

# Capsule Gage<sup>®</sup> [capsule-type strain gage] "CAPSULE TYPE" WELDABLE STRAIN GAGES

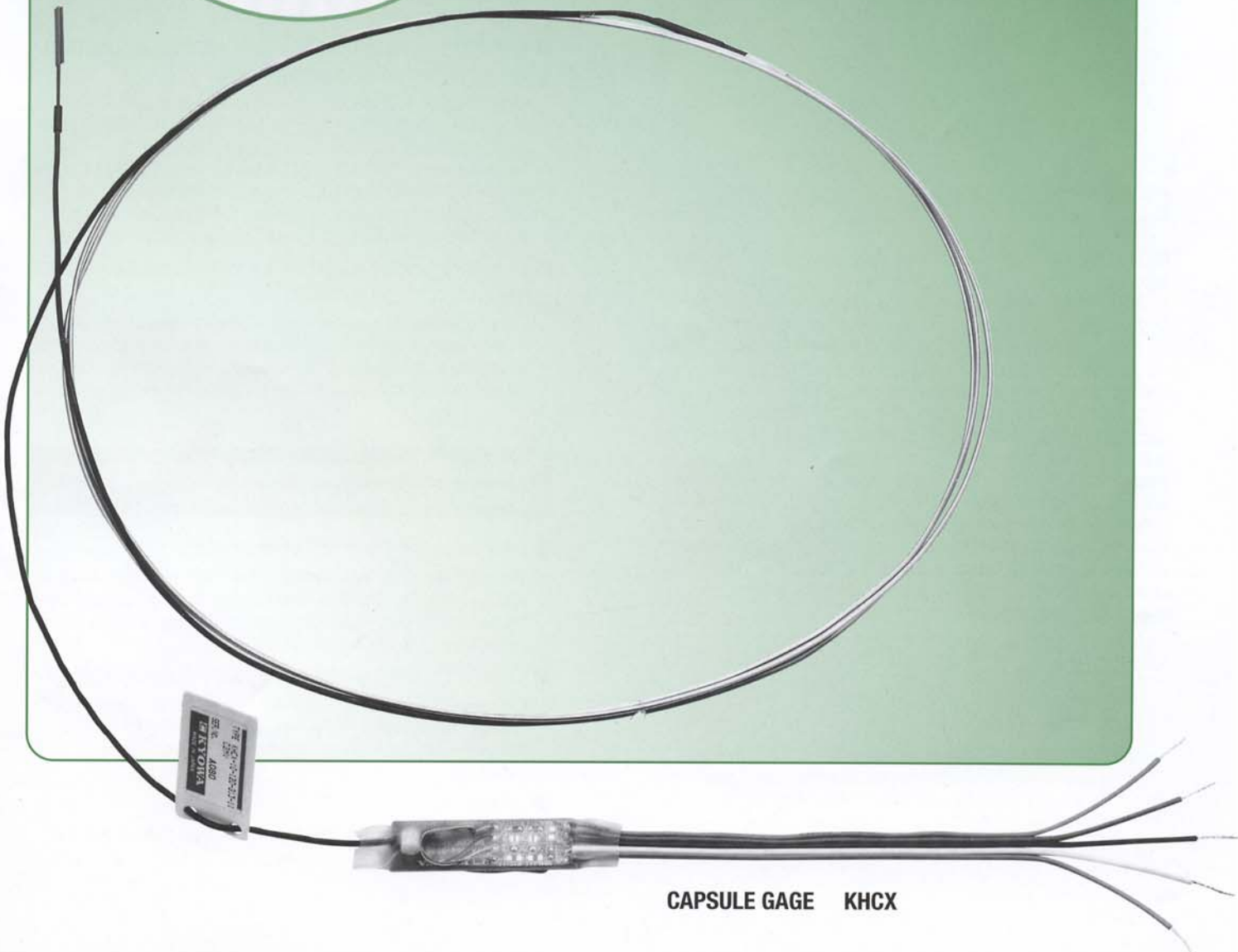


**CAPSULE GAGE  
KHCX**

Performing strain measurement at high temperatures, high pressures, and in water

A maximum measurement temperature up to 950°C, and high precision

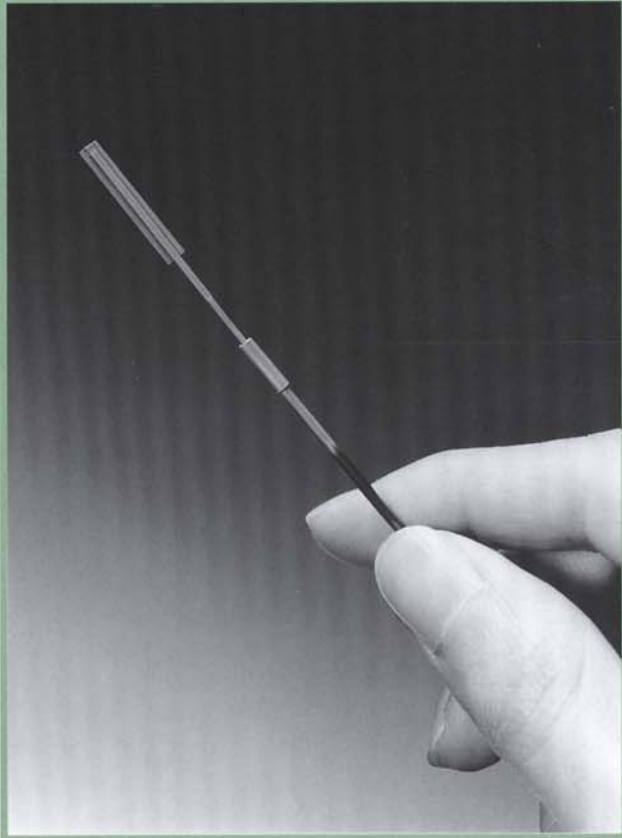
Easy-to-handle spot-welding type



**CAPSULE GAGE KHCX**

# CAPSULE GAGES

## KYOWA'S CAPSULE GAGES



Kyowa's capsule-gage-type strain gage (hereinafter, capsule gage® and ® are omitted) consists of a sensing unit comprised of an environmentally resistant, metallic tube and flange sealing a strain gage element in an insulator, and an environmentally resistant cable (MI cable) <sup>(NOTE)</sup> removing the signal output from the sensor unit. As the sensing unit is fixed to the measurement material by spot welding, strain measurement can be conducted even at high temperatures and under high pressures and high humidity. A soft cable is connected to the end of the MI cable for easy connection to a dedicated adaptor (HDB).

Capsule gages for use at high temperatures and room temperature are available. Those for use at high temperatures are employed in applications such as nuclear-power generation, cars, and planes. On the other hand, as those for use at room temperature are waterproof and provide stable performance over a long period, they are applicable to outdoor strain measurement for cars and civil engineering/construction.

(NOTE) MI cable (mineral-insulated metal-sheathed cable) is an inorganic insulator cable with heat-resistant insulating materials in powder form packed at a high density in a metallic sheath, with a conductor embedded in the powder.

\* Capsule gage®, our weldable hermetic strain gage, is a registered trademark.

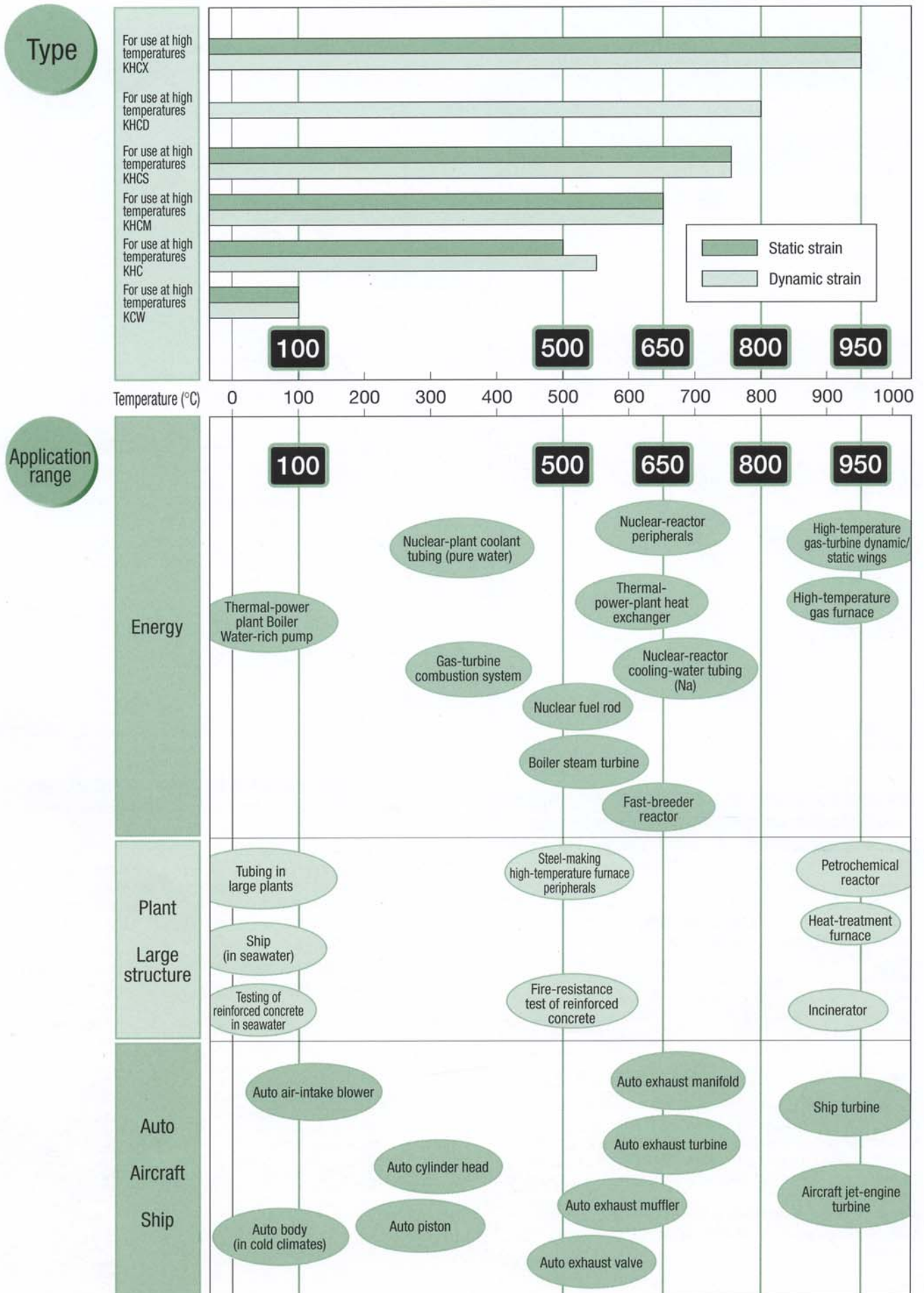
### Features of the capsule gage for use at high temperatures

