measure and predict with confidence

Strain Gages

and Accessories

www.hbm.com

HBM

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Strain gage series

The HBM strain gage range consists of the Y, C, G, K, V series and special strain gages. There are different type series within each strain gage series. Many specifications are identical for one strain gage series; therefore, in this catalog, the specifications of a series are given on the pages preceding the list of individual strain gages. Where the specifications of individual strain gages differ from those stated for the other strain gages of a series, these strain gages are provided with a relevant note. The specifications and their tolerances are stated in compliance with OIML directive IR62, which is essentially identical to the VDI/VDE directive 2635.

The specifications

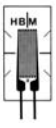
have been determined according to OIML directive IR62. The tolerances are stated per OIML with double standard deviation. If the specified tolerance values of the gage factor, transverse sensitivity, temperature coefficient, and temperature response are halved, the data complies with VDI/VDE directive 2635.
Below you will find further explanations regarding the terms used in the specifications tables.

Connection configuration

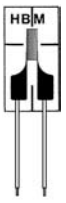
HBM supplies strain gages with different connection configurations.
Choose the configuration that best fits your application and personal preferences - the right connection for everyone.

Integrated solder tabs, e.g. LY41
- allow direct soldering on the strain gage

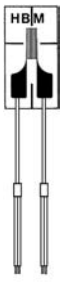
Big solder tabs with strain relief, e.g. LY61
- allow comfortable soldering directly on the strain gage, at the same time providing nearly full mechanical decoupling of solder tabs and strain gages



Leads: Ni-plated copper leads; uninsulated; 30 mm (1.18 inch) long, e.g. LY11
- no direct soldering on the strain gage
- for full mechanical decoupling of cables and strain gage
- Use of separate solder terminals directly on the strain gage required



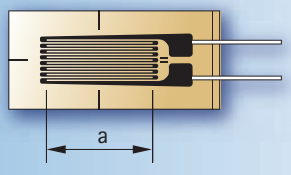
Teflon-insulated connection wires (50 mm (1.97 inch) long), e.g. K-LY41
- No soldering on the strain gage
- Teflon insulation prevents the cable from sticking during installation
- Solder terminals near the strain gage are required which are also used for the bridge connection



PVC-insulated ribbon cable, alternatively with 2, 3 or 4-wire circuit; e.g. K-LY41
- Cable length as required (0.5 to 10 m (1.64 to 32.81 ft))
- Soldering at measurement point not required at all
- Teflon wire on the strain gage prevents the cable from sticking during installation

Strain gage dimensions

The specified active measuring grid length "a" is the net length of the grid without the end loops (transverse bridges). If the following facts are taken into account, it is possible to cut the carrier foil: Cutting the foil in parallel to the measuring grid has only minor effects.
Shortening the carrier foil perpendicular to the measuring grid influences the way the strain is introduced, thereby also changing essential characteristics of the strain gage. A minimum distance of 1mm (0.04 inch) between the measuring grid end and the end of the carrier foil should therefore be maintained.



Active measuring grid length

Schematic diagram of a strain gage

Strain gage resistance

The electric resistance between the two metal leads, solder tabs or cable ends for connecting the measuring cable is called the resistance of a strain gage.[1] Please note that the nominal resistance for strain gages with connection cables* is specified without the cable.

HBM strain gages are available with 120 Ohm, 350 Ohm, 700 Ohm or 1000 Ohm resistance. The nominal resistance is stated on each strain gage package including the resistance tolerance per package. HBM strain gages are 100% resistance checked.

Gage factor (strain sensitivity)

The strain sensitivity k of a strain gage is the proportionality factor between the relative change in resistance $\Delta R/R_0$ and the strain to be measured ε: $\Delta R/R_0 = k \cdot \varepsilon$
The strain sensitivity yields a dimensionless number and is designated as gage factor. This gage factor is determined for each production batch by measuring and is specified on each strain gage package as a nominal value complete with tolerance. The gage factors vary between the production batches by just a few thousandths.

Temperature coefficient of the gage factor

The specified gage factor applies at room temperature. It changes as the temperature changes; however, with an excellent approximation, this correlation is linear. In the case of constantan measuring grids (V, G, K, Y series) the gage factor is proportional to temperature; in the case of chromium-nickel measuring grids (C series) the gage factor is inversely proportional to temperature. The temperature coefficient of the gage factor and its tolerance are stated on each strain gage package.

(1) SG / V series, LE11

* see page 39

Maximum permissible effective bridge excitation voltage

A strain gage is a resistor, converting electrical energy into heat. To prevent heating of the strain gage it is essential to choose a supply voltage that is not excessively high. The maximum permissible bridge excitation voltage is calculated for each strain gage and is listed in a table in this catalog.

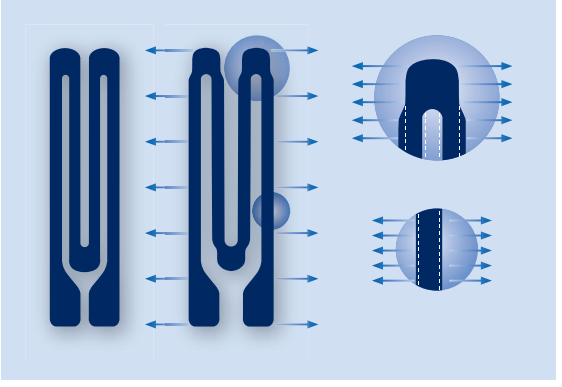
The specified excitation voltage always applies for the Wheatstone bridge as a whole. Only half the voltage may be applied to the individual strain gage.
The maximum values specified are permissible only for application on materials featuring excellent heat conduction characteristics (e.g. steel of sufficient thickness).
Strain gage measurements on plastic materials, and similar materials with poor heat conduction characteristics, require a reduction of the excitation voltage or switch-on period (impulse operation).
Also, with very low temperatures, the decreasing heat capacity of the materials may require a smaller excitation voltage.

Reference temperature

The reference temperature is the ambient temperature to which the specifications of the strain gage refer, unless no specific temperature ranges have been stated.
The specifications for the strain gages are based on the reference temperature of 23°C (73.4°F).

Transverse sensitivity

The transverse sensitivity is the ratio of the sensitivity of a strain gage transverse to the measuring grid direction to its sensitivity in the measuring grid direction. The transverse sensitivity is stated on each strain gage package.



Schematic diagram of the transverse sensitivity of a measuring grid

Operating temperature range

The operating temperature range is the range of ambient temperatures in which the strain gage can be used without lasting changes in measurement properties occurring. There are different operating temperature ranges for absolute (with zero point reference) or relative (without zero point reference) measurements.

Temperature response in a 1/4-bridge circuit

Strain gages that are connected individually show an output signal, if the temperature changes. This signal is called "apparent strain" or "thermal output" and is independent of the mechanical load on the test object.

However, it is possible to adjust a strain gage to the thermal expansion coefficient of a specific material such that the output signal is very small in the case of a temperature change. Such strain gages are called strain gages with "matched temperature response" or "self-compensated" strain gages. All HBM strain gages, with the exception of the LD20 high-strain gage, are self-compensated.

To benefit from their matching to the temperature response, strain gages must be selected according to the thermal expansion coefficient α of the test material. Therefore HBM offers strain gages for different materials. The code number for the temperature response matching is included in the strain gage type name.

1	for ferritic steel	with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)
3	for aluminum	with α = 23 · 10^{-6}/K (12.8 · 10^{-6}/°F)
5	for austenitic steel	with α = 16 · 10^{-6}/K (8.9 · 10^{-6}/°F)
6	for quartz	with α = 0.5 · 10^{-6}/K (0.3 · 10^{-6}/°F)
7	for titanium/gray cast iron	with α = 9 · 10^{-6}/K (5.0 · 10^{-6}/°F)
8	for plastic material	with α = 65 · 10^{-6}/K (36.1 · 10^{-6}/°F)
9	for molybdenum	with α = 5.4 · 10^{-6}/K (3.0 · 10^{-6}/°F)

Thus, for example, the types LY21 or RY31 (code number 1) have been matched to ferritic steel with α =10.8 ·10^{-6}/K. The material to which the respective strain gage has been matched is specified on the package with the applicable α.
Despite this measure, a residual error remains, which is printed on the package in the form of a mathematical function and a graphical representation.
The effects of strain gages using connection leads are also taken into account. This enables the apparent strain to be compensated by wiring and also mathematically.

The temperature response involves a tolerance and only applies in the temperature range of the temperature response matching. This temperature range is specified in the specifications of the individual series in this catalog.
Another possibility of compensating the apparent strain is to use appropriate wiring (e.g. circuit with compensating strain gage, half bridge circuit, etc.).

Creep adjustment

Spring element materials react with a spontaneous positive or negative strain when subjected to a sudden load. In the event of a constant load being applied, the material will continue to strain slowly in load direction, i.e. the material will creep.
As transducers are loaded within the strictly elastic range only, the process described here is reversible. It is called elastic after-effect. The elastic after-effect causes a time-dependent fault with a positive sign (in the direction of the deformation by the measuring quantity).

If a strain gage is subjected to a static load, it will show a slow change in resistance over time - in spite of the component strain being constant. This change in the measuring signal of an extended (or shortened) strain gage occurs in the direction of strain relief. This creep can be explained as follows: the extended measuring grid acts similar to a tensioned spring which generates shear stresses between measuring grid and carrier (mainly in the area of the measuring grid end loops).

Due to the influence of these stresses, the plastic materials of the strain gage and the adhesive relax. It is possible to influence such strain gage creep directly by modifying the end loops. The elastic after-effect of the spring element material will therefore lead to a positive fault while the strain gage creep generates a negative fault. In an ideal case, both faults will compensate each other. In order to approximate this ideal case as closely as possible, it is necessary to determine the most suitable strain gage by experiment. It is for this reason, that the K strain gage series provides three different creep adjustments for each strain gage type.

Mechanical hysteresis

The mechanical hysteresis of a strain gage is defined as the difference of the measured value displayed for increasing and decreasing strain loadings with the same strain value on the specimen. Hysteresis is not only dependent on the strain gage but to a major extent it is also dependent on application parameters such as type and layer thickness of the adhesive, etc. For this reason, the specifications include hysteresis values for different installation parameters.

Maximum elongation

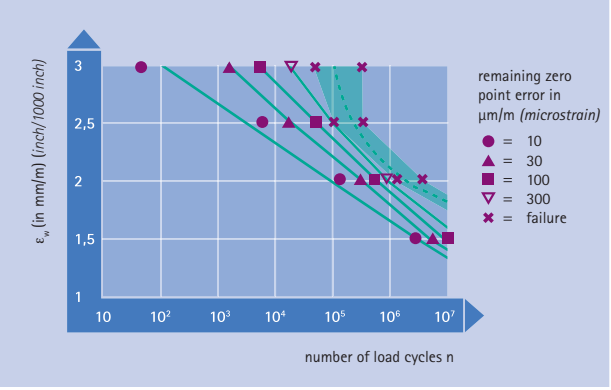
The maximum elongation of a strain gage is the strain where the characteristic curve (resistance change-strain characteristic) deviates by more than ± 5% from the mean characteristic curve of the type. This is often the case if the installation or the strain gage has been damaged.

Minimum radius of curvature

The flexibility of a strain gage is characterized by the minimum radius of curvature which it will withstand, without any auxiliary measures, in each direction respectively. The polyimide carriers of Y and C series strain gages are flexible to an extent that they can be bonded around edges. Although the carrier materials of the other strain gage series are more brittle, they can also be easily prepared for application to smaller radii by thermal pre-forming Exception: V series strain gages have a bigger radius of curvature because of their specific potting.

Fatigue life

If a strain gage is subjected to an alternating strain which can be superimposed over a static mean strain, an increase in the number of load cycles may create changes with regard to the zero point. The fatigue life is dependent upon the number of strain cycles and their amplitude and is independent of applied strain duration.
The achievable load cycle values are also dependent on the various installation parameters and are therefore only given for representative examples.



Example diagram of the fatigue life of strain gages

Applicable bonding materials

For each strain gage series, the relevant bonding materials are specified. With regard to bonding technique, the HBM range of accessories distinguishes among cold and hot curing adhesives as well as spot welding methods. One of the most important selection criteria is the application temperature range of the individual bonding materials.

Analysis of the biaxial stress state with unknown principal directions

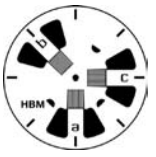
The principle of experimental stress analysis using strain gages (SG) consists in using strain gages to measure strains on the component surface.
From these measured strains and the known material properties (modulus of elasticity and Poisson's ratio), the absolute value and the direction of these mechanical stresses are determined. These calculations are based on Hooke's Law which applies to the elastic deformation range of linear-elastic materials.

In experimental stress analysis, so-called 3-grid rosettes are used for strain measurement. These are available in 0°/45°/90° and 0°/60°/120° versions. Both forms have a historical background.
It is up to the user to choose which version to use.

The 3 measuring grids of the rosettes are designated with the letters a, b and c. Therefore, a 3-grid rosette measures the three strains ε_a, ε_b and ε_c.

The principal normal stresses σ_1 and σ_2 are calculated for the 0°/45°/90° rosette using the formula:

$$\sigma_{1/2} = \frac{E}{1-\nu} \cdot \frac{\varepsilon_a + \varepsilon_c}{2} \pm \frac{E}{\sqrt{2}(1+\nu)} \cdot \sqrt{(\varepsilon_a - \varepsilon_b)^2 + (\varepsilon_c - \varepsilon_b)^2}$$



0°/45°/90° rosette
e.g. RY3x

and for the 0°/60°/120° rosette:

$$\sigma_{1/2} = \frac{E}{1-\nu} \cdot \frac{\varepsilon_a + \varepsilon_b + \varepsilon_c}{3} \pm \frac{E}{1+\nu} \cdot \sqrt{\left(\frac{2\varepsilon_a - \varepsilon_b - \varepsilon_c}{3}\right)^2 + \frac{1}{3}(\varepsilon_b - \varepsilon$$

0°/60°/120° rosette
e.g. RY7x

The principal directions are determined below. First the tangent of an auxiliary angle ψ is calculated.
For the 0°/45°/90° rosette using the formula:

$$\tan\psi = \frac{2\varepsilon_b - \varepsilon_a - \varepsilon_c}{\varepsilon_a - \varepsilon_c} \quad \Big| \quad \frac{Z}{N}$$

and for the 0°/60°/120° rosette according to the formula:

$$\tan\psi = \frac{\sqrt{3}(\varepsilon_b - \varepsilon_c)}{2\varepsilon_a - \varepsilon_b - \varepsilon_c} \quad \Big| \quad \frac{Z}{N}$$

Note: The tangent of an angle in the right-angled triangle is the ratio of the opposite side (numerator N) to the adjacent side (denominator D):

$$\tan\psi = \frac{\text{Opposite side}}{\text{Adjacent side}} = \frac{Z}{N}$$

This ambiguity of the tangent makes it necessary to determine the signs of the numerator (N) and the denominator (D) before carrying out the final calculation of the two above mentioned quotients. Determining the signs is important because they alone indicate the quadrant of the circular arc in which the angle ψ is located.
From the value of the tan, the value of the intermediate angle ψ must first be determined:

$$|\psi| = \arctan\,[°]$$

Then the angle φ should be determined using the following scheme:

$$\left.\begin{array}{l} Z \geq 0\,(+) \\ N > 0\,(+) \end{array}\right\} \quad \varphi = \frac{1}{2}(0° + |\psi|)$$

$$\left.\begin{array}{l} Z > 0\,(+) \\ N \leq 0\,(-) \end{array}\right\} \quad \varphi = \frac{1}{2}(180° - |\psi|)$$

$$\left.\begin{array}{l} Z \leq 0\,(-) \\ N < 0\,(-) \end{array}\right\} \quad \varphi = \frac{1}{2}(180° + |\psi|)$$

$$\left.\begin{array}{l} Z < 0\,(-) \\ N \geq 0\,(+) \end{array}\right\} \quad \varphi = \frac{1}{2}(360° - |\psi|)$$

The angle φ found in this manner should be applied from the axis of the reference measuring grid a in the mathematically positive direction (counterclockwise). The axis of the measuring grid a forms one arm of the angle φ. The other arm represents the first principal direction. This is the direction of the principal normal stress σ_1 (identical with the principal strain direction ε_1). The point of the angle is located at the intersection of the axes of the measuring grids. The second principal direction (direction of the principal normal stress σ_2) has the angle φ +90°.

The easy way to find the right strain gage

Geometry of the strain gage (dependent on the measurement task to be solved)

Linear strain gages (e.g. LY11), one measuring grid
Typical application:
- Strain measurement in one direction

Double SG with two measuring grids (e.g. DY11),
arranged in parallel
Typical application:
- Measurement on bending beams
For more detailed information see 1) and 2)

T-rosettes with two measuring grids (e.g. XY11), offset by 90°
Typical applications:
- Analysis of the biaxial stress state with known principal directions
- Measurements on tension/compression bars
For more detailed information see 1) and 2)

Rosettes with three measuring grids (e.g. RY81), 0°/45°/90° or 0°/60°/120° arrangement
Typical application:
- Analysis of the biaxial stress state with known principal stress directions
The three measuring grids are arranged in a so-called quarter bridge circuit. The absolute value and the direction of the first and second principal stress are computed as described on page 12.
For more detailed information see 2)

V-shaped strain gages (e.g. XY21), 2 measuring grids, arranged at ±45° relative to the SG axis
Typical applications:
- Measurements on torsion bars
- Determination of shear stresses occurring in shear beams around the neutral fiber
For more detailed information see 1) and 2)

Full bridge strain gages (e.g. VY41), 4 measuring grids, offset by 90° relative to each other
Typical applications:
- Measurements on tension/compression bars
- Measurements on torsion bars
- Determination of shear stresses occurring in shear beams around the neutral fiber
For more detailed information see 1) and 2)

Diaphragm rosettes (e.g. MY11), 4 measuring grids
Typical applications:
- Manufacture of diaphragm pressure transducers

Strain gage chains (e.g. KY11), 10 or 15 very small measuring grids, arranged equidistantly on a common carrier, plus one compensating SG
Typical application:
- Determination of strain gradients.
HBM also supplies strain gage chains complete with several rosettes and alternating measuring grid directions so that it is even possible to determine the gradient of a biaxial stress state.
For more detailed information see 2)

1) Brochure "Using the Wheatstone bridge circuit" (free)
2) Book: "An Introduction to Measurements Using Strain Gages"

SG measuring grid length dependent on aim of measurement, as the result of a measurement using strain gages will be the mean strain underneath the measuring grid.
In general, measuring grid lengths of 3 or 6 mm (0.118 or 0.236 *inch*) represent a good solution.
Long measuring grids are recommended where there is an inhomogeneous material such as e.g. concrete or wood.
A long strain gage will bridge the inhomogeneities of the work piece and, as a measurement result, will supply the strain underneath the measuring grid.

Short measuring grids are suitable for detecting a local strain state. They are therefore suitable for determining strain gradients (see strain gage chains), the maximum point of notch stresses and similar stresses.

SG series
The HBM strain gage range comprises various type series for the following typical applications:

Y SG: The universal strain gage for stress analysis and "simple" transducers. Easy to handle, robust, flexible, many geometries and nominal (rated) resistances available.
Measuring grid: Constantan; Measuring grid carrier: Polyimide

C SG: For measurements at extreme temperatures; operating temperature range from -269... up to +250°C (-452°F... up to +482°F); temperature response with matching in the range of -200... +250°C (-328°F... +482°F).
Measuring grid: Cr-Ni alloy; Measuring grid carrier: Polyimide

G SG: For the manufacture of transducers, nominal (rated) resistances of 120 Ω and 350 Ω available
Measuring grid: Constantan; Measuring grid carrier: phenolic resin, glass fiber reinforced.

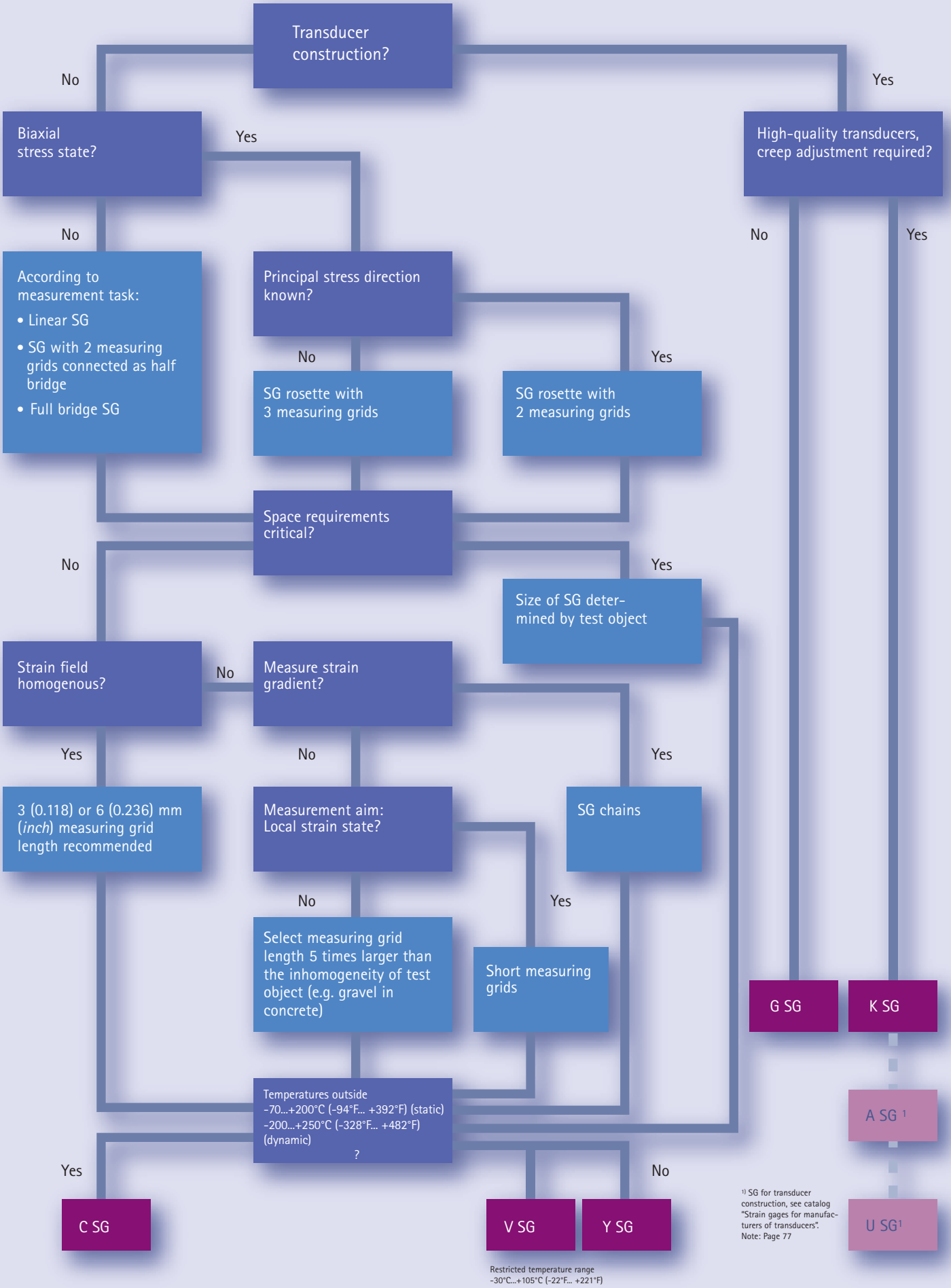
K SG: For the manufacture of transducers, different creep adjustments available; also as a "stick on" version complete with touch-dry adhesive coating for optimum measurement results.
Measuring grid: Constantan; Measuring grid carrier: phenolic resin, glass fiber reinforced.

V SG: Encapsulated strain gages for experimental stress analysis.
Measuring grid: Constantan; Measuring grid carrier: polyimide with potting made of special plastic material and 3 m (9.84 ft) stranded wire.

SG resistance
HBM strain gages are available in 120, 350, 700 and 1000 Ohm versions.
The selection of the resistance depends on the constraints of the measurement task. Other resistances on request.

120 ohm strain gages:
+ Relative insensitivity to variations in insulation resistance, e.g. caused by effects of humidity.

High ohm strain gages:
+ Less specific heat because of their lower measurement current
+ Less sensitive to ohmic resistances in the connection lines to the measurement amplifier.
- Better "antennae" for reception of noise pulses.


Transducer construction?
No
Yes
Biaxial stress state?
Yes
High-quality transducers, creep adjustment required?
No
No
Yes
According to measurement task:
• Linear SG
• SG with 2 measuring grids connected as half bridge
• Full bridge SG
Principal stress direction known?
No
Yes
SG rosette with 3 measuring grids
SG rosette with 2 measuring grids
Space requirements critical?
No
Yes
Size of SG determined by test object
Strain field homogenous?
No
Measure strain gradient?
Yes
No
Yes
3 (0.118) or 6 (0.236) mm (inch) measuring grid length recommended
Measurement aim: Local strain state?
SG chains
No
Yes
Select measuring grid length 5 times larger than the inhomogeneity of test object (e.g. gravel in concrete)
Short measuring grids
G SG
K SG
Temperatures outside -70...+200°C (-94°F... +392°F) (static) -200...+250°C (-328°F... +482°F) (dynamic)
?
A SG 1
Yes
No
C SG
V SG
Y SG
U SG1
Restricted temperature range -30°C...+105°C (-22°F... +221°F)
1) SG for transducer construction, see catalog "Strain gages for manufacturers of transducers". Note: Page 77

Type coding

Type coding

1-L Y 1 1 - 3 / 120 A

Options[1]: A = Application aid
V = Four wire connection
Z = Two wire connection

Measuring grid resistance in ohms

Measuring grid length in mm/*inch*
- For RY1x, RY3x, RY4x, RY7x: Diameter of circle which surrounds the measuring grid
- For SG chains: Distance of measuring grid centers relative to each other (pitch)

Material to which the SG temperature response is matched: If, at this position, you find the placeholder "x", replace it with the code number for the temperature response matching of your choice.

1	ferritic steel	with α = 10.8· 10^{-6}/K (6.0 · 10^{-6}/°F)
3	Aluminum	with α = 23· 10^{-6}/K (12.8 · 10^{-6}/°F)
5	austenitic steel	with α = 16· 10^{-6}/K (8.9 · 10^{-6}/°F)
6	Quartz	with α = 0.5· 10^{-6}/K (0.3 · 10^{-6}/°F)
7	titanium / gray cast iron	with α = 9 · 10^{-6}/K (5.0 · 10^{-6}/°F)
8	plastic material	with α = 65 · 10^{-6}/K (36.1 · 10^{-6}/°F)
9	molybdenum	with α = 5.4 · 10^{-6}/K (3.0 · 10^{-6}/°F)

Layout of grids, type and position of the connections

SG series

C series = Carrier and cover: Polyimide-/-Measuring grid foil Chromium/nickel alloy
Y series = Carrier and cover: Polyimide-/-Measuring grid foil Constantan
G series = Carrier and cover: Glass-fiber reinforced phenolic resin-/-Measuring grid foil: Constantan
K series = Carrier and cover: Glass-fiber reinforced phenolic resin-/-Measuring grid foil: Constantan, additionally, different creep adjustments available ex stock
V series = Carrier: Polyimide/Measuring grid foil: Constantan, Molded with special plastic material, 3 m (9.84 ft) stranded wire as standard

Number of measuring grids and their relative positions to each other

L = one measuring grid, linear SG
D = two measuring grids, measuring grid direction: parallel
X = two measuring grids, measuring grid direction: T or X-shaped, offset by 90°
R = three measuring grids, rosettes
V = 4 measuring grids, full bridge SG
M = full bridge SG as diaphragm rosette
K = SG chains for determining strain gradients

Standard or configurable

1 = Standard
K = with freely configurable connection cables

[1] available for selected strain gage types only

An even greater range of types – Easy to order

The current catalog offers a great selection of strain gages (SG).
In addition to our wide range of preferential strain gages (available ex stock), we hold a comprehensive choice of variants available for you.

This is how easily you can order our strain gages

Types available ex stock are printed on a shaded background in our price list.
Strain gage variants do not have a shaded background and are not always available ex stock.
We will be pleased to provide information on current availability if requested.
The minimum order quantity for these strain gages is 3 packages.

What does the "x" in the type designation of the strain gages in the "Variants" column stand for?

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	
1-LY11-0.6/120	1-LY13-0.6/120		120	0.6 *0.024*	1 *0.039*	5 *0.197*	3.2 *0.126*	1.5	LS 7
1-LY11-1.5/120	1-LY13-1.5/120	1-LY1x-1.5/120	120	1.5 *0.059*	1.2 *0.047*	6.5 *0.256*	4.7 *0.185*	2.5	LS 7
1-LY11-3/120	1-LY13-3/120	1-LY1x-3/120	120	3 *0.118*	1.4 *0.055*	8.5 *0.335*	4.5 *0.177*	4	LS 7
1-LY11-3/120A		1-LY1x-3/120A	120	3 *0.118*	1.4 *0.055*	8.5 *0.335*	4.5 *0.177*	4	LS 7
1-LY11-6/120	1-LY13-6/120	1-LY1x-6/120	120	6 *0.236*	2.8 *0.11*	13 *0.512*	6 *0.236*	8	LS 5
1-LY11-6/120A		1-LY1x-6/120A	120	6 *0.236*	2.8 *0.11*	13 *0.512*	6 *0.236*	8	LS 5
1-LY11-10/120	1-LY13-10/120	1-LY1x-10/120	120	10 *0.394*	4.9 *0.193*	18.5 *0.728*	9.5 *0.374*	13	LS 5
1-LY11-10/120A		1-LY1x-10/120A	120	10 *0.394*	4.9 *0.193*	18.5 *0.728*	9.5 *0.374*	13	LS 5
1-LY11-1.5/350	1-LY13-1.5/350		350	1.5 *0.059*	1.2 *0.047*	5.7 *0.224*	4.7 *0.185*	4.5	LS 212
1-LY11-3/350	1-LY13-3/350	1-LY1x-3/350	350	3 *0.118*	1.5 *0.059*	8.5 *0.335*	4.5 *0.177*	7	LS 7
		1-LY1x-3/350A	350	3 *0.118*	1.5 *0.059*	8.5 *0.335*	4.5 *0.177*	7	LS 7
1-LY11-6/350	1-LY13-6/350	1-LY1x-6/350	350	6 *0.236*	2.9 *0.114*	13 *0.512*	6 *0.236*	14	LS 5
1-LY11-6/350A		1-LY1x-6/350A	350	6 *0.236*	2.9 *0.114*	13 *0.512*	6 *0.236*	14	LS 5
1-LY11-10/350		1-LY1x-10/350	350	10 *0.394*	5 *0.197*	18.5 *0.728*	9.5 *0.374*	23	LS 5
1-LY11-10/350A		1-LY1x-10/350A	350	10 *0.394*	5 *0.197*	18.5 *0.728*	9.5 *0.374*	23	LS 5

Instead of the "x" in the strain gage type designation in the "Others" column, please enter the code number for the appropriate temperature response matching.

Example:

You wish matching of the type 1-LY1x-10/120 to plastic material. Then enter an "8" instead of the placeholder "x" when ordering; the exact order designation will then be 1-LY18-10/120.

The preferential strain gages are matched to steel or aluminum.

Please note the exceptions in the case of types marked by #!

