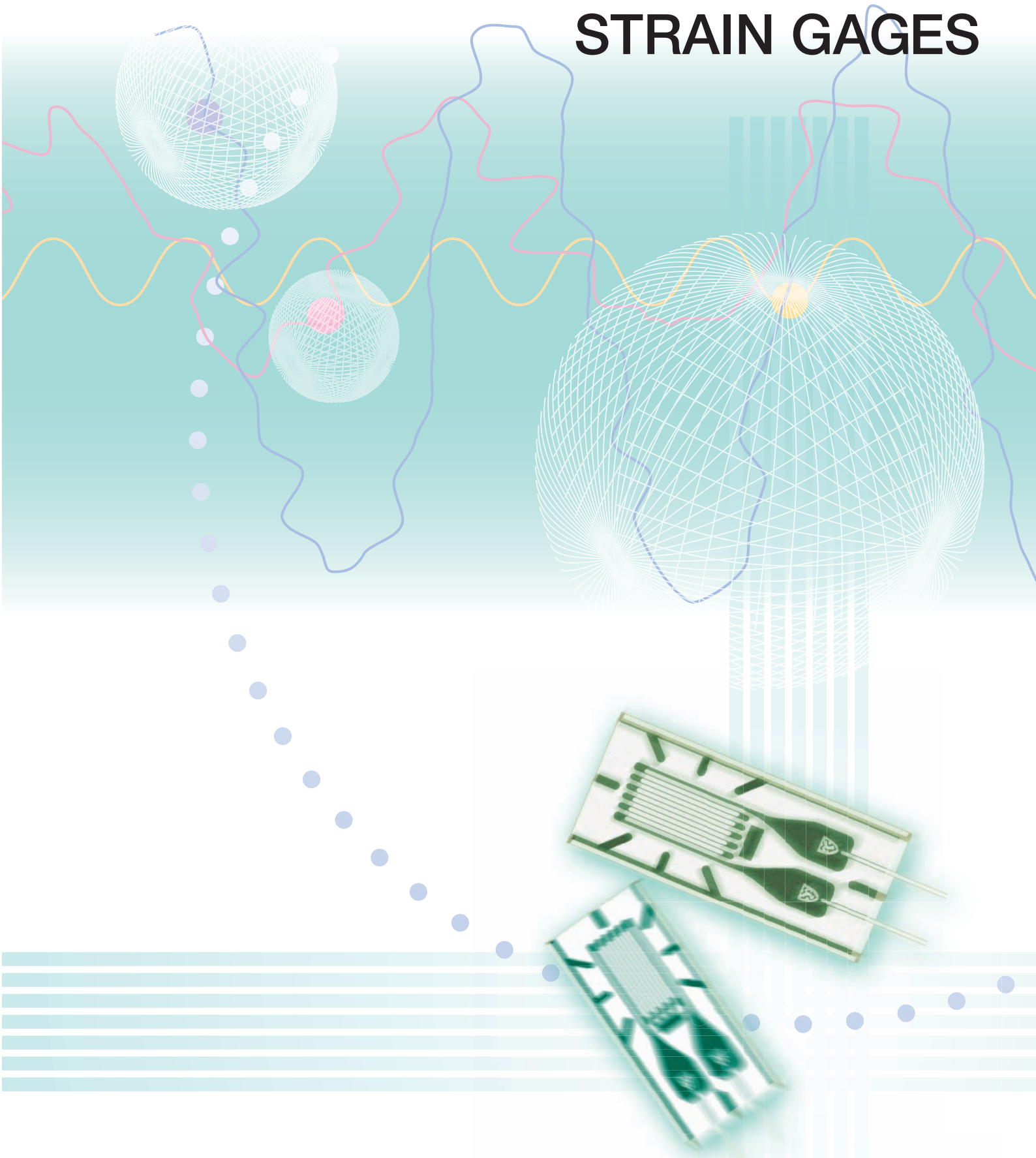


# STRAIN GAGES



# Wide range of applications and easy handling— essential factors for choosing KYOWA strain gages

Strain gages are designed to electrically detect “strain,” minute mechanical changes occurring in response to applied force. They are used not only for machines and moving objects but also in various fields including electrical equipment, civil engineering, building construction, chemicals and medicine. Strain gages enable detection of imperceptible elongations or shrinkages occurring in structures. Measurement of such elongations or shrinkages reveals the stress applied to the structure. Stress is an important factor to confirm the strength and safety of structures. KYOWA strain gages are available for measurement of varied types of strain, from static strain to dynamic strain occurring at higher than 100 kHz and impact-initiated strain. KYOWA strain gages also provide a wide range of

applications and can conveniently be applied to structures of varied materials and shapes.

In addition, strain gages are used as sensing elements for measuring load, pressure, acceleration, displacement and torque. Thus, they are widely utilized not only in experiments and research but also for industrial measurement and control. Over 50 years ago KYOWA produced the first strain gages in Japan, and based on the abundant experience and technologies accumulated throughout these years, the company now manufactures various kinds of high-performance strain gages to cope with multiple application environments.

NOTE: KYOWA performs various tests using testing facilities completely equipped in accordance with the National Aeronautics and Space Administration Standard (NAS-942) and the German Standards (VDI/VDE2635).

## Fundamentals of Strain Gages

### **Metal changes its electrical resistance as it deforms. Strain gages take advantage of this property.**

Generally, when metal deforms due to external force, its specific electrical resistance changes. The amount of electrical resistance is in inverse proportion to the cross-sectional area and is proportional to the length. If a metal wire is pulled, the cross-section becomes smaller and the length becomes longer, thereby making the resistance higher. If the wire is compressed, the resistance becomes lower. Elongation or shrinkage proportionally changes the electrical resistance of metal at a certain constant. By bonding the metal to the target structure, change in the electrical resistance of the metal is measured, thereby enabling detection of elongation or shrinkage, i.e. “strain” on the structure. The strain gage has fine wires or foil of such metal fixed onto an insulator base of resin, etc.

### **Resistance changes of strain gages bonded to the target object are extracted and amplified for stress measurement.**

To obtain the internal stress of a structure, the external force-initiated minute elongation or shrinkage (strain) on the surface of the target object is measured. The measured strain is multiplied by Young’s modulus to obtain the stress. For that purpose, the strain gage must elongate or shrink in tandem with the measuring object under testing, and thus it should be securely bonded using the dedicated adhesive. The resistance of a strain gage changes by one-millionths. For precise measurement of such resistance change, a bridge circuit is formed to convert the resistance change to voltage change. Usually, however, since the voltage is at a  $\mu\text{V}$  level, it is amplified by 5000 to 10000 times to be readable on analog and digital indicators.

### **Electrically amplified voltage changes are read out on a measuring instrument. Measured values are recorded and analyzed for multiple purposes.**

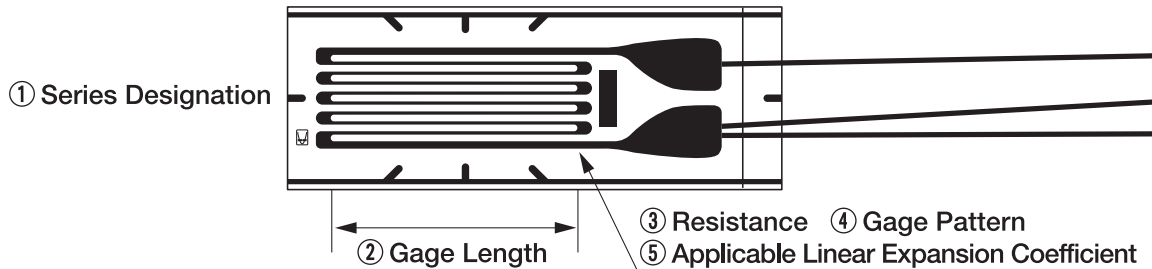
The dedicated indicator enables direct reading of amplified voltages as strain quantity. KYOWA strain amplifiers have their amplifier circuitry and digital indicator incorporated into one package. It is difficult to read moving dynamic strain on indicators. Usually, therefore, a recorder is used to obtain ever-changing strain quantity. In addition to conventional chart recorders, magnetic tape recorders and data loggers, KYOWA now has on the market a sensor interface which enables a PC to directly receive data from strain gages via a bridge box and a memory recorder/analyzer equipped with high-speed A-D converter and large-capacity memory for storage and analysis of dynamic strain data.

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# Strain Gage Model Number Coding System



## KFG - 2 - 120 - C1 -

### ① Series Designation

KFG: General-purpose foil strain gage  
 KFGT: Foil strain gage with temp. sensor  
 KFR: Foil strain gage  
 KFW: Waterproof foil strain gage  
 KFWS: Small waterproof foil strain gage  
 KCW: Weldable waterproof foil strain gage  
 KC: Wire strain gage  
 KM: Embedded foil strain gage for concrete  
 KMC: Embedded wire strain gage for concrete  
 KFRP: Foil strain gage for composite materials  
 KFRS: Foil strain gage for printed boards  
 KFP: Foil strain gage for plastics  
 KFML: Foil strain gage for low-elasticity materials  
 KSP: Semiconductor strain gage  
 KSN: Self-temperature-compensation semiconductor strain gage  
 KSPH: High-output semiconductor strain gage  
 KSPL: Ultralinear semiconductor strain gage  
 KHGX: Encapsulated strain gage  
 KHCV: Encapsulated strain gage  
 KHCR: Encapsulated strain gage  
 KHCS: Encapsulated strain gage  
 KHCM: Encapsulated strain gage  
 KHC: Encapsulated strain gage  
 KFU: High-temperature foil strain gage  
 KH: Weldable high-temp. foil strain gage  
 KFH: High-temperature foil strain gage  
 KFL: Low-temperature foil strain gage  
 KFEM: Ultrahigh-elongation foil strain gage  
 KFEL: High-elongation foil strain gage  
 KFN: Noninductive foil strain gage  
 KFS: Shielded foil strain gage  
 KFF: Foil bending strain gage  
 KCH: Foil strain gage with protector  
 KMP: Embedded foil strain gage for plastics  
 KV: Crack gage

### ② Gage Length

015: 0.15 mm  
 02N: 0.2 mm  
 02: 0.2 mm  
 03: 0.3 mm  
 05: 0.5 mm  
 1N: 1 mm  
 1: 1 mm  
 1.5: 1.5 mm  
 2N: 2 mm  
 2: 2 mm  
 3: 3 mm  
 4N: 4 mm  
 4: 4 mm  
 5: 5 mm  
 6: 6 mm  
 7: 7 mm  
 9: 9 mm  
 10: 10 mm  
 20: 20 mm  
 30: 30 mm  
 60: 60 mm  
 70: 70 mm  
 80: 80 mm  
 120: 120 mm

Suffix N denotes narrow gage base.

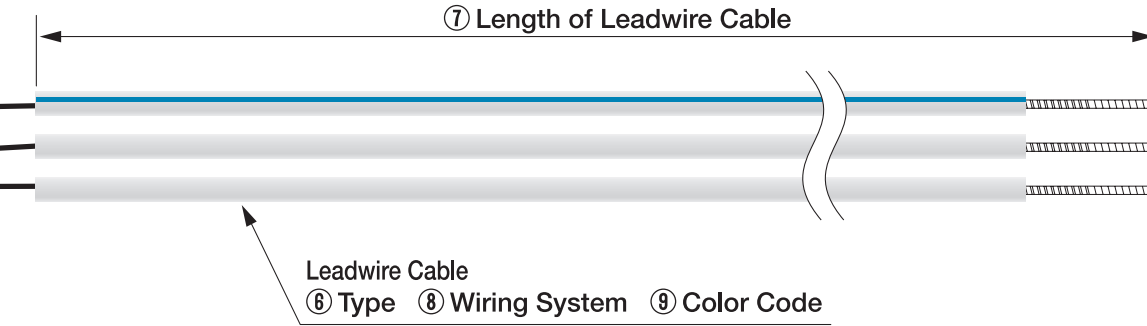
### ③ Resistance

60: 60  $\Omega$   
 120: 120  $\Omega$   
 350: 350  $\Omega$   
 500: 500  $\Omega$   
 1K: 1000  $\Omega$   
 2K: 2000  $\Omega$   
 10K: 10000  $\Omega$

### ④ Gage Pattern

A1: Uniaxial, leads at one end (KC, KTB gages)  
 C1: Uniaxial, leads at one end (foil gage)  
 C2: Uniaxial 90°, lead at both ends  
 C3: Uniaxial 0°, lead at both ends  
 C9: Uniaxial, leads at one end (KFN gage)  
 C11: Uniaxial, 2-element, 1mm thick (KFF gage)  
 C12: Uniaxial, 2-element, 2mm thick (KFF gage)  
 C15: Uniaxial right 45°, for shearing strain, leads at one end  
 C16: Uniaxial left 45°, for shearing strain, leads at one end  
 C20: Uniaxial, leads at a side (for bolt axial tension)  
 D1: Biaxial 0°/90°, lead at both ends  
 D2: Biaxial 0°/90°, lead at both ends (for torque)  
 D3: Triaxial 0°/90°/45°, lead at both ends, plane arrangement  
 D4: Triaxial 0°/120°/240°, plane arrangement  
 D6: Quadraaxial 0°/30°/90°/150°  
 D9: Uniaxial 5-element 90°  
 D16: Biaxial 0°/90° stacked rosette, round base  
 D17: Triaxial 0°/90°/45° stacked rosette, round base  
 D19: Uniaxial 5-element 0°  
 D20: Biaxial 0°/90° (KFN gage)  
 D22: Triaxial 0°/90°/45°, plane arrangement  
 D25: Triaxial 0°/90°/45°, plane arrangement  
 D28: Triaxial 0°/135°/90°, plane arrangement (for boring)  
 D29: Biaxial 0°/90°, leads at one end, plane arrangement  
 D30: Triaxial 0°/90°/45°, leads at one end, plane arrangement  
 D31: Biaxial 0°/90°, leads at one end (for torque)  
 D34: Biaxial 0°/90°, plane arrangement  
 D35: Triaxial 0°/90°/45°, plane arrangement  
 D39: Biaxial 5-element 0°/90°  
 E3: Uniaxial, lead at both ends (semiconductor gage)  
 E4: Uniaxial, leads at one end (semiconductor gage)  
 E5: Uniaxial, lead at both ends with no base (semiconductor gage)  
 F2: Uniaxial 2-element (semiconductor gage)  
 F3: Biaxial 0°/90° (semiconductor gage)  
 G4: Uniaxial, leads at one end (KH-G4)  
 G8: Uniaxial active/dummy 2-element, Inconel (for KHC)  
 G9: Uniaxial active/dummy 2-element, SUS (for KHC)  
 G10: Uniaxial (for KCW)  
 G12: Uniaxial active/dummy 2-element (for KHCS)  
 G13: Uniaxial active/dummy 2-element (for KHGX)  
 G15: Uniaxial active/dummy 2-element (for KHCM)  
 G16: Uniaxial active/dummy 2-element (for KHCR)  
 G17: Uniaxial (for KHCV)  
 H1: Uniaxial (for KM-30)  
 H2: Uniaxial (for KM-120)  
 H3: Uniaxial (for KMC)  
 H4: Uniaxial with T thermocouple (for KMC)  
 J1: Uniaxial (for KFS)

To select the most suitable strain gage and related products, refer to Pages 18 to 29.



Leadwire Cable

# 11

⑤ Applicable Linear Expansion Coefficient  
( $\times 10^{-6}/^{\circ}\text{C}$ )

- 1: CFRP, etc. for composite materials  
Amber (1.1)  
Diamond (1.2)
- 3: GFRP, etc. for composite materials  
Silicon (2.3)  
Sulfur (2.7)
- 5: GFRP, etc. for composite materials  
Tungsten (4.5)  
Lumber (5.0)  
Molybdenum (5.2)  
Zirconium (5.4)  
Kobar (5.9)
- 6: GFRP, etc. for composite materials  
28 Tantalum (6.6)
- 9: CFRP, GFRP, etc. for composite materials  
Titanium alloy (8.5)  
Platinum (8.9)  
Soda-lime glass (9.2)
- 11: Common steel (11.7)  
SUS631 (10.3)  
SUS630 (10.6)  
Cast iron (10.8)  
Nickel-molybdenum steel (11.3)  
Beryllium (11.5)  
Inconel X (12.1)
- 13: NCF, etc. for corrosion and heat-resistant alloys  
Nickel (13.3)  
Printed board (13.0)
- 16: Stainless steel SUS304 (16.2)  
Beryllium steel (16.7)  
Copper (16.7)
- 23: 2014-T4 aluminum (23.4)  
Brass (21.0)  
Tin (23.0)  
2024-T4 aluminum (23.2)
- 27: Magnesium alloy (27.0)  
Composite material GFRP (35.0)
- 65: Acrylic resin (65.0)  
Polycarbonate (66.6)

# L

⑥ Type

- B: Glass-coated cable of 3 Ni-clad copper wires
- C: MI cable (for KHC, KHCX, KHCR, KHCS, KHCM and KHCV gages)
- D: Glass-coated cable of 3 FeNi-clad copper wires
- F: Fluoplastic-coated high/low temp. 3-wire cable (equiv. to L-3 leadwire cable)
- G: Polyethylene-coated cross-link 3-wire cable
- H: High/low temp. 3-wire cable (equiv. to L-17 leadwire cable)
- J: Vinyl-coated normal temp. low-noise 3-wire cable (equiv. to L-13 leadwire cable)
- L: Vinyl-coated flat 2 or 3-wire cable (L-6, L-7, L-9 or L-10)
- N: Polyester-coated copper wire cable
- R: Mid-temp. 2 or 3-wire cable (L-11 or L-12)
- W: Vinyl-coated flat 3-wire cable (for KM-120)
- Y: Vinyl-coated flat 2-wire cable (for KM-30)

# 1M

⑦ Length

- C: Centimeter  
e.g. 30C = 30 cm
- M: Meter  
e.g. 3M = 3 m

# 3

⑧ Wiring System

- 2: 2-wire system
  - 3: 3-wire system
- In the case of encapsulated gage  
Number: Length of soft cable  
V: With bridge adapter  
F: With compression fitting  
FV: With both bridge adapter and compression fitting

# R

⑨ Color Code

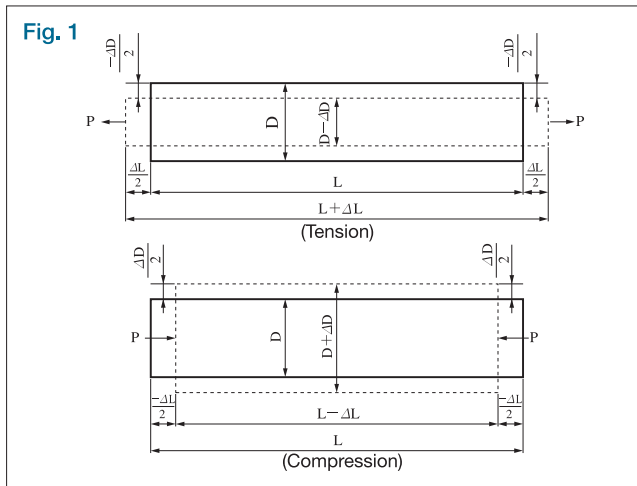
- Color codes are available for only vinyl-coated flat leadwire cables.
- 2-wire system  
R: Red  
W: White\*  
B: Black\*  
G: Green\*  
Y: Yellow\*  
\*Custom-made
- S: Multi-axial gages (Standard)
- Biaxial (D16)  
0° (1st axis): Red  
90° (2nd axis): White
  - Triaxial (D17)  
0° (1st axis): Red  
45° (3rd axis): Green  
90° (2nd axis): White
- 3-wire system  
The insulator color is white and the stripe color code is as follows.  
R: Red  
L: Blue\*  
B: Black\*  
G: Green\*  
Y: Yellow\*  
\*Custom-made
- S: Multi-axial gages (Standard)
- Biaxial (D16)  
0° (1st axis): Red  
90° (2nd axis): Yellow
  - Triaxial (D17)  
0° (1st axis): Red  
45° (3rd axis): Blue  
90° (2nd axis): Yellow

Note: Combination of codes is limited and menu options cannot freely be selected.

# How strain gages work.

## Strain, Stress, and Poisson's Ratio

When a material receives a tensile force  $P$ , it has a stress  $\sigma$  that corresponds to the applied force. In proportion to the stress, the cross section contracts and the length elongates by  $\Delta L$  from the length  $L$  the material had before receiving the tensile force (see upper illustration in Fig. 1).



The ratio of the elongation to the original length is called a tensile strain and is expressed as follows:

$$\epsilon = \frac{\Delta L}{L}$$

$\epsilon$ : Strain  
 $L$ : Original length  
 $\Delta L$ : Elongation

See the lower illustration in Fig. 1. If the material receives a compressive force, it bears a compressive strain expressed as follows:

$$\epsilon = \frac{-\Delta L}{L}$$

For example, if a tensile force makes a 100 mm long material elongate by 0.01 mm, the strain initiated in the material is as follows:

$$\epsilon = \frac{\Delta L}{L} = \frac{0.01}{100} = 0.0001 = 100 \times 10^{-6}$$

Thus, strain is an absolute number and is expressed with a numeric value plus  $\times 10^{-6}$  strain,  $\mu\epsilon$  or  $\mu\text{m}/\text{m}$ .

The relation between stress and the strain initiated in a material by an applied force is expressed as follows based on Hooke's law:

$$\sigma = E\epsilon$$

$\sigma$ : Stress  
 $E$ : Elastic modulus  
 $\epsilon$ : Strain

Stress is thus obtained by multiplying strain by the elastic modulus. When a material receives a tensile force, it elongates in the axial direction while contracting in the transverse direction. Elongation in the axial direction is called longitudinal strain and contraction in the transverse direction, transverse strain. The absolute value of the ratio between the longitudinal strain and transverse strain is called Poisson's ratio, which is expressed as follows:

$$\nu = \left| \frac{\epsilon_2}{\epsilon_1} \right|$$

$\nu$ : Poisson's ratio  
 $\epsilon_1$ : Longitudinal strain  $\frac{\Delta L}{L}$  or  $-\frac{\Delta L}{L}$  (Fig. 1)  
 $\epsilon_2$ : Transverse strain  $-\frac{\Delta D}{D}$  or  $\frac{\Delta D}{D}$  (Fig. 1)

Poisson's ratio differs depending on the material. For reference, major industrial materials have the following mechanical properties including Poisson's ratio.

## Mechanical Properties of Industrial Materials

$$G = \frac{E}{2(1+\nu)}$$

Material	Young's Modulus E (GPa)	Shearing Modulus G (GPa)	Tensile Strength (MPa)	Poisson's Ratio $\nu$
Carbon steel (C0.1 - 0.25%)	205	78	363 - 441	0.28 - 0.3
Carbon steel (C > 0.25%)	206	79	471 - 569	0.28 - 0.3
Spring steel (quenched)	206 - 211	79 - 81	588 - 1667	0.28 - 0.3
Nickel steel	205	78	549 - 657	0.28 - 0.3
Cast iron	98	40	118 - 235	0.2 - 0.29
Brass (casting)	78	29	147	0.34
Phosphor bronze	118	43	431	0.38
Aluminum	73	27	186 - 500	0.34
Concrete	20 - 29	9 - 13	—	0.1

## Principle of Strain Gages

Each metal has its specific resistance. An external tensile force (compressive force) increases (decreases) the resistance by elongating (contracting) it. Suppose the original resistance is  $R$  and a strain-initiated change in resistance is  $\Delta R$ . Then, the following relation is concluded:

$$\frac{\Delta R}{R} = K_s \frac{\Delta L}{L} = K_s \epsilon$$

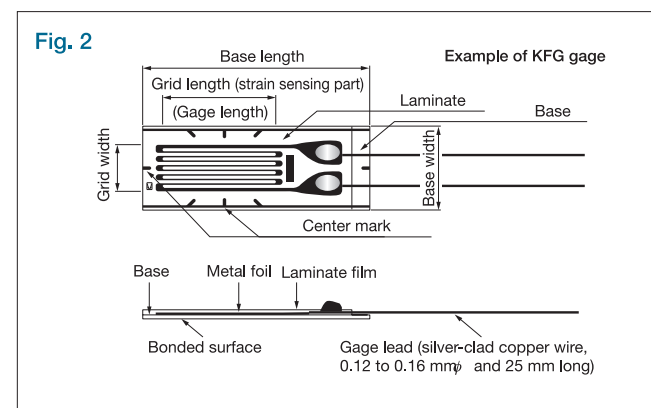
where,  $K_s$  is a gage factor, the coefficient expressing strain gage sensitivity. General-purpose strain gages use copper-nickel or nickel-chrome alloy for the resistive element, and the gage factor provided by these alloys is approximately 2.

## Types of Strain Gages

Types of strain gages include foil strain gage, wire strain gage and semiconductor strain gage.

## Structure of Foil Strain Gage

The foil strain gage has metal foil photo-etched in a grid pattern on the electric insulator of the thin resin and gage leads attached, as shown in Fig. 2 below



The strain gage is bonded to the measuring object with a dedicated adhesive. Strain occurring on the measuring site is transferred to the strain sensing element via the gage base. For accurate measurement, the strain gage and adhesive should match the measuring material and operating conditions including temperature. For the method of bonding the strain gage to metal, refer to Page 13.

## Principle of Strain Measurement

Strain-initiated resistance change is extremely small. Thus, for strain measurement a Wheatstone bridge is formed to convert the resistance change to a voltage change. Suppose in Fig. 3 resistances ( $\Omega$ ) are  $R_1$ ,  $R_2$ ,  $R_3$  and  $R_4$  and the excitation voltage (V) is  $E$ . Then, the output voltage  $e_o$  (V) is obtained with the following equation:

$$e_o = \frac{R_1 R_3 - R_2 R_4}{(R_1 + R_2)(R_3 + R_4)} \cdot E$$

Suppose the resistance  $R_1$  is a strain gage and it changes by  $\Delta R$  due to strain. Then, the output voltage is,

$$e_o = \frac{(R_1 + \Delta R)R_3 - R_2 R_4}{(R_1 + \Delta R + R_2)(R_3 + R_4)} \cdot E$$

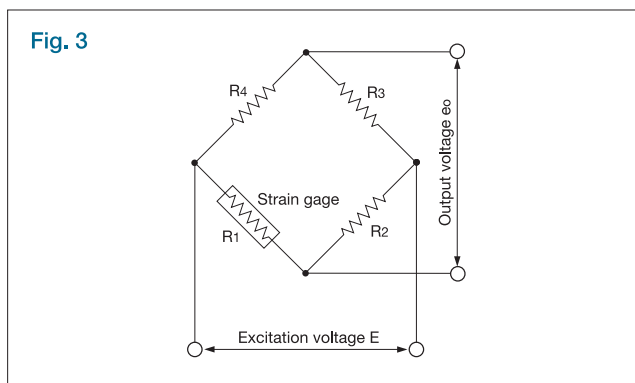
If  $R_1 = R_2 = R_3 = R_4 = R$ ,

$$e_o = \frac{R^2 + R \Delta R - R^2}{(2R + \Delta R) 2R} \cdot E$$

Since  $R$  may be regarded extremely larger than  $\Delta R$ ,

$$e_o \doteq \frac{1}{4} \cdot \frac{\Delta R}{R} \cdot E = \frac{1}{4} \cdot K_s \cdot \varepsilon \cdot E$$

Thus obtained is an output voltage that is proportional to a change in resistance, i.e. a change in strain. This microscopic output voltage is amplified for analog recording or digital indication of the strain.

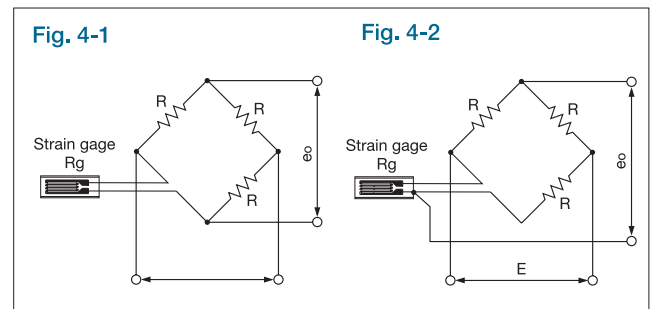


## Strain-gage Wiring Systems

A strain-gage Wheatstone bridge is configured with quarter, half or full bridge technique according to the measuring purpose. The typical wiring systems are shown in Figs. 4, 5 and 6. For varied strain-gage bridge formation systems, refer to Pages 14 and 15.

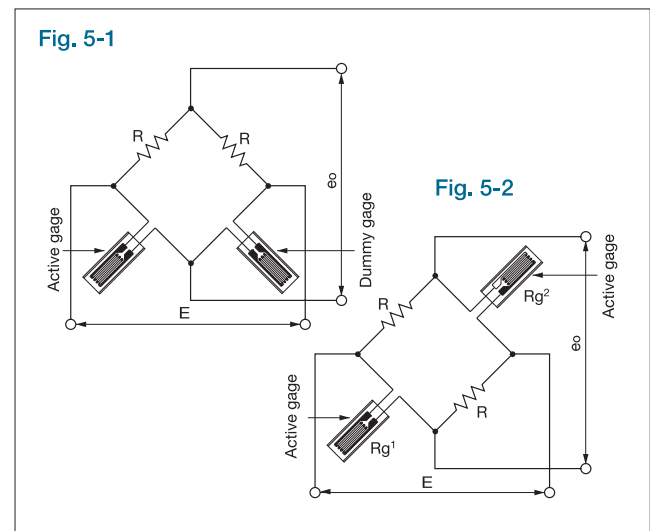
### ●Quarter Bridge Technique

With the quarter bridge technique, 1, 2 or 4 strain gages are connected to a side of the bridge and a fixed resistor is inserted into each of the other 3 sides. This system can easily be configured, and thus it is widely used for general stress/strain measurement. The quarter bridge 2-wire system shown in Fig. 4-1 receives much influence of leads. Therefore, if large temperature changes are anticipated or if the leadwire length is long, the quarter bridge 3-wire system shown in Fig. 4-2 must be used. For the quarter bridge 3-wire system, refer to "Method of Compensating Temperature Effect of Leadwire" (Page 10).



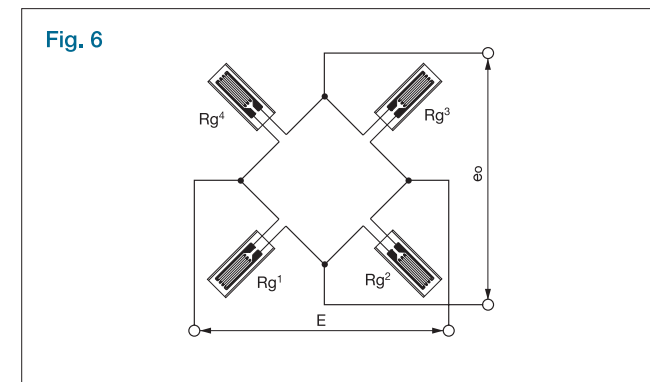
### ●Half Bridge Technique

With the half bridge technique, 2 strain gages are connected to the bridge, one each to the 2 sides; a fixed resistor is inserted into each of the other 2. See Figs. 5-1 and 5-2 below. There exist the active-dummy method, where one strain gage serves as a dummy gage for temperature compensation, and the active-active method, where both gages serve as active gages. The half bridge technique is used to eliminate strain components other than the target strain; according to the measuring purpose, 2 gages are connected to the bridge in different ways. For details, refer to "How to Form Strain-gage Bridges" (Pages 14 and 15).



### ●Full Bridge Technique

See Fig. 6. The full bridge technique has 4 strain gages connected one each to all 4 sides of the bridge. This circuit ensures large output of strain-gage transducers and improves temperature compensation as well as eliminates strain components other than the target strain. For details, refer to "How to Form Strain-gage Bridges" (Pages 14 and 15).





## ● Typical Measurements with Strain Gages

### Bending Stress Measurement

#### (1) Quarter Bridge Technique

As illustrated below, bond a strain gage on the top surface of a cantilever with a rectangular section. If load  $W$  is applied to the unfixed end of the cantilever, the strain-gage bonding site has the following surface stress  $\sigma$ :

$$\sigma = \epsilon_0 \cdot E$$

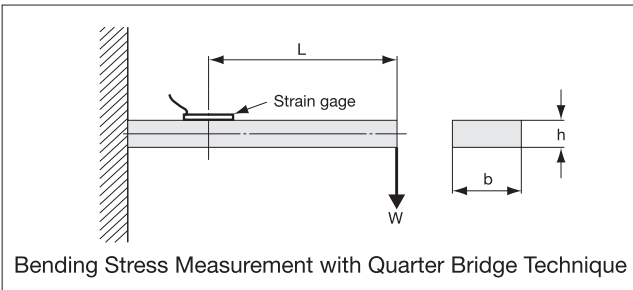
Strain  $\epsilon_0$  is obtained through the following equation:

$$\epsilon_0 = \frac{6WL}{Eb^3}$$

where,  $b$ : Width of cantilever

$h$ : Thickness of cantilever

$L$ : Distance from the load point to the center of strain gage

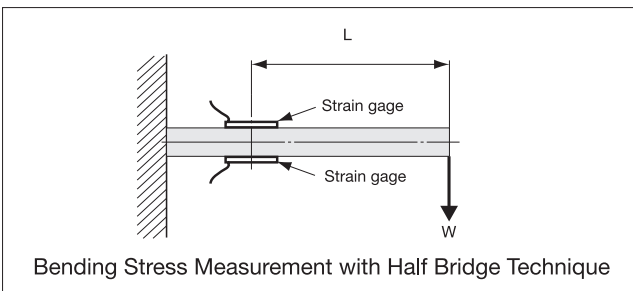


#### (2) Half Bridge Technique

Strain gages bonded symmetrically on the front and rear surfaces of the cantilever as illustrated below output plus and minus signals, respectively, with an equal absolute value. If these 2 gages are connected to adjacent sides of the bridge, the output of the bridge corresponding to the bending strain is doubled and the surface stress  $\sigma$  at the strain-gage bonding site is obtained through the following equation:

$$\sigma = \frac{\epsilon_0}{2} \cdot E$$

The half bridge technique discards strain-gage output corresponding to the force applied in the axial direction of the cantilever.



### Equation to Obtain Strain on Beams

Strain  $\epsilon_0$  on beams is obtained through the following equation:

$$\epsilon_0 = \frac{M}{ZE}$$

where,  $M$ : Bending moment (refer to Table 1)

$Z$ : Section modulus (refer to Table 2)

$E$ : Young's modulus (refer to "Mechanical Properties of Industrial Materials," page 6)

Typical shapes of beams and their bending moments  $M$  and section moduli  $Z$  are shown in Tables 1 and 2.

Table 1. Typical Equations to Obtain Bending Moment

Shape of Beam	Bending Moment $M$
	$M = WL$
	$0 \leq L \leq \frac{l}{2} \rightarrow M = \frac{WL}{2} \left( \frac{1}{4} - \frac{L}{l} \right)$ $L = 0L = \frac{l}{2} \rightarrow M = \pm \frac{WL}{8}$ $\frac{l}{2} \leq L \leq l \rightarrow M = \frac{WL}{2} \left( \frac{L}{l} - \frac{3}{4} \right)$
	$0 \leq L \leq \frac{l}{2} \rightarrow M = -\frac{WL}{2}$ $L = \frac{l}{2} \rightarrow M = -\frac{WL}{4}$ $\frac{l}{2} \leq L \leq l \rightarrow M = \frac{W(l-L)}{2}$
	$0 \leq L \leq l_1 \rightarrow M = WL$ $l_1 \leq L \leq (l_1 + l_2) \rightarrow M = Wl_1$

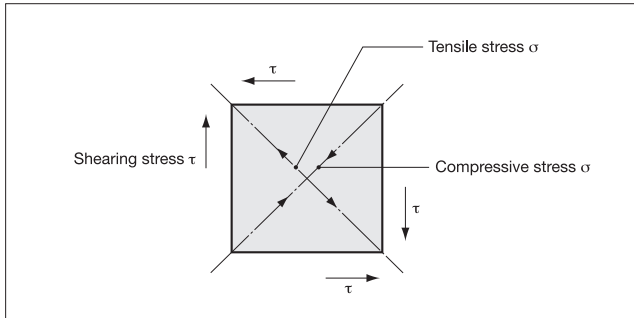
Table 2. Typical Equations to Obtain Section Modulus

Cross Section	Section Modulus $Z$
	$\frac{1}{6}bh^2$
	$\frac{1}{6} \cdot \frac{b(h_2^3 - h_1^3)}{h^2}$
	$\frac{\pi}{32}d^3$
	$\frac{\pi}{32} \cdot \frac{d_2^4 - d_1^4}{d_2}$

## Torsional and Shearing Stress Measurement of Axis

When twisted, an axis has shearing stress  $\tau$ , and in the 2 directions inclined by  $45^\circ$  from the axial line it has tensile and compressive stress in an equal magnitude to the shearing stress.

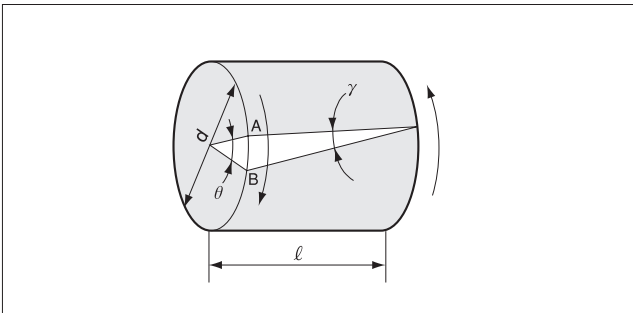
In measuring strain on a twisted axis under simple shearing stress status, the strain gage does not directly measure the shearing strain but detects tensile or compressive strain initiated by tensile or compressive stress that is simultaneously generated with the shearing stress. Stress conditions on a microscopic part of the surface of the axis may be as illustrated below.



Shearing stress  $\gamma$  is defined as illustrated below, and the magnitude is calculated through the following equation:

$$\gamma = \frac{\tau}{G}$$

where,  $G$ : Shearing modulus (refer to "Mechanical Properties of Industrial Materials," page 6)  
 $\tau$ : Shearing stress



When the axis is twisted, point A moves to point B, thereby initiating torsional angle  $\theta$ .

$$\theta = \frac{\ell\gamma}{\left(\frac{d}{2}\right)} = \frac{2\ell\gamma}{d}$$

### (1) Stress Measurement with Quarter Bridge Technique

Bond the strain gage on the twisted axis in the direction inclined by  $45^\circ$  from the axial line. The relation between strain  $\epsilon_0$  and stress  $\sigma$  is expressed with the following equation to obtain tensile or compressive stress  $\sigma$ :

$$\sigma = \frac{\epsilon_0 \cdot E}{1 + \nu}$$

where,  $\epsilon_0$ : Indicated strain  
 $E$ : Young's modulus (refer to "Mechanical Properties of Industrial Materials," page 6)  
 $\nu$ : Poisson's ratio

Stress  $\sigma$  and shearing stress  $\tau$  are equal in magnitude, and thus,

$$\tau = \sigma$$

### (2) Stress Measurement with Half or Full Bridge Technique

2 or 4 strain gages forming the strain-gage bridge are strained in an equal magnitude to enable 2 or 4 times larger output. Accordingly, the stress is calculated by dividing the indicated strain by 2 or 4.

### (3) Application to Torque Measurement

Strain on the surface of the axis is proportional to the torque applied to the axis. Thus, the torque is obtained by detecting the strain on the surface.

Shearing stress distributed on the lateral section is balanced with the applied torque  $T$ , establishing the following equation:

$$T = \tau \cdot Z_p$$

where,  $Z_p$ : Polar modulus of section

This equation may be rewritten as follows by substituting the shearing stress with the relational expression of tensile strain and stress:

$$T = \frac{\epsilon_0 \cdot E \cdot Z_p}{1 + \nu}$$

The polar modulus of the section is specific to each shape of the cross section as follows:

Cross Section	Polar Modulus of Section $Z_p$
	$\frac{\pi d^3}{16}$
	$\frac{\pi}{16} \left( \frac{d_2^4}{d_2} - \frac{d_1^4}{d_1} \right)$

A strain-gage torque transducer can be designed using the aforementioned relational expression of  $\epsilon_0$  and  $T$ .

Obtain  $\epsilon_0$  from the allowable stress for the material, and determine the width  $d$  of the axis which is matched with the magnitude of the applied torque. Then, amplify the strain output with a strain amplifier and read the output voltage with a measuring instrument.

### ● Principle of Self-temperature-compensation Gages (SELCOM Gages)

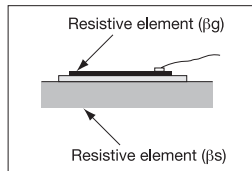
Suppose the measuring object and the resistive element of the strain gage have linear expansion coefficients  $\beta_s$  and  $\beta_g$ , respectively. Then, the strain gage bonded on the surface of the object provides a thermally-induced apparent strain  $\epsilon_T$  per  $1^\circ\text{C}$  that is expressed with the following equation:

$$\epsilon_T = \frac{\alpha}{K_s} + (\beta_s - \beta_g)$$

where,

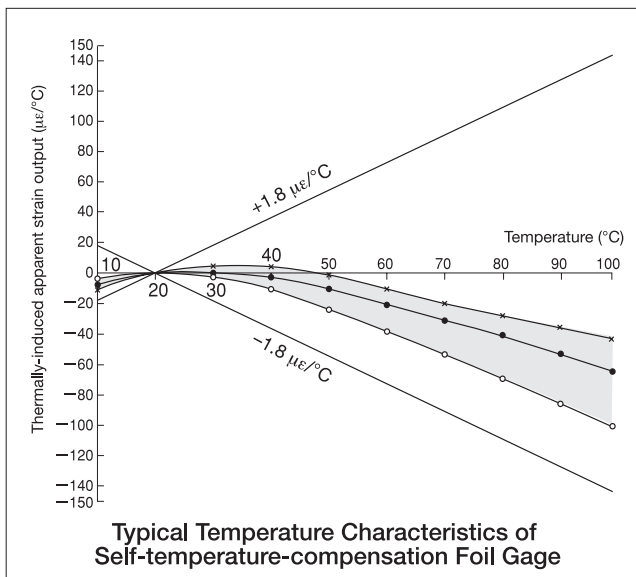
$\alpha$ : Resistive temperature coefficient of resistive element

$K_s$ : Gage factor of strain gage



The self-temperature-compensation gage is designed so that  $\epsilon_T$  in the above equation is approximated to zero by controlling the resistive temperature coefficient of the gage's resistive element according to the linear expansion coefficient of the measuring object.