- Enables strain measurement at up to 950°C  
The KHCX type is operable even at 950°C for dynamic/static strain measurement, and provides world-class performance.
- Completely airtight and environmentally resistant structure  
The gage and lead wire (MI cable) are covered with a heat-resistant, corrosion-resistant metal (such as Inconel 600). Their mono-body structure allows them to be used under high-temperature/high-pressure conditions, in seawater, in the molten metal such as Na, and in pure water.
- Resistor elements made of a heat-resistant special alloy
- Weldable and easy to handle at the measurement site  
The gage can be mounted easily on the measurement material by spot welding, enabling measurement to be started immediately after welding.
- Provides high-precision measurement with minimal thermally-induced apparent strain  
Thermally-induced apparent strain is virtually eliminated through the use of a temperature-compensating dummy gage, a sensing unit having a linear expansion coefficient suitable for the measurement material, and a temperature-compensating resistor that compensates for the apparent strain due to the linear expansion coefficient of the lead wire in the measurement temperature range.
- Linear expansion coefficient of 11, 13, or 16 x 10<sup>-6</sup>/°C selectable for the sensing unit  
Other selections are available at your request (the KHCD type is for use only with dynamic strain measurement using no temperature-compensation function).
- Detailed calibration sheet allows strain measurement to be conducted with high precision  
The calibration sheet report provided with your product includes resistance data to compensate for the temperature and zero point (bridge balance). If a temperature range is specified for measurement and the length of the heated portion of the MI cable, we can provide estimated data and graphs on the change in thermally-induced apparent strain and the gage factor (except for the KHCD type; available for the KHC type at your request).
- Gage with bridge adaptor (at your request) saves labor and ensures high reliability  
The bridge adaptor includes wiring for the compensating resistor, thus eliminating the need for wiring to the dedicated adaptor or its resistor, and enabling easy connection to measurement devices. We recommend the use of models complete with bridge adaptors.

### Features of the capsule gage for use at room temperature (weldable, waterproof, foil-type strain gage)

- Easy to use at the measurement site  
The gage can easily be mounted on the measurement material by spot welding. The stainless-steel-covered sensing unit eliminates the need for coating to perform bonding. The signal removal cable is built into the sensing unit.
- Excellent water-resistance and long-term reliability  
Can be used for 24 hours under water pressure of approx. 10 MPa (approx. 100 kgf/cm<sup>2</sup>). Sufficiently durable to conduct measurements outdoors, in water, and under high-humidity conditions.
- Low price  
Less expensive than the capsule gage for high-temperature use

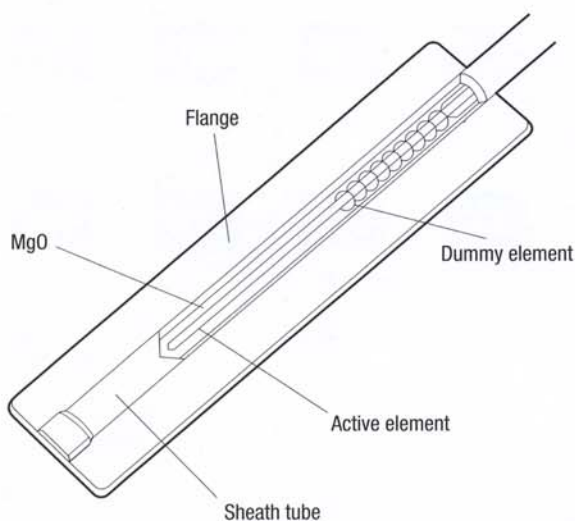
## Types of capsule gages and their application ranges



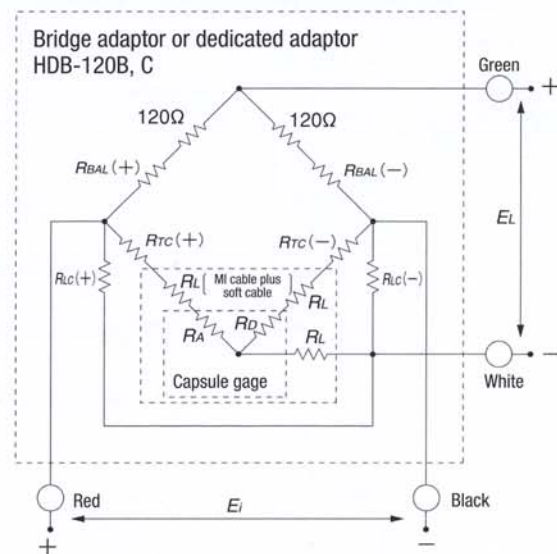
# CAPSULE GAGES

Before Using the Capsule Gage

KHCX, KHCS, KHCM, KHC

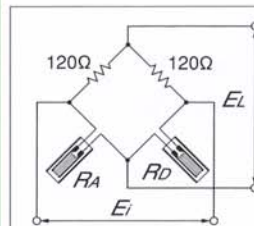


## Temperature-compensating circuit in the capsule gage



- $R_A$  Resistance of the active element
- $R_D$  Resistance of the dummy element
- $R_L$  Resistance of the cables
- $R_{RC}(+), R_{RC}(-)$  Temperature-compensating resistor (in the sensing unit)\*
- $R_{LC}(+), R_{LC}(-)$  Temperature-compensating resistor (in the lead wires)\*
- $R_{BAL}(+), R_{BAL}(-)$  Bridge-balance resistor \*
- $E_L$  Output voltage from the bridge
- $E_i$  Excitation voltage to the bridge
- $120\Omega$  Internal fixed resistor in the adaptor

\* Resistors are inserted at different locations, depending on the product type.



For reference purposes:  
Temperature-compensating  
circuit in the foil strain gage

## Temperature-compensation method for the capsule gage and bridge circuit

With the active/dummy method for temperature compensation in the bridge circuit using a foil strain gage, it is possible to compensate for the output due to the temperature coefficient of the resistor in the gage element and the output due to the difference in the linear expansion coefficients between the gage itself and the measurement material. As the dummy gage has no sensitivity in the capsule gage, the latter of the above outputs cannot be compensated for. As a result, an output (apparent strain) equivalent to the difference in linear expansion coefficients between the active gage and the measurement material is produced. Therefore, an external temperature-compensating resistor ( $R_{TC}$ ) is inserted into the bridge circuit to compensate for the latter output.

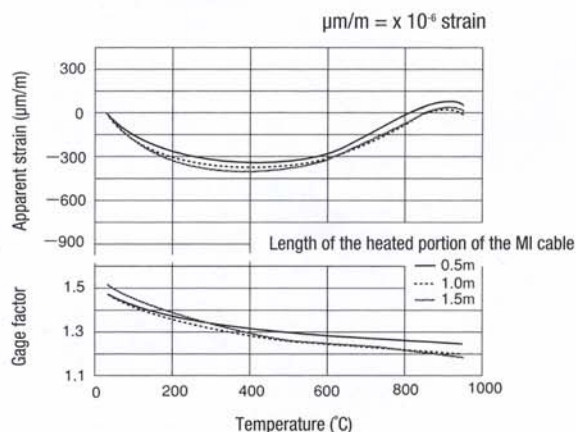
In addition, another external temperature-compensating resistor ( $R_{LC}$ ) is inserted in order to reduce the apparent strain caused by the heating of the MI cable. As the balance in the bridge is disturbed by the insertion of those resistors, however, a balance-adjustment resistor ( $R_{BAL}$ ) is also necessary. The individual resistance of each of these resistors depends on the temperature range best suited to your application.

A dedicated adaptor and a bridge adaptor, as well as resistors, are available as options to enable the easy assembly of such a bridge circuit.

## Calibration sheet for highly reliable measurement

The calibration sheets provided with the KHCX-, KHCS-, and KHCM-type capsule gages contain data on the thermally-induced apparent strain, estimates of changes in the gage factor, and diagrams of those estimates to help users conduct highly reliable strain measurement at high temperatures. The calibration sheet on the KHC type is also available at your request.

### Estimated thermally-induced apparent strain and change in the gage factor



CALIBRATION SHEET KYOKA ELECTRONIC INSTRUMENTS CO., LTD. TOKYO JAPAN

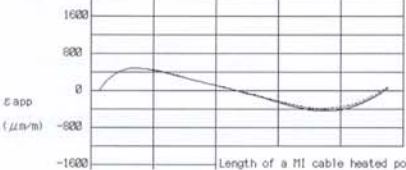
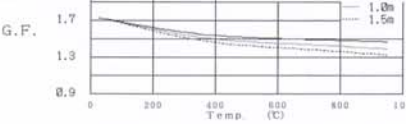
Model: KHCX-10-120-G13-C2M	Serial No. A13R	Supervisor	Inspector
Inspected date: May 10, 2001	Temp.: 24°C	Humid.: 42%RH	
Temp. compensation range: 25 ~ 950 °C	Adjustable thermal expansion coefficient: 11.7 PPM/°C		
MI cable length: 1.1 m	Soft cable length: 5 m		

1. Gauge factor: 1.72 (Standard deviation: 0.9%)
2. Gauge resistance: RAL: 110.2 Ω RDL: 113.7 Ω
3. Compensating resistance: RAL: 1.00 Ω ±1% RLC: 7500 Ω ±1%
4. Input/output resistance of bridge adaptor: Input: 50 Ω Output: 50 Ω

1) RAL and RDL denote respectively the Active and Dummy gauge resistance value (including the leadwire resistance).

2) H.T.C. and RAL are temperature compensating and zero balance adjusting resistors. When the gauge comes with a bridge adaptor attached, these resistors are already mounted in the P.C.B. When use the HDB-120 adaptor, the resistors are connected as described in the instruction manual.

3) Shown below are estimated curves and calculated result of thermally-induced apparent strain (ε<sub>app</sub>) and thermally-induced gauge factor (G.F.) changes for each of three different length of heated portion of the MI cable.

