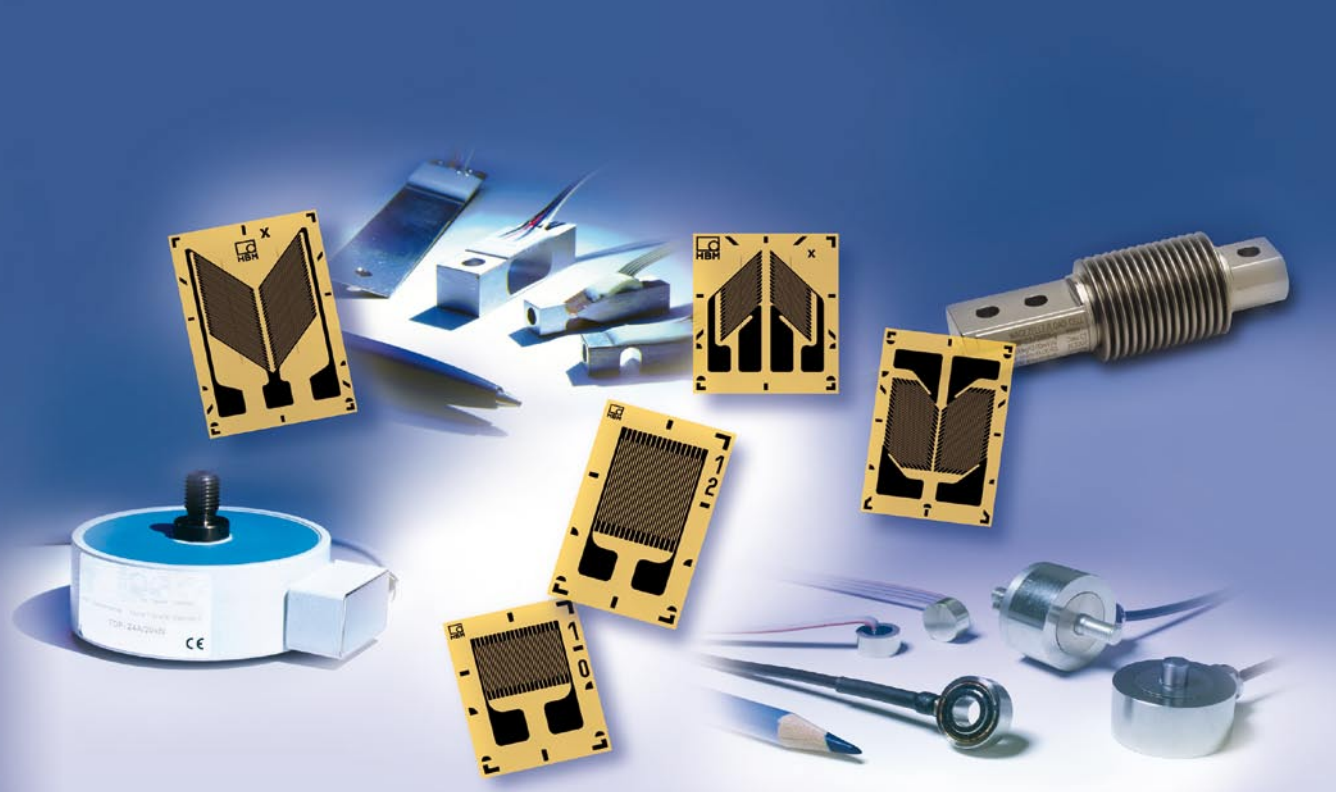
measure and predict with confidence



Strain Gages

for Transducer Manufacturers

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Strain Gages
for Transducer Manufacturers

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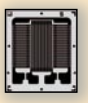 Columnar strain gages	27

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Strain gage mate

This chapter provides information about strain gage construction and, in particular, about the materials used for measuring grid materials, the carrier materials and the options that are available.

Measuring grid materials

Constantan

Constantan is a copper-nickel alloy. It is the preferred material for strain gages. The gage factor of strain gages with constantan as the measuring grid material is approx. 2.

Nickel-chromium special alloy (Modco)

Modco is an alloy of nickel and chromium. The gage factor is about 2.2. Due to this, there is a slightly higher output signal from the transducer in comparison to strain gages with a constantan measuring grid foil. In addition, Modco has a higher specific resistance than constantan and is frequently used for high impedance strain gages for this reason.

The temperature dependence of the gage factor in Modco strain gages is negative, which means that the sensitivity of the strain gage decreases with rising temperature. In contrast, the spring materials' modulus of elasticity is reduced which would lead to a greater sensitivity of the transducer under uniform load. Modco strain gages can compensate for this effect due to the negative temperature dependence of the gage factor. The sensitivity of the transducer is therefore essentially temperature-independent without the need for additional compensating elements.

Nickel

Nickel is used in foil-based resistors to compensate for the temperature dependence of both the zero point and the sensitivity of a transducer.

The resistance temperature coefficient is $4.8 \cdot 10^{-3}$/K (0°C) *(32°F)*.

rials and options

Strain gage carrier materials

All strain gages in this catalog are based on the carrier material PEEKF. This carrier material is characterized by the following properties:

- Easy to use during installation and soldering
- Very good metrological properties - therefore suitable for transducers with high accuracy requirements
- Very low humidity absorption, which can significantly improve the stability of the transducer
- Small curvature radii permit installation in, for example, small boreholes.

On request, we can also offer strain gages based on glass fiber reinforced phenolic resin. Glass fiber reinforced phenolic resin also offers excellent metrological properties, especially when the transducer is used in higher temperatures. Due to the higher stiffness of the carrier material, it can break if not handled correctly.

Options

In addition to our standard range of open and covered strain gages, we offer various options on request:

- Self-adhesive versions, so-called "stick-on" strain gages; these are described in more detail below.
- Connection leads made of nickel-plated copper
- Further options on request.

Self-adhesive strain gages – "Stick-on" option

No additional adhesive is needed anymore for mounting the strain gage. Self-adhesive "Stick-on" strain gages are supplied with an adhesive pre-coated on the strain gage carrier. The adhesive is dry, thus facilitating easy handling and positioning of the gage.

- Saves you one working step - Application of an adhesive.
- The storage life of these strain gages is 1 year.
- Strain gages with cover and without leads (nickel-plated Cu leads) can be supplied with the "stick-on" option (Option BE).

It's so easy, ...

...Using strain gages with the "Stick-on" option:

Preparation:	- Clean and degrease the installation surface (e.g. with RMS1 or RMS1 SPRAY) - Use emery (grain 220 ... 300) or sandblast (e.g. sandblasting grains and grain 80 ... 100) - Clean with high-purity solvent (e.g. RMS1 or RMS1 SPRAY)
Strain gage:	No preparation necessary
Fixing of strain gage:	With heat-resistant adhesive tape (e.g. 1-Klebeband)
Pressing of strain gage:	For instance, with a clamping device, protect the strain gage with separating foil (e.g. 1-Teflon) and pressure compensating pads against damage (e.g. silicone rubber; included in adhesive packets EP150, EP250 and EP310S)
Curing of the adhesives:	Optimum cross-linking occurs under the following conditions: - Contact pressure: 20 ... 35 N/cm^2 *(2.9 ... 5.1 lbf/sq. in)* - Heating rate (under pressure): 2.5 K/min from room temperature to 160 °C *(320°F)* - Curing time: 3.5 h at 160 °C *(320°)* - Cooling (under pressure): down to room temperature - Post-curing (without pressure): 1 h at 160 °C *(320°F)*
Adhesive:	Hot-curing adhesive based on phenolic resin
Layer thickness:	15 ± 2 µm *(590 ± 197 microinch)*

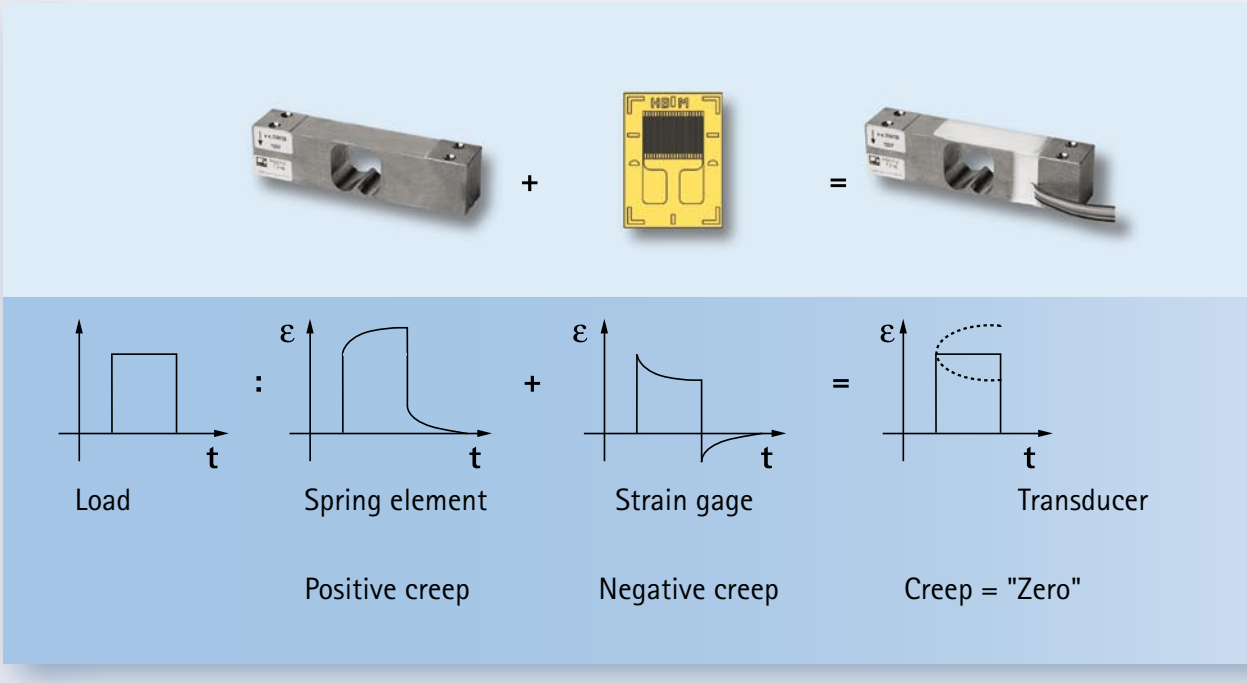
Creep adjustment

Spring element material exhibits a positive creep when it is loaded (elastic after-effect). This means that the material (spring element material) deforms under load even further in the load direction. This leads to a greater signal over time.
Strain gages behave differently and creep negatively. This means that the signal becomes smaller under load over time.

