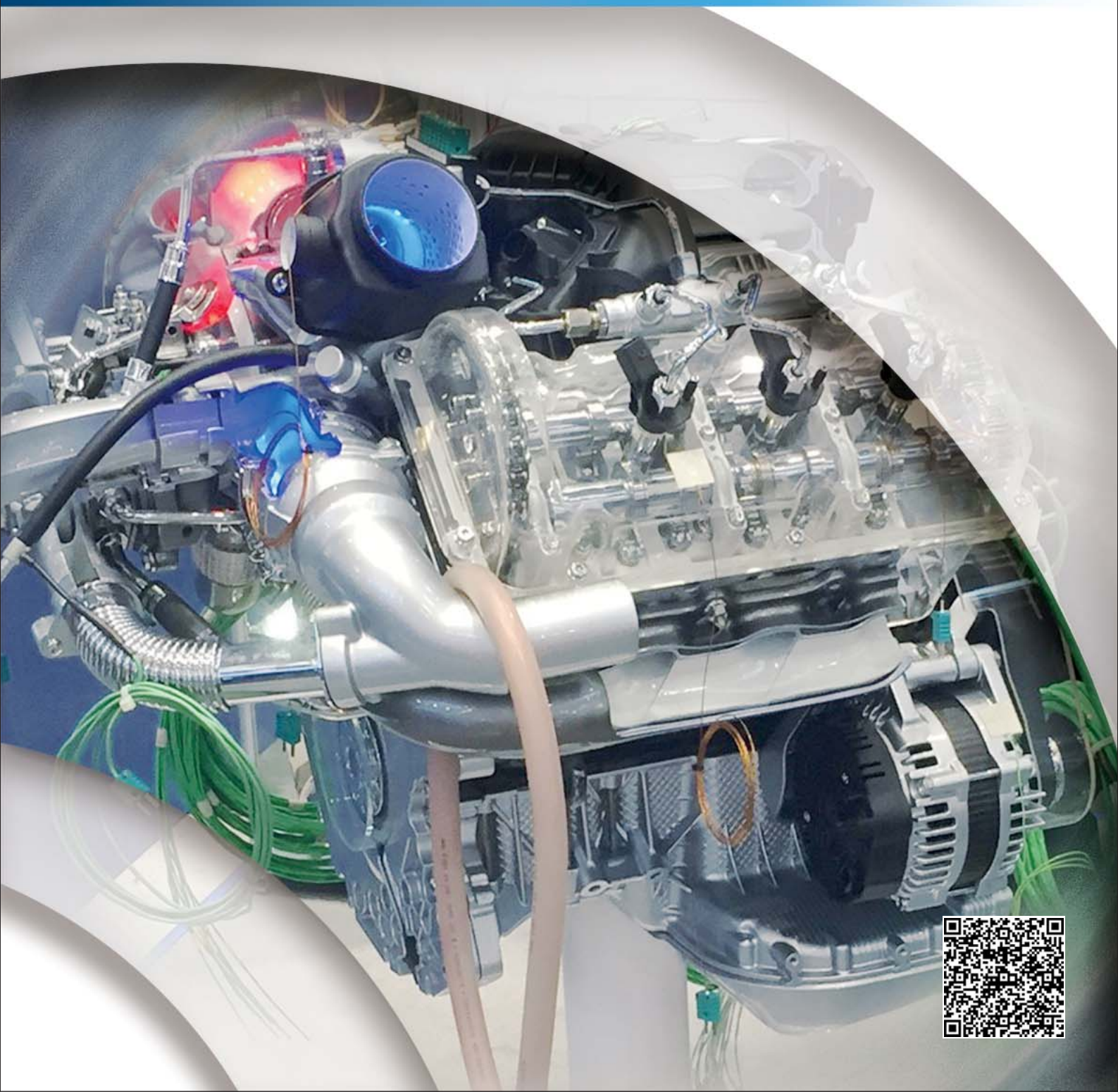
SPECIAL CABLES · TEMPERATURE MEASUREMENT · CABLE HARNESSING

SAB BRÖCKSKES

TEMPERATURE MEASUREMENT

IN TEST VEHICLES



CONTENT

REFERENCES

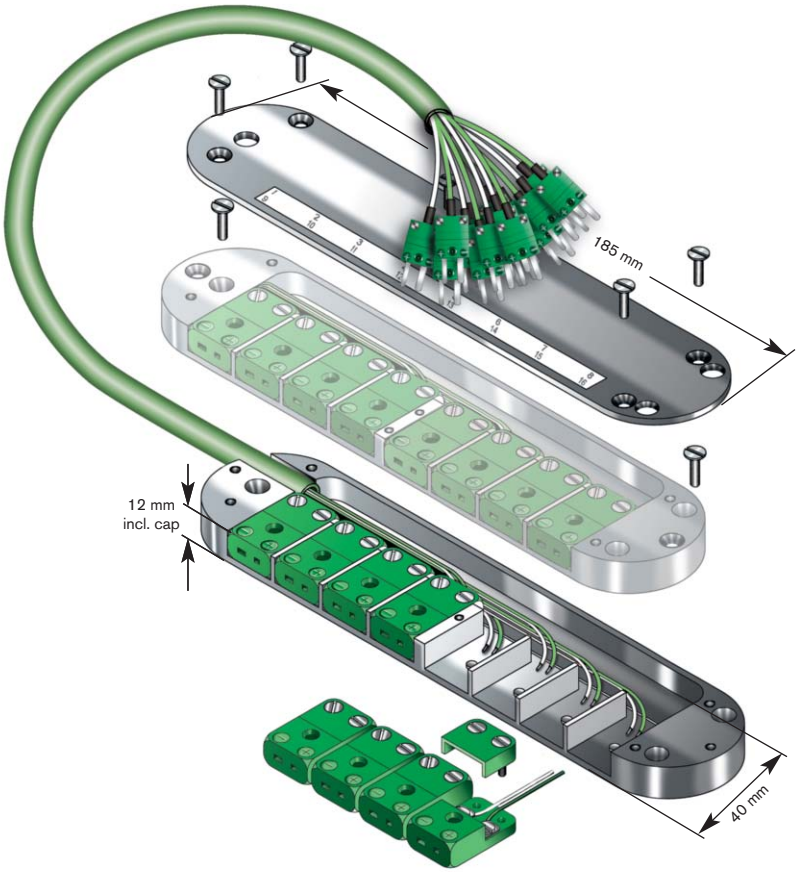
Customer	Branch	Product range
Volkswagen AG	Automobile industry	Thermocouples, special constructions, harnessing
Audi AG	Automobile industry	Mineral insulated thermocouples
Daimler AG	Automobile industry	Straight thermocouples, resistance thermometers
MAN AG	Automobile industry	Thermocouples, mineral insulated thermocouples, extension cables
Skoda	Automobile industry	Mineral insulated thermocouples, special constructions
Behr	Sub-supplier of automobile industry	Thermocouples, resistance thermometers
AVL	Sub-supplier of automobile industry	Mineral insulated thermocouples, special constructions
Magna	Sub-supplier of automobile industry	Resistance thermometers, extension cables
Horiba	Analytical tools and testing systems	Thermocouples, resistance thermometers
SMS Siemag	Steel industry	Thermocouples, harnessing
ThyssenKrupp Steel	Steel industry	Thermocouples, resistance thermometers, compensating cables
Lanxess	Chemical industry	Thermocouples
Bayer MaterialScience	Material industry	Mineral insulated thermocouples
Hotset	Hot runner technique	Mineral insulated thermocouples, resistance thermometers
PSG	Hot runner technique	Mineral insulated thermocouples, special cables
Ewikon	Hot runner technique	Mineral insulated thermocouples
Ökofen	Pellet heatings	Mineral insulated thermocouples
Krones AG	Mechanical engineering	Resistance thermometers
Krauss-Maffei	Mechanical engineering	Thermocouples, resistance thermometers
Currenta	Industrial services	Thermocouples
Wachtel	Baking oven manufacturer	Thermocouples
rbr	Measuring instruments	Thermocouples
BRP-Powertrain	Engine manufacturer	Resistance thermometers

8-PLUG AND 16-PLUG ALUMINUM CONNECTOR T065

Also available in type J + T

This item is used, for example in automobile industry in test vehicles. Thermocouples can be easily connected. In case of failure, the faulty element can be exchanged without much effort. Test engines require temperature measurements at the most different points, e.g. in oilpans, cooling tubes and combustion gases, etc. Cables coming from the different measuring points can be plugged into the connector conveniently. Advantage: Reduced wiring effort.

In general the application makes sense, whenever there are many measuring points and far distances that have to be overcome.



NUMBER OF CONNECTORS:

- ❑ 8 miniature sockets
- ❑ 16 miniature sockets

On request also in the version
with miniature connectors in aluminum housing!

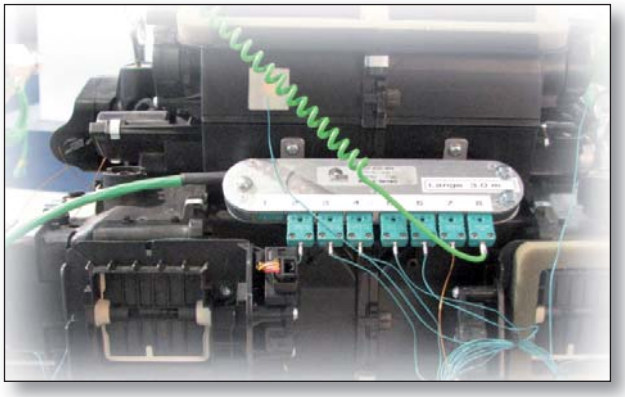
CABLE VERSION:

- ❑ strand / FEP / FEP
- ❑ strand / FEP / overall copper shield / FEP

CABLE LENGTH: _____

CONNECTION ENDS:

- ❑ miniature thermoplug
- ❑ miniature socket
- ❑ standard plug
- ❑ Lemo plug type _____
- ❑ Lemo socket type _____
- ❑ bare ends
- ❑ other cable ends _____



The photo shows an 8-plug connector used in automobile industry for example in test vehicles. Thermocouples can be easily connected.

DETAILS OF THE CONNECTION CABLES

■ **THL KX acc. to DIN EN 60584**

strand/FEP/FEP +180°C

8 x 2 x 0,22 mm²	Ø 6,4 mm
16 x 2 x 0,22 mm²	Ø 7,7 mm

■ **THL KX acc. to DIN EN 60584**

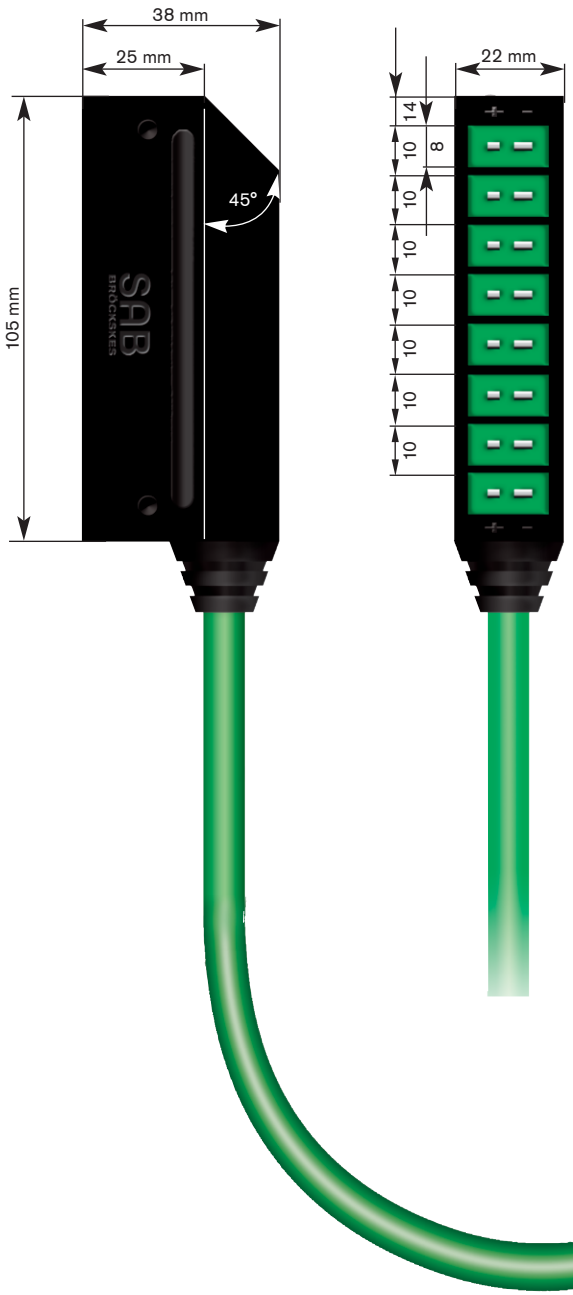
strand/FEP/overall copper shield/FEP +180°C

8 x 2 x 0,22 mm²	Ø 6,9 mm
16 x 2 x 0,22 mm²	Ø 8,3 mm

8-PLUG PLASTIC CONNECTOR T065

Also available in type J + T

This item is used, for example in automobile industry in test vehicles. Thermocouples can be easily connected. in case of failure, the faulty element can be exchanged without much effort. Test engines require temperature measurements at the most different points, e.g. in oilpans, cooling tubes and combustion gases, etc. Cables coming from the different measuring points can be plugged into the connector conveniently. Advantage: Reduced wiring effort. Furthermore, the plastic connector offers recessed grips for easy handling. On request we are able to provide the company logo as well as individual fixing bores. Due to the plastic housing damages in the passenger area are avoided. The small and space saving construction form offers an advantage compared with aluminium connectors.



NUMBER OF CONNECTORS:

- ❑ 8 miniature sockets

CABLE VERSION:

- ❑ strand / FEP / FEP
- ❑ strand / FEP / overall copper shield / FEP

CABLE LENGTH: _____

CONNECTION ENDS:

- ❑ miniature thermoplug
- ❑ miniature socket
- ❑ standard plug
- ❑ Lemo plug type _____
- ❑ Lemo socket type _____
- ❑ bare ends
- ❑ other cable ends _____

DETAILS OF THE CONNECTION CABLES

■ **THL KX acc. to DIN EN 60584**
strand/FEP/FEP +180°C
8 x 2 x 0,22 mm² Ø 6,4 mm

■ **THL KX acc. to DIN EN 60584**
strand/FEP/overall copper shield/FEP +180°C
8 x 2 x 0,22 mm² Ø 6,9 mm

MINERAL INSULATED THERMOCOUPLE with connector T302 / T303, with exposed cable ends T301

General Information

Type J class 1 and 2	-40°C / +750°C
Type K class 1 class 2	-40°C / +1000°C -40°C / +1100°C
Material 1.4541	+800°C
Material 2.4816	+1100°C

Please note that the temperature stability of the sensor is determined by the weakest parameters.

Especially appropriate to collect temperatures in test vehicles in the vehicle interior.

THERMOCOUPLE:

- ❑ 1 x type J
- ❑ 1 x type K
- ❑ 2 x type J
- ❑ 2 x type K
- ❑ other thermocouples _____

SHEATH-Ø:

- ❑ 0,5 mm
- ❑ 2,0 mm
- ❑ 4,5 mm
- ❑ 1,0 mm
- ❑ 3,0 mm
- ❑ 6,0 mm
- ❑ 1,5 mm
- ❑ other sheath-Ø _____

SHEATH MATERIAL:

- ❑ 1.4541 (+800°C)
- ❑ 2.4816 (+1100°C)
- ❑ other sheath materials _____

CONNECTION ELEMENTS:

- ❑ miniature thermoplug
- ❑ Lemo plug type _____
- ❑ standard plug
- ❑ Lemo socket type _____
- ❑ miniature socket
- ❑ free ends _____ mm
- ❑ other cable ends _____

TYPE OF MEASURING TIP:

- ❑ class 1, form A, insulated measuring tip
- ❑ class 1, form B, welded measuring tip
- ❑ class 2, form A, insulated measuring tip
- ❑ class 2, form B, welded measuring tip

NOMINAL LENGTH: _____ mm

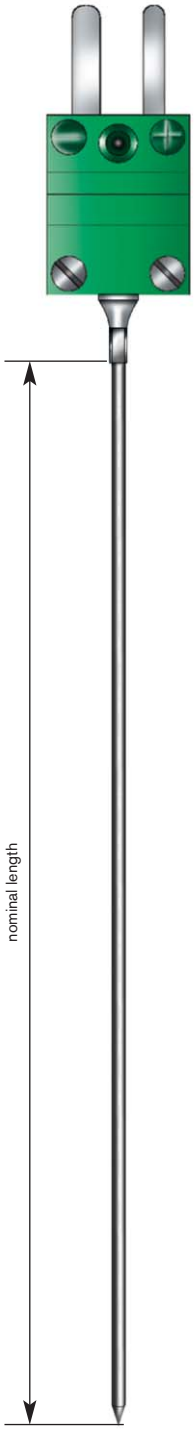
- ❑ with batch certificate and identification
- ❑ accessories (fix) _____

PLUG-IN THERMOCOUPLE T840

General Information

Type J class 1 and 2	-40°C / +750°C
Type K class 1 class 2	-40°C / +1000°C -40°C / +1100°C
Material 1.4541	+800°C
Material 2.4816	+1100°C
Please note that the temperature stability of the sensor is determined by the weakest parameters.	

