TECH NOTE :: Which strain gauge resistance is the right one for my measurement application?

The influence of the foil strain gauge resistance on self-heating of the measuring point

Version: 2019-05-29
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Status: public

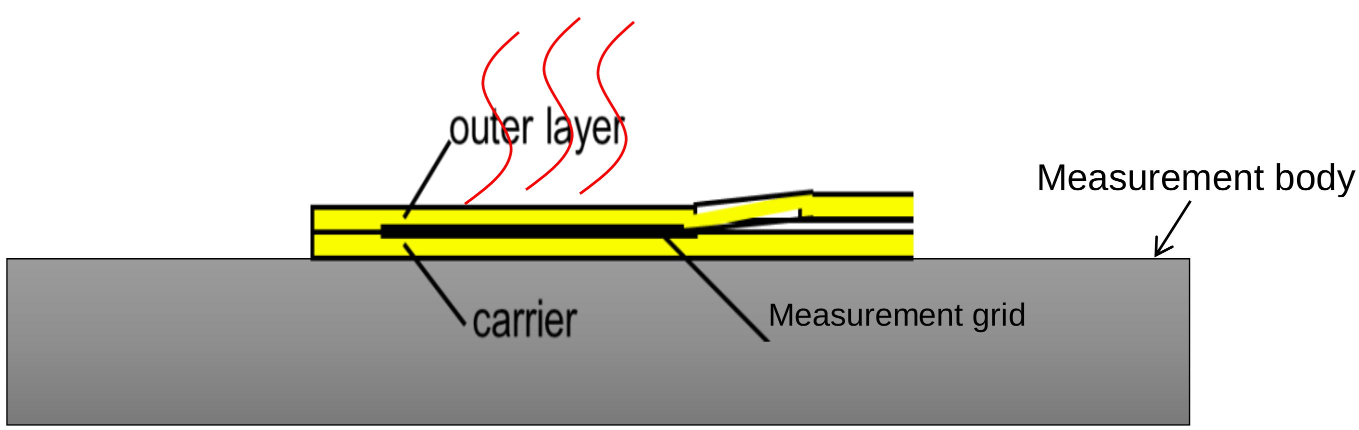
Intro

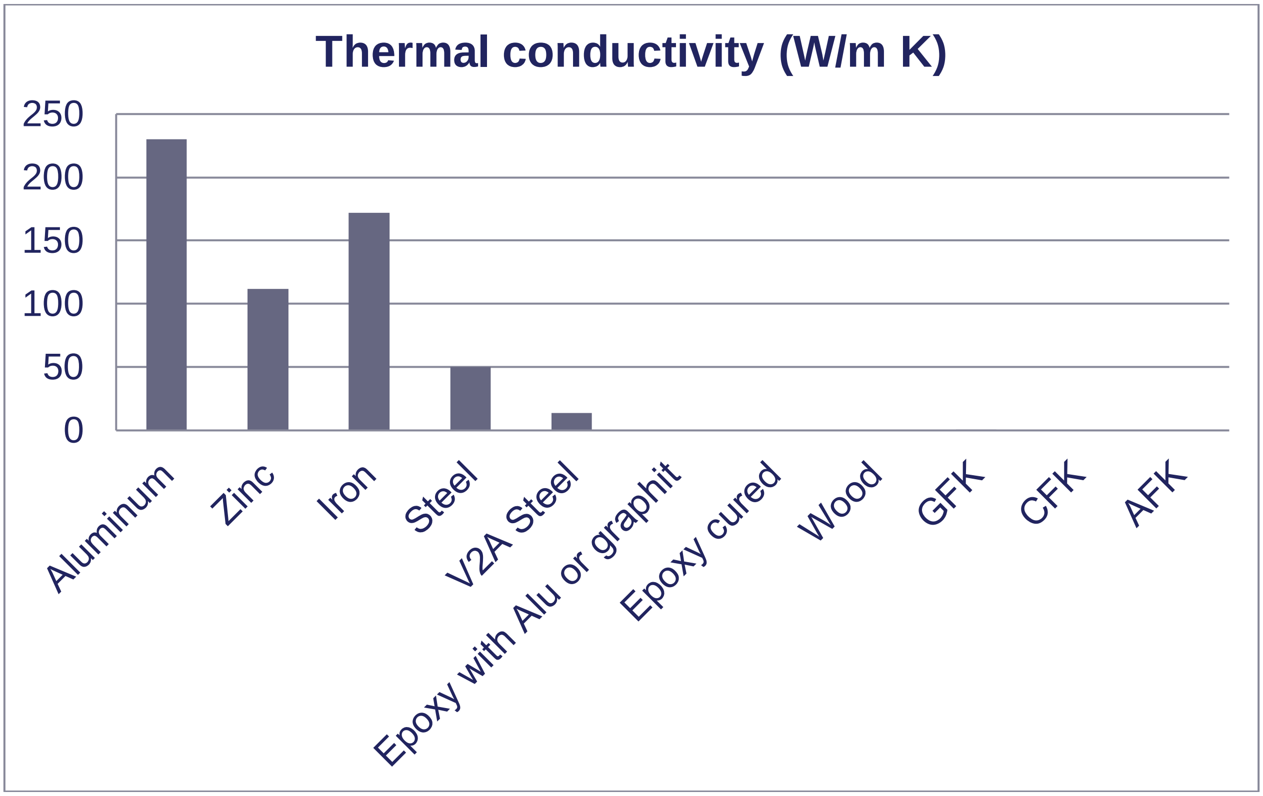
HBM strain gauges are available with different resistances such as the mostly used values of 120, 350, 700, and 1,000 ohms.

