

# Thermocouples for Flue Gas Temperature Measurements Model TC81 with Thermowell Model TW81

WIKA Data Sheet TE 65.81

## Applications

- Blast furnaces, air heaters
- Red-heat and heat treatment processes
- Combustion of waste and special waste products
- Major heating plants, heat generation

## Special Features

- Application ranges up to +1200 °C
- Thermowell made of heat resistant steel
- Measuring insert replaceable
- Gastight process connection

## Description

These straight thermocouples assemblies consist of a connection head Form B, a measuring insert per DIN 43 735 and a thermowell Model TW81. Form A or C DIN-thermowells as well as thermowells with customer specific design are available.

Process connection can be provided with a stop flange or pipe coupling, the latter type gives a gastight connection.

These temperature probes are suitable for gaseous media in low pressure ranges (up to approx. 1 bar). Various thermowell materials are used with or without enamelling to meet the requirements of thermal stress.

The replaceable measuring insert is removeable. This makes inspection and servicing straightforward. Sensor replacement is also possible during plant operation. Selection of standard lengths enables a short delivery time and the possibility of stocking spare components.

Thermowell material, connection head and sensor can be selected individually for the specific application.



**Thermocouple for Flue Gas Temperature Measurements, Model TC81**

A transmitter can be fitted as an option. One of the advantages of a built-in transmitter is the increased reliability of the signal transmission. Between the transmitter and the control room, lower-priced copper cable can be used rather than specific thermocouple or compensating cable. A cold junction is integrated in all WIKA transmitters.

## Sensor

### Sensor types

Type	Recommended max. operating temperature
K (NiCr-Ni)	1200 °C
N (NiCrSi-NiSi)	1200 °C
J (Fe-CuNi)	750 °C

The application range of these thermometers is limited by the maximum permissible temperature of the thermocouple as well as the maximum permissible temperature of the thermowell material.

Listed thermocouples are available both as single and dual. The measuring point (hot junction) of the probe is supplied ungrounded.

### Sensor limiting error

A cold junction temperature of 0 °C is taken as the basis for the definition of the sensor limiting error of thermocouples.

### Type K and N

Class	Temperature range	Limiting error
<b>DIN EN 60 584 part 2</b>		
1	-40 °C ... +375 °C	± 1.5 °C
1	+375 °C ... +1000 °C	± 0.0040 ·  t  <sup>1)</sup>
2	-40 °C ... +333 °C	± 2.5 °C
2	+333 °C ... +1200 °C	± 0.0075 ·  t  <sup>1)</sup>
<b>ISA (ANSI) MC96.1-1982</b>		
Standard	0 °C ... +1260 °C	± 2.2 °C or <sup>2)</sup> ± 0.75 %
Special	0 °C ... +1260 °C	± 1.1 °C or <sup>2)</sup> ± 0.4 %

Limiting error with selected temperatures in °C for Type K and Type N thermocouples

Temperature (ITS 90) °C	Limiting error DIN EN 60 584 part 2	
	Class 1 °C	Class 2 °C
350	± 1.5	± 2.625
500	± 2.0	± 3.75
600	± 2.4	± 4.50
700	± 2.8	± 5.25
800	± 3.2	± 6.00
900	± 3.6	± 6.75
1000	± 4.0	± 7.50
1100	-	± 8.25
1200	-	± 9.00

### Type J

Class	Temperature range	Limiting error
<b>DIN EN 60 584 part 2</b>		
1	-40 °C ... +375 °C	± 1.5 °C
1	+375 °C ... +750 °C	± 0.0040 ·  t  <sup>1)</sup>
2	-40 °C ... +333 °C	± 2.5 °C
2	+333 °C ... +750 °C	± 0.0075 ·  t  <sup>1)</sup>
<b>ISA (ANSI) MC96.1-1982</b>		
Standard	0 °C ... +760 °C	± 2.2 °C or <sup>2)</sup> ± 0.75 %
Special	0 °C ... +760 °C	± 1.1 °C or <sup>2)</sup> ± 0.4 %

1) |t| is the value of the temperature in °C without consideration of the sign.

2) Whichever is larger.