Especially appropriate to collect temperatures in test vehicles in the vehicle interior. By slight pressure, the plunge-in thermocouple can be placed for example in the seats or neck-rests to collect the temperature.



THERMOCOUPLE:

- ❑ 1 x type J
- ❑ 1 x type K
- ❑ 2 x type J
- ❑ 2 x type K
- ❑ other thermocouples _____

SHEATH-Ø:

- ❑ 0,5 mm
- ❑ 2,0 mm
- ❑ 4,5 mm
- ❑ 1,0 mm
- ❑ 3,0 mm
- ❑ 6,0 mm
- ❑ 1,5 mm
- ❑ other sheath-Ø _____

SHEATH MATERIAL:

- ❑ 1.4541 (+800°C)
- ❑ 2.4816 (+1100°C)
- ❑ other sheath materials _____

CONNECTION ELEMENTS:

- ❑ miniature thermoplug
- ❑ Lemo plug type _____
- ❑ standard plug
- ❑ Lemo socket type _____
- ❑ miniature socket
- ❑ free ends _____ mm
- ❑ other cable ends _____

TYPE OF MEASURING TIP:

- ❑ class 1, form A, insulated measuring tip
- ❑ class 2, form A, insulated measuring tip

NOMINAL LENGTH: _____ mm

- ❑ with batch certificate and identification

- ❑ accessories (fix) _____

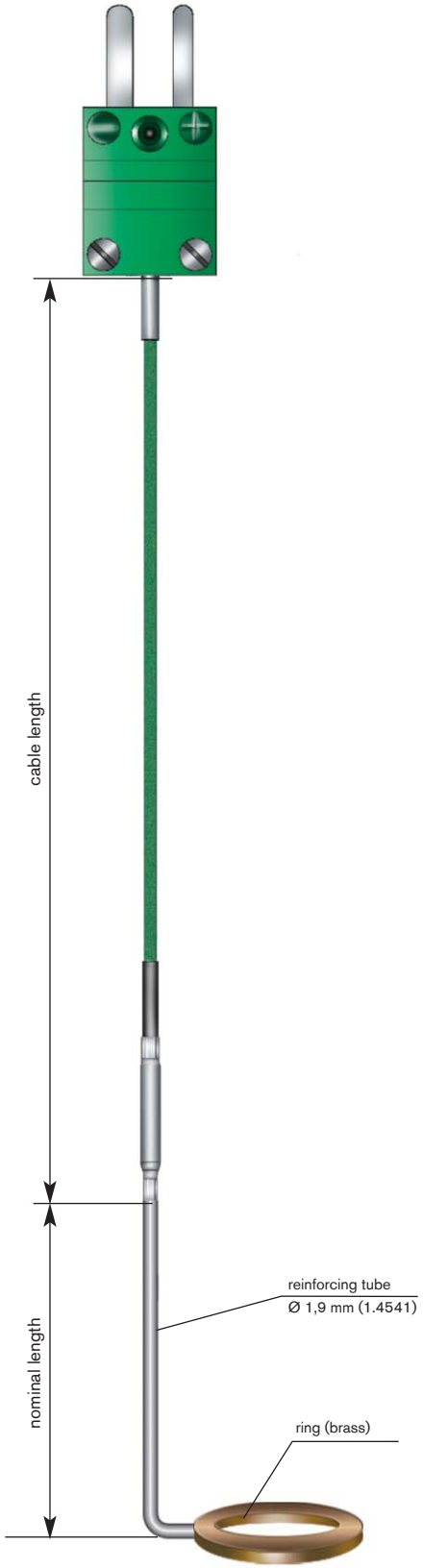
SPARK PLUG THERMOCOUPLE T207

General Information

Type J class 1	-40°C / +750°C
Type K class 1	-40°C / +1000°C
Limit deviation	Class 1
Measuring tip	Form A, insulated
Material	1.4541 +800°C

Please note that the temperature stability of the sensor is determined by the weakest parameters.

This item is used, for example in automobile industry, for the easy measurement at the sealing ring of spark plugs. Working with spark plug spanner isn't impeded.



THERMOCOUPLE:

❑ 1 x type J ❑ 1 x type K

❑ other thermocouples _____

TYPE OF RING:

❑ Ø 19 x 13,1 x 2,5 mm Ms (standard version for spark plugs)

❑ other type of ring _____

NOMINAL LENGTH: _____ mm

TYPE:

❑ with kink protection (shrinkable sleeve)

❑ without kink protection (shrinkable sleeve)

CONNECTION CABLE:

(see also survey of connecting cables for thermocouples page 33 and 34)

❑ extension cable strand / FEP / FEP

❑ extension cable strand / FEP / overall copper shield / FEP

❑ other connection cable _____

CABLE LENGTH: _____ m

CONNECTION ENDS:

❑ miniature thermoplug ❑ bare ends

❑ standard plug ❑ Lemo plug type _____

❑ miniature socket ❑ Lemo socket type _____

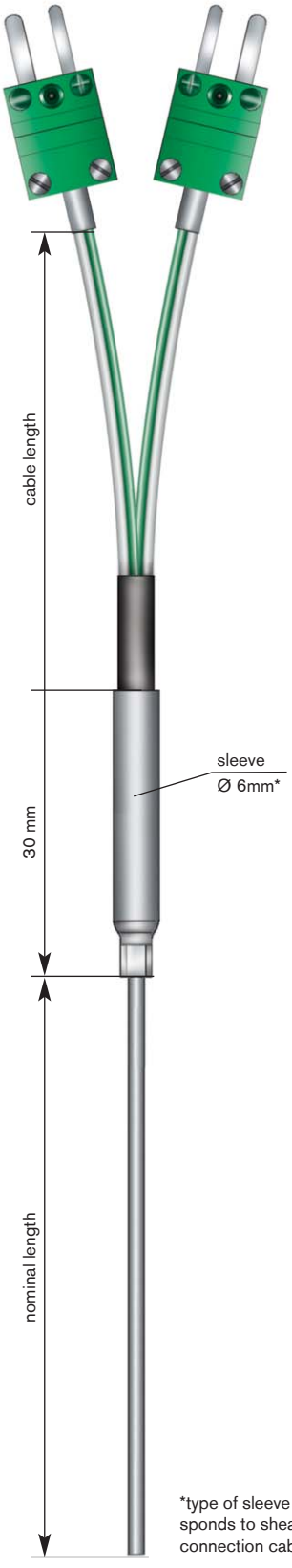
❑ other cable ends _____

❑ with batch certificate and identification

DOUBLE MINERAL INSULATED THERMOCOUPLE T207 with two cables

Thermocouple:	Type K or J acc. to DIN EN 60584
Measuring point:	Form A – ungrounded insulated or Form B – grounded insulated
Measuring temperature:	**Type K:** max. 800°C at sheath material 1.4541 max. 1100°C at sheath material 2.4816 **Type J:** max. 750°C

This item is used, for example in automobile industry, especially appropriate for temperature measurement at places difficult to reach.



*type of sleeve corresponds to sheath-Ø and connection cable

THERMOCOUPLE:

❑ 2 x type K ❑ other thermocouples _____

SHEATH-Ø:

❑ 1,5 mm ❑ other sheath-Ø _____

SHEATH MATERIAL:

❑ 1.4541 ❑ 2.4816 ❑ other sheath materials _____

CABLE ENDS:

❑ bare ends ❑ cable lugs M4
❑ end sleevers ❑ miniature thermoplug
❑ other cable ends _____

CONNECTION CABLE:

(see also survey of connecting cables for thermocouples page 33 and 34)

❑ extension cable strand / FEP / FEP
❑ extension cable strand / FEP / overall copper shield / FEP
❑ other connection cable _____

CONNECTION CABLE LENGTH:

❑ 1,0 m ❑ 2,5 m ❑ 5,0 m
❑ 1,5 m ❑ 3,0 m ❑ 10,0 m
❑ 2,0 m ❑ 4,0 m ❑ other length _____

TYPE OF MEASURING TIP:

❑ form A, insulated measuring tip, without kink protection
❑ form B, welded measuring tip, without kink protection
❑ form A, insulated measuring tip, with kink protection (shrinkable sleeve)
❑ form B, welded measuring tip, with kink protection (shrinkable sleeve)
all types in class 1

NOMINAL LENGTH: _____ mm

■ Also available as multi step element

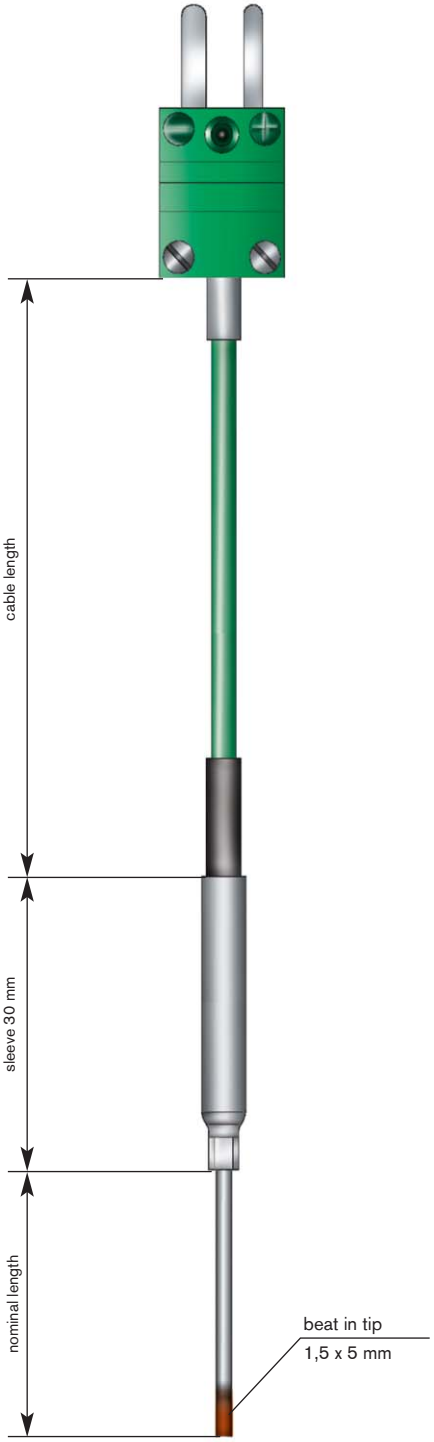
BEAT IN MINERAL INSULATED THERMOCOUPLE T207

General Information

Type J class 1	-40°C / +750°C
Type K class 1	-40°C / +1000°C
Material 1.4541	+800°C
Material 2.4816	+1100°C
Measuring tip	Form A, insulated
Limit deviation	Class 1

Please note that the temperature stability of the sensor is determined by the weakest parameters.

This item is used, for example in automobile industry and is particularly appropriate for surface temperature measurement. With the help of an appropriate groove, the element can be fixed by beating in. The measuring point is situated behind the copper tip and can easily be identified by the colour difference.



THERMOCOUPLE:

❑ 1 x type J ❑ 1 x type K

❑ other thermocouples _____

NOMINAL LENGTH: _____ mm

TYPE:

❑ with kink protection (shrinkable sleeve)

❑ without kink protection (shrinkable sleeve)

CONNECTION CABLE:

(see also survey of connecting cables for thermocouples page 33 and 34)

❑ extension cable strand / FEP / FEP

❑ extension cable strand / FEP / overall copper shield / FEP

❑ other connection cable _____

CABLE LENGTH: _____ m

CONNECTION END:

❑ miniature thermoplug ❑ bare ends

❑ standard plug ❑ Lemo plug type _____

❑ miniature socket ❑ Lemo socket type _____

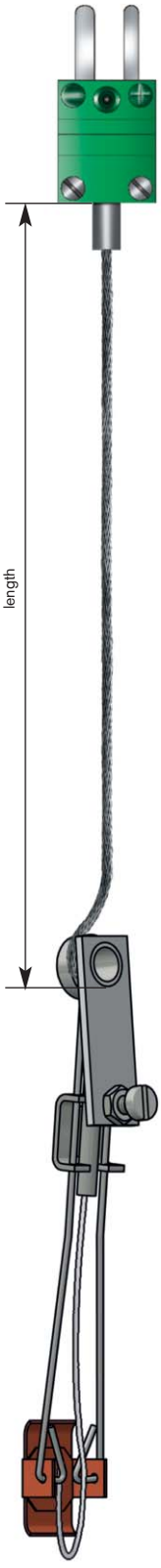
❑ other cable ends _____

❑ with batch certificate and identification

SURFACE THERMOCOUPLE FOR BRAKE DISCS T895

For the quick temperature recording on flat, rotating surfaces, such as brake discs. This thermocouple can be recorded temperatures up to +800°C.

up to +800°C



THERMOCOUPLE:

- ❑ 1 x type J
- ❑ 1 x type K
- ❑ other thermocouples _____

SHEATH MATERIAL:

Ø 0,5 with variable holding plate 11 x 17 mm (E-Cu)

LENGTH:

(sheath material with stainless steel wire armouring (VA))

- ❑ 0,5 m
- ❑ 1,0 m
- ❑ 1,5 m
- ❑ 2,0 m
- ❑ other length _____ m

CONNECTION ELEMENTS:

- ❑ miniature thermoplug
- ❑ standard plug
- ❑ miniature socket
- ❑ Lemo plug type _____
- ❑ Lemo socket type _____

- ❑ with batch certificate and identification

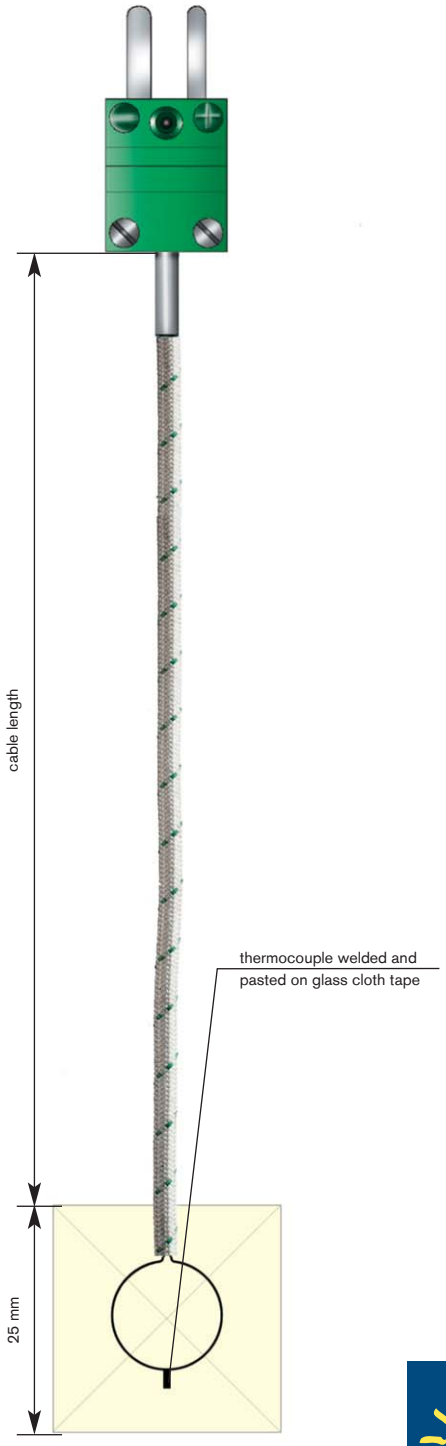
SELF-ADHESIVE SURFACE THERMOCOUPLE T130

General Information

Temperature range of the sensor is dependent of the temperature resistance of the cable e.g. FEP +180°C	
Limit deviation	Class 1
Please note that the temperature stability of the sensor is determined by the weakest parameters.	

Also available in type J + T

This item is used, for example in automobile industry, especially everywhere quick and uncomplicated temperatures must be measured. Advantage: No special preparation necessary at the measuring points. It only has to be paid attention to the fact that the surface is free of dust, grease and oils.



THERMOCOUPLE:

- ❑ 1 x type J ❑ 1 x type K
- ❑ other thermocouples _____

PAD SIZE:

- ❑ 25 x 25 mm (standard type) double
- ❑ other pad size _____

CONNECTION CABLE:

(see also survey of connecting cables for thermocouples page 33 and 34)

- ❑ single wire / fibre-glass / fibre-glass
- ❑ single wire / FEP / FEP
- ❑ single wire / polyimide / polyimide
- ❑ other connection cable _____

CABLE LENGTH: _____ m

CONNECTION ENDS:

- ❑ miniature thermoplug ❑ bare ends
- ❑ standard plug ❑ Lemo plug type _____
- ❑ miniature socket ❑ Lemo socket type _____
- ❑ other cable ends _____

- ❑ with batch certificate and identification

SPARE PADS are available with item no. T095-044-258, cut-outs 25 x 25 mm and a packaging unit of 100 pads on a roll!

