



THE OBNINSK THERMOELECTRIC COMPANY

30 Krasnykh Zor Street, Obninsk, Kaluga Region, 249031 Russia

Thermoelectric Transducers

(ThermoCouple probes)

TC-A, TC-B, TC-S,
TC-K, TC-N and TC-L

Product Catalog

Manufactured in accordance with Technical Specifications:
Technical Specifications 4211-001-14035255-03 (No. in the State Register
of Measuring Instruments of the Russian Federation 26589),
Technical Specifications 4211-002-14035255-03 (No. in the State Register
of Measuring Instruments of the Russian Federation 26588),
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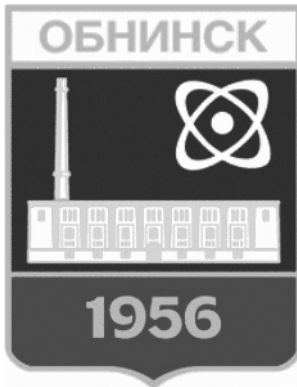
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Obninsk is a small town in the very heart of Russia. Many things were pioneered here. This is the sheath of the world's first nuclear power plant, which concerns the national strategy. In the field of science, this can be said of the focus of enormous scientific resources, both fundamental and applied. Obninsk is ranked as the first science town of the Russian Federation.

Obninsk has become a science city to implement target state-run R&D programs, which ensure the global leadership of Russia in fundamental domains of nuclear physics, radiation and aerospace materials science, radiation chemistry, medicine and biology, thermal engineering, radioecology, meteorology and metrology.

There is a need for the fast introduction of the current state of the art into industrial production. What is more, these shall be recent achievements, which shall have been introduced during as short as practicable terms. An instrument for this process to be carried out can be small research companies attached to local research centers. The Obninsk Thermoelectric Company represents one of these companies.

The Obninsk Center for Science and Technology is a partner of the Obninsk Thermoelectric Company. It manages the activities in innovation policy and advanced industrial developments.

The business profile of the company is **thermoelectricity, which includes physical phenomena and effects based on the direct conversion of a gradient temperature field in a material into electric field.** The principle of operation of thermoelectric temperature transducers, i.e., thermocouples and thermoelectric power sources, is based on the above-mentioned direct conversion.

The company is engaged in the production of thermoelectric temperature measuring instrumentation for highly corrosive high-temperature media and in solving problems of high-temperature measurements at Customer's facilities. We are pleased to make an offer of reliable instruments having a high measurement accuracy. Our products will be attractable for engineers of iron and steel plants, ceramics and glass factories, common and high-temperature treatment shops of machine-building and military plants, as well as foundries.

We use only high-quality materials and accessory components, including foreign-made ones, which have been subjected to total incoming inspection, employ the leading technologies and involve the long-experience of skilled professionals and the latest advances in materials science and temperature measurements.

We produce thermoelectric transducers of the following basic calibrations according to the requirements of CIS interstate standard GOST 6616-94 and international standard IEC 60584:

- A** - tungsten-rhenium 5% - tungsten-rhenium 20%;
- K** - chromel-alumel;
- B** - platinum-rhodium 30% - platinum-rhodium 6%;
- N** - nichrosil-nisil;
- S** - platinum-rhodium 10% - platinum;
- L** - chromel-copel.

All types of the thermoelectric transducers are listed in the State Register of Measuring Instruments of the Russian Federation.

Our motto: *"The higher temperature, the closer are we to you"*.

We are ready to satisfy your needs in reasonably priced reliable transducers.

Primary thermoelectric transducers can be supplied with secondary devices of temperature control and instrumentation as well as production process controllers.

Since 2006, the Obninsk Thermoelectric Company, Ltd., has launched the project on promotion at the Russian instrumentation market the systems of temperature field monitoring for chamber and tunnel industrial furnaces on the Russian instrumentation market. An electronic unit enclosed in a thermal-protection container to which 6 to 20 cable thermocouples in heat-resistant shields are connected passes through a furnace together with a product to be heat treated and performs the on-line recording of the temperature profile along the furnace length via every channel. Thermal-protection containers produced in dozens of versions allow the system to keep in the furnace for up to 9 h at the temperature of 1300°C. The system makes it possible to perform an optimum thermal tuning of the furnace in accordance with the assigned production process, which improves the thermal efficiency of the furnace in the aggregate and ensures the high end quality of the product. The system can be used to perform the temperature monitoring of furnaces for heating billets, soldering furnaces, furnaces for annealing ceramics and construction materials etc. It is an indispensable instrument in determining the temperature profile of furnaces on which strict requirements for temperature field uniformity are imposed, including vacuum furnaces.

Company engineers are ready for solving complex tasks of the automation of thermal processes at Customer's facilities, including the development of computer control algorithms, as well as the integration and installation of a turnkey automation system.

LIST OF CONVENTIONAL TERMS AND DEFINITIONS USED IN THIS CATALOG

GOST R 8.585-2001

Thermocouple means two conductors made of dissimilar materials, which are connected at one end and form a component of a device that uses thermoelectric effect to measure temperature. The thermocouple is a sensitive element (SE) of a thermoelectric transducer.

NSC (nominal static characteristic) of a thermocouple means the dependence of the thermal electromotive force (TEMF) on the temperature of the hot junction at a constant temperature of the "cold" leads, which is expressed in millivolts and nominally attributable to a thermocouple of a particular type.

Permissible deviation from NSC means the maximum possible deviation of the TEMF of a thermocouple from the rated value, which satisfies the technical specification for the thermocouple.

GOST 8.338-2002

Length of the immersion part of a thermoelectric transducer (TT) during calibration means the distance counted from the dip end of the protection sheath of the TT to be calibrated when placing it into a furnace body (or a thermostat) to the intersection of the TT sheath with the plane of the outer surface of the furnace (or thermostat) top end.

Extension wires means paired thermocouple wires, which collectively have the NSC of the basic thermocouple in a specified temperature range.

GOST 6616-94

Measured temperature range means a range of temperatures within which the provided measurement function of a TT is implemented.

Operating range means a range of temperatures measured by a particular TT, which lies within the measured temperature range.

Rated operating temperature means the most probable TT operating temperature for which reliability and durability indicators are rated.

Note: this temperature is generally 75-85% of the top limit of the operating temperature range. For TC-S platinum thermocouples, the rated operating temperature is ~1085°C (the melting point of copper) and for TC-B and TC-A thermocouples this temperature amounts to 80% of the top limit of the operating temperature range.

Thermal inertia index means the time necessary for the difference between the temperature of a medium with a constant temperature and the temperature of any point of a TT placed into this medium to become equal to 0.37 of the value that will be recorded at the moment of a regular thermal condition is established.

Mounting length of a TT: for TT with stationary sleeves or flanges it means the distance from working end of protection tube to the reference plane of the sleeve(flange) and for TT with movable sleeves(flanges) it means the distance from working end of the protection sheath to TT's head or to the sealing point of the tails, when head is absent.

Length of the outside part of a TT means the distance from the reference plane of the sleeve or flange to the upper part of the head.

Length of the immersion part of a TT means the distance from the working end of the protection sheath of the TT to the sites of possible operation of the TT at the upper range limit.

TT for short-term measurements means TT, which if used in measurement media ensure their metrological characteristics in a restricted number of measurement cycles or in a restricted time interval specified in the technical specification for TTs of a particular type.

GOST 356-80

Rated pressure means the maximum excess pressure at a temperature of a medium of 20°C at which the long-term operation of fittings and parts ... with specified dimensions is ensured.

Operating pressure means the maximum excess pressure at which predetermined operating conditions for fittings and parts are ensured.

GOST 27.002-83

Failure means an event, which involves the impairment of the serviceability of a facility.

Time to failure means the time of the operation of a facility from its commissioning to the occurrence of the first failure.

Service life means the calendar time from the commissioning of a facility ... to its transition to a limit state at which its subsequent intended use is inadmissible or impractical.

Failure modes according to the technical specifications:

- protection sheath destruction;
- the breaking or short circuit of the sensitive element (SE) circuit;
- the non-compliance of the nominal static characteristic (NSC) of a thermoelectric transducer and the maximum permissible deviations with rated values according to tolerance classes;
- a decrease in insulation resistance of the insulation between the SE circuit and the metal protection tube below permissible values (for thermal transducers with an insulated SE).

GOST 5632-72

Depending on their basic characteristics, steels and alloys can be divided into the following groups:

- **corrosion-resistant** (stainless) steels and alloys resistant against galvanic and chemical corrosion (atmospheric, soil, alkaline, acid and salt corrosion), grain-boundary corrosion, stress corrosion etc.;
- **heat-resistant** steels and alloys resistant against chemical surface destruction in gas media at temperatures above 550°C and used without load or under light loads;
- **high-temperature** steels and alloys capable of operating with load at high temperatures during a certain time and retaining sufficient heat resistance.

REQUIREMENTS FOR ELECTRICAL INSTALLATIONS ... as to the spark safety of thermocouples.

Chapter 7.3. Electrical Installations in Ex-Zones

7.3.72. ...

1. ...

2. Spark-safe circuits can include components specified in technical documentation for the system and provided with the marking "Complete with ...". It is permissible to include commercial general-purpose transducers without an intrinsic current, inductance or capacity source in these circuits. Among these transducers are commercial general-purpose **resistance temperature detectors, thermocouples, thermal resistors**, LEDs and similar components enclosed into protection sheaths.

3. A circuit that consists of commercial general-purpose thermocouple and galvanometer (millivoltmeter) is spark-safe for any explosion hazard medium.

Physical-mechanical characteristics of ceramic sheaths of thermoelectric transducers

Sheath material	Material designation	Maximum operating temperature, °C	Basic characteristics of material at temperature of 20°C			Brief description of protection sheaths	Conditions of use and resistance to operating media
			Thermal expansion coefficient, $10^{-6}K^{-1}$	Thermal conductivity, W/(m.K)	Compressive strength, MPa		
SiO ₂ - silica ceramics	21	1300 (1200)*	0.5	2.05	80	high resistance to repeated thermal shocks	oxidative gas media, inert media, resistant in metal and salt melts, except for BaCl ₂
SiC - silicon carbide (carborundum)	22	1400	4.5	40-100 (various production methods)	250	high hardness, as well as wear and thermal resistance; high resistance to thermal shocks	oxidative gas media, inert media, abrasive media, resistant in metal melts, except for Al, including Cu (1200°C), Sn (up to 400°C), Pb (up to 600°C), Mg (up to 800°C) and Zn (up to 600°C), and in salt melts, except for BaCl ₂
Si ₃ N ₄ - silicon nitride	23	1600 (1500)*	3.2	32	600	heat resistance	gas media of all types, including Cl ₂ and H ₂ S, resistant in metal melts, except for Fe, Cu and Mg, as well as in borax glass and salt melts
Al ₂ O ₃ - high-purity corundum	24	1600	5.5	29.1	350	high hardness, heat resistance and gas tightness	oxidative gas media, inert media and vacuum
Al ₂ O ₃ - leucosapphire	25	1950	7.7-8.5	29.3	> 800	high hardness, heat resistance and gas tightness in entire temperature range	oxidative gas media, inert media and vacuum. Avoid shock cooling
KTVP (high-density corundum modified by TiO ₂)	26	1600	8.8	13	250	high hardness, heat resistance and gas tightness	oxidative gas media, inert media and vacuum
MKR (multilite-alumina ceramics)	27	1300	5.45	20	63.3	higher resistance to thermal shocks than that of corundum ceramics	oxidative gas media, inert media and vacuum
High-density graphite	28	800 (2000)**	4.9	50	150	high resistance to thermal shocks; nonwettable with metal and glass melts	oxidative gas media, inert media and vacuum; resistant in metal melts

Note: 1)* - The maximum operating temperature in melts; ** - The maximum operating temperature in vacuum and inert media; 2) - To avoid the destruction of a ceramic sheath due to a high temperature gradient when placed into an operating medium, ensure the rate of heating of a thermoelectric transducer not higher than 20°C/min for leucosapphire, 60°C/min for corundum and 100°C/min for silicon carbide or silicon nitride ceramics. Thermoelectric transducers enclosed into silica ceramics (SiO₂) sheaths suffer any rate of dipping into an operating medium with a temperature of up to 1300°C and withstand short-time heating to a temperature of 1700°C.

Physical-mechanical characteristics of materials of metal sheaths of thermoelectric transducers

Sheath material	Material designation	Maximum operating temperature, °C	Basic characteristics of material at temperature of 20°C			Intensive scale formation temperature, °C	Conditions of use and resistance to operating media
			Density, g/cm ³	Ultimate tensile strength, MPa	Relative elongation, %		
Platinum-rhodium alloy	10	1600	20.00	118 ³⁾	15 ³⁾	-	oxidative gas media, inert media and liquid glass
Molybdenum	11	2000 ¹⁾	10.3	600	10	-	oxidative gas media and hydrogen
CrNi45Al (EP747)	12	1250	7.76	600	33	1300	Gas flows, combustion products and oxidative gas media
CrNi78Ti (EI435)	13	1050	8.35	610	38	1100	Stationary oxidative gas media and gas flows, non-resistant in sulfur-containing media
10Cr23Ni18 (AISI 310)	14	1000	7.8	550	34	1050	Stationary oxidative gas media and gas flows, mechanical loads Resistant in operating media of methane reforming and pyrolysis processes
12Cr18Ni10Ti (AISI 321)	15	800 ²⁾	7.9	549	35	850	Oxidative gas and fluid media, gas and fluid flows Non-resistant in hydrochloric, sulfuric, fluohydric and hot phosphoric acids and in boiling organic acids
10Cr17Ni13Mo2Ti (AISI 316Ti)	16	800	8.1	529	40	900	Gas and fluid flows, mechanical loads Resistant in corrosive acidic media up to temperature of 400°C, including H2S solutions (up to concentration of 10%)
20Cr20Ni14Si2 (AISI 309)	17	1000	7.9	301	35	1100	Oxidative gas and fluid media, gas and fluid flows Resistant in carburizing media
15Cr25Ti (AISI 446)	18	1000	7.6	440	45	1050	Gas and fluid corrosive media, pyrolysis plants and furnace gas with increased sulfur content
St 3	19	800	7.8	370-470	25		Salt melts

Note: 1) - The maximum operating temperature of molybdenum in vacuum shall not exceed 1500°C.
 2) - The maximum operating temperature of steel 12Cr18Ni10Ti under mechanical loading shall not exceed 600°C.
 3) At the temperature of 800°C.

SECTION 1. TC-A TUNGSTEN-RHENIUM THERMOELECTRIC TRANSDUCERS

Manufactured in accordance with Technical Specifications 4211-003-14035255-03.

No. 27922 in the State Register of Measuring Instruments of the Russian Federation.



GENERAL TECHNICAL CHARACTERISTICS OF THE THERMOELECTRIC TRANSDUCERS

1. The measured temperature range according to GOST 6616-94, °C:

✓ TC-A - a tungsten-rhenium thermocouple

(W-Re 5/20) calibrations

A-1 from 0 to 2200
(up to 2500 for short time)

A-2 from 0 to 1800

A-3 from 0 to 1800

The use of three calibrations for thermoelectric transducers of a single type (W-Re 5/20) is caused by severities of the production of identical batches of thermocouple wires.

A-1 type corresponds to type A thermocouple in the standard IEC 60584- 1 and 2 (ed.2013).

2. The nominal static characteristic (NSC) and the tolerance class:

the NSC and the tolerance classes comply with the requirements of GOST 6616-94 and GOST R 8.585-2001. The maximum permissible deviations (deviation limits) of the TEMF from the rated values in the operating temperature range do not exceed the tabulated values.

TT type designation	TT NSC designation	Tolerance class	Operating temperature range, °C	Maximum permissible deviations from NSC, °C
TC-A	A-1	2	from 0 to 1000 over 1000 to 1950	± 5 $\pm 0.005 \cdot t $
		3	from 0 to 1000 over 1000 to 1950	± 7 $\pm 0.007 \cdot t $
	A-2; A-3	2	from 0 to 1000 over 1000 to 1800	± 5 $\pm 0.005 \cdot t $
		3	from 0 to 1000 over 1000 to 1800	± 7 $\pm 0.007 \cdot t $

Here, t is the temperature of the medium being measured, °C.

3. The operating temperature range:

the operating temperature range of the thermoelectric transducers is governed by the heat resistance, the high-temperature strength and the corrosion resistance of the material of the protection sheath provided that the effect of an oxidative media on the material of the thermocouple wires is eliminated.

Type	Operating temperature range, °C	Rated operating temperature, °C	Sheath material
TC-A	from 0 to 1800	1450	molybdenum (Mo)
	from 0 to 1400	1150	SiC ceramics
	from 0 to 1600	1300	Si ₃ N ₄ ceramics
	from 0 to 1800	1450	Al ₂ O ₃ ceramics
	from 0 to 1950	1600	leucosapphire (Al ₂ O ₃ single crystal)

4. Resistance to mechanical impacts:

the thermoelectric transducers shall withstand sinusoidal vibrational load in a frequency range of 5 to 25 Hz with a transition frequency shift of 0.1 mm for group L3 according to the requirements of GOST 12997-84.

Vibrational impacts on the disabled (cold) thermoelectric transducers after a few hours of single-step operation in a temperature range of 1300-1700°C shall be avoided because of the embrittlement of the thermocouple wires.

5. Climatic version: UHL2 according to the requirements of GOST 15150-69.

6. Water and dust resistance: corresponds to protection class IP55 according to the requirements of GOST 14254-96.

7. Average time to failure (min.):

- 600 h for an operating temperature range of 0 to 1600°C;
- 200 h for an operating temperature range of 0 to 1800°C;
- 100 h for the top limit of an operating temperature range over 1800°C.

8. The designation of the thermoelectric transducers:

$$\overbrace{\text{T C} - \text{A X} \text{ X X X} [\text{x}] - (2 \times 0, 3 5) - \text{d} - \text{L}}^{\begin{array}{cccccccc} 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 \end{array}}$$

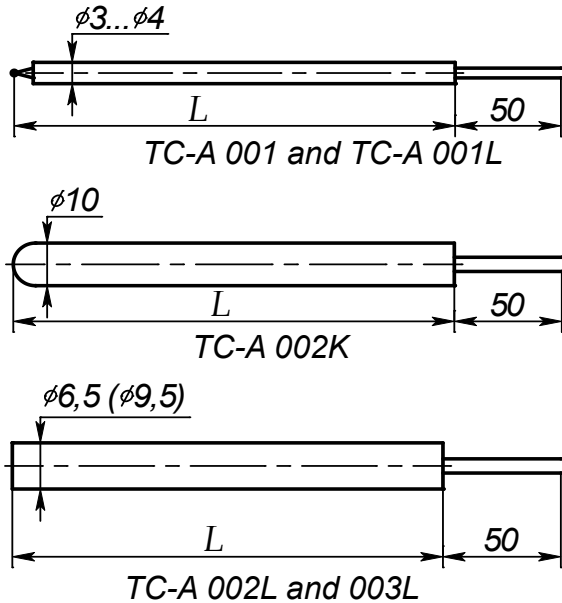
1. thermoelectric transducer (converter);
2. the NSC of the thermocouple of the thermoelectric transducer (A1, A2 or A3);
3. protection sheath type
(0 - exposed-junction thermoelectric transducer; 1 - metal sheath; 2 - ceramic sheath);
4. the code of the sheath material for the given protection sheath type (see the Table on pp. 7 and 8);
5. the number of the design version for the given sheath material;
6. the number of hot junctions (a single junction - not specified; 2 - two hot junctions);
7. the diameter of the thermocouple wires (2 x 0.5 mm - not specified);
8. the outer diameter of the refractory part of the protection sheath;
9. length of the mounting part.

9. List of versions of TC-A thermoelectric transducers:

Type	Number of sheath version	Outer sheath material	Operating temperature range, °C	Outer diameter d, mm	Number of hot junctions	Conditions of use (operating media)
TC-A	001	exposed-junction thermoelectric transducer	0-1800	3.0 (4.0)	1	inert gas, hydrogen or vacuum; used as sensitive elements (SE)
	001L	exposed-junction thermoelectric transducer	0-1950	3.0 (4.0)	1	inert gas, hydrogen or vacuum; used as sensitive elements (SE)
	002K	silica glass	0-1200 (1300 for sensitive elements (SE))	10	1	inert gas, hydrogen or vacuum; used as sensitive elements (SE)
	002L	leucosapphire	0-1800	6.5 (9.5)	1	inert gas, hydrogen or vacuum; used as sensitive elements (SE)
	003L	leucosapphire	0-1950	6.5 (9.5)	1	inert gas, hydrogen or vacuum; used as sensitive elements (SE)
	112	molybdenum	0-1500	9-16/20	1 or 2	vacuum ($\sim 10^{-5}$ mm Hg)
			0-1800			inert gas or hydrogen
	112L	molybdenum	0-1950	9-16/20	1 or 2	inert gas or hydrogen
	121K	CrNi45Al	0-1200	20	1 or 2	all types of gases or vacuum
	221K	SiC	0-1300	25/32	1 or 2	inert gas, oxidative gas medium or vacuum
	231K	Si ₃ N ₄	0-1300	25/32	1 or 2	inert gas, hydrogen,
	231L		0-1600			vacuum or oxidative gas medium
	241K	Al ₂ O ₃	0-1300	25/32	1 or 2	inert gas, oxidative gas medium or vacuum
	241L		0-1800			
	251	leucosapphire	0-1800	9.5/20	1	oxidative gas medium, inert gas, hydrogen or vacuum
	251L		0-1950			
	252		0-1800	6.5/12		
	252L		0-1950			
	253		0-1800	9.5/20		
	254		0-1800			

1.1. TC-A 001, TC-A 002 AND TC-A 003 EXPOSED-JUNCTION THERMOELECTRIC TRANSDUCERS

These thermoelectric transducers are designed for measuring temperature in non-corrosive gaseous media and vacuum.



