

High-Temperature Thermocouples

for temperatures up to 2000 °C and above

For temperatures up to 2000 °C and higher or for highly corrosive and/or reducing atmospheres we supply specially developed high-temperature thermocouples.

To a large extent these thermocouples are used in aeronautics, research laboratories and in industry. For the various areas of application suitable sheath materials, thermocouple combinations and insulation materials are available.

Only the precious-metal types S, R and B are standardized internationally in IEC 60 584-1. Type V is described in ASTM E 1751, types C, D and G in ASTM E 988 and type A in GOST 8.585.

In the revised version of IEC 60 584-1, which is available as a draft, the inclusion of types A (A1) and C (AE) is planned.

For the manufacturing of the measuring tips and protection tubes new technologies had to be developed in most cases, as the strain at very high temperatures is quite considerable due to various factors.

Only materials suitable and specially tested for these applications are used. The useability of the various materials depends mainly on the process conditions.

The use of high-temperature sheath materials in an oxidizing atmosphere is possible only up to a limited (low) temperature. Excluded from this are sheath materials of platinum alloys. The table on page 3 of this product information serves as an indication.

In the case of long thermocouples it can be advantageous for cost reasons to have a transition to a different material – e.g. INCONEL or stainless steel. The insertion length of the part exposed to the high temperature can be dimensioned as requested.

For special applications it is possible on request to mount several thermocouples into a common protection tube. The position of the measuring points for profile thermocouples can be chosen within a wide range.

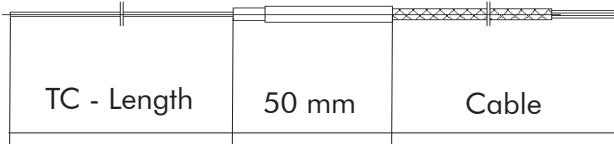


Special advantages:

- Custom-tailored designs available for many applications
- Suitable for oxidizing, reducing, neutral atmospheres and vacuum
- Pressure-/vacuum-proof bushings available in many forms
- Transition elements variable within a wide range
- Profile thermocouples available on request

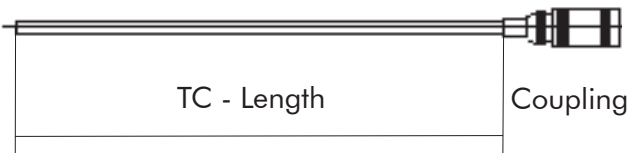
High-Temperature Metal-Sheathed Thermocouples

Type: AL with permanently connected cable



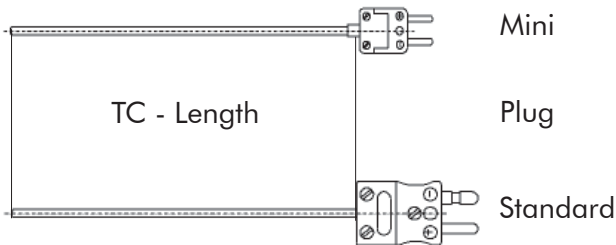
With this type the connecting cable – normally the compensating cable – is permanently connected. Depending on the sheath diameter the transition sleeve has a diameter of 5, 6 or 10 mm. The standard length is 50 mm. The cable type (conductor cross-section, insulation structure, screening) is variable within a wide range.

Type: S with permanently connected coupling



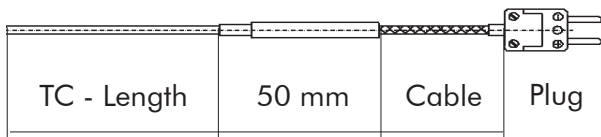
With type S the plug system is directly connected to the sheath thermocouple. The standard type is equipped with a coupling type RLK size 0 (up to 1.6 mm sheath diam., if larger size 1 is used). The positive pole is connected to the pin (male contact) of the connector. The contacts are made of brass and are galvanically gold-plated. The maximum coupling temperature is 150 °C. Other plug systems are available on request. (Please specify when ordering.)

