

DATA SHEET

Mineral insulated thermocouples



Description



Typical areas of application

- Heating, air conditioning and ventilation systems
- Cooling technology
- Furnace construction
- Apparatus engineering
- Machinery and plant engineering

Features

In a mineral insulated thermocouple, the thermocouple wires of the selected thermocouple type lie in a metallic tube (sheath) and are insulated from each other and against the sheath with highly compressed ceramic powder. Due to the manufacturing process, these mineral insulated thermocouple cables can be bent down to a bending radius of up to 5 times the sheath diameter. Due to the mineral insulation, the operating conditions of mineral insulated thermocouples are only limited by the thermocouple types themselves and the material of the sheath. For example, a mineral insulated thermocouple (MITC) type K with an inconel 600 sheath of diameter 3.0 mm can be operated up to 1200 °C. Available diameters for MITCs are 0.5 mm, 1.0 mm, 1.5 mm, 2.0 mm, 3.0 mm, 4.5 mm and 6.0 mm. Other customer-specific diameters are available on request. MITCs can be assembled on the connection side either with a directly connected connector or with a thermocouple extension or compensation cable. The connector contacts and wires of the thermocouple extension cables are generally made of thermocouple material, i.e. the same alloys as the thermocouple. Compensation cables use cores made of substitute alloys which have similar thermoelectric properties to the thermocouple alloys.

Types of thermocouples

B+B Thermo-Technik GmbH supplies all thermocouple types standardized according to the international standard DIN EN60584.

Designations, alloys and operating temperatures are listed in the following table:

| Type | (+) Wire | Composition | (-) Wire | Composition | Measuring range |
|------|-----------|-----------------------------------|----------|-----------------------------|-----------------|
| J | Fe JP | >99,5% Fe | CuNi JN | 55% Cu, 45% Ni | -210...+1200 °C |
| K | NiCr KP | 89% Ni, 9,5% Cr, 0,5% Si, 0,5% Fe | NiAl KN | 95% Ni, 2% Al, 1% Si, 2% Mg | -270...+1370 °C |
| N | NiCrSi NP | 84% Ni, 14,5% Cr, 1,5% Si | NiSi NN | 95,5% Ni, 4,5% Si | -200...+1200 °C |
| E | NiCr EP | 89% Ni, 9,5% Cr, 0,5% Si, 0,5% Fe | CuNi EN | 55% Cu, 45% Ni | -270...+1000 °C |
| T | Cu TP | >99,5% Cu | CuNi TN | 55% Cu, 45% Ni | -270...+400 °C |
| S | Pt10Rh SP | 90% Pt, 10% Rh | Pt SN | 100% Pt | -50...+1768 °C |
| R | Pt13Rh RP | 87% Pt, 13% Rh | Pt RN | 100% Pt | -50...+1768 °C |
| B | Pt30Rh BP | 70,4% Pt, 29,6% Rh | Pt6Rh BN | 95,5% Pt, 6,1% Rh | 0...+1820 °C |

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Accuracy classes

All thermocouples supplied by B+B Thermo-Technik GmbH comply with the accuracy class 1 of the DIN EN60584 standard, unless explicitly stated otherwise. The permissible deviations according to this class and the range of validity for the different thermocouple types are listed in the following table:

| Type | Class 1 | Scope of validity | Class 2 | Scope of validity |
|-------|--------------------------|-------------------|---------------------------|-------------------|
| J | ±1,5 % or ±0,004 x T | -40...+750 °C | ±2,5 % or ±0,0075 x T | -40...+750 °C |
| K | | -40...+1000 °C | | -40...+1200 °C |
| N | | -40...+1000 °C | | -40...+1200 °C |
| E | | -40...+800 °C | | -40...+900 °C |
| T | ±0,5 °C or ±0,004 x T | -40...+350 °C | ±1 °C or ±0,0075 x T | -40...+350 °C |
| S / R | ±1 °C | 0...+1100 °C | ±1,5 °C | 0...+600 °C |
| | ±(1+0,003x(T-1100)) °C | +1100...+1600 °C | ±0,0025 x T | +600...+1600 °C |
| B | - | - | ±0,0025 x T | +600...+1700 °C |

