Different Thermal Resistances of Heatsink-Mounted Resistors Within Real Applications

An important factor in applications for heatsink-mounted power resistors is the exact power dissipation that can be reached for “real” applications. Also important is the maximum temperature of the resistance element when 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.

To determine the values above, we need to know the thermal resistance of the element against the heatsink. If we know this, 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. However, these data should only be used for reference. The specifications are for a pressurized assembly and the use of a recommended heat conduction paste. The nominal power dissipation is also important in applications where the heatsink temperature is +25°C or +40°C.

With this data in 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.

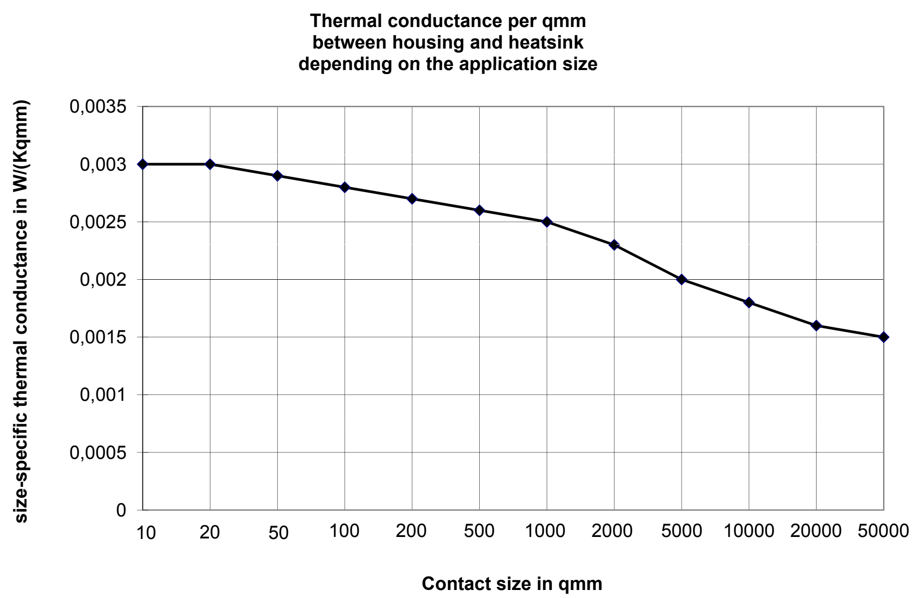
The thermal resistance RthR is the result of the thermal resistance between the resistance element and the mounting plate (Rthj-c), which is inherent in the design, and the thermal resistance between the mounting plate and the heatsink (RthRAppl), which depends on the application. The Rthj-c is fixed by the manufacturer of the resistor. The RthRAppl depends on the mounting method, the size of the mounting plate, the type of the fixing (i.e. the number of location holes or fixing strap), the force with which 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 dependency of the reachable average thermal conductance (optimal application) and the absolute thermal resistance (RthRAppl) on the mounting point (with normal heat conduction paste).

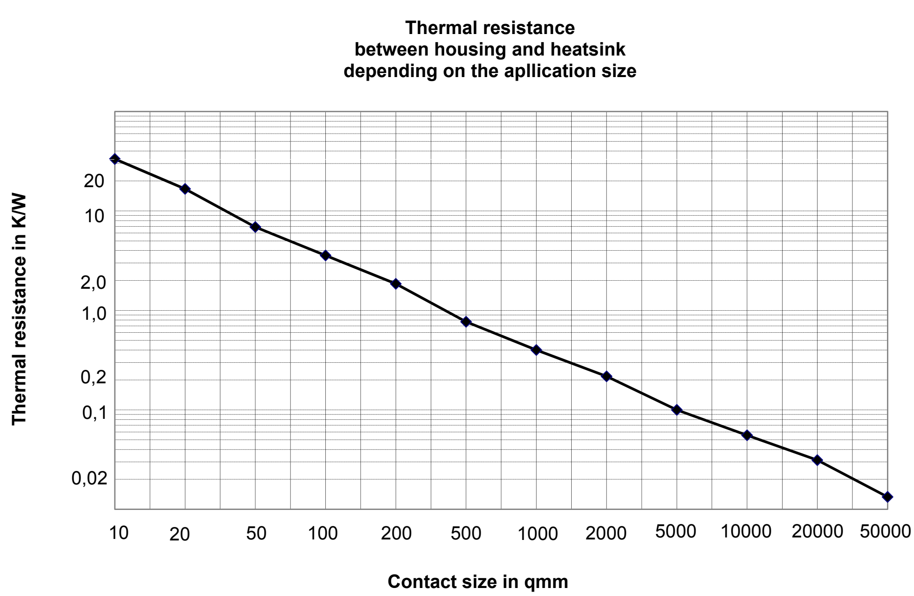
The decrease in the heat conductivity (depending on the surface) within big mounting areas makes it virtually impossible to reach an optimal constant pressure to fix the elements on the heatsink.

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 with a fixed resistor.