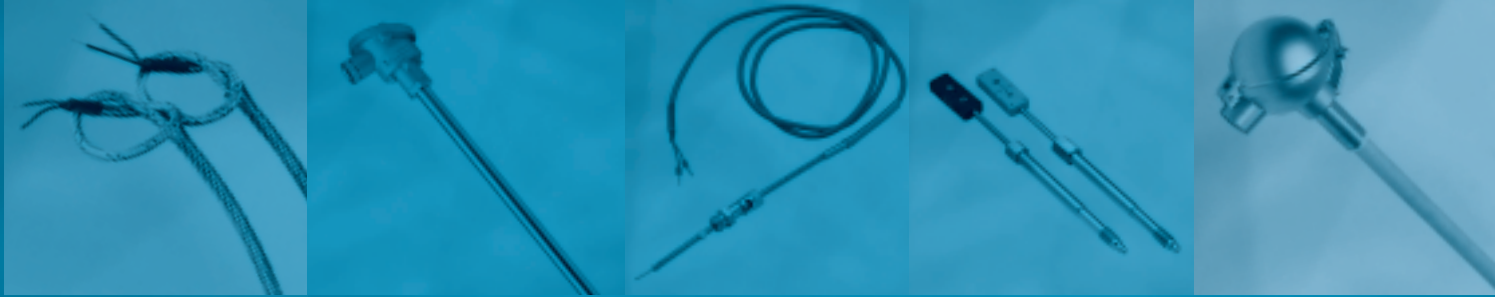


Thermocouples, Resistance Thermometers, Thermowells



Thermocouples, Resistance Thermometers,
Thermowells

GEFRAN

Introduction

- The thermocouple (TC) is a very simple and reliable sensor, made by 2 homogeneous metal conductors, chemically different, soldered on one end (hot or measure junction) and free on the other one (reference or cold junction).

The temperature difference between the two ends of the thermocouple causes an electromotive force, which is univocally related to it (E.M.F.).

This E.M.F. has a non-linear course, which is shown in the conversion table, referring to the cold junction at 0°C.

- The Resistance Thermometer (RT) is a passive element made by pure metal material, which resistive value depends on temperature change.

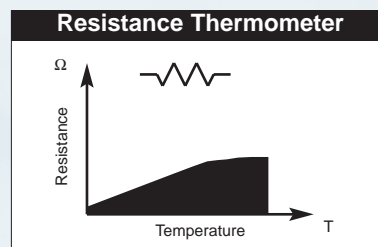
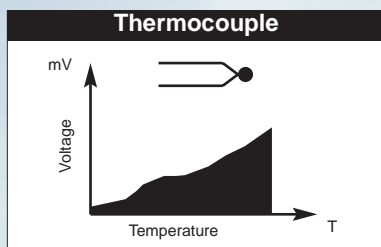
Used materials might be platinum or Nichel.

Such elements are usually designed in order to have a value equal to 100Ω at 0°C, which grows in linearity with temperature.

The choice of a temperature sensor has to be as a function of the kind of application, considering ambiental conditions, temperature ranges, precision of the measure.

Here is a diagram which could help in the choice either of a TC or of a RT.

| FACTORS | TC | RT |
|----------------------|-----------------------------------|-----------------------|
| Temperature range | from -20 to over 2000°C | from -200°C to +850°C |
| Cost | Low cost | Higher cost |
| Power supply | Not required | Required |
| Self-heating | None | Present |
| Stability | Good | Excellent |
| Ruggedness | Very good | Good |
| Signal/Output | (mv) unlinear | (Ohm) Linear |
| Size | Possibility of very small sizes | Quite small |
| Sensitivity | At the tip or along the stem | Sensitive at the tip |
| Vibration Resistance | More suitable (Mineral Insulated) | Less suitable |



TC / RT and Working Temperature Limits

| Symbol | Thermocouple Type | Temperature range °C | Max. Temperature as a function of wire ø | | | | | | | | |
|--------|---|----------------------|--|-------|------|-------|-------|-------|-------|-------|---|
| | | | 0.35 | 0.51 | 0.81 | 1.02 | 1.29 | 1.63 | 2.30 | 3.26 | |
| ANSI | Calibration | °C | | | | | | | | | |
| T | Copper-Constantan | -200 ÷ +390°C | / | 200° | 260° | / | / | / | 390° | / | / |
| J | Iron-Constantan | -200 ÷ +760°C | / | 370° | 480° | 500° | 540° | 590° | 690° | 760° | |
| E | Chromel-Constantan | -200 ÷ +990°C | / | 430° | 540° | 570° | 600° | 650° | 900° | 990° | |
| K | Chromel-Alumel | -200 ÷ +1270°C | / | 960° | 980° | 1000° | 1040° | 1060° | 1090° | 1270° | |
| S | Platinum 10% Rhodium-Platinum | 0 ÷ +1450°C | 1380° | 1760° | / | / | / | / | / | / | |
| R | Platinum 13% Rhodium-Platinum | 0 ÷ +1760°C | 1380° | 1760° | / | / | / | / | / | / | |
| B | Platinum 30% Rhodium Platinum 6% Rhodium | 0 ÷ +1820°C | 1460° | 1820° | / | / | / | / | / | / | |

The limit of the working temperature of a thermocouple depends on the diameter of the wires of the element: as bigger is the diameter of the wires, as bigger is the max. tolerable temperature.

