Move into the future with reliable measurements

KYOWA

Encapsulated Gages

KHCX, KHCV, KHCR, KHCS, KHCM, KHC, KCW

Static/Dynamic Strain Measurement
Max.

950°C

(KHCX)

KYOWA Encapsulated

Contents

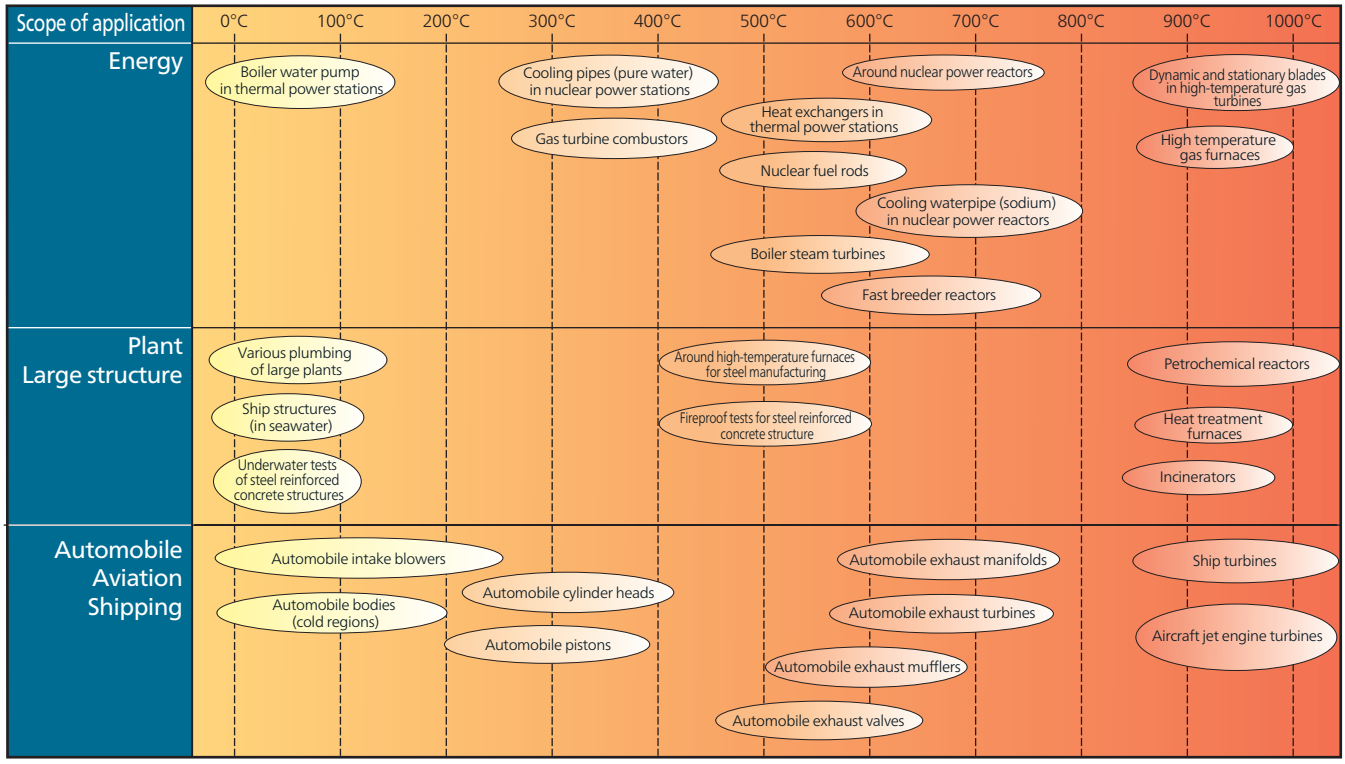
Weldable Strain Gages

Encapsulated gage is a welded type strain gage with completely airtight structure. The product consists of a sensing part and a cable for outputting the signal output from the sensing part. Sensing part is comprised of a flange and an environmentally resistant metallic tube with encapsulated gage and insulator. The sensing part can be fixed to the measurement material by spot welding.
There are high-temperature and normal-temperature types. The high-temperature cables use an inorganic insulated MI cable (Mineral Insulated metal sheathed cable) in which a metal sheath is filled with heat resistant insulating material powder and a conductor is embedded inside. Using the high-temperature model, strain measurement can be conducted even at harsh environment involving high temperature, high pressure, and high humidity, such as nuclear-power generation, automobiles, and planes.
Normal-temperature cables use crosslinked polyethylene sheath (heat resistant up to 100℃), and has waterproof property as well as long-term stability. It can be applied to strain measurement in outdoor environment such as automobiles, civil engineering, and construction.

Types and typical applications

Type	Normal Temp.	High Temp.					
Model	KCW	KHC	KHCM	KHCS	KHCR	KHCV	KHCX
Measuring strain	Static/Dynamic					Dynamic	Static/Dynamic
Max. oprg. temp.*1	100°C	500/550°C	650°C	750°C	750°C	800°C	950°C
Temp. comp.*2	Yes					No	Yes

*1 Max. oprg. temp.: Max. operating temperature
*2 Temp. comp.: Temperature compensation



High-temperature encapsulated gages

Features

Completely airtight structure and excellent environmental characteristics

Gages and lead-wire cables (MI cables) are covered and integrated with metals (such as Inconel 600) with excellent environmental properties including heat or corrosion resistance, and can be used in high temperature, high pressure environment, seawater, and pure water.

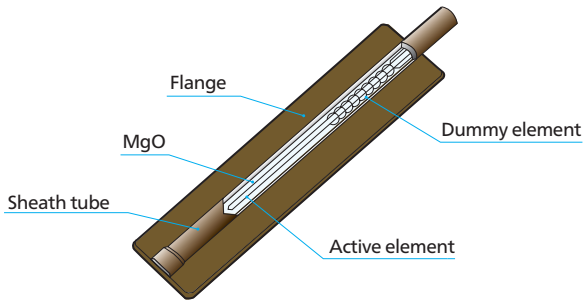
Adopts heat resistant special alloy for strain-gage element.

Able to be welded and easy handling at the measurement site

The gage can be mounted easily to the measurement material using spot welding, enabling measurement to be started immediately after installation.

Provides high-precision measurement with minimal thermally-induced apparent strain (KHCX, KHCR, KHCS, KHCM, KHC)

Thermally-induced apparent strain is virtually eliminated through the use of active-dummy system with a temperature-compensating dummy gage inside the sensing part, a sensing part with linear expansion coefficient suitable for the measurement material, and a temperature-compensating resistor that compensates for the apparent strain generated by the linear expansion coefficient of the lead-wire cable in the measurement temperature range. Highly accurate measurements can be undertaken.

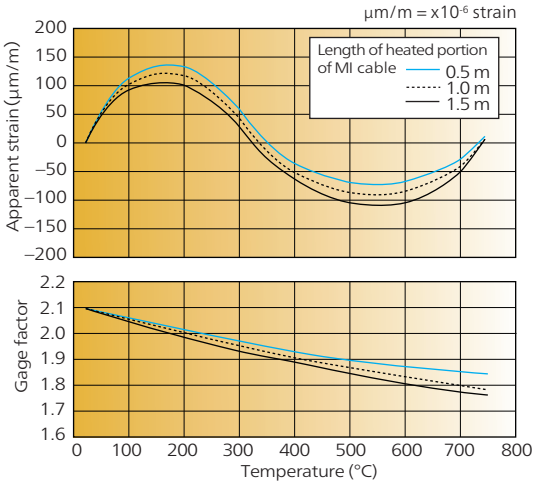


Linear expansion coefficient of 11, 13, 16×10^{-6}/°C selectable (KHCX: 11 and 13 ×10^{-6}/°C only)

Other selections are available at your request. (The KHCV does not provide any temperature compensation since it is designed for dynamic strain measurement only.)

Detailed test data sheet allows strain measurement to be conducted with high precision

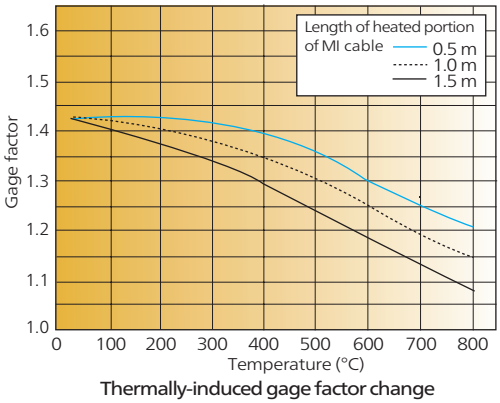
The test data sheet provided with your product includes resistance data to compensate for the temperature and zero point (bridge balance). If a temperature range and the length of the heated portion of the MI cable are other than specifications shown in the graph below, submit your requirement and we can provide estimated data and graphs on the change in thermally-induced apparent strain and the gage factor. (Except for the KHCV type where only the gage factor is available).



