

Welcome to the World of Aavid Heat Pipes

As a pioneer in heat pipe technology and their application, Aavid Thermalloy has developed a high quality manufacturing process to ensure long life and reliability in our heat pipes.

We've had over a decade of experience designing and fabricating heat pipes and heat pipe assemblies.

Heat Pipes are great thermal energy transporters that use an evaporator and condenser in place of a solid conductor. While they don't dissipate heat themselves, heat pipes quickly move heat from one area of the heat pipe to another area. The aerospace industry has been the proving ground of heat pipe reliability, and has been used for decades in harsh and demanding environments.

Applications

Heat pipes are great at moving or spreading heat, especially when embedded in a base plate. They can quickly move heat away from temperature sensitive devices to a place the heat can be dissipated. Heat pipes can also be used to increase fin efficiency by moving heat directly to the cooler top portion of fins. Many types of applications can benefit from heat pipes.

- » *Aerospace applications*
- » *Consumer Electronics (Desktops, notebooks)*
- » *Servers*
- » *Telecommunication*
- » *Motor Drives and Controllers*
- » *UPS*
- » *Transportation*

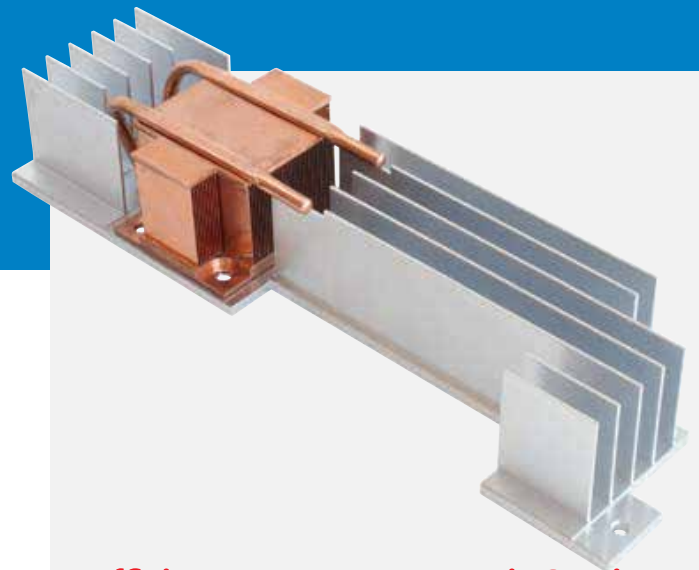
How do Heat Pipes Work?

A heat pipe is a closed evaporator-condenser system consisting of a sealed, hollow tube whose inside walls are lined with a capillary structure or wick.

Thermodynamic working fluid, with substantial vapor pressure at the desired operating temperature, saturates the pores of the wick in a state of equilibrium between liquid and vapor.

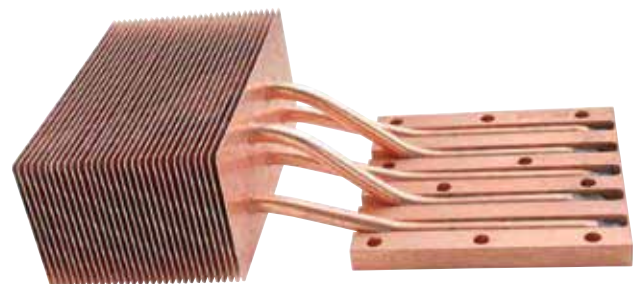
When heat is applied to the heat pipe, the liquid in the wick heats and evaporates. As the evaporating fluid fills the heat pipe hollow center, it diffuses throughout its length.

Condensation of the vapor occurs wherever the temperature is slightly below that of the evaporation area. As it condenses, the vapor gives up the heat it acquired during evaporation.



Efficient Heat Transport Air Cooling

- » *Improves conduction paths of heat away from devices*
- » *Extends thermal range of both natural and forced convection cooling*
- » *Aavid HiContact™ heat pipe embedding process improves thermal transfer*
- » *Reduces overall cost and weight without increasing the volume in a base plate*
- » *Best passive cooling system with no moving parts*
- » *Small diameter heat pipe assemblies provide greater thermal efficiency*
- » *Large diameter heat pipe assemblies transfer greater power loads*



This effective high thermal conductance helps maintain near constant temperatures along the entire length of the pipe.