Type: STE with permanently connected thermocouple plug, mini or standard



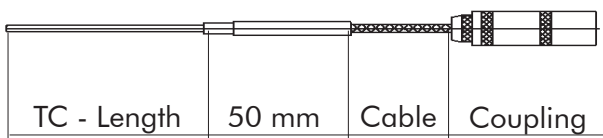
With this type the plug is directly connected to the metal-sheathed thermocouple. The standard type is equipped with a mini plug ((TC dia. \leq 1.6 mm) or a standard plug. The contacts are made of compensating wire, the outer body of temperature-resistant plastic material. The maximum plug temperature is 150 °C. Plug and coupling are put together polarity-correct and thus offer optimum contact reliability. Other plug systems are available on request, as well as suitable couplings. (Please specify when ordering.)

Type: ALSTE with permanently connected cable and thermocouple plug



Type ALSTE is the extension of type AL by a thermocouple plug. As per customer specification this type is equipped either with a mini or standard plug (see type STE). The plug and sleeve temperature depend on the type of cable used, maximum 150 °C.

Type: ALS with permanently connected cable and LEMO - round coupling



Type ALS is the extension of type AL by a LEMO round coupling. Depending on customer specification resp. cable diameter this type is equipped with a round coupling size 0 or 1. Other designs and sizes, e.g. with LEMO round plugs, are available on request.

Ordering code:

Example: ALSTE - 2A00 - 6,4 - 720 - 0,1 - H

- Type
 AL = with connecting cable
 ALS = with cable and round coupling
 ALSTE = with cable and TC plug
 S = with round coupling
 STE = with TC plug
- Number of thermocouples,
 No number --> 1 thermocouple
- Thermocouple types
 C (AE) = W5%Re - W26%Re(GOST 8.585)
 D (AO) = W3%Re - W25%Re (ASTM E 988)
 A (A1) = W5%Re - W20%Re (ASTM E 988)
 V = Ir40%Rh - Ir (ASTM E 1756)
 S = Pt10%Rh - Pt (IEC 60 584-1)
 R = Pt13%Rh - Pt (IEC 60 584-1)
 B = Pt6%Rh - Pt30%Rh (IEC 60 584-1)

- Sheath material identification letter*
 AA = Platinum 6% Rhodium
 AH = Platinum 10% Rhodium
 N = Tantalum
 O = Molybdenum
 BE = Mo 50 % Rhenium

*Other high-temperature sheath materials available on request

- Sheath diameters
 1.6 = Ø 1.6 mm
 3.2 = Ø 3.2 mm
 6.4 = Ø 6.4 mm
 8.0 = Ø 8.0 mm

Thermocouple length in mm

Cable length in m

Insulation material

- Magnesiumoxide (MgO) = M
 Aluminiumoxide (Al₂O₃) = A
 Berylliumoxide (BeO) * = B *
 Hafniumoxide (HfO₂) = H

* For health reasons BeO should not longer be used

Guidelines for use of high-temperature thermocouples

Sheath material	Type	Thermocouple Types	Insulation	Admissible atmosphere	Max. operating temperature
Pt 6 % Rh	AA	S, R, B & V	MgO	oxidizing	1400 °C
Pt 10 % Rh	AH	S, R, B & V	MgO	oxidizing	1400 °C
Pt 6 % Rh	AA	V, A, AA, C & D	MgO / HfO ₂	oxidizing	1700 °C
Pt 10 % Rh	AH	V, A, AA, C & D	MgO / HfO ₂	oxidizing	1700 °C
Tantalum	N	V, A, AA, C & D	MgO / HfO ₂	inert / vacuum	1700 °C
Tantalum	N	A, AA, C & D	HfO ₂	inert / vacuum	2150 °C
Molybdenum (Mo)	O	A, AA, C & D	HfO ₂	reducing / inert / vacuum	2200 °C (2500 °C)
Mo 50 % Rhenium	BE	A, AA, C & D	HfO ₂	reducing / inert / vacuum	2300 °C

Further informations are available on request. Please contact our technical sales department.