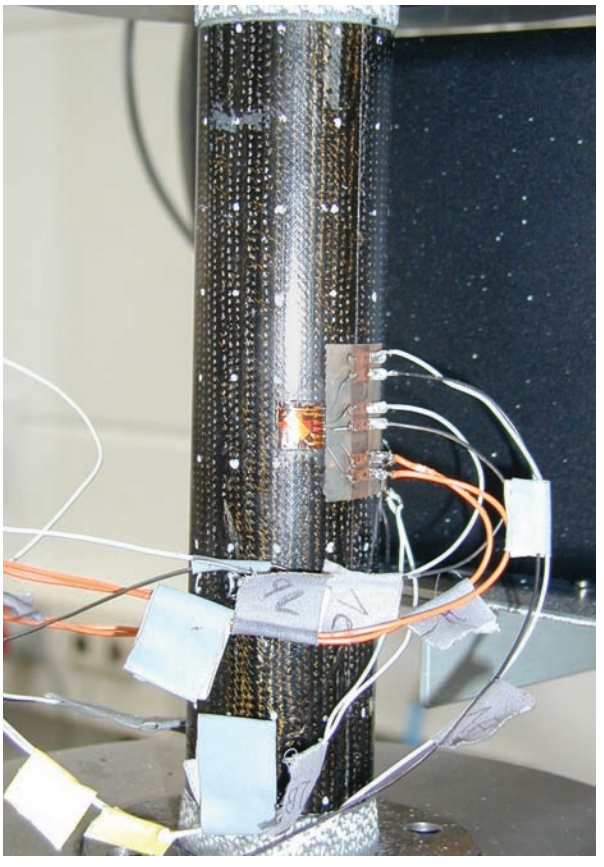
To simplify your order procedures, please also use our CD-ROM "SGdirect".
Order your example free of charge right now. For more information, go to: www.hbm.com

You can now also order via the new HBM online shop!
http://www.hbm.com/shop

SG / Y series

SG in series Y

- The universal SG
- Excellent measuring characteristics
- Different connection configurations
- Strain gage with connection cable (Page 39)
- Flexible, therefore easy to handle
- Wide range of geometries available ex stock
- Numerous geometries are available with different nominal (120, 350, 700, 1000 Ω) resistance values



Pipe specimen made of carbon-fiber reinforced plastic in torsion fracture test

Specifications

SG construction		Foil SG with embedded measuring grid
Measuring grid		
Material		Constantan foil
Thickness	µm *(microinch)*	3.8 or 5 *(150 or 197)*, depending on SG type
Carrier		
Material	µm *(microinch)*	Polyimide
Thickness		45 ± 10 *(1.772 ± 394)*
Covering agent		
Material	µm *(microinch)*	Polyimide
Thickness		25 ± 12 *(984 ± 472)*
Connections		Nickel plated Cu leads, approx. 30 mm in
length without connection leads		Integrated solder tabs, approx. 1.5 mm long, approx. 1.6 ... 2.2 mm (*0.063 ± 0.087 inch)* wide
Nominal resistance	Ω	120, 350, 700 or 1000, depending on SG type
Resistance tolerance[2]	%	± 0.3 without; ± 0.35 with connection leads
Gage factor		approx. 2
Nominal value of gage factor		Specified on each package
Gage factor tolerance with ≦ 1.5 mm (*0.059 inch*) measuring grid length	% ± 1.5	
with ≧ 3 mm (*0.118 inch*) measuring grid length	%	± 1
Temperature coefficient of the gage factor	1/K (*1/°F*)	approx. (115 ± 10) · 10^{-6} *(64 ± 5.5) · 10^{-6}*
Nominal value of gage factor temperature coefficient		Specified on each package
Reference temperature	°C (°F)	23 *(73.4)*
Operating temperature range		
for static, i.e. zero point-related measurements	°C (°F)	-70 ... + 200 *(-94...+392)*
for dynamic, i.e. non-zero point-related measurements	°C (°F)	-200 ... + 200 *(-328...+392)*
Transverse sensitivity		Specified on each package
at reference temperature when using Z70 adhesive on SG type LY11-6/120	%	- 0.1
Temperature response		Specified on each package
Temperature response as required, adapted to coefficients of thermal expansion		
α for ferritic steel	1/K (*1/°F*)	10.8 · 10^{-6} *(6.0 · 10^{-6})*
α for aluminum	1/K (*1/°F*)	23 · 10^{-6} *(12.8 · 10^{-6})*
α for plastic material	1/K (*1/°F*)	65 · 10^{-6} *(36.1 · 10^{-6})*
α for austenitic steel	1/K (*1/°F*)	16 · 10^{-6} *(8.9 · 10^{-6})*
α for titanium	1/K (*1/°F*)	9 · 10^{-6} *(5.0 · 10^{-6})*
α for molybdenum	1/K (*1/°F*)	5.4 · 10^{-6} *(3.0 · 10^{-6})*
α for quartz	1/K (*1/°F*)	0.5 · 10^{-6} *(0.3 · 10^{-6})*
Tolerance of temperature response	1/K (*1/°F*)	± 0.3 · 10^{-6} *± (0.17 · 10^{-6})*
Temperature response with matching in the range of [3]	°C (°F)	-10 ... + 20 *(14 ..248)*
Mechanical hysteresis[1]		
at reference temperature and strain ε = ± 1000 µm/m (*microstrain*)		
on SG type LY11-6/120		
at 1st load cycle and adhesive Z 70	µm/m (*microstrain*)	1
at 3rd load cycle and adhesive Z 70	µm/m (*microstrain*)	0.5
at 1st load cycle and adhesive X 60	µm/m (*microstrain*)	2.5
at 3rd load cycle and adhesive X 60	µm/m (*microstrain*)	1
at 1st load cycle and adhesive EP 250	µm/m (*microstrain*)	1
at 3rd load cycle and adhesive EP 250	µm/m (*microstrain*)	1
Maximum elongation[1]		
at reference temperature using adhesive Z 70		
on SG type LY11-6/120		
Absolute strain value ε for positive direction	µm/m (*microstrain*)	50-000 (≙ 5 %)
Absolute strain valueε for negative direction	µm/m (*microstrain*)	50-000 (≙ 5 %)
Fatigue life[1]		
at reference temperature using adhesive X 60		
on SG type LY61-6/120		
Achievable number of load cycles L_W at		
alternating strain ε_W = ± 1000 µm/m and zero point drift ε_m $\Delta \leqq$ 300 µm/m *(microstrain)*		>> 10^7 (test was interrupted at 10^7)
ε_m $\Delta \leqq$ 30 µm/m *(microstrain)*		> 10^7 (test was interrupted at 10^7)
Minimum radius of curvature, longitudinal and transverse,		
at reference temperature for strain gages with leads	mm (*inch*)	0.3 *(0.012)*
for SG with integrated solder tabs		
within measuring grid area	mm (*inch*)	0.3 *(0.012)*
within solder tabs area	mm (*inch*)	2 *(0.079)*
Bonding material than can be used		
Cold-curing adhesives		Z 70; X 60; X 280
Hot-curing adhesives		EP 150; EP 250; EP 310S

[1] The data depend on the various parameters of the specific application and are therefore stated for representative examples only.
[2] With measuring grid lengths of 0.3 mm *(0.012 inch)* and 0.6 mm *(0.024 inch)*, the nominal resistance may deviate by ± 1%. For the types LY 51/ LY5x the deviation is ± 0.75%. For XY9x, RY9x and the KY types (per chain) it is ± 0.5%.
[3] Matching to plastic (code number 8) is only possible in the temperature range of -10°C...+50°C *(14°F...+122°F)*.

SG / Series Y with 1 measuring grid / linear SG

LY11

Linear SG
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

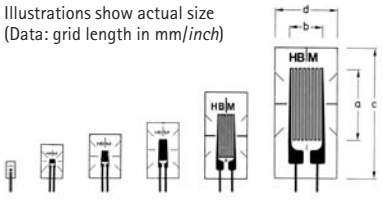
LY13

Temperature response matched to aluminum
with α = 23 · 10^{-6}/K (12.8 · 10^{-6}/°F)

LY1x

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: grid length in mm/*inch*)



0.3 (0.012) 0.6 (0.024) 1.5 (0.059) 3 (0.118) 6 (0.236) 10 (0.394)

Contents per package: 10 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	
1-LY11-0.3/120		1-LY1x-0.3/120#	120	0.3 *0.012*	0.9 *0.035*	2 *0.079*	1.2 *0.047*	0.6	LS 7
1-LY11-0.6/120	1-LY13-0.6/120	1-LY1x-0.6/120#	120	0.6 *0.024*	1 *0.039*	5 *0.197*	3.2 *0.126*	1.5	LS 7
1-LY11-1.5/120	1-LY13-1.5/120	1-LY1x-1.5/120	120	1.5 *0.059*	1.2 *0.047*	6.5 *0.256*	4.7 *0.185*	2.5	LS 7
1-LY11-3/120	1-LY13-3/120	1-LY1x-3/120	120	3 *0.118*	1.6 *0.063*	8.5 *0.335*	4.5 *0.177*	4	LS 7
1-LY11-3/120A		1-LY1x-3/120A	120	3 *0.118*	1.6 *0.063*	8.5 *0.335*	4.5 *0.177*	4	LS 7
1-LY11-6/120	1-LY13-6/120	1-LY1x-6/120	120	6 *0.236*	2.7 *0.106*	13 *0.512*	6 *0.236*	8	LS 5
1-LY11-6/120A		1-LY1x-6/120A	120	6 *0.236*	2.7 *0.106*	13 *0.512*	6 *0.236*	8	LS 5
1-LY11-10/120	1-LY13-10/120	1-LY1x-10/120	120	10 *0.394*	4.6 *0.181*	18.5 *0.728*	9.5 *0.374*	13	LS 5
1-LY11-10/120A		1-LY1x-10/120A	120	10 *0.394*	4.6 *0.181*	18.5 *0.728*	9.5 *0.374*	13	LS 5
1-LY11-1.5/350	1-LY13-1.5/350	1-LY1x-1.5/350#	350	1.5 *0.059*	1.2 *0.047*	5.7 *0.224*	4.7 *0.185*	4.5	LS 7
1-LY11-3/350	1-LY13-3/350	1-LY1x-3/350	350	3 *0.118*	1.6 *0.063*	8.5 *0.335*	4.5 *0.177*	7	LS 7
		1-LY1x-3/350A	350	3 *0.118*	1.6 *0.063*	8.5 *0.335*	4.5 *0.177*	7	LS 7
1-LY11-6/350	1-LY13-6/350	1-LY1x-6/350	350	6 *0.236*	2.8 *0.11*	13 *0.512*	6 *0.236*	13	LS 5
1-LY11-6/350A		1-LY1x-6/350A	350	6 *0.236*	2.8 *0.11*	13 *0.512*	6 *0.236*	13	LS 5
1-LY11-10/350		1-LY1x-10/350	350	10 *0.394*	5.0 *0.197*	18.5 *0.728*	9.5 *0.374*	23	LS 5
1-LY11-10/350A		1-LY1x-10/350A	350	10 *0.394*	5.0 *0.197*	18.5 *0.728*	9.5 *0.374*	23	LS 5

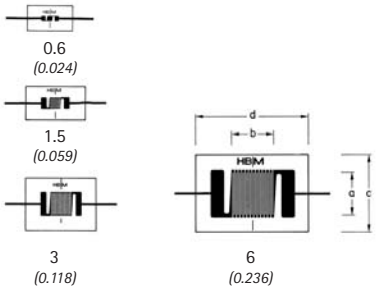
LY21

Linear SG
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

LY2x

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: grid length in mm/*inch*)



0.6 (0.024) 1.5 (0.059) 3 (0.118) 6 (0.236)

Contents per package: 10 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	
1-LY21-0.6/120		1-LY2x-0.6/120#	120	0.6 *0.024*	0.6 *0.024*	3.5 *0.138*	6.4 *0.252*	1	LS 7
1-LY21-1.5/120		1-LY2x-1.5/120	120	1.5 *0.059*	1.5 *0.059*	4.7 *0.185*	8.3 *0.327*	2	LS 5
1-LY21-3/120		1-LY2x-3/120	120	3 *0.118*	2.8 *0.11*	7.5 *0.295*	10 *0.394*	6	LS 5
		1-LY2x-6/120	120	6 *0.236*	6 *0.236*	11 *0.433*	16 *0.63*	12	LS 4

Types marked # are only available with matching to aluminum, ferritic or austenitic steel

SG / Series Y with 1 measuring grid / linear SG

LY41

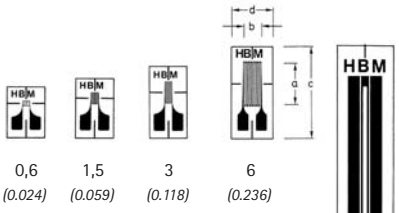
Linear SG
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

LY43

Temperature response matched to aluminum
with α = 23 · 10^{-6}/K (12.8 · 10^{-6}/°F)

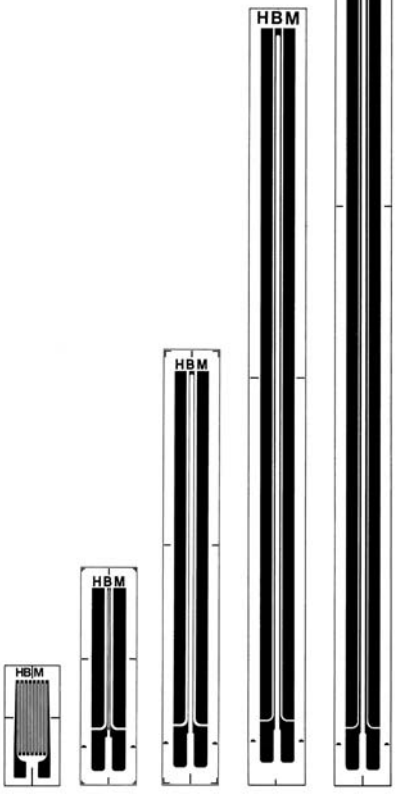
LY4x

Temperature response matched to customer's choice
see page 16



0,6 *(0.024)* 1,5 *(0.059)* 3 *(0.118)* 6 *(0.236)*

Illustrations show actual size
(Data: grid length in mm/inch)



10 *(0.394)* 20 *(0.787)* 50 *(2.968)* 100 *(3.937)* 150 *(5.905)*

Contents per package: 10 pcs.

Types available ex stock			Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals (1)
					Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other		Ω	a	b	c	d	V	
1-LY41-0.6/120		1-LY4x-0.6/120#	120		0.6 *0.024*	1.1 *0.043*	6 *0.236*	4 *0.157*	1.5	LS 5
1-LY41-1.5/120		1-LY4x-1.5/120	120		1.5 *0.059*	1.2 *0.047*	7 *0.276*	5 *0.197*	2.5	LS 5
1-LY41-3/120	1-LY43-3/120	1-LY4x-3/120	120		3 *0.118*	1.2 *0.047*	8 *0.315*	5 *0.197*	3.5	LS 5
		1-LY4x-3/120A	120		3 *0.118*	1.2 *0.047*	8 *0.315*	5 *0.197*	3.5	LS 5
1-LY41-6/120	1-LY43-6/120	1-LY4x-6/120	120		6 *0.236*	2.7 *0.106*	13.9 *0.547*	5.9 *0.232*	8	LS 5
1-LY41-6/120A		1-LY4x-6/120A	120		6 *0.236*	2.7 *0.106*	13.9 *0.547*	5.9 *0.232*	8	LS 5
1-LY41-10/120		1-LY4x-10/120	120		10 *0.394*	4.9 *0.193*	18 *0.709*	8 *0.315*	14	LS 5
		1-LY4x-10/120A	120		10 *0.394*	4.9 *0.193*	18 *0.709*	8 *0.315*	14	LS 5
1-LY41-20/120		1-LY4x-20/120	120		20 *0.787*	0.5 *0.020*	31.8 *1.252*	8.2 *0.323*	6.5	LS 5
1-LY41-50/120		1-LY4x-50/120	120		50 *1.969*	0.8 *0.031*	63.6 *2.504*	8.2 *0.323*	12	LS 5
1-LY41-100/120		1-LY4x-100/120	120		100 *3.937*	1 *0.039*	114.8 *4.520*	8.2 *0.323*	19	LS 5
1-LY41-150/120		1-LY4x-150/120	120		150 *5.906*	1.2 *0.047*	165.6 *6.520*	8.2 *0.323*	25	LS 5
1-LY41-1.5/350		1-LY4x-1.5/350#	350		1.5 *0.059*	2.3 *0.091*	9.2 *0.362*	5.9 *0.232*	6.5	LS 5
1-LY41-3/350	1-LY43-3/350	1-LY4x-3/350	350		3 *0.118*	2.5 *0.098*	10.9 *0.429*	5.9 *0.232*	9	LS 5
1-LY41-3/350A		1-LY4x-3/350A	350		3 *0.118*	2.5 *0.098*	10.9 *0.429*	5.9 *0.232*	9	LS 5
1-LY41-6/350	1-LY43-6/350	1-LY4x-6/350	350		6 *0.236*	2.8 *0.110*	13.9 *0.547*	5.9 *0.232*	15	LS 5
1-LY41-6/350A		1-LY4x-6/350A	350		6 *0.236*	2.8 *0.110*	13.9 *0.547*	5.9 *0.232*	15	LS 5
1-LY41-10/350		1-LY4x-10/350	350		10 *0.394*	5 *0.197*	18 *0.709*	8 *0.315*	24	LS 5
		1-LY4x-10/350A	350		10 *0.394*	5 *0.197*	18 *0.709*	8 *0.315*	24	LS 5
1-LY41-3/700	1-LY43-3/700	1-LY4x-3/700	700		3 *0.118*	2.7 *0.106*	10.9 *0.429*	5.9 *0.232*	13	LS 5
1-LY41-6/700		1-LY4x-6/700	700		6 *0.236*	4.1 *0.161*	13.9 *0.547*	5.9 *0.232*	23	LS 5
1-LY41-10/700		1-LY4x-10/700	700		10 *0.394*	5 *0.197*	18 *0.709*	8 *0.315*	33	LS 5
		1-LY4x-3/1000#	1000		3 *0.118*	2.7 *0.106*	10.9 *0.429*	5.9 *0.232*	16	LS 5
1-LY41-6/1000		1-LY4x-6/1000#	1000		6 *0.236*	4.2 *0.165*	13.9 *0.547*	5.9 *0.232*	27	LS 5
		1-LY4x-10/1000#	1000		10 *0.394*	5 *0.197*	18 *0.709*	8 *0.315*	40	LS 5

(1) Solder terminals are not compulsory
Types marked # are only available with matching to aluminum, ferritic or austenitic steel

SG / Series Y with 1 measuring grid / linear SG

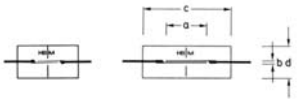
LY51

Linear SG
Temperature response matched to steel
with $\alpha = 10.8 \cdot 10^{-6}/K$ ($6.0 \cdot 10^{-6}/°F$)

LY5x

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: grid length in mm/*inch*)



3 *(0.118)* 6 *(0.236)*

Contents per package: 10 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	
1-LY51-3/120		1-LY5x-3/120	120	3 *0.118*	0.4 *0.016*	9 *0.354*	4.7 *0.185*	2	LS 7
		1-LY5x-6/120	120	6 *0.236*	0.4 *0.016*	13 *0.512*	4.7 *0.185*	3	LS 7

LY61

Linear SG
Temperature response matched to steel
with $\alpha = 10.8 \cdot 10^{-6}/K$ ($6.0 \cdot 10^{-6}/°F$)

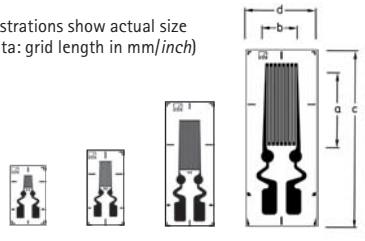
LY63

Temperature response matched to aluminum
with $\alpha = 23 \cdot 10^{-6}/K$ ($12.8 \cdot 10^{-6}/°F$)

LY6x

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: grid length in mm/*inch*)



1.5 *(0.059)* 3 *(0.118)* 6 *(0.236)* 10 *(0.394)*

Contents per package: 10 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	
1-LY61-1.5/120		1-LY6x-1.5/120	120	1.5 *0.059*	1.0 *0.039*	7.8 *0.307*	4.7 *0.185*	2.5	-
1-LY61-3/120		1-LY6x-3/120	120	3 *0.118*	1.5 *0.059*	9.8 *0.386*	4.7 *0.185*	4	-
		1-LY6x-3/120A	120	3 *0.118*	1.5 *0.059*	9.8 *0.386*	4.7 *0.185*	4	-
1-LY61-6/120	1-LY63-6/120	1-LY6x-6/120	120	6 *0.236*	2.7 *0.106*	16 *0.63*	6.3 *0.248*	8	-
		1-LY6x-6/120A	120	6 *0.236*	2.7 *0.106*	16 *0.63*	6.3 *0.248*	8	-
1-LY61-10/120		1-LY6x-10/120	120	10 *0.394*	4.6 *0.181*	23.5 *0.925*	9.3 *0.366*	13	-
1-LY61-3/350		1-LY6x-3/350	350	3 *0.118*	1.6 *0.063*	9.8 *0.386*	4.7 *0.185*	7	-
		1-LY6x-3/350A	350	3 *0.118*	1.6 *0.063*	9.8 *0.386*	4.7 *0.185*	7	-
1-LY61-6/350	1-LY63-6/350	1-LY6x-6/350	350	6 *0.236*	2.7 *0.106*	16 *0.63*	6.3 *0.248*	13	-
1-LY61-6/350A		1-LY6x-6/350A	350	6 *0.236*	2.7 *0.106*	16 *0.63*	6.3 *0.248*	13	-
1-LY61-10/350		1-LY6x-10/350	350	10 *0.394*	5 *0.197*	23.5 *0.925*	9.3 *0.366*	21	-

(1) Solder terminals are not compulsory
Types marked # are only available with matching to aluminum, ferritic or austenitic steel

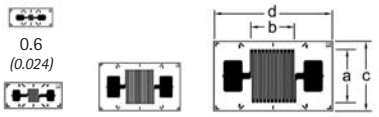
SG / Series Y with 1 measuring grid / linear SG

LY71
Linear SG
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

LY73
Temperature response matched to aluminum
with α = 23 · 10^{-6}/K (12.8 · 10^{-6}/°F)

LY7x
Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: grid length in mm/*inch*)



0.6 *(0.024)* | 1.5 *(0.059)* | 3 *(0.118)* | 6 *(0.236)*

Contents per package: 10 pcs.

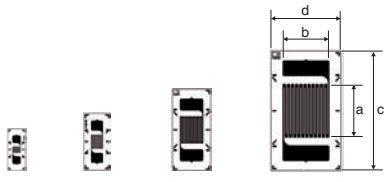
Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals (1)
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	
1-LY71-0.6/120		1-LY7x-0.6/120#	120	0.6 *0.024*	1 *0.039*	2.3 *0.091*	5.6 *0.22*	1	LS7
1-LY71-1.5/120		1-LY7x-1.5/120	120	1.5 *0.059*	1.5 *0.059*	3.4 *0.134*	7.5 *0.295*	2.5	LS5
1-LY71-3/120		1-LY7x-3/120	120	3 *0.118*	2.8 *0.11*	5.5 *0.217*	10.5 *0.413*	5	LS4
		1-LY7x-6/120	120	6 *0.236*	6 *0.236*	9 *0.354*	15.5 *0.61*	10	LS4
1-LY71-1.5/350	1-LY73-1.5/350	1-LY7x-1.5/350#	350	1.5 *0.059*	1.6 *0.063*	3.4 *0.134*	7.5 *0.295*	5	LS5
1-LY71- 3/350		1-LY7x-3/350	350	3 *0.118*	2.7 *0.106*	5.5 *0.217*	10.5 *0.413*	8.5	LS4
		1-LY7x-6/350	350	6 *0.236*	5.6 *0.22*	9 *0.354*	15.5 *0.61*	18	LS4

LY81
Linear SG
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

LY83
Temperature response matched to aluminum
with α = 23 · 10^{-6}/K (12.8 · 10^{-6}/°F)

LY8x
Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: grid length in mm/*inch*)



0.6 *(0.24)* | 1.5 *(0.059)* | 3 *(0.118)* | 6 *(0.236)*

Contents per package: 10 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals (1)
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	
		1-LY8x-0.6/120#	120	0.6 *0.024*	1 *0.039*	5.6 *0.22*	2.3 *0.091*	1	LS7
1-LY81-1.5/120		1-LY8x-1.5/120	120	1.5 *0.059*	1.5 *0.059*	7.5 *0.295*	3.4 *0.134*	2.5	LS5
1-LY81-3/120		1-LY8x-3/120	120	3 *0.118*	3 *0.118*	10.5 *0.413*	5.5 *0.217*	5	LS4
		1-LY8x-6/120	120	6 *0.236*	6 *0.236*	15.5 *0.61*	9 *0.354*	10	LS4
1-LY81-1.5/350	1-LY83-1.5/350	1-LY8x-1.5/350#	350	1.5 *0.059*	1.5 *0.059*	7.5 *0.295*	3.4 *0.134*	5	LS5
		1-LY8x-3/350	350	3 *0.118*	3 *0.118*	10.5 *0.413*	5.5 *0.217*	8.5	LS4
		1-LY8x-6/350	350	6 *0.236*	5.6 *0.22*	15.5 *0.61*	9 *0.354*	18	LS4

(1) Solder terminals are not compulsory
Types marked # are only available with matching to aluminum, ferritic or austenitic steel

SG / Series Y with 2 measuring grids / double SG

DY11

Double SG
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

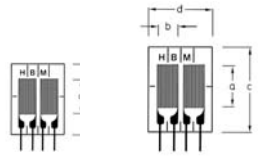
DY13

Temperature response matched to aluminum
with α = 23 · 10^{-6}/K (12.8 · 10^{-6}/°F)

DY1x

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: grid length in mm/*inch*)



3 *(0.118)* 6 *(0.236)*

Contents per package: 5 pcs.

Types available ex stock			Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals
					Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other		Ω	a	b	c	d	V	
1-DY11-3/350	1-DY13-3/350	1-DY1x-3/350		350	3 *0.118*	2.7 *0.106*	9 *0.354*	8 *0.315*	9	LS 7
1-DY11-6/350	1-DY13-6/350	1-DY1x-6/350		350	6 *0.236*	3.2 *0.126*	12.5 *0.492*	9.4 *0.370*	14	LS 7

DY41

Double SG
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

DY43

Temperature response matched to aluminum
with α = 23 · 10^{-6}/K (12.8 · 10^{-6}/°F)

DY4x

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: grid length in mm/*inch*)

1.5 *(0.059)* 3 *(0.118)* 6 *(0.236)*

Contents per package: 5 pcs.

Types available ex stock			Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals (1)
					Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other		Ω	a	b	c	d	V	
1-DY41-1.5/350		1-DY4x-1.5/350#		350	1.5 *0.059*	1.8 *0.071*	5.5 *0.217*	6 *0.236*	5	LS 7
1-DY41-3/350	1-DY43-3/350	1-DY4x-3/350		350	3 *0.118*	2.7 *0.106*	8.2 *0.323*	8 *0.315*	8.5	LS 7
1-DY41-6/350		1-DY4x-6/350		350	6 *0.236*	3.2 *0.126*	10.7 *0.421*	9 *0.354*	13	LS 7

(1) Solder terminals are not compulsory
Types marked # are only available with matching to aluminum, ferritic or austenitic steel

SG / Series Y with 2 measuring grids / T rosette

XY11

0°/90° T rosette
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

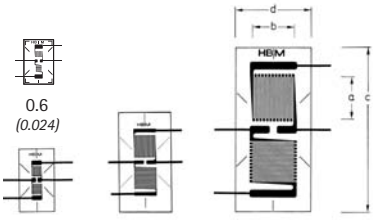
XY13

Temperature response matched to aluminum
with α = 23 · 10^{-6}/K (12.8 · 10^{-6}/°F)

XY1x

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: grid length in mm/*inch*)



0.6 *(0.024)* | 1.5 *(0.059)* | 3 *(0.118)* | 6 *(0.236)*

Contents per package: 5 pcs.

Types available ex stock			Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals
					Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other		Ω	a	b	c	d	V	
1-XY11-0.6/120		1-XY1x-0.6/120#	120		0.6 *0.024*	1.1 *0.043*	6 *0.236*	4 *0.157*	1.5	LS 7
1-XY11-1.5/120	1-XY13-1.5/120	1-XY1x-1.5/120	120		1.5 *0.059*	1.5 *0.059*	9 *0.354*	5 *0.197*	3	LS 5
1-XY11-3/120	1-XY13-3/120	1-XY1x-3/120	120		3 *0.118*	3.2 *0.126*	14.5 *0.571*	7.5 *0.295*	6	LS 4
1-XY11-6/120		1-XY1x-6/120	120		6 *0.236*	6.5 *0.256*	23.5 *0.925*	11 *0.433*	12	LS 5
1-XY11-1.5/350	1-XY13-1.5/350	1-XY1x-1.5/350#	350		1.5 *0.059*	1.5 *0.059*	9 *0.354*	5 *0.197*	5	LS 5
1-XY11-3/350	1-XY13-3/350	1-XY1x-3/350	350		3 *0.118*	3.1 *0.122*	14.4 *0.567*	7.3 *0.287*	10	LS 4
1-XY11-6/350	1-XY13-6/350	1-XY1x-6/350	350		6 *0.236*	6.3 *0.248*	23.3 *0.917*	10.5 *0.413*	20	LS 4

XY31

0°/90° T rosette
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

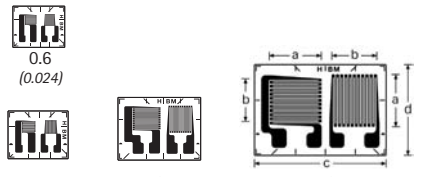
XY33

Temperature response matched to aluminum
with α = 23 · 10^{-6}/K (12.8 · 10^{-6}/°F)

XY3x

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: grid length in mm/*inch*



0.6 *(0.024)* | 1.5 *(0.059)* | 3 *(0.118)* | 6 *(0.236)*

Contents per package: 5 pcs.

