



Possible errors

Possible errors during the use of thermocouples in temperature measurement

Below you will find a summary of possible causes of error that might occur during temperature measurement with thermocouples. Please note that this listing is not exhaustive.

1. Error due to deviations (permitted by the standard) of the real thermocouple against the reference line (ideal thermocouple)

International and national standards indicate the permissible deviations of a thermocouple against the corresponding reference line. The type K serves as an example according to IEC 60584. A type K element may have a deviation of ± 2.5 K or ± 0.75 % of the hot junction temperature according to IEC 60584-2 in class 2. Thus, a measuring error of up to ± 2.5 K in the temperature range from -40 °C to 333.3 °C might occur. In the temperature range of 333.3 °C to 1200 °C, an error of the hot junction temperature of up to ± 0.75 % might occur (e. g. ± 3.75 K at 500 °C or ± 7.5 K at $1,000$ °C). However, the actual error can be considerably smaller. It is stated in the inspection certificates which are enclosed in our deliveries.

2. Error due to the use of extension or compensating leads

2.1 Exceeding or falling short of permissible temperature ranges for extension or compensating leads

Extension or compensating leads can be used in a temperature range from 0 °C to $+200$ °C, depending on the type. High deviations of the delivered EMF signal against reference line may appear above this temperature. These errors might even reach the two-digit values in degrees Kelvin very quickly. Thus, it has to be ensured that the temperature of the junction point thermocouple/extension or compensating lead does not exceed the maximum permissible temperature of the extension or compensating lead.

2.2 Error due to deviations (permitted by the standard) of the extension lead or compensating lead against the reference line

The IEC 60584-3 states the permissible deviations for this as well. The deviations, stated in μ V, result from the Seebeck coefficient at a temperature of the hot junction, which is stated in the standard, multiplied with the permitted deviation in K. In order to define the total error in the measuring chain of thermocouple and extension lead, please refer to the Law of Linear Superposition: it says that the total electromotive force (EMF) of a measuring chain equals the sum of the single thermoelectric voltages through the respective temperature arguments. This error has to be calculated with the following equation:

σ_{Total} = total error in K / in degrees C/F
 E = EMF in mV
 S = Seebeck coefficient in mV/K
 MST = hot junction temperature in degrees C/F
 VBT = cold junction temperature in degrees C/F
 EI = thermocouple
 TA = extension/compensating lead
 dev. = real deviation of the couple

$$\sigma_{Total} = \frac{E_{sollMST} - [(E_{EnominalMST} + E_{devEMST}) - (E_{EnominalEIVBT} + E_{devEIVBT}) + (E_{EnominalTAVBT} + E_{devTAVBT})]}{S_{MST}}$$