By the same working temperature, a thermocouple with thicker wires will have a longer life, but a slower answer time.

| Symbol | RT Type | Temperature range (°C) |
|--------|----------|------------------------|
| PT100 | Platinum | -200 ÷ +850°C |
| NI100 | Nichel | -60 ÷ +180°C |

Mineral Insulated Sensors

Such sensors are used with thermoelements insulated by the metal sheath by means of metal mineral oxide powder firmly compressed.

The mostly used material is magnesium oxide.

The main properties of this type of sensor are:

- **Long Working Life of the Element**

Due to the complete protection from the effects of chemical products and heat.

- **Mechanical Protection**

The compactness of the mineral insulated cable protects the wires and keeps them aligned even when the sheath is twisted or bent.

- **Electrical Protection**

The metal sheath screens the thermocouple from electrical interference.

- **Insulation Protection**

The magnesium oxide retains its insulating properties at high temperature and humidity, the homogeneity of the external sheath protects the thermocouple wires from gasses and liquids at high pressure.

- **Ease of Installation**

The flexible construction means that the thermocouple can be inserted into curved areas and can take up any required shape.

Here is a table with indicative max. temperature values, which can be reached depending on the sheath diameter of the thermocouple.

| Sheath ø mm | MgO K | MgO J | MgO T | MgO E |
|----------------|-----------|-----------|-----------|-----------|
| | T. max °C | T. max °C | T. max °C | T. max °C |
| 1 | 750 | 320 | - | - |
| 1.5 | 870 | 340 | 190 | - |
| 2 | 960 | 370 | - | - |
| 3 | 970 | 390 | 240 | 450 |
| 4.5 | 980 | 480 | 260 | 545 |
| 6 | 1050 | 550 | 310 | 595 |
| 8 | 1090 | 640 | - | - |

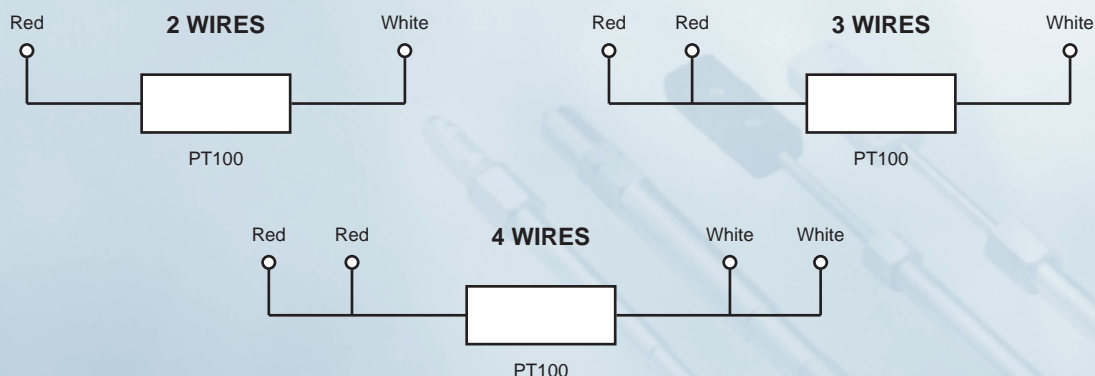
Resistance Thermometers Connections

Resistance thermometers can have a two, three or four-wire connection.

In the two wire connection measurement and supply of the resistance thermometer are obtained by one conductor only.

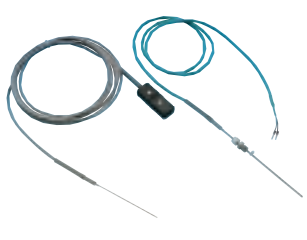
In the three-wire connection the third conductor used in the measurement compensates the voltage drop related to the conductor.

In the four-wire connection the voltage drop is compensated in both couples of conductors.








THERMOCOUPLES

Principle technical features








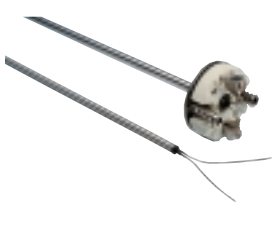



| MODEL | TC1 | TC1M | TC3 |
|---|--|--|---|
| TYPE | J - K | T - J - K | J - K |
| TEMPERATURE RANGE | -40...+250 °C | -80...+1050 °C | -40...+250 °C |
| CLASS of TOLLERANCE (Reference) | IEC584 - 2 CLASS 2 | IEC584 - 2 CLASS 1 / 2 | IEC584 - 2 CLASS 2 |
| GRADE of PROTECTION | - | - | - |
| DIMENSIONS min/max diameter | from 3 to 8 mm | from 1 to 6 mm | 4,8 mm |
| TYPE of TERMINATION | GSC silicon rubber cable Screened GSC silicon rubber cable TTS glass fibre cable TES Teflon cable | GSC silicon rubber cable Screened GSC silicon rubber cable TTS glass fibre cable TES Teflon cable | TTS glass fibre cable TES Teflon cable |
| ELECTRICAL CONNECTIONS | Free wires Cable terminals Compensated connectors | Free wires Cable terminals Compensated connectors | Free wires Cable terminals Compensated connectors |
| PROCESS CONNECTIONS | Nickel-plated brass or stainless steel adjustable or welded fitting with thread from 1/8" to 1/2" | Nickel-plated brass or stainless steel adjustable or welded fitting with thread from 1/8" to 1/2" | Connection thread from M8 to 1/4" |
| TYPE of MEASUREMENT | By immersion | By immersion | By contact |
| MATERIALS | AISI 300 series stainless steel | AISI 316 stainless steel INCONEL 600 Others on request | AISI 304 stainless steel Brass |
| ISOLATION RESISTANCE (At ambient temperature) | > 1000 MΩ at 500Vcc | for diameter < 1,5 > 500 MΩ at 50Vcc > 1000 MΩ at 500Vcc | > 1000 MΩ at 500Vcc |
| APPLICATIONS | Plastics materials Food processing ovens Domestic Appliances | Wide range of industrial uses in the chemical, food and engineering industries | Plastics extruders |