Types available ex stock			Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals (1)
					Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other		Ω	a	b	c	d	V	
1-XY31-0.6/120		1-XY3x-0.6/120#	120		0.6 *0.024*	1 *0.039*	7 *0.276*	6 *0.236*	1.5	LS7
1-XY31-1.5/120	1-XY33-1.5/120	1-XY3x-1.5/120	120		1.5 *0.059*	1.6 *0.063*	8 *0.315*	6.3 *0.248*	3	LS7
1-XY31-3/120		1-XY3x-3/120	120		3 *0.118*	3.2 *0.126*	10.5 *0.413*	8 *0.315*	5.5	LS7
1-XY31-6/120		1-XY3x-6/120	120		6 *0.236*	6.3 *0.248*	17.5 *0.689*	12 *0.472*	11	LS4
1-XY31-1.5/350	1-XY33-1.5/350	1-XY3x-1.5/350#	350		1.5 *0.059*	1.7 *0.067*	7.7 *0.303*	6.3 *0.248*	5	LS7
1-XY31-3/350	1-XY33-3/350	1-XY3x-3/350	350		3 *0.118*	3.3 *0.13*	10.9 *0.429*	7.6 *0.299*	10	LS5
1-XY31-6/350	1-XY33-6/350	1-XY3x-6/350	350		6 *0.236*	6.5 *0.256*	18 *0.709*	12 *0.472*	20	LS4

(1) Solder terminals are not compulsory
Types marked # are only available with matching to aluminum, ferritic or austenitic steel

SG / Series Y with 2 measuring grids / T rosette

XY71

0°/90° T rosette
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

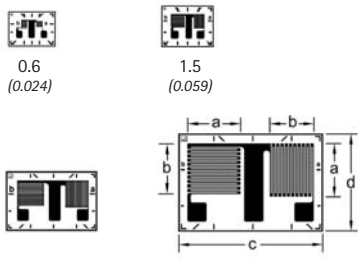
XY73

Temperature response matched to aluminum
with α = 23 · 10^{-6}/K (12.8 · 10^{-6}/°F)

XY7x

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: grid length in mm/*inch*)



Contents per package: 5 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals (1)
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	
		1-XY7x-0.6/120#	120	0.6 *0.024*	0.8 *0.031*	5.9 *0.232*	4.3 *0.169*	1	LS7
		1-XY7x-1.5/120	120	1.5 *0.059*	1.4 *0.055*	6.5 *0.256*	5 *0.197*	2.5	LS7
		1-XY7x-3/120	120	3 *0.118*	3 *0.118*	11.5 *0.453*	7.3 *0.287*	5.5	LS7
		1-XY7x-6/120	120	6 *0.236*	5.7 *0.224*	18.5 *0.728*	12.5 *0.492*	10	LS4
1-XY71-1.5/350	1-XY73-1.5/350	1-XY7x-1.5/350#	350	1.5 *0.059*	1.5 *0.059*	6.5 *0.256*	5 *0.197*	4.5	LS7
1-XY71-3/350	1-XY73-3/350	1-XY7x-3/350	350	3 *0.118*	3 *0.118*	11.5 *0.453*	7.3 *0.287*	9	LS5
		1-XY7x-6/350	350	6 *0.236*	5.8 *0.228*	18.5 *0.728*	12.5 *0.492*	18.5	LS4

XY91

0°/90° stacked T rosette
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

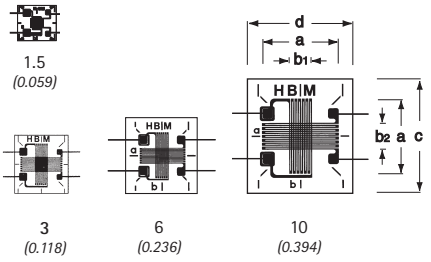
XY93

Temperature response matched to aluminum
with α = 23 · 10^{-6}/K (12.8 · 10^{-6}/°F)

XY9x

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: grid length in mm/*inch*)



Contents per package: 5 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)					Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid			Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b1	b2	c	d	V	
1-XY91-1.5/120		1-XY9x-1.5/120	120	1.5 *0.059*	1.2 *0.047*	1.2 *0.047*	4.7 *0.185*	6.7 *0.264*	1	LS 5
1-XY91-3/120	1-XY93-3/120	1-XY9x-3/120	120	3 *0.118*	1.4 *0.055*	1.3 *0.051*	6.2 *0.244*	7.9 *0.311*	2	LS 5
1-XY91-6/120	1-XY93-6/120	1-XY9x-6/120	120	6 *0.236*	1.9 *0.075*	2.2 *0.087*	10 *0.394*	9.6 *0.378*	3.5	LS 4
1-XY91-10/120		1-XY9x-10/120	120	10 *0.394*	3.2 *0.126*	3.8 *0.15*	15.2 *0.598*	14.0 *0.551*	6.5	LS 212
1-XY91-1.5/350	1-XY93-1.5/350	1-XY9x-1.5/350#	350	1.5 *0.059*	1.5 *0.059*	1.5 *0.059*	4.7 *0.185*	6.7 *0.264*	2.5	LS 5
1-XY91-3/350	1-XY93-3/350	1-XY9x-3/350	350	3 *0.118*	1.5 *0.059*	1.4 *0.055*	6.2 *0.244*	7.9 *0.311*	3.5	LS 5
1-XY91-6/350	1-XY93-6/350	1-XY9x-6/350	350	6 *0.236*	2 *0.079*	2.2 *0.087*	10 *0.394*	9.6 *0.378*	6	LS 4
		1-XY9x-10/350	350	10 *0.394*	3.3 *0.13*	3.7 *0.146*	15.2 *0.551*	14 *0.551*	11.5	LS 212

(1) Solder terminals are not compulsory
Types marked # are only available with matching to aluminum, ferritic or austenitic steel

SG / Series Y with 2 measuring grids / Shear/torsion SG / T rosette

XY101

0°/90° T rosette
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

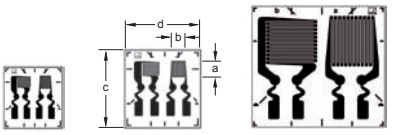
XY103

Temperature response matched to aluminum
with α = 23 · 10^{-6}/K (12.8 · 10^{-6}/°F)

XY10x

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: grid length in mm/*inch*)



1.5 *(0.059)* | 3 *(0.118)* | 6 *(0.236)*

Contents per package: 5 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals (1)
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	
1-XY101-1.5/120		1-XY10x-1.5/120	120	1.5 *0.059*	1.6 *0.063*	8 *0.315*	8.3 *0.327*	1.5	LS7
1-XY101-3/120	1-XY103-3/120	1-XY10x-3/120	120	3 *0.118*	3.2 *0.126*	10.6 *0.417*	9.8 *0.386*	3	LS5
		1-XY10x-6/120	120	6 *0.236*	6.5 *0.256*	18 *0.709*	16.5 *0.65*	5.5	LS4
1-XY101-3/350	1-XY103-3/350	1-XY10x-3/350	350	3 *0.118*	3.3 *0.13*	10.6 *0.417*	9.8 *0.386*	11	LS5
		1-XY10x-6/350	350	6 *0.236*	6 *0.236*	18 *0.709*	16.5 *0.65*	10	LS4

XY21

Shear/torsion half bridge
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

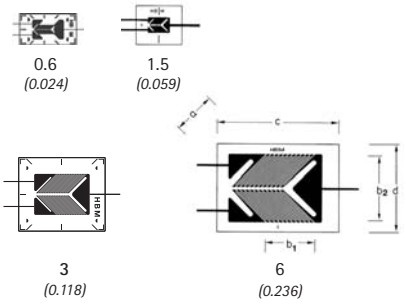
XY23

Temperature response matched to aluminum
with α = 23 · 10^{-6}/K (12.8 · 10^{-6}/°F)

XY2x

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: grid length in mm/*inch*)



0.6 *(0.024)* | 1.5 *(0.059)*

3 *(0.118)* | 6 *(0.236)*

Contents per package: 5 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)					Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid			Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b1	b2	c	d	V	
1-XY21-0.6/120		1-XY2x-0.6/120#	120	0.6 *0.024*	2.2 *0.087*	1.1 *0.043*	7.5 *0.295*	4 *0.157*	2.5	LS 7
1-XY21-1.5/120		1-XY2x-1.5/120	120	1.5 *0.059*	1.7 *0.067*	2.5 *0.098*	6.8 *0.268*	4.5 *0.177*	4.5	LS 7
1-XY21-3/120		1-XY2x-3/120	120	3 *0.118*	3.7 *0.146*	5.3 *0.209*	11.2 *0.441*	9.5 *0.374*	6	LS 5
1-XY21-6/120		1-XY2x-6/120	120	6 *0.236*	8 *0.315*	10 *0.394*	17.5 *0.689*	12.7 *0.5*	11	LS 4
1-XY21-1.5/350		1-XY2x-1.5/350#	350	1.5 *0.059*	2.2 *0.087*	2.5 *0.098*	7.4 *0.291*	4.5 *0.177*	5	LS 7
1-XY21-3/350	1-XY23-3/350	1-XY2x-3/350	350	3 *0.118*	4.2 *0.165*	5.3 *0.209*	11.2 *0.441*	9.5 *0.374*	10	LS 4
1-XY21-6/350	1-XY23-6/350	1-XY2x-6/350	350	6 *0.236*	8 *0.315*	10 *0.394*	17.5 *0.689*	12.7 *0.5*	19	LS 4
		1-XY2x-3/700#	700	3 *0.118*	4.0 *0.157*	4.7 *0.185*	11.2 *0.441*	9.5 *0.374*	14	LS 5
		1-XY2x-6/700	700	6 *0.236*	7.8 *0.307*	9.2 *0.362*	17.5 *0.689*	12.7 *0.5*	27	LS 4

(1) Solder terminals are not compulsory
Types marked # are only available with matching to aluminum, ferritic or austenitic steel

SG / Series Y with 2 measuring grids / Torsion/shear SG

XY41

Shear/torsion half bridge
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

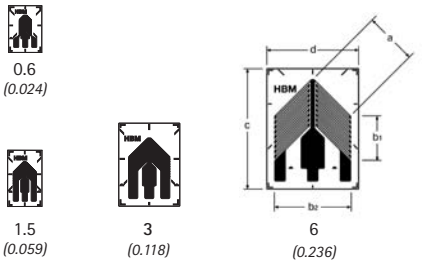
XY43

Temperature response matched to aluminum
with α = 23 · 10^{-6}/K (12.8 · 10^{-6}/°F)

XY4x

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: grid length in mm/*inch*)



Contents per package: 5 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)					Max. perm. effective bridge ex. voltage	Solder terminals (1)
				Measuring grid			Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b1	b2	c	d	V	
1-XY41-0.6/120		1-XY4x-0.6/120#	120	0.6 *0.024*	2.2 *0.087*	1.6 *0.063*	6.5 *0.256*	4.6 *0.181*	1.5	LS 7
1-XY41-1.5/120	1-XY43-1.5/120	1-XY4x-1.5/120	120	1.5 *0.059*	1.8 *0.071*	3.1 *0.122*	7.5 *0.295*	4.6 *0.181*	2.5	LS 7
1-XY41-3/120		1-XY4x-3/120	120	3 *0.118*	3 *0.118*	5.4 *0.213*	11 *0.433*	8 *0.315*	5	LS 7
1-XY41-6/120		1-XY4x-6/120	120	6 *0.236*	6 *0.236*	10.2 *0.402*	16 *0.63*	12.2 *0.48*	9.5	LS 4
1-XY41-1.5/350		1-XY4x-1.5/350#	350	1.5 *0.059*	2.1 *0.083*	3.1 *0.122*	7.5 *0.295*	4.5 *0.177*	4	LS7
1-XY41-3/350	1-XY43-3/350	1-XY4x-3/350	350	3 *0.118*	4.2 *0.165*	5.6 *0.22*	11 *0.433*	8 *0.315*	9.5	LS 7
1-XY41-6/350		1-XY4x-6/350	350	6 *0.236*	6 *0.236*	10 *0.394*	16 *0.63*	12.2 *0.48*	16	LS 4
1-XY41-3/700		1-XY4x-3/700#	700	3 *0.118*	4.2 *0.165*	5.6 *0.22*	11 *0.433*	8 *0.315*	13.5	LS 7
		1-XY4x-6/700	700	6 *0.236*	6.1 *0.24*	9.9 *0.39*	16 *0.63*	12.2 *0.48*	23	LS 4

(1) Solder terminals are not compulsory
Types marked # are only available with matching to aluminum, ferritic or austenitic steel

SG / Series Y with 3 measuring grids / rosettes

RY11

0°/45°/90° rosette
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

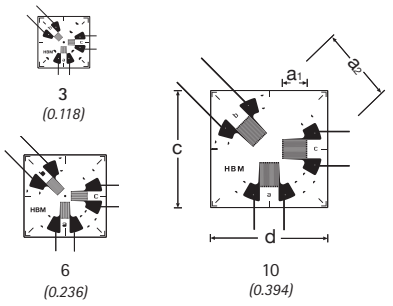
RY13

Temperature response matched to aluminum
with α = 23 · 10^{-6}/K (12.8 · 10^{-6}/°F)

RY1x

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: Dimension a_2 in mm/*inch*)



Contents per package: 5 pcs.

Types available ex stock			Variants	Nominal resistance	Dimensions (mm/*inch*)					Max. perm. effective bridge ex. voltage	Solder terminals
					Measuring grid			Measuring grid carrier			
Steel	Aluminum	Other		Ω	a1	a2	b	c	d	V	
1-RY11-3/120	1-RY13-3/120	1-RY1x-3/120#		120	0.8 *0.031*	3 *0.118*	0.8 *0.031*	7 *0.276*	7 *0.276*	1.5	LS 7
1-RY11-6/120	1-RY13-6/120	1-RY1x-6/120		120	2 *0.079*	6 *0.236*	1.4 *0.055*	11 *0.433*	11 *0.433*	3	LS 5
1-RY11-10/120		1-RY1x-10/120		120	2.9 *0.114*	10 *0.394*	2.7 *0.106*	15.4 *0.606*	15.4 *0.606*	5	LS 4

RY31

0°/45°/90° rosette
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

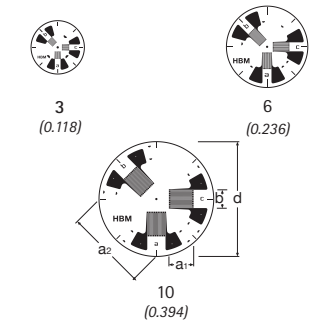
RY33

Temperature response matched to aluminum
with α = 23 · 10^{-6}/K (12.8 · 10^{-6}/°F)

RY3x

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: Dimension a_2 in mm/*inch*)



Contents per package: 5 pcs.

Types available ex stock			Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals (1)
					Measuring grid			Measuring grid carrier		
Steel	Aluminum	Other		Ω	a1	a2	b	d	V	
1-RY31-3/120		1-RY3x-3/120#		120	0.8 *0.031*	3 *0.118*	0.8 *0.031*	6.9 *0.272*	1.5	LS 7
1-RY31-6/120	1-RY33-6/120	1-RY3x-6/120		120	2 *0.079*	6 *0.236*	1.4 *0.055*	11 *0.433*	3	LS 5
1-RY31-10/120		1-RY3x-10/120		120	2.9 *0.114*	10 *0.394*	2.7 *0.106*	15.4 *0.606*	5	LS 4

(1) Solder terminals are not compulsory
Types marked # are only available with matching to aluminum, ferritic or austenitic steel

SG / Series Y with 3 measuring grids / rosettes

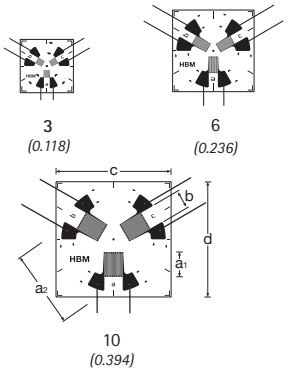
RY41

0°/60°/120° rosette
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (12.8 · 10^{-6}/°F)

RY4x

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: Dimension a_2 in mm/*inch*)



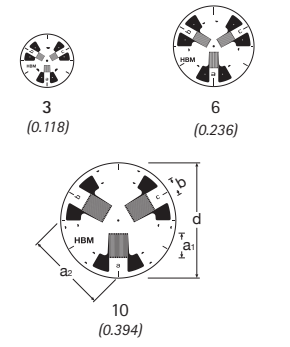
Contents per package: 5 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)					Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid			Measuring grid carrier			
Steel	Aluminum	Other	Ω	a1	a2	b	c	d	V	
		1-RY4x-3/120#	120	0.8 *0.031*	3 *0.118*	0.8 *0.031*	7 *0.276*	7 *0.276*	1.5	LS 7
1-RY41-6/120		1-RY4x-6/120	120	2 *0.079*	6 *0.236*	1.4 *0.055*	11 *0.433*	11 *0.433*	3	LS 5
1-RY41-10/120		1-RY4x-10/120	120	2.9 *0.114*	10 *0.394*	2.7 *0.106*	15.4 *0.606*	15.4 *0.606*	5	LS 4

RY7x

0°/60°/120° rosette
Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: Dimension a_2 in mm/*inch*)



Contents per package: 5 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals (1)
				Measuring grid			Measuring grid carrier		
Steel	Aluminum	Other	Ω	a1	a2	b	d	V	
		1-RY7x-3/120#	120	0.8 *0.031*	3 *0.118*	0.8 *0.031*	6.9 *0.272*	1.5	LS 7
		1-RY7x-6/120	120	2 *0.079*	6 *0.236*	1.4 *0.055*	11 *0.433*	3	LS 5
		1-RY7x-10/120	120	2.9 *0.114*	10 *0.394*	2.7 *0.106*	15.4 *0.606*	5	LS 4

(1) Solder terminals are not compulsory
Types marked # are only available with matching to aluminum, ferritic or austenitic steel

SG / Series Y with 3 measuring grids / rosettes

RY81

0°/45°/90° rectangular rosette
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

RY83

Temperature response matched to aluminum
with α = 23 · 10^{-6}/K (12.8 · 10^{-6}/°F)

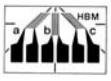
RY8x

Temperature response matched to customer's choice
see page 16

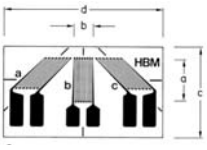
Illustrations show actual size
(Data: grid length in mm/*inch*)

0.6
(0.024)

1.5
(0.059)



3
(0.118)



6
(0.236)

Contents per package: 5 pcs.

Types available ex stock			Variants	No-minal resis-tance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals (1)
					Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other		Ω	a	b	c	d	V	
		1-RY8x-0.6/120#	120		0.6 *0.024*	1.2 *0.047*	4.8 *0.189*	8.7 *0.343*	1.6	LS 7
1-RY81-1.5/120		1-RY8x-1.5/120	120		1.5 *0.059*	1.4 *0.055*	8.2 *0.323*	14.6 *0.575*	2.5	LS 7
1-RY81-3/120	1-RY83-3/120	1-RY8x-3/120	120		3 *0.118*	1.1 *0.043*	9.7 *0.382*	14.6 *0.575*	3	LS 7
1-RY81-6/120		1-RY8x-6/120	120		6 *0.236*	3 *0.118*	13 *0.512*	22.9 *0.902*	7.5	LS 7
		1-RY8x-1.5/350#	350		1.5 *0.059*	1.6 *0.063*	8.2 *0.323*	14.6 *0.575*	5	LS 7
		1-RY8x-3/350	350		3 *0.118*	1.2 *0.047*	9.7 *0.382*	14.6 *0.575*	5.5	LS 7
1-RY81-6/350		1-RY8x-6/350	350		6 *0.236*	2.8 *0.11*	13.1 *0.516*	22.9 *0.902*	13	LS 5

RY91

0°/45°/90° – rosette, stacked measuring grids
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

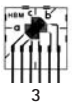
RY93

Temperature response matched to aluminum
with α = 23 · 10^{-6}/K (12.8 · 10^{-6}/°F)

RY9x

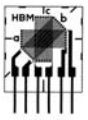
Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: grid length in mm/*inch*)

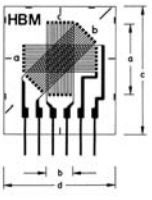


3
(0.118)

1.5
(0.059)



6
(0.236)



10
(0.394)

Contents per package: 5 pcs.

Types available ex stock			Variants	No-minal resis-tance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals
					Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other		Ω	a	b	c	d	V	
1-RY91-1.5/120		1-RY9x-1.5/120	120		1.5 *0.059*	1.3 *0.051*	9 *0.354*	8 *0.315*	1.5	LS 7
1-RY91-3/120	1-RY93-3/120	1-RY9x-3/120	120		3 *0.118*	1.3 *0.051*	9 *0.354*	9 *0.354*	2	LS 7
1-RY91-6/120	1-RY93-6/120	1-RY9x-6/120	120		6 *0.236*	2.6 *0.102*	12.5 *0.492*	11.4 *0.449*	4.5	LS 7
1-RY91-10/120		1-RY9x-10/120	120		10 *0.394*	4 *0.157*	17.5 *0.689*	16 *0.63*	7	LS 7
1-RY91-1.5/350		1-RY9x-1.5/350#	350		1.5 *0.059*	1.5 *0.059*	8 *0.315*	9 *0.354*	2.5	LS 7
1-RY91-3/350	1-RY93-3/350	1-RY9x-3/350	350		3 *0.118*	1.5 *0.059*	9 *0.354*	9 *0.354*	3.5	LS 7
1-RY91-6/350	1-RY93-6/350	1-RY9x-6/350	350		6 *0.236*	2.6 *0.102*	12.5 *0.492*	11.4 *0.449*	6	LS 7
		1-RY9x-10/350	350		10 *0.394*	4 *0.157*	17.6 *0.693*	16 *0.63*	11.5	LS 7

(1) Solder terminals are not compulsory
Types marked # are only available with matching to aluminum, ferritic or austenitic steel

SG / Series Y with 3 measuring grids / rosettes

RY101

0°/45°/90° rectangular rosette
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

RY103

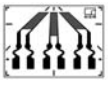
Temperature response matched to aluminum
with α = 23 · 10^{-6}/K (12.8 · 10^{-6}/°F)

RY10x

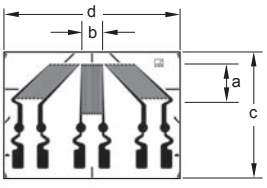
Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: grid length in mm/inch)

1.5
(0.059)



3
(0.118)



6
(0.236)

Contents per package: 5 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	
1-RY101-1.5/120		1-RY10x-1.5/120	120	1.5 *0.059*	1.4 *0.055*	8.2 *0.323*	13.5 *0.531*	2.5	LS 7
1-RY101-3/120	1-RY103-3/120	1-RY10x-3/120	120	3 *0.118*	1.1 *0.043*	9.7 *0.382*	13.5 *0.531*	3	LS 7
1-RY101-6/120	1-RY103-6/120	1-RY10x-6/120	120	6 *0.236*	3 *0.118*	16.4 *0.646*	22.9 *0.902*	7.5	LS 4
1-RY101-3/350	1-RY103-3/350	1-RY10x-3/350	350	3 *0.118*	1.2 *0.047*	9.7 *0.382*	13.5 *0.531*	5.5	LS 7
1-RY101-6/350	1-RY103-6/350	1-RY10x-6/350	350	6 *0.236*	2.8 *0.11*	16.4 *0.646*	22.9 *0.902*	12	LS4

(1) Solder terminals are not compulsory

SG / Series Y with 4 measuring grids / full bridges

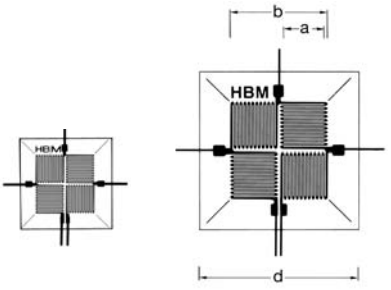
VY11

0°/90° – T full bridge
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

VY1x

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: grid length in mm/*inch*)



3 *(0.118)* 6 *(0.236)*

Contents per package: 5 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	
1-VY11-3/120		1-VY1x-3/120	120	3 *0.118*	7 *0.276*	13.5 *0.531*	13.5 *0.531*	6	LS 5/7
1-VY11-6/120		1-VY1x-6/120	120	6 *0.236*	14 *0.551*	23 *0.906*	23 *0.906*	12	LS 5/7

VY41

Shear/torsion full bridge
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

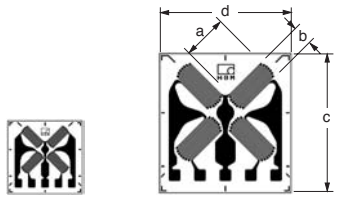
VY43

Temperature response matched to aluminum
with α = 23 · 10^{-6}/K (12.8 · 10^{-6}/°F)

VY4x

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: grid length in mm/*inch*)



3 *(0.118)* 6 *(0.236)*

Contents per package: 5 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals (1)
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	
1-VY41-3/120		1-VY41x-3/120	120	3 *0.118*	1.3 *0.051*	9.8 *0.386*	10 *0.394*	3.5	LS7
		1-VY41x-6/120	120	6 *0.236*	2.7 *0.106*	18 *0.709*	17 *0.669*	7.5	LS4
1-VY41-3/350	1-VY43-3/350	1-VY41x-3/350	350	3 *0.118*	1.2 *0.047*	9.8 *0.386*	10 *0.394*	6	LS7
		1-VY41x-6/350	350	6 *0.236*	2.7 *0.106*	18 *0.709*	17 *0.669*	13	LS4

(1) Solder terminals are not compulsory

SG / Series Y with 4 measuring grids / diaphragm rosettes

MY21

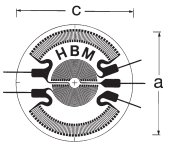
Diaphragm rosette
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

MY2x

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: Dimension a in mm/*inch*)

6
(0.236)



15
(0.???)

Contents per package: 5 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals (1)
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	
		1-MY2x-6/120	120	6 *0.236*	–	7.3 *0.287*	–	3.5	LS 7
1-MY21-15/350		1-MY2x-15/350	350	15 *0.591*	–	17 *0.669*	–	13	LS 5

SG / Series Y SG chains

KY11

SG chain
Comprising 10 measuring grids in parallel to the chain axis and 1 compensating SG.
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

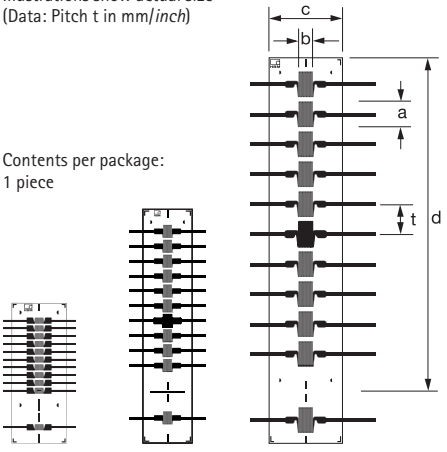
KY13

Temperature response matched to aluminum
with α = 23 · 10^{-6}/K (12.8 · 10^{-6}/°F)

KY1x

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: Pitch t in mm/*inch*)



Contents per package:
1 piece

1 *(0.039)* 2 *(0.079)* 4 *(0.157)*

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)					Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier		Pitch		
Steel	Aluminum	Other	Ω	a	b	c	d	t	V	
1-KY11-1/120	1-KY13-1/120	1-KY1x-1/120#	120	0.6 *0.024*	1 *0.039*	7.2 *0.283*	14.5 *0.571*	1 *0.039*	2	LS 7
1-KY11-2/120	1-KY13-2/120	1-KY1x-2/120	120	1.5 *0.059*	1.3 *0.051*	6.7 *0.264*	24.5 *0.965*	2 *0.079*	2.5	LS 7
1-KY11-4/120		1-KY1x-4/120	120	3 *0.118*	2.1 *0.083*	9.7 *0.382*	44.5 *1.752*	4 *0.157*	5	LS 7

KY21

SG chain
Comprising 10 measuring grids vertical to the chain axis and 1 compensating SG.
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

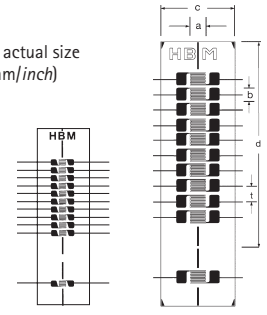
KY23

Temperature response matched to aluminum
with α = 23 · 10^{-6}/K (12.8 · 10^{-6}/°F)

KY2x

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: Pitch t in mm/*inch*)



Contents per package: 1 piece

1 *(0.039)* 2 *(0.079)*

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)					Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier		Pitch		
Steel	Aluminum	Other	Ω	a	b	c	d	t	V	
1-KY21-1/120	1-KY23-1/120	1-KY2x-1/120#	120	0.8 *0.031*	0.8 *0.031*	6.9 *0.272*	15 *0.591*	1 *0.039*	1.5	LS 7
1-KY21-2/120		1-KY2x-2/120	120	1.7 *0.067*	1.7 *0.067*	9.5 *0.374*	27 *1.063*	2 *0.079*	3.5	LS 7

Types marked # are only available with matching to aluminum, ferritic or austenitic steel

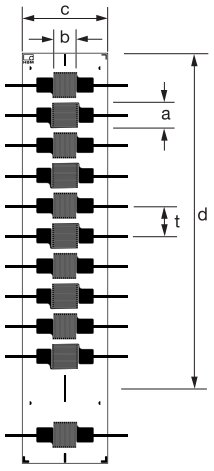
KY41

SG chain
Comprising 10 measuring grids (5 parallel, 5 vertical to chain axis, alternating)
and 1 compensating SG.
Temperature response matched to steel
with $\alpha = 10.8 \cdot 10^{-6}/K$ ($6.0 \cdot 10^{-6}/°F$)

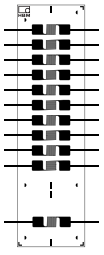
KY4x

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: Pitch t in mm/*inch*)



Contents per package:
1 piece



2
(0.079)

4
(0.157)

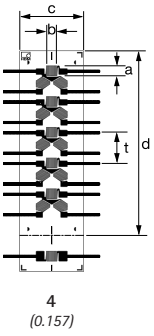
Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)					Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier		Pitch		
Steel	Aluminum	Other	Ω	a	b	c	d	t	V	
		1-KY4x-2/120	120	1.2 *0.047*	1.3 *0.051*	9.2 *0.362*	24.5 *0.965*	2 *0.079*	2.5	LS 7
1-KY41-4/120		1-KY4x-4/120	120	3 *0.118*	3 *0.118*	11.5 *0.453*	44.5 *1.752*	4 *0.157*	6	LS 5

KY3x

SG rosette chain
Comprising 5 rosettes each with 3 0°-/-60°-/-120° measuring grids and 1 compensating SG.

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: Pitch t in mm/*inch*)



4
(0.157)

Contents per package: 1 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)					Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier		Pitch		
Steel	Aluminum	Other	Ω	a	b	c	d	t	V	
		1-KY3x-4/120	120	1.2 *0.047*	1.3 *0.051*	8.3 *0.327*	24 *0.945*	4 *0.157*	2.5	LS 7

SG / Series Y SG chains

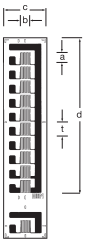
KY5x

SG chain
Comprising 10 measuring grids with common connection in parallel to chain axis and 1 compensating SG.

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: Pitch t in mm/*inch*)

1
(0.039)



2
(0.079)

Contents per package: 5 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)					Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier		Pitch		
Steel	Aluminum	Other	Ω	a	b	c	d	t	V	
		1-KY5x-1/120#	120	0.6 *0.024*	1.2 *0.047*	5.6 *0.22*	12.8 *0.504*	1 *0.039*	1.5	-
		1-KY5x-2/120	120	1.5 *0.059*	1.4 *0.055*	6 *0.236*	22.8 *0.898*	2 *0.079*	2.5	-

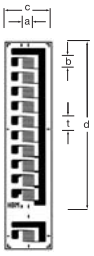
KY6x

SG chain
Comprising 10 measuring grids with common connection in vertical to chain axis and 1 compensating SG.

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: Pitch t in mm/*inch*)

1
(0.039)



2
(0.079)

Contents per package: 5 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)					Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier		Pitch		
Steel	Aluminum	Other	Ω	a	b	c	d	t	V	
		1-KY6x-1/120#	120	0.8 *0.031*	0.7 *0.028*	5.6 *0.22*	12.8 *0.504*	1 *0.039*	1.2	-
		1-KY6x-2/120	120	1.3 *0.051*	1.6 *0.063*	6 *0.236*	22.8 *0.898*	2 *0.079*	2.5	-

Types marked # are only available with matching to aluminum, ferritic or austenitic steel

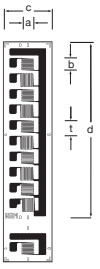
SG / Series Y SG chains

KY7x

SG chain
Comprising 10 measuring grids with common connection in (5 parallel, 5 vertical to chain axis, alternating) and 1 compensation SG.

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: Pitch t in mm/*inch*)



Contents per package: 5 pcs.

