High-Temperature Thermocouples

[Image of high-temperature thermocouples]
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Section 1
Introduction
This product data sheet is intended to be a complete reference and ordering guide of thermocouples and accessories for technical measurements mainly at high temperatures and their specific applications in a temperature range between 600 °C and 1800 °C.

Section 2
Thermocouples – Technical References
Describes the basic concepts of temperature measurement with thermocouples. Includes information on limit tolerances and application specific changes in the thermoelectric voltage and, in addition, important notes for installation of high temperature thermocouples.

Section 3
Standard-Application Thermocouples
Includes descriptions, specifications, and ordering information on Series 1075 Thermocouples with different protective tube designs.

Section 4
Thermocouples for Glass Industry
Includes descriptions, specifications, and ordering information on glass industry applications.

Section 5
Calibration and Certificates
Includes a description of tests and measurements of thermocouples, a performance overview of the DKD-calibration laboratory, and test specifications of calibrated Series 1075 Thermocouples.

Section 6
Accessories
Includes descriptions, specifications, and ordering information on transmitters, connection heads, mounting accessories, thermocouple wires, extension and compensating cables.

Thermocouple Questionnaire
Colour Coding Table for Extension and Compensating Cables
Colour coding table according to different standards.

For further information regarding this data sheet, please contact the application department of one of the following companies:

Fisher-Rosemount Limited
Heath Place
Bognor Regis
West Sussex PO22 9SH
U.K.
Phone: +44(1243) 863-121
Fax: +44(1243) 867 5541
Internet: www.rosemount.com
www.fisher-rosemount.de/hsg

Heraeus Sensor GmbH
Rosemount Heraeus Sensor
Frankenstr. 21
63791 Karlstein-Dettingen
Germany
Phone: +49 (6188) 992-0
Fax: +49 (6188) 992-286

Fisher-Rosemount Temperature BV
De Langkamp 3b
NL-3961 MR Wijk bij Duurstede
Netherlands
Phone: +31 (343) 596-363
Fax: +31 (343) 596-345
Introduction

Overview

The acquisition of Heraeus Sensor by the Fisher-Rosemount Group in 1997 significantly improves our ability to supply a comprehensive range of standard and customer specified products for temperature measurement. This Product Data Sheet (PDS), entitled "High-Temperature Thermocouples", contains standard thermocouples which conform to the German DIN standards and special thermocouples for applications in glass industry.

In addition to the products in this data sheet, Rosemount offers a wide range of other products for high-temperature measurements. Protective tubes made of special materials – such as Kanthal, silicon carbide, Stellite, tantalum, titanium, Hastelloy-alloys, Monel etc. – allow the use in different fields of application, e.g. ceramic, steel, and chemical industry as well as mining.

Beyond that, Rosemount provides a special thermocouple for high-pressure and high-temperature applications. For one particular production-scale gas reactor, operating at a temperature of 1400 °C and a pressure of 65 bars, Rosemount Heraeus Sensor developed an insulated thermocouple enclosed in a special capsule in order to protect it from corrosive gases. For this thermocouple-type we have a patent.

Series 1075 Thermocouples conform to the requirements of the DIN EN 60584-1/2 (IEC 584) standards. The DIN 43772 and DIN 43733 standards define all protective tube designs. Rosemount’s high-temperature thermocouples are manufactured of material of excellent quality. The state-of-the-art manufacturing process enables the use of the thermocouples in very different fields of application, among other things the monitoring and control of process temperatures up to 1800 °C.

High-temperature measurement requires a specialised knowledge. On the basis of our 100-years’ experience of innovation and application of thermometers, we offer a complete range of highly accurate temperature measuring solutions for process control.

It is our primary concern to steadily extend the service life of our products in operation by a continuous information exchange with the customer and to take up the resultant improvements in our research and development department.

Our DKD-authorized calibration laboratory certifies thermocouples and resistance thermometers on the basis of comparative and fixed-point measurements according to the regulations of the German Calibration Service. This enables the calibration and certification of every sensor for our customers.

As the DIN EN/ISO 9000 standards set growing requirements on a company’s quality assurance system, the documented supervision of test equipment is becoming increasingly an issue of international competitiveness.

Rosemount and the Rosemount logo are registered trade marks of Rosemount Inc. Inconel und Monel are registered trade marks of International Nickel Co. Hastelloy is registered trade mark of Cabot Corp. Kanthal is registered trade mark of Kanthal Sweden. Stellite is registered trade name of Deloro Stellite (UK Ltd.).
Thermoelectric Effect
A thermocouple consists of a connection of two different metals which produces a change of the thermoelectric EMF in comparison with a temperature change. A thermocouple provides a thermoelectric voltage in millivolts d.c. which depends on the temperature difference between the hot and cold junctions. The hot junction is that junction which is exposed to the temperature of measurement. The cold junction is the one for which the temperature is known. A thermocouple consists of two connected different leads, called positive or negative leg. In practice, these leads are connected to extension or compensating cable, or directly to the transmitter in the local connection head. The simplest practicable thermocouple consists of two wires welded together at one end, which forms the measuring tip.

Thermocouple Materials
The DIN EN 60584 (IEC 584) standards define the basic values and tolerances of the thermocouple types at a temperature range between 0 °C and 1800 °C. High-temperature measurements of 1200 °C up to 1800 °C can be carried out with precious-metal thermocouples only. Generally, precious-metal (platinum) thermocouples are the most stable. In comparison with base-metal types, they can be used up to 1800 °C, although their electrical outputs are low (see Table 1). Type K is a commonly used base-metal thermocouple and covers most industrial applications.

Rosemount transmitters are programmable for the majority of thermocouple inputs. The thermoelectric voltage is amplified and, for example, converted into a 4 - 20 mA output signal in proportion to temperature.

Table 1: Characteristics of standard thermocouples.

<table>
<thead>
<tr>
<th>Thermocouple Type</th>
<th>Alloy of Leads +/-</th>
<th>Temperature Range [°C]</th>
<th>Output [mV d.c.]</th>
</tr>
</thead>
<tbody>
<tr>
<td>J</td>
<td>Fe-CuNi</td>
<td>0 to 700</td>
<td>0 to 39.130</td>
</tr>
<tr>
<td>K</td>
<td>NiCr-Ni</td>
<td>0 to 1200</td>
<td>0 to 48.828</td>
</tr>
<tr>
<td>R</td>
<td>PtRh87/13%-Pt</td>
<td>0 to 1600</td>
<td>0 to 18.842</td>
</tr>
<tr>
<td>S</td>
<td>PtRh90/10%-Pt</td>
<td>0 to 1600</td>
<td>0 to 16.771</td>
</tr>
<tr>
<td>B</td>
<td>PtRh70/30%-PtRh94/6%</td>
<td>0 to 1800</td>
<td>0 to 13.585</td>
</tr>
</tbody>
</table>
Limit Tolerances
All thermocouples manufactured and supplied by Rosemount are in accordance with the DIN EN 60584-2 (IEC 584-2) limit tolerances. Calibration of one or more customer-specific measuring points can be provided on request with a DKD-certificate up to 1200 °C and a works certificate up to 1300 °C.

Important Reasons for a Change in the Thermoelectric Voltage during Operation
Above 1200 °C, precious-metal thermocouples are stable because of their excellent oxidation and corrosion resistance. Thermocouples based on platinum (type R, S, and B) are by far the most common. However, even PtRh thermocouples cannot guarantee reliable temperature measurement, for a longer period and without careful control. This may cause considerable measuring errors or even early failure. The thermoelectric voltage of precious-metal thermocouples can change due to environmental influences outside the protective tube. Above 1300 °C, in oxidizing and reducing atmospheres, impurities (mainly iron) of the protective tubes result in faulty measurements.

If thermocouples are used in reducing atmospheres, even a small amount of silicon causes rapid embrittlement and, therefore, a change in the thermoelectric voltage. Gas-tight alumina protection tubes are to be used for these applications. A complete range of Rosemount high-temperature thermocouples are available with 99.7% recrystallised alumina protective tubes to avoid early deterioration of the thermocouple wires.

Change in the Thermoelectric Voltage due to Interdiffusion
The thermoelectric voltage (EMF) between a material and a reference element depends on the composition of the thermocouple wires. As precious-metal thermocouples are generally used in a temperature range where solid state reactions and diffusion processes may occur on a large scale, a constant composition of the thermocouple wires cannot be guaranteed. One of the reasons for instability is an interdiffusion at the hot junction. Interdiffusion via gas phase is largely avoided by using high-purity alumina ceramic insulators in all high-temperature thermocouple assemblies.

Change in the Thermoelectric Voltage by Selective Evaporation
Different bonding energies and thus different evaporation rates of the alloying elements of a wire change the concentration during operation. The evaporation rate in a reducing atmosphere is lower than in an oxidizing atmosphere. Rh evaporation in a PtRh wire may cause considerable measuring errors if the other leg is Pt on a PtRh-Pt thermocouple. Therefore, the use of a thermocouple with a PtRh alloy in both legs (type B) is recommended in order to have a more stable signal for a longer period (Rh evaporation in both legs).

The rhodium diffusion at the measuring tip is based on the affinity of pure platinum for contamination and alloy components. The unalloyed platinum wire extracts rhodium from the alloyed wire. The microstructural change on both sides of the measuring tip causes measuring errors. For this reason, the use of type B-thermocouples is recommended as both legs contain rhodium parts. The long-term stability of the platinum-rhodium thermocouples increases with a growing rhodium content.
Change in the Thermoelectric Voltage due to Environmental Influences

The most important effect in practice is the influence of the environment, which has been intensively investigated. Diffusion by impurities in thermocouple wires changes their thermoelectric output, or even destroys them. At high temperatures and reducing atmospheres, the release of arsenic, silicon, phosphorus, sulphur and boron is very dangerous because they form eutectic phases which lead to a total failure.

For this reason, all Rosemount high-temperature thermocouples are protected by high-quality ceramic closed end tubes. In all our manufacturing areas, special care is taken to avoid any contamination with oil, grease, sulphur, and metallic impurities which eventually cause serious errors during operation.

Uncertainty due to Electrical Interference

The thermocouple output can be influenced by electromagnetic radiation, e.g. in electrically heated furnaces. Depending on the strength of the electrical field, serious reading errors may occur. Normally, shielded compensating cables are used to lead the output signal to the control room. In practice however, this measure is not sufficient to avoid all possible signal disturbances. Rosemount offers special, electrically shielded high-temperature thermocouples up to 1800 °C, supplied with gas-tight, ceramic protective tubes.

Important Information about Installation of High-Temperature Thermocouples

To reduce any risk of damage of gas-tight, ceramic protective tubes by thermal shock, it is necessary to pre-heat the thermocouple assembly before installation. Slow insertion into the ceramic protective tubes avoids possible damaging, caused by rapid changes in temperature. At high temperatures, it is recommended to assemble thermocouples vertically, so that distortion or breakage is prevented. Even hair-line cracks may cause contamination and drifts at thermocouples. To avoid bending or breakage, horizontally assembled thermocouples are to be supported.

Furthermore, it has to be taken into consideration that the temperature at the connection head and the terminal block must not exceed 200 °C.
Introduction

The Series 1075 thermocouples conform to DIN 43772 and 43733 standards, and can be ordered as complete thermocouple assemblies. The model number from the respective ordering table defines the thermocouple type, material, nominal length, process connection, protective tube and connection head.

The limit tolerances of thermocouples acc. to DIN EN 60584-2 standards are defined by values in °C or the percentages referred to the actual temperatures in °C.

Table 2: Limit tolerances of thermocouples.

<table>
<thead>
<tr>
<th>Type</th>
<th>Alloy</th>
<th>Standard</th>
<th>Temperature Range [°C]</th>
<th>Limit Tolerance DIN EN 60584-2</th>
<th>Tolerance Class</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Base-Metal Thermocouples</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>J</td>
<td>Fe-CuNi</td>
<td>DIN EN 60584-1</td>
<td>-40 °C to 375 °C, 375 °C to 750 °C</td>
<td>1.5 °C, 0.004 x (t)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-40 °C to 333 °C, 333 °C to 750 °C</td>
<td>2.5 °C, 0.0075 x (t)</td>
<td>2</td>
</tr>
<tr>
<td>K</td>
<td>NiCr-Ni</td>
<td>DIN EN 60584-1</td>
<td>-40 °C to 375 °C, 375 °C to 1000 °C</td>
<td>1.5 °C, 0.004 x (t)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-40 °C to 333 °C, 333 °C to 1200 °C</td>
<td>2.5 °C, 0.0075 x (t)</td>
<td>2</td>
</tr>
<tr>
<td>N</td>
<td>NiCrSi-NiSi</td>
<td>DIN EN 60584-1</td>
<td>-40 °C to 375 °C, 375 °C to 1000 °C</td>
<td>1.5 °C, 0.004 x (t)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-40 °C to 333 °C, 333 °C to 1200 °C</td>
<td>2.5 °C, 0.0075 x (t)</td>
<td>2</td>
</tr>
<tr>
<td>L</td>
<td>Fe-CuNi</td>
<td>DIN EN 60584-1</td>
<td>-40 °C to 400 °C, 400 °C to 750 °C</td>
<td>3 °C, 0.0075 x (t)</td>
<td>1</td>
</tr>
<tr>
<td><strong>Precious-Metal Thermocouples</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R</td>
<td>PtRh87/13%-Pt</td>
<td>DIN EN 60584-1</td>
<td>0 °C to 1100 °C, 1100 °C to 1600 °C</td>
<td>1 °C, [1+0.003 x (t-1100 °C)]</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 °C to 600 °C, 600 °C to 1600 °C</td>
<td>1.5 °C, 0.0025 x (t)</td>
<td>2</td>
</tr>
<tr>
<td>S</td>
<td>PtRh90/10%-Pt</td>
<td>DIN EN 60584-1</td>
<td>0 °C to 1100 °C, 1100 °C to 1600 °C</td>
<td>1 °C, [1+0.003 x (t-1100 °C)]</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 °C to 600 °C, 600 °C to 1600 °C</td>
<td>1.5 °C, 0.0025 x (t)</td>
<td>2</td>
</tr>
<tr>
<td>B</td>
<td>PtRh70/30%-PtRh94/6%</td>
<td>DIN EN 60584-1</td>
<td>600 °C to 1700 °C</td>
<td>0.0025 x (t)</td>
<td>2</td>
</tr>
</tbody>
</table>

1) DIN 43710 has been cancelled and replaced by a works standard.
Rosemount provides thermocouples of tolerance class 1 (except types L and B). In this product data sheet, types K, R, S, and B are defined as standard thermocouple types. All other types are available on request. Type L, according to the works standard, can be supplied for the spare-part demand of older plants.