| | | | | |
|--|---|---|---|---|
|  |  |  |  |  |
| T4A | T4F | T4P | TC5/TC5N | TC5M |
| J - K | J - K | J - K | J - K | J - K |
| -40...+250 °C | -40...+250 °C | -40...+250 °C | -40...+250 °C | -40...+390 °C for J -40...+960 °C for K |
| IEC584 - 2 CLASS 2 | IEC584 - 2 CLASS 2 | IEC584 - 2 CLASS 2 | IEC584 - 2 CLASS 2 | IEC584 - 2 CLASS 1 / 2 |
| - | - | - | - | - |
| hole int. \varnothing 4-10 mm hole ext. \varnothing 8-20 mm | \varnothing min. 14-168 mm \varnothing max. 24-188 mm | \varnothing 10 x 20 x 3 mm | from 5 to 8 mm | 3 mm |
| TTS glass fibre cable TES Teflon cable | TTS glass fibre cable TES Teflon cable | TTS glass fibre cable TES Teflon cable | GSC silicon rubber cable Screened GSC silicon rubber cable TTS glass fibre cable TES Teflon cable | GSC silicon rubber cable Screened GSC silicon rubber cable TTS glass fibre cable TES Teflon cable |
| Free wires Cable terminals Compensated connectors | Free wires Cable terminals Compensated connectors | Free wires Cable terminals Compensated connectors | Free wires Cable terminals Compensated connectors | Free wires Cable terminals Compensated connectors |
| With fixing screws | Fixing band | With fixing screws | AVP zinc-plated iron bayonet or screw fitting with thread from M12 x 1 / 1,5 / 1,75 to 1/4"G | AVP zinc-plated iron female bayonet fitting with thread from M10 to 1/4"G |
| By contact on a flat surface | By contact on piping or cylindrical surface | By contact on a flat surface | By immersion with compression spring | By immersion with compression spring |
| AISI 304 stainless steel Brass | Galvanised carbon steel AISI 304 stainless steel | AISI 304 stainless steel Copper | AISI 303 stainless steel | AISI 316 stainless steel for J type INCONEL 600 for K type |
| > 1000 M Ω at 500Vcc | > 1000 M Ω at 500Vcc | > 1000 M Ω at 500Vcc | > 1000 M Ω at 500Vcc | > 1000 M Ω at 500Vcc |
| Machine surfaces Flat surfaces in general | Piping in heating plants Monitoring | Machine surfaces Flat surfaces in general | Plastics extruders | Extruders for the new concept plastics materials |

THERMOCOUPLES

Principle technical features

| |  |  |  |  |
|--|---|--|--|---|
| MODEL | TCM | TC6/AC6 | TC6M/AC6M | TC7M |
| TYPE | J - K | T - J - K - E | J - K - T - E | T - J - E - K |
| TEMPERATURE RANGE | -40...+400 °C | -40...+1000 °C | -80...+1100 °C | -80...+1050 °C |
| CLASS of TOLLERANCE (Reference) | IEC584 - 2 CLASS 1 / 2 | IEC584 - 2 CLASS 1 / 2 | IEC584 - 2 CLASS 1 / 2 | IEC584 - 2 CLASS 1 / 2 |
| GRADE of PROTECTION | IP 55 except the connector | IP 44 - IP 65 | IP 44 - IP 65 | - |
| DIMENSIONS min/max diameter | from 12,7 to 17,8 mm | from 5 to 12 mm | from 2 to 8 mm | from 1 to 6 mm |
| TYPE of TERMINATION | Flexible sleeve Rigis stem | DIN and explosion-proof connection head with ceramic socket or 4...20mA transmitter | DIN and explosion-proof connection head with ceramic socket or 4...20mA transmitter | Rigid stem |
| ELECTRICAL CONNECTIONS | Compensated connector LEMO series connector | Watertight, ryton ceramic socket | Watertight, ryton ceramic socket | Compensated connector |
| PROCESS CONNECTIONS | 1/2" - 20UNF M18 x 1,5 Thread | Adjustable or welded fitting with thread from 1/8" to 1/2" | Nickel-plated brass or stainless steel adjustable or welded fitting with thread from 1/8" to 1/2" | Adjustable compression fitting with thread from 1/8" to 1/2" |
| TYPE of MEASUREMENT | By immersion By contact Elliptic tips | By immersion | By immersion | By immersion By contact |
| MATERIALS | AISI 316 TI stainless steel AISI 304 stainless steel Other on request | AISI 300 series stainless steel INCONEL 600 Other on request | AISI 300 series stainless steel INCONEL 600 Other on request | AISI 300 series stainless steel INCONEL 600 |
| ISOLATION RESISTANCE (At ambient temperature) | > 1000 MΩ at 500Vcc | > 1000 MΩ at 500Vcc | > 1000 MΩ at 500Vcc | > 1000 MΩ at 500Vcc |
| APPLICATIONS | Extrusion of plastics at high pressure and with abrasive materials | On pressurised piping Industrial plant | Industrial processes Ovens Chimneys Boilers | Process measurements Test laboratories |