Attaching a heat sink to a portion of the heat pipe makes condensation take place at this point of heat transfer and establishes a vapor flow pattern.

Capillary action within the wick returns the condensate to the

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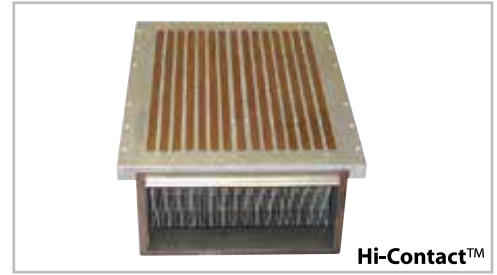
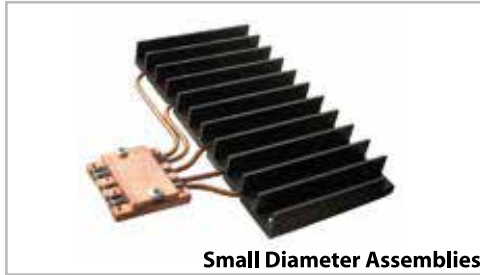
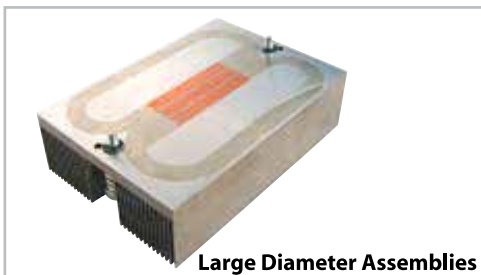
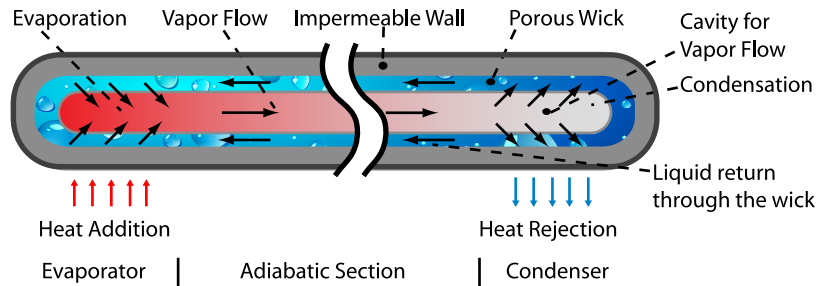
Heat Pipe Cycle

The internal liquid absorbs thermal energy conducted through the wall of the pipe and evaporates.

The pressure forces this vapor away from the heated portion of the heat pipe to the cooler region(s).

Thermal energy is absorbed by the cooler heat pipe region away from the heat source, where the vapor condenses back into liquid.

Capillary action from the wicking structure transports the liquid back to the area where evaporation occurs, starting the cycle again.



Heat Pipe Exploration and Discovery Kits

Aavid's Heat Pipe Exploration and Discovery Kits are designed for you to get your hands onto our heat pipes to get a feel for how they work, what they do, and try them in your own application. Assemble, bend, and rough together a prototype for your latest application then contact us for help with your design. We can fabricate prototypes with tighter bends in our quick turn shop or go to production in our worldwide manufacturing facilities.



Heat Pipe Exploration Kit - Part #: 056325

Kit Contents

Qty.	Item (mm)	Diameter (mm)
30	228.6 Heat Pipes	4, 6, 8
30	304.8 Heat Pipes	4, 6, 8
30	152.4 Heat Pipes	4, 6, 8
15	40 x 40 Evaporator Plates	4, 6, 8
15	40 x 40 Evaporator Caps	
15	40 x 150 Condenser Plates	4, 6, 8
15	40 x 150 Condenser Caps	
200	M3 Screws	
1oz.	Tube of Thermal Grease	

Heat Pipe Discovery Kit - Part #: 057455

Kit Contents

Qty.	Item (mm)	Diameter (mm)
10	228.6 Heat Pipes	4, 6
10	304.8 Heat Pipes	4, 6
10	152.4 Heat Pipes	4, 6
4	40 x 40 Evaporator Plates	4, 6
4	40 x 40 Evaporator Caps	
4	40 x 150 Condenser Plates	4, 6
4	40 x 150 Condenser Caps	
100	M3 Screws	
1 oz.	Tube of Thermal Grease	

Order Your Kits Online at www.aavid.com

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What can you do with your kit?