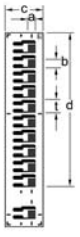
Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)					Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier		Pitch		
Steel	Aluminum	Other	Ω	a	b	c	d	t	V	
		1-KY7x-2/120	120	1.3 *0.051*	1.5 *0.059*	6 *0.236*	22.8 *0.898*	2 *0.079*	2.5	-

KY8x

SG chain
Comprising 10 measuring grids parallel to the chain axis and 1 compensating SG.

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: Pitch t in mm/*inch*)



2
(0.079)

Contents per package: 5 pcs.

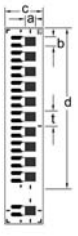
Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)					Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier		Pitch		
Steel	Aluminum	Other	Ω	a	b	c	d	t	V	
		1-KY8x-2/120	120	1 *0.039*	1 *0.039*	5 *0.197*	21.7 *0.854*	2 *0.079*	2	-

KY9x

SG chain
Comprising 10 measuring grids vertical to the chain axis and 1 compensating SG.

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: Pitch t in mm/*inch*)



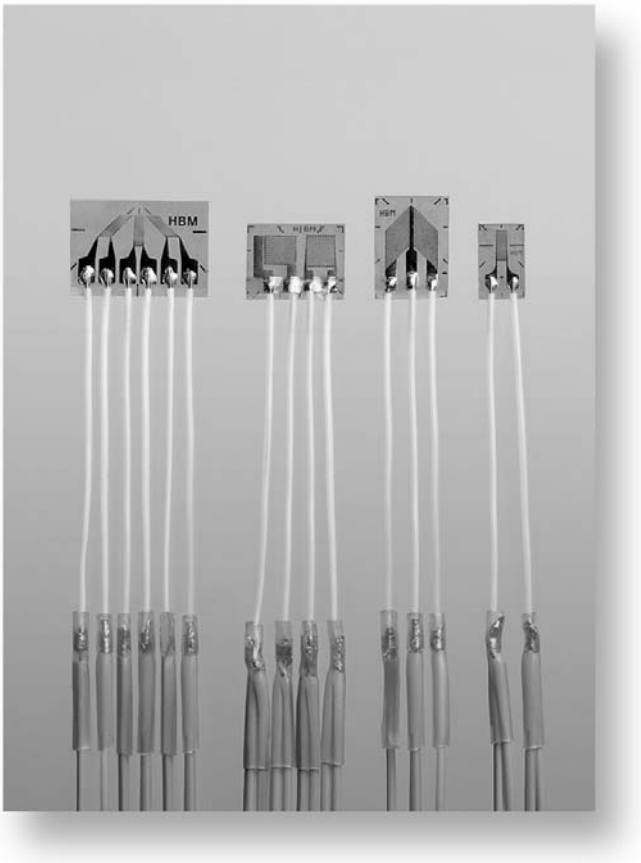
2
(0.079)

Contents per package: 5 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)					Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier		Pitch		
Steel	Aluminum	Other	Ω	a	b	c	d	t	V	
		1-KY9x-2/120	120	1.2 *0.047*	1.2 *0.047*	5 *0.197*	21.7 *0.854*	2 *0.079*	2	-

SG with connection cable K-LY... / K-XY.../ K-RY...

and RJ11 connector (optional)



Characteristic features

— Soldering at measurement point not required

— Proven quality of Y series SG, now also available with prewired PVC ribbon cable

— 50 mm (1.968 *inch*) Teflon wire, optional cable lengths from 0.5 m (1.64 ft) up to 10 m (32.81 ft)

— 2, 3 and 4 wire versions

— Linear strain gages, T rosettes, shear/torsion strain gages and 3-measuring grid rosettes

— Teflon wire on the SG prevents the cable from sticking during installation

Specifications

SG construction		Foil SG with embedded measuring grid
Measuring grid		
Material		Constantan
Thickness	µm *(microinch)*	3.8 or 5 (150 or 197), depending on SG type
Carrier		
Material	µm *(microinch)*	Polyimide
Thickness		45 ± 10 (1.772 ± 394)
Covering agent		
Material	µm *(microinch)*	Polyimide
Thickness		25 ± 12 (984± 472)
Connections		Teflon wires, Ø = 0.051 mm², approx. 50 mm long, connected to AWG28 ribbon cables (PVC insulated) through soldering sleeves in 2, 3 or 4-wire circuit, in different lengths
Nominal resistance [1]	Ω	120, 350, 700 or 1000, depending on SG type
Resistance tolerance[1]	%	± 0.35
with 0.6 mm and 1.5 mm measuring grid length	%	± 1
Gage factor		approx. 2 (stated on the packaging)
Gage factor tolerance[1]	%	± 1
with 0.6 mm and 1.5 mm measuring grid length	%	± 1.5
Temperature coefficient of gage factor[1]	1/K (*1/°F*)	(115 ± 10) · 10^{-6} ((64 ± 5.5) · 10^{-6})
Nominal value of gage factor temperature coefficient		Specified on each package
Reference temperature	°C (°F)	23
Operating temperature range		with PVC cable / without PVC cable
For static measurements (zero point related)	°C (°F)	-10 ... + 90 (-14 ... + 32) / - 10 ... +155 (-14 ... + 32)
for dynamic measurements (not zero point related measurements)	°C (°F)	-10 ... + 90 (-14 ... + 32) / - 10 ... +155 (-14 ... + 32)
Transverse sensitivity		Specified on each package;
for LY41-3/120	%	+0.2
Temperature response		Specified on each package
Temperature response as required, adapted to coefficients of thermal expansion		10.8 · 10^{-6} *(6.0 · 10^{-6})*
α for aluminum	1/K (*1/°F*)	23 · 10^{-6} *(12.8 · 10^{-6})*
α for plastic material	1/K (*1/°F*)	65 · 10^{-6} *(36.1 · 10^{-6})*
α for austenitic steel	1/K (*1/°F*)	16 · 10^{-6} *(8.9 · 10^{-6})*
α for titanium	1/K (*1/°F*)	9 · 10^{-6} *(5.0 · 10^{-6})*
α for molybdenum	1/K (*1/°F*)	5.4 · 10^{-6} *(3.0 · 10^{-6})*
α for quartz	1/K (*1/°F*)	0.5 · 10^{-6} *(0.3 · 10^{-6})*
Tolerance of temperature response	1/K (*1/°F*)	± 0.3 · 10^{-6} *(± 0.17 · 10^{-6})*
Temperature response with matching in the range of [2]	°C (°F)	-10 ... +120 (-14...+248)
Mechanical hysteresis		
1)at reference temperature and strain ε = ± 1000 µm/m (*microstrain*)		
on SG type LY41-3/120		
at 1st load cycle and adhesive Z 70	µm/m (*microstrain*)	1
at 3rd load cycle and adhesive Z 70	µm/m (*microstrain*)	0.5
at 1st load cycle and adhesive X 60	µm/m (*microstrain*)	2.5
at 3rd load cycle and adhesive X 60	µm/m (*microstrain*)	1
Maximum elongation		
at reference temperature using adhesive Z 70		
on SG type LY41-3/120		
Absolute strain value for positive direction	µm/m (*microstrain*)	20-000 (≙2 %)
Absolute strain value for negative direction	µm/m (*microstrain*)	25-000 (≙2.5%)
Fatigue life		
at reference temperature using adhesive Z 70		
on SG type LY41-3/120		
Achievable number of load cycles L_W at		
alternating strain ε_W = ± 1000 µm/m and		
Zero point variation ε_m Δ ≦300	µm/m (*microstrain*)	> 1 · 10^7 (test was interrupted at 1 · 10^7)
Zero point variation ε_m Δ ≦ 30	µm/m (*microstrain*)	5 · 10^6
Minimum radius of curvature, longitudinal and transverse, at reference temperature		
within measuring grid area	mm (*inch*)	0.3 (0.012)
within solder tabs area	mm (*inch*)	10 (0.394)
Applicable bonding materials		
Cold curing adhesives		Z70; X60; X280

[1] = Properties of strain gages without flat ribbon cables (incl. Teflon wire)

[2] Matching to plastic (code number 8) is only possible in the temperature range of -10°C...+50°C (14...122°F).

SG with connection cable (incl. Teflon wire) with 1 measuring grid

K-LY41

Linear SG
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

K-LY43

Temperature response matched to aluminum
with α = 23 · 10^{-6}/K (12.8 · 10^{-6}/°F)

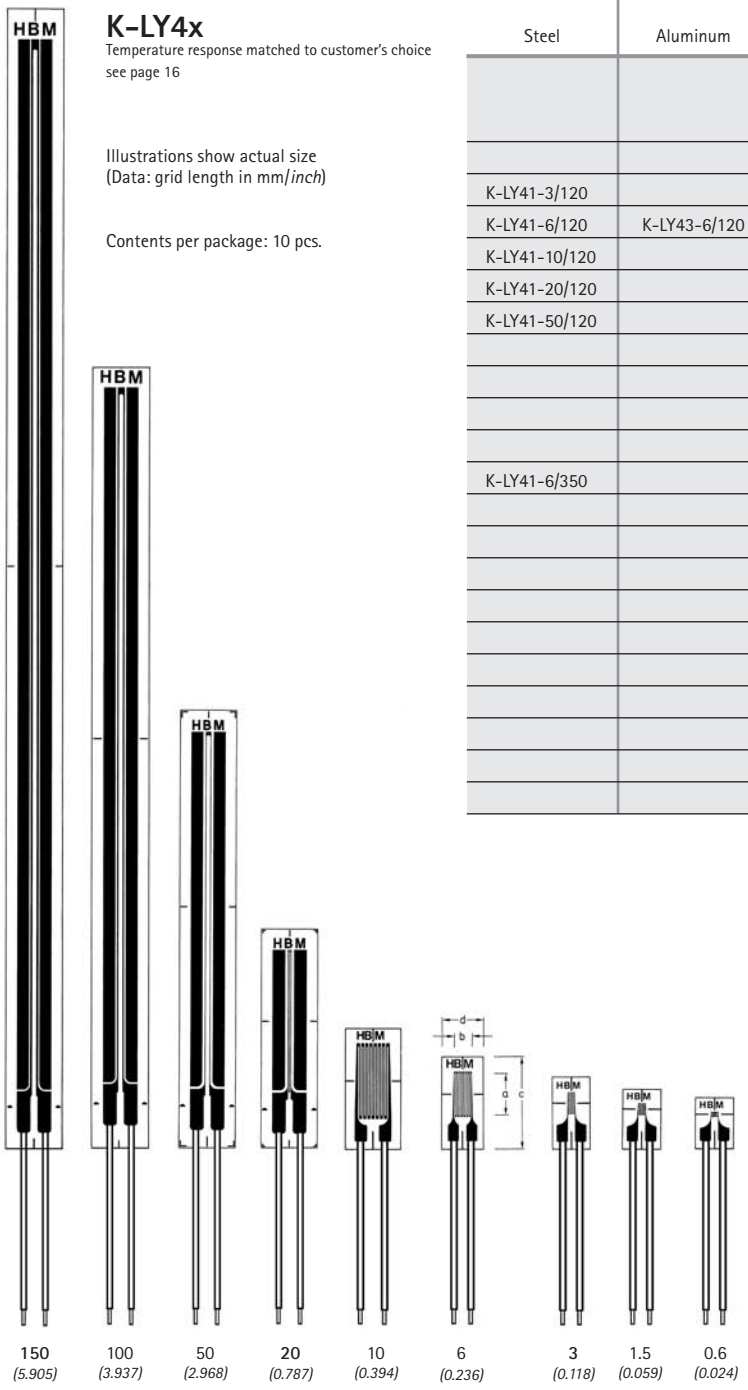
K-LY4x

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: grid length in mm/*inch*)

Contents per package: 10 pcs.

Types available at short notice		Variants*	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	not required
		K-LY4x-0.6/120#	120	0.6 *0.024*	1.1 *0.043*	6 *0.236*	4 *0.157*	1.5	
		K-LY4x-1.5/120	120	1.5 *0.059*	1.2 *0.047*	7 *0.276*	4 *0.157*	2.5	
K-LY41-3/120		K-LY4x-3/120	120	3 *0.118*	1.2 *0.047*	8 *0.315*	5 *0.197*	4	
K-LY41-6/120	K-LY43-6/120	K-LY4x-6/120	120	6 *0.236*	2.7 *0.106*	13.9 *0.547*	5.9 *0.232*	8	
K-LY41-10/120		K-LY4x-10/120	120	10 *0.394*	4.9 *0.193*	18 *0.709*	8 *0.315*	14	
K-LY41-20/120		K-LY4x-20/120	120	20 *0.787*	0.5 *0.02*	31.8 *1.252*	8.2 *0.323*	7	
K-LY41-50/120		K-LY4x-50/120	120	50 *1.969*	0.8 *0.031*	63.6 *2.504*	8.2 *0.323*	12	
		K-LY4x-100/120	120	100 *3.937*	1 *0.039*	114.8 *4.52*	8.2 *0.323*	19	
		K-LY4x-150/120	120	150 *5.906*	1.2 *0.047*	165.6 *6.52*	8.2 *0.323*	25	
		K-LY4x-1.5/350#	350	1.5 *0.059*	2.3 *0.091*	9.2 *0.362*	5.9 *0.232*	6.5	
		K-LY4x-3/350	350	3 *0.118*	2.5 *0.098*	10.9 *0.429*	5.9 *0.232*	9	
K-LY41-6/350		K-LY4x-6/350	350	6 *0.236*	2.8 *0.11*	13.9 *0.547*	5.9 *0.232*	15	
		K-LY4x-10/350	350	10 *0.394*	5 *0.197*	18 *0.709*	8 *0.315*	24	
		K-LY4x-3/700	700	3 *0.118*	2.7 *0.106*	10.9 *0.429*	5.9 *0.232*	13	
		K-LY4x-6/700	700	6 *0.236*	4.1 *0.161*	13.9 *0.547*	5.9 *0.232*	23	
		K-LY4x-10/700	700	10 *0.394*	5 *0.197*	18 *0.709*	8 *0.315*	33	
		K-LY4x-3/1000#	1000	3 *0.118*	2.7 *0.106*	10.9 *0.429*	5.9 *0.232*	16	
		K-LY4x-6/1000#	1000	6 *0.236*	4.2 *0.165*	13.9 *0.547*	5.9 *0.232*	27	
		K-LY4x-10/1000#	1000	10 *0.394*	5 *0.197*	18 *0.709*	8 *0.315*	40	



150 *(5.905)* 100 *(3.937)* 50 *(2.968)* **20** *(0.787)* 10 *(0.394)* 6 *(0.236)* **3** *(0.118)* 1.5 *(0.059)* 0.6 *(0.024)*

Available cable lengths
see page 44

*Variants: Minimum order quantity: 3 packages
Types marked # are only available with matching to aluminum, ferritic or austenitic steel

SG with connection cable (incl. Teflon wire) with 2 measuring grids

K-XY31

0°/90° T rosette
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

K-XY33

Temperature response matched to aluminum
with α = 23 · 10^{-6}/K (12.8 · 10^{-6}/°F)

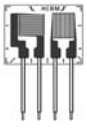
K-XY3x

Temperature response matched to customer's choice
see page 16

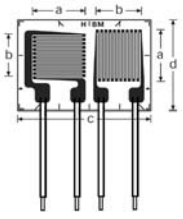
Illustrations show actual size

0.6
(0.024)

1.5
(0.059)



3
(0.118)



6
(0.236)

Contents per package: 5 pcs.

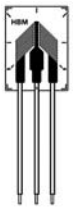
Types available at short notice		Variants*	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	not required
		K-XY3x-0.6/120#	120	0.6 *0.024*	1 *0.039*	7 *0.276*	6 *0.236*	1.5	
		K-XY3x-1.5/120	120	1.5 *0.059*	1.6 *0.063*	8 *0.315*	6.3 *0.248*	3	
		K-XY3x-3/120	120	3 *0.118*	3.2 *0.126*	10.5 *0.413*	8 *0.315*	5.5	
K-XY31-6/120		K-XY3x-6/120	120	6 *0.236*	6.3 *0.248*	17.5 *0.689*	12 *0.472*	11	
		K-XY3x-1.5/350#	350	1.5 *0.059*	1.7 *0.067*	7.7 *0.303*	6.3 *0.248*	5	
K-XY31-3/350		K-XY3x-3/350	350	3 *0.118*	3.3 *0.13*	10.9 *0.429*	7.6 *0.299*	10	
	K-XY33-6/350	K-XY3x-6/350	350	6 *0.236*	6.5 *0.256*	18 *0.709*	12 *0.472*	20	

K-XY4x

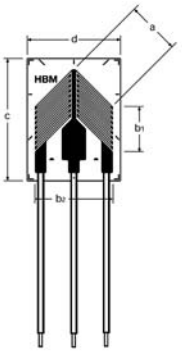
Shear/torsion half bridge

Temperature response matched to customer's choice
see page 16

Illustrations show actual size



3
(0.118)



6
(0.236)

Contents per package: 5 pcs.

Types available at short notice		Variants*	Nominal resistance	Dimensions (mm/*inch*)					Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid			Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b1	b2	c	d	V	not required
		K-XY4x-3/120	120	3 *0.118*	3 *0.12*	5.4 *0.21*	11 *0.433*	8 *0.315*	5	
		K-XY4x-6/120	120	6 *0.236*	6 *0.24*	10.2 *0.40*	16 *0.630*	12.2 *0.480*	9.5	
		K-XY4x-3/350	350	3 *0.118*	4.2 *0.17*	5.6 *0.22*	11 *0.433*	8 *0.315*	9.5	
		K-XY4x-6/350	350	6 *0.236*	6 *0.24*	10 *0.39*	16 *0.630*	12.2 *0.480*	16	
		K-XY4x-3/700#	700	3 *0.118*	4.2 *0.17*	5.6 *0.22*	11 *0.433*	8 *0.315*	13.5	
		K-XY4x-6/700	700	6 *0.236*	6.1 *0.24*	9.9 *0.39*	16 *0.630*	12.2 *0.480*	23	

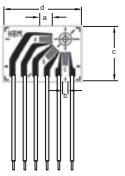
*Variants: Minimum order quantity: 3 packages
Types marked # are only available with matching to aluminum, ferritic or austenitic steel

SG with connection cable (incl. Teflon wire) with 3 measuring grids

K-RY61K

0°/45°/90° rectangular hole drilling rosette
Temperature response matched to customer's choice
see page 16

Illustrations show actual size



1.5
(0.059)

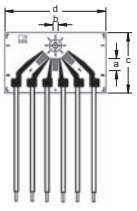
Contents per package: 5 pcs.

Types available at short notice		Variants*	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	not required
		K-RY6x-1.5/120K**	120	1.5 *0.059*	0.8 *0.031*	7.2 *0.283*	10.2 *0.402*	2	

K-RY61R

0°/45°/90° rectangular hole drilling rosette
Temperature response matched to customer's choice
see page 16

Illustrations show actual size



1.5
(0.059)

Contents per package: 5 pcs.

Types available at short notice		Variants*	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	not required
		K-RY6x-1.5/120R**	120	1.5 *0.059*	0.8 *0.031*	8 *0.315*	13.5 *0.531*	2	

K-RY81

0°/45°/90° rectangular rosette
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

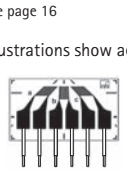
K-RY83

Temperature response matched to aluminum
with α = 23 · 10^{-6}/K (12.8 · 10^{-6}/°F)

K-RY8x

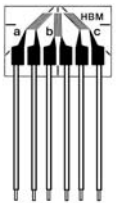
Temperature response matched to customer's choice
see page 16

Illustrations show actual size

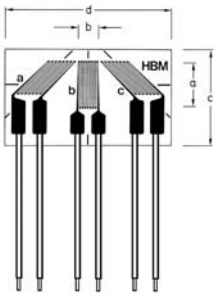


1.5
(0.059)

0.6
(0.024)



3
(0.118)



6
(0.236)

Contents per package: 5 pcs.

Types available at short notice		Variants*	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	not required
		K-RY8x-0.6/120#	120	0.6 *0.024*	1.2 *0.047*	4.8 *0.189*	8.7 *0.343*	1.6	
		K-RY8x-1.5/120	120	1.5 *0.059*	1.3 *0.051*	8.2 *0.323*	14.6 *0.575*	2.5	
K-RY81-3/120		K-RY8x-3/120	120	3 *0.118*	1.1 *0.043*	9.7 *0.382*	14.6 *0.575*	3	
K-RY81-6/120	K-RY83-6/120	K-RY8x-6/120	120	6 *0.236*	3 *0.118*	13 *0.512*	22.9 *0.902*	7.5	
		K-RY8x-1.5/350#	350	1.5 *0.059*	1.6 *0.063*	8.2 *0.323*	14.6 *0.575*	5	
		K-RY8x-3/350	350	3 *0.118*	1.2 *0.047*	9.7 *0.382*	14.6 *0.575*	5.5	
		K-RY8x-6/350	350	6 *0.236*	2.8 *0.11*	13.1 *0.516*	22.9 *0.902*	13	

*Variants: Minimum order quantity: 3 packages

**= only available with temperature response matched to ferritic steel

SG with connection cable and RJ11 connector

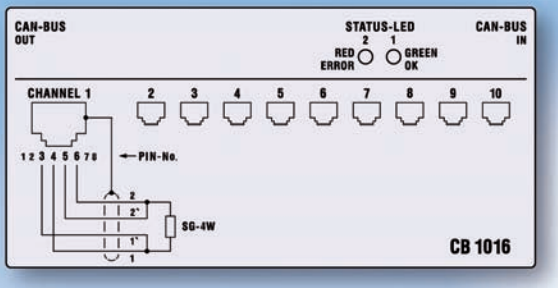
Available cable lengths (fitted PVC flat ribbon cable)

K-LY4...[1]) / K-XY3...[1])				
	2-	3-	4-	4-
	Wire design			+RJ11 [1])
0.5 m	✔	✔	✔	✔
1 m	-	✔	✔	✔
2 m	-	✔	✔	✔
3 m	-	✔	✔	✔
5 m	-	✔	✔	✔
7.5 m	-	✔	✔	✔
10 m	-	✔	✔	✔

K-XY4...				
	2-	3-	4-	4-
	Wire design			+RJ11 [1])
0.5 m	-	✔	-	-
1 m	-	✔	-	-
2 m	-	✔	-	-
3 m	-	✔	-	-
5 m	-	✔	-	-
7.5 m	-	✔	-	-
10 m	-	✔	-	-

K-RY6... / K-RY8...[1])				
	2-	3-	4-	4-
	Wire design			+RJ11 [1])
0.5 m	✔	✔	✔	✔
1 m	-	✔	✔	✔
2 m	-	✔	✔	✔
3 m	-	✔	✔	✔
5 m	-	✔	✔	✔
7.5 m	-	✔	✔	✔
10 m	-	✔	✔	✔

[1]) The option "connection cable in 4-wire design with RJ11 connector is available for the following SG:
K-LY4..., K-XY3... and K-RY8...



Advantages:

- No soldering on measuring point or cable end required
- No faulty measurements due to resistance changes in connector through 4-wire design
- Measurements without loss of time - after installation, measurements can start

Connection of SG to CANHEAD basic module CB1016
(SG with RJ11 connectors are not compatible with distributor boards VT810 and VT814)

SG / C series

- The specialist for extreme temperatures (-269... +250°C) (-452... +482°F)
- Temperature response with matching in the range of -200 ... +250°C (-328... +482°F)
- Flexible, therefore easy to handle

Tensile force measurement using C series strain gages at low temperatures (permafrost)

Specifications

SG construction		Foil SG with embedded measuring grid
Measuring grid		
Material		CrNi special alloy
Thickness	µm *(microinch)*	5 (197)
Carrier		
Material		Polyimide
Thickness	µm *(microinch)*	45 ± 10 (1772 ± 394)
Covering agent		
Material		Polyimide
Thickness	µm *(microinch)*	25 ± 12 (984 ± 472)
Connections		Nickel-plated Cu leads, approx. 30 mm long
Nickel-plated in SGs without connection leads		Strain relief solder tabs, 4-wire, copper-beryllium
Nominal resistance	Ω	120 or 350, depending on SG type
Resistance tolerance	%	± 0.35
Gage factor		approx. 2.2
Nominal value of gage factor		Specified on each package
Gage factor tolerance	%	± 1
Temperature coefficient of the gage factor		Specified on each package
Reference temperature	°C (°F)	23 (73.4)
Operating temperature range		
for static, i.e. zero point-related measurements	°C (°F)	-200 ... + 200 (-328 ... 392)
for dynamic, i.e. non-zero point-related measurements	°C (°F)	-269 ... + 250 (-452.2 ... 482)
Transverse sensitivity		Specified on each package
at reference temperature when using Z70 adhesive on SG type LC11-6/120	%	- 0.15
Temperature response		Specified on each package
Temperature response matched to thermal expansion coefficient		
α for ferritic steel	1/K	$10.8 \cdot 10^{-6}$
α for aluminum	1/K	$23 \cdot 10^{-6}$
Tolerance of temperature response	1/K	$\pm 0.6 \cdot 10^{-6}$
Adaptation of temperature response in range	°C (°F)	-200 ... + 250 (-328 ...482)
Mechanical hysteresis[1]		
at reference temperature and strain ε = ± 1000 µm/m *(microstrain)* on SG type LC11-6/120		
at 1st load cycle and adhesive Z 70	µm/m *(microstrain)*	1.25
at 3rd load cycle and adhesive Z 70	µm/m *(microstrain)*	0.75
Maximum elongation[1]		
at reference temperature using adhesive Z 70 on SG type LC11-6/120		
Absolute strain value ε for positive direction	µm/m *(microstrain)*	20-000 (≙ 2 %)
Absolute strain valueε for negative direction	µm/m *(microstrain)*	100-000 (≙ 10 %)
Fatigue life[1]		
at reference temperature using adhesive Z 70 on SG type LC61-6/120		
Achievable number of load cycles L_W at		
alternating strain ε_W = ± 1000 µm/m and zero point drift $\varepsilon_m \Delta \leqq 300$ µm/m *(microstrain)*		>> 10^7 (test was interrupted at 10^7)
$\varepsilon_m \Delta \leqq 30$ µm/m *(microstrain)*		> 10^7 (test was interrupted at 10^7)
Minimum radius of curvature, longitudinal and transverse, at reference temperature		
within measuring grid area	mm (*inch*)	0.3 (0.012)
within solder tabs area	mm (*inch*)	2 (0.079)
Bonding material than can be used		
Cold-curing adhesives		Z 70; X 60; X 280
Hot-curing adhesives		EP 150; EP 250; EP 310S

[1] The data depend on the various parameters of the specific application and are therefore stated for representative examples only.

SG / Series C with 1 measuring grid

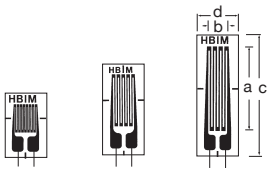
LC11

Linear SG
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

LC1x

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: grid length in mm/*inch*)



3 *(0.118)* 6 *(0.236)* 10 *(0.394)*

Contents per package: 10 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	
1-LC11-3/120			120	3 *0.118*	3.3 *0.13*	8.5 *0.335*	5.5 *0.217*	6	LS 5
1-LC11-6/120			120	6 *0.236*	3.2 *0.126*	12 *0.472*	5.5 *0.217*	9	LS 5
1-LC11-10/120			120	10 *0.394*	3.2 *0.126*	16 *0.63*	5.5 *0.217*	11	LS 5
1-LC11-1.5/350		1-LC1x-1.5/350*	350	1.5 *0.059*	3.3 *0.13*	6.4 *0.252*	5.5 *0.217*	6	LS5
1-LC11-3/350		1-LC1x-3/350*	350	3 *0.118*	3.4 *0.134*	8.5 *0.335*	5.5 *0.217*	10	LS 5
1-LC11-6/350		1-LC1x-6/350*	350	6 *0.236*	3.3 *0.13*	12 *0.472*	5.5 *0.217*	14	LS 5
1-LC11-10/350		1-LC1x -10/350*	350	10 *0.394*	3.3 *0.13*	16 *0.63*	5.5 *0.217*	18	LS 5

LC61

Linear SG
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

LC6x

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: grid length in mm/*inch*)

3 *(0.118)* 6 *(0.236)*

Contents per package: 10 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	
1-LC61-3/350		1-LC6x-3/350*	350	3 *0.118*	3.4 *0.134*	11 *0.433*	8 *0.315*	9.5	-
		1-LC6x-6/350*	350	6 *0.236*	3.4 *0.134*	14 *0.551*	8 *0.315*	16	-

Maximum elongation[1)] at reference temperature using adhesive Z 70 on SG type LC11-6/120		
Absolute strain value ε for positive direction	µm/m (*microstrain*)	25-000 (≙ 2.5 %)
Absolute strain valueε for negative direction	µm/m (*microstrain*)	50-000 (≙ 5 %)
Minimum radius of curvature, longitudinal and transverse, at reference temperature within measuring grid area	mm (*inch*)	0.5 (0.02)
within solder tabs area	mm (*inch*)	10 (0.39)

...Other specifications as on Page 46

Types marked * are only available with matching to aluminum or ferritic steel

SG / Series C with 2 measuring grids, with 3 measuring grids

XC11

0°/90° T rosette
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

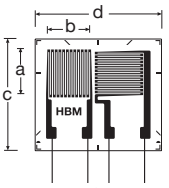
XC1x

Temperature response matched to customer's choice
see page 16

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	
1-XC11-3/350		1-XC1x-3/350*	350	3 *0.118*	3.3 *0.13*	10 *0.394*	10 *0.394*	10	LS 7
		1-XC1x-6/350*	350	6 *0.236*	6.4 *0.252*	16 *0.63*	18 *0.709*	20	LS 4

Illustrations show actual size
(Data: grid length in mm/*inch*)

3
(0.118)



6
(0.236)

Contents per package: 5 pcs.

RC11

0°/45°/90° rosette
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

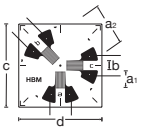
RC1x

Temperature response matched to customer's choice
see page 16

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)					Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid			Measuring grid carrier			
Steel	Aluminum	Other	Ω	a_1	a_2	b	c	d	V	
1-RC11-4/350		1-RC1x-4/350*	350	1.2 *0.047*	4 *0.157*	1.1 *0.043*	8 *0.315*	8 *0.315*	3.5	LS 7
		1-RC1x-6/350*	350	2 *0.079*	6 *0.236*	1.3 *0.051*	11 *0.433*	11 *0.433*	5	LS 5

Illustrations show actual size
(Data: Dimension a2 in mm/*inch*)

4
(0.157)



6
(0.236)

Contents per package: 5 pcs.

