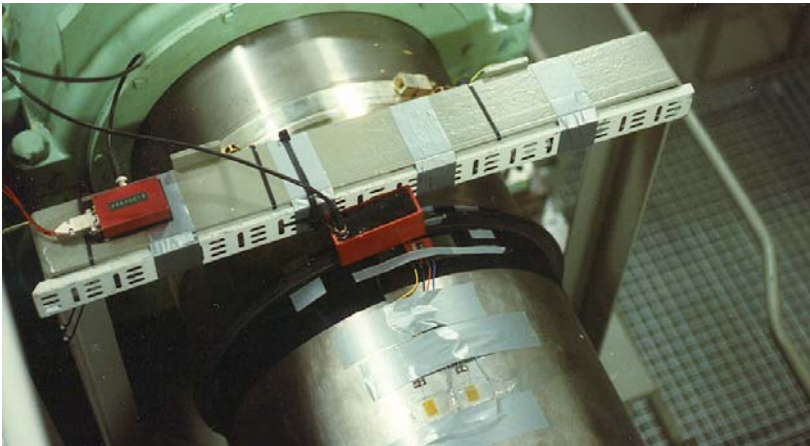


Features

- easy-to-use and low-cost
- acquisition of: strain, load, pressure, stress, torque, torsion, vibration

Applications

- supervision of processes
- development
- education and training



On the following pages, several connection examples demonstrate how to use the sensors together with bmcm measuring amplifiers.

All offered sensors consist of a constantan metal foil in phenolic resin.

They are delivered as simple components, so that their manual processing demands some technical skill.

Various accessories are provided, to install the strain gauges.

The strain gauge sensors of the SG-xxx series have been assorted from the available sensor supply with the aspect of

... easy-to-use and low-cost ...

application.

Strain gauge sensors are used to

... measure mechanical movements ...

The available sensors have been tested with bmcm products.

The manufacturer offers a great variety of other strain gauge types. Detailed specifications are available at: www.bcmsensor.com.

For further information about sensors and sensor manufacturers, please visit our website at

<http://www.bmcm.de>.

1 Available sensors

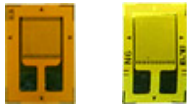
Order No.	Description	k-Factor	Physical meas. unit	Elec. quantity (typ.)	Accuracy	Sensor supply	Size (app.)
SG-1x350	strain gauge 350Ω	app. 2	0..±1mm/m	0..±0.5mV/V	±1%	tbd.	7.4 x 4.4
SG-1x1000	strain gauge 1000Ω	app. 2	0..±1mm/m	0..±0.5mV/V	±1%	tbd.	6.7 x 6.5
SG-2x350	strain gauge 2x350Ω	app. 2	0..±1mm/m	0..±1mV/V	±1%	+5V	8.0 x 6.0
SG-4x350	strain gauge 4x350Ω	app. 2	0..±1mm/m	0..±2mV/V	±1%	+5V	8.6 x 7.1

Accessories	Description	Material	Operat. temp.	Curing conditions	Characteristics
SG-GLUE603	2-component-adhesive for strain gauges	polyurethane	-30..+60°C	<ul style="list-style-type: none"> • room temp.: 24 hrs. or: • 80°C: 4 hrs. 	use for medium temperatures, easy to apply, long curing time
SG-GLUE610	2-component-adhesive for strain gauges	epoxy	-270..+370°C	<ul style="list-style-type: none"> • 135°C: 2 hrs. (1-3bar) afterwards: • 165°C: 2 hrs. 	fast drying, high stability, wide temperature range
SG-GLUE711	acrylate adhesive for strain gauges	cyanoacrylate	0..30°C	<ul style="list-style-type: none"> • room temp.: 3 hrs. (finger pressure) 	easy to apply, fast drying, high stability, for moderate temperatures only
SG-SILI613	coating or sealant for strain gauges	silicone	-30..+100°C	<ul style="list-style-type: none"> • room temp.: 16-24 hrs. (normal pressure) 	easy to apply, waterproof
SG-KIT	strain gauge starter kit	tools, consumables, strain gauge material for relating applications			

2 Strain gauge sensors

The standard strain gauge sensors offered consist of constantan foil on a phenolic resin carrier foil. They are either single strain gauges (**SG-1x350**, **SG-1x1000**) or designed as half-bridge (**SG-2x350**) or full-bridge (**SG-4x350**) types. Included with delivery are completion resistors allowing for any type of bridge configuration.