When bonded to a suitable material, KYOWA's self-temperature-compensation gage (SELCOM gage) minimizes apparent strain in the compensated temperature range to  $\pm 1.8 \mu\text{m/m}/^\circ\text{C}$  (graph below shows apparent strain output of 3-wire strain gage).



### ● Linear Expansion Coefficients of Materials ( $\times 10^{-6}/^\circ\text{C}$ )

Material	Linear Exp. Coef.	Material	Linear Exp. Coef.
Quartz glass	0.4	Beryllium	11.5
Amber	1.1	Common steel	11.7
Brick	3.0 to 5.0	Inconel X	12.1
Tungsten	4.5	Nickel	13.3
Lumber (grain dir.)	5.0	Gold	14.0
Molybdenum	5.2	SUS 304	16.2
Zirconium	5.4	Beryllium copper	16.7
Cobar	5.9	Copper	16.7
Concrete	6.8 to 12.7	Brass	21.0
Titanium alloy	8.5	2024-T4 aluminum	23.2
Platinum	8.9	2014-T4 aluminum	23.4
Soda-lime glass	9.2	Magnesium alloy	27.0
SUS 631	10.3	Lead	29.0
SUS 630	10.6	Acrylic resin	Approx. 65 to 100
Cast iron	10.8	Polycarbonate	66.6
NiCrMo steel	11.3	Rubber	Approx. 77

### ● Temperature Effect of Leadwire with 2-wire System

Leadwire Model	Cross-Sectional Area of Conductor (mm <sup>2</sup> )	Reciprocating Resistance of 10 m long Leadwire approx. (Ω)	Apparent Strain* with 10 m Extension approx. (μm/m/°C)
L-5	0.5	0.7	11.3
L-9	0.11	3.2	50.6
L-6	0.08	4.4	69.0

\*120 Ω gage

Thermally-induced apparent strain  $\epsilon_r$  ( $\mu\text{m/m}/^\circ\text{C}$ ) is obtained through the following equation.

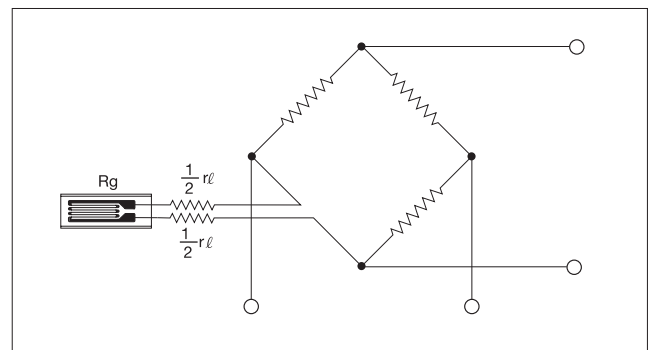
$$\epsilon_r = \frac{r\ell}{R_g + r\ell} \cdot \frac{\alpha}{K_s}$$

where,  $R_g$ : Resistance of strain gage (Ω)

$r\ell$ : Resistance of leadwire (Ω)

$K_s$ : Preset gage factor of strain amplifier, usually 2.00

$\alpha$ : Resistive temperature coefficient of copper wire ( $\Delta R/R/^\circ\text{C}$ ),  $3.9 \times 10^{-3}$

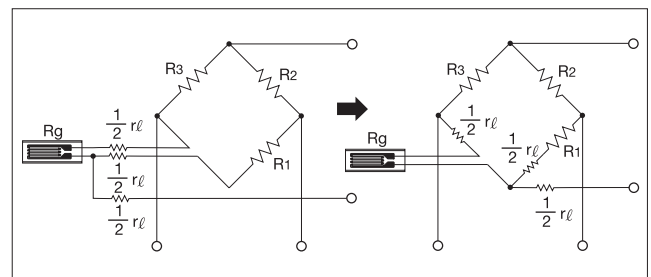


### ● Method of Compensating Temperature Effect of Leadwire (3-wire System)

For effective self-temperature-compensation, SELCOM gages adopt the quarter bridge technique. However, if the leadwire cable is a 2-wire system, strain output from the bridge is affected by temperature effect of the leadwire. To avoid such adverse effect, the 3-wire system is adopted.

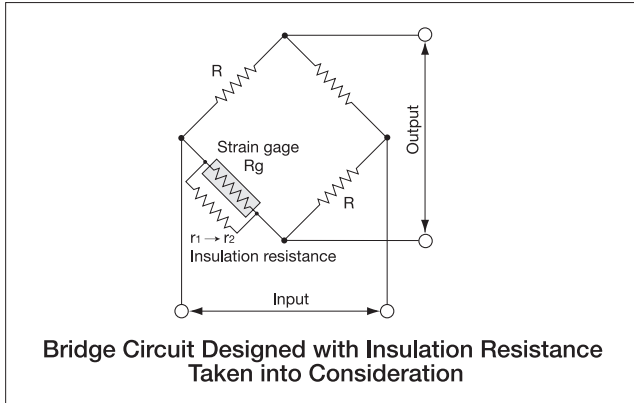
If 3 leads are connected to the strain gage as shown below, one half the leadwire resistance is applied to the adjacent side of the bridge to compensate the resistive components of the 2 leads affected by a similar temperature change, and thus the bridge output is free from any temperature effect of the leadwire. The temperature effect of a third lead connected directly to the amplifier can be ignored since the amplifier provides a high input impedance.

As precautions in using the 3-wire system, the 3 leads should be the same in type, length and cross section to receive the same temperature effect. If they are exposed to direct sunlight, the coating color too should be identical.



## ●Influence of Insulation Resistance

The insulation resistance of a strain gage including leads does not affect the measured value if it is higher than 100 MΩ. But if the insulation resistance changes drastically during measurement, it causes the measured value to include an error.



If the insulation resistance descends from  $r_1$  to  $r_2$  in the figure above, error strain  $\varepsilon$  is:

$$\varepsilon \doteq \frac{R_g(r_1 - r_2)}{K_s r_1 r_2}$$

Suppose,

- $R_g = 120\Omega$  (resistance of strain gage)
- $K_s = 2.00$  (gage factor of strain gage)
- $r_1 = 1000M\Omega$  (original insulation resistance)
- $r_2 = 10M\Omega$  (changed insulation resistance)

Then, the error strain is approximately  $6 \mu\text{m}/\text{m}$ . In general strain measurement, such an error causes virtually no problem. In practice, however, the lowered insulation resistance,  $r_2$ , is not kept constant but sharply changes due to temperature, humidity and other conditions. Thus, it is not possible to specify to which part of the circuit the insulation resistance  $r$  is applied. Accordingly, precautions should be taken.

## ●Resistance Change of Strain Gage Bonded to Curved Surface

The strain  $\varepsilon_c$  occurring on the resistive element of a strain gage bonded to a curved surface may be expressed with the following equation:

$$\varepsilon_c = \frac{t}{2r + t}$$

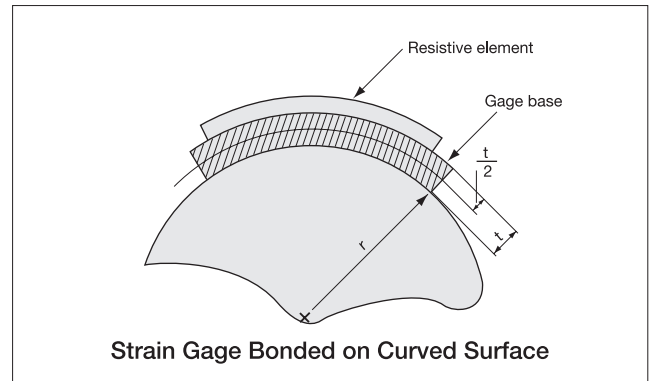
where,  $t$ : Thickness of gage base plus adhesive layer  
 $r$ : Radius of gage bonding surface

For example, if a uniaxial KFG gage of which the gage base including the adhesive layer is 0.015 mm thick, is bonded to a curved surface of 1.5r, the strain gage receives strain of approximately  $5000 \mu\text{m}/\text{m}$  under the mere bonding condition. If the gage factor  $K_s$  is 2.00,

$$\Delta R/R \doteq 10000 \mu\text{m}/\text{m}$$

since  $\Delta R/R = \varepsilon \cdot K_s$ .

If the gage resistance is 120 Ω, it increases by approximately 1.2 Ω. If the gage is bonded inside the curve, the resistance decreases.



## ●Method of Compensating Gage Factors

If the gage factor of the strain gage is different from that (2.00) of the strain amplifier, the real strain  $\varepsilon$  can be obtained through the following equation:

$$\varepsilon = \frac{2.00}{K_s} \times \varepsilon_i$$

where,  $\varepsilon_i$ : Measured strain  
 $K_s$ : Gage factor of strain gage

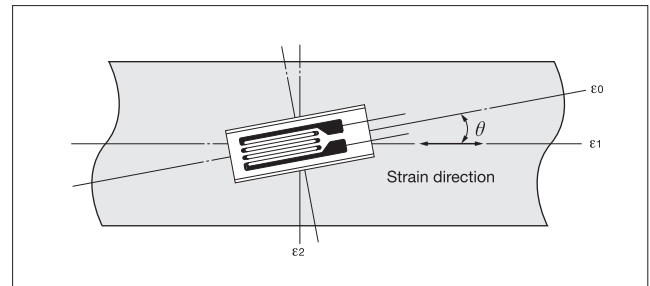
## ●Misalignment Effect

The strain  $\varepsilon_0$  measured by a strain gage that is misaligned by an angle  $\theta$  from the direction of the principal strain is expressed with the following equation:

$$\varepsilon_0 = \frac{1}{2} \{(\varepsilon_1 + \varepsilon_2) + (\varepsilon_1 - \varepsilon_2) \cos 2\theta\}$$

If  $\varepsilon_2 = -\nu\varepsilon_1$  ( $\nu$ : Poisson's ratio) under the uniaxial stress condition,

$$\varepsilon_0 = \frac{1}{2} \varepsilon_1 \{(1 - \nu) + (1 + \nu) \cos 2\theta\}$$



## ●Method of Compensating Leadwire Extension Effect

If the leadwire or cable is extended with the quarter or half bridge technique, additional resistance is initiated in series to the strain gage, thereby decreasing the apparent gage factor. For example, if a 10 m long leadwire with 0.3 mm<sup>2</sup> conductors is used, the gage factor decreases by 1%. In the case of the full bridge technique (transducer), the extension decreases the bridge voltage too. In these cases, the real strain  $\varepsilon$  can be obtained through the following equation (supposing the gage factor  $K_s$  is 2.00):

$$\varepsilon = \left(1 + \frac{r\ell}{R_g}\right) \times \varepsilon_i$$

where,  $\varepsilon_i$ : Measured strain  
 $R_g$ : Resistance of strain gage  
 $r\ell$ : Total resistance of leadwire (For reciprocating resistance, see the table on the next page.)  
 One-way resistance in the case of 3-wire system

### Reciprocating Resistance of Leadwire

Cross Section (mm <sup>2</sup> )	Number/Diameter of Strands	Reciprocating Resistance per 10m (Ω)	Remarks
0.08	7/0.12	4.4	L-6, 7
0.11	10/0.12	3.2	L-9, 10
0.3	12/0.18	1.17	L-2
0.5	20/0.18	0.7	L-5

### ● Method of Compensating Nonlinearity of Quarter Bridge Technique

Nonlinearity beyond the specification in large strain measurement with the quarter bridge technique can be compensated through the following equation to obtain the real strain  $\epsilon$ :

$$\epsilon = \frac{\epsilon_0}{1 - \epsilon_0}$$

where,  $\epsilon_0$ : Measured strain

Example: If  $\epsilon_0 = 2000 \mu\text{m/m}$ ,

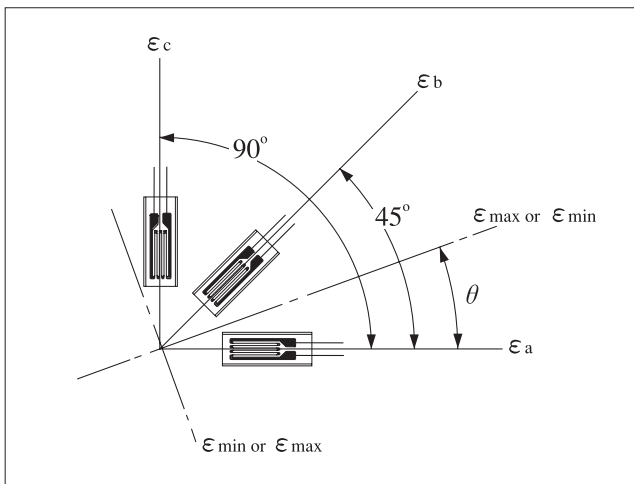
$$\epsilon = \frac{2000 \times 10^{-6}}{1 - 2000 \times 10^{-6}} = \frac{0.002}{1 - 0.002} = 2004 \mu\text{m/m}$$

### ● Method of Obtaining Magnitude and Direction of Principal Stress (Rosette Analysis)

Usually, if the direction of the principal stress is unknown in stress measurement of structures, a triaxial rosette gage is used and multiple physical quantities are obtained by putting measured strain values in the following equations. (These equations apply to right-angled triaxial rosette gages.)

#### Precautions in Analysis

- Regard  $\epsilon_a \rightarrow \epsilon_b \rightarrow \epsilon_c$  as the forward direction.
- Angle  $\theta$  is:
  - Angle of the maximum strain to the  $\epsilon_a$  axis when  $\epsilon_a > \epsilon_c$ .
  - Angle of the minimum strain to the  $\epsilon_a$  axis when  $\epsilon_a < \epsilon_c$ .
 Comparison between  $\epsilon_a$  and  $\epsilon_c$  in magnitude includes plus and minus signs.



$$\text{Max. principal strain } \epsilon_{\max.} = \frac{1}{2} \left[ \epsilon_a + \epsilon_c + \sqrt{2 \{ (\epsilon_a - \epsilon_b)^2 + (\epsilon_b - \epsilon_c)^2 \}} \right]$$

$$\text{Min. principal strain } \epsilon_{\min.} = \frac{1}{2} \left[ \epsilon_a + \epsilon_c - \sqrt{2 \{ (\epsilon_a - \epsilon_b)^2 + (\epsilon_b - \epsilon_c)^2 \}} \right]$$

$$\text{Direction of principal strain (from } \epsilon_a \text{ axis)} \theta = \frac{1}{2} \tan^{-1} \left[ \frac{2\epsilon_b - \epsilon_a - \epsilon_c}{\epsilon_a - \epsilon_c} \right]$$

$$\text{Max. shearing strain } \gamma_{\max.} = \sqrt{2 \{ (\epsilon_a - \epsilon_b)^2 + (\epsilon_b - \epsilon_c)^2 \}}$$

$$\text{Max. principal stress } \sigma_{\max.} = \frac{E}{2(1 - \nu^2)} \left[ (1 + \nu)(\epsilon_a + \epsilon_c) + (1 - \nu) \times \sqrt{2 \{ (\epsilon_a - \epsilon_b)^2 + (\epsilon_b - \epsilon_c)^2 \}} \right]$$

$$\text{Min. principal stress } \sigma_{\min.} = \frac{E}{2(1 - \nu^2)} \left[ (1 + \nu)(\epsilon_a + \epsilon_c) - (1 - \nu) \times \sqrt{2 \{ (\epsilon_a - \epsilon_b)^2 + (\epsilon_b - \epsilon_c)^2 \}} \right]$$

$$\text{Max. shearing stress } \tau_{\max.} = \frac{E}{2(1 + \nu)} \times \sqrt{2 \{ (\epsilon_a - \epsilon_b)^2 + (\epsilon_b - \epsilon_c)^2 \}}$$

$\nu$ : Poisson's ratio

E: Young's modulus

(Refer to "Mechanical Properties of Industrial Materials" (page 6).

### ● Generating Calibration Value based on Tip Parallel Resistance Method

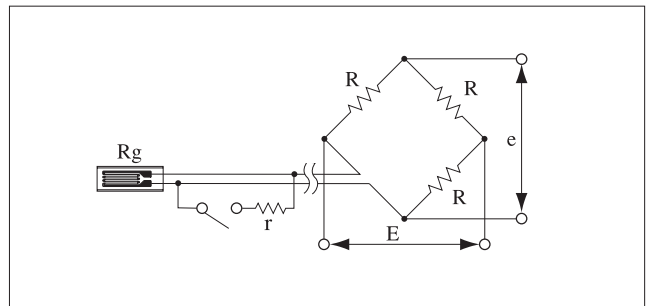
When extending the leadwire by several hundred meters or to obtain an accurate calibration value, use the tip parallel resistance method. The parallel resistance  $r$  can be obtained through the following equation:

$$r = \frac{R_g}{K_s \cdot \epsilon} - R_g$$

where,  $R_g$ : Resistance of strain gage

$K_s$ : Gage factor of strain gage

$\epsilon$ : Calibration strain value

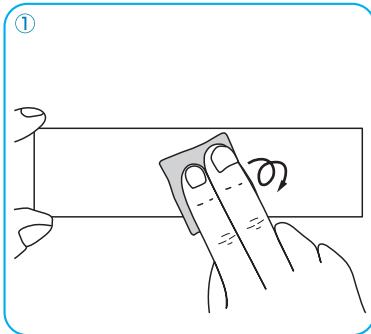


### Examples of Calibration Strain Value and Resistance ( $R_g = 120 \Omega$ , $K_s = 2.00$ )

Calibration Strain Value	Resistance, $r$ (approx.)
100 $\mu\text{m/m}$	600 k $\Omega$
200 $\mu\text{m/m}$	300 k $\Omega$
500 $\mu\text{m/m}$	120 k $\Omega$
1000 $\mu\text{m/m}$	60 k $\Omega$
2000 $\mu\text{m/m}$	30 k $\Omega$

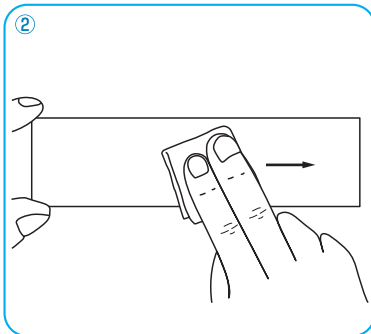
## Typical Strain Gage Bonding Method and Dampproofing Treatment

The strain gage bonding method differs depending on the type of adhesive applied. The description below applies to a case where the leadwire-equipped KFG gage is bonded to a mild steel test piece with a representative cyanoacrylate adhesive, CC-33A. The dampproofing treatment is in the case of using an butyl rubber coating agent, AK-22.

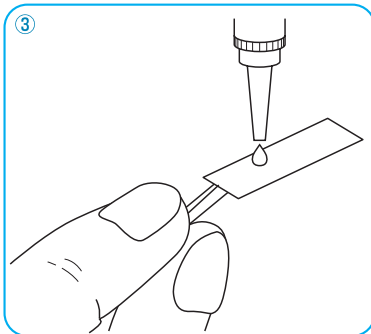


① Like drawing a circle with sandpaper (#320 or so), polish the strain gage bonding site in a considerably wider area than the strain gage size.

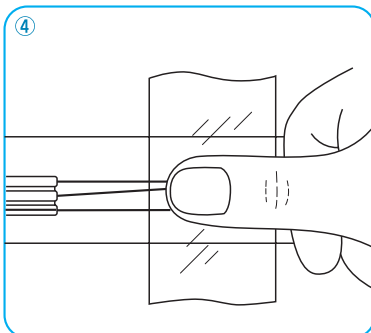
(If the measuring object is a practical structure, wipe off paint, rust and plating with a grinder or sand blast. Then, polish with sandpaper.)



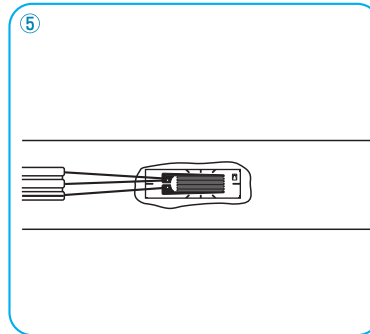
② Using an absorbent cotton, gauze or SILBON paper dipped in a highly volatile solvent such as acetone which dissolves oils and fats, strongly wipe the bonding site in a single direction to remove oils and fats. Reciprocated wiping does not clean the surface. After cleaning, mark the strain gage bonding position.



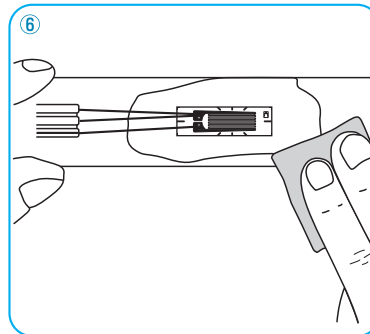
③ Make sure of the front (metal foil part) and the back of the strain gage. Apply a drop of adhesive to the back and immediately put the strain gage on the bonding site. (Do not spread the adhesive over the back. If so, curing is adversely accelerated.)



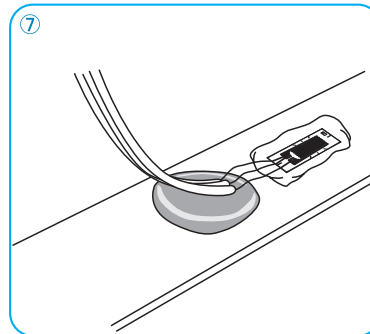
④ Cover the strain gage with the accessory polyethylene sheet and strongly press the strain gage over the sheet with a thumb for approximately 1 minute (do not detach midway). Quickly perform steps 3 and 4. Otherwise, the adhesive is cured. Once the strain gage is put on the bonding site, do not put it up to adjust the position.



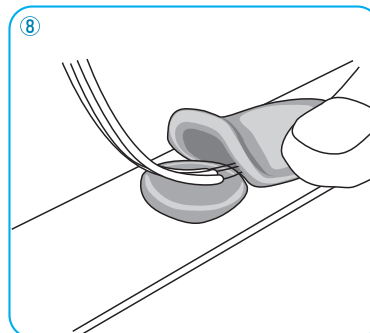
⑤ When the adhesive is cured, remove the polyethylene sheet and check the bonding condition. Ideally, the adhesive is slightly forced out from around the strain gage.



⑥ If the adhesive is widely forced out from around the gage base, remove the protruding adhesive with a cutter or sandpaper. Place gage leads in a slightly slackened condition.



⑦ Put up the leadwire from before the part where the adhesive is applied. Place a block of the coating agent below the leadwire with gage leads slightly slackened.



⑧ Completely cover the strain gage, protruding adhesive and part of the leadwire with another block of the coating agent. Do not tear the block to pieces but slightly flatten it with a finger to closely contact it with the strain gage and part of the leadwire. Completely hide protrusions including gage leads behind the coating agent.

"Strain Gage Bonding Manual" is available from KYOWA at a price of ¥1,200 per copy. If required, contact your KYOWA sales representative.

## How to Form Strain-gage Bridges

No.	Name	Application Sample	Circuit	Output	Remarks	Bridge Box DB-120A/350A
1	Quarter bridge 2-wire system  Number of gages: 1	 Uniaxial stress (uniform tension/compression)		$e_o = \frac{E}{4} K_s \cdot \epsilon_o$ Ks: Gage factor $\epsilon_o$ : Strain E: Excitation voltage $e_o$ : Output voltage Rg: Gage resistance R: Fixed resistance	Suitable for use under environment of less ambient temperature changes; no temperature compensation. x1 output	
2	Quarter bridge 3-wire system  Number of gages: 1	 Uniaxial stress (uniform tension/compression)		$e_o = \frac{E}{4} K_s \cdot \epsilon_o$	No temperature compensation; thermal effect of leadwires cancelled. x1 output	
3	Quarter bridge with 2 gages connected in series 2-wire system (to cancel bending strain)  Number of gages: 2	 Bending Uniaxial stress (uniform tension/compression)		$e_o = \frac{E}{4} K_s \cdot \epsilon_o$ Rg1 ..... Strain: $\epsilon_1$ Rg2 ..... Strain: $\epsilon_2$ $\epsilon_o = \frac{\epsilon_1 + \epsilon_2}{2}$ R: Fixed resistance $R = R_{g1} + R_{g2}$ *	No temperature compensation; bending strain cancelled. x1 output	
4	Quarter bridge with 2 gages connected in series 3-wire system (to cancel bending strain)  Number of gages: 2	 Bending Uniaxial stress (uniform tension/compression)		$e_o = \frac{E}{4} K_s \cdot \epsilon_o$ Rg1 ..... Strain: $\epsilon_1$ Rg2 ..... Strain: $\epsilon_2$ $\epsilon_o = \frac{\epsilon_1 + \epsilon_2}{2}$ R: Fixed resistance $R = R_{g1} + R_{g2}$ *	No temperature compensation; bending strain cancelled; thermal effect of leadwires cancelled. x1 output	
5	Active-dummy half bridge  Number of gages: 2	 Active gage Uniaxial stress (uniform tension/compression) Dummy gage		$e_o = \frac{E}{4} K_s \cdot \epsilon_o$ Ks: Gage factor $\epsilon_o$ : Strain E: Excitation voltage $e_o$ : Output voltage Rg1: Strain: $\epsilon_o$ R: Fixed resistance Rg2 ..... Strain: 0	Temperature compensation; thermal effect of leadwires cancelled. x1 output	
6	Half bridge for 2 gages in orthogonal arrangement  Number of gages: 2	 Uniaxial stress (uniform tension/compression)		$e_o = \frac{(1 + \nu) E}{4} K_s \cdot \epsilon_o$ $\nu$ : Poisson's ratio Gage resistance Rg1 ..... Strain: $\epsilon_o$ Rg2 ..... Strain: $-\nu \epsilon_o$ R: Fixed resistance	Temperature compensation; thermal effect of leadwires cancelled. x(1+ $\nu$ ) output	
7	Half bridge (for bending strain measurement)  Number of gages: 2	 Bending stress		$e_o = \frac{E}{2} K_s \cdot \epsilon_o$ Rg1 ..... Strain: $\epsilon_o$ Rg2 ..... Strain: $-\epsilon_o$ R: Fixed resistance	Temperature compensation; thermal effect of leadwires cancelled; compressive/tensile strain cancelled. x2 output	
8	Half bridge with 2 gages connected to opposite sides 2-wire system  Number of gages: 2	 Uniaxial stress (uniform tension/compression)		$e_o = \frac{E}{2} K_s \cdot \epsilon_o$ Rg1 ..... Strain: $\epsilon_o$ Rg2 ..... Strain: $\epsilon_o$ R: Fixed resistance	No temperature compensation; bending strain cancelled by bonding to the front and rear. x2 output	

\* If the bridge box is DB-120A, Rg1 and Rg2 should be strain gages of 60  $\Omega$ .

# How strain gages work.

No.	Name	Application Sample	Circuit	Output	Remarks	Bridge Box DB-120A/350A
9	Half bridge with 2 gages connected to opposite sides 3-wire system Number of gages: 2	 Uniaxial stress (uniform tension/compression)		$\epsilon_o = \frac{E}{2} K_s \cdot \epsilon_o$ $R_{g1}, \dots$ Strain: $\epsilon_o$ $R_{g2}, \dots$ Strain: $\epsilon_o$ $R$ : Fixed resistance	No temperature compensation; thermal effect of leadwires cancelled; bending strain cancelled by bonding to the front and rear. x2 output	
10	Active-dummy full bridge (for bending strain measurement) Number of gages: 4	 Bending stress		$\epsilon_o = K_s \cdot \epsilon_o \cdot E$ $R_{g1}, R_{g3}, \dots$ Bending strain: $\epsilon_o$ $R_{g2}, R_{g4}, \dots$ Bending strain: $-\epsilon_o$	Temperature compensation; thermal effect of leadwires cancelled; compressive/tensile strain cancelled. x4 output	
11	Full bridge for 4 gages in orthogonal arrangement Number of gages: 4	 Uniaxial stress (uniform tension/compression)		$\epsilon_o = \frac{(1 + \nu) E}{2} K_s \cdot \epsilon_o$ $\nu$ : Poisson's ratio $R_{g1}, R_{g3}, \dots$ Strain: $\epsilon_o$ $R_{g2}, R_{g4}, \dots$ Strain: $-\nu \epsilon_o$	Temperature compensation; thermal effect of leadwires cancelled. x2(1+ν) output	
12	Active-dummy full bridge Number of gages: 4	 Uniaxial stress (uniform tension/compression) Active gages Dummy gages		$\epsilon_o = \frac{E}{2} K_s \cdot \epsilon_o$ $R_{g1}, R_{g3}, \dots$ Strain: $\epsilon_o$ $R_{g2}, R_{g4}, \dots$ Strain: 0	Temperature compensation; thermal effect of leadwires cancelled; bending strain cancelled by bonding to the front and rear. x2 output	
13	Half bridge (for bending strain measurement) Number of gages: 2	 Bending strain		$\epsilon_o = \frac{E}{2} K_s \cdot \epsilon_o$ $R_{g1}, \dots$ Bending strain: $\epsilon_o$ $R_{g2}, \dots$ Bending strain: $-\epsilon_o$ $R$ : Fixed resistance	Temperature compensation; thermal effect of leadwires cancelled. x2 output	
14	Full bridge (for bending strain measurement) Number of gages: 4	 Bending strain		$\epsilon_o = K_s \cdot \epsilon_o \cdot E$ $R_{g1}, R_{g3}, \dots$ Bending strain: $\epsilon_o$ $R_{g2}, R_{g4}, \dots$ Bending strain: $-\epsilon_o$	Temperature compensation; thermal effect of leadwires cancelled. x4 output	
15	Quarter bridge with 4 gages connected to the side (for mean strain measurement) Number of gages: 4	 Uniaxial stress (uniform tension/compression)		$\epsilon_o = \frac{E}{2} K_s \cdot \epsilon_o$ $\epsilon_o = \frac{\epsilon_1 + \epsilon_2 + \epsilon_3 + \epsilon_4}{4}$ $R$ : Fixed resistance $R_g = R$ $R = R_{g1} = R_{g2} = R_{g3} = R_{g4}$	No temperature compensation; mean strain. x1 output	

## ●Relation between strain and voltage

The output of a strain-gage bridge is expressed as a strain quantity ( $\mu\text{m}/\text{m}$ ) or an output voltage ( $\text{mV}/\text{V}$  or  $\mu\text{V}/\text{V}$ ) against the bridge voltage. The strain quantity and the output voltage have the following relation:

$$\epsilon_o = \frac{E}{4} K_s \cdot \epsilon_o$$

If the excitation voltage  $E = 1\text{V}$  and the gage factor  $K_s = 2.00$ ,

$$2\epsilon_o = \epsilon_o.$$

Thus, a strain output is always 2 times larger than a bridge output voltage.

$$\text{e.g. } 3000 \mu\text{m}/\text{m} \rightarrow 1500 \mu\text{V}/\text{V} = 1.5 \text{mV}/\text{V}$$

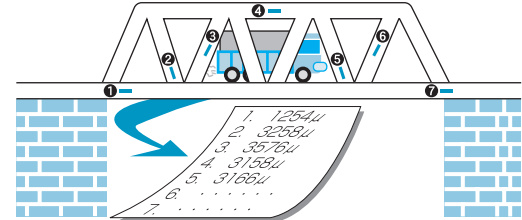


# In strain measurement, slow phenomena are known as "Static phenomena, as "Dynamic Strain." Dedicated strain amplifiers are

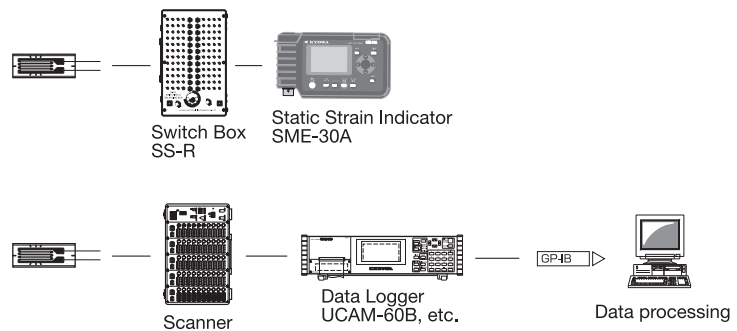
## Static Strain Measurement

Static strain is a strain whose magnitude does not change as time passes or changes extremely slowly. If the force applied to a structure is constant, the strain is constant, making it possible to be read on an analog or digital indicator. In many cases, however, static strain measurement is performed in multiple channels, and thus a scanner with channel selector and strain amplifier/indicator are used in combination.

### Measurement of strain initiated on a bridge by a stopped vehicle



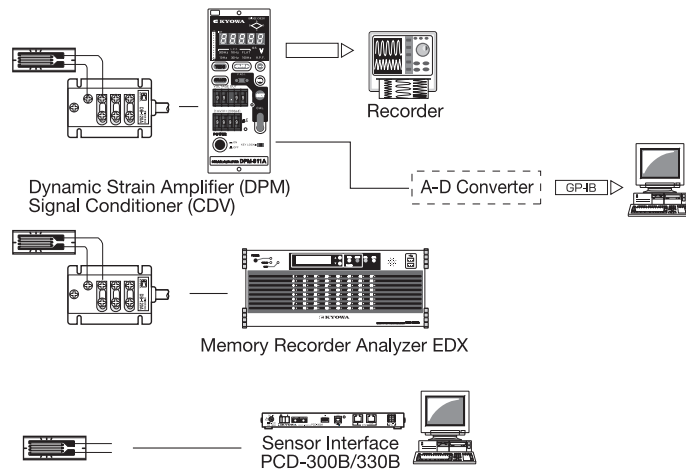
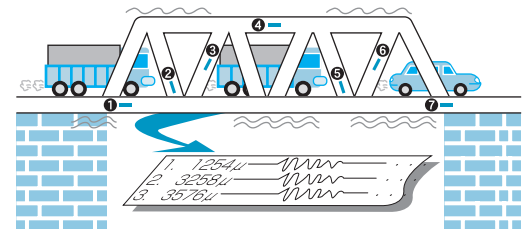
Strain measurement of bridge when car has stopped



## Dynamic Strain Measurement

Dynamic strain is a strain whose magnitude changes as time passes or which is initiated by vibration or impact. Since ever-changing strain cannot be read out on analog and digital indicators, a data recorder or analog recorder has been used to obtain the detected data. Recently, a high-speed interface that connects the dynamic strain amplifier with a PC or a multichannel digital memory recorder analyzer that has a high-speed A-D converter and large-capacity memory is used to acquire and analyze the detected data.

### Measurement of strain initiated on a bridge by running vehicles



## Simple static strain measurement with digital indicator

Strain values are measured with a digital static strain indicator SME-30A, etc. For multichannel measurement, multiple switch boxes are used.

## Multichannel measurement in short time and for data processing

UCAM series data loggers that enable correction, calculation and automatic measurement and applicable scanners are used. The UCAM-60B is used if the PC is not used in conjunction, and the UCAM-65B is used for online measurement with the PC connected constantly. The UCAM-500B enabling simultaneous sampling in all channels is used for measurement of static to quasi-dynamic phenomena fluctuating at several cycles per second. Acquired data can be graphically displayed and analyzed on the PC.

## Simple measurement of dynamic strain initiated by vibration, etc.

Dynamic strain fluctuating at up to 200 Hz can be measured simply with the PCD-300B/330B sensor interface. The sensor interface is equipped with bridge circuits, dynamic strain amplifiers and A-D converters, which enable its direct connection with the PC. Acquired data can be displayed in either graphic or digital format and processed on the PC.

## Measurement of various signals including impact-initiated dynamic strain

KYOWA provides measuring instruments which enable data acquisition for quick phenomena such as impact-initiated waveform as well as simultaneous input of voltage, thermocouple, pulse and digital signals together with strain gage and strain-gage transducer signals. A dedicated software program is available for PC-aided analysis of acquired digital data of dynamic phenomena.

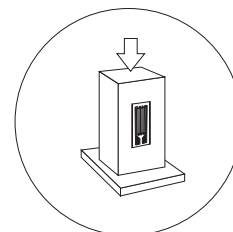
## As sensing elements for transducers

Based on strain gages, various kinds of transducers are manufactured. These transducers are intended not to obtain strain data but to measure physical quantities such as load, pressure, acceleration, displacement and torque. For direct reading of such physical quantities, measuring instruments are available for connection to transducers.

## Various applications of strain gages

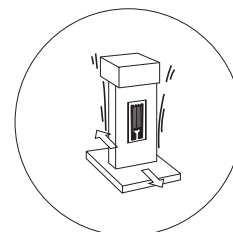
### Load Measurement

A strain gage bonded to a pillar enables detection of the force and load applied to the pillar.



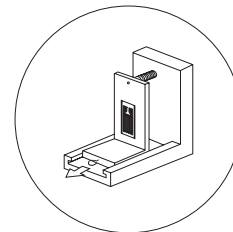
### Vibration/Acceleration Measurement

A strain gage bonded to a thin leaf spring enables detection of the cycle, frequency and magnitude of the vibration and acceleration the leaf spring receives.



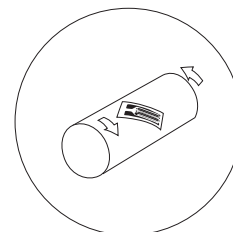
### Displacement Measurement

A strain gage bonded to a thin leaf spring detects the bending strain the leaf spring receives, thereby enabling measurement of moving amount and displacement of what is causing the bending strain.



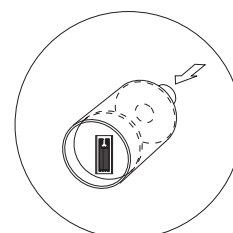
### Torque Measurement

A strain gage bonded to an automobile propeller shaft or the rotating shaft of a drilling machine enables measurement of transmission force, i.e. the torque, the shaft provides.



### Pressure Measurement

A strain gage bonded to a diaphragm enables detection of the fluid or air pressure the diaphragm receives. As a rule, the strain gage is bonded to the rear of the diaphragm so that the strain gage will not be damaged by directly receiving pressure.



# Selecting a Strain Gage

Select the most suitable strain gage for the measuring purpose, with the measuring object and conditions taken into account.

Select the leadwire and adhesive which meet the measuring environment.

Also, consider various accessories available for protection against severe environments and for labor saving.

# 1

## Selecting a strain gage based on operating temperatures and other measuring conditions

→ P. 19

Basically, a strain gage is selected based on the material of the measuring object and operating environmental temperature.

This Section facilitates selection of a strain gage based on each measuring material and temperature range.

# 2

## Selecting a strain gage based on operating environment and purpose

→ P. 20

This Section describes materials of strain gages and their features including self-temperature-compensation range, facilitating selection of a suitable strain gage based on its specific characteristics.

# 3

## Selecting the type and the length of a leadwire cable for the gage selected in 1 or 2

→ P. 22

After selecting a strain gage, select the type and length of leadwire, referring to this Section.

# 4

## Selecting a leadwire cable based on operating temperature range and connection examples

→ P. 24

From among various types available for high to low-temperature applications, select the most suitable leadwire cable for the measuring purpose.

# 5

## Selecting adhesive and bonding tools

→ P. 26

Select a suitable adhesive for each measuring environment, referring to this Section.

# 6

## Gage terminals and other accessories

→ P. 28

If required, select a gage terminal and coating agent, referring to this Section.

# 1

## Selecting a strain gage based on operating temperatures and other measuring conditions

	°C	-300	-200	-100	0	100	200	300	400	500	600	700	800	900	1000
General stress measurement	<b>KFG</b>	Measurement under general environment →P. 30													
	<b>KFG T-F7</b>	Residual stress measurement by cutting method →P. 41													
	<b>KFG D28</b>	Residual stress measurement by boring method →P. 42													
	<b>KFG C20</b>	Bolt axial force internal strain measurement →P. 43													
	<b>KFGT</b>	Simultaneous measurement of strain and temperature →P. 44													
	<b>KFR</b>	Measurement at middle temperatures up to 150°C →P. 45													
	<b>KFW</b>	For simplified waterproof treatment →P. 49													
	<b>KFWS</b>	For simplified waterproof treatment →P. 51													
	<b>KCW</b>	For simplified waterproof treatment and long-term stability →P. 52													
Strain measurement on concrete and mortar	<b>KFG</b>	Measurement under general environment →P. 53													
	<b>KC</b>	Surface strain measurement →P. 54													
	<b>KM</b>	Internal strain measurement →P. 56													
	<b>KMC</b>	Self-contraction strain measurement →P. 57													
For composite materials, plastics and rubber	<b>KFRP</b>	Applicable linear expansion coefficients 1 to 9 x10 <sup>-6</sup> /°C →P. 58													
	<b>KFRS</b>	Measurement of printed boards →P. 60													
	<b>KFP</b>	Applicable linear expansion coefficient 65 x10 <sup>-6</sup> /°C →P. 62													
	<b>KFML</b>	Measurement of polyurethane, rubber, etc. →P. 64													
Ultra-small strain measurement (semiconductor gages)	<b>KSPL KSN KSP</b>	Measurement of less than 100 μm/m strain under environment of less temperature change →P.68 →P.66 →P.65													
	<b>KSPH</b>	Impact-initiated strain measurement with no amplifier →P. 67													
Measurement at high temperatures	<b>KFH KH KFU KHC KHCM KHCS KHCR KHCV KHCX</b>	Measurement at: -196 to 250°C →P. 80   -50 to 350°C →P. 79   -196 to 350°C →P. 77   -196 to 550°C →P. 75   -196 to 650°C →P. 74   -196 to 750°C →P. 73   Normal temp. to 750°C →P. 72   Normal temp. to 800°C →P. 71   -196 to 950°C →P. 70													
	<b>KFL</b>	Measurement at down to -269°C →P. 83													
	<b>KFEM</b>	Elongation measurement up to approx. 20 to 30% →P. 86													
	<b>KFEL</b>	Elongation measurement up to approx. 15% →P. 87													
	<b>KFN</b>	Measurement under AC magnetic field →P. 89													
	<b>KFS</b>	Measurement under high electric field generating inductive noise →P. 90													
	<b>KFF</b>	In the case where any gage cannot be bonded inside the structure →P. 91													
	<b>KCH</b>	Simplified waterproof treatment and ruggedness →P. 92													
	<b>KMP</b>	Internal strain measurement of resin →P. 93													
	<b>KV</b>	Measurement of progress and propagation velocity of crack →P. 94													
	°F	-508	-328	-148	32	212	392	572	752	932	1112	1292	1472	1652	1832

Note: Stated above are operating temperatures.

