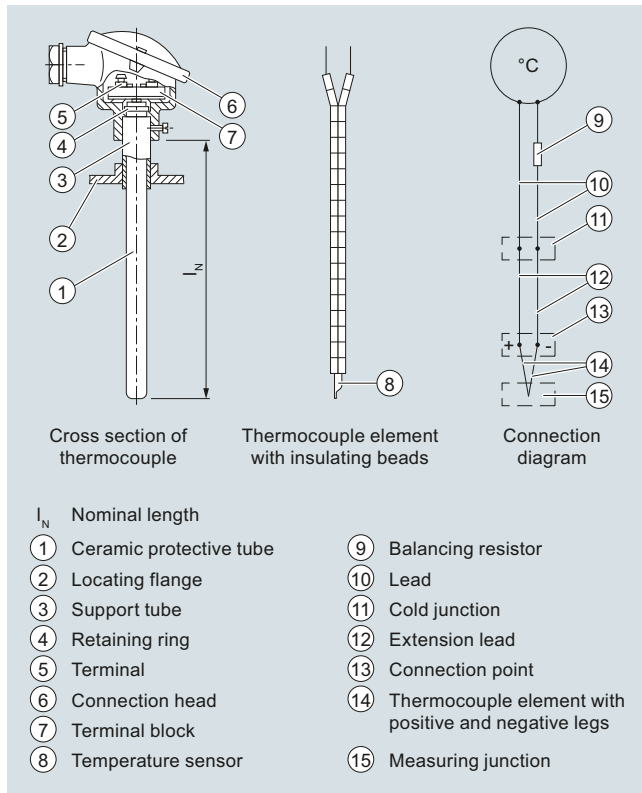


#### Design

A thermocouple comprises

- The thermocouple element (sensor) and
- The mounting and connection parts required in each case.

The thermocouple element is formed by two conductors of dissimilar metals or metal alloys which are soldered or welded together at one end, the measuring junction:



Thermocouple element

#### Function

##### Measuring principle of the thermocouple element

If the measuring junction is exposed to a temperature different from that at the free ends of the thermocouple, a voltage (the thermoelectric voltage, Seebeck effect) is produced at these free ends. The magnitude of the thermoelectric voltage depends on the difference in temperature between the measuring junction and the free ends, and on the combination of materials in the thermocouple. Since a thermocouple always measures a temperature difference, the free ends of the thermocouple must be connected to a reference junction (cold junction) and held constant at a known temperature.

##### Calibration data for thermoelectric voltages and permissible deviations

The calibration data and the permissible deviations for commonly used thermocouples are defined (see Technical Data, Table "Calibration data for thermoelectric voltages and error limits").

The thermocouples Cu-CuNi and Fe-CuNi to DIN 43710 are used for replacement purposes. Thermocouples of class 2 are supplied as standard. For more accurate measurements, thermocouples are available with half the DIN tolerance or with a test certificate. The tolerances only apply to the condition upon delivery.

During operation at high temperatures, the tolerances of the thermocouples may change due to absorption of foreign matter, oxidation or evaporation of alloy components.

##### Mode of operation

The thermocouples are extended from the connection point to a point whose temperature is as constant as possible (the cold junction) by means of extension leads.

The extension leads have the same color code as the associated thermocouple elements; the positive pole is marked in red. Correct polarity must be ensured since otherwise large errors will occur. Up to 200 °C, the same calibration data and tolerances apply to the extension leads as to the corresponding thermocouples.

The influence of temperature changes at the cold junction can be balanced by means of a compensating circuit, e.g. a compensating box. The reference temperature is 0 (32 °F) or 20 °C (68 °F).

It is also possible to keep the cold junctions at a constant temperature of 50, 60 or 70 °C (122, 140 or 158 °F) using a thermostat (for several measuring junctions).

The connections from the cold junction to the measuring or process instrument are made using copper leads. With energy-consuming instruments such as indicators or multipoint recorders, the complete measuring circuit (thermocouple, extension lead and copper lead) must be balanced in the operating condition using a resistor. SITRANS T transmitters and process recorders for connection to thermocouple elements have a built-in compensating circuit for balancing the effect of the ambient temperature on the cold junction. Lead balancing is not necessary in this case because of the high input impedance.