Self-adhesive thermocouple in practical application

Self-adhesive thermocouples to measure the temperature at the sleeves of the drive shaft.

The data transmission is done by a telemetric device. Several self-adhesive thermocouples can be mounted in a space saving way without any problem.

■ Temperature resistance of the adhesive pad +230°C

SURFACE THERMOCOUPLE T100 with ceramic housing

For an extended temperature range

This surface thermocouple is applied in the exhaust gas area. It is especially appropriate for a quick and uncomplicated measurement.
By welding the measuring tip the sensor can be easily positioned at the required measuring point. By welding the two wires the measuring point is created.

The measuring tip is formed by welding the two wires

THERMOCOUPLE:

- ❑ 1 x type K
- ❑ other thermocouples _____

CONNECTION CABLE:

(see also survey of connecting cables for thermocouples page 33 and 34)

- ❑ fibre-glass insulated thermo-cable 2 x 0,50 mm Ø +400°C
- ❑ other connection cable _____

CABLE LENGTH: _____ m

CONNECTION ENDS:

- ❑ miniature thermoplug
- ❑ miniature socket
- ❑ other cable ends _____

- ❑ with batch certificate and identification

The ceramic insulation is also available separately!

SURFACE THERMOCOUPLE T100 with welding bead (form A)

For an extended temperature range

This surface thermocouple with polyimide cable is also called miniature thermocouple. It is used for example in coil windings, electronic parts and narrow spaces. Batch certificate and identification can be delivered on request.

Miniature welding bead with covering

THERMOCOUPLE:

- ❑ 1 x type K
- ❑ 1 x type N
- ❑ 1 x type T
- ❑ other thermocouples _____

CONNECTION CABLE:

(see also survey of connecting cables for thermocouples page 33 and 34)

- ❑ Thermocouple cable 2 x 0,20 mmØ / polyimide +300°C
- ❑ other connection cable _____

CABLE LENGTH: _____ m

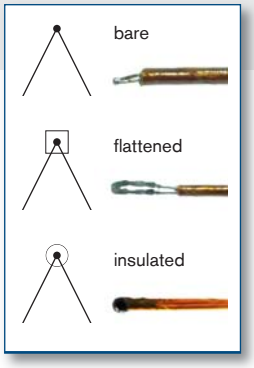
CONNECTION ENDS:

- ❑ miniature thermoplug
- ❑ miniature socket
- ❑ other cable ends _____

- ❑ with batch certificate and identification

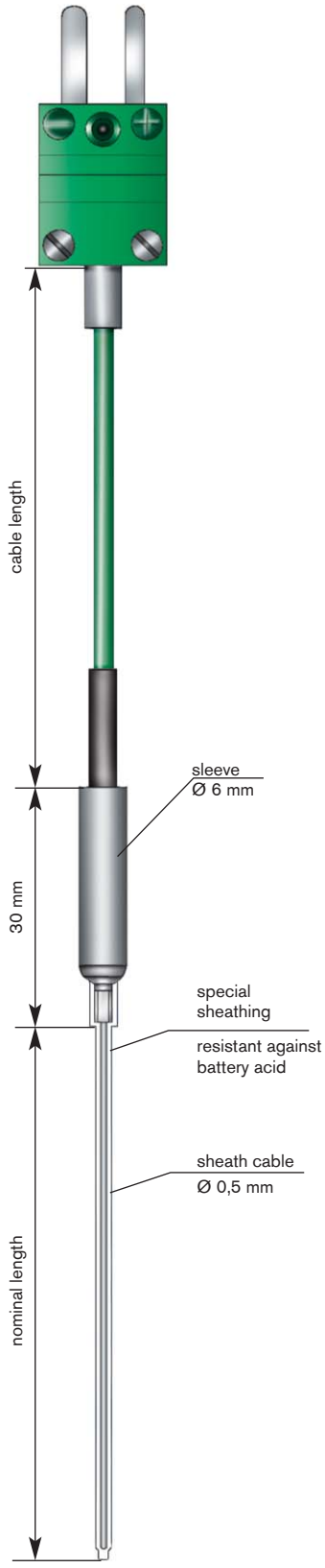
Response time in water - immersion depth 50 mm:	Average value taken from 3 measurements t 0,5 = 2,7 sec. t 0,9 = 4,7 sec.
Response time in air:	Average value taken from 3 measurements t 0,5 = 5,6 sec. t 0,9 = 12,0 sec.

Following measuring tips:



BATTERY THERMOCOUPLE T841

This item is used, for example in automobile industry. The special thermocouple is especially appropriate to collect temperatures in batteries. Considerable advantage is the special sheathing resistant against battery acids that enables a temperature measurement directly in the acid without any harm to the thermocouple itself.



THERMOCOUPLE:

❑ 1 x type J ❑ 1 x type K
❑ 2 x type J ❑ 2 x type K ❑ other thermocouples _____

SHEATH MATERIAL:

❑ 1.4541 ❑ 2.4816 ❑ other sheath materials _____

CONNECTION CABLE:

(see also survey of connecting cables for thermocouples page 33 and 34)

❑ extension cable strand / FEP / FEP
❑ extension cable strand / FEP / overall copper shield / FEP
❑ other connection cable _____

CABLE ENDS:

❑ bare ends ❑ cable lugs M4
❑ end sleeves ❑ miniature thermoplug
❑ other cable ends _____

CONNECTION LENGTH:

❑ 1,0 m ❑ 2,5 m ❑ 5,0 m
❑ 1,5 m ❑ 3,0 m ❑ 10,0 m
❑ 2,0 m ❑ 4,0 m ❑ other length _____ m

TYPE OF MEASURING TIP:

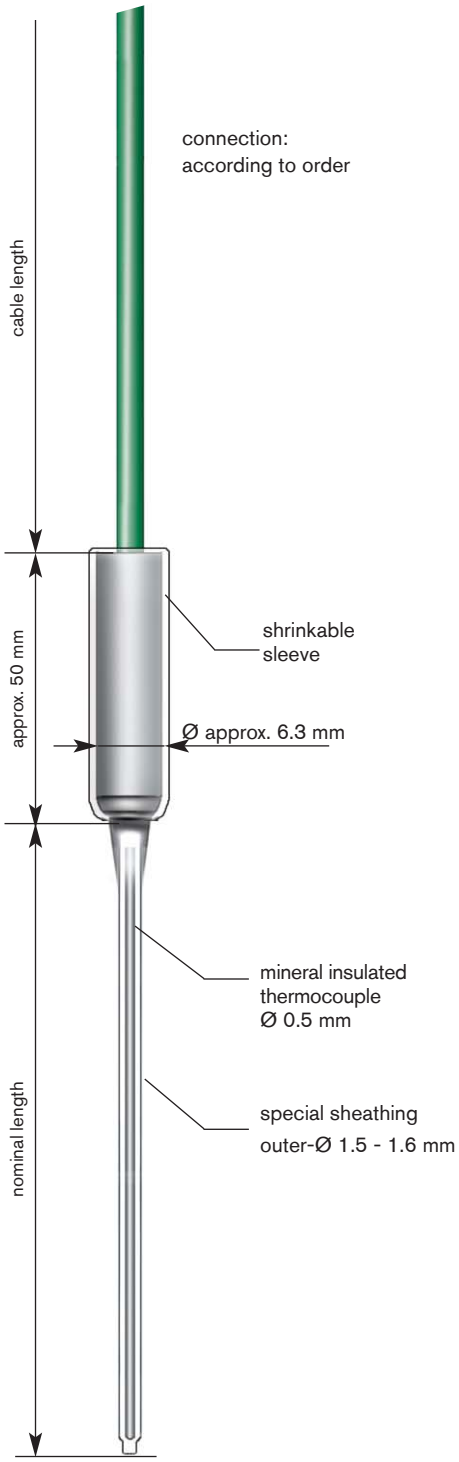
❑ form A, insulated measuring tip, without kink protection
❑ form B, welded measuring tip, without kink protection
❑ form A, insulated measuring tip, with kink protection (shrinkable sleeve)
❑ form B, welded measuring tip, with kink protection (shrinkable sleeve)
all types in class 1

NOMINAL LENGTH: _____ mm

■ Temperature range up to +205°C

SPECIAL MINERAL INSULATED THERMOCOUPLE T839

This item is used, for example in automobile industry, especially for temperature measurements on live parts e.g. in vehicles (at hybrid drives, at coils of electric engines, under cable insulators directly at the conductor etc.) Another advantage is the excellent resistance against acids, chemical agents, fuels, oils, cooling lubricants.



THERMOCOUPLE:

❑ 1 x type J ❑ 1 x type K ❑ other thermocouples _____

SHEATH MATERIAL:

❑ 1.4541 ❑ 2.4816

CONNECTION CABLE:

(see also survey of connecting cables for thermocouples page 33 and 34)

❑ extension cable strand / FEP / FEP

❑ extension cable strand / FEP / overall copper shield / FEP

❑ other connection cable _____

CABLE ENDS:

❑ bare ends

❑ miniature thermoplug

❑ other cable ends _____

CABLE LENGTH:

❑ 1,0 m ❑ 4,0 m

❑ 1,5 m ❑ 5,0 m

❑ 2,0 m ❑ 10,0 m

❑ 2,5 m ❑ other length _____ m

TYPE OF MEASURING TIP:

❑ form B, welded measuring tip, class 1

❑ form A, insulated measuring tip, class 1

NOMINAL LENGTH: _____ mm

■ Completely coated with special plastic material / measuring tip voltage-stable up to 2 kV/AC / individually tested / batch certificate / Temperature range up to +205 ° C

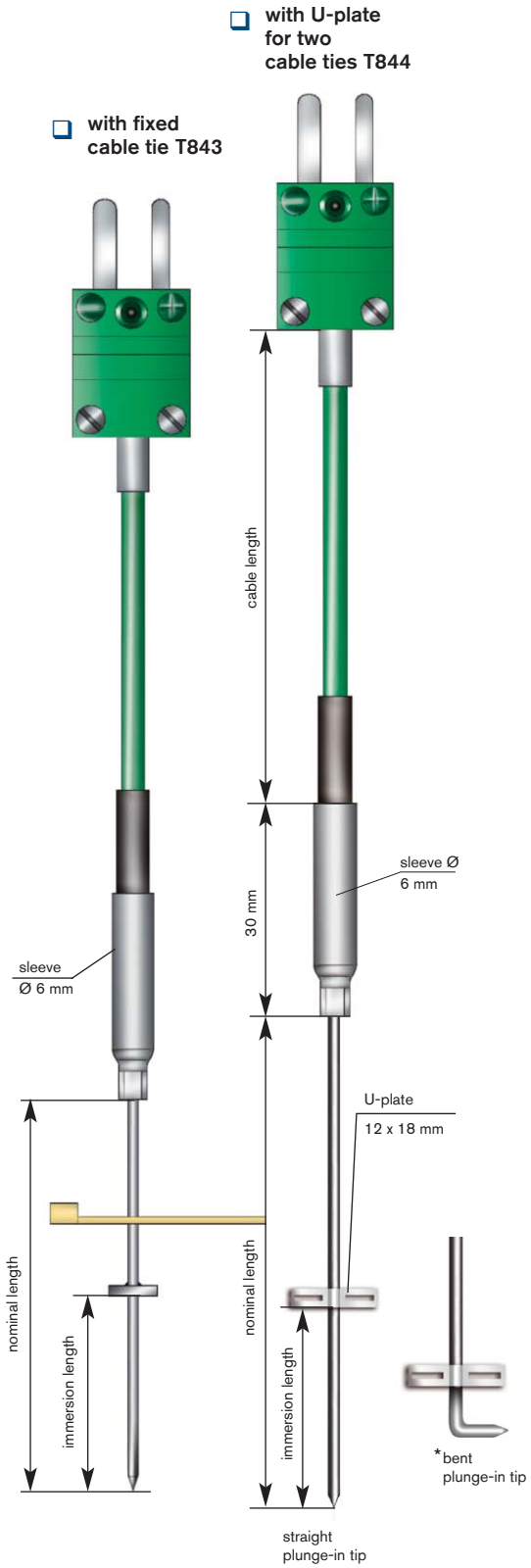
COOLING WATER TUBE THERMOCOUPLE T843 / T844

General Information

Temperature range of probe	-40°C / +150°C due to cable tie
Limit deviation	Class 1

Please note that the temperature stability of the sensor is determined by the weakest parameters.

Especially appropriate to collect the temperature of the cooling liquid in the cooling tubes at the engine. If temperature collection is no longer required, the sheath can be simply cut behind the high temperature cable tie. Considerable advantage is the achieved time saving, as it is no longer necessary to let off the cooling liquid. The system of cooling tubes remains tight.



THERMOCOUPLE:

❑ 1 x type J ❑ 1 x type K

❑ other thermocouples _____

TYPE OF MEASURING TIP:

❑ form A, insulated measuring tip ❑ form B, welded measuring tip

❑ with kink protection at the sleeve ❑ without kink protection

SHEATH-Ø:

❑ 1,5 mm

PLUNGE-IN TIP:

❑ without ❑ straight

❑ with ❑ bent*

SHEATH MATERIAL:

❑ 1.4541 ❑ 2.4816 ❑ other sheath materials _____

NOMINAL LENGTH: _____ mm

IMMERSION LENGTH: _____ mm

CONNECTION CABLE:

(see also survey of connecting cables for thermocouples page 33 and 34)

❑ extension cable strand / FEP / FEP

❑ extension cable strand / FEP / overall copper shield / FEP

❑ other connection cable _____

CABLE LENGTH: _____ m

CONNECTION ENDS:

❑ miniature thermoplug ❑ bare ends

❑ standard plug ❑ Lemo plug type _____

❑ miniature socket ❑ Lemo socket type _____

❑ other cable ends _____

❑ with batch certificate and identification

In order to reuse the cooling water tube sensor, the opening can be closed permanently by the blind plug.

▶ Item no.: T061-041-908

FUEL THERMOCOUPLE T850

General Information

Temperature range of probe	-40°C / +300°C
Limit deviation	Class 1
Measuring point	Form A, insulated

Please note that the temperature stability of the sensor is determined by the weakest parameters.

Especially appropriate to measure the temperature in the fuel line. The small diameter of the thermocouple situated in the middle of the T-tube connector, guarantees a quick response time. Another advantage offers the small diameter of the mineral insulated thermocouple so that neither the flow velocity nor the flow quantity are affected. The screening of the cable offers at the same time mechanical protection as well as protection against electromagnetic interference.

THERMOCOUPLE:

❑ 1 x type J ❑ 1 x type K ❑ other thermocouples _____

SHEATH-Ø:

❑ 0,5 mm (1.4404)

❑ other sheath-Ø (on request) _____

INNER TUBE-Ø:

❑ 4 - 5 mm (tube connector NW 3)

❑ 5 - 6 mm (tube connector NW 4)

❑ 7 - 8 mm (tube connector NW 6)

❑ 9 - 10 mm (tube connector NW 8)

❑ 11 - 12 mm (tube connector NW 10)

❑ 13 - 14 mm (tube connector NW 12)

❑ other tube inner-Ø (on request) _____

CONNECTION CABLE:

(see also survey of connecting cables for thermocouples page 33 and 34)

❑ extension cable strands / FEP / FEP

❑ extension cable strands / FEP / overall copper shield / FEP

❑ other connection cable _____

CABLE LENGTH: _____ m

CONNECTION ENDS:

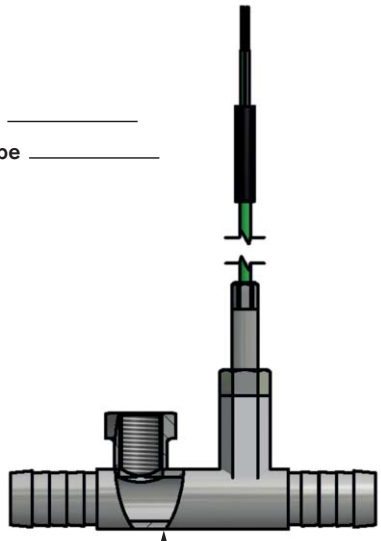
❑ miniature thermoplug ❑ bare ends

❑ standard plug ❑ Lemo plug type _____

❑ miniature socket ❑ Lemo socket type _____

❑ other cable ends _____

❑ with batch certificate and identification



Also available as combined element with connection for pressure sensors!

