

T4 - THERMOELEMENTS FOR FLUES



Genuine thermoelements with metal tubes are specially designed for use at increased temperatures, e.g. in flues for temperatures up to 700°C.

Electrical connection is made via a terminal block or a transmitter, in the connection head.

Basic parts of thermoelement are as follows:

- connection head,
- external protection tube,
- measuring insert,
- process connection.

Connection head of thermoelement can be of various dimensions and shapes and is defined via the configurator.

External protection tube of thermoelement is made of material selected to suit the process conditions. Protection tube can be enameled or non-enameled and is directly immersed in the medium in which the temperature is measured.

Measuring insert can be in classic and mantel design with different types of thermocouples (J, K, N, T) that are defined via the configurator.

We recommend the mantel design, which has a number of advantages:

- there is no contamination and oxidation of the hot end of the thermocouple, because it is in highly compressed magnesium oxide, without the presence of oxygen,
- faster response,
- great resistance to vibrations,
- higher reliability in operation,
- longer service life.

The only advantage of the classic measuring insert is the lower price.

Process connection is achieved using:

- flange, according to DIN 43734,
- movable connection (compression fitting)

Flange and movable connection (compression fitting) can be moved along the longitudinal axis of thermoelement, which regulates the installation length.

Technical characteristics

Basic technical characteristics are specified in the configurator.

By filling in the configurator, an order code is generated, which defines the product.

Use

- flues,
- air-circulation heat treatment furnaces.

Field of use

Group T4- thermoelements with external metal or metal enameled tubes are suitable for use in flues for temperatures up to 1200°C.

The main advantage of these thermoelements is their service life, which makes them suitable for use in a wide variety of flues, at increased temperatures, vibrations, and even in the presence of abrasion.

The installation of thermoelements is given in Figure 1.

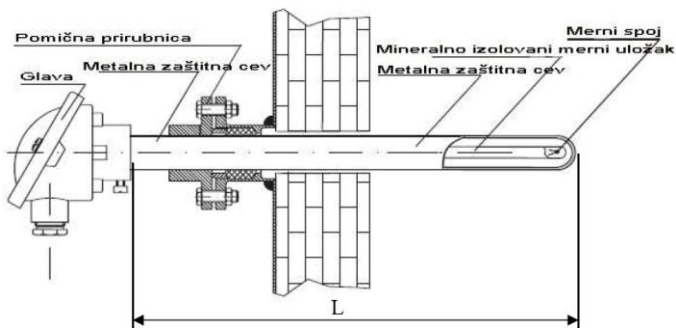


Figure 1. Installation of Group T4- thermoelements (Movable flange/Metal protection tube/Head, Measuring junction/Mineral insulated measuring insert/Metal protection tube)

Functionality and structure

Measurement principle

Thermocouple consists of two thermoelectrodes, made of materials of different conductivity, that are connected to each other with two junctions (hot and cold), so that they form one electrical circuit.

When one junction (hot junction) is at temperature T_1 , and the other (cold junction) is at temperature T_2 , an electromotive force is generated in the circuit, the value of which depends on the materials used and the values of temperatures T_1 and T_2 . This effect, on which thermoelectric temperature measurements are based, is known as the Seebeck effect.

In one industrial thermoelement, one junction of the thermocouple (hot junction) is a measuring junction (exposed to the temperature being measured) and the other junction (cold junction) is a reference junction which is at the known - reference temperature with which the measured temperature is compared to.

Thermovoltage values in mV depending on temperature, for thermocouples Type J, K, N and T..., are given in Table 5.

Constituent parts

Group T4- thermoelements are manufactured in line with the provisions of the international standard IEC 60584.

These products consist of a measuring insert $\varnothing 6$ (mantel structure), a protection tube, a connection head in which a transmitter or a ceramic block with terminals for electrical connection can be installed, depending on which output signal is needed (voltage or current).

Measuring insert – mantel structure

In this structure, the thermocouple is placed inside a metal shell. The thermoelectrodes of the thermocouple are insulated from each other, longitudinally, and from the metal shell with highly compressed magnesium oxide.