Limiting error with selected temperatures in °C for Type J thermocouples

Temperature (ITS 90) °C	Limiting error DIN EN 60 584 part 2	
	Class 1 °C	Class 2 °C
350	± 1.5	± 2.625
500	± 2.0	± 3.75
600	± 2.4	± 4.50
700	± 2.8	± 5.25

## Potential measuring uncertainties due to aging effects

Thermocouples age and change their temperature/thermo-electric voltage curve. Type J thermocouples age slightly due to oxidation of the pure metal leg. As for Type K and to a lesser extend Type N (NiCrSi-NiSi) thermocouples, considerable changes in thermoelectric voltage can occur at high temperatures due to chromium depletion in the NiCr leg, which results in a decreasing thermoelectric voltage.

This effect is accelerated if there is a shortage of oxygen, since a complete oxide skin is unable to form on the surface of the thermocouple and protect it from further oxidation. The chromium in the alloy oxidizes, but not the nickel, giving rise to the "green rot" that eventually destroys the thermocouple. During the fast cooling of NiCr-Ni thermocouples, that has been operating at temperatures above 700 °C, certain states occur within the crystal structure (**short-range order**), which in Type K elements can result in a change in thermoelectric voltage of up to 0.8 mV (K effect).

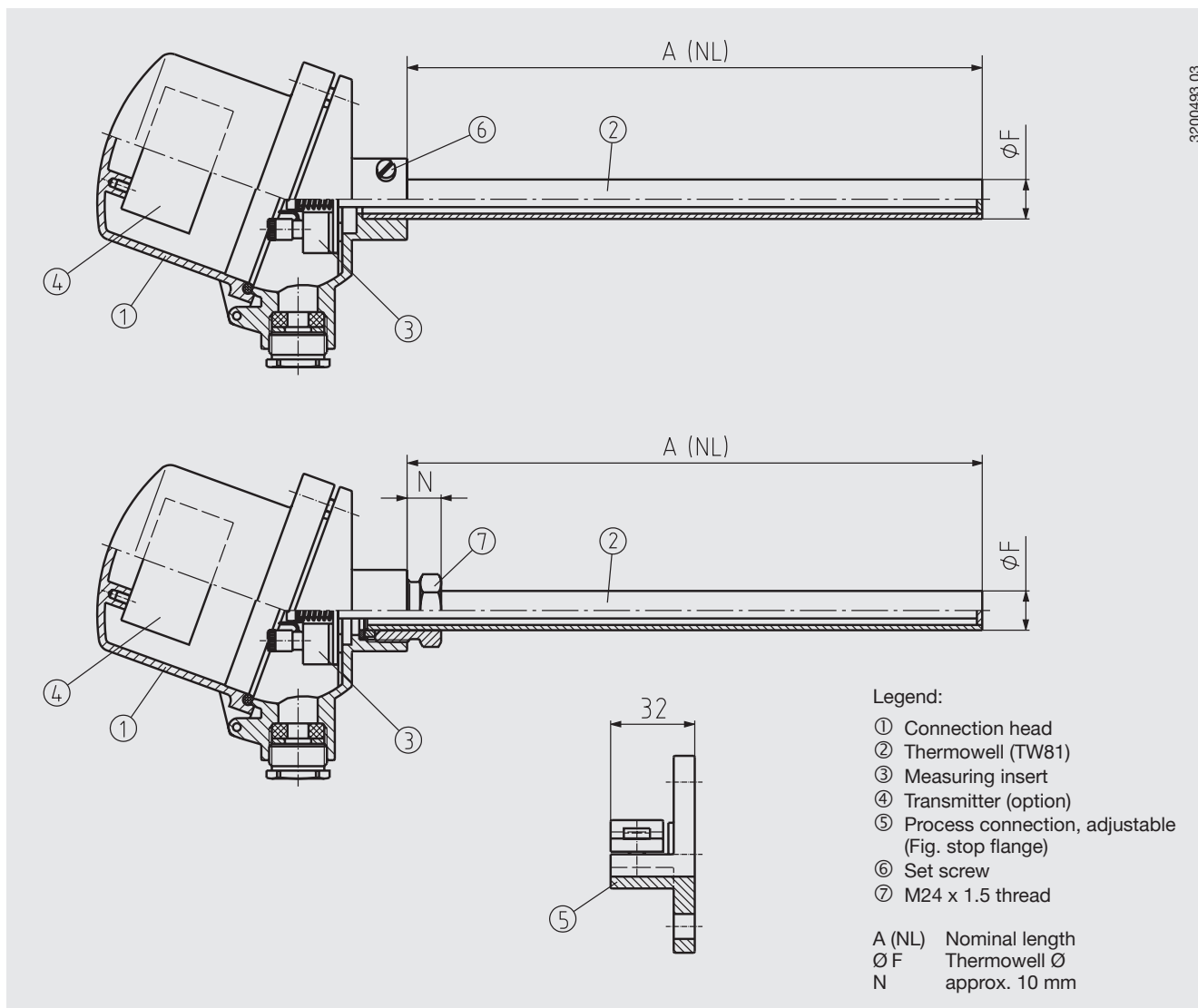
It has been possible to reduce the **short-range order effect** in Type N (NiCrSi-NiSi) thermocouples by alloying both legs with silicon. The effect is reversible and can be cancelled by annealing above 700 °C with subsequent slow cooling. Thermocouples with smaller diameters react sensitively in this respect. Even cooling in still air can cause deviations greater than 1 K.