# 2

## Selecting a strain gage based on operating environment and purpose






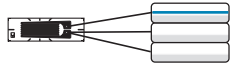
	Name/series designation		Materials		Operating temperature ranges in combination with major adhesives after curing*1 (°C)	Self-temperature-compensation range (°C)	Applicable linear expansion coefficient (x10 <sup>-6</sup> /°C)	Strain limit at room temp., approx. <sup>2</sup> (%)	Fatigue life at room temp., approx. <sup>3</sup> (times)	Ref. Page
			Resistive element	Base						
For general stress measurement	General-purpose foil strain gages KFG	For general purpose	CuNi alloy foil	Polyimide	CC-33A: -196 to 120 EP-34B: -55 to 150 PC-600: -196 to 150	10 to 100	5, 11, 16, 23, 27	5.0	1.2 x 10 <sup>7</sup>	30
		For sensing element of transducers			PC-600: -196 to 150 EP-34B: -55 to 150	10 to 100	11, 16, 23, 27	5.0	1.2 x 10 <sup>7</sup>	37
		For concrete			CC-35: -30 to 120	10 to 100	11	5.0	1.2 x 10 <sup>7</sup>	53
		Concentrated stress measurement			CC-33A: -196 to 120 EP-34B: -55 to 150 PC-600: -196 to 150	10 to 100	11, 16, 23, 27	—	—	36
		Residual stress measurement			CC-33A: -196 to 120 EP-34B: -55 to 150 PC-600: -196 to 150	10 to 100	11, 16, 23, 27	—	—	42
		Bolt axial tension measurement			EP-18: Room temp. to 50 EP-34B: Room temp. to 50	10 to 100	11	—	—	43
	Foil strain gages with temperature sensor KFGT		CuNi alloy foil	Polyimide	CC-33A: -10 to 120 EP-34B: -10 to 120 PC-600: -10 to 120	10 to 100	11, 16, 23	3	1 x 10 <sup>6</sup>	44
	Foil strain gages KFR	Strain measurement at middle temperatures; for transducers	NiCr alloy foil	Polyimide	PC-600: -196 to 150 CC-33A: -196 to 120 EP-34B: -55 to 150	0 to 150	11, 16, 23	2.2	1 x 10 <sup>6</sup>	45
		Concentrated stress measurement			PC-600: -196 to 150 CC-33A: -196 to 120 EP-34B: -55 to 150	0 to 150	11, 16, 23	—	—	46
	Waterproof foil strain gages KFW		CuNi alloy foil	Paper base + phenol-epoxy	CC-33A: -10 to 80 EP-18: -10 to 80	10 to 80	11, 16, 23	2.8	3 x 10 <sup>4</sup>	49
	Small-sized waterproof strain gages KFWS		CuNi alloy foil	Polyimide	CC-33A: -10 to 80 EP-18: -10 to 80	10 to 80	11, 16, 23	5.0	3 x 10 <sup>4</sup>	51
	Weldable waterproof strain gages KCW		NiCr alloy foil	Stainless steel	(Spot welding) -20 to 100	10 to 90	11	0.5	*A 1 x 10 <sup>6</sup>	52
	Wire strain gages KC		CuNi alloy foil	Paper base + phenol-epoxy	CC-35: -30 to 120	10 to 60	11	1.8	1.5 x 10 <sup>5</sup>	54
Embeddable strain gages KM		CuNi alloy	Acrylate	(Embedment) -10 to 70	0 to 50	11	0.3	—	56	
Embeddable strain gages for concrete KMC		CuNi alloy wire	Silicone	(Embedment) Room temp. to 70	—	—	0.3	—	57	
For composite materials, plastics and rubber	Foil strain gages for composite materials KFRP		NiCr alloy foil	Polyimide	EP-34B: -55 to 200 CC-33A: -196 to 120	0 to 150	1, 3, 6, 9	2.2	1 x 10 <sup>6</sup>	58
	Strain gages for printed boards KFRS		NiCr alloy foil	Polyimide	CC-33A: -196 to 120 PC-600: -196 to 150	-30 to 120	13	1.6	2 x 10 <sup>6</sup>	60
	Foil strain gages for plastics KFP		CuNi alloy foil	Paper base + phenol-epoxy	EP-34B: -20 to 80 CC-33A: -20 to 80	10 to 80	65	3.0	1 x 10 <sup>6</sup>	62
	Foil strain gages for low-elasticity materials KFML		CuNi alloy foil	Phenol-epoxy	EC-30: 0 to 60 CC-33A: 0 to 60	—	—	1.0	—	64
For infinitesimal strain measurement	Semiconductor strain gages KSP	Ultra-small strain measurement	P type Si	Paper base + phenol-epoxy	CC-33A: -50 to 120	—	—	0.3	*A 2 x 10 <sup>6</sup>	65
		For sensing element of highly sensitive transducers	P type Si	Paper base + phenol-epoxy	CC-33A: -50 to 120	—	—	0.3	*A 2 x 10 <sup>6</sup>	66
		Ultra-small strain meas.: 2-element, temperature-compensation type	P type Si N type Si	Paper base + phenol-epoxy	CC-33A: -50 to 120	20 to 70	11	0.3	*A 2 x 10 <sup>6</sup>	65
	Self-temperature-compensation semiconductor strain gages KSN		N type Si	Paper base + phenol-epoxy	CC-33A: -50 to 120 EP-17: -50 to 120(E5)	20 to 70	11, 16	0.3	*A 2 x 10 <sup>6</sup>	66
	High-output semiconductor strain gages KSPH		P type Si	Paper base + phenol-epoxy	CC-33A: -50 to 120	—	—	0.3	*A 2 x 10 <sup>6</sup>	69
	Ultralinear semiconductor strain gages KSPL		P type Si	Paper base + phenol-epoxy	CC-33A: -50 to 120	—	—	0.3	*A 2 x 10 <sup>6</sup>	68
Notes	<p>*1. Underlined adhesives are those used for strain limit tests at room temperature and for fatigue tests at room temperature.            *2. Typical values with uniaxial gages. Strain limit is the mechanical limit where a difference between the strain reading and mechanical strain initiated by applying tension load exceeds 10%            *3. Typical values with uniaxial gages. Strain level: ±1500 μm/m; *A ±1000 μm/m; *B ±500 μm/m, *C ±100 μm/m</p>									

	Name/series designation	Materials		Operating temperature ranges in combination with major adhesives after curing*1 (°C)	Self-temperature-compensation range (°C)	Applicable linear expansion coefficient (x10 <sup>-6</sup> /°C)	Strain limit at room temp., approx.*2 (%)	Fatigue life at room temp., approx.*3 (times)	Ref. Page
		Resistive element	Base						
For high-temperature applications	Encapsulated strain gages KHCX	Heat-resistant special alloy wire	Heat-resistant metal	(Spot welding) -196 to 950	25 to 950	11, 13	1.0 (950°C)	*C 1 x 10 <sup>6</sup> (950°C)	70
	Encapsulated strain gages KHCV	Heat-resistant special alloy wire	Heat-resistant metal	(Spot welding) Room temp. to 800	—	—	1.0 (800°C)	*B 1 x 10 <sup>6</sup> (800°C)	71
	Encapsulated strain gages KHCR	Heat-resistant special alloy wire	Heat-resistant metal	(Spot welding) Room temp. to 750	25 to 750	11, 13, 16	1.0 (750°C)	*B 1 x 10 <sup>6</sup> (750°C)	72
	Encapsulated strain gages KHCS	Heat-resistant special alloy wire	Heat-resistant metal	(Spot welding) -196 to 750	25 to 750	11, 13, 16	1.0 (750°C)	*B 1 x 10 <sup>6</sup> (750°C)	73
	Encapsulated strain gages KHCM	Heat-resistant special alloy wire	Heat-resistant metal	(Spot welding) -196 to 650	25 to 650	11, 13, 16	1.0 (650°C)	*B 1 x 10 <sup>6</sup> (650°C)	74
	Encapsulated strain gages KHC 20 type	NiCr alloy wire	Heat-resistant metal	(Spot welding) -196 to 550	Room temp. to 500	11, 16	0.8	*A 4 x 10 <sup>5</sup>	75
	Encapsulated strain gages KHC 10 type						0.5	*A 4 x 10 <sup>5</sup>	
	Encapsulated strain gages KHC 5 type						0.5	*A 2 x 10 <sup>5</sup>	
	High-temperature foil strain gages KFU	NiCr alloy foil	Polyimide	PI-32: -196 to 350	10 to 300	11, 16, 23	1.9	*B 1.5 x 10 <sup>6</sup> (300°C)	77
	High-temperature foil strain gages KH-G4	NiCr alloy foil	Stainless steel	(Spot welding) -50 to 350	10 to 300	11, 16	0.5	*B 1 x 10 <sup>7</sup>	79
High-temperature foil strain gages KFH	NiCr alloy foil	Polyimide	PC-600: -196 to 250 EP-34B: -55 to 200 PI-32: -196 to 250	10 to 250	11, 16, 23	2.1	2 x 10 <sup>5</sup>	80	
For low temp.	Low-temperature foil strain gages KFL	NiCr alloy foil	Polyimide	PC-600: -269 to 150 CC-33A: -196 to 120 UC-26: -196 to 50	-196 to 50	5, 11, 16, 23	2.2	1 x 10 <sup>6</sup>	83
For large strain measurement	Ultrahigh-elongation foil strain gages KFEM	CuNi alloy wire	Polyimide	CC-36: -20 to 80	—	—	20 to 30	—	88
	High-elongation foil strain gages KFEL	CuNi alloy foil	Polyimide	CC-36: -10 to 80	—	—	15	1 x 10 <sup>6</sup>	89
For antimagnetic applications	Noninductive foil strain gages KFN	NiCr alloy foil	Polyimide	PC-600: -196 to 150 CC-33A: -196 to 120	0 to 150	11, 16, 23	1	1 x 10 <sup>4</sup>	89
	Shielded foil strain gages KFS	CuNi alloy foil (120Ω) NiCr alloy foil (350Ω)	Copper foil	PC-600: -196 to 150 CC-33A: -196 to 120 EP-34B: -55 to 150	10 to 100	11, 16	0.5	1 x 10 <sup>4</sup>	90
Internal strain	Foil strain gages for bending strain measurement KFF	CuNi alloy foil	Acrylate	CC-33A: -50 to 80 EP-18: -50 to 80 EP-34B: -50 to 80	20 to 60	11, 16, 23	0.2	*B 4 x 10 <sup>6</sup>	91
With protector	Foil strain gages with protector KCH	CuNi alloy foil	Polyimide	Protector: Stud bolt Strain gage EP-34B, CC-33A: -40 to 100	—	11	1	*A 1.2 x 10 <sup>6</sup>	92
Notes	*1. Underlined adhesives are those used for strain limit tests at room temperature and for fatigue tests at room temperature. *2. Typical values with uniaxial gages. Strain limit is the mechanical limit where a difference between the strain reading and mechanical strain initiated by applying tension load exceeds 10% *3. Typical values with uniaxial gages. Strain level: ±1500 μm/m; *A ±1000 μm/m; *B ±500 μm/m, *C ±100 μm/m								

# 3

## Selecting the type and the length of a leadwire cable for the gage selected in 1 and 2

Virtually all KYOWA strain gages are delivered with a leadwire cable pre-attached to ensure labor saving in gage bonding works by eliminating the need for soldering. Types and lengths of the leadwire cable selectable for each gage are as follows.

Applicable Model of Strain Gage		KFG, KFR, KFRP, KFP, KFL, KFEM, KFEL		KFG, KFR, KFW, KFWS, KC, KFRP, KFP, KFEM, KFEL			
Type of Leadwire Cable		 2 polyester-coated copper wires	 3 polyester-coated copper wires	 Vinyl-coated flat 2-wire cable		 Vinyl-coated flat 3-wire cable	
				Uniaxial	Multiaxial	Uniaxial	Multiaxial
Length of Leadwire Cable	2 cm	N2C2	N2C3				
	3	N3C2	N3C3				
	4	N4C2	N4C3				
	5	N5C2	N5C3				
	10	N10C2	N10C3				
	15	N15C2	N15C3	L15C2R	L15C2S	L15C3R	L15C3S
	30	N30C2	N30C3	L30C2R	L30C2S	L30C3R	L30C3S
	50 cm	N50C2	N50C3	L50C2R	L50C2S	L50C3R	L50C3S
	1 m	N1M2	N1M3	L1M2R	L1M2S	L1M3R	L1M3S
	2			L2M2R	L2M2S	L2M3R	L2M3S
	3			L3M2R	L3M2S	L3M3R	L3M3S
	4			L4M2R	L4M2S	L4M3R	L4M3S
	5			L5M2R	L5M2S	L5M3R	L5M3S
	6			L6M2R	L6M2S	L6M3R	L6M3S
	8			L8M2R	L8M2S	L8M3R	L8M3S
	10			L10M2R	L10M2S	L10M3R	L10M3S
	15			L15M2R	L15M2S	L15M3R	L15M3S
	20			L20M2R	L20M2S	L20M3R	L20M3S
	30 m			L30M2R	L30M2S	L30M3R	L30M3S
Model, etc.	Twisted in the cases of 50cm and 1m long		L-6; L-9 for 6m long or more		L-7; L-10 for 6m long or more		
Coating colors	Note: 2-wire cable only is applicable for KFEL and KFEM.		 Red Red		 (independent wire)		











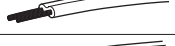

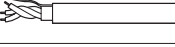
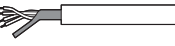
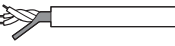
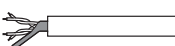




# 4

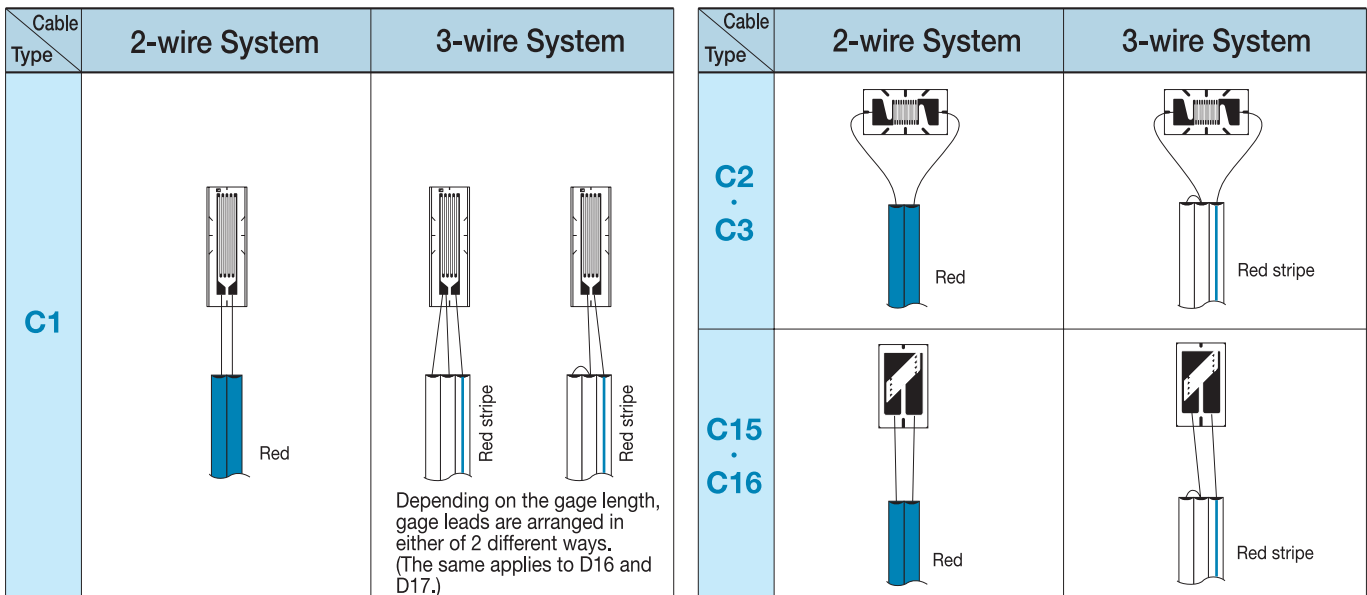
## Selecting a leadwire cable based on operating temperature range and connection examples

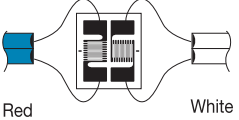
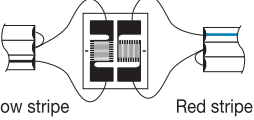
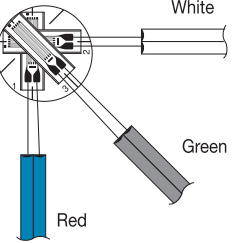
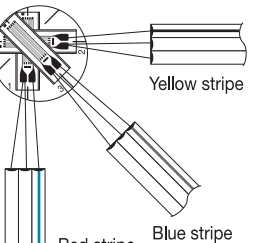
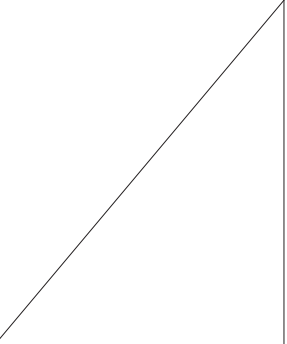
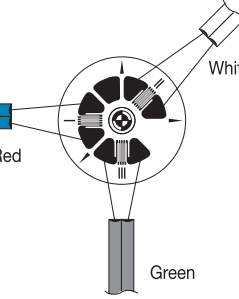
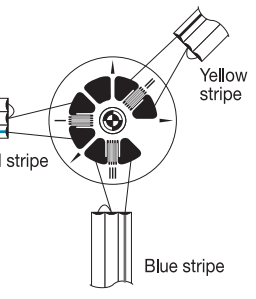
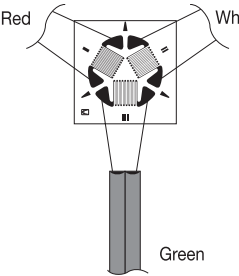
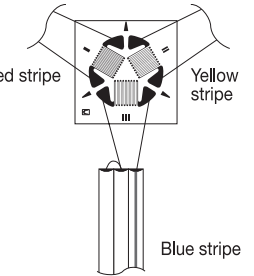
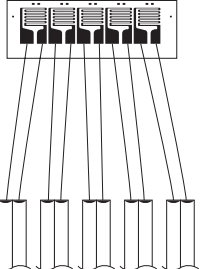
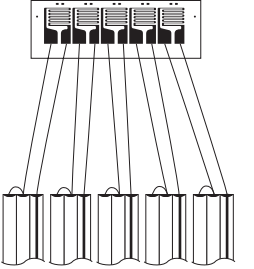
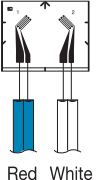
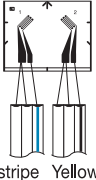
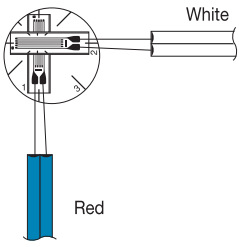
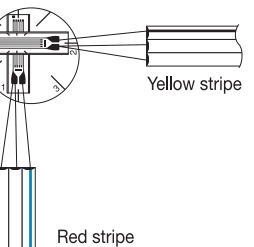
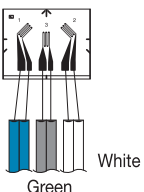
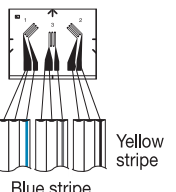
### L-type Leadwire Cables

Operating Temperature Range (°C)	Model	Type	Conductor Material	Nominal Cross Section of Conductor (mm <sup>2</sup> )	Number of Strands/Wire Diam. (mm)	Reciprocating Resistance per meter (Ω)	Coated Wire Diameter (mm)	Unit Length (m)
Room temp. to 350	<b>L-1</b>	 High-temperature leadwire	CuNi alloy wires	0.07	1/0.30	14.20	0.50	50
-10 to 80	<b>L-2</b>	 Vinyl-coated flat 3-wire cable	Copper wires	0.30	12/0.18	0.12	2.30	100
-269 to 250	<b>L-3</b>	 Fluoroplastic-coated high/low-temp. 3-wire cable	Silver-plated copper wires	0.14	7/0.16	0.28	0.98	50
Room temp. to 350	<b>L-4</b>	 High-temperature leadwire	Nickel-clad copper wires	0.20	1/0.50	0.18	0.70	30
-10 to 80	<b>L-5</b>	 Vinyl-coated flat 2-wire cable	Copper wires	0.50	20/0.18	0.07	2.50	100
-10 to 80	<b>L-6</b> <sup>*1</sup>	 Vinyl-coated flat 2-wire cable	Copper wires	0.08	7/0.12	0.44	1.00	100
-10 to 80	<b>L-7</b> <sup>*2</sup>	 Vinyl-coated flat 3-wire cable	Copper wires	0.08	7/0.12	0.44	1.00	100
-10 to 80	<b>L-9</b> <sup>*1</sup>	 Vinyl-coated flat 2-wire cable	Copper wires	0.11	10/0.12	0.32	1.00	100
-10 to 80	<b>L-10</b> <sup>*2</sup>	 Vinyl-coated flat 3-wire cable	Copper wires	0.11	10/0.12	0.32	1.00	100
-100 to 150	<b>L-11</b>	 Middle-temperature 2-wire cable	Silver-plated copper wires	0.08	7/0.12	0.50	0.86	100
-100 to 150	<b>L-12</b>	 Middle-temperature 3-wire cable	Silver-plated copper wires	0.08	7/0.12	0.50	0.86	100
-10 to 80	<b>L-13</b>	 Vinyl-coated normal-temp. low-noise 3-wire cable	Tin-plated copper wires	0.09	7/0.13	0.46	3.50	100
-50 to 90	<b>L-14</b>	 Chloroprene-coated normal-temp. low-noise 4-wire cable	Tin-plated copper wires	0.08	7/0.12	0.48	4.00	100
-269 to 250	<b>L-15</b>	 Fluoroplastic-coated high/low-temp. low-noise 3-wire cable	Silver-plated copper wires	0.08	7/0.12	0.48	2.50	10
-269 to 250	<b>L-16</b>	 Fluoroplastic-coated high/low-temp. low-noise 4-wire cable	Silver-plated copper wires	0.08	7/0.12	0.48	3.30	10
-269 to 350	<b>L-17</b>	 High/low-temperature 3-wire cable	Nickel-plated copper wires	0.07	1/0.30	0.50	0.38	30

\*1. These models have a suffix R, W, G, Y or B indicating the coating color; red, white, green, yellow or black. e.g. L-6B: Black vinyl coated.

\*2. These models have a suffix WR, WL or WY indicating the stripe color; red, blue or yellow on white vinyl coating. e.g. L-7WR: Red stripe on white coating.



Cable Type	2-wire System	3-wire System	Cable Type	2-wire System	3-wire System
D1	 Red White	 Yellow stripe Red stripe	D17	 Red Green	 Red stripe Blue stripe
D2			D28	 Red Green	 Red stripe Blue stripe
D4			 Red White	 Red stripe Yellow stripe	D31
D9 D19 D39			D29	 Red White	 Red stripe Yellow stripe
D16	 Red White	 Red stripe Yellow stripe	D30	 Red Green	 Red stripe Blue stripe Yellow stripe

# 5

## Selecting adhesive and bonding tools



To obtain good measurement results, the strain gage must be bonded completely to the measuring object. Thus, it is important to select a suitable adhesive for the materials of the measuring object and gage base and for measuring conditions.

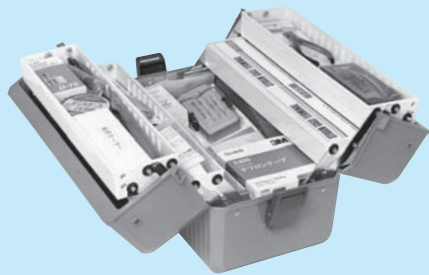
**Export controlled product:** Product which falls under export regulations on strategic commodities as provided for in the Foreign Exchange Law and the Foreign Trade Control Law.

Model	Type	Features	Curing Requirements	Operating Temperature Range (°C)	Ingredient	Capacity	Major Applicable Materials	Major Applicable Gages
CC-33A	Instantaneous adhesive cured at normal temperatures	<ul style="list-style-type: none"> <li>Suitable for bonding general-purpose gages, such as KFG and KFR, which are used for general stress measurement at normal temperatures of 20 to 80°C.</li> <li>Quick curing time and stable bonding of various materials in a wide range of temperature and humidity ranges.</li> <li>Quick curing ensures smooth bonding works.</li> <li>Enables measurement in approximately 1 hour from bonding.</li> </ul>	Apply finger pressure (100 to 300 kPa) for 15 to 60 seconds. Then, leave the gage as it is for 1 hour. The finger pressure application time differs depending on temperature and humidity conditions. The lower the temperature and humidity, the longer the finger pressure application time required.	-196 to 120	1 type of cyanoacrylate liquid	2 g x 1 or 2 g x 5	<ul style="list-style-type: none"> <li>Metals (steel, stainless steel, copper, aluminum alloys A1050/A2024, etc.)</li> <li>Plastics (acrylate, vinyl chloride, nylon, etc.)</li> <li>Composite materials (CFRP, GFRP, printed board, etc.)</li> <li>Rubber</li> </ul>	KFG, KFGT, KFR, KFW, KFWS, KFRP, KFRS, KFP, KFML, KSP, KSN (exc. E5), KSPH, KSPL, KFL, KFN, KFS, KFF, KCH, KV
CC-35	Instantaneous adhesive cured at normal temperatures	<ul style="list-style-type: none"> <li>Suitable for bonding a gage to porous materials such as concrete for general stress measurement at normal temperatures of 20 to 80°C.</li> <li>High viscosity makes it suitable for bonding to porous materials such as concrete.</li> </ul>	Apply finger pressure (100 to 300 kPa) for 30 to 60 seconds. Then, leave the gage as it is for 1 hour or more. The finger pressure application time differs depending on temperature and humidity conditions. The lower the temperature and humidity, the longer the finger pressure application time required.	-30 to 120	1 type of cyanoacrylate liquid	2 g x 1 or 2 g x 5	<ul style="list-style-type: none"> <li>Concrete</li> <li>Mortar</li> <li>Lumber</li> </ul>	KFG, KFGT, KFR, KC, KFRP, KFP
CC-36	Instantaneous adhesive cured at normal temperatures	<ul style="list-style-type: none"> <li>Suitable for bonding a high-elongation gage such as KFEM and KFEL at normal temperatures of 20 to 80°C.</li> <li>Suitable for bonding to hard-to-bond materials, such as aluminum alloy (A7075) and magnesium alloy.</li> <li>High peeling resistance, high impact resistance and less aging deterioration of bonding strength.</li> <li>Strong bonding power to hard-to-bond materials.</li> <li>Curing time is longer than CC-33A.</li> </ul>	Apply finger pressure (100 to 300 kPa) for 30 to 60 seconds. Then, leave the gage as it is for 1 hour or more. The finger pressure application time differs depending on temperature and humidity conditions. The lower the temperature and humidity, the longer the finger pressure application time required.	-30 to 100	1 type of cyanoacrylate liquid	2 g x 1 or 2 g x 5	<ul style="list-style-type: none"> <li>Metals (steel, stainless steel, copper, aluminum alloys A1050/A2024/A7075, magnesium alloy, etc.)</li> <li>Plastics (acrylate, vinyl chloride, nylon, polypropylene, etc.)</li> <li>Composite materials (CFRP, GFRP, printed board, etc.)</li> <li>Concrete</li> <li>Mortar</li> <li>Lumber</li> <li>Rubber</li> </ul>	KFEM, KFEL, KFG, KFGT, KFR, KFW, KFWS, KFRP, KFRS, KFP, KFML, KSP, KSN (excl. E5), KSPH, KSPL, KFF, KV
EP-34B	Cured at normal temperatures or by heating	<ul style="list-style-type: none"> <li>Suitable for strain measurement at middle temperatures and for bonding gages for transducers.</li> </ul>	Apply pressure (30 to 50 kPa) for 24 hours at approx. 25°C or for 2 hours at 80°C. Pressing is possible with tape.	-55 to 200	2 types of epoxy liquid mixed	30 g Main agent: 5.6 g x 4 Curing agent: 2.1 g x 4	<ul style="list-style-type: none"> <li>Metals (steel, stainless steel, copper, aluminum alloy, etc.)</li> <li>Plastics (acrylate, PVC, etc.)</li> <li>Composite materials (CFRP, GFRP, printed board, etc.)</li> </ul>	KFG, KFGT, KFR, KFRP, KFP, KFH, KFF
EP-18	Cured at normal temperatures or by heating	<ul style="list-style-type: none"> <li>Low viscosity makes it suitable for bonding gages (KFG-C20) embeddable in bolts.</li> </ul>	Apply pressure (50 to 100 kPa) for 24 hours at approx. 25°C or for 2 hours at 80°C.	-50 to 100	2 types of epoxy liquid mixed	30 g	<ul style="list-style-type: none"> <li>Metals (steel, stainless steel, copper, aluminum alloy, etc.)</li> <li>Plastics (acrylate, PVC, etc.)</li> </ul>	KFG (C20), KFW, KFWS, KFF
PC-600	Cured by heating	<ul style="list-style-type: none"> <li>Suitable for strain measurement at low, middle and high temperatures and for bonding gages for transducers.</li> </ul>	Apply pressure (150 to 300 kPa) for 1 hour at 80°C, 2 hours at 130°C and then, 2 hours at 150°C.	-269 to 250	1 heating type of phenol liquid	100 g	<ul style="list-style-type: none"> <li>Metals (steel, stainless steel, copper, aluminum alloy, etc.)</li> </ul>	KFG, KFR, KFH, KFL, KFN, KFS, KFRS, KV
PI-32	Cured by heating	<ul style="list-style-type: none"> <li>Suitable for bonding gages for strain measurement at high temperature.</li> </ul>	Apply pressure (200 to 500 kPa) for 1 hour at 100°C, 2 hours at 200°C and then, heat for 2 hours at the operating temperature with the pressure removed. If it is difficult to heat to 200°C, 2 hours at 200°C may be changed to 5 hours at 160°C with all other conditions followed.	-269 to 350	1 heating type of polyimide liquid	20 g	<ul style="list-style-type: none"> <li>Metals (steel, stainless steel, copper, aluminium alloy, etc.)</li> </ul>	KFU, KFH

Export controlled product

Note: The stated operating temperature range is for the adhesive only, and may differ depending on combinations with gages. When using, read the attached instruction manual carefully.

## Gage Bonding Tool Kit



### ●GTK-77 Tool Kit

This kit includes all tools, gage terminals, solder and other expendables required for gage bonding work.

#### Contents

Tool box, screwdriver set, tweezers, nippers, radio pliers, tape measure (2 m), stainless steel scale, protractor, sandpaper (#100), sandpaper (#320), soldering iron tip cleaner, knife, cutter, scribe, soldering iron (40 W), compasses, marking pencil, mending tape, pencils (4H, 6H), scissors, cotton swabs, clean paper, high-temperature solder, flux for high-temperature solder, heat-resistant glass tube, gage terminals (T-P1, T-P4, T-P5, T-P6, T-P7, T-P8, T-P9, T-P10, T-F2, T-F3, T-F7, T-F8, T-F10, T-F13, T-F17, T-F25, T-H11, T-R9), hair dryer (1200 W), insulation vinyl tape, table tap (2.5 m), soldering iron (ANTEX), silicon rubber (2 mm), fluoroplastic sheet (0.1 mm)

## Gage Pressers



G-MATE-B

### ●Gage Pressers G-MATE

The G-MATE can apply pressure to a bonded strain gage continuously until the adhesive is cured. It consists of a frame equipped with a strong ferrite magnet to firmly fix the object under testing and a presser disk equipped with silicon sponge rubber and coil spring to apply constant pressure to the strain gage.

Name	Model	Application
Gage Mate	G-MATE-B	For normal temperature (up to approx. 80°C)
High-temperature Gage Mate	G-MATE-H	For high temperature (up to approx. 180°C)

Sales unit: 6 pieces per pack

## Compact Spot Welder



### ●GW-3C Compact Spot Welder

Developed to mount encapsulated strain gages such as the KHCX, KHCS and KHCD and to fix high-temperature leadwires and thermocouples, the GW-3C is an easy-to-use welder providing an increased welding capability and allowing continuously variable settings of welding energy. (Patent pending)

#### Specifications

##### Welding Energy:

LOW: 0 to 25 Ws, continuously variable

HIGH: 0 to 50 Ws, continuously variable

##### Welding Speed:

1Ws: 150 times/min., 5 Ws: 120 times/min., 10Ws: 80 times/min., 20 Ws: 60 times/min., 50 Ws: 30 times/min.

Power Requirements: 90 to 110 VAC, 50/60 Hz: 500 VA max.

Dimensions and Weight: 183(W) x 153(H) x 313(D) mm (excluding protrusions), approx. 8.2 kg (mainframe)

##### Accessories:

Square welding head, grounding clip (with 1.3 m long cable), 2 electrodes (GW-02), metal file, fuse (5 A), hexagonal wrench, instruction manual










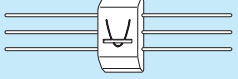
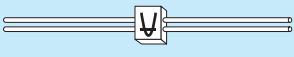

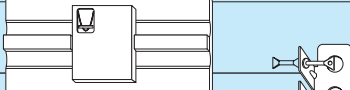

Option: Aluminum trunk (GW-01)

# 6

## Gage terminals and other accessories

### Gage Terminals

A gage terminal is applied to the connection between a strain gage and leadwire to protect the gage leads. It prevents the strain gage from receiving force and the gage leads from breaking or peeling off if the leadwire is pulled to some extent.

	Model	Dimensions (mm) (W x L x t)	Base Material	Conductor Material	Q'ty per Pack	Operating Temperature Range (°C)	Recommended Adhesive	Remarks
Foil type	 <b>T-F2</b>	5-pole 13 x 55 x 0.1 1-pole 13 x 11 x 0.1	Glass epoxy	Copper foil	20 sheets (5 poles/ sheet)	-196 to 120	CC-33A EP-18	
	 <b>T-F3</b>	5-pole 13 x 65 x 0.1 1-pole 13 x 13 x 0.1	Glass epoxy	Copper foil	20 sheets (5 poles/ sheet)	-196 to 120	CC-33A EP-18	For 3-wire system
	<b>T-F13</b>	5-pole 13 x 65 x 0.15 1-pole 13 x 13 x 0.15	Glass epoxy + double-coated adhesive tape			-30 to 50	Not required	Self-bonding
	 <b>T-F7</b>	5-pole 6 x 25 x 0.1 1-pole 6 x 5 x 0.1	Glass epoxy	Copper foil	20 sheets (5 poles/ sheet)	-196 to 120	CC-33A EP-18	Compact
	<b>T-F17</b>	5-pole 6 x 25 x 0.15 1-pole 6 x 5 x 0.15	Glass epoxy + double-coated adhesive tape			-30 to 50	Not required	Self-bonding
	 <b>T-F8</b>	5-pole 4 x 30 x 0.1 1-pole 4 x 6 x 0.1	Glass epoxy	Copper foil	20 sheets (5 poles/ sheet)	-196 to 120	CC-33A EP-18	
	 <b>T-F10</b>	15 x 50 x 0.1	Glass epoxy	Copper foil	10 sheets	-196 to 120	CC-33A EP-18	Mainly for 5-element gages
	 <b>T-F23</b>	5-pole 14 x 55 x 0.1 1-pole 14 x 11 x 0.1	Polyimide	Copper foil	20 sheets (5 poles/ sheet)	-196 to 200, -196 to 120 with CC-33A	CC-33A EP-34B	For high temperature, compact
	<b>T-F24</b>	5-pole 9 x 40 x 0.1 1-pole 9 x 8 x 0.1						
	<b>T-F25</b>	5-pole 6 x 25 x 0.1 1-pole 6 x 5 x 0.1						
 <b>T-F26</b>	5-pole 14 x 55 x 0.1 1-pole 14 x 11 x 0.1	Polyimide	Copper foil	20 sheets (5 poles/ sheet)	-196 to 350	PI-32	For high temperature	
<b>T-F27</b>	5-pole 9 x 40 x 0.1 1-pole 9 x 8 x 0.1							
<b>T-F28</b>	5-pole 6 x 25 x 0.1 1-pole 6 x 5 x 0.1							
Mold type	 <b>T-P1</b>	14 x 10 x 4	Styrene	Tin-plated copper wire	20 pieces	-30 to 80	CC-33A	
	<b>T-P4</b>	14 x 10 x 4.5	Styrene + double-coated adhesive tape			-30 to 50	Not required	Self-bonding
	 <b>T-P5</b>	6 x 6 x 2	ABS	Tin-plated copper wire	20 pieces	-30 to 120	CC-33A	Compact
	<b>T-P6</b>	6 x 6 x 2.5	ABS + double-coated adhesive tape			-30 to 50	Not required	Self-bonding
	 <b>T-P7</b>	15 x 10 x 4	ABS	Tin-plated copper wire	20 pieces	-30 to 80	CC-33A	For 3-wire system
	<b>T-P8</b>	15 x 10 x 4.5	ABS + double-coated adhesive tape			-30 to 50	Not required	Self-bonding
	 <b>T-P9</b>	6 x 5 x 4	Heat-resistant styrene	Tin-plated copper wire	40 pieces	-30 to 90	CC-33A	Compact
	<b>T-P10</b>	6 x 5 x 6	Heat-resistant styrene + rubber					Rubber on the rear
	 <b>T-R9</b>	10 x 10 x 5	Neoprene rubber	Tin-plated copper wire	20 pieces	-30 to 80	CC-33A	For large strain
	 <b>T-R10</b>	15 x 30 x 6	Neoprene rubber	Tin-plated copper wire	20 pieces	-10 to 80	CC-33A	With lead contact preventing plate
Welding type	 <b>T-H11</b>	7 x 20 x 8	Stainless steel + silicic acid glass	Kobar	10 pieces	Room temperature to 300	Welding	For high- temperature gage

## Coating Agents



### ● Coating Agents

Coating agents are applied to gages and gage terminals to prevent gages from adsorbing moisture in outdoor or

◎ : Excellent  
 ○ : Somewhat excellent  
 △ : Somewhat inferior  
 × : Inferior

Model	C-1B	C-4	C-5	AK-22	VMTAP	ARALDITE-T,-C	HAMATITE-Y	KE-4898W
Type	Hot-melt type	Hot-melt type	Rubber solvent type	Special clay	Press-fitting rubber type	2-liquid type (1:1)	Rubber solvent type	Silicon solvent type
Operating Temp. Range	-30 to 40°C	-50 to 60°C	-269 to 60°C	-196 to 170°C	-30 to 80°C	-50 to 100°C	-20 to 70°C	-50 to 200°C
Curing Requirements	Heat-melted & cured at room temp.	Heat-melted & cured at room temp.	Melted & dried at room temp. 12 hrs.	Press-fitted	Press-fitted	24 hours at room temp.	Melted & dried at room temp. 12 hrs.	Melted & dried at room temp. 12 hrs.
Moisture/Water-proofness	◎	◎	◎	◎	○	△	○	△
Mechanical Protection	△	△	△	△	△	◎	△	△
Oil Resistance	△	△	△	△	△	○	△	△
Alcohol Resistance	○	○	○	○	○	○	○	○
Toluene Resistance	×	×	×	×	×	○	×	×
Alkaline Resistance	○	○	○	○	○	○	△	△
Weak-acid Resistance	○	○	○	○	○	○	△	△
Content	500 g	500 g	100 g	500 g	38 mm x 6 m	T: 170 g C: 1.8 kg	1.5 kg	100 g
Material	Paraffin wax	Microcrystalline wax	Butyl rubber	Butyl rubber + inorganic additive	Butyl rubber	Epoxy	Chloroprene rubber	Silicon
Color	White	White	Light yellow	Dark green	Black	Main agent: Light milk white Curing agent: Light yellow	Black	Milk white
Features	Can be applied with a brush after melting through heating. Suitable for underlayer of multilayer coating.	Excellent cohesiveness makes it suitable for application to wall surface.	Minimal restriction in ultra-low temperature applications.	The clay-like shape ensures easy coating work. Operating temp. range is wide.	The tape shape facilitates coating work.	Highly effective mechanical protection makes it suitable for upper layer of multilayer coating.	Suitable for final finish of multilayer coating.	Highly heat-resistant coating agent.

When using, read the attached Instruction Manual carefully.

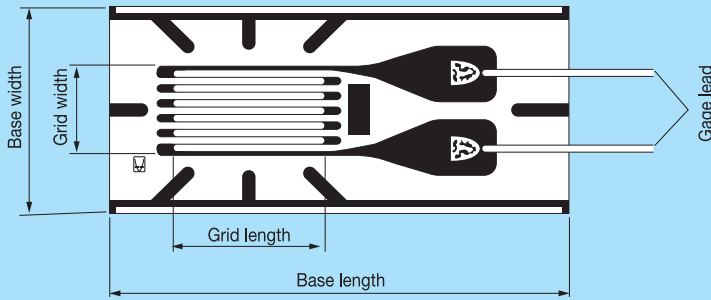
## Accessories for High-temperature Gages

### ● HTG Series Accessories for High-temperature Gages



Description	Model	Specifications	Q'ty
High-temperature solder	HTG-S-B	Fusion temperature: 309°C Maximum operating temperature: 350°C	40 cm long bar x 2
Flux for high-temperature solder	HTG-S-F	Ingredients: Inorganic acid + alcohol	20 mL
Heat-resistant glass tube	HTG-G-TUBE	Inner diameter: 1.5 mm Length: 1 m	10 pieces
Heat-resistant Teflon tape	HTG-T-TAPE	Heat resistance: 200°C Width: 12.7 mm	32.9 m long
Heat-resistant glass tape	HTG-G-TAPE	Heat resistance: 350°C Width: 25 mm	33 m long

Note: The maximum operating temperature of 350°C for the high-temperature solder and the heat resistance of 350°C for the heat-resistant glass tape apply to a short-term operation.

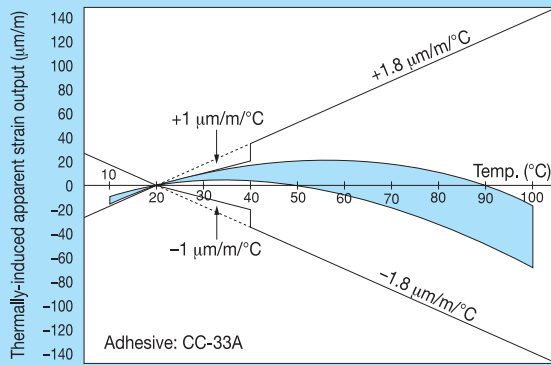


- Gage Factor Approx. 2.1
- Applicable Linear Expansion Coefficients 5, 11, 16, 23, 27 ( $\times 10^{-6}/^{\circ}\text{C}$ )
- Self-temperature-compensation Range 10 to  $100^{\circ}\text{C}$

### Applicable Adhesives and Operating Temperature Ranges

- CC-33A:  $-196$  to  $120^{\circ}\text{C}$       EP-34B:  $-55$  to  $150^{\circ}\text{C}$
- CC-35:  $-30$  to  $120^{\circ}\text{C}$       PC-600:  $-196$  to  $150^{\circ}\text{C}$
- CC-36:  $-30$  to  $120^{\circ}\text{C}$

### Typical characteristic curve of thermally-induced apparent strain with KFG gage



Strain gages with 3-leadwire cable attached

## General-purpose Foil Strain Gages

The KFG gages use polyimide resin for the base approximately  $13\mu\text{m}$  thick, ensuring excellent flexibility. Besides indoor measurement, the outstanding moisture resistance lets them effectively perform outdoor measurement. Unless directly exposed to waterdrops, no coating treatment is required.