Protection tubes

With **Group T4-** thermoelements, metal tubes and metal-enameled tubes are used as external protection tubes.

Depending on the temperature and more or less on the severity of the working conditions in which they are used, metal protection tubes are produced from different steels and special alloys, with different diameters and wall thickness and are used for:

- gas temperature up to 550°C, Č.1214 is used, non-enameled tubes;
- gas temperature up to 700°C, Č.1214 is used, enameled tubes;
- air temperature from 800°C up to 1100°C, or Č.4970(1.4762), Č.4578(W.Nr.1.4841) or W.Nr.1.4749.

Use of protection tubes made of the above steel largely depends on the type of flue gas composition (sulfur concentration, primarily), the presence of currents, vibrations, abrasion, etc.

The tips of the protection tubes that are in the working medium are welded with special technology and guarantee optimal mechanical resistance and ensure effective temperature measurement, i.e. fast response.

Connection head

Group T4- thermoelements use connection heads, shape B, according to DIN 43729, connection head KNH-L, in which a transmitter and a ceramic block or two transmitters can be installed, and many other connection heads of different shapes and materials.

The connection heads are given in Figure 2.

Length

All **Group T4-** thermoelements can be ordered in the lengths specified in the Ordering information. Lengths 500, 710, 1000, 1400 and 2000mm are considered standard.

Thermoelements of non-standard lengths can be ordered depending on the specification and technical characteristics of the process.

Table 1: Standard materials and dimensions of thermoelectrodes for thermocouples

Thermocouple type	Thermoelectrode material	Thermoelectrode diameter [mm]
J	(+) Fe / (-) CuNi	1.00; 1.38; 2.00; 2.50; 3.00
K	(+) NiCr / (-) Ni	1.00; 1.38; 2.00; 2.50; 3.00
N	(+) NiCrSi / (-) NiSi	1.00; 1.38; 2.00; 2.50; 3.00
T	(+) Cu / (-) CuNi	1.00; 1.38; 2.00; 2.50; 3.00

Table 2: Standard materials of metal protection tubes

External protection tubes	Diameter	Max temp.
Material	mm	°C
Č.1214; W.Nr.1.0305, St. 35.8	15	550
Č.1214; W.Nr.1.0305, St. 35.8, enameled	15	700
Č.4970; W.Nr.1.4762	15	1200
Č.4578;1.4841	17.34	1200
W.Nr.1.4749	17.34	110

Č.1214; W.Nr.1.0305, St. 35.8

Non-alloyed steel, suitable for enameling. Protection tubes made of this steel:

- **non-enameled tubes;** resistant to water in closed systems, neutral gases, flue gases. Maximum temperature of use: generally, 550°C, it can be lower depending on the working medium.
- **Enameled tubes:** resistant to water and steam, hot acids and vapors, liquefied gas, sulfur vapors and gases, molten lead, tin and zinc, alkaline environments, gasoline. Maximum temperature of use: generally, 700°C, it can be lower depending on the working medium.

Č.4574; W.Nr.1.4571

Austenitic stainless steel, resistant to corrosion in acidic environments but not to oxidation in sulfuric and phosphoric acids (even at concentrated and low temperatures). Not resistant to high temperatures in environments containing chlorine. Maximum temperature of use: 800°C.

Č.4970; W.Nr.1.4762

Fire resistant, stainless steel, ferroalloy, resistant to sulfur atmosphere (very good in oxidation and good in reduction). Not recommended in atmospheres containing nitrogen. Maximum temperature of use: 1200°C.

Č.4578; W.Nr.1.4841

Good thermal, mechanical and corrosion resistance. Resistant to nitrogen atmosphere with low oxygen concentration. It is similar but at the same time better than steel Č.4574. Not resistant to gases containing sulfur. Maximum temperature of use: 1200°C.

W.Nr.1.4749

Fire resistant, stainless steel, ferroalloy, resistant to the reducing atmosphere containing high concentrations of sulfur, to oxidation in the air and gases generated during oil combustion. Maximum temperature of use: 1100°C.

