

Temperature Sensors for Liquid Metals and Liquid Metal Alloys



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Temperature Sensors for Liquid Metals and Liquid Metal Alloys

The following Operation Manual provides information of temperature sensors with ceramic sheaths made of tungsten and silicon nitride, suitable for operating in liquid metals and liquid metal alloys.

Temperature sensor series TT...C-37, PTT.C-39 and TT...C-33 are with a terminal block and/or with temperature transmitter converting TC/RTD signal to 4÷20 mA or 0÷10V signal (if a high cover head is used).

Temperature sensors are manufactured in compliance with PN-EN 60584 norm.

1. Construction and principle of operation.

The basic element of temperature sensors is the thermocouple measuring insert connected to terminals placed on a ceramic disc and protected with connection head made of aluminium.

The sensing element placed in the measuring insert reacts to temperature change of the process through the change of electromotive force /emf/. These changes are compatible with thermocouple properties specified in PN-EN 60584-1.

The measuring insert is placed in metal-ceramic sheath which consists of:

- ceramic sheath made of carbide or silicon nitride, placed in a special stainless steel mounting fitting,
- 100 mm pipe is used for connecting the sheath and mounting fitting directly to the connection head (straight sensors). In case of angular sensors, the sheath and mounting fitting are connected to an elbow, this construction enables placing the connection head out of the influence of the temperature of liquid metal, due to 400 mm pipe.

If necessary, when a high cover head is used, a temperature transmitter 4÷20 mA or 0÷10V can be used.

Specifications:

TC type	1 or 2x Fe-CuNi /J/, NiCr-Ni /K/ acc. to PN-EN 60584
Maximum temperature range.....	0÷700°C for J 0÷1200°C for K
Measuring junction type.....	insulated
Acceptable temp. of connection head operating.....	100°C
Degree of protection	IP55
Cable gland dimension	M20x1,5

2. Resistance to environmental influence.

Ceramic sheath is resistant to corrosive action of liquid metals such as Zn, Sn, Pb, Al, Cu and their alloys.

Sheath type	Basic component	Density	Porosity	Max. operating temperature	Thermal shock	Available dimensions OD/ID x L _{max}
SYALON 101	90% Si ₃ N ₄	~3,2 g/cm ³	0 %	1200	534°	(16/9, 22/12, 28/16) x 2000
EKATHERM	92% Si ₃ N ₄	~3,2 g/cm ³	0 %	1100	602°	22/12x900, 28/16x1200
REFRAX 20E	73% SiC	~2,2 g/cm ³	28%	1450	–	25/12x1100
CRYSTON 178	75% SiC	~2,8 g/cm ³	8%	1550	–	25/12x700
SILIT SK	85% SiC	~3,0 g/cm ³	0 %	1350	–	25/18(15)x1500
HEXOLOY	SiC	~3,1 g/cm ³	1 %	1650	600°	19(25)/13x1300

3. Marking the connection terminals.

Terminal block

Since the thermocouple sensors must be connected with the adequate polarity, a sign "+" (positive pole) is put on the terminal block for the purpose of correct connection. In case of connecting TC sensor with the outer devices, the correct pole of a terminal block must be connected with the correct pole of cable (correct colour). Rules of connection and insulation colours are given below:

Type of thermoelectric sensor	Type of wire		Metal Composition		Colour Code, "+"		Tolerances		Temperature range.
	Compensation	Thermoelectric	Wire +	Wire -	IEC 584 „-”white	ANSI „-”red.	Class 1	Class 2	
J	-	JX	Fe	CuNi	czarny	niebieski	±1.5	±2.5	-25÷200°C
K	-	KX	NiCr	NiAl	zielony	żółty	±1.5	±2.5	-25÷200°C
K	KCA	-	Fe	CuNi	zielony	-	-	±2.5	0÷150°C
K	KCB	-	Cu	CuNi	zielony	-	-	±2.5	0÷100°C

- cross-sections of compensation and extension cables:

0,22 mm²; 0,5 mm²; 0,75 mm²; 1,0 mm²; 1,5 mm²

Recommended cross-sections of compensation and extension cables for connecting temperature sensors with outer devices are 1,0mm² or 1,5 mm² acc. to PN-89/M-53859.

General rules for marking (colour coding) of thermocouple sensor cable:

- acc. to PN-EN 60584 colour of the outer insulation and positive conductor that is assigned to positive thermocouple element is the same; negative conductor insulation - **white**
- acc. to PN-89/M-53859 cable outer insulation - different colours; positive conductor insulation assigned to positive thermocouple element - **red**; negative conductor insulation assigned to negative thermocouple - any colour except red, pink and purple

4. Recommended cable outer diameters for cable glands in connection heads of temperature sensors manufactured by Limatherm Sensor Sp. z o.o.

For seal without notches

- cable diameter /ø5,5-7,5 mm/

For seal with notches

- cable diameter /ø4-12,5 mm/

5. Packing and storing instructions, transportation.

The sensors to be transported must always be properly packed in order to avoid any damage during the transportation. It is recommended to place the sensors to be transported either in one general, shared package or in individual unit packages. The sensors should be stored in their packages in indoor storage spaces: the indoor air must contain **no traces of vapours and/or aggressive substances**, the indoor air temperatures must range from +5 °C to 50°C, and the relative humidity **must not exceed 85%**. Whilst being transported, the sensors must be protected against shifting inside the packagings. The sensors manufactured by 'Limatherm Sensor' can be transported using maritime, rail, road, or air modes of transport, in all cases provided that the direct impact of atmospheric factors on the sensors during the transportation is totally eliminated. The detailed transportation conditions are specified in the Polish Standard PN-81/M-42009.

6. Warranty.

- The Manufacturer provides the original purchaser of the sensor (sensors) with a twelve (12) month warranty and necessary service; for this period, the Manufacturer guarantees the uninterrupted and error free functioning of sensors;
- The twelve (12) month warranty begins on the day of purchase;
- Also, the Manufacturer provides the original purchaser of the sensors with a post-warranty service;
- The warranty voids in the case of any changes in and repairs of the instrument performed by the user;
- This warranty does not cover damages resulting from improper transportation, nor defects and errors caused by bad handling or misuse which does not comply with the provisions as set forth in this Operation Manual.

7. Recommended examples of assembling the sensors.

The sensor should be installed over the furnace crucible with an instrument that enables quick and easy immersion or taking the sensor out from liquid metal as well as regulation of the ceramic sheath immersion in metal. Sensors can be held by the steel pipe extending the sheath or extension pipe.

While sensor mounting and operating one should abide by the following rules:

- Temperature sensor with sheath has some porosity, therefore it must be dried in temperature about 200°C for at least 3 hours before its installation on a furnace.
- After each application the sensor must be cleaned of metal remnants using wooden lath.
- The sheath shall not be exposed to thermal shock (temperature difference up to 200K) if a higher resistance is assumed.
- The sensor must be taken out of the crucible before the furnace is turned off and cleaned. Freezing the sensor in cooling metal is unacceptable.
- Replacement of metal-ceramic sheath is necessary in case of defects or cracks exposing the thermocouple and causing the risk of direct contact with liquid metal.

During the sensor operating one shall:

- Check the insulation resistance of connecting wires (minimum 3 MΩ).
- Check whether the terminals of a terminal block or transmitter are tight.
- If the sensor works in the upper level of temperature range, the compatibility of sensor properties with the norm shall be checked at least once a year.