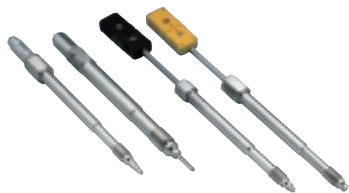
| | | | | |
|---|---|---|---|---|
|  |  |  |  |  |
| TC2/AC2 | TCI | TC8/AC8 | TC9/AC9 | TC10 |
| T - J - E - K | T - J - E - K | J - E - K | K - S - R - B | J - K |
| -40...+1050 °C | -40...+1050 °C | -40...+1000 °C | -40...+1600 °C | -40...+1200 °C |
| IEC584 - 2 CLASS 1 / 2 | IEC584 - 2 CLASS 1 / 2 | IEC584 - 2 CLASS 2 | IEC584 - 2 CLASS 1 / 2 | IEC584 - 2 CLASS 1 / 2 |
| IP 44 - IP 65 | Thermometric insert | IP 44 - IP 65 | IP 44 - IP 65 | IP 44 - IP 65 |
| from 10 mm to 3/4" | from 1 to 6 mm | from 16 mm to 3/4" | from 10 to 26 mm | from 1/2" to 55 mm |
| DIN and explosion-proof connection head with ceramic socket or 4...20mA transmitter | - | DIN and explosion-proof connection head with ceramic socket or 4...20mA transmitter | DIN and explosion-proof connection head with ceramic socket or 4...20mA transmitter | DIN and DIN BUS connection head |
| Watertight, ryton ceramic socket | Watertight, ryton ceramic socket | Watertight, ryton ceramic socket | Watertight, ryton ceramic socket | Watertight, ryton ceramic socket |
| Welded fitting with thread from 3/8" to 1" Adjustable flange | - | Welded fitting with thread from 1/2" to 1" Adjustable flange | Support coupling | - |
| By immersion | By immersion | By immersion | By immersion | By immersion |
| AISI 300 series stainless steel INCONEL 600 | AISI 316 series stainless steel INCONEL 600 | AISI 300 series AISI 446 series stainless steel INCONEL 600 | Ceramics with different grades of purity KER 530 / 610 / 710 | AISI 310/316 INCONEL 600 Spheroidal Cast Iron Graphite AISI 446 |
| > 1000 MΩ at 500Vcc | > 1000 MΩ at 500Vcc | > 1000 MΩ at 500Vcc | > 1000 MΩ at 500Vcc | > 1000 MΩ at 500Vcc |
| On pressurised piping Industrial plant | Thermometric insert | Industrial processes Ovens Chimneys Boilers | Baking ovens for ceramics Glass vault furnaces Chimneys | Non ferrous metal smelting furnaces Molten salt baths |

PT100
RESISTANCE THERMOMETERS

Principle
technical
features



| MODEL | TR1 | TR1M | TR5/TR5N |
|--|---|---|---|
| TYPE | Thin film | Wirewound | Thin film |
| TEMPERATURE RANGE | -40...+250 °C | -40...+600 °C | -40...+250 °C |
| CLASS of TOLLERANCE (Reference) | UNI 7937 IEC 751 CLASS B: 0,3 + 0,005 X ltl CLASS A: 0,15 + 0,002 X ltl | UNI 7937 IEC 751 CLASS B: 0,3 + 0,005 X ltl CLASS A: 0,15 + 0,002 X ltl 1/3 DIN | UNI 7937 IEC 751 CLASS B: 0,3 + 0,005 X ltl CLASS A: 0,15 + 0,002 X ltl |
| GRADE of PROTECTION | - | - | - |
| DIMENSIONS min/max diameter | from 3 to 8 mm | from 3 to 6 mm | from 5 to 8 mm |
| TYPE of TERMINATION | GSC silicon rubber cable Screened GSC silicon rubber cable TTS glass fibre cable TES Teflon cable | GSC silicon rubber cable Screened GSC silicon rubber cable TTS glass fibre cable TES Teflon cable | GSC silicon rubber cable Screened GSC silicon rubber cable TTS glass fibre cable TES Teflon cable |
| ELECTRICAL CONNECTIONS | Free wires Cable terminals Compensated connectors | Free wires Cable terminals Compensated connectors | Free wires Cable terminals Compensated connectors |
| PROCESS CONNECTIONS | Nickel-plated brass or stainless steel adjustable or welded fitting with thread from 1/8" to 1/2" | Nickel-plated brass or stainless steel adjustable or welded fitting with thread from 1/8" to 1/2" | AVP zinc-plated iron bayonet or screw fitting with thread from M12 x 1 / 1,5 / 1,75 to 1/4" GAS |
| TYPE of MEASUREMENT | By immersion | By immersion | By immersion with compression spring |
| MATERIALS | AISI 300 stainless steel | AISI 316 stainless steel | AISI 303 stainless steel |
| ISOLATION RESISTANCE (At ambient temperature) | > 100 MΩ with voltage from 10 to 100Vcc | > 100 MΩ with voltage from 10 to 100Vcc | > 100 MΩ with voltage from 10 to 100Vcc |
| APPLICATIONS | Plastics machinery Food processing ovens Domestic appliances | Wide range of industrial applications Chemical, Food Engineering | Plastic extruders with low vibration |