Pipe Selection - Diameter and Length

The vapor pressure differential between the condenser end and the evaporator end controls the rate at which the vapor travels from one end to the other. Diameter and length of the heat pipe also affect the speed at which the vapor moves and must be considered when designing with heat pipes. The larger the diameter, the more cross sectional area available to allow vapor to move from the evaporator to the condenser. This allows for greater power carrying capacity.

Conversely, length when in opposition to gravity has a negative effect on heat transport as the rate at which the working fluid returns from the condenser end to the evaporator end is controlled by the capillary limit of the wick which is an inverse function of the length of the pipe. Therefore, shorter heat pipes carry more power than longer pipes when used in application not assisted by gravity.

Aavid has included a selection of standard heat pipe diameters in a few lengths. The power carried by the heat pipe depends upon diameter and length of the heat pipe.

Expected Power Ranges

4mm: 5-15 W 6mm: 25-45 W 8mm: 35-60 W

Aavid can customize heat pipes into a variety of diameters, lengths, and internal structures to cover the whole range of heat pipe applications dissipating as low as a few watts and up into the kilowatt range.

We can design and fabricate the right heat pipe for your application. We've had plenty of experience optimizing each heat pipe in many different conditions.



Pipe Forming or Shaping

Heat pipes are easily bent or flattened to accommodate the needs of the heat sink design. Forming heat pipes may affect the power handling capability as the bends and flattening will cause a change in fluid movement inside the pipe. Therefore design rules that take into consideration heat pipe configurations and the effect on thermal performance ensure the desired performance.

Bending

Bending heat pipes by hand can be tricky since it's easy to collapse the pipe. The diameter is what will define the centerline bend radius. Soft tooling or generic pipe benders can tighten that radius.



By Hand:

4mm: 4 x dia. 6mm: 4 x dia. 8mm: 5 x dia.

Generic or Soft Tooling:

4mm: 3 x dia. 6mm: 3 x dia. 8mm: 4 x dia.



Pipe Flattening

More contact area your heat pipe has you're your device, the less distance and resistance heat needs to overcome to enter the heat pipe. Using simple tooling (like a smooth faced vice), it is possible to flatten heat pipes to lower the profile and increase contact area of the heat pipe surface

Before the flat surface bends inwards, you can generally get to a heat pipe thickness of:

4mm: 2.3mm 6mm: 3.0mm 8mm: 5.0mm

Need Tighter Bends or Flatter Pipes?

With our specialized tooling we can achieve centerline bend radius as tight as 1.5x the pipe diameter without collapsing the bend. We're experts in bending complex shapes with heat pipes to avoid any keep out zones or other hardware you may have in your system.

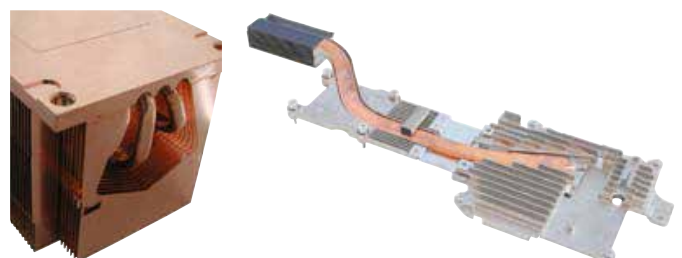
Aavid can flatten heat pipes for any low profile applications. Our technique prevents concave surfaces from forming to produce the optimal heat pipe surface for mounting your device.

For our standard sintered wick heat pipes, we can flatten heat pipes as thin as:

4mm: 2.0 mm 6mm: 2.0 mm 8mm: 2.5 mm

If you require even thinner heat pipe profiles, Aavid can meet your needs. We can fabricate Ultra Thin heat pipes with our specialized internal structure that will not sacrifice performance at low profiles.