The thermocouple wire diameter varies in the design of the thermocouple. The standard diameter for precious-metal thermocouples is 0.5 mm for long-term stability. Other thermocouple wire diameters are available on request. The price of precious metals is subject to daily quotation and, therefore, it will be quoted separately. Please see corresponding additional clause at the end of this section.

### Table 3: Recommended thermocouple wire diameter depending on the application temperature.

<table>
<thead>
<tr>
<th>Thermocouple Type</th>
<th>Thermocouple Wire Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.35 mm</td>
</tr>
<tr>
<td>J / L</td>
<td>400 °C</td>
</tr>
<tr>
<td>K / N</td>
<td>700 °C</td>
</tr>
<tr>
<td>R / S</td>
<td>1400 °C</td>
</tr>
<tr>
<td>B</td>
<td>1500 °C</td>
</tr>
</tbody>
</table>

Thermocouples have to be protected from pressure, flow, corrosion and other mechanical and chemical influences. A protective tube is used to resist these influences permanently. The selection of a suitable protective tube is the crucial factor for the actual service life of the thermocouple assembly. A multiplicity of proven designs of different materials and alloys was standardized for the use of our thermocouple assemblies. Depending on the process conditions, we offer a wide range of application-specific protective tubes.

Metal protective tubes of heat-resistant materials, such as Inconel or CrNi-steel, provide the advantages of high-mechanical stress and can be used at temperatures up to 1200 °C. As standard design, we offer protective tubes of following materials: AISI 446 (1,4762) and AISI 314 (1,4841). Protective tubes of Kanthal AF and Kanthal Super are suitable for temperatures of 1350 °C or 1700 °C, e.g. in corrosive furnace atmospheres. Particularly in refuse incinerators, the Kanthal protective tubes find multiple application.

Ceramic protective tubes are predominantly used for high-temperature ranges. **Table 4** shows the characteristics and fields of application for standard materials and ceramic types C 530, C 610 and C 799.

Gas-tight protective tubes, made of silicon carbide for use in high dust loads and corrosive environments up to 1400 °C, are available on request. Special characteristics of reaction-sintered, silicon-infiltrated silicon-carbide protective tubes guarantee high service lives under extreme operating conditions.

If protective tubes in this data sheet seem to be unsuitable for special applications, please provide us with exact information on the operating conditions, so that an appropriate offer can be submitted.
High-temperature thermocouples are used for technical temperature measurements in heat treatment and combustion processes, and hot-gas environments of glass, ceramic, and metal industry.

The most frequent fields of application are temperature monitoring and control of incinerators, industrial furnaces, and reactors.

### Table 4: Characteristics and types of application for metallic and ceramical protective tubes.

<table>
<thead>
<tr>
<th>Material</th>
<th>Max. Temperature</th>
<th>Particularly Suitable</th>
<th>Less Suitable</th>
<th>Field of Application</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Metal Protective Tubes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.0305 (St 35.8)</td>
<td>600 °C</td>
<td>For air, average resistance to nitrogenous gases</td>
<td>Poor resistance to sulphurous gases</td>
<td>Temperature furnaces for thermal treatment processes, galvanisation and tinning plants, carbon-dust-air mixture pipelines in steam power stations</td>
</tr>
<tr>
<td>1.0305 enamelled (St 35.8 enamelled)</td>
<td>600 °C</td>
<td>For corrosive applications within the dew-point range of flue gases</td>
<td>Sensitive to shock, inflexibility</td>
<td>Flue-gas desulphurisation plants, bearing metal, lead and tin melts</td>
</tr>
<tr>
<td>1.4762</td>
<td>1200 °C</td>
<td>High resistance to sulphurous gases</td>
<td>Poor resistance to nitrogenous gases</td>
<td>Combustion exhausts, cement and ceramic furnaces, thermal treatment processes, annealing furnaces</td>
</tr>
<tr>
<td>1.4749</td>
<td>1200 °C</td>
<td>Very high resistance to sulphurous gases</td>
<td>Poor resistance to nitrogenous gases</td>
<td>Flue ducts, cooling furnaces</td>
</tr>
<tr>
<td>Kanthal AF™ 1.4767</td>
<td>1350 °C</td>
<td>High heat resistance, high resistance to sulphurous gases, high abrasion resistance</td>
<td>Poor resistance to nitrogenous gases</td>
<td>Industrial furnaces, glass, ceramic and cement industry, refuse incinerators</td>
</tr>
<tr>
<td>Kanthal Super™ (Molybdenum Disilicide)</td>
<td>1700 °C</td>
<td>Very high heat resistance, high resistance to corrosion, high thermal conductivity, excellent hardness characteristics, high abrasion resistance</td>
<td>Poor resistance to nitrogenous gases</td>
<td>Glass and ceramic industry, carbon pressure-gasification, refuse incinerators</td>
</tr>
<tr>
<td>1.4841</td>
<td>1200 °C</td>
<td>High resistance to nitrogenous and low-oxygen gases</td>
<td>Poor resistance to sulphurous gases</td>
<td>Combustion chambers, industrial furnaces, petrochemical industry, nitrogenous blast heaters, cyanide baths</td>
</tr>
</tbody>
</table>

| **Ceramic Protective Tubes acc. to DIN VDE 0335 Standards (except Silicon Carbide)** | | | | |
| Type C 530 (Al₂O₃ Content: 73 - 75%) | 1600 °C | Resistant to thermal shocks | Fine pored, not gas-tight, sensitive to shock | Electrically heated furnaces up to 1300 °C and other industrial furnaces, glass tank furnaces, regenerator checkerwork |
| Type C 610 (Al₂O₃ Content: 60%) | 1400 °C | Gas-tight, high refractory quality, average resistance to thermal shocks | Low Al₂O₃-purity, sensitive to shock | Gas-tight furnaces, diffusion furnaces |
| Type C 799 (Al₂O₃ Content: 99.7%) | 1800 °C | Very gas-tight, highest refractory quality, resistant to acids, alkalines and hot steam, high flexibility | Poor resistance to thermal shocks, sensitive to shock | Protective gas furnaces as well as gas-tight and electrically heated furnaces up to 1700 °C (glass tank furnaces), flue-gas desulphurisation, chemical industry, cement production |
| Silicon-Infiltrated, Reaction Sintered, Silicon Carbide (e.g. Halsic™, Protec™, Silit SK™) | 1400 °C | Very high consistency, extremely high corrosion resistance to acids and alkalines, excellent thermal conductivity, very resistant to thermal shocks, high abrasion resistance | Low mechanical stress | Flue-gas desulphurisation plants, carbon mills, combustion chambers, flue-gas channels (in corrosive environment and at high temperatures) |
Usually, the ceramic protective tube is cemented into a holding tube, for easy installation of the connection head. As the temperature above the fitting is generally low, unalloyed steel is used for holding tubes. If the holding tube reaches into the body of the furnace, heat resistant steel is to be used.

Several connection head versions are available, which differ in sizes and type of covers. All connection heads have a rubber o-ring-seal on the cable entry, which limits the permissible temperature at this point to about 80 °C. If, instead of rubber, a silicone o-ring-seal is used, the max. temperature at the aluminium-alloy connection heads is 200 °C. You will find suitable connection heads in Section 6.

Besides our standard connection heads with inserted terminal block, the thermocouples of this product data sheet are also available with head-mounted transmitters of series 244 and 644.

It is recommended to insert these transmitters into the cover of the connection head TZ-A/BL or TZ-/AL. The permissible temperature at the connection head is reduced to 70 °C. You will find a summary of all available transmitters in Section 6.

The process connections are mainly supplied with adjustable and removable mounting elements, which are sealed with a stuffing bush. As standard, we offer adjustable stop flanges and threaded fittings in appropriate sizes. The process connection at the metal protective tubes is freely movable. The mounting element of ceramic protective tubes with stop and counter flange is situated at the end of the holding tube with a seal on the protective tube. The position of the threaded fitting or welded-on flange on the holding tube can be selected as desired. To avoid gas penetration into the connection head after breakage of the protective tube, the connection head is to be sealed. For further details see Section 6.

### Table 5: Summary of material standards.

<table>
<thead>
<tr>
<th>Material No. DIN</th>
<th>Material Code</th>
<th>AISI (USA)</th>
<th>B.S. (Great Britain)</th>
<th>AFNOR NF (France)</th>
<th>Product Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0305</td>
<td>St. 35.8</td>
<td></td>
<td></td>
<td></td>
<td>Carbon steels</td>
</tr>
<tr>
<td>1.4749</td>
<td>X 18 CrN 28</td>
<td>446</td>
<td></td>
<td></td>
<td>Heat-resistant steels</td>
</tr>
<tr>
<td>1.4762</td>
<td>X 10 CrAl 24</td>
<td>446</td>
<td></td>
<td>Z 10 CAS 24</td>
<td>Heat-resistant steels</td>
</tr>
<tr>
<td>1.4767</td>
<td>CrAl 20 5 (Kanthal AF™)</td>
<td></td>
<td></td>
<td></td>
<td>Heat-resistant steels</td>
</tr>
<tr>
<td>1.4841</td>
<td>X 15CrNiSi 25 20</td>
<td>314</td>
<td>314 S 25</td>
<td>Z 12 CNS 25-20</td>
<td>Heat-resistant steels</td>
</tr>
<tr>
<td>Super Kanthal™</td>
<td>Molybdenum disilicide</td>
<td></td>
<td></td>
<td></td>
<td>Sintered metals</td>
</tr>
</tbody>
</table>
Series 1075 Immersion Thermocouples, Type BM – with Metal Protective Tube and without Ceramic Inner Tube (Max. Temperature 1200 °C)

This design consists of a ceramic-insulated thermocouple and a housing with a protective tube, type BM according to DIN 43733 (form 1 in accordance with DIN 43772).

The single or double thermocouple legs are insulated with ceramic elements. Oxygen-poor, neutral and reducing atmospheres, particularly in conjunction with humidity or carbon monoxide, can produce “selective chrome oxidation” at temperatures between 800 °C and 1000 °C.

Figure 2: Immersion thermocouples Series 1075, type BM.

Figure 3: Dimensional drawing - Type BM.

This process changes the EMF of the thermocouple (type K). If the operating temperature is constantly within this range, we recommend the use of a mineral-insulated thermocouple.

For gas-tight installation of the protective tube, a gas-tight threaded fitting is necessary (pressure load up to max. 1 bar). The standard heat resistant materials for protective tubes are 1.4762 and 1.4841. Protective tubes of material 1.4762 have a longitudinal weld. This causes a brittleness which may be responsible for superficial fissures. For temperatures up to 1200 °C, we therefore recommend weldless protective tubes made of material 1.4749, instead of the above mentioned material.
Flue-gas thermocouples with a fire enamelled protective tube (up to 600 °C) in dimensions of 15 x 3 mm and of material 1.0305 (St 35.8) are available on request. The maximal length is 2,000 mm.