The signal of a loaded transducer is the sum of both effects.
For high accuracy transducers, the strain gage creep has to be matched as closely as possible to the creep of the spring material.

Creep behavior depends on many parameters such as spring material, strain field, type and thickness of the adhesive, strain gage carrier material and layout of the strain gage.
The end loop length (see next page) is one of many parameters affecting creep. The strain gage creep can be adjusted by changing the end loop length.
Most strain gages in this catalog are available with different end loop lengths.

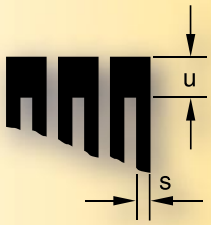
The effects of the various end loop lengths on the transducer creep must be determined experimentally, keeping all other parameters constant.



Schematic diagram of the elastic after-effect of spring elements, strain gage creep and the behavior of the transducer

End loop length

The end loop length "u" of the strain gage is a multiple of the grid line width "s". The data is shown as an alphabetical letter or directly as the ratio between end loop length and grid line width. The following table shows which letter is used for the respective end loop lengths.



A: u = 1s	M: u = 7s
C: u = 2s	O: u = 8s
E: u = 3s	Q: u = 9s
G: u = 4s	S: u = 10s
I: u = 5s	U: u = 11s
K: u = 6s	W: u = 12s

Would you like ...

___more information?

___an offer?

___free samples for tests?

___to discuss your application with us?

Then contact your nearest HBM representative.
You can find our representatives under www.hbm.com.
Or email us at:

makingtransducers@hbm.com

Sales quantity unit

The sales quantity unit of the strain gages listed in the catalog, as well as the balancing and compensating elements, is 100 pieces.

The "Strain Gages and Accessories" catalog provides more information about ...

- Strain gages for experimental stress analysis
- Further accessories, including adhesives, covering materials and cleaning agents
- Strain gages with connecting cables

Request a catalog at: info@hbm.com

Strain gage – inquiry form

If your requirements are not met by the solutions in this catalog, please use the form below to contact us.

FAX to HBM: +49 6151 803 9100

This form is also available on our website, at: www.hbm.com/sg-inquiry

Strain gage specifications:

Resistance: (for a measuring grid)	☐ 120 Ω	☐ 350 Ω	☐ 700 Ω	☐ 1000 Ω	☐ Other (Ω)
Grid length:	☐ 1.5 mm	☐ 3 mm	☐ 6 mm	☐ 10 mm	☐ Other (mm)
Grid width:	☐ mm	☐ mm			
Carrier dimensions:	☐ mm length	☐ mm width			
Measuring grid material:	☐ Constantan	☐ Ni-Cr alloy (Modco)	☐ Nickel (compensation elements)		
Properties:	☐ Connection leads	☐ Integrated solder terminals	☐ Insulated cable	☐ Covered grid	
Carrier material:	☐ Glass fiber reinforced phenolic resin	☐ PEEKF	☐ Polyimide		
Temperature response matched to:	☐ Steel	☐ Aluminum	☐ Others		
Annual requirement:	☐ Pieces				
Your special requirements:					
Type number of strain gage currently in use:					

Inquiry for customized strain gages

Your profile:

Company

Department

First name

Last name

Country

State

City

Postcode

Street

Tel.

Fax

Email

Please provide a sketch of the strain gage

Type designation

Option 1: Number of grids and their positions

L	Linear
D	Double-linear or half bridge
X	Single or double shear
T	T rosette or columnar strain gage
V	Full brigde
M	Membrane rosette

Option 2: Strain gage series

A	Carrier: PEEKF/ Measuring grid foil: Constantan
U	Carrier: PEEKF/ Measuring grid foil: Ni-Cr alloy

Not all combinations are possible; please refer to individual strain gage examples

Option 3: Layout of grids, type and position of connections

1-9	Please refer to individual strain gage examples

Option 4: Material to which the strain gage temperature response is matched

1	Ferritic steel with $\alpha = 10.8 \cdot 10^{-6}/K$
3	Aluminum with $\alpha = 23 \cdot 10^{-6}/K$

Other matchings available on request

Option 5: Creep adjustment*

A	u = 1s
C	u = 2s
E	u = 3s
G	u = 4s
I	u = 5s
K	u = 6s
M	u = 7s
O	u = 8s
Q	u = 9s
S	u = 10s

Other creep adjustments on request.

* The end loop length u is equal to a multiple of the grid line width s.

Option 6: Measuring grid length in mm

With membrane rosettes, this is the diameter of the circle that surrounds the measuring grid.

Option 7: Measuring grid resistance in ohms

175	175 Ω
350	350 Ω
1K0	1000 Ω

Option 8: Covering, connections, "stick-on"

_E	Measuring grid with covering
BE	"Stick-on" - self-adhesive strain gages, strain gages supplied with adhesive already applied to the carrier; only in combination with measuring grid covering
LE	Nickel-plated Cu leads, approx. 30 mm long; only in combination with measuring grid covering
_W	Measuring grid without covering

1- ☐ ☐ ☐ ☐ ☐ ☐ / ☐ ☐

Example:

1- L A 1 1 K 1.6 / 350 _E

Preferred types or variants
1- = Preferred types
K- = Variants

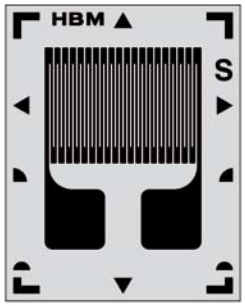
Specifications – A series strain gages

Strain gage construction		Foil strain gage
Measuring grid		
Material		Constantan
Thickness	µm *(microinch)*	3.8 or 5, *(150 or 197)* depending on strain gage type
Carrier		
Material		PEEKF
Thickness	µm *(microinch)*	40 ±5 *(1,575 ± 197)*
Cover		
Material		PEEKF
Thickness	µm *(microinch)*	40 ±5 *(1,575 ± 197)*
Connections		Nickel-plated Cu leads, approx. 30 mm long,
in strain gages without connection leads		integrated solder tabs
Nominal resistance	Ω	175, 350, 1000, depending on strain gage type
Resistance tolerance	%	±0.3 without, ±0.35 with leads
Gage factor		Approx. 2
Nominal value of gage factor		Data on request
Gage factor tolerance		
at ≤ 1.5mm measuring grid length	%	±1.5
at > 1.5mm measuring grid length	%	±1
Reference temperature	°C *(°F)*	23 *(73.4)*
Operating temperature range		
for static, i.e. zero point-related measurements	°C *(°F)*	-40 ... +200 *(-40...+392°F)*
for dynamic, i.e. non-zero point-related measurements	°C *(°F)*	-70 ... +200 *(-94...+392°F)*
Transverse sensitivity		Data on request
Temperature response		Data on request
Temp. response as required, matched to thermal expansion coefficient		
for ferritic steel	1/K *(1/°F)*	$10.8 \cdot 10^{-6}$ $(6.0 \cdot 10^{-6})$
for aluminum	1/K *(1/°F)*	$23 \cdot 10^{-6}$ $(12.8 \cdot 10^{-6})$
Temperature response tolerance	1/K *(1/°F)*	$\pm 0.3 \cdot 10^{-6}$ $(\pm 0.17 \cdot 10^{-6})$
Matching of temperature response in the range of	°C *(°F)*	-10 ... +120 *(14°F...248°F)*
Maximum elongation		
at reference temperature when using Z70 adhesive		
on strain gage type K-LA11E3/350_W		
Absolute strain value ε for positive direction	µm/m *(microstrain)*	50,000 (≙5%)
Absolute strain value ε for negative direction	µm/m *(microstrain)*	50,000 (≙5%)
Fatigue life		
at reference temperature when using Z70 adhesive on		
strain gage type K-LA11E3/350_W		
Achievable number of load cycles L_W at alternating strain		
$\varepsilon_W = \pm 1000$µm/m and zero point variation of		
$\varepsilon_m \leq 300$µm/m		>> 10^7 (test aborted at 10^7)
$\varepsilon_m \leq 30$µm/m		> 10^7 (test aborted at 10^7)
Minimum radius of curvature at reference temperature		
longitudinal	mm *(inch)*	0.5 *(0.020)*
transverse	mm *(inch)*	0.5 *(0.020)*
For strain gages with leads in the area of the solder terminals	mm *(inch)*	5 *(0.197)*
Bonding material that can be used		
Cold curing adhesives		Z70, X280
Hot curing adhesives		EP150, EP250, EP310S

Specifications – U series strain gages

Strain gage construction		Foil strain gage
Measuring grid		
Material		Nickel-chrome special alloy
Thickness	µm *(microinch)*	5 *(197)*
Carrier		
Material		PEEKF
Thickness	µm *(microinch)*	40 ±5 *(1,575 ± 197)*
Cover		
Material		PEEKF
Thickness	µm *(microinch)*	40 ±5 *(1,575 ± 197)*
Connections		Nickel-plated Cu leads, approx. 30 mm long
in strain gages without connection leads		Integrated solder tabs, nickel-plated
Nominal resistance	Ω	350, 1000, depending on strain gage type
Resistance tolerance	%	±0.3 without, ±0.35 with leads
Gage factor		Approx. 2.2
Nominal value of gage factor		Data on request
Gage factor tolerance		
at ≤ 1.5mm measuring grid length	%	±1.5
at > 1.5mm measuring grid length	%	±1
Reference temperature	°C *(°F)*	23 *(73.4)*
Operating temperature range		
for static, i.e. zero point-related measurements	°C *(°F)*	-40 ... +200 *(-40...+392°F)*
for dynamic, i.e. non-zero point-related measurements	°C *(°F)*	-70 ... +200 *(-94...+392°F)*
Transverse sensitivity		Data on request
Temperature response		Data on request
Temperature response as required, matched to thermal expansion coefficient		
for ferritic steel	1/K *(1/°F)*	$10.8 \cdot 10^{-6}$ $(6.0 \cdot 10^{-6})$
for aluminum	1/K *(1/°F)*	$23 \cdot 10^{-6}$ $(12.8 \cdot 10^{-6})$
Temperature response tolerance	1/K *(1/°F)*	$\pm 0.6 \cdot 10^{-6}$
Matching of temperature response in the range of	°C *(°F)*	-10 ... +120 *(14°F...248°F)*
Maximum elongation		
at reference temperature when using Z70 adhesive on strain gage type K-LU11E3/350_W		
Absolute strain value ε for positive direction	µm/m *(microstrain)*	10,000 (≙1%)
Absolute strain value ε for negative direction	µm/m *(microstrain)*	35,000 (≙3,5%)
Fatigue life		
at reference temperature when using Z70 adhesive on strain gage type K-LU11E3/350_W		
Achievable number of load cycles L_W at alternating strain $\varepsilon_W = \pm 1000$µm/m and zero point variation of		
$\varepsilon_m \leq$ 300µm/m		>> 10^7 (test aborted at 10^7)
$\varepsilon_m \leq$ 30µm/m		> 10^7 (test aborted at 10^7)
Minimum radius of curvature at reference temperature		
longitudinal	mm *(inch)*	0.5 *(0.020)*
transverse	mm *(inch)*	0.5 *(0.020)*
For strain gages with leads in the area of the solder terminals	mm *(inch)*	5 *(0.197)*
Bonding material that can be used		
Cold curing adhesives		Z70, X280
Hot curing adhesives		EP150, EP250, EP310S