TRM

TRD

TR6/AR6

TR6M/AR6M

Wirewound

Wirewound

Encapsulated
thin film

Wirewound

-40...+600 °C

-40...+150 °C

-40...+600 °C

-80...+600 °C

UNI 7937 IEC 751
CLASS B:
0,3 + 0,005 X ltl
CLASS A:
0,15 + 0,002 X ltl
1/3 DIN

UNI 7937 IEC 751
CLASS B:
0,3 + 0,005 X ltl
CLASS A:
0,15 + 0,002 X ltl
1/3 DIN

UNI 7937 IEC 751
CLASS B:
0,3 + 0,005 X ltl
CLASS A:
0,15 + 0,002 X ltl
1/3 DIN

UNI 7937 IEC 751
CLASS B:
0,3 + 0,005 X ltl
CLASS A:
0,15 + 0,002 X ltl
1/3 DIN

IP 55

IP 65

IP 45 - IP 65

IP 44 - IP 65

from 12,7 to 17,8 mm

6 mm

from 5 to 12 mm

from 3 to 6 mm

Flexible sleeve
Rigid stem

Tinned copper
extension cable
Silicon rubber sleeve

DIN and explosion-proof
connection head with
ceramic socket or
4...20mA transmitter

DIN and explosion-proof
connection head with
ceramic socket or
4...20mA transmitter

Compensated connector
LEMO series connector

Free terminals

Watertight, ryton
ceramic socket

Watertight, ryton
ceramic socket

Thread
1/2" - 20UNF
M18 x 1,5

Direct immersion

Adjustable or welded fitting with
thread from 1/8" to 1/2"

Adjustable or welded fitting with
thread from 1/8" to 1/2"

By immersion
By contact
Elliptic tips

Buried in cement

By immersion

By immersion

AISI 316 TI steel
AISI 304 steel
Other on request

Stainless steel

AISI 300 series
stainless steel
INCONEL 600

AISI 300
stainless steel

> 1000 MΩ to 500Vcc

> 100 MΩ with voltage
from 10 to 100Vcc

> 100 MΩ with voltage
from 10 to 100Vcc

> 100 MΩ with voltage
from 10 to 100Vcc

Extrusion of plastics
at high pressure and
with abrasive materials



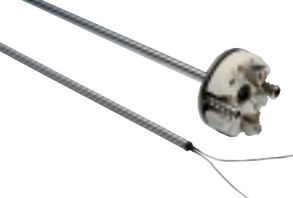
Monitoring of dykes
Civil plant

Measurement of fluids
in conduits
Electrical machines

Measurement of fluids
in conduits
Electrical machines





PT100
RESISTANCE THERMOMETERS

Principle
technical
features

| | | | |
|--|--|--|--|
| |  |  |  |
| MODEL | TR7M | TR2/AR2 | TRI |
| TYPE | Wirewound | Wirewound | Wirewound |
| TEMPERATURE RANGE | -40...+600 °C | -40...+600 °C | -40...+600 °C |
| CLASS of TOLLERANCE (Reference) | UNI 7937 IEC 751 CLASS B: 0,3 + 0,005 X ltl CLASS A: 0,15 + 0,002 X ltl 1/3 DIN | UNI 7937 IEC 751 CLASS B: 0,3 + 0,005 X ltl CLASS A: 0,15 + 0,002 X ltl 1/3 DIN | UNI 7937 IEC 751 CLASS B: 0,3 + 0,005 X ltl CLASS A: 0,15 + 0,002 X ltl 1/3 DIN |
| GRADE of PROTECTION | - | IP 44 - IP 65 | - |
| DIMENSIONS min/max diameter | from 3 to 6 mm | from 10 mm to 3/4" | from 3 to 6 mm |
| TYPE of TERMINATION | Rigid stem | DIN and explosion-proof connection head with ceramic socket or 4...20mA transmitter | - |
| ELECTRICAL CONNECTIONS | Compensated connector | Watertight, ryton, sprung, ceramic socket | Watertight, ryton, sprung, ceramic socket |
| PROCESS CONNECTIONS | Adjustable fitting with thread from 1/8" to 1/2" | Welded fitting with thread from 3/8" to 1" Adjustable flange | - |
| TYPE of MEASUREMENT | By immersion | By immersion | By immersion |
| MATERIALS | AISI 316 stainless steel | AISI 300 series stainless steel INCONEL 600 | AISI 316 stainless steel |
| ISOLATION RESISTANCE (At ambient temperature) | > 100 MΩ with voltage from 10 to 100Vcc | > 100 MΩ with voltage from 10 to 100Vcc | > 100 MΩ with voltage from 10 to 100Vcc |
| APPLICATIONS | Process measurements Test laboratoires | On large diameter piping In tanks | Thermometric insert |