## Measuring insert

The measuring insert is made of a vibration-resistant sheathed mineral-insulated cable (MI cable). In order to ensure that the measuring insert is firmly in contact with the thermowell bottom, the insert is spring-loaded (spring travel: maximum 10 mm).

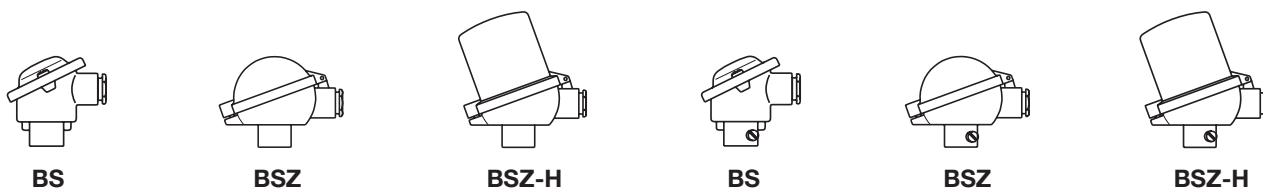
The standard material used for the measuring insert sheath is Inconel 600 (2.4816).

## TC81 components (with thermowell TW81)



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## Connection head



Model	Material	Cable entry	Ingress protection	Cap	Surface finish
<b>BS</b>	Aluminium	M20 x 1.5	IP 53 / IP 65	Cap with 2 screws	blue, painted <sup>2)</sup>
<b>BSZ</b>	Aluminium	M20 x 1.5	IP 53 / IP 65	Flap cap with screw	blue, painted <sup>2)</sup>
<b>BSZ-H</b>	Aluminium	M20 x 1.5	IP 53 / IP 65	Flap cap with screw	blue, painted <sup>2)</sup>

1) IP 53: lateral set screw; IP 65: M24 x 1.5 thread  
 2) RAL5022, polyester paint saltwater-proof

## Transmitter (option)

The transmitter can be directly mounted into the head. The permissible ambient temperature of the transmitter as specified in the matching data sheet. In case of direct connection of the thermocouple to the transmitter, the risk of high heating of the transmitter terminals rises due to thermal conduction of the thermo wires. For this reason we recommend mounting the transmitter in the cap of a connection head Model BSZ-H. Here the thermocouple is indirectly connected to the transmitter via a compensating cable between terminal block and transmitter.