Linear strain gages: 1.6 mm (0.063 inch), 350 and 1000 ohms



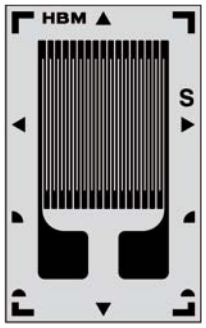
Original size

Dimensions in mm and inch			
Measuring grid length	Measuring grid width	Total length	Total width
1.6 mm	3.0 mm	5.7 mm	4.5 mm
0.063 inch	0.118 inch	0.224 inch	0.177 inch

Preferred types		Variants	Option 4)	Option 5)	Option 8)	
Steel	Aluminum	Other	Temperature resp. matched to	Creep adjustment	Option	Nominal resistance
1-LA11K1.6/350_E	1-LA13K1.6/350_E	K-LA1x[4]x[5]1.6/350xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	350 Ω ± 0.3 %
1-LA11S1.6/350_E	1-LA13S1.6/350_E					350 Ω ± 0.3 %
1-LU11K1.6/1K0_E	1-LU13K1.6/1K0_E	K-LU1x[4]x[5]1.6/1K0xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	1000 Ω ± 0.3 %
1-LU11S1.6/1K0_E	1-LU13S1.6/1K0_E					1000 Ω ± 0.3 %

Linear strain gages

Linear strain gages: 3 mm (0.118 inch), 350 and 1000 ohms



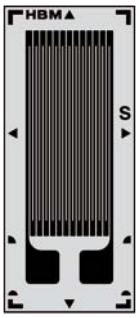
Original size

The 1000 ohms version has a slightly wider measuring grid; however, the external dimensions are as shown.

Dimensions in mm and inch			
Measuring grid length	Measuring grid width	Total length	Total width
3.0 mm	3.0 mm	7.3 mm	4.5 mm
0.118 inch	0.118 inch	0.287 inch	0.177 inch

Preferred types		Variants	Option 4)	Option 5)	Option 8)	
Steel	Aluminum	Other	Temperature resp. matched to	Creep adjustment	Option	Nominal resist-ance
1-LA11K3/350_E	1-LA13K3/350_E	K-LA1x[4]x[5]3/350xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	350 Ω ± 0.3 %
1-LA11S3/350_E	1-LA13S3/350_E					350 Ω ± 0.3 %
1-LA11K3/1K0_E	1-LA13K3/1K0_E	K-LA1x[4]x[5]3/1K0xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	1000 Ω ± 0.3 %
1-LA11S3/1K0_E	1-LA13S3/1K0_E					1000 Ω ± 0.3 %

Linear strain gages: 6 mm (0.236 inch), 350 and 1000 ohms

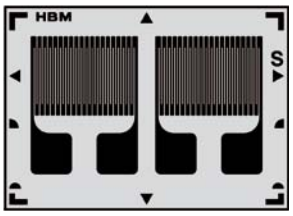


Original size

Dimensions in mm and inch			
Measuring grid length	Measuring grid width	Total length	Total width
6.0 inch	3.0 mm	10.6 mm	4.5 mm
0.236 inch	0.118 inch	0.417 inch	0.177 inch

Preferred types		Variants	Option 4)	Option 5)	Option 8)	
Steel	Aluminum	Other	Temperature resp. matched to	Creep adjustment	Option	Nominal resistance
1-LA11K6/350_E	1-LA13K6/350_E	K-LA1x[4]x[5]6/350xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	350 Ω ± 0.3 %
1-LA11S6/350_E	1-LA13S6/350_E					350 Ω ± 0.3 %
1-LA11K6/1K0_E	1-LA13K6/1K0_E	K-LA1x[4]x[5]6/1K0xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	1000 Ω ± 0.3 %
1-LA11S6/1K0_E	1-LA13S6/1K0_E					1000 Ω ± 0.3 %

Double linear strain gages: 1.6 mm (0.063 inch), 350 and 1000 ohms



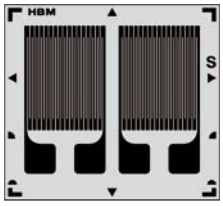
Original size

Dimensions in mm and inch			
Measuring grid length	Measuring grid width	Total length	Total width
1.6 mm	3.0 mm	5.7 mm	8.0 mm
0.063 inch	0.118 inch	0.224 inch	0.315 inch

Preferred types		Variants	Option 4)	Option 5)	Option 8)	
Steel	Aluminum	Other	Temperature resp. matched to	Creep adjustment	Option	Nominal resistance
1-DA11K1.6/350_E	1-DA13K1.6/350_E	K-DA1x[4]x[5]1.6/350xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	350 Ω ± 0.3 %
1-DA11S1.6/350_E	1-DA13S1.6/350_E					350 Ω ± 0.3 %
1-DU11K1.6/1K0_E	1-DU13K1.6/1K0_E	K-DU1x[4]x[5]1.6/1K0xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	1000 Ω ± 0.3 %
1-DU11S1.6/1K0_E	1-DU13S1.6/1K0_E					1000 Ω ± 0.3 %

Double linear strain gages

Double linear strain gages: 3 mm (0.118 inch), 350 and 1000 ohms



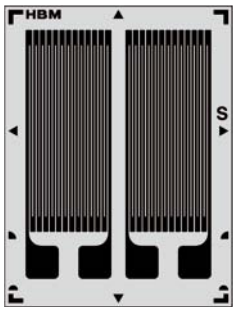
Original size

The 1000 ohms version has a slightly wider measuring grid; however, the external dimensions are as shown.

Dimensions in mm and inch			
Measuring grid length	Measuring grid width	Total length	Total width
3.0 mm	3.0 mm	7.3 mm	8.0 mm
0.118 inch	0.118 inch	0.287 inch	0.315 inch

Preferred types		Variants	Option 4)	Option 5)	Option 8)	
Steel	Aluminum	Other	Temperature resp. matched to	Creep adjustment	Option	Nominal resistance
1-DA11K3/350_E	1-DA13K3/350_E	K-DA1x[4]x[5]3/350xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	350 Ω ± 0.3 %
1-DA11S3/350_E	1-DA13S3/350_E					350 Ω ± 0.3 %
1-DA11K3/1K0_E	1-DA13K3/1K0_E	K-DA1x[4]x[5]3/1K0xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	1000 Ω ± 0.3 %
1-DA11S3/1K0_E	1-DA13S3/1K0_E					1000 Ω ± 0.3 %

Double linear strain gages: 6 mm (0.236 inch), 350 and 1000 ohms



Original size

Dimensions in mm and inch			
Measuring grid length	Measuring grid width	Total length	Total width
6.0 mm	3.0 mm	10.6 mm	8.0 mm
0.236 inch	0.118 inch	0.417 inch	0.315 inch

Preferred types		Variants	Option 4)	Option 5)	Option 8)	
Steel	Aluminum	Other	Temperature resp. matched to	Creep adjustment	Option	Nominal resistance
1-DA11K6/350_E	1-DA13K6/350_E	K-DA1x[4]x[5]6/350xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	350 Ω ± 0.3 %
1-DA11S6/350_E	1-DA13S6/350_E					350 Ω± 0.3 %
1-DA11K6/1K0_E	1-DA13K6/1K0_E	K-DA1x[4]x[5]6/1K0xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	1000 Ω ± 0.3 %
1-DA11S6/1K0_E	1-DA13S6/1K0_E					1000 Ω ± 0.3 %

Single shear strain gages: 1.9 mm (0.075 inch), 350 ohms, left version

Original size

Dimensions in mm and inch			
Measuring grid length	Measuring grid width	Total length	Total width
1.9 mm	1.4 mm	7.1 mm	3.2 mm
0.075 inch	0.055 inch	0.280 inch	0.126 inch

Preferred types		Variants	Option 4)	Option 5)	Option 8)	
Steel	Aluminum	Other	Temperature resp. matched to	Creep adaptation	Option	Nominal resistance
1-XU91S1.9/350_W		K-XU9x[4]x[5]1.9/350_W[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_W	350 Ω ± 0.3 %

Single shear strain gages

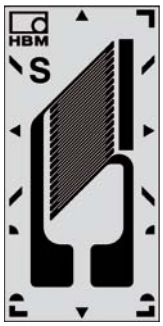
Single shear strain gages: 1.9 mm (0.075 inch), 350 ohms, right version

Original size

Dimensions in mm and inch			
Measuring grid length	Measuring grid width	Total length	Total width
1.9 mm	1.4 mm	7.1 mm	3.2 mm
0.075 inch	0.055 inch	0.280 inch	0.126 inch

Preferred types		Variants	Option 4)	Option 5)	Option 8)	
Steel	Aluminum	Other	Temperature resp. matched to	Creep adaptation	Option	Nominal resistance
1-XU01S1.9/350_W		K-XU0x[4]x[5]1.9/350_W[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_W	350 Ω ± 0.3 %

Single shear strain gages: 1.9 mm (0.075 inch), 350 ohms

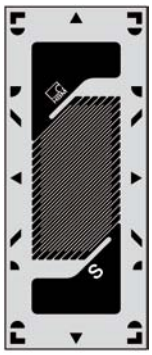


Original size

Dimensions in mm and inch			
Measuring grid length	Measuring grid width	Total length	Total width
1.9 mm	2.4 mm	9.0 mm	4.4 mm
0.075 inch	0.094 inch	0.354 inch	0.173 inch

Preferred types		Variants	Option 4)	Option 5)	Option 8)	
Steel	Aluminum	Other	Temperature resp. matched to	Creep adaptation	Option	Nominal resistance
1-XA51S1.9/350_E		K-XA5x[4]x[5]1.9/350xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	350 Ω ± 0.3 %

Single shear strain gages: 2.8 mm (0.110 inch), 175, 350 and 1000 ohms, left version



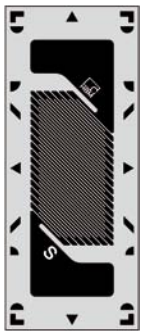
Original size

The 175 and 1000 ohms versions have a slightly smaller measuring grid;
however, the external dimensions are as shown.

