



EPOXY BONDED-FIN HEAT SINKS OVERVIEW



Applications

- Thermoelectric Modules - TECs
- Un-interruptible Power Supplies - UPSs
- Variable Speed Motor Controls
- AC Welding Switches
- Power Rectification Equipment
- Laser Power Supplies
- Traction Control Motor Drives

Features and Benefits

- Dissipate more heat than conventional heat sinks with the same footprint
- Reduce heat sink and overall system volume
- Increase the aluminum extrusion cooling surface area by two to three times

Can bonded fin parts be black anodized?

No, it is not technically possible to Black Anodize bonded fin parts. Even if it were possible, the black finish would not contribute significantly to heat removal in Forced Convection but it would increase costs substantially. Economical gold chromate is available as a finish to help protect against corrosion.

Will the fins fall out?

Proper materials, surface preparation, strict process control, and exceptional quality standards ensure error-free products. Wakefield Solutions has refined the fin-to-base



attachment process to the point that failures do not occur. Thousands of defect-free parts per year attest to the success of this process.

Does the epoxy joint restrict the flow of heat into the fins?

The design of the joint and the conductivity of the epoxy combine to hold the overall temperature rise to an immeasurable level. (Average >1.0 °C rise at 25 watt heat per fin)

Why not dip-braze the assembly instead of using epoxy bond?

Cost — fixturing and processing a dip-brazed heat sink would add substantially to cost while adding very little to performance.

Do the tops of the long thin fins really increase the bonded fin heat sink's ability to remove heat?

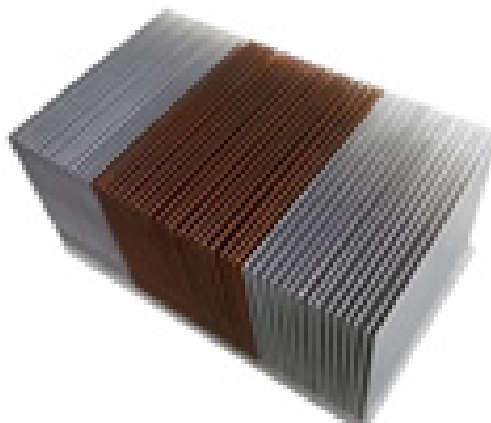
Yes, in many cases, the overall fin efficiency for Bonded-Fin heat sinks is between 60% and 75%. While fin efficiency of conventional extrusions may be high as 85%, bonded fin heat sink's 200% to 300% increase in surface area more than compensates for lower fin efficiency.

How closely can the fins be spaced?

This depends on the width of the base. Typically, on bases up to 8.0" wide, 0.032" thick fins can be spaced 0.125" on center. For bases between 8.0" and 16.0", 0.050" thick fins can be spaced 0.20" center to center. Base widths above 16.0" must be examined on an individual basis.

Can the part be made of copper for increased conductivity?

Yes, Wakefield Solutions has successfully Epoxy Bonded Copper Fins into Aluminum Bases – both Extruded and Machined. In some applications Copper Fins are assembled in combination with Aluminum Fins to save cost and increase thermal performance. For certain applications requiring very high thermal performance - both the Fins and Base must be made of Copper. For these applications, the part will be Brazed or Soldered, not Epoxy Bonded. The cost of a Copper part is typically three times that of the comparable part in Aluminum.





What materials are typically used?

At Wakefield Solutions – the Bonded-Fin heat sink base material is typically made from Extruded 6063-T5 Aluminum Alloy and the fins made of Roll Stock Aluminum Alloy 1100-H14. This Aluminum fin material is ~15% more conductive than the fin material of conventional Extruded Aluminum heat sinks, increasing the fin efficiency – off setting any minor conductivity loss from the epoxy joint – resulting in overall thermal performance of the Bonded-Fin heat sink being essentially equal to an Extruded heat sink of similar fin geometry.

The Bonded-Fin Advantage

Bonded-Fin heat sinks offer thermal design engineers many benefits over conventional extruded aluminum heat sinks. The increased fin count of bonded fin heat sinks is the result of a tightly controlled assembly technique, allowing fin manufacture as a process independent from base extrusion.

This Bonded-Fin process removes the conventional fin extrusion ratio limitation dictated by the strength of the steel in extrusion dies. Extrusion Ratios greater than 6:1 (fin height above the base as compared to the narrowest open space between fins) are common place, but ratios of 8:1 and 10:1 can only be done on a limited basis and have been found to be very application specific.

Bonded-Fin parts offer fin ratios as high as is practical. Increasing the number of fins increases the surface area exposed to cooling air, and greater exposed surface area means more heat transferred away from the electronics. In most typical air cooled applications - heat sinks are convection limited, and the overall thermal performance of an air cooled heat sink can often be improved significantly if more surface area can be exposed to the air stream. Wakefield Solution's high performance Bonded-Fin heat sinks utilize thermally conductive metal-filled epoxy to bond planar fins onto a grooved extrusion base plate. This process allows for a much greater fin height-to-gap aspect ratio of 20 to 40, greatly increasing the cooling capacity without increasing volume requirements.

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