The TC-A 001 exposed-junction thermoelectric transducers are supplied in a two-channel tube made of high-purity corundum (Al_2O_3). In order to increase the top limit of the operating temperature range to 1950°C, a custom-made leucosapphire (a single crystal of alumina) two-channel insulating tube for the thermocouple wires can be used (design version 001L).

The TC-A 002K, TC-A 002L and TC-A 003L thermoelectric transducers are supplied in sealed protection tubes made of silica glass (TC-A 002K) or leucosapphire (TC-A 002L and TC-A 003L) and filled with inert gas. The insulating element is a two-channel tube made of high-purity corundum (TC-A 002K and TC-A 002L) or leucosapphire (TC-A 003L). The tightness of the thermoelectric transducers makes them suitable for use in oxidative media.

The materials for the thermocouple wires of the thermoelectric transducers with calibrations A-1 and A-2 or A3 are wires made of tungsten-rhenium 5% (W-Re 5) and tungsten-rhenium 20% (W-Re 20) alloys.

The TC-A 001, TC-A 002 and TC-A 003 thermoelectric transducers serve as sensitive elements for thermoelectric transducers enclosed into protective sheaths.

Technical characteristics of exposed-junction thermoelectric transducers

Characteristic	Version				
	TC-A 001	TC-A 001L	TC-A 002K	TC-A 002L	TC-A 003L
Operating temperature range, °C	0-1800	0-1950	0-1200 (1300)	0-1800	0-1950
Protection tube material	Corundum	Leucosapphire	Silica glass	Leucosapphire	Leucosapphire
Operating pressure	0.1 MPa				
Tolerance class	2 or 3				
Number of hot junctions	1				
Diameter of thermocouple wires	0.5 mm				

Note: if necessary, the thermoelectric transducers can be equipped with thermocouple wires of other diameters, which shall be explicitly stated in the order.

List of versions of exposed-junction thermoelectric transducers

Version	Outer diameter, mm	Length of mounting part, mm							
		320	500	630	800	1000	1250	1600	2000
TC-A 001	4.0	+	+	+	+	+	+	+	+
TC-A 001L	4.0	+	+	+	+	+	+	+	+
TC-A 002K	10	+	+	+	+	+	+	+	+
TC-A 002L	6.5 (9.5)	+	+	+	+	+	+	—	—
TC-A 003L	6.5 (9.5)	+	+	+	+	+	+	—	—

Designation: TC-A1 (A2; A3) 001-**d**-**L**,

where **d** is the corundum tube diameter and **L** is the length of the mounting part.

An example of notation in the order:

TC-A1 001-3-500 - the tungsten-rhenium thermoelectric transducer, with calibration **A-1**, of design version **001**, with 0.5-mm thermocouple wires, a 3-mm in diameter (**d**) corundum tube and a 500-mm length of the mounting part (**L**);

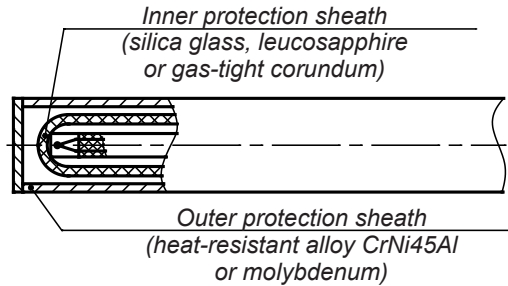
TC-A1 002K-(2 x 0.35)-10-500 - the tungsten-rhenium thermoelectric transducer, with calibration **A-1**, of design version **002K**, with 0.35-mm thermocouple wires, a 10-mm in diameter (**d**) sealed silica glass protective tube and a 500-mm length of the mounting part (**L**).

Unless specially noticed, the TC-A thermoelectric transducers are supplied of accuracy class 3 with 0.5-mm thermocouple wires.

1.2. TC-A 112 AND TC-A 121 THERMOELECTRIC TRANSDUCERS IN METAL SHEATHS

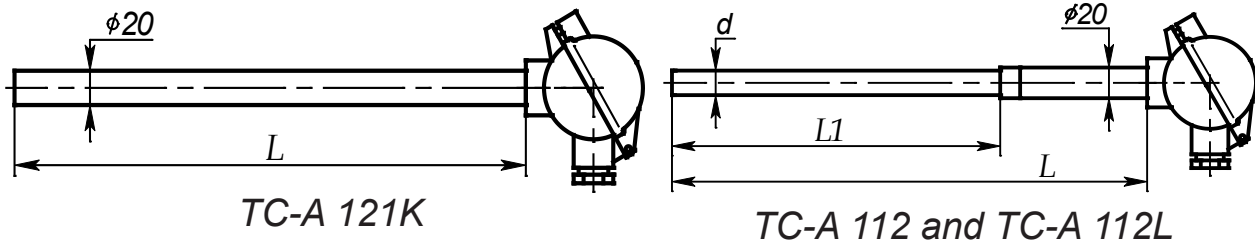
These thermoelectric transducers are designed for measuring temperature in high-temperature inert-gas and hydrogen media, which do not induce the destruction of the protection sheath material, as well as in vacuum.

The thermoelectric transducers are enclosed into double protection sheaths. The outer sheath is made of a metal and the inner sheath is made of silica glass (TC-A 121K) or leucosapphire (TC-A 112 and TC-A 112L). In order to increase the top limit of the operating temperature range to 1950°C, a custom-made leucosapphire (a single crystal of alumina) two-channel insulating tube for the thermocouple wires can be used (design version 112L).



The TC-A 112 and TC-A 112L thermoelectric transducers are enclosed into two-part sheaths. The working part of the sheath 600 mm long and 9-16 mm in diameter is made of molybdenum and the other part of the sheath 20 mm in diameter is made of stainless steel 12Cr18Ni10Ti. During operation, the welded joint shall not be subjected to a temperature over 800°C.

The TC-A 121K thermoelectric transducers are enclosed into solid-metal sheaths 20 mm in diameter made of heat-resistant alloy CrNi45Al.



The thermoelectric transducers can be used with movable sleeves. Mounting units of the thermoelectric transducers can be manufactured using Customer's working drawings. The protection sheaths and tubes are sealed. The TC-A 121K thermoelectric transducers can be used in oxidative media.

Technical characteristics of thermoelectric transducers

Characteristic	Version		
	TC-A 112	TC-A 112L	TC-A 121K
Operating temperature range, °C	0-1800	0-1950	0-1200
Protection tube material	molybdenum / 12Cr18Ni10Ti	molybdenum / 12Cr18Ni10Ti	CrNi45Al
Rated pressure range, MPa	vacuum; 0.1-0.4		
Tolerance class	2 or 3		
Number of hot junctions	1 or 2		
Diameter of thermocouple wires, mm	0.5		
Thermal inertia index, s	240 max.		

Note: If necessary, the thermoelectric transducers can be equipped with thermocouple wires of other diameters, which shall be explicitly stated in the order.

List of versions of TC-A thermoelectric transducers enclosed into metal sheaths

Version	Outer diameter d, mm	Outer sheath material	Length of mounting part, mm				
			800	1000	1250	1600	2000
TC-A 112	9, 10 12 and 16	molybdenum / 12Cr18Ni10Ti	+	+	+	+	+
TC-A 112L	9, 10 12 and 16	molybdenum / 12Cr18Ni10Ti	+	+	+	+	+
TC-A 121K	20	CrNi45Al	+	+	+	+	+

Designation: TC-A1 (A2; A3) XXX-d-L,

where **XXX** is the number of the version, **d** is the protection sheath diameter and **L** is the length of the mounting part.

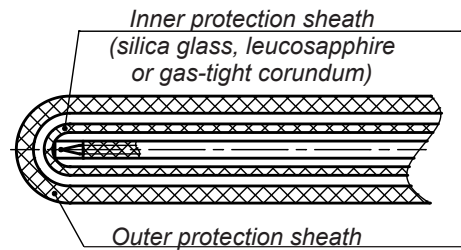
An example of notation in the order: TC-A1 112-10-1000 - the tungsten-rhenium thermoelectric transducer, with calibration **A-1**, in a molybdenum sheath, of design version **112**, with a diameter (**d**) of 10 mm and a 1000-mm length of the mounting part (**L**).

Unless specially noticed, the thermoelectric transducers are supplied of accuracy class 3.

1.3. TC-A 221, 231, 241 AND 251 THERMOELECTRIC TRANSDUCERS IN CERAMIC SHEATHS

These thermoelectric transducers are designed for measuring temperature in high-temperature gaseous oxidative, inert and hydrogen media, which do not induce the destruction of the protection sheath material, as well as in vacuum.

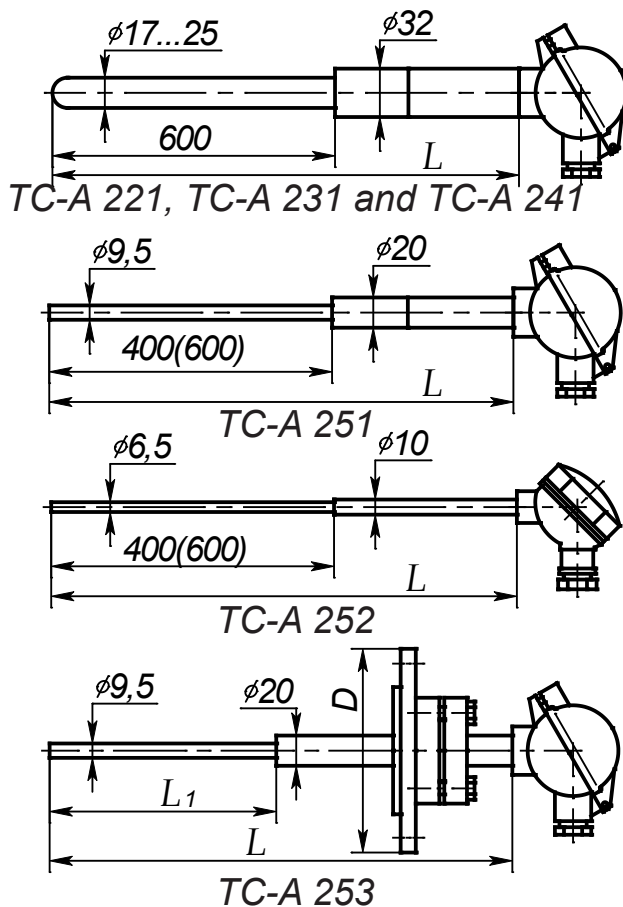
The thermoelectric transducers are enclosed into double ceramic sheaths. The sealed inner sheath is made of silica glass (K) or leucosapphire (L) and the outer sheath is made of silicon carbide (SiC) for version 221, silicon nitride (Si_3N_4) for version 231 and corundum (Al_2O_3) for version 241. The thermoelectric transducers of versions 251, 252 and 253 are enclosed into a whole sheath made of leucosapphire (a single crystal of Al_2O_3).



To avoid the ingress of ambient oxygen into the inner sheath, the thermocouple wires are sealed in the sheath and in the thermocouple head. This allows one to use the thermoelectric transducers in oxidative gas media instead of precious-metal thermocouples.

The design of the TC-A 251 thermoelectric transducers is covered by utility patent No. 42311 on November 27, 2004.

The outer sheath of the thermoelectric transducer is partly reinforced with a steel covering pipe. The high-temperature part of the metal reinforcing element of the sheath is made of alloy CrNi45Al and is designed to withstand a temperature of up to 1200 °C. The length of the ceramic part of the sheath is equal to 600 mm for all lengths of the mounting part of the thermal transducers, except for TC-A 251. The thermocouple wires of the thermoelectric transducers are put in a two-channel tube made of oxide ceramics (Al_2O_3).



Technical characteristics of TC-A thermoelectric transducers enclosed into ceramic sheaths

Characteristic	221K	231K	231L	241K	241L	251	251L	252	252L	253	253L
NSC	A-1; A-2 or A-3										
Protection tube material	SiC	Si ₃ N ₄	Si ₃ N ₄	Al ₂ O ₃	Al ₂ O ₃	Leucosapphire					
Maximum operating temperature, °C	1300	1300	1600	1300	1800	1800	1950	1800	1950	1800	1950
Thermal inertia index, s	240		240			120					
Rated pressure range, MPa	0-1.0 (with movable sleeve manufactured using Customer's drawings)										
Tolerance class	2 or 3										
Number of hot junctions	1 or 2										
Diameter of thermocouple wires, mm	0.5										

To avoid the destruction of a ceramic sheath due to a high temperature gradient when placed into an operating medium, ensure the heating rate of a thermoelectric transducer not higher than 20°C/min for leucosapphire, 60°C/min for corundum or silicon nitride and 100°C/min for silicon carbide or silicon nitride ceramics. At temperatures above 1000°C, avoid the direct contact of oxide ceramics with graphite.

List of versions of TC-A thermoelectric transducers enclosed into ceramic sheaths

Version	Outer diameter, mm	Length of mounting part, mm						
		500	630	800	1000	1250	1600	2000
TC-A 221K	25/32	-	-	+	+	+	+	+
TC-A 231K TC-A 231L	25/32	-	-	+	+	+	+	+
TC-A 241K TC-A 241L	17/32	-	-	+	+	+	+	+
TC-A 251 TC-A 251L	9.5/20	+	+	+	+	+	+	+
TC-A 252 TC-A 252L	6.5/12	+	+	+	+	+	-	-
TC-A 253	9.5/20	+	+	+	+	+	+	+

Designation: TC-A1 (A2; A3) XXX-d-L

where **XXX** is the number of the version, **d** is the protection sheath diameter and **L** is the length of the mounting part.

An example of notation in the order:

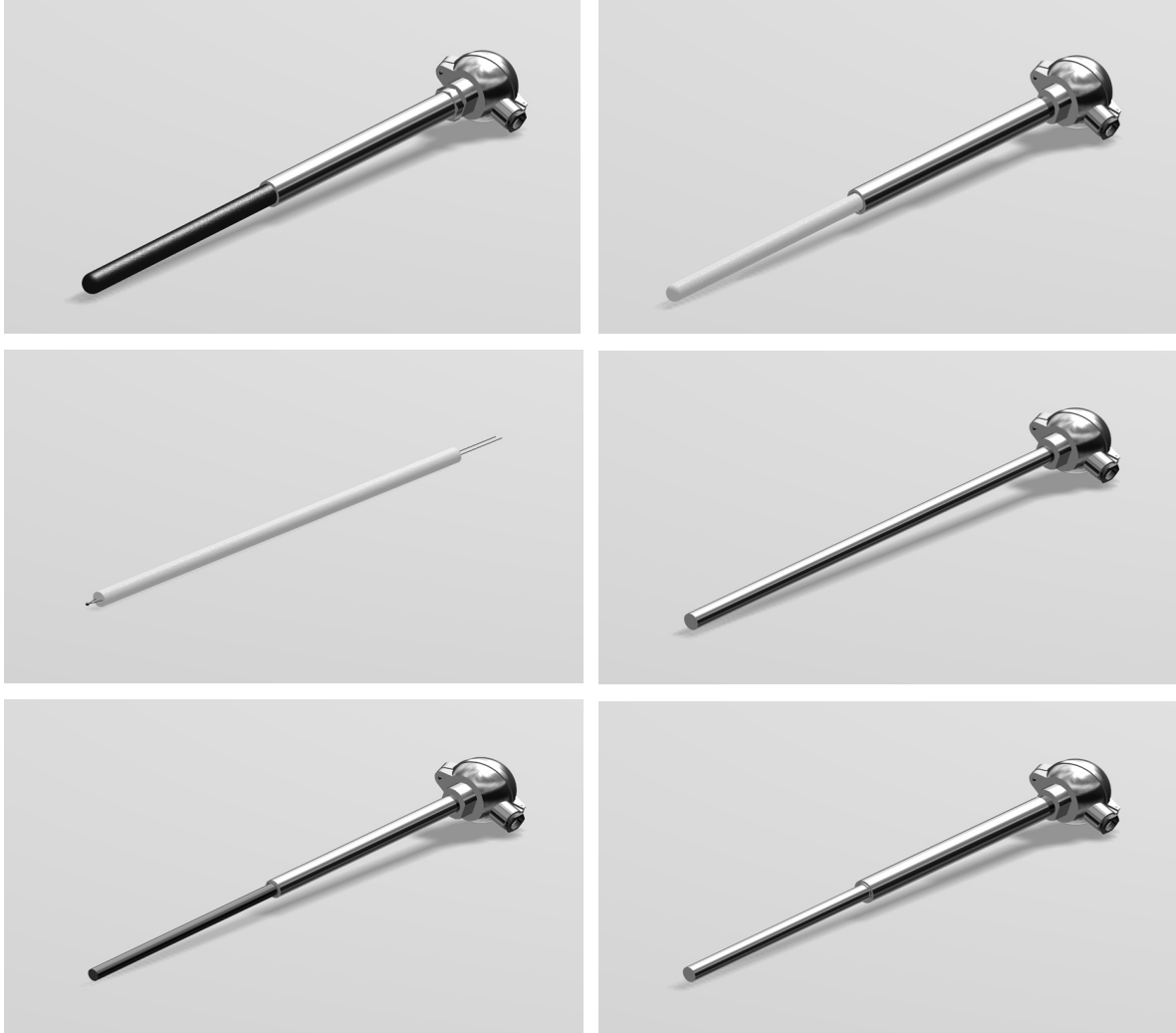
TC-A1 241K-17-1000 - tungsten-rhenium thermoelectric transducer, with calibration **A-1**, in a corundum (24) outer sheath, of design version **241**, in a silica glass (**K**) inner sheath, with an outer diameter (**d**) of 17 mm and a 1000-mm length of the mounting part (**L**).

Unless specially noticed, the TC-A thermoelectric transducers are supplied of accuracy class 3.

SECTION 2. TC-S AND TC-B THERMOELECTRIC TRANSDUCERS BASED ON PRECIOUS-METAL THERMOCOUPLES

Manufactured in accordance with Technical Specifications 4211-001-14035255-03.

No. 26589 in the State Register of Measuring Instruments of the Russian Federation.



GENERAL TECHNICAL CHARACTERISTICS OF THE THERMOELECTRIC TRANSDUCERS

1. The measured temperature range according to GOST 6616-94, °C:

- ✓ TC-S - a platinum-verse platinum-rhodium thermocouple TPP 10 (type S) from 0 to 1300
(up to 1600 for short time)
- ✓ TC-B - a platinum-rhodium-verse platinum-rhodium thermocouple TPR (type B) from 600 to 1700

2. The nominal static characteristic (NSC) and the tolerance class:

the NSC and the tolerance classes comply with the requirements of GOST 6616-94 and GOST R 8.585-2001. The maximum permissible deviations of the TEMF from the rated values in the operating temperature range do not exceed the tabulated values.

Thermoelectric transducer type	Tolerance class	Operating temperature range, °C	Maximum permissible deviations from NSC, °C
TC-S	1	from 0 to 1100 from 1100 to 1300	± 1.0 $\pm [1.0 + 0.003(t - 1100)]$
	2	from 0 to 600 from 600 to 1300	± 1.5 $\pm 0.0025 \cdot t $
TC-B	2	from 600 to 1700	$\pm 0.0025 \cdot t $
	3	from 600 to 800 from 800 to 1700	± 4.0 $\pm 0.005 \cdot t $

Here, t is the temperature of the medium being measured, °C.

3. The operating temperature range:

the operating temperature range of the thermoelectric transducers is governed by the type of the sensitive element, as well as the heat resistance, the high-temperature strength and the corrosion resistance of the material of the protection sheath.

Type	Operating temperature range, °C	Rated operating temperature, °C	Sheath material
TC-S	from 0 to 1250	1085	alloy CrNi45Al
	from 0 to 1300	1085	molybdenum (Mo)
	from 0 to 1300	1085	ceramics (SiO ₂ , SiC, Si ₃ N ₄ and Al ₂ O ₃)
TC-B	from 600 to 1700	1450	molybdenum (Mo) for inert and hydrogen media
	from 600 to 1500	1200	molybdenum (Mo) for vacuum
	from 600 to 1300	1085	silica (SiO ₂)
	from 600 to 1400	1150	silicon carbide (SiC)
	from 600 to 1600	1300	silicon nitride (Si ₃ N ₄)
	from 600 to 1700	1450	corundum (Al ₂ O ₃)

4. Resistance to mechanical impacts:

The thermoelectric transducers shall withstand sinusoidal vibrational load in a frequency range of 5 to 25 Hz with a transition frequency shift of 0.1 mm for group L3 according to the requirements of GOST 12997-84.