Standards for mineral insulated thermocouples and mineral insulated cables

The minimum technical requirements for mineral insulated thermocouples and cables, such as the diameter of the conductors as a function of the outer diameter and the number of conductors, the thickness of the sheath, the insulation resistance and the dielectric strength, are laid down in the DIN EN61515 standard. Insulation resistance in particular should be emphasized here. This is due to the strong hygroscopic properties of the insulation material (ceramic powder). If the mineral insulated cable is stored incorrectly or the thermocouples are not properly sealed during manufacture, the insulation material will absorb water from the air. This leads to a strong sinking of the insulation conductor - conductor and conductor - sheath. This can lead to a large error in the measurement and even to the explosion of the thermocouple at fast and high temperature cycles, as is the case in combustion engines, for example. The following table shows the minimum values for insulation resistance at room temperature.

| MTE outer diameter | Test voltage | Minimum insulation resistance |
|--------------------|--------------|-------------------------------|
| 0,5...1,6 mm | 100 VDC | 20 MΩ |
| 1,6 mm < D | 500 VDC | 100 MΩ |

For thermocouples with a nominal length greater than 10 meters, the required minimum insulation resistance must be coordinated and agreed between the manufacturer and the user.

Sheath materials

In addition to the thermocouple type, mineral insulated thermocouples are also restricted in their operating conditions by the sheath materials that are being used, e.g. the max. temperature. The most common sheath materials for MITCs are listed in the following table together with a few properties. The specified maximum operating temperatures generally apply to diameters from 3 mm and higher. The maximum temperature is greatly reduced for smaller diameters. For example, the maximum application temperature of Inconel 600 with a diameter of 0.5 mm is 800 °C instead of 1200 °C. In addition, the composition of the atmospheres / media to be measured plays a very important role in the service life of the MITC, especially at high temperatures.

| Material | Max. operating temperature | Features and areas of application |
|----------------------|----------------------------|---|
| 1.4541 (AISI321) | 800 °C | Corrosion and oxidation resistant. Reactors, chemical equipment, furnaces, petrochemicals, paper and textile industry, soaps, oils, steam, combustion gases |
| 1.4571 (AISI 316Ti) | 800 °C | Increased corrosion resistance. Reactors, chemical equipment, ovens, pharmaceutical and food industry, resistant to pitting and salt water |
| 1.4841 (AISI 314) | 1200 °C | Corrosion and oxidation resistant at high temperatures. Carbon and sulphur atmospheres, blast furnaces, brick and glass production, petrochemical industry, furnace construction |
| 1.4845 (AISI 310 S) | 1150 °C | Resistant to oxidation and sulphidization. Cyanide and neutral molten salts, blast furnaces, steam generators, cement, brick and glass production, petrochemicals, furnace construction |
| 2.4816 (Inconel 600) | 1200 °C | Corrosion and oxidation resistant. Nuclear power plants, reactors, chemical equipment, furnaces, petrochemicals, paper and textile industry, soaps, oils, steam, pharmaceutical and food industry |
| 2.4851 (Inconel 601) | 1200 °C | Resistant to corrosion, oxidation, sulphidization and carburization. Chemical and petrochemical industry, combustion gases, aerospace, blast furnaces, furnace construction, environment, reactors, ... |

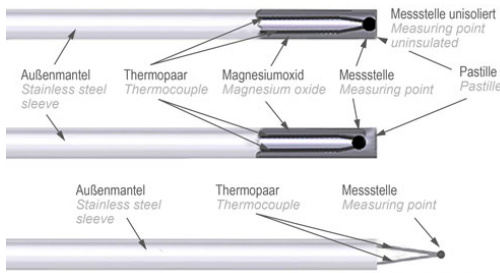
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Construction types

In the standard case and if it is not explicitly mentioned, the hot junction of mineral insulated thermocouples is insulated against the sheath. In special cases, the hot junction can be welded to the sheath (grounded). This leads to a much smaller response time than with the standard insulated variant. In other cases, the application requires an open hot junction.