Length of MI cable heated portion (m)	25	200	400	600	800	950
ε <sub>app</sub> (μm/m)	0.5	0	456	123	-240	-405
G.F.	1.0	0	451	124	-231	-378
ε <sub>app</sub> (μm/m)	1.5	0	447	127	-211	-344
G.F.	1.0	1.72	1.81	1.83	1.49	1.47
G.F.	1.0	1.72	1.60	1.49	1.44	1.41
G.F.	1.0	1.72	1.58	1.45	1.40	1.35

Approximate equation of thermally induced apparent strain & gauge factor are shown below.  
 $\epsilon_{app} = 25.06 \times 10^{-6} \times (498.2807 - M) \times (\mu m/m)$   
 $G.F. = 1.0000$   
 Where Temp. is expressed by T(°C) & the length of a heated portion of the MI cable by L(m).  
 $A = 1.8 \times 10^{-8} - 3.05819E-06 \times T^2 + 1.03125E-07 \times T^3 + 1.49592E-09 \times T^4 - 1.70057E-12 \times T^5 + 4.61043E-16 \times T^6$   
 $B = -282.331 + 12.8732 \times T - 0.66206 \times T^2 + 1.68822E-04 \times T^3 - 1.9313E-07 \times T^4 + 8.52782E-11 \times T^5$   
 $C = 102.547 + 0.037101 \times T - 1.13031E-04 \times T^2 + 2.27191E-07 \times T^3 + 2.76819E-10 \times T^4 + 1.19703E-13 \times T^5$   
 $D = 1.01466 \times C \times (1 + A \times (X - P) \times (T - 25) + 2 \times B) \times (E - D)$   
 $Q = 8.14573E-03 - 1.72071E-04 \times T + 9.94033E-08 \times T^2 - 1.4802E-07 \times T^3 + 1.49525E-10 \times T^4 - 5.28214E-14 \times T^5$   
 $P = 0.011 - 3.048 \times 10^{-7} \times T + 2.278 \times 10^{-10} \times T^2$   
 $J = (D \times P)$   
 $K = (C \times H + 1) \times (Q + 75000) / (C \times G + P + 75001)$   
 $M = K \times (J \times X) \times (1 - G) / (75000 + G)$   
 $N = 11.7 \times (1/300) \times T$   
 $P = 11.2955 + 0.0378805 \times T - 1.44211E-04 \times T^2 + 3.22494E-07 \times T^3 + 3.46918E-10 \times T^4 + 1.41054E-13 \times T^5$   
 For information, Equation 8 is used to calculate the coefficient of thermal expansion of a measuring object material. In case the coefficient of thermal expansion of a measuring object material is known, use the coefficient & substitute the result for Equation 8.  
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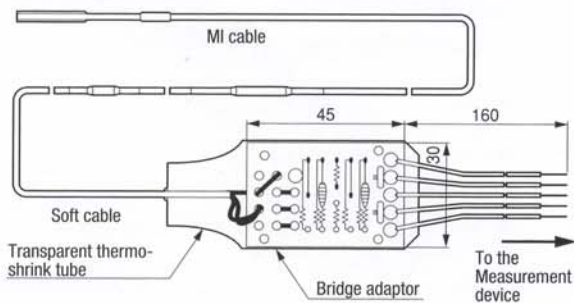
Calibration sheet

**Options**

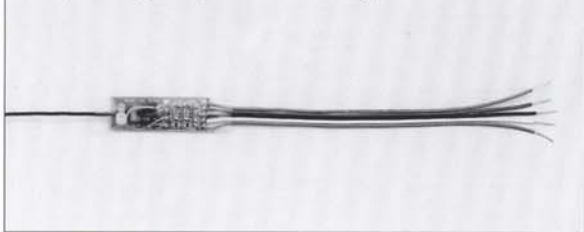
● **Bridge adaptor**

This is an adaptor having temperature-compensating resistors best suited for the temperature range of your use on a substrate attached to a soft cable. Through the use of this adaptor, improper wiring can be eliminated and work can be saved. Refer to "Extension of the MI cable" in each capsule-gage manual for the model types.

Diagram for connection between the dedicated adaptor and the capsule gage



Compact bridge adaptor of the KHCX type



● **Dedicated adaptor HDB-B, C type**

This adaptor enables the easy assembly of a bridge circuit through the installation of a capsule gage and various temperature-compensation resistors.

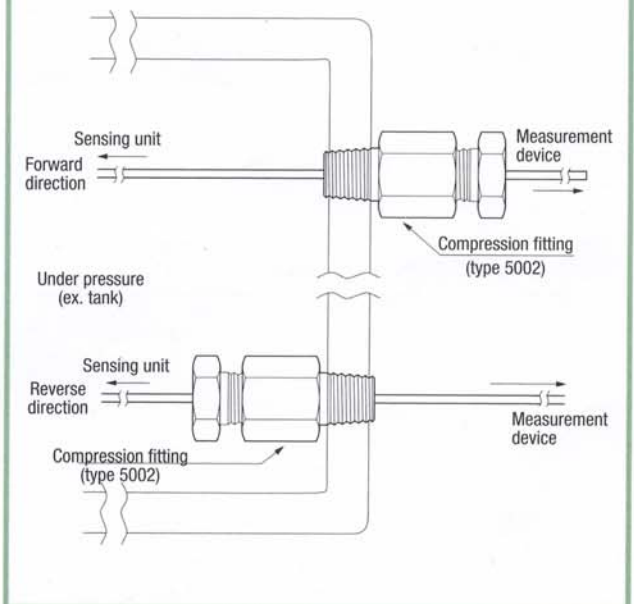
Applicable gages	Type	Cable	External dimensions and weight
120 Ω gage	HDB-120B	1 m in length, equipped with press-fit terminal	86 x 54 x 33 mm Approx. 200 g
	HDB-120C	1 m in length, terminated with a connector plug (NDIS standard)	
60 Ω gage KHC-60 type	HDB-60B	1 m in length, equipped with press-fit terminal	
	HDB-60C	1 m in length, terminated with a connector plug (NDIS standard)	



● **Compression fitting**

At your request, we will add compression fitting for removing the MI cable from the pressure-applied measurement site. Please request its installation when placing an order. Refer to "Extension of MI cable" in each capsule-gage manual for the model types.

Example of insertion of the compression fitting



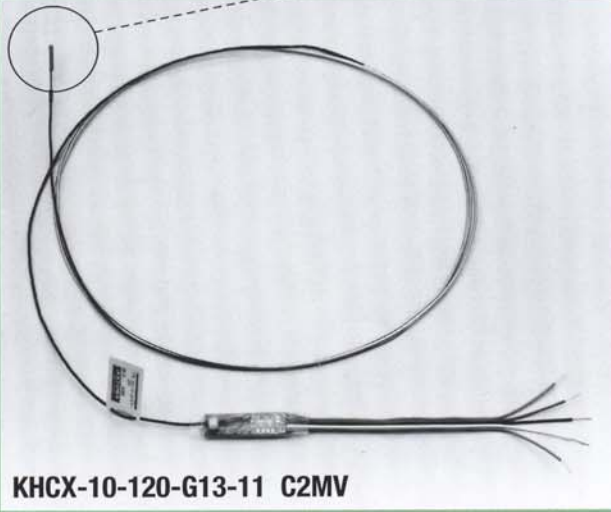
# KHCX 950°C

For use  
at high  
temperatures

Maximum temperature for the  
measurement of dynamic/  
static strain **950°C**

## KHCX Capsule-type strain gage

Maximum temperature : 950°C (highest in the world)



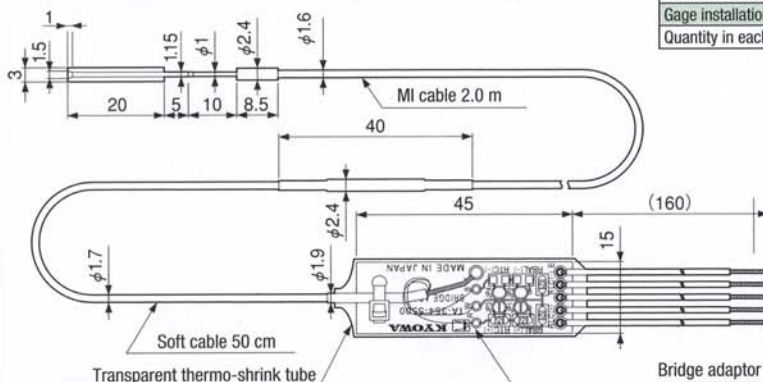
**KHCX-10-120-G13-11 C2MV**

### Specifications

Type	KHCX-10-120-G13-11 C2M For common steel materials KHCX-10-120-G13-11 C2MV Same as above provided with a bridge adaptor KHCX-10-120-G13-13 C2M For Inconel600 (JIS NCF600 equivalent) KHCX-10-120-G13-13 C2MV Same as above provided with a bridge adaptor
Gage type	Uniaxial, 2-element, temperature-compensated
Material of resistor element	Heat-resistant special alloy
Sensing unit	Gage length: 10 mm Both the sheath tube and flange are made of Inconel600 (JIS NCF600 equivalent).
Resistance	Gage resistance: Approx. 120 Ω; resistance deviation in active/dummy elements: 5 Ω
Lead wire	MI-cable outer diameter: 1.6 mm; Ni wire: 3-wire, approx. 2 m Soft-cable outer diameter: 1.7 mm; 3-wire ETFE provided with a shield, approx. 50 cm, bare end
Max. operating temperature	Static strain: Approx. 950°C; dynamic strain: approx. 950°C
Applicable linear expansion coefficients	11, 13 x 10 <sup>-6</sup> /°C, or as specified by the user
Gage factor	Room temperature: 25°C; approx. 1.7 High temperature: 950°C; approx. 1.5 (when the heated length of the MI cable is 1 m, after temperature compensation)
Thermally induced apparent strain	Estimate curves are provided in the calibration sheet
Compensated temperature range	25 to 950°C
Operating temperature range	-196 to 950°C
Drift	High temperature: 950°C; ±20 x 10 <sup>-6</sup> strain/h
Strain limit	High temperature: 950°C; 10000 x 10 <sup>-6</sup> strain
Fatigue life	High temperature: 950°C; 1 x 10 <sup>8</sup> times or more (strain level ±100 x 10 <sup>-6</sup> strain)
Allowable max. current	50 mA
Insulation resistance	Room temperature: 25°C; at least 1000 MΩ
Allowable minimum radius of curvature for gage installation	20 mm (The allowable minimum radius of curvature of the flange is 75 mm, it can be delivered with minimum radius of curvature 20 mm upon request.)
External dimensions	See the drawing of external dimensions.
Gage installation method	Spot welding, one line on each side (welding spot interval: 0.7 to 0.8 mm)
Quantity in each box	One

### Drawing of external dimensions

Provided with a compact bridge adaptor of the KHCX type



**KHCX-10-120-G13-11 (13) C2MV**

### Standard accessories

Resistor for temperature compensation, resistor for bridge balance, metal straps for fastening the MI cable (100 mm in length, 3 mm in width, two pieces), metal pieces for the welding test (30 mm in length, 4 mm in width, two pieces), calibration sheet, operation manual

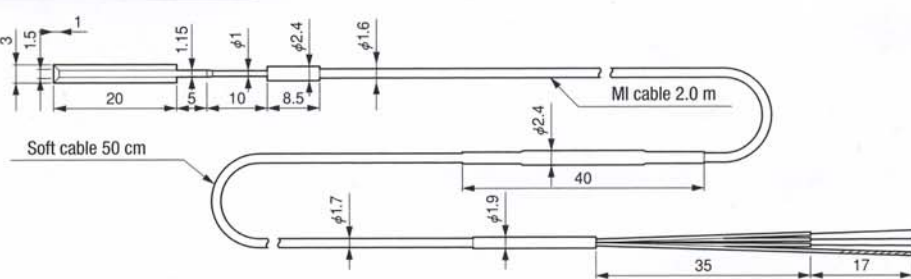
### Optional accessories

- Bridge adaptor
- Dedicated adaptor HDB-120B, 120C  
See "Options" on p. 5.
- Spot welder: See p. 13 for GW-3C.