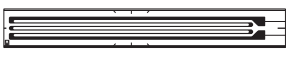
- Various lengths and patterns are available to cope with multiple applications.
- Excellent moisture resistance.
- The thin gage base provides less resiliency, and thus ensures excellent workability and easy bonding to curved surfaces.
- Compensated temperature range is as wide as  $10$  to  $100^{\circ}\text{C}$  and thermal effect in a range of  $20$  to  $40^{\circ}\text{C}$  is as small as  $\pm 1 \mu\text{m}/\text{m}/^{\circ}\text{C}$ .
- Strain limit at room temperatures is approximately  $5\%$  and fatigue life is  $1.2 \times 10^7$  times (uniaxial gages), making them suitable for material tests.
- For gages with a 2-wire cable, the resistance and the gage factor are as stated including the leadwires.
- For gages with a 3-wire cable, the gage factor is as stated including the leadwires but the stated resistance does not include the effect of the leadwires.

### Types, lengths and codes of leadwire cables pre-attached to KFG gages

Type	2 polyester-coated copper wires		3 polyester-coated copper wires		Vinyl-coated flat 2-wire cable		Vinyl-coated flat 3-wire cable		Middle-temperature 2-wire cable	Middle-temperature 3-wire cable
	C1, C2, C3, C15, C16, D1, D3, D4, D6, D16, D17, D28, D29, D30, D31	C1, C2, C3, C15, C16, D1, D2, D4, D16, D17, D29, D30, D31	C1, C2, C3, C15, C16, D9, D19, D39	D1, D4, D16, D17, D28, D29, D30	C1, C2, C3, C15, C16, D2, D9, D19, D31, D39	D1, D4, D16, D17, D28, D29, D30	C1, C2, C3, C15, C16, D16, D17, D19, D28, D29, D30, D39	C1, C2, C3, C15, C16, D1, D2, D4, D9, D16, D17, D19, D28, D29, D30, D31, D39	C1, C2, C3, C15, C16, D1, D2, D4, D9, D16, D17, D19, D28, D29, D30, D31, D39	C1, C2, C3, C15, C16, D1, D2, D4, D9, D16, D17, D19, D28, D29, D30, D31, D39
2 cm	N2C2	N2C3								
3	N3C2	N3C3								
4	N4C2	N4C3								
5	N5C2	N5C3								
10	N10C2	N10C3								
15	N15C2	N15C3	L15C2R	L15C2S	L15C3R	L15C3S	R15C2	R15C3		
30	N30C2	N30C3	L30C2R	L30C2S	L30C3R	L30C3S	R30C2	R30C3		
50	N50C2	N50C3	L50C2R	L50C2S	L50C3R	L50C3S	R50C2	R50C3		
1 m	N1M2	N1M3	L1M2R	L1M2S	L1M3R	L1M3S	R1M2	R1M3		
2			L2M2R	L2M2S	L2M3R	L2M3S	R2M2	R2M3		
3			L3M2R	L3M2S	L3M3R	L3M3S	R3M2	R3M3		
4			L4M2R	L4M2S	L4M3R	L4M3S	R4M2	R4M3		
5			L5M2R	L5M2S	L5M3R	L5M3S	R5M2	R5M3		
6			L6M2R	L6M2S	L6M3R	L6M3S	R6M2	R6M3		
8			L8M2R	L8M2S	L8M3R	L8M3S	R8M2	R8M3		
10			L10M2R	L10M2S	L10M3R	L10M3S	R10M2	R10M3		
15			L15M2R	L15M2S	L15M3R	L15M3S	R15M2	R15M3		
20			L20M2R	L20M2S	L20M3R	L20M3S	R20M2	R20M3		
30 m			L30M2R	L30M2S	L30M3R	L30M3S	R30M2	R30M3		
Oprg. temp. range	$-196$ to $150^{\circ}\text{C}$			$-10$ to $80^{\circ}\text{C}$				$-100$ to $150^{\circ}\text{C}$		
Remarks	Twisted for 50 cm and 1 m long (with some exception)			L-6; L-9 for 6 m or longer		L-7; L-10 for 6 m or longer		L-11	L-12	

# KFG Gages

## Uniaxial



**KFG-30-120-C1-11**

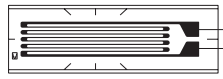
16  
23  
27

**Uniaxial**

Base Size	37 x 5.2 mm
Gage Length	30 mm
Resistance	120 Ω
Pieces per Pack	10

**Leadwire Cable Code**

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2



**KFG-20-120-C1-11**

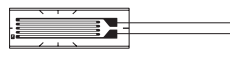
16  
23  
27

**Uniaxial**

Base Size	28 x 8 mm
Gage Length	20 mm
Resistance	120 Ω
Pieces per Pack	10

**Leadwire Cable Code**

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2



**KFG-10-120-C1-11**


16  
23  
27

**Uniaxial**

Base Size	16 x 5.2 mm
Gage Length	10 mm
Resistance	120 Ω
Pieces per Pack	10

**Leadwire Cable Code**

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2



**KFG-6-120-C1-11**


16  
23  
27

**Uniaxial**

Base Size	10 x 3.4 mm
Gage Length	6 mm
Resistance	120 Ω
Pieces per Pack	10

**Leadwire Cable Code**

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2



**KFG-5-120-C1-11**


16  
23  
27  
5

**Uniaxial**

Base Size	9.4 x 2.8 mm
Gage Length	5 mm
Resistance	120 Ω
Pieces per Pack	10

**Leadwire Cable Code**

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2



**KFG-4N-120-C1-11**

16  
23  
27

**Uniaxial**

Base Size	8 x 1.4 mm
Gage Length	4 mm
Resistance	120 Ω
Pieces per Pack	10

**Leadwire Cable Code**

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C2  
N50C2  
N1M2

When ordering, specify the model number as follows:

**KFG-□-120-C1-□** Leadwire Cable Code

(e.g.)


**KFG-30-120-C1-11 L1M3R**

Leadwire Cable – Type and Shape	Oprg. Temp. Range	Leadwire Length	Leadwire Cable Code
Vinyl-coated flat 3-wire cable L-7 (L-10 for 6 m or longer)	-10 to 80°C	1 m	L1M3R
		3 m	L3M3R
		5 m	L5M3R
Vinyl-coated flat 2-wire cable L-6 (L-9 for 6 m or longer)	-10 to 80°C	1 m	L1M2R
		3 m	L3M2R
		5 m	L5M2R
Middle-temperature 3-wire cable L-12	-100 to 150°C	1 m	R1M3
		3 m	R3M3
		5 m	R5M3
Middle-temperature 2-wire cable L-11	-100 to 150°C	1 m	R1M2
		3 m	R3M2
		5 m	R5M2
3 polyester-coated copper wires	-196 to 150°C	30 cm	N30C3
		50 cm • 1 m	N50C3
		1 m	N1M3
2 polyester-coated copper wires	-196 to 150°C	30 cm	N30C2
		50 cm • 1 m	N50C2
		1 m	N1M2
Silver-clad copper wires	-196 to 150°C	25 mm	



# KFG Gages

## ● Uniaxial/Biaxial




**KFG-3-120-C1- 11**  
**16**  
**23**  
**27**

**Uniaxial**

Base Size	7.4 x 2.8 mm
Gage Length	3 mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire Cable Code

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2




**KFG-2-120-C1- 11**  
**16**  
**23**  
**27**  
**5**

**Uniaxial**

Base Size	6.3 x 2.8 mm
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire Cable Code

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2




**KFG-2N-120-C1-11**  
**16**  
**23**  
**27**

**Uniaxial**

Base Size	5.3 x 1.4 mm
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire Cable Code

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C2  
N50C2  
N1M2




**KFG-1-120-C1- 11**  
**16**  
**23**  
**27**

**Uniaxial**

Base Size	4.8 x 2.4 mm
Gage Length	1 mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire Cable Code

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C2  
N50C2  
N1M2




**KFG-1N-120-C1-11**  
**16**  
**23**  
**27**

**Uniaxial**

Base Size	4.2 x 1.5 mm
Gage Length	1 mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire Cable Code

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C2  
N50C2  
N1M2




**KFG-03-120-C1-11**  
**16**  
**23**  
**27**

**Uniaxial**

Base Size	3.5 x 2.4 mm
Gage Length	0.3 mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire Cable Code

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C2  
N50C2  
N1M2



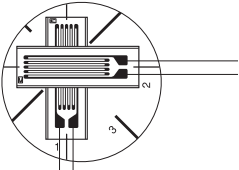
**KFG-02-120-C1-11**  
**16**  
**23**  
**27**

**Uniaxial**

Base Size	3.3 x 2.4 mm
Gage Length	0.2 mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire Cable Code

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C2  
N50C2  
N1M2



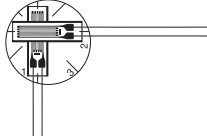
**KFG-10-120-D16-11**  
**16**  
**23**  
**27**

**Biaxial, 0°/90° stacked rosette**

Base Size	21 mm φ
Gage Length	10 mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire Cable Code

L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2



**KFG-5-120-D16-11**  
**16**  
**23**  
**27**

**Biaxial, 0°/90° stacked rosette**

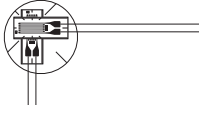
Base Size	11 mm φ
Gage Length	5 mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire Cable Code

L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2

# KFG Gages

## Biaxial/Triaxial

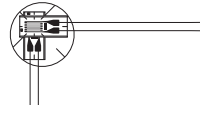


**KFG-3-120-D16-11**  
16  
23  
27

**Biaxial, 0°/90° stacked rosette**

Base Size	10 mm $\phi$
Gage Length	3 mm
Resistance	120 $\Omega$
Pieces per Pack	10

**Leadwire Cable Code**  
L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2S  
R3M2S  
R5M2S  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2

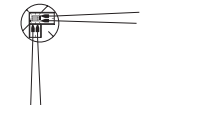


**KFG-2-120-D16-11**  
16  
23  
27

**Biaxial, 0°/90° stacked rosette**

Base Size	8 mm $\phi$
Gage Length	2 mm
Resistance	120 $\Omega$
Pieces per Pack	10

**Leadwire Cable Code**  
L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C2  
N50C2  
N1M2




**KFG-1-120-D16-11**  
16  
23  
27

**Biaxial, 0°/90° stacked rosette**

Base Size	5 mm $\phi$
Gage Length	1 mm
Resistance	120 $\Omega$
Pieces per Pack	10

**Leadwire Cable Code**  
L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C2  
N50C2  
N1M2

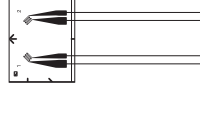


**KFG-2-120-D29-11**  
16  
23  
27

**Biaxial, 0°/90° plane arrangement**

Base Size	9.3 x 11.6 mm
Gage Length	2 mm
Resistance	120 $\Omega$
Pieces per Pack	10

**Leadwire Cable Code**  
L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2

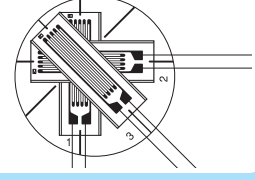


**KFG-1-120-D29-11**  
16  
23  
27

**Biaxial, 0°/90° plane arrangement**

Base Size	8.8 x 11.6 mm
Gage Length	1 mm
Resistance	120 $\Omega$
Pieces per Pack	10

**Leadwire Cable Code**  
L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2



**KFG-10-120-D17-11**  
16  
23  
27

**Triaxial, 0°/90°/45° stacked rosette for stress analysis**

Base Size	21 mm $\phi$
Gage Length	10 mm
Resistance	120 $\Omega$
Pieces per Pack	10



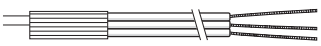
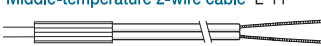
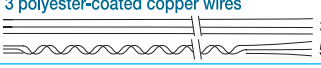
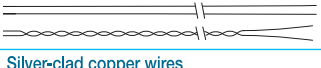

**Leadwire Cable Code**  
L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2

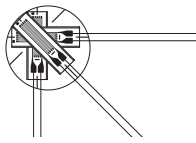
When ordering, specify the model number as follows:

**KFG-□-120-□-□** Leadwire Cable Code

e.g.

**KFG-10-120-D17-11 L1M3S**

Leadwire Cable – Type and Shape	Oprg. Temp. Range	Leadwire Length	Leadwire Cable Code
Vinyl-coated flat 3-wire cable L-7 (L-10 for 6m or longer) 	-10 to 80°C	1 m	L1M3R; L1M3S
		3 m	L3M3R; L3M3S
		5 m	L5M3R; L5M3S
Vinyl-coated flat 2-wire cable L-6 (L-9 for 6m or longer) 	-10 to 80°C	1 m	L1M2R; L1M2S
		3 m	L3M2R; L3M2S
		5 m	L5M2R; L5M2S
Middle-temperature 3-wire cable L-12 	-100 to 150°C	1 m	R1M3
		3 m	R3M3
		5 m	R5M3
Middle-temperature 2-wire cable L-11 	-100 to 150°C	1 m	R1M2
		3 m	R3M2
		5 m	R5M2
3 polyester-coated copper wires 	-196 to 150°C	30 cm	N30C3
		50 cm · 1 m	N50C3
		1 m	N1M3
2 polyester-coated copper wires 	-196 to 150°C	30 cm	N30C2
		50 cm	N50C2
		1 m	N1M2
Silver-clad copper wires 	-196 to 150°C	25 mm	



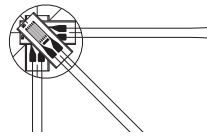
**KFG-5-120-D17-11**  
16  
23  
27

Triaxial, 0°/90°/45°  
stacked rosette  
for stress analysis

Base Size	11 mm φ
Gage Length	5 mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire  
Cable Code

L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2



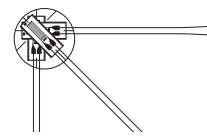
**KFG-3-120-D17-11**  
16  
23  
27

Triaxial, 0°/90°/45°  
stacked rosette  
for stress analysis

Base Size	10 mm φ
Gage Length	3 mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire  
Cable Code

L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2



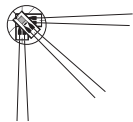
**KFG-2-120-D17-11**  
16  
23  
27

Triaxial, 0°/90°/45°  
stacked rosette  
for stress analysis

Base Size	8 mm φ
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire  
Cable Code

L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C2  
N50C2  
N1M2



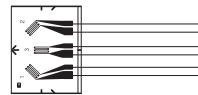
**KFG-1-120-D17-11**  
16  
23  
27

Triaxial, 0°/90°/45°  
stacked rosette  
for stress analysis

Base Size	5 mm φ
Gage Length	1 mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire  
Cable Code

L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C2  
N50C2  
N1M2



**KFG-2-120-D30-11**  
16  
23  
27

Triaxial, 0°/90°/45°  
plane arrangement

Base Size	9.3 x 11.6 mm
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire  
Cable Code

L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2



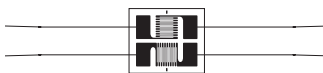
**KFG-1-120-D30-11**  
16  
23  
27

Triaxial, 0°/90°/45°  
plane arrangement

Base Size	8.8 x 11.6 mm
Gage Length	1 mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire  
Cable Code

L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2



**KFG-2-120-D1-11**  
11  
16  
23  
27  
5

Biaxial, 0°/90°

Base Size	10 x 8.5 mm
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire  
Cable Code

L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N5C2  
N15C2  
N30C2



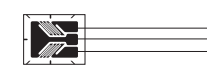
**KFG-2-120-D2-11**  
11  
16  
23  
27

Biaxial, 0°/90°  
for torque measurement

Base Size	12 x 7 mm
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire  
Cable Code

L1M3R  
L3M3R  
L5M3R  
R1M3  
R3M3  
R5M3  
N5C2  
N15C2  
N30C2



**KFG-2-120-D31-11**  
11  
16  
23  
27

Biaxial, 0°/90°  
for torque measurement

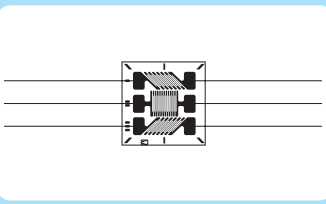
Base Size	8 x 6.5 mm
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire  
Cable Code

L1M3R  
L3M3R  
L5M3R  
R1M3  
R3M3  
R5M3  
N5C2  
N15C2  
N30C2

# KFG Gages

## ● Triaxial/Quadraaxial/Uniaxial with gage lead at both ends

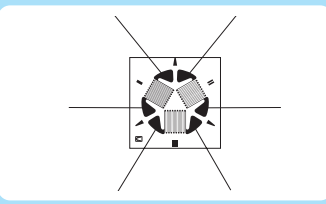


**Leadwire Cable Code**  
N5C2  
N15C2  
N30C2

**KFG-2-120-D3- 11**  
16  
23  
27

**Triaxial, 0°/90°/45°**

Base Size	11 x 11 mm
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	10

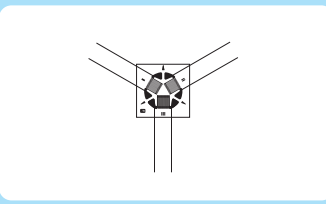


**Leadwire Cable Code**  
L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N5C2  
N15C2  
N30C2

**KFG-2-120-D4- 11**  
16  
23  
27

**Triaxial, 0°/120°/240°**

Base Size	12 x 12 mm
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	10

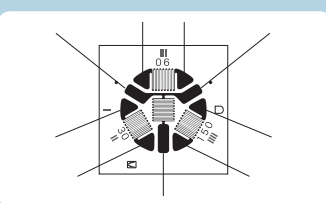


**Leadwire Cable Code**  
L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N5C2  
N15C2  
N30C2

**KFG-1-120-D4- 11**  
16  
23  
27

**Triaxial, 0°/120°/240°**

Base Size	7 x 7 mm
Gage Length	1 mm
Resistance	120 Ω
Pieces per Pack	10

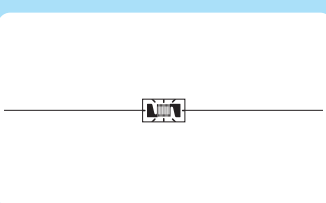


**Leadwire Cable Code**  
N5C2  
N15C2  
N30C2

**KFG-2-120-D6- 11**  
16  
23  
27

**Quadraaxial, 0°/30°/90°/150°**

Base Size	17 x 17 mm
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	10

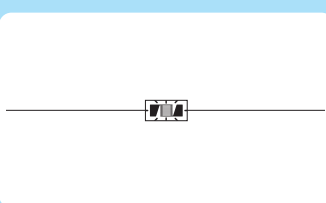


**Leadwire Cable Code**  
L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N5C2  
N15C2  
N30C2

**KFG-1-120-C2- 11**  
16  
23  
27

**Uniaxial, gage lead at both ends**

Base Size	5.6 x 3 mm
Gage Length	1 mm
Resistance	120 Ω
Pieces per Pack	10



**Leadwire Cable Code**  
L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N5C2  
N15C2  
N30C2

**KFG-1-120-C3- 11**  
16  
23  
27

**Uniaxial, gage lead at both ends**

Base Size	5.5 x 2.7 mm
Gage Length	1 mm
Resistance	120 Ω
Pieces per Pack	10

When ordering, specify the model number as follows:

**KFG-□-120-C3-□** **Leadwire Cable Code**

e.g.  
**KFG-1-120-C3-11 L1M3R**

Leadwire Cable – Type and Shape	Oprg. Temp. Range	Leadwire Length	Leadwire Cable Code
Vinyl-coated flat 3-wire cable L-7 (L-10 for 6 m or longer)	-10 to 80°C	1 m	L1M3R; L1M3S
		3 m	L3M3R; L3M3S
		5 m	L5M3R; L5M3S
Vinyl-coated flat 2-wire cable L-6 (L-9 for 6 m or longer)	-10 to 80°C	1 m	L1M2R; L1M2S
		3 m	L3M2R; L3M2S
		5 m	L5M2R; L5M2S
Middle-temperature 3-wire cable L-12	-100 to 150°C	1 m	R1M3
		3 m	R3M3
		5 m	R5M3
Middle-temperature 2-wire cable L-11	-100 to 150°C	1 m	R1M2
		3 m	R3M2
		5 m	R5M2
3 polyester-coated copper wires	-196 to 150°C	30 cm	N30C3
		50 cm	N50C3
		50 cm • 1 m	1 m
2 polyester-coated copper wires	-196 to 150°C	30 cm	N30C2
		50 cm	N50C2
		50 cm • 1 m	1 m
Polyester-coated copper wires	-196 to 150°C	5 cm	N5C2
		15 cm	N15C2
		30 cm	N30C2
Silver-clad copper wires	-196 to 150°C	25 mm	

Strain Gage Model Number Coding System

How strain gages work.

Static Strain and Dynamic Strain

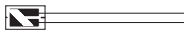
Unknown physical quantities such as load, pressure and displacement can be revealed through strain measurement.

Selecting a Strain Gage

Strain Gages

# KFG Gages

● Uniaxial for shearing strain/Uniaxial 5-element for concentrated stress/Uniaxial 60 Ω



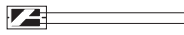
**KFG-2-120-C15-11**

Uniaxial for shearing strain measurement (torque measurement possible in combination with C16)

Base Size	5.2 x 3 mm
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire Cable Code

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2



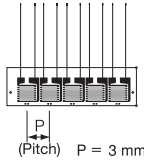
**KFG-2-120-C16-11**

Uniaxial for shearing strain measurement (torque measurement possible in combination with C15)

Base Size	5.2 x 2 mm
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire Cable Code

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2



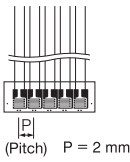
**KFG-2-120-D9-11**

Uniaxial 5-element for concentrated stress measurement

Base Size	17 x 5 mm
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	5

Leadwire Cable Code

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N10C2



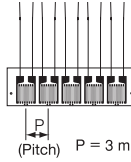
**KFG-1-120-D9-11**

Uniaxial 5-element for concentrated stress measurement

Base Size	12 x 4 mm
Gage Length	1 mm
Resistance	120 Ω
Pieces per Pack	5

Leadwire Cable Code

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N10C2



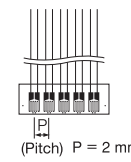
**KFG-2-120-D19-11**

Uniaxial 5-element for concentrated stress measurement

Base Size	17 x 5 mm
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	5

Leadwire Cable Code

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N10C2



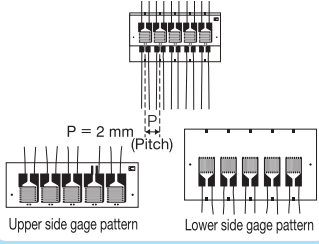
**KFG-1-120-D19-11**

Uniaxial 5-element for concentrated stress measurement

Base Size	12 x 4 mm
Gage Length	1 mm
Resistance	120 Ω
Pieces per Pack	5

Leadwire Cable Code

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N10C2




**KFG-1-120-D39-11**

Biaxial 5-element for concentrated stress measurement

Base Size	12 x 6.4 mm
Gage Length	1 mm
Resistance	120 Ω
Pieces per Pack	5

Leadwire Cable Code

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N10C2



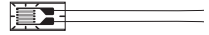
**KFG-5-60-C1-11**

Uniaxial 60 Ω

Base Size	10 x 3.4 mm
Gage Length	5 mm
Resistance	60 Ω
Pieces per Pack	10

Leadwire Cable Code

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2



**KFG-2-60-C1-11**

Uniaxial 60 Ω


Base Size	7.2 x 3.7 mm
Gage Length	2 mm
Resistance	60 Ω
Pieces per Pack	10

Leadwire Cable Code

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2

# KFG Gages

## ● Uniaxial 350 Ω/Biaxial 350 Ω




**KFG-5-350-C1- 11  
16  
23  
27**

**Uniaxial 350 Ω**

Base Size	9.4 x 4.2 mm
Gage Length	5 mm
Resistance	350 Ω
Pieces per Pack	10

**Leadwire Cable Code**

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2




**KFG-3-350-C1- 11  
16  
23  
27**

**Uniaxial 350 Ω**

Base Size	7.4 x 4.2 mm
Gage Length	3 mm
Resistance	350 Ω
Pieces per Pack	10

**Leadwire Cable Code**

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2




**KFG-2-350-C1- 11  
16  
23  
27**

**Uniaxial 350 Ω**

Base Size	6.3 x 4.2 mm
Gage Length	2 mm
Resistance	350 Ω
Pieces per Pack	10

**Leadwire Cable Code**

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2



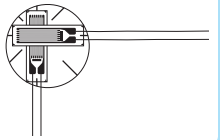
**KFG-1-350-C1- 11  
16  
23  
27**

**Uniaxial 350 Ω**

Base Size	4.8 x 3.4 mm
Gage Length	1 mm
Resistance	350 Ω
Pieces per Pack	10

**Leadwire Cable Code**

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C2  
N50C2  
N1M2



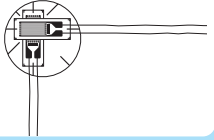
**KFG-5-350-D16-11  
16  
23  
27**

**Biaxial, 0°/90° stacked rosette 350 Ω**

Base Size	11 mm φ
Gage Length	5 mm
Resistance	350 Ω
Pieces per Pack	10

**Leadwire Cable Code**

L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2



**KFG-3-350-D16-11  
16  
23  
27**

**Biaxial, 0°/90° stacked rosette 350 Ω**

Base Size	10 mm φ
Gage Length	3 mm
Resistance	350 Ω
Pieces per Pack	10

**Leadwire Cable Code**



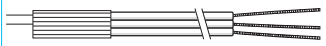


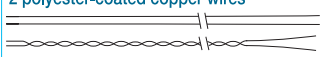

L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2

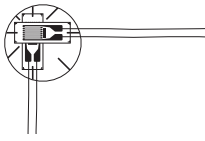
When ordering, specify the model number as follows:

**KFG-□-350-□-□** Leadwire Cable Code



**KFG-3-350-D16-11 L1M3S**

Leadwire Cable – Type and Shape	Oprg. Temp. Range	Leadwire Length	Leadwire Cable Code
Vinyl-coated flat 3-wire cable L-7 (L-10 for 6 m or longer) 	-10 to 80°C	1 m	L1M3R
		3 m	L3M3R
		5 m	L5M3R
Vinyl-coated flat 2-wire cable L-6 (L-9 for 6 m or longer) 	-10 to 80°C	1 m	L1M2R
		3 m	L3M2R
		5 m	L5M2R
Middle-temperature 3-wire cable L-12 	-100 to 150°C	1 m	R1M3
		3 m	R3M3
		5 m	R5M3
Middle-temperature 2-wire cable L-11 	-100 to 150°C	1 m	R1M2
		3 m	R3M2
		5 m	R5M2
3 polyester-coated copper wires 	-196 to 150°C	30 cm	N30C3
		50 cm · 1 m	N50C3
		1 m	N1M3
2 polyester-coated copper wires 	-196 to 150°C	30 cm	N30C2
		50 cm · 1 m	N50C2
		1 m	N1M2
Silver-clad copper wires 	-196 to 150°C	25 mm	



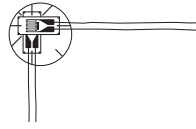
**KFG-2-350-D16-11**  
16  
23  
27

**Biaxial, 0°/90°  
stacked rosette 350 Ω**

Base Size	10 mm φ
Gage Length	2 mm
Resistance	350 Ω
Pieces per Pack	10

Leadwire  
Cable Code

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2



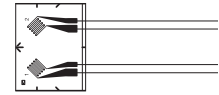
**KFG-1-350-D16-11**  
16  
23  
27

**Biaxial, 0°/90°  
stacked rosette 350 Ω**

Base Size	8 mm φ
Gage Length	1 mm
Resistance	350 Ω
Pieces per Pack	10

Leadwire  
Cable Code

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C2  
N50C2  
N1M2



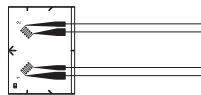
**KFG-2-350-D29-11**  
16  
23  
27

**Biaxial, 0°/90°  
plane arrangement 350 Ω**

Base Size	9.3 x 11.6 mm
Gage Length	2 mm
Resistance	350 Ω
Pieces per Pack	10

Leadwire  
Cable Code

L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2



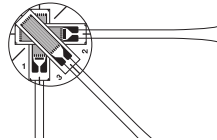
**KFG-1-350-D29-11**  
16  
23  
27

**Biaxial, 0°/90°  
plane arrangement 350 Ω**

Base Size	8.8 x 11.6 mm
Gage Length	1 mm
Resistance	350 Ω
Pieces per Pack	10

Leadwire  
Cable Code

L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2



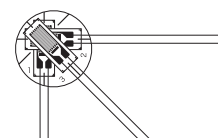
**KFG-5-350-D17-11**  
16  
23  
27

**Triaxial, 0°/90°/45°  
stacked rosette 350 Ω  
for stress analysis**

Base Size	11 mm φ
Gage Length	5 mm
Resistance	350 Ω
Pieces per Pack	10

Leadwire  
Cable Code

L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2



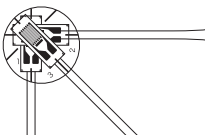
**KFG-3-350-D17-11**  
16  
23  
27

**Triaxial, 0°/90°/45°  
stacked rosette 350 Ω  
for stress analysis**

Base Size	10 mm φ
Gage Length	3 mm
Resistance	350 Ω
Pieces per Pack	10

Leadwire  
Cable Code

L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2



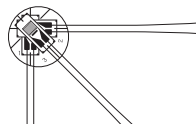
**KFG-2-350-D17-11**  
16  
23  
27

**Triaxial, 0°/90°/45°  
stacked rosette 350 Ω  
for stress analysis**

Base Size	10 mm φ
Gage Length	2 mm
Resistance	350 Ω
Pieces per Pack	10

Leadwire  
Cable Code

L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C2  
N50C2  
N1M2



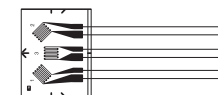
**KFG-1-350-D17-11**  
16  
23  
27

**Triaxial, 0°/90°/45°  
stacked rosette 350 Ω  
for stress analysis**

Base Size	8 mm φ
Gage Length	1 mm
Resistance	350 Ω
Pieces per Pack	10

Leadwire  
Cable Code

L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C2  
N50C2  
N1M2



**KFG-2-350-D30-11**  
16  
23  
27

**Triaxial, 0°/90°/45°  
plane arrangement 350 Ω**

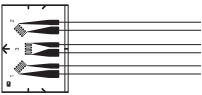
Base Size	9.3 x 11.6 mm
Gage Length	2 mm
Resistance	350 Ω
Pieces per Pack	10

Leadwire  
Cable Code

L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2

# KFG Gages

● Triaxial 350 Ω/Biaxial 350 Ω/Biaxial 350 Ω for torque measurement




**KFG-1-350-D30-11**  
16  
23  
27

Triaxial, 0°/90°/45°  
plane arrangement 350 Ω

Base Size	8.8 x 11.6 mm
Gage Length	1 mm
Resistance	350 Ω
Pieces per Pack	10

Leadwire Cable Code  
L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2




**KFG-2-350-D1-11**  
16  
23  
27

Biaxial, 0°/90° 350 Ω

Base Size	10 x 8.5 mm
Gage Length	2 mm
Resistance	350 Ω
Pieces per Pack	10

Leadwire Cable Code  
L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N5C2  
N15C2  
N30C2




**KFG-2-350-D2-11**  
16  
23  
27

Biaxial, 0°/90° 350 Ω  
for torque measurement

Base Size	12 x 6.8 mm
Gage Length	2 mm
Resistance	350 Ω
Pieces per Pack	10

Leadwire Cable Code  
L1M3R  
L3M3R  
L5M3R  
R1M3  
R3M3  
R5M3  
N5C2  
N15C2  
N30C2



**KFG-2-350-D31-11**  
16  
23  
27

Biaxial, 0°/90° 350 Ω  
for torque measurement




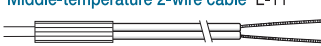

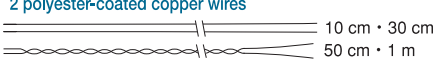


Base Size	10.5 x 6.5 mm
Gage Length	2 mm
Resistance	350 Ω
Pieces per Pack	10

Leadwire Cable Code  
L1M3R  
L3M3R  
L5M3R  
R1M3  
R3M3  
R5M3  
N5C2  
N15C2  
N30C2

When ordering, specify the model number as follows:

**KFG-□-350-□-□** Leadwire Cable Code

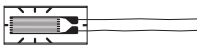
e.g.  
**KFG-2-350-D31-11 L1M3S**

Leadwire Cable – Type and Shape	Oprg. Temp. Range	Leadwire Length	Leadwire Cable Code
Vinyl-coated flat 3-wire cable L-7 (L-10 for 6 m or longer) 	-10 to 80°C	1 m	L1M3R, L1M3S
		3 m	L3M3R, L3M3S
		5 m	L5M3R, L5M3S
Vinyl-coated flat 2-wire cable L-6 (L-9 for 6 m or longer) 	-10 to 80°C	1 m	L1M2R, L1M2S
		3 m	L3M2R, L3M2S
		5 m	L5M2R, L5M2S
Middle-temperature 3-wire cable L-12 	-100 to 150°C	1 m	R1M3
		3 m	R3M3
		5 m	R5M3
Middle-temperature 2-wire cable L-11 	-100 to 150°C	1 m	R1M2
		3 m	R3M2
		5 m	R5M2
3 polyester-coated copper wires 	-196 to 150°C	30 cm	N30C3
		50 cm · 1 m	N50C3
		1 m	N1M3
2 polyester-coated copper wires 	-196 to 150°C	10 cm · 30 cm	N10C2
		30 cm	N50C2
		50 cm	N1M2
		1 m	N5C2
Polyester-coated copper wires 	-196 to 150°C	5 cm	N15C2
		15 cm	N30C2
		30 cm	N30C2
Silver-clad copper wires 	-196 to 150°C	25 mm	



# KFG Gages

## ● Uniaxial 500 Ω for transducers/Uniaxial 1000 Ω for transducers




**KFG-5-500-C1- 11  
16  
23  
27**

**Uniaxial 500 Ω  
for transducers**

Base Size	11 x 4.9 mm
Gage Length	5 mm
Resistance	500 Ω
Pieces per Pack	10

- Leadwire Cable Code
- L1M3R
  - L3M3R
  - L5M3R
  - L1M2R
  - L3M2R
  - L5M2R
  - R1M3
  - R3M3
  - R5M3
  - R1M2
  - R3M2
  - R5M2
  - N30C3
  - N50C3
  - N1M3
  - N30C2
  - N50C2
  - N1M2

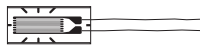


**KFG-2-500-C1- 11  
16  
23  
27**

**Uniaxial 500 Ω  
for transducers**

Base Size	7.5 x 4.4 mm
Gage Length	2 mm
Resistance	500 Ω
Pieces per Pack	10

- Leadwire Cable Code
- L1M3R
  - L3M3R
  - L5M3R
  - L1M2R
  - L3M2R
  - L5M2R
  - R1M3
  - R3M3
  - R5M3
  - R1M2
  - R3M2
  - R5M2
  - N30C3
  - N50C3
  - N1M3
  - N30C2
  - N50C2
  - N1M2




**KFG-5-1K-C1- 11  
16  
23  
27**

**Uniaxial 1000 Ω  
for transducers**

Base Size	11 x 4.9 mm
Gage Length	5 mm
Resistance	1000 Ω
Pieces per Pack	10

- Leadwire Cable Code
- L1M3R
  - L3M3R
  - L5M3R
  - L1M2R
  - L3M2R
  - L5M2R
  - R1M3
  - R3M3
  - R5M3
  - R1M2
  - R3M2
  - R5M2
  - N30C3
  - N50C3
  - N1M3
  - N30C2
  - N50C2
  - N1M2



**KFG-2-1K-C1- 11  
16  
23  
27**

**Uniaxial 1000 Ω  
for transducers**

Base Size	7.2 x 4.5 mm
Gage Length	2 mm
Resistance	1000 Ω
Pieces per Pack	10

- Leadwire Cable Code
- L1M3R
  - L3M3R
  - L5M3R
  - L1M2R
  - L3M2R
  - L5M2R
  - R1M3
  - R3M3
  - R5M3
  - R1M2
  - R3M2
  - R5M2
  - N30C3
  - N50C3
  - N1M3
  - N30C2
  - N50C2
  - N1M2

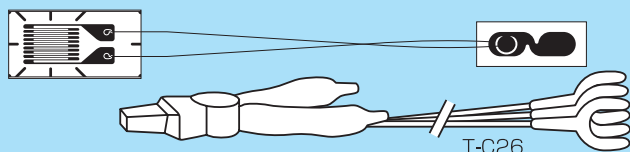
When ordering, specify the model number as follows:

**KFG-□-□-C1-□** Leadwire Cable Code

(e.g.)

**KFG-2-1K-C1-11 L1M3R**

Leadwire Cable – Type and Shape	Oprg. Temp. Range	Leadwire Length	Leadwire Cable Code
Vinyl-coated flat 3-wire cable L-7 (L-10 for 6 m or longer)	-10 to 80°C	1 m	L1M3R
		3 m	L3M3R
		5 m	L5M3R
Vinyl-coated flat 2-wire cable L-6 (L-9 for 6 m or longer)	-10 to 80°C	1 m	L1M2R
		3 m	L3M2R
		5 m	L5M2R
Middle-temperature 3-wire cable L-12	-100 to 150°C	1 m	R1M3
		3 m	R3M3
		5 m	R5M3
Middle-temperature 2-wire cable L-11	-100 to 150°C	1 m	R1M2
		3 m	R3M2
		5 m	R5M2
3 polyester-coated copper wires	-196 to 150°C	30 cm	N30C3
		50 cm • 1 m	N50C3
		1 m	N1M3
2 polyester-coated copper wires	-196 to 150°C	30 cm	N30C2
		50 cm • 1 m	N50C2
		1 m	N1M2
Silver-clad copper wires	-196 to 150°C	25 mm	



(When a clip-equipped dedicated cable is used, the operating temperature range is -10 to 80°C after any of applicable adhesives is cured.)

- Gage Factor Approx. 2.1
- Applicable Linear Expansion Coefficients 11, 16, 23 ( $\times 10^{-6}/^{\circ}\text{C}$ )
- Self-temperature-compensation Range 10 to 100°C

### Applicable Adhesives and Operating Temperature Ranges

PC-600: -196 to 150°C	CC-35: -30 to 120°C
CC-33A: -196 to 120°C	CC-36: -30 to 100°C

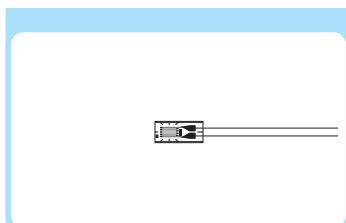
## ■ Foil Strain Gages with Gage Terminal

Gages for residual stress measurement are KFG gages equipped with a gage terminal which enables one-touch connection/disconnection of the leadwire cable. They are suitable for residual stress measurement with the cutting method. A clip-equipped dedicated cable T-C26 (vinyl-coated, 2 m long) is optionally available.

Leadwire Cable - Type and Shape	Oprg. Temp. Range	Leadwire Length
Polyester-coated copper wires with gage terminal	-196 to 150°C	15 mm

## KFG Gages

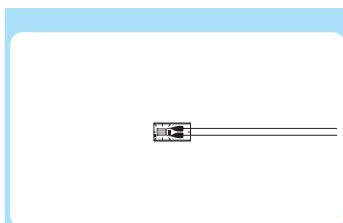
### ● Uniaxial/Biaxial/Triaxial (with gage terminal)



**KFG-2-120-C1-11 T-F7**  
16  
23

#### Uniaxial

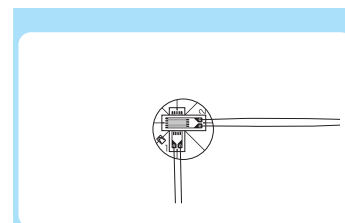
Base Size	6.3 x 2.8 mm
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	10



**KFG-1-120-C1-11 T-F7**  
16  
23

#### Uniaxial

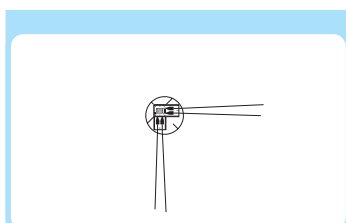
Base Size	4.8 x 2.4 mm
Gage Length	1 mm
Resistance	120 Ω
Pieces per Pack	10



**KFG-2-120-D16-11 T-F7**  
16  
23

#### Biaxial, 0°/90° stacked rosette

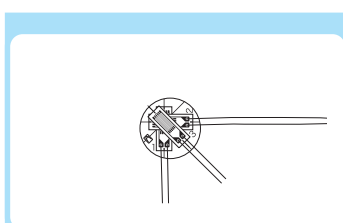
Base Size	8 mm φ
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	10



**KFG-1-120-D16-11 T-F7**  
16  
23

#### Biaxial, 0°/90° stacked rosette

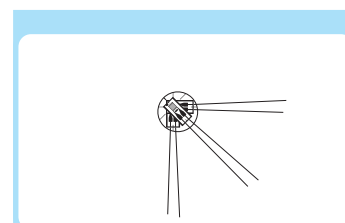
Base Size	5 mm φ
Gage Length	1 mm
Resistance	120 Ω
Pieces per Pack	10



**KFG-2-120-D17-11 T-F7**  
16  
23

#### Triaxial, 0°/90°/45° stacked rosette

Base Size	8 mm φ
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	10



**KFG-1-120-D17-11 T-F7**  
16  
23

#### Triaxial, 0°/90°/45° stacked rosette

Base Size	5 mm φ
Gage Length	1 mm
Resistance	120 Ω
Pieces per Pack	10

● Gage Factor	Approx. 2.1
● Applicable Linear Expansion Coefficients	11, 16, 23, 27 ( $\times 10^{-6}/^{\circ}\text{C}$ )
● Self-temperature-compensation Range	10 to 100°C

### Applicable Adhesives and Operating Temperature Ranges

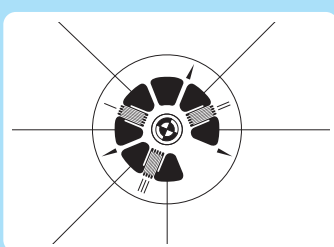
CC-33A:	-196 to 120°C
CC-35:	-30 to 120°C
CC-36:	-30 to 100°C
EP-34B:	-55 to 150°C
PC-600:	-196 to 150°C

## ■ Foil Strain Gages for Boring Method

These gages are designed to measure residual stress by releasing stress with a boring method.

