computers and Data Centers
- Telecommunications
- Aerospace
- Transportation

KEY FEATURES
• Material: Copper • Wick Structure: Copper Mesh/Powder • Light Weight • Versatile with high thermal performance

HOW VAPOR CHAMBERS OPERATE



VAPOR CHAMBER BASICS



When considering the use of a vapor chamber in your application, it is important to consider the orientation with respect to gravity and overall heat load for the thermal system. The transport of vapor within the vapor chamber is responsible for the thermal conduction from one area to the other. A thicker vapor chamber can trasnport more vapor, translating into a larger heat carrying capacity. Although vapor chambers can have complex shapes and mounting features, they are not typically bent and integration can be more direct with the heat source than with heat pipes.

VAPOR CHAMBER		HEAT PIPE
2-Phase heat transfer	Theory	2-Phase heat transfer
2-D heat distribution. Spreding heat by a single vapor chamber. Suitable for large heat flux and high power	Application	1-D distribution. Using one or more heat pipes to spread heat. Suitable for long distance between heat source and heat exchanger.
Complex shape in X and Y direction with pedestal	Shape	Round, flattened or bent in any direction
Mounted with through-holes in vapor chamber	Fixtures	Additional fixure plates needed to mount heat pipes.
Direct contact. Mounting pressure to 90PSI	Heat Source Contact	A base plate required to contact the heat source unless flattened/machined,
T=5mm > 400; T=3mm > 200W; T=1mm > 60W	Qmax	Ø5 > 20W; Ø6> 40W; Ø8 > 60W
Vapor chamber has larger tooling cost so high volume solution may need only 1 vapor chamber compared to many heat pipes and fixture/base plates.	Cost	Lower cost for a single heat pipe, but may also need tooling cost for bending/flattening.

In many applications, the decision to use a vapor chamber is frequently compared to a thermal solution using heat pipes. In both cases, 2-phase transport is used as vapor moves heat within the chamber or pipe and the liquid is condensed at the heat exchanger and transported back to the heat source. However, the main aspects of applications that differentiate vapor chambers from heat pipes are:

- **High power density:** when the heat source is small but heat generation is large, vapor chambers can more easily transport the heat to a larger area. A heat pipe solution would require multiple pipes, which may be difficult to integrate within the footprint of the heat source.
- **High power:** when the application must dissipate large wattage, a vapor chamber spreads the heat to a large area efficiently with similar temperatures of the chamber surface. This allows more efficient use of the final heat exchanger since hot spots are minimized. Heat pipes can also spread the heat, but unless many are ganged together, the hot spots may still persist.

VAPOR CHAMBERS
THERMAL CAPACITY

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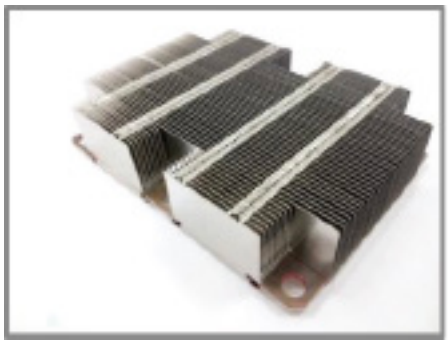
Much like heat pipes, the ultimate dimension in determining heat carrying capacity of a vapor chamber is the volume of the vapor space. This is determined by the thickness and area of the vapor chamber. For most applications, the thickness of the vapor chamber does not exceed 3mm, however pedestals and other surface features can be used to contact specific heat sources while leaving clearance for other board mounted objects. These pedestals can be extended 5mm from the vapor chamber lid plate. Mounting holes can also be integrated within the area of the vapor chamber for better integration with the heat source while locating the heat source at the center of the vapor chamber with good pressure application.

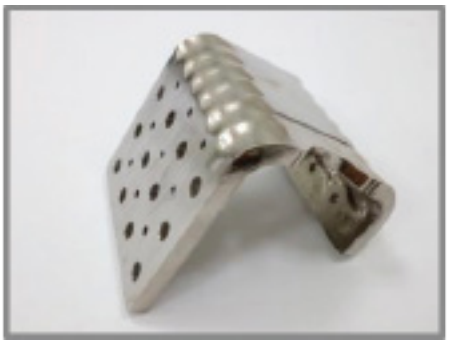
HEAT CARRYING CAPACITY (Q-MAX) BY VAPOR CHAMBER THICKNESS

	1.0mm	1.2mm	1.5mm	2.0mm	2.3mm	2.5mm	3.0mm	>3.0mm
45*45	10W	15W	20W	25W	60W	80W	100W	>100W
90*90	40W	50W	80W	100W	150W	180W	250W	>300W
120*120	40W	50W	80W	100W	160W	200W	275W	>300W
150*150			80W	100W	170W	220W	300W	>300W
200*200				100W	175W	225W	>300W	>300W
250*250					180W	240W	>300W	>300W
300*300								>300W

Note: Heat source = 30*30mm

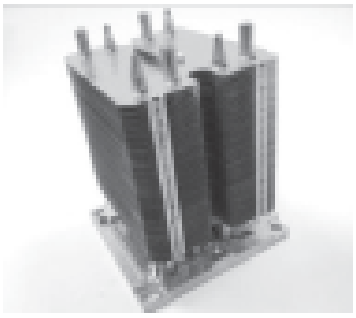
This table is for reference. Q-max is related to heat source power density and effectiveness of final heat exchanger.