### Precautions

- Carefully read "Before using the capsule gage" on p. 4, "Precautions" on p. 14, and "Measurement block diagram" on p. 15.

### Drawing of external dimensions



**KHCX-10-120-G13-11 (13) C2MV**

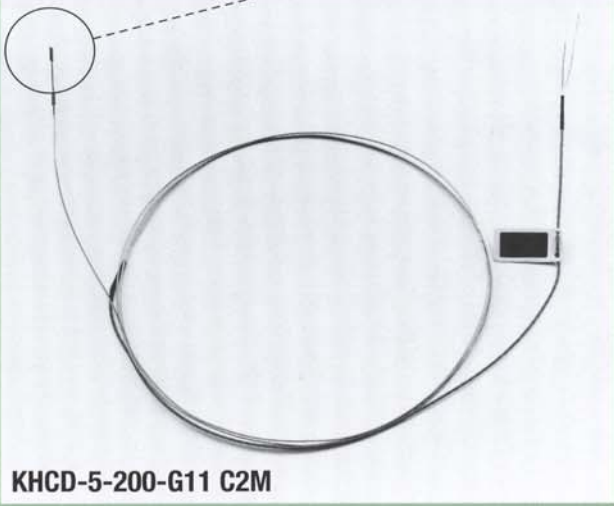
# KHCD 800°C

For use  
at high  
temperatures

Maximum temperature for the  
measurement of dynamic  
strain **800°C**

## KHCD Capsule-type strain gage

For the measurement of dynamic strain only



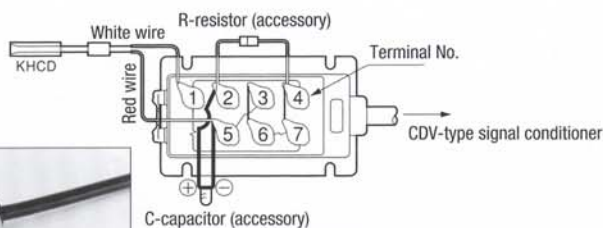
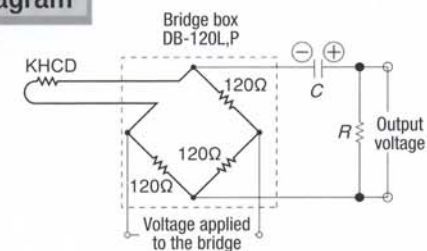
KHCD-5-200-G11 C2M

Temperature monitoring can be performed, as the core of the MI cable uses a compensation conductor for the K thermocouple. Your own system can be assembled, as no dummy gage is used (patent pending).

### Specifications

Type	KHCD-5-200-G11 C2M
Gage type	Uniaxial, 1-element, active
Material of resistor element	Heat-resistant special alloy
Sensing unit	Gage length: 5 mm Both the sheath tube and flange are made of Inconel600 (JIS NCF600 equivalent).
Resistance	Gage resistance: Approx. 200 Ω
Lead wire	MI-cable outer diameter: 1.0 mm; approx. 2 m in length Soft-cable outer diameter: 1.74 mm; 2-wire ETFE provided with a shield, approx. 50 cm, bare end
Max. operating temperature	Dynamic strain: Approx. 800°C
Gage factor	Room temperature 25°C; approx. 0.9 High temperature: 800°C; approx. 0.8 (when the heated length of the MI cable is 1 m)
Compensated temperature range	-196 to 800°C
Strain limit	High temperature: 800°C, 10000 x 10 <sup>-6</sup> strain
Fatigue life	High temperature: 800°C, 1 x 10 <sup>6</sup> times or more (strain level: ±500 x 10 <sup>-6</sup> strain)
Allowable max. current	50 mA
Insulation resistance	Room temperature: 25°C; at least 1000 MΩ High temperature: 800°C; at least 50 kΩ
Allowable minimum radius of curvature for gage installation	15 mm
External dimensions	See the drawing of external dimensions.
Gage installation method	Spot welding, one line on each side (welding spot interval: 0.7 to 0.8 mm)
Quantity in each box	One

### Circuit diagram



### Standard accessories

Capacitor (1, 2.2, 10 μF), resistor (10 kΩ), metal straps for fastening the MI cable (100 mm in length, 3 mm in width, two pieces), metal pieces for the welding test (30 mm in length, 4 mm in width, two pieces), calibration sheet, operation manual

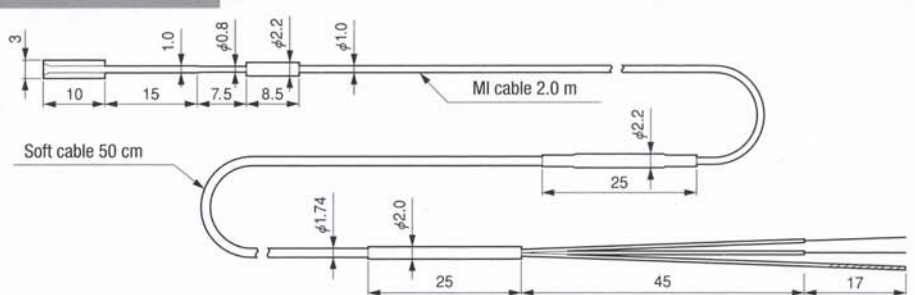
### Optional accessories

- Bridge box DB-120P, DB-120L  
These are provided to form the Wheatstone bridge by connecting the gage.  
DB-120P Cable: Polyethylene, 5 m, connector plug edge (NDIS standard)  
External dimensions/weight: 86 mm x 54 mm x 35 mm, approx. 200 g (body only)  
DB-120L (compact plug-in type)  
Cable: Detachable connection cable, 5 m, connector plug edge (NDIS standard)  
External dimensions/weight: 60 mm x 20 mm x 20 mm, approx. 60 g (body only)
- Spot welder : See p. 13 for GW-3C.

### Precautions

- This gage is only for use in the measurement of dynamic strain, and is not applicable to the measurement of static strain. Carefully read "Precautions" on p. 14 and "Measurement block diagram" on p. 15.

### Drawing of external dimensions



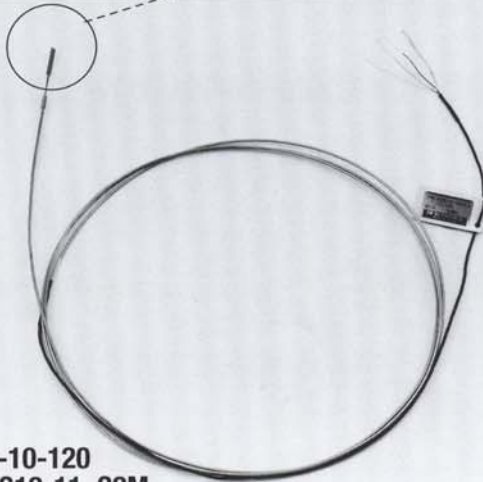
KHCD-5-200-G11 C2M

# KHCS 750°C

For use  
at high  
temperatures

Maximum temperature for the  
measurement of dynamic/  
static strain **750°C**

## KHCS Capsule-type strain gage



**KHCS-10-120  
-G12-11 C2M**

### Extension of MI cable

When placing an order, add the code name of the ordered MI cable to the type name, following a space. The soft cable is 50 cm in length.

- Example
- If the MI cable is 5 m: KHCS-10-120-G12-11 C5M
  - If the MI cable is 5 m in length and is provided with a bridge adaptor: KHCS-10-120-G12-11 C5MV
  - If the MI cable is 5 m in length and is provided with compression fitting: KHCS-10-120-G12-11 C5MF
  - If the MI cable is 5 m in length and is provided with a bridge adaptor and compression fitting: KHCS-10-120-G12-11 C5MFV

### Specifications

Type	KHCS-10-120-G12-11 C2M For common steel materials KHCS-10-120-G12-13 C2M For Inconel600 (JIS NCF600 equivalent) KHCS-10-120-G12-16 C2M For stainless steel materials
Gage type	Uniaxial, 2-element, temperature-compensated
Material of resistor element	Heat-resistant special alloy
Sensing unit	Gage length: 10 mm Both the sheath tube and flange are made of Inconel 600 (JIS NCF600 equivalent).
Resistance	Gage resistance: Approx. 120 Ω Resistance deviation in active/dummy elements: 5 Ω
Lead wire	MI-cable outer diameter: 1.6 mm; Ni wire, 3-wire, approx. 2 m (standard) Refer to "Extension of MI cable" for the length of the MI cables. Soft-cable outer diameter: 1.7 mm; 3-wire ETFE provided with a shield, 50 cm, bare end
Max. operating temperature	Static strain: Approx. 750°C; dynamic strain: approx. 750°C
Applicable linear expansion coefficients	11, 13, 16 x 10 <sup>-6</sup> /°C, or as specified by the user
Gage factor	Room temperature: 25°C; approx. 2.0 (in the case of MI cable 2 m in length) High temperature: 750°C; approx. 1.98 (when the heated length of 2-m MI cable is 1 m, after temperature compensation)
Thermally-induced apparent strain	Estimate curves are provided in the calibration sheet
Compensated temperature range	25 to 750°C
Operating temperature range	-196 to 750°C
Drift	High temperature: 750°C, ±20 x 10 <sup>-6</sup> strain/h
Strain limit	High temperature: 750°C, 10000 x 10 <sup>-6</sup> strain
Fatigue life	High temperature: 750°C, 1 x 10 <sup>6</sup> times or more (strain level ±500 x 10 <sup>-6</sup> strain)
Allowable max. current	50 mA
Insulation resistance	Room temperature: 25°C, at least 1000 MΩ High temperature: 750°C, at least 50 kΩ (when the heated length of 2-m MI cable is 1 m)
Allowable minimum radius of curvature for gage installation	20 mm
External dimensions	See the drawing of external dimensions.
Gage installation method	Spot welding, one line on each side (welding spot interval: 0.7 to 0.8 mm)
Quantity in each box	One

Length of the MI cable	MI cable plus soft cable: 50 cm ①	① plus Bridge adaptor ②	① plus compression fitting	② plus compression fitting
1 m	C1M	C1MV	C1MF	C1MFV
2 m	C2M (standard)	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
15 m	C15M	C15MV	C15MF	C15MFV
20 m	C20M	C20MV	C20MF	C20MFV
30 m	C30M	C30MV	C30MF	C30MFV

Contact us for information on the extension of the soft cable.