Connection head	Transmitter Model				
	T12	T19	T32	T91	T53
BS	-	-	-	-	-
BSZ	-	-	-	-	-
BSZ-H	•	•	•	•	•

- Mounted within the cap of the connection head
- Mounting is not recommendable because of thermal reasons

Model	Description	Data sheet
T19	Analogue transmitter, configurable	TE 19.03
T91	Analogue transmitter, fixed measuring ranges	TE 91.01
T12	Digital transmitter, PC-configurable	TE 12.03
T32	Digital transmitter, HART protocol	TE 32.03 + TE 32.04
T53	Digital transmitter FOUNDATION™ Fieldbus and PROFIBUS® PA	TE 53.01

## Thermowell Model TW81

### Metal thermowell

The thermowells are made of tube. The bottom of the thermowell is either flat or dished, in the case of enamelled thermowells it is always dished. The thermowell is plugged into the connection head and compression fitted. Additionally we offer the possibility of a connection head screwed at the thermowell. This allows ingress protection IP 65. A slideable process connection is compression fitted on the thermowell, thus allowing a variable insertion length. Preference is to be given to standard nominal lengths to DIN EN 50 446.

### Standard nominal lengths

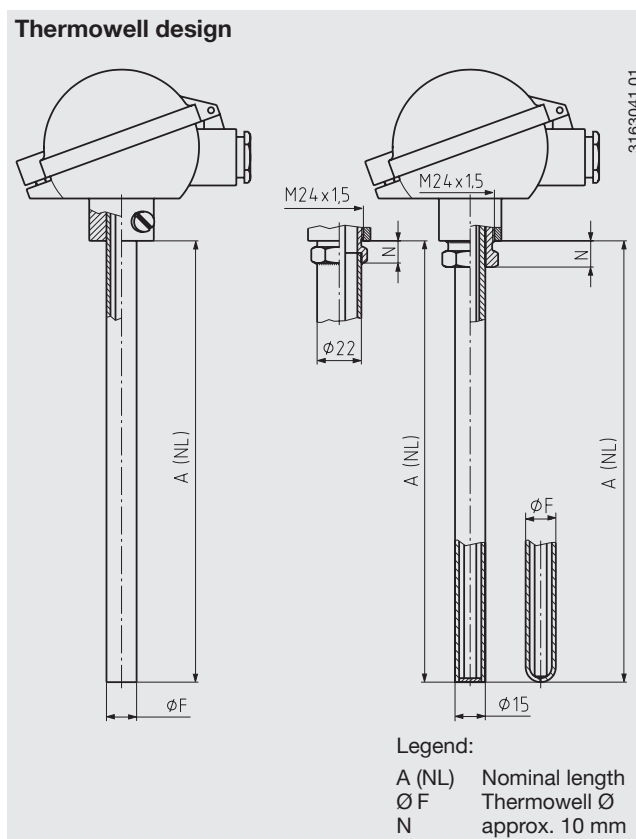
A = 500, 710, 1000, 1400, 2000 mm

Others on request

### Thermowell materials

- Carbon steel 1.0305  
up to 550 °C (air), low corrosion resistance to sulphurous gases, medium corrosion resistance to nitrogenous gases
- Carbon steel 1.0305, enamelled  
up to 550 °C, resistance to a max. applied pressure of 1 bar, for the low pressure range in furnaces and flue gas ducts
- Stainless steel 1.4571  
up to 700 °C (air), good corrosion resistance to aggressive media
- Stainless steel 1.4841  
up to 1150 °C (air), low corrosion resistance to sulphurous gases; high corrosion resistance to nitrogenous gases and gases with low oxygen content; high long-time rupture strength
- Stainless steel 1.4762  
up to 1200 °C (air), high corrosion resistance to sulphurous gases; low corrosion resistance to nitrogenous gases

Other materials on request



### Dimensions in mm

Metal thermowell	
outer Ø	tube thickness
Ø F	s
22	2
15	2

## Remarks on the selection and operation of metal thermowells

The following table does not claim to be extensive. All information is non-binding and does not represent guaranteed

characteristics. They should be fully tested by the customer using the conditions of the respective application.