## KFG Gages

### ● Triaxial for boring method



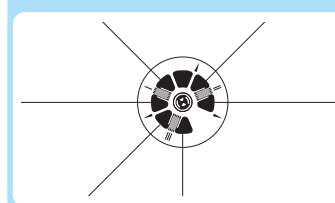
**Leadwire Cable Code**

- L1M3S
- L3M3S
- L5M3S
- L1M2S
- L3M2S
- L5M2S
- R1M3
- R3M3
- R5M3
- R1M2
- R3M2
- R5M2
- N5C2
- N15C2
- N30C2

**KFG-3-120-D28-11**  
**16**  
**23**  
**27**

**Triaxial, 0°/135°/90°**

Base Size	19.8 mm $\phi$
Gage Length	3 mm
Resistance	120 $\Omega$
Pieces per Pack	10



**Leadwire Cable Code**

- L1M3S
- L3M3S
- L5M3S
- L1M2S
- L3M2S
- L5M2S
- R1M3
- R3M3
- R5M3
- R1M2
- R3M2
- R5M2
- N5C2
- N15C2
- N30C2

**KFG-1.5-120-D28-11**  
**16**  
**23**  
**27**

**Triaxial, 0°/135°/90°**




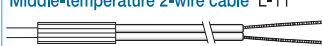


Base Size	12 mm $\phi$
Gage Length	1.5 mm
Resistance	120 $\Omega$
Pieces per Pack	10

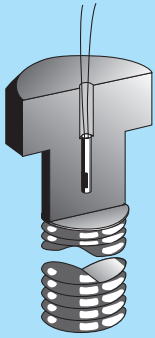
When ordering, specify the model number as follows:

**KFG-□-120-D28-□** Leadwire Cable Code

(e.g.)

**KFG-3-120-D28-11 L1M3S**

Leadwire Cable – Type and Shape	Oprg. Temp. Range	Leadwire Length	Leadwire Cable Code
Vinyl-coated flat 3-wire cable L-7 (L-10 for 6 m or longer) 	-10 to 80°C	1 m	L1M3S
		3 m	L3M3S
		5 m	L5M3S
Vinyl-coated flat 2-wire cable L-6 (L-9 for 6 m or longer) 	-10 to 80°C	1 m	L1M2S
		3 m	L3M2S
		5 m	L5M2S
Middle-temperature 3-wire cable L-12 	-100 to 150°C	1 m	R1M3
		3 m	R3M3
		5 m	R5M3
Middle-temperature 2-wire cable L-11 	-100 to 150°C	1 m	R1M2
		3 m	R3M2
		5 m	R5M2
2 polyester-coated copper wires 	-196 to 150°C	5 cm	N5C2
		30 cm	N15C2
Silver-clad copper wires 	-196 to 150°C	25 mm	N30C2



- Gage Factor Approx. 1.9
- Applicable Linear Expansion Coefficients  $11 ( \times 10^{-6} / ^\circ\text{C} )$

**Applicable Adhesives and Operating Temperature Ranges**

- EP-18: Room temp. to 50°C
- EP-34B: Room temp. to 50°C

## ■ Foil Strain Gages for Measuring Axial Tension of Bolt

If it is difficult to bond a strain gage to the surface of a bolt for measuring the tightening stress, these gages enable the measurement by embedding into a hole, 2 mm diameter, bored through the top head of the bolt. They are applicable to materials having a linear expansion coefficient of  $11 \times 10^{-6} / ^\circ\text{C}$ .

## KFG Gages ● Uniaxial



With 2 polyester-coated copper wires 5 cm long

### KFG-3-120-C20-11

**Uniaxial**

Base Size	11.5 x 1.9 mm $\phi$
Gage Length	3 mm
Resistance	120 $\Omega$
Pieces per Pack	5



With 2 polyester-coated copper wires 5 cm long

### KFG-1.5-120-C20-11

**Uniaxial**

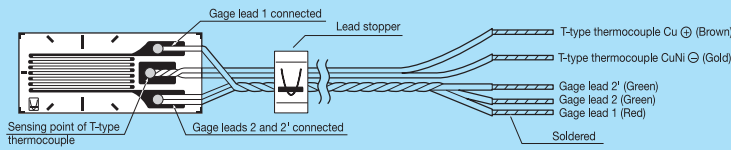
Base Size	5 x 1.9 mm $\phi$
Gage Length	1.5 mm
Resistance	120 $\Omega$
Pieces per Pack	5

When ordering, specify the model number as follows:

(e.g.)

### KFG-3-120-C20-11

- Various types of gages for measuring axial tension of bolt can be manufactured. For details, contact us.



● Gage Factor	Approx. 2.1
● Applicable Linear Expansion Coefficients	11, 16, 23, 27 ( $\times 10^{-6}/^{\circ}\text{C}$ )
● Self-temperature-compensation Range	10 to 100°C
● Resistance	120 $\Omega$
● Pieces per Pack	5

### Applicable Adhesives and Operating Temperature Ranges

- CC-33A: -10 to 120°C
- CC-35: -10 to 120°C
- CC-36: -30 to 100°C
- EP-34B: -10 to 120°C

## ■ Foil Strain Gages with Temperature Sensor

The KFGT gages are foil strain gages incorporating a T-type thermocouple for simultaneous measurement of strain and temperature. They ensure not only efficient strain measurement under environments where temperature change or temperature gradient necessitates simultaneous measurement of strain and temperature but also highly precise compensation of thermally-induced apparent strain. It is recommended to use KYOWA data logger UCAM-60B or UCAM-65B as a mating measuring instrument.

## KFGT Gages ● Uniaxial



With 2 polyester-coated copper wires

**KFGT-5-120-C1-11**  
16  
23  
27

### Uniaxial

Base Size	10 x 4.5 mm
Gage Length	5 mm



With 2 polyester-coated copper wires

**KFGT-2-120-C1-11**  
16  
23  
27

### Uniaxial

Base Size	7 x 4.5 mm
Gage Length	2 mm

When ordering, specify the model number as follows:

**KFGT-□-120-C1-□** Leadwire Cable Code

### Leadwire Cable – Type and Shape

3 polyester-coated copper wires



### Oprg. Temp. Range

-10 to 120°C

### Leadwire Length

1 m

### Leadwire Cable Code

**N1M3**

### Standard Accessory

Leadwire stopper to prevent the gage from damaging

### Options

#### Extension Leadwire Cables

Model	Dimensions (mm)			Quantity per Case	Remarks
	Length	Width	Thickness		
NT-1M	1000	7.2	1.2	5	With gage terminal T-F25
NT-2M	2000				
NT-4M	4000				

e.g.

**KFGT-5-120-C1-11 N1M3**



- Applicable Linear Expansion Coefficients 11, 16, 23 ( $\times 10^{-6}/^{\circ}\text{C}$ )
- Self-temperature-compensation Range 0 to 150°C

### Applicable Adhesives and Operating Temperature Ranges

- CC-33A: -196 to 120°C
- CC-35: -30 to 120°C
- EP-34B: -55 to 150°C
- PC-600: -196 to 150°C

## Foil Strain Gages

The KFR gages are durable and easy-to-use high-grade strain gages. The gage element is sandwiched between heat-resistant polyimide base and cover, thereby letting them exhibit high performance in a wide temperature range.

- Highly heat-resistant polyimide resin is used to make them durable.
- A wide compensated temperature range of 0 to 150°C makes them usable under diversified operating conditions.
- The resistive element is made of NiCr alloy foil, thereby ensuring minimal drift under high temperatures and excellent weather and moisture resistances.
- Suitable for incorporation into transducers

### Types, lengths and codes of leadwire cables pre-attached to KFR gages

Type	2 polyester-coated copper wires		3 polyester-coated copper wires		Vinyl-coated flat 2-wire cable		Vinyl-coated flat 3-wire cable		Middle-temperature 2-wire cable	Middle-temperature 3-wire cable
	C1, D25	C1, D25	C1	D25	C1	D25	C1, D25	C1, D25		
2 cm	N2C2	N2C3								
3	N3C2	N3C3								
4	N4C2	N4C3								
5	N5C2	N5C3								
10	N10C2	N10C3								
15	N15C2	N15C3	L15C2R	L15C2S	L15C3R	L15C3S	R15C2	R15C3		
30	N30C2	N30C3	L30C2R	L30C2S	L30C3R	L30C3S	R30C2	R30C3		
50	N50C2	N50C3	L50C2R	L50C2S	L50C3R	L50C3S	R50C2	R50C3		
1 m	N1M2	N1M3	L1M2R	L1M2S	L1M3R	L1M3S	R1M2	R1M3		
2			L2M2R	L2M2S	L2M3R	L2M3S	R2M2	R2M3		
3			L3M2R	L3M2S	L3M3R	L3M3S	R3M2	R3M3		
4			L4M2R	L4M2S	L4M3R	L4M3S	R4M2	R4M3		
5			L5M2R	L5M2S	L5M3R	L5M3S	R5M2	R5M3		
6			L6M2R	L6M2S	L6M3R	L6M3S	R6M2	R6M3		
8			L8M2R	L8M2S	L8M3R	L8M3S	R8M2	R8M3		
10			L10M2R	L10M2S	L10M3R	L10M3S	R10M2	R10M3		
15			L15M2R	L15M2S	L15M3R	L15M3S	R15M2	R15M3		
20			L20M2R	L20M2S	L20M3R	L20M3S	R20M2	R20M3		
30 m			L30M2R	L30M2S	L30M3R	L30M3S	R30M2	R30M3		
Oprg. temp. range	-196 to 150°C		-10 to 80°C				-100 to 150°C			
Remarks	Twisted for 50 cm and 1 m long (with some exception)		L-6; L-9 for 6 m or longer		L-7; L-10 for 6 m or longer		L-11		L-12	

- 3-wire cable is applicable to strain gages with the gage length of 2 or 5 mm.

# KFR Gages

## ● Uniaxial/Triaxial/Uniaxial 5-element



**KFR-5-120-C1- 11**  
**16**  
**23**

### Uniaxial

Gage Factor	Approx. 2.1
Base Size	10 x 3.7 mm
Gage Length	5 mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire  
Cable Code

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2



**KFR-2-120-C1- 11**  
**16**  
**23**

### Uniaxial

Gage Factor	Approx. 2.1
Base Size	6 x 3.7 mm
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire  
Cable Code

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2



**KFR-1-120-C1- 11**  
**16**  
**23**

### Uniaxial

Gage Factor	Approx. 2.1
Base Size	4 x 2.7 mm
Gage Length	1 mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire  
Cable Code

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C2  
N50C2  
N1M2



**KFR-05-120-C1-11**  
**16**  
**23**

### Uniaxial

Gage Factor	Approx. 2.1
Base Size	3.3 x 2.7 mm
Gage Length	0.5 mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire  
Cable Code

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C2  
N50C2  
N1M2



**KFR-02-120-C1-11**  
**16**  
**23**

### Uniaxial

Gage Factor	Approx. 2.1
Base Size	2.5 x 2.2 mm
Gage Length	0.2 mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire  
Cable Code

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C2  
N50C2  
N1M2



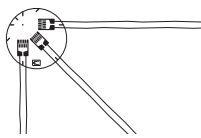
**KFR-02N-120-C1-11**  
**16**  
**23**

### Uniaxial

Gage Factor	Approx. 1.9
Base Size	1.6 x 1.2 mm
Gage Length	0.2mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire  
Cable Code

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N10C2



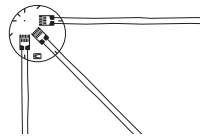
**KFR-1-120-D25-11**  
**16**  
**23**

### Triaxial, 0°/90°/45°

Gage Factor	Approx. 2.1
Base Size	8 mm φ
Gage Length	1 mm
Resistance	120 Ω
Pieces per Pack	5

Leadwire  
Cable Code

L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C2  
N50C2  
N1M2



**KFR-05-120-D25-11**  
**16**  
**23**

### Triaxial, 0°/90°/45°

Gage Factor	Approx. 2.1
Base Size	7.5 mm φ
Gage Length	0.5 mm
Resistance	120 Ω
Pieces per Pack	5

Leadwire  
Cable Code

L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C2  
N50C2  
N1M2



**KFR-5-350-C1- 11**  
**16**  
**23**

### Uniaxial 350 Ω


Gage Factor	Approx. 2.1
Base Size	10 X 3.7 mm
Gage Length	5 mm
Resistance	350 Ω
Pieces per Pack	10

Leadwire  
Cable Code

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2

# KFR Gages

## Uniaxial 5-element/Triaxial/Uniaxial 350 Ω




**KFR-2-350-C1- 11  
16  
23**

**Uniaxial 350 Ω**

Base Size	6 x 3.7 mm
Gage Length	2 mm
Resistance	350 Ω
Pieces per Pack	10

**Leadwire Cable Code**

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2




**KFR-1-350-C1- 11  
16  
23**

**Uniaxial 350 Ω**

Base Size	4 x 2.7 mm
Gage Length	1 mm
Resistance	350 Ω
Pieces per Pack	10

**Leadwire Cable Code**

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C2  
N50C2  
N1M2




**KFR-05-350-C1-11  
16  
23**

**Uniaxial 350 Ω**

Base Size	3.5 x 2.7 mm
Gage Length	0.5 mm
Resistance	350 Ω
Pieces per Pack	10

**Leadwire Cable Code**

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C2  
N50C2  
N1M2



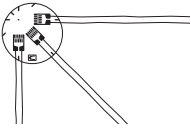
**KFR-02-350-C1-11  
16  
23**

**Uniaxial 350 Ω**

Base Size	3 x 2.7 mm
Gage Length	0.2 mm
Resistance	350 Ω
Pieces per Pack	10

**Leadwire Cable Code**

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C2  
N50C2  
N1M2



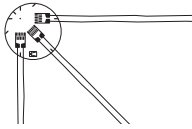
**KFR-1-350-D25- 11  
16  
23**

**Triaxial. 0°/90°/45° 350 Ω**

Base Size	8 mm φ
Gage Length	1 mm
Resistance	350 Ω
Pieces per Pack	5

**Leadwire Cable Code**

L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C2  
N50C2  
N1M2



**KFR-05-350-D25-11  
16  
23**

**Triaxial. 0°/90°/45° 350 Ω**

Base Size	7.5 mm φ
Gage Length	0.5 mm
Resistance	350 Ω
Pieces per Pack	5

**Leadwire Cable Code**





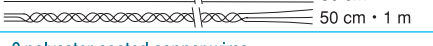
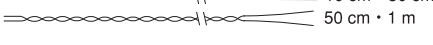


L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C2  
N50C2  
N1M2

When ordering, specify the model number as follows:

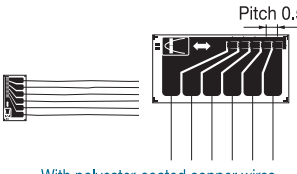
**KFR-□-120-C1-□** Leadwire Cable Code

(e.g.)

**KFR-5-120-C1-11 L1M3R**

Leadwire Cable – Type and Shape	Oprg. Temp. Range	Leadwire Length	Leadwire Cable Code
 Vinyl-coated flat 3-wire cable L-7 (L-10 for 6 m or longer)	-10 to 80°C	1 m	L1M3R; L1M3S
		3 m	L3M3R; L3M3S
		5 m	L5M3R; L5M3S
 Vinyl-coated flat 2-wire cable L-6 (L-9 for 6 m or longer)	-10 to 80°C	1 m	L1M2R; L1M2S
		3 m	L3M2R; L3M2S
		5 m	L5M2R; L5M2S
 Middle-temperature 3-wire cable L-12	-100 to 150°C	1 m	R1M3
		3 m	R3M3
		5 m	R5M3
 Middle-temperature 2-wire cable L-11	-100 to 150°C	1 m	R1M2
		3 m	R3M2
		5 m	R5M2
 3 polyester-coated copper wires	-196 to 150°C	30 cm	N30C3
		50 cm · 1 m	N50C3
		1 m	N1M3
 2 polyester-coated copper wires	-196 to 150°C	10 cm	N10C2
		30 cm	N30C2
		50 cm	N50C2
 Polyester-coated copper wires	-196 to 150°C	1 m	N5C2
		5 cm	N15C2
		15 cm	N30C2
 Silver-clad copper wires	-196 to 150°C	25 mm	





Pitch 0.5

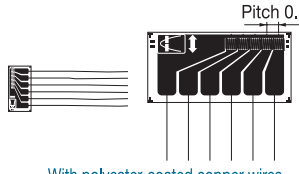
Leadwire Cable Code  
**N10C2**

With polyester-coated copper wires

**KFR-015-120-D9-11**  
**16**  
**23**

**Uniaxial 5-element  
for concentrated stress  
measurement**

Gage Factor	Approx. 1.95
Base Size	6 x 3 mm
Gage Length	0.15 mm
Resistance	120 Ω
Pieces per Pack	5



Pitch 0.5

Leadwire Cable Code  
**N10C2**

With polyester-coated copper wires

**KFR-015-120-D19-11**  
**16**  
**23**

**Uniaxial 5-element  
for concentrated stress  
measurement**





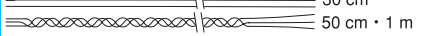
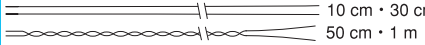


Gage Factor	Approx. 1.95
Base Size	6 x 3 mm
Gage Length	0.15 mm
Resistance	120 Ω
Pieces per Pack	5

When ordering, specify the model number as follows:

**KFR-□-120-C1-□** Leadwire Cable Code

(e.g.)

**KFR-5-120-C1-11 L1M3R**

Leadwire Cable – Type and Shape	Oprg. Temp. Range	Leadwire Length	Leadwire Cable Code
Vinyl-coated flat 3-wire cable L-7 (L-10 for 6 m or longer) 	-10 to 80°C	1 m	L1M3R; L1M3S
		3 m	L3M3R; L3M3S
		5 m	L5M3R; L5M3S
Vinyl-coated flat 2-wire cable L-6 (L-9 for 6 m or longer) 	-10 to 80°C	1 m	L1M2R; L1M2S
		3 m	L3M2R; L3M2S
		5 m	L5M2R; L5M2S
Middle-temperature 3-wire cable L-12 	-100 to 150°C	1 m	R1M3
		3 m	R3M3
		5 m	R5M3
Middle-temperature 2-wire cable L-11 	-100 to 150°C	1 m	R1M2
		3 m	R3M2
		5 m	R5M2
3 polyester-coated copper wires 	-196 to 150°C	30 cm	N30C3
		50 cm	N50C3
		1 m	N1M3
2 polyester-coated copper wires 	-196 to 150°C	10 cm	N10C2
		30 cm	N30C2
		50 cm	N50C2
		1 m	N1M2
Polyester-coated copper wires 	-196 to 150°C	5 cm	N5C2
		15 cm	N15C2
		30 cm	N30C2
Silver-clad copper wires 	-196 to 150°C	25 mm	

# Waterproof Strain Gages

# KFW

- Gage Factor Approx. 2.1
- Applicable Linear Expansion Coefficients 11, 16, 23 ( $\times 10^{-6}/^{\circ}\text{C}$ )
- Self-temperature-compensation Range 0 to 80°C

Applicable Adhesives and Operating Temperature Ranges  
 CC-33A: -10 to 80°C CC-36: -10 to 80°C EP-18: -10 to 80°C

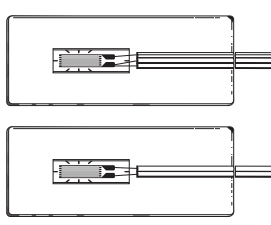
## Waterproof Foil Strain Gages

The KFW gages have the surface covered with a special resin for waterproofing. The waterproof structure enables these gages to serve for outdoor or underwater measurement merely by being bonded to measuring objects. The insulation resistance shows virtually no deterioration even after 100 hours of use under an underwater pressure of approximately 10 MPa (100 kgf/cm<sup>2</sup>). In addition, the covering resin is flexible enough to enable easy bonding to curved surfaces.

## Types, lengths and codes of leadwire cables pre-attached to KFW gages

Type Length	Vinyl-coated flat 2-wire cable		Vinyl-coated flat 3-wire cable	
	C1	D16, D17	C1	D16, D17
15 cm	L15C2R	L15C2S	L15C3R	L15C3S
30	L30C2R	L30C2S	L30C3R	L30C3S
50	L50C2R	L50C2S	L50C3R	L50C3S
1 m	L1M2R	L1M2S	L1M3R	L1M3S
2	L2M2R	L2M2S	L2M3R	L2M3S
3	L3M2R	L3M2S	L3M3R	L3M3S
4	L4M2R	L4M2S	L4M3R	L4M3S
5	L5M2R	L5M2S	L5M3R	L5M3S
6	L6M2R	L6M2S	L6M3R	L6M3S
8	L8M2R	L8M2S	L8M3R	L8M3S
10	L10M2R	L10M2S	L10M3R	L10M3S
15	L15M2R	L15M2S	L15M3R	L15M3S
20	L20M2R	L20M2S	L20M3R	L20M3S
30 m	L30M2R	L30M2S	L30M3R	L30M3S
Oprg. temp. range	-10 to 80°C			
Remarks	L-6; L-9 for 6 m or longer		L-7; L-10 for 6 m or longer	

## KFW Gages • Uniaxial/Biaxial

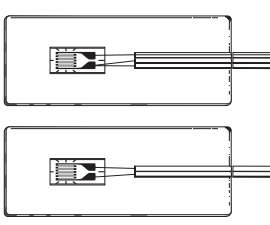


Leadwire Cable Code  
 L1M3R  
 L3M3R  
 L5M3R  
 L1M2R  
 L3M2R  
 L5M2R

**KFW-5-120-C1-11**  
 16  
 23

**Uniaxial 120 Ω**

Base Size	30 x 12 mm
Gage Length	5 mm
Resistance	120 Ω
Pieces per Pack	10

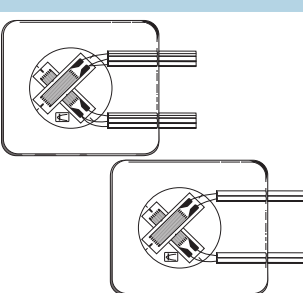


Leadwire Cable Code  
 L1M3R  
 L3M3R  
 L5M3R  
 L1M2R  
 L3M2R  
 L5M2R

**KFW-2-120-C1-11**  
 16  
 23

**Uniaxial 120 Ω**

Base Size	30 x 12 mm
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	10



Leadwire Cable Code  
 L1M3S  
 L3M3S  
 L5M3S  
 L1M2S  
 L3M2S  
 L5M2S

**KFW-5-120-D16-11**  
 16  
 23

**Biaxial, 0°/90° stacked rosette**

Base Size	21 x 18 mm
Gage Length	5 mm
Resistance	120 Ω
Pieces per Pack	5

When ordering, specify the model number as follows:

**KFW-□-120-C1-□** Leadwire Cable Code

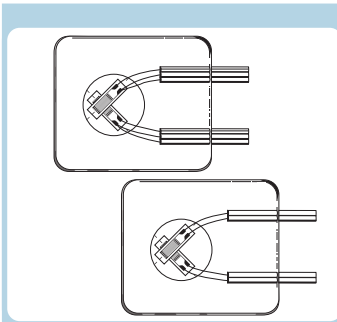
Leadwire Cable – Type and Shape	Oprg. Temp. Range	Leadwire Length	Leadwire Cable Code
Vinyl-coated flat 3-wire cable L-7 (L-10 for 6 m or longer)	-10 to 80°C	1 m	L1M3R; L1M3S
		3 m	L3M3R; L3M3S
		5 m	L5M3R; L5M3S
Vinyl-coated flat 2-wire cable L-6 (L-9 for 6 m or longer)	-10 to 80°C	1 m	L1M2R; L1M2S
		3 m	L3M2R; L3M2S
		5 m	L5M2R; L5M2S



**KFW-5-120-C1-11 L1M3R**

# KFW Gages

## ● Biaxial/Triaxial/Uniaxial 350 Ω/Biaxial 350 Ω/Triaxial 350 Ω



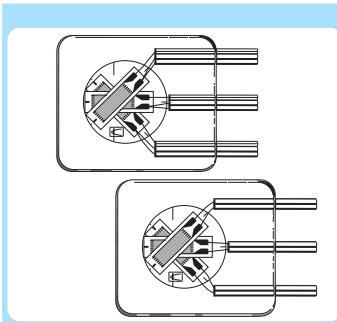
Leadwire Cable Code  
L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S

**KFW-2-120-D16-11**

16  
23

**Biaxial, 0°/90° stacked rosette**

Base Size	21 x 18 mm
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	5



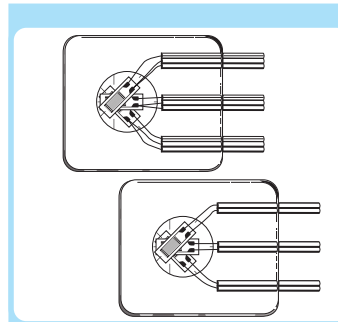
Leadwire Cable Code  
L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S

**KFW-5-120-D17-11**

16  
23

**Triaxial, 0°/90°/45° stacked rosette**

Base Size	21 x 18 mm
Gage Length	5 mm
Resistance	120 Ω
Pieces per Pack	5



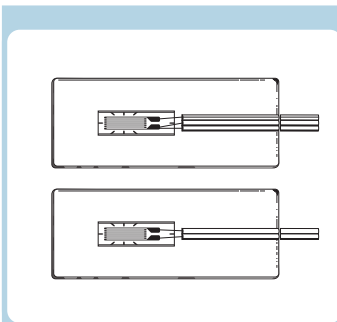
Leadwire Cable Code  
L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S

**KFW-2-120-D17-11**

16  
23

**Triaxial, 0°/90°/45° stacked rosette**

Base Size	21 x 18 mm
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	5



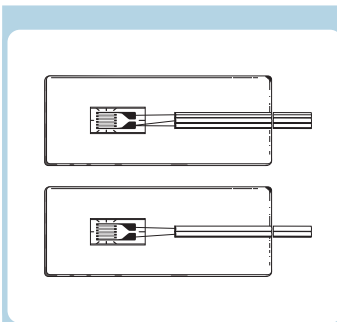
Leadwire Cable Code  
L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R

**KFW-5-350-C1-11**

16  
23

**Uniaxial 350 Ω**

Base Size	30 x 12 mm
Gage Length	5 mm
Resistance	350 Ω
Pieces per Pack	10



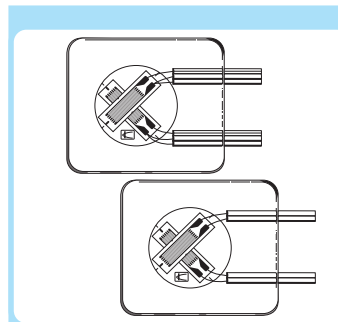
Leadwire Cable Code  
L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R

**KFW-2-350-C1-11**

16  
23

**Uniaxial 350 Ω**

Base Size	30 x 12 mm
Gage Length	2 mm
Resistance	350 Ω
Pieces per Pack	10



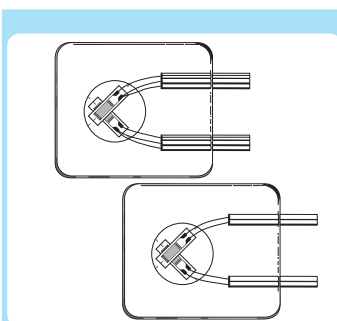
Leadwire Cable Code  
L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S

**KFW-5-350-D16-11**

16  
23

**Biaxial, 0°/90° stacked rosette, 350 Ω**

Base Size	21 x 18 mm
Gage Length	5 mm
Resistance	350 Ω
Pieces per Pack	5



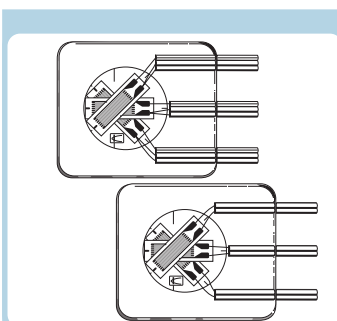
Leadwire Cable Code  
L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S

**KFW-2-350-D16-11**

16  
23

**Biaxial, 0°/90° stacked rosette, 350 Ω**

Base Size	21 x 18 mm
Gage Length	2 mm
Resistance	350 Ω
Pieces per Pack	5



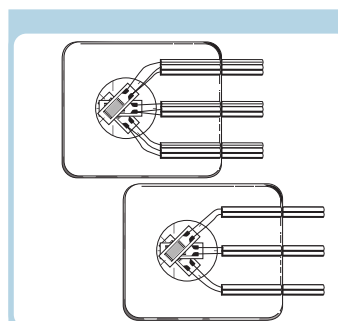
Leadwire Cable Code  
L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S

**KFW-5-350-D17-11**

16  
23

**Triaxial, 0°/90°/45° stacked rosette, 350 Ω**

Base Size	21 x 18 mm
Gage Length	5 mm
Resistance	350 Ω
Pieces per Pack	5



Leadwire Cable Code  
L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S

**KFW-2-350-D17-11**

16  
23

**Triaxial, 0°/90°/45° stacked rosette, 350 Ω**

Base Size	21 x 18 mm
Gage Length	2 mm
Resistance	350 Ω
Pieces per Pack	5

# Waterproof Strain Gages

# KFWS

- Gage Factor Approx. 2.1
- Applicable Linear Expansion Coefficients 11, 16, 23 ( $\times 10^{-6}/^{\circ}\text{C}$ )
- Self-temperature-compensation Range 0 to 80°C

Applicable Adhesives and Operating Temperature Ranges  
 CC-33A: -10 to 80°C CC-36: -10 to 80°C EP-18: -10 to 80°C

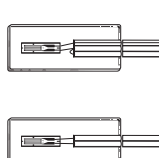
## Small-sized Waterproof Foil Strain Gages

The KFWS gages are small-sized waterproof gages suitable for outdoor or underwater strain measurement where gage bonding space is limited. The waterproofing resin is as thin as 1.3mm, making them flexible enough to be bonded to a curved surface of 10 mm diameter.

### Types, lengths and codes of leadwire cables pre-attached to KFWS gages

Type Length	Vinyl-coated flat 2-wire cable		Vinyl-coated flat 3-wire cable	
	C1	D16	C1	D16
15 cm	L15C2R	L15C2S	L15C3R	L15C3S
30	L30C2R	L30C2S	L30C3R	L30C3S
50	L50C2R	L50C2S	L50C3R	L50C3S
1 m	L1M2R	L1M2S	L1M3R	L1M3S
2	L2M2R	L2M2S	L2M3R	L2M3S
3	L3M2R	L3M2S	L3M3R	L3M3S
4	L4M2R	L4M2S	L4M3R	L4M3S
5	L5M2R	L5M2S	L5M3R	L5M3S
6	L6M2R	L6M2S	L6M3R	L6M3S
8	L8M2R	L8M2S	L8M3R	L8M3S
10	L10M2R	L10M2S	L10M3R	L10M3S
15	L15M2R	L15M2S	L15M3R	L15M3S
20	L20M2R	L20M2S	L20M3R	L20M3S
30 m	L30M2R	L30M2S	L30M3R	L30M3S
Oprg. temp. range	-10 to 80°C			
Remarks	L-6; L-9 for 6 m or longer		L-7; L-10 for 6 m or longer	

## KFWS Gages • Uniaxial/Biaxial



Leadwire Cable Code

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R

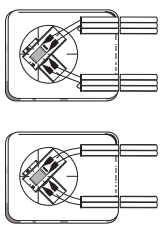
KFWS-2N-120-C1-11

16

23

Uniaxial

Base Size	15 x 6 mm
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	10



Leadwire Cable Code

L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S

KFWS-2-120-D16-11

16


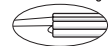

23

Biaxial, 0°/90°  
stacked rosette

Base Size	15 x 12 mm
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	10

When ordering, specify the model number as follows:

**KFWS-□-120-C1-** Leadwire Cable Code

Leadwire Cable – Type and Shape	Oprg. Temp. Range	Leadwire Length	Leadwire Cable Code
Vinyl-coated flat 3-wire cable L-7 (L-10 for 6 m or longer)  or 	-10 to 80°C	1 m 3 m 5 m	L1M3R; L1M3S L3M3R; L3M3S L5M3R; L5M3S
Vinyl-coated flat 2-wire cable L-6 (L-9 for 6 m or longer) 	-10 to 80°C	1 m 3 m 5 m	L1M2R; L1M2S L3M2R; L3M2S L5M2R; L5M2S

e.g.

**KFWS-2N-120-C1-11 L1M3R**

# Waterproof Strain Gages

# KCW

- Applicable Linear Expansion Coefficients 11 ( $\times 10^{-6}/^{\circ}\text{C}$ )
- Self-temperature-compensation Range 10 to  $90^{\circ}\text{C}$
- Flange Size 21 x 5 x 0.1 mm
- Gage Length 8 mm

### Mounting Method and Operating Temperature Range

Spot welding:  $-20$  to  $100^{\circ}\text{C}$

## Weldable Waterproof Foil Strain Gages

The KCW gages are weldable foil strain gages ensuring easy handling in the field. They require no coating for use under severe underwater conditions.

The KCW gages are available in 2 types. The G10 incorporates 1 element.

Withstand water pressure

G10 Approx. 10 MPa (Approx. 100 kgf/cm<sup>2</sup>)

### Types, lengths and codes of leadwire cables pre-attached to KCW gages

Type	Polyethylene-coated cross-link 3-wire cable
Length	G10
15 cm	G15C3S
30	G30C3S
50	G50C3S
1 m	G1M3S
2	G2M3S
3	G3M3S
4	G4M3S
5	G5M3S
6	G6M3S
8	G8M3S
10	G10M3S
15	G15M3S
20	G20M3S
30 m	G30M3S
Oprg. temp. range	$-20$ to $100^{\circ}\text{C}$

When ordering, specify the model number as follows:

**KCW-5-□-□-11** Leadwire Cable Code

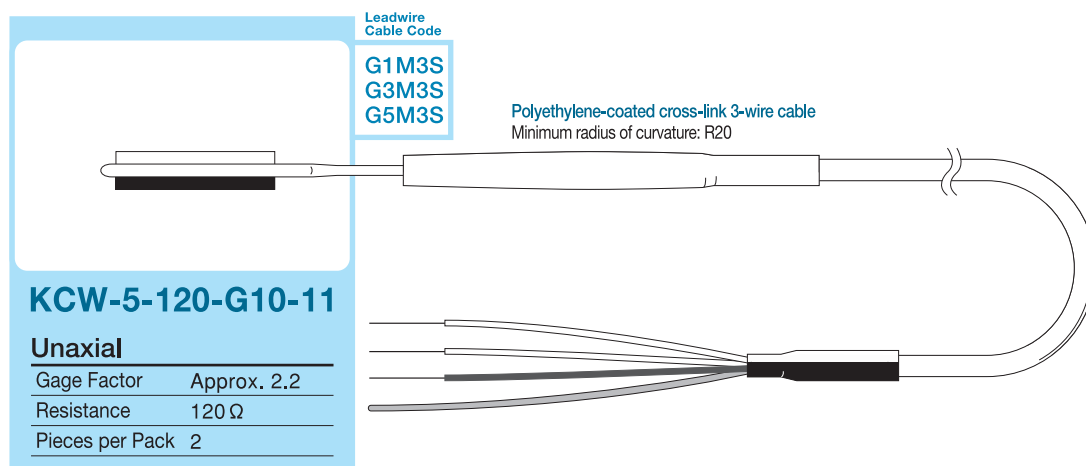
e.g.

**KCW-5-120-G10-11 G1M3S**

Type of Leadwire Cable	Oprg. Temp. Range	Leadwire Length	Leadwire Cable Code
Polyethylene-coated cross-link 3-wire cable Minimum radius of curvature: R20	$-20$ to $100^{\circ}\text{C}$	1 m	G1M3S
		3 m	G3M3S
		5 m	G5M3S

## KCW Gages

### Uniaxial



# Strain Gages for Concrete

# KFG

- Gage Factor Approx. 2.1
- Applicable Linear Expansion Coefficients 11 ( $\times 10^{-6}/^{\circ}\text{C}$ )
- Self-temperature-compensation Range 10 to 100°C

Applicable Adhesives and Operating Temperature Ranges  
CC-35: -10 to 80°C

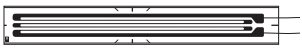
## General-purpose Foil Strain Gages

Listed here are leadwire-equipped gages selected from KFG gages applicable to strain measurement for concrete.

- For the types and lengths of the leadwire cables, refer to page 23.

## KFG Gages

### ● Uniaxial/Biaxial/Triaxial



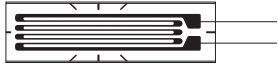
**Leadwire Cable Code**

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2

**KFG-30-120-C1-11**

**Uniaxial**

Base Size	37 x 5.2 mm
Gage Length	30 mm
Resistance	120 Ω
Pieces per Pack	10



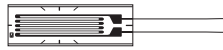
**Leadwire Cable Code**

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2

**KFG-20-120-C1-11**

**Uniaxial**

Base Size	28 x 8 mm
Gage Length	20 mm
Resistance	120 Ω
Pieces per Pack	10



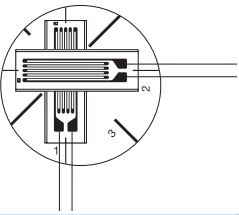
**Leadwire Cable Code**

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2

**KFG-10-120-C1-11**

**Uniaxial**

Base Size	16 x 5.2 mm
Gage Length	10 mm
Resistance	120 Ω
Pieces per Pack	10



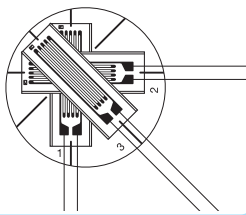
**Leadwire Cable Code**

L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2

**KFG-10-120-D16-11**

**Biaxial, 0°/90° stacked rosette**

Base Size	21 mm φ
Gage Length	10 mm
Resistance	120 Ω
Pieces per Pack	10



**Leadwire Cable Code**

L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2

**KFG-10-120-D17-11**

**Triaxial, 0°/90°/45° stacked rosette for stress analysis**

Base Size	21 mm φ
Gage Length	10 mm
Resistance	120 Ω
Pieces per Pack	10

When ordering, specify the model number as follows:

**KFG-□-120-C1-11** Leadwire Cable Code

(e.g.)

**KFG-30-120-C1-11 L1M3R**

Leadwire Cable – Type and Shape	Oprg. Temp. Range	Leadwire Length	Leadwire Cable Code
Vinyl-coated flat 3-wire cable L-7 (L-10 for 6 m or longer)	-10 to 80°C	1 m	L1M3R
		3 m	L3M3R
		5 m	L5M3R
Vinyl-coated flat 2-wire cable L-6 (L-9 for 6 m or longer)	-10 to 80°C	1 m	L1M2R
		3 m	L3M2R
		5 m	L5M2R
Middle-temperature 3-wire cable L-12	-100 to 150°C	1 m	R1M3
		3 m	R3M3
		5 m	R5M3
Middle-temperature 2-wire cable L-11	-100 to 150°C	1 m	R1M2
		3 m	R3M2
		5 m	R5M2

Strain Gage Model Number Coding System

How strain gages work.

Static Strain and Dynamic Strain

Unknown physical quantities such as load, pressure and displacement can be revealed through strain measurement.

Selecting a Strain Gage

Strain Gages

- Gage Factor Approx. 2.1
- Applicable Linear Expansion Coefficients 11 ( $\times 10^{-6}/^{\circ}\text{C}$ )
- Self-temperature-compensation Range 10 to 60°C

Applicable Adhesives and Operating Temperature Ranges  
 CC-35: -30 to 120°C

## ■ Wire Strain Gages

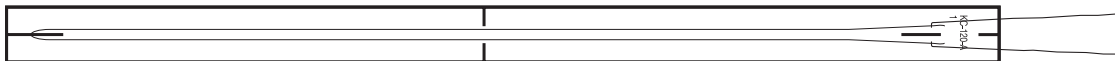
Featuring a longer gage length, the KC gages are wire strain gages suitable for mean strain measurement of concrete under test. Usually, a model with the gage length over 3 times longer than the maximum diameter of the aggregate is selected for the purpose.

## ■ Types, lengths and codes of leadwire cables pre-attached to KC gages

Type	Vinyl-coated flat 2-wire cable	Vinyl-coated flat 3-wire cable
Length	A1	
15 cm	L15C2R	L15C3R
30	L30C2R	L30C3R
50	L50C2R	L50C3R
1 m	L1M2R	L1M3R
2	L2M2R	L2M3R
3	L3M2R	L3M3R
4	L4M2R	L4M3R
5	L5M2R	L5M3R
6	L6M2R	L6M3R
8	L8M2R	L8M3R
10	L10M2R	L10M3R
15	L15M2R	L15M3R
20	L20M2R	L20M3R
30 m	L30M2R	L30M3R
Oprg. temp. range	-10 to 80°C	
Remarks	L-6; L-9 for 6 m or longer	L-7; L-10 for 6 m or longer

## KC Gages

### ● Uniaxial



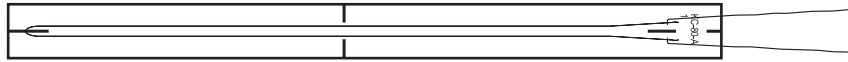
Leadwire Cable Code

L1M3R  
 L3M3R  
 L5M3R  
 L1M2R  
 L3M2R  
 L5M2R

### KC-120-120-A1-11

#### Uniaxial

Base Size	132 x 6 mm
Gage Length	120 mm
Resistance	120 Ω
Pieces per Pack	10



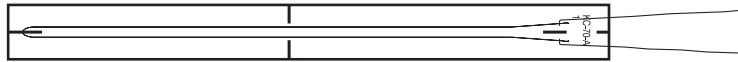
Leadwire Cable Code

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R

### KC-80-120-A1-11

#### Uniaxial

Base Size	95 x 8 mm
Gage Length	84 mm
Resistance	120 Ω
Pieces per Pack	10



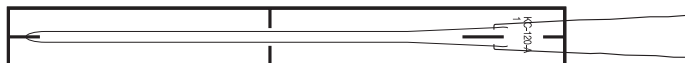
Leadwire Cable Code

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R

### KC-70-120-A1-11

#### Uniaxial

Base Size	80 x 7.5 mm
Gage Length	67 mm
Resistance	120 Ω
Pieces per Pack	10



Leadwire Cable Code

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R

### KC-60-120-A1-11

#### Uniaxial

Base Size	74 x 8 mm
Gage Length	60 mm
Resistance	120 Ω
Pieces per Pack	10

When ordering, specify the model number as follows:

**KC-□-120-A1-11** Leadwire Cable Code

e.g.