Electronics

If the customer wants a current output signal, a 2-wire transmitter is installed in the connection head.

Transmitters in 2-wire technology and with an output signal of 4-20 mA are very easily programmed with the help of a personal computer, a programming unit and the appropriate software. Transmitters are galvanically isolated.

If the transmitter is intended for installation on a DIN rail, then a ceramic block with terminals for electrical connection is installed in the connection head.

Performances

Working conditions for the connection head

Ambient temperature - the case when the connection head is without transmitter: - 40 to 130°C.

Ambient temperature - the case when the transmitter is installed in the connection head: - 40 to 85°C.

Process temperature

Operating range is defined - determined based on the combination of the type of thermocouple and the material of the protection tube.

Accuracy (certainty)

Standard IEC 60584 defines the standard values and tolerances (permissible errors) of thermocouples. The standard accuracy classes for thermocouples type J, K, N, T, ...; are class 2.

Permissible measurement errors are listed in Table 3.

Table 3: Permissible measurement errors

Type	Standard tolerance (IEC 60584)		Reduced tolerance (IEC 60584)	
	Class	Permissible measurement error	Class	Permissible measurement error
J Fe-CuNi	2	$\pm 2.5^{\circ}\text{C}$ (-40...333) $^{\circ}\text{C}$ $\pm 0.0075 t $ (333...750) $^{\circ}\text{C}$	1	$\pm 1.5^{\circ}\text{C}$ (-40...375) $^{\circ}\text{C}$ $\pm(0.004 t)$ (375...750) $^{\circ}\text{C}$
K NiCr-Ni	2	$\pm 2.5^{\circ}\text{C}$ (-40...333) $^{\circ}\text{C}$ $\pm 0.0075 t $ (333...1200) $^{\circ}\text{C}$	1	$\pm 1.5^{\circ}\text{C}$ (-40...375) $^{\circ}\text{C}$ $\pm(0.004 t)$ (375...1200) $^{\circ}\text{C}$
N NiCrSi- NiSi	2	$\pm 2.5^{\circ}\text{C}$ (-40...333) $^{\circ}\text{C}$ $\pm 0.0075 t $ (333...1200) $^{\circ}\text{C}$	1	$\pm 1.5^{\circ}\text{C}$ (-40...375) $^{\circ}\text{C}$ $\pm(0.004 t)$ (375...1200) $^{\circ}\text{C}$
T Cu-CuNi	2	$\pm 1^{\circ}\text{C}$ (-40...133) $^{\circ}\text{C}$ $\pm 0.0075 t $ (133...350) $^{\circ}\text{C}$	1	$\pm 0.5^{\circ}\text{C}$ (-40...125) $^{\circ}\text{C}$ $\pm(0.004 t)$ (125...350) $^{\circ}\text{C}$

Transmitter error must be added to the thermocouple error, including reference junction compensation.

Response time

Response time for these types of thermocouples is not a circular parameter. If you want that information, contact the Technical Service - TERMOTEHNA.

Insulation

Resistance of the insulation between the electrical terminals on the ceramic block and the external tube is fully guaranteed by the manufacturing procedures. For thermoelements with a measuring insert, according to the IEC 1515 standard, the value of the insulation resistance between the terminal and the protection tube is:

- at 25 $^{\circ}\text{C}$, testing at 500 Vdc $\geq 1000 \text{ M}\Omega$
- at 500 $^{\circ}\text{C}$, testing at 500 Vdc $\leq 5 \text{ M}\Omega$

Self-heating

Does not occur.

Installation

Given in Figure 1. It is possible to replace the measuring insert during operation, without stopping the process.

Connection head

Pursuant to the provisions of the DIN 43729 standard, the housing of the connection head, shape B, contains a ceramic block with electrical terminals or a transmitter. It can be of different types and materials (e.g. painted aluminum, crude iron or stainless steel).