### Standard accessories

Resistor for temperature compensation, resistor for bridge balance, metal straps for fastening the MI cable (100 mm in length, 3 mm in width, two pieces), metal pieces for the welding test (30 mm in length, 4 mm in width, two pieces), calibration sheet, operation manual

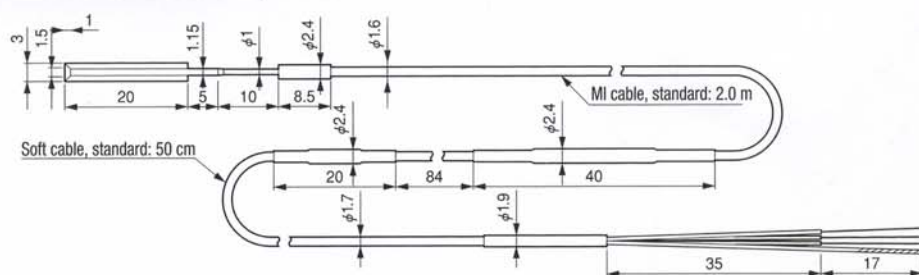
### Optional accessories

- Bridge adaptor
- Dedicated adaptor HDB-120B, 120C  
See "Options" on p. 5.
- Spot welder: See p. 13 for GW-3C.

### Precautions

- Carefully read "Before using the capsule gage" on p. 4, "Precautions" on p. 14, and "Measurement block diagram" on p. 15.

### Drawing of external dimensions



**KHCS-10-120-G12-11 (13,16) C2M**



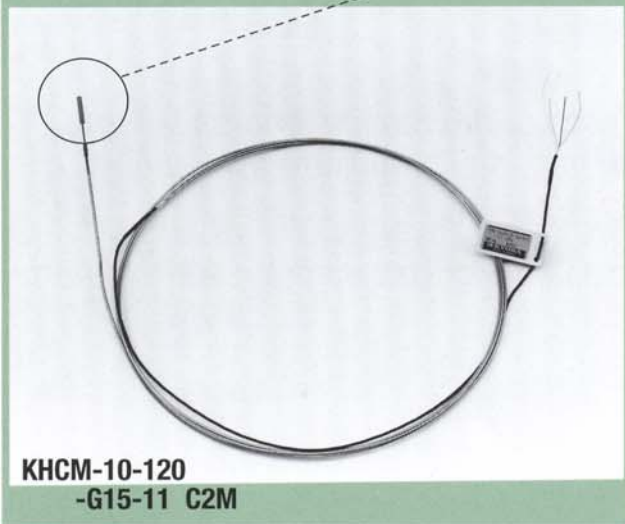
# KHCM 650°C

For use  
at high  
temperatures

Maximum temperature for the  
measurement of dynamic/  
static strain

**650°C**

## KHCM Capsule-type strain gage



**KHCM-10-120  
-G15-11 C2M**

### Extension of MI cable

When placing an order, add the code name of the ordered MI cable to the type name, following a space. The soft cable is 50 cm in length.

- Example
- If the MI cable is 5 m: KHCM-10-120-G15-11 C5M
  - If the MI cable is 5 m in length and is provided with a bridge adaptor: KHCM-10-120-G15-11 C5MV
  - If the MI cable is 5 m in length and is provided with compression fitting: KHCM-10-120-G15-11 C5MF
  - If the MI cable is 5 m in length and is provided with a bridge adaptor and compression fitting: KHCM-10-120-G15-11 C5MFV

### Specifications

Type	KHCM-10-120-G15-11 C2M For common steel materials KHCM-10-120-G15-13 C2M For Inconel600 (JIS NCF600 equivalent) KHCM-10-120-G15-16 C2M For stainless steel materials
Gage type	Uniaxial, 2-element, temperature-compensated
Material of resistor element	Heat-resistant special alloy
Sensing unit	Gage length: 10 mm Both the sheath tube and flange are made of Inconel600 (JIS NCF600 equivalent).
Resistance	Gage resistance: Approx. 120 Ω Resistance deviation in active/dummy elements: 5 Ω
Lead wire	MI-cable outer diameter: 1.6 mm, Cu wire, 3-wire, approx. 2 m (standard) Refer to "Extension of MI cable" for the length of the MI cables. Soft-cable outer diameter: 1.7 mm; 3-wire ETFE provided with a shield, 50 cm, bare end
Max. operating temperature	Static strain: Approx. 650°C; dynamic strain: approx. 650°C
Applicable linear expansion coefficients	11, 13, 16 x 10 <sup>-6</sup> /°C, or as specified by the user
Gage factor	Room temperature: 25°C; approx. 2.0 (in the case of MI cable 2 m in length) High temperature: 650°C; approx. 1.8 (when the heated length of 2-m MI cable is 1 m, after temperature compensation)
Thermally-induced apparent strain	Estimate curves are provided in the calibration sheet
Compensated temperature range	25 to 650°C
Operating temperature range	-196 to 650°C
Drift	High temperature: 650°C; ±10 x 10 <sup>-6</sup> strain/h
Strain limit	High temperature: 650°C; 10000 x 10 <sup>-6</sup> strain
Fatigue life	High temperature: 650°C; 1 x 10 <sup>6</sup> times or more (strain level 500 x 10 <sup>-6</sup> strain)
Allowable max. current	50 mA
Insulation resistance	Room temperature: 25°C; at least 1000 MΩ
Allowable minimum radius of curvature for gage installation	20 mm
External dimensions	See the drawing of external dimensions.
Gage installation method	Spot welding, one line on each side (welding spot interval: 0.7 to 0.8 mm)
Quantity in each box	One

Length of the MI cable	MI cable plus soft cable: 50 cm ①	① plus Bridge adaptor ②	① plus compression fitting	② plus compression fitting
1 m	C1M	C1MV	C1MF	C1MFV
2 m	C2M (standard)	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
15 m	C15M	C15MV	C15MF	C15MFV
20 m	C20M	C20MV	C20MF	C20MFV
30 m	C30M	C30MV	C30MF	C30MFV

Contact us for information on the extension of the soft cable.

### Standard accessories

Resistor for temperature compensation, resistor for bridge balance, metal straps for fastening the MI cable (100 mm in length, 3 mm in width, two pieces), metal pieces for the welding test (30 mm in length, 4 mm in width, two pieces), calibration sheet, operation manual

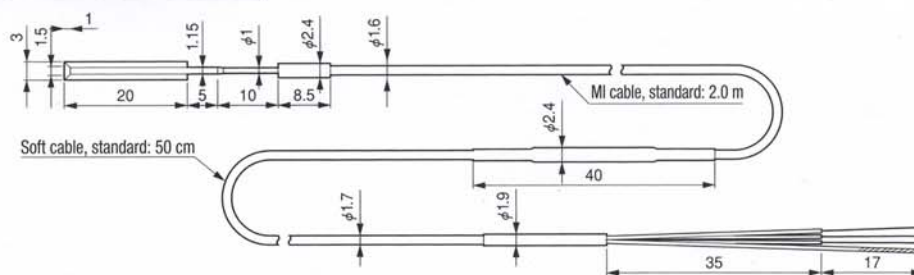
### Optional accessories

- Bridge adaptor
- Dedicated adaptor HDB-120B, 120C  
See "Options" on p. 5.
- Spot welder: See p. 13 for GW-3C.

### Precautions

- Carefully read "Before using the capsule gage" on p. 4, "Precautions" on p. 14, and "Measurement block diagram" on p. 15.

### Drawing of external dimensions



**KHCM-10-120-G15-11 (13,16) C2M**

# KHC 550°C 500°C

For use  
at high  
temperatures

Maximum temperature for the  
measurement of dynamic  
strain **550°C**

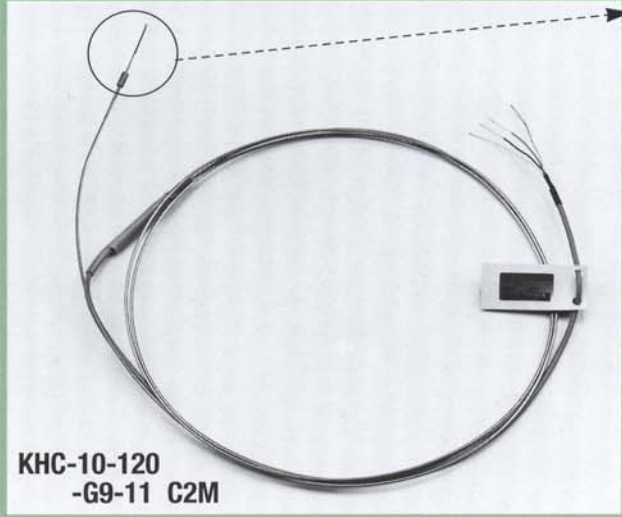
Maximum temperature for the  
measurement of static strain **500°C**

## KHC Capsule-type strain gage



*Types of three gage lengths, 20 mm,  
10 mm, and 5 mm, are available.*

*Two types, Inconel600 and SUS321, are  
available for use as the sheath material*



