Design Case Study

Heat Pipes for Power Control

BOYD TRUSTED INNOVATION

The Design Challenge

A manufacturer of industrial appliances had a new power conditioning and control system with very limited heatsink space available. The new system had three high power IGBT's in close proximity with a small thermal window due to a 50°C max ambient temperature condition. To compound the complexity of the project, there was a transient condition to the system that would double the power for 1 minute every 10 minutes. Boyd, had assisted many other projects with similar form factors although not with this level of power. The cabinet that housed the heatsink had two fans for forced convection but the airflow was shared with another heatsink to cool an SCR.

Project Details

Customer: Confidential

Application: Power Control

Technology: Bonded Fin with Integrated Heat Pipes

Industry: Power

Location: Industrial Installations

Although the heatsinks were fully ducted to force all of the available air through them, the top of the system was obstructed by baffling the restricted 65% of the airflow. The new heatsink design would need to mind the difficult balance of airflow vs pressure drop through the entire cabinet.

The Boyd Solution

Similar applications in the past had been addressed by Boyd with extruded solutions but with this high power the fin density of an extrusion was not going to cut it. A bonded fin approach with higher fin density was adopted to increase the surface area for heat transfer. The next performance enhancement was to spread the power throughout as much of the base as possible to lower the temperature of the localized hot spots. Using multiple heat pipes under each IGBT, the effective footprint of each device was increased. This made it easier for heat to get into the fins that were not directly over the IGBT's.

The heat pipes embedded in the base helped to meet the thermal requirements for the 9 minute steady state but the performance was still lacking for the double power 1 minutes transient state. To give the heatsink a performance bump, heat pipes were run from the top of the base and then in through the middle of the fins. By transporting heat to the middle of the fins, the fin tips furthest from the base became more effective.

Following extensive thermal CFD design work, prototypes were built and tested with passing results. This design is now in successful mass production.

The end result was a very efficient heatsink that took up no more volume than a typical extruded or plain bonded fin heatsink.