COMBUSTION GAS THERMOCOUPLE T848 / T849

General Information

Type J class 1 and 2	-40°C / +750°C
Type K class 1 class 2	-40°C / +1000°C -40°C / +1100°C
Material 1.4541	+800°C
Material 2.4816	+1100°C

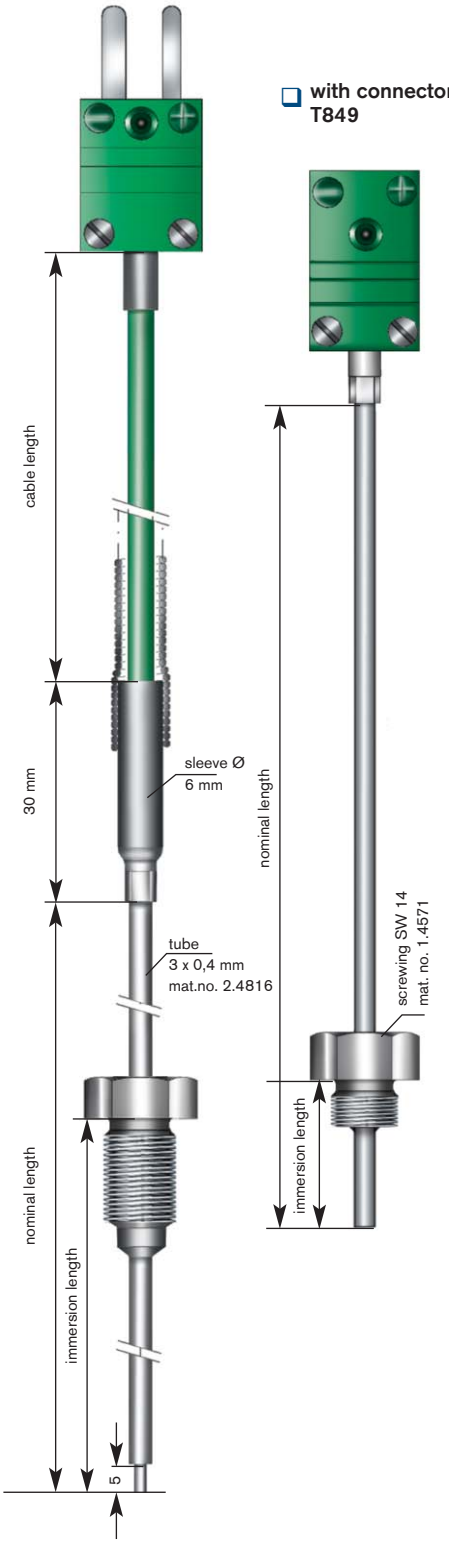
Please note that the temperature stability of the sensor is determined by the weakest parameters.

Also available in type J + T

For temperature measurement at engine test benches. Especially appropriate to collect the temperature in the combustion gas flow at the manifold. The reinforcement tube shall increase service life. The small diameter of the thermocouple guarantees a short response time. The screening of the cable is equally a mechanical protection as well as protection against electro-magnetic interference.

❑ with connection cable T848

❑ with connector T849



THERMOCOUPLE:

❑ 1 x type J ❑ 1 x type K ❑ other thermocouples _____

TYPE OF MEASURING TIP:

❑ form A, insulated measuring tip ❑ form B, welded measuring tip

KINK PROTECTION BEHIND SLEEVE: (only for type T848)

❑ with kink protection ❑ without kink protection

SHEATH-Ø:

❑ 1,5 mm ❑ 3,0 mm ❑ 4,5 mm ❑ 6,0 mm

REINFORCING TUBE-Ø:

❑ without ❑ 3,0 mm ❑ _____ mm

SHEATH MATERIAL:

❑ 2.4816 ❑ other sheath materials (on request) _____

NOMINAL LENGTH: _____ mm IMMERSION LENGTH: _____ mm

SCREWING: _____

CONNECTION CABLE: (only for type T848)

(see also survey of connecting cables for thermocouples page 33 and 34)

❑ extension cable strand / FEP / FEP

❑ extension cable strand / FEP / overall copper shield / FEP

❑ other connection cable _____

CABLE LENGTH: _____ m (only for type T848)

CONNECTION ENDS:

❑ miniature thermoplug ❑ bare ends

❑ standard plug ❑ Lemo plug type _____

❑ miniature socket ❑ Lemo socket type _____

❑ other cable ends _____

❑ with batch certificate and identification

■ Construction type also available without screwing. Fixing by clamping screw connection.

DIP-STICK THERMOCOUPLE T860

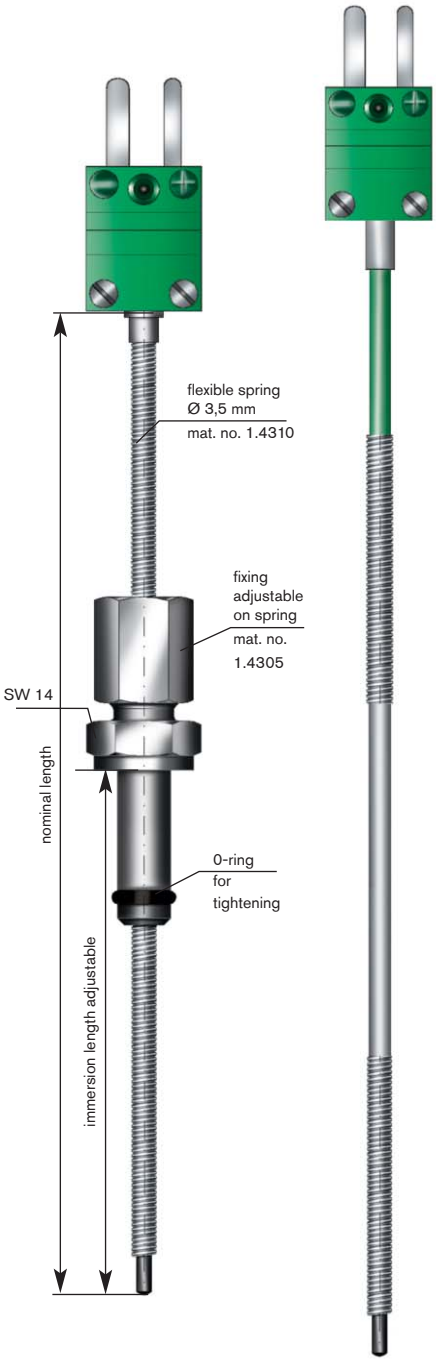
General Information

Temperature range of probe	0°C / +200°C
Limit deviation	Class 1

Please note that the temperature stability of the sensor is determined by the weakest parameters.

Especially appropriate for temperature measurement in engine oil!

This dipstick thermocouple is especially appropriate to collect the temperature in engine oil. The dipstick can easily be inserted instead of the normal oil dipstick. The adjustable fixing tightens the opening so that during operation the oil cannot penetrate. With the help of the fixing, the immersion length of the dipstick can be modified.



THERMOCOUPLE:

❑ 1 x type K ❑ other thermocouples _____

TYPE OF MEASURING TIP:

❑ form A, insulated measuring tip ❑ form B, welded measuring tip

SPRING-Ø:

❑ 3,5 mm

SPRING MATERIAL:

❑ 1.4571 ❑ _____ (on request)

❑ construction with gas tight tube

CONNECTION CABLE:

(see also survey of connecting cables for thermocouples page 33 and 34)

❑ without connection cable

❑ extension cable strand / FEP / FEP

❑ extension cable strand / FEP / overall copper shield / FEP

❑ other connection cable _____

CABLE LENGTH: _____ m (only for type with gas tight tube)

CONNECTION ENDS:

❑ miniature thermoplug ❑ bare ends

❑ standard plug ❑ Lemo plug type _____

❑ miniature socket ❑ Lemo socket type _____

❑ other cable ends _____

ACCESSORIES:

❑ fixing adjustable on spring tightening on Ø _____ mm

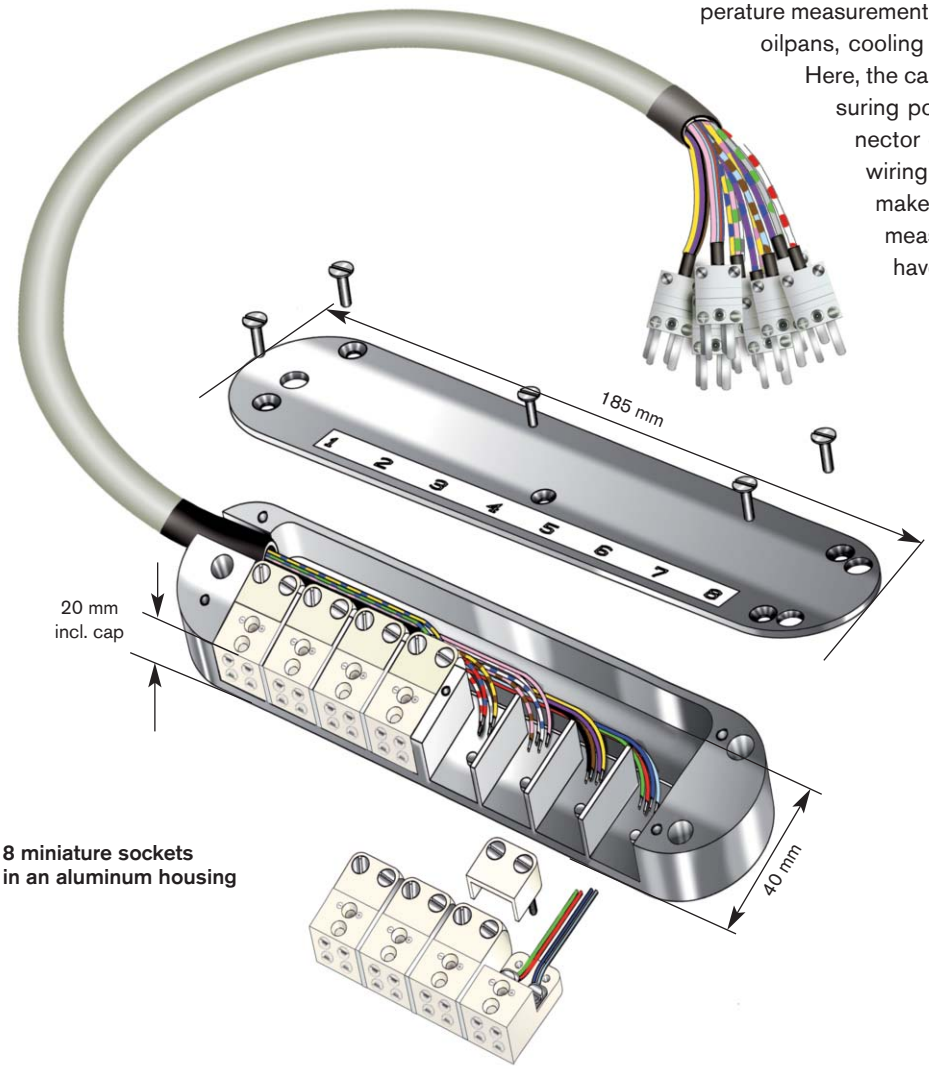
❑ with batch certificate and identification

- Due to the adjustable immersion depth, it can be applied for the most different engine types!
- Different tightening-Ø on request!!

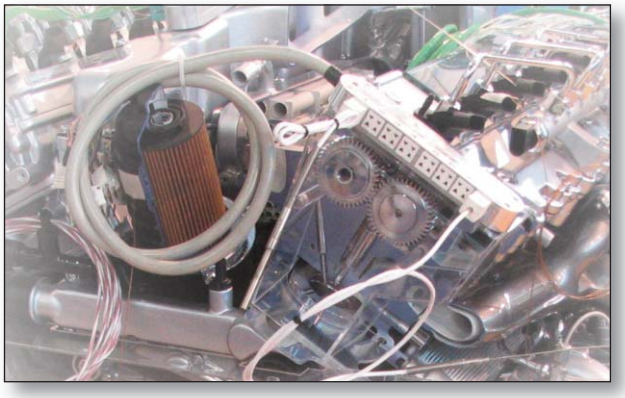
- Construction with gas tight tube

PT100 / PT1000 8-PLUG CONNECTOR T065 (4-wire circuit)

This item is used, for example in automobile industry for use in test benches. Thermocouples can be easily connected. In case of failure, the faulty element can be exchanged without much effort. Test engines require temperature measurements at the most different points, e.g. in oilpans, cooling tubes and combustion gases, etc. Here, the cables coming from the different measuring points can be plugged into the connector conveniently. Advantage: Reduced wiring effort. In general the application makes sense, whenever there are many measuring points and far distances that have to be overcome.



8 miniature sockets in an aluminum housing



The photo shows an 8-plug connector used in automobile industry for example in test vehicles. Thermocouples can be easily connected.

CABLE VERSION 32 cores:

- ❑ PVC / PVC
- ❑ Besilen / Besilen
- ❑ FEP / FEP
- ❑ TPE / PUR
- ❑ other cable version _____

CABLE LENGTH: _____ m

CONNECTION ENDS:

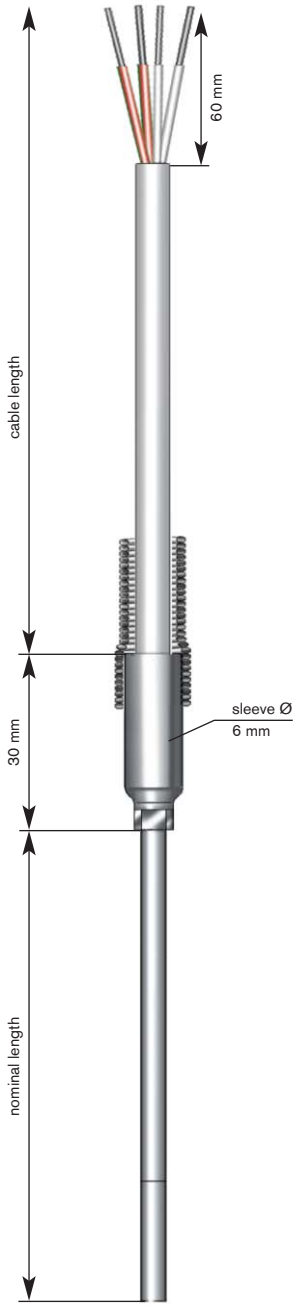
- ❑ miniature thermoplug 4-pole
- ❑ bare ends
- ❑ other cable ends _____

MINERAL INSULATED RESISTANCE THERMOMETER T505 with connection cable (article group T50x)

General Information

With a 2-wire circuit only one class accuracy class B accuracy can be confirmed.	
Material 1.4541	+ 800°C
Please note that the temperature stability of the sensor is determined by the weakest parameters.	

This temperature probe is versatile due to its design and high temperature resistance. With its slim design and flexible sheath material, the probe can even be installed in hardly reachable positions. Easy installation is ensured in conjunction with a clamping screw connection.



RTD:

- ❑ 1 x Pt 100
- ❑ 2 x Pt 100

LIMITING DEVIATION:

- ❑ class A
- ❑ class B
- ❑ -30°C / +300°C
- ❑ -50°C / +500°C
- ❑ -100°C / +450°C
- ❑ -196°C / +600°C

CONNECTION TYPES OF INNER WIRE:

- ❑ 2-wire circuit
- ❑ 3-wire circuit
- ❑ 4-wire circuit

SHEATH-Ø (stainless steel)**:**

- ❑ 1,6 mm
- ❑ 3,0 mm
- ❑ 4,5 mm
- ❑ other sheath-Ø _____

NOMINAL LENGTH: _____ mm

TYPE:

- ❑ with kink protection
- ❑ without kink protection

CONNECTION CABLE:

(see also survey of connecting cables for resistance thermometer page 33 and 34)

- ❑ TTL (PFA / PFA)
- ❑ other connection cable _____

CABLE LENGTH: _____ m

CONNECTION ENDS:

- ❑ bare ends
- ❑ endsleeves
- ❑ other cable ends _____
- ❑ cable lugs M4
- ❑ tinned

- ❑ with batch certificate and identification

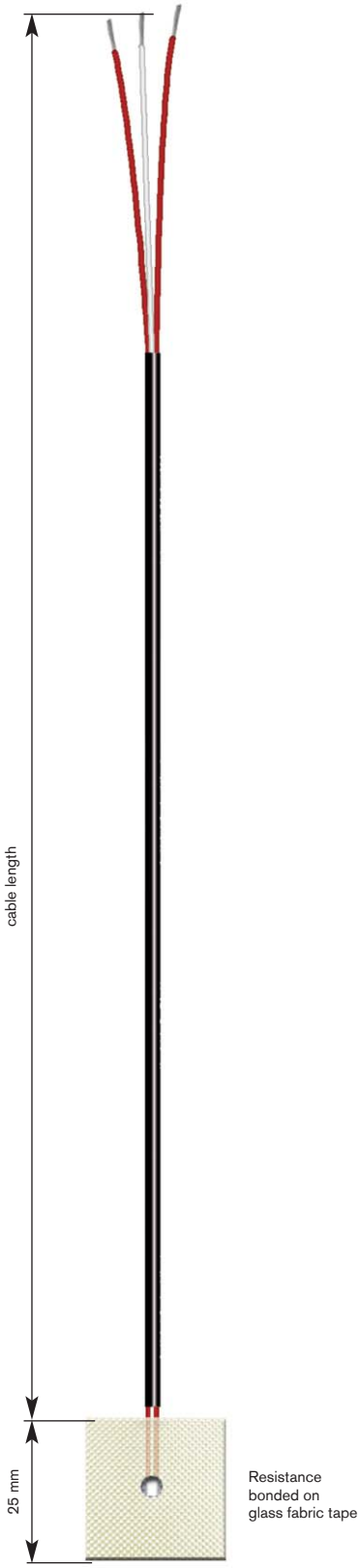
■ Class AA on request!