Dimensions in mm and inch			
Measuring grid length	Measuring grid width	Total length	Total width
2.8 mm	3.5 mm	9.7 mm	4.0 mm
0.110 inch	0.138 inch	0.382 inch	0.157 inch

Preferred types		Variants	Option 4)	Option 5)	Option 8)	
Steel	Aluminum	Other	Temperature resp. matched to	Creep adjustment	Option	Nominal resistance
1-XA91K2.8/175_E		K-XA9x[4]x[5]2.8/175xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	175 Ω ± 0.3 %
1-XA91S2.8/175_E						175 Ω ± 0.3 %
1-XA91K2.8/350_E		K-XA9x[4]x[5]2.8/350xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	350 Ω ± 0.3 %
1-XA91S2.8/350_E						350 Ω ± 0.3 %
1-XU91K2.8/1K0_E		K-XU9x[4]x[5]2.8/1K0xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	1000 Ω ± 0.3 %
1-XU91S2.8/1K0_E						1000 Ω ± 0.3 %

Single shear strain gages: 2.8 mm (0.110 inch), 175, 350 and 1000 ohms, right version



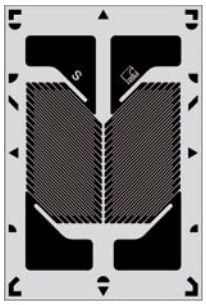
Original size

The 175 and 1000 ohms versions have a slightly smaller measuring grid;
however, the external dimensions are as shown.

Dimensions in mm and inch			
Measuring grid length	Measuring grid width	Total length	Total width
2.8 mm	3.5 mm	9.7 mm	4.0 mm
0.110 inch	0.138 inch	0.382 inch	0.157 inch

Preferred types		Variants	Option 4)	Option 5)	Option 8)	
Steel	Aluminum	Other	Temperature resp. matched to	Creep adjustment	Option	Nominal resistance
1-XA01K2.8/175_E		K-XA0x[4]x[5]2.8/175xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	175 Ω ± 0.3 %
1-XA01S2.8/175_E						175 Ω ± 0.3 %
1-XA01K2.8/350_E		K-XA0x[4]x[5]2.8/350xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	350 Ω ± 0.3 %
1-XA01S2.8/350_E						350 Ω ± 0.3 %
1-XU01K2.8/1K0_E		K-XU0x[4]x[5]2.8/1K0xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	1000 Ω ± 0.3 %
1-XU01S2.8/1K0_E						1000 Ω ± 0.3 %

Double shear strain gages: 2.8 mm (0.110 inch), 350 and 1000 ohms



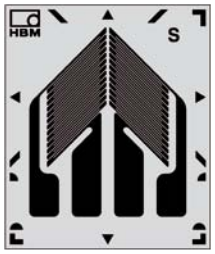
Original size

The 1000 ohms version has a slightly smaller measuring grid; however, the external dimensions are as shown.

Dimensions in mm and inch			
Measuring grid length	Measuring grid width	Total length	Total width
2.8 mm	3.5 mm	9.7 mm	6.5 mm
0.110 inch	0.138 inch	0.382 inch	0.256 inch

Preferred types		Variants	Option 4)	Option 5)	Option 8)	
Steel	Aluminum	Other	Temperature resp. matched to	Creep adjustment	Option	Nominal resistance
1-XA11K2.8/350_E		K-XA1x[4]x[5]2.8/350x[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	350 Ω ± 0.3 %
1-XA11S2.8/350_E						350 Ω ± 0.3 %
1-XU11K2.8/1K0_E		K-XU1x[4]x[5]2.8/1K0x[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	1000 Ω ± 0.3 %
1-XU11S2.8/1K0_E						1000 Ω ± 0.3 %

Double shear strain gages: 2 mm (0.079 inch), 350 ohms



Original size

Dimensions in mm and inch			
Measuring grid length	Measuring grid width	Total length	Total width
2.0 mm	1.8 mm	7.5 mm	6.3 mm
0.079 inch	0.071 inch	0.295 inch	0.248 inch

Preferred types		Variants	Option 4)	Option 5)	Option 8)	
Steel	Aluminum	Other	Temperature resp. matched to	Creep adjustment	Option	Nominal resistance
1-XA31K2/350_E		K-XA3x[4]x[5]2/350xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	350 Ω ± 0.3 %
1-XA31S2/350_E						350 Ω ± 0.3 %

Double shear strain gages

Double shear strain gages: 3.2 mm (0.126 inch), 350 and 1000 ohms

Original size

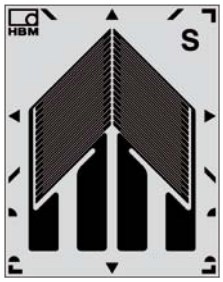
The 1000 ohms version has a slightly wider measuring grid; however, the external dimensions are as shown.

Dimensions in mm and inch			
Measuring grid length	Measuring grid width	Total length	Total width
3.2 inch	3.1 mm	11.2 mm	7.8 mm
0.126 inch	0.122 inch	0.441 inch	0.307 inch

Preferred types		Variants	Option 4)	Option 5)	Option 8)	
Steel	Aluminum	Other	Temperature resp. matched to	Creep adjustment	Option	Nominal resistance
1-XA71K3.2/350_E		K-XA7x[4]x[5]3.2/350xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	350 Ω ± 0.3 %
1-XA71S3.2/350_E						350 Ω ± 0.3 %
1-XA71K3.2/1K0_E		K-XA7x[4]x[5]3.2/1K0xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	1000 Ω ± 0.3 %
1-XA71S3.2/1K0_E						1000 Ω ± 0.3 %

Double shear strain gages

Double shear strain gages: 3.2 mm (0.126 inch), 350 and 1000 ohms



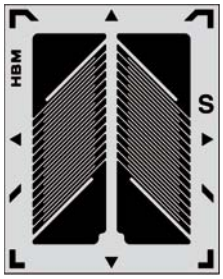
Original size

The 1000 ohms version has a slightly wider measuring grid; however, the external dimensions are as shown.

Dimensions in mm and inch			
Measuring grid length	Measuring grid width	Total length	Total width
3.2 mm	2.7 mm	10.2 mm	7.9 mm
0.126 inch	0.106 inch	0.402 inch	0.311 inch

Preferred types		Variants	Option 4)	Option 5)	Option 8)	
Steel	Aluminum	Other	Temperature resp. matched to	Creep adjustment	Option	Nominal resistance
1-XA31K3.2/350_E		K-XA3x[4]x[5]3.2/350xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	350 Ω ± 0.3 %
1-XA31S3.2/350_E						350 Ω ± 0.3 %
1-XA31K3.2/1K0_E		K-XA3x[4]x[5]3.2/1K0xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	1000 Ω ± 0.3 %
1-XA31S3.2/1K0_E						1000 Ω ± 0.3 %

Double shear strain gages: 2 mm (0.079 inch), 350 and 1000 ohms

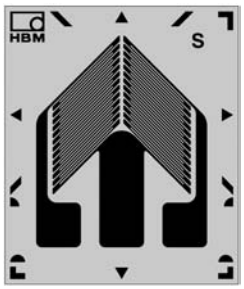


Original size

Dimensions in mm and inch			
Measuring grid length	Measuring grid width	Total length	Total width
2.0 mm	2.3 mm	7.3 mm	5.8 mm
0.079 inch	0.091 inch	0.287 inch	0.228 inch

Preferred types		Variants	Option 4)	Option 5)	Option 8)	
Steel	Aluminum	Other	Temperature resp. matched to	Creep adjustment	Option	Nominal resistance
1-XU11K2/350_W		K-XU1x[4]x[5]2/350_W[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_W	350 Ω ± 0.3 %
1-XU11S2/350_W						350 Ω ± 0.3 %
1-XU11K2/1K0_W		K-XU1x[4]x[5]2/1K0_W[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_W	1000 Ω ± 0.3 %
1-XU11S2/1K0_W						1000 Ω ± 0.3 %

Double shear strain gages: 2 mm (0.079 inch), 350 ohms

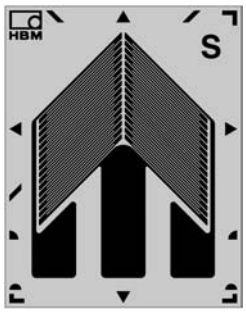


Original size

Dimensions in mm and inch			
Measuring grid length	Measuring grid width	Total length	Total width
2.0 mm	1.8 mm	7.5 mm	6.3 mm
0.079 inch	0.071 inch	0.295 inch	0.248 inch

Preferred types		Variants	Option 4)	Option 5)	Option 8)	
Steel	Aluminum	Other	Temperature resp. matched to	Creep adjustment	Option	Nominal resistance
1-XA41K2/350_E		K-XA4x[4]x[5]2/350xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	350 Ω ± 0.3 %
1-XA41S2/350_E						350 Ω ± 0.3 %

Double shear strain gages: 3.2 mm (0.126 inch), 350 and 1000 ohms



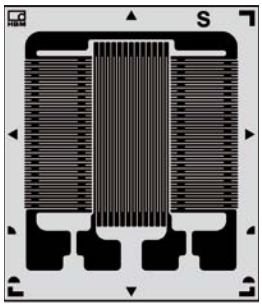
Original size

The 1000 ohms version has a slightly wider measuring grid; however, the external dimensions are as shown.

Dimensions in mm and inch			
Measuring grid length	Measuring grid width	Total length	Total width
3.2 mm	2.7 mm	10.2 mm	7.9 mm
0.126 inch	0.106 inch	0.402 inch	0.311 inch

Preferred types		Variants	Option 4)	Option 5)	Option 8)	
Steel	Aluminum	Other	Temperature resp. matched to	Creep adjustment	Option	Nominal resistance
1-XA41K3.2/350_E		K-XA4x[4]x[5]3.2/350xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	350 Ω ± 0.3 %
1-XA41S3.2/350_E						350 Ω ± 0.3 %
1-XA41K3.2/1K0_E		K-XA4x[4]x[5]3.2/1K0xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	1000 Ω ± 0.3 %
1-XA41S3.2/1K0_E						1000 Ω ± 0.3 %

Columnar strain gages: 5.1 mm (0.201 inch), 350 and 1000 ohms



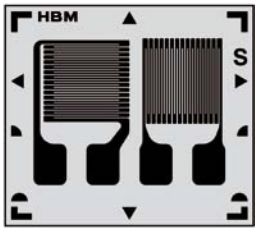
Original size

The 1000 ohms version has a slightly smaller measuring grid; however, the external dimensions are as shown.