**Fields of Application:**
- Tempering furnaces for thermal treatment processes
- Pipelines
- Curtains and air ducts
- Flue-gas desulphurization plants
- Bearing metal -, lead - and tin melts

**Ordering Information:** Series 1075, Type BM, (Form 1, DIN 43772), (Previously, Type T-EA 15) – High-Temperature Thermocouple with Metal Protection Tube and without Ceramic Inner Tube (Max. Temperature 1200 °C)

<table>
<thead>
<tr>
<th>Model</th>
<th>Product Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1075BM</td>
<td>Thermocouple, DIN EN 60584-1 (IEC 584), Tolerance Class 1 acc. to DIN EN 60584-2 (IEC 584)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Connection Head</th>
<th>IP Rating</th>
<th>Conduit Connection Thread</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>T2-A/BL (BUZH), Aluminium</td>
<td>54</td>
<td>M20 x 1.5</td>
</tr>
<tr>
<td>U</td>
<td>GN-BL, Aluminium, DIN 43729</td>
<td>43</td>
<td>M20 x 1.5</td>
</tr>
<tr>
<td>Y</td>
<td>HR-A/BL (BUS), Aluminium</td>
<td>54</td>
<td>M20 x 1.5</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Sensor Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Terminal block, Form B</td>
</tr>
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</table>

<table>
<thead>
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<th>Code</th>
<th>Number of Elements</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
<td>02</td>
<td>Double</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Code</th>
<th>Thermocouple Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>K</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Code</th>
<th>Wire Diameter in Millimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>1.38 (duplex) K</td>
</tr>
<tr>
<td>20</td>
<td>2 K</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Thermocouple Type</th>
<th>Max. Temperature [°C]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.4762 (AISI 446 - heat-resistant steel), 15 x 2</td>
<td>1200</td>
</tr>
<tr>
<td>B</td>
<td>1.4841 (AISI 314 - heat-resistant steel), 15 x 2</td>
<td>1200</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.4762 (AISI 446 - heat-resistant steel), 15 x 2</td>
<td>without</td>
<td>1200</td>
</tr>
<tr>
<td>B</td>
<td>1.4841 (AISI 314 - heat-resistant steel), 15 x 2</td>
<td>without</td>
<td>1200</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Nominal Length (NL) in Millimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td>0250</td>
<td>250</td>
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<tr>
<td>0500</td>
<td>500</td>
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<tr>
<td>0710</td>
<td>710</td>
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<tr>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>XXXX</td>
<td>Other lengths (max. 2,000 mm)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Process Connection</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>Adjustable stop flange</td>
<td>GTW-35 (cast iron)</td>
</tr>
<tr>
<td>B1</td>
<td>Adjustable threaded fitting with G 3/4</td>
<td>1.0711 (steel)</td>
</tr>
<tr>
<td>NN</td>
<td>No fitting</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Additional Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>R24</td>
<td>TAG plate, stainless steel</td>
</tr>
<tr>
<td>X1</td>
<td>Fit sensor to temperature transmitter</td>
</tr>
</tbody>
</table>

**Other Options:**
- Other connection heads
- Other protective tube materials
- Calibration and material certificates (see page 43)

**Ordering Example:**

<table>
<thead>
<tr>
<th>Model-No.:</th>
<th>Connection Head</th>
<th>Sensor Connection</th>
<th>Number of Elements</th>
<th>Thermocouple Type</th>
<th>Wire Diameter</th>
<th>Material Prot. Tube</th>
<th>Nominal Length</th>
<th>Process Connection</th>
<th>Additional Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1075BM</td>
<td>Y</td>
<td>2</td>
<td>01</td>
<td>K</td>
<td>20</td>
<td>A</td>
<td>0250</td>
<td>NN</td>
<td></td>
</tr>
</tbody>
</table>
**Series 1075 Immersion Thermocouples, Type AM(K) – with Metal Protective Tube and with/without Ceramic Inner Tube (Max. Temperature 1700 °C)**

It consists of a base-metal thermocouple type K or precious-metal thermocouples types R, S, or B, and a housing with a protective tube type AM according to DIN 43733. The single or double type K thermocouple legs are insulated with ceramic elements. Precious-metal thermocouples are insulated with a 4-hole insulating rod and provided with a gas-tight inner tube of 15 x 2 mm of ceramic type C 610.

For gas-tight installation of the protective tube, a gas-tight threaded fitting is necessary (pressure load up to max. 1 bar). Our standard heat-resistant materials for protective tubes are 1.4762 and 1.4841. In addition, we supply two protective tube types made of heat-resistant Kanthal with an outer diameter of 22 mm.

Protective tubes of **Kanthal AF** offer following advantages:
- Application temperature up to 1350 °C
- High service life, even with a low wall thickness of 1.3 mm
- Faster heat transfer due to low wall thickness leads to a fast response time of the thermocouples
- High temperatures form a tight and adhered alumina film, which keeps away impurities
- Protective tube length max. 6,000 mm.

Protective tubes of **Kanthal Super** consist of sinter material and have following properties:
- Application temperature up to 1700 °C
- Lower porosity and embrittlement, therefore, used at high temperatures and in corrosive furnace atmospheres
- Metal protective tubes are influenced among other things by electromagnetic oscillations, which may disturb the function of the thermocouple. Protective tubes of Kanthal Super suppress these oscillations
- Protective tube length max. 1,500 mm.
Flue-gas thermocouples with a fire-enamelled protective tube (up to 600 °C) in dimensions of 22 x 2 mm and made of material 1.0305 (St 35.8) are available on request. The max. length is 2,000 mm.

**Fields of Application:**
- Pipelines
- Curtains and air ducts
- Flue-gas desulphurization plants
- Cooling furnaces in glass tank furnaces in glass melts
- Refuse incinerators

*Figure 6: Dimensional drawing – type AM(K).*
**Model** | **Product Description**
--- | ---
1075AM | Thermocouple, DIN EN 60584-1 (IEC 584), Tolerance Class 1 acc. to DIN EN 60584-2 (IEC 584)

<table>
<thead>
<tr>
<th>Code</th>
<th>Connection Head</th>
<th>IP Rating</th>
<th>Conduit Connection Thread</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>HR-AL (AUS), aluminium</td>
<td>54</td>
<td>M20 x 1.5</td>
</tr>
<tr>
<td>G</td>
<td>TZ-AL (A2ZH), aluminium</td>
<td>54</td>
<td>M20 x 1.5</td>
</tr>
<tr>
<td>P</td>
<td>GN-AL, aluminium, DIN 43729</td>
<td>43</td>
<td>M20 x 1.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Sensor Connection</th>
</tr>
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<tbody>
<tr>
<td>3</td>
<td>Terminal block, Form A</td>
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<table>
<thead>
<tr>
<th>Code</th>
<th>Number of Elements</th>
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<td>01</td>
<td>Single</td>
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<td>02</td>
<td>Double</td>
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<table>
<thead>
<tr>
<th>Code</th>
<th>Thermocouple Type</th>
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<tbody>
<tr>
<td>B</td>
<td>B</td>
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<tr>
<td>K</td>
<td>K</td>
</tr>
<tr>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>S</td>
<td>S</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Wire Diameter in Millimeters</th>
<th>Thermocouple Type</th>
<th>Max. Temperature [°C]</th>
</tr>
</thead>
<tbody>
<tr>
<td>05</td>
<td>0.5</td>
<td>B, R, S</td>
<td>1600 / R, S; 1800 / B</td>
</tr>
<tr>
<td>20</td>
<td>2</td>
<td>K</td>
<td>1200</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>1.4762 (AISI 446 - heat-resistant steel), 22 x 2</td>
<td>without</td>
<td>1200</td>
</tr>
<tr>
<td>D</td>
<td>1.4841 (AISI 314 - heat-resistant steel), 22 x 2</td>
<td>without</td>
<td>1200</td>
</tr>
<tr>
<td>E</td>
<td>1.4762 (AISI 446 - heat-resistant steel), 22 x 2</td>
<td>Typ C 610 / 15 x 2</td>
<td>1200 / R, S</td>
</tr>
<tr>
<td>F</td>
<td>1.4841 (AISI 314 - heat-resistant steel), 22 x 2</td>
<td>Typ C 610 / 15 x 2</td>
<td>1200 / R, S</td>
</tr>
<tr>
<td>G</td>
<td>1.4767 (Kanthal AF) 22 x 1.3</td>
<td>Typ C 610 / 15 x 2</td>
<td>1350 / R, S</td>
</tr>
<tr>
<td>H</td>
<td>Kanthal Super 22 x 4.5</td>
<td>Typ C 799 / 10 x 1.5</td>
<td>1700 / B</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Nominal Length (NL) in Millimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td>0500</td>
<td>500</td>
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<tr>
<td>0710</td>
<td>710</td>
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<td>1000</td>
<td>1000</td>
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<td>1400</td>
</tr>
<tr>
<td>XXXX</td>
<td>Other lengths (max. 6,000 mm)</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Process Connection</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>A2</td>
<td>Adjustable stop flange</td>
<td>GTW-35 (cast iron)</td>
</tr>
<tr>
<td>B2</td>
<td>Adjustable threaded fitting with G 1</td>
<td>1.0711 (steel)</td>
</tr>
<tr>
<td>NN</td>
<td>No fitting</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Additional Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>R24</td>
<td>TAG plate, stainless steel</td>
</tr>
<tr>
<td>X1</td>
<td>Fit sensor to temperature transmitter</td>
</tr>
</tbody>
</table>

Other Options:
- Other connection heads
- Other types of thermocouples
- Other protective tube materials
- Other process connections
- Calibration and material certificates (see page 43)

**Ordering Example**

<table>
<thead>
<tr>
<th>Model</th>
<th>Connection Head</th>
<th>Sensor Connection</th>
<th>Number of Elements</th>
<th>Thermocouple Type</th>
<th>Wire Diameter</th>
<th>Material Prot. Tube</th>
<th>Nominal Length</th>
<th>Process Connection</th>
<th>Additional Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1075AM</td>
<td>G</td>
<td>3</td>
<td>01</td>
<td>S</td>
<td>05</td>
<td>E</td>
<td>1000</td>
<td>A2</td>
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</tr>
</tbody>
</table>

**Ordering Information:** Series 1075, Type AM(K), (Previously, Type T-EA 22) – High-Temperature Thermocouple with Metal Protection Tube and with/without Ceramic Inner Tube (Max. Temperature 1700 °C)
Series 1075 Immersion Thermocouples, Type AKK — with Ceramic Protective Tube and Ceramic Inner Tube (Max. Temperature 1800 °C)

This design consists of a base-metal thermocouple type K or precious-metal thermocouples type R, S or B and a housing with a protective tube type AKK according to DIN 43733.

The single or double type K thermocouple legs are insulated with ceramic elements. Precious-metal thermocouples are insulated with a 4-hole insulating rod and provided with a gas-tight inner tube made of ceramic type C 610 or C 799.
Stop flanges or threaded fittings are necessary for installation. Standard materials for the protective tubes are ceramic types C 530, C 610 and C 799. Gas-tight ceramic materials are sensitive to thermal shock and impact stress. The tolerance level is optimized by correct selection of materials for protective tube and inner tube.

We recommend following combinations of ceramic protective tubes and inner tubes (see Table 6).

The holding tube is made of material 1.0305. At temperatures above 200 °C, it is recommended to use holding tubes made of heat-resistant materials AISI 446 (1.4762) or AISI 314 (1.4841).

### Table 6: Protective and inner tube combinations.

<table>
<thead>
<tr>
<th>Outer Protective Tube Material</th>
<th>Inner Tube</th>
<th>Thermo-couple Type</th>
<th>Applications</th>
<th>Max. Application Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>C 530</td>
<td>C 610</td>
<td>K</td>
<td>Ceramic furnaces in brickworks</td>
<td>1200 °C</td>
</tr>
<tr>
<td>C 530</td>
<td>C 799</td>
<td>R</td>
<td>Glass tank furnaces: regenerator checkerwork (above)</td>
<td>1600 °C</td>
</tr>
<tr>
<td>C 799</td>
<td>C 799</td>
<td>B</td>
<td>Glass tank furnaces: side walls, crown, bottom (in pre-drilled channels up to 50 mm below the bottom)</td>
<td>1800 °C</td>
</tr>
<tr>
<td>C 799</td>
<td>C 799</td>
<td>B</td>
<td>Glass melting pot</td>
<td>1800 °C</td>
</tr>
</tbody>
</table>
Ordering Information: Series 1075, Type AKK, (Previously Type T-EZI 26) – High-Temperature Thermocouple with Ceramic Protective Tube and Ceramic Inner Tube (Max. Temperature 1800 °C)

<table>
<thead>
<tr>
<th>Model</th>
<th>Product Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1075AKK</td>
<td>Thermocouple, DIN EN 60584-1 (IEC 584), Tolerance Class 1 acc. to DIN EN 60584-2 (IEC 584)</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Connection Head</th>
<th>IP Rating</th>
<th>Conduit Connection Thread</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>HR-AL (AUS), aluminium</td>
<td>54</td>
<td>M20 x 1.5</td>
</tr>
<tr>
<td>G</td>
<td>TZ-AL (AUZH), aluminium</td>
<td>54</td>
<td>M20 x 1.5</td>
</tr>
<tr>
<td>P</td>
<td>GN-AL, aluminium, DIN 43729</td>
<td>43</td>
<td>M20 x 1.5</td>
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</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Sensor Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Terminal block, Form A</td>
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</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Number of Elements</th>
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<tbody>
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<td>Single</td>
</tr>
<tr>
<td>02</td>
<td>Double</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Code</th>
<th>Thermocouple Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>K</td>
<td>K</td>
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<tr>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>S</td>
<td>S</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Wire Diameter in Millimeters</th>
<th>Thermocouple Type</th>
<th>Max. Temperature [°C]</th>
</tr>
</thead>
<tbody>
<tr>
<td>05</td>
<td>0.5</td>
<td>R, S, B</td>
<td>1600 / R, S; 1800 / B</td>
</tr>
<tr>
<td>20</td>
<td>2.0</td>
<td>K (double)</td>
<td>1200</td>
</tr>
<tr>
<td>30</td>
<td>3.0</td>
<td>K (single)</td>
<td>1200</td>
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<th></th>
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<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>Type C 530 / 26 x 4</td>
<td>Type C 610 (15 x 2)</td>
<td>1200 / K</td>
</tr>
<tr>
<td>U</td>
<td>Type C 530 / 26 x 4</td>
<td>Type C 610 (15 x 2)</td>
<td>1400 / R, S</td>
</tr>
<tr>
<td>V</td>
<td>Type C 530 / 26 x 4</td>
<td>Type C 799 (15 x 2.5)</td>
<td>1600 / S</td>
</tr>
<tr>
<td>W</td>
<td>Type C 799 / 24 x 3</td>
<td>Type C 799 (15 x 2.5)</td>
<td>1600 / R, S</td>
</tr>
<tr>
<td>Z</td>
<td>Type C 799 / 24 x 3</td>
<td>Type C 799 (15 x 2.5)</td>
<td>1800 / B</td>
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</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Nominal Length (NL) in Millimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td>0500</td>
<td>500</td>
</tr>
<tr>
<td>0710</td>
<td>710</td>
</tr>
<tr>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>1400</td>
<td>1400</td>
</tr>
<tr>
<td>2000</td>
<td>2000</td>
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<tr>
<td>XXXX</td>
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<table>
<thead>
<tr>
<th>Code</th>
<th>Process Connection</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>A3</td>
<td>Adjustable stop flange</td>
<td>GTW-35 (cast iron)</td>
</tr>
<tr>
<td>B3</td>
<td>Adjustable threaded fitting with G 1 1/4</td>
<td>1.0711 (carbon steel)</td>
</tr>
<tr>
<td>NN</td>
<td>No fitting</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Holding Tube Material</th>
<th>Dimensions in Millimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>1.4762 (AISI 446 - heat-resistant steel)</td>
<td>32 x 2</td>
</tr>
<tr>
<td>H</td>
<td>1.4841 (AISI 314 - heat-resistant steel)</td>
<td>32 x 2</td>
</tr>
<tr>
<td>J</td>
<td>1.0305 (mild steel)</td>
<td>32 x 2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Holding Tube Length (RL) in Millimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>XXX</td>
<td>Other lengths</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Additional Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>R24</td>
<td>TAG plate, stainless steel</td>
</tr>
<tr>
<td>X1</td>
<td>Fit sensor to temperature transmitter</td>
</tr>
</tbody>
</table>

Other Options:
- Other connection heads
- Other protective tube materials
- Other holding tube materials
- Other types of thermocouples
- Other process connections
- Calibration and material certificates (see page 43)

Ordering Example

<table>
<thead>
<tr>
<th>Model</th>
<th>Connection Head</th>
<th>Sensor Connection</th>
<th>Number of Elements</th>
<th>Thermocouple Type</th>
<th>Wire ø</th>
<th>Material Prot. Tube</th>
<th>Nom. Length</th>
<th>Process Connc.</th>
<th>Holding Tube Material</th>
<th>Holding Tube Length</th>
<th>Additional Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1075AKK</td>
<td>P</td>
<td>3</td>
<td>01</td>
<td>S</td>
<td>05</td>
<td>W</td>
<td>1400</td>
<td>NN</td>
<td>H</td>
<td>200</td>
<td></td>
</tr>
</tbody>
</table>
Series 1075 Immersion Thermocouples, Type BK — with Ceramic Protective Tube and without Ceramic Inner Tube (Max. Temperature 1800 °C)

It consists of a base-metal thermocouple type K or precious-metal thermocouples type R, S, or B and a housing with a protective tube type BK according to DIN 43733.