Types marked * are only available with matching to aluminum or ferritic steel

SG / G series

- SG for manufacture of transducers
- Nominal resistances of 120 ohms and 350 ohms available
- Carrier material: Glass-fiber reinforced phenolic resin
  Measuring grid material: Constantan
- Leads: fitted as standard

G series strain gages for manufacture of transducers on different base bodies

Specifications

SG construction		Foil SG with embedded measuring grid
Measuring grid		
Material		Constantan foil
Thickness	µm *(microinch)*	3.8 (118) or 5 (197), depending on SG type
Carrier		
Material		Phenolic resin, glass fiber reinforced
Thickness	µm *(microinch)*	35 ± 10 (1378 ± 394)
Cover		
Material		Phenolic resin, glass fiber reinforced
Thickness	µm *(microinch)*	25 ± 8 (984 ± 315)
Connections		Nickel-plated copper leads, 0.2 or 0.3 x 0.06 x 30 mm
Nominal resistance	Ω	120 or 350, depending on SG type
Resistance tolerance[2]	%	± 0.35
Gage factor		approx. 2
Nominal value of gage factor		Specified on each package
Gage factor tolerance with 0.6 and 1.5 mm measuring grid length	%	± 1.5
with ≧ 3 mm measuring grid length	%	± 0.7
Temperature coefficient of the gage factor	1/K (1/°F)	approx. (115 ± 10) · 10^{-6} (64 ± 5.5) · 10^{-6}
Nominal value of gage factor temperature coefficient		Specified on each package
Reference temperature	°C (°F)	23 (73)
Operating temperature range		
for static, i.e. zero point-related measurements	°C (°F)	-70 ... + 200 (-94 ... 392)
for dynamic, i.e. non-zero point-related measurements	°C (°F)	-200 ... + 200 (-328 ... 392)
Transverse sensitivity		Specified on each package
at reference temperature when using Z70 adhesive		
on SG type LG11-6/120	%	- 0.1
Temperature response		Specified on each package
Temperature response as required, adapted to coefficients of thermal expansion		
α for ferritic steel	1/K (1/°F)	10.8 · 10^{-6} (6.0 · 10^{-6})
α for aluminum	1/K (1/°F)	23 · 10^{-6} (12.8 · 10^{-6})
α for austenitic steel	1/K (1/°F)	16 · 10^{-6} (8.9 · 10^{-6})
Other adaptation available on request		
Tolerance of temperature response	1/K (1/°F)	± 0.3 · 10^{-6} (± 0.17 · 10^{-6})
Temperature range of temperature response matching	°C (°F)	-10 ... + 120 (14 ... 248)
Mechanical hysteresis[1]		
at reference temperature and strain ε = ± 1000 µm/m (*microstrain*)		
on SG type LG11-6/120		
at 1st load cycle and adhesive EP 250	µm/m (*microstrain*)	0.5
at 3rd load cycle and adhesive EP 250	µm/m (*microstrain*)	0.5
at 1st load cycle and adhesive X 60	µm/m (*microstrain*)	3
at 3rd load cycle and adhesive X 60	µm/m (*microstrain*)	1.5
on SG type LG11-3/350		
at 1st load cycle and adhesive Z 70	µm/m (*microstrain*)	1.6
at 3rd load cycle and adhesive Z 70	µm/m (*microstrain*)	0.8
Maximum elongation[1]		
at reference temperature using adhesive Z 70		
on SG type LG11-6/120		
Absolute strain value ε for positive direction	µm/m (*microstrain*)	20-000 (≙ 2 %)
Absolute strain valueε for negative direction	µm/m (*microstrain*)	50-000 (≙ 5 %)
Fatigue life[1]		
at reference temperature using adhesive Z 70		
on SG type LG61-6/120		
Achievable number of load cycles L_W at alternating strain ε_W = ± 1000 µm/m and		
zero point drift $\varepsilon_m \Delta$ ≦300 µm/m (*microstrain*)		>> 10^7
$\varepsilon_m \Delta$ ≦ 30 µm/m (*microstrain*)		3 · 10^6
on SG type LG11-6/350		
$\varepsilon_m \Delta$ ≦300 µm/m (*microstrain*)		>> 10^7
$\varepsilon_m \Delta$ ≦ 30 µm/m (*microstrain*)		3 · 10^6
Minimum radius of curvature, longitudinal and transverse, at reference temperature	mm (inch)	3 (0.12)
Bonding material than can be used		
Cold-curing adhesives		Z 70; X 60; X 280
Hot-curing adhesives		EP 150; EP 250; EP 310S

1) The data depend on the various parameters of the specific installation and are therefore stated for representative examples only.
2) With measuring grid lengths of 0.6 mm, the nominal resistance may deviate by ± 1%

SG / Series G with 1 measuring grid, 2 measuring grids

LG11

Linear SG
Temperature response matched to steel
with a = 10.8 · 10⁻⁶/K (6.0 · 10⁻⁶/°F)

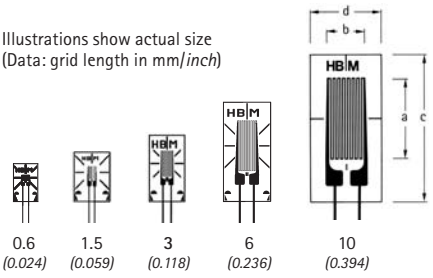
LG13

Temperature response matched to aluminum
with a = 23 · 10⁻⁶/K (12.8 · 10⁻⁶/°F)

LG1x

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: grid length in mm/*inch*)



0.6 *(0.024)* | 1.5 *(0.059)* | 3 *(0.118)* | 6 *(0.236)* | 10 *(0.394)*

Contents per package: 10 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	
		1-LG1x-0.6/120#	120	0.6 *0.024*	1 *0.039*	5 *0.197*	3.2 *0.126*	1.5	LS 7
		1-LG1x-1.5/120	120	1.5 *0.059*	1.2 *0.047*	6.5 *0.256*	4.7 *0.185*	2.5	LS 7
1-LG11-3/120		1-LG1x-3/120	120	3 *0.118*	1.6 *0.063*	8.5 *0.335*	4.5 *0.177*	4	LS 7
1-LG11-6/120		1-LG1x-6/120	120	6 *0.236*	2.8 *0.11*	13 *0.512*	6 *0.236*	8	LS 5
1-LG11-10/120		1-LG1x-10/120	120	10 *0.394*	4.6 *0.181*	18.5 *0.728*	9.5 *0.374*	13	LS 5
1-LG11-3/350		1-LG1x-3/350	350	3 *0.118*	1.6 *0.063*	8.5 *0.335*	4.5 *0.177*	7	LS 7
1-LG11-6/350	1-LG13-6/350	1-LG1x-6/350	350	6 *0.236*	2.8 *0.11*	13 *0.512*	6 *0.236*	13	LS 5
1-LG11-10/350		1-LG1x-10/350	350	10 *0.394*	5 *0.197*	18.5 *0.728*	9.5 *0.374*	23	LS 5

XG11

T rosette
Temperature response matched to steel
with α = 10.8 · 10⁻⁶/K (6.0 · 10⁻⁶/°F)

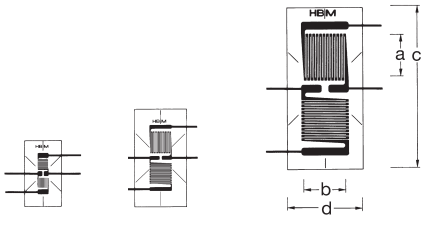
XG13

Temperature response matched to aluminum
with α = 23 · 10⁻⁶/K (12.8 · 10⁻⁶/°F)

XG1x

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: grid length in mm/*inch*)



1.5 *(0.059)* | 3 *(0.118)* | 6 *(0.236)*

Contents per package: 5 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	
		1-XG1x-1.5/120	120	1.5 *0.059*	1.5 *0.059*	9 *0.354*	5 *0.197*	3	LS 5
1-XG11-3/120		1-XG1x-3/120	120	3 *0.118*	3.2 *0.126*	14.5 *0.571*	7.5 *0.295*	6	LS 4
1-XG11-6/120		1-XG1x-6/120	120	6 *0.236*	6.5 *0.256*	23.5 *0.925*	11 *0.433*	12	LS 5
1-XG11-3/350	1-XG13-3/350	1-XG1x-3/350	350	3 *0.118*	3.1 *0.122*	14.4 *0.567*	7.3 *0.287*	10	LS 4
1-XG11-6/350		1-XG1x-6/350	350	6 *0.236*	6.3 *0.248*	23.3 *0.917*	10.5 *0.413*	20	LS 5

Types marked # are only available with matching to aluminum, ferritic or austenitic steel

SG / Series G with 2 measuring grids

XG21

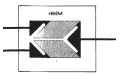
Shear/torsion half bridge
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

XG2x

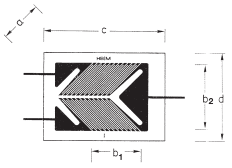
Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: grid length in mm/*inch*)

1.5
(0.059)



3
(0.118)



6
(0.236)

Contents per package: 5 pcs.

Types available ex stock			Variants	Nominal resistance	Dimensions (mm/*inch*)					Max. perm. effective bridge ex. voltage	Solder terminals terminals
					Measuring grid			Measuring grid carrier			
Steel	Aluminum	Other		Ω	a	b	c	d	V		
		1-XG2x-1.5/120		120	1.5 *0.06*	1.7 *0.07*	2.5 *0.10*	6.8 *0.268*	4.5	2.5	LS 7
		1-XG2x-3/120		120	3 *0.18*	3.7 *0.12*	5.3 *0.15*	11.2 *0.209*	9.5	6	LS 5
		1-XG2x-6/120		120	6 *0.44*	7.9 *0.37*	10 *0.24*	17.5 *0.311*	12.7	11	LS4
1-XG21-3/350		1-XG2x-3/350		350	3 *0.39*	4.5 *0.69*	5.3 *0.5*	11.2 *0.118*	9.5	10	LS4
1-XG21-6/350		1-XG2x-6/350		350	6 *0.18*	7.9 *0.21*	10 *0.44*	17.5 *0.374*	12.7	19	LS 5

Types marked # are only available with matching to aluminum, ferritic or austenitic steel

SG / K series

- Optimum SG for manufacture of transducers
- Carrier material: Glass-fiber reinforced phenolic resin
  Measuring grid material: Constantan
- Various SG available with different creep adjustments
- Specially matched compensating elements for zero point, TCO and TCS balancing
- On request, every K series strain gage without leads can be supplied as stick-on strain gages (with touch-dry adhesive coating, hot curing) – for maximum precision and easy use in the manufacture of transducers.

SG installation on customized machine element

K series strain gages for manufacture of transducers

Specifications

Type		LK1x, DK1x, XK5x, XK1x, MK1x	LK2x, LK4x, DK2x, XK2x, XK6x, MK2x
SG construction		Foil SG with embedded measuring grid, with integrated connection leads	Foil SG without cover with integrated solder tabs
Measuring grid			
Material		Constantan foil	
Thickness	µm *(microinch)*	5 (197)	
Carrier			
Material		Phenolic resin, glass fiber reinforced	
Thickness	µm *(microinch)*	35 ± 10 (1,378 ± 394)	
Covering agent			
Material		Phenolic resin, glass fiber reinforced	
Thickness	µm *(microinch)*	25 ± 8 (984 ± 315)	–
Connections		Nickel-plated copper leads approx. 30 mm (1.18 inch) long	integrated contact surfaces
Nominal resistance	Ω	350	
Resistance tolerance	%	± 0.35	± 0.3
Gage factor		approx. 2	
Nominal value of gage factor [3]		Specified on each package	
Gage factor tolerance[3)]	%	± 0.7	
Temperature coefficient of the gage factor	1/K (*1/°F*)	approx. (115 ± 10) · 10^{-6} (64 ± 5.5) · 10^{-6}	
Nominal value of gage factor temperature coefficient		Specified on each package	
Reference temperature	°C (°F)	23 (73.4)	
Operating temperature range			
for static, i.e. zero point-related measurements	°C (°F)	- 70 ... + 200 (-94... +392)	
for dynamic, i.e. non-zero point-related measurements	°C (°F)	-200 ... + 200 (-328... +392)	
Transverse sensitivity		Specified on each package	
at reference temperature when using Z70 adhesive on SG type LK11E-3/350	%	- 0.09	
Temperature response		Specified on each package	
Temperature response as required, adapted to coefficients of thermal expansion			
α for ferritic steel	1/K (*1/°F*)	10.8 · 10^{-6} (6.0 · 10^{-6})	
α for aluminum	1/K (*1/°F*)	23 · 10^{-6} (12.8 · 10^{-6})	
α for austenitic steel	1/K (*1/°F*)	16 · 10^{-6} (8.9 · 10^{-6})	
Other adaptation available on request			
Tolerance of temperature response	1/K (*1/°F*)	± 0.3 ...· 10^{-6} (± 0.17 · 10^{-6})	
Adaptation of temperature response in range	°C (°F)	-10 ... + 120 (14... 248)	
Creep adjustment[2)]			
The end loop length u corresponds to a multiple of the grid line width s		Code letter	
		A: u = 1-s	M: u = 7-s
		C: u = 2-s	O: u = 8-s
 Umkehrstelle		E: u = 3-s	Q: u = 9-s
		G: u = 4-s	S: u = 10-s
		I: u = 5-s	U: u = 11-s
		K: u = 6-s	W: u = 12-s
Mechanical hysteresis[1)]			
at reference temperature and strain ε = ± 1000 µm/m (*microstrain*) on SG type LK11E-3/350			
at 1st load cycle and adhesive Z 70	µm/m (*microstrain*)	1.1	
at 3rd load cycle and adhesive Z 70	µm/m (*microstrain*)	0.8	
Maximum elongation[1)]			
at reference temperature using adhesive Z 70 on SG type LK11E-3/350			
Absolute strain value ε for positive direction	µm/m (*microstrain*)	20-000 (≙ 2 %)	
Absolute strain valueε for negative direction	µm/m (*microstrain*)	50-000 (≙ 5 %)	
Fatigue life [1)]			
at reference temperature when using Z70 adhesive and alternating strain ε_w = ± 1000 µm/m on SG type K11E- 3/350			
Achievable number of stress cycles with zero point variation			
ε_m Δ ≦ 300 µm/m (*microstrain*)		>> 10^7	
ε_m Δ ≦ 30 µm/m (*microstrain*)		3 · 10^6	
Minimum radius of curvature, longitudinal and transverse, at reference temperature	mm (*inch*)	3 (0.118)	
Applicable bonding materials			
Cold curing adhesives		Z 70; X 60; X 280	
Hot-curing adhesives		EP 150; EP 250; EP 310S	

[1)] The data depend on the various parameters of the specific application and are therefore stated for representative examples only. [2)] Different creep adjustments are available per type.
[3)] Does not apply for MK1x, MK2x.

SG / Series K with 1 measuring grid / linear SG

LK11

Linear SG with cover
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

LK13

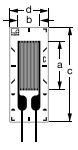
Temperature response matched to aluminum
with α = 23 · 10^{-6}/K (12.8 · 10^{-6}/°F)

LK1x

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: grid length in mm/*inch*)

3
(0.118)



6
(0.236)

Contents per package: 10 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	
		1-LK1xE-3/350#	E	3 *0.118*	3 *0.118*	9.5 *0.374*	5 *0.197*	10	LS 212
		1-LK1xG-3/350#	G	3 *0.118*	3 *0.118*	9.5 *0.374*	5 *0.197*	10	LS 212
1-LK11K-3/350	1-LK13K-3/350	1-LK1xK-3/350#	K	3 *0.118*	3 *0.118*	9.5 *0.374*	5 *0.197*	10	LS 212
1-LK11O-3/350		1-LK1xO-3/350#	O	3 *0.118*	3 *0.118*	9.5 *0.374*	5 *0.197*	10	LS 212
		1-LK1xA-6/350#	A	6 *0.236*	3 *0.118*	12.5 *0.492*	5 *0.197*	14	LS 212
		1-LK1xC-6/350#	C	6 *0.236*	3 *0.118*	12.5 *0.492*	5 *0.197*	14	LS 212
1-LK11E-6/350	1-LK13E-6/350	1-LK1xE-6/350#	E	6 *0.236*	3 *0.118*	12.5 *0.492*	5 *0.197*	14	LS212
		1-LK1xG-6/350#	G	6 *0.236*	3 *0.118*	12.5 *0.492*	5 *0.197*	14	LS212
		1-LK1xI-6/350#	I	6 *0.236*	3 *0.118*	12.5 *0.492*	5 *0.197*	14	LS212

LK21

Linear SG without cover
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

LK23

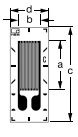
Temperature response matched to aluminum
with α = 23 · 10^{-6}/K (12.8 · 10^{-6}/°F)

LK2x

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: grid length in mm/*inch*)

3
(0.118)



6
(0.236)

Contents per package: 10 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	
1-LK21K-3/350		1-LK2xK-3/350#	K	3 *0.118*	3 *0.118*	9.5 *0.374*	5 *0.197*	9	LS 212
1-LK21O-3/350	1-LK23O-3/350	1-LK2xO-3/350#	O	3 *0.118*	3 *0.118*	9.5 *0.374*	5 *0.197*	9	LS 212
1-LK21S-3/350	1-LK23S-3/350	1-LK2xS-3/350#	S	3 *0.118*	3 *0.118*	9.5 *0.374*	5 *0.197*	9	LS 212
	1-LK23W-3/350	1-LK2xW-3/350#	W	3 *0.118*	3 *0.118*	9.5 *0.374*	5 *0.197*	9	LS 212
		1-LK2xG-6/350#	G	6 *0.236*	3 *0.118*	12.5 *0.492*	5 *0.197*	13	LS 212
1-LK21K-6/350		1-LK2xK-6/350#	K	6 *0.236*	3 *0.118*	12.5 *0.492*	5 *0.197*	13	LS 212
		1-LK2xO-6/350#	O	6 *0.236*	3 *0.118*	12.5 *0.492*	5 *0.197*	13	LS212

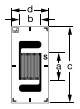
(1) Solder terminals are not compulsory
Types marked # are only available with matching to aluminum, ferritic or austenitic steel

SG / Series K with 1 measuring grid / linear SG

LK4x

Linear SG without cover
Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: grid length in mm/*inch*)



3
(0.118)

Contents per package: 10 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	
		1-LK4xK-3/350#	K	3 *0.118*	3 *0.118*	10.5 *0.413*	5 *0.197*	9	LS 212
		1-LK4xO-3/350#	O	3 *0.118*	3 *0.118*	10.5 *0.413*	5 *0.197*	9	LS 212
		1-LK4xS-3/350#	S	3 *0.118*	3 *0.118*	10.5 *0.413*	5 *0.197*	9	LS 212

(1) Solder terminals are not compulsory
Types marked # are only available with matching to aluminum, ferritic or austenitic steel

SG / Series K with 2 measuring grids / double SG

DK11

Double SG with cover
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

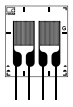
DK13

Temperature response matched to aluminum
with α = 23 · 10^{-6}/K (12.8 · 10^{-6}/°F)

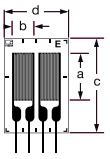
DK1x

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: grid length in mm/*inch*)



3
(0.118)



6
(0.236)

Contents per package: 5 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	
		1-DK1xE-3/350#	E	3 *0.118*	3 *0.118*	9.5 *0.374*	8.5 *0.335*	10	LS 224
1-DK11G-3/350	1-DK13G-3/350	1-DK1xG-3/350#	G	3 *0.118*	3 *0.118*	9.5 *0.374*	8.5 *0.335*	10	LS 224
1-DK11K-3/350		1-DK1xK-3/350#	K	3 *0.118*	3 *0.118*	9.5 *0.374*	8.5 *0.335*	10	LS 224
		1-DK1xO-3/350#	O	3 *0.118*	3 *0.118*	9.5 *0.374*	8.5 *0.335*	10	LS 224
		1-DK1xA-6/350#	A	6 *0.236*	3 *0.118*	12.5 *0.492*	8.5 *0.335*	14	LS 224
		1-DK1xC-6/350#	C	6 *0.236*	3 *0.118*	12.5 *0.492*	8.5 *0.335*	14	LS 224
1-DK11E-6/350		1-DK1xE-6/350#	E	6 *0.236*	3 *0.118*	12.5 *0.492*	8.5 *0.335*	14	LS224
1-DK11G-6/350		1-DK1xG-6/350#	G	6 *0.236*	3 *0.118*	12.5 *0.492*	8.5 *0.335*	14	LS224
		1-DK1xI-6/350#	I	6 *0.236*	3 *0.118*	12.5 *0.492*	8.5 *0.335*	14	LS224

DK21

Double SG without cover
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

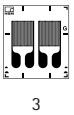
DK23

Temperature response matched to aluminum
with α = 23 · 10^{-6}/K (12.8 · 10^{-6}/°F)

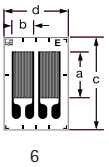
DK2x

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: grid length in mm/*inch*)



3
(0.118)



6
(0.236)

Contents per package: 5 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	
1-DK21K-3/350		1-DK2xK-3/350#	K	3 *0.118*	3 *0.118*	9.5 *0.374*	8.5 *0.335*	9	LS 224
1-DK21O-3/350		1-DK2xO-3/350#	O	3 *0.118*	3 *0.118*	9.5 *0.374*	8.5 *0.335*	9	LS 224
		1-DK2xS-3/350#	S	3 *0.118*	3 *0.118*	9.5 *0.374*	8.5 *0.335*	9	LS 224
		1-DK2xW-3/350#	W	3 *0.118*	3 *0.118*	9.5 *0.374*	8.5 *0.335*	9	LS 224
		1-DK2xG-6/350#	G	6 *0.236*	3 *0.118*	12.5 *0.492*	8.5 *0.335*	13	LS 224
1-DK21K-6/350	1-DK23K-6/350	1-DK2xK-6/350#	K	6 *0.236*	3 *0.118*	12.5 *0.492*	8.5 *0.335*	13	LS 224
		1-DK2xO-6/350#	O	6 *0.236*	3 *0.118*	12.5 *0.492*	8.5 *0.335*	13	LS224

(1) Solder terminals are not compulsory
Types marked # are only available with matching to aluminum, ferritic or austenitic steel

SG / Series K with 2 measuring grids / Torsion/shear SG

XK11

Shear/torsion SG with cover
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

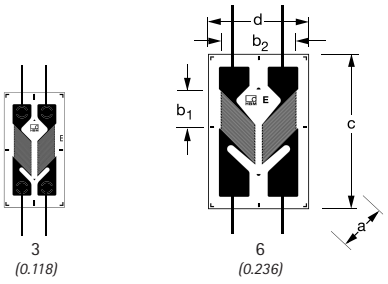
XK13

Temperature response matched to aluminum
with α = 23 · 10^{-6}/K (12.8 · 10^{-6}/°F)

XK1x

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: grid length in mm/*inch*)



Contents per package: 5 pcs.

Types available ex stock			Variants	Nominal resistance	Dimensions (mm/*inch*)					Max. perm. effective bridge ex. voltage	Solder terminals
					Measuring grid			Measuring grid carrier			
Steel	Aluminum	Other			a	b1	b2	c	d	V	
1-XK11E-3/350		1-XK1xE-3/350#	E		3 *0.118*	4.5 *0.18*	5.8 *0.23*	15 *0.591*	8 *0.315*	10	LS224
		1-XK1xG-3/350#	G		3 *0.118*	4.5 *0.18*	5.8 *0.23*	15 *0.591*	8 *0.315*	10	LS224
1-XK11K-3/350		1-XK1xK-3/350#	K		3 *0.118*	4.5 *0.18*	5.8 *0.23*	15 *0.591*	8 *0.315*	10	LS224
1-XK11O-3/350		1-XK1xO-3/350#	O		3 *0.118*	4.5 *0.18*	5.8 *0.23*	15 *0.591*	13 *0.512*	10	LS224
		1-XK1xA-6/350#	A		6 *0.236*	5.7 *0.22*	10.4 *0.41*	20 *0.787*	13 *0.512*	15	LS212
		1-XK1xC-6/350#	C		6 *0.236*	5.7 *0.22*	10.4 *0.41*	20 *0.787*	13 *0.512*	15	LS212
1-XK11E-6/350		1-XK1xE-6/350#	E		6 *0.236*	5.7 *0.22*	10.4 *0.41*	20 *0.787*	13 *0.512*	15	LS212
		1-XK1xG-6/350#	G		6 *0.236*	5.7 *0.22*	10.4 *0.41*	20 *0.787*	13 *0.512*	15	LS212
		1-XK1xI-6/350#	I		6 *0.236*	5.7 *0.22*	10.4 *0.41*	20 *0.787*	13 *0.512*	15	LS212

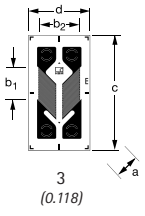
XK21

Shear/torsion SG without cover
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

XK2x

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: grid length in mm/*inch*)



Contents per package: 5 pcs.

Types available ex stock			Variants	Nominal resistance	Dimensions (mm/*inch*)					Max. perm. effective bridge ex. voltage	Solder terminals
					Measuring grid			Measuring grid carrier			
Steel	Aluminum	Other			a	b1	b2	c	d	V	
1-XK21K-3/350		1-XK2xK-3/350#	K		3 *0.118*	4.5 *0.177*	5.8 *0.217*	15 *0.591*	8 *0.315*	9	LS224
1-XK21O-3/350		1-XK2xO-3/350#	O		3 *0.118*	4.5 *0.177*	5.8 *0.217*	15 *0.591*	8 *0.315*	9	LS224
1-XK21S-3/350		1-XK2xS-3/350#	S		3 *0.118*	4.5 *0.177*	5.8 *0.217*	15 *0.591*	8 *0.315*	9	LS224

(1) Solder terminals are not compulsory
Types marked # are only available with matching to aluminum, ferritic or austenitic steel

SG / Series K with 2 measuring grids / T rosette

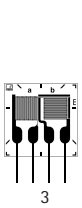
XK51

0°/90° T rosette with cover
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

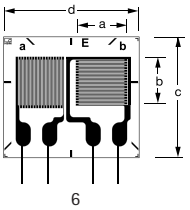
XK5x

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: grid length in mm/*inch*)



3
(0.118)



6
(0.236)

Contents per package: 5 pcs.

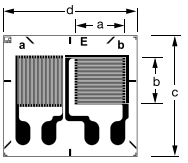
Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other		a	b	c	d	V	
		1-XK5xA-3/350#	A	3 *0.118*	3 *0.118*	10 *0.394*	10 *0.394*	10	LS 224
1-XK51E-3/350		1-XK5xE-3/350#	E	3 *0.118*	3 *0.118*	10 *0.394*	10 *0.394*	10	LS 224
1-XK51M-3/350		1-XK5xM-3/350#	M	3 *0.118*	3 *0.118*	10 *0.394*	10 *0.394*	10	LS 224
1-XK51A-6/350		1-XK5xA-6/350#	A	6 *0.236*	6 *0.236*	16 *0.63*	18 *0.709*	20	LS 224
		1-XK5xC-6/350#	C	6 *0.236*	6 *0.236*	16 *0.63*	18 *0.709*	20	LS 224
1-XK51E-6/350		1-XK5xE-6/350#	E	6 *0.236*	6 *0.236*	16 *0.63*	18 *0.709*	20	LS 224

XK6x

0°/90° T rosette without cover
Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: grid length in mm/*inch*)

3
(0.118)



6
(0.236)

Contents per package: 5 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other		a	b	c	d	V	
		1-XK6xA-3/350#	A	3 *0.118*	3 *0.118*	10 *0.394*	10 *0.394*	9	LS 224
		1-XK6xE-3/350#	E	3 *0.118*	3 *0.118*	10 *0.394*	10 *0.394*	9	LS 224
		1-XK6xM-3/350#	M	3 *0.118*	3 *0.118*	10 *0.394*	10 *0.394*	9	LS 224
		1-XK6xA-6/350#	A	6 *0.236*	6 *0.236*	16 *0.63*	18 *0.709*	18	LS 224
		1-XK6xE-6/350#	E	6 *0.236*	6 *0.236*	16 *0.63*	18 *0.709*	18	LS 224
		1-XK6xI-6/350#	I	6 *0.236*	6 *0.236*	16 *0.63*	18 *0.709*	18	LS 224

(1) Solder terminals are not compulsory
Types marked # are only available with matching to aluminum, ferritic or austenitic steel

SG / Series K with 4 measuring grids / diaphragm SG

MK11

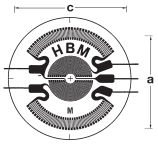
Diaphragm full bridge with cover
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

MK1x

Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: Dimension a in mm/*inch*)

10
(0.394)



15
(0.591)

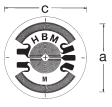
Contents per package: 5 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other		a	b	c	d	V	
1-MK11M-10/350		1-MK1xM-10/350#	M	10 *0.394*	-	13 *0.512*	-	8	LS 224
1-MK11M-15/350		1-MK1xM-15/350#	M	15 *0.591*	-	18 *0.709*	-	13	LS 224

MK2x

Diaphragm full bridge without cover
Temperature response matched to customer's choice
see page 16

Illustrations show actual size
(Data: grid length in mm/*inch*)



10
(0.394)

Contents per package: 5 pcs.

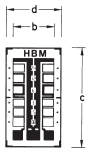
Types available ex stock		Variants	Creep adaptation	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals (1)
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other		a	b	c	d	V	
		1-MK2xM-10/350#	M	10 *0.394*	- -	12 *0.512*	- -	7	LS 224

(1) Solder terminals are not compulsory
Types marked # are only available with matching to aluminum, ferritic or austenitic steel

NA1 6/4.73

Adjustable foil resistor for zero point balancing on a polyimide carrier with a raw resistance of two times approx. 9 Ω. Per bridge branch, maximum 4.73 Ω can be connected, with the following stages:
2.4 Ω – 1.2 Ω – 0.6 Ω – 0.3 Ω – 0.15 Ω – 0.08 Ω ± 20% [a]

Zero point balancing resistor



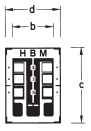
Contents per package: 10 pcs.

Type	Dimensions (mm/*inch*) Grid a	Grid b	Carrier c	Carrier d
1-NA1-6/4.73		6 *0.236*	14.5 *0.571*	8 *0.315*

TN1 3/1.05

Adaptable foil resistor for temperature compensation of the zero point. Nickel foil on polyimide carrier with raw resistance of two times approx. 0.7 Ω. Each bridge branch can be connected with maximum 1.05 Ω, with the following stages:
0.6 Ω – 0.3 Ω – 0.15 Ω ± 20% [a]
Temperature coefficient of resistance:
(+ 20°C...+ 70°C) (+68...+128°F): 4.9 · 10^{-3}/K

TCO compensating resistor



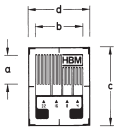
Contents per package: 10 pcs.

Type	Dimensions (mm/*inch*) Grid a	Grid b	Carrier c	Carrier d
1-TN1-3/1.05		6 *0.236*	11 *0.433*	8 *0.315*

TC1 4/60

Adaptable foil resistor for temperature compensation of the sensitivity. Nickel foil on polyimide carrier with a raw resistance of approx. 1 Ω. Maximum 60 Ωcan be connected, with the following stages:
32 Ω – 16 Ω – 8 Ω – 4 Ω ± 20% [a]
Temperature coefficient of resistance:
(+ 20°C...+ 70°C) (+68...+128°F): 4.9 · 10^{-3}/K

TCS compensating resistor
(Data: grid length in mm/*inch*)

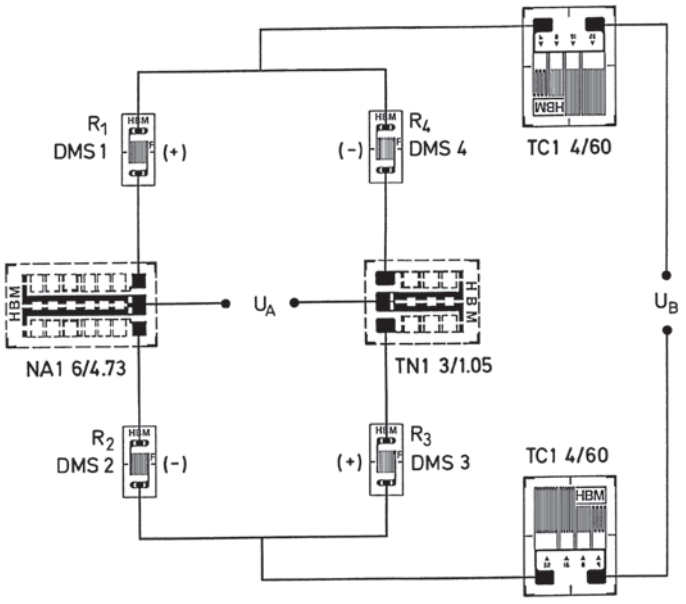


Contents per package: 10 pcs.