SELF-ADHESIVE SURFACE RESISTANCE THERMOMETER T630

General Information

Please note that the temperature stability of the sensor is determined by the weakest parameters.

It is especially appropriate for quick and uncomplicated temperature measurement. Advantage: No special preparation necessary at the measuring points. It only has to be paid attention to the fact that the surface is free of dust, grease and oils.



RTD:

❑ 1 x Pt 100 class B

CONNECTION TYPES OF INNER WIRE:

❑ 2-wire circuit ❑ 3-wire circuit ❑ 4-wire circuit

SIZE OF PAD (double layered):

❑ 25 x 25 mm (standard size)

❑ other size _____

CONNECTION CABLE:

(see also survey of connecting cables for resistance thermometer page 33 and 34)

❑ TTL (PFA / PFA)

❑ other connection cable _____

CABLE LENGTH: _____ m

CONNECTION ENDS:

❑ bare ends ❑ cable lugs M4

❑ endsleeves ❑ tinned

❑ other cable ends _____

Self-adhesive thermocouple in practical application

Self-adhesive thermocouples to measure the temperature at the sleeves of the drive shaft.

The data transmission is done by a telemetric device. Several self-adhesive thermocouples can be mounted in a space saving way without any problem.

- Different dimensions of the adhesive pad available
- Temperature resistance of the adhesive pad +230°C

AIRFLOW RESISTANCE THERMOMETER T870

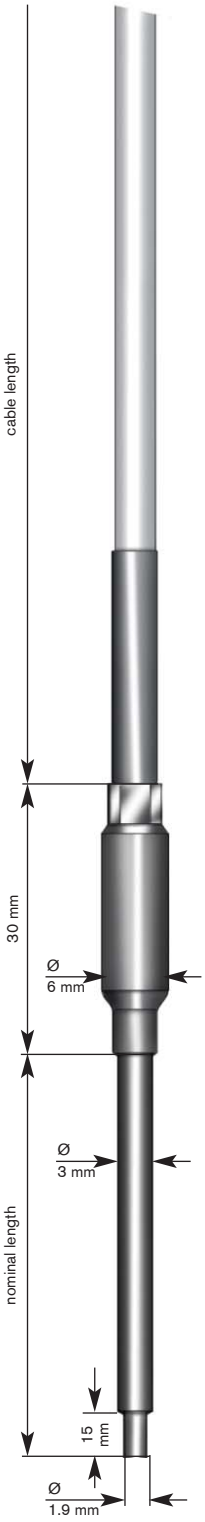
General Information

With a 2-wire circuit only one class accuracy class B accuracy can be confirmed.	
Material 1.4541	+ 800°C

Please note that the temperature stability of the sensor is determined by the weakest parameters.

Small measuring tip Ø garantees quick response times!

For temperature measurement, for example at engine test benches. Especially appropriate to collect the temperature of the airflow, for example in the turbocharger. The small diameter of the measuring tip guarantees a quick response time. The screening of the cable offers at the same time mechanical protection as well as protection against electromagnetic interference. Usually fixing can be done by clamping screw connections.



RTD:

- ❑ 1 x Pt 100
- ❑ 2 x Pt 100

LIMITING DEVIATION:

- ❑ class A
- ❑ class B
- ❑ -30°C / +300°C
- ❑ -50°C / +500°C
- ❑ -100°C / +450°C
- ❑ -196°C / +600°C

CONNECTION TYPES OF INNER WIRE:

- ❑ 2-wire circuit
- ❑ 3-wire circuit
- ❑ 4-wire circuit

NOMINAL LENGTH: _____ mm

TYPE:

- ❑ with kink protection
- ❑ without kink protection

CONNECTION CABLE:

(see also survey of connecting cables for resistance thermometer page 33 and 34)

- ❑ TTL (PFA / PFA)
- ❑ other connection cable _____

CABLE LENGTH: _____ m

CONNECTION ENDS:

- ❑ bare ends
- ❑ endsleeves
- ❑ other cable ends _____
- ❑ cable lugs M4
- ❑ tinned

❑ with batch certificate and identification

■ Class AA on request!

SCREW-IN RESISTANCE THERMOMETER T871

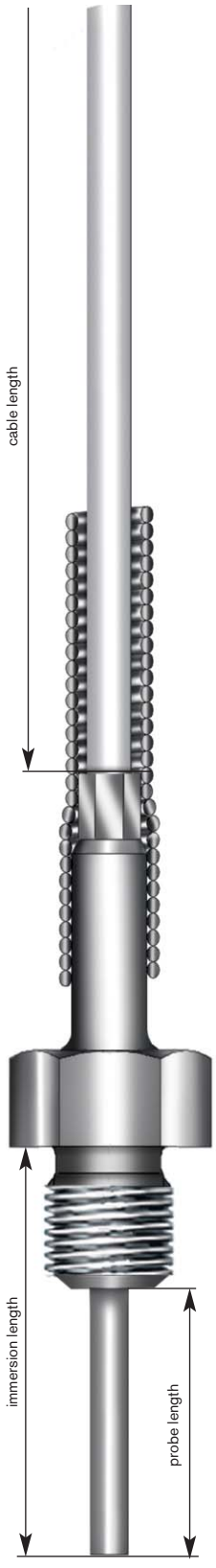
General Information

With a 2-wire circuit only one class accuracy class B accuracy can be confirmed.	
Material 1.4541	+ 800°C

Please note that the temperature stability of the sensor is determined by the weakest parameters.

Different threads possible on request!

For temperature measurement, for example at engine test benches. Especially appropriate to collect the temperature in the engine room, for example at the oil pressure switch or wherever the same thread is to be found.



RTD:

- ❑ 1 x Pt 100
- ❑ 2 x Pt 100

LIMITING DEVIATION:

- ❑ class A
- ❑ class B
- ❑ -30°C / +300°C
- ❑ -50°C / +500°C
- ❑ -100°C / +450°C
- ❑ -196°C / +600°C

CONNECTION TYPES OF INNER WIRE:

- ❑ 2-wire circuit
- ❑ 3-wire circuit
- ❑ 4-wire circuit

PROBE LENGTH: _____ mm

IMMERSION LENGTH: _____ mm

THREAD: _____

TYPE:

- ❑ with kink protection
- ❑ without kink protection

CONNECTION CABLE:

(see also survey of connecting cables for resistance thermometer page 33 and 34)

- ❑ TTL (PFA / PFA)
- ❑ other connection cable _____

CABLE LENGTH: _____ m

CONNECTION ENDS:

- ❑ bare ends
- ❑ endsleeves
- ❑ other cable ends _____
- ❑ cable lugs M4
- ❑ tinned

- ❑ with batch certificate and identification

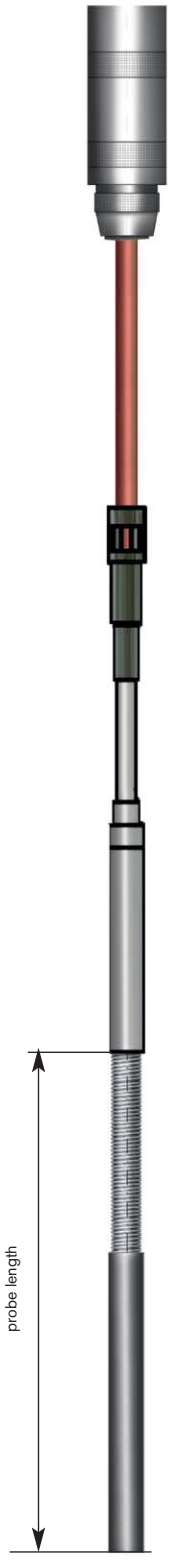
DIP STICK RESISTANCE THERMOMETER T861

General Information

With a 2-wire circuit only one class accuracy class B accuracy can be confirmed.

Especially appropriate for temperature measurement in engine oil!

This dipstick resistance thermometer is especially appropriate to collect the temperature in engine oil. The dipstick can easily be inserted instead of the normal oil dipstick. The adjustable fixing tightens the opening so that during operation the oil cannot penetrate. With the help of the fixing, the immersion length of the dipstick can be modified.



RTD:

- ❑ 1 x Pt 100
- ❑ 2 x Pt 100

LIMITING DEVIATION:

- ❑ class A
- ❑ class B
- ❑ -30°C / +300°C
- ❑ -50°C / +500°C
- ❑ -100°C / +450°C
- ❑ -196°C / +600°C

CONNECTION TYPES OF INNER WIRE:

- ❑ 2-wire circuit
- ❑ 3-wire circuit
- ❑ 4-wire circuit

NOMINAL LENGTH: _____ mm

FIXING ADJUSTABLE:

- ❑ for tightening-Ø 8 mm
- ❑ for tightening-Ø _____ mm

CONNECTION ENDS:

- ❑ bare ends
- ❑ Lemo socket
- ❑ other cable ends _____
- ❑ cable lugs M4
- ❑ Lemo plug

- ❑ with batch certificate and identification

- Due to the adjustable immersion depth, it can be applied for the most different engine types!
- Different tightening-Ø on request!!

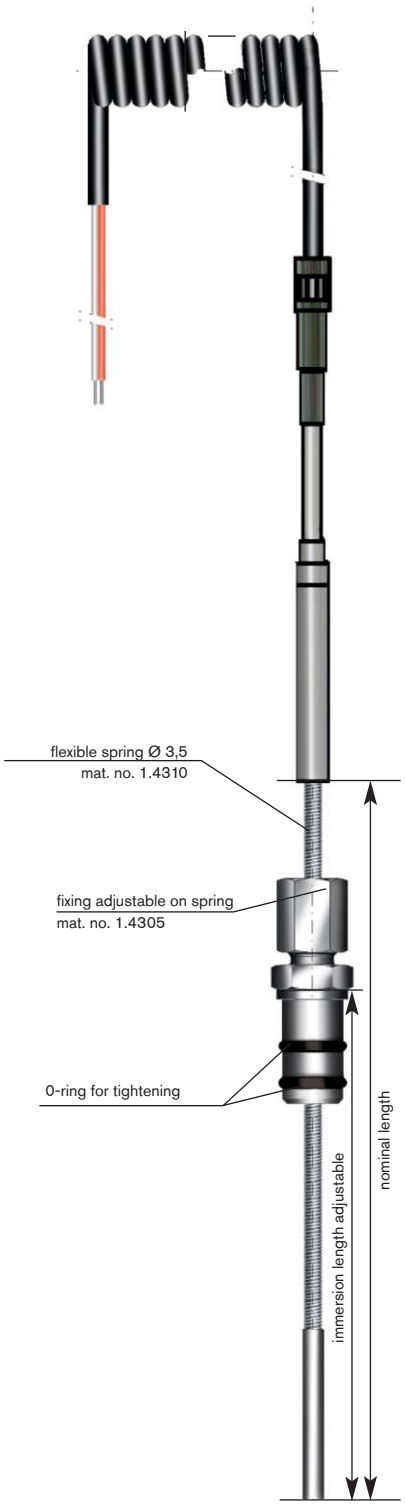
DIP STICK RESISTANCE THERMOMETER T862 with helix cable 4 x 0,14 mm² (+90°C)

General Information

With a 2-wire circuit only one class accuracy class B accuracy can be confirmed.

This dipstick resistance thermometer is especially appropriate to collect the temperature in engine oil. The dipstick can easily be inserted instead of the normal oil dipstick. The adjustable fixing tightens the opening so that during operation the oil cannot penetrate. With the help of the fixing, the immersion length of the dipstick can be modified.

An additional advantage of the spiral cable is that the element can be put into the required position in case of use and afterwards the cable contracts again like a spring.



RTD:

- ❑ 1 x Pt 100
- ❑ 2 x Pt 100

LIMITING DEVIATION:

- ❑ class A
- ❑ class B
- ❑ -30°C / +300°C
- ❑ -50°C / +500°C
- ❑ -100°C / +450°C
- ❑ -196°C / +600°C

CONNECTION TYPES OF INNER WIRE:

- ❑ 2-wire circuit
- ❑ 3-wire circuit
- ❑ 4-wire circuit

NOMINAL LENGTH: _____ mm

FIXING ADJUSTABLE:

- ❑ for tightening-Ø 8 mm
- ❑ for tightening-Ø _____ mm

CONNECTION ENDS:

- ❑ bare ends
- ❑ Lemo socket
- ❑ other cable ends _____
- ❑ cable lugs M4
- ❑ Lemo plug

- ❑ with batch certificate and identification

- Due to the adjustable immersion depth, it can be applied for the most different engine types!
- Different tightening-Ø on request!!

Lemo socket
for mineral insulated thermocouples and resistance thermometers

2-pole up to max. 200°C		
item no.	size	outer-Ø
T 021-011-146	0	0,64
T 021-011-147	0	1,0
T 021-009-083	1	1,5
T 021-000-600	1	3,0
T 021-011-149	1	4,5
T 021-011-152	2	6,0

4-pole up to max. 200°C		
item no.	size	outer-Ø
T 021-011-148	0	1,64
T 021-000-599	0	1,0
T 021-011-150	1	1,5
T 021-011-151	1	3,0
T 021-000-677	1	4,5
T 021-000-678	2	6,0

Lemo plug for cable connection

2-pole up to max. 200°C		
item no.	size	outer-Ø*
T 021-011-153	0	3,2
T 021-011-154	1	3,2
T 021-000-594	1	4,7
T 021-011-156	2	3,2
T 021-000-596	2	4,7
T 021-000-597	2	6,4

4-pole up to max. 200°C		
item no.	size	outer-Ø*
T 021-008-967	0	3,2
T 021-011-155	1	3,2
T 021-000-195	1	4,7
T 021-011-157	2	3,2
T 021-011-158	2	4,7
T 021-000-598	2	6,4

*outer-Ø of cable

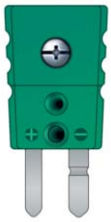
Cable tie		
item no.	identification	colour
T 098-033-194	standard up to +105°C	black
T 098-033-194	high-temperature up to +150°C	nature

Please note that not all types are available from stock and that there are possibly min. order quantities!

Thermo plug

Standard thermo plug up to max. 200°C	
item no.	min.t/c type
T 021-007-056	J (Fe-CuNi)
T 021-007-057	K (NiCr-Ni)

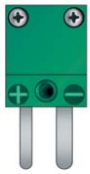
High-temp. thermo plug up to max. 350°C	
item no.	min.t/c type
T 021-007-064	J (Fe-CuNi)
T 021-007-065	K (NiCr-Ni)



Standard thermo socket up to max. 200°C	
item no.	min.t/c type
T 021-007-104	J (Fe-CuNi)
T 021-000-679	K (NiCr-Ni)

Miniature thermo plug up to max. 200°C	
item no.	min.t/c type
T 021-007-071	J (Fe-CuNi)
T 021-007-072	K (NiCr-Ni)

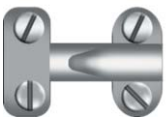
Miniature thermo socket up to max. 200°C	
item no.	min.t/c type
T 021-007-118	J (Fe-CuNi)
T 021-007-119	K (NiCr-Ni)



Cable fixing for:

Standard and high temperature plug
item no.
T 021-007-035

Miniature plug
item no.
T 021-007-041



Locking plate
item no.
T 021-029-182

Clamp screw connection made of steel 1.0718 for …

min.t/c ø mm	thread	with pressure ring made of PTFE item no.
1,5	M 8 x 1	T 025-007-148
2,0	M 8 x 1	T 025-007-151
3,0	M 8 x 1	T 025-000-681
4,5	G 1/4 A	T 025-007-157
6,0	G 1/4 A	T 025-000-685

Clamp screw connections made of steel 1.0718 for …

min.t/c ø mm	thread	with tapered ring made of stainless steel 1.4571 item no.
1,5	M 8 x 1	T 025-007-147
2,0	M 8 x 1	T 025-007-150
3,0	M 8 x 1	T 025-000-680
4,5	G 1/4 A	T 025-007-156
6,0	G 1/4 A	T 025-000-684

Clamp screw connections made of stainless steel 1.4571 for …

min.t/c ø mm	thread	with pressure ring made of PTFE item no.
1,5	M 8 x 1	T 025-007-146
2,0	M 8 x 1	T 025-007-149
3,0	M 8 x 1	T 025-007-153
4,5	G 1/4 A	T 025-007-155
6,0	G 1/4 A	T 025-007-160

Clamp screw connections made of stainless steel 1.4571 for …

min.t/c ø mm	thread	with tapered ring made of stainless steel 1.4571 item no.
1,5	M 8 x 1	T 025-007-145
3,0	M 8 x 1	T 025-007-152
4,5	G 1/4 A	T 025-007-154
6,0	G 1/4 A	T 025-007-159

Please note that not all types are available from stock and that there are possibly min. order quantities!