SPECIAL VERSION
ON REQUEST







Principle technical features

| |  |  |  |  |
|--|---|--|---|---|
| MODEL | TCMG | TCV | TCMK | TCMM |
| TYPE | T - J - E - K - N Multilevel up to 24 points of measurement | S - R - B Single or Multilevel up to 3 points of measurement | T - J - E - K - N | T - J - E - K - N Multilevel up to 5 points of measurement |
| TEMPERATURE RANGE | -80...+600 °C | -600...+1600 °C | -80...+1050 °C | -40...+1100 °C |
| CLASS of TOLLERANCE (Reference) | IEC584 - 2 CLASS 1 / 2 | IEC584 - 2 CLASS 1 / 2 | IEC584 - 2 CLASS 1 / 2 | IEC584 - 2 CLASS 1 / 2 |
| GRADE of PROTECTION | IP 54 | IP 55 | - | IP 54 |
| DIMENSIONS min/max diameter | from 4 to 6 mm | from 10 to 24 mm Ceramic sleeve | from 3 to 6 mm | from 1 to 4,5 mm Single sleeve |
| TYPE of TERMINATION | Explosion-proof connexion box | DIN connection heads | Metal sleeve | Explosion-proof connexion box |
| ELECTRICAL CONNECTIONS | Multipole terminal block Screw terminals | Ceramic terminal block | Free terminals | Multipole terminal block Screw terminals |
| PROCESS CONNECTIONS | Fitting Flange | Immersion in the refractory seat | Compression fitting with thread from 1/8" to 3/4" | Fixed flange |
| TYPE of MEASUREMENT | By differential immersion | By immersion | Fixed superficial contact measurement | By differential immersion |
| MATERIALS | AISI 300 series stainless steel INCONEL 600 | Stabilised platinum sleeve | AISI 316 series stainless steel INCONEL 600 | AISI 300 series stainless steel INCONEL 600 |
| ISOLATION RESISTANCE (At ambient temperature) | > 1000 MΩ to 500Vcc | > 1000 MΩ to 500Vcc | > 1000 MΩ to 500Vcc | ∅ < 1,5 mm: 500 MΩ at 50Vcc ∅ > 1,5 mm: > 1000 MΩ at 500Vcc |
| APPLICATIONS | Chemical reactors Fermentation silos Refining towers | Molten glass baths | Boiler internal piping Heat exchangers | Molten glass baths |

SPECIAL VERSION
ON REQUEST

Principle technical features

| |  |  |  |  |
|--|---|--|---|--|
| MODEL | TCC | TCP | TCGK | TCE/ACE |
| TYPE | T - J - E - K - N | T - J - E - K | T - J - E - K - N | J - E - K |
| TEMPERATURE RANGE | -80...+1250 °C | -40...+300 °C | -40...+1050 °C | -40...+1000 °C |
| CLASS of TOLLERANCE (Reference) | IEC584 - 2 CLASS 1 / 2 | UNI 7938 IEC584 - 2 CLASS 1 / 2 | UNI 7938 IEC584 - 2 CLASS 1 / 2 | IEC584 - 2 CLASS 2 |
| GRADE of PROTECTION | IP 65 | IP 65 | IP 55 | IP 44 - IP 65 |
| DIMENSIONS min/max diameter | from 3 to 6 mm | 4,5 mm | from 3 to 6 mm | from 16 mm to 3/4" |
| TYPE of TERMINATION | Weather proof adaptor or with gasket | Hand held with extension cable | Explosion-proof connection head | DIN and explosion-proof connection head with ceramic socket or 4...20mA transmitter |
| ELECTRICAL CONNECTIONS | Military series connector with ally contacts | Free terminals Compensated connectors | Ceramic socket | Ceramic terminal block Ryton Airtight |
| PROCESS CONNECTIONS | Threaded spring fitting | - | Welded fitting with thread from 1/4" to 3/4" | Welded stainless steel fitting with thread from 1/2" to 1" |
| TYPE of MEASUREMENT | By immersion By contact | By penetration | By fixed contact | By immersion |
| MATERIALS | AISI 300 series stainless steel INCONEL 600 | AISI 316 series stainless steel INCONEL 600 | AISI 316 series stainless steel INCONEL 600 | AISI 300 series stainless steel AISI 446 INCONEL 600 |
| ISOLATION RESISTANCE (At ambient temperature) | > 1000 MΩ to 500Vcc | > 1000 MΩ to 500Vcc | > 1000 MΩ to 500Vcc | > 1000 MΩ to 500Vcc |
| APPLICATIONS | Multifuel boilers Community heating systems Energy generation | Food industry Sundry applicatyions | Boiler tubes Hrat exchangers | Industrial processes Ovens Chimneys Boilers |