Dimensions in mm and inch			
Measuring grid length 1 and 2	Measuring grid width 1 and 2	Total length	Total width
1.3; 5.1 mm	5.1; 2.5 mm	9.7 mm	8.4 mm
0.051; 5.105 mm	0.201; 0.098 inch	0.382 inch	0.311 inch

Preferred types		Variants	Option 4)	Option 5)	Option 8)	
Steel	Aluminum	Other	Temperature resp. matched to	Creep adjustment	Option	Nominal resistance
1-TA31S5.1/350_E		K-TA3x[4]x[5]5.1/350xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	350 Ω ± 0.3 %
1-TU31S5.1/1K0_E		K-TU3x[4]x[5]5.1/1K0xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	1000 Ω ± 0.3 %

T rosette: 1.6 mm, (0.063 inch), 350 ohms



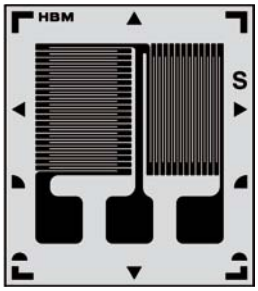
Original size

Dimensions in mm and inch			
Measuring grid length	Measuring grid width	Total length	Total width
1.6 mm	2.0 mm	5.4 mm	6.1 mm
0.063 inch	0.079 inch	0.213 inch	0.240 inch

Preferred types		Variants	Option 4)	Option 5)	Option 8)	
Steel	Aluminum	Other	Temperature resp. matched to	Creep adjustment	Option	Nominal resistance
1-TA11K1.6/350_E		K-TA1x[4]x[5]1.6/350xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	350 Ω ± 0.3 %
1-TA11S1.6/350_E						350 Ω ± 0.3 %

T rosette

T rosette: 1.6 mm (0.063 inch), 350 and 1000 ohms



Original size

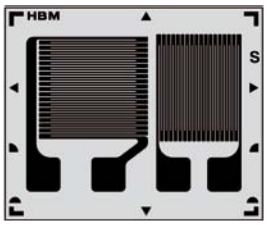
The 1000 ohms version has a slightly wider and slightly longer measuring grid;
however, the external dimensions are as shown.

Dimensions in mm and inch			
Measuring grid length	Measuring grid width	Total length	Total width
1.6 mm 2.5 mm	3.1 mm 1.8 mm	6.6 mm	5.8 mm
0.063 inch 0.098 inch	0.122 inch 0.071 inch	0.260 inch	0.228 inch

Preferred types		Variants	Option 4)	Option 5)	Option 8)	
Steel	Aluminum	Other	Temperature resp. matched to	Creep adjustment	Option	Nominal resistance
1-TA21K1.6/350_E		K-TA2x[4]x[5]1.6/350xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	350 Ω ± 0.3 %
1-TA21S1.6/350_E						350 Ω ± 0.3 %
1-TU21K1.6/1K0_E		K-TU2x[4]x[5]1.6/1K0xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	1000 Ω ± 0.3 %
1-TU21S1.6/1K0_E						1000 Ω ± 0.3 %

T rosette

T rosette: 3 mm (0.118 inch), 350 and 1000 ohms



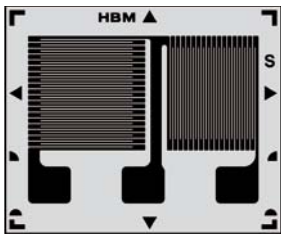
Original size

The 1000 ohms version has a slightly wider longitudinal grid and a slightly smaller transverse grid;
however, the external dimensions are as shown.

Dimensions in mm and inch			
Measuring grid length	Measuring grid width	Total length	Total width
3.0 mm	3.0 mm 3.6 mm	7.5 mm	9.1 mm
0.118 inch	0.118 inch 0.142 inch	0.295 inch	0.358 inch

Preferred types		Variants	Option 4)	Option 5)	Option 8)	
Steel	Aluminum	Other	Temperature resp. matched to	Creep adjustment	Option	Nominal resistance
1-TA11K3/350_E		K-TA1x[4]x[5]3/350xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	350 Ω ± 0.3 %
1-TA11S3/350_E						350 Ω ± 0.3 %
1-TA11K3/1K0_E		K-TA1x[4]x[5]3/1K0xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	1000 Ω ± 0.3 %
1-TA11S3/1K0_E						1000 Ω ± 0.3 %

T rosette: 3 mm (0.118 inch), 350 and 1000 ohms



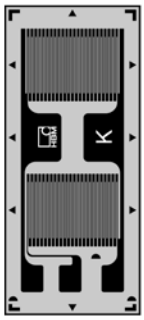
Original size

The 1000 ohms version has a slightly wider longitudinal grid and a slightly smaller transverse grid;
however, the external dimensions are as shown.

Dimensions in mm and inch			
Measuring grid length	Measuring grid width	Total length	Total width
3.0 mm	3.0 mm 3.8 mm	7.5 mm	9.1 mm
0.118 inch	0.118 inch 0.150 inch	0.295 inch	0.358 inch

Preferred types		Variants	Option 4)	Option 5)	Option 8)	
Steel	Aluminum	Other	Temperature resp. matched to	Creep adjustment	Option	Nominal resistance
1-TA21K3/350_E		K-TA2x[4]x[5]3/350xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	350 Ω ± 0.3 %
1-TA21S3/350_E						350 Ω ± 0.3 %
1-TA21K3/1K0_E		K-TA2x[4]x[5]3/1K0xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	1000 Ω ± 0.3 %
1-TA21S3/1K0_E						1000 Ω ± 0.3 %

Half bridge strain gages: 2.5 mm (0.098 inch), 1000 ohms, Measuring grid spacing* 6.5 mm



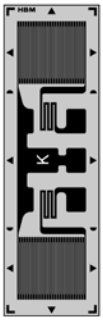
Original size

* Distance between the centers of both measuring grids

Dimensions in mm and inch			
Measuring grid length	Measuring grid width	Total length	Total width
2.5 mm	4.1 mm	13.8 mm	6.0 mm
0.098 inch	0.161 inch	0.543 inch	0.236 inch

Preferred types		Variants	Option 4)	Option 5)	Option 8)	
Steel	Aluminum	Other	Temperature resp. matched to	Creep adjustment	Option	Nominal resistance
1-DU31K2.5/1K0_E	1-DU33K2.5/1K0_E	K-DU3x[4]x[5]2.5/1K0xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	1000 Ω ± 0.3 %

Half bridge strain gages: 3.2 mm (0.126 inch), 1000 ohms, Measuring grid spacing* 13.2 mm



Original size

* Distance between the centers of both measuring grids

Dimensions in mm and inch			
Measuring grid length	Measuring grid width	Total length	Total width
3.2 mm	4.2 mm	19.0 mm	5.8 mm
0.126 inch	0.165 inch	0.748 inch	0.228 inch

Preferred types		Variants	Option 4)	Option 5)	Option 8)	
Steel	Aluminum	Other	Temperature resp. matched to	Creep adjustment	Option	Nominal resistance
1-DA51K3.2/1K0_E	1-DA53K3.2/1K0_E	K-DA5x[4]x[5]3.2/1K0xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	1000 Ω ± 0.3 %

Half bridge strain gages: 2.2 mm (0.087 inch), 350 ohms, Measuring grid spacing* 6.7 mm

Original size

* Distance between the centers of both measuring grids

Dimensions in mm and inch			
Measuring grid length	Measuring grid width	Total length	Total width
2.2 mm	3.0 mm	11.5 mm	4.4 mm
0.087 inch	0.118 inch	0.453 inch	0.173 inch

Preferred types		Variants	Option 4)	Option 5)	Option 8)	
Steel	Aluminum	Other	Temperature resp. matched to	Creep adjustment	Option	Nominal resistance
1-DA61K2.2/350_E	1-DA63K2.2/350_E	K-DA6x[4]x[5]2.2/350xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	350 Ω ± 0.3 %

Half bridge strain gages: 3.2 mm (0.126 inch), 350 ohms, Measuring grid spacing* 10.5 mm

Original size

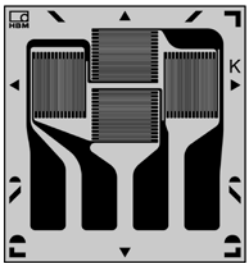
* Distance between the centers of both measuring grids

Dimensions in mm and inch			
Measuring grid length	Measuring grid width	Total length	Total width
3.2 mm	2.5 mm	16.5 mm	4.1 mm
0.126 inch	0.098 inch	0.650 inch	0.161 inch

Preferred types		Variants	Option 4)	Option 5)	Option 8)	
Steel	Aluminum	Other	Temperature resp. matched to	Creep adjustment	Option	Nominal resistance
1-DA51K3.2/350_E	1-DA53K3.2/350_E	K-DA5x[4]x[5]3.2/350xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	350 Ω ± 0.3 %

Half bridge strain gages

Full bridge strain gages: 1.6 mm (0.063 inch), 350 ohms



Original size

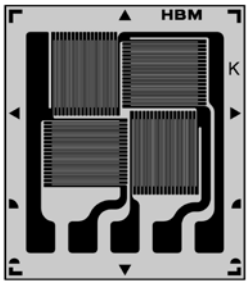
Bridge output adjusted to ± 0.5 mV/V

Dimensions in mm and inch			
Measuring grid length	Measuring grid width	Total length	Total width
1.6 mm	1.7 mm	8.0 mm	7.5 mm
0.063 inch	0.067 inch	0.315 inch	0.295 inch

Preferred types		Variants	Option 4)	Option 5)	Option 8)	
Steel	Aluminum	Other	Temperature resp. matched to	Creep adjustment	Option	Nominal resistance
1-VA71K1.6/350_E	1-VA73K1.6/350_E	K-VA7x[4]x[5]1.6/350xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	350 Ω ± 15 %

Full bridge strain gages

Full bridge strain gages: 2.5 mm (0.098 inch), 350 and 1000 ohms

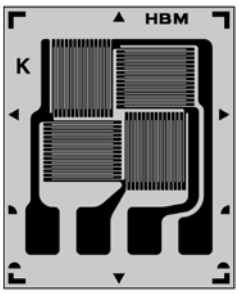


Original size

Dimensions in mm and inch			
Measuring grid length	Measuring grid width	Total length	Total width
2.5 mm	2.6 mm	10.4 mm	9.1 mm
0.098 inch	0.102 inch	0.409 inch	0.358 inch