SG-1x350 / SG-1x1000:



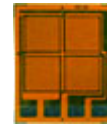
- electr. connection: 2 solder pads
- delivery: 2 strain gauges, 2x 1kΩ SMD resistors 0.1%
- manufacturer: BCM Sensor
- info: www.bcmsensor.com

SG-2x350:

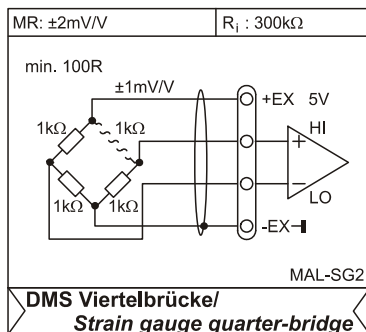


- electr. connection: 2 solder pads
- delivery: 1 strain gauge, 2x 1kΩ SMD resistors 0.1%
- manufacturer: BCM Sensor
- info: www.bcmsensor.com

SG-4x350:



- electr. connection: 2 solder pads
- delivery: 1 strain gauge
- manufacturer: BCM Sensor
- info: www.bcmsensor.com

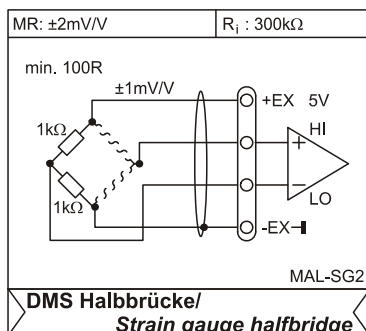


Connection example with MAL-SG2 in quarter-bridge circuit

The strain gauge bridge with **SG-1x350** or **SG-1x1000** is supplied with +5V DC voltage. The input amplifier of the *MAL-SG2* is operated differentially.

The measuring range of the quarter-bridge is $\pm 0.5\text{mV/V}$.

The strain gauge quarter-bridge must be completed with 3 resistors (e.g. 1x passive strain gauge, 2x 1kΩ). Make sure the bridge is balanced (see chapter 3). Occurring offset errors can be calibrated.

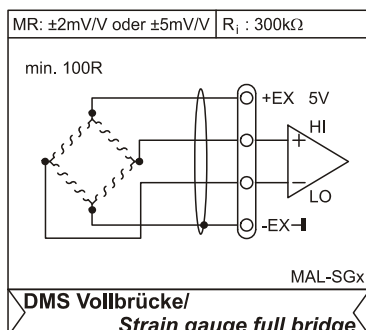


Connection example with MAL-SG2 in half-bridge circuit

The strain gauge bridge with **SG-2x350** or 2x **SG-1x350** (or 2x **SG-1x1000**) is supplied with a +5V DC voltage. The input amplifier of the *MAL-SG2* is operated differentially.

The measuring range of the half-bridge is $\pm 1\text{mV/V}$ with two active strain gauges and $\pm 0.5\text{mV/V}$ with one active strain gauge.

The strain gauge half-bridge must be completed with a resistor half-bridge (e.g. 2x 1kΩ, 0.1%). Occurring offset errors caused by different values of the completion resistors on one side and the strain gauges on the other can be calibrated.



Connection example with MAL-SG2/5 in full-bridge circuit

The strain gauge bridge with **SG-4x350**, 2x **SG-2x350** or 4x **SG-1x350** (or 4x **SG-1x1000**) is supplied with +5V DC voltage. The input amplifier of the *MAL-SG2/5* is operated differentially.

The measuring range of the full-bridge is $\pm 2\text{mV/V}$ with four active strain gauges and $\pm 1\text{mV/V}$ with two active strain gauges.

For wide measuring ranges or high offset ranges the *MAL-SG5* with $\pm 5\text{mV/V}$ measuring range is recommended. Alternatively the *MA-UNI* with several measuring ranges can be used.



- Strain gauge sensors can be overstrained to max. 250%, more strain damages the sensors.
- Alternatively the 5B universal amplifier *MA-UNI* with several measuring ranges can be used.
- The specifications of sensitivity refer to a mechanical load of 1000μm/m.