##### Protection fitting/protective tubes

The thermocouple can be protected against mechanical stress and chemical attack by a ceramic or metal protective tube which may be mounted using flanges, screwed glands or by welding into the pipeline or tank. The thermocouple element terminates in the connection head.

Installation examples with specification of the recommended thermocouples and protective tube materials are listed on pages "Technical Data" and "Installation Examples".

Owing to the different operating conditions, no guarantee can be given for protective fittings. The manufacturer is responsible for damages and measuring errors caused by wrong installation in compliance with the General Terms of Delivery if the instruments have been installed by the manufacturer and if the specifications for the operating conditions furnished by the customer were correct and sufficiently detailed.

Thermocouple elements are very compatible since it is almost always possible to adapt them in shape and size to the particular problem. The temperature-responsive part is almost point-shaped. Thermocouple elements are therefore particularly suitable for measuring rapidly changing temperatures.

## Temperature Measurement

### Thermocouples

#### Straight thermocouples to DIN 43733, with connection head

##### Overview

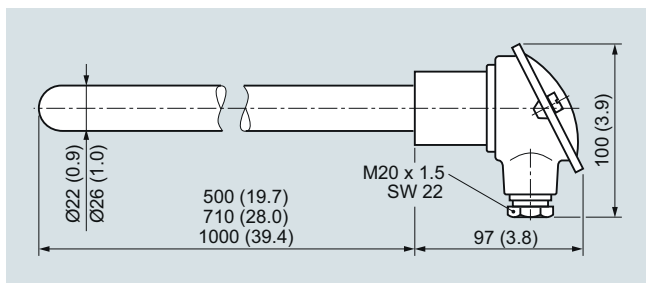


The straight thermocouple together with a metal protective tube is suitable for temperatures from 0 to 1250 °C (32 to 2282 °F) and can be supplied with a built-in temperature transmitter.

##### Technical specifications

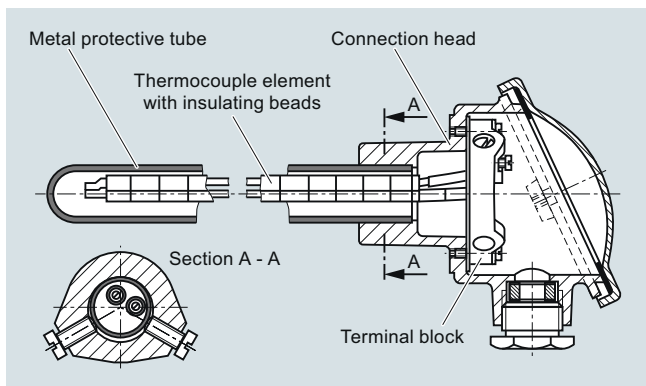
Thermocouples	Ni Cr/Ni type K
• Number	1 or 2
• Leg diameter	2 ... 3 mm (0.08 ... 0.12 inch)
• Insulation of legs	Insulating beads
Protective tube	Metal
Connection head	Form A, DIN 43729; made of cast light alloy, with one cable bushing

##### Dimensional drawings



Straight thermocouple, dimensions in mm (inches)

##### Design



Straight thermocouple with base-metal element Ni Cr/Ni with metal protective tube

##### Selection and Ordering data

Article No.

##### Straight thermocouple with Ni Cr/Ni thermocouple (type K)

7MC2000 - 0

with metallic protective tube

Click on the Article No. for the online configuration in the PIA Life Cycle Portal.