### Resistance when in contact with gases

Material No.	AISI Nr.	Usable in air up to °C	Resistance against sulphurous gases oxidizing	Resistance against reducing	Nitrogenous, low-oxygen gases	Carburisation
1.0305		550	low	low	medium	low
1.4571	316Ti	800	low	low	medium	medium
1.4762		1200	very high	high	low	medium
1.4841	310 / 314	1150	very low	very low	high	low

### Operation with gases

Material No.	Application
1.0305 (St35.8)	Temperature furnaces for heat treatment processes, galvanising and tinning plants, carbon-dust-air mixture pipelines in steam power stations
1.0305 enamelled (St35.8 enamelled)	Flue-gas desulphurisation plants, white metal, lead and tin smelters
1.4762 X 10 CrAlSi 25	Combustion exhaust gases, cement and ceramic furnaces, heat treatment processes, annealing furnaces
1.4841 X 15 CrNiSi 25-21	Combustion chambers, industrial furnaces, petrochemical industry, cowper stoves, cyanide baths

### Operation in melting plants

Material No.	Application	Temperature range
1.4841	Aluminium	up to 700 °C
1.0305	Babbitt metal	up to 600 °C
1.0305	Lead	up to 700 °C
1.4841	Lead	up to 700 °C
1.0305	Zinc	up to 480 °C
1.4762	Zinc	up to 480 °C
1.0305	Tin	up to 650 °C
1.4762	Copper	up to 1250 °C
1.4841	Copper-zinc alloy	up to 900 °C

## Process connection

### Not gastight

A stop flange is sufficient; a mating flange is not necessary. The stop flange slides onto the thermowell and is secured using a clamp. The insertion length of the thermometer is variable and can be easily adjusted at the mounting point.

### Gastight up to 1 bar

A threaded bushing or a combination stop flange / mating flange is required.

#### Threaded bushing:

This is secured onto the metal thermowell using a clamp. After loosening the clamp, the threaded bushing slides onto the thermowell. The insertion length of the thermometer is variable and can be easily adjusted at the mounting location.

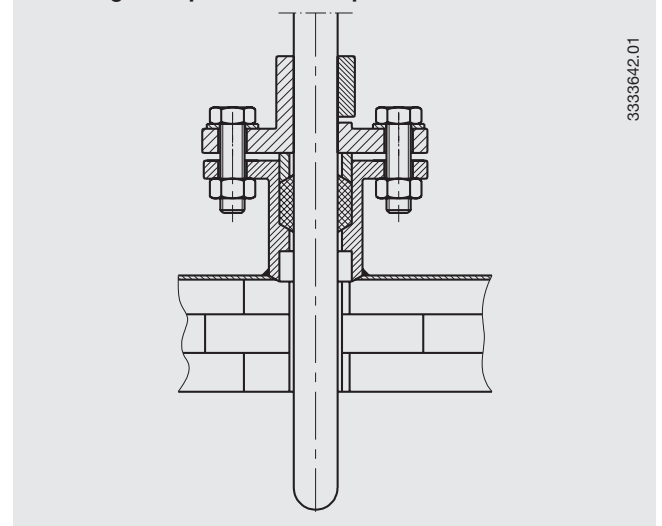
#### Stop flange / mating flange:

Sealing is made via a stuffing-box packing between mating flange and thermowell. The assembly is secured by clamping the stop flange and thermowell together. The insertion length of the thermometer is adjustable.

### Enamelled thermowell

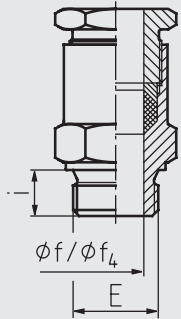
When using enamelled thermowells a threaded bushing should be used to prevent the enamelled surface layer from being damaged.

Mounting example: thermocouple with metal thermowell



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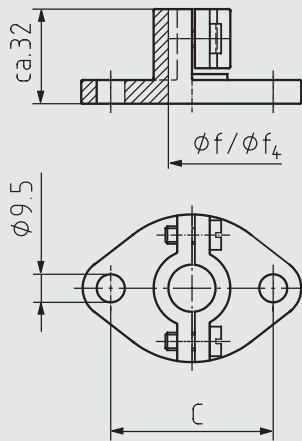
**Threaded bushing**  
adjustable,  
gastight up to 1 bar  
Sealing: asbestos free,  
up to max. 300 °C,  
higher temperatures  
on request