| | | | | | |
|---|--|--|---|---|---|
|  |  |  |  |  |  |
| TR4 | TR8M | TR9M | TR9S/TR9D | TRA | TRP |
| Thin film Wirewound | Wirewound | Wirewound | Thin film | Thin film | Wirewound |
| -40...+200 °C | -40...+600 °C | -40...+600 °C | -40...+150 °C | -40...+80 °C | -80...+300 °C |
| UNI 7937 IEC 751 CLASS B: 0,3 + 0,005 X ltl CLASS A: 0,15 + 0,002 X ltl | UNI 7937 IEC 751 CLASS B: 0,3 + 0,005 X ltl CLASS A: 0,15 + 0,002 X ltl 1/3 DIN | UNI 7937 IEC 751 CLASS B: 0,3 + 0,005 X ltl CLASS A: 0,15 + 0,002 X ltl | UNI 7937 IEC 751 CLASS B: 0,3 + 0,005 X ltl CLASS A: 0,15 + 0,002 X ltl | UNI 7937 IEC 751 CLASS B: 0,3 + 0,005 X ltl CLASS A: 0,15 + 0,002 X ltl | UNI 7937 IEC 751 CLASS B: 0,3 + 0,005 X ltl CLASS A: 0,15 + 0,002 X ltl |
| IP 54 | IP 44 - IP 65 | IP 44 - IP 65 | IP 65 | IP 54 | IP 65 |
| to define | from 3 to 6 mm | 6 mm | 10 x 10 mm | 14 mm | 4,5 mm |
| DIN and explosion-proof connection head | Plug adaptor with screwed gasket | Plug adaptor with screwed gasket | Metal stem | Polycarbonate cassette 110 x 80 x 65 mm | Handle with extension cable |
| Ceramic terminal block Ryton Airtight | Connectors with MIL. standard contacts | Connectors with MIL. standard contacts | Free terminals | Screw fixing terminal box | Free terminals Compensated connectors |
| Welded stainless steel fitting with thread from 1/2" to 3/4" | Stainless steel or nickel plated brass compression fitting with thread from 1/4" to 1/2" | Sliding threaded fitting in stainless steel nickel plated brass with 1/4" to 1/2" compression spring | Resin sealed in suitable seat | With fixing screws on the walls Metal brackets | - |
| By immersion in the fluid | By immersion | By immersion with point contact | By contact | By immersion | By penetration |
| AISI 300 stainless steel | AISI 316 stainless steel | AISI 316 stainless steel with silver plated tip | Needle probe in tinnes brass | AISI 304 stainless steel | AISI 316 stainless steel |
| > 100 MΩ with voltage from 10 to 100Vcc | > 100 MΩ with voltage from 10 to 100Vcc | > 100 MΩ with voltage from 10 to 100Vcc | > 100 MΩ with voltage from 10 to 100Vcc | > 100 MΩ with voltage from 10 to 100Vcc | > 100 MΩ with voltage from 10 to 100Vcc |
| Air conduits Ambient measurement | Test laboratories Chemical plant | Hydroelectric and thermal power generation Pumps | Bearing temperature measurement on electric motors | Monitoring Metrology laboratories Ambient temperature measurement | Food industry Sundry applications |



THERMOWELLS

Principle technical features

| |  |  |  |  |
|---|---|---|---|---|
| MODEL | TWB1 | TWT1 | TWB2 | TWT2 |
| TYPE | Thermowell from cylindrical bar stock | Thermowell from cylindrical tube stock | Flanged thermowell from cylindrical bar stock | Flanged thermowell from cylindrical tube stock |
| EXTERNAL DIMENSIONS min/max diameter | from 12 to 20 mm | from 12 to 21,3 mm | from 16 to 22 mm | > 10 mm |
| INTERNAL HOLE DIMENSIONS Diameter | from 7 to 9 mm | Standard 8 (for 12 mm) Others > 10 mm | from 7 to 9 mm | from 7 to 9 mm |
| PROBE CONNECTIONS | Threaded fitting from 1/4" to 1/2" | Threaded fitting from 1/4" to 1/2" | Threaded fitting from 1/4" to 1/2" | Threaded fitting from 1/4" to 1/2" |
| PROCESS CONNECTIONS | Threaded fitting from 1/2" to 1" | Threaded fitting from 1/2" to 1" | UNI - ASA threaded fitting | UNI - ASA threaded fitting |
| MATERIALS | AISI 300 series stainless steel INCONEL 600 | AISI 300 series stainless steel INCONEL 600 | AISI 300 series stainless steel ASTM A105 | AISI 300 series stainless steel ASTM A10 |