Estimated thermally-induced apparent strain and gage factor change

Approximately 50% improvement in gage factor (compared to our previous products KHCV)

This is made possible through improved spot welding method and use of low resistance MI cable. We also achieved the gage resistance of 120Ω at a gage length of 5 mm.



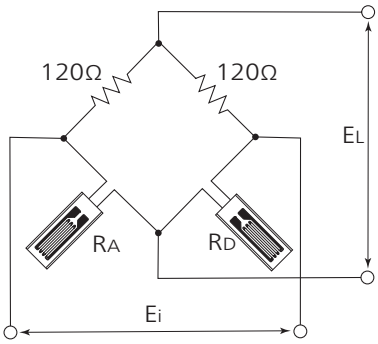
Thermally-induced gage factor change

Gages with bridge adapter (optional) save labor and ensure high relibaility

The bridge adaptor includes wiring for the temperature-compensating resistor (KHCX, KHCR, KHCS, KHCM, KHC), thus eliminating the need for wiring to the dedicated adaptor, and enabling easy connection to measurement devices.

Temperature compensation methods and bridge circuits (KHCX, KHCR, KHCS, KHCM, KHC)

With the active-dummy system 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.

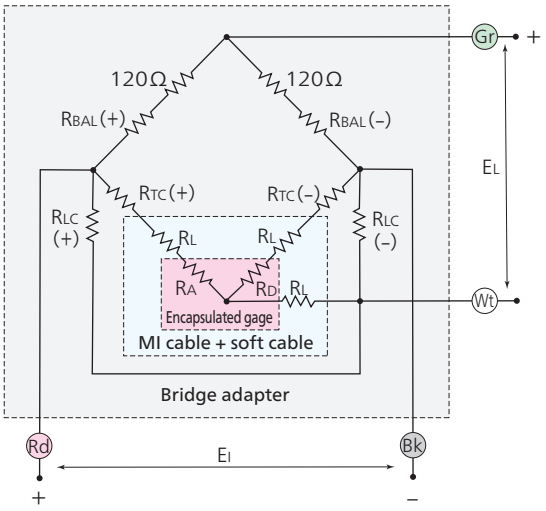


Temperature compensation circuit for foil strain gages

The dummy gage in encapsulated gage can compensate for the apparent strain caused by temperature coefficient of resistance but it has no sensitivity, therefore the latter of the above outputs cannot be compensated for. As a result, an output signal (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. Furthermore, external temperature compensation resistor (R_{LC}) is inserted to the bridge circuit to reduce the apparent strain initiated by the heated MI cable.
As the balance in the bridge is disturbed by the insertion of those resistors, a balance-adjustment resistor (R_{BAL}) is also necessary. The individual resistance applied to each of these resistors depends on the temperature range best suited to your application.

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

Temperature compensation circuit of KHCX, KHCR, KHCS, KHCM and KHC



R_A	Active element
R_D	Dummy element
R_L	Leadwire resistance
R_{TC} (+), R_{TC} (–)	Temp. *2 compensation resistor (sensing part)*1
R_{LC} (+), R_{LC} (–)	Temp. *2 compensation resistor (lead-wire)*1
R_{BAL} (+), R_{BAL} (–)	Balance adjustment resistor*1
E_L	Bridge output voltage
E_I	Bridge application voltage
120Ω	Fixed resistor in bridge adapter

*1 Inserted positions of asterisked resistors differ by product.
*2 Temp: Temperature

Normal-temperature encapsulated gages

Features

KCW

(Weldable waterproof foil strain gage)

Weldable type for easy handling on-site

The gage can be mounted easily to the measurement material using spot welding.
The sensing part is covered with stainless steel and it requires no coating related to adhesion.
Easy to take out with cable integrated structure.

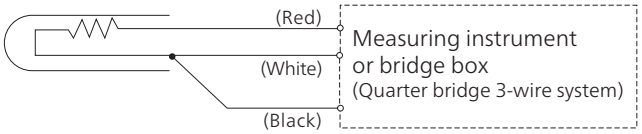
Excellent waterproofing and long-term stability

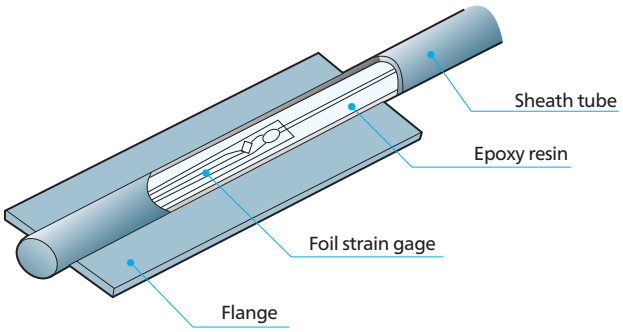
Offers waterproofing performance of approx. 10 MPa up to 24 hours.
Able to be used for outdoor, underwater, and high humidity measurements.

Low price

Lower pricing compared to the encapsulated gage for high-temperature applications.

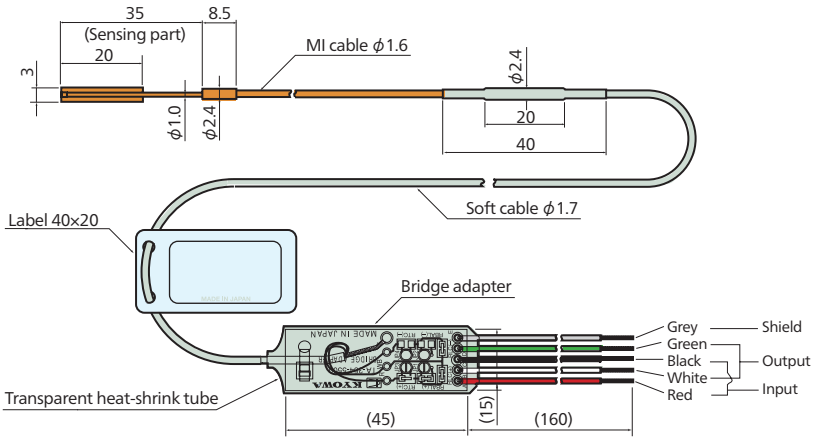
Circuit





KHCX

Static and Dynamic Strain Measurement
High-temperature encapsulated gages



Specifications

Model	For common steel	KHCX-10-120-G13-11 C2MV
	For Inconel 600	KHCX-10-120-G13-13 C2MV
Gage type		Uniaxial 2-element temperature-compensation type
Resistive element		Heat-resistant special alloy
Sensing part	Gage length	10 mm
	Flange	3 (W) × 20 (L) mm, t=0.1 mm
	Material	Sheath tube and flange: Inconel 600 (Equivalent to JIS NCF600)
Gage resistance		Approx. 120 Ω
Lead-wire cable		MI cable: Inconel 600-sheathed 3-Ni-conductor cable, 1.6 mm diameter by approx. 2 m long (Standard)
		Soft cable: ETFE-coated 3-conductor shielded cable, 1.7 mm diameter by approx. 50 cm long
Max. operating temperature		Approx. 950°C
Applicable linear expansion coefficient		11, 13×10^{-6}/°C
Gage factor (Sensing part only)		Approx. 1.7 (Normal temperature) Approx. 1.5 (950°C)
Thermally-induced apparent strain		The estimated curve is shown on the test data sheet.
Compensated temperature		25 to 950°C
Operating temperature		-196 to 950°C
Max. allowable current		50 mA
Min. radius of curvature		75 mm
RoHS directive		EN50581

*Models with no bridge adapter are also available.

Actual value at 950°C (Reference)

Drift	Within ±20 μm/m/h
Strain limit	10000 μm/m
Fatigue life	1×10^{6} times, strain level: ±100 μm/m

Standard accessories

- MI cable fixing metal belt (Length: 100 mm, × 2)
- Metal piece for welding test (Length: 30 mm, × 2)
- Test data sheet
- Instruction manual

For models with no bridge adapter, the following resistors are additionally provided.