**KC-120-120-A1-11 L1M3R**

Leadwire Cable – Type and Shape	Oprg. Temp. Range	Leadwire Length	Leadwire Cable Code
Vinyl-coated flat 3-wire cable L-7 (L-10 for 6 m or longer) 	-10 to 80°C	1 m	L1M3R
		3 m	L3M3R
		5 m	L5M3R
Vinyl-coated flat 2-wire cable L-6 (L-9 for 6 m or longer) 	-10 to 80°C	1 m	L1M2R
		3 m	L3M2R
		5 m	L5M2R
Silver-clad copper wires 	-196 to 150°C	25 mm	



# Strain Gages for Concrete



● Resistance	120 Ω
● Applicable Linear Expansion Coefficients	11 ( $\times 10^{-6}/^{\circ}\text{C}$ )
● Self-temperature-compensation Range	0 to 50°C
Operating Temperature Range	-10 to 70°C

## ■ Embedded Strain Gages

The KM gages are designed to be embedded in mortar or concrete for the purpose of measuring the internal stress. To ensure better adhesion to mortar or the like, the KM gages feature a specially treated surface. They also provide suitable waterproofness and elastic modulus for the intended purpose.

## ■ Types, lengths and codes of leadwire cables pre-attached to KM gages



Type Length	Vinyl-coated flat 2-wire cable for KM-30	Vinyl-coated flat 3-wire cable for KM-120
	H1	H2
1 m	Y1M2	W1M3
2	Y2M2	W2M3
3	Y3M2	W3M3
4	Y4M2	W4M3
5	Y5M2	W5M3
6	Y6M2	W6M3
8	Y8M2	W8M3
10	Y10M2	W10M3
15	Y15M2	W15M3
20	Y20M2	W20M3
30 m	Y30M2	W30M3
Oprg. temp. range	-10 to 70°C	

When ordering, specify the model number as follows:

**KM-□-120-H1-11** Leadwire Cable Code

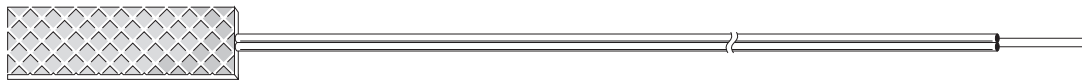
(e.g.)

**KM-30-120-H1-11 Y1M2**

Leadwire Cable – Type and Shape	Oprg. Temp. Range	Leadwire Length	Leadwire Cable Code
Vinyl-coated flat 2-wire cable 	-10 to 70°C	1 m	Y1M2
		3 m	Y3M2
		5 m	Y5M2
Vinyl-coated flat 3-wire cable 	-10 to 70°C	1 m	W1M3
		3 m	W3M3
		5 m	W5M3

## KM Gages

### ● Uniaxial

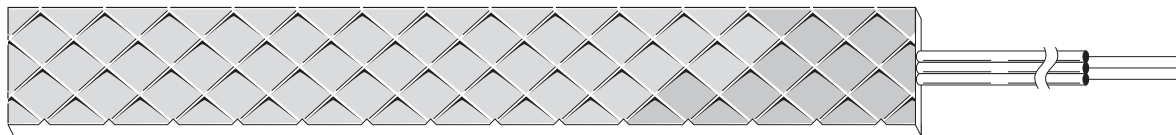


Leadwire Cable Code  
Y1M2  
Y3M2  
Y5M2

### KM-30-120-H1-11

Uniaxial foil strain gage with vinyl-coated flat 2-wire cable

Gage Factor	Approx. 1.8
Base Size	30 x 9 x 3 mm
Gage Length	30 mm
Pieces per Pack	1



Leadwire Cable Code  
W1M3  
W3M3  
W5M3

### KM-120-120-H2-11

Uniaxial wire strain gage with vinyl-coated flat 3-wire cable

Gage Factor	Approx. 2.0
Base Size	120 x 15 x 5 mm
Gage Length	120 mm
Pieces per Pack	1

Operating Temperature Ranges  
Room temperature to 70°C

## Concrete-embedded Strain Gages

The KMC gages are designed to measure self-shrinkage and self-stress of cemented materials. They enable measurement of the self-shrinkage of high-strength and high-fluidity concrete from immediately after placing. They are also used effectively to check for cracks of cemented materials. Usually, a T-type thermocouple is installed near the gage, while the KMC gage of H4 type does not require such the installation since it is equipped with a built-in thermocouple.

When ordering, specify the model number as follows:

**KMC-70-120-H□**

(e.g.)

**KMC-70-120-H3**

## KMC Gages ● Uniaxial



### KMC-70-120-H3

Uniaxial wire strain gage  
with vinyl-coated flat 3-wire cable 3 m long

Base Size	80 x 10 x 2 mm
Gage Length	67 mm
Resistance	120 Ω
Pieces per Pack	1



### KMC-70-120-H4

Uniaxial wire strain gage  
with vinyl-coated flat 3-wire cable 3 m long

Base Size	80 x 10 x 2mm
Gage Length	67 mm
Resistance	120 Ω
Pieces per Pack	1

- Gage Factor Approx. 2.1
- Applicable Linear Expansion Coefficients 1, 3, 6, 9 ( $\times 10^{-6}/^{\circ}\text{C}$ )
- Self-temperature-compensation Range 0 to 150°C

### Applicable Adhesives and Operating Temperature Ranges

- CC-33A: -196 to 120°C
- CC-35: -30 to 120°C
- EP-34B -55 to 200°C

## Foil Strain Gages for Composite Materials

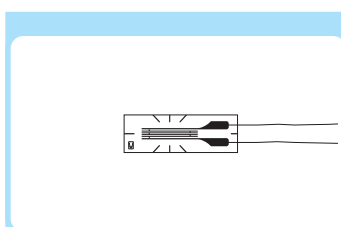
The KFRP gages are self-temperature compensation gages (SELCOM gages) suitable for strain measurement of composite materials such as CFRP and GFRP. The special gage pattern minimizes the effect of self-heating due to gage current and the effect of reinforcement against low-elasticity materials.

### Types, lengths and codes of leadwire cables pre-attached to KFRP gages

Type	2 polyester-coated copper wires		3 polyester-coated copper wires		Vinyl-coated flat 2-wire cable		Vinyl-coated flat 3-wire cable		Middle-temperature 2-wire cable	Middle-temperature 3-wire cable	Fluoroplastic coated high/low-temp. 3-wire cable
	C1, D22	C1, D22	C1, D22	C1, D22	C1	D22	C1	D22	C1, D22	C1, D22	C1, D22
Length	C1, D22	C1, D22	C1, D22	C1, D22	C1	D22	C1	D22	C1, D22	C1, D22	C1, D22
2cm	N2C2	N2C3									
3	N3C2	N3C3									
4	N4C2	N4C3									
5	N5C2	N5C3									
10	N10C2	N10C3									
15	N15C2	N15C3	L15C2R	L15C2S	L15C3R	L15C3S	R15C2	R15C3	F15C3		
30	N30C2	N30C3	L30C2R	L30C2S	L30C3R	L30C3S	R30C2	R30C3	F30C3		
50	N50C2	N50C3	L50C2R	L50C2S	L50C3R	L50C3S	R50C2	R50C3	F50C3		
1m	N1M2	N1M3	L1M2R	L1M2S	L1M3R	L1M3S	R1M2	R1M3	F1M3		
2			L2M2R	L2M2S	L2M3R	L2M3S	R2M2	R2M3	F2M3		
3			L3M2R	L3M2S	L3M3R	L3M3S	R3M2	R3M3	F3M3		
4			L4M2R	L4M2S	L4M3R	L4M3S	R4M2	R4M3	F4M3		
5			L5M2R	L5M2S	L5M3R	L5M3S	R5M2	R5M3	F5M3		
6			L6M2R	L6M2S	L6M3R	L6M3S	R6M2	R6M3	F6M3		
8			L8M2R	L8M2S	L8M3R	L8M3S	R8M2	R8M3	F8M3		
10			L10M2R	L10M2S	L10M3R	L10M3S	R10M2	R10M3	F10M3		
15			L15M2R	L15M2S	L15M3R	L15M3S	R15M2	R15M3	F15M3		
20			L20M2R	L20M2S	L20M3R	L20M3S	R20M2	R20M3	F20M3		
30m			L30M2R	L30M2S	L30M3R	L30M3S	R30M2	R30M3	F30M3		
Oprg. temp. range	-196 to 150°C		-10 to 80°C				-100 to 150°C		-196 to 200°C		
Remarks	Twisted for 50 cm and 1 m long		L-6; L-9 for 6 m or longer		L-7; L-10 for 6 m or longer		L-11	L-12	L-3		

## KFRP Gages

### Uniaxial/Triaxial/Uniaxial 350 Ω



Leadwire Cable Code

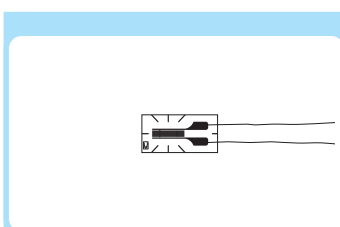
- L1M3R
- L3M3R
- L5M3R
- L1M2R
- L3M2R
- L5M2R
- R1M3
- R3M3
- R5M3
- R1M2
- R3M2
- R5M2
- F1M3
- F3M3
- F5M3
- N30C3
- N50C3
- N1M3
- N30C2
- N50C2
- N1M2

**KFRP-5-120-C1- 1**

**3  
6  
9**

#### Uniaxial

Base Size	15 x 5 mm
Gage Length	5 mm
Resistance	120 Ω
Pieces per Pack	10



Leadwire Cable Code

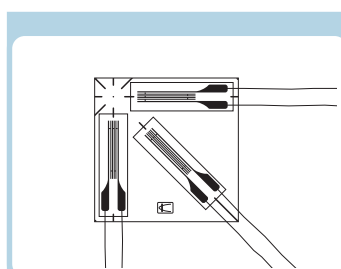
- L1M3R
- L3M3R
- L5M3R
- L1M2R
- L3M2R
- L5M2R
- R1M3
- R3M3
- R5M3
- R1M2
- R3M2
- R5M2
- F1M3
- F3M3
- F5M3
- N30C3
- N50C3
- N1M3
- N30C2
- N50C2
- N1M2

**KFRP-2-120-C1- 1**

**3  
6  
9**

#### Uniaxial

Base Size	10 x 5 mm
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	10



Leadwire Cable Code

- L1M3S
- L3M3S
- L5M3S
- L1M2S
- L3M2S
- L5M2S
- R1M3
- R3M3
- R5M3
- R1M2
- R3M2
- R5M2
- F1M3
- F3M3
- F5M3
- N30C3
- N50C3
- N1M3
- N30C2
- N50C2
- N1M2

**KFRP-5-120-D22-1**

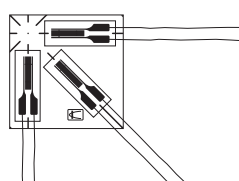
**3  
6  
9**

#### Triaxial, 0°/90°/45°

Base Size	19 x 19 mm
Gage Length	5 mm
Resistance	120 Ω
Pieces per Pack	10

# KFRP Gages

## ● Uniaxial/Triaxial/Uniaxial 350 Ω



**KFRP-2-120-D22-1**

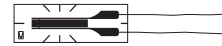
3  
6  
9

**Triaxial, 0°/90°/45°**

Base Size	15 x 15 mm
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	10

**Leadwire Cable Code**

L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
F1M3  
F3M3  
F5M3  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2



**KFRP-5-350-C1-1**

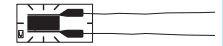
3  
6  
9

**Uniaxial 350 Ω**

Base Size	15 x 5 mm
Gage Length	5 mm
Resistance	350 Ω
Pieces per Pack	10

**Leadwire Cable Code**

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
F1M3  
F3M3  
F5M3  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2



**KFRP-2-350-C1-1**

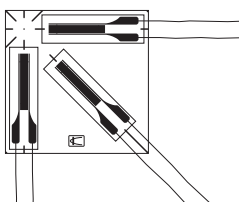
3  
6  
9

**Uniaxial 350 Ω**

Base Size	10 x 5 mm
Gage Length	2 mm
Resistance	350 Ω
Pieces per Pack	10

**Leadwire Cable Code**

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
F1M3  
F3M3  
F5M3  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2



**KFRP-5-350-D22-1**

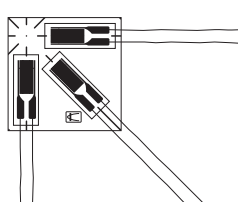
3  
6  
9

**Triaxial, 0°/90°/45° 350 Ω**

Base Size	19 x 19 mm
Gage Length	5 mm
Resistance	350 Ω
Pieces per Pack	10

**Leadwire Cable Code**

L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
F1M3  
F3M3  
F5M3  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2



**KFRP-2-350-D22-1**

3  
6  
9

**Triaxial, 0°/90°/45° 350 Ω**

Base Size	15 x 15 mm
Gage Length	2 mm
Resistance	350 Ω
Pieces per Pack	10

**Leadwire Cable Code**

L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
F1M3  
F3M3  
F5M3  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2

When ordering, specify the model number as follows:

**KFRP-□-120-□-□** Leadwire Cable Code



**KFRP-5-120-C1-11 L1M3R**

Leadwire Cable – Type and Shape	Oprg. Temp. Range	Leadwire Length	Leadwire Cable Code
Vinyl-coated flat 3-wire cable L-7 (L-10 for 6 m or longer)	-10 to 80°C	1 m	L1M3R; L1M3S
		3 m	L3M3R; L3M3S
		5 m	L5M3R; L5M3S
Vinyl-coated flat 2-wire cable L-6 (L-9 for 6 m or longer)	-10 to 80°C	1 m	L1M2R; L1M2S
		3 m	L3M2R; L3M2S
		5 m	L5M2R; L5M2S
Middle-temperature 3-wire cable L-12	-100 to 150°C	1 m	R1M3
		3 m	R3M3
		5 m	R5M3
Middle-temperature 2-wire cable L-11	-100 to 150°C	1 m	R1M2
		3 m	R3M2
		5 m	R5M2
Fluoroplastic-coated high/low-temp. 3-wire cable L-3	-196 to 200°C	1 m	F1M3
		3 m	F3M3
		5 m	F5M3
3 polyester-coated copper wires	-196 to 150°C	30 cm	N30C3
		50 cm	N50C3
		1 m	N1M3
2 polyester-coated copper wires	-196 to 150°C	30 cm	N30C2
		50 cm	N50C2
		1 m	N1M2
Silver-clad copper wires	-196 to 200°C	25 mm	

● Gage Factor                      Approx. 2.0

● Applicable Linear Expansion Coefficients    13 ( $\times 10^{-6}/^{\circ}\text{C}$ )

● Self-temperature-compensation Range     $-30$  to  $120^{\circ}\text{C}$

Applicable Adhesives and Operating Temperature Ranges

CC-33A:  $-196$  to  $120^{\circ}\text{C}$

PC-600:  $-196$  to  $150^{\circ}\text{C}$

## ■ Foil Strain Gages for Printed Boards

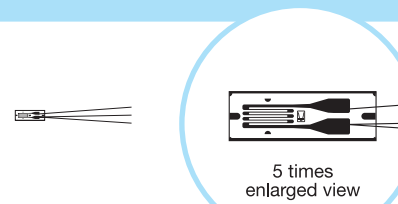
Printed boards are used for varieties of products including cellular phones, car navigation systems and digital cameras. To evaluate the mechanical and thermal characteristics of these printed boards, the KFRS gages were developed by integrating the advantageous features of KFG and KFR gages.

- Ultra-small gage bases enable bonding of these gages to components mounted on a printed board and narrow spaces on the printed board. The gage base of the uniaxial model is 1.2 mm long by 1.1 mm wide; that of biaxial and triaxial model is 2.5 mm<sup>2</sup>.
- The linear expansion coefficient is  $13 \times 10^{-6}/^{\circ}\text{C}$  that is applicable to component-mounted PC boards.
- The self-temperature compensation range is widened to  $-30$  to  $120^{\circ}\text{C}$  to meet heat cycle tests.

### ■ Types, lengths and codes of leadwire cables pre-attached to KFRS gages

Type	2 polyester-coated copper wires	3 polyester-coated copper wires	Vinyl-coated flat 2-wire cable		Vinyl-coated flat 3-wire cable		Middle-temperature 2-wire cable	Middle-temperature 3-wire cable
	C1, D34, D35	C1, D34, D35	C1	D34, D35	C1	D34, D35	C1, D34, D35	C1, D34, D35
Length								
10 cm	N10C2	N10C3						
30	N30C2	N30C3						
1 m			L1M2R	L1M2S	L1M3R	L1M3S	R1M2	R1M3
3			L3M2R	L3M2S	L3M3R	L3M3S	R3M2	R3M3
5			L5M2R	L5M2S	L5M3R	L5M3S	R5M2	R5M3
Oprg. temp. range	$-196$ to $150^{\circ}\text{C}$		$-10$ to $80^{\circ}\text{C}$				$-100$ to $150^{\circ}\text{C}$	
Remarks			L-6		L-7		L-11	L-12

## KFRS Gages ● Uniaxial



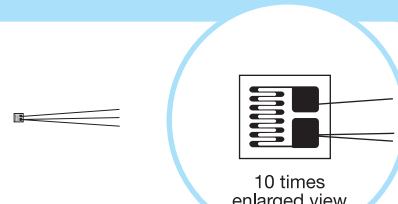
Leadwire Cable Code

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N10C3  
N30C3  
N10C2  
N30C2

**KFRS-1-120-C1-13**

**Uniaxial**

Base Size	4 x 1.4 mm
Gage Length	1 mm
Resistance	120 Ω
Pieces per Pack	10



Leadwire Cable Code

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N10C3  
N30C3  
N10C2  
N30C2

**KFRS-02-120-C1-13**

**Uniaxial**

Base Size	1.2 x 1.1 mm
Gage Length	0.2 mm
Resistance	120 Ω
Pieces per Pack	10

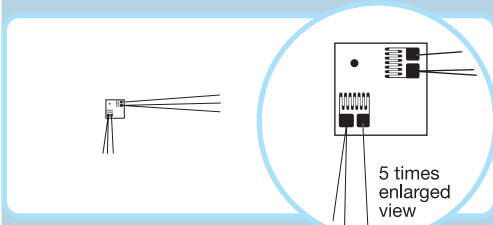
When ordering, specify the model number as follows:

**KFRS-□-120-C1-13** Leadwire Cable Code

e.g.  
**KFRS-1-120-C1-13 L1M3R**

Leadwire Cable – Type and Shape	Oprg. Temp. Range	Leadwire Length	Leadwire Cable Code
Vinyl-coated flat 3-wire cable L-7 (L-10 for 6 m or longer)	$-10$ to $80^{\circ}\text{C}$	1 m	L1M3R; L1M3S
		3 m	L3M3R; L3M3S
		5 m	L5M3R; L5M3S
Vinyl-coated flat 2-wire cable L-6 (L-9 for 6 m or longer)	$-10$ to $80^{\circ}\text{C}$	1 m	L1M2R; L1M2S
		3 m	L3M2R; L3M2S
		5 m	L5M2R; L5M2S
Middle-temperature 3-wire cable L-12	$-100$ to $150^{\circ}\text{C}$	1 m	R1M3
		3 m	R3M3
		5 m	R5M3
Middle-temperature 2-wire cable L-11	$-100$ to $150^{\circ}\text{C}$	1 m	R1M2
		3 m	R3M2
		5 m	R5M2
3 polyester-coated copper wires	$-196$ to $200^{\circ}\text{C}$	10 cm	N10C3
		30 cm	N30C3
2 polyester-coated copper wires	$-196$ to $200^{\circ}\text{C}$	10 cm	N10C2
		30 cm	N30C2

# KFRS Gages ● Biaxial/Triaxial



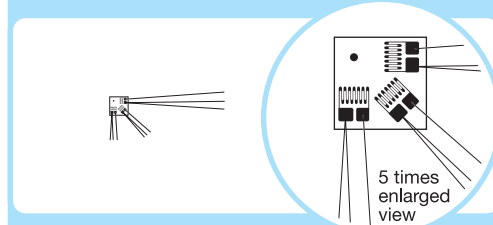
**KFRS-02-120-D34-13**

**Biaxial, 0°/90°**

Base Size	2.5 x 2.5 mm
Gage Length	0.2 mm
Resistance	120 Ω
Pieces per Pack	5

**Leadwire Cable Code**

L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N10C3  
N30C3  
N10C2  
N30C2



**KFRS-02-120-D35-13**

**Triaxial, 0°/90°/45°**

Base Size	2.5 x 2.5 mm
Gage Length	0.2 mm
Resistance	120 Ω
Pieces per Pack	5

**Leadwire Cable Code**


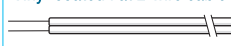




L1M3S  
L3M3S  
L5M3S  
L1M2S  
L3M2S  
L5M2S  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N10C3  
N30C3  
N10C2  
N30C2

When ordering, specify the model number as follows:

**KFRS-□-120-□-13** Leadwire Cable Code

e.g.

**KFRS-1-120-C1-13 L1M3R**

Leadwire Cable – Type and Shape	Oprg. Temp. Range	Leadwire Length	Leadwire Cable Code
 Vinyl-coated flat 3-wire cable L-7 (L-10 for 6 m or longer)	-10 to 80°C	1 m	L1M3R   L1M3S
		3 m	L3M3R   L3M3S
		5 m	L5M3R   L5M3S
 Vinyl-coated flat 2-wire cable L-6 (L-9 for 6 m or longer)	-10 to 80°C	1 m	L1M2R   L1M2S
		3 m	L3M2R   L3M2S
		5 m	L5M2R   L5M2S
 Middle-temperature 3-wire cable L-12	-100 to 150°C	1 m	R1M3
		3 m	R3M3
		5 m	R5M3
 Middle-temperature 2-wire cable L-11	-100 to 150°C	1 m	R1M2
		3 m	R3M2
		5 m	R5M2
 3 polyester-coated copper wires	-196 to 150°C	10 cm	N10C3
		30 cm	N30C3
 2 polyester-coated copper wires	-196 to 150°C	10 cm	N10C2
		30 cm	N30C2

● Gage Factor	Approx. 2.1
● Applicable Linear Expansion Coefficients	65 ( $\times 10^{-6}/^{\circ}\text{C}$ )
● Self-temperature-compensation Range	10 to 80°C

### Applicable Adhesives and Operating Temperature Ranges

CC-33A:	-196 to 80°C
CC-35:	-30 to 80°C
CC-36:	-30 to 100°C
EP-34B:	-20 to 80°C

## ■ Foil Strain Gages for Plastics

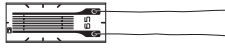
The KFP gages of which the applicable linear expansion coefficient is  $65 \times 10^{-6}/^{\circ}\text{C}$  are suitable for strain measurement of plastics materials such as acrylic resin.

### ■ Types, lengths and codes of leadwire cables pre-attached to KFP gages

Type	2 polyester-coated copper wires	3 polyester-coated copper wires	Vinyl-coated flat 2-wire cable	Vinyl-coated flat 3-wire cable
Length	C1			
2 cm	N2C2	N2C3		
3	N3C2	N3C3		
4	N4C2	N4C3		
5	N5C2	N5C3		
10	N10C2	N10C3		
15	N15C2	N15C3	L15C2R	L15C3R
30	N30C2	N30C3	L30C2R	L30C3R
50	N50C2	N50C3	L50C2R	L50C3R
1 m	N1M2	N1M3	L1M2R	L1M3R
2			L2M2R	L2M3R
3			L3M2R	L3M3R
4			L4M2R	L4M3R
5			L5M2R	L5M3R
6			L6M2R	L6M3R
8			L8M2R	L8M3R
10			L10M2R	L10M3R
15			L15M2R	L15M3R
20			L20M2R	L20M3R
30 m			L30M2R	L30M3R
Oprg. temp. range	-196 to 80°C		-10 to 80°C	
Remarks	Twisted for 50 cm and 1 m long		L-6; L-9 for 6 m or longer	L-7; L-10 for 6 m or longer

# KFP Gages

## ● Uniaxial/Uniaxial 350 Ω



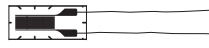
### KFP-5-120-C1-65

#### Uniaxial

Base Size	13 x 5.2 mm
Gage Length	5 mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire Cable Code

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2



### KFP-2-120-C1-65

#### Uniaxial

Base Size	10 x 4.7 mm
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire Cable Code

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2



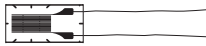
### KFP-5-350-C1-65

#### Uniaxial 350 Ω

Base Size	13 x 5.2 mm
Gage Length	5 mm
Resistance	350 Ω
Pieces per Pack	10

Leadwire Cable Code

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2



### KFP-2-350-C1-65

#### Uniaxial 350 Ω

Base Size	10 x 5.2 mm
Gage Length	2 mm
Resistance	350 Ω
Pieces per Pack	10

Leadwire Cable Code

L1M3R  
L3M3R  
L5M3R  
L1M2R  
L3M2R  
L5M2R  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2

When ordering, specify the model number as follows:

**KFP-□-120-C1-65** Leadwire Cable Code

e.g.

**KFP-5-120-C1-65 L1M3R**

Leadwire Cable – Type and Shape	Oprg. Temp. Range	Leadwire Length	Leadwire Cable Code
Vinyl-coated flat 3-wire cable L-7 (L-10 for 6 m or longer) 	-10 to 80°C	1 m	L1M3R
		3 m	L3M3R
		5 m	L5M3R
Vinyl-coated flat 2-wire cable L-6 (L-9 for 6 m or longer) 	-10 to 80°C	1 m	L1M2R
		3 m	L3M2R
		5 m	L5M2R
3 polyester-coated copper wires 	-196 to 80°C	30 cm	N30C3
		50 cm • 1 m	N50C3
		1 m	N1M3
2 polyester-coated copper wires 	-196 to 80°C	30 cm	N30C2
		50 cm • 1 m	N50C2
		1 m	N1M2
Silver-blade copper wires 	-196 to 80°C	25 mm	

Strain Gage Model Number Coding System

How strain gages work.

Static Strain and Dynamic Strain

Unknown physical quantities such as load, pressure and displacement can be revealed through strain measurement.

Selecting a Strain Gage

Strain Gages



# Gages for Low-elasticity Materials

# KFML

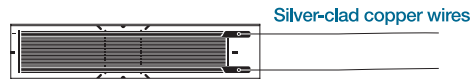
● Gage Factor Approx. 2.0

Applicable Adhesives and Operating Temperature Ranges  
 CC-33A: 0 to 60°C

## ■ Foil Strain Gages for Low-elasticity Materials

The KFML gages use a base with extremely low rigidity, enabling strain measurement of rubber or the similar materials with Young's modulus lower than approximately 10 MPa (1 kgf/mm<sup>2</sup>).

## KFML Gages ● Uniaxial 350 Ω



### KFML-5-350-C1

#### Uniaxial 350 Ω

Base Size	33 x 7 mm
Gage Length	5 mm
Resistance	350 Ω
Pieces per Pack	10

When ordering, specify the model number as follows:

**KFML-5-350-C1**

Leadwire Cable – Type and Shape	Oprg. Temp. Range	Leadwire Length
Silver-clad copper wires	0 to 60°C	25 mm

# Semiconductor Strain Gages for Ultra-small Strain Measurement

# KSP

Strain Gage Model Number Coding System

How strain gages work.

Static Strain and Dynamic Strain

Unknown physical quantities such as load, pressure and displacement can be revealed through strain measurement.

Selecting a Strain Gage

Strain Gages

## Applicable Adhesives and Operating Temperature Ranges

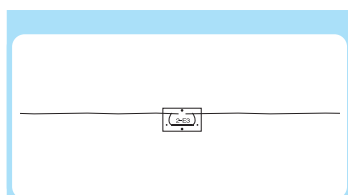
CC-33A: -50 to 120°C  
CC-36: -30 to 100°C

## Semiconductor Strain Gages

The KSP gages are stable-performance semiconductor strain gages usable for general stress measurement and transducers. The F2 type has a half-bridge formed with 2 elements, positive and negative, for self-temperature compensation and is suitable for strain measurement of steel products.

## KSP Gages

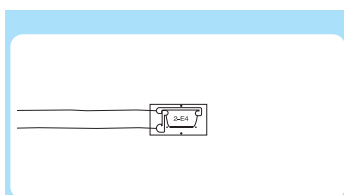
● Uniaxial/Uniaxial 350 Ω/Uniaxial 1000 Ω/Uniaxial 2-element



### KSP-2-120-E3

#### Uniaxial

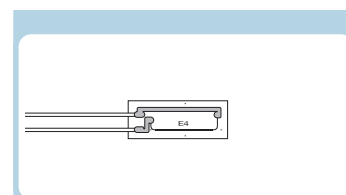
Gage Factor	Approx. 120
Base Size	5 x 3 mm
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	4



### KSP-2-120-E4

#### Uniaxial

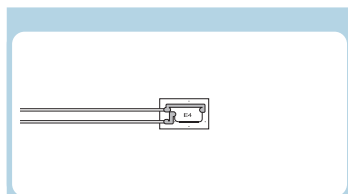
Gage Factor	Approx. 120
Base Size	7.7 x 4 mm
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	4



### KSP-6-350-E4

#### Uniaxial 350 Ω

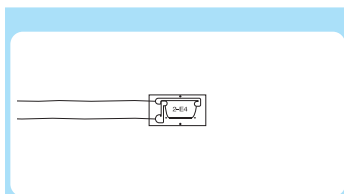
Base Size	Approx. 120
Gage Length	13 x 5 mm
Resistance	6 mm
Pieces per Pack	350 Ω
	4



### KSP-1-350-E4

#### Uniaxial 350 Ω

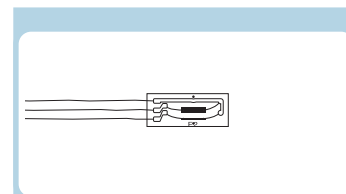
Gage Factor	Approx. 150
Base Size	6.6 x 4 mm
Gage Length	1 mm
Resistance	350 Ω
Pieces per Pack	4



### KSP-2-1K-E4

#### Uniaxial 1000 Ω

Gage Factor	Approx. 160
Base Size	7.7 x 4 mm
Gage Length	2 mm
Resistance	1000 Ω
Pieces per Pack	4



### KSP-3-120-F2

#### Uniaxial 2-element

Gage Factor	Approx. 225
A.L.E.C.	11
S.T.C.R.	20 to 70°C
Base Size	10 x 4 mm
Gage Length	3 mm
Resistance	120 Ω
Pieces per Pack	2

A.L.E.C.: Applicable Linear Expansion Coefficient  
S.T.C.R.: Self-Temperature Compensation Range

When ordering, specify the model number as follows:

KSP-□-120-□

e.g.

KSP-2-120-E3

Leadwire Cable – Type and Shape	Oprg. Temp. Range	Leadwire Length
Silver-clad copper wires	-50 to 150°C	25 mm
Silver-clad copper wires	-50 to 150°C	25 mm
Silver-clad copper wires	-50 to 150°C	25 mm

# Semiconductor Strain Gages for Ultra-small Strain Measurement

# KSN

● Applicable Linear Expansion Coefficients 11, 16 ( $\times 10^{-6}/^{\circ}\text{C}$ )

● Self-temperature-compensation Range 20 to 70°C

### Applicable Adhesives and Operating Temperature Ranges

CC-33A: -50 to 120°C

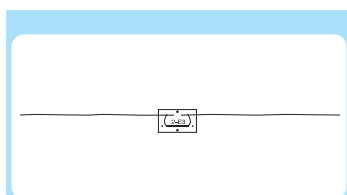
CC-36: -30 to 100°C

## Self-temperature-compensation Semiconductor Strain Gages

The KSN gages use an n-type silicon for the resistive element to control the resistance temperature coefficient of the material according to the linear expansion coefficient of the measuring object. Thus, thermally-induced resistance change is minimized.

## KSN Gages

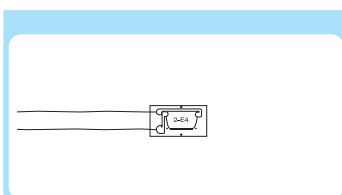
## ● Uniaxial/Biaxial/Uniaxial 350 Ω



**KSN-2-120-E3- 11  
16**

### Uniaxial

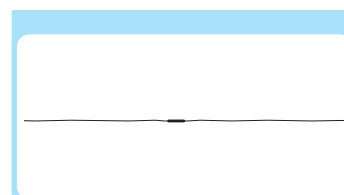
Gage Factor	Approx. -100
Base Size	5 x 3 mm
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	4



**KSN-2-120-E4- 11  
16**

### Uniaxial

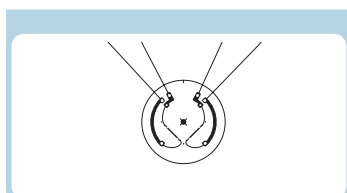
Gage Factor	Approx. -100
Base Size	7.5 x 4 mm
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	4



**KSN-2-120-E5- 11  
16**

### Uniaxial

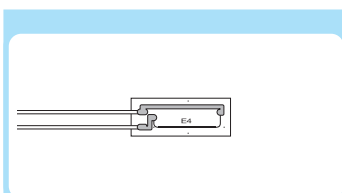
Gage Factor	Approx. -110
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	4



**KSN-2-120-F3- 11  
16**

### Biaxial, 0°/90°

Gage Factor	Approx. -100
Base Size	11 mm φ
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	4



**KSN-6-350-E4- 11  
16**

### Uniaxial 350 Ω

Gage Factor	Approx. -100
Base Size	13 x 5 mm
Gage Length	6 mm
Resistance	350 Ω
Pieces per Pack	4

When ordering, specify the model number as follows:

**KSN-□-120-□-□**

e.g.

**KSN-2-120-E3-11**

Leadwire Cable – Type and Shape	Oprg. Temp. Range	Leadwire Length
Silver-clad copper wires	-50 to 150°C	25 mm
Silver-clad copper wires	-50 to 150°C	25 mm
Oxygen-free tin-plated copper wires	-50 to 150°C	40 mm

# Semiconductor Strain Gages for Ultra-small Strain Measurement

# KSPH

● Gage Factor Approx. 170

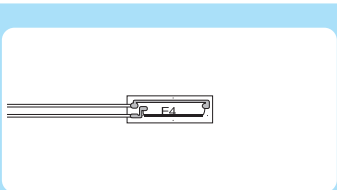
### Applicable Adhesives and Operating Temperature Ranges

CC-33A: -50 to 120°C  
CC-36 -30 to 100°C

## ■ High-output Semiconductor Strain Gages

The KSPH gages have the resistance especially increased, thereby making high bridge voltage applicable to obtain high output voltage.

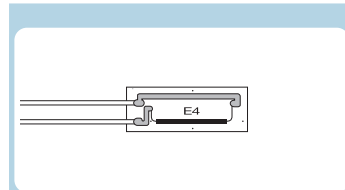
## KSPH Gages ● Uniaxial 2000 Ω / Uniaxial 10000 Ω



### KSPH-4-2K-E4

#### Uniaxial 2000 Ω

Base Size	11 x 4 mm
Gage Length	4 mm
Resistance	2000 Ω
Pieces per Pack	4



### KSPH-9-10K-E4

#### Uniaxial 10000 Ω

Base Size	16 x 5 mm
Gage Length	9 mm
Resistance	10000 Ω
Pieces per Pack	4

When ordering, specify the model number as follows:

**KSPH-□-□K-E4**

(e.g.)

**KSPH-4-2K-E4**

Leadwire Cable – Type and Shape	Oprg. Temp. Range	Leadwire Length
Silver-clad copper wires	-50 to 150°C	25 mm

# Semiconductor Strain Gages for Ultra-small Strain Measurement

# KSPL

● Gage Factor Approx. 90

### Applicable Adhesives and Operating Temperature Ranges

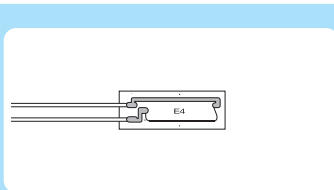
CC-33A: -50 to 120°C

CC-36: -30 to 100°C

## ■ Ultralinear Semiconductor Strain Gage

The KSPL gage features a superior linearity of resistance change against strain in a comparatively wide range, thereby making it suitable as a sensing element of transducers.

## KSPL Gages ● Uniaxial 60 Ω



### KSPL-7-60-E4

#### Uniaxial

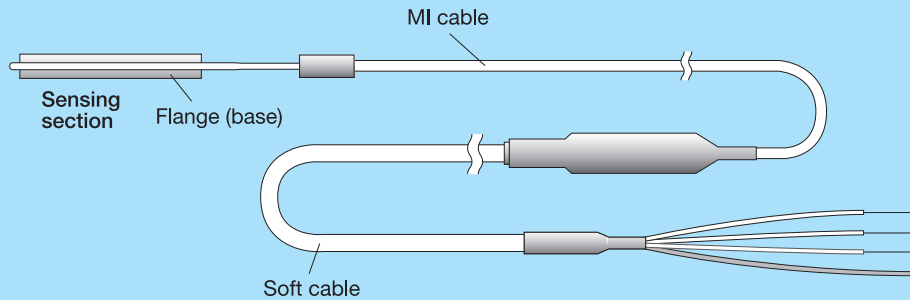
Base Size	14 x 5 mm
Gage Length	7 mm
Resistance	60 Ω
Pieces per Pack	4

When ordering, specify the model number as follows:

**KSPL-7-60-E4**

Leadwire Cable – Type and Shape	Oprg. Temp. Range	Leadwire Length
Silver-clad copper wires	-50 to 150°C	25 mm

# Encapsulated Weldable Strain Gages



Except for 1-element KHCV, encapsulated strain gages are 2-element, temperature compensation gages applicable at high temperatures. The capsule has active and dummy gages embedded in a metal tube filled with insulation (MgO). The leadwire cable is composed of an MI cable and a soft cable, 3 conductors each, for easy handling. To easily form a strain-gage bridge, the dedicated bridge adapter is available which is connected directly to the terminal of the soft cable.

## Codes of MI Cable Length and Optional Accessories

When ordering, specify the model number together with the code of the desired MI cable length, suffixed with a space in between. The suffix may include codes of the optional bridge adapter and compression fitting (see table at the right). In all cases, the length of the soft cable is 50 cm (for extension, contact us).

Examples

- KHCS-10-120-G12-11 C5M for KHCS with 5 m long MI cable
- KHCS-10-120-G12-11 C2MV for KHCS with 2 m long MI cable and bridge adapter pre-attached

MI Cable Length	Code of MI Cable Length	Bridge Adapter Pre-attached ①	Compression Fitting Pre-attached ②	①+②
1 m	C1M	C1MV	C1MF	C1MFV
2 m (std.)	C2M	C2MV	C2MF	C2MFV
3 m	C3M	C3MV	C3MF	C3MFV
4 m	C4M	C4MV	C4MF	C4MFV
5 m	C5M	C5MV	C5MF	C5MFV
6 m	C6M	C6MV	C6MF	C6MFV
8 m	C8M	C8MV	C8MF	C8MFV
10 m	C10M	C10MV	C10MF	C10MFV

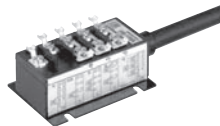
## Options

### Bridge Boxes DB-120A/L

Designed to configure a Wheatstone bridge circuit with the KHCV or KCW connected.

#### DB-120A

Cable: Chloroprene-coated, 5 m long, terminated with NDIS connector plug  
Dimensions: 60 x 42 x 25 mm  
Weight: Approx. 600 g (including cable)

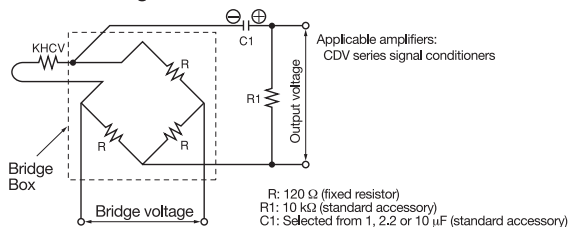


#### DB-120L (Compact plug-in type)

Cable: Removable connection cable, 5 m long, terminated with NDIS connector plug  
Dimensions: 60 x 20 x 20 mm  
Weight: Approx. 60 g (main unit only)

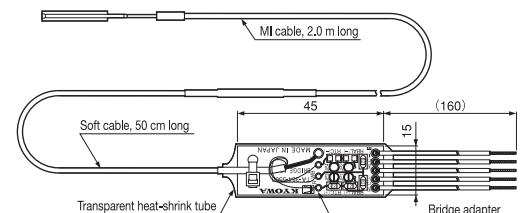


### KHCV Measuring Circuit

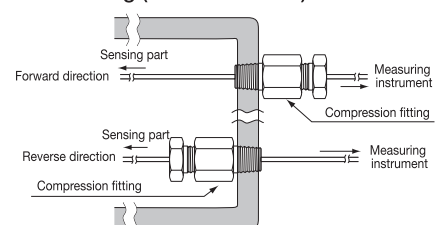


### Bridge Adapter (for KHCV, KHCR, KHCS, KHCM and KHC)

The bridge adapter has the most suitable temperature compensation resistor for the operating temperature range mounted to the board. It is connected to the soft cable when delivered. It eliminates any possible erroneous wiring while ensuring labor-saving. (A bridge adaptor for KHCV is also available.)