3 Mechanical – electrical relation of strain gauge sensors

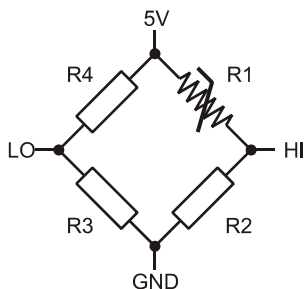
Strain gauges sensors change their resistance value in proportion to strain. The Wheatstone bridge is the preferred circuit for strain gauge measurements allowing for the acquisition of tiniest resistance changes with small efforts. Strain gauges can be integrated in different ways into a Wheatstone bridge, as shown in the following chapter. Depending if thermal strain and mechanical transverse stress have to be considered, a quarter-, half- or full-bridge configuration is used.



- For a bridge to be balanced (output voltage = 0V), the following relation must be fulfilled between the strain gauges and the completion resistors: $R_1/R_2=R_4/R_3$
- All examples assume a k-factor (ratio of resistance change and strain) of $k=2$ for the strain gauges.
- The mechanical load of the sensor must be in the principle strain direction. Transverse and thermal strains falsify the measuring result.

3.1 Quarter-bridge

If thermal or transverse strain is not to be expected, a simple quarter-bridge is sufficient.



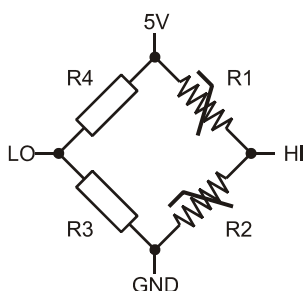
Conversion formula:
 $1000\mu\text{m/m} \hat{=} 0.5\text{mV/V}$

at the amplifier output:
 $1000\mu\text{m/m} \hat{=} 1.25\text{V}$
 (with MAL-SG2)

3.2 Half-bridge

The half-bridge allows for optimal temperature compensation. Compared to circuits with one active strain gauge, the half-bridge with two active strain gauges features double sensitivity.

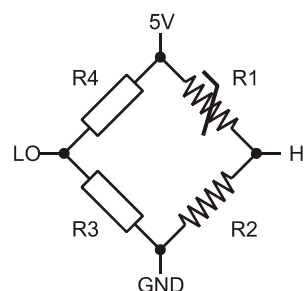
- with 2 active strain gauges:



Conversion formula:
 $1000\mu\text{m/m} \hat{=} 1\text{mV/V}$

at the amplifier output:
 $1000\mu\text{m/m} \hat{=} 2.5\text{V}$
 (with MAL-SG2)

- with 1 active strain gauge:



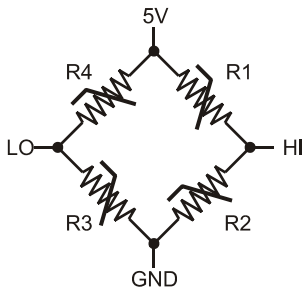
Conversion formula:
 $1000\mu\text{m/m} \hat{=} 0.5\text{mV/V}$

at the amplifier output:
 $1000\mu\text{m/m} \hat{=} 1.25\text{V}$
 (with MAL-SG2)

3.3 Full-bridge

The full-bridge compensates for temperature and transverse stress. The configuration with 4 active strain gauges features double sensitivity compared to the full-bridge with only 2 active strain gauges.

- with 4 active strain gauges:

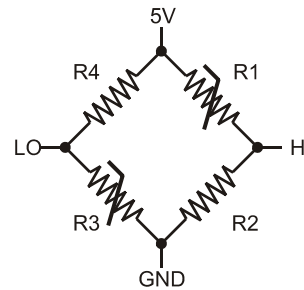


Conversion formula:
 $1000\mu\text{m/m} \hat{=} 2\text{mV/V}$

at the amplifier output:

$1000\mu\text{m/m} \hat{=} 5\text{V}$
 (with MAL-SG2)
 or
 $1000\mu\text{m/m} \hat{=} 2\text{V}$
 (with MAL-SG5)

- with 2 active strain gauges:



Conversion formula:
 $1000\mu\text{m/m} \hat{=} 1\text{mV/V}$

at the amplifier output:

$1000\mu\text{m/m} \hat{=} 2,5\text{V}$
 (with MAL-SG2)
 or
 $1000\mu\text{m/m} \hat{=} 1\text{V}$
 (with MAL-SG5)

4 Strain gauges in practice

4.1 Preparations

To realize a strain gauge application, one should consider the following aspects:

- **Choose strain gauge type**

Strain gauges are available in the most different types. The sensors offered by bmc are standard types made of constantan foil on phenolic resin foil with 350Ω or 1000Ω nominal resistance and a k-factor of 2, suitable for a wide range of applications within temperatures between -30°C and $+80^\circ\text{C}$. On demand, special types for specific tasks are available at the manufacturer.