- Temperature-compensation resistor
- Bridge-balance resistor

Optional accessories

- Bridge adapter (Page 12)
- Compression fitting (Page 13)
- Compact spot welder GW-3C (Page 14)

Example applications

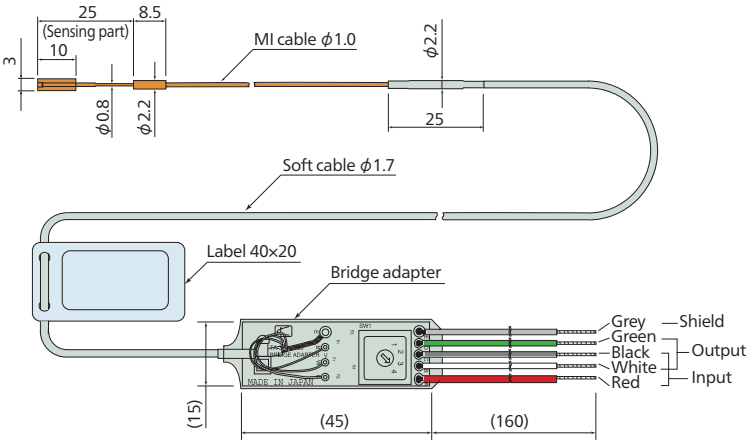
- Dynamic and stationary blades in high-temperature gas turbines
- Aircraft jet engine turbines
- Incinerators and heat treatment furnaces
- Petrochemical reactors
- Measuring physical characteristics of heat-resistant alloys

Precautions

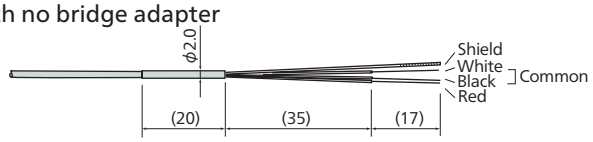
- Models with bridge adapter can be connected directly to a static strain measuring instrument such as UCAM via the bridge adapter cord. However, for dynamic strain measuring instrument such as EDX, optional input cable must be used for connection.
- Models with no bridge adapter require an optional dedicated adapter.
- Prior to use, "High-temperature encapsulated gages, Features" (page 2) must be studied and items stated in "In order to use encapsulated gages correctly" (page 15) must be observed.
- When attaching the sensing part, avoid excessive force applied to the sensing part. Do not bend the sensing part.
- We recommend measuring instrument with constant direct current. (CDV etc.)
- The specifications are for reference purpose only. Actual values may vary depending on operating conditions including temperatures.

KHCV

Dynamic Strain Measurement Only
High-temperature encapsulated gages



•Model with no bridge adapter



Specifications

Model	KHCV-5-120-G17 C2MV	
Gage type	Uniaxial 1-element	
Resistive element	Heat-resistant special alloy	
Sensing part	Gage length	5 mm
	Flange	3 (W) × 10 (L) mm, t=0.1 mm
	Material	Sheath tube and flange: Inconel 600 (Equivalent to JIS NCF600)
Gage resistance	Approx. 120 Ω	
Lead-wire cable	MI cable: Inconel 600-sheathed 3-Ni-conductor cable, 1.0 mm diameter by approx. 2 m long (Standard)	
	Soft cable: ETFE-coated 3-conductor shielded cable, 1.7 mm diameter by approx. 50 cm long	
Max. operating temperature	Approx. 800°C	
Gage factor (Sensing part only)	Approx. 1.5 (Normal temperature)	
	Approx. 1.2 (800°C)	
Operating temperature	25 to 800°C	
Max. allowable current	50 mA	
Min. radius of curvature	15 mm	
RoHS directive	EN50581	

*For the model with no bridge adapter, use the bridge box DB-120A/L.

Actual value at 800°C (Reference)

Strain limit	10000 μm/m
Fatigue life	1×10^6 times (800°C), strain level: ±500 μm/m

Standard accessories

- MI cable fixing metal belt (Length: 100 mm, × 2)
- Metal piece for welding test (Length: 30 mm, × 2)
- Test data sheet
- Instruction manual

For models with no bridge adapter, the following resistors are additionally provided.

- Capacitors (1, 2.2, 10 μF)
- Resistor (10 kΩ)

Optional accessories

- Bridge box DB-120A/L (Page 12)
- Bridge adapter (Page 12)
- Compression fitting (Page 13)
- Compact spot welder GW-3C (Page 14)

Example applications

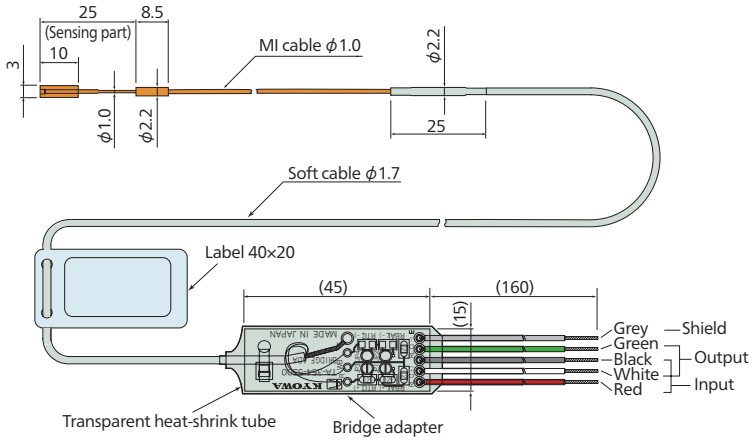
- Dynamic and stationary blades in high-temperature gas turbines
- Aircraft jet engine turbines
- Incinerators and heat treatment furnaces
- Petrochemical reactors
- Measuring physical characteristics of heat-resistant alloys

Precautions

- The KHCV is dedicated to dynamic strain measurements. Do not use it for static measurements.
- Use the DC-excited CDV signal conditioner as the measuring instrument.
- Prior to use, "High-temperature encapsulated gages, Features" (page 2) must be studied and items stated in “In order to use encapsulated gages correctly” (page 15) must be observed.
- The specifications are for reference purpose only. Actual values may vary depending on operating conditions including temperatures.

KHCR

Static and Dynamic Strain Measurement
High-temperature encapsulated gages



Specifications

Model	For common steel	KHCR-5-120-G16-11 C2MV
	For Inconel 600	KHCR-5-120-G16-13 C2MV
	For stainless steel	KHCR-5-120-G16-16 C2MV
Gage type		Uniaxial 2-element temperature-compensation type
Resistive element		Heat-resistant special alloy
Sensing part	Gage length	5 mm
	Flange	3 (W) × 10 (L) mm, t=0.1 mm
	Material	Sheath tube and flange: Inconel 600(Equivalent to JIS NCF600)
Gage resistance		Approx. 120 Ω
Lead-wire cable		MI cable: Inconel 600-sheathed 3-Ni-conductor cable, 1.0 mm diameter by approx. 2 m long (Standard)
		Soft cable: ETFE-coated 3-conductor shielded cable, 1.7 mm diameter by approx. 50 cm long
Max. operating temperature		Approx. 750°C
Applicable linear expansion coefficient		11, 13, 16×10^{-6}/°C
Gage factor (Sensing part only)		Approx. 1.5 (Normal temperature) Approx. 1.2 (750°C)
Thermally-induced apparent strain		The estimated curve is shown on the test data sheet.
Compensated temperature		25 to 750°C
Operating temperature		25 to 750°C
Max. allowable current		50 mA
Min. radius of curvature		15 mm
RoHS directive		EN50581

*Models with no bridge adapter are also available.

Actual value at 750°C (Reference)

Drift	Within ±20 μm/m/h
Strain limit	10000 μm/m
Fatigue life	1×10^6 times, strain level: ±500 μm/m

Standard accessories

- MI cable fixing metal belt (Length: 100 mm, × 2)
- Metal piece for welding test (Length: 30 mm, × 2)
- Test data sheet
- Instruction manual

For models with no bridge adapter, the following resistors are additionally provided.