4mm-8mm: <1mm



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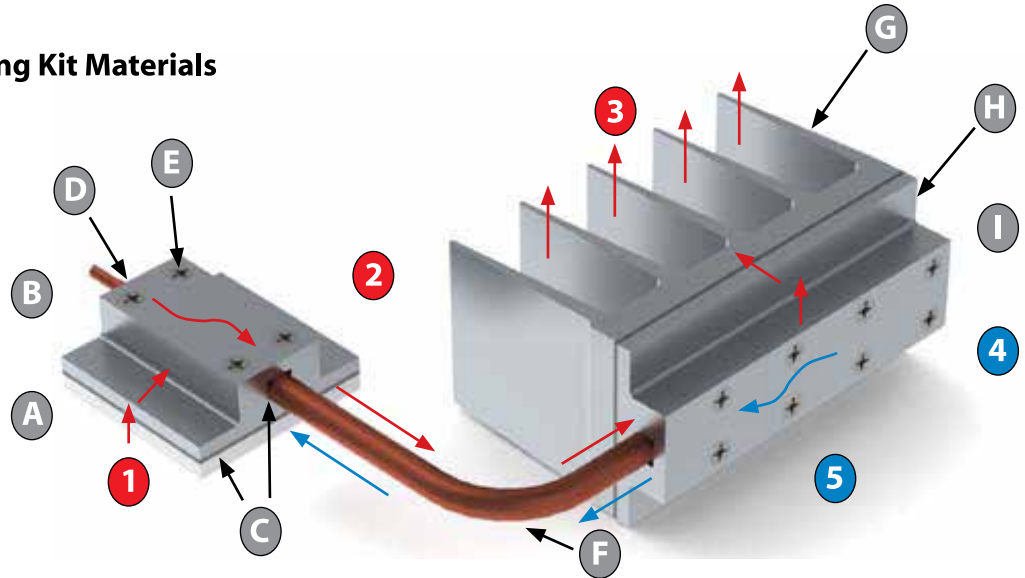
Heat Pipe Assemblies

The Heat Pipe Exploration Kit includes basic interfacing hardware between heat pipes, devices, and cooling solutions of your choosing. Each aluminum evaporator and condenser has a tight channel and matching screw on caps to clamp down onto these heat pipes and minimize thermal resistance from the gap between the pipe surface and channel groove. Matching the heat pipe diameter to the correct sized evaporator and condenser will provide the best thermal connection. Depending upon length, your interface resistance ((m2K)/W) between the heat pipe and the aluminum plates will be between: 4mm: 5-15 W, 6mm: 25-45 W, 8mm: 35-60 W.

Heat Pipe Assembly Example Using Kit Materials

- 1 Heat generated by the device will evaporate liquid in the section attached to it.
- 2 Vapor, driven by the internal pressure differential, will travel to the condenser end of the heat pipe.
- 3 Heat from the vapor will escape the system through the condenser plate and attached cooling means.
- 4 Vapor condenses back into liquid and seeps into the internal wicking structure of the heat pipe.
- 5 Liquid travels back to the evaporator end of the heat pipe by capillary action.

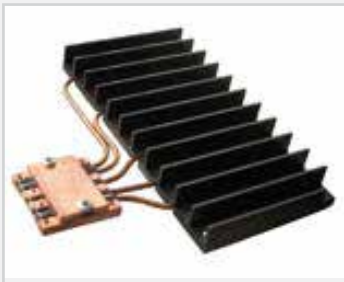
- A Attach an Evaporator Plate to collect thermal energy from your heat source.
- B Modify the Evaporator Plate to make mounting to your component easier.
- C Use Thermal Grease in between surfaces to improve heat transfer.



- D Apply thermal grease and insert heat pipe into Evaporator and Condenser Plate.
- E Screw on caps to plates to secure and apply light pressure to heat pipe to reduce thermal resistance from the thermal grease.
- F Bend the heat pipe to fit in tight spaces or avoid obstacles. Bends should be no tighter than a radius of 3x the heat pipe diameter to keep the pipe from collapsing or pinching.
- G Add a heat sink or attach to a cold wall to remove heat from the system.
- H Modify Condenser Plate to mount heat sinks or other cooling methods.
- I Cut Condenser Plate to length needed.

Aavid's Assembly Capabilities

Aavid's HiContact™ puts the heat pipe in direct contact with your device with geometry that tightly fits heat pipes within a plate. HiContact™ grooves have a much thinner interface layer that we fill with highly conductive thermal epoxy or solder. Depending on length, thermal interface resistance ((m2K)/W) using epoxy in a HiContact groove will be between: 4mm: 0.005-0.02, 6mm: 0.003-0.01, 8mm: 0.003-0.009.



For more design guidelines visit www.aavid.com