Heat Sink Quick Reference from EngineerDog.com

How are Heat sinks rated?:

- All heat sinks have a characteristic **Thermal Resistance in °C/Watt** . If a heat sink operates at 1.0°C/Watt, it will increase in temperature by 1°C per watt of heat dissipated. (Note: *Lower* °C/Watt *is better!*)

How big of a heat sink do I need?

- Room temperature is taken into account too: A heat sink with a thermal resistance of 40°C/W will limit a 1 Watt device to 40°C *above* room temperature (which is 20°C at NTP conditions). The max temperature would be: 'device + ambient' = 60°C.

Example: Find the proper heat sink size given the following:
*A device creates 60 W of heat, but cannot be allowed to reach 100 °C. Ambient Temp = 20°C.
Answer:

1. The device can only increase its temperature by: '100°C -20°C' = 80°C.
2. Calculate '80°C/60W' = 1.33°C/Watt, so we need a heatsink rated at or below 1.33°C/Watt.

How can I find the heat dissipation rating of a heat sink?

- The heat dissipation rate is provided on any store bought heat sink.
- You can make one cheaply from aluminum and estimate the heat dissipation rating.

$$\frac{50}{\sqrt{A}} = °\text{C/watt} \qquad A = \text{area (square CM)}$$

How can I optimize my heat sink design?

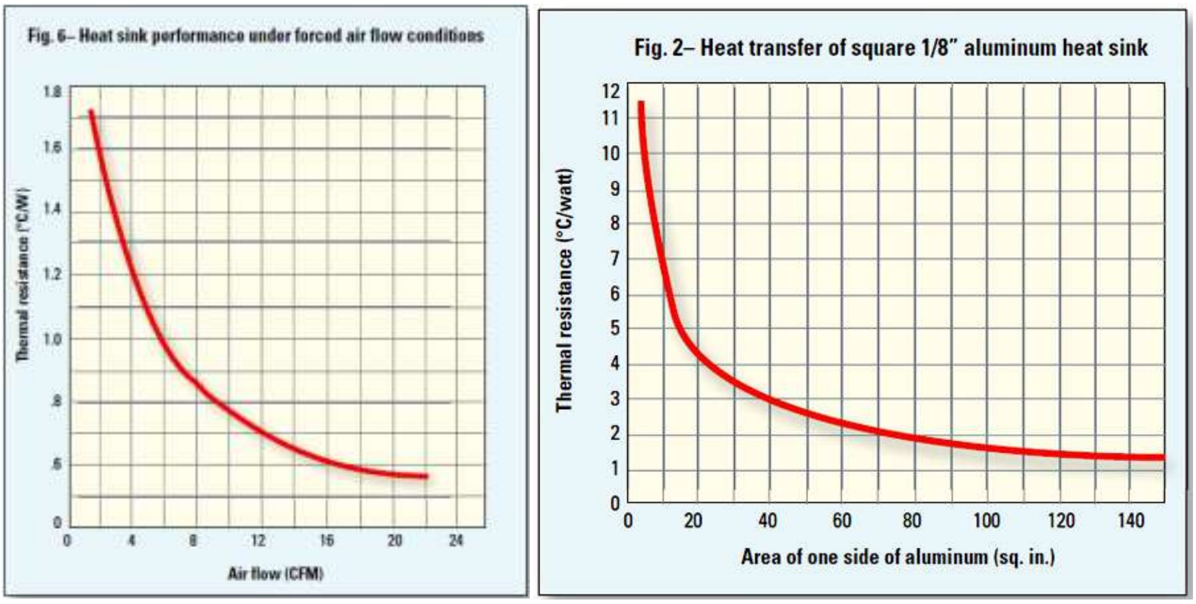
- The best possible heat sink would have infinite surface area, very little mass, and have a giant fan forcing some kind of fluid over it. (Note: Minimizing the mass of the heat sink reduces the time it takes for the heat sink to warm up relative to the device you are trying to cool. With the heat sink at higher temperatures relative to the ambient air, more heat is removed from the heat sink/device system.)
- The heat sink would be oriented to facilitate good air flow.
- The heat sink would be kept clean.
- It would maximize the surface area of contact with the device. (Note: the effectiveness of a heat sink is a logarithmic function of its surface area, so while more is better, the results diminish until eventually any additional surface area will have a negligible effect. Similarly, forced air has a large effect on heat transfer when comparing 'some' to 'none', but the difference between 'some' and 'a lot' is negligible.)

The above heat sink optimization techniques can be proven from the following set of boring equations and colourful graphs:

$q = k A \Delta T / L$ Conductive Heat Transfer from device to heat sink: Maximize surface area (A) between device and heat sink, also use conductive paste to increase thermal conductivity (k). Maintain a very thin paste layer thickness (L). Large differences in temperature (ΔT) between the heatsink and the device will transfer heat faster.