- Temperature-compensation resistor
- Bridge-balance resistor

Optional accessories

- Bridge adapter (Page 12)
- Compression fitting (Page 13)
- Compact spot welder GW-3C (Page 14)

Example applications

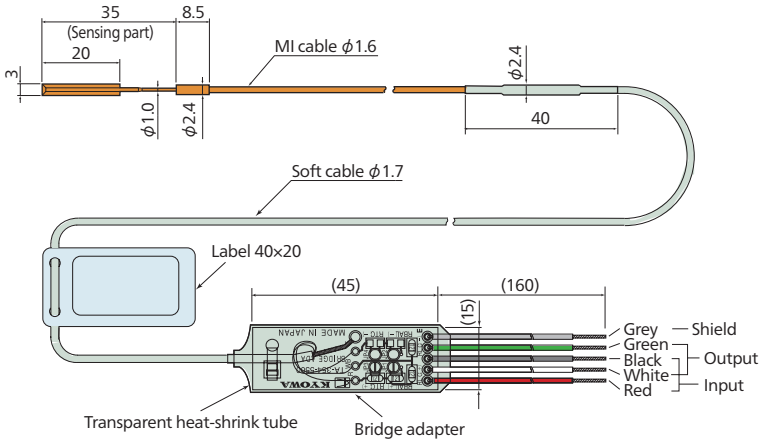
- Dynamic and stationary blades in high-temperature gas turbines
- Aircraft jet engine turbines
- Incinerators and heat treatment furnaces
- Petrochemical reactors
- Measuring physical characteristics of heat-resistant alloys

Precautions

- Models with bridge adapter can be connected directly to a static strain measuring instrument such as UCAM via the bridge adapter cord. However, for dynamic strain measuring instrument such as EDX, optional input cable must be used for connection.
- Models with no bridge adapter require an optional dedicated adapter.
- Prior to use, "High-temperature encapsulated gages, Features" (page 2) must be studied and items stated in “In order to use encapsulated gages correctly” (page 15) must be observed.
- The specifications are for reference purpose only. Actual values may vary depending on operating conditions including temperatures.

KHCS

Static and Dynamic Strain Measurement
High-temperature encapsulated gages



Specifications

Model	For common steel	KHCS-10-120-G12-11 C2MV
	For Inconel 600	KHCS-10-120-G12-13 C2MV
	For stainless steel	KHCS-10-120-G12-16 C2MV
Gage type		Uniaxial 2-element temperature-compensation type
Resistive element		Heat-resistant special alloy
Sensing part	Gage length	10 mm
	Flange	3 (W) × 20 (L) mm, t=0.1 mm
	Material	Sheath tube and flange: Inconel 600 (Equivalent to JIS NCF600)
Gage resistance		Approx. 120 Ω
Lead-wire cable		MI cable: Inconel 600-sheathed 3-Ni-conductor cable, 1.6 mm diameter by approx. 2 m long (Standard)
		Soft cable: ETFE-coated 3-conductor shielded cable, 1.7 mm diameter by approx. 50 cm long
Max. operating temperature		Approx. 750°C
Applicable linear expansion coefficient		11, 13, 16×10^{-6}/°C or user-specified
Gage factor (Sensing part only)		Approx. 2.0 (Normal temperature) Approx. 1.8 (750°C)
Thermally-induced apparent strain		The estimated curve is shown on the test data sheet.
Compensated temperature		25 to 750°C
Operating temperature		-196 to 750°C
Max. allowable current		50 mA
Min. radius of curvature		20 mm
RoHS directive		EN50581

*Models with no bridge adapter are also available.

Actual value at 750°C (Reference)

Drift	Within ±10 μm/m/h
Strain limit	10000 μm/m
Fatigue life	1×10^6 times, strain level: ±500 μm/m

Standard accessories

- MI cable fixing metal belt (Length: 100 mm, × 2)
- Metal piece for welding test (Length: 30 mm, × 2)
- Test data sheet
- Instruction manual

For models with no bridge adapter, the following resistors are additionally provided.

- Temperature-compensation resistor
- Bridge-balance resistor

Optional accessories

- Bridge adapter (Page 12)
- Compression fitting (Page 13)
- Compact spot welder GW-3C (Page 14)

Example applications

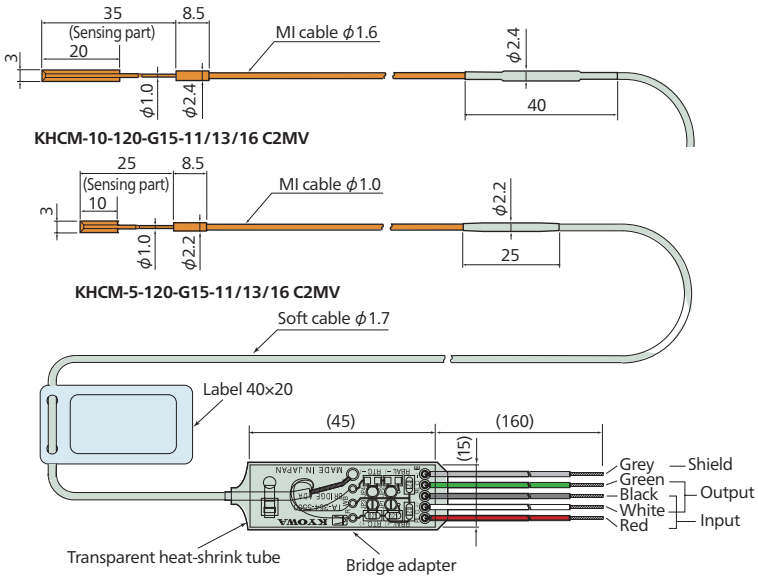
- Dynamic and stationary blades in high-temperature gas turbines
- Aircraft jet engine turbines
- Incinerators and heat treatment furnaces
- Petrochemical reactors
- Measuring physical characteristics of heat-resistant alloys

Precautions

- Models with bridge adapter can be connected directly to a static strain measuring instrument such as UCAM via the bridge adapter cord. However, for dynamic strain measuring instrument such as EDX, optional input cable must be used for connection.
- Models with no bridge adapter require an optional dedicated adapter.
- Prior to use, "High-temperature encapsulated gages, Features" (page 2) must be studied and items stated in “In order to use encapsulated gages correctly” (page 15) must be observed.
- The specifications are for reference purpose only. Actual values may vary depending on operating conditions including temperatures.

KHCM

Static and Dynamic Strain Measurement
High-temperature encapsulated gages



Specifications

		KHCM-10	KHCM-5
Model	For common steel	KHCM-10-120-G15-11 C2MV	KHCM-5-120-G15-11 C2MV
	For Inconel 600	KHCM-10-120-G15-13 C2MV	KHCM-5-120-G15-13 C2MV
	For stainless steel	KHCM-10-120-G15-16 C2MV	KHCM-5-120-G15-16 C2MV
Gage type		Uniaxial 2-element temperature-compensation type	
Resistive element		Heat-resistant special alloy	
Sensing part	Gage length	10 mm	5 mm
	Flange	3 (W) × 20 (L) mm, t=0.1 mm	3 (W) × 10 (L) mm, t=0.1 mm
	Material	Sheath tube and flange: Inconel 600 (Equivalent to JIS NCF600)	
Gage resistance		Approx. 120 Ω	
Lead-wire cable	MI cable	1.6 mm diameter by approx. 2 m long (Standard)	1.0 mm diameter by approx. 2 m long (Standard)
		Inconel 600-sheathed 3-Cu-conductor cable	
	Soft cable	ETFE-coated 3-conductor shielded cable, 1.7 mm diameter by approx. 50 cm long	
Max. operating temperature		Approx. 650°C	
Applicable linear expansion coefficient		11, 13, 16×10^{-6}/°C or user-specified	
Gage factor (Sensing part only)		Approx. 2.0 (Normal temperature)	Approx. 1.5 (Normal temperature)
		Approx. 1.8 (650°C)	Approx. 1.4 (650°C)
Thermally-induced apparent strain		The estimated curve is shown on the test data sheet.	
Compensated temperature		25 to 650°C	
Operating temperature		-196 to 650°C	
Max. allowable current		50 mA	
Min. radius of curvature		20 mm	15 mm
RoHS directive		EN50581	

*Models with no bridge adapter are also available.

Actual value at 650°C (Reference)

Drift	Within ±10 μm/m/h	Within ±20 μm/m/h (650°C)
Strain limit	10000 μm/m	
Fatigue life	1×10^6 times, strain level: ±500 μm/m	

Standard accessories

- MI cable fixing metal belt (Length: 100 mm, × 2)
- Metal piece for welding test (Length: 30 mm, × 2)
- Test data sheet
- Instruction manual

For models with no bridge adapter, the following resistors are additionally provided.

