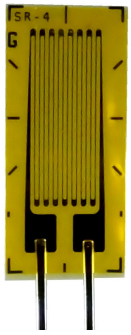
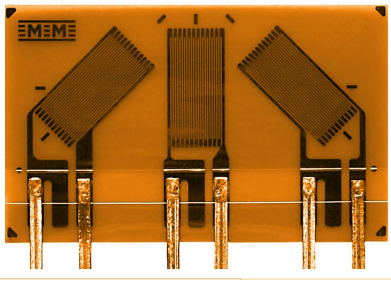
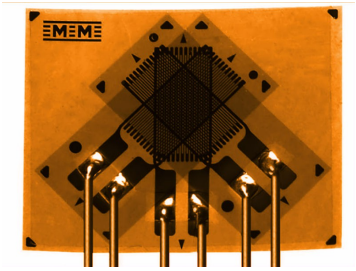
Criteria for the selection of strain gauges

Purpose of measurement

Strain gauges are essentially used with two different objectives: if it is a matter of determining the amount of the mechanical load in order to compare it with the allowable load or with a calculation model, e.g. Finite Element Method (FEM), this is called "stress analysis".
If it is matter of determining force or torque, than it is called “transducer construction” or “sensor system”.
For each of these objectives, there are specially adapted strain gauges, but strain gauges for transducer construction are also used in voltage analysis and vice versa.

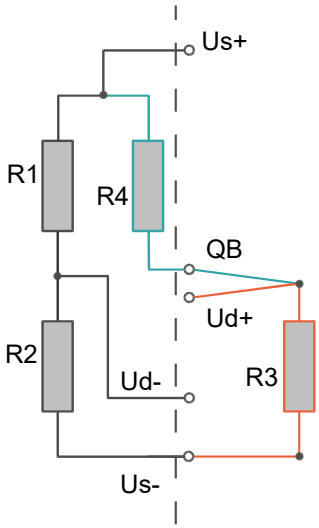
Stress analysis

For stress analysis, single grids or triple rosettes are used.
Single grids are used when the direction of maximum strain is known.

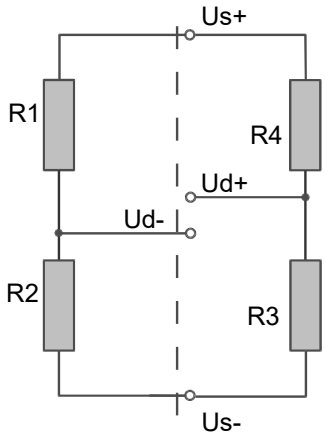
		
Single grid, with connecting lug	Rosette 3x45° with connecting lug	Rosette 3x45° as a stack with connecting lug

If the direction of strain is unknown, for example near a notch or weld, or on geometries with ribs and breakouts, a triple rosette must be used.

The direction and the amount of the maximum strain (or mechanical stress) can only be determined with a 3-fold rosette without doubt.
A single, active strain gauge is always used for stress analysis.
The connection of the active strain gauge to a measuring amplifier with internal bridge extension is made in 3-wire technology. The supplement to the half-bridge can be carried out in the measuring amplifier or by an additional passive strain gauge.



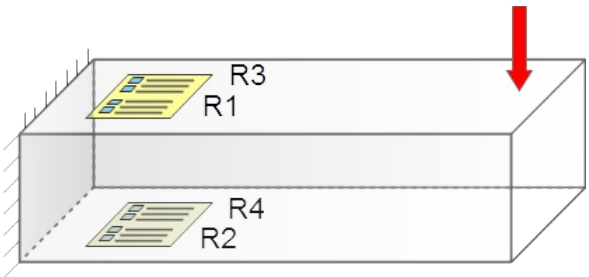
Three-wire technology with active strain gauge R3 for compensation of the line resistances

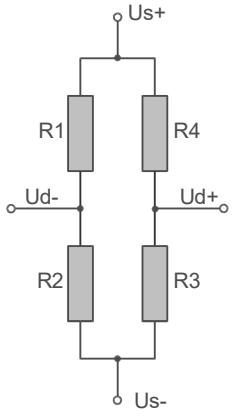


Half-bridge circuit with active strain gauge R3 and passive strain gauge R4 for compensation of the temperature-induced strain.

Sensor system

In the sensor system four active strain gauges are preferably connected to a full bridge. The circuit with four strain gauges attempts to maximize the signal in the measuring direction and to minimize other influences. For example, in the case of a trailer drawbar, the bearing force is to be measured, but not the tensile load. For the measurement of axial stress, bending stress and torsional stress, there are prefabricated grid arrangements.





Full bridge circuit with 4 active measuring grids for measuring a force direction with compensation of transverse forces.

Selection criteria

Grid length

The most widely used grid length in sensor technology and stress analysis is 3mm.
For small sensors or for stress analysis in very inhomogeneous loads, e.g. near the notches, weld seams or screw connections, a grid length of 1.5 mm is preferred.
In special cases, e.g. when measuring strain on circuit boards, grid lengths of 0.5mm ... 1.0mm are also used.
On inhomogeneous materials, e.g. fiber composite materials, wood or concrete, strain gauges with a grid length of 6 mm or more are used.

Resistance

The most commonly used resistance is 350 ohms. With this resistance, a supply voltage of 5V is generally allowed from a grid length of 1.5mm. With a resistance of 120 Ohm, the maximum supply voltage is often only 2.5V, in order to avoid self-heating.

Carrier material

The carrier material polyimide (Kapton) is also suitable for application on cylindrical surfaces down to a diameter of 1 mm due to its flexibility.
The carrier material Peek is also used for the construction of sensors. The flexibility of Peek is lower compared to polyimide. The adhesive bond, on the other hand, is stronger. In contrast to polyimide, no sealing against moisture with epoxy resin is necessary if the measuring grid is encapsulated in Peek.

Contact

The strain gauges are contacted, e.g. by soldering on the contact surface provided for this purpose. The area may be e.g. particularly large, or it is coated with a copper layer to improve the solderability. Specially for external applications, there are strain gauges with connecting ribbon and strain gauges with connecting cables. As a rule, solder joints on the strain gauge are used for the construction of sensors with additional soldering points in front of the contact surfaces for strain relief. Soldering on strain gauge contact surfaces as well as the soldering of connecting tapes requires practice and dexterity.

Geometry

After the selection of the grid length and the preferred contacting and contact surfaces, further criteria are applied, such as e. g. grid arrangement, grid width, length of the reversing points, interconnection of the grids

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