The single or double type K thermocouple legs are insulated with ceramic elements. Precious-metal thermocouples are insulated with a 4-hole insulating rod.

Stop flanges and threaded fittings are necessary for installation. Standard materials for the protective tubes are ceramic types C 610 and C 799. The holding tube is made of materials AISI 314 (1.4841), AISI 446 (1.4762) or mild steel (1.0305).

Fields of Application:
- Glass industry
- Vitrified clay furnaces
- Hardening bays
- Steel industry
### Standard-Application Thermocouples

**Ordering Information:** Series 1075, Type BK, (Previously, Type T-EZI 10) – High-Temperature Thermocouple with Ceramic Protective Tube, without Ceramic Inner Tube (Max. Temperature 1800 °C)

<table>
<thead>
<tr>
<th>Model</th>
<th>Product Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1075BK</td>
<td>Thermocouple, DIN EN 60584-1 (IEC 584), Tolerance Class 1 acc. to DIN EN 60584-2 (IEC 584)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Connection Head</th>
<th>IP Rating</th>
<th>Conduit Connection Thread</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>TZ-A/BL (BUZH), aluminium</td>
<td>54</td>
<td>M20 x 1.5</td>
</tr>
<tr>
<td>U</td>
<td>GN-BL, aluminium, DIN 43729</td>
<td>43</td>
<td>M20 x 1.5</td>
</tr>
<tr>
<td>Y</td>
<td>HR-A/BL (BUS), aluminium</td>
<td>54</td>
<td>M20 x 1.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Sensor Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Terminal block, Form B</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Number of Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Single</td>
</tr>
<tr>
<td>02</td>
<td>Double</td>
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<table>
<thead>
<tr>
<th>Code</th>
<th>Thermocouple Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>K</td>
<td>K</td>
</tr>
<tr>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>S</td>
<td>S</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Wire Diameter in Millimeters</th>
<th>Thermocouple type</th>
<th>Max. Temperature [°C]</th>
</tr>
</thead>
<tbody>
<tr>
<td>05</td>
<td>0.5</td>
<td>R, S, B</td>
<td>1600 / R, S; 1800 / B</td>
</tr>
<tr>
<td>13</td>
<td>1.38</td>
<td>K</td>
<td>1200</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>J</td>
<td>Type C 610 / 10 x 1.5</td>
<td>without</td>
<td>1000 / K</td>
</tr>
<tr>
<td>K</td>
<td>Type C 610 / 10 x 1.5</td>
<td>without</td>
<td>1400 / R, S</td>
</tr>
<tr>
<td>L</td>
<td>Type C 799 / 10 x 1.5</td>
<td>without</td>
<td>1600 / R, S</td>
</tr>
<tr>
<td>M</td>
<td>Type C 799 / 10 x 1.5</td>
<td>without</td>
<td>1800 / B</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Nominal Length (NL) in Millimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td>0250</td>
<td>250</td>
</tr>
<tr>
<td>0500</td>
<td>500</td>
</tr>
<tr>
<td>0710</td>
<td>710</td>
</tr>
<tr>
<td>XXXX</td>
<td>Other lengths (max. 1,000 mm)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Process Connection</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>Adjustable stop flange</td>
<td>GTW-35 (cast iron)</td>
</tr>
<tr>
<td>B1</td>
<td>Adjustable threaded fitting with G 3/4</td>
<td>1.0711 (carbon steel)</td>
</tr>
<tr>
<td>NN</td>
<td>No fitting</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Holding Tube Material</th>
<th>Dimensions in Millimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.4762 (AISI 446 - heat-resistant steel)</td>
<td>15 x 2</td>
</tr>
<tr>
<td>B</td>
<td>1.4841 (AISI 314 - heat-resistant steel)</td>
<td>15 x 2</td>
</tr>
<tr>
<td>C</td>
<td>1.0305 (mild steel)</td>
<td>15 x 2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Holding Tube Length (RL) in Millimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td>080</td>
<td>80</td>
</tr>
<tr>
<td>XXXX</td>
<td>Other length</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Additional Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>R24</td>
<td>TAG plate, stainless steel</td>
</tr>
<tr>
<td>X1</td>
<td>Fit sensor to temperature transmitter</td>
</tr>
</tbody>
</table>

**Other Options:**
- Other connection heads
- Other types of thermocouples
- Other protective tube materials
- Other process connections
- Other holding tube materials
- Calibration and material certificates (see page 43)

**Ordering Example**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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<td>L</td>
<td>0500</td>
<td>A1</td>
<td>A</td>
<td>080</td>
<td></td>
</tr>
</tbody>
</table>

21
Series 1075 Immersion Thermocouple, Type AK – with Ceramic Protective Tube and without Ceramic Inner Tube (Max. Temperature 1800 °C)

It consists of a base-metal thermocouple type K or precious-metal thermocouples type R, S, or B and a housing with a protective tube type AK according to DIN 43733.

The single or double type K thermocouple legs are insulated with ceramic elements. Precious-metal thermocouples are insulated with a 4-hole insulating rod.

Stop flanges and threaded fittings are necessary for installation. Standard materials for the protective tubes are ceramic types C 610 and C 799. The holding tube is made of materials AISI 314 (1.4841), AISI 446 (1.4762) or mild steel (1.0305).

Fields of Application:
- Glass industry (e.g. regenerator checkerwork, tempering furnaces)
- Vitrified clay furnaces
- Steel industry (annealing and tempering areas)
# Standard-Application Thermocouples

**Ordering Information:** Series 1075, Type AK, (Previously, Type T-EZI 15) — High-Temperature Thermocouple with Ceramic Protective Tube, without Ceramic Inner Tube (Max. Temperatur 1800 °C)

<table>
<thead>
<tr>
<th>Model</th>
<th>Product Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1075AK</td>
<td>Thermocouple, DIN EN 60584-1 (IEC 584), Tolerance Class 1 acc. to DIN EN 60584-2 (IEC 584)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Connection Head</th>
<th>IP Rating</th>
<th>Conduit Connection Thread</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>HR-AL (AUS), aluminium</td>
<td>54</td>
<td>M20 x 1.5</td>
</tr>
<tr>
<td>G</td>
<td>TZ-AL (AUZH), aluminium</td>
<td>54</td>
<td>M20 x 1.5</td>
</tr>
<tr>
<td>P</td>
<td>GN-AL, aluminium, DIN 43729</td>
<td>43</td>
<td>M20 x 1.5</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Code</th>
<th>Sensor Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Terminal block, Form A</td>
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<table>
<thead>
<tr>
<th>Code</th>
<th>Number of Elements</th>
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</thead>
<tbody>
<tr>
<td>01</td>
<td>Single</td>
</tr>
<tr>
<td>02</td>
<td>Double</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Thermocouple Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>K</td>
<td>K</td>
</tr>
<tr>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>S</td>
<td>S</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Wire Diameter in Millimeters</th>
<th>Thermocouple Type</th>
<th>Max. Temperature [°C]</th>
</tr>
</thead>
<tbody>
<tr>
<td>05</td>
<td>0.5</td>
<td>R, S, B</td>
<td>1600 / R, S; 1800 / B</td>
</tr>
<tr>
<td>13</td>
<td>1.38</td>
<td>K (double)</td>
<td>1000</td>
</tr>
<tr>
<td>30</td>
<td>3.0</td>
<td>K (single)</td>
<td>1200</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>Type C 610 / 15 x 2</td>
<td>without</td>
<td>1200 / K</td>
</tr>
<tr>
<td>Q</td>
<td>Type C 610 / 15 x 2</td>
<td>without</td>
<td>1400 / R, S</td>
</tr>
<tr>
<td>R</td>
<td>Type C 799 / 15 x 2.5</td>
<td>without</td>
<td>1600 / R, S</td>
</tr>
<tr>
<td>S</td>
<td>Type C 799 / 15 x 2.5</td>
<td>without</td>
<td>1800 / B</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Nominal Length (NL) in Millimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td>0500</td>
<td>500</td>
</tr>
<tr>
<td>0710</td>
<td>710</td>
</tr>
<tr>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>1400</td>
<td>1400</td>
</tr>
<tr>
<td>XXXX</td>
<td>Other lengths (max. 2,000 mm)</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Process Connection</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>A2</td>
<td>Adjustable stop flange</td>
<td>GTW-35 (cast iron)</td>
</tr>
<tr>
<td>B2</td>
<td>Adjustable threaded fitting with G 1</td>
<td>1.0711 (carbon steel)</td>
</tr>
<tr>
<td>NN</td>
<td>No fitting</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Holding Tube Material</th>
<th>Dimensions in Millimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>1.4762 (AISI 446 - heat-resistant steel)</td>
<td>22 x 2</td>
</tr>
<tr>
<td>E</td>
<td>1.4841 (AISI 314 - heat-resistant steel)</td>
<td>22 x 2</td>
</tr>
<tr>
<td>F</td>
<td>1.0305 (mild steel)</td>
<td>22 x 2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Holding Tube Length (RL) in Millimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>XXX</td>
<td>Other length</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Additional Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>R24</td>
<td>TAG plate, stainless steel</td>
</tr>
<tr>
<td>X1</td>
<td>Fit sensor to temperature transmitter</td>
</tr>
</tbody>
</table>

**Other Options:**
- Other connection heads
- Other types of thermocouples
- Other protective tube materials
- Other process connections
- Other holding tube materials
- Calibration and material certificates (see page 43)

## Ordering Example

<table>
<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>1075AK</td>
<td>P</td>
<td>3</td>
<td>01</td>
<td>B</td>
<td>05</td>
<td>S</td>
<td>0710</td>
<td>B2</td>
<td>E</td>
<td>150</td>
<td></td>
</tr>
</tbody>
</table>

Typical Model-No.: 1075AK P 3 01 B 05 S 0710 B2 E 150
Price Calculation of Precious Metals

The thermocouple wire diameter varies depending on the thermocouple. We offer a wire diameter of 0.5 mm for precious-metal thermocouples, as the long-term stability is much better with a thicker thermocouple wire. Other thermocouple wire diameters, e.g. 0.35 mm, are available on request.

The price of precious metals is subject to daily quotation and, therefore, it will be quoted separately. For the price calculation of precious metals, the nominal length (NL), the thermocouple type and the wire diameter are taken over from the corresponding ordering table with the help of the model number.

Depending on the connection head size, 55 mm or 80 mm have to be added to the nominal length (NL), in order to get the actual thermocouple length (TL). With the assistance of the table below, the total weight of precious metals per thermocouple can be calculated. After delivery, the confirmed precious metal weight will be changed into the real weight on our invoice. Due to the daily quotation, precious metal prices have to be inquired at our company.

Afterwards, all variables are added to the corresponding formula.

Following information helps for the price calculation:

<table>
<thead>
<tr>
<th>Precious Metal of following Model-No:</th>
<th>_____________________________</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (NL) / Wire Diameter / Weight (g/m) / (see Weight Table)</td>
<td>_____________________________</td>
</tr>
<tr>
<td>Date / Daily Quotation (DM/g) 1)</td>
<td>________________________________________________</td>
</tr>
</tbody>
</table>

1) For daily quotation, please contact Rosemount.

Price Calculation for Thermocouples

1. In Connection with DIN-Form B-Connection Head (Protective Tubes, Type BM & BK):

\[
\text{Price} = \frac{\text{NL (mm) + 55 (mm)}}{1,000 \text{ (mm)}} \times G \text{ (g/m)} \times T \text{ (DM/g)}
\]

**Example:**

Price for 5 pieces

\[
\frac{500 \text{ mm + 55 mm}}{1,000 \text{ mm}} \times 8.2 \text{ g/m} \times 32.55 \text{ DM/g} = 146.80 \text{ DM}
\]

--> 5 pieces = 734 DM

2. In Connection with DIN-Form A-Connection Head (Prot. Tubes, Type AM, AK & AKK):

\[
\text{Price} = \frac{\text{NL (mm) + 80 (mm)}}{1,000 \text{ (mm)}} \times G \text{ (g/m)} \times T \text{ (DM/g)}
\]

**Example:**

Price for 5 pieces
Model-No.: 1075AK-P-30-01-B-05-S-0710-B2-E-150

\[
\frac{710 \text{ mm + 80 mm}}{1,000 \text{ mm}} \times 7.6 \text{ g/m} \times 37.25 \text{ DM/g} = 223.64 \text{ DM}
\]

--> 5 pieces = 1,118.20 DM

Table 7: Weight table (both legs).

