



HiK™ (HIGH THERMAL CONDUCTIVITY) PLATES

Overview

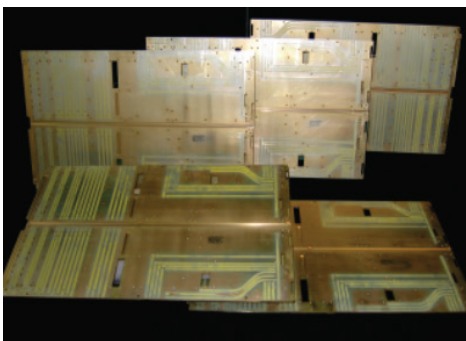
HiK™ plates are heat spreaders made by embedding heat pipes into a structural plate. Heat pipes, because of their two phase behavior, have effective thermal conductivities between 10,000 and 200,000 W/m-K depending on the heat pipe length. The installation of heat pipes into an aluminum plate increases the effective thermal conductivity from 600 W/m-K to 1200 W/m-K.

ACT's HiK™ Aluminum Plate Specifications:

Materials	Copper/Water Heat Pipes Aluminum Plates
Dimensions	Max: 60 cm x 60 cm
Thickness	1.8 to 6.0 mm
Heat Flux	Design Dependent
k Effective	600 to 1,200 W/m-K

The layout of the embedded heat pipes is designed based on the heat source profiles and locations.

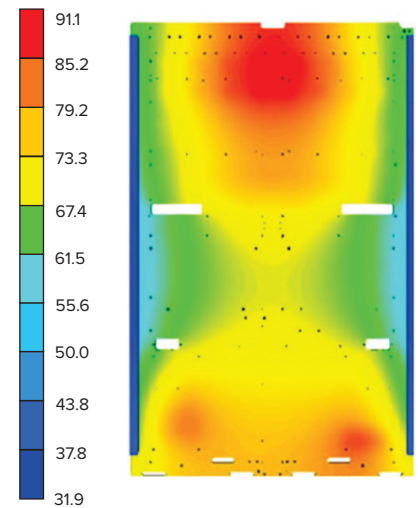
HiK™ Aluminum Plates for military cooling



QUICK FACTS

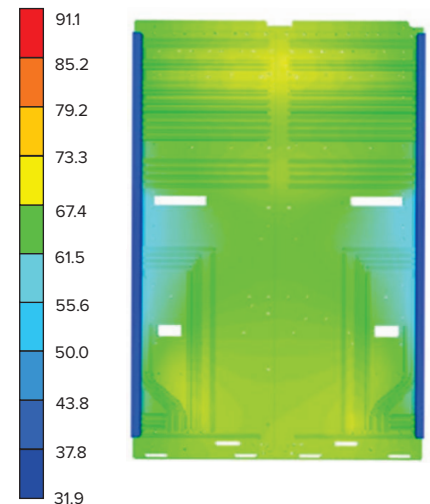
- Freeze-thaw tolerant 55°C to +85°C survival
- Shock & vibration ACT frequently delivers shock & vibration tolerant hardware
- Environmental considerations Corrosion resistant coatings

Temp (°C)



(a) Temperature Profile on an aluminum plate

Temp (°C)



(b) Temperature Profile on a HiK™ plate

The conventional aluminum plate's highest temperature was 90.3° C whereas the HiK™ aluminum plate is 69.1° C. This is a considerable performance improvement.

Case Study: HiK™ Plates to Improve SWAP

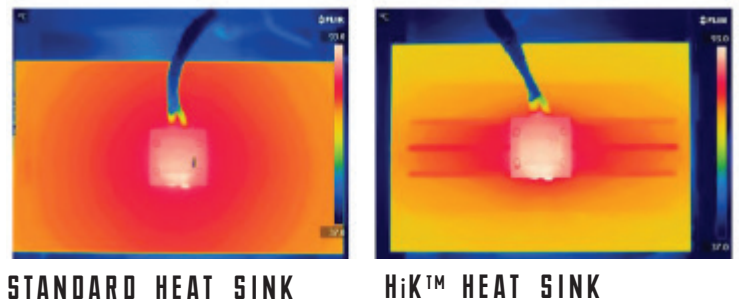
High Conductivity (HiK™) heat sinks can improve the Size, Weight, and Power (SWAP) compared to standard heat sinks. It is well known that placing a discreet heat source on a large metal heat sink will produce large thermal gradients as the heat slowly conducts through the aluminum to the fins. Embedding heat pipes in a HiK™ sink can increase the thermal conductivity from around 180 W/m K to 500-1,200 W/m K, providing an opportunity to reduce heat sink plate thickness and fin area. This approach can be implemented in a variety of LED applications including large arrays, outdoor lighting, and some downlighting applications.

Embedded heat pipes can improve the performance and reduce that mass of forced and natural convection heat sinks. ACT fabricated a HiK™ heat sink and an all-aluminum heat sink with the same performance; see Figure 1. The total heat dissipation is 150W in both cases. The conventional aluminum heat sink is 12 inches (30.5 cm) long, weighs 9.6 lbs. (4.4 kg) and has a base thickness of 0.6 inch (1.5 cm).

Introduction of 5 heat pipes, 3 in close proximity to the heat source and another two a little further out for improved spreading reduced the length to 10 inches (25.4 cm), reduced the thickness to 0.28 in (0.7 cm), and reduced the mass to 6.3 lbs. (2.9 kg) for an overall material reduction of over 34%.

	STANDARD HEAT SINK	HiK™ HEAT SINK
Materials	Aluminum	Aluminum & Heat Pipes
Extrusion Length	12 in (30.5 cm)	10 in (25.4 cm)
Fin Height	2.2 in (5.6 cm)	2.2 in (5.6 cm)
Base Thickness	0.6 in (1.5 cm)	0.28 in (0.7 cm)
Weight	9.6 lb (4.4 kg)	6.3 lb (2.9 kg)

Thermal images that demonstrate the improvement are shown in Figure 2. The Hi-K heat sink seen on the right maintains the same source temperature, even though the heat sink is shorter, lighter, and thinner. The improvement is directly attributable to the addition of heat pipes which can be seen as red lines in the picture on the right.



Thermal images of the two natural convection heat sinks show that the HiK™ Plate has similar performance to the standard heat sink, with a reduction in mass of over 34%.

ACT's Copper-Water Heat Pipes and HiK™ Plates Now Have Space Fight Heritage

ACT offers full system thermal solutions; spot cooling of electronic devices with our copper-water heat pipes, effective heat spreading of electronic boards and enclosures with our HiK™ Plates, and efficient heat transport outside the electronics control box to dissipate the heat with our CCHPs.