It is possible to simultaneously install a ceramic block and a transmitter or two transmitters in the housing of the connection head, shape KNH-L.

Connection heads are given in Figure 2.

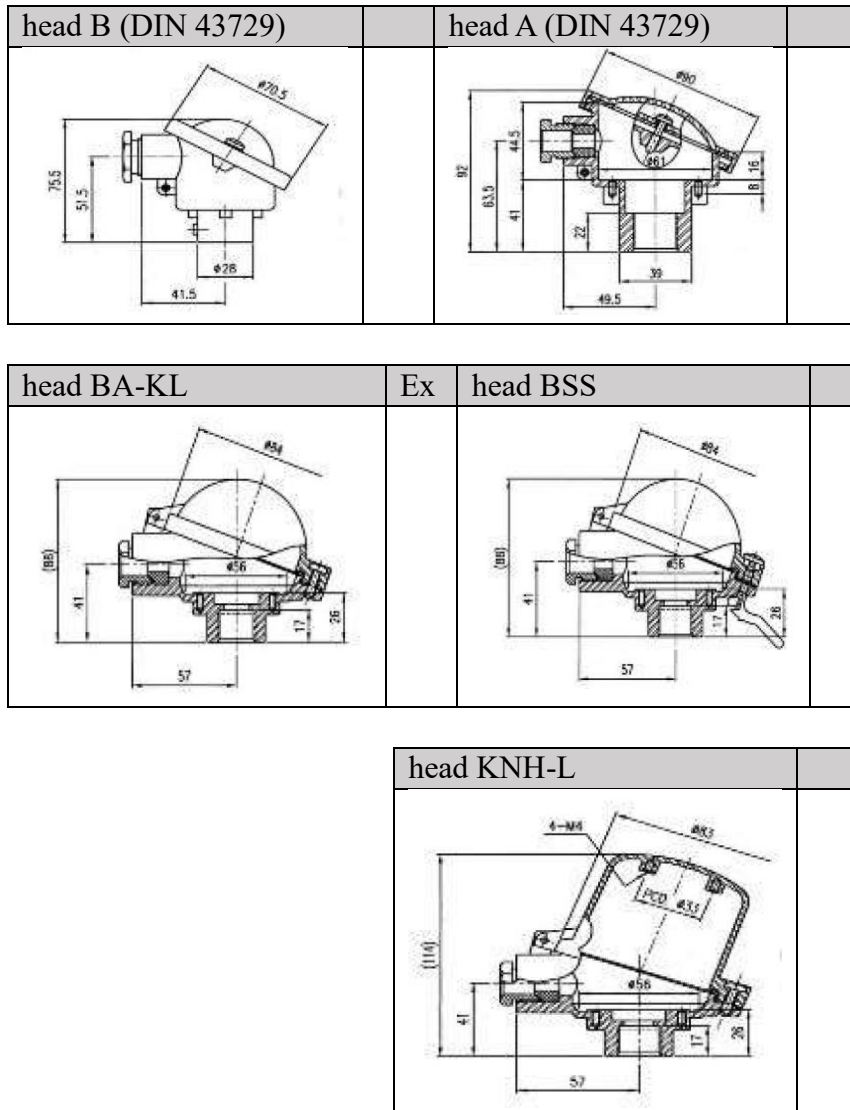


Figure 2. Connection heads

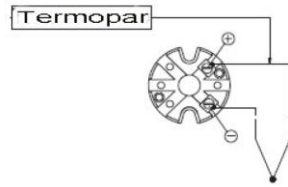
Transmitters

The following transmitters are applicable:

- PC programmable transmitters 4...20mA (galvanically isolated)
- Transmitters with HART protocol (galvanically isolated), the output contains 4...20mA and HART superimposed signals
- Transmitters (galvanically isolated) PROFIBUS PA with output signal, the communication address can be set via the appropriate software or by means of mechanical switches. Customer can request the desired configuration during the ordering process.

If the transmitters are installed on a DIN rail, ceramic blocks are installed in the connection head.

Measuring insert



- **measuring insert** – mantel structure, directly placed into the metal protection tube.