Type	Dimensions (mm/*inch*) Grid a	Grid b	Carrier c	Carrier d
1-TC1-4/60	4.2 *0.165*	7 *0.276*	11.5 *0.453*	9 *0.354*

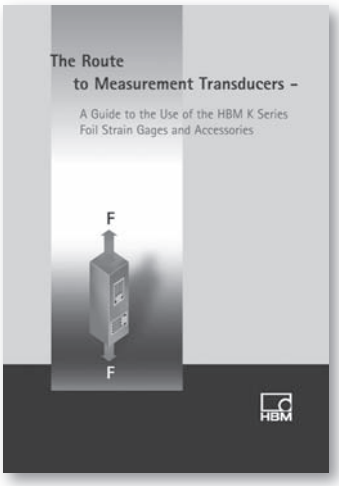
[a] Reference temperature for resistance data: T=23°C (73.4°F)

SG / Series K Balancing and compensating elements



Example circuit of balancing and compensating elements in a strain gage full bridge

Note: For more details, please refer to the HBM book "The route to measurement transducers"



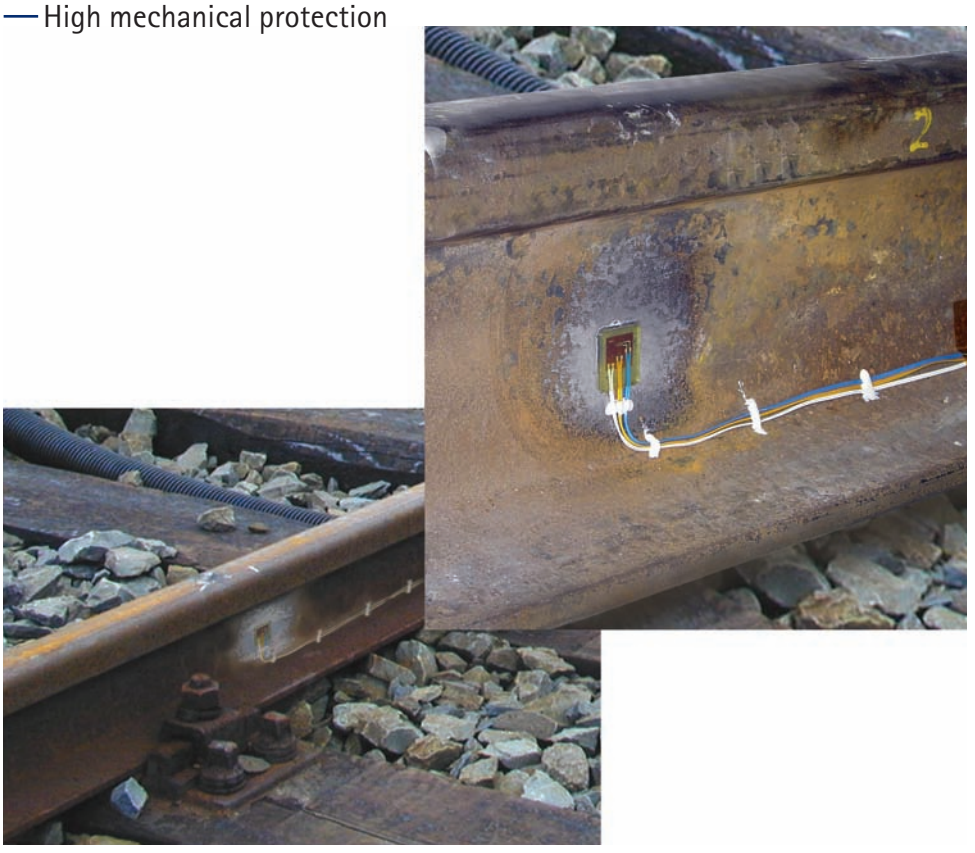
It's so easy, ...
...using stick-on strain gages:

Preparation:	- Roughly clean and degrease the installation area (e.g. with RMS1) - Grind (grain size 220-300), sandblast (e.g. corundum, grain size 80-100) - Clean with ultra-pure solvent (e.g. RMS1)
SG:	No preparation required
Fixing the SG:	With heat-resistant adhesive tape (e.g. 1-adhesive tape)
SG press-fitting:	e.g. with a clamping device - protect the SG with separating foil (e.g. 1-Teflon) and pressure compensation pads (e.g. silicone) against damage
Curing the adhesives:	Optimum curing occurs under the following conditions: - Contact pressure: 20-35 N/cm² (36 – 51 lbf/sq. in.) - Heating rate (under pressure): 2.5 K (4.5 °F)/min from room temperature to 160°C (320°F) - Curing time: 3.5h at 160 °C (320°F) - Cooling (under pressure): down to room temperature - Subsequent curing (without pressure): 1h at 160 °C (320°F)

Series K strain gages without leads are also available with the stick-on option

SG / V series

- Encapsulated SG
- 3m (9.84 ft) stranded connection wire, PVC insulated
- High mechanical protection



Experimental investigations
on a railway rail

SG / Series V

Encapsulated SG with 3m (9.842 ft) stranded connection wire

LV41
Linear SG Contents per package: 10 pcs.

XV91
0°/90° T rosette
Contents per package: 5 pcs.

RV91
0°/45°/90° rosette
Contents per package: 5 pcs.
Temperature response matched to steel
with $\alpha = 10.8 \cdot 10^{-6}/K$ ($6.0 \cdot 10^{-6}/°F$)

LV41

XV91

RV91

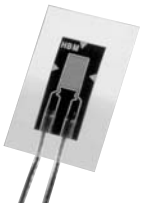
Types available ex stock	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage
		Measuring grid		Measuring grid carrier		
Steel	Ω a	b	c	d	V	
1-LV41-3/120	120	3 *0.118*	1.1 *0.043*	19 *0.748*	12 *0.472*	2
1-XV91-3/120	120	3 *0.118*	1.4 *0.055*	24.5 *0.965*	20.5 *0.807*	2
1-RV91-3/120	120	3 *0.118*	1.25 *0.049*	24.5 *0.965*	20.5 *0.807*	1

Specifications

SG construction		Foil SG with embedded measuring grid and cable in plastic potting
Measuring grid		
Material		Constantan foil
Thickness	µm *(microinch)*	5 (197)
Carrier		
Material		Polyimide
Thickness	µm *(microinch)*	45 ± 10 (1772 ± 394)
Covering agent		
Material		Polyimide
Thickness	µm *(microinch)*	25 ± 5 (984 ± 197)
Potting		
Material		Plastic
Thickness	mm (*inch*)	approx. 1.5 (0.04)
Connections		PVC-coated stranded connection wires, 3m long in two-wire circuit
Nominal resistance	Ω	120; including stranded connection wire
Resistance tolerance	%	± 0.5
Gage factor		approx. 2
Nominal value of gage factor		Specified on each package
Gage factor tolerance	%	± 1
Temperature coefficient of the gage factor	1/K (*1/°F*)	approx. (115 ± 10) · 10^{-6} ((64 ± 5.5) · 10^{-6})
Nominal value of gage factor temperature coefficient	°C (°*F*)	Specified on each package (Reference temperature 23 (73.4)
Operating temperature range		
for static, i.e. zero point-related measurements	°C (°*F*)	–30 ... + 105 (-22 ... + 221)
for dynamic, i.e. non-zero point-related measurements	°C (°*F*)	–30 ... + 105 (-22 ... +221)
Temperature response		Specified on each package
Adaptation of temperature response in range	°C (°*F*)	–10 ... + 105 (-22 ... + 221)
Maximum elongation[1] at reference temperature using adhesive Z 70 on SG type LV41-3/120		
Absolute strain value ε for positive direction	µm/m (*microstrain*)	20-000 (≙ 2 %)
Absolute strain valueε for negative direction	µm/m (*microstrain*)	50-000 (≙ 5 %)
Minimum radius of curvature, longitudinal and transverse, at reference temperature	mm (*inch*)	100 (3.94)
Bonding material than can be used		
Cold-curing adhesives		Z 70; X 60; X280

[1] The data depend on the various parameters of the specific application and are therefore stated for representative examples only.

Special SG Encapsulated SG with stranded wire

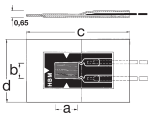


- IP 67[1] protection
- With 1m Teflon-insulated stranded connection wire
- Moisture proof and resistant against chemicals[2] due to full encapsulation in special plastic material
- Excellent zero signal stability with changing moisture
- Optionally 2-wire or 4-wire circuit

LE11

Encapsulated linear SG
Temperature response matched to steel
$\alpha = 10.8 \cdot 10^{-6}/K$ ($6.0 \cdot 10^{-6}/°F$)

Illustrations show actual size



Contents per package: 5 pcs.

Types available ex stock	Nominal resistance	Dimensions (mm/*inch*) Measuring grid		Measuring grid carrier		Max. perm. effective bridge ex. voltage
Steel	Ω	a	b	c	d	V
1-LE11-3/350Z (2-wire circuit)	350	3 *0.118*	2 *0.079*	15 *0.591*	9 *0.354*	6
1-LE11-3/350V (4-wire circuit)	350	3 *0.118*	2 *0.079*	15 *0.591*	9 *0.354*	6

Specifications

Type		LE11-3/350
SG construction		Foil SG, IP 67, resistant against chemicals [2]
Measuring grid material		Constantan foil
Measuring grid length	mm (*inch*)	3 (0.12)
Carrier		
Material		Special plastic material
Thickness	µm *(microinch)*	25 (984)
Covering material		Special plastic material, 25 µm *(microinch)* thick
Thickness of complete SG	mm (*inch*)	0.65 (0.026)
Nominal resistance	Ω	350
Resistance tolerance per package	%	± 0.5
Gage factor		approx. 2
Nominal value of gage factor		Specified on each package
Gage factor tolerance	%	± 1
Reference temperature	°C (°*F*)	+ 23 (73.4)
Operating temperature range		
for installation with Z 70	°C (°*F*)	- 70 ... + 120 (-94 ... + 248)
for installation with EP 250/EP 310S/X 280	°C (°*F*)	-200 ... + 180 (-328... +356)
Temperature response matched to thermal expansion coefficient α for ferritic steel	1/K (*1/°F*)	$10.8 \cdot 10^{-6}$ ($6.0 \cdot 10^{-6}$)
Temperature range of temperature response matching	°C (°*F*)	- 10...+ 120 (14... +248)
Transverse sensitivity at reference temperature when using Z70 adhesive	%	0.25
Minimum radius of curvature, longitudinal and transverse, at reference temperature	mm (*inch*)	3 (0.118)
Maximum elongation at reference temperature	µm/m (*microstrain*)	± 50 000 (≙ ± 5 %)
Fatigue life at reference temperature when using Z70 adhesive		
Achievable number of load cycles L_W at alternating strain		
ε_W = ± 1000 µm/m and zero point drift $\varepsilon_m \Delta \leqq 300$ µm/m (*microstrain*)		>> 10^7 (test was interrupted at 10^7)
$\varepsilon_m \Delta \leqq 30$ µm/m (*microstrain*)		> 10^7 (test was interrupted at 10^7)
Connection cable, 1 m long		2 or 4 Teflon-insulated stranded wires
Applicable bonding materials		Z 70, EP 150, EP 310S, EP 250, X 280

[1] Please note the resistance of the adhesives used.

[2] Only concentrated acids (sulphuric acid, nitric acid) will destroy this special plastic material. High resistance against fuels and engine oils.

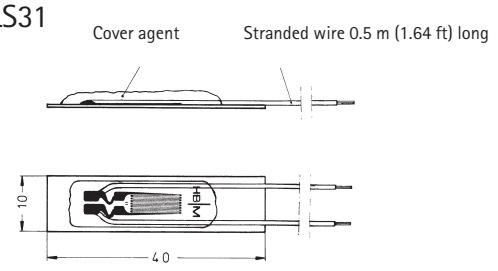
Special SG / Weldable SG

Field of application: Strain measurements at increased temperatures on weldable components on which – due to their size – strain gage installation using hot curing adhesive is not possible. Use of strain gages "on site" where the cleanliness required for bonding cannot be guaranteed (construction sites, production plants, etc.).

Bonding: Spot welding is a simple bonding method for strain gages as hardly any preparations are necessary and very little practical experience is required of users.

Layout design: Y series foil strain gage on carrier plate, covered with transparent silicone rubber; fitted with 0.5 m (1.64 ft) stranded connection wires

LS31



Contents per package: 5 pcs. [1)]

Specifications

Type		LS 31-6/350
SG construction		Foil SG (quarter bridge) with polyimide carrier and constantan measuring grid, hot-bonded to carrier plate
Measuring grid length	mm/*inch*	6
Carrier plate		
l x w	mm (*inch*)	40 x 10
Thickness	mm (*inch*)	0.1
Material		X 8 Cr 17 (1.4016)
Nominal resistance	Ω	350
Resistance tolerance per package	%	± 1 ; measured at end of cable
Gage factor		approx. 2
Nominal value of gage factor		Specified on each package
Maximum permissible bridge excitation voltage	V	15
Reference temperature	°C (°*F*)	+ 23 (73.4)
Operating temperature range	°C (°*F*)	- 200 ... + 150 (-328... +302)
Temperature response matched to thermal expansion coefficient α for ferritic steel	1/K (*1/°F*)	$10.8 \cdot 10^{-6}$ ($6.0 \cdot 10^{-6}$)
Adaptation of temperature response in range	°C	- 10...+ 120 (14... 248)
Minimum radius of curvature, longitudinal and transverse, at reference temperature	mm (*inch*)	75 (2.95)
Maximum elongation at reference temperature	µm/m (*microstrain*)	±3000 (≙ ± 0.3 %)
Strain-related restoring force	N (lbf) / 1,000 µm/m(microstrain)	< 250 (< 56)
Bonding method		Spot welding method

[1)] Each package is supplied with two plates for welding exercises

SG for high strains

SG for high strains

These strain gages are used in all applications where they are extended or shortened by > 5%.

Specifications: Maximum elongation ± 100-000 µm/m (≙ ±10%).

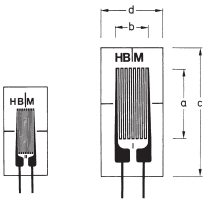
Fatigue life: less resistance to alternating loads than with Y series strain gages.

More specifications: see page 19

LD20

Linear strain gages for high strains
No matching of temperature response

Illustrations show actual size
(Data: grid length in mm/*inch*)

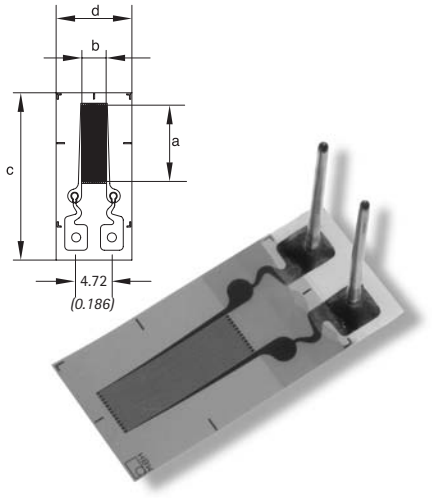


6 *(0.236)* 10 *(0.394)*

Contents per package: 10 pcs.

Types available ex stock	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals
		Measuring grid		Measuring grid carrier			
	Ω	a	b	c	d	V	
1-LD20-6/120	120	6 *0.236*	2.8 *0.11*	13 *0.512*	6 *0.236*	8	LS 7
1-LD20-10/120	120	10 *0.394*	4.6 *0.181*	18.5 *0.728*	9.5 *0.374*	13	LS 5
1-LD20-6/350	350	6 *0.236*	2.8 *0.11*	13 *0.512*	6 *0.236*	13	LS 7
1-LD20-10/350	350	10 *0.394*	5 *0.197*	18.5 *0.728*	9.5 *0.374*	23	LS 5

LI66-10/350 Strain gages for integration in composites



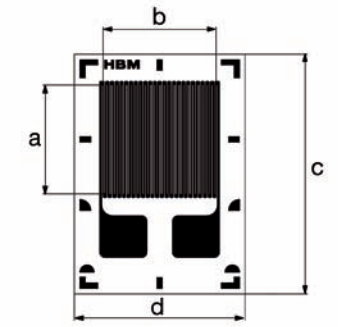
Types available ex stock Temperature response adapted to: Quartz	Nominal restistance Ω	Dimensions (mm/*inch*) Measuring grid a	 b	Measuring grid carrier c	 d	Max. perm. effective bridge ex. voltage V	Solder terminals (1)
1-LI66-10/350	350	10 *0.394*	3.8 *0.15*	22 *0.866*	10 *0.394*	2.5	-

Specifications[1)]

Configuration		Foil strain gage with embedded measuring grid Application of strain via the carrier foil
Connections		Integrated solder tabs with strain relief, connected to vertically positioned, insulated connection pins
Measuring grid		
Material	Ω	Constantan
Thickness	µm *(microinch)*	5 (197)
Carrier material		
Material		Polyimide
Thickness	µm *(microinch)*	45 ±10 (1.772 ± 394)
Basis foil		
Material		Polyimide
Thickness	µm *(microinch)*	45 ±10 (1.772 ± 394)
Nominal resistance	Ω	350
Resistance tolerance	%	±0.35
Gage factor		approx. 2 (specified on each package)
Gage factor tolerance	%	±1
Temperature coefficient of the gage factor, approx.	1/K (*1/°F*)	(115±10) · 10^{-6} ((64 ± 5.5) · 10^{-6})
Nominal value of gage factor temperature coefficient		Specified on each package
Transverse sensitivity		Specified on each package
Reference temperature	°C	23 (73.4)
Operating temperature range		
for static measurements (zero point related measurements)	°C	-40 ...+180 (-40 ...+356)
for dynamic measurements (not zero point related measurements)	°C	-40 ...+180 (-40 ...+356)
Temperature response		Specified on each package
Temperature response adapted to coefficients of thermal expansion α for quartz		1/K (*1/°F*) 0.5 ·10^{-6} (0.3 · 10^{-6})
Temperature response tolerance	1/K (*1/°F*)	±0.3·10^{-6} (±0.17 · 10^{-6})
Adaptation of temperature response in range	°C	-10 ... +120 (14... 248)
Max. elongation		
Absolute strain value for positive direction	µm/m (*microstrain*)	±50.000 (≙5%)
Absolute strain value for negative direction	µm/m (*microstrain*)	±50.000 (≙5%)
Fatigue life		
at reference temperature using a multi-directional CFP sample		
Ach. number of load cycles L_W at alternating strain ε_W = ± 1000 mm/m u.		
Zero point variation $\varepsilon_m\Delta$ < 100 µm/m (*microstrain*)		5 000 000
Zero point variation $\varepsilon_m\Delta$ < 300 µm/m (*microstrain*)		10 000 000
Minimum radius of curvature (longitudinal and transverse)		
at reference temperature		
within measuring grid area	mm (*inch*)	0.3 (0.012)
within solder tabs area	mm (*inch*)	∞
Applicable bonding materials		Matrix resin

[1)] All data according to OIML guideline IR62

TT-3/100 Temperature sensor

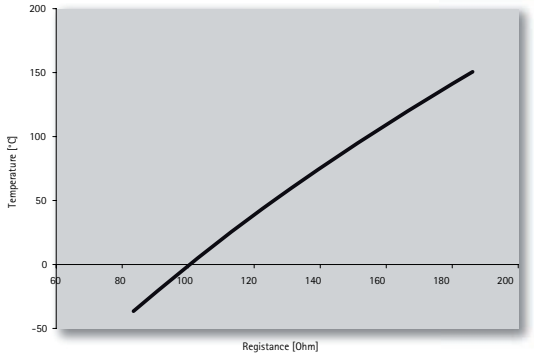


Original size

Special features

- Rapid response time, through good thermal contact with component and very low heat capacity
- Can be installed like metallic strain gages
- Can also be installed on curved surfaces
- Any resistance meter suitable for measured value acquisition

Typical characteristic curve of the TT-3/100 temperature sensor



Types available ex stock:	Nominal resistance (at 0°C) (32°F)	Dimensions (mm/*inch*)			
		Measuring grid		Measuring grid carrier	
	Ω	a	b	c	d
1-TT-3/100	100	3 *0.118*	3.3 *0.13*	6.6 *0.26*	4.7 *0.185*

Specifications[1)]

SG construction		Nickel temperature sensor (embedded)
Measuring grid Material Thickness	 µm *(microinch)*	 Nickel 5 ±0.3 (197±11.8),
Carrier material Material Thickness	 µm *(microinch)*	 Polyimide 40 ±5 (1575±197)
Cover Material Thickness	 µm *(microinch)*	 Polyimide 25 ±5 (9841±197)
Connections		Integrated solder tabs
Nominal resistance (at 0°C) Resistance tolerance of nominal resistance	Ω %	100 ±1
Specification of nominal resistance Specification of resistance tolerance	Ω %	stated on packaging ±0.3
Characteristic curve of the sensor Sensitivity error	 %	stated on the packaging 0.5 (at reference temperature)
Temperature range	°C	-50 ... +180 (-58... +356)
Minimum radius of curvature (longitudinal and transverse) at reference temperature	mm (*inch*)	2, within solder tabs area 5
Applicable bonding materials Cold curing adhesives Hot curing adhesives		 Z70, X60, X280 EP150, EP250, EP310S

[1)] All data according to OIML guideline IR62

Crack propagation gages

These strain gages are used to determine the crack propagation on a component. HBM offers three different types: Types RDS20 and RDS40 consist of electrically separated resistors, i.e. as the crack extends, individual circuits will be interrupted.

Type RDS22 consisting of conductor tracks connected in parallel which will tear if the crack extends under the crack propagation gage. This will gradually increase the electrical resistance of the strain gage as the crack continues to extend.

This change in resistance can be measured using a resistance meter or a strain gage amplifier (see connection diagram).

RDS20, RDS22, RDS40

Crack propagation gages
Illustrations show actual size
(Data: grid length in mm/*inch*)

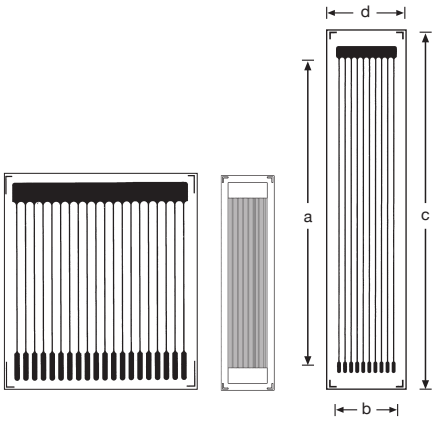
Design:

Carrier: Phenolic resin, glass fiber reinforced
Thickness (35 ± 10) (1.378 ± 394) µm/micro*inch*

Grid foil: Constantan foil, thickness 5 µm *(197 microinch)*

Product number of standard types	Resistance per link	Dimensions (mm/*inch*) Link length	Meas. - grid width	Measuring grid carrier		Pitch t Link center/ Link center	Number of links	Max. perm. effective excitation voltage
	Ω	a	b	c	d	mm (*inch*)		V
1-RDS 20	13	20 *0.787*	22.5 *0.886*	28 *1.102*	25 *0.984*	1.15 *0.045*	20	1.5
1-RDS 22	44	22 *0.866*	5 *0.197*	27.8 *1.094*	6.8 *0.268*	0.1 *0.004*	50	0.8
1-RDS 40	28	40 *1.575*	8.4 *0.331*	47 *1.85*	10 *0.394*	0.85 *0.033*	10	2.5

Resistance tolerance ± 20%



20 *(0.787)* 22 *(0.866)* 40 *(1.575)*

Contents per package: 5 pcs.

Crack propagation gages

Connecting a crack propagation gage

There are two different types of crack propagation gages:
RDS22 consisting of conductor tracks connected in parallel which will tear if the crack extends under the crack propagation gage. This will gradually increase the electrical resistance of the strain gage as the crack continues to extend.
Types RDS20 and RDS40 consist of electrically separated resistor lines, i.e. as the crack extends, individual circuits will be interrupted.
If these are contacted individually, the direction in which the gap extends can be detected.

The easiest way to detect the signals of crack propagation gages (RDS) is to measure the resistance.
Many amplifiers from HBM enable such direct resistance measurements to be taken (e.g. MGCplus or Spider8 with the appropriate modules).

The resulting resistance (R) of the RDS is dependent on the number of torn links and can easily be calculated. n identical resistors (R_i) are connected in parallel:

$$R_n = \frac{R_i}{n}$$

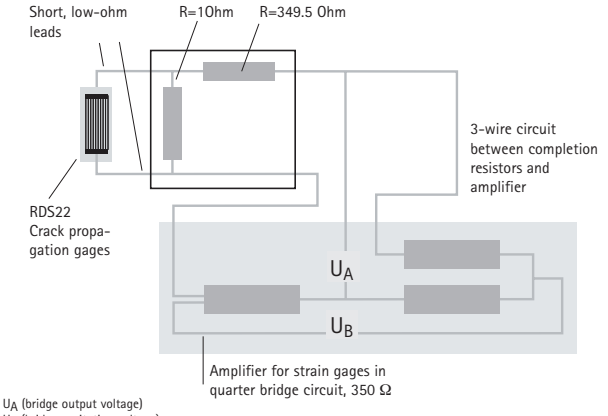
If a grid line is interrupted, this is described by

$$R_{(n-1)} = \frac{R_i}{(n-1)}$$

The measurement can also be taken using an amplifier for strain gage measurements.
The connection diagram shows how the RDS has to be complemented to obtain a resistance change that is inside the measuring range of an amplifier for strain gage quarter bridges.

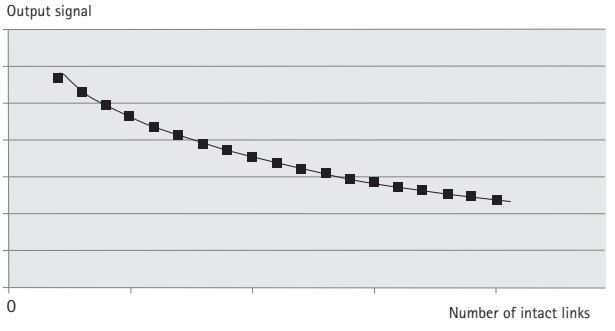
Temperature effects can be minimized using temperature stable fixed resistors or strain gages as completion resistors. A higher sensitivity can be obtained by selecting a parallel resistor with a higher resistance value.

Connecting an RDS crack propagation gage to an SG amplifier



U_A (bridge output voltage)
U_B (bridge excitation voltage)

Typical signal curve for RDS20 with links connected in parallel



SG for determination of residual stress

For determining residual stresses, the two following proven strain gage based technologies are frequently used: the ring core method and the hole-drilling method. A common feature of both methods is that, after installation of the strain gage rosettes onto the work piece, the residual stress condition is disturbed by a suitable action. In case of the ring core method, this is done by cutting a circular groove around the strain gage rosette. In case of the hole-drilling method, a hole is drilled into the center of the rosette.

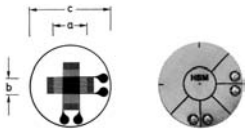
Following this action, residual stresses cause strains on the surface of the work piece, which are detected by the strain gage and then used for calculating the residual stress state.

Ring core method
The XY51 rosettes (for residual stresses with known principal direction) and RY51 (for residual stresses with unknown principal direction) are specifically designed for the ring core method. This process enables high precision measurements to be taken and the residual stresses to be represented in relation to the drilling depth.

XY51

0°/90° ring core rosette
Temperature response matched to steel
with $\alpha = 10.8 \cdot 10^{-6}$/K
($6.0 \cdot 10^{-6}$/°F)Operating temperature range: + 10°... + 60°C
(+50°... +140°F)

Illustrations show actual size



Contents per package: 5 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	
1-XY51-5/350			350	5 *0.197*	2.5 *0.098*	12 *0.472*	– –	6.5	–

Specifications:

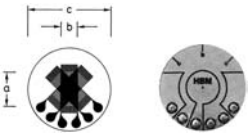
Resistance tolerance ± 1-%
More specifications: see page 23

As these strain gages are covered by a print plate, they can be used on level or weakly curved surfaces only.

RY51

0°/45°/90° ring core rosette
Temperature response matched to steel
with $\alpha = 10.8 \cdot 10^{-6}$/K ($6.0 \cdot 10^{-6}$/°F)
Operating temperature range: + 10°... + 60°C
(+50°... +140°F)

Illustrations show actual size



Contents per package: 5 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	
1-RY51-5/350			350	5 *0.197*	2.5 *0.098*	12 *0.472*	– –	4.5	–

Specifications:

Resistance tolerance ± 1-%
More specifications: see page 23

As these strain gages are covered by a print plate, they can be used on level or weakly curved surfaces only.

SG for determination of residual stress

Hole-drilling method according to the integral method

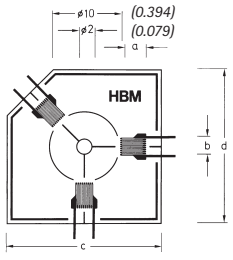
Using RY21 or, particularly easy to handle, RY61 and the associated drilling device, (page 76), it is possible to determine the residual stresses according to the integral method.

The result is the integral mean value of the residual stresses over the entire drilling depth.

RY21

0°/45°/90° hole-drilling rosette
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

Illustrations show actual size



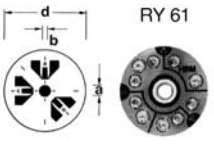
Contents per package: 5 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	
1-RY21-3/120			120	3 *0.118*	2.5 *0.098*	22.1 –	22.1 *0.866*	4.5	LS 5

RY61

0°/45°/90°hole-drilling rosette
for use with HBM drilling device RY 61
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K
+ 10°... + 60°C (+50°... +140°F)

Illustrations show actual size



Contents per package: 5 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals (1)
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	
1-RY61-1.5/120			120	1.5 *0.059*	0.8 *0.031*	–	12 *0.472*	2	LS 5

Specifications:

Resistance tolerance ± 1-%
More specifications: see page 23

(1) Solder terminals are not compulsory

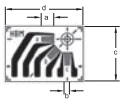
As these strain gages are covered by a print plate, they can be used on level or weakly curved surfaces only.

SG for determination of residual stress

RY61K

0°/45°/90° rectangular hole drilling rosette
Strain gages with integrated contact surfaces
Temperature response matched to steel with
$\alpha = 10.8 \cdot 10^{-6}/K$ ($6.0 \cdot 10^{-6}/°F$)

Illustrations show actual size



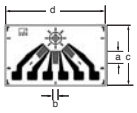
Contents per package: 5 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals (1)
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	
1-RY61-1.5/120K			120	1.5 *0.059*	0.8 *0.031*	7.2 *0.283*	10.2 *0.402*	2	LS 7

RY61R

0°/45°/90°hole-drilling rosette
Temperature response matched to steel
with $\alpha = 10.8 \cdot 10^{-6}/K$
($6.0 \cdot 10^{-6}/°F$)

Illustrations show actual size



Contents per package: 5 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals (1)
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	
		1-RY6x-1.5/120R**	120	1.5 *0.059*	0.8 *0.031*	8 *0.315*	13.5 *0.531*	2	LS 7

RY61S

0°/45°/90°hole-drilling rosette
Temperature response matched to steel
with $\alpha = 10.8 \cdot 10^{-6}/K$
($6.0 \cdot 10^{-6}/°F$) (see page 47).