Note:
Clamp screw connections with a thrust collar made of PTFE are appropriate for temperature up to +200°C and for pressures up to 10 bar. Later loosening and moving is possible.

Clamp screw connections with a tapered ring made of steel or stainless steel are appropriate for temperature above + 200°C and for pressures up to 40 bar. By tightening the screw connection,
the tapered ring is fixed on the tube and can't be loosened anymore. Therefore, later loosening isn't possible at all.

Clamp screw connection made of stainless steel with clamping cone PTFE

MTE ø mm	thread	width across flat	item no.	clamping cone in exchange item-no.
1,0	M 6 x 1	10	T025-050-911	T025-050-912
1,5	M 6 x 1	10	T025-041-015	T025-050-913
1,5	M 8 x 1	10	T025-044-648	T025-048-577
1,5	M 8 x 1,25	10	T025-041-016	T025-041-402
2,0	M 8 x 1	10	T025-046-947	auf Anfrage
3,0	M 8 x 1	10	T025-044-649	T025-048-578
3,0	M 8 x 1,25	10	T025-041-017	T025-041-403

Pressure resistance for clamp screw connection with clamping cone PTFE: up to approx. 10 bar max. application up to +200°C

Clamp screw connection made of stainless steel with clamping cone stainless steel

MTE ø mm	thread	width across flat	item no.	clamping cone in exchange item-no.
1,0	M 6 x 1	10	T025-048-328	T025-048-329
1,0	M 8 x 1	10	T025-046-946	T025-048-329
1,5	M 6 x 1	10	T025-041-404	T025-050-914
1,5	M 8 x 1	10	T025-044-647	T025-049-313
1,5	M 8 x 1,25	10	T025-041-019	T025-049-313
2,0	M 8 x 1	10	T025-046-945	T025-048-323
2,0	M 12 x 1,5	17	T025-048-324	T025-048-325
2,0	M 14 x 1,5	17	T025-048-326	T025-048-327
3,0	M 8 x 1	10	T025-044-646	T025-049-150
3,0	M 8 x 1,25	10	T025-041-018	T025-049-150

Pressure resistance for clamp screw connection with clamping cone stainless steel: up to approx. 200 bar max. application up to +600°C

Other dimension are possible on request!
Each clamp screw connection includes a clamping cone in delivery.

1. Temperature as measured variable

For nearly all procedures in research and production, temperature is a factor to be considered. It is of considerable importance as measured variable. For temperature measurements, temperature dependent characteristics of materials can be used, as for example the changing electrical resistance (resistance thermometer), the electromagnetic radiation of hot bodies (radiation pyrometer) and resulting thermoelectric voltage (thermocouple). The different electric contact thermometers are frequently used for the field temperature measurement.

2. Physical basis

2.1. Resistance thermometer

Temperature measurement with the help of resistance thermometers base on the special characteristic of conducting materials to change their resistance dependent on temperature. For metals the resistance increases with rising temperature. In case that the correlation between temperature and resistance is known, the temperature can be determined by resistance measurement. The suggestion to use the temperature dependent resistance of metal conductors for temperature measurement, was first made by Wilhelm von Siemens, the brother of Werner von Siemens in 1861 and was realized in the development of a thermometer for the measurement of deep sea temperatures. The works of H.L. Callendar made the resistance thermometer a precision device in 1886.

2.2. Thermocouples

The first basis of the thermovoltage effect was discovered by Seebeck in 1821. Thirty years later the exact correlations were found out by Thompson. The thermovoltage between 2 different metals depend on the thermal motion of electrons. It is not dependent on the absolute temperature values, but on temperature differences. The higher the temperature difference between "hot" and "cold", the higher the thermovoltage. The voltage at 1 degree Celsius is called the thermoelectric force of the thermocouple. It depends on the nature of the two materials whose connection point is heated.

3. The response time of contact thermometers

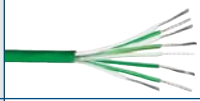
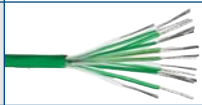
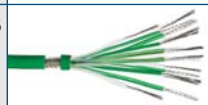
The temperature measurement with the help of contact thermometers is generally afflicted with a delayed indication. The result is that a changing temperature is not immediately indicated correctly but only after a certain time when the heat exchange between the measured medium and the temperature probe has been fully realized. This inertia of thermometers shall be as small as possible for certain measuring tasks. This is called the response time of a thermometer which means generally the time constant. Generally spoken: the time constant corresponds to the relation of the capacity of heat absorption and heat release of the thermometer. Both characterisitics are mainly determined by:

- heat capacity
- transversal thermal conductivity of the thermometer
- relation of surface to volume of the thermometer
- coefficient of thermal conductivitiy between medium and surface of the thermometer as well as of the medium velocity, its thermal conductivity and its specific heat.

If a thermometer is suddenly exposed to another temperature, as for example by taking it out of water with a temperature of +20°C and putting it into water of +40°C, the indicated temperature rises almost according to the exponential function. The usual quantity for the changing velocity of such exponential procedures is the time constant. The time constant is equal to the time that passes until 63,2% of the temperature leap is indicated. In many cases, the temperature indication does not change according to the exponential function. For those cases the time constant is not sufficient to characterise the time response. Therefore it is useful to indicate the half-time z 0.5 and the 9/10 time value z 0.9. This is the definition of time from the sudden change of temperature to the reach of 50% either 90% of this temperature change. The exponential course shows z 0.5 = 0.693 (time constant) resp. z 0.9 = 2.303 (time constant) and the ratio z 0.9/z 0.5 has to be equal to 3.32.

SAB item no.	Picture	Cable type	T/C type	Insu-lation	Section	Cond.	Form	Outer-Ø	Temp.-range of insulation	thermoelectric voltage
fibre-glass insulated thermo-cables (wire)										
0489-9002		thermo-cable	type K	GL/GL	2 x 0,2 mm	wire	oval	approx. 0,8 x 1,3 mm	flexible: -25°C up to +200°C fixed: -25°C up to +200°C	DIN IEC 584 class 1, tolerance +/- 1,5°C
0489-2144		thermo-couple-cable	type K	GL/GL	2 x 0,5 mm	wire	oval	approx. 1,9 x 1,1 mm	flexible: -40°C up to +250°C fixed: -40°C up to +250°C	DIN IEC 584 class 1
0489-9003		thermo-cable	type K	GL/GL	2 x 0,8 mm	wire	oval	approx. 2,5 x 1,4 mm	flexible: -25°C up to +200°C fixed: -25°C up to +200°C	DIN IEC 584 class 1
0490-9016		thermo-couple-cable	type K	GL/GL	2 x 0,5 mm	wire	oval	approx. 2,0 x 1,2 mm	flexible: max. +400°C fixed: max. +400°C	DIN IEC 584 class 1
polyimide insulated thermo-cables (wire)										
0433-9138		thermo-couple-cable	type K	KN-polyimide KP-blank/ polyimide	2 x 0,2 mm	wire	oval	approx. 0,9 x 0,5 mm	flexible: -40°C up to +250°C fixed: -40°C up to +250°C	DIN IEC 584 class 1, tolerance +/- 1,5°C
0433-9186		thermo-couple-cable	type K	KN-polyimide KP-blank/ polyimide	2 x 0,2 mm	wire	oval	approx. 0,7 x 0,5 mm	flexible: -40°C up to +250°C fixed: -40°C up to +250°C	DIN IEC 584 class 1, tolerance +/- 1,5°C
0433-9149		thermo-couple-cable	type K	polyimide + PTFE/ polyimide	2 x 0,3 mm	wire	oval	approx. 0,9 x 1,7 mm	flexible: -40°C up to +250°C fixedt: -40°C up to +250°C	DIN IEC 584 class 1, tolerance +/- 1,5°C
0433-9168		thermo-couple-cable	type K	KN-polyimide KP-PTFE/ polyimide	2 x 0,2 mm	wire	oval	approx. 1,0 x 0,8 mm	flexible: -40°C up to +250°C fixed: -40°C up to +250°C	DIN IEC 584 class 1
polyimide/PFA insulated thermo-cables (wire)										
0433-9196		thermo-couple-cable	type K	KN-polyimide KP blank/ polyimide/ PFA	2 x 0,2 mm	wire	round	max. 1,0 mm	flexible: -40°C up to +250°C fixed: -40°C up to +250°C	DIN IEC 584 class 1
FEP insulated thermo-cables (wire)										
0433-9152		thermo-couple-cable	type K	FEP/FEP	2 x 0,2 mm	wire	oval	approx. 1,7 x 1,1 mm	flexible: -40°C up to +180°C fixed: -40°C up to +180°C	DIN IEC 584 class 1
TPE insulated thermo-cable (strands)										
0433-9177		thermo-couple-cable	type K	TPE/TPE	2 x 0,2 mm²	strands	round	approx. 3,0 mm	flexible: -40°C up to +90°C fixed: -40°C up to +90°C	DIN IEC 584 class 1
FEP/Besilen® insulated thermo-cables (strands)										
0433-9193		thermo-cable	type K	FEP/FEP/ Bi	2 x 0,2 mm²	strands	round	approx. 3,8 mm	flexible: -25°C up to +180°C fixed: -40°C up to +180°C	DIN IEC 584 class 2

SURVEY COMPENSATING AND EXTENSION CABLES AS WELL AS CONNECTION CABLES FOR RESISTANCE THERMOMETERS

SAB item no.	Picture	Cable type	T/C type	Insu-lation	Section	Cond.	Form	Outer-Ø	Temp.-range of insulation	thermoelectric voltage
FEP/Besilen® connection cables for resistance thermometers (strands)										
0470-9224		connection cable	tinned copper strand. copper figure: 2,7 kg/km	FEP/Bi	2 x 0,14 mm²	strands	round	approx. 2,8 mm	flexible: -25°C up to +180°C fixed: -40°C up to +180°C	
0470-0423		connection cable	tinned copper strand. copper figure: 8,4 kg/km	FEP/Bi	4 x 0,22 mm²	strands	round	approx. 3,9 mm	flexible: -25°C up to +180°C fixed: -40°C up to +180°C	
3833-9132		connection cable	tinned copper strand. copper figure: 19,3 kg/km	FEP/C/ FEP	4 x 0,22 mm²	strands	round	approx. 3,0 mm	flexible: -55°C up to +180°C fixed: -90°C up to +180°C	
FEP insulated thermo-cables (strands)										
0433-9240		thermo-couple-cable	type K	FEP	2 x 0,20 mm	wire	round	approx. 1,0 mm	flexible: -25°C up to +180°C fixed: -25°C up to +180°C	DIN IEC 584, class 1
0433-9157		thermo-cable	type K	FEP/FEP	2 x 0,22 mm²	strands	flat	approx. 2,5 x 1,5 mm	flexible: -25°C up to +180°C fixed: -25°C up to +180°C	DIN IEC 584, tolerance +/- 1°C
0433-9223		thermo-cable	type K	FEP/FEP	2 x 0,22 mm²	strands	oval	approx. 2,5 mm	flexible: -25°C up to +180°C fixed: -25°C up to +180°C	DIN IEC 584, tolerance +/- 1°C
0433-9154		thermo-cable	type K	FEP/FEP	8 x 2 x 0,22 mm² twisted pair	strands	round	approx. 6,4 mm	flexible: -25°C up to +180°C fixed: -25°C up to +180°C	DIN IEC 584 class 2
0435-9129		thermo-cable	type K	FEP/C/ FEP	8 x 2 x 0,22 mm² twisted pair	strands	round	approx. 6,9 mm	flexible: -25°C up to +180°C fixed: -25°C up to +180°C	DIN IEC 584 class 2
0433-9135		thermo-cable	type K	FEP/FEP	16 x 2 x 0,22 mm² twisted pair	strands	round	approx. 7,7 mm	flexible: -25°C up to +180°C fixed: -25°C up to +180°C	DIN IEC 584 class 2
0435-9135		thermo-cable	type K	FEP/C/ FEP	16 x 2 x 0,22 mm² twisted pair	strands	round	approx. 8,3 mm	flexible: -25°C up to +180°C fixed: -25°C up to +180°C	DIN IEC 584 class 2
0435-9085		thermo-couple-cable	type K	FEP-F-ZF-D(B)-FEP/F-C (B)-FEP	8 x (2 x 0,5 mm)D	strands	round	approx. 11,0 mm	flexible: -55°C up to +180°C fixed: -90°C up to +180°C	DIN IEC 584 class 1
FEP insulated thermo-cables with screening (strands)										
0435-9037		thermo-cable	type K	FEP/C/ FEP	2 x 0,22 mm²	strands	round	approx. 2,6 mm	flexible: -25°C up to +180°C fixed: -25°C up to +180°C	DIN IEC 584, tolerance +/- 1,5°C
Besilen® insulated thermo-cables (strands)										
0451-9019		thermo-cable	type K	GL/ Silicone	2 x 0,22 mm²	strands	round	approx. 3,2 mm	flexible: -25°C up to +200°C fixed: -25°C up to +200°C	DIN IEC 584 class 1

COMPARISON THERMOCOUPLES / RESISTANCE THERMOMETERS

Resistance thermometers

- Platinum resistance thermometers are the most accurate sensors and have the best long-time stability.

  Due to the chemical resistance of Platinum, the risk of impurity by oxidation and other chemical influences is reduced.
- High consistency.

Thermocouples

- Larger temperature range than resistance thermometers.
- Small hot junction enables short response time.
- More robust and resistant against mechanical stress.
- Cheaper.

General:

A reliable temperature measurement requires a most exact adaptation to the corresponding process. This statement is valid for thermocouples as well as for resistance thermometers.

Characteristics	Resistance thermometer	Thermocouples
dimensions	comparatively large sensor surface	small sensor surface possible
response time	relatively long	short
connection cables	copper cables	thermo compensating cable
accuracy	very good	good
consistency	very good	satisfactory
surface temperature measurement	not possible	possible
hot junction	over the whole length of the RTD	punctual
robustness	good	very good
spontaneous heating	has to be considered	does not occur
temperature range	up to +600°C	higher temperature possible
cold junction	not necessary	necessary
circuit supply	yes	no
vibration resistance	relatively sensitive	very rugged

■ Mineral insulated thermocouples

Insulated hot junction	Response time in			
(form A) sheath- Ø (mm)	water with 0,2 m/s t 0,5 (s)	t 0,9 (s)	air with 2,0 m/s t 0,5 (s)	t 0,9 (s)
0,5	0,06	0,13	1,80	5,50
1,0	0,15	0,50	3,00	10,00
1,5	0,21	0,60	8,00	25,00
3,0	1,20	2,90	23,00	80,00
4,5	2,50	5,90	37,00	120,00
6,0	4,00	9,60	60,00	200,00
8,0	7,00	17,00	100,00	360,00
Welded hot junction	**Response time in**			
(form B) sheath- Ø (mm)	water with 0,2 m/s t 0,5 (s)	t 0,9 (s)	air with 2,0 m/s t 0,5 (s)	t 0,9 (s)
0,5	0,03	0,10	1,80	6,00
1,0	0,06	0,18	3,00	10,00
1,5	0,13	0,40	8,00	25,00
3,0	0,22	0,75	23,00	80,00
4,5	0,45	1,60	33,00	110,00
6,0	0,55	2,60	55,00	185,00
8,0	0,75	4,60	97,00	310,00

■ Mineral insulated resistance thermometer

Sheath-ø (mm)	Response time in			
	water with 0,2 m/s t 0,5 (s)	t 0,9 (s)	air with 2,0 m/s t 0,5 (s)	t 0,9 (s)
1,6	3,6	5,5	10,8	26,3
3,0	5,2	9,8	20,0	51,0
6,0	10,4	23,2	46,8	121,0

These indications are only reference values as the response time depends on the applied RTD.

■ General:

Mineral insulated thermocouples and mineral insulated resistance thermometers can be bent with a radius of 5 x the outer diameter of the sheath material. Herewith it must be considered that any bending of the measuring tip over a length of 60 mm has to be avoided.

Test certificates:

We offer test reports or test certificates acc. to DIN EN 10204.

1. Test certificate acc. to DIN EN 10204-2.1 **charge: 18.00 Euro**

Certificate in which the manufacturer confirms that the delivered goods correspond to the requirements of the order without indicating any test results.

2. Test certificate acc. to DIN EN 10204-2.2 (batch certificate) **charge: 23.00 Euro**

Certificate in which the manufacturer confirms that the delivered goods correspond to the requirements of the order by indicating results of not specific tests.