### Compression Fitting (Cable Extractor)



- Gage Factor Approx. 1.5 (950°C)
- Applicable Linear Expansion Coefficients 11, 13 ( $\times 10^{-6}/^{\circ}\text{C}$ )

**Mounting Method and Operating Temperature Range**  
 Spot welding:  $-196$  to  $950^{\circ}\text{C}$

## ■ Encapsulated Gages for Static/Dynamic Strain Measurement at $950^{\circ}\text{C}$

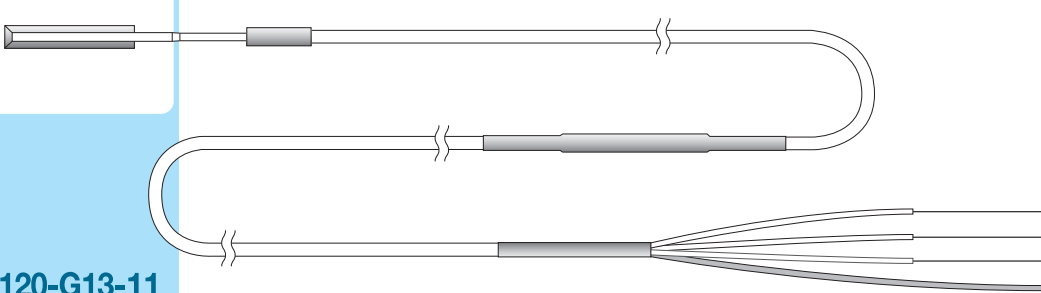
The KHCX gages are uniaxial 2-element temperature compensation Capsule Gages. While they are equipped with a built-in temperature compensation element, use of a proper compensation resistor for the measuring object enables further reduction of thermally-induced apparent strain. The sensing section and MI cable are made of Inconel 600.

## KHCX Gages ● Uniaxial

Leadwire Cable Code

**C2M**

**C2MV**



**KHCX-10-120-G13-11**  
**13**

**Uniaxial 2-element, temperature compensation**

Flange Size	20 x 3 x 0.1 mm
Gage Length	10 mm
Resistance	120 $\Omega$
Pieces per Pack	1

When ordering, specify the model number as follows:

**KHCX-10-120-G13-**  Leadwire Cable Code

Type of Leadwire Cable	Oprg. Temp. Range	Leadwire Length	Leadwire Cable Code
3-conductor shielded cable	$-196$ to $950^{\circ}\text{C}$	MI cable 2 m Soft cable 50 cm	<b>C2M</b>
3-conductor shielded cable with bridge adapter	$-196$ to $950^{\circ}\text{C}$	MI cable 2 m Soft cable 50 cm	<b>C2MV</b>

(e.g.)

**KHCX-10-120-G13-11 C2M**

# Encapsulated Weldable Strain Gages

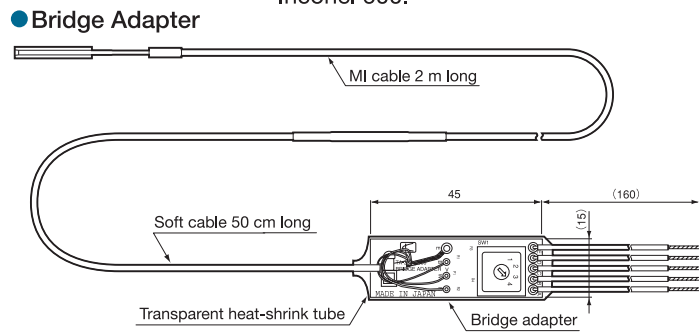
# KHCV

● Gage Factor Approx. 1.2 (800°C)

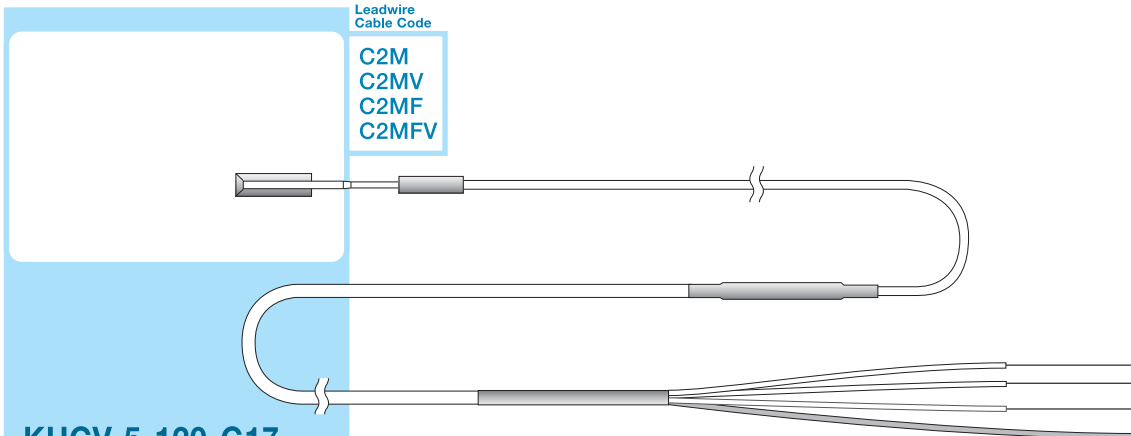
Mounting Method and Operating Temperature Range  
Spot welding: Room temperature to 800°C

## ■ Encapsulated Gages for Dynamic Strain Measurement at 800°C

The KHCV gages are uniaxial 1-element Capsule Gages. Matching instruments are bridge boxes DB-120A/L and signal conditioners in CDV series.  
The sensing section and MI cable are made of Inconel 600.



## KHCV Gages ● Uniaxial



### Uniaxial 1 active element

Flange Size	10 x 3 x 0.1 mm
Gage Length	5 mm
Resistance	120 Ω
Pieces per Pack	1

When ordering, specify the model number as follows:

**KHCV-5-120-G17** Leadwire Cable Code



**KHCV-5-120-G17 C2M**

Type of Leadwire Cable	Oprg. Temp. Range	Leadwire Length	Leadwire Cable Code
3-conductor shielded cable	Room temp. to 800°C	MI cable 2 m Soft cable 50 cm	C2M
3-conductor shielded cable with bridge adapter	Room temp. to 800°C	MI cable 2 m Soft cable 50 cm	C2MV
3-conductor shielded cable with compression fitting and bridge adapter	Room temp. to 800°C	MI cable 2 m Soft cable 50 cm	C2MFV



- Gage Factor Approx. 1.2 (750°C)
- Applicable Linear Expansion Coefficients 11, 13, 16 ( $\times 10^{-6}/^{\circ}\text{C}$ )

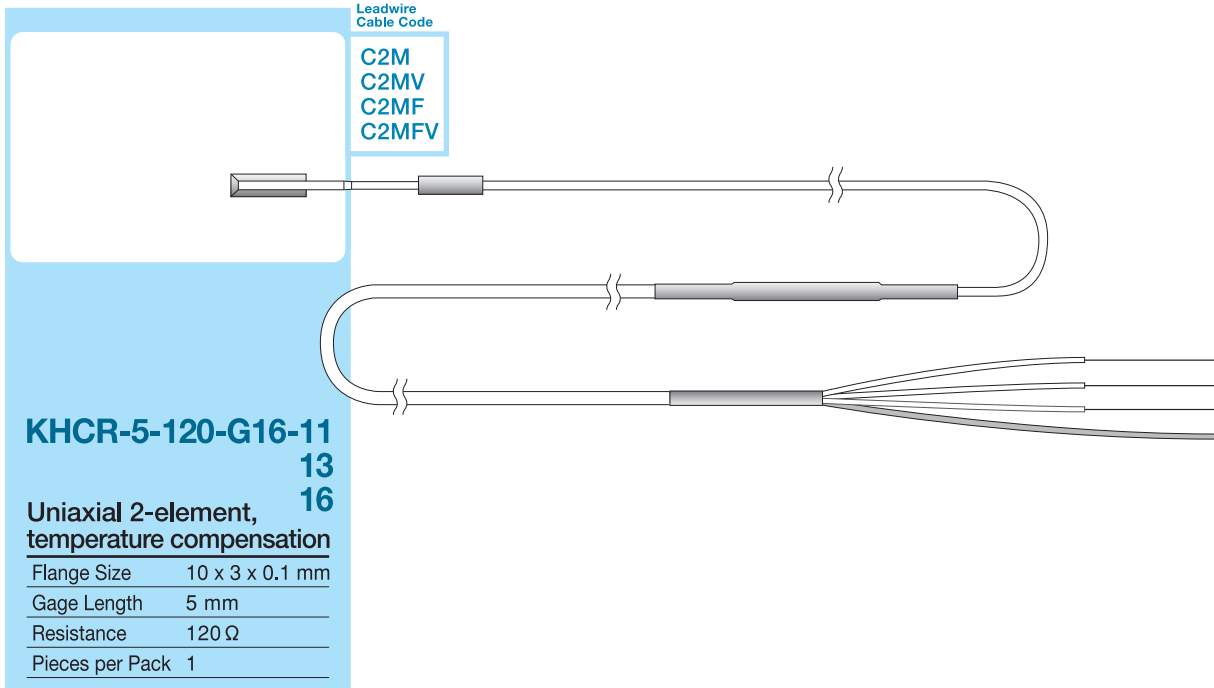
### Mounting Method and Operating Temperature Range

Spot welding: Room temperature to 750°C

## Encapsulated Gages for Static/Dynamic Strain Measurement at 750°C

The KHCR gages are uniaxial 2-element temperature compensation Capsule Gages. While they are equipped with a built-in temperature compensation element, use of a proper compensation resistor for the measuring object enables further reduction of thermally-induced apparent strain. The sensing section and MI cable are made of Inconel 600.

## KHCR Gages ● Uniaxial



When ordering, specify the model number as follows:

**KHCR-5-120-G16-**  **Leadwire Cable Code**

e.g.

**KHCR-5-120-G16-11 C2M**

Type of Leadwire Cable	Oprg. Temp. Range	Leadwire Length	Leadwire Cable Code
3-conductor shielded cable	Room temp. to 750°C	MI cable 2 m Soft cable 50 cm	C2M
3-conductor shielded cable with bridge adapter	Room temp. to 750°C	MI cable 2 m Soft cable 50 cm	C2MV
3-conductor shielded cable with compression fitting	Room temp. to 750°C	MI cable 2 m Soft cable 50 cm	C2MF
3-conductor shielded cable with compression fitting and bridge adapter	Room temp. to 750°C	MI cable 2 m Soft cable 50 cm	C2MFV

- Gage Factor Approx. 1.8 (750°C)
- Applicable Linear Expansion Coefficients 11, 13, 16 (x10<sup>-6</sup>/°C)

**Mounting Method and Operating Temperature Range**  
 Spot welding: -196 to 750°C

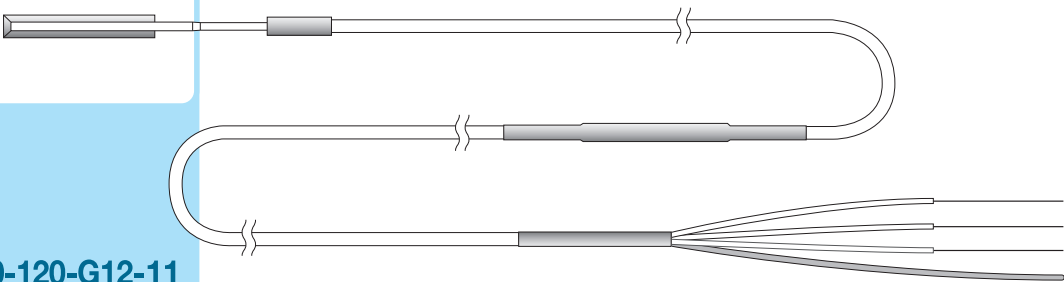
## Encapsulated Gages for Static/Dynamic Strain Measurement at 750°C

The KHCS gages are uniaxial 2-element temperature compensation Capsule Gages. While they are equipped with a built-in temperature compensation element, use of a proper compensation resistor for the measuring object enables further reduction of thermally-induced apparent strain. The sensing section and MI cable are made of Inconel 600.

## KHCS Gages ● Uniaxial

**Leadwire Cable Code**

C2M  
C2MV  
C2MF  
C2MFV



**KHCS-10-120-G12-11**  
13  
16  
 Uniaxial 2-element, temperature compensation

Flange Size	20 x 3 x 0.1 mm
Gage Length	10 mm
Resistance	120 Ω
Pieces per Pack	1

When ordering, specify the model number as follows:

**KHCS-10-120-G12-**  **Leadwire Cable Code**



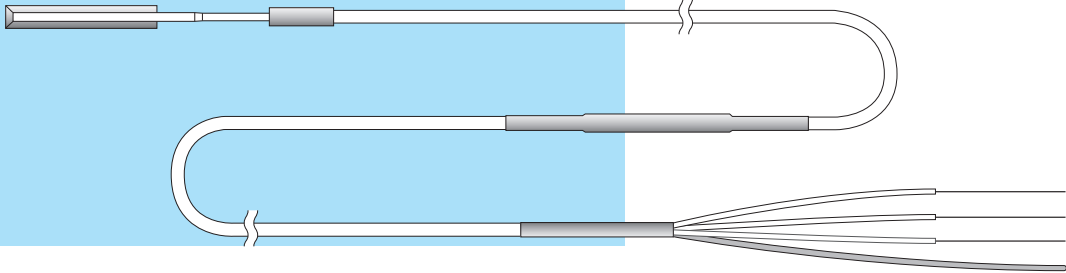
**KHCS-10-120-G12-11 C2M**

Type of Leadwire Cable	Oprg. Temp. Range	Leadwire Length	Leadwire Cable Code
3-conductor shielded cable	-196 to 750°C	MI cable 2 m Soft cable 50 cm	C2M
3-conductor shielded cable with bridge adapter	-196 to 750°C	MI cable 2 m Soft cable 50 cm	C2MV
3-conductor shielded cable with compression fitting	-196 to 750°C	MI cable 2 m Soft cable 50 cm	C2MF
3-conductor shielded cable with compression fitting and bridge adapter	-196 to 750°C	MI cable 2 m Soft cable 50 cm	C2MFV

● Applicable Linear Expansion Coefficients 11, 13, 16 ( $\times 10^{-6}/^{\circ}\text{C}$ )

Mounting Method and Operating Temperature Range

Spot welding:  $-196$  to  $650^{\circ}\text{C}$



## Encapsulated Gages for Static/Dynamic Strain Measurement at $650^{\circ}\text{C}$

The KHCM gages are uniaxial 2-element temperature compensation Capsule Gages. Equipped with a built-in temperature compensation element, these gages can measure both static strain and dynamic strain at a maximum operating temperature of  $650^{\circ}\text{C}$ .

The sensing section and MI cable is made of Inconel 600.

## KHCM Gages ● Uniaxial

Leadwire Cable Code  
C2M  
C2MV  
C2MF  
C2MFV

**KHCM-10-120-G15-11**  
13  
16

Uniaxial 2-element, temperature compensation

Gage Factor	Approx. 1.8 ( $650^{\circ}\text{C}$ )
Flange Size	20 x 3 x 0.1 mm
Gage Length	10 mm
Resistance	120 $\Omega$
Pieces per Pack	1

Leadwire Cable Code  
C2M  
C2MV  
C2MF  
C2MFV

**KHCM-5-120-G15-11**  
13  
16

Uniaxial 2-element, temperature compensation

Gage Factor	Approx. 1.4 ( $650^{\circ}\text{C}$ )
Flange Size	10 x 3 x 0.1 mm
Gage Length	5 mm
Resistance	120 $\Omega$
Pieces per Pack	1

When ordering, specify the model number as follows:

**KHCM-□-120-G15-□** Leadwire Cable Code

(e.g.)

**KHCM-10-120-G15-11 C2M**

Type of Leadwire Cable	Oprg. Temp. Range	Leadwire Length	Leadwire Cable Code
3-conductor shielded cable	$-196$ to $650^{\circ}\text{C}$	MI cable 2 m Soft cable 50 cm	C2M
3-conductor shielded cable with bridge adapter	$-196$ to $650^{\circ}\text{C}$	MI cable 2 m Soft cable 50 cm	C2MV
3-conductor shielded cable with compression fitting	$-196$ to $650^{\circ}\text{C}$	MI cable 2 m Soft cable 50 cm	C2MF
3-conductor shielded cable with compression fitting and bridge adapter	$-196$ to $650^{\circ}\text{C}$	MI cable 2 m Soft cable 50 cm	C2MFV

- Applicable Linear Expansion Coefficients 11, 16 ( $\times 10^{-6}/^{\circ}\text{C}$ )

Mounting Method and Operating Temperature Range

Spot welding:  $-196$  to  $550^{\circ}\text{C}$

## Encapsulated Gages for Measurement of Dynamic Strain at $550^{\circ}\text{C}$ and Static Strain at $500^{\circ}\text{C}$

The KHC gages are uniaxial temperature compensation Capsule Gages with 2 elements, active and dummy, forming a half bridge. The sensing part and MI cable are made of Inconel 600 with the G8 type and of stainless steel with the G9 type. Thus, an optimum model for the operating environment can be selected.

## KHC Gages

### ● Uniaxial

**Leadwire Cable Code**

C2M  
C2MV  
C2MF  
C2MFV

**KHC-20-120-G8- 11 16**

**Uniaxial 2-element, temperature compensation**

Gage Factor	Approx. 1.75 ( $500^{\circ}\text{C}$ )
Flange Size	$30 \times 4 \times 0.1$ mm
Gage Length	20, 10, 5 mm
Resistance	$120 \Omega$
Pieces per Pack	1

When ordering, specify the model number as follows:

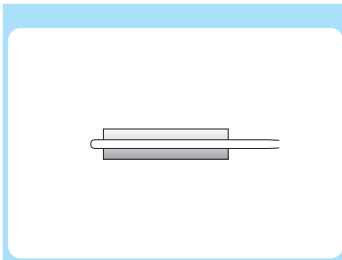
**KHC-20-120-G8-**  **Leadwire Cable Code**

e.g.

**KHC-20-120-G8-11 C2M**

Type of Leadwire Cable	Oprg. Temp. Range	Leadwire Length	Leadwire Cable Code
Polyethylene-coated cross-link 3-conductor cable	$-196$ to $550^{\circ}\text{C}$	MI cable 2 m Soft cable 50 cm	<b>C2M</b>
Polyethylene-coated cross-link 3-conductor cable with bridge adapter	$-196$ to $550^{\circ}\text{C}$	MI cable 2 m Soft cable 50 cm	<b>C2MV</b>
Polyethylene-coated cross-link 3-conductor cable with compression fitting	$-196$ to $550^{\circ}\text{C}$	MI cable 2 m Soft cable 50 cm	<b>C2MF</b>
Polyethylene-coated cross-link 3-conductor cable with compression fitting and bridge adapter	$-196$ to $550^{\circ}\text{C}$	MI cable 2 m Soft cable 50 cm	<b>C2MFV</b>

# KHC Gages ● Uniaxial

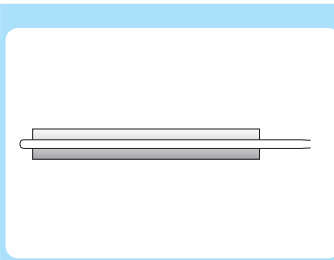


Leadwire Cable Code  
C2M  
C2MV  
C2MF  
C2MFV

**KHC-10-120-G8- 11  
16**

**Uniaxial 2-element,  
temperature compensation**

Gage Factor	Approx. 1.5 (500°C)
Flange Size	16.5 × 4 × 0.1 mm
Gage Length	10 mm
Resistance	120 Ω
Pieces per Pack1	

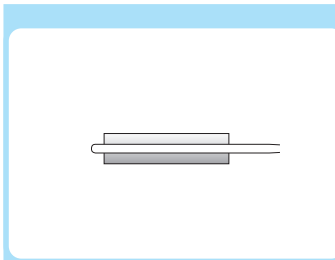


Leadwire Cable Code  
C2M  
C2MV  
C2MF  
C2MFV

**KHC-20-120-G9- 11  
16**

**Uniaxial 2-element,  
temperature compensation**

Gage Factor	Approx. 1.75 (500°C)
Flange Size	30 × 5 × 0.1 mm
Gage Length	20 mm
Resistance	120 Ω
Pieces per Pack	1

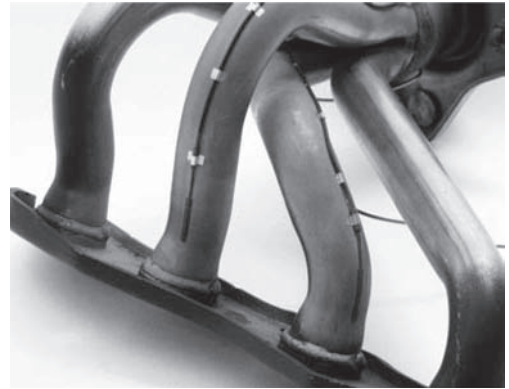


Leadwire Cable Code  
C2M  
C2MV  
C2MF  
C2MFV

**KHC-10-120-G9- 11  
16**

**Uniaxial 2-element,  
temperature compensation**

Gage Factor	Approx. 1.5 (500°C)
Flange Size	16.5 × 5 × 0.1 mm
Gage Length	10 mm
Resistance	120 Ω
Pieces per Pack1	



When ordering, specify the model number as follows:

**KHC-□-120-□-□** Leadwire Cable Code

e.g.

**KHC-10-120-G8-11 C2M**

Type of Leadwire Cable	Oprg. Temp. Range	Leadwire Length	Leadwire Cable Code
Polyethylene-coated cross-link 3-conductor cable	-196 to 550°C	MI cable 2 m Soft cable 50 cm	C2M
Polyethylene-coated cross-link 3-conductor cable with bridge adapter	-196 to 550°C	MI cable 2 m Soft cable 50 cm	C2MV
Polyethylene-coated cross-link 3-conductor cable with compression fitting	-196 to 550°C	MI cable 2 m Soft cable 50 cm	C2MF
Polyethylene-coated cross-link 3-conductor cable with compression fitting and bridge adapter	-196 to 550°C	MI cable 2 m Soft cable 50 cm	C2MFV

# High-temperature Gages

# KFU

- Gage Factor Approx. 1.8 (350°C)
- Applicable Linear Expansion Coefficients 11, 16, 23 ( $\times 10^{-6}/^{\circ}\text{C}$ )
- Self-temperature-compensation Range 10 to 300°C

Applicable Adhesives and Operating Temperature Ranges  
 PI-32: -196 to 350°C


## High-temperature Foil Strain Gages

The base is made of highly heat-resistant polyimide and the gage element is made of NiCr alloy foil, thereby letting the KFU gages exhibit superior characteristics over a wide temperature range.

### Types, lengths and codes of leadwire cables pre-attached to KFU gages

Type	High/low temp 3-wire cable	Glass-coated cable of 3 Ni-clad copper wires
Length	C1, D16, D17	
15 cm	H15C3	B15C3
30	H30C3	B30C3
50	H50C3	B50C3
1m	H1M3	B1M3
2	H2M3	B2M3
3	H3M3	B3M3
4	H4M3	B4M3
5	H5M3	B5M3
6	H6M3	B6M3
8	H8M3	B8M3
10	H10M3	B10M3
15	H15M3	B15M3
20	H20M3	B20M3
30 m	H30M3	B30M3
Oprg. temp. range	-196 to 350°C	Room temp. to 280°C
Remarks	L-17	

## KFU Gages • Uniaxial/Biaxial




Leadwire Cable Code

H1M3  
H3M3  
H5M3  
B1M3  
B3M3  
B5M3

**KFU-5-120-C1- 11  
16  
23**

**Uniaxial**

Base Size	10 x 3.7 mm
Gage Length	5 mm
Resistance	120 Ω
Pieces per Pack	10



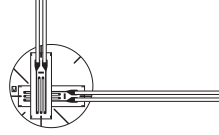
Leadwire Cable Code

H1M3  
H3M3  
H5M3  
B1M3  
B3M3  
B5M3

**KFU-2-120-C1- 11  
16  
23**

**Uniaxial**

Base Size	6 x 3.7 mm
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	10



Leadwire Cable Code

H1M3  
H3M3  
H5M3  
B1M3  
B3M3  
B5M3

**KFU-5-120-D16-11  
16  
23**

**Biaxial. 0°/90° stacked rosette**

Base Size	11 mm φ
Gage Length	5 mm
Resistance	120 Ω
Pieces per Pack	10

When ordering, specify the model number as follows:

**KFU-□-□-□-□** Leadwire Cable Code

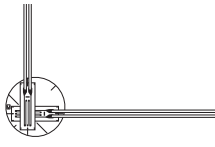
(e.g.)  
**KFU-5-120-C1-11 H1M3**

Leadwire Cable – Type and Shape	Oprg. Temp. Range	Leadwire Length	Leadwire Cable Code
High/low temp. 3-wire cable L-17	-196 to 350°C	1 m	H1M3
		3 m	H3M3
		5 m	H5M3
Glass-coated cable of 3 Ni-clad copper wires	Room temp. to 280°C	1 m	B1M3
		3 m	B3M3
		5 m	B5M3
Advance ribbon cable	-196 to 350°C	25 mm	

Strain Gage Model Number  
 Coding System  
 How strain gages work.  
 Static Strain and Dynamic Strain  
 Unknown physical quantities such as load, pressure and displacement can be revealed through strain measurement.  
 Selecting a Strain Gage  
 Strain Gages

# KFU Gages

## ● Biaxial/Triaxial/Uniaxial 350 Ω/Biaxial 350 Ω/Triaxial 350 Ω

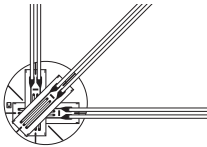


**KFU-2-120-D16-11**  
16  
23

**Biaxial, 0°/90° stacked rosette**

Base Size	8 mm φ
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire Cable Code  
H1M3  
H3M3  
H5M3  
B1M3  
B3M3  
B5M3

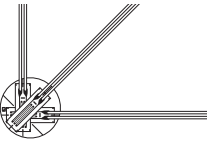


**KFU-5-120-D17-11**  
16  
23

**Triaxial, 0°/90°/45° stacked rosette**

Base Size	11 mm φ
Gage Length	5 mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire Cable Code  
H1M3  
H3M3  
H5M3  
B1M3  
B3M3  
B5M3




**KFU-2-120-D17-11**  
16  
23

**Triaxial, 0°/90°/45° stacked rosette**

Base Size	8 mm φ
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire Cable Code  
H1M3  
H3M3  
H5M3  
B1M3  
B3M3  
B5M3




**KFU-5-350-C1-11**  
16  
23

**Uniaxial 350 Ω**

Base Size	10 x 3.7 mm
Gage Length	5 mm
Resistance	350 Ω
Pieces per Pack	10

Leadwire Cable Code  
H1M3  
H3M3  
H5M3  
B1M3  
B3M3  
B5M3

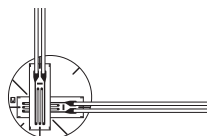


**KFU-2-350-C1-11**  
16  
23

**Uniaxial 350 Ω**

Base Size	6 x 3.7 mm
Gage Length	2 mm
Resistance	350 Ω
Pieces per Pack	10

Leadwire Cable Code  
H1M3  
H3M3  
H5M3  
B1M3  
B3M3  
B5M3

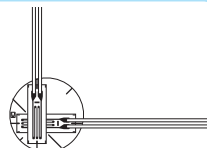


**KFU-5-350-D16-11**  
16  
23

**Biaxial, 0°/90° stacked rosette, 350 Ω**

Base Size	11 mm
Gage Length	5 mm
Resistance	350 Ω
Pieces per Pack	10

Leadwire Cable Code  
H1M3  
H3M3  
H5M3  
B1M3  
B3M3  
B5M3

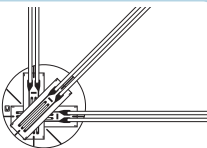


**KFU-2-350-D16-11**  
16  
23

**Biaxial, 0°/90° stacked rosette, 350 Ω**

Base Size	10 mm φ
Gage Length	2 mm
Resistance	350 Ω
Pieces per Pack	10

Leadwire Cable Code  
H1M3  
H3M3  
H5M3  
B1M3  
B3M3  
B5M3

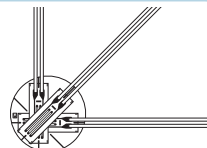


**KFU-5-350-D17-11**  
16  
23

**Triaxial, 0°/90°/45° stacked rosette, 350 Ω**

Base Size	11 mm φ
Gage Length	5 mm
Resistance	350 Ω
Pieces per Pack	10

Leadwire Cable Code  
H1M3  
H3M3  
H5M3  
B1M3  
B3M3  
B5M3



**KFU-2-350-D17-11**  
16  
23

**Triaxial, 0°/90°/45° stacked rosette, 350 Ω**

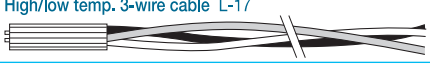


Base Size	10 mm φ
Gage Length	2 mm
Resistance	350 Ω
Pieces per Pack	10

Leadwire Cable Code  
H1M3  
H3M3  
H5M3  
B1M3  
B3M3  
B5M3

When ordering, specify the model number as follows:

**KFU-□-□-□-□** Leadwire Cable Code

e.g., **KFU-5-120-C1-11 H1M3**

Leadwire Cable – Type and Shape	Oprg. Temp. Range	Leadwire Length	Leadwire Cable Code
 <p>High/low temp. 3-wire cable L-17</p>	-196 to 350°C	1 m	H1M3
		3 m	H3M3
		5 m	H5M3
 <p>Glass-coated cable of 3 Ni-clad copper wires</p>	Room temp. to 280°C	1 m	B1M3
		3 m	B3M3
		5 m	B5M3
 <p>Advance ribbon cable</p>	-196 to 350°C	25 mm	

- Gage Factor Approx. 2.0 (350°C)
- Applicable Linear Expansion Coefficients 11, 16 ( $\times 10^{-6}/^{\circ}\text{C}$ )
- Self-temperature-compensation Range 10 to 300°C

Mounting Method and Operating Temperature Range  
Spot welding: -50 to 350°C

## High-temperature Foil Strain Gages

The G4 type KH gages are 350 Ω gages with a metal base which enables easy mounting with a compact spot welder.

## KH Gages

### Uniaxial



Leadwire Cable Code

D1M3  
D3M3  
D5M3

**KH-5-350-G4- 11  
16**

### Uniaxial 350 Ω



Base Size	30 x 8 mm
Gage Length	5 mm
Resistance	350 Ω
Pieces per Pack	5

### Types, lengths and codes of leadwire cables pre-attached to KFU gages

Type Length	Glass-coated cable of 3 Ni-clad copper wires	
	G4	
15 cm	D15C3	
30	D30C3	
50	D50C3	
1m	D1M3	
2	D2M3	
3	D3M3	
4	D4M3	
5	D5M3	
6	D6M3	
8	D8M3	
10	D10M3	
15	D15M3	
20	D20M3	
30 m	D30M3	
Oprg. temp. range	-50 to 350°C	

When ordering, specify the model number as follows:

**KH-5-350-G4-**  **Leadwire Cable Code**

Leadwire Cable – Type and Shape	Oprg. Temp. Range	Leadwire Length	Leadwire Cable Code
Glass-coated cable of 3 Ni-clad copper wires 	-50 to 350°C	1 m	D1M3
		3 m	D3M3
		5 m	D5M3
Advance ribbon cable 	-50 to 350°C	20 mm	

(e.g.)

**KH-5-350-G4-11 D1M3**



- Gage Factor Approx. 1.9 (250°C)
- Applicable Linear Expansion Coefficients 11, 16, 23 ( $\times 10^{-6}/^{\circ}\text{C}$ )
- Self-temperature-compensation Range 10 to 250°C

### Applicable Adhesives and Operating Temperature Ranges

- PC-600: -196 to 250°C
- EP-34B: -55 to 200°C
- PI-32: -196 to 250°C

## High-temperature Foil Strain Gages

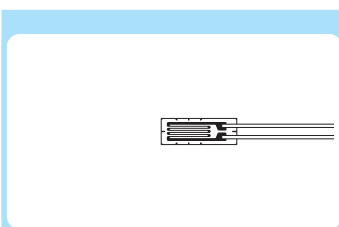
The base is made of highly heat-resistant polyimide and the gage element is made of NiCr alloy foil, thereby ensuring less thermal output and excellent temperature characteristics.

### Types, lengths and codes of leadwire cables pre-attached to KH gages

Type	High/low-temp. 3-wire cable	Glass-coated cable of 3 Ni-clad copper wires	Fluoroplastic-coated high/low-temp. 3-wire cable
Length	C1, D25		
15 cm	H15C3	B15C3	F15C3
30	H30C3	B30C3	F30C3
50	H50C3	B50C3	F50C3
1 m	H1M3	B1M3	F1M3
2	H2M3	B2M3	F2M3
3	H3M3	B3M3	F3M3
4	H4M3	B4M3	F4M3
5	H5M3	B5M3	F5M3
6	H6M3	B6M3	F6M3
8	H8M3	B8M3	F8M3
10	H10M3	B10M3	F10M3
15	H15M3	B15M3	F15M3
20	H20M3	B20M3	F20M3
30 m	H30M3	B30M3	F30M3
Orig. temp. range	-196 to 250°C	Room. temp. to 250°C	-196 to 250°C
Remarks	L-17		L-3

## KFH Gages

### Uniaxial



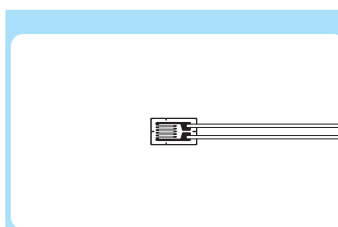
Leadwire Cable Code

H1M3  
H3M3  
H5M3  
B1M3  
B3M3  
B5M3  
F1M3  
F3M3  
F5M3

**KFH-5-120-C1- 11  
16  
23**

#### Uniaxial

Base Size	10 x 3.7 mm
Gage Length	5 mm
Resistance	120 Ω
Pieces per Pack	10



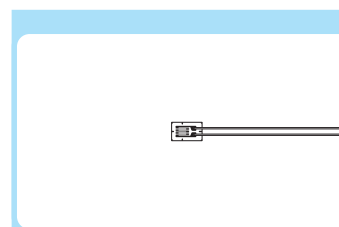
Leadwire Cable Code

H1M3  
H3M3  
H5M3  
B1M3  
B3M3  
B5M3  
F1M3  
F3M3  
F5M3

**KFH-2-120-C1- 11  
16  
23**

#### Uniaxial

Base Size	6 x 3.7 mm
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	10



Leadwire Cable Code

H1M3  
H3M3  
H5M3  
B1M3  
B3M3  
B5M3  
F1M3  
F3M3  
F5M3

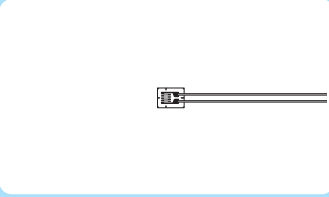
**KFH-1-120-C1- 11  
16  
23**

#### Uniaxial

Base Size	4 x 2.7 mm
Gage Length	1 mm
Resistance	120 Ω
Pieces per Pack	10

# KFH Gages

## ● Biaxial/Triaxial/Uniaxial 350 Ω



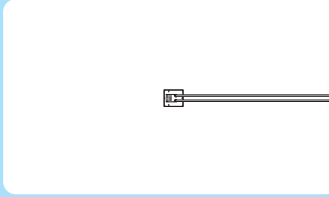
**Leadwire Cable Code**

H1M3  
H3M3  
H5M3  
B1M3  
B3M3  
B5M3  
F1M3  
F3M3  
F5M3

**KFH-05-120-C1- 11**  
**16**  
**23**

**Uniaxial**

Base Size	3.3 x 2.7 mm
Gage Length	0.5 mm
Resistance	120 Ω
Pieces per Pack	10



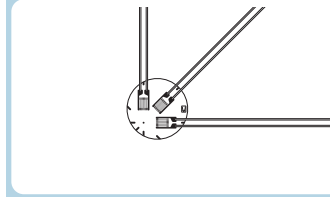
**Leadwire Cable Code**

H1M3  
H3M3  
H5M3  
B1M3  
B3M3  
B5M3  
F1M3  
F3M3  
F5M3

**KFH-02-120-C1- 11**  
**16**  
**23**

**Uniaxial**

Base Size	2.5 x 2.2 mm
Gage Length	0.2 mm
Resistance	120 Ω
Pieces per Pack	10



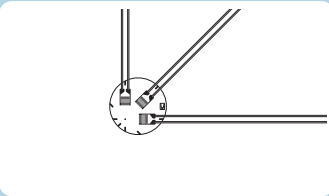
**Leadwire Cable Code**

H1M3  
H3M3  
H5M3  
B1M3  
B3M3  
B5M3  
F1M3  
F3M3  
F5M3

**KFH-1-120-D25- 11**  
**16**  
**23**

**Triaxial, 0°/90°/45°**

Base Size	8 mm φ
Gage Length	1 mm
Resistance	120 Ω
Pieces per Pack	5



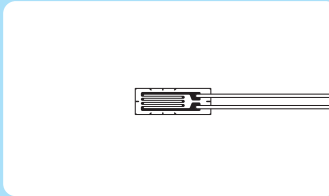
**Leadwire Cable Code**

H1M3  
H3M3  
H5M3  
B1M3  
B3M3  
B5M3  
F1M3  
F3M3  
F5M3

**KFH-05-120-D25-11**  
**16**  
**23**

**Triaxial, 0°/90°/45°**

Base Size	7.5 mm φ
Gage Length	0.5 mm
Resistance	120 Ω
Pieces per Pack	5



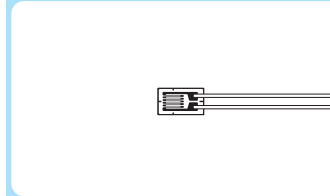
**Leadwire Cable Code**

H1M3  
H3M3  
H5M3  
B1M3  
B3M3  
B5M3  
F1M3  
F3M3  
F5M3

**KFH-5-350-C1- 11**  
**16**  
**23**

**Uniaxial 350 Ω**

Base Size	10 x 3.7 mm
Gage Length	5 mm
Resistance	350 Ω
Pieces per Pack	10



**Leadwire Cable Code**

H1M3  
H3M3  
H5M3  
B1M3  
B3M3  
B5M3  
F1M3  
F3M3  
F5M3

**KFH-2-350-C1- 11**  
**16**  
**23**

**Uniaxial 350 Ω**





Base Size	6 x 3.7 mm
Gage Length	2 mm
Resistance	350 Ω
Pieces per Pack	10

When ordering, specify the model number as follows:

**KFH-□-□-□-□** **Leadwire Cable Code**

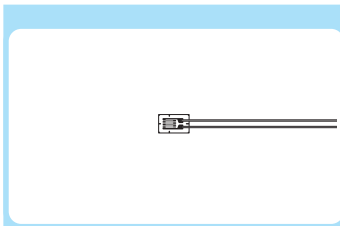
e.g.

**KFH-5-120-C1-11 H1M3**

Leadwire Cable – Type and Shape	Oprg. Temp. Range	Leadwire Length	Leadwire Cable Code
High/low temp. 3-wire cable L-17 	-196 to 250°C	1 m	H1M3
		3 m	H3M3
		5 m	H5M3
Glass-coated cable of 3 Ni-clad copper wires 	Room temp. to 250°C	1 m	B1M3
		3 m	B3M3
		5 m	B5M3
Fluoroplastic-coated high/low temp. 3-wire cable L-3 	-196 to 250°C	1 m	F1M3
		3 m	F3M3
		5 m	F5M3
Advance ribbon cable 	-196 to 250°C	25 mm	

# KFH Gages

## Uniaxial 350 Ω

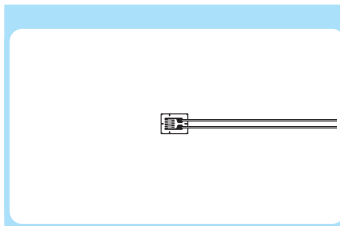


Leadwire Cable Code  
 H1M3  
 H3M3  
 H5M3  
 B1M3  
 B3M3  
 B5M3  
 F1M3  
 F3M3  
 F5M3

**KFH-1-350-C1- 11**  
**16**  
**23**

### Uniaxial 350 Ω

Base Size	4 x 2.7 mm
Gage Length	1 mm
Resistance	350 Ω
Pieces per Pack	10

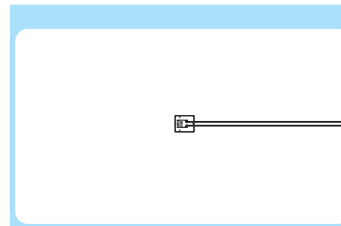


Leadwire Cable Code  
 H1M3  
 H3M3  
 H5M3  
 B1M3  
 B3M3  
 B5M3  
 F1M3  
 F3M3  
 F5M3

**KFH-05-350-C1- 11**  
**16**  
**23**

### Uniaxial 350 Ω

Base Size	3.5 x 2.7 mm
Gage Length	0.5 mm
Resistance	350 Ω
Pieces per Pack	10

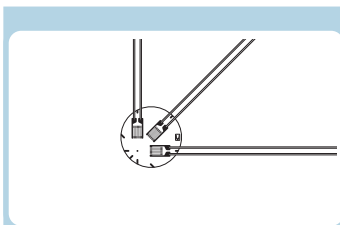


Leadwire Cable Code  
 H1M3  
 H3M3  
 H5M3  
 B1M3  
 B3M3  
 B5M3  
 F1M3  
 F3M3  
 F5M3

**KFH-02-350-C1- 11**  
**16**  
**23**

### Uniaxial 350 Ω

Base Size	3.0 x 2.7 mm
Gage Length	0.2 mm
Resistance	350 Ω
Pieces per Pack	10

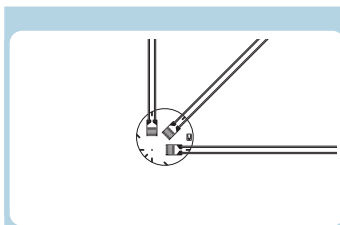


Leadwire Cable Code  
 H1M3  
 H3M3  
 H5M3  
 B1M3  
 B3M3  
 B5M3  
 F1M3  
 F3M3  
 F5M3

**KFH-1-350-D25- 11**  
**16**  
**23**

### Triaxial, 0°/90°/45°, 350 Ω

Base Size	8 mm φ
Gage Length	1 mm
Resistance	350 Ω
Pieces per Pack	5



Leadwire Cable Code  
 H1M3  
 H3M3  
 H5M3  
 B1M3  
 B3M3  
 B5M3  
 F1M3  
 F3M3  
 F5M3

**KFH-05-350-D25- 11**  
**16**  
**23**

### Triaxial, 0°/90°/45°, 350 Ω

Base Size	7.5 mm φ
Gage Length	0.5 mm
Resistance	350 Ω
Pieces per Pack	5

When ordering, specify the model number as follows:

**KFH-□-□-□-□** Leadwire Cable Code



**KFH-5-120-C1-11 H1M3**

Leadwire Cable – Type and Shape	Oprg. Temp. Range	Leadwire Length	Leadwire Cable Code
High/low temp. 3-wire cable L-17 	-196 to 250°C	1 m	H1M3
		3 m	H3M3
		5 m	H5M3
Glass-coated cable of 3 Ni-clad copper wires 	Room temp. to 250°C	1 m	B1M3
		3 m	B3M3
		5 m	B5M3
Fluoroplastic-coated high/low temp. 3-wire cable L-3 	-196 to 250°C	1 m	F1M3
		3 m	F3M3
		5 m	F5M3
Advance ribbon cable 	-196 to 250°C	25 mm	

- Gage Factor Approx. 2.1
- Applicable Linear Expansion Coefficients 5, 11, 16, 23 ( $\times 10^{-6}/^{\circ}\text{C}$ )
- Self-temperature-compensation Range -196 to 50°C

#### Applicable Adhesives and Operating Temperature Ranges

PC-600: -269 to 150°C  
 CC-33A: -196 to 120°C

## Low-temperature Foil Strain Gages

The gage element is made of NiCr alloy, which exhibits excellent characteristics under low-temperature environments and is sandwiched between polyimide films. Thus, the KFL gages are suitable for strain measurement of tanks and vessels containing low-temperature liquids such as LNG and LPG.