Illustrations show actual size

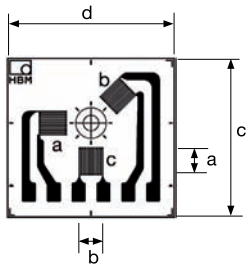
Contents per package: 5 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/inch)				Max. perm. effective bridge ex. voltage	Solder terminals (1)
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	
1-RY61-1.5/120S			120	1.5 *0.059*	0.8 *0.031*	– –	10.2 *0.402*	2	LS 5

RY61-3.2/120S

0°/45°/90°hole-drilling rosette
Temperature response matched to steel
with $\alpha = 10.8 \cdot 10^{-6}/K$
($6.0 \cdot 10^{-6}/°F$) (see page 47).

Illustrations show actual size



Contents per package: 5 pcs.

Types available ex stock		Variants	No minal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals (1)
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	
1-RY61-3.2/120S			120	3.2 *0.126*	3.2 *0.126*	20.9 *0.823*	22 *0.866*	10	LS 5

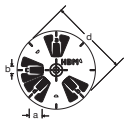
(1) Solder terminals are not compulsory
**= only available with temperature response matched to ferritic steel

SG for determination of residual stress

VY61S

0°/45°/90°/135° hole-drilling rosette
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

Illustrations show actual size



Contents per package: 5 pcs.

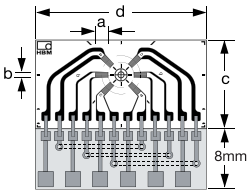
Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals (1)
				Measuring grid		Measuring grid carrier			
Steel	Aluminum	Other	Ω	a	b	c	d	V	
		1-VY6x-1.5/120S**	120	1.5 *0.059*	0.8 *0.031*	-	10.2 *0.402*	2	LS 5

(1) Solder terminals are not compulsory
**= only available with temperature response matched to ferritic steel

RY61M

0°/45°/90°hole-drilling rosette, symmetrical
Temperature response matched to steel
with α = 10.8 · 10^{-6}/K (6.0 · 10^{-6}/°F)

Illustrations show actual size



Contents per package: 5 pcs.

Types available ex stock		Variants	Nominal resistance	Dimensions (mm/*inch*)				Max. perm. effective bridge ex. voltage	Solder terminals
				Measuring grid		Measuring grid carrier*			
Steel	Aluminum	Other	Ω	a	b	c	d	V	
1-RY61-1.5/120M			120	1.5 *0.059*	0.77 *0.03*	11.7 *0.461*	22.5 *0.886*	2.5	-
1-RY61-1.5/350M			350	1.5 *0.059*	0.77 *0.03*	11.7 *0.461*	22.5 *0.886*	4.5	-

*= Dimensions of SG without circuit board

In residual stress analysis based on the hole drilling method, even small eccentricities can cause relatively large measurement errors.
The symmetrical hole drilling rosette RY61M, with 6 measuring grids, has the advantage, due to the opposing radially arranged measurement grids, that any measurement errors in a common measurement direction can be almost completely compensated for.

MTS 3000

System for automatically determining residual stress based on the hole drilling method

SINT Technology, a HBM partner, offers the measurement chain MTS3000 with which it is easy to implement the hole drilling method. To create the hole, a cutter with a speed of 400,000 rpm is used, driven by a stepper motor. The strain changes arising due to the step by step drilling of the hole into the work piece will be detected by a strain gage rosette (see page 74) specifically designed for this process.

For more information refer to page 98.

Integral hole drilling method

Drilling device for hole drilling rosette 1-RY61-1.5/120
The drilling device is used to apply the hole in the center of the installed hole drilling rosette.
It comprises a magnetic holder, a centering pin, a shaft drill, and a universal coupling:
Order No.: 1-RY61
Spare drill for material hardness up to 30 HRC:
Order No..: 1-8410.0019
Carbide drill for material hardness up to 45 HRC:
Order No.: 2-9219.9133

Customized strain gages

— You have special requirements which cannot be met by a strain gage from our standard product range?

— You are looking for a strain gage equivalent to the one you currently use?

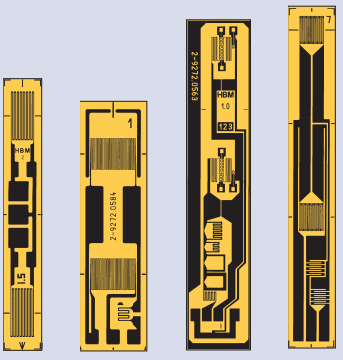
— You have designed your own strain gage?

Contact us, we will produce customized strain gages according to your requirements! From quantities of 20 packages onwards. Please use the request form included in our strain gage price list or send your request or layout direct via fax or e-mail to: info@hbm.com

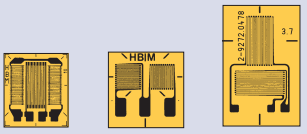
Please also refer to our catalog "Strain gages for manufacturers of transducers"

Customized strain gages

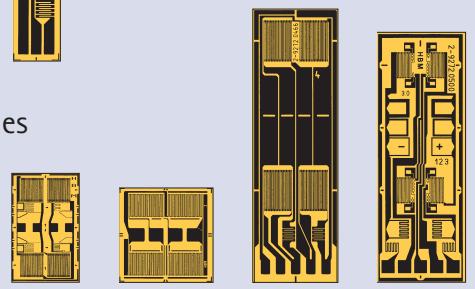
Diaphragm rosette strain gages



Half bridge strain gages

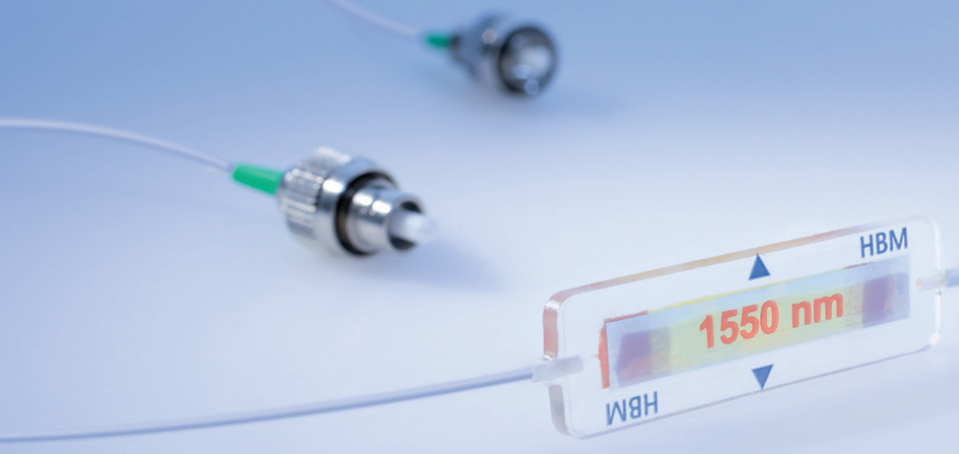


T strain gages



Full bridge strain gages

Optical strain gages Based on fiber Bragg grating



K-OP

Characteristic features

- Optical strain gages - based on fiber Bragg grating
- Up to 13 optical strain gages per glass fiber
- Installation like electrical strain gages
- All relevant data determined and displayed, e.g. gage factor
- Insensitive to electromagnetic interferences
- Application in Ex-areas possible
- Lower wiring outlay compared to electrical strain gages
- Lower mass of glass fiber compared to standard connecting cables

Optical strain gages with glassfiber

FC/APC plug

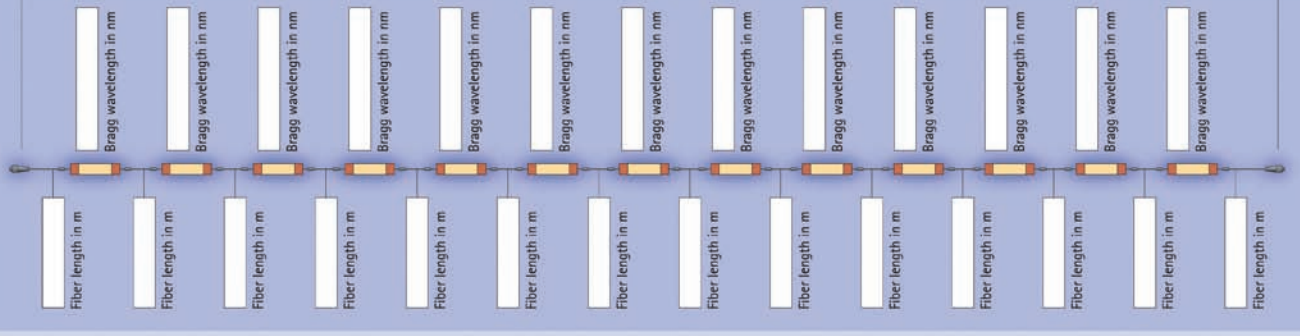
☐ Please check if the chain is to be equipped with a plug.

Maximum configuration of an optical sensor chain:

- 13 optical strain gages (SG) (available wavelength of optical strain gages, see table below)
- Total chain length: max. 200 m
- Fiber length, selectable in steps of 0.5 m
- Minimum distance from plug to optical strain gage = 0.5 m
- Minimum distance from optical SG to the next optical SG = 0.5 m.

FC/APC plug

☐ Please check if the chain is to be equipped with a second plug. The second plug is for redundancy in the event of fiber rupture.



1520 nm	1525 nm	1530 nm	1535 nm	1540 nm	1545 nm
1550 nm	1555 nm	1560 nm	1565 nm	1570 nm	1575 nm
1580 nm					

Available wavelength in nm

Please use the "Bragg wavelength in nm" box to specify the desired wavelength.
Enter the wavelength at the position where the optical SG is to be connected in the chain.

Each wavelength may be used only once per chain. The position in the chain is arbitrary.

Please use the "Fiber length in m" box to specify the distance between plug and optical SG or the distance between two neighboring optical SGs, respectively.

measure and predict with confidence

HBM

Specifications

SG construction		Glass fibers with Bragg grating symmetrically embedded in modified modified acrylic resin, potted in plastic material			
Outside diameter of glass fiber	µm *(microinch)*	185 (7283)			
Core diameter of glass fiber, approx.	µm *(microinch)*	5 (197)			
Diameter with buffer, approx.	mm (*inch*)	1.5 (0.06)			
Dimensions		SG with potting		SG without potting	
	(Standard)		(Customer requirem.)		
Length	mm (*inch*)	40±1	(1.575±0.039)	30±1	(1.181±0.039)
Width	mm (*inch*)	12±0.5	(0.472±0.02)	5±1	(0.197±0.039)
Thickness	mm (*inch*)	2.0±0.5	(0.079±0.02)	0.5±0.01	(0.02±0.0004)
Connector (plug)[1]		FC/ACP			
Available Bragg wavelengths	nm	1520, 1525, 1530, 1535, 1540, 1545, 1550, 1555, 1560, 1565, 1570, 1575, 1580			
Bragg wavelength tolerance	nm	±1			
Gage factor		approx. 0.79 (stated on the packaging)			
Gage factor tolerance	%	2			
Reference temperature	°C (°*F*)	23 (73.4)			
Operating temperature range	°C (°*F*)	-10 ... +80 (-14 ... +176)			
Storage temperature range	°C (°*F*)	-20 ... +100 (--4 ... +212)			
Temperature response (thermal expansion coefficient of measurement object 0 µm/m/K)	µm/m/K	7.8			
Tolerance of temperature response	µm/m/K	1			
Maximum elongation at reference temperature when using Z70 adhesive					
Absolute strain value for positive direction	µm/m (*microstrain*)	10.000 (1%)			
Absolute strain value for negative direction	µm/m (*microstrain*)	10.000 (1%)			
Fatigue life at reference temperature when using Z70 adhesive					
Achieved no. of load cycles L_W at alternating strain ε_W = ± 1000 µm/m (*microstrain*) and Zero point variation $\varepsilon_m\Delta \leq 30$ µm/m (*microstrain*)		>>10^7 (interrupted after 10^7 load cycles)			
Alternating strain ε_W = ± 3000 µm/m (*microstrain*) and Zero point variation $\varepsilon_m\Delta \leq 60$ µm/m (*microstrain*)		>>10^7 (interrupted after 10^7 load cycles)			
Fatigue life at reference temperature when using adhesive X280[2]					
Achieved no. of load cycles L_W at alternating strain ε_W = ± 5000 µm/m (*microstrain*) and zero point variation $\varepsilon_m\Delta \leq 100$ µm/m (*microstrain*)		>>10^7 (interrupted after 10^7 load cycles)			
Minimum radius of curvature, longitudinal and transverse, at ref. temperature	mm (*inch*)	25 (0.98			
Applicable bonding materials Cold curing adhesives		Z70, X60, X280			

[1] Spliced fiber optic cable with plug and buffer is available as an option (length as requested by customer).

[2] Contact pressure when using X280 with optical strain gage: 1 N/cm²
Achievable number of load cycles dependent on quality of installation and fatigue life of component under investigation.

SG accessories ... SG fastening materials

The most usual way to connect strain gages to the test object is by bonding. It is essential that adhesives are used that are application-specific and that meet the following requirements:

- Loss-free transfer of deformation of the test object to the strain gage
- Stable behavior across a temperature and strain range which is as wide as possible
- The strain gage and test object must not be chemically attacked

All adhesive packages from HBM include the adhesive and the accessories (such as Teflon foil) required for bonding and, in addition, a safety data sheet. Your criteria for adhesive selection should be:

- Application temperature
- Material of the measuring body and recommendations for the relevant strain gage
- Requirements for long-term stability and reproducibility
- Surface roughness


Z 70


BCY 01


X 60


X 280


EP 150


EP 250


EP 310 S

Hot curing adhesives

Hot curing adhesives can be used where the test object can be brought up to the curing temperature. This is generally possible in the manufacture of transducers, but also where installations can be made before machine assembly or where the machine can be disassembled. Hot curing adhesives meet higher quality demands and can be used within a greater temperature range than cold curing adhesives.

Adhesive	Description	Suitable SG	Pot life at room temperature (RT)
Cold curing Z 70 Order No.: 1 Z 70 for optional use with Z 70 1-BCY 01	Cyanacrylate adhesive, low viscosity, Accelerator for Z 70	optimum: Y, C, LD, LE, V SG residual stress good: K, G	–
X 60 Order No.: 1-X 60	Methyl metacrylate Two-component adhesive pasty, also suitable for absorbent or uneven surfaces	optimum: Y, C, LD, V SG residual stress good: K, G, LS	5 minutes
X 280 Order No.: 1-X 280	Two-component Epoxy resin adhesive for smooth and absorbent surfaces	optimum: Y, C, LD, LE, V good: G, K	30 minutes
Hot curing EP 150, EP 150 GP Order No.: 1-EP150 Order No.: 1-EP150-GP	Single-component Epoxy resin adhesive Low viscosity	optimum: Y, C, K, G, LD, LE good: SG residual stress	-
EP 310 S Order No.: 1-EP 310 S	Two-component Epoxy resin adhesive low viscosity,	optimum: Y, C, K, G, LD, LE good: SG residual stress	1 month (at RT) 6 months (at + 2°C (+36°F)) 12 months (at – 32°C (-26°F))
EP 250 Order No.: 1-EP 250	Two-component Epoxy resin adhesive pasty, also suitable for absorbent surfaces	optimum: Y, C, K, G, LD, LE good: SG residual stress	24 h

SG accessories ... SG fastening materials

Cold curing adhesives

Cold curing adhesives are easy to use and can be processed at minimum cost and effort as they harden under normal ambient conditions. If they have short curing times they are also called "superglues". The preferred field of application is in experimental stress analysis. However, if the temperature around the measuring point is higher than about 80° C (176°F), we recommend using a hot curing adhesive or a heat resistant cold curing epoxy resin adhesive (X280).

Spot weld joints

Spot weld joints are only possible with the special strain gage type LS 31, and if the test object is of a weldable material. This method is particularly suitable for applications where cleanliness required for bonding cannot be guaranteed. Hardly any preparations or experience are necessary. However, it is essential to follow the process instructions supplied with the strain gages.

Storage life Dry	Curing temperature	Curing time[3]	Contact pressure (N/mm²)	Temperature limits lower	upper static[1]	upper dynamic[2]	Delivery quantity
6 months at – 15°C (5°F): minimum 2 years	5°C (41°F) [3] 20°C (68°F) 30°C (86°F)	10 minutes 1 minute 0.5 minutes	Thumb pressure	– 55°C -67°F) (briefly - 70°C (-94°F))	+ 100°C (212°F)	+120°C (248°F)	10 ml
> 1 year	0°C (32°F) 20°C (68°F) 35°C (95°F)	60 minutes 10 minutes 2 minutes	Thumb pressure	– 200°C (-328°F)	+ 60°C (140°F)	+ 80°C (176°F) Other container	Components A= 0.1 kg B = 80 ml sizes, see price list
1 year at + 4°C (39°F)	RT . . . 95°C (203°F)	8 h . . . 1 h	0.05 . . . 2.0	– 70°C (-94°F)	+ 200°C (392°F)	+ 280°C (536°F)	6 double bags à 10 g = 60 g
12 months at Storage in refrigerator (7 °C (44.6°F))	160 . . . (320...) 190 °C (374°F)	6 h . . . 1 h	0.3 . . . 0.5	– 70 °C (-94°F)	+ 150 °C (302°F)	+ 150 °C (302°F)	2 x 30 ml bottles (EP 150) 10 x 20 ml bottles (EP 150-GP)
6 months	95... (203°F. . .) 205°C (401°F)	5 h . . . 0.5 h	0.1 . . . 0.5	-270°C (-454°F)	+ 260°C (500°F)	+ 310°C (590°F)	Components A = 60 ml B = 30 ml
1 year	95 . . . (203°F...) 200°C (392°F)	16 h . . . 0.5 h	0.1 . . . (0.15...) 1.5 (2.18)	– 240°C (-400°F)	+ 250°C (428°F)	+ 315°C (599°F)	5 double bags à 10.5 g (0.37 oz) = 52.5 g (1.85 oz)

[1] Zero-point based measurement [2] Non-zero-point based measurement [3] Curing condition: Relative humidity of 30 - 80%

SG accessories ... SG covering materials

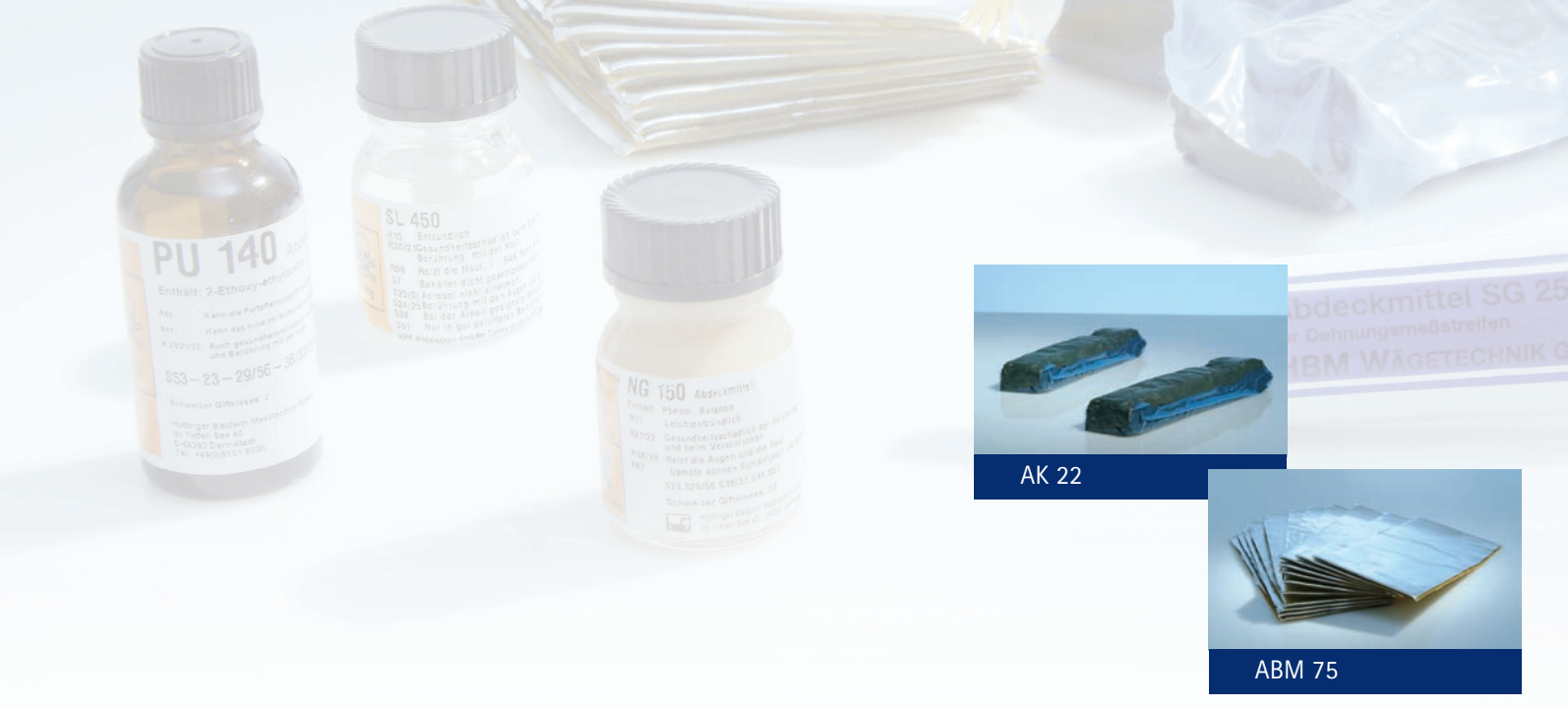
The quality of a measuring point with strain gages is not only dependent on the strain gage itself but mainly on the type of installation and its implementation. A properly functioning measuring point requires thorough preparation of the installation surface, careful bonding, correct connections and also a protective covering. It is therefore important to provide the user with all necessary aids. The HBM strain gage accessory product range offers everything necessary for good strain gage installation.

SG covering agents

In general, it is recommended that strain gages be protected against external effects such as humidity or mechanical damage since even small fluctuations in the atmospheric humidity affect the measured signal of a strain gage.
Suitable covering agents should have only minimum effects on the measuring point. The strain gage and test object must not be attacked. Criteria for selecting the appropriate covering agent should be:

- Application temperature
- Media surrounding the measuring point

The following table will help in the selection of a suitable means of measuring point protection, which for special requirements can also be carried out in several layers. For instance, it would make sense to apply AK22, with - in extremely humid environments - additional sealing by ABM 75. Caution: NG 150 cannot be combined with PU 140.
Please ensure, in the case of multi-layer covering, that the second layer may only be applied after full curing of the first layer and that it should overlap on all sides.
All HBM covering agents are supplied with a safety data sheet.



AK 22

ABM 75

SG accessories ... SG covering agents

SG covering materials	Temperature range of resistance in air in °C	Package contents	One package sufficient for approx.	Application method	Curing conditions	Storage life at room temperature	Components
AK 22 Viscous putty Order No.: 1-AK 22	– 50 °C . . . + 170 °C (-58°F. . . +338°F)	1 kg (2.2 lb)	30 SGs	kneading on by hand	–	unlimited	viscous, kneadable, sticky putty
ABM 75 Aluminum foil with kneading compound Order No.: 1-ABM 75	– 196 °C . . . + 75 °C (-321°F. . . +167°F)	11 pcs. 205 mm x 100 mm (8.07 x 3.94 in.)	200 SGs	pressing on by hand	–	unlimited	0.05 mm thick aluminum foil, coated with 3 mm thick kneading compound
NG 150 [1)] Nitrile rubber Order No.: 1-NG 150	– 269 °C . . . + 150 °C (-452°F. . . +302°F)	3 bottles each with approx. 25 cm^3 (0.85 liquid ounce, US)	35 SGs	brush on with brush	air-drying at room temperature	max. 1 year	solvent-containing single-component nitrile rubber
SG 200 white Silicone rubber Order No.: 1-SG 200	-55 °C . . . +200 °C -67°F . . . + 392°F)	Tube with approx. 85 g (3.0 oz)	20 SGs	application from tube	room temperature	6 months	white single-component silicone rubber
SG 250 Transparent Silicone rubber Order No.: 1-SG 250	– 70 °C . . . + 250 °C (-94°F . . . +482°F)	Tube with approx. 85 g (3.0 oz)	20 SGs	application from tube	Air-drying at room temperature	6 months	transparent, solvent free single-component silicone rubber
PU 140 [1)] Polyurethane paint Order No.: 1-PU 120	– 40 °C . . . + 140 °C -40°F . . . + 284°F)	3 bottles each with 30 ml (1.0 liquid ounce, US)	250 SGs	brush on with brush	room temperature . . . + 80°C (. . . + 176°F)	9 months	solvent containing single-component polyurethane paint
SL 450 Transparent Silicone resin Order No.: 1-SL 450	– 50 °C . . . + 450 °C (-58°F . . . +842°F)	3 bottles each with 25 g (0.9 oz)	90 SGs	brush on with brush	in temperature stages from 95°C to 315°C (203°F... 599°F)	6 months	transparent, solvent containing silicone resin

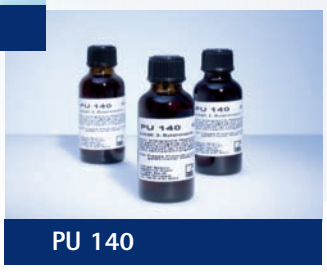
1) Caution: PU 140 and NG 150 cannot be combined


NG 150


SG 250


SG 200


SL 450


PU 140

SG accessories ... SG covering agents

Chemical resistance of HBM covering agents

Chemical substance	AK 22	ABM 75	NG 150	SG200	SG 250	PU 140	SL 450
Witterung	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Water:	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Water under press. (400 bar (5,800 psi))	Yes	–	–	-	–	–	–
Condensation	–	–	–	-	–	Yes	–
Tropical climate	–	–	–	-	–	Yes	–
Water vapor	No	–	–	No	No	–	–
Oils:	No	No	Yes	Yes	Yes	Yes	–
Engine oil (RT/70°C (158°F))	–	–	Yes	-	–	–	–
Mineral oil (RT/70°C (158°F))	–	–	Yes	-	–	–	–
Hydraulic oil (RT/70°C (158°F))	–	–	Yes	-	–	–	–
Fats	-	–	–	-	–	Yes	–
Solvents general	No	Conditional	Conditional	Conditional	No	-	Conditional
Fuels:	No	No	Yes	-	No	–	–
Petrol	No	No	Yes	-	No	–	–
Kerosene	–	–	Yes	-	–	–	–
Aromatic/Aliphatic mixtures	–	–	Conditional	-	–	–	–
Aromatic substances:	No	No	Conditional	No	No	No	No
Benzene	–	–	No	-	–	–	–
Toluene	No	No	Conditional	-	No	-	No
Xylene	No	No	Conditional	-	No	No	No
Chlorinated solvents:	No	No	No	No	No	No	No
Dichloromethane	No	No	No	-	No	No	No
Carbon tetrachloride	–	–	No	-	–	–	–
Perchloroethylene	–	–	No	-	–	–	–
1.2-Dichloroethane	–	–	No	-	–	–	–
o-Dichlorobenzene	–	–	No	-	–	–	–
Alcohols:	Conditional	Yes[1)]	Conditional	Conditional	Conditional	No	Yes
Ethyl alcohol	Conditional	Yes[1)]	Conditional	-	Conditional	No	Yes
Methyl glycole	–	–	No	-	–	-	–
Butyl alcohol	–	–	Conditional	-	–	-	–
iso-propyl alcohol	–	–	Conditional	-	–	-	–
Ethylene glycole	–	–	Yes	-	–	–	–
Ketones:	Conditional	Conditional	No	No	No	No	Conditional
Acetone	Conditional	Conditional	No	No	No	No	Yes
Methyl ethyl ketone (MEK)	No	No	No	No	No	No	Conditional
Terpenes:	–	–	Conditional	-	–	–	–
Dipentenes	–	–	Conditional	-	–	–	–
Turpentine	–	–	Yes	-	–	–	–
Acids:	No	Conditional[2)]	Conditional	Conditional	Yes	No	Yes
Hydrochloric acid conc.	No	–	Conditional	-	Yes	No	Yes
Sulphuric acid 50 %	No	–	Yes	-	Yes	No	Yes
Acetic acid 50 %	No	–	No	-	Yes	No	Conditional
Nitric acid 50%	No	–	No	-	Yes	No	Yes
Oleic acid conc.	–	–	Yes	-	–	–	–
Lactic acid conc.	–	–	Conditional	-	–	–	–
Air containing acids	–	–	–	-	–	Yes	–
Alkalis:	Conditional	Conditional[2)]	Conditional	Conditional	No	Conditional	Yes
Sodium hydroxide 10 %	Conditional	–	No	-	No	No	Yes
Potassium hydroxide 10 %	–	–	No	-	–	–	–
Ammonia 28 %	–	–	Conditional	-	–	–	–
Air containing alkalis	–	–	–	-	–	Yes	–
Liquefied gases (excluding oxygen)	–	–	Yes	-	–	–	–
UV resistance	Yes	Yes	Yes	Yes	Yes	Yes	–

[1)] Low alcohols
[2)] Up to 5-% (destruction of aluminum foil!)
Conditional = conditionally resistant (min. 10 days at RT)

Chemical resistance
Unless identified specifically, the resistance refers to room temperature. No information can be provided on long term effects. The data is based on our own experience or was taken from literature. Since the specific conditions vary with each user, it is recommended that individual users carry out their own tests on resistance Some covering agents become milky when in contact with some chemicals.

SG accessories ... Cleaning agents, gluing and soldering materials

Cleaning agent RMS1

Environmentally-friendly solvent mixture that dissolves all normal contamination. One packing unit contains 1 l cleaning agent and 450 cleaning pads.
Order No.: 1-RMS1

Cleaning agent RMS1 SPRAY

Environmentally-friendly solvent mixture. Contains 5 spray cans with 200 ml cleaning agent each and 450 cleaning pads.
Order No.: 1-RMS1-SPRAY

Teflon foil

33 m (108.27 ft)Teflon foil on reel, suitable for cold and hot curing strain gage bonding. The Teflon foil prevents other material except the strain gage from bonding to the component. Thickness: 0.05 mm (0.000164 *inch*), width: 60 mm (0.197 *inch*)
Order No.: 1-Teflon

Flux pen

Soldering aid in felt pen format for production of smaller soldering connections. Suitable for solders with melting points up to 350 °C (662°F). The flux pen contains non-corrosive flux without chloride. Package contents: 5 pcs.
Order No.: 1-FS01

Polyimide tape

33 m (108.27 ft)heat resistant tape, 19 mm (0.748 *inch*) wide, ca. 70 µm *(microinch)* total thickness.
Temperature application range: -70°C to +260 °C (-94°F to 500°F).
Order No.: 1-Klebeband

Cleaning pads

Cellulose pads for cleaning test objects before strain gage installation. Format 5 cm x 5 cm (1.967 x 1.967 inch).
Package contents: 450 pcs
Order No.: 1-8402.0026

Cleaning agent dispenser

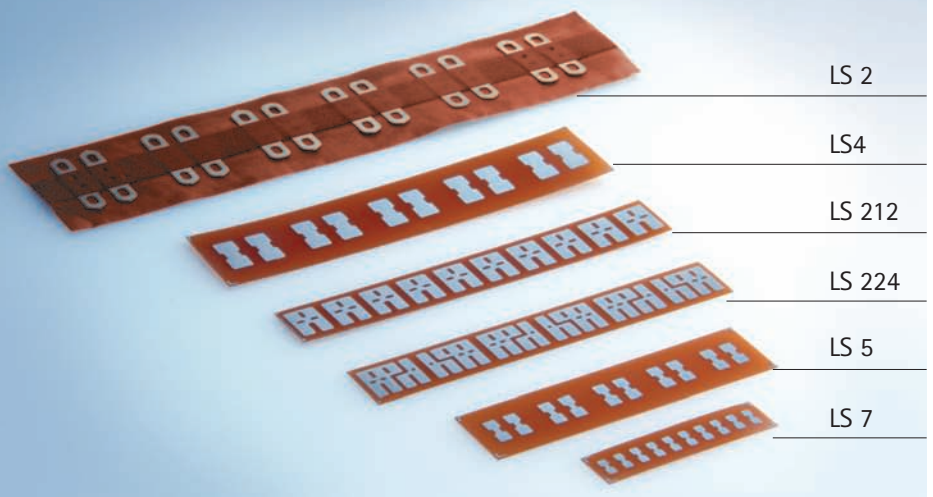
In order to avoid contamination of the solvent over time, we recommend using the RSP 120 cleaning agent dispenser. Order No.: 1-RSP120

Cleaning agent RMS1 SPRAY

Flux pen

Cleaning agent dispenser

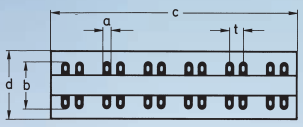
SG accessories ... Soldering terminals



For strain gages with leads or wires, solder terminals should be installed between the connecting cables and the strain gage itself. This will facilitate the execution of a perfect solder joint and provide strain relief for the SG connections. The solder terminals are installed in the same way on the test object as on the SG. HBM offers solder terminals in various designs and dimensions.