3. Inspection certificate acc. to DIN EN 10204-3.1 **charge: 29.00 Euro**

Certificate in which the manufacturer confirms that the delivered goods correspond to the requirements of the order by indicating test results. **plus charge for tests acc. to the following list**

The test unit and the execution of the test are determined in the product specification, in official or technical prescriptions and/ or order. The certificate is confirmed by a person independent of production and named by the manufacturer.

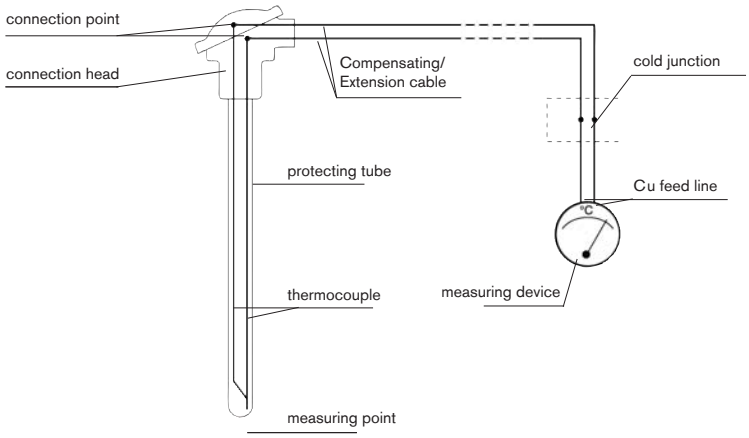
List of individual tests	
Calibration in „Kyrostat" bath:	
Temperature range -50°C up to +50°C	
Basic price	12,10 Euro
Unit price for each test piece and measuring point	4,00 Euro
Calibration in oil bath:	
Temperature range +60°C up to +200°C	
Basic price	12,10 Euro
Unit price for each test piece and measuring point	4,00 Euro
Calibration in AMETEK Trockenblock-Kalibrator:	
Temperature range +50°C up to +320°C, +300°C up to +1205°C	
Basic price	12,10 Euro
Unit price for each test piece and measuring point	4,00 Euro
Response time in water:	
Determination of 0,1-time, 0,5-time and 0,9-time	
Basic price	16,10 Euro
Unit price for each test piece	5,80 Euro
Response time in air:	
Determination of 0,1-time, 0,5-time and 0,9-time	
Basic price	16,10 Euro
Unit price for each test piece	8,00 Euro

Temperature is an important factor in many areas concerning the environment, scientific research and production. It is a thermo-dynamic variable that defines the heat content of a material. Material strength changes with alternating temperature. As a consequence, the characteristics of materials have to be examined at different temperatures. To obtain a temperature value, defined temperature parameters are used. Here the parameters can be defined, for example, as the freezing and boiling points of water.

For temperature measurement temperature dependent characteristics of materials have to be taken into account. These include such things as thermal expansion (expansion thermometer), the dependance of the electric resistance of metallic conductors (electrical thermometer) and electromotive force (thermocouple) etc.. A temperature measuring device with a thermocouple as a data indicator tends to consist of the thermometer itself with a measuring point, an extension cable, a cold junction with a specified constant temperature and a voltmeter.

The value of the electromotive force (EMF) produced by the thermocouple is determined by the difference between the measuring temperature and the so-called free ends of the thermocouple which are mounted in the connection head. As the connection head is usually relatively close to the measuring point, it is frequently exposed to temperature fluctuations. For this reason, a connection cable with the same thermo-electric properties as the thermocouple is used between the thermocouple and the cold junction.

Sketch



Materials

We differentiate between thermocouple cable and compensating cable. Cables made of original materials are called extension or thermocouple cables, whereas conductor materials made of substitutes are known as compensating cables.

Compensating cables

The compensating wires and strands are composed of alloys which do not have to be identical with the corresponding thermocouple. Substitute material means that the thermo-electric characteristics in the allowed temperature range (usually 0 up to +200°C) for the compensating cable must be the same as those of the corresponding thermocouple. They are identified with the letter "C" adapted to DIN IEC 584. The "C" appears behind the code letter identifying the thermocouple, for example "KC".

Extension cables

Extension cables are made of conductors with identical nominal structure to the corresponding thermocouple. They are identified with the letter "X" adapted to DIN IEC 584 which appears behind the code letter identifying the thermocouple, for example "JX". They are normally tested within a temperature range of 0 up to +200°C.

Thermocouple cables

Thermocouple cables consist of the same element material as the thermocouple and are tested for the same temperatures. These SAB special cables are manufactured on customer request. PVC, fibre-glass and SABtex insulated or sheathed compensating and extension cables are not suitable for outdoor use. Exception: PVC sheathed solid conductors can be used for underground laying.

Cables for resistance thermometers

Cables with copper conductors have to be laid between thermometer and measuring device. In order to keep faults by cable resistances and their temperature dependent fluctuations as small as possible, an appropriate cable section has to be chosen. Resistance thermometers are manufactured in 2-, 3-, and 4-wire circuit dependent on the required accuracy. By choosing the wire circuit it has to be considered that the cable resistance fully affects the measuring result.

The cables have to be chosen that they are appropriate for their environment that means that they resist against thermal, mechanical and chemical influences. All cable contacts have to be well done. Measuring cable shall be laid > 0,5 m away from any energy cable. In order to suppress electromagnetic or magnetic interferences, the cables shall be screened and have twisted pairs.

BASIC VALUES OF THERMOELECTRIC VOLTAGE IN mV

tempe-rature t 90/°C	type K	type L	type J	type U	type T	type E	type N	type S	type R	type B
	+NiCr -Ni	+Fe -CuNi	+Fe -CuNi	+ECu -CuNi	+ECu -CuNi	+NiCr -CuNi	+NiCrSi -NiSi	+PtRh 10 -Pt	+PtRh 13 -Pt	+PtRh 30 -PtRh 6
	DIN EN 60584	(1)DIN 43710	DIN EN 60584	(1)DIN 43710	DIN EN 60584	DIN EN 60584	DIN EN 60584	DIN EN 60584	DIN EN 60584	DIN EN 60584
-100	-3,554	-4,75	-4,633	-3,40	-3,379	-5,237	-2,407	-	-	-
0	0	0	0	0	0	0	0	0	0	0
100	4,096	5,37	5,269	4,25	4,279	6,319	2,774	0,646	0,647	0,033
200	8,138	10,95	10,779	9,20	9,288	13,421	5,913	1,441	1,469	0,178
300	12,209	16,56	16,327	14,90	14,862	21,036	9,341	2,323	2,401	0,431
400	16,397	22,16	21,848	21,00	20,872	28,946	12,974	3,259	3,408	0,787
500	20,644	27,85	27,393	27,41	-	37,005	16,748	4,233	4,471	1,242
600	24,905	33,67	33,102	34,31	-	45,093	20,613	5,239	5,583	1,972
700	29,129	39,72	39,132	-	-	53,112	24,527	6,275	6,743	2,431
800	33,275	46,22	-	-	-	61,017	28,455	7,345	7,950	3,154
900	37,326	53,14	-	-	-	68,787	32,371	8,449	9,205	3,957
1000	41,276	-	-	-	-	76,373	36,256	9,587	10,506	4,834
1100	45,119	-	-	-	-	-	40,087	10,757	11,850	5,780
1200	48,838	-	-	-	-	-	43,846	11,951	13,228	6,786
1250	50,644	-	-	-	-	-	45,694	12,554	13,926	7,311
1300	52,410	-	-	-	-	-	47,513	13,159	14,629	7,848
1400	-	-	-	-	-	-	-	14,373	16,040	8,956
1450	-	-	-	-	-	-	-	14,978	16,746	9,524
1500	-	-	-	-	-	-	-	-	-	10,099
1600	-	-	-	-	-	-	-	-	-	11,263
1700	-	-	-	-	-	-	-	-	-	12,433

(1) Since April 1994 the standard DIN 43710 is no longer valid

Thermoelectric voltage in mV with reference to a cold junction temperature of 0°C.

Ø-TOLERANCES OF MINERAL INSULATED THERMOCOUPLES / THERMOCOUPLE TYPES FORM A, FORM B

Table 1: tolerance of outer- Ø	
outer –Ø of cable	nominal value +/- limit dimensions
0,5 mm	+/- 0,025 mm
1,0 mm	+/- 0,025 mm
1,5 mm	+/- 0,025 mm
2,0 mm	+/- 0,025 mm
3,0 mm	+/- 0,030 mm
4,5 mm	+/- 0,045 mm
6,0 mm	+/- 0,060 mm
8,0 mm	+/- 0,080 mm

Thermocouple types form A / form B:

Mineral insulated thermocouples listed in this catalogue are according to DIN EN 61515 with regard to shape, construction and geometrical dimensions or refer to it. Regarding the basic values and tolerances the standards DIN EN 60584-1 and DIN EN 60584-2 are valid.
We furnish mineral insulated thermocouples with insulated hot junction (form A) as standard version acc. to DIN EN 61515

Form A – ungrounded mineral insulated thermocouple

- The measuring tip isn't directly welded to the bottom.

We also manufacture grounded mineral insulated thermocouples (form B) acc. to DIN EN 61515 on customer' s request.

Form B – grounded mineral insulated thermocouple

- The measuring tip is electrically connected to the sheath.

Mineral insulated thermocouples keep the given min. insulation resistance acc. to DIN EN 61515 of ≥1000 MΩ at room temperature.

TOLERANCES OF THERMOCOUPLES

			class 1		class 2		class 3	
type	standard	maretial	temperature range	(2) limit deviation	temperature range	(2) limit deviation	temperature range	(2) limit deviation
T	DIN EN 60584	Cu-CuNi	-40 up to +350°C	±0,5°C or 0,40%	-40 up to +350°C	±1,0°C or 0,75%	-200 up to +40°C	±1,0°C or 1,5%
(1)U	DIN 43710	Cu-CuNi	-	-	0 up to +600°C	±3°C or 0,75%	-	-
J	DIN EN 60584	Fe-CuNi	-40 up to +750°C	±1,5°C or 0,40%	-40 up to +750°C	±2,5°C or 0,75%	-	-
(1)L	DIN 43710	Fe-CuNi	-	-	0 up to +900°C	±3°C or 0,75%	-	-
K	DIN EN 60584	NiCr-Ni	-40 up to +1000°C	±1,5°C or 0,40%	-40 up to +1200°C	±2,5°C or 0,75%	-200 up to +40°C	±2,5°C or 1,5%
E	DIN EN 60584	NiCr-CuNi	-40 up to +800°C	±1,5°C or 0,40%	-40 up to +900°C	±2,5°C or 0,75%	-200 up to +40°C	±2,5°C or 1,5%
N	DIN EN 60584	NiCrSi-NiSi	-40 up to +1000°C	±1,5°C or 0,40%	-40 up to +1200°C	±2,5°C or 0,75%	-200 up to +40°C	±2,5°C or 1,5%
S	DIN EN 60584	PtRh 10-Pt	0 up to +1600°C	±1,0°C or (3)	0 up to +1600°C	±1,5°C or 0,25%	-	-
R	DIN EN 60584	PtRh13-Pt	0 up to +1600°C	±1,0°C or (3)	0 up to +1600°C	±1,5°C or 0,25%	-	-
B	DIN EN 60584	PtRh30-PtRh6	-	-	+600 up to +1700°C	±1,5°C or 0,25%	+600 up to +1700°C	±4,0°C or 0,5%

Classes 1, 2, and 3 are valid for thermocouples.
(1) Since April 1994 the standard DIN 43710 is no longer valid.
(2) For the limit deviation, the higher value is valid.
(3) 1°C or [1 + (t - 1100) x 0,003] °C

CHARACTERISTICS OF THERMOCOUPLES

characteristics / thermocouples	general	composition	tempera-ture range	suitable application	unsuitable application
type E	base metal thermocouple NiCr -CuNi (nickel-chrome/ copper-nickel) single wires made of non precious metals	**EP-leg:** 89-90% nickel, 9-9,5% chrome, 0,5% silicium and iron balance: C, Mn, Nb, Co **EN-leg:** 55% copper, 45% nickel approx. 0,1%, cobalt, iron and manganese	-200°C/+700°C	▶ in pure, oxidizing (air) or neutral atmosphere (inert gases) ▶ high resistance against corrosion ▶ small thermal conductivity	▶ not sulphuric, reducing or alternately oxidizing and reducing atmosphere ▶ do not apply in vacuum for a long time
type J	base metal thermocouple Fe - CuNi (iron/copper-nickel) single wires made of non precious metals	**JP-leg:** 99,5% iron, approx. 0,25% manganese, approx. 0,12% copper, balance: other impurities **JN-leg:** 55% copper, 45% nickel approx. 0,1%, cobalt, iron and manganese	-180°C/+700°C	▶ from 0 - +760°C in vacuum, oxidizing (air), reducing or inert atmosphere (inert gases)	▶ temperatures below 0°C ▶ sulphurous atmosphere above +500°C ▶ above +760°C only with bigger wire diameters
type K	base thermocouple NiCr - NiAl (nickel-chrome/ nickel-aluminium) single wires made of non precious metals	**KP-leg:** 89-90% nickel, 9-9,5% chrome, 0,5% silicium and iron, balance: C, Mn, Nb, Co **KN-leg:** 95-96% nickel, 1-1,5% silicium, 1-2,3% aluminium, 1-3,2% manganese, 0,5% cobalt, balance: Fe, Cu, Pb	-270°C/+1372°C	▶ from +250°C - +1260°C in pure, oxidizing (air) and neutral atmosphere (inert gases) ▶ for higher temperatures bigger wire diameters are recommended	▶ between +250°C up to +600°C not suitable for exact measurements with quick temperature changes ▶ not appropriate for a longer time with high temperatures in vacuum ▶ do not apply with high temperatures in sulphurous, reducing or alternately oxidizing and reducing atmoshere without protection ▶ do not use in atmosphere favourizing "green mould"
type L	base thermocouple Fe - CuNi (iron/copper-nickel) single wires made of non precious metals	**LP-leg:** 99,5% iron, approx. 0,25% manganese, ap-prox. 0,12% copper, ballance: other impurities **LN-leg:** 55% copper, 45% nickel, approx. 0,1% cobalt, iron and manganese	0°C/+900°C	▶ from 0°C - +760°C in vacuum, oxidizing (air), reducing or inert atmosphere (inert gases) ▶ above +500°C bigger wire diameters are recommended	▶ temperatures below 0°C ▶ sulphurous atmosphere above +500°C ▶ above +760°C only with bigger wire diameters
type N	base thermocouple NiCrSi - NiSi (nickel-chrome-silicium/ nickel-silicium-magnesium) single wires made of non precious metals	**NP-leg:** 84% nickel, 14-14,4% chrome, 1,3-1,6% silicium, ballance (not more than 0,1%): Mn, Fe, C, Co **NN-leg:** 95% nickel, 4,2-4,6% silicium, 0,5-1,5% magnesium, ballance: Fe, Co, Mn, C, (altogether 0,1-0,3%)	-270°C/+1300°C	▶ from +300°C - +1260°C in pure, oxidizing (air) and neutral atmosphere (inert gases)	▶ do not use with high temperatures in sulphurous, reducing or alternately oxidizing and reducing atmosphere without protection ▶ do not use with high temperatures in vacuum ▶ do not use in atmosphere faviourizing "green mould" ▶ reducing atmosphere
type R	base thermocouple Pt13%Rh - Pt (platinum 13% rhodium/platinum) single wires made of platinum and platinum - rhodium alloy	**RP-leg:** platinum with 99,99% purity with a rhodium alloy (purity 99,98%) 13±0,05% rhodium portion **RN-leg:** platinum with 99,99% purity	-50°C/+1768,1°C (melting point) recommended: up to +1300°C	▶ pure, oxidizing atmosphere (air), non aggresive (inert-) gases and short-term in vacuum ▶ above +1200°C type B more appropriate	▶ reducing atmosphere ▶ metal gases (for example plomb or zinc) ▶ agressive vapours containing arsenic, phosphor or sulphur ▶ do never use metal protecting tubes with higher temperatures ▶ sensitive against impurities of impure metals
type S	base thermocouple Pt10%Rh - Pt (platinum 10%Rhodium/platinum). single wires made of platinum and platinum - rhodium alloy	**SP-leg:** platinum with 99,99% purity with a rhodium alloy (purity 99,98%) 10±0,05% rhodium portion **SN-leg:** platinum with 99,99% purity	-50°C/+1768,1°C (melting point) recommended: up to +1300°C	▶ pure, oxidizing atmospheres (air), non agressive (inert-) gases and short-term in vacuum ▶ above +1200°C type B more appropriate	▶ reducing atmosphere ▶ metal gases (for example plomb or zinc) ▶ agressive vapours containing arsenic, phosphor or sulphur ▶ do never use metal protecting tubes with higher temperatures ▶ sensitive against impurities of impure metals
type B	base thermocouple (Pt30%Rh - Pt6%Rh platinum - 0% rhodium/ platinum-6% rhodium) single wires made of platinum and platinum - rhodium alloy	**BP-leg:** platinum with 99,99% purity with a rhodium alloy (purity 99,98%) 29,60±0,2% rhodium portion **BN-leg:** platinum with 99,99% purity with a rhodium alloy (purity 99,98%) 6,12±0,02% rhodium portion	max. +1820°C (melting point) ordinary up to +1700°C	▶ pure, oxidizing atmosphers ▶ neutral atmospheres ▶ vacuum	▶ reducing atmosphere or such with agressive vapours or impurities which react with metals of the platinum group, if it isn't protected with a non metal protecting tube
type T	base thermocouple Cu - CuNi (copper/copper-nickel) single wires made of non precious metals	**TP-leg:** 99,95% copper, 0,02-0,07% oxygen 0,01% impurities **TN-leg:** 55% copper, 45% nickel approx. 0,1% cobalt, iron and manganese	-270°C/+400°C	▶ from -200°C - +370°C in vacuum, oxidizing (air), reducing or inert atmosphere (inert gases) ▶ with higher temperatures bigger wire diameters are recommended	▶ above +370°C not appropriate in a hydrogen atmosphere ▶ not appropriate in radioactive environment
type U	base thermocouple Cu - CuNi (copper/copper-nickel) single wires made of non precious metals	**UP-leg:** 99,95% copper, 0,02-0,07% oxygen 0,01% impurities **UN-leg:** 55% copper, 45% nickel approx. 0,1% cobalt, iron and manganese	0°C/+600°C (+400°C)	▶ from -200°C - +370°C in vacuum, oxidizing (air), reducing or inert atmosphere (inert gases) ▶ with higher temperatures bigger wire diameters are recommended	▶ above +370°C not appropriate in a hydrogen atmosphere ▶ not appropriate in radioactive environment

Abbreviations: C= carbon, Mn= manganese, Nb=niobium, Co=cobalt, Fe= iron, Pb=plomb, Cu=copper

CuNi is also called constantan®

Application temperature limits:

The different mineral insulated thermocouple types have generally a metal sheath made of special steel material no. 1.4541 or of Inconel material no. 2.4816.