The choice of resistance depends on the boundary conditions of the measuring task.

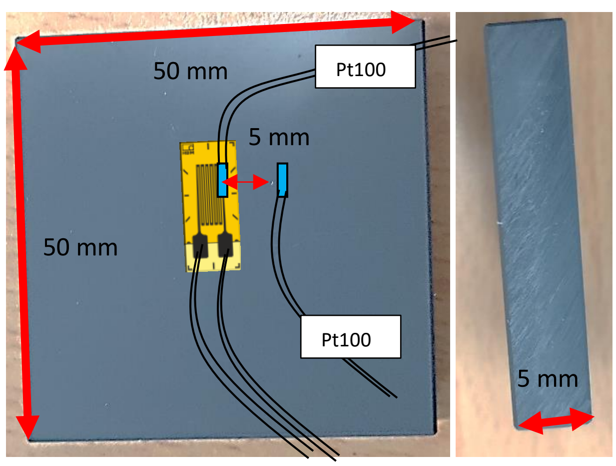
Low-resistance strain gauges (120 and 350 ohms)	**High-resistance strain gauges (700 and 1,000 ohms)**
+ Weaker influence of electromagnetic fields + Weaker influence of changes in insulation resistance - Higher power requirement - Stronger self-heating due to higher current flow compared to higher-impedance strain gauges	+ Weaker influence of the electrical resistance on the connection path (slip rings, cables, etc.) + Better signal-to-noise ratio due to higher possible supply voltages (less self-heating of the strain gauge) - Greater influence of changes in insulation resistance - Antennas in case of EMI/RMI interference

Today, an increasing number of polymers and composites are tested, which are bad heat conductors. In this context, it is essential to choose a matching strain gauge with the right resistance value.





In this article, the temperature effect of strain gauges on the direct environment is shown and recommendations are given which resistor is the right one for your application. To achieve this we compare the measurement results of an experiment which was performed on a PVC plate. Different strain gauges were bonded to a poorly heatconducting PVC plate and the temperature was measured directly on the measurement grid and 5 mm next to the gauge. All strain gauges were connected with a 4-wire cable to a QuantumX MX1615B and an MX1616B (for 1000-ohm resistors).



Test object:

PVC plate (heat transfer coefficient: 17 W/(mK))