<table>
<thead>
<tr>
<th>Wire Diameter [mm]</th>
<th>Type R</th>
<th>Weight [g/m] Type S</th>
<th>Type B</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.35</td>
<td>3.9</td>
<td>4.0</td>
<td>3.7</td>
</tr>
<tr>
<td>0.5</td>
<td>8.1</td>
<td>8.2</td>
<td>7.6</td>
</tr>
</tbody>
</table>
Introduction

Rosemount supplies high-temperature thermocouples worldwide for measurement and control of temperatures in furnaces and chambers, e.g. in glass industry. Because of high temperatures and corrosive environment conditions, platinum-cladded or coated ceramic protective tubes are used in these applications. According to the melting composition, strong oxidations may occur. Depending on the specific process conditions, the service life of thermocouples with platinum protective tubes can be up to 4 - 6 years. Generally, the use of platinum parts is not recommended in reducing atmospheres.

In glass melts, present reducing conditions may cause low melting phases of oxides (aluminium, silicon, arsenic, lead) with platinum, which quickly penetrate into the grain boundaries. Furthermore, conventional alloys show strong coarse-grain formation at higher operating temperatures. Structure damage by contamination leads to loss of stability and breakage of components.

The introduction of dispersion hardening (DPH) for platinum and its alloys solved these problems to a large extent. The finely dispersed oxides impede grain growth and dislocations just below the melting point. This results in a clear reduction of the creep rate and an increase in stress rupture strength especially at high temperatures. Because grain growth is impeded, a fine-grained structure is formed, which remains stable even at the highest application temperatures. Compared to non-dispersion hardened materials, this characteristic microstructure guarantees clear improvement in corrosion resistance.

The current platinum DPH materials (Pt-DPH, PtRh90/10%-Pt DPH) distinguish themselves through following advantages:

- High creep and stress-rupture up to the highest application temperatures
- Excellent corrosion resistance, even in aggressive glass melts
- Ideal microstructural stability in long-term service
- Good formability
- Weldability comparable to non-dispersion hardened platinum materials
Thermocouples with Platinum Protective Tubes

Introduction
Depending on application-specific conditions, like temperature measurement in the molten glass, clad or coated protective tubes are used with platinum or platinum alloys. As a result, the lifetime of the thermocouple is substantially increased.

Construction
This design consists of single or double thermocouples type R, S, or B and a housing with a ceramic protective tube type C 799, whose measuring tip is either clad or coated with precious metal. The platinum-covered protective tube is ground in and the precious-metal tube is cemented-up. To achieve a longer service life, the wire diameter of the thermocouple is 0.5 mm. The thermocouple legs are insulated with a 4-hole insulating rod.

Usually, the ceramic protective tube is cemented into the holding tube. For easy installation, the connection head is mounted on the holding tube. As the temperature above the fitting is generally low, unalloyed steel is used for holding tubes. If the holding tube reaches into the body of the furnace, heat-resistant steel is to be used.

Stop flanges and threaded fittings are necessary for installation. You will find an appropriate selection in Section 6 - Accessories.

Temperature Range
Depending on the type of glass, thermocouples with platinum protective tubes can be used in molten glass at temperatures up to 1,650 °C. Alloys with a higher rhodium content have a longer lifetime.
**Price Calculation**
The total price includes the prices for the thermocouple, the thermocouple precious metal wires, and the precious-metal tube or coating. The precious-metal prices are subject to daily fluctuations and, therefore, to be inquired at the thermocouple supplier.

**Ordering Notes**
The thermocouples – with protective tubes coated or clad with Pt – are manufactured almost exclusively according to customer’s specification.

For this reason, a thermocouple can be described only approximately with the help of an ordering table. The indicated options are only an ordering help. If none of the specified options applies, it is absolutely necessary for the handling of an inquiry to fill in all empty fields (options with the codes 0 or X) the appropriate technical information.

**Ordering Example**
T-EY-E-2-01-S-05-X-1500-C-560-NN-D-940

---

**Figure 18**: Dimensional drawing – thermocouple with Pt-tube.

**Figure 19**: Dimensional drawing – thermocouple with Pt-coated protective tube.
**Study:**

**Platinum-Coating Technology**

Coating technology of ceramic protective tubes represents an alternative to the platinum-covered ceramic protective tubes. These thermocouples are manufactured by applying a thin platinum or a platinum-alloy film on a ceramic tube. The use of platinum-coated thermocouples is particularly suitable for applications where high temperatures exist and excellent corrosion resistance is required.

The use of coating instead of cladding offers following advantages:

- Substantial cost saving by reduction of precious metal weight of 40 to 60%
- To increase the protective effect, Pt coatings can be increased where it is necessary, e.g. at the glass line
- Solder-free design: the risk, that platinum falls off the thermocouple because of a soft junction and is lost in the furnace, is impossible
- Suitable for a large number of ceramic substrates

However, there is following disadvantage:

- Sensitivity in relation to mechanical damage which substantially influences the service life

<table>
<thead>
<tr>
<th>Operating Temperature</th>
<th>Recommended Substrate</th>
<th>Type of Coating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1600 °C</td>
<td>Ceramic type C 530 (resistant to thermal shocks)</td>
<td>Pt</td>
</tr>
<tr>
<td>1600 °C</td>
<td>Ceramic type C 799</td>
<td>Pt</td>
</tr>
<tr>
<td>1650 °C</td>
<td>Ceramic type C 799</td>
<td>Pt/Rh90/10%</td>
</tr>
</tbody>
</table>

Table 8 shows the different coating combinations, recommended for the different temperature ranges.

**Application**

Due to empirical values two standard designs developed:

- Thermocouples for the forehearth zone and
- Thermocouples for the crown zone

**Installation Notes**

To reduce the risk of a thermal shock, it is recommended to pre-heat the thermocouple assembly before installation into the gas-tight, ceramic protective tube. Like all other platinum-containing parts, the assemblies are not suitable for a use in reducing atmospheres.

**Recycling**

At the end of their service life, Pt coatings can be completely recycled.
**Ordering Information:** Immersion Thermocouple – with Pt-(Alloy) Clad or Coated Protective Tube (Max. Temperature 1650 °C)

<table>
<thead>
<tr>
<th><strong>Model</strong></th>
<th><strong>Product Description</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>T-EYI</td>
<td>Immersion Thermocouple, DIN EN 60584-1 (IEC 584), Tolerance Class 1 acc. to DIN EN 60584-2 (IEC 584)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Connection Head</th>
<th>IP rating</th>
<th>Conduit Connection Thread</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>HR-AL (AUS), aluminium</td>
<td>54</td>
<td>M20 x 1.5</td>
</tr>
<tr>
<td>Y</td>
<td>HR-A/BL (BUS), aluminium</td>
<td>54</td>
<td>M20 x 1.5</td>
</tr>
<tr>
<td>G</td>
<td>TZ-AL (AUZH), aluminium</td>
<td>54</td>
<td>M20 x 1.5</td>
</tr>
<tr>
<td>L</td>
<td>TZ-A/BL (BUZH), aluminium</td>
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<td>M20 x 1.5</td>
</tr>
<tr>
<td>P</td>
<td>GN-AL, aluminium, DIN 43729</td>
<td>43</td>
<td>M20 x 1.5</td>
</tr>
<tr>
<td>U</td>
<td>GN-BL, aluminium, DIN 43729</td>
<td>43</td>
<td>M20 x 1.5</td>
</tr>
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<td>Other connection head</td>
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<table>
<thead>
<tr>
<th>Code</th>
<th>Sensor Connection</th>
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</thead>
<tbody>
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<td>1</td>
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<tr>
<td>2</td>
<td>Terminal block, Form B</td>
</tr>
<tr>
<td>0</td>
<td>Other connection</td>
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<td>Double</td>
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<td>B</td>
</tr>
<tr>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>S</td>
<td>S</td>
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<table>
<thead>
<tr>
<th>Code</th>
<th>Wire Diameter in Millimeters</th>
<th>Thermocouple Type</th>
<th>Max. Temperature [°C]</th>
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</thead>
<tbody>
<tr>
<td>05</td>
<td>0.5</td>
<td>R, S, B</td>
<td>1600 / R, S; 1800 / B</td>
</tr>
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<td>Other diameter</td>
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<td></td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Protective Tube Material</th>
<th>Dimensions in Millimeters</th>
<th>Max. Temperature [°C]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Type C 799</td>
<td>10</td>
<td>1800</td>
</tr>
<tr>
<td>B</td>
<td>Type C 799</td>
<td>15</td>
<td>1800</td>
</tr>
<tr>
<td>C</td>
<td>Type C 530</td>
<td>10</td>
<td>1600</td>
</tr>
<tr>
<td>D</td>
<td>Type C 530</td>
<td>15</td>
<td>1600</td>
</tr>
<tr>
<td>X</td>
<td>Other material</td>
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<td></td>
</tr>
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<table>
<thead>
<tr>
<th>Code</th>
<th>Nominal Length (NL) in Millimeters</th>
</tr>
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<tr>
<td>XXXX</td>
<td>Customer-specified length</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Precious-Metal Tube / Coating Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Pt</td>
</tr>
<tr>
<td>B</td>
<td>Pt-DPH (dispersion hardened)</td>
</tr>
<tr>
<td>C</td>
<td>PtRh90/10%</td>
</tr>
<tr>
<td>D</td>
<td>PtRh90/10%-DPH (dispersion hardened)</td>
</tr>
<tr>
<td>E</td>
<td>PtRh80/20%</td>
</tr>
<tr>
<td>F</td>
<td>Pt (coated)</td>
</tr>
<tr>
<td>G</td>
<td>PtRh90/10% (coated)</td>
</tr>
<tr>
<td>N</td>
<td>Without tube / coating</td>
</tr>
<tr>
<td>X</td>
<td>Other material</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Length of Precious-Metal Tube / Coating (PL) in Millimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td>XXXX</td>
<td>Customer-specified length</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Process Connection Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>Adjustable stop flange GTW-35 (cast iron)</td>
</tr>
<tr>
<td>B1</td>
<td>Adjustable threaded fitting 1.0711 (carbon steel)</td>
</tr>
<tr>
<td>NN</td>
<td>No fitting</td>
</tr>
<tr>
<td>XX</td>
<td>Other connection</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Holding Tube Material</th>
<th>Dimensions in Millimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.4762 (AISI 446 - heat-resistant steel)</td>
<td>15</td>
</tr>
<tr>
<td>B</td>
<td>1.4641 (AISI 314 - heat-resistant steel)</td>
<td>15</td>
</tr>
<tr>
<td>C</td>
<td>1.0305 (mild steel)</td>
<td>15</td>
</tr>
<tr>
<td>D</td>
<td>1.4762 (AISI 446 - heat-resistant steel)</td>
<td>22</td>
</tr>
<tr>
<td>E</td>
<td>1.4841 (AISI 314 - heat-resistant steel)</td>
<td>22</td>
</tr>
<tr>
<td>F</td>
<td>1.0305 (mild steel)</td>
<td>22</td>
</tr>
<tr>
<td>X</td>
<td>Other material</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Holding Tube Length (RL) in Millimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>XXXX</td>
<td>Other length</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Additional Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>R24</td>
<td>TAG plate, stainless steel</td>
</tr>
<tr>
<td>X1</td>
<td>Fit sensor to temperature transmitter</td>
</tr>
</tbody>
</table>

**Other Options:**
- Calibration and material certificates (see page 43)
**Multipoint Thermocouples**

**Introduction**
The production of glass depends greatly on temperature. Even slight variations in temperature can change the yield of the final product. For exact temperature measurement, different types of thermocouples are used. Single, sometimes double thermocouples are placed in the crown of the furnace above the glass surface. The “forehearth thermocouple” consists of a pure alumina (Al₂O₃) protective tube, and the Pt-coated or clad measuring tip. The feeder channel is within the liquid glass. Platinum and its alloys (e.g. with rhodium) are not soluble in molten glass, have a high melting point, and highly stable.

**Application**
Currently, multipoint gradient thermocouple assemblies are being used to measure temperatures at different depths in the molten glass to control and maintain a uniform temperature throughout the melt.

**Construction**
This design consists of precious multipoint thermocouples type R, S, or B and a housing with a ceramic protective tube type C 799, whose measuring tip is covered optionally with precious metal. Usually, the protective tube is ground in and the precious metal tube is cemented up. To achieve a longer service life, the wire diameter of the thermocouple is 0.5 mm. The multipoint thermocouple legs are insulated with ceramic elements.

According to the ambient temperature, the holding tube is made of unalloyed or heat-resistant steel. For easy installation, an aluminium connection head is mounted on the holding tube according to DIN-standards. The size of the connection head varies in the outer diameter of the holding tube. On the connection head, a glassfibre/silicone/glassfibre-insulated compensating cable can be connected. Stop flanges and threaded fittings are necessary for installation. You will find an appropriate selection in **Section 6 - Accessories**.

![Figure 20: Multipoint thermocouples.](image)
**Temperature Range**
Depending on the type of glass, thermocouples with platinum protective tubes can be used in the molten glass at temperatures up to 1,650 °C. Alloys with higher rhodium contents or dispersion-hardened platinum (Pt-DPH) have a longer lifetime.

**Table 9** illustrates the relationship between protective tube material, type of thermocouple and max. application temperature.

