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Thermovations™

Pelham, New Hampshire –Corporate Headquarters 603-635-2800

Technical Discussion …

What is a Heat Sink?

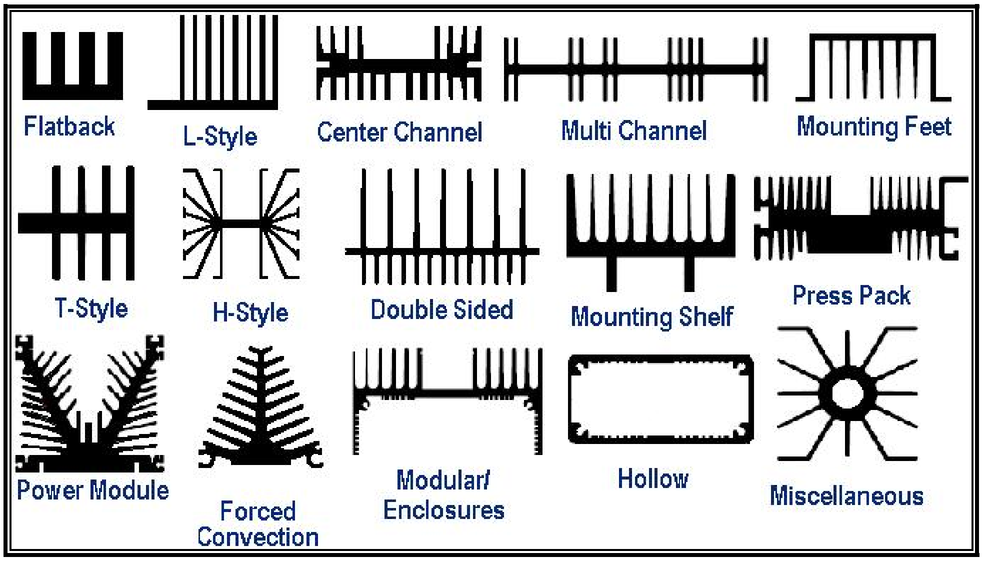
Background:

A heat sink (or heatsink) is an environment or object that absorbs and dissipates heat from another object using thermal contact (either direct or radiant). Heat sinks are used in a wide range of applications wherever efficient heat dissipation is required; major examples include refrigeration, heat engines, cooling electronic devices and lasers.

Principle:

Heat sinks function by efficiently transferring thermal energy ("heat") from an object at a relatively high temperature to a second object at a lower temperature with a much greater heat capacity. This rapid transfer of thermal energy quickly brings the first object into thermal equilibrium with the second, lowering the temperature of the first object, fulfilling the heat sink's role as a cooling device. Efficient function of a heat sink relies on rapid transfer of thermal energy from the first object to the heat sink, and the heat sink to the second object.

The most common design of a heat sink is a metal device with many fins. The high thermal conductivity of the metal combined with its large surface area due to the fins result in the rapid transfer of thermal energy to the surrounding, cooler, air. This cools the heat sink and whatever it is in direct thermal contact with. Use of fluids (for example coolants in refrigeration) and thermal interface material (in cooling electronic devices) ensures good transfer of thermal energy to the heat sink. Similarly a fan may improve the transfer of thermal energy from the heat sink to the air by moving cooler air between the fins.