Dimensions: 50 mm x 50 mm x 5 mm

Strain gauges used

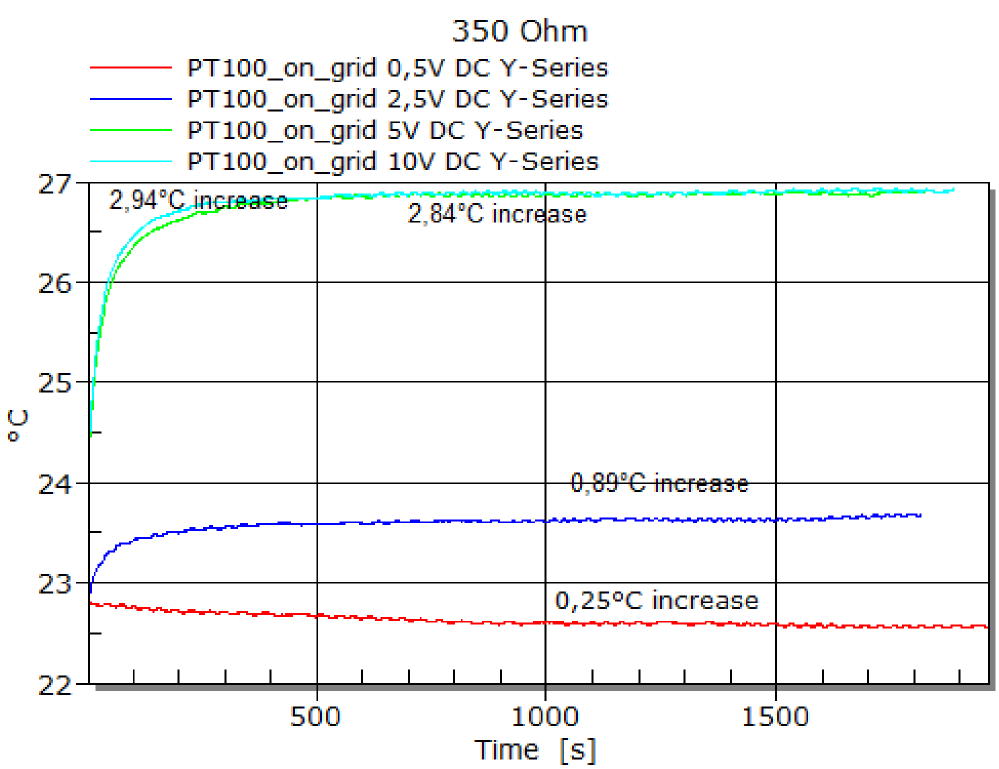
1-LY41-3/350
1-LY41-3/1000
1-LM11-3/350
1-LM11-3/1000
Pt100 accuracy class: A

Results:

- The **excitation voltage** has a high influence on the heat-up process of a strain gauge and the base material. For 0.5 V and 2.5 V, there are only heat increases of approximately 0.1-0.3 °C on the measurement grid. For higher excitation voltages, a heat-up phase with a temperature increase of 1 °C up to 3.77 °C was measured. The heat-up time can take approximately 8-10 minutes for high excitation voltages from 5-10 V. All excitation voltages show a saturation behavior regarding the temperature increase.

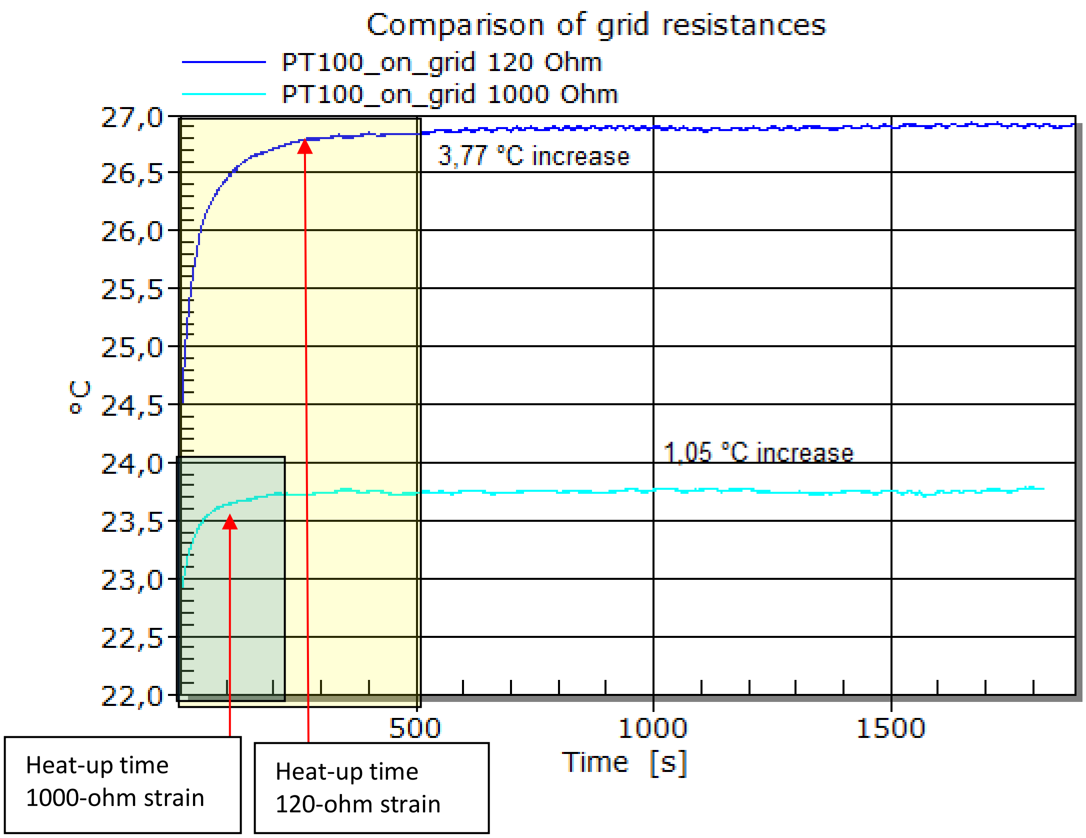
  ➔ For 1000-ohm strain gauges, the heat-up phase is approximately 3-4 minutes.