**KHC-10-120  
-G9-11 C2M**

### Specifications

		KHC-20type	KHC-10type	KHC-5type
Type	For common steel materials	KHC-20-120-G8-11 C2M KHC-20-120-G9-11 C2M	KHC-10-120-G8-11 C2M KHC-10-120-G9-11 C2M	KHC-5-60-G8-11 C2M KHC-5-60-G9-11 C2M
	For stainless steel materials	KHC-20-120-G8-16 C2M KHC-20-120-G9-16 C2M	KHC-10-120-G8-16 C2M KHC-10-120-G9-16 C2M	KHC-5-60-G8-16 C2M KHC-5-60-G9-16 C2M
Gage type		Uniaxial, 2-element, temperature-compensated		
Material of resistor element		Ni-CrV		
Sensing unit	Gage length	20 mm	10 mm	5 mm
	Material	Inconel600 for both the sheath tube and flange in G8 SUS321 for both the sheath tube and flange in G9		
Gage resistance		Approx. gage resistance: 120 Ω Resistance deviation in active/dummy elements: 5 Ω	Approx. gage resistance: 120 Ω	Approx. gage resistance: 60 Ω
Lead wire		MI-cable outer diameter: 1.6 mm, Cu wire, 3-wire, approx. 2 m (standard) Refer to "Extension of MI cable" for the length of the MI cables. Soft-cable outer diameter: 3 mm, 3-wire, provided with a crosslinked polyethylene shield, 50 cm, bare end		
Max. operating temperature		Dynamic strain: Approx. 550°C; static strain: approx. 500°C		
Applicable linear expansion coefficients		11, 16 x 10 <sup>-6</sup> /°C, or as specified by the user		
Gage factor	Room temperature: 25°C	Approx. 1.9 (Note 1)	Approx. 1.65 (Note 1)	Approx. 1.2 (Note 1)
	High temperature: 500°C	Approx. 1.75 (Note 2)	Approx. 1.5 (Note 2)	Approx. 1.1 (Note 2)
Thermally-induced apparent strain		Room temperature: 25 to 550°C ±300 x 10 <sup>-6</sup> strain (when compensated for by the external temperature-compensation resistor) Estimate curves are provided in the calibration sheet (upon request).		
Compensated temperature range		25 to 500°C		
Operating temperature range		Dynamic strain: -196 to 550°C; static strain: -196 to 500°C		
Drift: High temperature: 500°C		±20 x 10 <sup>-6</sup> strain/h	±20 x 10 <sup>-6</sup> strain/h	±30 x 10 <sup>-6</sup> strain/h
Strain limit: Room temperature: 25°C		8000 x 10 <sup>-6</sup> strain	5000 x 10 <sup>-6</sup> strain	5000 x 10 <sup>-6</sup> strain
Fatigue life		4 x 10 <sup>5</sup> times	4 x 10 <sup>5</sup> times	2 x 10 <sup>5</sup> times
Room temperature: 25°C		Strain level: ±1000 x 10 <sup>-6</sup> strain		
Allowable max. current		30 mA		
Insulation resistance		Room temperature: 25°C; at least 1000 MΩ; high temperature: 500°C; at least 5 MΩ (Note 2)		
Allowable minimum radius of curvature for gage installation		25 mm	20 mm	15 mm
External dimensions for gage installation for gage installation		See the drawing of external dimensions.		
Gage installation method		Spot welding in one line on both sides (welding spot interval: 0.8 mm)	Spot welding in one line on both sides (welding spot interval: 0.8 mm)	Spot welding in two line on both sides (welding spot interval: 0.8 mm)
Quantity in each box		One		

(Note 1) When using MI cable 2 m in length

(Note 2) When the heated length of 2-m MI cable is 1 m, after temperature compensation

#### Standard accessories

Resistor for temperature compensation, resistor for bridge balance, metal straps for fastening the MI cable (100 mm in length, 3 mm in width, two pieces), metal pieces for the welding test (20 mm in length, 4 mm in width, two pieces), calibration sheet, operation manual

#### Optional accessories

- Bridge adaptor
- Dedicated adaptor HDB-120B, 120C, 60B, 60C
- See "Options" on p. 5 for the compression fitting.
- Spot welder: See p. 13 for GW-3C.

### Precautions

- Carefully read "Before using the capsule gage" on p. 4, "Precautions" on p. 14, and "Measurement block diagram" on p. 15.

### Extension of MI cable

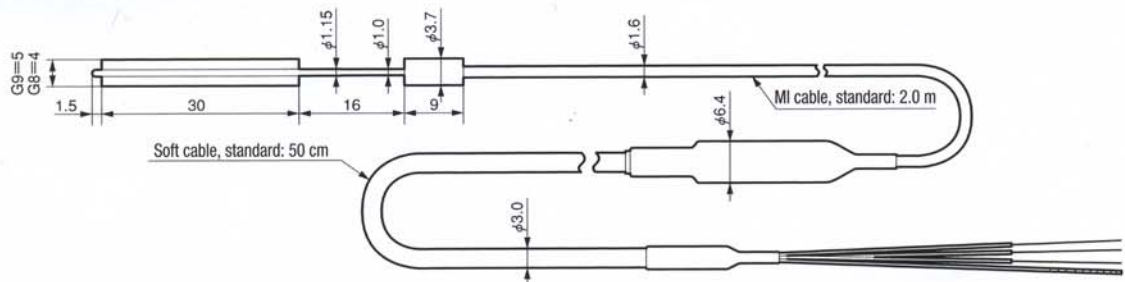
When placing an order, add the code name of the ordered MI cable to the type name, following a space. The soft cable is 50 cm in length.

- Example
- If the MI cable is 5 m: KHC-10-120-G8-11 C5M
  - If the MI cable is 5 m in length and is provided with a bridge adaptor: KHC-10-120-G8-11 C5MV
  - If the MI cable is 5 m in length and is provided with compression fitting: KHC-10-120-G8-11 C5MF
  - If the MI cable is 5 m in length and is provided with a bridge adaptor and compression fitting: KHC-10-120-G8-11 C5MFV

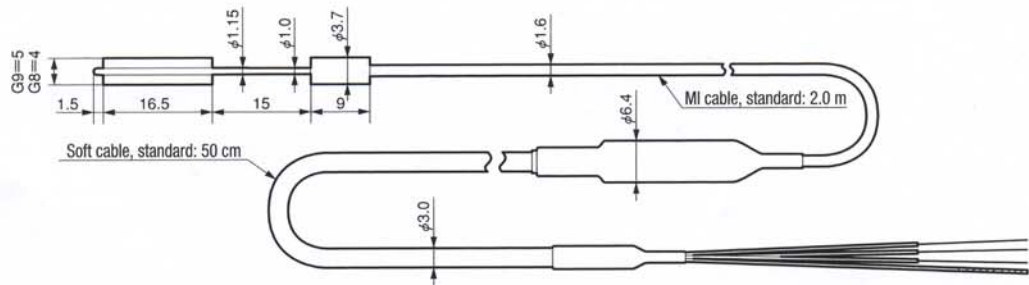
Length of the MI cable	MI cable plus soft cable: 50 cm ①	① plus Bridge adaptor ②	① plus compression fitting	② plus compression fitting
1 m	C1M	C1MV	C1MF	C1MFV
2 m	C2M(standard)	C2MV	C2MF	C2MFV
3 m	C3M	C3MV	C3MF	C3MFV
4 m	C4M	C4MV	C4MF	C4MFV
5 m	C5M	C5MV	C5MF	C5MFV
6 m	C6M	C6MV	C6MF	C6MFV
8 m	C8M	C8MV	C8MF	C8MFV
10 m	C10M	C10MV	C10MF	C10MFV
15 m	C15M	C15MV	C15MF	C15MFV
20 m	C20M	C20MV	C20MF	C20MFV
30 m	C30M	C30MV	C30MF	C30MFV

Contact us for information on the extension of the soft cable.

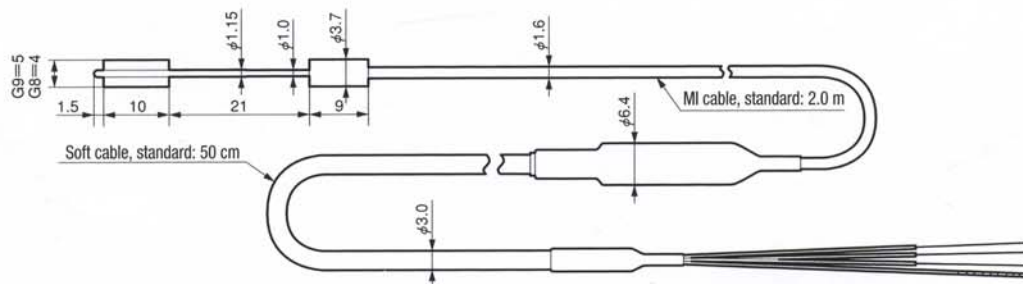
### Drawing of external dimensions



**KHC-20-120-G8 (G9) -11 (16) C2M**



**KHC-10-120-G8 (G9) -11 (16) C2M**



**KHC-5-60-G8 (G9) -11 (16) C2M**

# KCW 100°C

For use  
at room  
temperatures

Maximum temperature for the  
measurement of dynamic/  
static strain

# 100°C

## KCW

Weldable waterproof foil strain gage



**For measurement outdoors, in conditions  
involving water and high humidity**

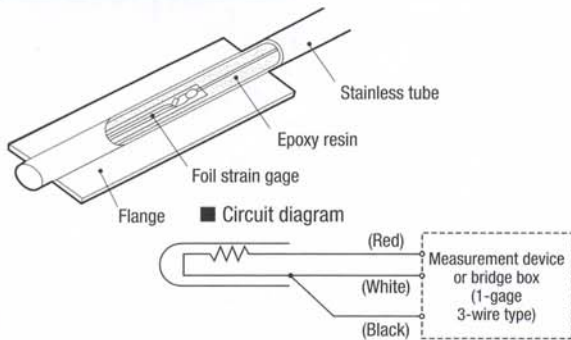
This gage comprises a sensing unit in which a foil strain gage is sealed in a stainless tube embedded in epoxy resin, and a crosslinked polyethylene-sheathed cable built into the sensing unit to provide an environmentally resistant structure. The sensing unit is fixed on the measurement material by spot welding. Its price is lower than that of the capsule gage for use at high temperatures (patent pending).

### Specifications

Type	KCW-5-120-G10-11 G3M3S For common steel materials
Gage type	Uniaxial, 1-element (1-gage, 3-wire type)
Material of resistor element	Ni-Cr-based alloy foil
Sensing unit	Gage length: 5 m Both the sheath tube and flange are made of stainless steel
Resistance	Gage resistance: Approx. 120 Ω ;
Lead wire	Outer diameter: 3 mm; 3-wire crosslinked polyethylene-sheathed, 3 m Bear end (standard) Refer to "Extension of lead wire" for the length of the lead wires.
Max. operating temperature	Static strain: Approx. 100°C; dynamic strain: approx. 100°C
Applicable linear expansion coefficients	11 x 10 <sup>-6</sup> /°C
Gage factor	Approx. 2.2
Compensated temperature range	-20 to 100°C
Operating temperature range	0 to 100°C
Strain limit	9000 x 10 <sup>-6</sup> strain
Fatigue life	1 x 10 <sup>6</sup> (strain level: ±1000 x 10 <sup>-6</sup> strain)
Waterproof	Pressure resistance in water: Approx. 10 MPa (approx. 100 kgf/cm <sup>2</sup> ), 24 hours
Drift	±100 x 10 <sup>-6</sup> strain/500 h (80°C, 90% RH or higher, 1000 hours) ±40 x 10 <sup>-6</sup> strain/500 h (by immersion, 1000 hours)
Allowable minimum radius of curvature for gage installation	20 mm
External dimensions	See the drawing of external dimensions.
Gage installation method	Spot welding, one line on each side (welding spot interval: 0.7 to 0.8 mm)
Quantity in each box	Two

KCW-5-120-G10-11 G3M3S

### Structure/circuit diagram



### Extension of lead wire

When placing an order, add the code name of the ordered lead wire to the type name, following a space.