Variety of Wakefield Extrusion Profiles used as Heat Sinks

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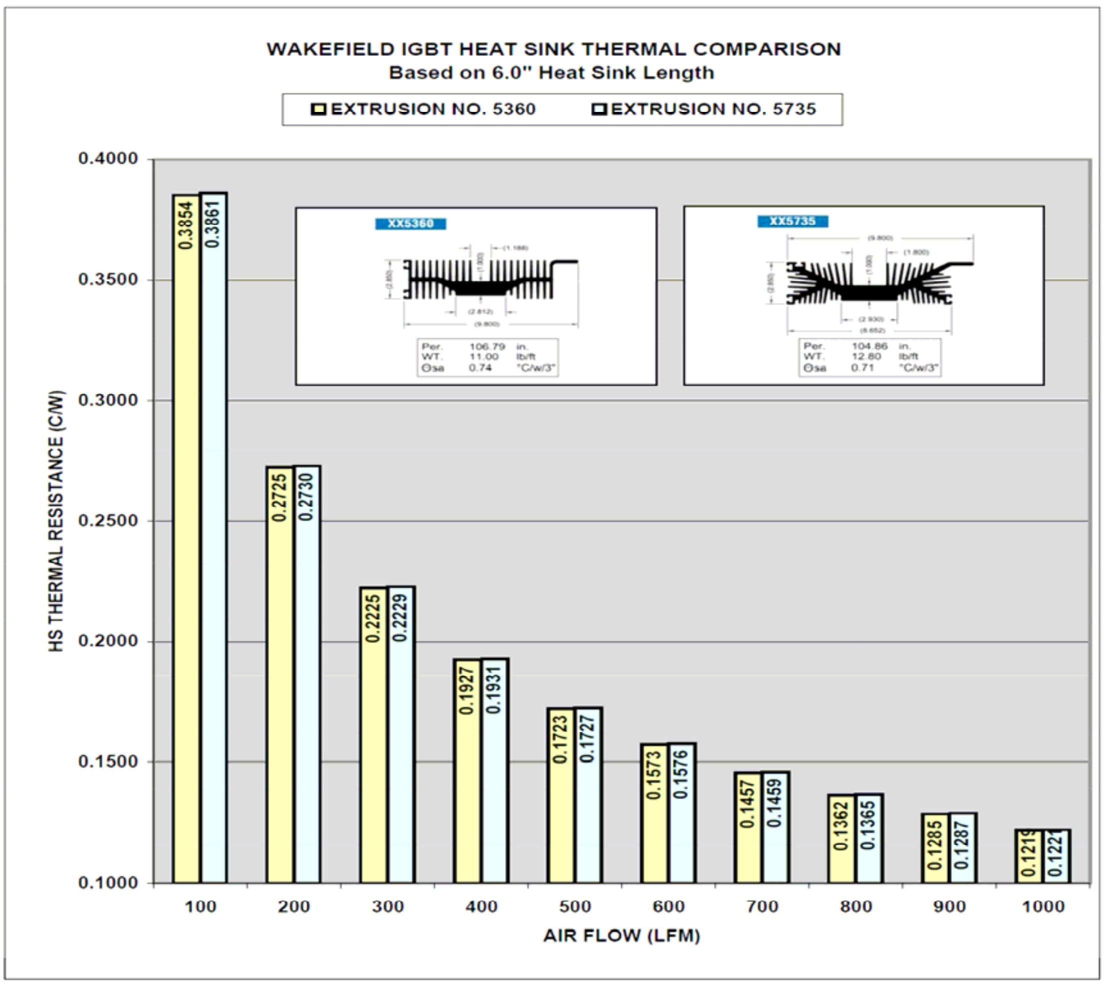
Performance:

Heat sink performance (including free convection, forced convection, liquid cooled, and any combination thereof) is a function of material, geometry, and overall surface heat transfer coefficient. Generally, forced convection heat sink thermal performance is improved by increasing the thermal conductivity of the heat sink materials, increasing the surface area (usually by adding extended surfaces, such as fins or foam metal) and by increasing the overall area heat transfer coefficient (usually by increase fluid velocity, such as adding fans, pumps, et cetera).



The Chart illustrates the Heat Sink Thermal Resistance Values, (C/W) for two different Wakefield IGBT Extrusion Profiles as a function of Air Flow, (Linear Feet per Minute – LFM).

Note: the essentially equal thermal performance of each profile as independent of the actual profile geometry – but, with essentially equal Profile Perimeters.

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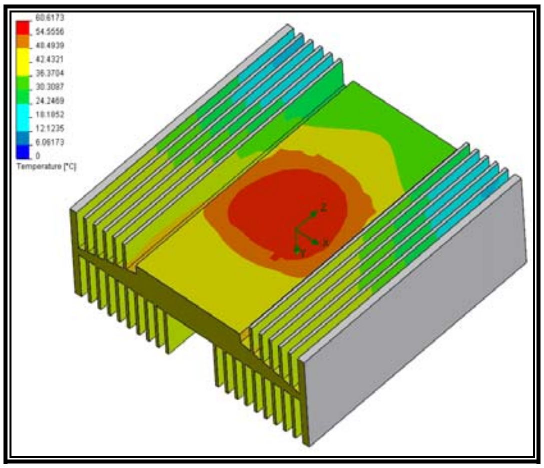
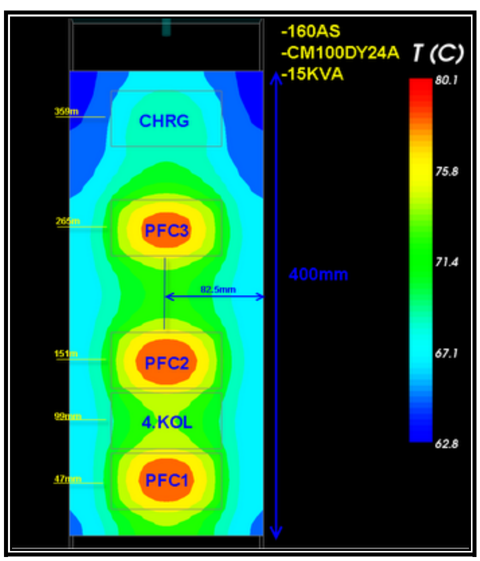
Explanation:

In common use, a heat sink is a metal object brought into contact with an electronic component's hot surface — though in most cases, a thin thermal interface material mediates between the two surfaces. Microprocessors and power handling semiconductors are examples of electronics that need a heat sink to reduce their temperature through increased thermal mass and heat dissipation (primarily by conduction and convection and to a lesser extent by radiation). Heat sinks are widely used in electronics, and have become almost essential to modern integrated circuits like microprocessors, DSPs, GPUs, IGBTs and more.