##### Nominal length

Enter customer specific length with Y44, see Order codes below

300 ... 500 mm (11.81 ... 19.68 inch)  
Initial: 500 mm (19.68 inch)

501 ... 710 mm (19.72 ... 27.95 inch)  
Initial: 710 mm (27.95 inch)

711 ... 1 000 mm (27.11 ... 39.37 inch)  
Initial: 1 000 mm (39.37 inch)

##### Protective tube

to 1 000 °C (1 832 °F)  
X 10 CrAl 24, material No. 1.4762  
Ø 22 mm x 2 mm (0.87 inch x 0.079 inch)  
Leg diameter 2 mm (0.08 inch)

to 1 100 °C (2 012 °F)  
X 18 CrNi 28, material No. 1.4749  
Ø 26 mm x 4 mm (1.02 inch x 0.16 inch)  
Leg diameter 3 mm (0.12 inch)

to 1 200 °C (2 192 °F)  
X 15 CrNi Si 24 19, material No. 1.4841  
Ø 22 mm x 2 mm (0.87 inch x 0.079 inch)  
Leg diameter 2 mm (0.08 inch)

to 1 250 °C (2 282 °F)  
CrAl 205 (Kantal AF), material No. 1.4767  
Ø 22 mm x 2 mm (0.87 inch x 0.079 inch)  
Leg diameter 3 mm (0.12 inch)

##### Number of thermocouples

1 thermocouple  
2 thermocouples

##### Connection head, form A,

made of cast light alloy, with 1 cable inlet and  
- screw cover  
- high hinged cover

##### Selection and Ordering data

Order code

##### Straight thermocouple with Ni Cr/Ni thermocouple (type K)

for temperatures to 1250 °C (2282 °F);  
with metallic protective tube

##### Further designs

Please add "-Z" to Article No. and specify Order code(s) and plain text.

Special version, specify in plain text

Y98

Process number for special version

Y99

TAG plate made of stainless steel  
specify TAG No. in plain text

Y15

Calibration carried out at one point, specify desired temperature in plain text (order equivalent number of times for several calibration points).

Y33

##### Insertion length customer-specific

Y44

Select range,  
enter desired length in plain text  
(No entry = standard length)

To order a temperature transmitter installed in the connection head, see "Temperature transmitters for installation in the connection head" (page 2/114).

Installation of a transmitter is only possible here in the versions with a high hinged cover (7MC2000-...6).

Selection and Ordering data	Article No.	Selection and Ordering data	Article No.
<b>Metallic protective tubes for straight thermocouple elements according to DIN 43733</b>		<b>Thermocouples elements for straight thermocouple according to DIN 43733</b>	
<b>X 10 CrAl 24, material No. 1.4762</b> Ø 22 mm x 2 mm (Ø 0.87 inch x 0.08 inch), 0.55 ... 1.10 kg (1.21 ... 2.42 lb), dished Nominal length      Protective tube length in mm (inch):      in mm (inch): • 500 (19.7)      520 (20.5) • 710 (28.0)      730 (28.7) • 1000 (39.4)      1020 (40.2)	<b>7MC2900-1DA</b> <b>7MC2900-2DA</b> <b>7MC2900-3DA</b>	<b>Base-metal thermocouple with insulating beads</b> Wire diameter 3 mm (0.12 inch) Ni Cr/Ni, to 1000 °C (maximal 1300 °C), (to 1832 °F (max. 2372 °F)) 0.55 ... 2.10 kg (1.21 ... 4.63 lb) Nominal length L1 in      Thermocouple mm (inch):      length L2 in mm (inch): • 500 (19.7)      540 (21.3) • 710 (28.0)      750 (29.5) • 1000 (39.4)      1040 (40.9)	<b>7MC2903-1CA</b> <b>7MC2903-2CA</b> <b>7MC2903-3CA</b>
<b>X 10 CrAl 24, material No. 1.4749</b> Ø 26 mm x 4 mm (Ø 1.02 inch x 0.16 inch), 1.25 ... 2.20 kg (2.76 ... 4.85 lb), dished Nominal length      Protective tube length in mm (inch):      in mm (inch): • 500 (19.7)      520 (20.5) • 710 (28.0)      730 (28.7) • 1000 (39.4)      1020 (40.2)	<b>7MC2900-1EC</b> <b>7MC2900-2EC</b> <b>7MC2900-3EC</b>		
<b>X 15 CrNiSi 25 20, material No. 1.4841</b> Ø 22 mm x 2 mm (Ø 0.87 inch x 0.08 inch), 1.05 kg (2.31 lb), dished Nominal length      Protective tube length in mm (inch):      in mm (inch): • 1000 (39.4)      1020 (40.2)	<b>7MC2900-3FA</b>		
<b>CrAl 205 (Megapyr), material No. 1.4767</b> Ø 22 mm x 2 mm (Ø 0.87 inch x 0.05 inch), 0.55 ... 1.10 kg (1.21 ... 2.42 lb) Nominal length      Protective tube length in mm (inch):      in mm (inch): • 500 (19.7)      520 (20.5) • 710 (28.0)      730 (28.7) • 1000 (39.4)      1020 (40.2)	<b>7MC2900-1HA</b> <b>7MC2900-2HA</b> <b>7MC2900-3HA</b>		