Preferred types		Variants	Option 4)	Option 5)	Option 8)	
Steel	Aluminum	Other	Temperature resp. matched to	Creep adjustment	Option	Nominal resistance
1-VA61K2.5/350_E	1-VA63K2.5/350_E	K-VA6x[4]x[5]2.5/350xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	350 Ω ± 0.3 %
1-VU61K2.5/1K0_E	1-VU63K2.5/1K0_E	K-VU6x[4]x[5]2.5/1K0xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	1000 Ω ± 0.3 %

Full bridge strain gages: 1.8 mm (0.071 inch), 350 ohms



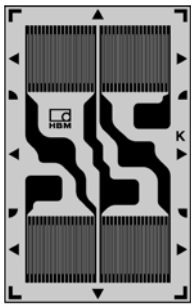
Original size

Bridge output adjusted to ± 0.5 mV/V

Dimensions in mm and inch			
Measuring grid length	Measuring grid width	Total length	Total width
1.8 mm	1.8 mm	8.3 mm	6.8 mm
0.071 inch	0.071 inch	0.327 inch	0.268 inch

Preferred types		Variants	Option 4)	Option 5)	Option 8)	
Steel	Aluminum	Other	Temperature resp. matched to	Creep adjustment	Option	Nominal resistance
1-VA51K1.8/350_E	1-VA53K1.8/350_E	K-VA5x[4]x[5]1.8/350xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	350 Ω ± 15 %

Full bridge strain gages: 1.9 mm (0.075 inch), 350 ohms, Measuring grid spacing* 7.5 mm



Original size

* Distance between the centers of both measuring grids

Dimensions in mm and inch			
Measuring grid length	Measuring grid width	Total length	Total width
1.9 mm	2.8 mm	11.7 mm	7.3 mm
0.075 inch	0.110 inch	0.461 inch	0.287 inch

Preferred types		Variants	Option 4)	Option 5)	Option 8)	
Steel	Aluminum	Other	Temperature resp. matched to	Creep adjustment	Option	Nominal resistance
1-VA31K1.9/350_E	1-VA33K1.9/350_E	K-VA3x[4]x[5]1.9/350xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, _W	350 Ω ± 0.3 %

Full bridge strain gages: 3 mm (0.118 inch), 350, 1000 ohms, Measuring grid spacing* 10.3 mm

Original size

* Distance between the centers of both measuring grids

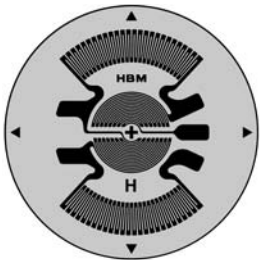
Bridge output adjusted to ± 0.5 mV/V

The 1000 ohms version has a slightly wider measuring grid; however, the external dimensions are as shown.

Dimensions in mm and inch			
Measuring grid length	Measuring grid width	Total length	Total width
3.0 mm	2.1 mm	17.8 mm	7.0 mm
0.118 inch	0.083 inch	0.701 inch	0.276 inch

Preferred types		Variants	Option 4)	Option 5)	Option 8)	
Steel	Aluminum	Other	Temperature resp. matched to	Creep adjustment	Option	Nominal resistance
1-VA21K3/350_E	1-VA23K3/350_E	K-VA2x[4]x[5]3/350xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	350 Ω ± 15 %
1-VA21K3/1K0_E	1-VA23K3/1K0_E	K-VA2x[4]x[5]3/1K0xx[8]	1= Steel 3= Aluminum	A, C, E, G, I, K, M, O, Q, S	_E, BE, LE, _W	1000 Ω ± 15 %

Membrane rosette: 6.5 mm (0.256 inch), 350 ohms

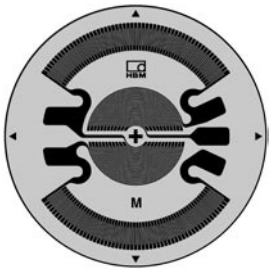


Original size

Dimensions in mm and inch	
Measuring grid diameter	Diameter measuring grid carrier
6.5 mm	8.0 mm
0.256 inch	0.315 inch

Preferred types		Variants	Option 4)	Option 5)	Option 8)	
Steel	Aluminum	Other	Temperature resp. matched to	Creep adjustment	Option	Nominal resistance
1-MU11H6.5/350_W		K-MU1x[4]H6.5/350xx[8]	1= Steel 3= Aluminum	H	LE, _W	350 Ω ± 0.3 %
1-MU11H6.5/350LE						350 Ω ± 0.3 %

Membrane rosette: 10 mm (0.394 inch), 350 and 1000 ohms

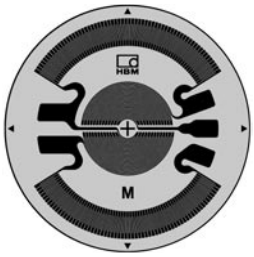


Original size

Dimensions in mm and inch	
Measuring grid diameter	Diameter measuring grid carrier
10.0 mm	11.5 mm
0.394 inch	0.452 inch

Preferred types		Variants	Option 4)	Option 5)	Option 8)	
Steel	Aluminum	Other	Temperature resp. matched to	Creep adjustment	Option	Nominal resistance
1-MA11M10/350_W		K-MA1x[4]M10/350xx[8]	1= Steel 3= Aluminum	M	LE, _W	350 Ω ± 0.3 %
1-MA11M10/350LE						350 Ω ± 0.3 %
1-MU11M10/1K0_W		K-MU1x[4]M10/1K0xx[8]	1= Steel 3= Aluminum	M	LE, _W	1000 Ω ± 0.3 %
1-MU11M10/1K0LE						1000 Ω ± 0.3 %

Membrane rosette: 15 mm (0.591 inch), 350 and 1000 ohms

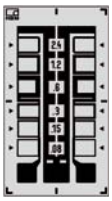


Original size

Dimensions in mm and inch	
Measuring grid diameter	Diameter of measuring grid carrier
15.0 mm	16.7 mm
0.591 inch	0.657 inch

Preferred types		Variants	Option 4)	Option 5)	Option 8)	
Steel	Aluminum	Other	Temperature resp. matched to	Creep adjustment	Option	Nominal resistance
1-MA11M15/350_W		K-MA1x[4]M15/350xx[8]	1= Steel 3= Aluminum	M	LE, _W	350 Ω ± 0.3 %
1-MA11M15/350LE						350 Ω ± 0.3 %
1-MA11M15/1K0_W		K-MA1x[4]M15/350xx[8]	1= Steel 3= Aluminum	M	LE, _W	1000 Ω ± 0.3 %
1-MA11M15/1K0LE						1000 Ω ± 0.3 %

Balancing element for the zero point
2.4 ohms, 1.2 ohms, 0.6 ohms, 0.3 ohms



Original size

Dimensions in mm and inch		
Measuring grid width	Total length	Total width
6.0 mm	14.5 mm	8.0 mm
0.236 inch	0.571 inch	0.315 inch

Type	
1-ANA1-6/4.73_W	Adjustable foil resistor for zero point balancing on polyimide carrier with a raw resistance of twice approx. 9 Ω. Each bridge branch can be connected with maximum 4.73 Ω, in steps as follows: 2.4 Ω– 1.2 Ω– 0.6 Ω – 0.3 Ω – 0.15 Ω – 0.08 Ω ± 20 % [1])

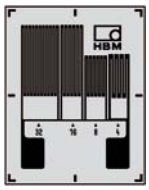
Compensating elements for TCO balancing
0.6 ohms, 0.3 ohms, 0.15 ohms

Original size

Dimensions in mm and inch		
Measuring grid width	Total length	Total width
6.0 mm	11.0 mm	8.0 mm
0.236 inch	0.433 inch	0.315 inch

Type	
1-ATN1-3/1.05_W	Adjustable foil resistor for temperature compensation of the zero point (TCO). Nickel foil on polyimide carrier with a raw resistance of twice approx. 0.7 Ω Each bridge branch can be connected with maximum 1.05 Ω, in steps as follows: 0.6 Ω – 0.3 Ω – 0.15 Ω ± 20 % [1]) Temperature coefficient of the resistor: (+ 20 °C...+ 70 °C) *(68 °F...158 °F)*: 4,9 · 10^{-3}/K *(2.7 · 10-3/°F)*

Compensating elements for TCS balancing
32 ohms, 16 ohms, 8 ohms, 4 ohms



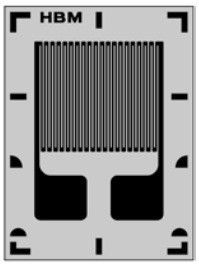
Original size

Dimensions in mm and inch			
Measuring grid length	Measuring grid width	Total length	Total width
4.2 mm	7.0 mm	11.5 mm	9.0 mm
0.165 inch	0.276 inch	0.453 inch	0.354 inch

Type	
1-ATC1-4/60_W	Adjustable foil resistor for temperature compensation of the sensitivity (TCS). Nickel foil on polyimide carrier with a raw resistance of approx. 1 Ω Maximum 60 Ω can be connected, in steps as follows: 32 Ω – 16 Ω – 8 Ω – 4 Ω ± 20 % [1]) Temperature coefficient of the resistor: (+ 20 °C...+ 70 °C) *(68°F...158 °F)*: 4.9 · 10^{-3}/K *(2.7 · 10^{-3}/°F)*

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

Nickel resistors for TCS balancing (temperature coefficient of sensitivity)



Original size

Carrier material: Polyimide

Dimensions in mm and inch			
Measuring grid length	Measuring grid width	Total length	Total width
2.0 ... 2.5 mm	3.2 mm	6.3 mm	4.7 mm
0.079 ... 0.098 inch	0.126 inch	0.248 inch	0.185 inch

Preferred types	Nominal resistance	Variants	Option 8)
1-ATC1-10_E	10 Ω ± 0.3 Ω	1-ATC1-10xx[8)]	Option
1-ATC1-12.5_E	12.5 Ω ± 0.3 Ω	1-ATC1-12.5xx[8)]	
1-ATC1-15_E	15 Ω ± 0.3 Ω	1-ATC1-15xx[8)]	_E, BE, LE, _W
1-ATC1-17.5_E	17.5 Ω ± 0.3 Ω	1-ATC1-17.5xx[8)]	
1-ATC1-20_E	20 Ω ± 0.3 Ω	1-ATC1-20xx[8)]	
1-ATC1-22.5_E	22.5 Ω ± 0.3 Ω	1-ATC1-22.5xx[8)]	
1-ATC1-25_E	25 Ω ± 0.3 Ω	1-ATC1-25xx[8)]	
1-ATC1-30_E	30 Ω ± 0.3 Ω	1-ATC1-30xx[8)]	
1-ATC1-35_E	35 Ω ± 0.4 Ω	1-ATC1-35xx[8)]	
1-ATC1-40_E	40 Ω 0.4 Ω	1-ATC1-40xx[8)]	
1-ATC1-50_E	50 Ω ± 0.5 Ω	1-ATC1-50xx[8)]	
1-ATC1-60_E	60 Ω ± 0.6 Ω	1-ATC1-60xx[8)]	
1-ATC1-70_E	70 Ω ± 0.7 Ω	1-ATC1-70xx[8)]	