CFD Example of Thermal Heat Dissipation – IGBT Heat Sink



Example of Thermal Heat Dissipation – IGBT Heat Sink with Three Heat Sources – View is of the Heat Sink Base

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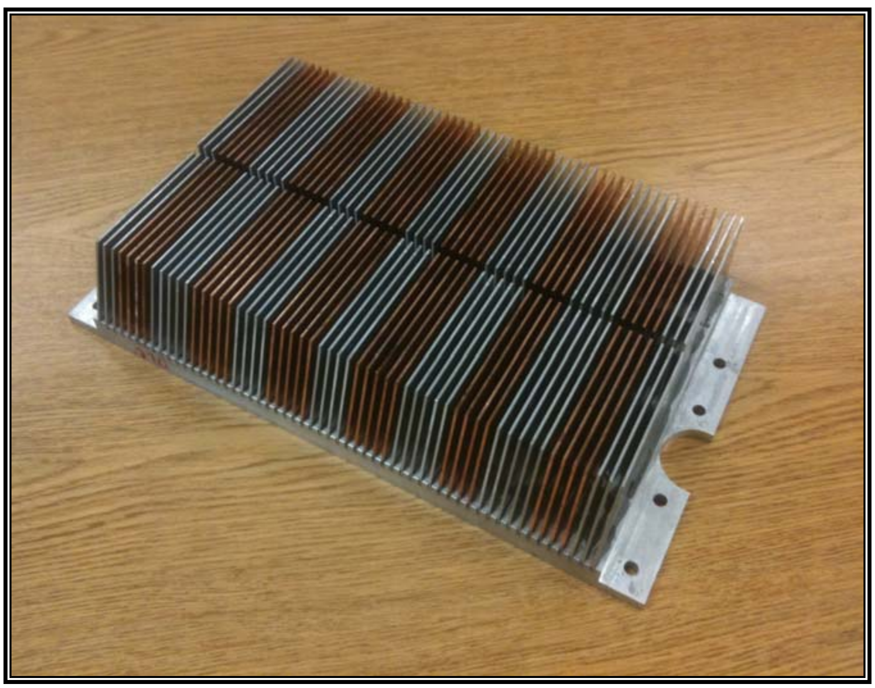
Construction and Materials:

A heat sink usually consists of a base with one or more flat surfaces and an array of comb or fin-like protrusions to increase the heat sink's surface area contacting the air, and thus increasing the heat dissipation rate. While a heat sink is a static object, a fan often aids a heat sink by providing increased airflow over the heat sink — thus maintaining a larger temperature gradient by replacing the warmed air more quickly than passive convection achieves alone — this is known as a forced air system.

Heat sinks are made from a good thermal conductor such as copper or aluminum alloy. Copper (401 W/(m·K) at 300 K) is significantly heavier and more expensive than aluminum (237 W/(m·K) at 300 K) but is also roughly twice as efficient as a thermal conductor. Aluminum has the significant advantage that it can be easily formed by extrusion, thus making complex cross-sections possible. The heat sink's contact surface (the base) must be flat and smooth to ensure the best thermal contact with the object needing cooling. Frequently, a thermally conductive grease is used to ensure optimal thermal contact; such grease usually contains ceramic materials such as beryllium oxide and aluminum nitride, but may alternatively contain finely divided metal particles, e.g. zinc oxide and colloidal silver. Further, a clamping mechanism, screws, or thermal adhesive hold the heat sink tightly onto the component to maximize thermal conductivity, but specifically without pressure that would crush the component.



**Custom Wakefield Epoxy Bonded Heat Sink –
Utilizing Copper Fins in combination with Aluminum Fins
to optimize the heat conduction and avoid costly Heat Pipes**

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Heat Sink optimization through design and use of material options has enabled Wakefield Solutions to provide customers with cost effective thermal/mechanical solutions to their most demanding applications.

WAKEFIELD THERMOVATIONS **can support customers during the any stage of new product development – using the combined knowledge of over 100 years of designing and manufacturing experience – our Thermal and Mechanical Engineers are most effective when they are engaged early in the development process.**

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