Different thermal resistances of heatsink-mounted resistors within real applications

Important in the applications of heatsink-mounted power resistors is the question of ‘what exact power dissipation can be reached’ for ‘real’ applications. Also, what is the maximum temperature of the resistance element when appearing under a defined stress. If we know these two data points, it is possible to determine the change of the resistance through stress, the long-term stability, and the failure rate for a given product.

An important factor for the answer of the above question is: ‘what is the thermal resistance of the element against the heatsink?’ If we know this answer, then it is possible to calculate the inherent temperature of the resistance element under stress with the following equation:

$$T_{resistor} = P * R_{thR} + T_{heatsink}$$

Our data sheets state the thermal resistance for all our heatsink-mounted resistors in K/W . These data should only be used for reference. The specifications are for a pressurized assembly and use of a recommended heat conduction paste. Also the mentioned nominal power dissipation is related to such applications where the heatsink-temperature is 25°C or 40°C.

With this data to hand, it is necessary to pay attention to the real heatsink-temperature. This is reliant on the thermal resistance of the heatsink, the total power balance (sum of all power dissipations from the parts assembled to the heatsink), and the ambient temperature.

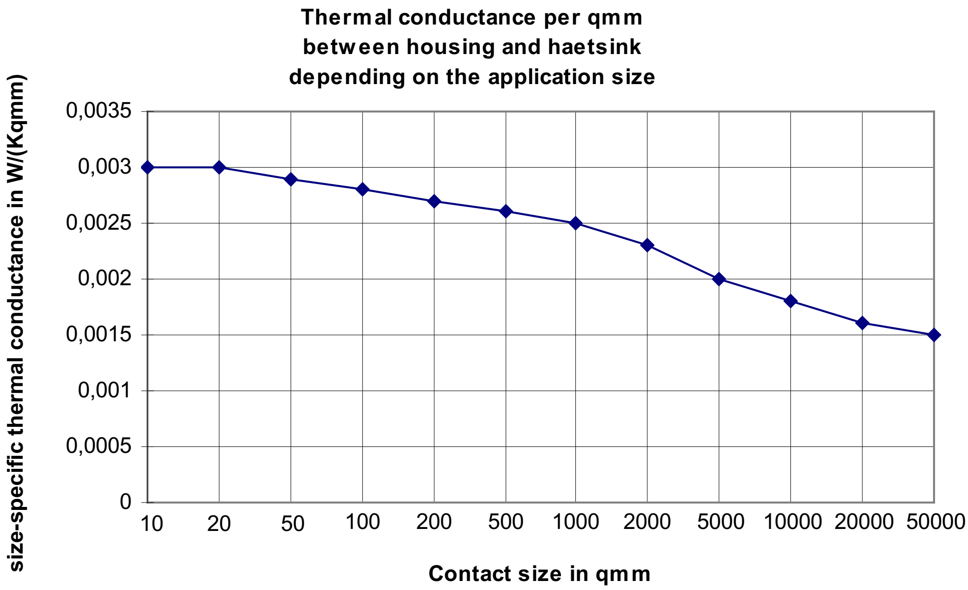
The thermal resistance R_{thR} is the result of the thermal resistance between the resistance element and the mounting plate (R_{thj-c}), inherent in design, and the thermal resistance between the mounting plate and the heatsink ($R_{thRAppl}$), depending on the application. The R_{thj-c} is fixed from the manufacturer of the resistor. The RthRAppl depends from the mounting possibilities, the size of the mounting plate, type of the fixing (i.e. number of the location holes or fixing strap), the force the resistor is assembled to the heatsink and the specialized experience of the customer for the application.

The following diagrams (picture 1 and picture 2) show the reachable average thermal conductance (optimal application) and the absolute thermal resistance ($R_{thRAppl}$) dependency from the mounting point (with normal heat conduction paste).