Balancing and compensating elements for the zero point and TCO balancing

Original size

Carrier material: Polyimide

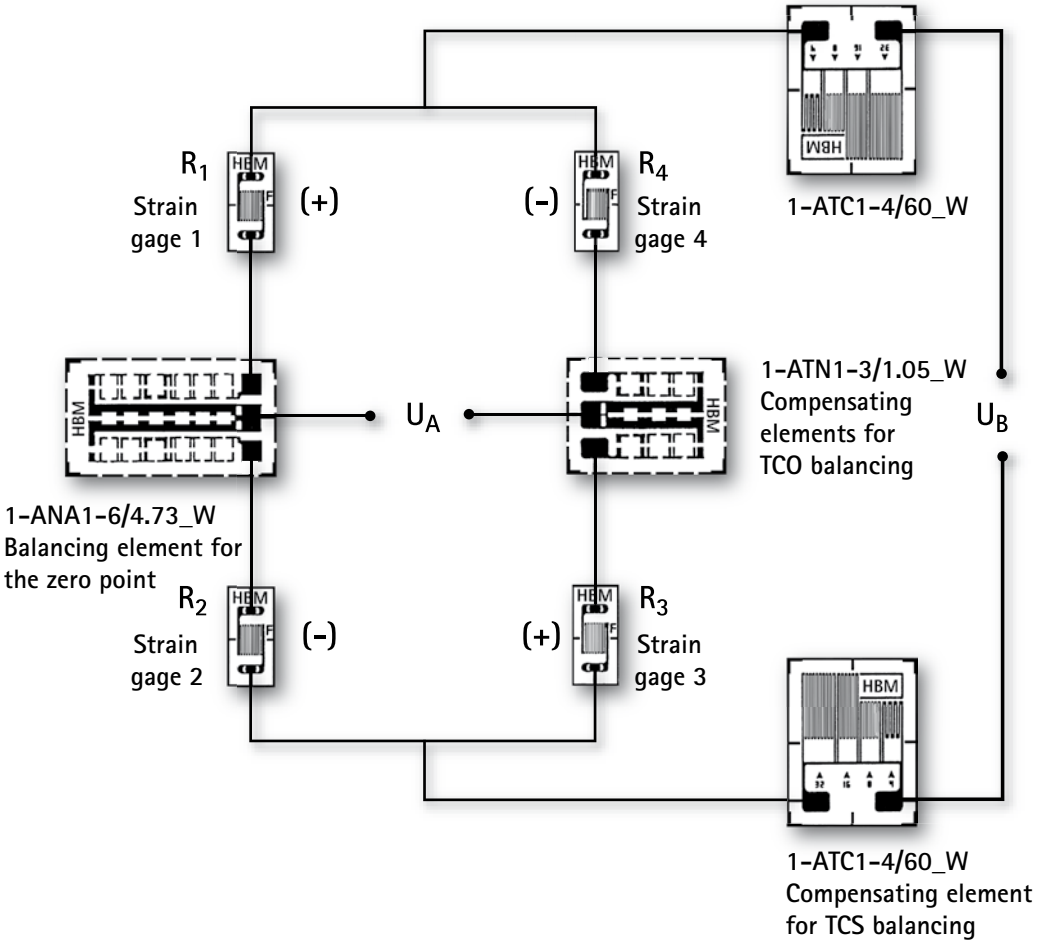
[1)] Balancing element for the zero point
[2)] Compensating element for TCO balancing (Temperature coefficient of zero point)

Dimensions in mm and inch	
Total length	Total width
5.6 mm	8.9 mm
0.220 inch	0.350 inch

Preferred types	Resistance	Maximum balancing range[3)]
1-ANA-1/0.4_W [1)]	2.5 Ω ± 20 % + max 0.4 Ω	0.4 Ω
1-ANA-1/1.0_W [1)]	6 Ω ± 20 % + max 1.0 Ω	1.0 Ω
1-ATN-1/0.2_W [2)]	1 Ω ± 20 % + max 0.2 Ω	0.2 Ω

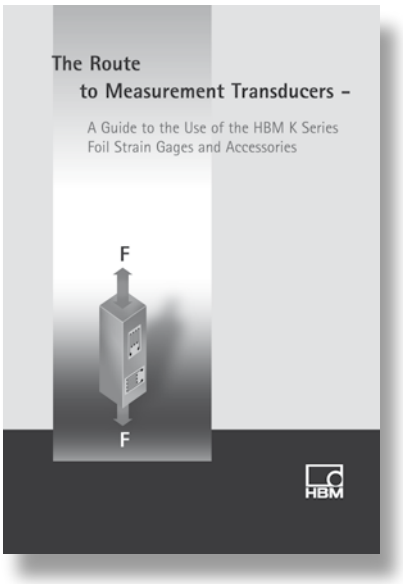
[3)] Per bridge branch

Typical circuits for balancing and compensating elements in an strain gage full bridge



Note: Further details can be found in the book "The Route to Measurement Transducers".

This book can also be downloaded in PDF format under: www.hbm.com/sensors



Strain gage accessories ... Bonding

The most common way in which strain gages are attached to the test object is by bonding.
It is prerequisite to use application-specific adhesives that meet the following requirements:

- Loss-free of the transmission deformations of the test object to the strain gages
- Stable behavior across a temperature and strain range which is as wide as possible
- Strain gage and test object must not be chemically attacked
- Appropriate and reproducible relaxation behavior.

EP 150 Epoxy resin adhesive

Adhesive	Description	Pot life at room temperature (RT)	Storage life dry	Curing temperature
Z 70 Order no.: 1-Z70	Cyanacrylate adhesive, low viscosity	-	6 months; at -15 °C *(+5 °F)*: at least 2 years	5 °C [3] *(41 °F)* 20 °C *(68 °F)* 30 °C *(86 °F)*
EP 150 and EP 150 GP Order no.: 1-EP150 1-EP150-GP	Single-components Epoxy resin adhesive, low viscosity	-	12 months when stored in refrigerator (7 °C) *(44 °F)*	160 °C ...190 °C *(320 °F ... 374 °F)*
EP 250 Order no.: 1-EP250	Two-component Epoxy resin adhesive, pasty, also for use on absorbent surfaces	24 h	1 year	95 ... 200 °C *(203 °F ... 392 °F)*
EP 310 S Order no.: 1-EP310S	Two-component Epoxy resin adhesive, low viscosity	1 month (at RT) 6 months (at + 2 °C/ *+36 °F)* 12 months (at - 32 °C/ *-26 °F)*	6 months	95 ... 205 °C *(203 °F ...401 °F)*

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

materials

Cyanacrylate adhesive

EP 310S Epoxy resin adhesive

EP 150 -GP
Epoxy resin adhesive

EP 250 Epoxy resin adhesive

Curing time	Contact pressure	Temperature limits			Delivery quantity
		lower	upper static[1)]	upper dynamic[2)]	
10 minute 1 minute 0.5 minute	Z70: thumb pressure	– 55 °C *(-67 °F)*	+ 100 °C *(212 °F)*	+120 °C *(248 °F)*	10 ml *(0.34 liquid ounce, US)*
6 h ...1 h	EP150: 0.3... 0.5 N/mm² *(43 ... 73 lbf/sq. in.)*	– 70 °C *(-94 °F)*	+ 150 °C *(302 °F)*	+ 150 °C *(302 °F)*	2 x 30 ml bottles (EP 150) *(2x1.0 liquid ounce, US)* 10 x 20 ml bottles (EP 150-GP) *(10x 0.7 liquid ounce, US)*
16 h ... 0.5 h	EP250: 0.1... 1.5 N/mm² *(14 ... 217 lbf/sq. in.)*	– 240 °C *(-400 °F)*	+ 250 °C *(428 °F)*	+ 315 °C *(599 °F)*	5 double bags at 10.5 g = 52.5 g *(5 x 0.35 oz =1.75 oz)*
5 h ... 0.5 h	EP310S: 0.1... 0.5 N/mm² *(14 ... 73 lbf/sq. in.)*	-270 °C *(-454 °F)*	+ 260 °C *(500 °F)*	+ 310 °C *(590 °F)*	Components A = 60 ml *(2.0 liquid ounce, US)* B = 30 ml *(1.0 liquid ounce, US)*

...Covering materials

PU 120 Polyurethane paint

NG 150 Nitrile rubber

SG 250 Transparent silicone rubber

Strain gage covering materials	Temperature range of stability in air	Package contents	Application method	Curing conditions	Storage life at room temperature	Components
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	Paint on with brush	Air-drying at room temperature	Max. 1 year	Solvent-containing single-component
SG 250 Transparent silicone rubber Order no.: 1-SG 250	– 70°C ... + 250°C *(-94°F...+482°F)*	Tube with approx. 85 g	Apply from tube	Air-drying at room temperature	6 months	Transparent, solvent-free single-component silicone rubber
PU 120 [1] polyurethane paint Order no.: 1-PU 120	– 40°C ...+ 120°C *(-40°F...+248°F)*	3 bottles each with 30 ml	Paint on with brush	Room temperature ... + 100°C *(...212°F)*	1 year	Solvent-containing single-component polyurethane

[1] Caution: PU 120 and NG 150 cannot be combined

...Cleaning agents, materials for gluing and soldering

Cleaning agent RMS1
Environmentally-friendly solvent mixture
Contains 1l 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 *(6.67 oz)* cleaning agent each and 450 cleaning pads.
Order no.: 1-RMS1-SPRAY

Cleaning agent RMS1 SPRAY

Teflon foil
33 m *(108 ft)* Teflon foil on a roll, suitable for cold and hot-curing strain gage bonds.
Thickness: 0.05 mm *(0.002 inch)*, width: 60 mm *(2.36 inch)*
Order no.: 1-Teflon

Flux pen for resin-cored solder 1-LOT
Soldering aid in felt-tip pen form for small soldering joints.
Suitable for leaded soldering with melting points up to approx. 200°C *(392°F).*
The flux pen contains non-corrosive flux without chloride.
Package contents 5 pieces
Order no.: 1-FS01

Flux pen for resin-cored solder 1-LOT

Polyimide adhesive tape
33 m *(108 ft)* heat-resistant adhesive tape, 19 mm *(0.75 inch)* wide.
Temperature resistant to 270 °C *(518°F)*
Order no.: 1-Klebeband