Other sheath materials are available on request.

The max. application temperature of mineral insulated thermocouples in pure air without any further harmful gaseous components are as follows:

material no.	sheath material	max. application temperature
1.4541	special steel	800°C
2.4816	Inconel	1100°C

- An important quality characteristic of the sheath material is its resistance against corrosion
- With higher measuring temperatures especially with cyclic stress, the wall thickness is reduced by scaling
- Aggressive gaseous components can be harmful to the sheath material
- Bigger diameters increase the service life of mineral insulated thermocouples

The above mentioned information do not claim to be complete.
Herewith, we would like to point out that the allowed application temperature and service life of mineral insulated thermocouples are influenced by lots of circumstances.

Mineral insulated material:

The following table shows in which fields mineral insulated materials have good oxidation and alternating temperature resistance. The application temperature limits in different media are as follows:

Measuring medium	Application temperature	
	1.4541	2.4816
air	approx. 800°C	approx. 1100°C
carbon dioxide	approx. 650°C	approx. 500°C
benzene	approx. 100°C	not recommended
benzol	approx. 100°C	not recommended
boric acid	approx. 100°C	not recommended
butyl alcohol	approx. 100°C	not recommended
up to 50°G.L phosphoric acid	approx. 100°C	not recommended
nitric acid	approx. 100°C	not recommended
liquid sodium	not recommended	approx. 750°C
sulphurous air	not recommended	approx. 550°C
chlorine free water	not recommended	approx. 590°C

BASICS OF RESISTANCE THERMOMETERS

Resistance thermometers change their electrical resistance in dependence on the temperature or in other words resistance thermometers use the fact that the electrical resistance of an electrical conductor varies with changing temperature. In order to collect the output signal, the resistance is fed with a constant measuring current and the created voltage drop is measured. Platinum RTDs Pt100, Pt 500 and Pt1000 are used as measuring probes. They are standardized acc. to DIN EN 60751. Their resistance is 100 Ω at 0°C. The most different construction types of platinum resistance thermometers are applied in industrial measuring technique.

Our standard mineral insulated resistance thermometers are delivered for measuring ranges from - 50 °C up to + 400 °C and - 50 °C up to + 600 °. This indicated measuring range refers to the allowed temperature at the measuring tip of the resistance thermometer. In those temperature ranges the Pt100 resistance thermometer is situated in a fixed characteristic line. Deviations from this characteristic line, also called basic values, are approved according to 2 tolerance classes A and B. Limit deviations please see page 40.

Platinum resistance thermometers are the most accurate sensors and show an excellent long-time stability. Due to the chemical insensitiveness of the platinum, the risk of contamination by oxidation and other chemical influences is reduced.

- high chemical reistance
- consistency
- long-term stability
- easy treatment

The standard value for the accuracy of platinum resistance thermometers is approx. -/+ 0,5% of the measured temperature. They are applied in nearly all fields of industrial temperature measurement.

A reliable temperature measurement requires a most exact adaptation to the corresponding process. This statement can be applied for thermocouples as well as for resistance thermometers. Thermocouples in contrast to resistance thermometers are more simple, more robust, mostly cheaper, applicable in a broad temperature range and have small measuring points. Due to the punctual measurement with thermocouples, they have a quicker response time than resistance thermometers.

Resistance thermometers, however, have a high accuracy and reproducibility and the measuring points are a little bit bigger than those of thermocouples. Due to the planar measurement with resistance thermometers for reasons of construction, they show a slower response time.

TECHNICAL DESCRIPTION MINERAL INSULATED RESISTANCE THERMOMETER

Technical description

1. General information
In general SAB Bröckskes furnishes its insulated resistance thermometers with Platinum Pt100 acc. to DIN EN 60751. On request we are also able to deliver mineral insulated resistance thermometers with Pt 500, Pt1000. We recommend the use of Platinum RTDs due to their high level of stability and consistency. Mineral insulated resistance thermometers are often used for temperature measurement in containers, tubes, appliances and machines. They are applied whenever the flexible mounting and dismounting of the measuring probes are of great importance. Please note that mineral insulated resistance thermometers are only appropriate for low pressures and small flow rates.

2. Construction
The flexible and thin special steel tube of sheath contains 2, 4 or 6 inner wires which are pressed into magnesium oxide. The measuring resistance is connected to the inner wires and embedded into magnesium oxide powder. In general, material no. 1.4541 is used as sheath material.

3. Response times
Mineral insulated thermometers have short response times and react quickly onto changing temperatures. You will find the approximate values in the table on page 36.

■ Accuracy classes acc. to DIN EN 60751:2009-5

class	validity range °C		limit deviation[a] °C
	leaded resistor	film resistor	
AA	-50 uo to +250	0 uo to +150	± (0,1 + 0,0017 [t])
A	-100 uo to +450	-30 uo to +300	± (0,15 + 0,002 [t])
B	-196 uo to +600	-50 uo to +500	± (0,3 + 0,005 [t])
C	-196 uo to +600	-50 uo to +600	± (0,6 + 0,01 [t])
[a] [t] = Value of temperature in °C without considering the sign.			

For resistance thermometers that belong to the above context, the temperature coefficient a is defined as:

$$\alpha = \frac{R_{100} - R_0}{100 \times R_0} = \text{and has the numerical value } 0{,}003\ 85\,°C^{-1}$$

with: R_{100} is the resistance at 100°C and R_0 is the resistance at 0°C.
(for calculation purpose the exact value of 0,003 850 55°C^{-1} is valid)

■ Limit deviations for PT 100 thermometers

abbreviation of RTD Pt 100 DIN EN 60751					
RTD material platinum					
application range -200 up to + 850 °C (class B)					
ITS 90 resistance and permitted deviation					
measuring temperature °C	basic value Ω	allowed deviation class A Ω	class A °C	class B Ω	class B °C
-200	18,52	±0,24	±0,55	±0,56	±1,30
-100	60,26	±0,14	±0,35	±0,32	±0,80
0	100,00	±0,06	±0,15	±0,12	±0,30
100	138,51	±0,13	±0,35	±0,30	±0,80
200	175,86	±0,20	±0,55	±0,48	±1,30
300	212,05	±0,27	±0,75	±0,64	±1,80
400	247,09	±0,33	±0,95	±0,79	±2,30
500	280,98	±0,38	±1,15	±0,93	±2,80
600	313,71	±0,43	±1,35	±1,06	±3,30
650	329,64	±0,46	±1,45	±1,13	±3,60
700	345,28	-	-	±1,17	±3,80
800	375,70	-	-	±1,28	±4,30
850	390,48	-	-	±1,34	±4,60
for the term “basic values” see DIN 16160 part 5.					

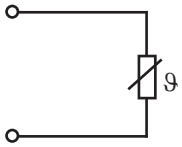
Resistance thermometers with different accuracy classes and validity ranges as for example acc. to DIN EN 60751: 2009-5 (class AA) are available on request.

■ Connection of resistance thermometers

Resistance thermometers change their electrical resistance in dependence on temperature. In order to record the output signal, the line drop created by a constant measuring circuit is measured. Acc. to the Ohm´s law the following is valid for this line drop:
U = R x I

In order to avoid the heating of the sensor, a small measuring circuit shall be chosen. A measuring circuit of 1 mA doesn´t have any considerable impact. This current creates a line drop of 0,1 V with a PT 100 at 0°C. This measuring voltage has to be transferred to the display for evaluation as accurately as possible. We distinguish between four connection techniques:

■ 2-wire circuit



The connection between evaluation unit and thermometer is made by a 2 conductor cable. Like any other electrical conductor such a cable has a resistance itself in serial mounting with the resistance thermometer. Thus the two resistances are added that is interpreted as a higher temperature by the processing unit. In case of far distances the cable resistance can amount to several ohms and in this way falsify the measuring result.

example:

cable section: 0,35 mm^2

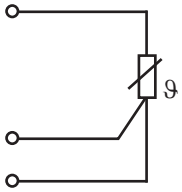
spec. resistance: 0,0175 Ω mm^2 m^{-1}

cable length: 50 m

cable material: E-copper (E-CU) $\quad R = 0{,}0175\ \Omega\ mms^2\ m^{-1} \times \frac{2 \times 50\ m}{0{,}35\ mm^2} = 5{,}0\ \Omega$

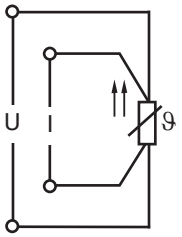
5,0 Ω correspond to a temperature change of 12,8 °C with a Pt 100. In order to avoid this fault, the cable resistance is compensated electrically: The electronic unit is designed in a way that always a cable resistance of 10 Ω is considered. When the resistance thermometer is connected, a balancing resistance is connected into one of the measuring cables and first of all the sensor is replaced by a 100-Ω-resistance. Now the balancing resistance is changed as long as the display unit shows 0°C. The balancing resistance together with the cable resistance amount to 10 Ω. In most cases the balancing resistance wire is wound so that the balance is done by unwinding the wire. Due to this extensive balancing work, and the unknown temperature impact on the measuring cable , the 2-wire circuit is declining.

■ 3-wire circuit



In order to minimize the influences of the cable resistance and its temperature dependant fluctuations, the 3-wire circuit is frequently used instead of the above mentioned 2-wire circuit. Therefore, an additional cable is led to a contact of the RTD. Thus 2 measuring circuits are created, one of them being used as reference. Due to the 3-wire circuit, the cable resistance is compensated with regard to its amount as well as with regard to its temperature dependence provided that the 3 conductors have the same characteristics and are exposed to the same temperature. Thus a compensation of the cable resistance is no longer necessary.

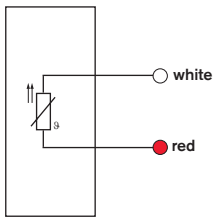
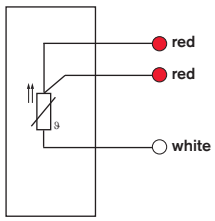
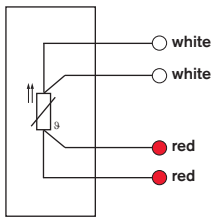
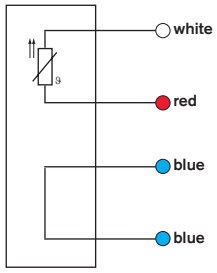
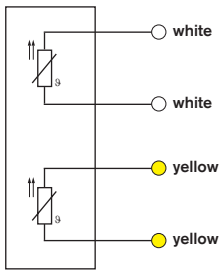
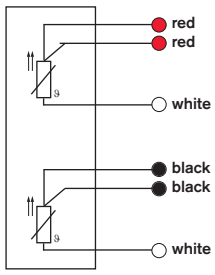
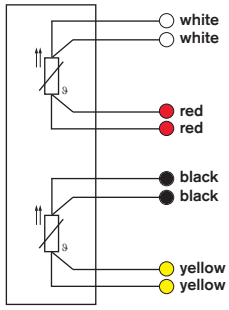
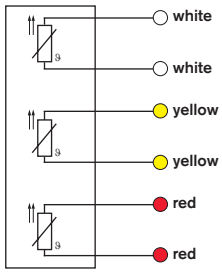
■ 4-wire circuit



U= voltage path
I = current path

The best connection type for resistance thermometers is the 4-wire circuit. The measuring result is neither influenced by the cable resistance nor by their temperature dependant fluctuations. A compensation of the cable resistance is no longer necessary. The thermometer is fed with the measuring circuit via cable. Is the incoming resistance of the topped electronics a multiple of the cable resistance, it is to be neglected. Thus the voltage drop is independent from the characteristics of the line. For the 3-wire as well as for the 4-wire circuit it has to be considered that the circuit is not always led to the measuring element. The connection of the sensor to the connection head in the armature, the so called inner circuit, is often done in a 2-wire circuit. This results in the problems of a 2-wire circuit – even to a smaller extent.

INNER WIRES OF RESISTANCE THERMOMETERS

number of percision winding	circuit of inner wires			
	2-wire	3-wire	4-wire	2-wire with loop
Pt100				
2 x Pt100				
3 x Pt100				

for compensating and extension cables

THERMOCOUPLE		DIN IEC 584	DIN 43710*	ANSI MC 96.1	BS 4937	NF C 42-324
Code	Material ⊕ ⊖	Identification THL AGL	Identification THL AGL	Identification THL AGL	Identification THL AGL	Identification THL AGL
T	Cu - Cu Ni	TX -25° to +100°C		0° to +100°C	0° to +100°C	-25° to +200°C
U	Cu - Cu Ni		UX 0° to +200°C			
J	Fe - Cu Ni	JX -25° to +200°C		0° to +200°C	0° to +200°C	-25° to +200°C
L	Fe - Cu Ni		LX 0° to +200°C			
E	Ni Cr - Cu Ni	EX -25° to +200°C		0° to +200°C	0° to +200°C	-25° to +200°C
K	Ni Cr - Ni	KX -25° to +200°C		0° to +200°C	0° to +200°C	-25° to +200°C
K	Ni Cr - Ni	KCA 0° to +150°C				0° to +150°C
K	Ni Cr - Ni	KCB 0° to +100°C			0° to +100°C	0° to +100°C
N	Ni Cr Si - Ni Si	NX -25° to +200°C NC 0° to +150°C				
R S	Pt Rh 13 - Pt Pt Rh 10 - Pt	RCB/ SCB 0° to +200°C		0° to +200°C	0° to +200°C	0° to +200°C
B	Pt Rh 30 - Pt Rh 6			0° to +100°C		0° to +100°C

The application temperature range of the cable is limited by the highest application temperature of the insulating material or the application temperature range of the conductor material. In all cases the respective lower figure is valid. The compensating cable for the thermocouple type B can also be manufactured, deviating from the corresponding standards, for a temperature range from 0 up to +200°C (S-Type BC-200). Variant colour codes can be manufactured for a minimum order quantity.

** The standard 43710 was withdrawn in April 1994. Therefore, the element types "U" and "L" are not standardized anymore.*

THL = extension cable · AGL = compensating cable

FLEXIBLE CABLES

- Halogen-free cables
- Cable track cables
- Servo motor cables
- ETFE, FEP, PFA cables
- Bus cables
- Torsion cables
- Hybrid and special cables
- Control and connection cables
- Data cables
- Besilen® (Silicone) cables
- Compensating and extension cables
- Tray cables

TEMPERATURE MEASUREMENT

- Protecting armatures and gauge slides
- Mineral insulated thermocouples and Mineral insulated resistance thermometers
- Temperature measurement in plastics processing industry/Hot runner technique
- Diesel thermocouples
- Probe with stainless steel sleeve
- Temperature measurement in test vehicles
- Converter
- HV sensors
- Measurement techniques

CABLE HARNESSING

- Harnessed cables acc. to customer's specification
- Harnessed cable track cables
- Helix cables
- Cable harnesses
- Harnessed motor and transmission cables for Siemens and Indramat drives

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