<table>
<thead>
<tr>
<th>Protective Tube Material</th>
<th>Thermocouple Type</th>
<th>Max. Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pt</td>
<td>Type R/S</td>
<td>1600 °C</td>
</tr>
<tr>
<td>PtRh90/10%</td>
<td>Type B</td>
<td>1650 °C</td>
</tr>
<tr>
<td>Pt-DPH</td>
<td>Type B</td>
<td>1600 °C</td>
</tr>
<tr>
<td>PtRh80/20%</td>
<td>Type B</td>
<td>1650 °C</td>
</tr>
</tbody>
</table>

**Price Calculation**
The total price for a multipoint-thermocouple includes the prices for thermocouple, thermocouple precious-metal wires and the precious-metal tube or coating. Precious-metal prices are subject to daily fluctuations and, therefore, to be inquired at the thermocouple supplier.

**Ordering Notes**
The multipoint thermocouples are manufactured almost exclusively according to customer’s specification. For this reason, a thermocouple can be described only approximately with the help of an ordering table. The indicated options are only an ordering help. If none of the specified options applies, it is absolutely necessary for the handling of an inquiry to fill in the appropriate technical information in all empty fields (options with the codes 0 or X).

**Ordering Example**
TX-EYI-P-1-03-S-05-A-0710-N-000-NN-B-150-M1-0705-M2-0655-M3-0605-AGL2-1000
**Order Information:** Multipoint Thermocouple – with Ceramic Protective Tube; Optionally, with Precious-Metal Clad or Coated Protective Tube (Max. Temperature 1800 °C) – Part 1

<table>
<thead>
<tr>
<th>Model</th>
<th>Product Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TX-EYI</td>
<td>Multipoint Thermocouple, DIN EN 60584-1 (IEC 584), Tolerance Class 1 acc. to DIN EN 60584-2 (IEC 584)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Connection Head</th>
<th>IP Rating</th>
<th>Conduit Connection Thread</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>HR-AL (AUS), aluminium</td>
<td>54</td>
<td>M20 x 1.5</td>
</tr>
<tr>
<td>Y</td>
<td>HR-A/BL (BUS), aluminium</td>
<td>54</td>
<td>M20 x 1.5</td>
</tr>
<tr>
<td>G</td>
<td>TZ-AL (AUZH), aluminium</td>
<td>54</td>
<td>M20 x 1.5</td>
</tr>
<tr>
<td>L</td>
<td>TZ-A/BL (BUZH), aluminium</td>
<td>54</td>
<td>M20 x 1.5</td>
</tr>
<tr>
<td>P</td>
<td>GN-AL, aluminium, DIN 43729</td>
<td>43</td>
<td>M20 x 1.5</td>
</tr>
<tr>
<td>U</td>
<td>GN-BL, aluminium, DIN 43729</td>
<td>43</td>
<td>M20 x 1.5</td>
</tr>
<tr>
<td>X</td>
<td>Other connection head</td>
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<table>
<thead>
<tr>
<th>Code</th>
<th>Sensor Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Terminal block, Form A</td>
</tr>
<tr>
<td>2</td>
<td>Terminal block, Form B</td>
</tr>
<tr>
<td>0</td>
<td>Other connection</td>
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<thead>
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<th>Code</th>
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<td>B</td>
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<tr>
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<td>R</td>
</tr>
<tr>
<td>S</td>
<td>S</td>
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</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Wire Diameter in Millimeters</th>
<th>Thermocouple Type</th>
<th>Max. Temperature [°C]</th>
</tr>
</thead>
<tbody>
<tr>
<td>05</td>
<td>0.5</td>
<td>R, S, B</td>
<td>1600 / R, S; 1800 / B</td>
</tr>
<tr>
<td>XX</td>
<td>Other diameter</td>
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<td></td>
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<table>
<thead>
<tr>
<th>Code</th>
<th>Protective Tube Material</th>
<th>Dimensions in Millimeters</th>
<th>Max. Temperature [°C]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Type C 799</td>
<td>10</td>
<td>1800</td>
</tr>
<tr>
<td>B</td>
<td>Type C 799</td>
<td>15</td>
<td>1800</td>
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<tr>
<td>X</td>
<td>Other material</td>
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<table>
<thead>
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<th>Code</th>
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<table>
<thead>
<tr>
<th>Code</th>
<th>Precious-Metal Tube / Coating Material</th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>Pt</td>
</tr>
<tr>
<td>B</td>
<td>Pt-DPH (dispersion hardened)</td>
</tr>
<tr>
<td>C</td>
<td>PtRh90/10%</td>
</tr>
<tr>
<td>D</td>
<td>PtRh90/10%-DPH (dispersion hardened)</td>
</tr>
<tr>
<td>E</td>
<td>PtRh80/20%</td>
</tr>
<tr>
<td>F</td>
<td>Pt (coated)</td>
</tr>
<tr>
<td>G</td>
<td>PtRh90/10% (coated)</td>
</tr>
<tr>
<td>N</td>
<td>No tube / coating</td>
</tr>
<tr>
<td>X</td>
<td>Other material</td>
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**Multipoint Thermocouple** — with Ceramic Protective Tube; Optionally, with Precious-Metal Clad or Coated Protective Tube (Max. Temperature 1800 °C) — Part 2

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<tr>
<th>Code</th>
<th>Length of Precious-Metal Tube / Coating (PL) in Millimeters</th>
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<tr>
<td>000</td>
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<thead>
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<th>Code</th>
<th>Process Connection</th>
<th>Material</th>
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</thead>
<tbody>
<tr>
<td>A1</td>
<td>Adjustable stop flange</td>
<td>GTW-35 (cast iron)</td>
</tr>
<tr>
<td>B1</td>
<td>Adjustable threaded fitting</td>
<td>1.0711 (carbon steel)</td>
</tr>
<tr>
<td>NN</td>
<td>No fitting</td>
<td></td>
</tr>
<tr>
<td>XX</td>
<td>Other connection</td>
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<table>
<thead>
<tr>
<th>Code</th>
<th>Holding Tube Material</th>
<th>Dimensions in Millimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.4762 (AISI 446 - heat-resistant steel)</td>
<td>15</td>
</tr>
<tr>
<td>B</td>
<td>1.4841 (AISI 314 - heat-resistant steel)</td>
<td>15</td>
</tr>
<tr>
<td>C</td>
<td>1.0305 (mild steel)</td>
<td>15</td>
</tr>
<tr>
<td>D</td>
<td>1.4762 (AISI 446 - heat-resistant steel)</td>
<td>22</td>
</tr>
<tr>
<td>E</td>
<td>1.4841 (AISI 314 - heat-resistant steel)</td>
<td>22</td>
</tr>
<tr>
<td>F</td>
<td>1.0305 (mild steel)</td>
<td>22</td>
</tr>
<tr>
<td>X</td>
<td>Other material</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Holding Tube Length (RL) in Millimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td>XXX</td>
<td>Customer-specified length</td>
</tr>
</tbody>
</table>

<table>
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<th>Code</th>
<th>Length of Measuring Point (ML) in Millimeters</th>
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<td>M1-XXXX</td>
<td>Measuring point 1</td>
</tr>
<tr>
<td>M2-XXXX</td>
<td>Measuring point 2</td>
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<td>Measuring point 3</td>
</tr>
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<td>MX-XXXX</td>
<td>Measuring point X</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Additional Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGL1-XXXX</td>
<td>Glass fibre/silicone rubber/glass fibre insulated compensating cable with connected miniature thermocouple plug incl. specified length</td>
</tr>
<tr>
<td>AGL2-XXXX</td>
<td>Glass fibre/silicone rubber/glass fibre insulated compensating cable with connected standard thermocouple plug incl. specified length</td>
</tr>
<tr>
<td>R24</td>
<td>TAG plate, stainless steel</td>
</tr>
<tr>
<td>X1</td>
<td>Fit sensor to temperature transmitter</td>
</tr>
</tbody>
</table>

Other Options:
- Calibration and material certificates (see page 43)
**Thermocouples with Electrical Shielding**

**Introduction**
The thermocouple output can be influenced by electromagnetic radiation, e.g. in electrically heated furnaces. Depending on the strength of the electrical field, serious reading errors may occur. Usually, shielded compensating cables are used to lead the output signal to the control room. In practice however, this measure is not sufficient to avoid all possible signal disturbances. Rosemount offers special, electrically shielded high-temperature thermocouples up to 1800 °C, supplied with gas-tight, ceramic protective tubes.

**Application**
Thermocouples with electrical shielding are used among other things in glow processes, e.g. during fluorescence powder manufacturing. Additionally, these thermocouples are used in the production of technical ceramics for electrotechnical and mechanical applications.

**Construction**
This design consists of single or double thermocouples type R, S, or B and a housing with a gas-tight, ceramic protective tube type C 799 or porous type C 530. To achieve a longer service life, the wire diameter of the thermocouple is 0.5 mm. The thermocouple legs are insulated with a 4-hole insulating rod. The Pt electrical protection is reelied up the insulating rod and extended by a nickel wire to the terminal block.

From the connection head shielded compensating cables lead the output signal to the control room.

Figure 22: Thermocouple with electrical shielding.

Usually, the ceramic protective tube is cemented into the holding tube. For easy installation, the connection head is mounted on the holding tube. As the temperature above the fitting is generally low, unalloyed steel is used for holding tubes. If the holding tube reaches into the body of the furnace, heat-resistant steel is to be used. Stop flanges and threaded fittings are necessary for installation. You will find an appropriate selection in Section 6 - Accessories.
Temperature Range
Thermocouples with electrical shielding can be used at temperatures up to 1800 °C.

Price Calculation
The total price for a thermocouple with electrical shielding includes the prices for thermocouple, thermocouple precious metal wires and band. The precious metal prices are subject to daily fluctuations and, therefore, to be inquired at the thermocouple supplier.

Ordering Notes
Thermocouples with electrical shielding are manufactured almost exclusively according to customer’s specification. For this reason, a thermocouple can be described only approximately with the help of an ordering table. The indicated options are only an ordering help. If none of the specified options applies, it is absolutely necessary for the handling of an inquiry to fill the appropriate technical information in all empty fields (options with the codes 0 or X).

Ordering Example
TEP-P-2-01-S-05-B-0710-B-720-NN-D-150

Figure 23: Dimensional drawing – thermocouples with electrical shielding.
### Ordering Information: Immersion Thermocouple – with Electrical Shielding (Max. Temperature 1800 °C)

<table>
<thead>
<tr>
<th>Model</th>
<th>Product Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEP</td>
<td>Immersion Thermocouple, DIN EN 60584-1 (IEC 584), Tolerance Class 1 acc. to DIN EN 60584-2 (IEC 584)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Connection Head</th>
<th>IP Rating</th>
<th>Conduit Connection Thread</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>HR-AL (AUS), aluminium</td>
<td>54</td>
<td>M20 x 1.5</td>
</tr>
<tr>
<td>Y</td>
<td>HR-A/BL (BUS), aluminium</td>
<td>54</td>
<td>M20 x 1.5</td>
</tr>
<tr>
<td>G</td>
<td>TZ-AL (AUZH), aluminium</td>
<td>54</td>
<td>M20 x 1.5</td>
</tr>
<tr>
<td>L</td>
<td>TZ-A/BL (BUZH), aluminium</td>
<td>54</td>
<td>M20 x 1.5</td>
</tr>
<tr>
<td>P</td>
<td>GN-AL, aluminium, DIN 43729</td>
<td>43</td>
<td>M20 x 1.5</td>
</tr>
<tr>
<td>U</td>
<td>GN-BL, aluminium, DIN 43729</td>
<td>43</td>
<td>M20 x 1.5</td>
</tr>
<tr>
<td>X</td>
<td>Other connection head</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Sensor Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Terminal block, Form A</td>
</tr>
<tr>
<td>2</td>
<td>Terminal block, Form B</td>
</tr>
<tr>
<td>0</td>
<td>Other connection</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Number of Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Single</td>
</tr>
<tr>
<td>02</td>
<td>Double</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Thermocouple Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>S</td>
<td>S</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Wire Diameter in Millimeters</th>
<th>Thermocouple Type</th>
<th>Max. Temperature [°C]</th>
</tr>
</thead>
<tbody>
<tr>
<td>05</td>
<td>0.5</td>
<td>R, S, B</td>
<td>1600 / R, S; 1800 / B</td>
</tr>
<tr>
<td>XX</td>
<td>Other diameter</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Protective Tube Material</th>
<th>Dimensions in Millimeters</th>
<th>Max. Temperature [°C]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Type C 799</td>
<td>10</td>
<td>1800</td>
</tr>
<tr>
<td>B</td>
<td>Type C 799</td>
<td>15</td>
<td>1800</td>
</tr>
<tr>
<td>C</td>
<td>Type C 530</td>
<td>10</td>
<td>1600</td>
</tr>
<tr>
<td>D</td>
<td>Type C 530</td>
<td>15</td>
<td>1600</td>
</tr>
<tr>
<td>X</td>
<td>Other material</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Nominal Length (NL) in Millimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td>XXXX</td>
<td>Customer-specific length</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Electrical Shielding</th>
<th>Dimensions in Millimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Pt electrical protection</td>
<td>2 x 0.1</td>
</tr>
<tr>
<td>B</td>
<td>Pt electrical protection</td>
<td>2 x 0.05</td>
</tr>
<tr>
<td>X</td>
<td>Other material</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Length of Electrical Shielding</th>
</tr>
</thead>
<tbody>
<tr>
<td>XXXX</td>
<td>Customer-specific length</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Process Connection</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>Adjustable stop flange</td>
<td>GTW-35 (cast iron)</td>
</tr>
<tr>
<td>B1</td>
<td>Adjustable threaded fitting</td>
<td>1.0711 (carbon steel)</td>
</tr>
<tr>
<td>NN</td>
<td>No fitting</td>
<td></td>
</tr>
<tr>
<td>XX</td>
<td>Other connection</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Holding Tube Material</th>
<th>Dimensions in Millimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.4762 (AISI 446 - heat-resistant steel)</td>
<td>15</td>
</tr>
<tr>
<td>B</td>
<td>1.4841 (AISI 314 - heat-resistant steel)</td>
<td>15</td>
</tr>
<tr>
<td>C</td>
<td>1.0305 (mild steel)</td>
<td>15</td>
</tr>
<tr>
<td>D</td>
<td>1.4762 (AISI 446 - heat-resistant steel)</td>
<td>22</td>
</tr>
<tr>
<td>E</td>
<td>1.4841 (AISI 314 - heat-resistant steel)</td>
<td>22</td>
</tr>
<tr>
<td>F</td>
<td>1.0305 (mild steel)</td>
<td>22</td>
</tr>
<tr>
<td>X</td>
<td>Other material</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Holding Tube Length (RL) in Millimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td>XXXX</td>
<td>Customer-specified length</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Additional Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGL3-XXXX</td>
<td>Glass fibre/silicone rubber/glass fibre insulated and shielded compensating cable incl. specified length</td>
</tr>
<tr>
<td>R24</td>
<td>TAG plate, stainless steel</td>
</tr>
<tr>
<td>X1</td>
<td>Fit sensor to temperature transmitter</td>
</tr>
</tbody>
</table>

**Other Options:**
- Calibration and material certificates (see page 43)
Glass-Level Electrodes

Introduction and Application
These sensors are a very efficient tool for accurate level measurement. Our sensors are provided with two electrodes (double sensor), which avoids an unintended burn-out of an electrode, due to potential differences between molten glass and earth, as happened to single sensors. This clearly extends the service life of the sensor.