Example • If the 3-wire-type crosslinked polyethylene-sheathed wire is 5 m in length, KCW-5-120-G10-11 G5M3S

Length of the lead wire	Code name
30 cm	G30C3S
50 cm	G50C3S
1 m	G1M3S
2 m	G2M3S
3 m (standard)	G3M3S
4 m	G4M3S
5 m	G5M3S
6 m	G6M3S
8 m	G8M3S
10 m	G10M3S
15 m	G15M3S
20 m	G20M3S
30 m	G30M3S

### Standard accessories

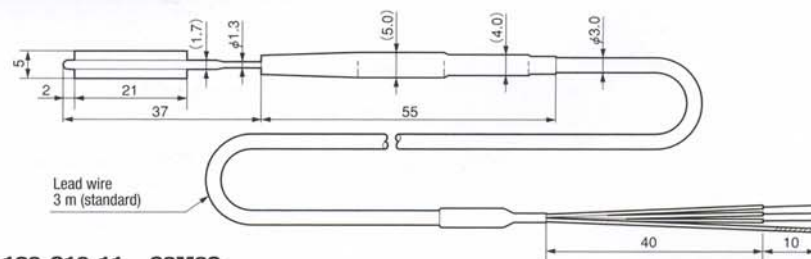
Metal straps for fastening the lead wire (100 mm in length, 3 mm in width, two pieces), metal pieces for the welding test (30 mm in length, 4 mm in width), calibration sheet, operation manual

### Optional accessories

- Bridge box: DB-120P, DB-120L (see p. 7 for their photographs)  
These are provided for formation of the Wheatstone bridge through connection of the gage.  
DB-120P Cable: Polyethylene, 5 m, connector plug edge (NDIS standard)  
External dimensions/weight: 86 mm x 54 mm x 35 mm, approx. 200 g (body only)  
DB-120L (compact plug-in type) Cable: Detachable connection cable, 5 m, connector plug edge (NDIS standard)  
External dimensions/weight: 60 mm x 20 mm x 20 mm, approx. 60 g (body only)
- Spot welder: See p. 13 for GW-3C.
- Carefully read "Precautions" on p. 14 and "Measurement block diagram" on p. 15.

### Precautions

### Drawing of external dimensions



KCW-5-120-G10-11 G3M3S

# GW-3C Welder

**Welding capability**  
0.3 mm in thickness, 10 W-s, 80 times/min

## GW-3C

Compact spot welder for use in a capsule gage

**Welding capability, 0.3 mm in thickness, 10 W-s, 80 times/min**



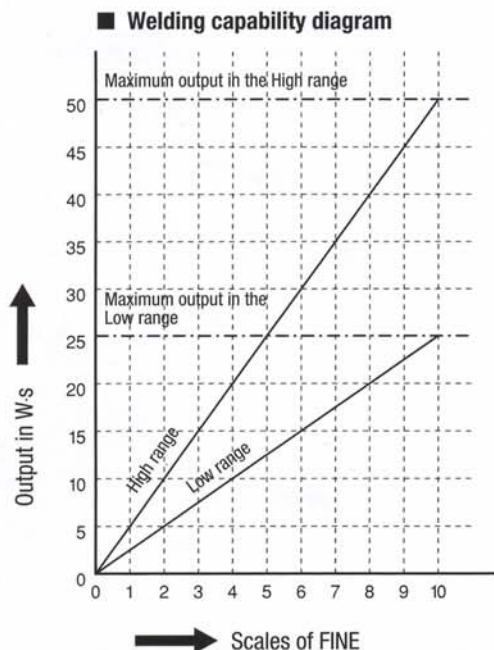
### Precautions

- Refer to "Precautions" on p. 14 for the procedure for performing spot welding of the capsule gage.

Examples of setting of the FINE volume and the thickness of the stainless steel plate

Thickness of the stainless steel plate	COARSE range		Welding energy (W-s)
	LOW	HIGH	
0.1	2	1	5
0.2	6	3	13
0.3	-	6	30

[Caution] Can not use in the [High] range, [FINE]5 for approx. 4 minutes or longer continuously at 1-second intervals, or in the [Low] range, [FINE]10 for approx. 10 minutes or longer continuously.



This is a spot welder for fixing the capsule gage and lead wires for use at high temperatures. It is compact, lightweight, low price, and provides improved welding capabilities.

### Features

- With the welding current suitable for welding stainless steel, it is possible to weld stainless steel plates 0.3 mm in thickness.
- The electrodes are round bars 1 mm in diameter.
- The power level can be selected between High and Low, with continuous adjustability to provide the level of energy best suited for welding.
- An optional aluminum trunk is available for easy transport and storage.
- CE mark version available.

### Specifications

Welding energy:	Low 0 to 25 W-s, continuously variable (FINE 0-10) High 0 to 50 W-s, continuously variable (FINE 0-10)
Welding speed:	1 W-s 150 times/min 5 W-s 120 times/min 10 W-s 80 times/min 20 W-s 60 times/min 50 W-s 30 times/min
Operation temperature/humidity	0 to 40°C, 85% RH or less
Temperature for storage	-10 to 60°C
Power source	AC line, 50/60 Hz, 500 VA or less
External dimensions	183 mm (W) x 153 mm (H) x 313 mm (D), excluding protrusions
Weight	Approx. 8.2 kg (body only)

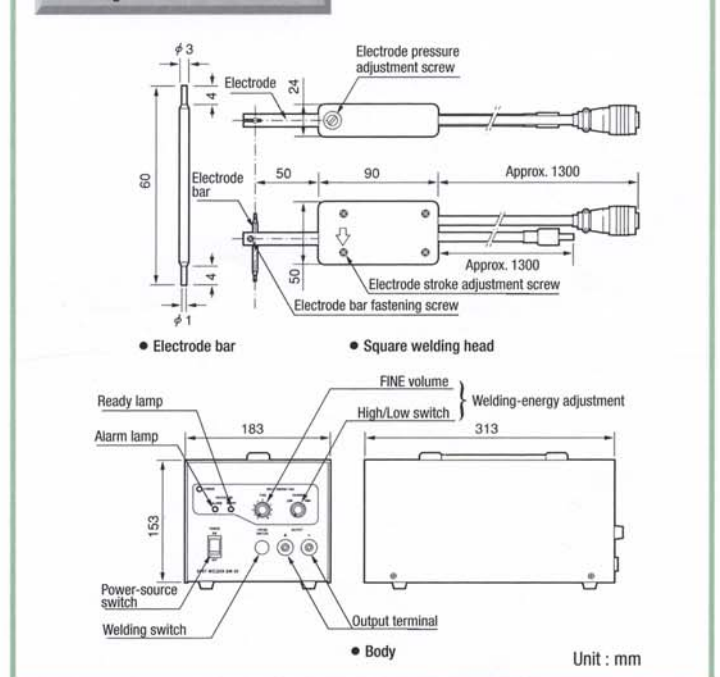
### Standard accessories

Square welding head (with cable, approx. 1.3 m in length), ground clip (with cable, approx. 1.3 m), electrode bar (GW-02), metallic file, fuse (5 A), Allen wrench, operation manual

### Optional accessories

Aluminum trunk (GW-01)

### Drawing of external dimensions



# Precautions

- For welding of the sensing unit, we recommend use of our spot welder GW-3C (see p. 13). Spot-weld the sensing unit after preliminary welding has been performed, following the steps indicated in Fig. 2. Standard welding conditions: diameter of the top of electrode, 0.8 mm; welding energy, approx. 10 W-s; and electrode pressure, approx. 10 N (approx. 1 kgf); see Fig. 2.

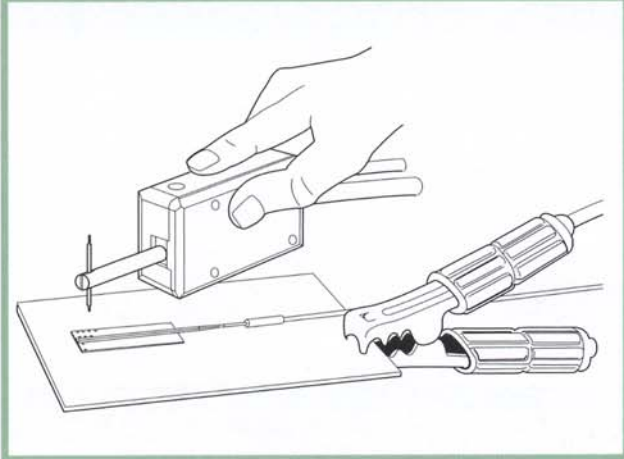
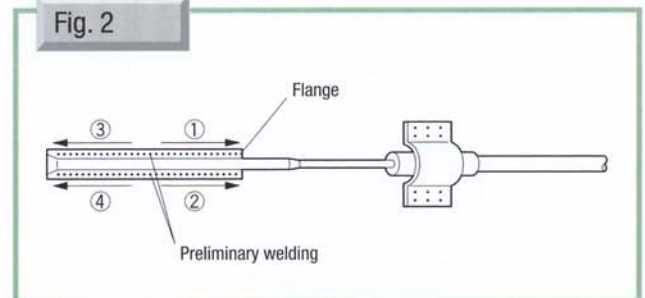
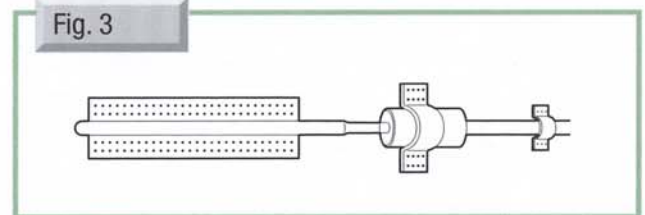


Fig. 2



Add another line of welding spots outside the above spot-welding line in the case of KHC-5-60-G8 and G9 (multi spots); see Fig. 3.