5. Climatic version: UHL2 according to the requirements of GOST 15150-69.

6. Water and dust resistance: corresponds to protection class IP55 according to the requirements of GOST 14254-96.

7. Average time to failure: not less than 6000 h when used at the rated operating temperature.

8. The designation of the thermoelectric transducers:

$\text{TC} - \text{X} \text{ X X X } [\text{x}] - (0, 4 / 0, 5) - \text{d} - \text{L}$

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1. thermoelectric transducer (converter);
2. NSC of the thermocouple of the thermal transducer (S or B);
3. protection sheath type
(0 - exposed-junction thermoelectric transducer; 1 - metal sheath; 2 - ceramic sheath);
4. the code of the sheath material for the given protection sheath type (see the Table on pp. 7 and 8);
5. the number of the design version for the given sheath material;
6. the number of hot junctions (a single junction - not specified; 2 - two hot junctions);
7. the diameter of the thermocouple wires (0.5/0.5 mm - not specified);
8. the outer diameter of the refractory part of the protection sheath;
9. length of the mounting part.

9. List of versions of TC-S and TC-B thermoelectric transducers

TT type	Number of version	Outer sheath material	Operating temperature range, °C	Outer diameter d, mm	Number of hot junctions	Conditions of use (operating media)	
TC-S	001	—	0-1300	2.5, 3.2 and 4.0	1	oxidative gas medium or inert medium; used as sensitive elements (SE)	
	121	CrNi45Al	0-1250	20	1 or 2	all types of gases or vacuum	
	121L	CrNi45Al	0-1250	20	1 or 2	hydrogen or gas media of all types	
	121U	CrNi45Al	0-1250	20	1 or 2	metal and salt melts	
	105 105L	platinum-rhodium alloy	0-1300	7-12/21 (32)	1 or 2	glass melts and corrosive fluids	
	106 106L	platinum-rhodium alloy	0-1300	7-12/20 (32)	1 or 2	glass melts and corrosive fluids	
	112	molybdenum	0-1300	16/20	1 or 2	inert gas, hydrogen or vacuum	
	122	CrNi45Al	0-1250	20/32	1 or 2	all types of gases or vacuum	
	124U	CrNi45Al	0-1250	40	1 or 2	metal and salt melts	
	144U	10Cr23Ni18	0-1250	40	1 or 2	metal and salt melts	
	154U	Cr18Ni10Ti	0-1250	40	1 or 2	metal and salt melts	
	221 221U	SiC	0-1300	25/32	1 or 2	oxidative gas medium, inert medium or abrasive medium, as well as metal (except for aluminum) and salt (except for BaCl ₂) melts	
	231 231U	Si ₃ N ₄	0-1300	25/32	1 or 2	gas media of all types, including Cl ₂ and H ₂ S, as well as metal (except for copper), borax glass and salt melts	
	241	Al ₂ O ₃	0-1300	25/32	1 or 2	oxidative gas media, inert media and vacuum	
	242			12 (10)/20	1 or 2		
	251	Al ₂ O ₃ - leucosapphire		9.5/20	1 or 2		
	252			6.5/12	1		
	261	Al ₂ O ₃ - KTVP		22/32	1 or 2		
	TC-B	001		—	600-1600		2.5, 3.2 and 4.0
		105 105L	platinum-rhodium alloy	0-1600	7-12/21 (32)	1 or 2	glass melts and corrosive fluids
106 106L		platinum-rhodium alloy	0-1600	7-12/20 (32)	1 or 2	glass melts and corrosive fluids	
112		molybdenum	600-1700	16/20	1 or 2	inert gas or hydrogen	
			600-1500			vacuum	
221 221U		SiC	600-1400	25/32	1 or 2	oxidative gas medium, inert medium or abrasive medium, as well as metal (except for aluminum) melts	
231		Si ₃ N ₄	600-1600	25/32	1 or 2	gas media of all types	
			600-1500			metal (except for copper and iron) and salt melts	
231U			600-1600	25/32	1 or 2	gas media of all types	
			600-1500			metal (except for copper and iron), borax glass and salt melts	
241		Al ₂ O ₃	600-1600	25/32	1 or 2	oxidative gas media, inert media and vacuum	
251		Al ₂ O ₃ - leucosapphire	600-1700	9.5/20	1 or 2		
252				6.5/12	1		
261	Al ₂ O ₃ - KTVP	600-1600	22/32	1 or 2			

2.1. TC-S(B) 001 EXPOSED-JUNCTION THERMOELECTRIC TRANSDUCERS

These thermoelectric transducers are designed to measure high temperatures of non-corrosive gaseous media.

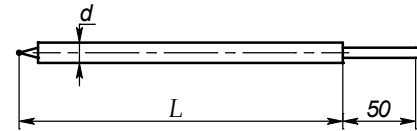
The TC-S(B) 001 exposed-junction thermoelectric transducers are supplied in two-channel corundum tubes. The thermocouple wires are made of the following alloys:

platinum 10% - rhodium/platinum for the S type;

platinum 30% - rhodium/platinum 6% - rhodium for the

B type.

The TC-S(B) 001 thermoelectric transducers serve as sensitive elements for thermoelectric transducers enclosed into protective sheaths.



TC-S(B) 001

Technical characteristics of exposed-junction thermoelectric transducers

Characteristic	TC-S 001	TC-B 001
Operating temperature range, °C	0-1300	600-1600
Operating pressure, MPa	0.1	
Tolerance class	1 or 2	2 or 3
Protection tube material	corundum (Al ₂ O ₃ , purity 99.5%)	
Number of hot junctions	1	
Diameter of thermocouple wires, mm	0.5/0.5	

Note: if necessary, the thermoelectric transducers can be equipped with thermocouple wires of other diameters (0.4+/0.5, 0.4/0.4 and 0.3/0.3), which shall be explicitly stated in the order.

List of versions of exposed-junction thermoelectric transducers

Version	Outer diameter, mm	Length of mounting part L, mm							
		320	500	630	800	1000	1250	1600	2000
TC-S 001 TC-B 001	2.2, 2.5, 3.2 and 4.0	+	+	+	+	+	+	+	+

Designation: TC-S 001-d-L or TC-B 001-d-L

where d is the corundum tube diameter and L is the length of the mounting part.

An example of notation in the order:

TC-S 001-3-500 - the thermoelectric conductor with calibration S, of design version **001**, with a 0.5-mm thermocouple wire made of the alloy PtRh30 and a 0.5-mm thermocouple wire made of the alloy PtRh6, in a 3-mm in diameter (**d**) two-channel corundum tube, with a 500-mm length (**L**) of the mounting part.

TC-B 001-(0.4/0.5)-3-600 - the thermoelectric conductor with calibration **B**, of design version **001**, with a 0.4-mm thermocouple wire made of the alloy PtRh30 and a 0.5-mm thermocouple wire made of the alloy PtRh6, in a 3-mm in diameter (**d**) two-channel corundum tube, with a 600-mm length (**L**) of the mounting part.

Unless specially noticed, the TC-S thermoelectric transducers are supplied of accuracy class 2 and the TC-B thermoelectric transducers are supplied of accuracy class 3, both with 0.5-mm thermocouple wires.

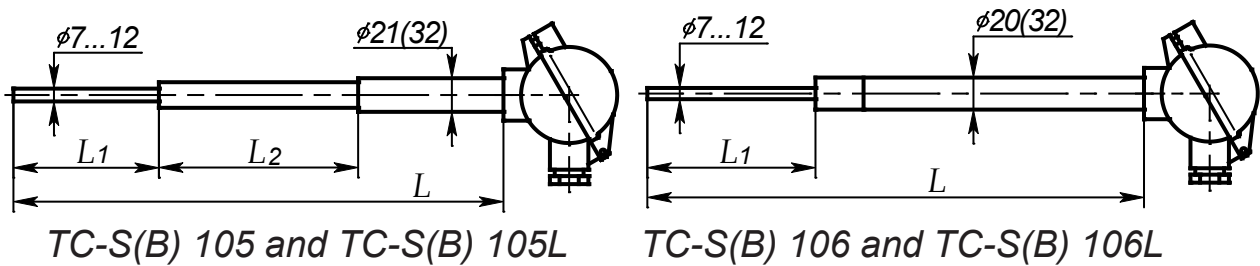
2.2. TC-S(B) 105, TC-S(B) 105L, TC-S(B) 106 AND TC-S(B) 106L THERMOELECTRIC TRANSDUCERS IN PLATINUM-RHODIUM SHEATHS

These thermoelectric transducers are designed to measure temperature of glass melts and highly corrosive media.

The TC-B 105 and TC-B 105L thermoelectric transducers are enclosed into double sheaths. The inner sheath is made of corundum or leucosapphire (L). The outer sheath consists of the three following parts: the dip part of the sheath with a length L_1 and a diameter of 7-12 mm, which is made of the platinum-rhodium alloy, the part of the sheath with a length L_2 , which is made of corundum ceramics, and the rest part of the sheath, which is made of the stainless steel 12Cr18Ni10Ti.

The TC-S(B) 106 and TC-S(B) 106L thermoelectric transducers are enclosed into double sheaths. The inner sheath is made of corundum or leucosapphire. The outer sheath consists of the three following parts: the dip part of the sheath with a length L_1 and a diameter of 7-12 mm, which is made of the platinum-rhodium alloy, the adapter sleeve, which is made of the high-temperature alloy CrNi45Al, and the rest part of the sheath, which is made of the heat-resistant steel 10Cr23Ni18 or the stainless steel 12Cr18Ni10Ti.

The length of the dip part of the thermoelectric transducer (the platinum-rhodium sheath) shall be explicitly stated in the order.



Technical characteristics of thermoelectric transducers

Characteristic	TC-S 105 TC-S 106	TC-S 105L TC-S 106L	TC-B 105 TC-B 106	TC-B 105L TC-B 106L
Operating temperature range, °C	0-1300		600-1600	
Operating pressure, MPa	0.1			
Tolerance class	1 or 2		2 or 3	
Inner protection sheath material	corundum	leucosapphire	corundum	leucosapphire
Number of hot junctions	1, 2 or 3			
Diameter of thermocouple wires, mm	0.5/0.5			
Thermal inertia index, s, max.	120			

List of versions of thermoelectric transducers

Version	Outer diameter, mm	Outer sheath material	Length of mounting part, mm				
			500	630	800	1000	1250
TC-S 105	7-12/21 (32)	alloy PR10 / corundum / steel 12Cr18Ni10Ti	+	+	+	+	+
TC-S 105L	7-12/21 (32)	alloy PR10 / corundum / steel 12Cr18Ni10Ti	+	+	+	+	+
TC-S 106	7-12/21 (32)	alloy PR10 / alloy CrNi45Al / steel 10Cr23Ni18	+	+	+	+	+
TC-S 106L	7-12/21 (32)	alloy PR10 / alloy CrNi45Al / steel 10Cr23Ni18	+	+	+	+	+
TC-B 105	7-12/20 (32)	alloy PR10 / corundum / steel 12Cr18Ni10Ti	+	+	+	+	+
TC-B 105L	7-12/20 (32)	alloy PR10 / corundum / steel 12Cr18Ni10Ti	+	+	+	+	+
TC-B 106	7-12/20 (32)	alloy PR10 / alloy CrNi45Al / steel 10Cr23Ni18	+	+	+	+	+
TC-B 106L	7-12/20 (32)	alloy PR10 / alloy CrNi45Al / steel 10Cr23Ni18	+	+	+	+	+

Designation: **TC-S XXX - d×t - D_c/D-L/L_p/L_c** or **TC-B XXX - d×t - D_c/D-L/L_p/L_c**, where **XXX** is the number of the version, **d** is the platinum-rhodium protection sheath diameter, **t** is the wall thickness of the platinum-rhodium protection sheath, **L** is the length of the mounting part, **L_p** is the length of the working part of the platinum sheath and **L_c** is the length of the corundum part of the sheath.

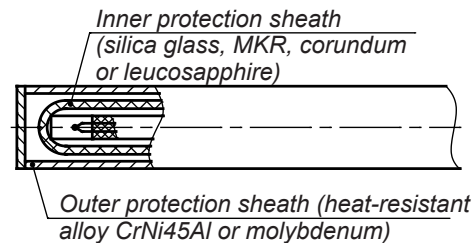
An example of notation in the order: TC-S 106 - 8 x 0.5 - 15/20 - 1000/200 - the thermoelectric transducer with calibration **S**, of design version **106**, in a 8-mm in diameter (**d**) platinum-rhodium alloy protection sheath with a 0.5-mm thick (**t**) wall and a 200-mm length of the working part (**L_p**), with a corundum inner protection sheath, with a 1000-mm total installation length (**L**).

Unless specially noticed, the TC-S thermoelectric transducers are supplied of accuracy class 2 and the TC-B thermoelectric transducers are supplied of accuracy class 3.

2.3. TC-S 121, 122 AND TC-S(B) 112 THERMOELECTRIC TRANSDUCERS IN METAL SHEATHS

These thermoelectric transducers are designed for measuring temperature of high-temperature gaseous media, which do not induce the destruction of the protection sheath material.

The thermoelectric transducers are enclosed into double protection sheaths. The outer sheath is made of a metal. The inner protection sheath is made of corundum (Al₂O₃) or leucosapphire (a single crystal of alumina); the latter is used to provide the best possible protection of the thermocouple wires, e.g., in hydrogen. If a leucosapphire protective sheath is used, the number of the version is added with letter L (e.g., TC-S 121L).

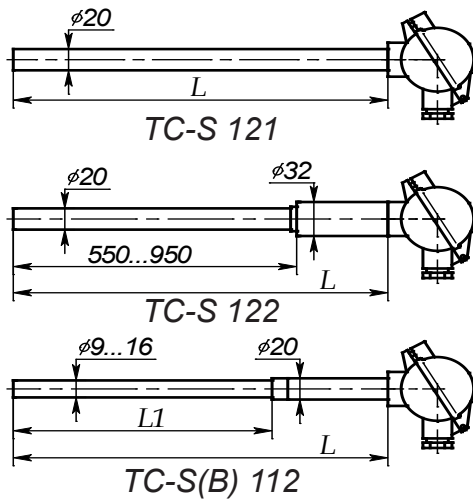


For the TC-S 121 thermoelectric transducers, heat-resistant solid-metal protection sheaths made of the alloy CrNi45Al are used.

The TC-S 122 thermoelectric transducers are enclosed into two-part sheaths. The use of two-part sheaths is recommended to increase the sheath rigidity. The working part of the sheath 550-950 mm long and 20 mm in diameter is made of the heat-resistant alloy CrNi45Al and the other part of the sheath 32 mm in diameter is made of the heat-resistant steel 10Cr23Ni18 or the stainless steel 12Cr18Ni10Ti. The two parts of the sheath are welded together using argon-arc welding. During operation, the welded joint shall not be subjected to a temperature over 1000°C (800°C for the steel 12Cr18Ni10Ti). The outer diameter **d** of the metal protection sheath of the TC-S 122 thermoelectric transducer is double designated as 20/32 mm.

The TC-S(B) 112 thermoelectric transducers are enclosed into two-part sheaths with a molybdenum working part 600 mm long and 16 mm in diameter. The other part of the sheath 20 mm in diameter is made of the heat-resistant alloy CrNi45Al or the steel 12Cr18Ni10Ti. During operation, the welded joint shall not be subjected to a temperature over 800°C. These thermoelectric transducers are only suitable for use in inert gases, such as nitrogen or argon, as well as in hydrogen and vacuum.

The thermoelectric transducers can be used with movable sleeves. Mounting units of the thermoelectric transducers can be manufactured using Customer's working drawings.



Technical characteristics of thermoelectric transducers

Characteristic	TC-S 121	TC-S 122	TC-S 112	TC-B 112
Maximum operating temperature, °C	1250	1250	1300	1700*
Rated pressure range, MPa	0.1-0.4			
Tolerance class	1 or 2			2 or 3
Protection tube material	CrNi45Al	CrNi45Al/ 10Cr23Ni18	molybdenum / 12Cr18Ni10Ti	
Number of hot junctions	1 or 2			
Diameter of thermocouple wires, mm	0.5/0.5			
Thermal inertia index, s, max.	120			

Note: * - The maximum operating temperature in vacuum is 1500°C

List of versions of thermoelectric transducers

Version	Outer diameter, mm	Outer sheath material	Length of mounting part, mm						
			500	630	800	1000	1250	1600	2000
TC-S 121	20	CrNi45Al	+	+	+	+	—	—	—
TC-S 122	20/32	CrNi45Al/10Cr23Ni18	—	—	—	—	+	+	+
TC-S(B) 112	9-16/20	molybdenum/CrNi45Al	+	+	+	+	+	+	+

Designation: **TC-S(B) XXX-d-L**,

where **XXX** is the number of the version, **d** is the protection sheath diameter and **L** is the length of the mounting part.

An example of notation in the order: **TC-S 121-20-1000** - the thermoelectric transducer with calibration **S**, in a smooth heat-resistant sheath of design version **121** made of the alloy CrNi45Al, with a diameter (**d**) of 20 mm and a length of the mounting part (**L**) of 1000 mm.

Unless specially noticed, the TC-S thermoelectric transducers are supplied of accuracy class 2 and the TC-B thermoelectric transducers are supplied of accuracy class 3.

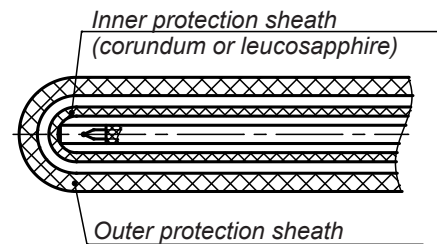
2.4. TC-S(B) 221, 231, 241, 251, 261, 252 AND TC-S 242 THERMOELECTRIC TRANSDUCERS IN CERAMIC SHEATHS

These thermoelectric transducers are designed for measuring the temperature of high-temperature non-corrosive gaseous media, as well as corrosive media, which do not induce the destruction of the protection sheath material. Versions TC-S(B) 221 and 231 can also be used to measure the temperature of metal and salt melts (see the table of the physical-mechanical characteristics of ceramic sheaths).

The thermoelectric transducers of versions 221, 231, 241 and 261 are enclosed into two-part ceramic sheaths. The inner sheath is made of high-purity gas-tight corundum (Al_2O_3) or leucosapphire (L) and the outer sheath is made of silicon carbide (SiC) for version 221, silicon nitride (Si_3N_4) for version 231 and corundum (Al_2O_3) for versions 241 and 261.

The thermoelectric transducers of versions TC-S(B) 242, TC-S(B) 251 and TC-S(B) 252 are enclosed into one-piece sheaths made of high-purity gas-tight corundum (Al_2O_3) for version TC-S(B) 242 or a single crystal of alumina (leucosapphire) for versions TC-S(B) 251 and TC-S(B) 252, which provides the best possible protection of the thermocouple wires against the impact of the operating medium.

The outer sheath of the thermoelectric transducer is partly reinforced with a steel covering pipe. The metal reinforcing element of the sheath is made of the steel 10Cr23Ni18 and is designed to withstand a temperature of up to 1000 °C. The high-temperature part of the metal reinforcing element of the sheath for versions TC-B 231, 241, 251, 261 and 242 is made of the alloy CrNi45Al and is designed to withstand a temperature of up to 1200 °C.



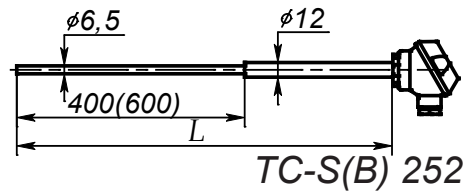
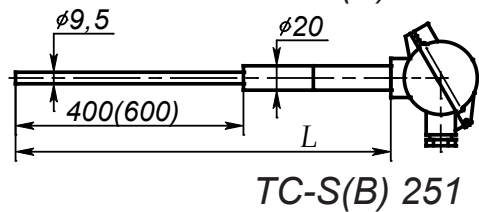
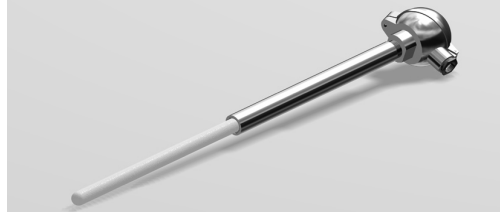
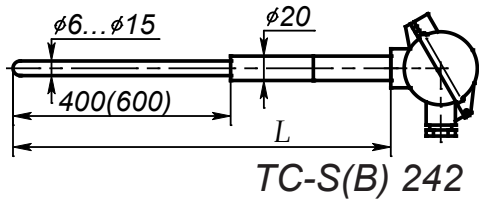
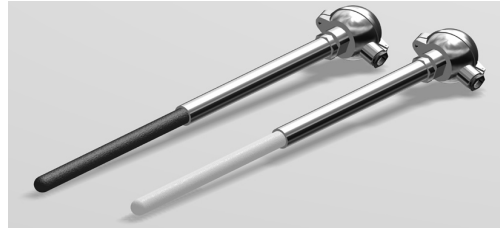
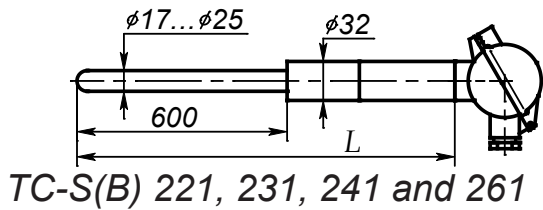
The length of the ceramic part of sheaths for the thermoelectric transducers of versions 221, 231, 241 and 261 is equal to 600 mm for all lengths of the mounting part of the thermoelectric transducer.

