

## Ultra High Temperature Thermocouples

### High-Temperature Thermocouples



#### Temperatures up to 2000°C and above

Tempsens offers special Ultra high temperature thermocouples for high temperatures upto 2300 °C for highly corrosive and/or reducing atmospheres.

These thermocouples are offered in either Platinum/Rhodium (types R, S, or B) or Tungsten/Rhenium (types C or D) elements, with a variety of insulations and sheath materials. Depending upon the sheath material selected, these thermocouples are used in inert, oxidizing, reducing or vacuum conditions. The maximum temperature is based on the lowest max. temperature of the element, insulation and sheath material.

The use of high-temperature sheath materials in an oxidizing atmosphere is possible only to a limited (low) temperature. Excluded from this are sheath materials of platinum alloys. The table on page 4 of this product information serves as an indication.

To a large extent these thermocouples are used in aeronautics, research laboratories and in industry.

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. also compensating cables can be used after the transition sleeve

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.

These thermocouples are supplied with traceable calibration and material certificates, in case required each of the thermocouple can be calibrated in specific inert or vacuum atmosphere. Accessories like compensation cables etc are available as per requirement.

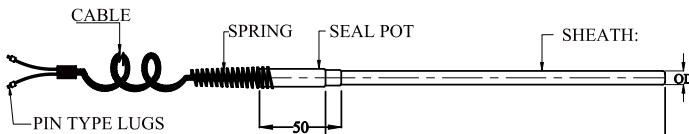
### Special Advantages :

- 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
- Calibration at high temperature in Inert or vacuum atmosphere

# High Temperature Thermocouples

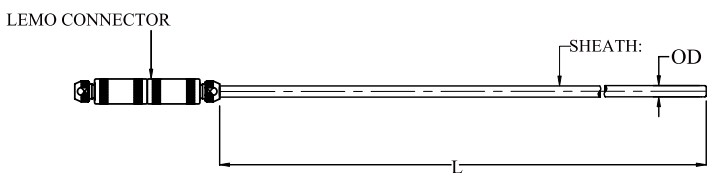
## High-Temperature Metal-Sheath Thermocouples

**Type: T-88**  
with permanently connected cable



The compensating cable is permanently connected. Depending on the sheath diameter the transition sleeve has a diameter of 5, 6 or 10 mm, standard length is 50 mm. The cable type (conductor cross-section, insulation structure, screening) is as per customer requirement.

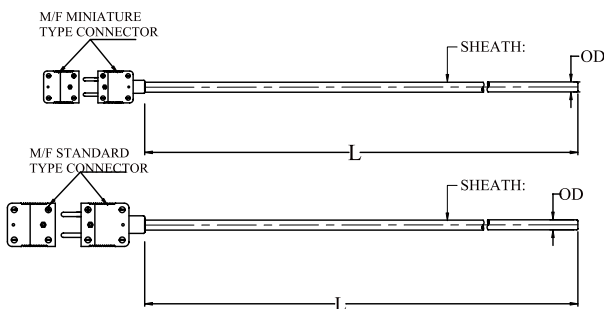
**Type: T-89**  
with permanently connected LEMO Connector.



The LEMO Connector is directly connected to the sheath thermocouple. The standard type is equipped with a connector type 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.

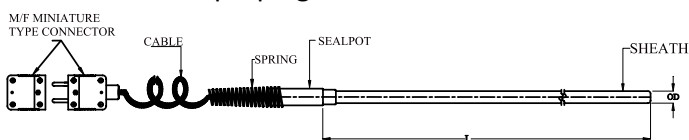
The maximum coupling temperature is 150 °C. Other plug systems are available on request. (Please specify when ordering.)

**Type: T-90**  
with permanently connected thermocouple plug, mini or standard



With this type the plug is directly connected to the metal sheathed thermocouple, mini plug for T/C dia  $\leq 1.6$  mm or standard plug. The contacts are made of compensating conductor, 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.)

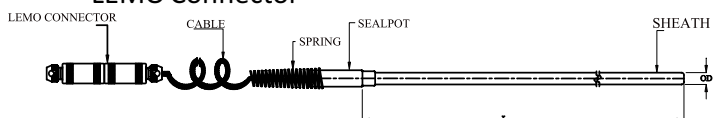
**Type: T-91**  
with permanently connected cable and thermocouple plug



Type T-91 is the extension of type T-88 by a thermocouple plug. As per customer specification this type is equipped either with a mini or standard plug.

The plug and sleeve temperature depend on the type of cable used, maximum 150 °C.

**Type: T-92**  
with permanently connected cable and LEMO Connector



Type T-92 is the extension of type T-89 by a LEMO Connector. Depending on customer specification and cable diameter, this type is equipped with a connector size 0 or 1.