Typical measuring circuits are shown in Figures 25 and 26 for single and double sensor system.

Construction
This design consists of one (single sensor) or two (double sensor) precious-metal wires, platinum or its alloys and a housing with a ceramic protective tube type C 799, whose measuring tip is provided with an electrode. The electrode tip has usually an outer diameter of 3 mm and a length of 20 mm. It is cemented into the ceramic protective tube. The diameter of the Pt wire, insulated with ceramic elements, is normally 1 mm.
According to the ambient temperature, the holding tube is made of unalloyed or heat-resistant steel. For easy installation, an aluminium connection head is mounted on the holding tube. The size of the connection head varies in the outer diameter of the holding tube. Stop flanges and threaded fittings are necessary for installation. You will find an appropriate selection in Section 6 - Accessories.

Temperature Range
Depending on the type of glass, thermocouples with a precious-metal electrode can be used in the molten glass at temperatures up to 1650 °C. Alloys with higher rhodium parts have a longer lifetime.

Ordering Notes
Thermocouples with glass-level electrodes are manufactured almost exclusively according to customer’s specification. For this reason, a thermocouple can be described only approximately with the help of an ordering table. The indicated options are only an ordering help. If none of the specified options applies, it is absolutely necessary for the handling of an inquiry to fill the appropriate technical information in all empty fields (options with the codes 0 or X).

Ordering Example
GLE-P-2-01-S-10-A-0710-NN-B-150
Figure 25: Single-sensor system.

Figure 26: Double-sensor system.

Figure 27: Dimensional drawing – glass-level electrode.
## Ordering Information: Glass-Level Electrode – with Ceramic Protective Tube, Measuring Tip with Precious-Metal Electrode (Max. Temperature 1650 °C)

<table>
<thead>
<tr>
<th>Model</th>
<th>Product Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GLE</td>
<td>Glass-Level Electrode with Precious-Metal Electrode</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Connection Head</th>
<th>IP Rating</th>
<th>Conduit Connection Thread</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>HR-AL (AUS), aluminium</td>
<td>54</td>
<td>M20 x 1.5</td>
</tr>
<tr>
<td>Y</td>
<td>HR-A/BL (BUS), aluminium</td>
<td>54</td>
<td>M20 x 1.5</td>
</tr>
<tr>
<td>G</td>
<td>TZ-AL (AuzH), aluminium</td>
<td>54</td>
<td>M20 x 1.5</td>
</tr>
<tr>
<td>L</td>
<td>TZ-A/BL (BUZH), aluminium</td>
<td>54</td>
<td>M20 x 1.5</td>
</tr>
<tr>
<td>P</td>
<td>GN-AL, aluminium, DIN 43729</td>
<td>43</td>
<td>M20 x 1.5</td>
</tr>
<tr>
<td>U</td>
<td>GN-BL, aluminium, DIN 43729</td>
<td>43</td>
<td>M20 x 1.5</td>
</tr>
<tr>
<td>X</td>
<td>Other connection head</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Sensor Connection</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Terminal block, Form A</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Terminal block, Form B</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>Other connection</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Number of Elements</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Single</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>Double</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Electrode Wire Material</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>PtRh90/10%</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>Other material</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Wire Diameter in Millimeters</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>XX</td>
<td>Other diameter</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Protective Tube Material</th>
<th>Dimensions in Millimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Type O 799</td>
<td>15</td>
</tr>
<tr>
<td>X</td>
<td>Other material</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Nominal Length (NL) in Millimeters</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>XXXX</td>
<td>Customer-specified length</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Process Connection</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>Adjustable stop flange</td>
<td>GTW-35 (cast iron)</td>
</tr>
<tr>
<td>B1</td>
<td>Adjustable threaded fitting</td>
<td>1.0711 (carbon steel)</td>
</tr>
<tr>
<td>NN</td>
<td>No fitting</td>
<td></td>
</tr>
<tr>
<td>XX</td>
<td>Other connection</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Holding Tube Material</th>
<th>Dimensions in Millimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>1.4762 (AISI 446 - heat-resistant steel)</td>
<td>22</td>
</tr>
<tr>
<td>E</td>
<td>1.4841 (AISI 314 - heat-resistant steel)</td>
<td>22</td>
</tr>
<tr>
<td>F</td>
<td>1.0305 (mild steel)</td>
<td>22</td>
</tr>
<tr>
<td>X</td>
<td>Other material</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Holding Tube Length (RL) in Millimeters</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>XXXX</td>
<td>Customer-specified length</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Additional Options</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>R24</td>
<td>TAG plate, stainless steel</td>
<td></td>
</tr>
<tr>
<td>X1</td>
<td>Fit sensor to temperature transmitter</td>
<td></td>
</tr>
</tbody>
</table>
Section 5
Calibration and Certificates

Tests and Measurements on Thermocouples

General Principles
Verification in compliance with quality characteristics, properties, characteristic data and specific requirements is defined in standard EN 10204. This standard specifies who may issue certificates on which conditions.

EN 10204
This standard deals with the certification of metallic materials (protective tubes, thermocouple wires) by means of works test certificates and acceptance test certificates.

Material Testing
Material testing ensures the identifiability of certified material from melting to the end product and thus that chemical and mechanical data are verifiable.

• Works certification according to EN 10204-2.1
  In the works certification the manufacturer confirms on the basis of non-specific tests and without expressly stated test results that the product supplied meets the requirements of the order.

• Works certificate according to EN 10204-2.2
  In the works certificate the manufacturer confirms on the basis of non-specific tests and with the stated test results that the product supplied is in accordance with official regulations, the corresponding material and manufacturing process and meets the requirements of the order.

• Works test certificate according to EN 10204-2.3
  In the works test certificate the manufacturer confirms on the basis of specific tests and with the stated test results that the product supplied is in accordance with official regulations, the corresponding material and manufacturing process and meets the requirements of the order.

• Acceptance test certificate according to EN 10204-3.1A
  In the above mentioned acceptance test certificate an officially authorized expert confirms on the basis of specific tests and with the stated test results that the product supplied is in accordance with official regulations, the corresponding material and manufacturing process and meets the requirements of the order.

• Acceptance test certificate according to EN 10204-3.1B
  In the above mentioned acceptance test certificate a works expert, authorized by the manufacturer, confirms on the basis of specific tests and with the stated test results that the product supplied is in accordance with official regulations, the corresponding material and manufacturing process and meets the requirements of the order. The necessary tests have to be carried out by a checking station, which is independent of the production department.

All above mentioned certificates are available upon request.
Calibration with DKD-Certificate

The calibration of temperature sensors is to be effected in our calibration laboratory DKD-K-05601. For many applications, especially in connection with the quality assurance system ISO 9000, precise documentation of carried out measurements is essential. Maximum measurement reliability is guaranteed by the calibration certificates of our calibration laboratory, represented in the German Calibration Service (DKD). It provides documentation with traceability to national standards on temperature representation in conformity with the international standards (SI).

During the process of compiling a DKD or works certificate, the thermocouple or measuring system, e.g. transmitter with connected thermocouple, is checked on precise and traceable comparison standards regarding measurement accuracy. DKD-certified thermocouples are used as a secondary reference for checking subordinate measuring systems within a customer’s QA system. Thermocouples with a works certificate can be used for documentation of carried out measurements at the service and quality assurance department.

Our DKD laboratory is authorized to issue DKD calibration certificates for temperature in relation to thermocouples as calibration subject in the measurement ranges shown in Table 10. The measurement uncertainties are defined in the various calibration points and based on the double standard deviation (k = 2), (probable coincidence approx. 95%).

The calibrations carried out by the Calibration Laboratory are services for the customer. It is our intention to meet the high quality requirements of the customer in relation to thermocouple calibration including traceability to national standards and to accomplish always the contract commitments with the accreditation authority – PTB (German Physical Technical Authority). The thermocouple, which provides the measurement result on its own or as a measuring chain, is compared with the national standards. This comparison measurement produces quantitative verification of traceability. A report giving results is issued in form of a calibration certificate according to DKD specifications (Figure 28).

Table 10: Measured quantities, for which the DKD-laboratory is authorized (extract).

<table>
<thead>
<tr>
<th>Subject of Calibration</th>
<th>Temperature Range</th>
<th>Measurement Conditions</th>
<th>Measurement Uncertainty</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermocouples</td>
<td>0 °C to 1200 °C</td>
<td>Comparison with standard thermocouples in tube furnaces</td>
<td>1.5 K</td>
<td></td>
</tr>
<tr>
<td>Thermocouples Type S and R</td>
<td></td>
<td></td>
<td>1 K</td>
<td>Comparison without protective tube in a Pt tube</td>
</tr>
<tr>
<td>Transmitter with connected thermocouples</td>
<td>as for thermocouples</td>
<td>as for thermocouples</td>
<td>U(TE) + 500 mK</td>
<td>U(TE) is the measurement uncertainty of calibrating the thermocouple by itself</td>
</tr>
</tbody>
</table>
Works Certificates

The calibrated values can also be certified on a works certificate by using the comparison method. The max. test temperature is 1,300 °C.

A pre-condition for the calibration is a suitable design of the thermocouple, e.g. it has to have a certain minimum insertion length.

When ordering a thermocouple, the customer has to inform about the number and values of the test variables, at which the thermocouple is to be calibrated.

Note
Before specifying a temperature value, consider the temperature limits of the thermocouple.

For individual order options see Table 11.

Table 11: Ordering information for calibration options.

<table>
<thead>
<tr>
<th>Type of Certificate</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Works Certificate:</strong> Comparison measurement at thermocouple</td>
<td></td>
</tr>
<tr>
<td>with 1 temperature point</td>
<td>W1</td>
</tr>
<tr>
<td>with 2 temperature points</td>
<td>W2</td>
</tr>
<tr>
<td>with 3 temperature points</td>
<td>W3</td>
</tr>
<tr>
<td>with 4 temperature points</td>
<td>W4</td>
</tr>
<tr>
<td>with 5 temperature points</td>
<td>W5</td>
</tr>
<tr>
<td>for measuring system with 1 thermocouple</td>
<td>W12</td>
</tr>
<tr>
<td><strong>DKD Calibration Certificate:</strong> DKD Certificate</td>
<td></td>
</tr>
<tr>
<td>for 1 temperature point specified by the customer</td>
<td>K1</td>
</tr>
<tr>
<td>for 2 temperature points specified by the customer</td>
<td>K2</td>
</tr>
<tr>
<td>for 3 temperature points specified by the customer</td>
<td>K3</td>
</tr>
<tr>
<td>for 4 temperature points specified by the customer</td>
<td>K4</td>
</tr>
<tr>
<td>for 5 temperature points specified by the customer</td>
<td>K5</td>
</tr>
<tr>
<td>for measuring system with 1 thermocouple</td>
<td>K12</td>
</tr>
</tbody>
</table>

Of course it is possible to calibrate more than 5 temperatures. Prices upon request.
Figure 28: DKD certificate for thermocouples – example.
Figure 29: Works certificate for thermocouples – example.
Figure 30: DKD certificate – transmitter with thermocouple connected.
Transmitters

Into the extended cover of the connection head types TZ-A/BL (BUZH) or TZ-AL (AUZH), Rosemount transmitter models **244EH** and **644H** can be inserted.

These transmitters have following common properties:
- User selectable inputs with a variety of RTDs and thermocouples
- High RFI immunity
- Linearization of RTD and thermocouple inputs
- Galvanically isolated inputs / outputs
- Electronics module completely sealed in epoxy resin within a housing. This enhances transmitter stability and reliability
- Thermocouple outputs are automatically provided with a comparison junction.
- µP-based for enhanced accuracy and stability
- Ambient temperature effects reduced by temperature-corrected electronics

The **Model 244EH** is PC-programmable using Windows®-based software.

The **Model 644H** communicates using HART®-protocol (Highway Addressable Remote Transducer) and is compatible with Rosemount HART-communicator, HART-based control systems, and µP-based AMS software (Asset Management Solutions). The model 644H enables sensor trimming (one-point or two-point trimming) for enhanced total system accuracy.