The length of the ceramic part of sheaths for the thermoelectric transducers of versions 251, 242 and 252 is equal to 400 mm for the lengths of the mounting part of the thermoelectric transducer of 500 and 630 mm and 600 mm for other lengths of the mounting part of the thermoelectric transducer.

The thermocouple wires of the thermoelectric transducers over a length of up to 1000 mm are reinforced with a two-channel solid tube made of high-purity oxide ceramics (Al_2O_3 , purity over 99.5%), which protects the thermocouple wires in the entire high-temperature area and eliminates a possibility of their breaks at the joints of the tubes. In all versions of the TTs, thermocouple wires 0.5 mm in diameter are used since reducing the diameter, e.g., to 0.4 mm, halves the mechanical strength of the thermocouple wires.

Technical characteristics of TC-S thermoelectric transducers enclosed into ceramic sheaths

Characteristic	TC-S 221	TC-S 231	TC-S 241	TC-S 251	TC-S 261	TC-S 242	TC-S 252
Protection tube material	SiC	Si_3N_4	Al_2O_3	Leucosap- phire	KTVP	Al_2O_3	Leucosap- phire
Operating temperature range, °C	0-1300						
Number of hot junctions	1 or 2						
Thermal inertia index, s	240			120	240	120	120
Tolerance class	1 or 2						
Diameter of thermocouple wires, mm	0.5/0.5						
Rated pressure range, MPa	0-1.0 (with movable sleeve manufactured using Customer's drawings)						



Technical characteristics of TC-B thermoelectric transducers enclosed into ceramic sheaths

Characteristic	TC-B 221	TC-B 231	TC-B 241	TC-B 251	TC-B 261	TC-B 252
Protection tube material	SiC	Si ₃ N ₄	Al ₂ O ₃	Leucosapphire	KTVP	Leucosapphire
Operating temperature range, °C	600-1400	600-1600 (600-1500)*	600-1700			
Number of hot junctions	1 or 2					
Thermal inertia index, s	240			120	240	120
Tolerance class	2 or 3					
Diameter of thermocouple wires, mm	0.5/0.5					
Rated pressure range, MPa	0-1.0					

Note: 1) * - Operating temperature range in melt.

2) To avoid the destruction of a ceramic sheath due to a high temperature gradient when placed into an operating medium, ensure the rate of heating of a thermoelectric transducer not higher than 60°C/min for corundum, 100°C/min for silicon carbide or silicon nitride ceramics and 20°C/min for leucosapphire.

3) The thermoelectric transducers designed for use at excess pressure of the operating medium are supplied in the sealed version (the thermocouple wires are sealed in the terminal head), which shall be explicitly stated in the order.

List of versions of TC-S and TC-B thermoelectric transducers enclosed into ceramic protection sheaths

Version	Outer diameter, mm	Length of mounting part, mm						
		500	630	800	1000	1250	1600	2000
TC-S 221	25/32	—	—	+	+	+	+	+
TC-S 231	25/32	—	—	+	+	+	+	+
TC-S 241	25/32	—	—	+	+	+	+	+
TC-S 251	9.5/20	+	+	+	+	+	+	+
TC-S 261	25/32	—	—	+	+	+	+	+
TC-S 242	12/20	+	+	+	+	+	+	+
TC-S 252	6.5/12	+	+	+	+	+	—	—
TC-B 221	25/32	—	—	+	+	+	+	+
TC-B 231	25/32	—	+	+	+	+	+	+
TC-B 241	25/32	—	—	+	+	+	+	+
TC-B 251	9.5/20	+	+	+	+	+	+	+
TC-B 261	25/32	—	—	+	+	+	+	+
TC-B 252	6.5/12	+	+	+	+	+	—	—

Designation: **TC-S XXX-d-L** or **TC-B XXX-d-L**,

where **XXX** is the number of the version, **d** is the protection sheath diameter and **L** is the mounting length of the mounting part.

An example of notation in the order:

TC-S 221-25-1000 - the thermoelectric transducer with calibration **S**, in a silicon carbide sheath, of design version **221**, with a diameter (**d**) of 25 mm and a length of the mounting part (**L**) of 1000 mm;

TC-B 241-17-1600 - the thermoelectric transducer with calibration **B**, in a corundum (Al_2O_3) sheath, of design version **241**, with an outer diameter (**d**) of 17 mm and a mounting length of the mounting part (**L**) of 1600 mm.

Unless specially noticed, the TC-S thermoelectric transducers are supplied of accuracy class 2 and the TC-B thermoelectric transducers are supplied of accuracy class 3.

2.5. TC-S 121U, 124U, 144U, 154U AND TC-S(B) 211U, 221U, 231U BENT THERMOELECTRIC TRANSDUCERS IN METAL AND CERAMIC SHEATHS

These thermoelectric transducers are designed for measuring the temperature of metal, salt and glass melts (see the table of the physical-mechanical characteristics of the ceramic sheaths), as well as the temperature of high-temperature non-corrosive gaseous media and corrosive media, which do not induce the destruction of the protection sheath material.

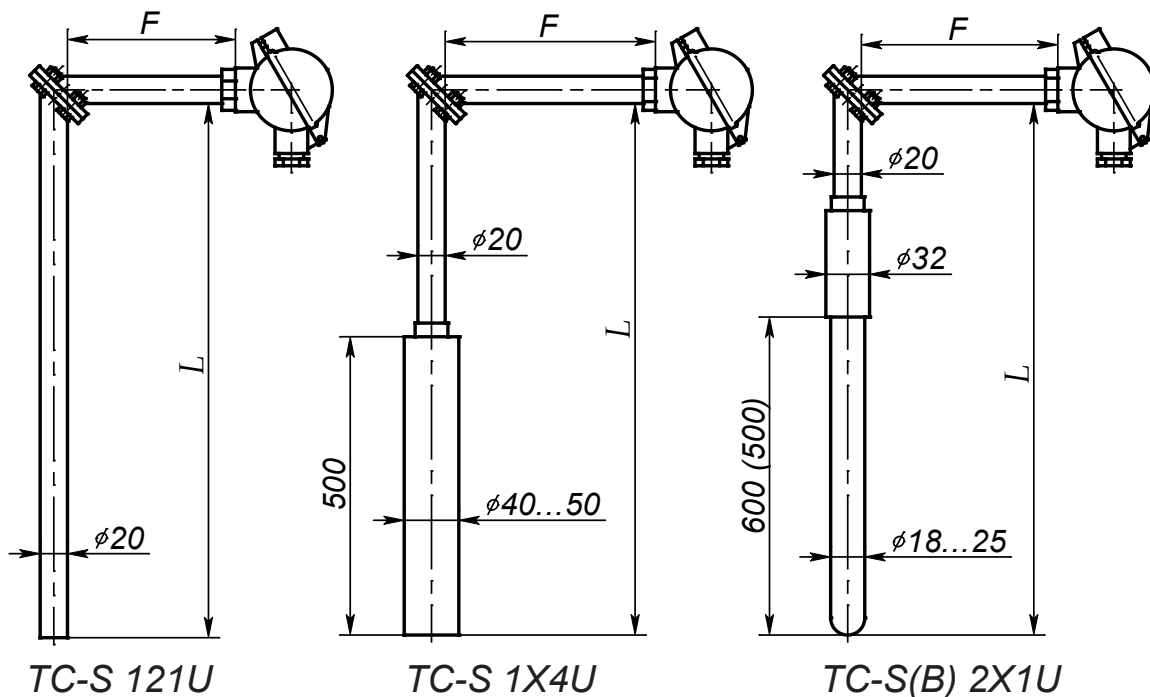
The TC-S 121U, 124U, 144U and 154U thermoelectric transducers are enclosed into two-part protection sheaths. The outer sheath is made of a metal. The inner protection sheath is made of corundum (Al_2O_3). For the TC-S 121U thermoelectric transducers, heat-resistant solid-metal protection sheaths made of the alloy CrNi-45Al are used. To prolong the operating life of the thermoelectric transducers in salt melts, metal outer sheaths with a wall thickness of 10 mm min. is used (versions TC-S 124U, 144U and 154U). The dip part of the sheath 500 mm long and 40-50 mm in diameter is made of the heat-resistant alloy CrNi45Al (version TC-S 124U) or the stainless steel 12Cr18Ni10Ti (version TC-S 154U). The other part of the protective sheath is made of a 20-mm in diameter heat-resistant or stainless-steel tube. The site of the coupling of the vertical operating part with the horizontal bearing part is made in the form of a dismountable flange joint, which allows one to replace the dip part of the protection sheath.

The TC-S(B) 221U and 231U thermoelectric transducers are enclosed into two-part ceramic sheaths. The inner sheath is made of high-purity gas-tight corundum (Al_2O_3) and the outer sheath is made of silicon carbide (SiC) for version 221U or silicon nitride (Si_3N_4) for version 231U.

The outer sheath of the thermoelectric transducer is partly reinforced with a steel covering pipe. The metal reinforcing element of the sheath is made of the steel 10Cr23Ni18 and is designed to withstand a temperature of up to 1000°C.

The length of the ceramic part of sheaths for the 221U thermoelectric transducers is equal to 600 mm (500 mm for version 231U) for all lengths of the mounting part of the thermoelectric transducer.

The thermocouple wires of the thermoelectric transducers over a length of up to 1000 mm are reinforced with a two-channel tube made of high-purity oxide ceramics (Al_2O_3 , purity over 99.5%), which protects the thermocouple wires in all high-temperature area and eliminates a possibility of their breaks points of the tube ends.



Technical characteristics of bent thermoelectric transducers in metal and ceramic sheaths

Characteristic	TC-S 121U	TC-S 124U	TC-S 144U	TC-S 154U	TC-S 221U	TC-S 231U	TC-B 221U	TC-B 231U
Protection tube material	CrNi45Al	CrNi45Al/ 10Cr23Ni18	10Cr23Ni18	12Cr18Ni10Ti	SiC	Si ₃ N ₄	SiC	Si ₃ N ₄
Maximum operating temperature, °C	1250				1300			
Thermal inertia index, s	120	240						
Tolerance class	1 or 2						2 or 3	
Diameter of thermocouple wires, mm	0.5/0.5							
Number of hot junctions	1 or 2							
Operating pressure, MPa	0.1							

List of versions of bent thermoelectric transducers in metal and ceramic sheaths

L, mm	F, mm	Version					
		TC-S 121U	TC-S 124U	TC-S 144U	TC-S 154U	TC-S(B) 221U	TC-S(B) 231U
400	400	+	—	—	—	—	—
500	400	+	—	—	—	—	—
	500	+	—	—	—	—	—
630	400	+	+	+	+	—	—
	630	+	+	+	+	—	—
800	400	+	+	+	+	+	+
	630	+	+	+	+	+	+
	800	+	+	+	+	+	+
1000	400	+	+	+	+	+	+
	630	+	+	+	+	+	+
	800	+	+	+	+	+	+
1250	630	+	+	+	+	+	+
	800	+	+	+	+	+	+
1600	630	+	+	+	+	+	+
	800	+	+	+	+	+	+
2000	800	+	+	+	+	+	+
	1000	+	+	+	+	+	+

Designation: **TC-S XXX-d-L/F** or **TC-B XXX-d-L/F**,

where **XXX** is the number of the version, **d** is the protection sheath diameter, **L** is the length of the vertical operating part and **F** is the length of the horizontal bearing part.

An example of notation in the order:

TC-S 154U-40-800/630 - the bent thermoelectric transducer with calibration **S**, in a metal protection sheath, of design version **154U**, with a diameter (**d**) of 40 mm, a length of the the vertical operating part (**L**) of 800 mm and a length of the horizontal bearing part (**F**) of 630 mm;

TC-B 221U-25-1600/800 - the bent thermoelectric transducer with calibration **B**, in a silicon carbide (SiC) sheath, of design version **221U**, with an outer diameter (**d**) of 25 mm, a length of the the vertical operating part (**L**) of 1600 mm and a length of the horizontal bearing part (**F**) of 800 mm.

Unless specially noticed, the TC-S thermoelectric transducers are supplied of accuracy class 2 and the TC-B thermoelectric transducers are supplied of accuracy class 3.

SECTION 3. TC-K, TC-N AND TC-L THERMOELECTRIC TRANSDUCERS BASED ON BASE-METAL THERMOCOUPLES

Manufactured in accordance with Technical Specifications 4211-002-14035255-03.

No. 26588 in the State Register of Measuring Instruments of the Russian Federation.



GENERAL TECHNICAL CHARACTERISTICS OF THE THERMOELECTRIC TRANSDUCERS

These thermoelectric transducers are designed for temperature measuring in vacuum, on solid surfaces, in non-corrosive granular, fluid and gaseous media, as well as in corrosive media, which do not induce the destruction of the protection sheath material.

1. The measured temperature range according to GOST 6616-94, °C:

✓	TC-K	(chromel-alumel)	from -40 to 1200°C (up to 1300°C for a short time);
✓	TC-N	(nichrosil-nisil)	from -40 to 1200°C (up to 1300°C for a short time);
✓	TC-L	(chromel-copel)	from -40 to 600°C (up to 800°C for a short time).

2. The nominal static characteristic (NSC) and the tolerance class:

The NSC and the tolerance classes comply with the requirements of GOST 6616-94 and GOST R 8.585-2001 and IEC60584 standard. The maximum permissible deviations of the TEMF do not exceed the tabulated values.

Thermal transducer type	Tolerance class	Operating temperature range, °C	Maximum permissible deviations from NSC, °C
TC-K	1	from -40 to 375	± 1.5
		from 375 to 1100	± 0.004· t
	2	from -40 to 333,4	± 2.5
		from 333.4 to 1100	± 0.0075· t
TC-N	1	from -40 to 375	± 1.5
		from 375 to 1100	± 0.004· t
	2	from -40 to 333,4	± 2.5
		from 333.4 to 1100	± 0.0075· t
TC-L	2	from -40 to 300	± 2.5
		from 300 to 600	± (0.7 + 0.005·t)

Here, t is the temperature of the medium being measured, °C.

3. The operating temperature range:

The operating temperature range of the thermoelectric transducers is governed by the type of the sensitive element, as well as heat resistance, high-temperature strength and corrosion resistance of the protection sheath material.

Thermal transducer type	Operating temperature range, °C	Rated operating temperature (0.75·Toper.max.), °C	Notes
TC-K and TC-N	from -40 to 1100	825	exposed-junction wire transducers
TC-K	from -40 to 1100*	825	transducers in ceramic protection sheaths
	from -40 to 1100*	825	transducers in metal protection sheaths made of alloy CrNi45Al or CrNi78Ti
	from -40 to 1000	750	transducers in metal protection sheaths made of steel 10Cr23Ni18 or 15Cr25Ti
	from -40 to 800	600	transducers in metal protection sheaths made of steel Cr18Ni10Ti or 10Cr17Ni13Mo2Ti
TC-N	from -40 to 1100*	900	transducers in ceramic protection sheaths
	from -40 to 1100*	900	transducers in metal protection sheaths made of alloy CrNi45Al
	from -40 to 1000	750	transducers in metal protection sheaths made of steel 10Cr23Ni18
	from 40 to 800	600	transducers in metal protection sheaths made of steel 12Cr18Ni10Ti or 10Cr17Ni13Mo2Ti
TC-L	from -40 to 600	450	transducers in metal protection sheaths made of steel 12Cr18Ni10Ti

* 1200°C for short-time operation.

4. Resistance to mechanical impacts:

The thermoelectric transducers are supplied in the vibration-proof design versions (groups N2, V3, L1 and L3) according to the requirements of GOST 2997-84 in the following frequency bands:

1. from 10 to 150 Hz with a shift for the frequency below the transition frequency of 0.35 mm and an acceleration for the frequency above the transition frequency of 49.0 m/s² (design group V3 according to GOST 12997-84) for 0X02 and 0X03 thermoelectric transducers with a length of the mounting part up to 250 mm incl.;
2. from 5 to 35 Hz with an amplitude of the shift for the frequency below the transition frequency of 0.35 mm (design group L1 according to GOST 12997-84) for 1X05 and 1X06 thermoelectric transducers with a length of the mounting part of 500 mm or longer;
3. from 5 to 25 Hz with a shift in the transition frequency of 0.1 mm (design group L3 according to GOST 12997-84) for 2X01 and 2X02 thermoelectric transducers;
4. from 10 to 55 Hz with a shift for the frequency below the transition frequency of 0.35 mm (design group N2 according to GOST 12997-84) for thermoelectric transducers of all other modifications and design versions.

The 0X01 and 0X02 exposed-junction cable thermoelectric transducers (without an outer protective tube) should withstand a single cycle of bending by an angle of 180° around the cylinder with the diameter equal to the five-fold diameter of the thermocouple cable.

5. Climatic version: UHL2 or UHL3 according to the requirements of GOST 15150-69.

6. Water and dust resistance: corresponds to protection class IP55 according to the requirements of GOST 14254-96.

7. Average time to failure when used at the rated operating temperature is equal to 50000 h min. for the thermoelectric transducers enclosed into metal protection sheaths and 25000 h min. for the thermoelectric transducers enclosed into ceramic protection sheaths, as well as the exposed-junction and cable thermoelectric transducers.

8. Average service life of the thermoelectric transducers is equal to

3 yrs for the exposed-junction and cable thermoelectric transducers, as well as the thermoelectric transducers enclosed into ceramic protection sheaths;

5 yrs for the thermoelectric transducers enclosed into metal protection sheaths.

9. The designation of the thermoelectric transducers:

T	C	-	X		X	X	X	X	X	[x]	-	И	-	d	-	L	
1	2	3	4	5	6	7	8	9											

1. thermoelectric transducer (converter);
2. the NSC of the thermocouple of the thermoelectric transducer (K, N or L);
3. protection sheath type (0 - exposed-junction thermoelectric transducer; 1 - metal sheath; 2 - ceramic sheath);
4. the code of the sheath material for the given protection sheath type (see the Table on pp. 7 and 8);
5. the number of the design version for the given sheath material;
6. the number of hot junctions (a single junction - not specified; 2 - two hot junctions);
7. hot junction type (I - insulated; N - non-insulated);
8. the outer diameter of the refractory part of the protection sheath;
9. length of the mounting part.