- Temperature-compensation resistor
- Bridge-balance resistor

Optional accessories

- Bridge adapter (Page 12)
- Compression fitting (Page 13)
- Compact spot welder GW-3C (Page 14)

Example applications

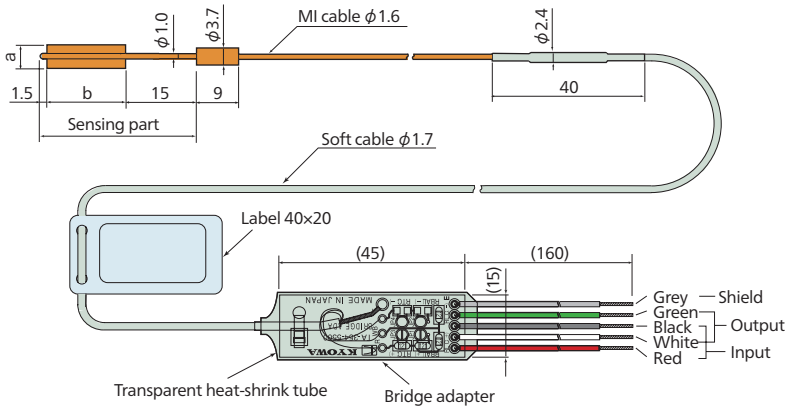
- Around nuclear power reactors
- Heat exchangers in thermal power stations
- Cooling waterpipe (sodium) in nuclear power reactors
- Fast breeder reactors
- Automobile exhaust manifolds
- Understanding physical characteristics of automobile exhaust turbines/ mufflers/valves

Precautions

- Models with bridge adapter can be connected directly to a static strain measuring instrument such as UCAM via the bridge adapter cord. However, for dynamic strain measuring instrument such as EDX, optional input cable must be used for connection.
- Models with no bridge adapter require an optional dedicated adapter.
- Prior to use, "High-temperature encapsulated gages, Features" (page 2) must be studied and items stated in "In order to use encapsulated gages correctly" (page 15) must be observed.
- The specifications are for reference purpose only. Actual values may vary depending on operating conditions including temperatures.

KHC

Static and Dynamic Strain Measurement
High-temperature encapsulated gages



Dimensions: mm

Type	a	b
KHC-10-120-G8	4	16.5
KHC-10-120-G9	5	16.5

Type	a	b
KHC-20-120-G8	4	30
KHC-20-120-G9	5	30

Specifications

		KHC-20	KHC-10
Model	For common steel	KHC-20-120-G8-11 C2MV	KHC-10-120-G8-11 C2MV
		KHC-20-120-G9-11 C2MV	KHC-10-120-G9-11 C2MV
	For Inconel 600	KHC-20-120-G8-13 C2MV	KHC-10-120-G8-13 C2MV
		KHC-20-120-G9-13 C2MV	KHC-10-120-G9-13 C2MV
	For stainless steel	KHC-20-120-G8-16 C2MV	KHC-10-120-G8-16 C2MV
		KHC-20-120-G9-16 C2MV	KHC-10-120-G9-16 C2MV
Gage type		Uniaxial 2-element temperature-compensation type	
Resistive element		Heat-resistant special alloy	
Sensing part	Gage length	20 mm	10 mm
	Flange	Width and length: See the dimensional drawing above. t=0.1 mm	
	Material	G8 Sheath tube and flange: Inconel 600 (equivalent to JIS NCF600)	
		G9 Sheath tube and flange: SUS321	
Gage resistance		Approx. 120 Ω	
Lead-wire cable		MI cable 1.6 mm diameter by approx. 2 m long (Standard), G8: Inconel 600, G9: SUS347	
		Soft cable ETFE-coated 3-conductor shielded cable, 1.7 mm diameter by approx. 50 cm long	
Max. operating temperature		Dynamic strain: Approx. 550°C , Static strain: Approx. 500°C	
Applicable linear expansion coefficient		11, 13, 16×10^{-6}/°C or user-specified	
Gage factor (Sensing part only)		Approx. 1.9 (Normal temperature)	Approx. 1.6 (Normal temperature)
		Approx. 1.75 (500°C)	Approx. 1.5 (500°C)
Thermally-induced apparent strain		The estimated curve is shown on the test data sheet.	
Compensated temperature		25 to 500°C	
Operating temperature		Dynamic strain: -196 to 550°C, Static strain: -196 to 500°C	
Max. allowable current		30 mA	
Min. radius of curvature		25 mm	20 mm
RoHS directive		EN50581	

Actual value (Reference)

Drift	Within ±20 μm/m/h (500°C)	
Strain limit	8000 μm/m (Normal temperature)	5000 μm/m (Normal temperature)
Fatigue life	4×10^{5} times (25°C, 500 μm/m)	

Standard accessories

- MI cable fixing metal belt (Length: 100 mm, × 2)
- Metal piece for welding test (Length: 30 mm, × 2)
- Test data sheet
- Instruction manual

For models with no bridge adapter, the following resistors are additionally provided.

- Temperature-compensation resistor
- Bridge-balance resistor

Optional accessories

- Bridge adapter (Page 12)
- Compression fitting (Page 13)
- Compact spot welder GW-3C (Page 14)

Example applications

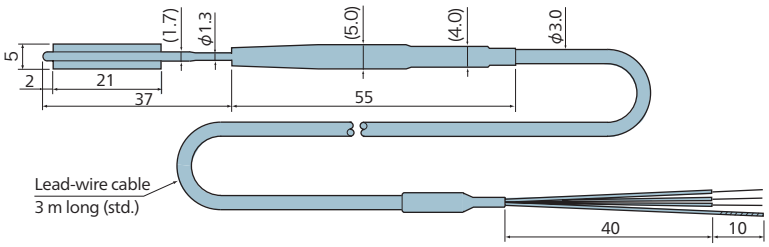
- Nuclear fuel rods
- Boiler steam turbines
- Around high-temperature furnaces for steel manufacturing
- Fireproof tests for steel reinforced concrete structure
- Automobile exhaust valves
- Cooling pipes (pure water) in nuclear power stations
- Gas turbine combustors
- Automobile cylinder heads
- Automobile pistons
- Measuring physical characteristics of heat-resistant alloys

Precautions

- Models with bridge adapter can be connected directly to a static strain measuring instrument such as UCAM via the bridge adapter cord. However, for dynamic strain measuring instrument such as EDX, optional input cable must be used for connection.
- Models with no bridge adapter require an optional dedicated adapter.
- Prior to use, "High-temperature encapsulated gages, Features" (page 2) must be studied and items stated in “In order to use encapsulated gages correctly” (page 15) must be observed.
- The specifications are for reference purpose only. Actual values may vary depending on operating conditions including temperatures.

KCW

Static and Dynamic Strain Measurement Normal-temperature weldable waterproof foil strain gages



For measurement outdoors, involving water and high humidity

Normal-temperature encapsulated gage KCW comprises of a sensing part 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 part to provide an environmentally resistant structure.
The sensing part is fixed on the measurement material by spot welding.
Its price is lower than that of the encapsulated gage for use at high temperatures.

Specifications

Model For common steel	KCW-5-120-G10-11 G3M3S	
Gage type	Uniaxial 1-element	
Resistive element	NiCr alloy	
Sensing part	Gage length	5 mm
	Flange	5 (W) × 21 (L) mm, t=0.1 mm
	Material	Sheath tube and flange: Stainless steel
Gage resistance	Approx. 120 Ω	
Lead-wire cable	Polyethylene-coated crosslink 3-conductor cable, 3 mm diameter by approx. 3 m long (Standard)	
Max. operating temperature	Approx. 100°C	
Applicable linear expansion coefficient	11×10^{-6}/°C	
Gage factor	Approx. 2.2	
Compensated temperature	10 to 90°C	
Operating temperature	-20 to 100°C	
Waterproof	Approx. 10 MPa for 24 hours	
Min. radius of curvature	20 mm	
Standard packing quantity	2	

Actual value (Reference)

Strain limit	5000 μm/m
Fatigue life	1×10^{6} times, strain level: ±1000 μm/m
Stability (Drift)	Within ±100 μm/m/500 h (80°C, 90%RH or higher, 1000 hours)
	Within ±40 μm/m/500 h (Soaked condition, 1000 hours)

Standard accessories

- Lead-wire cable fixing metal belt (Length: 100 mm, × 4)
- Metal piece for welding test (Length: 30 mm, × 2)
- Test data sheet
- Instruction manual

Optional accessories

- Bridge box DB-120A/L (Page 12)
- Compact spot welder GW-3C (Page 14)

Lead-wire cable lengths and codes

Lead-wire cable length	Code
15 cm	G15C3S
30 cm	G30C3S
1 m	G1M3S
3 m (Standard)	G3M3S
5 m	G5M3S

*When ordering, specify the model number together with the code of the desired cable length, suffixed with a space in between.