Thermal-electric voltages of high-temperature thermocouples

Temp. in °C	Type G (AA)	Type D (AO)	Type C (AE)	Type A (A1)	Type S	Type R	Type B	Type V
0	0	0	0	0	0.0	0.0	0.0	0.0
100	344	1145	1381	1337	645.9	647.4	33.2	0.371
200	1005	2603	2987	2871	1440.8	1468.6	178.3	0.841
300	1985	4289	4767	4513	2323.0	2400.6	430.6	1.380
400	3282	6129	6654	6203	3259.4	3407.7	786.5	1.961
500	4793	8098	8573	7908	4233.3	4471.3	1241.4	2.562
600	6487	10092	10508	9606	5238.7	5583.5	1791.9	3.172
700	8330	12128	12450	11284	6275.2	6742.7	2430.6	3.861
800	10299	14183	14374	12934	7345.0	7949.8	3153.6	4.448
900	12318	16225	16265	14550	8449.2	9204.9	3956.9	5.021
1000	14392	18242	18120	16127	9587.1	10506.0	4834.3	5.576
1100	16497	20229	19943	17662	10756.5	11849.6	5779.5	6.116
1200	18647	22191	21724	19150	11950.5	13228.0	6786.4	6.643
1300	20767	24081	23423	20589	13159.1	14628.7	7848.2	7.159
1400	22813	25896	25032	21976	14372.6	16040.1	8956.2	7.669
1500	24841	27686	26582	23311	15581.7	17450.7	10099.1	8.177
1600	26849	29450	28078	24593	16776.8	18848.9	11263.0	8.687
1700	28841	31181	29528	25821	17947.3	20221.7	12432.5	9.205
1800	30813	32874	30922	26997	-	-	13591.3	9.732
1900	32589	34359	32298	28119	-	-	-	10.272
2000	34245	35723	33632	29186	-	-	-	10.826
2100	35851	37037	34914	30194	-	-	-	-
2200	37435	38306	36088	31142	-	-	-	-
2300	38896	39350	36928	32028	-	-	-	-
2400	-	-	-	32855	-	-	-	-
2500	-	-	-	33640	-	-	-	-

Thermal voltages in μV , reference temperature 0 °C

Permitted deviations

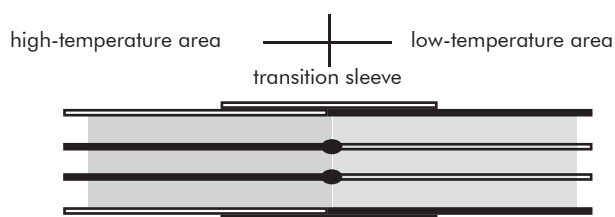
The permitted deviations of the noble-metal types S, R and B are standardized in IEC 60 584-2. Types S and R are available in class 1 and 2 while type B is available in class 2 and 3 only.

The permitted deviations of the refractory types C, D and G are given in ASTM E 988. The deviation is stated as 1% in the range of 440 °C to 2315 °C. Type A is included in GOST 8.585. Type V is in accordance with ASTM E 1756.

Transition thermocouple

With long thermocouples it can be advantageous for cost reasons to have a transition to a different sheath material – e.g. Inconel or stainless steel.

The insertion length of the part exposed to high temperature as well as the total length can be offered as per customer specification.



Standard transition sleeve: SS 316TI or INCONEL
 High-temperature sheath:
 AA, AH, N, O, W, AV to INCONEL 600
 Insulation material:
 HfO_2 (BeO) to MgO or Al_2O_3

All recommendations are given without liability and do not constitute guaranteed properties. All these recommendations are to be checked and verified by the customer with regard to the intended individual application. The right to modifications, which serve technical progress, is reserved.

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