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INNOVATIVE BONDING SOLUTIONS

APPLICATION NOTE

Using Epoxy in Bonded Fin Heat Sinks

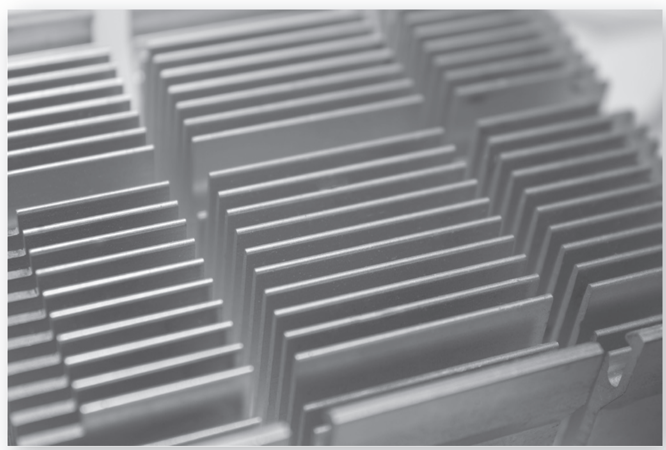
As modern power electronics devices continue to follow Moore's law, the density of transistors in an integrated circuit continues to increase, as does the amount of heat produced. Thus, thermal design engineers need to continue to improve their methods for dissipating heat. In this article we will highlight a popular thermal management application for an engineered epoxy material.

If you're involved in the manufacturing of equipment such as power supplies, rectifiers, and variable speed motor controls, you know they require considerable thought in the design process to ensure that the produced heat is carried away in the most efficient manner possible. As an engineer, you have a few options to consider. Transistor datasheets and experimentation allow you to find the amount of heat that needs to be dissipated. Then depending on the value, you could utilize natural convection heat sinks, forced convection heat sinks, or bonded fin heat sinks among others.

The most common heat sink is the die extruded variety. There are many manufacturers of die extruded heat sinks and they publish data sheets with thermal resistance values in order to facilitate calculations. When a manufacturer designs the heat sink geometry, the predominant factors are the fin area and spacing. However, extruded fin spacing is limited by the strength of the die material. The fin aspect ratio, or the fin height divided by spacing is limited to values around 5:1 to 10:1 depending on the die and the quantity of the production run. This means that for a given footprint, there is a maximum amount of heat that a die extruded heat sink can carry away. Thermal performance can be increased by forcing flow across the fins using a fan. The forced convection data is also published by heat sink manufacturers. But what happens when the amount of heat that needs to be dissipated is greater than can be carried away by using forced convection?

For high heat applications where the footprint needs to remain small, bonded fin heat sinks have become a popular choice. A bonded fin heat sink has separate fins that are attached to a base plate, thereby eliminating the restrictions of the extrusion method of manufacture. Fin aspect ratios are then only limited by practical considerations. The way the fins are fastened to the base plate can vary. Soldering and brazing are popular methods, though they can expose workers to extreme temperature risks. One simple and safe method for bonding the fins to the base is to use a high thermal transfer epoxy.

Since epoxy itself is not very conductive, high heat transfer epoxies are filled systems. An epoxy formulator has many choices in finding the appropriate filler for a specific application. Most bonded fin heat sinks are constructed of 6063-T5 and 1100-H14 aluminum and electrical conductivity is not an issue, so a great choice is to use an aluminum filled system.



In addition to choosing the filler, a high thermal transfer epoxy must have other properties optimized. Since heat will be flowing through the material, you must consider adhesion and hardness at elevated temperatures. Ease of assembly is also important, so uncured viscosity is another property that needs attention. A design engineer can work with an epoxy formulator to reduce the cycle time and be sure that they specify the best product for the application.

This is just one example of how an engineered epoxy can help solve problems in thermal management. The concept of the bonded fin frees the engineer to design the best performing heat sink possible. When assembled with high thermal transfer epoxy, the manufacture is greatly simplified.