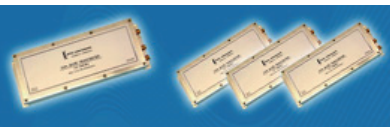

How to dimension a heat sink

July 2009

Many questions are: “How big does a heat sink have to be?”

Unfortunately this question couldn’t be answered in one sentence. However, the proverb “A lot helps a lot” is surely appropriate in this case. Amplifiers built up of semiconductors always works best at moderate ambient temperature due to the physical properties of the transistors.
Exceeding the max. working temperature given by the manufacturer will cause the termination of the transistor. Furthermore the lifetime of semiconductors will detach enormously at high working temperature.

Here are some hints to mind helping you dimensioning and working with heat sinks:

1.) What is the max. air temperature for a heat sink to work well? For example, in southern Spain the ambient temperature is much higher as in Norway.

2.) Is the device continuously active or just for a short time? At short times of activity a smaller heat sink can be used as the device cools down during the off-time.

3.) When using heat sinks with a profile and without additional cooling of a fan, it’s very important to assemble it vertically because the air must go unhindered through the cooling ribs.

4.) Black anodized heat sinks will cause a better cooling effect as bright surfaces.

5.) When using heat sinks out of doors, direct solar radiation should be avoided. This can lead to an exceedance of the max. working temperature of the amplifier even when it’s not operating.

6.) RF power amplifiers usually will be supplied in aluminium or copper cases with a flat floor space. The mounting area of the heat sink should also be flat to enable best heat transfer.

7.) The use of thermal paste improves the thermal resistance between the amplifier and the heat sink. Silver-bearing pastes like ARCTIC SILVER 5 have a better heat conductance value as common products.

Here is an example for dimensioning a heat sink:

Max. air temperature: Tair = 25°C
Power loss of the amplifier: TV = 60W
(Power consumption of the amplifier minus output power)
Max. case temperature of the amplifier: Tcase = 50°C

Max. thermal resistance (Rth) of the heat sink is the difference between air temp. and the case temp. divided by the power loss of the amplifier.

$$\Delta T = T_{case} - T_{air} = 50°C - 25°C = 25°C$$

$$R_{th} = \frac{\Delta T}{P_V} = \frac{25°C}{60W} = 0.41\frac{°C}{W}$$

In common the thermal resistance of a heat sink is determined by the manufacturer.
In comparison to the computed value of Rth, principally a heat sink with a smaller value should be used to avoid overheating.
Please check the case temperature of the amplifier after mounting the heat sink and the first start-up to exclude errors. A thermal switch on the heat sink which interrupts the operating voltage and therefore protects the amplifier when a cooler is defect or other troubles to the cooling occur could be very useful.

We think the hints in this description will help you dimensioning a heat sink for your purposes. As shown the size of a heat sink depends on different factors and has to be adapted to the individual conditions.

Your Kuhne Electronic Team