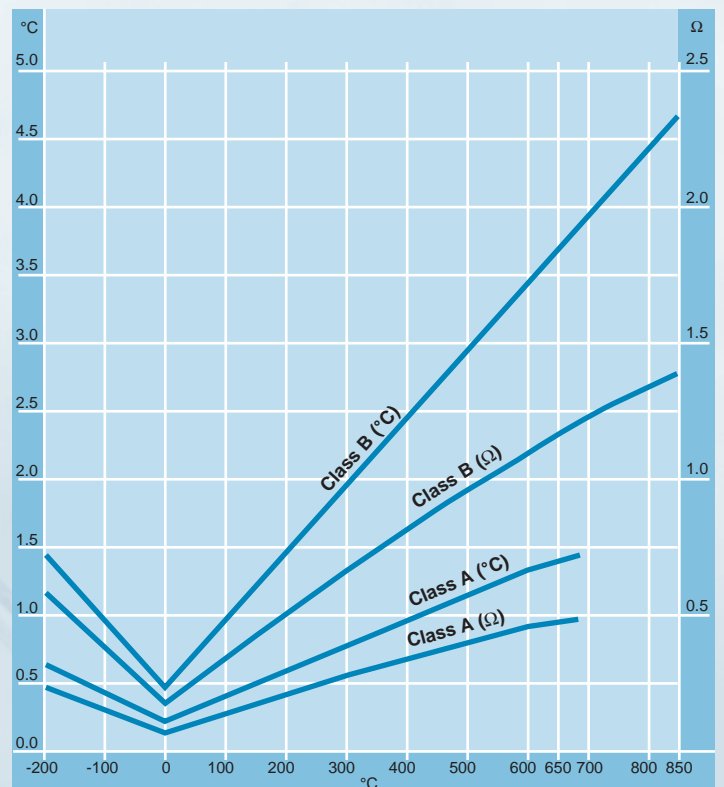
TOLERANCE FOR THERMOCOUPLES

| TYPE | T | E | J | K/N | R/S | B |
|--------------------------|---------------|----------------|---------------|----------------|------------------------|---------------|
| TOLERANCE CLASS 1 | | | | | | |
| Temperature range | -40...+125 °C | -40...+375 °C | -40...+375 °C | -40...+375 °C | -40...+125 °C | - |
| Tolerance | ±0,5 °C | ±1,5 °C | ±1,5 °C | ±1,5 °C | ±0,5 °C | - |
| Temperature range | 125...350 °C | 375...800 °C | 375...750 °C | 375...1000 °C | 1100...1600 °C | - |
| Tolerance | ±0,004 • t | ±0,004 • t | ±0,004 • t | ±0,004 • t | ±[1+0,003 (t-1100)] °C | - |
| TOLERANCE CLASS 2 | | | | | | |
| Temperature range | -40...+133 °C | -40...+333 °C | -40...+333 °C | -40...+333 °C | 0...+600 °C | - |
| Tolerance | ±1 °C | ±2,5 °C | ±2,5 °C | ±2,5 °C | ±1,5 °C | - |
| Temperature range | 133...350 °C | 333...900 °C | 333...750 °C | 333...1200 °C | 600...1600 °C | 600...1700 °C |
| Tolerance | ±0,0075 • t | ±0,0075 • t | ±0,0075 • t | ±0,0075 • t | ±0,0025 • t | ±0,0025 • t |
| TOLERANCE CLASS 3 | | | | | | |
| Temperature range | -67...+40 °C | -167...+40 °C | - | -167...+40 °C | - | 600...800 °C |
| Tolerance | ±1 °C | ±2,5 °C | - | ±2,5 °C | - | ±4 °C |
| Temperature range | -200...-67 °C | -200...-167 °C | - | -200...-167 °C | - | 800...1700 °C |
| Tolerance | ±0,015 • t | ±0,015 • t | - | ±0,015 • t | - | ±0,005 • t |

| | | | | | |
|---|---|---|---|---|---|
|  |  |  |  |  |  |
| TWB3 | TWB4 | TWT4 | TWB5 | TWB6 | TWB7 |
| Thermowell from conical bar stock | Thermowell from bar stock with narrowed tip | Thermowell from tube stock with narrowed tip | Thermowell from conical bar stock | Flanged thermowell from conical bar stock | Thermowell from bar stock for welding |
| from 16 to 24 mm with taper to 16 mm | Fixed 14/7 | Fixed 14/7 | from 18 to 24 mm with taper to 14 mm | from 12 to 20 mm | min diameter: from 14 to 19 mm max. diameter: from 17 to 30 mm |
| from 7 to 9 mm | from 7 to 9 mm | 10 mm | 7 mm | from 7 to 9 mm | 7 mm |
| Threaded fitting from 1/4" to 1/2" | Threaded fitting from 1/4" to 1/2" | Threaded fitting from 1/4" to 1/2" | Threaded fitting from 1/4" to 1/2" | Threaded fitting from 1/4" to 3/4" | Threaded fitting from 1/4" to 1/2" |
| Threaded fitting from 1/2" to 1" | Threaded fitting from 1/2" to 1" | Threaded fitting from 1/2" to 1" | Threaded fitting from 3/4" to 1" | UNI - ASA type flanged fitting | Fitting to weld |
| AISI 300 series stainless steel INCONEL 600 | AISI 300 series stainless steel INCONEL 600 | AISI 300 series stainless steel INCONEL 600 | AISI 300 series stainless steel INCONEL 600 ASTM A182 F11 & F22 | AISI 300 series stainless steel INCONEL 600 ASTM A182 F11 & F22 | AISI 300 series stainless steel INCONEL 600 ASTM A182 F11 & F22 |

TOLERANCES FOR Pt100 RESISTANCE THERMOMETERS

| TEMPERATURE °C | TOLERANCE CLASS A | | TOLERANCE CLASS B | |
|-------------------|-------------------|------|-------------------|------|
| | ±°C | ±Ω | ±°C | ±Ω |
| -200 | 0,55 | 0,24 | 1,3 | 0,56 |
| -100 | 0,35 | 0,14 | 0,8 | 0,32 |
| 0 | 0,15 | 0,06 | 0,3 | 0,12 |
| 100 | 0,35 | 0,13 | 0,8 | 0,30 |
| 200 | 0,55 | 0,20 | 1,3 | 0,48 |
| 300 | 0,75 | 0,27 | 1,8 | 0,64 |
| 400 | 0,95 | 0,33 | 2,3 | 0,79 |
| 500 | 1,15 | 0,38 | 2,8 | 0,93 |
| 600 | 1,35 | 0,43 | 3,3 | 1,06 |
| 650 | 1,45 | 0,46 | 3,6 | 1,13 |
| 700 | - | - | 3,8 | 1,17 |
| 800 | - | - | 4,3 | 1,28 |
| 850 | - | - | 4,6 | 1,34 |



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