# High Temperature Thermocouples

**Ordering code:**

**Example:**

**Type**

**T-91 - C - T - 6.4 - 500 - 1 - H**

- T-88 = with connecting cable
- T-89 = with LEMO Connector
- T-90 = with TC plug
- T-91 = with cable and TC plug
- T-92 = with cable and LEMO Connector

**Thermocouple Types**

- C = W5%Re - W26%Re
- D = W3%Re - W25%Re
- S = Pt10%Rh - Pt
- R = Pt13%Rh - Pt
- B = Pt30%Rh - Pt6%Rh

**Sheath material identification letter\***

- I = Inconel-600
- P = Platinum Alloy
- T = Tantalum
- M = Molybdenum

Other high temperature sheath materials available on request

**Sheath diameters**

- Ø1.6 mm
- Ø3.2 mm
- Ø6.4 mm
- Ø8.0 mm

Other are available on request

Thermocouple length in mm/M

Cable length in meters

**Insulation material**

- Magnesiumoxide(MgO) = M
- Aluminiumoxide(Al<sub>2</sub>O<sub>3</sub>) = A
- Berylliumoxide(BeO)\* = B
- Hafniumoxide(HfO<sub>2</sub>) = H

\*For health reasons BeO should not longer be used

**High Temperature Sheath Materials**

SHEATH TYPE	MAX. TEMP	MELTING TEMP	ALLOWABLE ENVIRONMENT	STD SHEATH DIA. (mm)	MIN. BEND RADIUS
Inconel 600	1175°C	1345°C	Inert, Vacuum, Oxidizing	1.016, 1.57, 3.17, 4.77, 6.35	5 X Sheath Diameter
Platinum Alloy	1550°C	1850°C	Inert, Oxidizing	1.016, 1.57, 3.17	5 X Sheath Diameter
Tantalum	2200°C	2995°C	Inert, Vacuum	1.016, 1.57, 3.17	10 X Sheath Diameter
Molybdenum	2000°C	2620°C	Inert, Vacuum, Reducing	1.57, 3.17, 4.77, 6.35	Do Not Bend

# High Temperature Thermocouples

## High Temperature Wire Types

THERMOCOUPLE COMBINATIONS	CALIBRATION TYPE	STANDARD LIMITS OF ERROR*	RECOMMENDED TEMPERATURE RANGE
Tungsten 5% Rhenium (+) Vs Tungsten 26% Rhenium (-)	C	±4.4°C or ±1%	0-2200°C
Tungsten 3% Rhenium (+) Vs. Tungsten 25% Rhenium (-)	D	±4.4°C or ±1%	0-2200°C
Platinum 13% Rhodium (+) Vs. Platinum (-)	R	±1.5°C or .25% **	0-1450°C
Platinum 10% Rhodium (+) Vs. Platinum (-)	S	±1.5°C or .25% **	0-1450°C
Platinum 30% Rhodium (+) Vs. Platinum 6% Rhodium (-)	B	±0.5%	800-1700°C

## High Temperature Insulators

INSULATION TYPE	MAX. OPERATING TEMP	APROX MELTING TEMP.	COMMENTS
Magnesia (MgO)	1700°C	2800°C	Very hygroscopic. Used mostly in compacted sheaths.
Alumina Oxide (Al <sub>2</sub> O <sub>3</sub> )	1550°C	2040°C	Excellent with Platinum alloys.
Hafnium Oxide (HfO <sub>2</sub> )	2200°C	2790°C	Comparable to Beryllium Oxide and safe to handle
Beryllium Oxide (BeO)	2200°C	2650°C	Excellent High Temperature thermal conductivity and resistivity

## Thermal-electric voltages of high-temperature thermocouples

Temp. in °C	Type D	Type C	Type S	Type R	Type B
0	0,0	0,0	0,0	0,0	0,0
100	1,145	1,381	645,9	647,4	33,2
200	2,603	2,987	1440,8	1468,6	178,3
300	4,289	4,767	2323,0	2400,6	430,6
400	6,129	6,654	3259,4	3407,7	786,5
500	8,098	8,573	4233,3	4471,3	1241,4
600	10,092	10,508	5238,7	5583,5	1791,9
700	12,128	12,450	6275,2	6742,7	2430,6
800	14,183	14,374	7345,0	7949,8	3153,6
900	16,225	16,265	8449,2	9204,9	3956,9
1000	18,242	18,120	9587,1	10506,0	4834,3
1100	20,229	19,943	10756,5	11849,6	5779,5
1200	22,191	21,724	11950,5	13228,0	6786,4
1300	24,081	23,423	13159,1	14628,7	7848,2
1400	25,896	25,032	14372,6	16040,1	8956,2
1500	27,686	26,582	15581,7	17450,7	10099,1
1600	29,450	28,078	16776,8	18848,9	11263,0
1700	31,181	29,528	17947,3	20221,7	12432,5
1800	32,874	30,922	-	-	13591,3
1900	34,359	32,298	-	-	-
2000	35,723	33,632	-	-	-
2100	37,037	34,914	-	-	-
2200	38,306	36,088	-	-	-
2300	39,350	36,928	-	-	-
2400	-	-	-	-	-
2500	-	-	-	-	-