Figure 3. Standard connecting

Figure 4 shows parts of the **Group T4-** thermoelement.

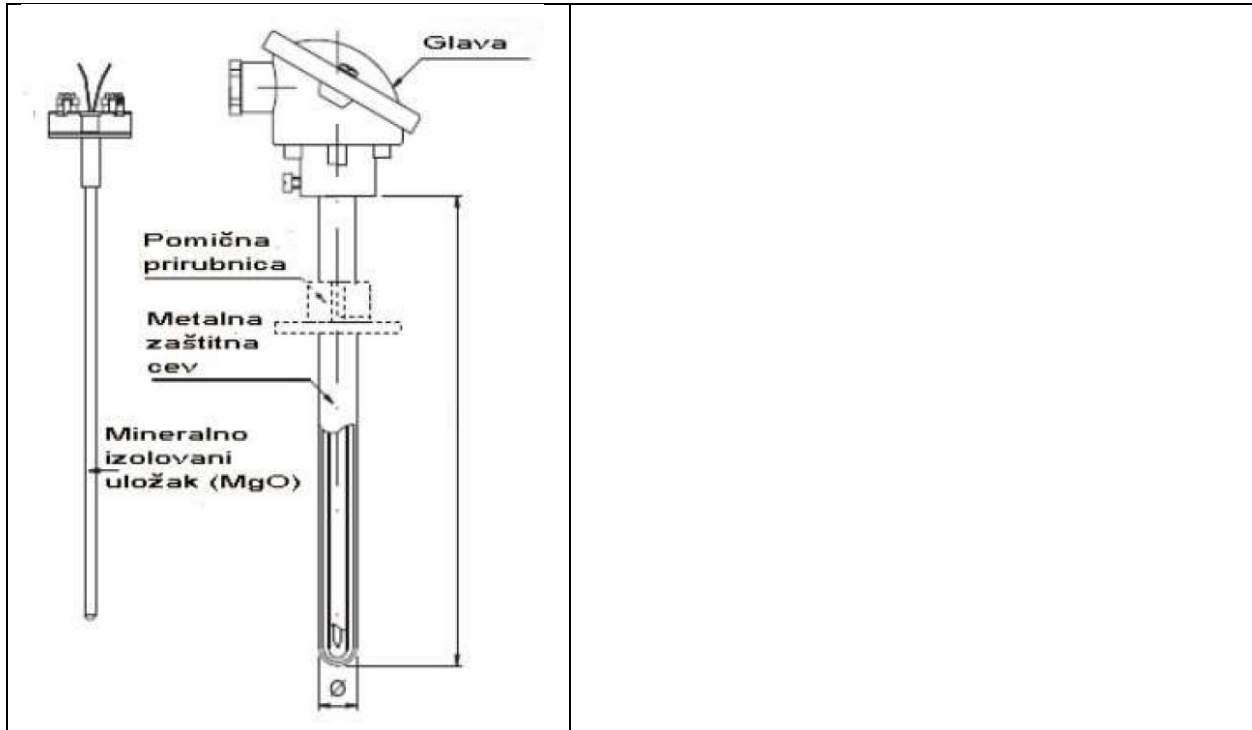


Figure 4. Parts of Group T4- thermoelements (Head/Movable flange/Metal protection tube/ Mineral insulated insert (MgO))

When replacing the measuring insert, the installation length (L_u) depends on the length (L) of the protection tube.

Auxiliary equipment

Movable Flange

For $A = 15$ [mm]

$B = 55$ [mm]; $C = 75$ [mm].