Example)
For KCW with 5 m long polyethylene-coated crosslink 3-conductor cable
KCW-5-120-G10-11 G5M35

Example applications

- Boiler water pump in thermal power stations
- Various plumbing of large plants
- Ship structures (in seawater)
- Underwater tests of steel reinforced concrete structures
- Automobile intake blowers
- Automobile bodies

Precautions

- Prior to use, "Normal-temperature encapsulated gages, Features" (page 4) must be studied and items stated in "In order to use encapsulated gages correctly" (page 15) must be observed.
- The specifications are for reference purpose only. Actual values may vary depending on operating conditions including temperatures.

To connect measuring instruments

Optional accessories

Bridge boxes DB-120A/L

Designed to configure a Wheatstone bridge circuit with the KHCV or KCW connected.

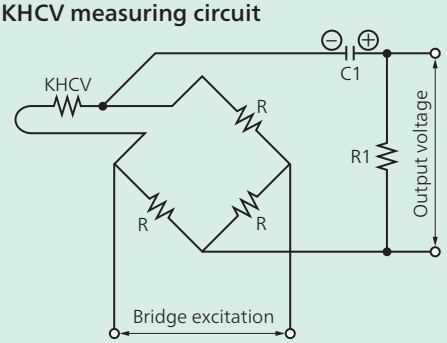
●DB-120A

Cable: Chloroprene-coated, 5 m long,
terminated with NDIS connector plug
Dimensions: 60 × 42 × 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 × 20 × 20 mm
Weight: Approx. 60 g (Main unit only)

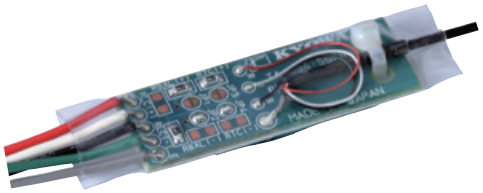
KHCV measuring circuit

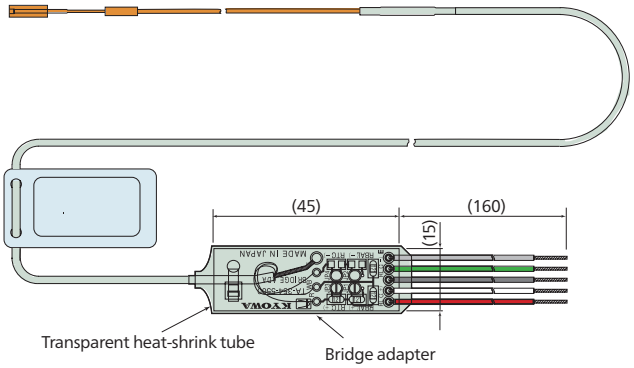


R: 120Ω (Fixed resistor)
R1: 10 kΩ (Accessory)
C1: Selected from 1, 2.2 or 10 μF (Accessory)

Half bridge adapter

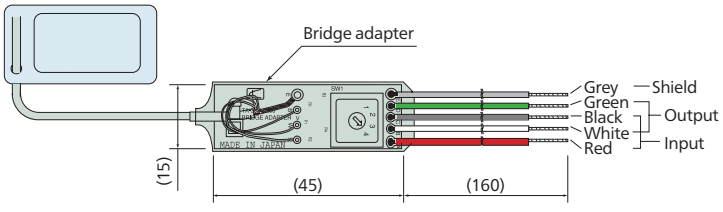
This is an adaptor having temperature-compensating resistors best suited for the temperature range of your use on a substrate attached to a soft cable. Through the use of this adaptor, improper wiring can be eliminated and work can be saved.





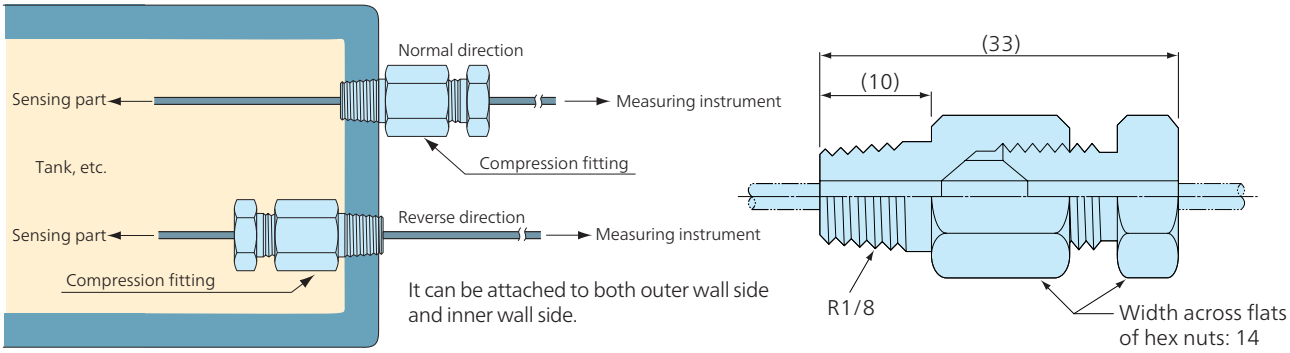
Quarter bridge adapter

The dedicated bridge adapter for KHCV allows for easy selection of cut-off frequency (1.6, 7.23, 16 Hz, FLAT).
Able to be connected easily to the measuring instrument and eliminates risks of improper wiring.



Compression fitting

At your request, we will add compression fitting for attaching the MI cable.
Please request its installation when placing an order.



MI cable length codes and optional accessories

When ordering, specifiy 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 bottom.)
In all cases, the length of the soft cable is 50 cm. (For extension, contact us.)

Examples
- For KHCS with 5 m long MI cable
  KHCS-10-120-G12-11 C5M
- For KHCS with 2 m long MI cable and bridge adapter pre-attached
  KHCS-10-120-G12-11 C2MV

MI cable length	Code	With bridge adapter ①	With compression fitting ②	①+②
1 m	C1M	C1MV	C1MF	C1MFV
2 m (Standard)	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

GW-3C

Compact spot welder for encapsulated gages

Features

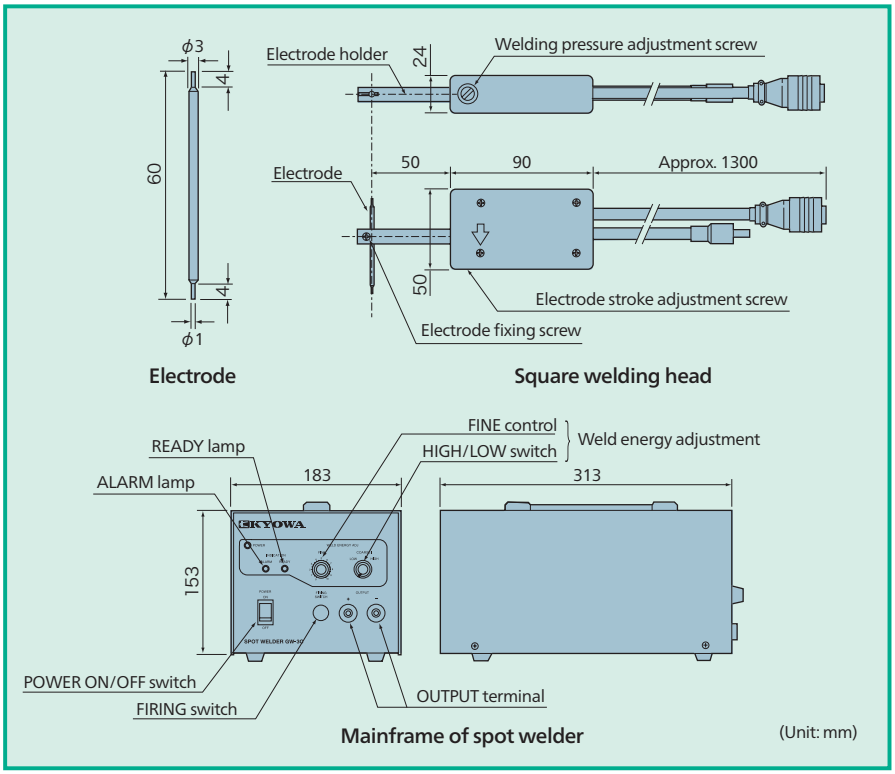
- Welding current output is suitable for stainless steel, enabling welding of 0.3 mm thick stainless steel sheets.
- The electrode is 1 mm diameter at both ends.
- To enable optimum welding, energy is switchable between high and low ranges and is continuously variable in each range.
- An aluminum trunk is optionally available for transportation and storage.