## Temperature Measurement

### Thermocouples

#### Straight thermocouples Individual parts and accessories

##### Connection heads

Connection head, Type A (without terminal block and terminals) for protective tube diameter (bore = protective tube diameter +0.5 mm (0.02 inch))

##### Selection and Ordering data

Article No.

##### Connection head, Type A, (without terminal block and terminals)

1 Cable inlet, degree of protection IP53, 0.35 kg (0.77 lb)

##### Cast light alloy

fastener, unscrewable

for protective tube diameter in mm (inch) (bore = protective tube diam. +0.5 mm) (0.02 inch):

- 22 (0.87)
- 26 (1.02)

**7MC2905-1AA**  
**7MC2905-1BA**

##### Cast light alloy

high hinged cover

for protective tube diameter in mm (inch) (bore = protective tube diam. +0.5 mm) (0.02 inch):

- 22 (0.87)
- 26 (1.02)

**7MC2905-4AA**  
**7MC2905-4BA**

##### Installation accessories for connection heads

- Terminal block
- Terminal
- Set of gaskets
- Set of washers
- Mounting flange
- Threaded sleeve

##### Selection and Ordering data

Article No.

##### Mounting accessories

##### Terminal block without terminals

for base-metal thermocouples; 0.06 kg (0.13 lb)

**7MC2998-1AA**

##### Terminal

for base-metal thermocouples; 0.01 kg (0.02 lb)

**7MC2998-1BA**

##### Set of gaskets (100 off)

for the connection head cover; 0.01 kg (0.02 lb)

**7MC2998-1CA**

##### Set of washers (100 off)

for the terminal block; 0.01 kg (0.02 lb)

**7MC2998-1CB**

##### Mounting flange, adjustable; made of GTW

• for protective tube outer diameters 22 mm (0.87 inch); 0.35 kg (0.77 lb)

**7MC2998-2CB**

• for protective tube outer diameters 26 mm (1.02 inch); 0.32 kg (0.71 lb)

**7MC2998-2CC**

##### Threaded sleeve

Gas-tight up to 1 bar (14.5 psi), adjustable, material No. 1.0718, with gasket; 0.40 kg (0.88 lb)

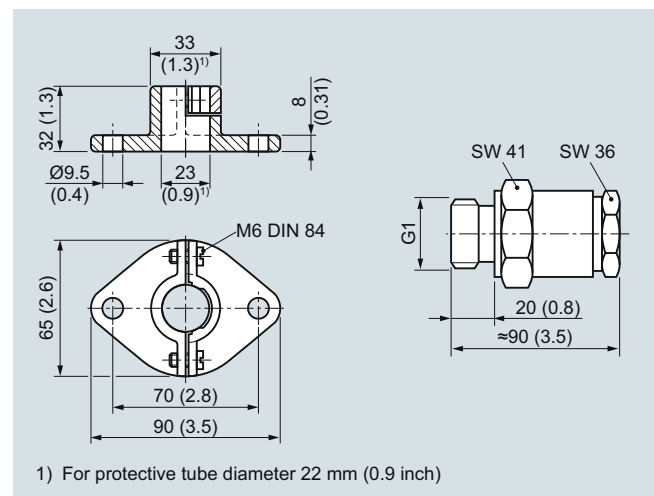
• for protective tube outer diameters 22 mm (0.87 inch), **G1**

**7MC2998-2DB**

• for protective tube outer diameters 26 mm (1.02 inch), **G1**

**7MC2998-2DC**

#### Dimensional drawings



Mounting flange to DIN 43734 (left) and threaded sleeve (right) for installing straight thermocouples, dimensions in mm (inches)