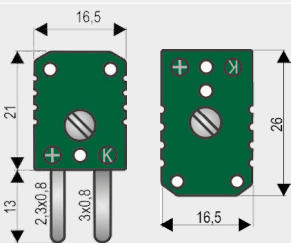
Confection

Mineral insulated thermocouples can be assembled with a directly connected connector, thermocouple extension or compensation cable or as measuring inserts in head probes. The most commonly used connectors are plugs and sockets (miniature and standard connectors), which are standardized in accordance with DIN EN50212, and Lemo connectors.

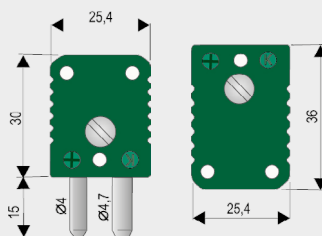
Thermocouple compensation and extension cables are standardized according to the international standard DIN EN60584-3. The insulation materials for both connectors and cables are not specified in the regulating standards.

B+B Thermo-Technik GmbH supplies thermocouple connectors in plastic housings up to 220 °C and ceramic housings up to 600 °C temperature resistance.

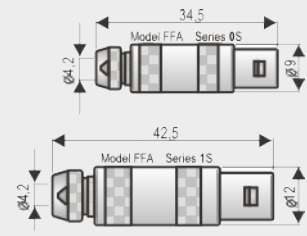
Miniature connectors



Standard connectors



Lemo connectors



The thermocouple compensation and extension cables from B+B Thermo-Technik GmbH can be adapted to application requirements from PVC-insulated (T_{max} 105 °C) to ceramic fiber textiles (T_{max} 1400 °C). The following table lists the different possible and available insulation materials for cables and their areas of application:

| Name | Abbreviation | Temperature range |
|--------------------------|----------------|-------------------|
| Polyvinyl chloride | PVC | -10 °C .. 105 °C |
| Polyurethanes | PUR | -5 °C .. +70 °C |
| Thermoplastic polyethers | TPE | -40 °C .. +130 °C |
| Silicone | SIL | -50 .. 180 °C |
| Fluoroethylene propylene | FEP (Teflon®) | -100 °C .. 205 °C |
| Polytetrafluoroethylene | PTFE (Teflon®) | -190 °C .. 260 °C |
| Perfluoroalkoxylalkane | PFA (Teflon®) | -190 °C .. 260 °C |
| E-glass silk | GLS | -40 .. 350 °C |
| R-glass silk | R-GLS | -40 .. 600 °C |
| Quartz glass silk | Q-GLS | -40 .. 1000 °C |
| Ceramic fiber silk | KERF | up to 1400 °C |

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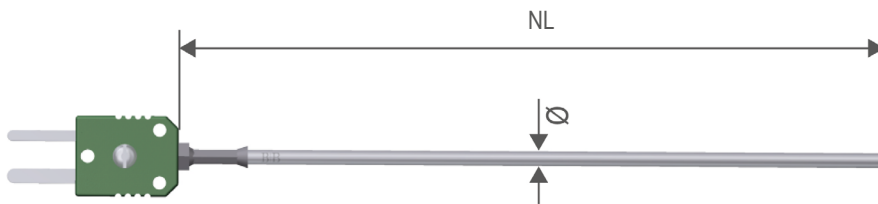


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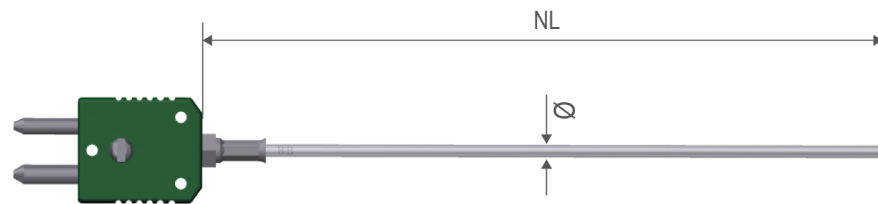
Open ends:



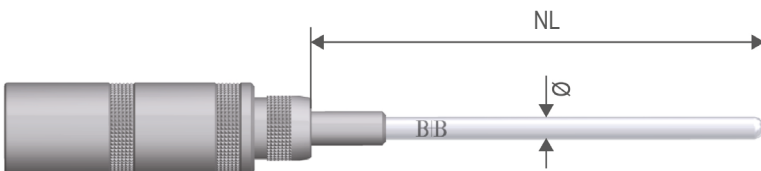
Miniature connector:



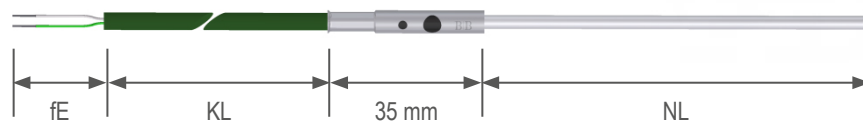
Standard connector:



Lemo connector:



Silicone cable:



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Mineral insulated thermocouples



B+B Thermo-Technik GmbH offers prefabricated mineral insulated thermocouples (from stock) in the following types: Free ends, with miniature, standard or Lemo plug and with connected compensation cable. All standard versions are with insulated hot junction. The technical specifications of these MITCs offered from stock are summarized in the following table:

| Specifications | | | |
|------------------------|---|-------------------|------------------------------------|
| Thermoelement Type | Type K (NiCr-Ni) | | Type J (Fe-CuNi) |
| Sheath material | Inconel 600 (2.4816) | | Stainless steel 1.4541 |
| MITC diameter | 1 mm, 1,5 mm, 3,0 mm, 6,0 mm | | |
| MITC nominal length | 50 mm, 100 mm, 250 mm, 500 mm and 1000 mm | | |
| Confection form | Open ends, miniature connector, standard connector, Lemo connector or with compensation cable | | |
| Connector | | | |
| Size | Miniature | Standard | Lemo 1S |
| Type | B+B Miniature plug | B+B Standard plug | PCA, 1S.302.CLL |
| Connector housing | PA6-GF-30 | PA6-GF-30 | Chrome-plated brass |
| Temperature resistance | 180 °C | 180 °C | 250 °C |
| Connection cable | | MTE Type K | MTE Type J |
| Type | Compensation cable KCA | | Extension cable JX |
| Core cross-section | 2 x 0,22 mm ² (AWG24/7) | | 2 x 0,22 mm ² (AWG24/7) |
| Core insulation | FEP (205 °C) | | GLS (350 °C) |
| Sheath | SIL (180 °C) | | GLS (350 °C) |
| Shielding | None | | V2A mesh, outside |
| Cable length | 2000 mm | | 3000 mm |
| Connection | Open ends 50 mm | | Open ends 50 mm |

| Order details standard | | | | | | | |
|------------------------|-------|---|-----------------|----------------|---------|----------|--------|
| TE Type | | Confection | | Nominal length | | Diameter | |
| K- | Typ K | 363 | Open ends 15 mm | 0050 - | 50 mm | 10 | 1,0 mm |
| J- | Typ J | M625 | Miniature plug | 0100 - | 100 mm | 15 | 1,5 mm |
| | | S625 | Standard plug | 0250 - | 250 mm | 30 | 3,0 mm |
| | | L625 | Lemo connector | 0500 - | 500 mm | 60 | 6,0 mm |
| | | H625 | Cable | 1000 - | 1000 mm | | |
| Example: | | K-M625 0250-30 | | | | | |
| | | Thermocouple type K, with connected miniature connector, NL 250 mm, D3.0 mm | | | | | |