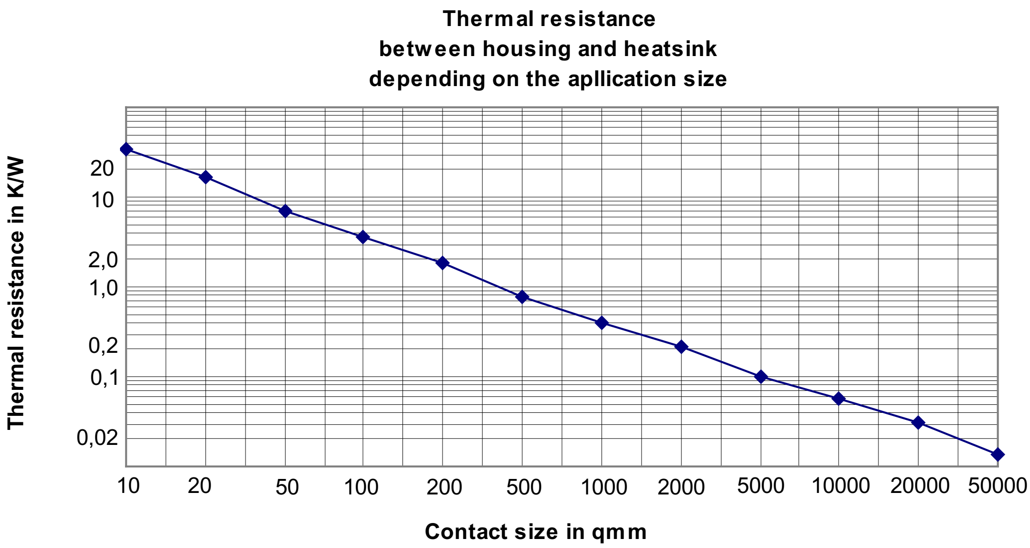
The decrease of the heat conductivity (depending on the surface) within big mounting areas, results in the problem that it is virtually impossible to reach an optimal constant pressure to fix the elements on the heatsink.

Approximated guide values for thermal paste with 1W/mK

Picture 1:



Picture 2:



The results of these calculations are the thermal resistances between the mounting-plate and the surface of the heatsink ($R_{thRAppl}$) for the most important heatsink-mountable resistors within our product portfolio. The specific inherent thermal resistance of each resistor (resistance element / mounting-plate) R_{thj-c} is also mentioned:

type/size	$R_{thRAppl}$ (guide value)	R_{thj-c}
USR T220	2.2 K/W	10.8 K/W
UNR T220	2.2 K/W	6.8 K/W
USR 3425	0.5 K/W	3.5 K/W
UNR 3425	0.5 K/W	2.1 K/W
USR 4020	0.5 K/W	3.6 K/W
UNR 4020	0.5 K/W	2.2 K/W
FPR T220	1.8 K/W	4.8 K/W
FPR T218	1.0 K/W	2.5 K/W
FHR 3025	0.52 K/W	2.0 K/W
FHR 3825	0.46 K/W	1.6 K/W
FHR T238	0.42 K/W	1.3 K/W
FNR T238	0.42 K/W	1.0 K/W
FPR T227	0.2 K/W	1.3 K/W
FNR T227	0.2 K/W	1.0 K/W
FHR 8065	0.096 K/W	0.16 K/W
FHR 80110	0.060 K/W	0.09 K/W
FHR 80216	0.036 K/W	0.04 K/W
FHR 80320	0.025 K/W	0.026 K/W
FHR 80370	0.02 K/W	0.022 K/W
NPR T220 / T221	0.6 K/W	3.5 K/W
KPR T218	0.3 K/W	2.1 K/W
NHR T220 / T221	0.6 K/W	2.1 K/W
KHR T218	0.3 K/W	0.8 K/W
KPR T227	0.2 K/W	0.7 K/W
KHR T227	0.2 K/W	0.35 K/W

With these specifications it is possible to calculate the maximal allowed power dissipation. It is only necessary to define the temperature of the housing (i.e. 85°C at the mounting-plate). This temperature must be secured by the application.

$$P_{max} = (T_{limit} - T_{housing}) / R_{thj-c}$$

An additional increase of the heat dissipation can be reached with the use of a heat adhesive agent. The disadvantage is that it is difficult to remove at a later time fixed resistor.