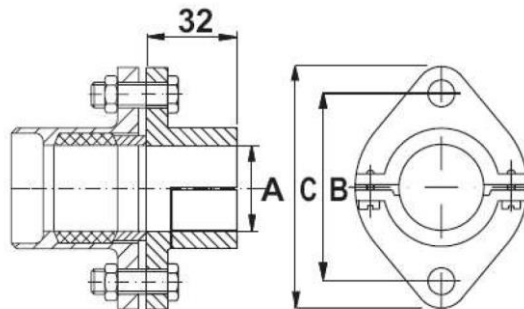


Figure 4. Movable flange DIN 43734

Certificates

- Calibration certificate for temperature measuring instruments
- Calibration certificate for temperature measuring equipment
- Certificate of calibration laboratory accreditation - accreditation no.: 02-058

Other details

Maintenance

Group T4- thermocouples do not require any special maintenance.

Periodic inspections are recommended because mechanical damage and thermal shocks, aggressive environments, occurrence of abrasion can cause tube damage.

Furthermore, periodic calibrations are recommended, on an annual basis, in order to check the metrological characteristics of thermocouples, by an authorized laboratory, and in line with the Law.

Table 4. *Catalog codes for standard thermocouples*

Temperature	Thermocouple	Material of metal protection tube	Nominal length L [mm]	Measuring insert Ø6 Length Lu [mm]	Catalog number	
					thermocouple 1	thermocouple 2
up to 550°C	Fe-CuNi Type J, according to IEC 60584-1 in mantel measuring insert	W.Nr. 1.0305 St. 35.8 Ø15x2	500	525	T4- 1101	T4- 2101
			710	735	T4-1102	T4-2102
			1000	1025	T4-1103	T4-2103
			1400	1425	T4-1104	T4-2104
up to 700°C	Fe-CuNi Type J, according to IEC 60584-1 in mantel measuring insert	W.Nr. 1.0305 St. 35.8 Enameled Ø15x2 enameled	500	525	T4-1121	T4-2121
			710	735	T4-1122	T4-2122
			1000	1025	T4-1123	T4-2123
			1400	1425	T4-1124	T4-2124
up to 550°C	NiCr-NiAl Type K, according to IEC 60584-1 in mantel measuring insert	W.Nr. 1.0305 St. 35.8 Ø15x2	500	525	T4-1201	T4-2201
			710	735	T4-1202	T4-2202
			1000	1025	T4-1203	T4-2203
			1400	1425	T4-1204	T4-2204
up to 700°C	NiCr-NiAl Type K, according to IEC 60584-1 in mantel measuring insert	W.Nr. 1.0305 St. 35.8 Ø15x2 enameled	500	525	T4-1221	T4-2221
			710	735	T4-1222	T4-2222
			1000	1025	T4-1223	T4-2223
			1400	1425	T4-1224	T4-2224

Table 5: Thermovoltage values in mV depending on temperature

Thermocouple Fe-CuNi, Type J, according to IEC 60584-1 - Thermovoltage values in mV






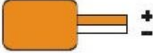


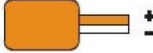

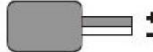
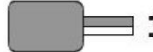
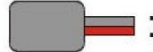
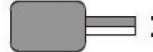





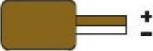
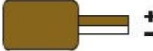

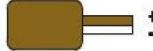

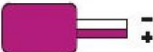
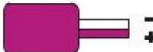
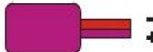
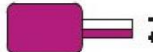
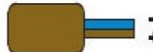



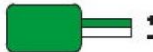

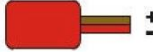
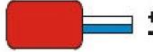
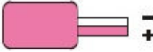
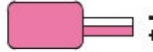
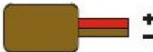
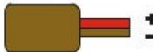
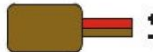