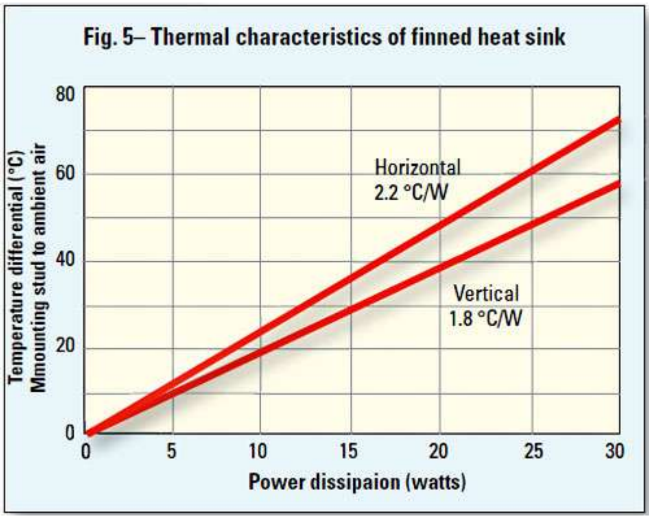
$Q = m C \Delta T$ Heat energy of the heatsink: Good heatsinks are made of materials with a large specific heat capacity (C). Furthermore, heatsinks with a smaller mass (m) will attain a high temperature rise (ΔT) with the same heat input (Q) as a large heatsink.

$q = h_c A \Delta T$ Convective heat transfer from heatsink to air: a greater surface area (A), temperature difference (ΔT), and convective heat transfer coefficient (h) results in greater heat transfer (q).



Diminishing effects of more airflow and more surface area

Image Source: http://www.designworldonline.com/how-to-select-a-suitable-heat-sink/#



Just changing the orientation can affect performance.

Image Source: http://www.designworldonline.com/how-to-select-a-suitable-heat-sink/#

How do I get my hands on a heat sink?

You can buy pre-made heat sinks, but they can be surprisingly expensive. I would recommend checking your local computer store or getting one here: www.heatsinkusa.com

Alternatively, you might be able to make your own by copying one of the easy to build designs below.

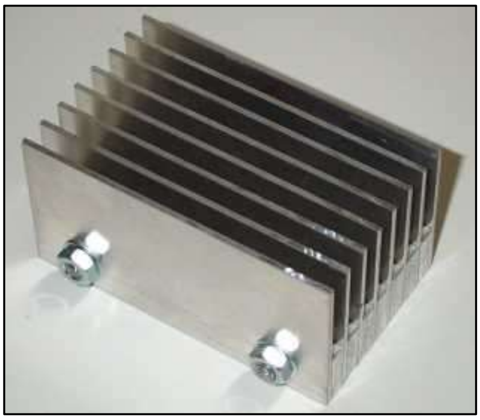


Image 1 Source: http://sound.westhost.com/articles/diy-heatsink.htm

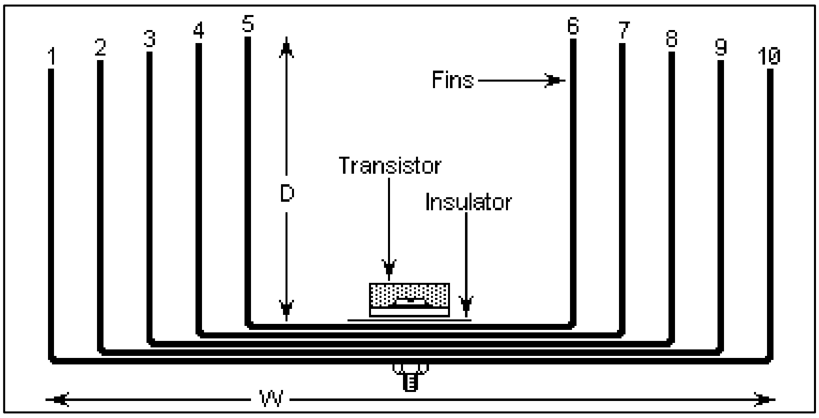


Image 2 Source: http://www.sm0vpo.com/begin/heat-0.htm

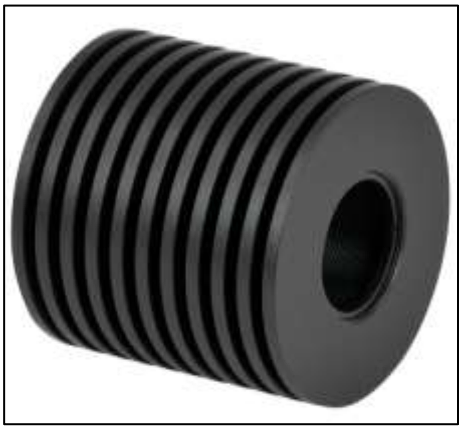


Image 3 Source: http://www.thorlabs.com/