### Types, lengths and codes of leadwire cables pre-attached to KFL gages

Type	2 polyester-coated copper wires	3 polyester-coated copper wires	Middle-temp. 2-wire cable	Middle-temp. 3-wire cable	Fluoroplastic-coated high/low-temp. 3-wire cable
Length	C1, D25				
2 cm	N2C2	N2C3			
3	N3C2	N3C3			
4	N4C2	N4C3			
5	N5C2	N5C3			
10	N10C2	N10C3			
15	N15C2	N15C3	R15C2	R15C3	F15C3
30	N30C2	N30C3	R30C2	R30C3	F30C3
50	N50C2	N50C3	R50C2	R50C3	F50C3
1 m	N1M2	N1M3	R1M2	R1M3	F1M3
2			R2M2	R2M3	F2M3
3			R3M2	R3M3	F3M3
4			R4M2	R4M3	F4M3
5			R5M2	R5M3	F5M3
6			R6M2	R6M3	F6M3
8			R8M2	R8M3	F8M3
10			R10M2	R10M3	F10M3
15			R15M2	R15M3	F15M3
20			R20M2	R20M3	F20M3
30 m			R30M2	R30M3	F30M3
Oprg. temp. range	-196 to 150°C		-100 to 150°C		-196 to 150°C
Remarks	Twisted for 50 cm and 1 m long		L-11	L-12	L-3

# KFL Gages

## ● Uniaxial/Uniaxial 350 Ω



**KFL-5-120-C1- 11**  
**16**  
**23**

### Uniaxial

Base Size	10 x 3.7 mm
Gage Length	5 mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire  
Cable Code

F1M3  
F3M3  
F5M3  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2



**KFL-2-120-C1- 11**  
**16**  
**23**

### Uniaxial

Base Size	6 x 3.7 mm
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire  
Cable Code

F1M3  
F3M3  
F5M3  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2



**KFL-1-120-C1- 11**  
**16**  
**23**

### Uniaxial

Base Size	4 x 2.7 mm
Gage Length	1 mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire  
Cable Code

F1M3  
F3M3  
F5M3  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C2  
N50C2  
N1M2



**KFL-05-120-C1- 11**  
**16**  
**23**

### Uniaxial

Base Size	3.3 x 2.7 mm
Gage Length	0.5 mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire  
Cable Code

F1M3  
F3M3  
F5M3  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C2  
N50C2  
N1M2



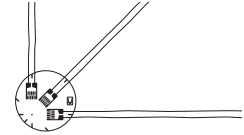
**KFL-02-120-C1- 11**  
**16**  
**23**

### Uniaxial

Base Size	2.5 x 2.2 mm
Gage Length	0.2 mm
Resistance	120 Ω
Pieces per Pack	10

Leadwire  
Cable Code

F1M3  
F3M3  
F5M3  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C2  
N50C2  
N1M2



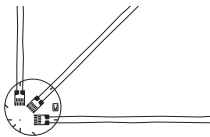
**KFL-1-120-D25- 11**  
**16**  
**23**

### Triaxial, 0°/90°/45°

Base Size	8 mm φ
Gage Length	1 mm
Resistance	120 Ω
Pieces per Pack	5

Leadwire  
Cable Code

F1M3  
F3M3  
F5M3  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C2  
N50C2  
N1M2



**KFL-05-120-D25- 11**  
**16**  
**23**

### Triaxial, 0°/90°/45°

Base Size	7.5 mm φ
Gage Length	0.5 mm
Resistance	120 Ω
Pieces per Pack	5

Leadwire  
Cable Code

F1M3  
F3M3  
F5M3  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C2  
N50C2  
N1M2



**KFL-5-350-C1- 11**  
**16**  
**23**

### Uniaxial 350 Ω

Base Size	10 x 3.7 mm
Gage Length	5 mm
Resistance	350 Ω
Pieces per Pack	10

Leadwire  
Cable Code

F1M3  
F3M3  
F5M3  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2



**KFL-2-350-C1- 11**  
**16**  
**23**

### Uniaxial 350 Ω


Base Size	6 x 3.7 mm
Gage Length	2 mm
Resistance	350 Ω
Pieces per Pack	10

Leadwire  
Cable Code

F1M3  
F3M3  
F5M3  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2

# KFL Gages

## ● Uniaxial 350 Ω/Triaxial 350 Ω/Uniaxial 350 Ω for concrete and lumber




**Leadwire Cable Code**

F1M3  
F3M3  
F5M3  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C2  
N50C2  
N1M2

**KFL-1-350-C1- 11**  
**16**  
**23**

**Uniaxial 350 Ω**

Base Size	4 x 2.7 mm
Gage Length	1 mm
Resistance	350 Ω
Pieces per Pack	10




**Leadwire Cable Code**

F1M3  
F3M3  
F5M3  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C2  
N50C2  
N1M2

**KFL-05-350-C1- 11**  
**16**  
**23**

**Uniaxial 350 Ω**

Base Size	3.5 x 2.7 mm
Gage Length	0.5 mm
Resistance	350 Ω
Pieces per Pack	10



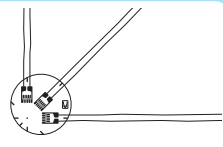
**Leadwire Cable Code**

F1M3  
F3M3  
F5M3  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C2  
N50C2  
N1M2

**KFL-02-350-C1- 11**  
**16**  
**23**

**Uniaxial 350 Ω**

Base Size	3 x 2.7 mm
Gage Length	0.2 mm
Resistance	350 Ω
Pieces per Pack	10



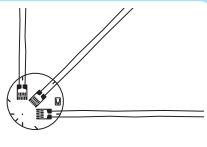
**Leadwire Cable Code**

F1M3  
F3M3  
F5M3  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C2  
N50C2  
N1M2

**KFL-1-350-D25- 11**  
**16**  
**23**

**Triaxial, 0°/90°/45°, 350 Ω**

Base Size	8 mm φ
Gage Length	1 mm
Resistance	350 Ω
Pieces per Pack	5




**Leadwire Cable Code**

F1M3  
F3M3  
F5M3  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C2  
N50C2  
N1M2

**KFL-05-350-D25- 11**  
**16**  
**23**

**Triaxial, 0°/90°/45°, 350 Ω**

Base Size	7.5 mm φ
Gage Length	0.5 mm
Resistance	350 Ω
Pieces per Pack	5



**Leadwire Cable Code**

F1M3  
F3M3  
F5M3  
R1M3  
R3M3  
R5M3  
R1M2  
R3M2  
R5M2  
N30C3  
N50C3  
N1M3  
N30C2  
N50C2  
N1M2

**KFL-30-350-C1- 11**  
**5**

**Uniaxial 350 Ω for concrete and lumber**


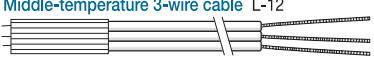
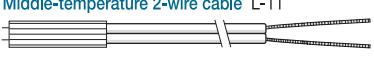
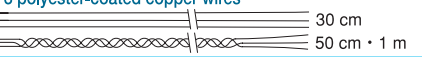
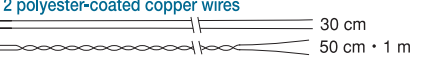

Base Size	36 x 5.2 mm
Gage Length	30 mm
Resistance	350 Ω
Applicable Linear Expansion Coefficient	5 (lumber) 11 (concrete)
Pieces per Pack	10

When ordering, specify the model number as follows:

**KFL-□-□-□-□** Leadwire Cable Code



**KFL-5-120-C1-11 F1M3**

Leadwire Cable – Type and Shape	Oprg. Temp. Range	Leadwire Length	Leadwire Cable Code
 Fluoroplastic-coated high/low temp. 3-wire cable L-3	-196 to 150°C	1 m	F1M3
		3 m	F3M3
		5 m	F5M3
 Middle-temperature 3-wire cable L-12	-100 to 150°C	1 m	R1M3
		3 m	R3M3
		5 m	R5M3
 Middle-temperature 2-wire cable L-11	-100 to 150°C	1 m	R1M2
		3 m	R3M2
		5 m	R5M2
 3 polyester-coated copper wires	-196 to 150°C	30 cm	N30C3
		50 cm	N50C3
		1 m	N1M3
		50 cm · 1 m	N1M3
 2 polyester-coated copper wires	-196 to 150°C	30 cm	N30C2
		50 cm	N50C2
		1 m	N1M2
 Silver-clad copper wires	-196 to 150°C	25 mm	

Strain Gage Model Number

How strain gages work.

Static Strain and Dynamic Strain

Unknown physical quantities such as load, pressure and displacement can be revealed through strain measurement.

Selecting a Strain Gage

Strain Gages

# High-elongation Strain Gages

# KFEM

● Resistance	120 Ω
● Gage Factor	Approx. 2.0
● Operating Temperature Range	-20 to 80°C
● Strain Limit at Room Temperature	20 to 30%
● Applicable Adhesive	CC-36

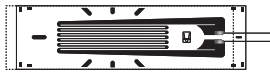
- Strain limit of 20 to 30% is ensured for simple tension applied to the gage bonded on stainless steel (SUS 304) or aluminum alloy (A1050) at normal temperature.
- Strain limit is lowered in the following cases:
  - The measuring object is a difficult-to-bond aluminum alloy (A7075) or plastics (polypropylene, etc.)
  - The transformation of the material is discontinuous.
  - Crack is caused on the surface.
  - Measurement at high/low temperatures.

## ■ Ultrahigh-Elongation Foil Strain Gages

KFEM series ultrahigh-elongation foil gages can measure strain in elastic to plastic region on structures and are suitable for large strain measurement or rupture tests of metals (steel, stainless steel, aluminum) and plastics (polyethylene, polypropylene).

- Measurement of 20 to 30% material deformation possible
- Laminate protruded from the tip of gage base ensures improved adhesive property, making the gages hard to peel off.
- Foil material has an improved elongation property and is hard to disconnect.

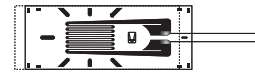
## KFEM Gages ● Uniaxial



**KFEM-5-120-C1**

### Uniaxial

Base Size	11.5 x 3 mm
Gage Length	5 mm
Resistance	120 Ω
Pieces per Pack	10



**KFEM-2-120-C1**

### Uniaxial

Base Size	8.5 x 3 mm
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	10

When ordering, specify the model number as follows:

**KFEM-□-120-C1** Leadwire Cable Code

e.g.

**KFEM-5-120-C1**

## ■ Types, lengths and codes of leadwire cables pre-attached to KFEM gages

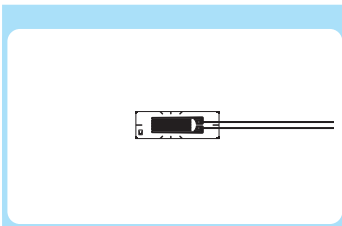
Type	2 polyester-coated copper wires	Vinyl-coated flat 2-wire cable	Vinyl-coated flat 3-wire cable
Length	C1	C1	C1
2 cm	N2C2		
3	N3C2		
4	N4C2		
5	N5C2		
10	N10C2		
15	N15C2	L15C2R	L15C3R
30	N30C2	L30C2R	L30C3R
50	N50C2	L50C2R	L50C3R
1 m	N1M2	L1M2R	L1M3R
2		L2M2R	L2M3R
3		L3M2R	L3M3R
4		L4M2R	L4M3R
5		L5M2R	L5M3R
6		L6M2R	L6M3R
8		L8M2R	L8M3R
10		L10M2R	L10M3R
15		L15M2R	L15M3R
20		L20M2R	L20M3R
30 m		L30M2R	L30M3R
Oprg. temp. range	-10 to 80°C		
Remarks	Twisted for 50 cm and 1 m long	L-6; L-9 for 6 m or longer	L-7; L-10 for 6 m or longer





# KFEL Gages

## Uniaxial/Biaxial/Triaxial

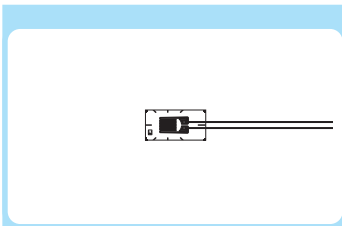


Leadwire Cable Code  
**L1M3R**  
**L3M3R**  
**L5M3R**  
**L1M2R**  
**L3M2R**  
**L5M2R**  
**N30C2**  
**N50C2**  
**N1M2**

**KFEL-5-120-C1**

**Uniaxial**

Base Size	11 x 3.5 mm
Gage Length	5 mm
Resistance	120 Ω
Pieces per Pack	10

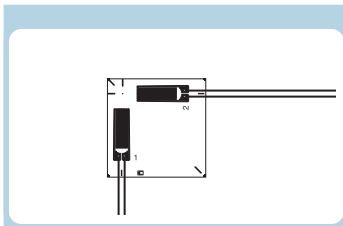


Leadwire Cable Code  
**L1M3R**  
**L3M3R**  
**L5M3R**  
**L1M2R**  
**L3M2R**  
**L5M2R**  
**N30C2**  
**N50C2**  
**N1M2**

**KFEL-2-120-C1**

**Uniaxial**

Base Size	8 x 4 mm
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	10

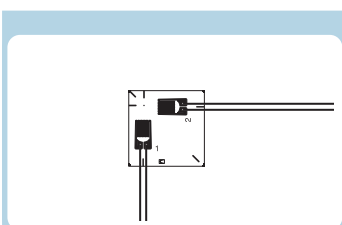


Leadwire Cable Code  
**L1M3S**  
**L3M3S**  
**L5M3S**  
**L1M2S**  
**L3M2S**  
**L5M2S**  
**N30C2**  
**N50C2**  
**N1M2**

**KFEL-5-120-D34**

**Biaxial, 0°/90°**

Base Size	13 x 13 mm
Gage Length	5 mm
Resistance	120 Ω
Pieces per Pack	10

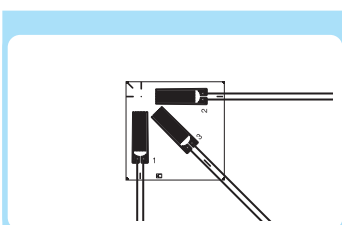


Leadwire Cable Code  
**L1M3S**  
**L3M3S**  
**L5M3S**  
**L1M2S**  
**L3M2S**  
**L5M2S**  
**N30C2**  
**N50C2**  
**N1M2**

**KFEL-2-120-D34**

**Biaxial, 0°/90°**

Base Size	10 x 10 mm
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	10

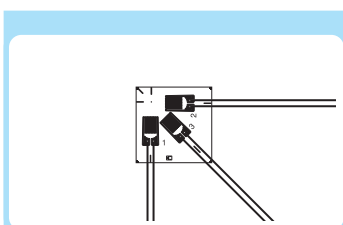


Leadwire Cable Code  
**L1M3S**  
**L3M3S**  
**L5M3S**  
**L1M2S**  
**L3M2S**  
**L5M2S**  
**N30C2**  
**N50C2**  
**N1M2**

**KFEL-5-120-D35**

**Triaxial, 0°/90°/45°**

Base Size	13 x 13 mm
Gage Length	5 mm
Resistance	120 Ω
Pieces per Pack	10



Leadwire Cable Code  
**L1M3S**  
**L3M3S**  
**L5M3S**  
**L1M2S**  
**L3M2S**  
**L5M2S**  
**N30C2**  
**N50C2**  
**N1M2**

**KFEL-2-120-D35**

**Triaxial, 0°/90°/45°**

Base Size	10 x 10 mm
Gage Length	2 mm
Resistance	120 Ω
Pieces per Pack	10

When ordering, specify the model number as follows:



e.g.  
**KFEL-5-120-C1 L1M3R**

Leadwire Cable – Type and Shape	Oprg. Temp. Range	Leadwire Length	Leadwire Cable Code
Vinyl-coated flat 3-wire cable L-7 (L-10 for 6 m or longer) 	-10 to 80°C	1 m	<b>L1M3R</b> ; <b>L1M3S</b>
		3 m	<b>L3M3R</b> ; <b>L3M3S</b>
		5 m	<b>L5M3R</b> ; <b>L5M3S</b>
Vinyl-coated flat 2-wire cable L-6 (L-9 for 6m or longer) 	-10 to 80°C	1 m	<b>L1M2R</b> ; <b>L1M2S</b>
		3 m	<b>L3M2R</b> ; <b>L3M2S</b>
		5 m	<b>L5M2R</b> ; <b>L5M2S</b>
2 polyester-coated copper wires 	-10 to 80°C	30 cm	<b>N30C2</b>
		50 cm	<b>N50C2</b>
		50 cm • 1 m	<b>N1M2</b>
Silver-clad copper wires 	-10 to 80°C	25 mm	

# Non-magneto-resistive Gages

# KFN

- Gage Factor Approx. 2.0
- Applicable Linear Expansion Coefficients 11, 16, 23 ( $\times 10^{-6}/^{\circ}\text{C}$ )
- Self-temperature-compensation Range 0 to 150°C

### Applicable Adhesives and Operating Temperature Ranges

PC-600: -196 to 150°C  
 CC-33A: -196 to 120°C

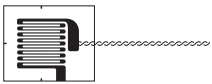
### Types, lengths and codes of leadwire cables pre-attached to KFN gages

Type Length	Vinyl-coated low-noise 3-wire cable
	C9, D20
15 cm	J15C3
30	J30C3
50	J50C3
1 m	J1M3
2	J2M3
3	J3M3
4	J4M3
5	J5M3
6	J6M3
8	J8M3
10	J10M3
15	J15M3
20	J20M3
30 m	J30M3
Oprg. temp. range	-10 to 80°C
Remarks	L-13

## Noninductive Foil Strain Gages

The gage element is made of a special alloy which provides less magneto-resistive effect; also, the shape is designed to eliminate induction. Thus, the KFN gages can accurately measure strain under AC magnetic field environments.

## KFN Gages ● Uniaxial 350 Ω/Biaxial 350 Ω

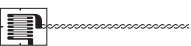


Leadwire Cable Code  
**J1M3  
 J3M3  
 J5M3**

**KFN-5-350-C9- 11  
 16  
 23**

**Uniaxial 350 Ω**

Base Size	12 x 10 mm
Gage Length	5 mm
Resistance	350 Ω
Pieces per Pack	10

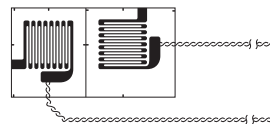


Leadwire Cable Code  
**J1M3  
 J3M3  
 J5M3**

**KFN-2-350-C9- 11  
 16  
 23**

**Uniaxial 350 Ω**

Base Size	6 x 5 mm
Gage Length	2 mm
Resistance	350 Ω
Pieces per Pack	10

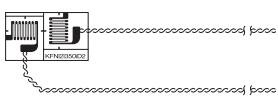


Leadwire Cable Code  
**J1M3  
 J3M3  
 J5M3**

**KFN-5-350-D20- 11  
 16  
 23**

**Biaxial, 0°/90°, 350 Ω**

Base Size	22 x 12 mm
Gage Length	5 mm
Resistance	350 Ω
Pieces per Pack	5



Leadwire Cable Code  
**J1M3  
 J3M3  
 J5M3**

**KFN-2-350-D20- 11  
 16  
 23**

**Biaxial, 0°/90°, 350 Ω**

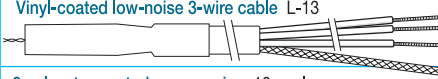
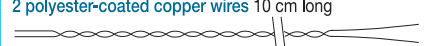
Base Size	11 x 6 mm
Gage Length	2 mm
Resistance	350 Ω
Pieces per Pack	5

When ordering, specify the model number as follows:

**KFN-□-350-□-□** Leadwire Cable Code

e.g.

**KFN-5-350-C9-11 J1M3**

Leadwire Cable - Type and Shape	Oprg. Temp. Range	Leadwire Length	Leadwire Cable Code
 Vinyl-coated low-noise 3-wire cable L-13	-10~80°C	1 m	<b>J1M3</b>
		3 m	<b>J3M3</b>
		5 m	<b>J5M3</b>
 2 polyester-coated copper wires 10 cm long	-196~150°C	25 mm	

# Non-magneto-resistive Gages

# KFS

- Applicable Linear Expansion Coefficients 11, 16, 23 ( $\times 10^{-6}/^{\circ}\text{C}$ )
- Self-temperature-compensation Range 10 to  $100^{\circ}\text{C}$

### Applicable Adhesives and Operating Temperature Ranges

PC-600:  $-196$  to  $150^{\circ}\text{C}$   
 CC-33A:  $-196$  to  $120^{\circ}\text{C}$

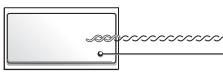
### Types, lengths and codes of leadwire cables pre-attached to KFS gages

Type	Vinyl-coated low-noise 3-wire cable
Length	C9, D20
15 cm	J15C3
30	J30C3
50	J50C3
1 m	J1M3
2	J2M3
3	J3M3
4	J4M3
5	J5M3
6	J6M3
8	J8M3
10	J10M3
15	J15M3
20	J20M3
30 m	J30M3
Oprg. temp. range	$-10$ to $80^{\circ}\text{C}$
Remarks	L-13

## Shielded Foil Strain Gages

The KFS gages are shielded by the copper foil covering the whole body. Thus, if a large current flows to or around the gage bonding site, noise is prevented from entering the measuring circuit.

## KFS Gages ● Uniaxial/Uniaxial 350 $\Omega$

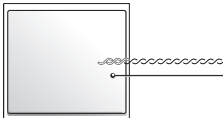


Leadwire Cable Code  
**J1M3**  
**J3M3**  
**J5M3**

**KFS-5-120-J1- 11**  
**16**  
**23**

**Uniaxial**

Gage Factor	Approx. 2.1
Base Size	15 x 10mm
Gage Length	5 mm
Resistance	120 $\Omega$
Pieces per Pack	10



Leadwire Cable Code  
**J1M3**  
**J3M3**  
**J5M3**

**KFS-5-350-J1- 11**  
**16**  
**23**

**Uniaxial 350  $\Omega$**

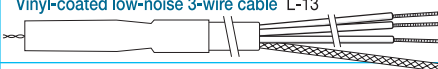

Gage Factor	Approx. 20
Base Size	17 x 16 mm
Gage Length	5 mm
Resistance	350 $\Omega$
Pieces per Pack	10

When ordering, specify the model number as follows:

**KFS-5-□-J1-□** Leadwire Cable Code

e.g.

**KFS-5-120-J1-11 J1M3**

Leadwire Cable - Type and Shape	Oprg. Temp. Range	Leadwire Length	Leadwire Cable Code
 Vinyl-coated low-noise 3-wire cable L-13	$-10 \sim 80^{\circ}\text{C}$	1 m	<b>J1M3</b>
		3 m	<b>J3M3</b>
		5 m	<b>J5M3</b>
 2 polyester-coated copper wires 10 cm long	$-196 \sim 150^{\circ}\text{C}$	25 mm	

# Bending-strain Measuring Gages

# KFF

- Gage Factor Approx. 2.1
- Applicable Linear Expansion Coefficients 11, 16, 23 ( $\times 10^{-6}/^{\circ}\text{C}$ )
- Self-temperature-compensation Range 20 to 60°C

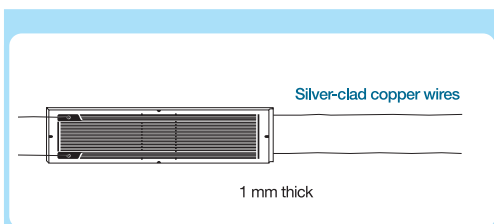
### Applicable Adhesives and Operating Temperature Ranges

- CC-33A: -50 to 80°C
- EP-34B -50 to 80°C
- EP-18 -50 to 80°C

## ■ Foil Strain Gages for Bending-strain Measurement

The KFF gages have one sensing element on both the upper and lower sides of the thick plastic base. Thus, if a gage cannot be bonded directly to the inside of the object under testing as in the case of measuring stress due to internal pressure in high-pressure vessels or stress measurement in box structures such as bridge girders, the KFF gages can be bonded to the surface to obtain strain at the rear.

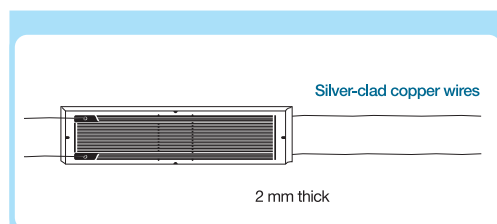
## KFF Gages ● Uniaxial 350 Ω



**KFF-30-350-C11-11**  
**16**  
**23**

### Uniaxial 2-element 350 Ω

Base Size	30 x 7 x 1 mm
Resistance	350 Ω
Pieces per Pack	5



**KFF-30-350-C12-11**  
**16**  
**23**

### Uniaxial 2-element 350 Ω

Base Size	30 x 7 x 2 mm
Resistance	350 Ω
Pieces per Pack	5



## ■ Foil Strain Gages with Protector

The unique design simplifies gage bonding, wiring and moisture-proofing work in the field. In addition, the metal case protects the strain gage and markedly improves reliability compared with conventional gages. Using stud bolts and adhesive, the gages can be mounted to the bottom and side plate of tank for strain measurement, to a hopper or tank for weight measurement, to the shaft of a truck for tare weight measurement or in any similar applications where the gages need to be protected against moisture, water or small stones. (Patent pending)

## KCH Gages ● Uniaxial/Uniaxial 350 Ω

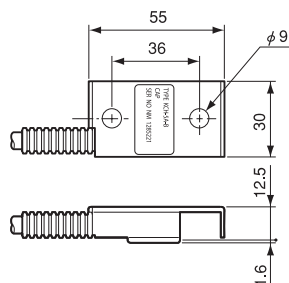
<p><b>KCH-5A-B</b> <b>KCH-5A-BJ</b></p> <p><b>Bridge</b> (for bending strain)</p> <p>Gage Length 2 mm</p> <p>Resistance 350 Ω</p> <p>Connection Full bridge</p>	<p><b>KCH-5A-S</b> <b>KCH-5A-SJ</b></p> <p><b>Bridge</b> (for shearing strain)</p> <p>Gage Length 2 mm</p> <p>Resistance 350 Ω</p> <p>Connection Full bridge</p>	<p><b>KCH-5A-1</b></p> <p><b>Uniaxial</b></p> <p>Gage Length 5 mm</p> <p>Resistance 350 Ω</p> <p>Connection 3-wire</p>	<p><b>KCH-5A-2</b></p> <p><b>Biaxial, 0°/90°</b> <b>stacked rosette</b></p> <p>Gage Length 5 mm</p> <p>Resistance 350 Ω</p> <p>Connection 3-wire</p>	<p><b>KCH-5A-3</b></p> <p><b>Triaxial, 0°/90°/45°</b> <b>stacked rosette</b></p> <p>Gage Length 5 mm</p> <p>Resistance 350 Ω</p> <p>Connection 2-wire</p>

### Cable

KCH-5A-B and S come with special flexible vinyl-shielded 4-conductor (0.3 mm<sup>2</sup>) cable, 10 m long, 6.8mm in outer diameter and bared at the tip; KCH-5A-BJ and SJ, with flexible vinyl-shielded 4-conductor (0.3 mm<sup>2</sup>) cable, 2 m long (cable cover 1.75 m long), 6.3mm in outer diameter (that of cable cover 10.2 mm) and terminated with waterproof connector plug (R04-P6-M6.8). Relay cables TN-29 to 33 are separately sold.

Comes with special flexible vinyl-shielded 4-conductor (0.3 mm<sup>2</sup>) cable, 10 m long, 6.8 mm in outer diameter and bared at the tip.

Come with special flexible vinyl-shielded 6-conductor (0.3 mm<sup>2</sup>) cable, 10 m long, 6.8 mm in outer diameter and bared at the tip.

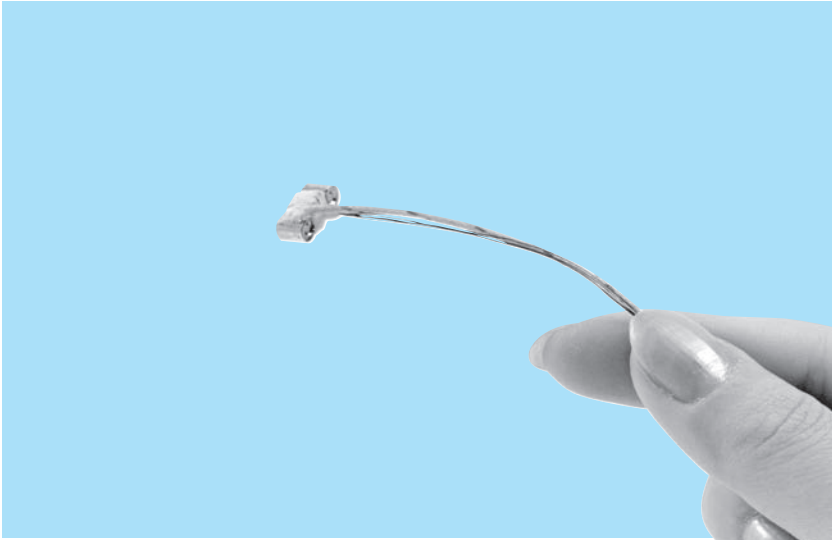


### ● Relay Cables (for KCH-5A-BJ/SJ) (Option)

Model	TN-29	TN-30	TN-31	TN-32	TN-33
Cable length	2 m	3 m	7 m	10 m	12 m
Cable cover length	1.5 m	2.5 m	6.5 m	9.5 m	11.5 m
Remarks	With waterproof connector jack (R04-J6-F6.8): the other end is bared.				

# Embeddable Gage

# KMP



## Embeddable Gage

Embedded in resin, the KMP gage measures cure-shrinkage and internal strain. The compact design enables embedment in shaped resins and is suitable for internal stress measurement of products made by combining epoxy resin and metal.

## KMP Gages

• This gage was developed by Mitsubishi Electric and commercialized by KYOWA.

When ordering, specify the model number as follows:

**KMP-9-H3-L100**

Resistance	Gage Factor	Length of Sensing Element	Apparent Young's Modulus	Oprg. Temp. Range	Built-in Thermocouple
120 Ω	Approx. 2.0	1 mm	Approx. 70 GPa	20 to 150°C	K (0.1 mm φ)

## ■ Crack Gages

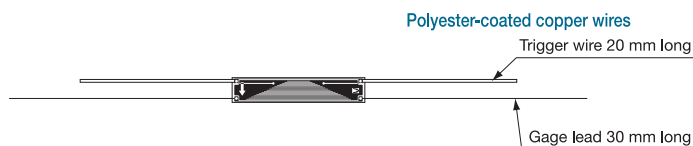
Bonded to a cracked or crack-expected part of structures and materials, the KV gages measure the propagation length and velocity of the crack. Different from usual strain gages, the grid of the KV gages is cut along with crack development, resulting in resistance change. (Utility model)

- Progress and propagation velocity of a crack are electrically obtained.

- High response speed
- Applicable to both flat and curved surfaces
- Resistance change versus crack length is virtually linear.
- Dedicated adapter enables use of a conventional strain amplifier.
- Extremely simple and convenient compared with the conventional optical method.
- 2 trigger wires each before and behind the grid (KV-5C) can be used for automation of measurement.

## KV Gages

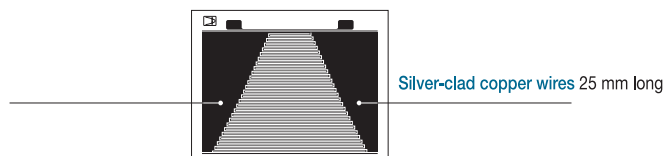
### ● Uniaxial



### KV-5C

#### Uniaxial

Base Size	30 x 5 mm
Resistance	Approx. 1 Ω
Pieces per Pack	5



### KV-25B

#### Uniaxial

Base Size	42 x 32 mm
Resistance	Approx. 1 Ω
Pieces per Pack	5

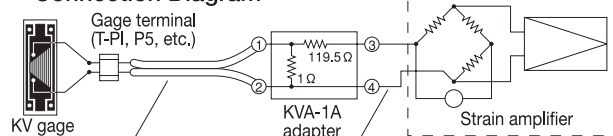
When ordering, specify the model number as follows:

**KV-5C**  
**KV-25B**

#### ● Adapter KVA-1A (option)



#### ● Connection Diagram

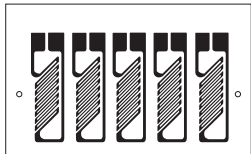


Note: Leadwires to/from the adapter should provide lower resistance (0.1 Ω or lower).

# Customized Gages

While we provide various strain gages with different designs including gage lengths and patterns to satisfy various needs for strain/stress measurement, we are able to prepare custom made strain gages according to customers' individual requirements. The following are several samples of customized products. Please contact us for more detail.

**5-element shearing strain measuring gage**



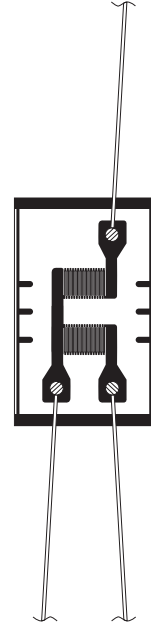
x3.5 enlarged view

**Small-sized uniaxial type with lead at both ends**



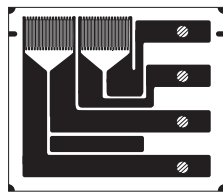
x12 enlarged view

**2-element uniaxial half-bridge type**



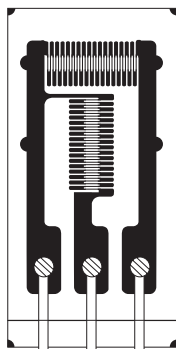
x3 enlarged view

**2-tandem uniaxial strain gage**



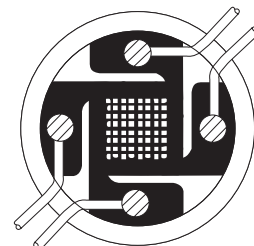
x3.5 enlarged view

**Orthogonal biaxial half-bridge type**



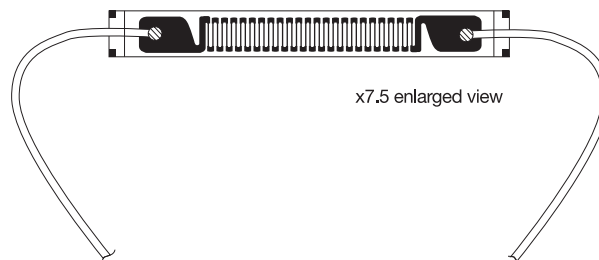
x9 enlarged view

**Ultra-miniature biaxial type 0°/90° stacked rosette**



x12 enlarged view

**Small-sized uniaxial type with lead at both ends**



x7.5 enlarged view



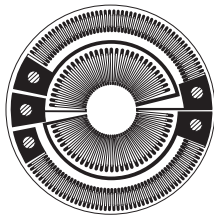
# Strain Gages for Transducers

Strain gages are used not only for stress measurement but also as sensing elements for various transducers owing to their excellent repeatability and linearity. Needless to say, they are applied to a variety of KYOWA strain-gage transducers, leading to the high reliability on our products.

To cope with users' needs for making their original transducers, we manufacture various strain gages for load, pressure and torque transducers. Shown below are typical examples of strain gages for transducers. For details, contact KYOWA or our sales representative.

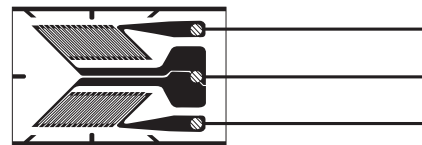
## Diaphragm Type

Major Applicable Transducers Pressure Transducer



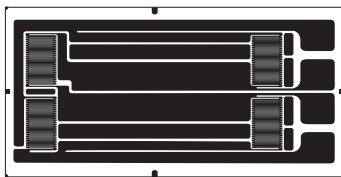
## Biaxial Shearing Type

Major Applicable Transducers Torque Transducer



## Full-bridge Type

Major Applicable Transducers Load Cell, Displacement Transducer



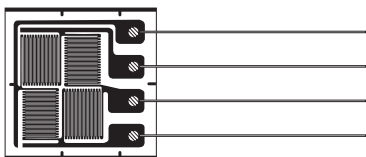
## Uniaxial 2-element Half-bridge Type

Major Applicable Transducers Load Cell, Pressure Transducer



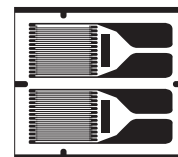
## Full-bridge Type

Major Applicable Transducers Load Cell



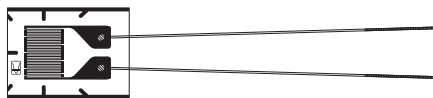
## Uniaxial 2-tandem Type

Major Applicable Transducers Load Cell, Displacement Transducer



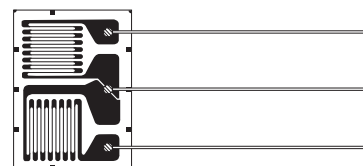
## Uniaxial Type

Major Applicable Transducers Load Cell, Pressure Transducer, Displacement Transducer, Acceleration Transducer

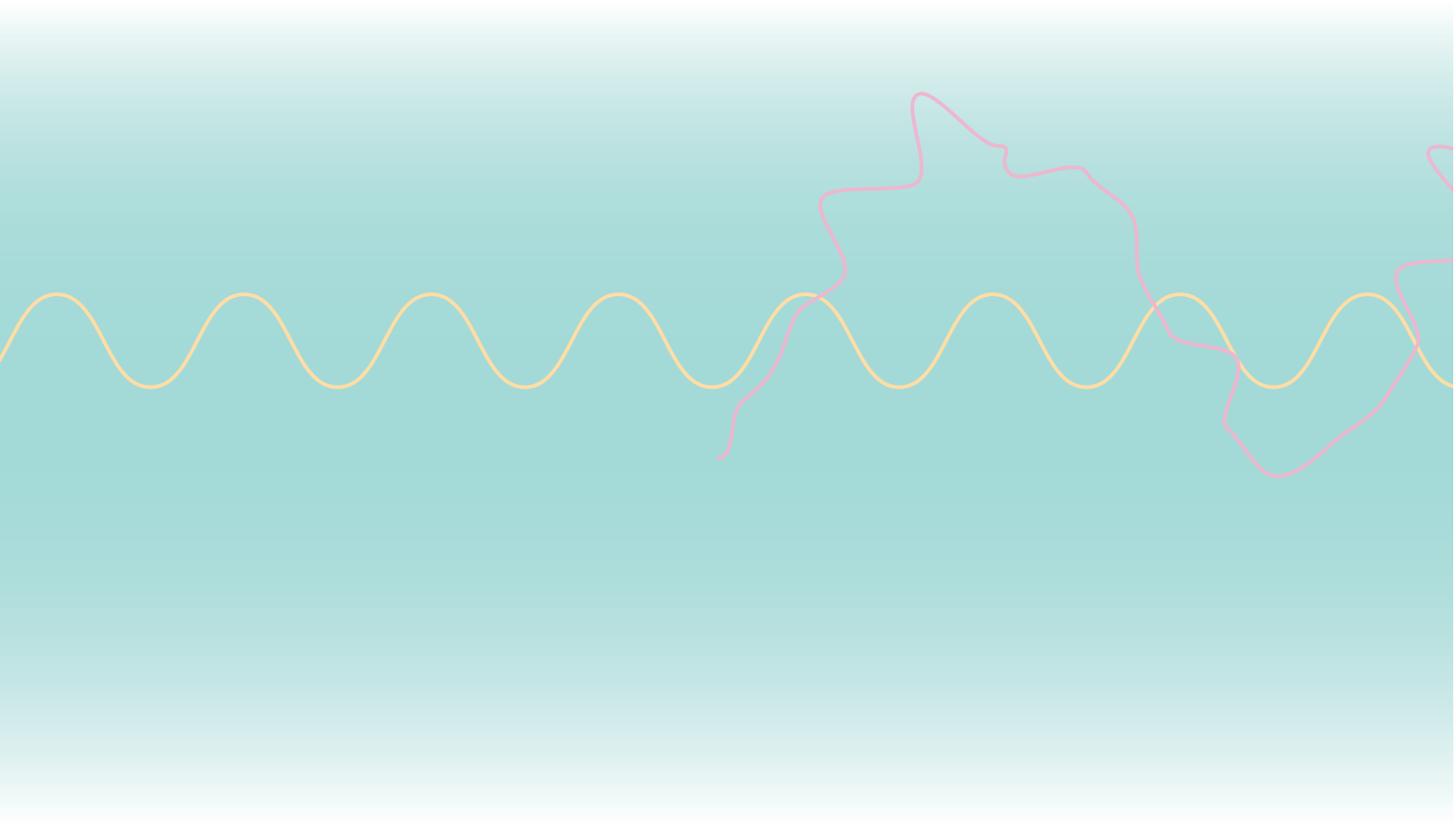


## Biaxial Half-bridge Type

Major Applicable Transducers Load Cell, Pressure Transducer







JQA-0821  
JQA-EM4824

Specifications are subject to change without notice for improvement.



**Safety precautions**

Be sure to observe the safety precautions given in the instruction manual, in order to ensure correct and safe operation.

**KYOWA ELECTRONIC INSTRUMENTS CO., LTD.**

**Overseas Department:**

3-5-1, Chofugaoka, Chofu, Tokyo 182-8520, Japan  
Phone: +81-42-489-7220 Facsimile: +81-42-488-1122  
<http://www.kyowa-ei.com>  
e-mail: [overseas@kyowa-ei.co.jp](mailto:overseas@kyowa-ei.co.jp)

Cat. No. 101I-3 E1-1 H.P

Manufacturer's Representative

*For further information please contact:*

**T**EST **M**ACHINES **A**USTRALIA

0418 369 505

[sales@testmachines.com.au](mailto:sales@testmachines.com.au)

[www.testmachines.com.au](http://www.testmachines.com.au)

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