IXAN0034

Recommendations for Using NTC Temperature Sensors Integrated into IXYS Power Semiconductor Modules

New generations of power semiconductor modules incorporate more and more additional functions. For example, integrated temperature sensors allow easy thermal measurements without additional assembly effort. However, to guarantee safe operation of the equipment, some basic rules need to be followed.

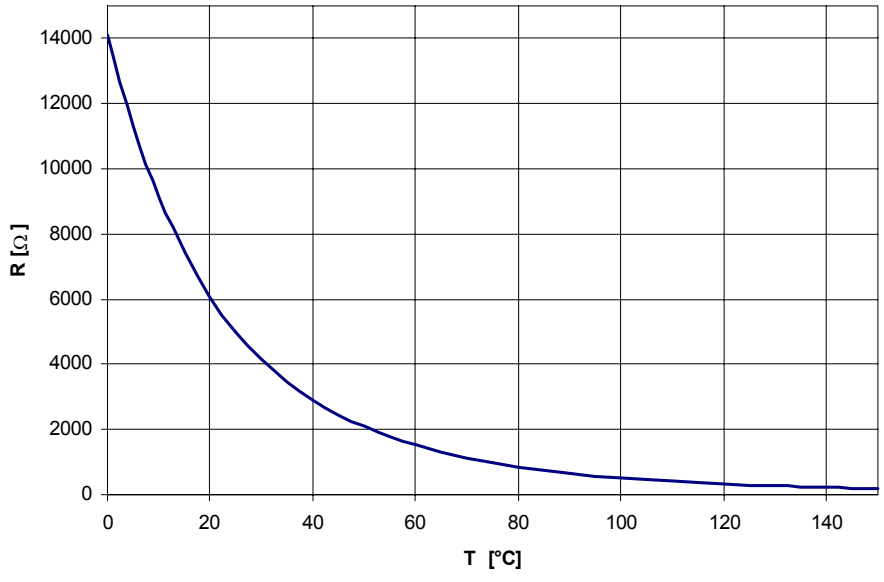
1. Temperature Measurement

The temperature at the NTC corresponds approximately to the temperature of the heat sink below the module. The NTC can be used to monitor ambient and cooling conditions. Relatively slow temperature changes, as for example a blocked fan or loss of water cooling, can be detected in time to take remedial action before the power semiconductor module fails. The arrangement of the NTC in the module and the slow temperature response doesn't allow a direct assessment of the short-term temperature conditions at the power semiconductors. Therefore the NTC is not suitable for the dynamic temperature monitoring of the power semiconductors due to excessive current flow or short-circuit conditions.

Using the data of the NTC from the module datasheet and the following formula, temperature versus NTC resistance can be plotted. From this graph or from a corresponding table of data, the temperature for a certain resistance can be easily ascertained. The following example shows the calculation and values for the NTC used in our E2-pack and E3-pack module series.

datasheet values: R25 = 5000 Ω +/- 5%, B25/50 = 3375K, T25 = 298K;
Rx is the resistance of the NTC at the temperature Tx,
Tx is the actual temperature in Kelvin

$$R_X = R_{25} * \exp\left[B_{25/50} * \left(\frac{1}{T_X} - \frac{1}{T_{25}}\right)\right]$$



T [°C]	R [Ohm]
0	14106
5	11293
10	9113
15	7409
20	6066
25	5000
30	4148
35	3462
40	2906
45	2453
50	2081
55	1775
60	1520
65	1309
70	1131
75	982
80	856
85	749
90	658
95	580
100	513
105	455
110	405
115	362
120	324
125	291
130	262
135	236
140	214
145	194
150	176

2. Safety Issues

These power semiconductor modules are UL recognized. This recognition applies to the voltage isolation of the semiconductors to the heatsink. The temperature sensor itself doesn't have a separate UL recognition. In the module, the power semiconductor dice and the NTC as well as the corresponding copper traces on the DCB are located relatively close together. Potting the modules with a silicone gel ensures the isolation of the components for normal operation.

During final testing, the temperature sensor is tested for its electrical parameters. To check the isolation capability of the module, a high voltage test between all components including the NTC and the baseplate is conducted. In addition, a high voltage test between the NTC and all other components is conducted. This ensures the isolation capability for normal operation.

Any malfunction, for example a short circuit, may lead to a destruction of the power semiconductors and a mechanical destruction of the module by melting of wire bonds or arcing resulting in a high energy plasma. This may create an electrical connection from the power circuitry to the copper traces or the terminals of the NTC that could result in high voltage potential appearing at the NTC terminals.

The European Norm EN 50178 regulates the safety requirements for parts of equipment that can be touched by a person. This applies also in case of a failure as described above. The modules do not fulfill the requirements of the EN 50178 as far as doubled or reinforced isolation is concerned.

Therefore the user of the integrated temperature sensor is requested to apply appropriate safety measures to ensure that persons, other living beings or things can't be endangered and that no dangerous voltages are applied to parts that can be touched.

An appropriate isolation according to the EN 50178 can be achieved using different measures. For example suitable optocoupler or signal transformer can be used for galvanic isolation. Isolating all conductive parts of the equipment could be another method.