In addition Rosemount offers a wide range of rail- or field-mounted transmitters. See the corresponding product data sheets:
- **Model 244EH and 244ER** – PC-Programmable Temperature Transmitters (publication no. 00813-0101-4737)
- **Model 644H** – Smart Head-Mount Temperature Transmitters (publication no. 00813-0101-4728)
- **Model 644R** – Smart Rail Mount Temperature Transmitters (publication no. 00813-0201-4728)
- **Model 3144 and 3244MV** – Smart Temperature Transmitters (publication no. 00813-0101-4724)
Connection Heads (Fig. 32)

The present section includes the technical data of all connection heads mentioned in this product data sheet. The screwed cable gland is available with thread M 20 x 1.5. A silicone gasket is used at temperatures up to 200 °C. This gasket is necessary for protection class IP 65.

Model: TZ-A/BL (BUZH) (Fig. 33)

Materials
Housing: Aluminium
Form: B acc. to DIN 43729
Finish: Aluminium lacquer
O-Ring-Seal: Rubber
Temp. Limits: -40 to +80 °C
Weight: 0.20 kg
Protection Class: IP 54
Cover: Hinged lid, screwed
Transmitter Inst.: Within cover

Model: TZ-AL (AUZH) (Fig. 34)

Materials
Housing: Aluminium
Form: A acc. to DIN 43729
Finish: Aluminium lacquer
O-Ring-Seal: Rubber
Temp. Limits: -40 to +80 °C
Weight: 0.22 kg
Protection Class: IP 54
Cover: Hinged lid, screwed
Transmitter Inst.: Within cover
Model: HR-A/BL (BUS) (Fig. 35)
Materials
Housing: Aluminium  
Form B acc. to DIN 43729
Finish: Aluminium lacquer
O-Ring-Seal: Rubber
Temp. Limits: -40 to +80 °C
Weight: 0.24 kg
Protection Class: IP 54
Cover: Hinged lid, with lever lock
Transmitter Inst.: Possible

Model: GN-BL (B) (Fig. 37)
Materials
Housing: Aluminium  
Form B acc. to DIN 43729
Finish: Aluminium lacquer
O-Ring-Seal: Rubber
Temp. Limits: -40 to +80 °C
Weight: 0.18 kg
Protection Class: IP 43
Cover: Loose lid, with 2 screws
Transmitter Inst.: Not possible

Model: HR-AL (AUS) (Fig. 36)
Materials
Housing: Aluminium  
Form A acc. to DIN 43729
Finish: Aluminium lacquer
O-Ring-Seal: Rubber
Temp. Limits: -40 to +80 °C
Weight: 0.24 kg
Protection Class: IP 54
Cover: Hinged lid, with lever lock
Transmitter Inst.: Possible

Model: GN-AL (A) (Fig. 38)
Materials
Housing: Aluminium  
Form A acc. to DIN 43729
Finish: Aluminium lacquer
O-Ring-Seal: Rubber
Temp. Limits: -40 to +80 °C
Weight: 0.20 kg
Protection Class: IP 43
Cover: Loose lid, with 2 screws
Transmitter Inst.: Not possible
Mounting Accessories

The connection fittings of thermocouples are supplied mainly with detachable mounting elements, sealed with a stuffing bush:
- Adjustable stop flanges
- Adjustable threaded fittings

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Material</th>
<th>Tube Diameter [mm]</th>
<th>Inner Diameter / Process Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSG 32.400.011</td>
<td>Stop flange</td>
<td>GTW-35 (cast iron)</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>HSG 32.400.021</td>
<td>Stop flange</td>
<td>GTW-35 (cast iron)</td>
<td>22</td>
<td>23</td>
</tr>
<tr>
<td>HSG 32.400.031</td>
<td>Stop flange</td>
<td>GTW-35 (cast iron)</td>
<td>32</td>
<td>33</td>
</tr>
<tr>
<td>HSG 32.395.216</td>
<td>Threaded fitting</td>
<td>1.0711 (mild steel)</td>
<td>15</td>
<td>G1 1/4 A</td>
</tr>
<tr>
<td>HSG 32.395.386</td>
<td>Threaded fitting</td>
<td>1.0711 (mild steel)</td>
<td>15</td>
<td>G1 A</td>
</tr>
<tr>
<td>HSG 32.395.426</td>
<td>Threaded fitting</td>
<td>1.0711 (mild steel)</td>
<td>22</td>
<td>G1 A</td>
</tr>
<tr>
<td>HSG 32.395.496</td>
<td>Threaded fitting</td>
<td>1.0711 (mild steel)</td>
<td>32</td>
<td>G1 1/4 A</td>
</tr>
</tbody>
</table>
Thermocouple Wires, Extension and Compensating Cables

Thermocouple Wires
Thermocouple wires are used to manufacture thermocouples for temperature measurement. The tolerances and application temperatures of DIN EN 60584-1/2 standards are valid for the thermocouple wires. Our thermocouple wires are selected and tested in the laboratory. The tolerances between desired and actual values are recorded. This guarantees a uniform and stable quality of the delivered goods. The indicated basic values and their tolerances are only valid for thermocouple wires supplied in pairs. The individual thermocouples are designated by a letter, e.g. K for NiCr-Ni thermocouple. The colour coding table is on the back page of this product data sheet.

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DIN 43722 Standards for Extension and Compensating Cables
The DIN 43722 standards include the German version of the European Harmonization Document HD 446.3 S, which contains the International Standard IEC 584-3: 1989 with common alterations made by CENELEC.

This standard specifies limit tolerances of thermoelectric voltages for extension and compensating cables, in accordance with the basic values of part 1 of the IEC 584-1 standard. Furthermore, this standard specifies the method for identification of insulated extension and compensating cables. This standard is not valid for mineral insulated cables.

Definitions
Extension and compensating cables are used for the electrical connection between the open ends of a thermocouple and the comparison junction in those installations where the thermocouple legs are not directly connected to the comparison junction.

Limit Tolerances
The limit tolerances of an extension or compensating cable are the maximum possible deviation in microvolts caused by insertion of the extension or compensating cable into the measuring circuit.

Extension Cables
Extension cables are manufactured of the same material as the corresponding thermocouple. They are available as stranded lead or solid wire with different insulations. They are designated by letter “X” following the designation of the thermocouple, e.g. “KX” - extension cable for NiCr-Ni-thermocouple, type K.

For thermocouple cables two limit tolerance classes are defined. For the thermocouple types J, E, K, and N the limit tolerance in class 1 is ±1.5 °C, and in class 2 is ±2.5 °C. The limit tolerances for extension cable are only valid for an application temperature range of -25 °C up to +200 °C.
The application temperature range indicates the ambient temperature, which the whole cable may be exposed to, from connection point to comparison junction, in order to keep the stated tolerances.

With regard to the thermoelectrical properties, the maximum temperature is limited to 200 °C, even if the insulating materials would tolerate higher temperatures.

**Compensating Cables**
Compensating cables are manufactured of special materials which have the same thermoelectrical properties in limited temperature ranges as the thermocouple. They are available as stranded lead or solid wire with different insulations.

They are designated by letter “C” following the designation of the thermocouple, e.g. “SC” – compensating cable for PtRh10%-Pt thermocouple, type S.

Different alloys may be used for the same thermocouple type. They are to be distinguished by an additional letter, e.g. KCA and KCB.

For compensating cables only limit tolerance class 2 is defined. For the types KCA, KCB, NC, RCA, and SCA the limit tolerance is ± 2.5 °C, for types RCB and SCB ± 5.0 °C. Depending on the type of compensating cable limit tolerances for an application temperature range of 0 °C up to 100 °C, 150 °C, or 200 °C are valid.

For special purposes, additional requirements are to be fulfilled with regard to the cable construction (kind of wiring, number of twists, shield, additional leads) as well as insulation.

Rosemount offers cables with a high chemical resistance and excellent protection against magnetic and electrical influences as well as cables with a high mechanical shield and wide ambient temperature range.

**Table 12** shows an overview of maximum application temperatures of the most important insulation materials. The indicated values are to be regarded only as reference values.

The maximum application temperature for glass fibre, special glass fibre, and Q-fibres is valid only for single measurements. In this case the cable is not to be moved and the insulation is wrapped. The maximum temperature for wrapped glass fibre insulation is 250 °C. Information about the insulation material is related to the single lead only. Looking at the outer sheath, a mechanical armouring could be attached. That means that the outer sheath is the most external insulation position of the cable construction.

Our special catalogue – **Thermocouple Wires, Extension and Compensating Cables** – includes all standard cables available from stock. Special cables are delivered on request.
# Thermocouple Questionnaire

## I. General Information

<table>
<thead>
<tr>
<th>Name, Department</th>
<th>☐</th>
</tr>
</thead>
<tbody>
<tr>
<td>Telephone No.</td>
<td>☐</td>
</tr>
<tr>
<td>Company</td>
<td>☐</td>
</tr>
<tr>
<td>Address</td>
<td>☐</td>
</tr>
<tr>
<td>Inquiry / Ordering No.</td>
<td>☐</td>
</tr>
</tbody>
</table>

## II. Thermocouple Assembly

- ☐ Series 1075 standard thermocouples with deviations
- ☐ Special thermocouples, e.g. for glass industry

## III. Operating Conditions

### 1. Field of Application

<table>
<thead>
<tr>
<th>Place of installation</th>
<th>☐</th>
</tr>
</thead>
</table>

### 1.1 Position of installation

<table>
<thead>
<tr>
<th>Operating temperature</th>
<th>☐</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature range</td>
<td>☐</td>
</tr>
</tbody>
</table>

### 1.2 Temperature change

- ☐ often
- ☐ middle
- ☐ rarely
- ☐ min.
- ☐ max.

### 1.3 Medium

<table>
<thead>
<tr>
<th>Nominal pressure</th>
<th>☐</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating pressure</td>
<td>☐</td>
</tr>
</tbody>
</table>

### 1.4 Pressure

| Flow rate | ☐ |
| Vibration | ☐ |
| Miscellaneous | ☐ |

## IV. Environmental Conditions

| Ambient temperatures [°C] | ☐ |
| Air humidity [% RH] | ☐ |
| Electrical interferences | ☐ existing ☐ not existing |
V. Thermocouple Configuration

1. **Temperature Sensor**
   - 1.1 Tolerance
   - 1.2 Configuration
   - 1.3 IP rating

2. **Protective Housing**
   - 2.1 Protective tube
   - 2.2 Mounting details
   - 2.3 Extension / holding tube
   - 2.4 Insertion / nom. length

3. **Material Certificates**

4. **Connection**
   - 4.1 Connection head / box
   - 4.2 Cable / lead
   - 4.3 Transmitter
   - 4.4 Others

5. **Test, Certificates**

6. **Accessories**

7. **Add. Requirements**

VI. Additional Information

1. Competition

2. Target price

3. Quantity _____________ Monthly _______ Annually _______ Once _________

4. Requested delivery date

5. Packing instruction

Remarks, sketch, plan of installation, photographs (on a separate page, if necessary)
<table>
<thead>
<tr>
<th>Themocouple Type</th>
<th>Designation</th>
<th>Positive (+)</th>
<th>Negative (-)</th>
<th>Sheath</th>
<th>Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>NiCr-Ni</td>
<td>K</td>
<td>green</td>
<td>white</td>
<td>green</td>
<td>DIN EN 60584-3</td>
</tr>
<tr>
<td>Fe-CuNi</td>
<td>J</td>
<td>black</td>
<td>white</td>
<td>black</td>
<td>DIN EN 60584-3</td>
</tr>
<tr>
<td>Cu-CuNi</td>
<td>T</td>
<td>brown</td>
<td>white</td>
<td>brown</td>
<td>DIN EN 60584-3</td>
</tr>
<tr>
<td>NiCr-CuNi</td>
<td>E</td>
<td>violet</td>
<td>white</td>
<td>violet</td>
<td>DIN EN 60584-3</td>
</tr>
<tr>
<td>PtRh13%-Pt</td>
<td>R</td>
<td>orange</td>
<td>white</td>
<td>orange</td>
<td>DIN EN 60584-3</td>
</tr>
<tr>
<td>PtRh10%-Pt</td>
<td>S</td>
<td>orange</td>
<td>white</td>
<td>orange</td>
<td>DIN EN 60584-3</td>
</tr>
<tr>
<td>PtRh70%-PtRh6%</td>
<td>B</td>
<td>grey</td>
<td>white</td>
<td>grey</td>
<td>DIN 43722</td>
</tr>
<tr>
<td>NiCrSi-NiSi</td>
<td>N</td>
<td>pink</td>
<td>white</td>
<td>pink</td>
<td>DIN 43722</td>
</tr>
<tr>
<td>NiCr-Ni</td>
<td>K</td>
<td>red</td>
<td>green</td>
<td>green</td>
<td>DIN 43714</td>
</tr>
<tr>
<td>Fe-CuNi</td>
<td>L</td>
<td>red</td>
<td>blue</td>
<td>blue</td>
<td>DIN 43714</td>
</tr>
<tr>
<td>Cu-CuNi</td>
<td>U</td>
<td>red</td>
<td>brown</td>
<td>brown</td>
<td>DIN 43714</td>
</tr>
<tr>
<td>PtRh13%-Pt</td>
<td>R</td>
<td>red</td>
<td>white</td>
<td>white</td>
<td>DIN 43714</td>
</tr>
<tr>
<td>PtRh10%-Pt</td>
<td>S</td>
<td>red</td>
<td>white</td>
<td>white</td>
<td>DIN 43714</td>
</tr>
<tr>
<td>PtRh70%-PtRh6%</td>
<td>B</td>
<td>red</td>
<td>grey</td>
<td>grey</td>
<td>DIN 43714</td>
</tr>
</tbody>
</table>

**Note**
For the outer insulation of glass fibre or steel wire braiding, the colour coding is to be effected with a coloured tracer acc. to DIN EN 60584-3 standards, and the colour of the positive leg.