Fig. 3



- Be sure to read the Operation Manual.
- Spot welding can be performed on ferrous materials, but cannot be performed on aluminum, copper, or ceramic materials.
- For surface treatment, polish the surface of the measurement material with sandpaper (such as #320) to remove any rust or paint. Then, wipe the surface using a solvent such as acetone to remove stains and oil. The sensing unit has been sandblasted to expose a clean surface. Wipe using a solvent such as acetone to remove any wax.
- Never cut the MI cable or make a pinhole; otherwise, the insulating materials filled into the MI cable will absorb moisture and become unusable.
- Fasten the sensing unit, the MI-cable connection, and the MI cable itself using the metallic strap included among the standard accessories, so that a pulling force or torsion is applied to the sensing unit due to the weight of the MI cable or for another reason, in order to prevent damage to the gage. Then, weld the sensing unit (Fig. 1).

- For welding of the flange on a curvature, bend the flange along another curvature, such as a pipe, having the same radius of curvature as the material location, before welding the flange (Fig. 4). We will provide a strain gage that has the radius of curvature in its flange, upon request. Therefore, specify the desired radius of curvature and the curvature direction. Particularly with KHCX-type gages, do not bend the flange into a curvature with a radius of 75 mm or less, in order to prevent wire breakage inside the flange. Upon request prior to shipment, we can manufacture flanges of a curvature radius as small as 20 mm. Do not bend any part located within 10 mm of the connection. Read the Operation Manual for helpful hints in positioning and fixing the gage.
- Refer to "Before using the capsule gage" on p. 4 for the method of temperature compensation.

Fig. 1

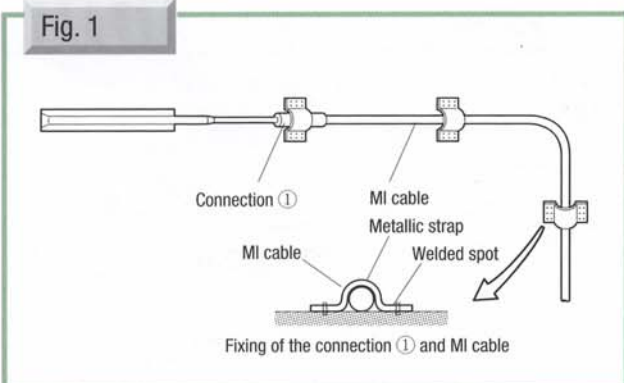
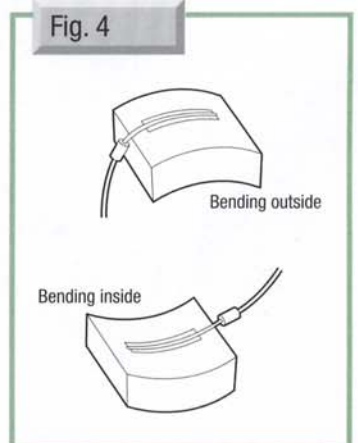


Fig. 4

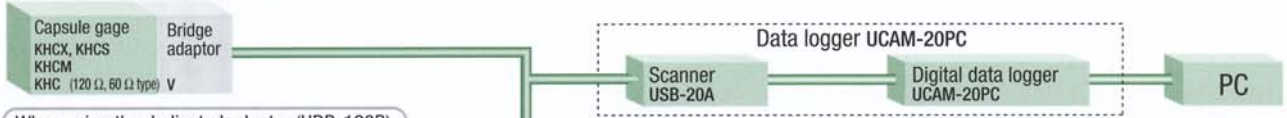


For measurement of static strain

## Measurement block diagram

### ● KHCX, KHCS, KHCM, KHC

When the bridge adaptor is provided:



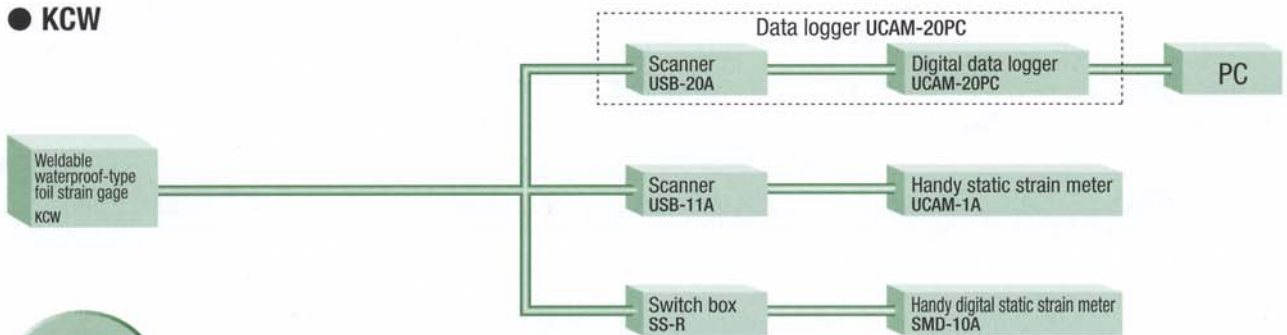
When using the dedicated adaptor (HDB-120B):



When using the dedicated adaptor (HDB-60B):



### ● KCW



For measurement of dynamic strain

### ● KHCX, KHCS, KHCM, KHC

When the bridge adaptor is provided:



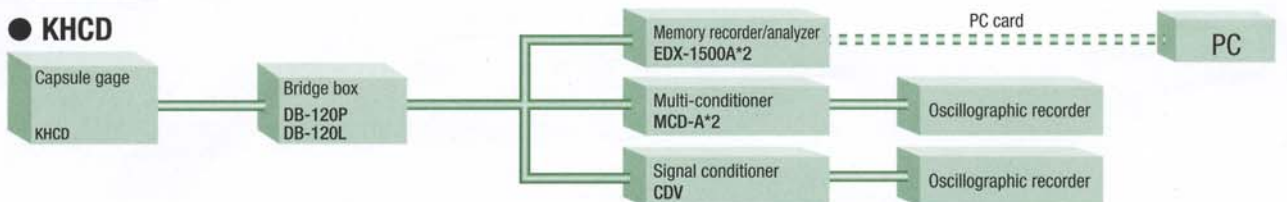
When using the dedicated adaptor (HDB-120C):



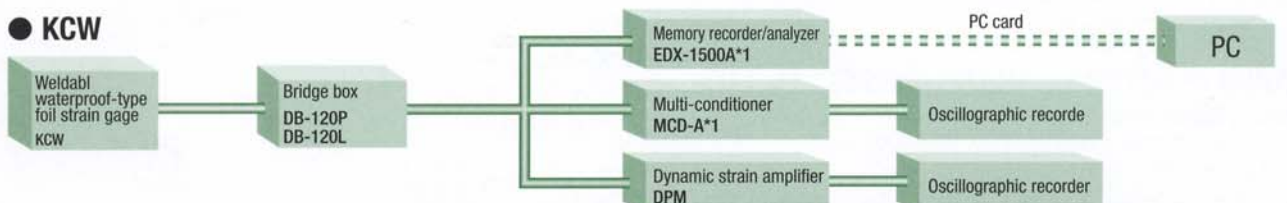
When using the dedicated adaptor (HDB-60C):



### ● KHCD



### ● KCW



\*1: Use the dynamic strain measurement card and signal conditioner cards.

\*2: Use the signal conditioner cards.

**Fill in the form below upon contacting us or nearest Kyowa distributor**

Company name/school name:	
Address:	
Division:	Name:
TEL:	E-mail:
FAX:	

① Objectives of measurement:	
② Type of measurement:	<input type="checkbox"/> Static <input type="checkbox"/> Dynamic (      Hz)
③ Strain level:	<input type="checkbox"/> Approx. (      ) x 10 <sup>-6</sup> strain <input type="checkbox"/> Unknown
④ Temperature during measurement:	<input type="checkbox"/> (      to      °C), cycle count (      ) times <input type="checkbox"/> (      to      °C), time (      ) h
⑤ Exposed length under high temperatures:	<input type="checkbox"/> (      ) m, necessary MI cable length (      ) m
⑥ Exposed length under room temperature:	<input type="checkbox"/> (      ) m, necessary soft-cable length (      ) m
⑦ Special atmosphere during measurement:	<input type="checkbox"/> (      ) (example: in gas, seawater, etc.)
⑧ Cable offtake from pressure vessels, etc.:	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Need the compression-fittings (yes/no)      installation direction (forward/reverse)
⑨ Material of the measurement:	<input type="checkbox"/> (      ) (composition of the material in the case of an unusual material)
⑩ Heat treatment of the measurement material:	<input type="checkbox"/> (      )
⑪ Linear expansion coefficient of the measurement material:	<input type="checkbox"/> If expressed by an equation: function of temperature ( <i>T</i> ) (approximating equation), the equation: $f(T) = (      )$ <input type="checkbox"/> At room temperature (      °C) (      x 10 <sup>-6</sup> /°C) <input type="checkbox"/> At high temperatures (      °C) (      x 10 <sup>-6</sup> /°C); <input type="checkbox"/> Unknown
⑫ Space for installation:	<input type="checkbox"/> (      ) mm x (      ) mm
⑬ Radius of curvature for mounting:	<input type="checkbox"/> Flat plane; <input type="checkbox"/> Inside of R (      ) mm; <input type="checkbox"/> Outside of R (      ) mm
⑭ Necessary gage length:	<input type="checkbox"/> 5 mm <input type="checkbox"/> 10 mm <input type="checkbox"/> 20 mm <input type="checkbox"/> Not specified
⑮ Capsule gage you requested:	<input type="checkbox"/> (type      )
⑯ Adaptor:	<input type="checkbox"/> Need gage with bridge adaptor <input type="checkbox"/> Have an HDB <input type="checkbox"/> Need HDB
⑰ Estimated data on the apparent strain and gage factor:	<input type="checkbox"/> Necessary (provided with KHCX, KHCS, and KHCM as a standard accessory) <input type="checkbox"/> Need actual measurement data (for KHC)
⑱ Measurement system:	<input type="checkbox"/> Capsule gage — <input type="checkbox"/> Bridge adaptor or HDB — (Amplifier, etc.) — (Recorder, etc.)
⑲ Spot welder:	<input type="checkbox"/> Have one <input type="checkbox"/> Need one



• Be sure to read the "Safety Precautions" in the Operation Manual to ensure proper use.  
• Do not install the products in a location affected by water, humidity, steam, dust, or flammable gas; otherwise, problems such as fire, electric shock, or failure may result.

■ The specs and design are subject to change without prior notice. ■ Contact us if our products are to be used in unusual applications. ■ The company names and product names are the trademarks and registered trademarks of the respective companies.



Reliability through integration



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