Specifications

Welding energy (COARSE)	LOW	0 to 25 W·s, contiuously variable (FINE 0 to 10)
	HIGH	0 to 50 W·s, contiuously variable (FINE 0 to 10)
Welding speed	1 W·s	150 times/minute
	5 W·s	120 times/minute
	10 W·s	80 times/minute
	20 W·s	60 times/minute
	50 W·s	30 times/minute
Operating temp. & humidity ranges	0° to 40°C, 85% RH or less	
Storage temperature range	-10° to 60°C	
Power supply	90 to 110 VAC, 500 VA or less	
Dimensions	183 W × 153 H × 313 D mm (Excluding protrusions)	
Weight	Approx. 8.2 kg (mainframe)	

*Products corresponding to welding speed 50 W・s, approx. 180 times/minute can also be manufactured. (Note: Does not comply with overseas laws and regulations. For use in Japan only.) Please contact us for details.

Specifications



Standard accessories

- Square welding head (With cable approx. 1.3 m long)
- Grounding clip (With cable approx. 1.3 m long)
- Electrode (GW-02)
- Metal file
- Fuse (5 A)
- Hexagon wrench
- Instruction manual

Optional accessories

- Aluminum trunk (GW-01)

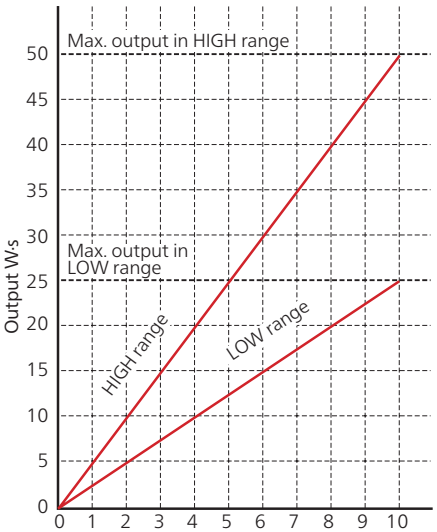
Precautions

Items stated in "In order to use encapsulated gages correctly" (page 15) must be observed.

Stainless steel sheet thickness and FINE control setting reference values

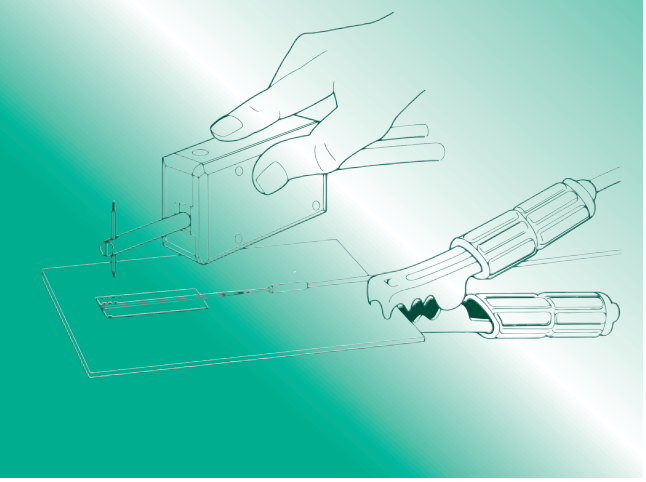
Stainless steel sheet thickness (mm)	COARSE range LOW (FINE control)	COARSE range HIGH (FINE control)	Welding energy (W·S)
0.1	2	1	5
0.2	6	3	15
0.3	—	6	30

Welding capability



Max. continuous usage shall not exceed the following:
- 4 minutes continuous at 1 second interval using HIGH range and FINE5.
- 10 minutes continuous at 1 second interval using LOW range and FINE10.

In order to use encapsulated gages correctly



- Be sure to read the instruction manual before use.
- Spot welding can be performed on ferrous materials, but cannot be performed on aluminum, copper, or ceramic materials.
- Surface treatment: Remove rust and paint from the surface of the measuring point by polishing with sandpaper (#320, etc.). Wipe away dirt and oil with a solvent such as acetone. While the flange is cleaned by sand-blasting at the factory, degrease it with acetone or the like as required.
- Be sure not to cut the MI cable or make any hole on it. The insulating material filled in the cable may absorb moisture through a hole, there by disabling measurement.
- To prevent the sensing part from any damage due to tension or twisting caused by the weight or handling of the MI cable, fix the connection between the sensing part and MI cable, and the MI cable at proper intervals using accessory metal belts. Then, spot-weld the flange. (Fig. 1)
- Apparent strain is generated when external pressure is applied.

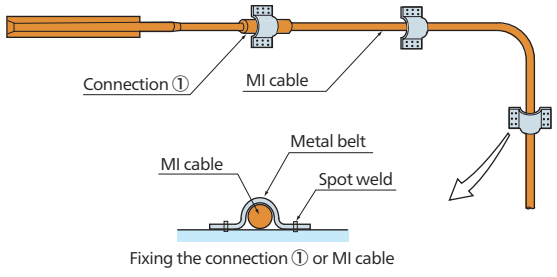


Fig. 1

- Spot-welding the flange: It is recommended to use Kyowa GW-3C compact spot welder (see page 14). When spot welding the flange, temporarily weld the center point and then perform welding in the order shown in the figure. Standard welding conditions are as follows:
  Tip of electrode: 0.8 mm diameter
  Welding energy: Approx. 10 W·s
  Electrode pressing force: Approx. 10 N (Fig. 2)

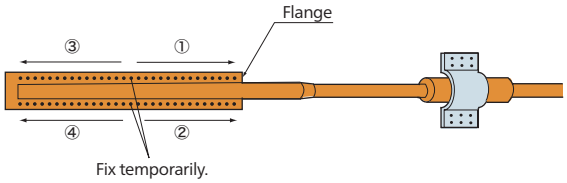
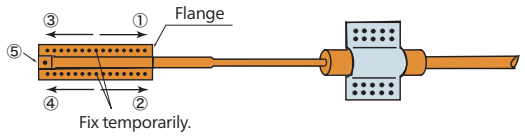


Fig. 2

Note:
Add another line of welding spots to the end of the center line. (Fig. 3)



Temporarily fix the flange at the center and then spot-weld it in order of ① to ⑤.
*⑤: For KHCV, KHCR and KHCM-5 only.

Fig. 3

- Spot-welding the flange to a curved surface:
  Before spot welding the flange, bend the flange along another curvature, such as a pipe, having the same radius of curvature as the material location. (Fig. 4)
  If the curvature radius and curved direction are specified when ordering, the gage will be delivered with the specified shape.

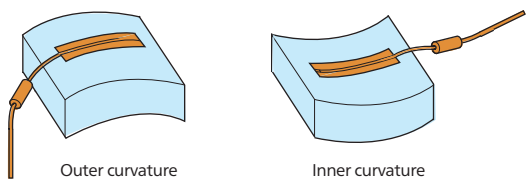
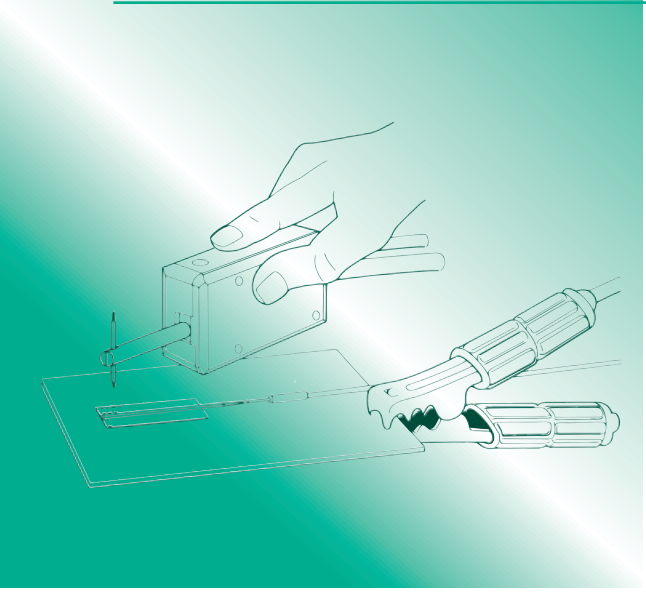


Fig. 4

- For the temperature compensation method, refer to "Temperature compensation methods and bridge circuits (KHCX, KHCR, KHCS, KHCM,KHC)," page 3.