LS2

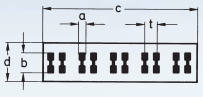
Bronze soldering tag on Teflon carrier suitable for dynamic loads
Attachment to test object: Bonding
Can be used up to 180°C, briefly up to 260°C



Product number	Dimensions (mm/*inch*)					Contents per package:
	Solder tag		Carrier		Distance	
	a	b	c	d	t	
1-LS 2	2.6 *0.102*	14 *0.551*	72 *2.835*	20 *0.787*	4 *0.157*	36 pairs (6 strips)

LS7/5/4

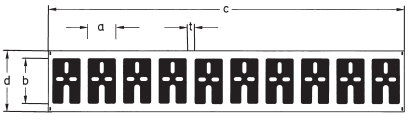
Copper, nickel-plated, on polyimide
Attachment to test object: Bonding
Can be used up to 180°C (356°F), briefly up to 260°C (500°F)



Product number	Dimensions (mm/*inch*)					Contents per package:
	Solder tag		Carrier		Distance	
	a	b	c	d	t	
1-LS 7	1 *0.039*	3 *0.118*	21 *0.827*	6 *0.236*	2 *0.079*	125 pairs
1-LS 5	1.5 *0.059*	4.5 *0.177*	35 *1.378*	10 *0.394*	2.5 *0.098*	125 pairs
1-LS 4	2.5 *0.098*	6.5 *0.256*	50.1 *1.972*	13 *0.512*	4 *0.157*	125 pairs (25 strips each)

LS212

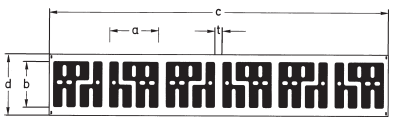
Copper, nickel-plated, on polyimide
Attachment to test object: Bonding
Can be used up to 180°C (356°F), briefly up to 260°C (500°F)



Product number	Dimensions (mm/*inch*)					Contents per package:
	Solder tag		Carrier		Distance	
	a	b	c	d	t	
1-LS 212	3.7 *0.146*	6 *0.236*	47.5 *1.870*	8 *0.315*	1 *0.039*	125 pairs (25 strips)

LS224

Copper, nickel-plated, on polyimide
Attachment to test object: Bonding
Can be used up to 180°C (356°F), briefly up to 260°C (500°F)



Product number	Dimensions (mm/*inch*)					Contents per package:
	Solder tag		Carrier		Distance	
	a	b	c	d	t	
1-LS 224	6.5 *0.256*	6 *0.236*	45 *1.772*	8 *0.315*	1 *0.039*	150 pairs (25 strips)

SG accessories ... Cables and stranded wires

PVC flat ribbon cable

PVC insulated flat ribbon cable, consisting of 6 wires with a cross-section of 0.14 mm² (0.0002 sq. in.) each, 50 m (164 ft) per roll, resistance 0.131 Ω/m (0.04 Ω/ft).
Order No.: 1-3133.0034

Paint-insulated copper wire

Polyurethane-insulated copper wire with a cross-section of 0.04 mm² (6.2 · 10-5 sq. in.), 25 m (82 ft) long.
Order No.: 1-CULD01

Jumper wire

Teflon insulated jumper wire with a cross section of 0.05 mm²,(7.75 · 10-5 sq. in.), yellow, 100 m (328 ft) per reel, resistance 0.34 Ω/m (ft) (0.104 Ω/ft).
Order No.: 1-3130.0239-G

Very flexible stranded wire

for internal, exposed wiring of transducers;
cross-section 0.04 mm² (6.2 · 10-5 sq. in.) (multi-wire), 0.6 mm (0.024 *inch*) external diameter, resistance 0.417 Ω/m (0.127 Ω/ft), permissible temperature + 70°C (158°F), 25 m (82 ft) per reel, PVC insulation.
Order No.: 1-SLI 01

Flexible stranded wire

Teflon-insulated flexible stranded wire with a cross-section of 0.24 mm² (0.0004 sq. in.) (multi-wire), external diameter of 0.9 mm (0.035 *inch*), 100 m (328.08 ft) per roll, resistance 0.0741 Ω/m (0.023 Ω/ft).

blue	Order No.: 1-3301.0092-B	black	Order No.: 1-3301.0088-S
green	Order No.: 1-3301.0091-GR	red	Order No.: 1-3301.0089-R
white	Order No.: 1-3301.0094-W		

Designation	Insulation	Thermal resistance	Chemical resistance	Typ. application
Flexible stranded wire 1-3301.0088-S 1-3301.0089-R 1-3301.0091-GR 1-3301.0092-B 1-3301.0094-W	Teflon	– 200 . . . + 260 °C (-328°F... +500°F)	Not resistant against: elementary fluoride, chorine trifluoride, molten Alkali metals. Otherwise resistant against all chemicals	for internal connection of SG bridges or for connection from SG to solder terminal point
Jumper wire 1-3130.0239-G	Teflon	– 200 . . . + 260 °C (-328°F... +500°F)	See flexible stranded wire	See flexible stranded wire
Very flexible stranded wire 1-SLI 01	PVC	Briefly 105° C (221°F) Continuous ...70 °C (... 158°F)	Not resistant against: Esters, chlorinated hydrocarbons ketones, aromatics, benzene, liquid halogens, conc. nitric acid, aqueous solutions depending on the plasticizer	for internal connection of SG in transducer
PVC flat ribbon cable 1-3133.0034	PVC	Briefly 105° C (221°F) Continuous ...90 °C (194°F)	See very flexible stranded wire	See flexible stranded wire
Paint-insulated copper wire 1-CULD 01	Polyurethane	Briefly 120 ° C (248°F) Continuous -40...80 °C (-40°F... +176°F)	Not resistant against: strong acids, strong alkalis Alcohols, aromatics, saturated vapor, hot water	for internal connection of SG in transducer

SG accessories ... Cables and stranded wires

Shielded mea

Type	Kab4.1/00-3	Kab5/00-4	Kab8/00-4	Kab7/00-4	Kab9/00-4
Notes	Inexpensive cable for connecting 1/4 bridges in 3-wire circuits (CF 600Hz <50m (164 ft); CF 4.8kHz <20m (65 ft))	Reduced capacitance, therefore also suitable for CF amplifiers and longer distances. Very thin, therefore predestined for geometrically critical conditions	Very reduced capacitance cable with low resistance, therefore suitable for longer distances	Wide temperature range and good chemical resistance. When using CF amplifiers, the applicable cable length is restricted (CF 600Hz <50m (164 ft); CF 4.8kHz <20m (65 ft))	Like KAB7/00-4, but with smaller resistance, therefore greater range for lower-frequency CF or DC amplifiers
Sheath color	gray	gray	gray	gray	gray
No. of cores	3	4	4	4	4
Outside diameter [mm (inch)]	4.1 (0.161)	5 (0.197)	8 (0.215)	6.5 (0.256)	8.8 (0.346)
Core cross-section [mm (inch)]	0.14 (0.006)	0.17 (0.007)	0.26 (0.010)	0.5 (0.020)	1.25 (0.049)
Insulation material (core)	PVC	PE	PE	Teflon	Teflon
Sheath material	PVC	PVC	PVC	Silicone	Silicone
Resistance [Ω/m (Ω/ft)]	0.130 (0.04)	0.106 (0.305)	0.075 (0.0229)	0.040 (0.0122)	0.014 (0.00427)
Insulation resistance (core-core) [Ω/m (Ω/ft)]	10^{12} (0.305 · 1012)	10^{12} (0.305 · 1012)	10^{12} (0.305 · 1012)	10^{12} (0.305 · 1012)	10^{12} (0.305 · 1012)
Capacitance (core-core) [pF/m]	110 (33.5 pF/ft)	80 (24.4 pF/ft)	67 (20.4 pF/ft)	140 (42.7 pF/ft)	140 (42.7 pF/ft)
Capacitance (core-shield) [pF/m]	110 (33.5 pF/ft)	80 (24.4 pF/ft)	67 (20.4 pF/ft)	140 (42.7 pF/ft)	140 (42.7 pF/ft)
Temperature range [°C (°F)]	-20....80 (-4... +176)	-35....80 (-31... +176)	-35....80 (-31... +176)	-50...180 (-58... +356)	-50...180 (-58... +356)
1/4 bridges in 3-wire circuit, full bridges without sensing lead connected	x	x	x	x	x
1/4 bridges in 4-wire circuit, full bridges without sensing lead connected	x	x	x	x	x
Half bridges; full bridges with sensing lead connected					
Order number	4-3131.0017	4-3133.0002	4-3133.0023	4-3131.0048	4-3131.0012

Minimum order quantity: 10 m (32.8 ft)

Further information can be found in the price list (load cells, transducers, amplifiers, data acquisition and software)

surement cable

	Kab5.4/00-6	Kab6.5/00-6-TPE	Kab6.5/00-6-SIL	Kab4.2/00-6-PUR	Kab8/00-2/2/2	Kab8/00-2/2/2 SIC
	Inexpensive 6-wire cable for uncritical applications (CF 600Hz <50m (164 ft); CF 4.8kHz <20m (65 ft))	Like Kab5.4/00-6, but with extended temperature range	Chemically resistant cable with extended temperature range. Also suitable for longer distances due to reduced capacitance and resistance	Special cable for use in the soil (CF 600Hz <50m (164 ft); CF 4.8kHz <20m (65 ft))	Quad-shielded cable twisted in pairs, also suitable for longer distances and higher-frequency CF amplifiers	Like Kab8/00-2/2/2, but better chemical resistance
	gray	gray	gray	black	gray	gray
	6	6	6	6	6	6
	5.4 (0.213)	6.5 (0.256)	6.5 (0.256)	4.2 (0.165)	7.5 (0.295)	7.5 (0.295)
	0.14 (0.006)	0.25 (0.010)	0.25 (0.010)	0.15 (0.006)	0.14 (0.006)	0.14 (0.006)
	PE	TPE	Teflon	TPE	PE	PE
	PVC	TPE	Silicone	PUR	PVC	Silicone
	0.130 (0.04)	0.077 (0.0235)	0.080 (0.0244)	0.120 (0.0366)	0.138 (0.0421)	0.138 (0.0421)
	10^{12}(0.305 · 1012)	10^{12}(0.305 · 1012)	10^{12}(0.305 · 1012)	10^{12} (0.305 · 1012)	10^{12}(0.305 · 1012)	10^{12}(0.305 · 1012)
	82 (25 pF/ft)	100 (30.5 pF/ft)	100 (30.5 pF/ft)	95 (42.7 pF/ft)	75 (22.9 pF/ft)	75 (22.9 pF/ft)
	82 (25 pF/ft)	100 (30.5 pF/ft)	100 (30.5 pF/ft)	140 (42.7 pF/ft)	130 (39.6 pF/ft)	130 (39.6 pF/ft)
	30... 85 (-22... +185)	50... 120 (-58... +248)	-50... 180 (-58... +356)	-50... 125 (-58... +257)	-30... 70 (-22... +158)	-30... 70 (-22... +158)
	x	x	x	x	x	x
	4-3131.0071	4-3301.0115	4-3301.0108	4-3301.0151	4-3301.0071	4-3301.0169

SG accessories ... Bridge completions / resin-cored solder / lead-free solder

Bridge completions

Bridge completion resistors are connected to the strain gages of a measuring point to form the Wheatstone bridge circuit. In accordance with the nominal strain gage resistances, HBM offers various resistance values.
2 x 120 Ω Order No.: 3-3054.0334
2 x 350 Ω Order No.: 3-3054.0282

Resin-cored solder

Resin cored solder for SG applications. Soldering wire Ø 0.5 mm (0.019 *inch*), consisting of cored solder S-SN60Pb38Cu2 with resin core type F-SW32. The flux is non-corrosive.
Melting range: 183 ... 190° C (361.4°F ... 374°F). Delivery form: 1 kg (2.2 lb) on reel
Order No.: 1-Lot

Lead-free solder

Lead-free resin cored solder for SG applications. Diameter: 0.5 mm (0.02 *inch*); Sn95, 5Ag3, 8Cu0,7 ("no clean").
Melting range: 217 °C to 219 °C (422.6°F to 426.2°F). Delivery form: 500 g on reel
Order No.: 1-Lot-LF

SG accessories ... SG installation case

SG Starter Kit DAK 1

This handy case contains all the equipment needed for installing strain gages for the first time. It provides an easy introduction to strain gage technology. Comprehensive know-how around installation and wiring of strain gages, and evaluation of measured values is provided by the specialized book written by Karl Hoffmann, an experienced specialist in strain gage technology.
For the first practical steps, containing:

- Strain gages
- Solder terminals
- Cleaning agents and cleaning pads
- Emery cloth
- Cold-curing adhesives X60 and Z70
- Stranded connection wires
- 2 agents for measuring point protection: AK22 and ABM75

Because DAK1 has been used for many years in company-internal SG and instrumentation seminars, the contents have been continuously optimized.
Order No.: 1-DAK1

DAK 1 contents	
10	SG LY11-6/120A
1	Z 70
1	X 60
1	AK 22
1	ABM 75
	Soldering terminals
	Stranded connection wires
	Emery cloth
	RMS 1
	Cleaning pads
	Solder
1	Petri dish
1	Specialist book: "Eine Einführung in die Technik Messens mit Dehnungsmessstreifen" (An introduction to strain gage measurement technology)

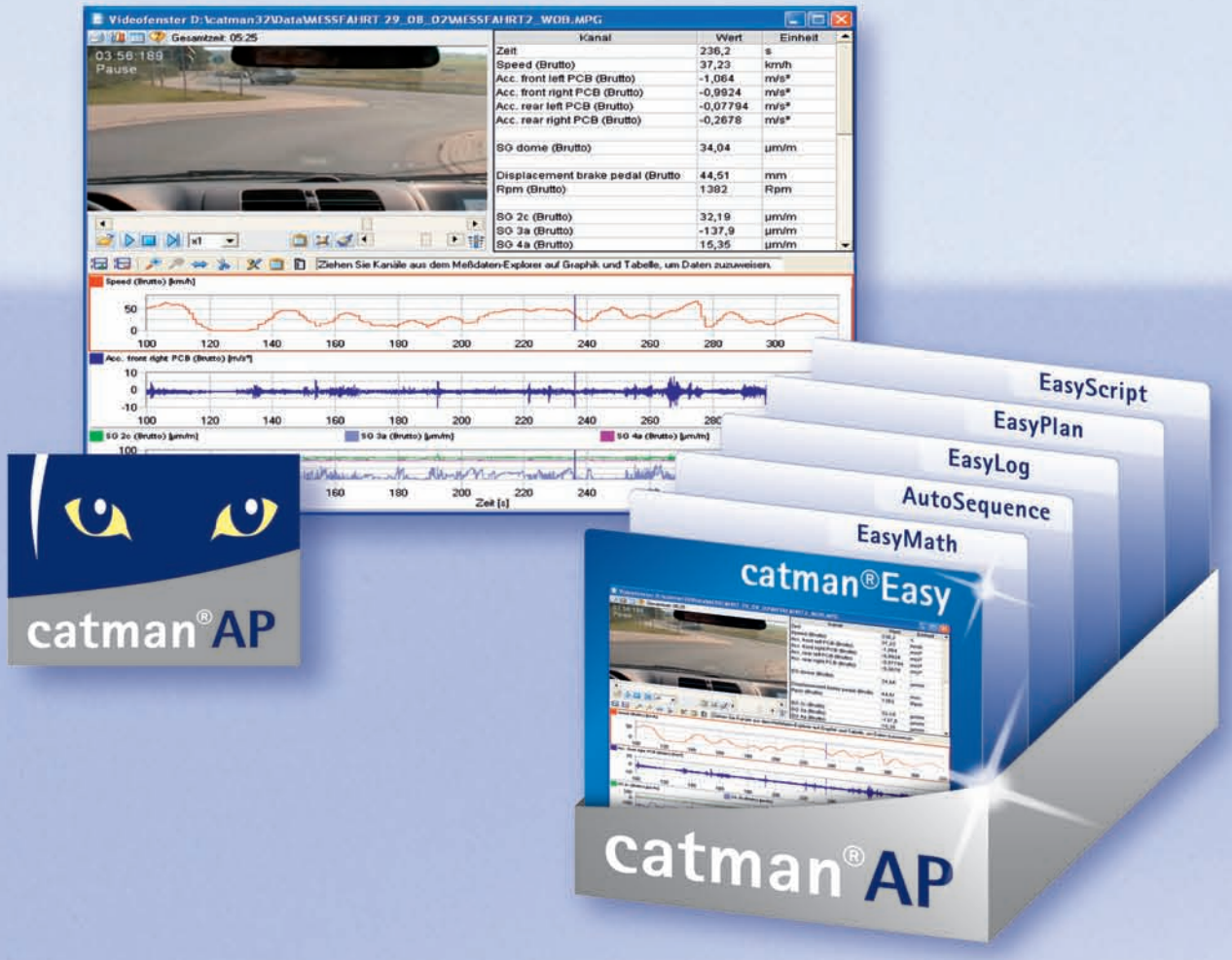
SG installation case DAK 2

The DAK 2 strain gage installation case contains all tools and aids required for strain-gage installations. It is portable and lockable. In the bottom part of the DAK 2 there is space for various adhesives and other uses, below the removable insert.
Dimensions: 470 x 170 x 360 mm (18.50 x 6.69 x 14.17 *inch*)
Weight: Approx. 6 kg (13.23 lb)
(incl. standard scope of delivery)
Order No.: 1-DAK 2

DAK 2 contents			
1	Ersa soldering iron (16 W)	1	Scalpel holder plus 6 blades
1	Flat brush	10 m *(32.8 ft)*	Flat ribbon cable 6 x 0.14 mm², various colors
1	Folding magnifying glass (6x)	25 g *(0.88 oz)*	Soldering wire Ø 1 mm
1	Graduated ruler, 150 mm *(5.91 inch)*	1	Flux pen
1	Glass fiber erasing brush, plus 1 spare brush	1	Roll of Scotch tape
1	Scissors, toothed	1	Rubber
1	Pointed scissors	1	HBM ballpoint pen
1	Tweezers, wide	1 each	corundum cloth sheets, grain size 180/220/360
1	Tweezers, pointed	100 cm³ *(3.38 liquid ounce, US)*	Cleaning agent RMS 1
1	Flexible ruler, 300 mm *(11.81 inch)*	200	Cleaning pads, 50 x 50 mm (*1.97 x 1.97 inch)*
1	Dental probe with bent tip		
1	Cement spatula		
1	Cutting and stripping pliers		
1	Petri dish 60/15		

HBM software

...for configuring, displaying and analyzing your



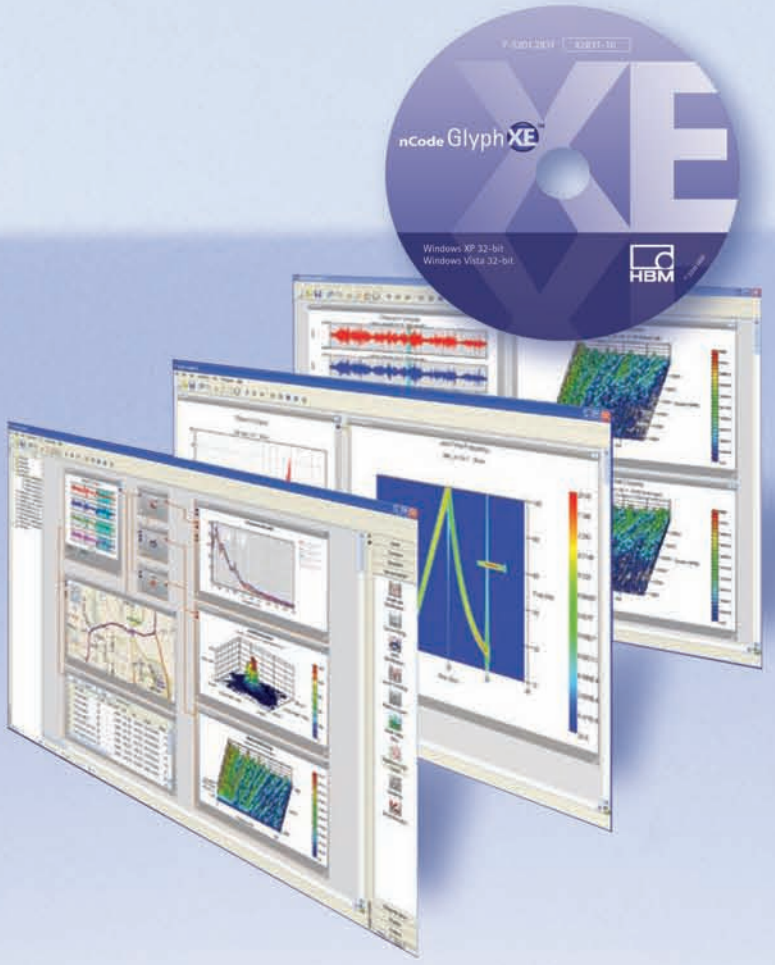
catman®Easy
– Acquisition and visualization of measured data

The quick and simple way to handle your many and varied measurement tasks - without wasting time and energy on programming - catman®Easy. Thanks to the optimum interplay between hardware and software, you can rapidly configure your amplifier, define your measurement parameters such as measuring rate or triggers and select your preferred visualization. Data can be graphically displayed, analyzed and exported using various formats (e.g. Excel or ASCII).

catman®AP
– Complete measurement technology packet – simple and professional

Profit from the latest generation measurement data acquisition software. catman®AP bundles together highly efficient modules for a wide variety of different measurement tasks. Each one a champion in its own application area. Together, the modules form a flexible, powerful and networked high-performance package.
Measurement data can be acquired, visualized, evaluated and output as reports with catman®AP. In addition, complete measurement sequences can be automated.

measurement results



catman® Enterprise
– Software solution for multi-channel systems

The software package catman®Enterprise was specially developed for tasks with numerous channels. The actual measurement is implemented by a Server PC; in addition, several Client PCs can access the data of this server in real time and so track the measurement.

GlyphXE™
– Analysis software for a clear view of the measurement results

GlyphXE™ is a modern and powerful analysis software that simply, rapidly and securely produces meaningful test reports, even from large data volumes.
With GlyphXE™, you can develop individual analysis calculations yourself with the help of a graphical user interface and execute them reproducibly for all measurements.
You obtain your report at the click of a mouse.

Universal measuring amplifier systems
...for data acquisition

HBM offers a wide selection of flexible data acquisition systems: From simple mobile desktop devices via PC measurement electronics to powerful and expandable universal measurement systems.

MGCplus – universal and scalable system
Measure static or dynamic force, mass, displacement, pressure, temperature, torque, acceleration, elongation, electr. voltage, current, frequency, resistance. MGCplus always has the appropriate module.

eDAQ – Rugged and mobile data acquisition system
Data can be recorded with the self-contained eDAQ system even under hard environmental conditions. The data volume can be drastically reduced thanks to the intelligent data modes. A Peak-to-Peak-Valley or Rainflow matrix for example can be calculated online. The system is therefore also optionally suitable for the sector of mobile fatigue testing.

ring amplifier systems

QuantumX – XXL performance in mini format

The universal amplifier system for demanding inspection and test projects. An all-round system with all current transducer technologies for all current transducers and sensors. Data acquisition at the highest level, small, fast and universal.

CANHEAD

– for experimental structural and stress analysis

Whether for static structural testing, material fatigue testing or long-term monitoring - CANHEAD saves cabling time.
Because CANHEAD® is installed right next to the measuring point.

Literature · Teaching pack · Seminars · CD-ROM

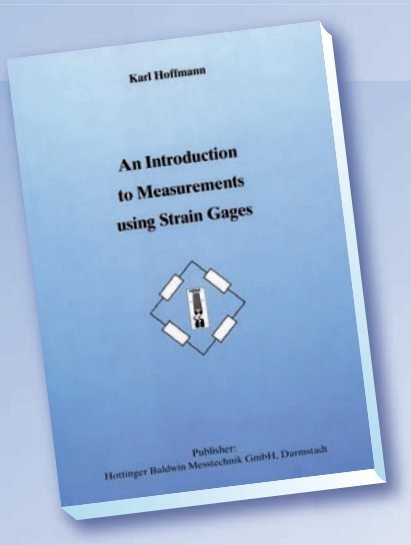
SG specialized book

"Eine Einführung in die Technik des Messens mit Dehnungsmessstreifen"
(An introduction to measurement using strain gages)
A practical introduction into this specialist area of measurement technology with a focus on how to avoid or correct measuring errors.
Order No.: 1-Hoffm. Buch-D (deutsch)
1-Hoffm. Buch-E (English)

SG teaching pack

The strain gage teaching pack provides a multimedia introduction to the installation of strain gages. The film explains the competent installation of strain gages using cold curing and hot curing adhesives. In addition, the tips and tricks shown can be read in the manuscript and in the specialized book "An Introduction to Measurements Using Strain Gages".
Order No.: 1-DMS-Lernpaket

An Introduction
to Measurements
using Strain Gages



Seminars

Learning by rote is not our style. HBM offers you practical basic and advanced training in the field of the electrical measurement of mechanical quantities. The basics in this field will first be explained and demonstrated by means of hands-on lectures. Subsequent practical training will follow. Theory and practice sessions alternate several times during the course of the seminar, in order to discuss and clarify questions - which usually first occur in practical application sessions - in the next theory block.

Our seminar concept offers the right seminar for everybody – ranging from the free one-day lecture through workshops up to 1-week seminars.

DK

Basics of strain gage bonding and measuring technology
Target group: Specialist personnel, master tradesmen or engineers who want to implement SG installations independently.

DM

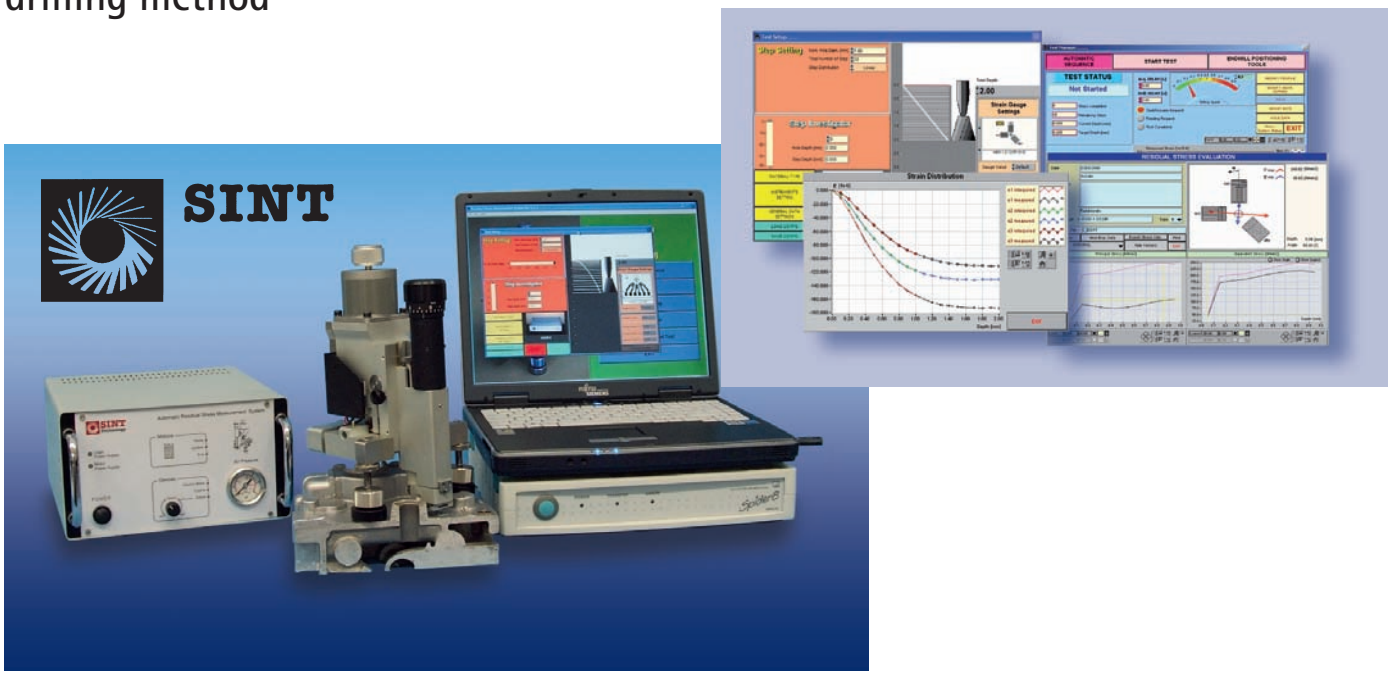
Strain gage measuring technology in transducer construction and experimental stress analysis
Target group: Users from all specialist disciplines who want to carry out measurements with strain gages.

For more detailed information on our seminars on HBM device technology and software and all seminar dates, please visit our homepage at www.hbm.com. Or request our seminar program from seminare@hbm.com.

It is of course possible to implement all seminars that are offered in our seminar center at Darmstadt directly on your own premises.
On request, we can modify our seminars in order to enable us to offer you target-oriented basic and advanced training.

MTS 3000

System for automatically determining residual stress based on the hole drilling method



The strength behavior of components is influenced by residual stresses existing in these components without showing any visible signs.
It is therefore sensible to determine the mechanical stresses present in the components in order to take them into account when dimensioning a component.

With the hole-drilling method for determining residual stresses, a small hole approx. Ø 1.8 mm (0.071 *inch*) is drilled into the work piece surface and strain gages are used to measure the resulting strain changes.

SINT Technology, a HBM partner, offers the measurement chain MTS3000 with which it is easy to implement this method. To create the hole, a cutter with a speed of 400,000 rpm is used, driven by a stepper motor. The strain changes created by the incremental creation of the bore in the measurement object are recorded by a strain gage rosette developed specially for this procedure.

Signal processing is performed digitally. In addition to system control functions, the software package comprises four different evaluation algorithms.

The entire measurement process is PC-controlled. This ensures a high degree of measurement reliability as well as optimum reproducibility.

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Vietnam: refer to Singapore

Yugoslavia: see Serbia

* = Weighing technology
** = Process measurement technology

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measure and predict with confidence

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