Cleaning agent dispenser
Protects the solvent from contamination
Order no.: 1-RSP120

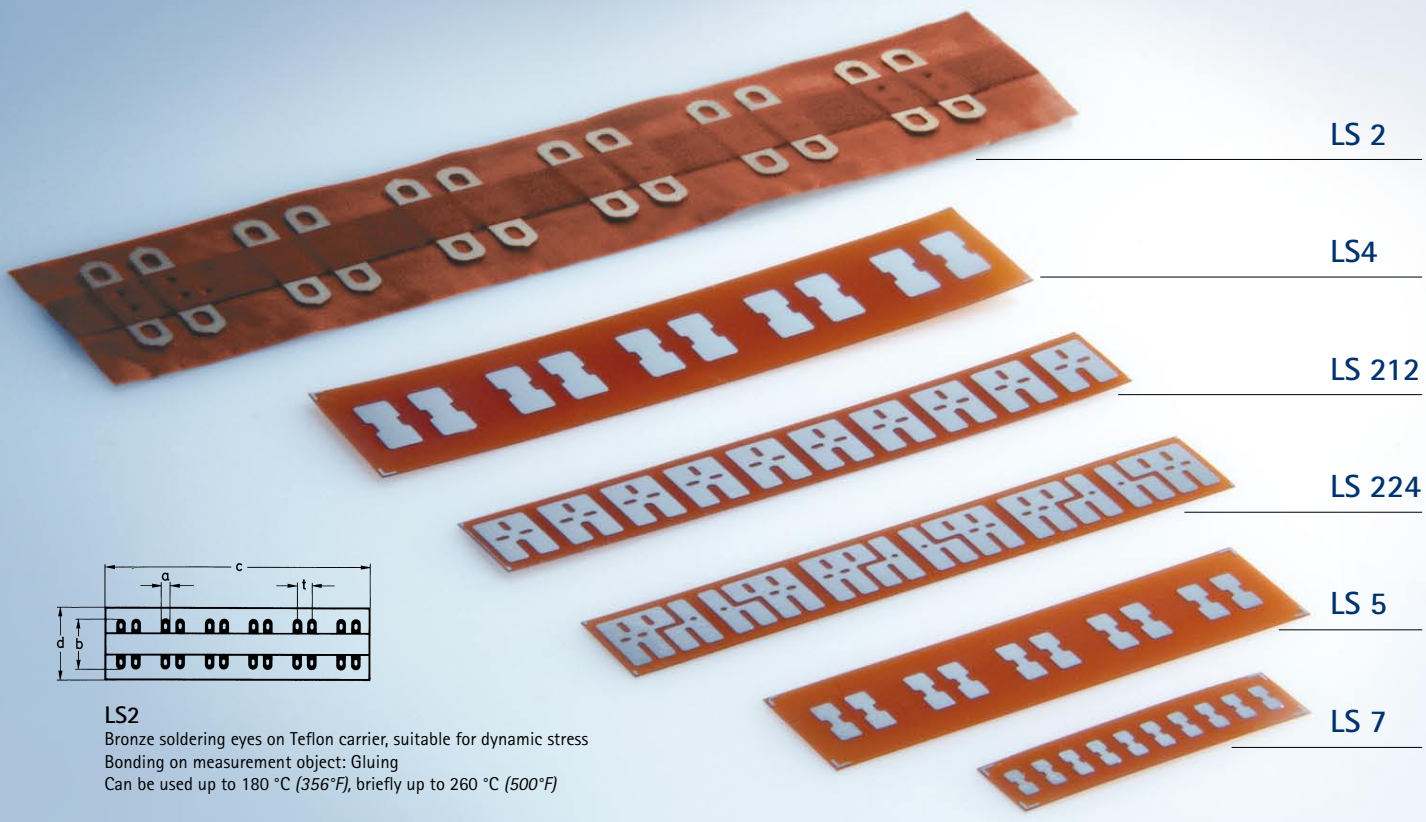
Cleaning agent dispenser

Resin-cored solder
Cored solder (contains lead) for strain gage applications
Diameter: 0.5 mm *(0.02 inch)*; Sn60Pb38Cu2 with resin core type F-SW32
Melting range: 183 ... 190 °C *(361°F...374°F)*
Delivery form: 1 kg *(2.2 lb)* on a roll
Order no.: 1-Lot

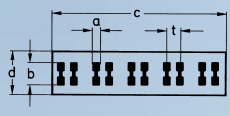
Lead-free solder
Lead-free resin-cored solder for strain gage applications
Diameter: 0.5 mm *(0.02 inch)*; Sn95.5Ag3.8Cu0.7 ("no clean")
Melting range: 217 °C to 219 °C *(423°F to 426°F)*
Delivery form: 500 g *(17.637 oz)* on a roll
Order no.: 1-Lot-LF

...Solder terminals

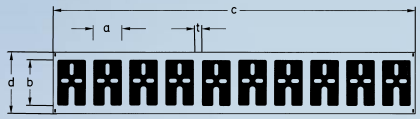
For strain gages with leads or wires, solder terminals should be installed between the connecting cables and the strain gage itself. This facilitates the perfect soldering joint and provides strain relief of the strain gage connections. The solder terminals are installed in the same manner as the strain gages onto the test object. HBM offers solder terminals in different designs and dimensions.



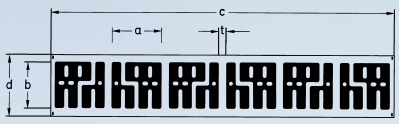
LS2
Bronze soldering eyes on Teflon carrier, suitable for dynamic stress
Bonding on measurement object: Gluing
Can be used up to 180 °C *(356°F)*, briefly up to 260 °C *(500°F)*



LS7/5/4
Copper, nickel-plated, on polyimide
Bonding on measurement object: Gluing
Can be used up to 180 °C *(356°F)*, briefly up to 260 °C *(500°F)*



LS212
Copper, nickel-plated, on polyimide
Bonding on measurement object: Gluing
Can be used up to 180 °C *(356°F)*, briefly up to 260 °C *(500°F)*



LS224
Copper, nickel-plated, on polyimide
Bonding on measurement object: Gluing
Can be used up to 180 °C *(356°F)*, briefly up to 260 °C *(500°F)*

Order designation	Dimensions in mm/*inch*					Contents per pack
	Solder tag		Carrier		Spacing	
	a	b	c	d	t	
1-LS 2	2.5 *0.098*	14 *0.551*	72 *2.835*	20 *0.787*	4 *0.157*	36 pairs
1-LS 7	1 *0.039*	3 *0.118*	20 *0.787*	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 *1.969*	13 *0.512*	4 *0.157*	125 pairs
1-LS 212	3.7 *0.146*	6 *0.236*	47.5 *1.870*	8 *0.315*	1 *0.039*	125 pairs
1-LS 224	6.5 *0.256*	6 *0.236*	45 *1.772*	8 *0.315*	1 *0.039*	150 pairs

...Cables and stranded wires

PVC ribbon cable

PVC insulated ribbon cable consisting of six leads each with a cross section of 0.14 mm² *(0.0002 sq. in.)*, 50 m *(164 ft)* per reel, 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 *($6.2 \cdot 10^{-5}$ sq. in.)*, 25 m *(82 ft)* in length.
Order no.: 1-CULD01

Jumper wire

Teflon insulated jumper wire with a cross section of 0.05 mm² *($7.75 \cdot 10^{-5}$ sq. in.)*, yellow, 100 m *(328 ft)* per reel, resistance 0.34 Ω/m *(0.104 Ω/ft)*.
Order no.: 1-3130.0239-G

Very flexible stranded wire

For internal, exposed wiring of transducers;
cross section of 0.04 mm² *($6.2 \cdot 10^{-5}$ sq. in.)* (multi-wire) and 0.6 mm *(0.024 inch)* outer 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) and an outside diameter of 0.9 mm *(0.035 inch)*, 100 m *(328 ft)* per reel, resistance 0.0741 Ω/m *(0.023 Ω/ft)*.

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

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)*	resistant against nearly all chemicals except elementary fluoride, chlorine trifluoride, molten alkali metals	for internal connection of strain gage bridges or for contacting from strain gage through to solder terminal
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	short period 105° C *(221°F)* permanent ...70 °C *(158°F)*	non resistant against: esters, chlorinated hydrocarbons, ketones, aromatics hydrocarbons, benzene, liquid halogens, nitric acid conc., depending on the softener used, also aqueous solutions	for internal connection of the strain gages in the transducer
PVC ribbon cable 1-3133.0034	PVC	short period 105° C *(221°F)* permanent ...90 °C *(194°F)*	see very flexible stranded wire	see very flexible stranded wire
Paint-insulated copper wire 1-CULD 01	Polyurethane	short period 120° C *(248°F)* permanent -40...80 °C *(-40°F... 176°F)*	non resistant against: strong acids, strong lyes, alcohols, aromatic, hydrocarbons, saturated vapor, hot water	for internal connection of the strain gages in the transducers

Amplifiers and calibrations

Amplifiers for calibration

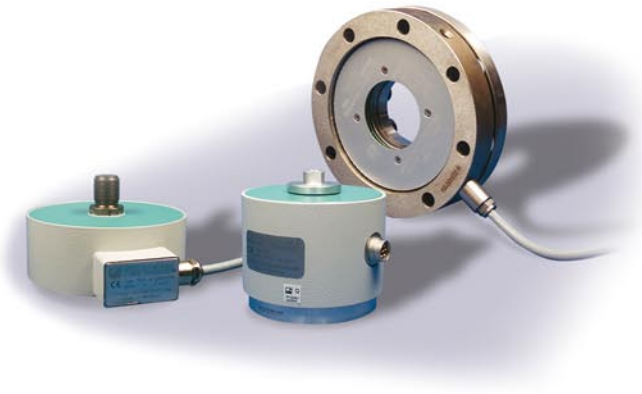
Calibration is implemented successfully around the world using HBM precision amplifiers. The DMP40 and ML38B amplifiers bring you to the cutting edge of a long-term metrological development.

The DMP40 with an accuracy class of 0.0005 is the norm as yet unachieved worldwide and sets the standards regarding accuracy in national metrological institutes. The ML38B module, with an accuracy class of 0.0025, in the modular amplifier system MGCplus, offers intelligent additional functions such as e.g. polynomial correction of transducer characteristic curves.

Reference transducers

HBM has a range of various reference transducers for calibration of standard parameters such as force and torque with which you can check the accuracy of your transducers.

Do your reference transducers need calibrating? We carry out calibrations for the parameters force, pressure, torque and voltage ratio mV/V in our accredited DKD calibration laboratory.



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