  ➔ For 120/350-ohm strain gauges, the heat-up phase is approximately 5-6 minutes.



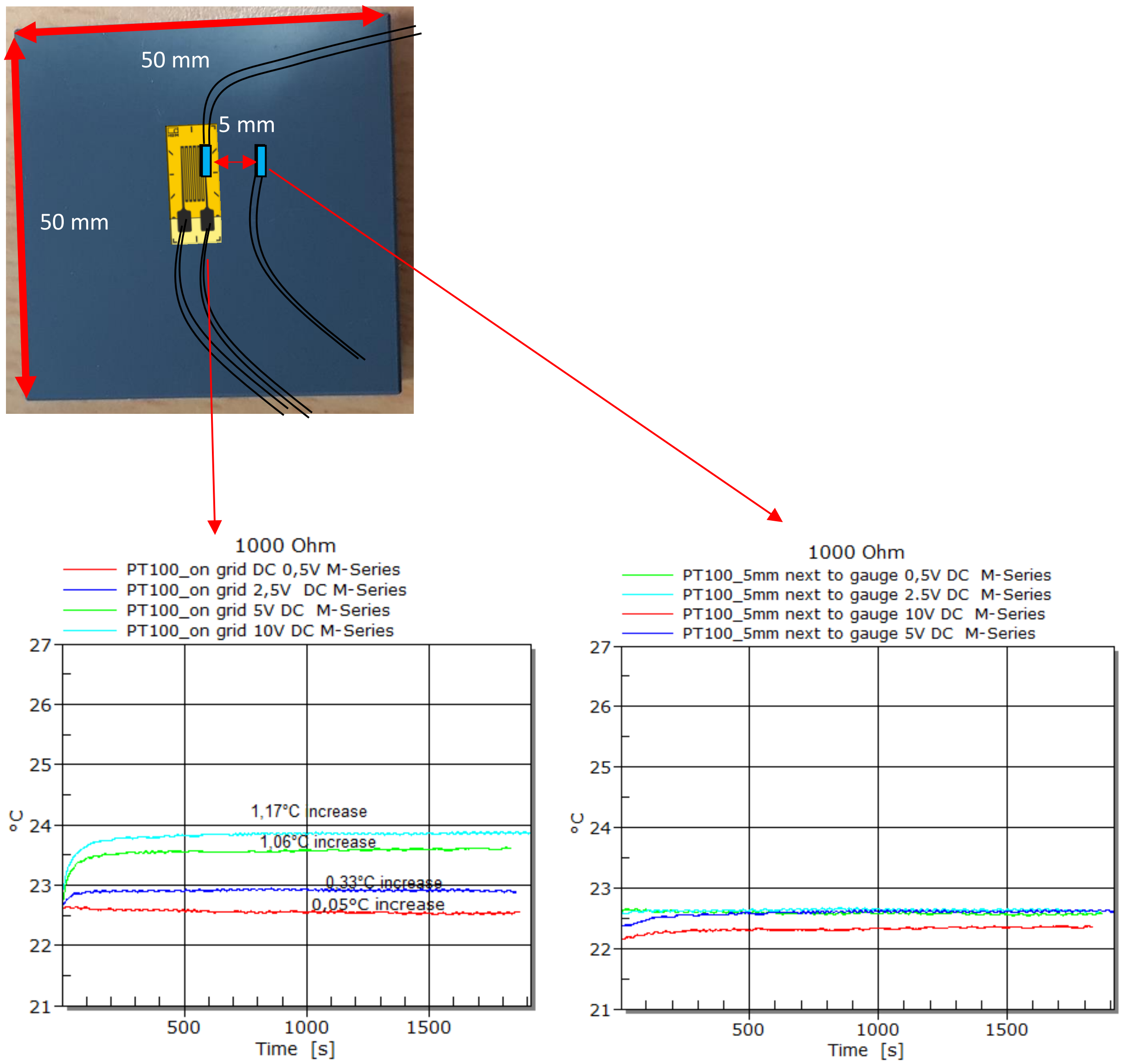
- The **gauge resistance** has a significant impact on the temperature increase when a strain gauge measurement spot is excited.