Performing a preliminary test

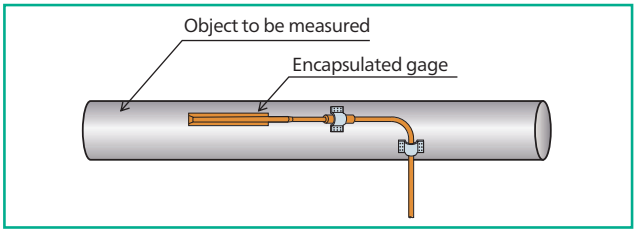


The characteristics of the encapsulated gage specified in the catalog and specification document are for reference only. The values are subject to operating conditions including the temperature. In order to improve accuracy of measurements, we recommend a preliminary test using the actual device followed by a calibration using the preliminary test result.

[Test example]

●Attaching the encapsulated gage

Follow the instruction manual to attach the encapsulated gage to the object to be measured.

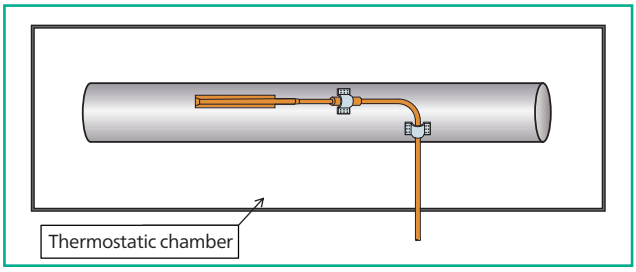


●Checking the zero temperature effect

Using a thermostatic chamber, check the apparent strain at the temperature of the actual test.

〈Precautions〉

When the encapsulated gage welded to the object to be measured is subjected to the temperature rise and fall cycle, the state of attachment and/or spot welding may affect the output. This may result in fluctuation between the temperature rise and fall cycles or between the first cycle and second cycle onwards. The process may also produce residual output after the temperature returns to normal temperature. Although this thermal hysteresis generally decreases gradually through repetitive temperature cycles, the temperature drift may affect the output of the encapsulated gage itself through increase in the number of repetitive temperature cycles.



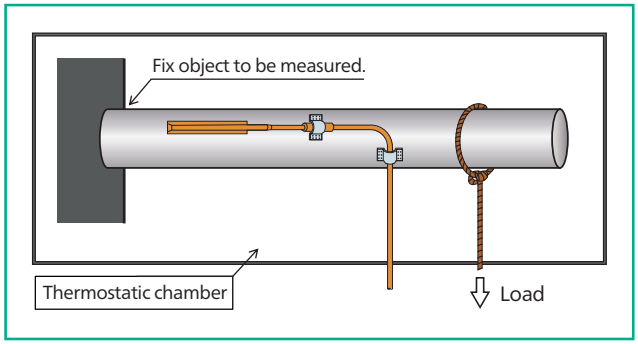
●Checking the gage factor

Check the output of the encapsulated gage against the strain of the object to be measured placed under load. Using a thermostatic chamber set to the temperature to be used in the actual test, the output of the encapsulated gage under load must be tested. The thermostatic chamber must be able to withstand the applied load.

The applied load should be appropriate for the deformation mode. A simulation must be performed in advance to estimate the deformation mode of the actual test.

〈Precautions〉

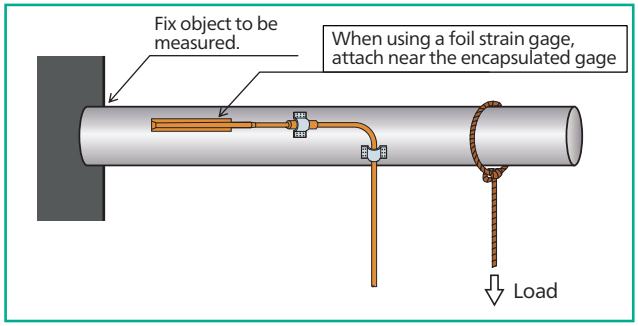
Since the thickness of the object to be measured affects the measurement value, a calibration must be performed. When measuring the bending strain, the measured value becomes larger than that of the actual strain. As the thickness of the object to be measured decreases, this effect becomes more exaggerated. In addition, the size of the object to be measured must be accounted for. This is due to the rigidity of the encapsulated gage itself losing its negligibility when the size of the object to be measured is small. Under such condition, the surface strain of the area where the gage is attached to can be affected because of the neutral axis of the object to be measured is shifted.



(Reference) Checking the gage factor at normal temperatures

When the above procedure for checking the output of the encapsulated gage under load using the temperature of the actual test cannot be performed, first check the gage factor at normal temperature and then use the table of the test data sheet to estimate the gage factor at the temperature of the actual test.

Alternatively, a foil strain gage can be used as a reference tool to check the gage factor at normal temperature. When a foil strain gage is used to check the gage factor, ensure the foil strain gage is removed before placing the object to be measured in the high temperature of the actual test.



●Checking apparent strain caused by pressure

When the ambient pressure of the actual test differs greatly from the atmospheric pressure, we recommend that the calibration of the gage meets the apparent strain caused by pressure. To perform this calibration, first remove the load applied to the object to be measured and then apply only the ambient pressure to check the apparent strain caused by pressure.

●Undertaking the actual test

After undertaking the actual test, perform calibration of the measurement data using the "zero temperature effect", "gage factor" and "apparent strain caused by pressure", which were obtained in the preliminary test.

Kyowa Overseas Department overseas@kyowa-ei.co.jp

Please fill the following form when ordering or inquiring the encapsulated gages.

Date :

Company name (school name)			
ZIP/Postal code Address			
Department		Your name	
Telephone		E-mail address	
Facsimile			

	Items	Details	Supplements
1	Application	Business fields ( ) ☐ a. Experiment and research ( ) ☐ b. Management and survey ( )	
2	Operating environment	☐ a. Laboratory ☐ b. Plant ☐ c. Moving object (☐ vehicle, ☐ railroad, ☐ aircraft, ☐ others)	
3	Models	☐ a. KHCX ☐ b. KHCV ☐ c. KHCR ☐ d. KHCS ☐ e. KHCM ☐ f. KHC ☐ g. Custom-made (model)	
4	Detailed models Quantity	( ) ( )	
5	Welding methods	☐ a. Spot welding (GW-3C) ☐ b. Spot welding (others)	
6	Curvature radius of welding area	☐ a. Flat ☐ b. Curve (curvature radius: mm, inside/outside)	
7	Welding space	(mm × mm)	
8	Operating temperature	Temperature (°C)	
9	Cable length, etc.	Heated length (m) (in MI cable) Non-heated length (m) (in soft cable) Bridge adapter (☐ required / ☐ not required)	
10	Strain	Expected strain (to μm/m)	
11	Measurement object	Materials ( ) Linear expansion coefficient (ppm/°C)	
12	Test conditions	☐ a. Dynamic (1 Hz or faster) ☐ b. Static (slower than 1 Hz) ☐ c. Thermal stress	
13	Test time	☐ a. Continuously ☐ b. Intermittently (every houes) ☐ c. Cycle test (to °C, h/cycle × times)	
14	Special instruction (test environments, etc.)	Ambient environment ☐ Gas ( ) / ☐ Seawater / ☐ Pure water / ☐ Others ( ) Ambient pressure (Mpa / ☐ atmospheric pressure) a. Vibration (G, to Hz) b. Impact (G) c. ☐ Non-rotating object / ☐ Rotating object (G)	
15	Actual calibration	Actual load calibration ☐ a. Yes ☐ b. No Thermometry in no load ☐ c. Yes ☐ d. No	
16	Bridge excitation	Voltage (V) ☐ a. Dynamic strain amplifier (DC type / AC type) ☐ b. Static strain amplifier	
17	Others		
18	Name of sales representatives		

Sales Network

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KYOWA AMERICAS, Inc.
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⚠ Safety Precautions

Be sure to observe the safety precautions given in the instruction manual, in order to ensure correct and safe operation.

• Specifications are subject to change without notice for improvement.

JQA-0821
JQA-EM4824

Manufacturer's Representative

Cat. No. 917d E1-2

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