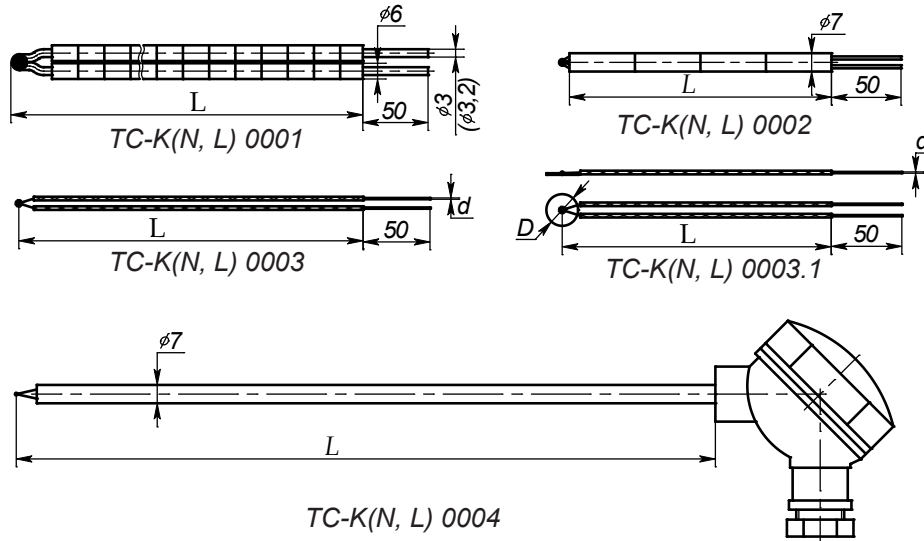
10. List of versions of TC-K, TC-N and TC-L thermoelectric transducers

Type	Version	Outer diameter, mm	Number of hot junctions	Length of mounting part, mm
K or N	0001	2 x 6.0	1	320-3150
	0002	7	1	250-3150
	0003	2 x 0.5	1	250-3150
	0004	7	1	250-500
	0X01	1.5, 2, 3, 4, 4.6, 5 and 6	1 or 2	250-3150
	0X02	3, 4, 4.6, 5 and 6	1 or 2	250-10000
	0502P(F)	3, 4, 4.6, 5 and 6	1 or 2	250-3150
	0X03	1, 1.5, 2, 3, 4, 4.6, 5 and 6	1 or 2	250-10000
	0503P(F)	1, 1.5, 2, 3, 4, 4.6, 5 and 6	1 or 2	250-3150
	0X21	1, 1.5, 2, 3, 4, 4.6, 5 and 6	1 or 2	250-3150
	0521P(F)	1, 1.5, 2, 3, 4, 4.6, 5 and 6	1 or 2	250-3150
	1504	10	1 or 2	32-1000
	1X05	10	1 or 2	250-3150
	1505P(F)	10	1 or 2	250-3150
	1X06	20	1 or 2	250-3150
	1X06U	20	1 or 2	400-2000
	1X07	10	1 or 2	80-2000
	1507P(F)	10	1 or 2	80-2000
	1X08	20	1 or 2	200-2000
	1X09U	40	1 or 2	630-2000
	1X10	20, 25, 30 and 40	1 or 2	320-1250
	1X11	20	1 or 2	320-1250
	1522	3, 4, 4.6, 5 and 6	1 or 2	6-320
	1523	3, 4, 4.6, 5 and 6	1 or 2	6-320
	1524	10	1	32-1000
	2201	25/32	1 or 2	800-2000
	2301	25/32	1 or 2	800-2000
	2401	25/32	1 or 2	800-2000
	2402	12/20	1 or 2	500-2000
	2601	25/32	1 or 2	800-2000
	2701	25/32	1 or 2	800-2000
	2201U	25/32	1 or 2	800-2000
	2301U	25/32	1 or 2	800-2000
	L	0001	2 x 3.2	1
0002		2 x 1.2	1	250-3150
0003		2 x 0.5	1	250-3150
0004		7	1	250-500
0X01		1.5, 3, 4, 4.6 and 5	1 or 2	250-3150
0X02		3, 4, 4.6 and 5	1 or 2	250-10000
0502P(F)		3, 4, 4.6 and 5	1 or 2	250-3150
0503		3, 4, 4.6 and 5	1 or 2	250-10000
0503P(F)		3, 4, 4.6 and 5	1 or 2	250-3150
0X21		1,0; 1,5; 3; 4; 4,6; 5	1 or 2	250-3150
0521P(F)		1.5, 3, 4, 4.6 and 5	1 or 2	250-3150
1504		10	1	32-1000
1X05		10	1 or 2	250-3150
1505P(F)		10	1 or 2	250-3150
1X06		20	1 or 2	250-3150
1X06U		20	1 or 2	400-2000
1X07		10	1 or 2	80-2000
1507P(F)		10	1 or 2	80-2000
1X08		20	1 or 2	200-2000
1522		3, 4, 4.6, 5 and 6	1 or 2	6-320
1523		3, 4, 4.6, 5 and 6	1 or 2	6-320
1524		10	1	32-1000

Note: here and elsewhere, the sign X in the number of the version means the numerical code of the sheath material: 2 - the alloy CrNi45Al (EP 747); 3 - the alloy CrNi78Ti (an analog for the alloy Inconel 600); 4 - the steel 10Cr23Ni18 (an analog for the steel 310 SS); 5 - the steel 12Cr18Ni10Ti (an analog for the steel 321 SS); 6 - the steel Cr17Ni13Mo2Ti (an analog for the steel 316 Ti); 7 - the steel 20Cr20Ni14Si2 (analog of 309); 8 - the steel 15Cr25Ti (analog of 446); and 9 - the steel St 3 (carbon steel).

3.1. TC-K(N, L) 0001 AND 0002 WIRE EXPOSED-JUNCTION THERMOELECTRIC TRANSDUCERS

These exposed-junction thermoelectric transducers are designed for measuring surface temperatures in oxidative and neutral gas media, which contain no substances reacting with the thermocouple material, and for using as sensitive elements for thermoelectric transducers of other design versions.



Technical characteristics of thermoelectric transducers

Characteristic		TC-K and TC-N	TC-L
Operating temperature range, °C		from -40 to 1100	from -40 to 600
Operating pressure, MPa		0.1	0.1
Tolerance class		1 or 2	2
Protection sheath material		exposed-junction thermo-electric transducer	exposed-junction thermo-electric transducer
Number of hot junctions		1	1
Thermal inertia index, s	for version 0001	10	10
	for versions 0002 and 0004	3	3
	for version 0003	1	1

List of versions of thermoelectric transducers

Thermoelectric transducer type	Version	Diameter of thermocouple wires, mm	Insulation of thermocouple wires	Length of mounting part L, mm												
				250	320	400	500	630	800	1000	1250	1600	2000	2500	3150	
TC-K (N, L)	0001	2 x 3.0 (3.2)	MKR tube	—	+	+	+	+	+	+	+	+	+	+	+	+
TC-K (N, L)	0002	2 x 1.2	MKR tube	+	+	+	+	+	+	+	+	+	+	+	+	+
TC-K (N, L)	0003	2 x 0.3; 2 x 0.5	KN-11 thread	+	+	+	+	+	+	+	+	+	+	+	+	+
TC-K (N, L)	0004	2 x 1.2	MKR tube	+	+	+	+									

Note: 1) The thermoelectric transducers can be equipped with thermocouple wires of other diameters, which shall be explicitly stated in the order; 2) optionally, the 0002 and 0003 thermoelectric transducers can be supplied with a length of up to 50 m.

Designation: TC-X 0001-(2 x 6)-L or TC-X 0002-7-L,

where X is the calibration of the thermoelectric transducer (K, N or L) and L is the length of its mounting part.

An example of notation in the order:

TC-K 0001-(2 x 6)-800 - the wire exposed-junction thermoelectric transducer with calibration K (chromel-alumel), with 3.2-mm thermocouple wires in 6-mm in diameter single-channel insulating tubes, with a 800-mm length of the mounting part (L).

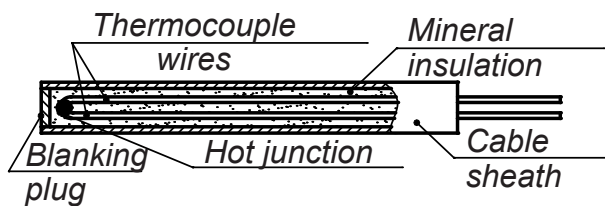
The thermoelectric transducers are commonly supplied of accuracy class 1.

3.2. TC-K(N, L) 0X01, 0X02, 0X03 AND 0X21 CABLE EXPOSED-JUNCTION THERMOELECTRIC TRANSDUCERS

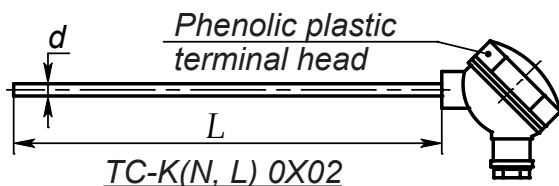
These cable exposed-junction thermoelectric transducers are designed for measuring surface temperatures in oxidative and neutral gas media, which contain no substances reacting with the cable sheath material, and for using as sensitive elements for thermoelectric transducers of other design versions.

The cable sheath is made of the following materials:

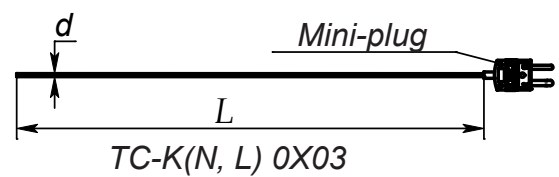
- the alloy Inconel 600, as well as the steels 310 SS and 321 SS for foreign-made cables;
- the alloys CrNi78Ti, CrNi45Al as well as the steels 10Cr23Ni18 and Cr18Ni10Ti for Russian-made cables.



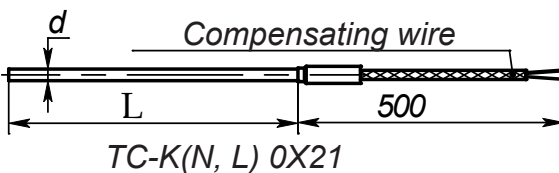
Cable thermocouple design



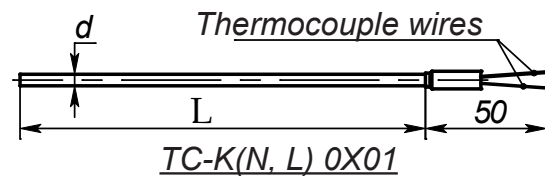
TC-K(N, L) 0X02



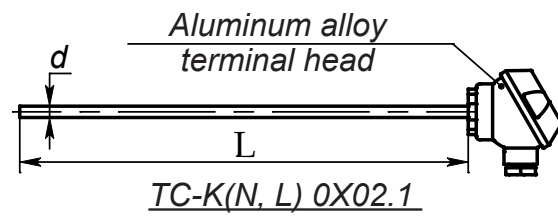
TC-K(N, L) 0X03



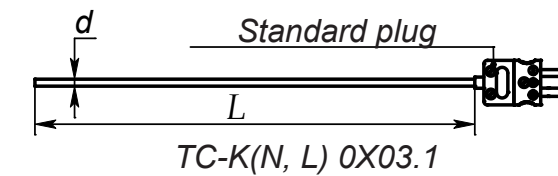
TC-K(N, L) 0X21



TC-K(N, L) 0X01



TC-K(N, L) 0X02.1



TC-K(N, L) 0X03.1

Hot junction type	Thermal inertia index, s (for diameter of cable sheath d, mm)				
	1.0 (1.5)	3.0	4.0	4.6	5.0
Insulated hot junction	1.5	2.0	3.0	3.0	4.0
Non-insulated hot junction	1.0	1.5	2.0	2.0	3.0

Advantages and disadvantages of cable thermoelectric transducers

Advantages:

- minimum thermal lag;
- flexibility and possibility of installation of the hot junction at a required point when measuring the temperature of complex-shaped objects;
- possibility of performing local temperature measurements in the bulk or on the surface of solids when determining temperature fields.

Disadvantages:

- a short service life of the thermoelectric transducers at high ($\geq 1000^{\circ}\text{C}$) temperatures due to the small diameter of the thermocouple wires;
- susceptibility to the selective oxidation of chromium in the chromel wire due to the presence of the weakly oxidizing medium inside the thermocouple cable.

Technical characteristics of thermoelectric transducers

Characteristic		TC-K (chromel-alumel)	TC-N (nichrosil-nisil)	TC-L (chromel-copel)
Operating pressure, MPa		0.1	0.1	0.1
Tolerance class		1 or 2	1 or 2	2 or 3
Operating temperature range for various cable sheath materials, °C	CrNi78Ti (Inconel 600)	from -40 to 1100	from -40 to 1100	—
	Cr20N14Si2	from -40 to 1000	from -40 to 1000	—
	10Cr23Ni18 (310 SS)	from -40 to 1000	from -40 to 1000	—
	12Cr18Ni10Ti (321 SS)	from -40 to 800	from -40 to 800	from -40 to 600
Number of hot junctions		1 or 2		
Diameter of cable sheath d, mm		1.0, 2.0, 1.5, 3.0, 4.0, 4.6, 5.0 and 6.0		

List of versions of TC-K, TC-N and TC-L cable thermoelectric transducers

Version	Outer diameter, mm	Number of hot junctions	Length of mounting part L, mm														
			250	320	400	500	630	800	1000	1250	1600	2000	2500	3150	...	100000	
0X01	1.5, 2, 3, 4, 5 and 6	1	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-
0X02	3, 4, 5 and 6	1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0X03	1, 1.5, 2, 3, 4, 5 and 6	1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0X21	1, 1.5, 2, 3, 4, 5 and 6	1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0X01[2]	4.5 (4.6)	2	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-
0X02[2]	4.5 (4.6)	2	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0X03[2]	4.5 (4.6)	2	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
0X21[2]	4.5 (4.6)	2	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-

Designation: **TC-X 0XXX[x]-I(N)-d-L**

An example of notation in the order:

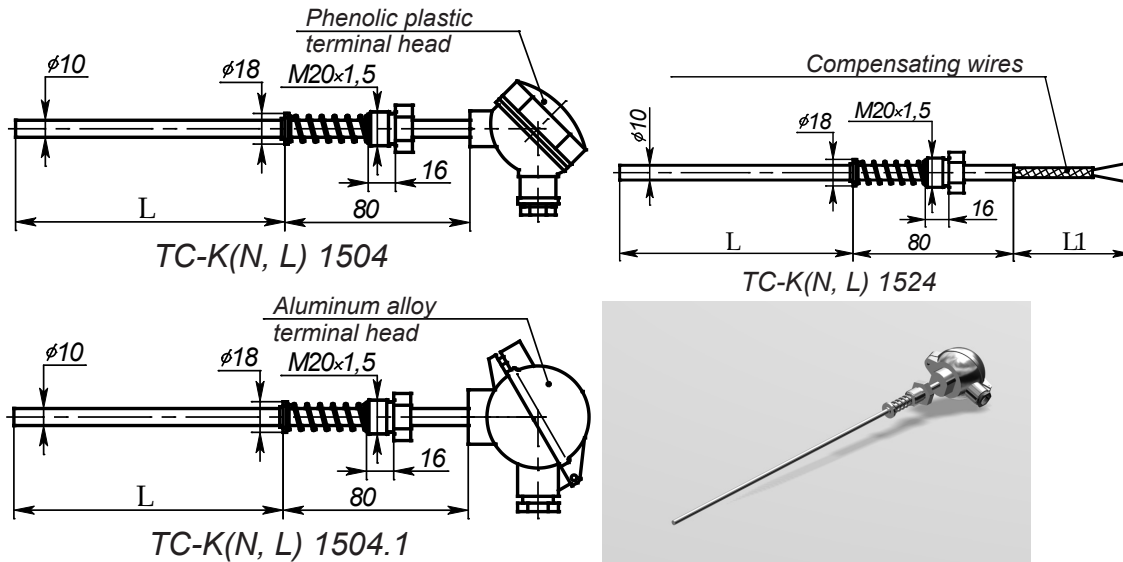
TC-K 0301-I-3-800 - the cable thermoelectric transducer with calibration **K** (chromel-alumel), with Inconel 600 alloy sheath (**03**), of design version **01**, with an insulated (**I**) hot junction, with an outer diameter (**d**) of 3 mm and the length of the mounting part (**L**) of 800 mm.

The thermoelectric transducers are commonly supplied of accuracy class 1.

3.3. THERMOELECTRIC TRANSDUCERS IN METAL PROTECTION SHEATHS

3.3.1. TC-K(N, L) 1504 AND 1524 THERMOELECTRIC TRANSDUCERS IN METAL PROTECTION Sheaths

The TC-K(N, L) 1504 and 1524 thermoelectric transducers are designed for measuring the temperature of solid surfaces. The thermoelectric transducers are equipped with an installer ring, a spring and a movable thread fitting. The TC-K(N, L) 1514 thermoelectric transducers are equipped with compensating wires with the length L_1 (by default, $L_1 = 500$ mm) instead of a terminal head.



Technical characteristics of thermoelectric transducers

Characteristic	Value
Operating temperature range, °C for TC-K and N for TC-L	from -40 to 800 0-600
Operating pressure, MPa	0.1
Tolerance class	1 or 2
Number of hot junctions	1
Thermal inertia index, s: insulated hot junction non-insulated hot junction	12 6
Outer diameter, mm	10
Sheath material	12Cr18Ni10Ti

The length of the mounting part of the thermoelectric transducers shall be chosen from the following sequence: 32, 60, 80, 100, 120, 160, 200, 250, 320, 400, 500, 630, 800 and 1000.

Designation of the thermoelectric transducers:

TC-K(N, L) 1504-I(N)-10-L or TC-K(N, L) 1524--I(N)-10-L/L1

An example of notation in the order:

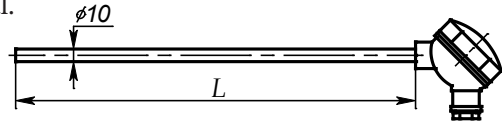
TC-K 1504-I-10-100 - the thermoelectric transducer with calibration **K** (chromel-alumel), in a steel 12Cr18Ni10Ti (**15**) sheath, of design version **04**, with a single insulated (**I**) hot junction, with a diameter (**d**) of 10 mm and a length of the mounting part (**L**) of 100 mm;

TC-K 1524-I-10-160/2000 - the thermoelectric transducer with calibration **K** (chromel-alumel), in a steel 12Cr18Ni10Ti (**15**) sheath, of design version **24**, with a single insulated (**I**) hot junction, with a diameter (**d**) of 10 mm and a length of the mounting part (**L**) of 160 mm, with 2000-mm long (**L1**) compensating wires.

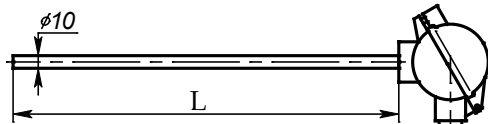
The thermoelectric transducers are commonly supplied of accuracy class 1.

3.3.2. TC-K(N, L) 1X05 AND 1X06 THERMOELECTRIC TRANSDUCERS IN METAL PROTECTION SHEATHS

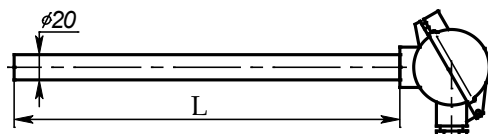
These thermoelectric transducers are designed for measuring the temperature of non-corrosive fluid and gaseous media, as well as corrosive media, which do not induce the destruction of the protection sheath material.



TC-K(N, L) 1X05



TC-K(N, L) 1X05.1



TC-K(N, L) 1X06



Technical characteristics of 1X05 and 1X06 thermoelectric transducers

Characteristic	1X05 and 1X05.1	1X06
Operating pressure range, MPa	0.1-0.4*	0.1-0.4*
Tolerance class	1 or 2	1 or 2
Number of hot junctions	1 or 2	1 or 2
Thermal inertia index, s	40	60
Outer diameter, mm	10	20

* Can be used at a rated pressure of 0.4 MPa when supplied with a movable fitting.

Operating temperature range (°C) for various sheath materials

Outer sheath material	Numerical designation of sheath	TC-K (chromel-alumel)	TC-N (nichrosil-nisil)	TC-L (chromel-copel)
CrNi45Al	12	from -40 to 1100*	from -40 to 1100*	-
CrNi78Ti	13	from -40 to 1100*	from -40 to 1100*	-
10Cr23Ni18	14	from -40 to 1000	from -40 to 1000	-
Cr18Ni10Ti	15	from -40 to 800	from -40 to 800	from -40 to 600
10Cr17Ni13Mo2Ti	16	from -40 to 800	from -40 to 800	from -40 to 600
20Cr20Ni14Si2	17	from -40 to 1000	from -40 to 1000	-
15Cr25Ti	18	from -40 to 1000	from -40 to 1000	-

* 1200°C for short-time use.

List of versions of TC-K(N, L) 1X05 and 1X06 thermoelectric transducers

Version	Diameter d, mm	Length of mounting part, mm											
		250	320	400	500	630	800	1000	1250	1600	2000	2500	3150
TC-K 1X05 TC-K 1X05.1	10	+	+	+	+	+	+	+	+	+	+	+	+
TC-N 1X05 TC-N 1X05.1	10	+	+	+	+	+	+	+	+	+	+	+	+
TC-L 1X05 TC-L 1X05.1	10	+	+	+	+	+	+	+	+	+	+	+	+
TC-K 1X06	20	+	+	+	+	+	+	+	+	+	+	+	+
TC-N 1X206	20	+	+	+	+	+	+	+	+	+	+	+	+
TC-L 1X06	20	+	+	+	+	+	+	+	+	+	+	+	+

Designation of the thermoelectric transducers:

TC-K(N, L) 1X0X[x]-I(N)-X-L

An example of notation in the order:

TC-N 1405-I-10-400 - the thermoelectric transducer with calibration **N** (nichrosil-nisil), in a steel 10Cr23Ni18 (**14**) sheath, of design version **05**, with a single insulated (**I**) hot junction, with a diameter (**d**) of 10 mm and a length of the mounting part (**L**) of 400 mm;

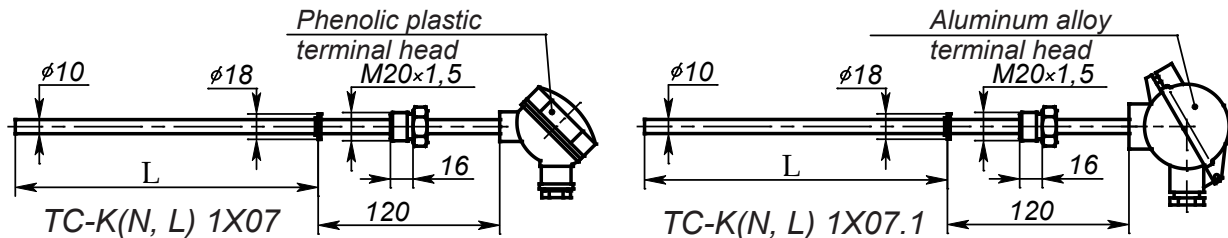
TC-L 1606[2]-I-20-630 - the thermoelectric transducer with calibration **L** (chromel-copel), in a steel 10Cr17Ni13Mo2Ti (**16**) sheath, of design version **06**, with two (**[2]**) insulated (**I**) hot junctions, with a diameter (**d**) of 20 mm and a length of the mounting part (**L**) of 630 mm.