- **Adhesives**

In most cases, strain gauges are glued to the measuring point. The selection of a suitable adhesive depends on the strain gauge material and the material to be tested, the environmental conditions (e.g. temperature, humidity) the adhesive is permanently exposed to, the curing time and the processing temperature. Using hot curing plastic adhesives is often not possible or not suitable for the test material. The strain gauges adhesives available at bmc as accessories feature different characteristics, but are all suitable for mounting the **SG-xxx** sensors (see chapter 5.1).

Sometimes, even direct bonding of the strain gauge into resin, concrete or ceramic mastic is necessary.

- **Electrical connection**

The strain gauges of the **SG** series have solder pads for the electrical connection. Since strain gauges are installed in bridge circuitry, the integration of completion resistors has to be considered in addition. How the electrical connection is realized also depends on the stress the gauge is exposed to.

- **Electrical circuit**

Strain gauges are installed in bridge circuitry. Some sensors already feature a half- or a full-bridge. The decision to use a quarter-, half- or full-bridge depends on whether temperature extensions or interfering bending strain have to be compensated (see chapter 3).

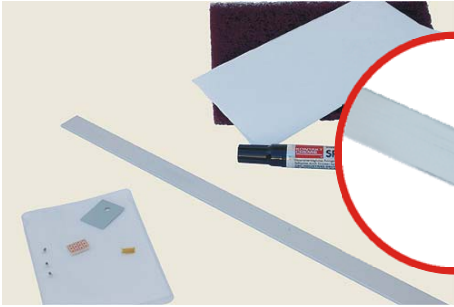
- **Protection of the measuring point**

According to the ambient conditions, the completed measuring point must be protected. Different coatings or sealants (e.g. silicone rubber, self-sealing insulating tape, lacquers, resins, mastic, aluminum foil) prevent harmful environmental influences, such as weather, oils, solvents or mechanical pressure, which can lead to wrong measuring results.

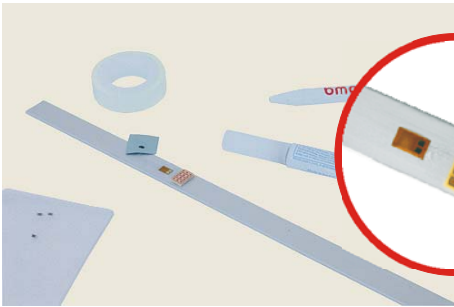


- All information and connection examples in this data sheet are meant as help only. You cannot assert claims to applicability in a specific individual case.
- For further information about strain gauge sensors and their processing we recommend the following links: http://en.wikipedia.org/wiki/Strain_gauge (basic introduction about strain gauges) and http://www.bcmsensor.com/strain-gauges/gauge_installation.htm (bonding instructions of the manufacturer).

4.2 Setting-up a strain gauge measuring application



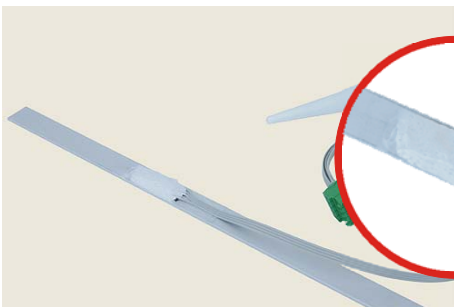
- **Preparing the test material**
 - remove lacquers and residues
 - roughen the surface
 - clean with alcohol



- **Positioning and gluing**
 - mark the measuring point
 - position the strain gauge(s) with adhesive tape
 - apply the adhesive
 - pressing of the strain gauge(s) with silicone pads
 - curing of the adhesive



- **Connecting**
 - solder the cables
 - complete the bridge with completion resistors



- **Sealing and finishing**
 - seal measuring point
 - hardening (e.g. of silicone)
 - fix the measuring cable (e.g. with tip-wrap)
 - calibrate the measurement set-up (see chapter 4.3)

4.3 Calibration

As applied strain gauge sensors provide errors of accuracy, a calibration directly at the object is advisable: Therefore, put the sensor in mechanical zero position, to get or adjust the offset. Then apply a known value to the object to determine the gain.