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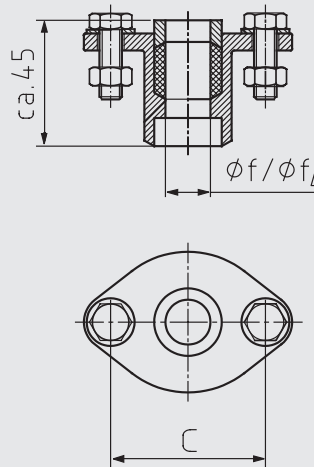
**Material:**  
carbon steel or  
stainless steel 1.4571

**Stop flange per  
DIN EN 50 446**  
adjustable

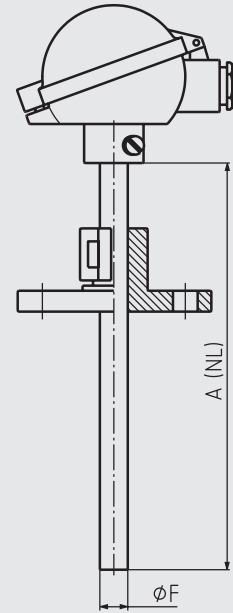


**Material:**  
carbon steel or malleable cast iron  
others on request

**Mating flange only**  
applic-able in conjunc-  
tion with a stop flange  
adjustable,  
gastight up to 1 bar  
Sealing: asbestos free



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#### Selectable threaded bushings

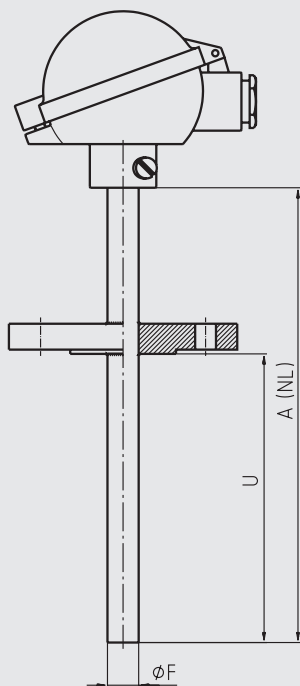
Thermowell outer $\phi$	Dimensions in mm $\phi f / \phi f_4$	Process connection i min.	E
22	22.5	20	G 1, G 1½
15	15.5	20	G ½, G ¾, G 1

other threads on request

#### Selectable stop flanges

Thermowell outer $\phi$	Dimensions in mm $\phi f / \phi f_4$	C (hole spacing)
22	22.5	70
15	15.5	55

#### Flange connection with welded thermowell



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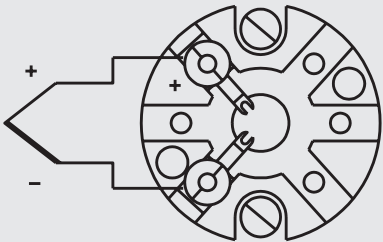
#### Selectable flange sizes

Flange $\phi$	Material
1 ½ inch, 150 lbs, RF	316 SS
1 ½ inch, 300 lbs, RF	316 SS
2 inch, 150 lbs, RF	316 SS
2 inch, 300 lbs, RF	316 SS
3 inch, 150 lbs, RF	316 SS
3 inch, 300 lbs, RF	316 SS
4 inch, 150 lbs, RF	316 SS
4 inch, 300 lbs, RF	316 SS

Other flange sizes on request

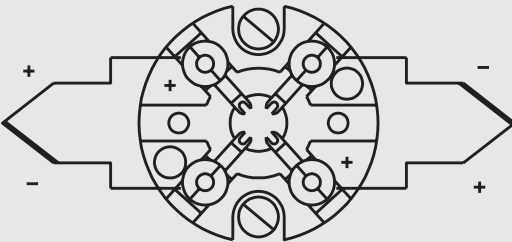
# Electrical connection

Single thermocouple



The colour coding at the positive pole of the device always decides the correlation of polarity and connection terminal.

Dual thermocouple



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Modifications may take place and materials specified may be replaced by others without prior notice.  
Specifications and dimensions given in this leaflet represent the state of engineering at the time of printing.



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