The thermoelectric transducers are commonly supplied of accuracy class 1.

3.3.3. TC-K(N, L) 1X07 THERMOELECTRIC TRANSDUCERS IN METAL PROTECTION SHEATHS

These thermoelectric transducers are designed for measuring the temperature of non-corrosive fluid and gaseous media, including media in motion, as well as corrosive media, which do not induce the destruction of the protection sheath material.

The 1X07 thermoelectric transducers consist of an inner sensitive element, a protection sheath and mounting elements. The sheath is equipped with an M20 x 1.5 thread fitting.



Operating temperature range (°C) for various sheath materials

Technical characteristics of 1X07 thermoelectric transducers

Outer sheath material	Numerical designation of sheath	TC-K (chromel-alumel)	TC-N (nichrosil-nisil)	TC-L (chromel-copel)
CrNi45Al	12	from -40 to 1100*	from -40 to 1100*	-
10Cr23Ni18	14	from -40 to 1000	from -40 to 1000	-
12Cr18Ni10Ti	15	from -40 to 600	from -40 to 600	from -40 to 600
10Cr17Ni13Mo2Ti	16	from -40 to 800	from -40 to 800	from -40 to 600

Characteristic	Value
Rated pressure range, MPa	0.1-6.3
Tolerance class	1 or 2
Number of hot junctions	1 or 2
Thermal inertia index, s	40
Outer diameter, mm	10

* 1200°C for short-time operation.

List of versions of TC-K(N, L) 1X07 thermoelectric transducers

Version	Diameter d, mm	Length of mounting part, mm														
		80	100	120	160	200	250	320	400	500	630	800	1000	1250	1600	2000
TC-K 1X07 TC-K 1X07.1	10	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
TC-N 1X07 TC-N 1X07.1	10	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
TC-L 1X07 TC-L 1X07.1	10	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

Designation of the thermoelectric transducers: TC-K(N, L) 1X07[x]-I(N)-10-L

An example of notation in the order:

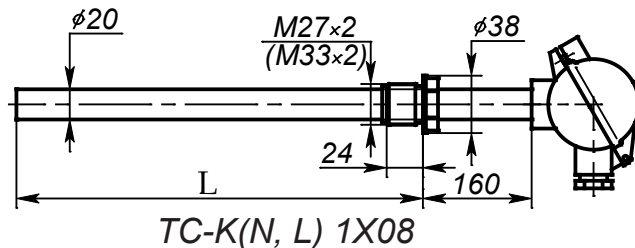
TC-N 1407-I-10-80 - the thermoelectric transducer with calibration N (nichrosil-nisil), in a steel 10Cr23Ni18 (14) sheath, of design version 07, with a single insulated (I) hot junction, with a diameter (d) of 10 mm and a length of the mounting part (L) of 80 mm.

The thermoelectric transducers are commonly supplied of accuracy class 1 and equipped with an M20 x 1.5 thread fitting. The fitting can be manufactured using Customer's working drawings.

3.3.4. TC-K(N, L) 1X08 THERMOELECTRIC TRANSDUCERS IN METAL PROTECTION SHEATHS

These thermoelectric transducers are designed for measuring the temperature of non-corrosive fluid and gaseous media, including media in motion, as well as corrosive media, which do not induce the destruction of the protection sheath material.

The 1X08 thermoelectric transducers consist of an inner sensitive element, a protection sheath and an M27 x 2 thread fitting welded to the sheath (optionally, an M33 x 2 thread fittings can be supplied).



Technical characteristics of 1X08 thermoelectric transducers

Characteristic	Value
Rated pressure range, MPa	0.1-4.0
Tolerance class	1 or 2
Number of hot junctions	1 or 2
Thermal inertia index, s	60
Outer diameter, mm	20

Operating temperature range (°C) for various sheath materials

Outer sheath material	Numerical designation of sheath	TC-K (chromel-alumel)	TC-N (nichrosil-nisil)	TC-L (chromel-copel)
CrNi45Al	12	from -40 to 1100	from -40 to 1100	-
CrNi78Ti	13	from -40 to 1000	from -40 to 1000	-
10Cr23Ni18	14	from -40 to 900	from -40 to 900	-
12Cr18Ni10Ti	15	from -40 to 600	from -40 to 600	from -40 to 600
10Cr17Ni13Mo2Ti	16	from -40 to 800	from -40 to 800	from -40 to 600
20Cr20Ni14Si2	17	from -40 to 900	from -40 to 900	-
15Cr25Ti	18	from -40 to 900	from -40 to 900	-

List of versions of TC-K(N, L) 1X08 thermoelectric transducers

Version	Diameter d, mm	Length of mounting part, mm										
		200	250	320	400	500	630	800	1000	1250	1600	2000
TC-K 1X08	20	+	+	+	+	+	+	+	+	+	+	+
TC-N 1X08	20	+	+	+	+	+	+	+	+	+	+	+
TC-L 1X08	20	+	+	+	+	+	+	+	+	+	+	+

Designation of the thermoelectric transducers: TC-K(N, L) 1X08[x]-I(N)-20-L

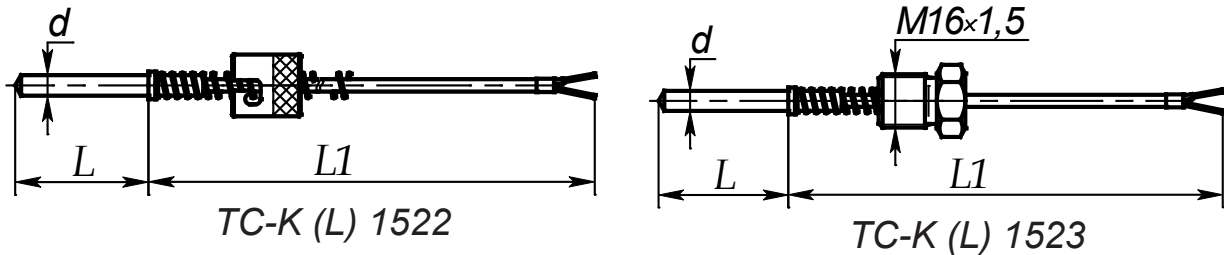
An example of notation in the order:

TC-L 1608[2]-I-20-630 - the thermoelectric transducer with calibration L (chromel-copel), in a steel 10Cr17Ni13Mo2Ti (16) sheath, of design version 08, with two ([2]) insulated hot junctions, with a diameter (d) of 20 mm and a length of the mounting part (L) of 630 mm.

The thermoelectric transducers are commonly supplied of accuracy class 1 and equipped with an M27 x 2 thread fitting. The fitting can be manufactured using Customer's working drawings.

3.3.5. TC-K(L) 1522 AND TC-K(L) 1523 THERMOELECTRIC TRANSDUCERS IN METAL PROTECTION SHEATHS

These thermoelectric transducers are designed for measuring the temperature of plastics in automatic molding machines, molding machines and molding presses, as well as the temperature of fluid and gaseous media and solids, which do not induce the destruction of the protection sheath material.



Technical characteristics of thermoelectric transducers

Characteristic	Value
Operating temperature range, °C	from -40 to 400
Protection sheath material	12Cr18Ni10Ti
Rated pressure range, MPa	0.1
Tolerance class	1 or 2
Hot junction	1 or 2
Outer diameter, mm	3.0, 4.0, 4.6, 5.0 and 6.0

Thermal inertia index

Hot junction type	Thermal inertia index, s (for diameter d, mm)				
	3.0	4.0	4.6	5.0	6.0
Insulated hot junction	2.0	3.0	3.0	4.0	5.0
Non-insulated hot junction	1.5	2.0	2.0	3.0	4.0

List of versions of TC-K and TC-L thermoelectric transducers

Version	Outer diameter, mm	Number of hot junctions	Length of mounting part L, mm											
			6	10	32	60	80	100	120	160	200	250	320	
1522	3.0, 4.0, 5.0 and 6.0	1	+	+	+	+	+	+	+	+	+	+	+	+
1522[2]	4.6 and 6.0	2	+	+	+	+	+	+	+	+	+	+	+	+
1523	3.0, 4.0, 5.0 and 6.0	1	+	+	+	+	+	+	+	+	+	+	+	+
1523[2]	4.6 and 6.0	2	+	+	+	+	+	+	+	+	+	+	+	+

Designation: TC-X 1522[x]-I(N)-d-L/L1 or TC-X 1523[x]-I(N)-d-L/L1

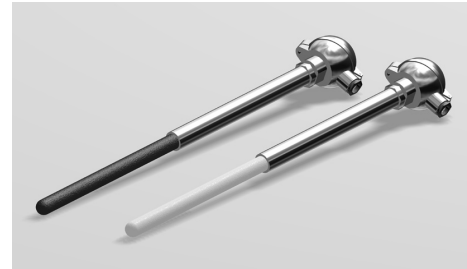
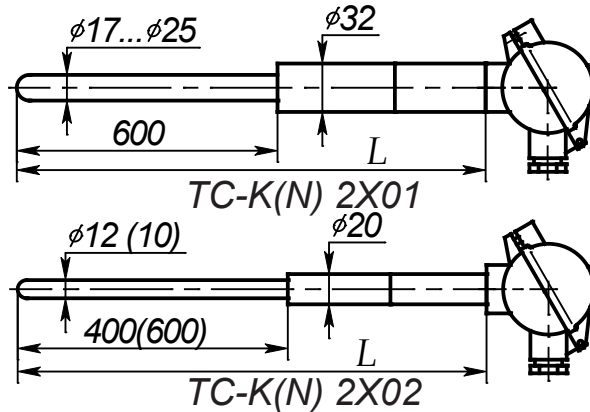
An example of notation in the order:

TC-K 1523-I-6-20/2000 - the thermoelectric transducer with calibration K (chromel-alumel), in a steel 12Cr18Ni10Ti (15) sheath, of design version 23, with a single insulated (I) hot junction, with an outer diameter (d) of 6 mm and a length of the mounting part (L) of 20 mm, with 2000-mm long (L1) compensating wires.

The thermoelectric transducers are commonly supplied of accuracy class 1.

3.4. TC-K(N) 2X01 THERMOELECTRIC TRANSDUCERS IN CERAMIC PROTECTION SHEATHS

The chromel-alumel and nichrosil-nisil thermoelectric transducers enclosed into ceramic protection sheaths are designed for measuring the temperature of high-temperature gas media, as well as metal and salt melts.



Technical characteristics of 2X01 thermoelectric transducers

Characteristic	Value
Operating temperature range, °C for TC-K (chromel-alumel) transducers TC-N (nichrosil-nisil)	from 0 to 1100* from 0 to 1100*
Operating pressure, MPa	0.1
Tolerance class	1 or 2
Number of hot junctions	1 or 2
Thermal inertia index, s	up to 120
Outer diameter of ceramic part of sheath, mm	25
Length of ceramic part of sheath, mm	600
Permissible depth of immersion into operating medium, mm	500

* 1200°C for short-time operation.

The thermoelectric transducers are enclosed into single ceramic protection sheaths, which are partly reinforced with heat-resistant covering tubes. The protection sheaths are made of the following types of ceramics: SiC - silicon carbide (carborundum), Si₃N₄ - silicon nitride, Al₂O₃ - corundum and MKR - mullite-alumina ceramics.

The thermoelectric transducers enclosed into carborundum protection sheaths with an increased wear resistance can be used for measuring temperature in abrasive-containing media.

The rate of heating of a thermoelectric transducer shall not exceed 100°C/min for the thermoelectric transducers enclosed into silicon carbide (SiC) or silicon nitride (Si₃N₄) sheaths and 60°C/min for the thermoelectric transducers enclosed into corundum (Al₂O₃) sheaths.

List of versions of 2X01 thermoelectric transducers

Version	Sheath material	Number of hot junctions	Diameter d, mm	Length of mounting part, mm				
				800	1000	1250	1600	2000
TC-K(N) 2201	SiC	1 or 2	25	+	+	+	+	+
TC-K(N) 2301	Si ₃ N ₄	1 or 2	25	+	+	+	+	+
TC-K(N) 2401	Al ₂ O ₃	1 or 2	17-25	+	+	+	+	+
TC-K(N) 2601	KTVF	1 or 2	25	+	+	+	+	+
TC-K(N) 2701	MKR	1 or 2	25	+	+	+	+	+

Designation of the thermoelectric transducers: TC-K(N) 2X01[x]-25-L

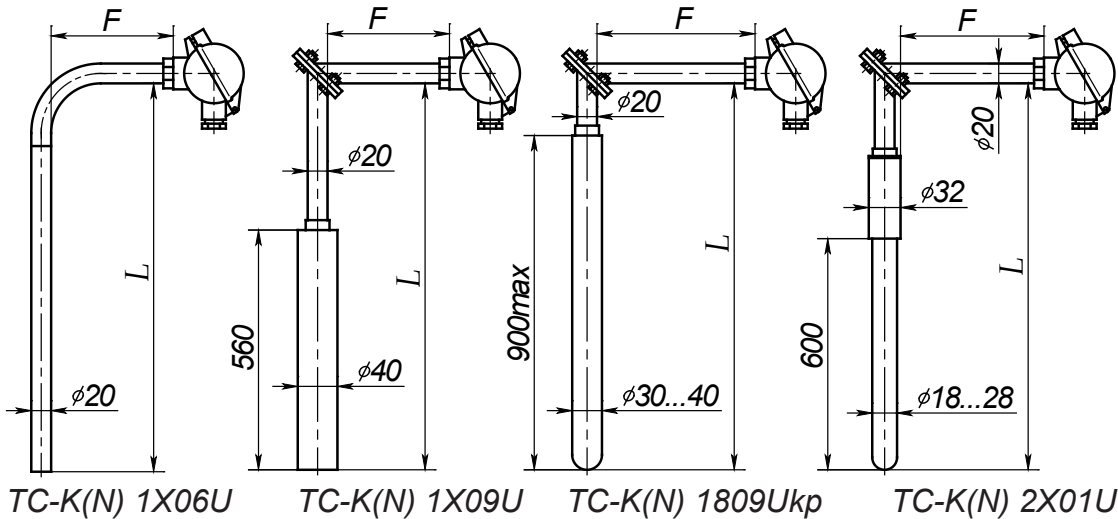
An example of notation in the order:

TC-K 2401-17-800 - the thermoelectric transducer with calibration **K** (chromel-alumel), in a corundum ceramics (**24**) sheath, of design version **01**, with a diameter (**d**) of 17 mm and a length of the mounting part (**L**) of 800 mm.

The thermoelectric transducers are commonly supplied of accuracy class 1.

3.5. TC-K(N, L) 1X06U, TC-K(N, L) 1X09U AND TC-K(N) 2X01U THERMOELECTRIC TRANSDUCERS IN BENT PROTECTION SHEATHS

These thermoelectric transducers are designed for measuring the temperature of high-temperature fluid media, as well as metal and salt melts. The thermoelectric transducers are supplied enclosed into metal (versions 1X06U and 1X09U), ceramics-coated metal (version 1809Ukp), silicon carbide (version 2201U) or silicon nitride (version 2301U) sheaths.



Technical characteristics of 1X06U, 1X09U, 1809Ukp and 2X01U thermoelectric transducers

Operating pressure - 0.1 MPa;
Tolerance class - 1 or 2;
Number of hot junctions - 1 or 2.

Technical characteristics of 1X06U and 1X09U thermoelectric transducers

Characteristic	Version						
	1206U	1406U	1506U	1209U	1409U	1509U	1809Ukp
Sheath material	CrNi45Al	10Cr23Ni18	12Cr18Ni10Ti	CrNi45Al	10Cr23Ni18	12Cr18Ni10Ti	Composite material
Operating temperature range, °C	TC-K	0-1100	0-1100	0-800	0-1100	0-1100	0-1100
	TC-N	0-1200	0-1100	0-800	0-1200	0-1200	0-1200
Thermal inertia index, s	60			120			120
Outer diameter, mm	20			40			30-40

Technical characteristics of 2201U and 2301U thermoelectric transducers

Characteristic	Version	
	2201U	2301U
Sheath material	SiC	Si ₃ N ₄
Operating temperature range, °C	TC-K (chromel-alumel)	0-1100
	TC-N (nichrosil-nisil)	0-1100
Thermal inertia index, s	240	
Outer diameter, mm	18-28	
Length of ceramic part of sheath, mm	600	
Permissible depth of immersion into operating medium, mm	500	

List of versions of TC-K(N, L) 1X06U and TC-K(N, L) 1X09U thermoelectric transducers

L, mm	F, mm	Version						TC-K(N) 1809Ukp
		TC-K(N) 1206U	TC-K(N) 1406U	TC-K(N, L) 1506U	TC-K(N) 1209U	TC-K(N) 1409U	TC-K(N, L) 1509U	
400	400	+	+	+	—	—	—	+
500	400	+	+	+	—	—	—	+
	500	+	+	+	—	—	—	+
630	400	+	+	+	+	+	+	+
	630	+	+	+	+	+	+	+
800	400	+	+	+	+	+	+	+
	630	+	+	+	+	+	+	+
	800	+	+	+	+	+	+	+
1000	400	+	+	+	+	+	+	+
	630	+	+	+	+	+	+	+
	800	+	+	+	+	+	+	+
1250	630	+	+	+	+	+	+	+
	800	+	+	+	+	+	+	+
1600	630	+	+	+	+	+	+	+
	800	+	+	+	+	+	+	+
2000	800	+	+	+	+	+	+	+
	1000	+	+	+	+	+	+	+

List of versions of TC-K(N) 2X01U thermoelectric transducers

L, mm	800			1250			1000		1600		2000	
F, mm	400	630	800	400	630	800	630	800	630	800	630	800
TC-K(N) 2201U	+	+	+	+	+	+	+	+	+	+	+	+
TC-K(N) 2301U	+	+	+	+	+	+	+	+	+	+	+	+

For the thermoelectric transducers enclosed into silicon carbide (SiC), silicon nitride (Si₃N₄) and graphite protection sheaths, the rate of heating of a thermoelectric transducer shall not exceed 100°C/min.

Designation of the thermoelectric transducers:

TC-K(N) 2X01U[x]-d-L/F or **TC-K(N) 1X0XU[x]-I(N)-d-L/F**

An example of notation in the order:

TC-K 2201U-25-800/400 - the bent (U) thermoelectric transducer with calibration **K** (chromel-alumel), in a silicon carbide (**22**) sheath, of design version **01**, with a single hot junction, with a diameter (**d**) of 25 mm, a length of the vertical operating part (**L**) of 800 mm and a length of the horizontal bearing part (**F**) of 400 mm;

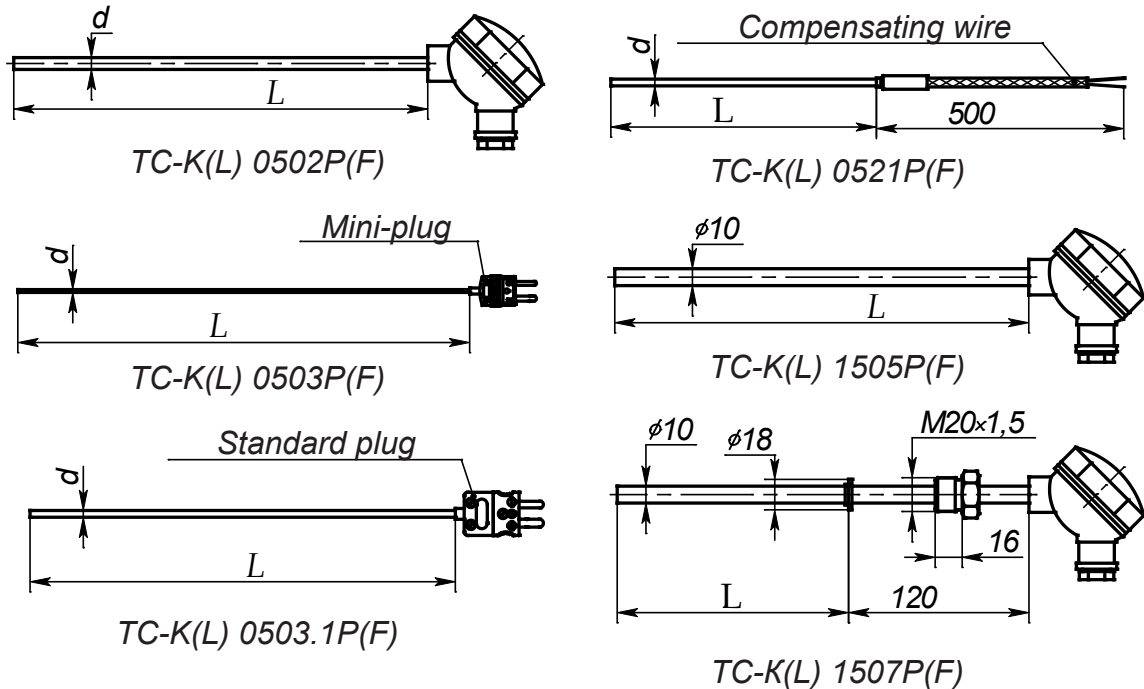
TC-N 1509U-I-40-800/800 - the bent (U) thermoelectric transducer with calibration **N** (nichrosil-nisil), in a steel 12Cr18Ni10Ti (**15**) sheath, of design version **09**, with a single hot junction, with a diameter (**d**) of 40 mm, a length of the vertical operating part (**L**) of 800 mm and a length of the horizontal bearing part (**F**) of 800 mm;

TC-K 1809Ukp-I-30-600/500 - the bent (U) thermoelectric transducer with calibration **K** (chromel-alumel), in a ceramics-coated metal (**18**) sheath, of design version **09**, with a single hot junction, with a diameter (**d**) of 30 mm, a length of the vertical operating part (**L**) of 600 mm and a length of the horizontal bearing part (**F**) of 500 mm.