Usually a software calibration of these two points should be sufficient and easy to realize with measuring systems and software (**NextView®**) by bmcm.

5 Accessories for strain gauges

5.1 Adhesives and silicone

To apply strain gauge sensors, several special adhesives (**SG-GLUE603**, **SG-GLUE610**, **SG-GLUE711**) are available as accessories. Concerning processing temperature, curing time and operating temperature, those feature different characteristics (see chapter 1).



The **SG-SILI613** is a protective silicone coating, to seal the strain gauge measuring point and all connection points. Absolutely recommended to protect high-quality applications!

5.2 Strain gauge starter kit SG-KIT

The starter kit **SG-KIT** is a reasonable possibility to get into the installation of strain gauges. It contains several tools, consumables and strain gauges.



- **Tools**
battery-powered soldering iron, DVM, wire cutter with stripping function, cutter, tweezers with magnifier, miniature screw driver, ball point pen
- **Consumables**
tin-solder (diameter: 1mm, charge: 100m), abrasive web, 10 cleaning tissues (lint-free), alcohol tipped cleaning pen (12ml), superglue (3g), wire (1m), self-sealing rubber insulating tape (w: 19mm, l: 25cm), adhesive tape
- **Strain gauge kit**
2x **SG-1x350R**, 3 silicone pads (13 x 21mm), drilled board, 4x 1kΩ resistors (SMD)

6 Important notes for using the SG-xxx sensors

- The **SG-xxx** sensors are only suitable for extra-low voltages - please observe the relevant regulations! For power supply an electrically isolated power unit (with CE) must be used. During installation turn off the power!
- For 5V sensors the values for accuracy always relate to exactly 5V ($\leq \pm 1\%$). Errors might add at worst.
- In case of doubt the data of the manufacturers apply. The relevant documentation (if existing) can be downloaded as PDF file at www.bmcm.de.
- The sensor lines should be shielded, connect shield to the measuring system at on end only.
- For cleaning use water and mild detergent only. The sensors are maintenance-free.
- The product must not be used for any safety-relevant tasks. By using or processing this product the customer becomes manufacturer by law and therefore is responsible for the proper installation, use and handling of the product. In the case of improper use or unauthorized interference our warranty ceases and any warranty claims are excluded.



Do not dispose of the product in the domestic waste or at any waste collection places. It has to be either duly disposed according to the WEEE Directive or can be returned to bmcm at your own expense.

7 Technical data SC-xxx (typ. at 20°C and 5V supply)

• General

Material // Power supply // Accuracy:
Resistance // k-factor (amplification):
Connection // Overload // Durability:
CE standards:
ElektroG // ear registration:
Max. potentials:
Temperature range // Relative humidity:
Dimensions in mm (L x B):
Delivery:
Available accessories:
Guarantee:

constantan metal foil on a phenolic resin carrier foil // with bmcm measuring systems: 5V // $\leq \pm 1\%$
SG-1x350, SG-2x350, SG-4x350: 350Ω; SG-1x1000: 1kΩ // 2.0-2.2
at solder pads as quarter, half- or full-bridge // max. 2.5% // min. 10^7 strains
EN61000-6-1, EN61000-6-3, EN61010-1
RoHS and WEEE compliant // WEEE Reg.-No. DE75472248
max. 60V DC (acc. to VDE) , max. 1kV ESD on open lines
-30°C..+80°C // 0..90% not condensing
SG-1x350: 7,4 x 4,4; SG-1x1000: 6,7 x 6,5; SG-2x350: 8 x 6; SG-4x350: 8,6 x 7,1
SG-1x350, SG-1x1000: 2x strain gauges, 2x 1kΩ SMD resistors; SG-2x350: 1x strain gauge, 2x 1kΩ SMD resistors; SG-4x350: 1x strain gauge; description
strain gauge starter kit SG-KIT, adhesives SG-GLUE603, SG-GLUE610, SG-GLUE711, silicone SG-SILI613
2 years with effect from sales date, damages resulting from improper use excluded

Manufacturer: BMC Messsysteme GmbH. Subject to change due to technical improvements. Errors and printing errors excepted. 12/05/2008