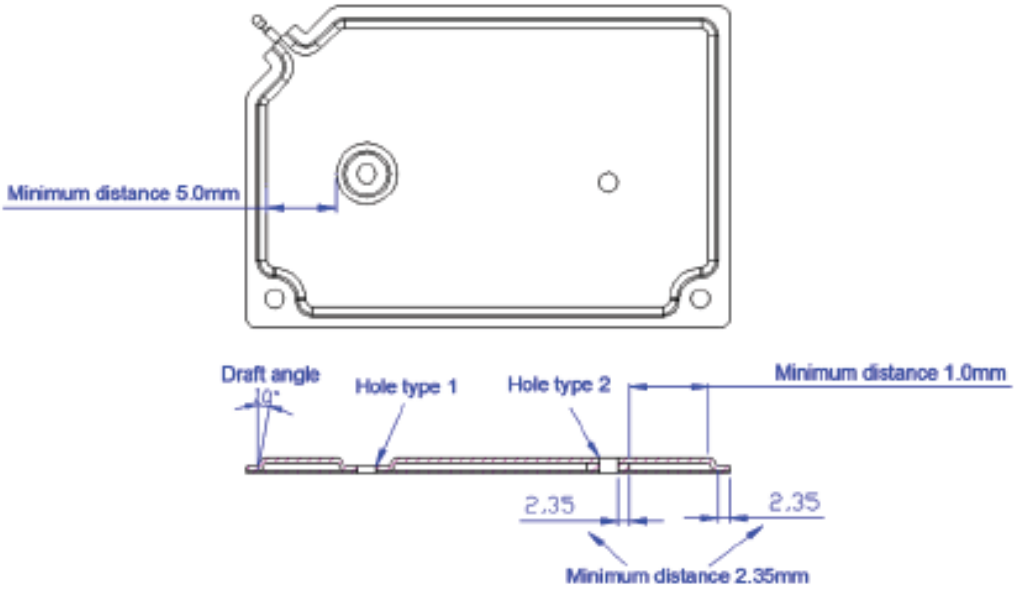
VAPOR CHAMBER ASSEMBLIES



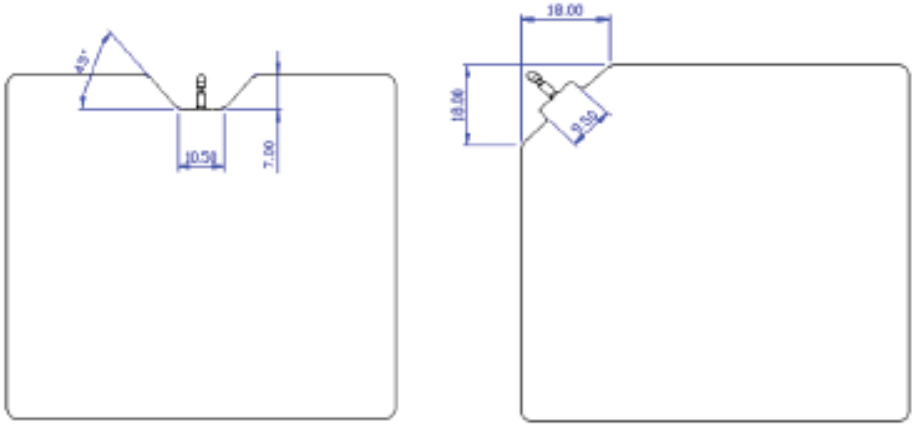
Interfacing vapor chambers with plates and heat exchangers is predominately about maximizing contact area. In most cases, the vapor chambers are soldered to heat exchanger fins for air cooled applications. The vapor chambers can also be soldered to liquid cold plates to take advantage of spreading the heat before final heat exchange with the liquid. In many cases, the vapor chambers are also integrated with heat pipes to take the heat that has spread in the plane of the vapor chamber and extend it in the vertical dimension to more efficiently interact with cooling fins. Integrating with the heat source is most commonly done with pressure, up to 90 psi, and the use of thermal grease or other interface material to maximize surface area contact to the source.







2 TYPES OF FILLING PORTS
(7MM MAXIMUM):

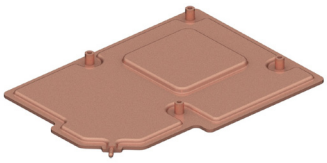


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STANDARD VAPOR CHAMBERS

Wakefield-Thermal offers individual vapor chambers through distribution. These most common offerings are a great option for testing, sampling, and validating your vapor chamber solution into eventual production. When building or testing your heat sink assembly please feel free to contact one of Wakefield-Thermal's authorized distributors to purchase. Always remember to contact us for free consultation on assembly design or parameter questions.