The thermoelectric transducers are commonly supplied of accuracy class 1.

3.6. THERMOELECTRIC TRANSDUCERS FOR HIGHLY CORROSIVE ACIDIC AND ALKALINE MEDIA

For measuring the temperature of highly corrosive acidic and alkaline media, we supply the general purpose industrial version of the thermoelectric transducers with a top polymer coating on the cable sheath or the metal protection sheath.



The protection coating is made of polyethylene (the operating temperature is up to 100°C) or polytetrafluoroethylene (the operating temperature is up to 250°C).

Technical characteristics of thermoelectric transducers

Characteristic	TC-K(L) 0502P TC-K(L) 0503P TC-K(L) 0521P	TC-K(L) 1505P TC-K(L) 1507P	TC-K(L) 0502F TC-K(L) 0503F TC-K(L) 0521F	TC-K(L) 1505F TC-K(L) 1507F
Operating pressure, MPa	0.1	0.1	0.1	0.1 (6.3*)
Tolerance class	1 or 2	1 or 2	1 or 2	1 or 2
Protection sheath (cable sheath) material	12Cr18Ni10Ti	12Cr18Ni10Ti	12Cr18Ni10Ti	12Cr18Ni10Ti
Protection coating material	Polyethylene	Polyethylene	Polytetrafluoroethylene	Polytetrafluoroethylene
Operating temperature range, °C	0-100	0-100	0-250	0-250
Number of hot junctions	1 or 2 (for d = 4.6 mm)	1 or 2	1 or 2 (for d = 4.6 mm)	1 or 2
Outer diameter d, mm (uncoated)	1.5, 3.0, 4.0, 4.6 and 5.0	10	1.5, 3.0, 4.0, 4.6 and 5.0	10
Coating thickness, mm	0.3-0.6			

* - For design version 1507P(F).

List of versions of TC-K and TC-L thermoelectric transducers

Version	Outer diameter, mm	Number of hot junctions	Length of mounting part L, mm																	
			80	100	120	160	200	250	320	400	500	630	800	1000	1250	1600	2000	2500	3150	
0502P(F)	3, 4, 5 and 6	1	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+
0503P(F)	1, 1.5, 2, 3, 4, 5 and 6	1	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+
0521P(F)	1, 1.5, 2, 3, 4, 5 and 6	1	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+
0502P(F)[2]	4.6 (4.5)	2	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+
0503P(F)[2]	4.6 (4.5)	2	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+
0521P(F)[2]	4.6 (4.5)	2	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+
1505P(F)	10	1	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+
1507P(F)	10	1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-
1505P(F)[2]	10	2	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+
1507P(F)[2]	10	2	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-

Designation: **TC-X 05XXP(F)[x]-I(N)-d-L** or **TC-X 150XP(F)[x]-I(N)-10-L**

An example of notation in the order:

TC-K 0502P-I-3-800 - the cable exposed-junction thermoelectric transducer with calibration **K** (chromel-alumel), with steel 12Cr18Ni10Ti sheath (**05**), of design version **02**, with a polyethylene (**P**) coating, with an insulated (**I**) hot junction, with an outer diameter (**d**) of 3 mm and a length of the mounting part (**L**) of 800 mm;

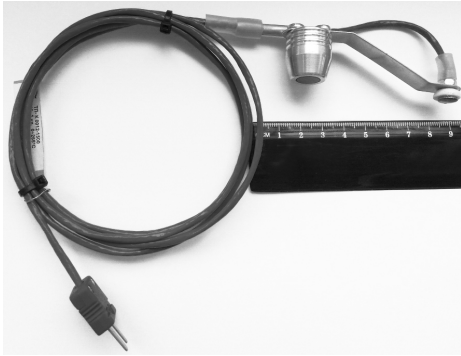
TC-L 1505F[2]-I-10-400 - the thermoelectric transducer with calibration **L** (chromel-copel), in a steel 12Cr18Ni10Ti (**15**) sheath, of design version **05**, with a polytetrafluoroethylene (**F**) coating, with two (**[2]**) insulated (**I**) hot junctions, with a diameter (**d**) of 10 mm and a length of the mounting part (**L**) of 400 mm.

The thermoelectric transducers are commonly supplied of accuracy class 1.

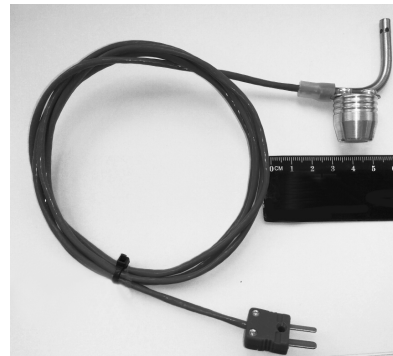
Upon Customer's request, the thermoelectric transducers can be supplied with a polymer coating of other design versions or a coating produced using Customer's working drawings.

3.7. MAGNETIC- AND SPRING-MOUNT THERMOCOUPLES FOR MEASURING SURFACE AND AIR TEMPERATURE

These thermocouples are designed for measuring the surface and air temperature in the low-temperature treatment of magnetic and non-magnetic materials.



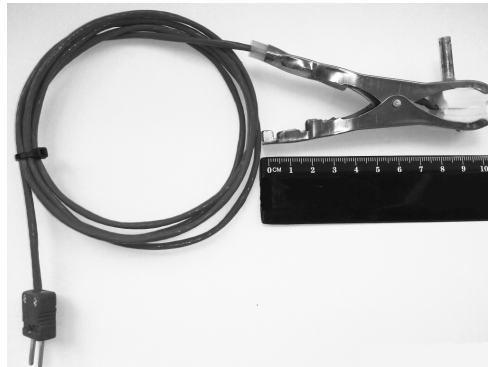
TC-K 0012-L



TC-K 0013-L



TC-K 0014-L



TC-K 0015-L



TC-K 0003.18-(2 x 0.3)-L

The TC-K 0012-L thermoelectric transducer is designed for measuring surface temperature. It is supplied in the magnetic-mount version.

The TC-K 0013-L thermoelectric transducer is designed for measuring air temperature. It is supplied in the magnetic-mount version.

The TC-K 0014-L thermoelectric transducer is designed for measuring surface temperature. It is supplied in the spring-mount version (mounted using a peg clip).

The TC-K 0015-L thermoelectric transducer is designed for measuring air temperature. It is supplied in the spring-mount version (mounted using a peg clip).

The TC-K 0003.18-(2 x 0.3)-L thermoelectric transducer is designed for measuring surface temperature. It is mounted using an adhesive tape.

The maximum operating temperature of the thermoelectric transducers is 265 °C.

The length of the extension wires of the thermoelectric transducers L shall be chosen from the following sequence: 1500, 2000, 2500 and 3000 mm.

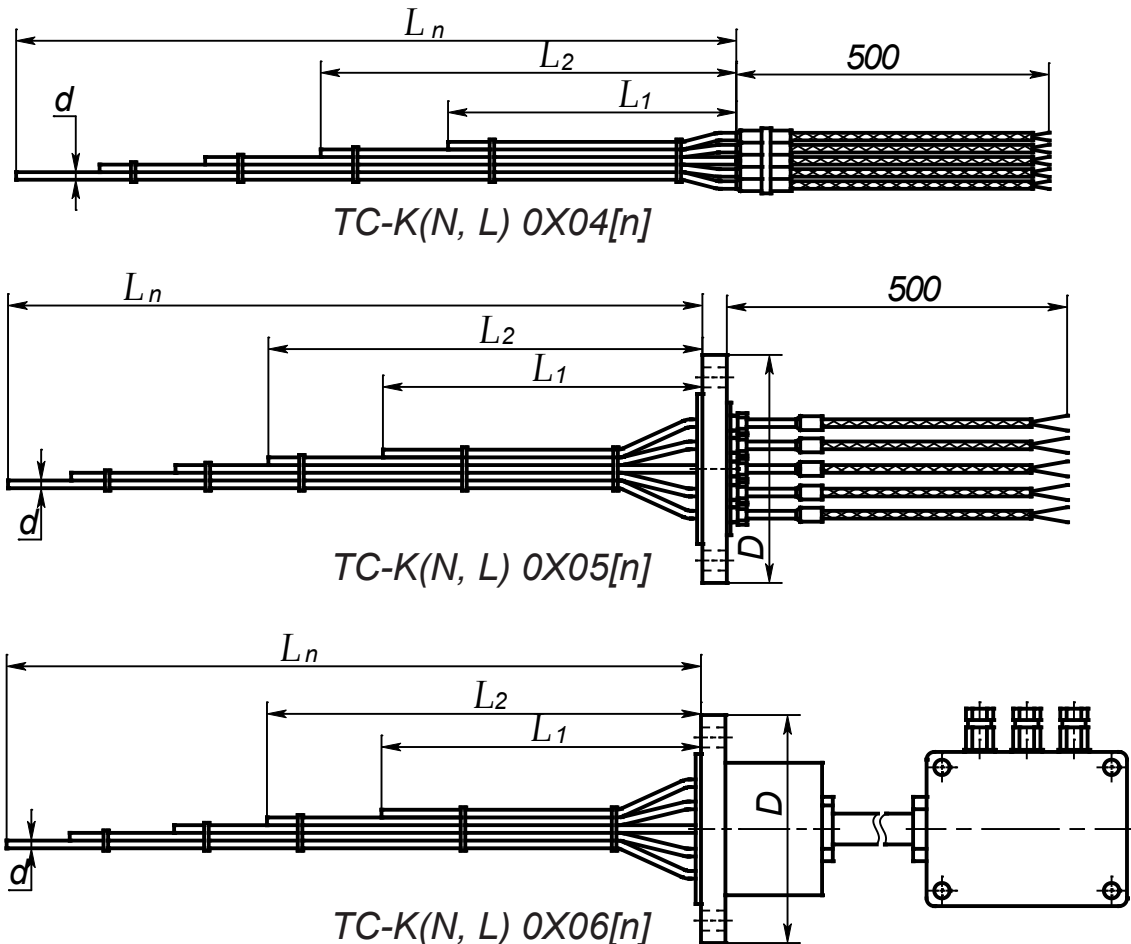
An example of notation in the order:

TC-K 0012-1500 - the thermoelectric transducer with calibration **K** (chromel-alumel) for measuring surface temperature (design version **12**), in the magnetic-mount version, with a 1500-mm length of the mounting part (**L**).

3.8. THERMOCOUPLE ASSEMBLIES

3.8.1. TC-K(N, L) 0X04 AND TC-K(N, L) 0X05 MULTI-ZONE THERMOELECTRIC TRANSDUCERS

The thermocouple assemblies based on the cable thermoelectric transducers are designed for performing multi-zone temperature measurements in oxidative and neutral gas media, which contain no substances reacting with the cable sheath material.



The TC-K(N, L) 0X04 thermoelectric transducer used for multi-zone measurements is an assembly of a few TC-K(N, L) 0X21 thermoelectric transducers. The number of measurement zones n is equal to the number of the thermoelectric transducers in the assembly. The length of the compensating wires is 500 mm and can be increased upon Customer's request.

The TC-K(N, L) 0X05 thermoelectric transducer used for multi-zone measurements is an assembly of a few TC-K(N, L) 0X21 thermoelectric transducers mounted on a flange. The mounting flange is made of the steel 12Cr18Ni10Ti according to the requirements of GOST 12821-80 for the nominal flange inner diameter $D_n = 25-100$ mm or according to Customer's working drawings.

The TC-K(N, L) 0X06 thermoelectric transducer used for multi-zone measurements is an assembly of a few TC-K(N, L) 0X21 thermoelectric transducers mounted on a flange. The outputs of the thermoelectric transducers are covered with the protection cover and connected to the terminal box with the flexible (shielded) cable. The terminal box may contain terminal blocks to connect the compensating wires or transducers of thermocouple signals into the unified 4-20 mA output signal. Upon Customer's request, the terminal box can be supplied in the explosion-proof version. The mounting flange is made of the steel 12Cr18Ni10Ti according to the requirements of GOST 12821-80 for the nominal flange inner diameter $D_n = 25-100$ mm or according to Customer's working drawings.

Technical characteristics of multi-zone thermocouple assemblies

Characteristic		TC-K	TC-N	TC-L
Operating pressure, MPa	0X04	0.1	0.1	0.1
	0X05	1.0	1.0	1.0
	0X06	1.0	1.0	1.0
Tolerance class		1 or 2	1 or 2	1 or 2
Operating temperature range, °C	CrNi78Ti (Inconel 600)	from -40 to 1100	from -40 to 1100	—
	20Cr20Ni14Si2	from -40 to 1000	from -40 to 1000	—
	10Cr23Ni18 (310 SS)	from -40 to 1000	from -40 to 1000	—
	12Cr18Ni10Ti (321 SS)	from -40 to 800	from -40 to 800	from -40 to 600
Hot junction of thermoelectric transducer for each measurement zone		Single (insulated or non-insulated from cable sheath)		
Diameter of cable sheath, mm		3.0, 4.0 and 5.0	3.0, 4.0 and 5.0	3.0, 4.0 and 5.0

The values of the Thermal inertia index correspond to the values specified for the TC-K(N, L) 0X21 thermoelectric transducers at the same protection sheath diameters.

List of versions of multi-zone thermocouple assemblies

Version	Outer diameter, mm	Length of mounting part L, mm										
		320	400	500	630	800	1000	1250	1600	2000	...	100000
0X04	3, 4 and 5	+	+	+	+	+	+	+	+	+	+	+
0X05	3, 4 and 5	+	+	+	+	+	+	+	+	+	+	+
0X06	3, 4 and 5	+	+	+	+	+	+	+	+	+	+	+

Designation: TC-X 0X04[n]-I(N)-d-L_n or TC-X 0X05[n]-I(N)-d-L_n
Measurement zones: L₁, L₂, L₃... L_n

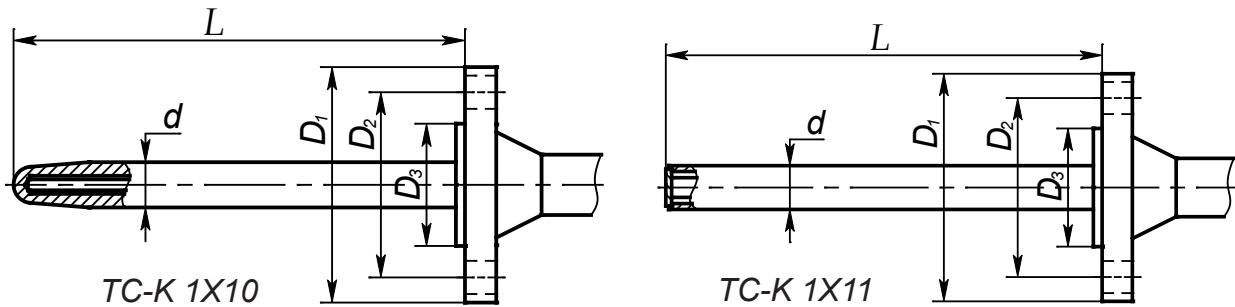
An example of notation in the order:

TC-K 0504[5]-I-3-10000 - the multi-zone thermocouple assembly with calibration **K** (chromel-alumel), of design version 04, with five ([5]) measurement zones, with sensitive elements made of a thermocouple cable with steel 12Cr18Ni10Ti (**05**) sheath, with an insulated (**I**) hot junction, with an outer diameter (**d**) of 3 mm, a maximum length (**L₅**) of 10000 mm and lengths of the measurement zones **L₁, L₂, L₃, L₄** and **L₅** (shall be explicitly stated in the order).

The thermoelectric transducers are commonly supplied of accuracy class 1.

3.8.2. TC-K(N, L) 1X10 AND TC-K(N, L) 1X11 THERMOCOUPLE ASSEMBLIES

These thermocouple assemblies are designed for measuring the temperature of high-temperature corrosive gaseous and fluid media.



The sensitive element is a cable thermoelectric transducer in heat-resistant sheath 3.0, 4.6 or 5.0 mm in diameter or a wire thermoelectric transducer with calibration K (chromel-alumel), N (nichrosil-nisil) or L (chromel-copel). The mounting flange is made of the steel 12Cr18Ni10Ti according to the requirements of GOST 12821-80 for the nominal flange inner diameter $D_n = 25-100$ mm and the nominal pressure of up to 10 MPa.

The TC-K 1X10 thermoelectric transducers are supplied in turned solid protection sheaths made of high-temperature or stainless steel.

The TC-K 1X11 thermoelectric transducers are supplied in protection sheaths made of high-temperature or stainless-steel tubes.

Technical characteristics of TC-K 1X10 and TC-K 1X11 thermoelectric transducers

Characteristic	Version					
	1210	1410	1510	1211	1411	1511
Sheath material	CrNi45Al	10Cr23Ni18	12Cr18Ni10Ti	CrNi45Al	10Cr23Ni18	12Cr18Ni10Ti
Operating temperature range, °C	0-1000	0-800	0-600	0-1000	0-800	0-600
Operating pressure, MPa	0 ÷ 10,0			0-4.0		
Tolerance class	1 or 2					
Number of hot junctions	1 or 2					
Thermal inertia index, s	120-240			90		
Outer sheath diameter, mm	20, 25, 30 and 40			16 and 20		

List of versions of TC-K 1X10 and TC-K 1X11 thermoelectric transducers

Version	Outer sheath diameter, mm	Length of mounting part L, mm						
		320	400	500	630	800	1000	1250
TC-K 1210		+	+	+	+	+	+	+
TC-K 1410	20, 25, 30 and 40	+	+	+	+	+	+	+
TC-K 1510		+	+	+	+	+	+	+
TC-K 1211		+	+	+	+	+	+	+
TC-K 1411	16 and 20	+	+	+	+	+	+	+
TC-K 1511		+	+	+	+	+	+	+

Note: 1) The design and dimensions of the mounting flange shall be specifically stated in the order. 2) Protection sheaths can be made of other steel grades. 3) The outer part of the thermoelectric transducers shall be manufactured using Customer's working drawings.

Designation: TC-K 1X10[x]-d-L or TC-K 1X11[x]-20-L

An example of notation in the order:

TC-K 1210-30-1000 - the thermocouple assembly with calibration **K** (chromel-alumel), of design version **10**, with a CrNi45Al high-temperature alloy (**12**) sheath, with an outer diameter (**d**) of 30 mm and a length of the mounting part (**L**) of 1000 mm.

The thermoelectric transducers are commonly supplied of accuracy class 1.

SECTION 4. THERMOELECTRIC TRANSDUCERS FOR TEMPORARY MEASUREMENTS OF TEMPERATURE IN METAL, SALT AND GLASS MELTS

4.1. TC-A 212PT AND TC-K 212PT THERMAL PROBES

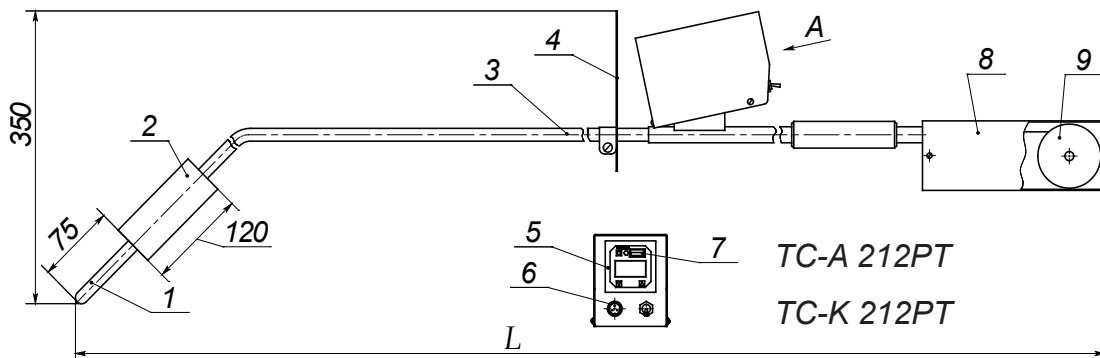
These thermal probes are designed for performing temporary measurements of the temperature of metal melts, as well as the temperature in induction and resistance furnaces and in pouring ladles.