°C	0	- 10	- 20	- 30	- 40	- 50	- 60	- 70	- 80	- 90
- 200	- 7,890	- 8,096								
- 100	- 4,632	- 5,036	- 5,426	- 5,801	- 6,159	- 6,499	- 6,821	- 7,122	- 7,402	- 7,659
0	0	- 0,501	- 0,995	- 1,481	- 1,960	- 2,431	- 2,892	- 3,344	- 3,785	- 4,215
°C	0	10	20	30	40	50	60	70	80	90
0	0	0,507	1,019	1,536	2,058	2,585	3,115	3,649	4,186	4,725
100	5,268	5,812	6,359	6,907	7,457	8,008	8,560	9,113	9,667	10,222
200	10,777	11,332	11,887	12,442	12,998	13,553	14,108	14,663	15,217	15,771
300	16,325	16,879	17,432	17,984	18,537	19,089	19,640	20,192	20,743	21,295
400	21,846	22,397	22,949	23,501	24,054	24,607	25,161	25,716	26,272	26,829
500	27,388	27,949	28,511	29,075	29,642	30,210	30,762	31,356	31,933	32,513
600	33,096	33,683	34,273	34,867	35,464	36,066	36,671	37,280	37,893	38,510
700	39,130	39,754	40,382	41,013	41,647	42,283	42,922	43,563	44,207	44,852
800	45,498	46,144	46,790	47,434	48,076	48,716	49,354	49,989	50,621	51,249
900	51,875	52,496	53,115	53,729	54,341	54,948	55,553	56,155	56,753	57,349

Thermocouple NiCr-NiAl, Type K, according to IEC 60584-1 - Thermovoltage values in mV

°C	0	- 10	- 20	- 30	- 40	- 50	- 60	- 70	- 80	- 90
- 100	- 3,553	- 3,852	- 4,138	- 4,410	- 4,669	- 4,912	- 5,141	- 5,354	- 5,550	- 5,730
0	0	- 0,392	- 0,777	- 1,156	- 1,527	- 1,889	- 2,243	- 2,586	- 2,920	- 3,242
°C	0	10	20	30	40	50	60	70	80	90
0	0	0,397	0,798	1,203	1,611	2,022	2,436	2,850	3,266	3,681
100	4,095	4,508	4,919	5,327	5,733	6,137	6,539	6,939	7,338	7,737
200	8,137	8,537	8,938	9,341	9,745	10,151	10,560	10,969	11,381	11,793
300	12,207	12,623	13,039	13,456	13,874	14,292	14,712	15,132	15,552	15,974
400	16,395	16,818	17,241	17,664	18,088	18,513	18,938	19,363	19,788	20,214
500	20,640	21,066	21,493	21,919	22,346	22,772	23,196	23,624	24,050	24,476
600	24,902	25,327	25,751	26,176	26,599	27,022	27,445	27,867	28,288	28,709
700	29,128	29,547	29,965	30,383	30,799	31,214	31,629	32,042	32,455	32,866
800	33,277	33,686	34,095	34,502	34,909	35,314	35,718	36,121	36,524	36,925
900	37,325	37,724	38,122	38,519	38,915	39,310	39,703	40,096	40,488	40,879
1000	41,269	41,657	42,045	42,432	42,817	43,202	43,585	43,968	44,349	44,729
1100	45,108	45,486	45,863	46,238	46,612	46,985	47,356	47,726	48,095	48,462
1200	48,828	49,192	49,555	49,916	50,276	50,633	50,990	51,344	51,697	52,049
1300	52,398	52,747	53,093	53,439	53,782	54,125	54,466	54,807		

TERMOTEHNA

International Colour Codes applied to temperature engineering

Thermocouple type		Europe  DIN43722(IEC 584-3)	Germany  DIN 43714	USA  ANSI MC 96.1	Serbia  IEC 584-3	Great Britain  BS 4937 / 1843
R S	⊕ Platinum-13% Rhodium					
	⊖ Platinum ⊕ Platinum-10% Rhodium ⊖ Platinum					
B	⊕ Platinum-30% Rhodium					
	⊖ Platinum-6% Rhodium					
J	⊕ Iron					
	⊖ Copper-Nickel					
T	⊕ Copper					
	⊖ Copper-Nickel					
E	⊕ Nickel- Chromium					
	⊖ Copper-Nickel					
K	⊕ Nickel- Chromium					
	⊖ Nickel					
N	⊕ Nickel- Chromium-Silicon					
	⊖ Nickel- Silicon					
U	⊕ Copper					
	⊖ Copper-Nickel					
L	⊕ Iron					
	⊖ Copper-Nickel					