  For a high excitation voltage of 10 V, there is a much longer heat-up time for low-resistance strain gauges than for high-resistance strain gauges.

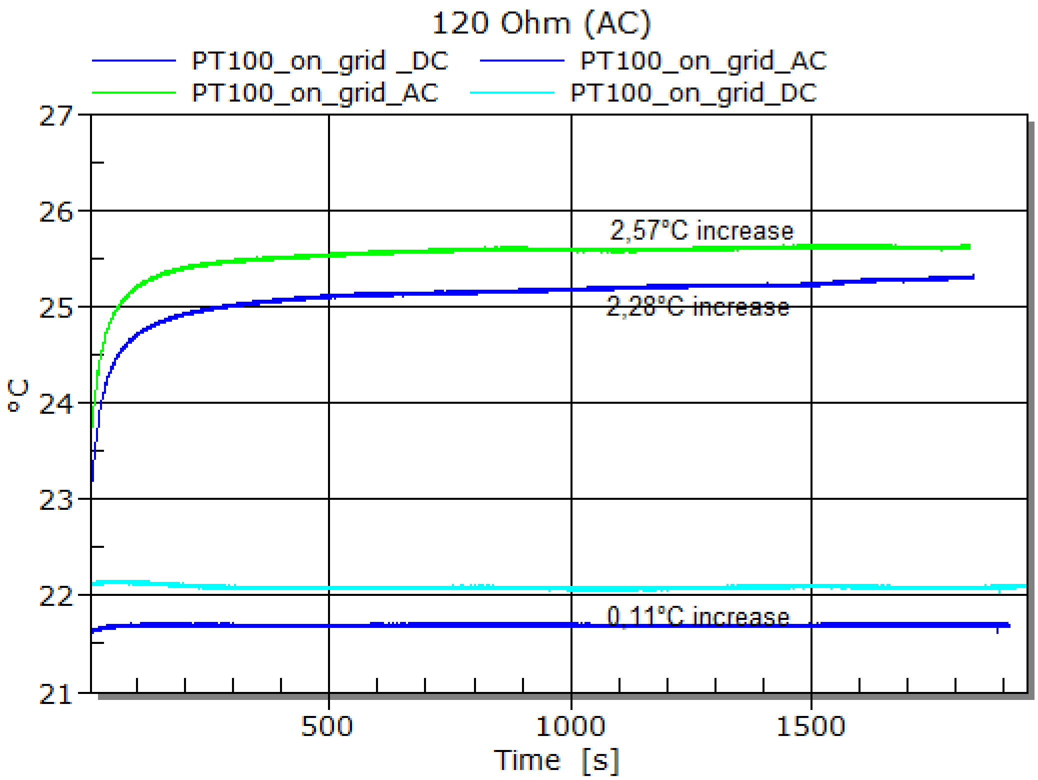


- **Location of measurement:** The heat effect is measurable mainly in the direct area of the strain gauge grid.

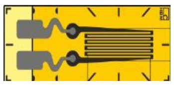
5 mm next to the gauge no heat-up effect of the material is measurable with 1000-ohm strain gauges. With 350-ohm and 120-ohm gauges, a slight heat-up effect of around 1 °C is measurable!



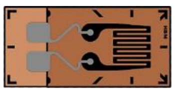
- **Carrier frequency vs. DC:** There is no difference in terms of heat-up effects of the strain gauge whether you are measuring with a carrier frequency (AC) or with a DC voltage.



- **Strain gauge construction:** There is no significant measurable effect of the strain gauge construction. It doesn't matter whether you use a strain gauge with a polyimide or a phenolic resin carrier. Also, the grid material has no measurable influence in this respect.



Carrier: Polyimide
Grid material: Constantan



Carrier: Phenolic resin
Grid material: CrNi

Practical tips summarized for your measurement:

When you are measuring on low-conducting materials:

1. **Resistance choice:**

➔ For low resistance values (120 and 350 ohms), wait approximately 10 minutes after excitation before measuring to ensure thermally stable test conditions.
➔ For high resistance values (700 and 1000 ohms), wait approximately 5 minutes after excitation before measuring.

HBM recommends using 1000-ohm strain gauges for experimental measurements on low-heat-conducting materials. This recommendation is aimed at providing the best accuracy of your measurement. Low resistances can slightly heat up the measurement spot constantly even if the temperature does not further increase during the measurement.

2. **Excitation voltage:**

➔ Using 0.5 to 2.5 V results in low thermal output effects and is recommended for use with plastics and composites (Carrier frequency or DC excitation).