The thermal probe is a hollow tube (3) which contains a thermocouple enclosed into two-channel ceramic tubes

From the working end, the probe is bent at the angle of 45° and terminates with changeable sheath (1), which serves to protect the hot junction of the thermocouple. The thermocouple wires are traced inside the metal tube (3) from the hot junction to reel (9) placed into metal sheath (8). The rest part of the thermocouple wires is wound on the reels, which serves to replace a life-expired thermocouple section. The probe is equipped with digital temperature indicator (5) and protection plate (4). The measuring instrument is used to measure, display and archive temperature data. The instrument is equipped with USB interface (7) via which the archived temperature data can be transferred to a flash drive. On the front panel of the measuring unit there is the port (6) to connect the unit to a PC via RS485 interface. The indicator is powered with a 12 V self-contained power supply.



The thermal probe is equipped with graphite float (12), which provides the buoyancy of the working end of the thermal probe.



The following sensitive elements are used in the thermal probe:

- a tungsten-rhenium 5% - tungsten-rhenium 20% (W-Re 5/20) thermocouple with the wires 0.35 mm in diameter and 10 m long;
- a chromel-alumel thermocouple with the wires 0.5 mm in diameter and 10 m long.

Changeable protection sheath (1) of the thermal probe is made of high-purity modified silicon dioxide. The dimensions of the protection sheath are as follows: the length - 115 mm, the outer diameter - 12 mm and the inner diameter - 7 mm. The thermal probe is provided with ten changeable sheaths, which are designed to withstand about ten immersions into a cast iron melt with a temperature of ~ 1500°C. The weight of the thermal probe is from 1.0 to 2.9 kg.

Technical characteristics

Characteristic	Value	
Operating temperature range, °C and tolerance class for thermocouples of type	A	100-1700 / 2 or 3
	K	100-1250 / 1 or 2
Protection sheath material	SiO ₂ /12Cr18Ni10Ti	
Diameter of thermocouple wires, mm for thermocouples of type	A	0.35
	K	0.5
Average measurement duration, s	60	

List of versions of thermal probes

Version	Protection sheath material	Outer protection sheath diameter, mm	Total thermal probe length L, mm					Length of thermocouple wires, m
			1250	1600	2000	2500	3000	
TC-A 212PT	SiO ₂	12	+	+	+	+	+	10
TC-K 212PT	SiO ₂	12	+	+	+	+	+	10

Designation: **The TC-A 212PT-d-L or TC-A 212P-d-L** thermal probe,

where **d** is protection sheath diameter and **L** is total thermoelectric transducer length.

An example of notation in the order:

TC-A 212PT-12-1600 - the thermal probe with a thermoelectric transducer of calibration **A-1** or **A-2** (tungsten-rhenium), in a silicon dioxide sheath, of design version **212**, with protection sheath diameter (**d**) of 12 mm and the total thermoelectric transducer length (**L**) of 1600 mm;

TC-K 212PT-12-1600 - the thermal probe with a thermoelectric transducer of calibration **K** (chromel-alumel), in a metal sheath, of design version **212**, with protection sheath diameter (**d**) of 12 mm and total thermoelectric transducer length (**L**) of 1600 mm.

The thermoelectric transducers are supplied, as a rule, of accuracy class 2 (type K) or 3 (type A) with 0.5-mm (type K) or 0.35-mm (type A) thermocouple wires.

4.2. TC-K 185 AND TC-K 186T THERMAL PROBES

The TC-K 185 thermal probes are designed for performing temporary measurements of the temperature of glass and salt melts, as well as the temperature in resistance furnaces and salt-bath hardening furnaces.

The sensitive element of the thermal probe is a chromel-alumel (type K) thermocouple.

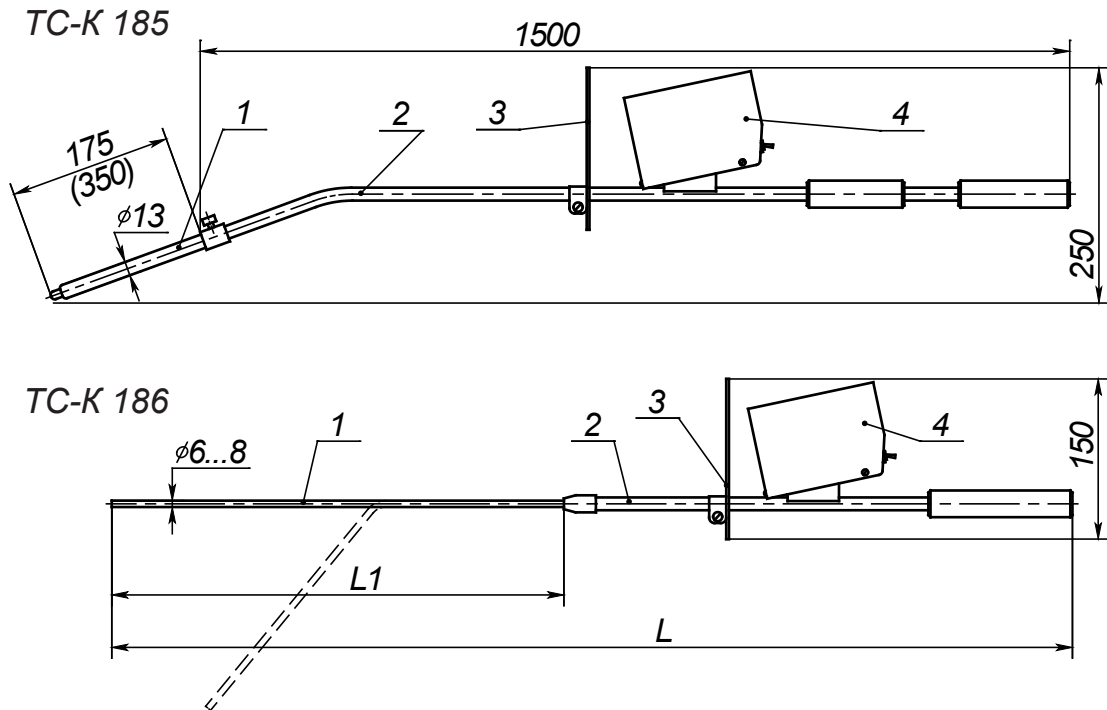
The thermal probe is hollow metal tube (2) with sensitive element (1) fixed to it. The sensitive element is a solid rod made of the steel AISI 446, which has internal blind hole and outer protection coating. Thermocouple wires are fixed inside the hole. In order to shorten the measurement duration, the hot junction is not insulated from the sheath shell. The thermocouple wires are traced through the metal tube from the hot junction to digital measuring instrument (4) placed on the probe body. The measuring instrument is used to measure, display and archive temperature data. The instrument is equipped with a USB interface via which the archived temperature data can be transferred to a flash drive. Front panel of the measuring unit has the port to connect the unit to a PC via the RS485 interface. The indicator is equipped with a 12 V self-contained power supply. Metal plate (3) fixed to the rod serves to protect the measuring instrument from thermal radiation.

Changeable sensitive element of the thermal probe is made of heat-resistant steel and is capable to do short-time measurements of temperatures up to 1300°C.

The TC-K 186T thermal probe is designed to perform temporary measurements of the temperature of aluminum melt.

The sensitive element of the thermal probe is a cable chromel-alumel (type K) thermocouple sheathed by the alloy AISI 446.

The thermal probe is hollow metal rod (2) in which cable sensitive element (1) is fixed. For convenience of measurement, the cable sensitive element can be bent with a bending radius of 35 mm min. The probe body is equipped with digital temperature instrument (4) and protection plate (3). The measuring instrument is used to measure, display and archive temperature data. The instrument is equipped with a USB interface via which the archived temperature data can be transferred to a flash drive. Front panel of the measuring unit has the port to connect the unit to a PC via the RS485 interface. The indicator is equipped with a 12 V self-contained power supply.



Technical characteristics

Characteristic	TC-K 145T	TC-K 186T
Operating temperature range, °C and tolerance class for thermocouples	100-1300 1 or 2	100-1300 1 or 2
Number of hot junctions	1 (non-insulated)	1 (insulated)
Diameter of thermocouple wires, mm	1.2/1.2	1.0/1.0
Average measurement duration, s	15	30

List of versions of thermal probes

Version	Protection sheath material	Outer protection sheath diameter, mm	Total thermal probe length L, mm		
			1250	1600	2000
TC-K 145T	10Cr23Ni18	10	+	+	+
TC-K 186T	AISI 446	6 (3; 8)	+	+	+

Designation: **The TC-K 145T-d-L or TC-K 186T-d-L/L1 thermal probe,**

where **d** is the protection sheath diameter, **L** is total thermoelectric transducer length and **L1** is cable part length.

An example of notation in the order:

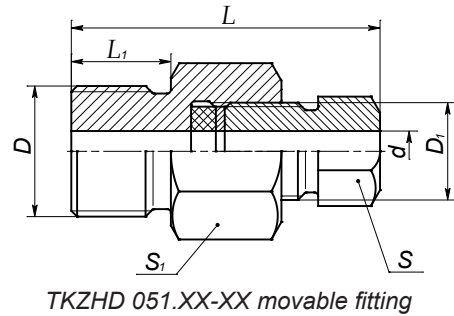
TC-K 145T-10-1600 - the thermal probe with thermoelectric transducer of calibration **K** (chromel-alumel), in a metal sheath, of design version **145**, with protection sheath diameter (**d**) of 10 mm and total thermoelectric transducer length (**L**) of 1600 mm;

TC-K 186T-6-1600/600 - the thermal probe with thermoelectric transducer of calibration **K** (chromel-alumel), of design version **186**, with cable sensitive element 6 mm in diameter (**d**), total thermoelectric transducer length (**L**) of 1600 mm and the length of the protruding part of the sensitive element (**L1**) of 600 mm.

SECTION 5. UNITS AND COMPONENTS OF THERMOELECTRIC TRANSDUCERS

5.1. MOVABLE FITTING

The movable fittings are designed for mounting thermoelectric transducers of the following types at operation points: TC-A-1 121, 112 and 251, TC-S(B) 102, 105, 121, 112, 242 and 251, as well as TC-K(N, L) 1X05 and 1X06. The fittings are made of the steel 12Cr18Ni10Ti.



List of versions of movable fitting

Designation	Dimensions, mm						
	L	L1	D	D1	d	S	S1
TKZHD 051.20-10	49	16	M20 x 1.5	M20 x 1.5	10.5	22	24
TKZHD 051.27-10	50	20	M27 x 2	M20 x 1.5	10.5	22	32
TKZHD 051.27-20	69	20	M27 x 2	M33 x 2	21.0	36	41
TKZHD 051.33-20	73	24	M33 x 2	M33 x 2	21.0	36	41

Designation:

Movable fitting TKZHD 051.D - d

1	2	3	4
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1. Manufacturer's design code;
2. material code;
3. version number;
4. mounting thread diameter;
5. inside diameter.

An example of notation in the order:

TKZHD 051.20-10 - the movable fitting made of the steel 12Cr18Ni10Ti (5), of design version **1**, with M20 x 1.5 (**20**) mounting thread, with an inside diameter of 10 mm (**10**).

5.2. TKZHD XX01, TKZHD XX02, TKZHD XX03 AND TKZHD XX04 PROTECTION SLEEVES

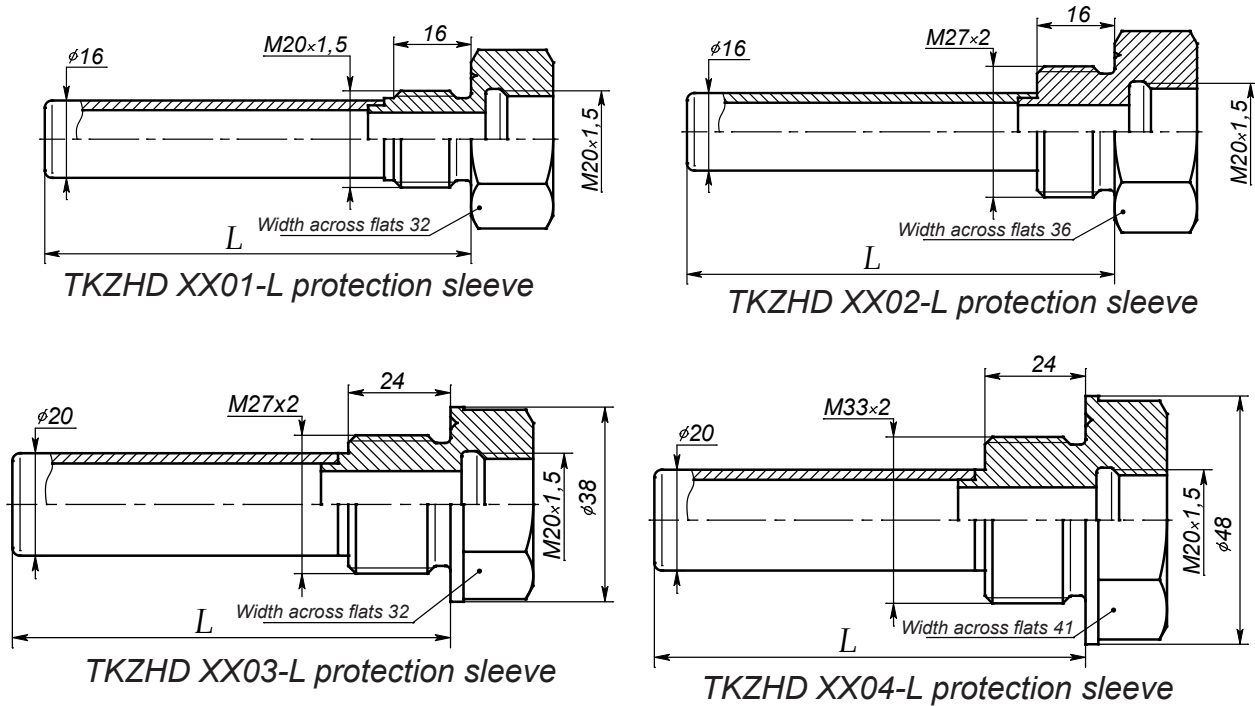
These protection sleeves are designed for mounting thermoelectric transducers at operation points and for additional protection the transducers against mechanical and chemical impacts of the working medium. The protection sleeve is made of the steel 12Cr18Ni10Ti (15) or the steel 10Cr17Ni13Mo2Ti (16). The sleeves are intended to withstand a rated pressure of 25 MPa.

Designation:

Protection sleeve TKZHD 1X0X - L

1	2	3	4
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1. Manufacturer's design code;
2. protection sleeve material code (15 or 16);
3. version number;
4. length of mounting part of thermoelectric transducer, mm.



List of versions

Sleeve type	Length of mounting part L, mm														
	80	100	120	160	200	250	320	400	500	630	800	1000	1250	1600	2000
TKZHD XX01-L	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
TKZHD XX02-L	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
TKZHD XX03-L	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
TKZHD XX04-L	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

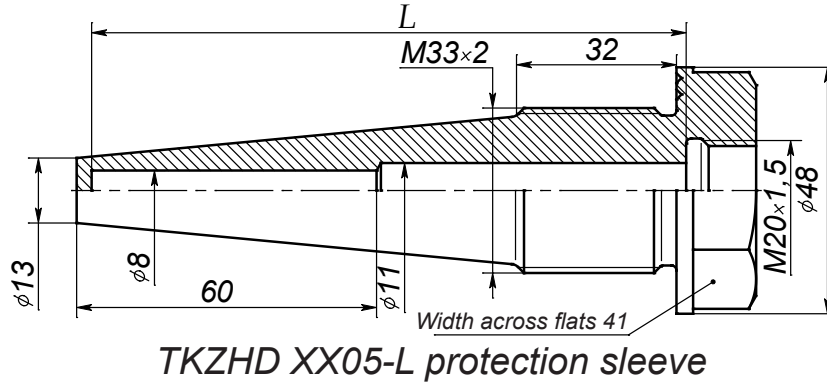
An example of notation in the order:

TKZHD 1501-250 - the protection sleeve made of the steel 12Cr18Ni10Ti (**15**), of design version **01**, with M20 x 1.5 mounting thread, with an outer diameter of the working part of 16 mm and a length of the mounting part of 250 mm;

TKZHD 1602-400 - the protection sleeve made of the steel 10Cr17Ni13Mo2Ti (**16**), of design version **02**, with M33 x 2 mounting thread, with an outer diameter of the working part of 20 mm and a length of the mounting part of 400 mm.

5.3. TKZHD XX05 PROTECTION SLEEVE

This protection sleeve is designed for mounting thermoelectric transducers at operation points and for additionally providing the transducers against mechanical and chemical impacts of the operating medium. The sleeve is fabricated as whole-turned solid. The protection sleeve is made of the steel 12Cr18Ni10Ti (15) or the steel 10Cr17Ni13Mo2Ti (16). The sleeve is intended to withstand a rated pressure of 50 MPa.



Designation:

Protection sleeve TKZHD XX05 - L

1	2	3	4
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1. Manufacturer's design code;
2. protection sleeve material code (15 or 16);
3. version number;
4. length of mounting part of thermoelectric transducer, mm.

List of versions

Sleeve type	Length of mounting part L, mm				
	120	160	200	250	320
TKZHD XX05-L	+	+	+	+	+

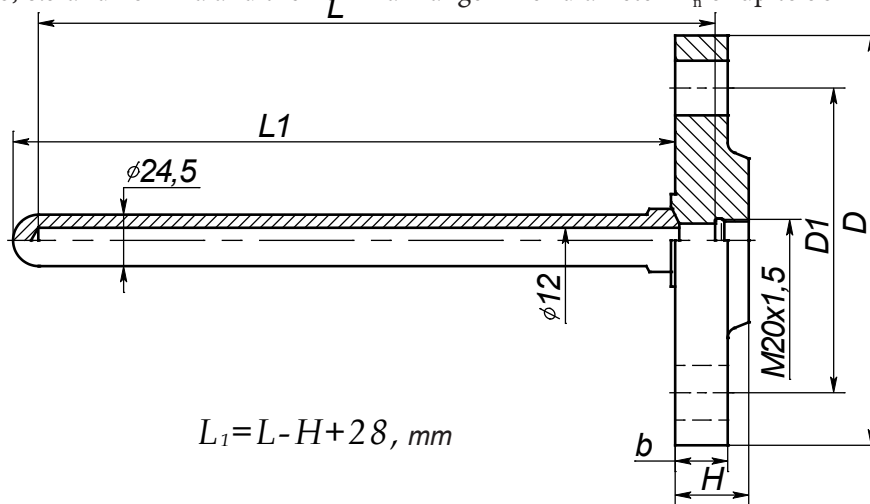
An example of notation in the order:

TKZHD 1505-250 - the protection sleeve made of the steel 12Cr18Ni10Ti (15), of design version **05**, with M33 x 2 mounting thread, with a length of the mounting part of 250 mm.

5.4. TKZHD XX06 PROTECTION SLEEVE

This protection sleeve is designed for mounting thermoelectric transducers at operation points according to the requirements of GOST 22811-83 and for additionally providing the transducers against mechanical and chemical impacts of the operating medium. The mounting flange is made of the steel 12Cr18Ni10Ti and the protection sheath is made of the alloy CrNi45Al (material code 12) or the steel 10Cr23Ni18 (material code 14), or the steel 12Cr18Ni10Ti (material code 15). The protection sheath is fabricated as whole-turned solid.

The mounting flanges are produced according to the requirements of GOST 12821-80 for nominal pressures P_n of 2.5, 4.0, 6.3 and 10 MPa and the nominal flange inner diameter D_n of up to 50 mm.



TKZHD XX06- D_n - P_n -L protection sleeve

Optionally, the protection sleeves can be manufactured with the sealing surfaces according to the requirements of GOST 12815-80 using Customer's working drawings. Flange sleeves can also be manufactured according to the requirements of standard DIN 43772-2000.

Designation:

Protection sleeve TKZHD XX06 - D_n - P_n - L

1	2	3	4	5	6
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1. Manufacturer's design code;
2. protection sleeve material code (15 or 16);
3. version number;
4. nominal flange inner diameter, mm;
5. nominal pressure, MPa;
6. length of mounting part, mm.

List of versions of protection sleeve according to length of mounting part of thermoelectric transducer

Sleeve type	Length of mounting part of thermoelectric transducer L, mm					
	200	250	320	400	500	630
TKZHD XXo6-D _N -P _N -L	+	+	+	+	+	+

Overall dimensions of sleeves rated for various nominal pressures

P _n , MPa	D _n , mm	D, mm	D1, mm	H, mm	b, mm
2.5	25	115	85	24	14
	32	135	100	26	16
	40	145	110	26	16
	50	160	125	27	17
4.0	25	115	85	24	14
	32	135	100	26	16
	40	145	110	26	16
	50	160	125	27	17
6.3	25	135	100	30	20
	32	150	110	31	21
	40	165	125	31	21
	50	175	135	33	23
10.0	25	135	100	32	22
	32	150	110	32	22
	40	165	125	33	23
	50	195	145	35	25

An example of notation in the order:

TKZHD 1506-50-4.0-400 - the protection sleeve made of the steel 12Cr18Ni10Ti (15), of design version **06**, rated for a nominal flange inner diameter of 50 mm and a nominal pressure of 4.0 MPa, for mounting a thermoelectric transducer with a length of a mounting length of 400 mm.