WKV Part #	Product Description	Thermal Resistance (°C/W)	Length (mm)	Width (mm)	Thickness (mm)	qMax (W)
VC-1131-8175-517	Standard Vapor Chamber 113.1mm x 81.75mm x 5.17mm	0.145	113.1	81.75	5.7	~200
VC-90-90-3	Standard Vapor Chamber 90mm x 90mm x 3.00mm	0.143	90	90	3	~150
VC-106-70-3	Standard Vapor Chamber 106mm x 70mm x 3mm	0.150	106	70	3	~150
VC-106-82-3	Standard Vapor Chamber 106mm x 82mm x 3mm	0.140	106	82	3	~150



PART NUMBER VC-1131-8175-517

Product Info Description

Dimension(mm): Length: 90mm / Width: 90mm / Thickness: 3mm
Operation Power: ~180W

Product Info Details

Thermal Resistance: 0.143 °C/W
Operation Temp: 40~130 °C
Primary Platform: Intel 2011 Square

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STANDARD VAPOR CHAMBERS



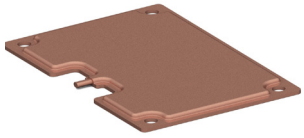
PART NUMBER VC-90-90-3

Product Info Description

Dimension(mm): Length: 90mm /
Width: 90mm / Thickness: 3mm
Operation Power: ~150W

Product Info Details

Thermal Resistance: 0.143 °C/W
Operation Temp: 40~140 °C
Primary Platform: Intel 2011 Square



PART NUMBER VC-106-70-3

Product Info Description

Dimension(mm): Length: 106mm /
Width: 70mm / Thickness: 3mm
Operation Power: ~150W

Product Info Details

Thermal Resistance: 0.150 °C/W
Operation Temp: 40~140 °C
Primary Platform: Intel 2011 Narrow



PART NUMBER VC-106-82-3

Product Info Description

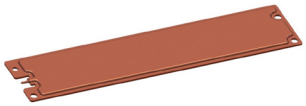
Dimension(mm): Length: 106mm /
Width: 82mm / Thickness: 3mm
Operation Power: ~150W

Product Info Details

Thermal Resistance: 0.140 °C/W
Operation Temp: 40~140 °C
Primary Platform: Intel 2011 Narrow

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STANDARD VAPOR CHAMBERS



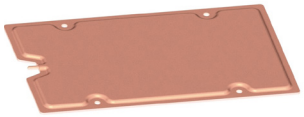
PART NUMBER VC-239-54-3

Product Info Description

Dimension(mm): Length: 239.1mm /
Width: 54.34mm / Thickness: 3.203mm
Operation Power: ~110W

Product Info Details

Thermal Resistance: 0.125 °C/W
Operation Temp: 40~130 °C
Primary Platform: VGA



PART NUMBER VC-140-85-2.5

Product Info Description

Dimension(mm): Length: 140mm /
Width: 85mm / Thickness: 2.5mm
Operation Power: ~260W

Product Info Details

Thermal Resistance: 0.05 °C/W
Operation Temp: 40~130 °C
Primary Platform: VGA



PART NUMBER VC-90-90-5.5

Product Info Description

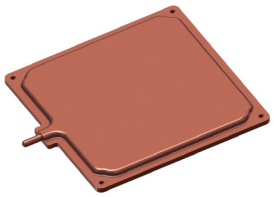
Dimension(mm): Length: 90mm /
Width: 90mm / Thickness: 5.5mm
Operation Power: ~200W

Product Info Details

Thermal Resistance: 0.074 °C/W
Operation Temp: 40~130 °C
Primary Platform: VGA

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STANDARD VAPOR CHAMBERS



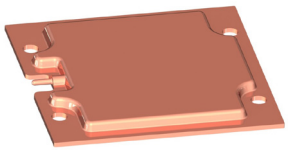
PART NUMBER VC-56-56-3

Product Info Description

Dimension(mm): Length: 56mm /
Width: 56mm / Thickness: 3.0mm
Operation Power: ~60W

Product Info Details

Thermal Resistance: 0.11 °C/W
Operation Temp: 40~130 °C
Primary Platform: VGA



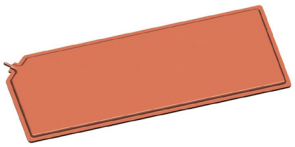
PART NUMBER VC-80-80-5

Product Info Description

Dimension(mm): Length: 80mm /
Width: 80mm / Thickness: 4.9mm
Operation Power: ~120W

Product Info Details

Thermal Resistance: 0.1037 °C/W
Operation Temp: 40~130 °C
Primary Platform: VGA



PART NUMBER VC-185-75-3

Product Info Description

Dimension(mm): Length: 185mm /
Width: 75mm / Thickness: 3.0mm
Operation Power: ~200W

Product Info Details

Thermal Resistance: 0.08 °C/W
Operation Temp: 40~130 °C
Primary Platform: VGA

NOTES

NOTES

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