Cryogenic thermometer

Applications

- Extremely-low temperature measurements
- Applications with liquid hydrogen (LH_2)
- Cryogenic tanks
- Cryogenic pipelines
- Hydrogen liquefaction plants

Special features

- Innovative design with high accuracy
- Usable with all relevant thermometers
- Approved for applications in hazardous areas

Thermometer in cryo design

Description

Due to the global use of hydrogen, extremely low-temperature measurement during transport and storage is gaining an ever-greater relevance. With the cryo design, WIKA provides a suitable option for all relevant temperature measuring instruments for this demanding application.

In laboratory trials, resistance thermometers (Pt1000) and thermocouples (type E) were tested for their suitability in cryogenic applications. The special design of the cryogenic thermometer features a high accuracy of ±3 Kelvin at -253 °C [-423 °F] as well as high reproducibility.

The test data from laboratory investigations served as the basis for calculating new polynomials for Pt1000 resistance thermometers in the range of -258 ... -200 °C [-432 ... -328 °F] which are used in the configuration of WIKA transmitters.

Thermometers suitable for cryo design

For detailed information on the individual thermometers – explosion protection in particular – see the data sheets:

Thermometer description	RTD	Data sheet	TC	Data sheet
For additional thermowell	TR10-B	TE 60.02	TC10-B	TE 65.02
Process version	TR12-B	TE 60.17	TC12-B	TE 65.17
Cable thermometers	TR40	TE 60.40	TC40	TE 65.40
Threaded thermometer	TR10-C	TE 60.03	TC10-C	TE 65.03
Flanged resistance thermometer	TR10-F	TE 60.06	TC10-F	TE 65.06
Operation without thermowell	TR10-H	TE 60.08	TC10-H	TE 65.08

→ Further thermometer versions in cryo design on request

Construction of the cryo design

Resistance thermometers

In sheathed resistance thermometers the flexible part of the probe consists of a mineral-insulated metal-sheathed cable (MIMS cable). It features a stainless steel outer sheath, which contains the insulated internal leads, embedded within a high-density ceramic compound. The measuring resistor is connected directly to the internal leads of the sheathed cable.

The graphic shows the construction of a standard probe.

The cryo design is different to standard versions through the special construction of the probe tip and a special measuring resistor.

Resistance thermometers in cryo design have very low self-heating due to the low resistance values at working temperatures of less than -196 °C [-320.4 °F]. When using a WIKA transmitter, the self-heating is generally much smaller than the heating of the sensor due to heat transfer from the environment.

Thermocouples

In sheathed thermocouples the flexible part of the probe consists of a mineral-insulated metal-sheathed cable (MIMS cable). It features a metal outer sheath, which contains the insulated internal leads, embedded within a high-density ceramic compound. Sheathed thermocouples, due to their flexibility and the small diameters that are possible, can be used in areas that are difficult to access.

The graphic shows the construction of a standard probe.

The cryo design is different to standard versions through the special construction of the probe tip.

Self-heating can be ruled out due to the measurement principle.

Definition of the term “cryogenic”

Depending on the gas used, the term “cryogenic” is used at different temperatures. For most cryogenic gases, standard resistance thermometers and thermocouples can be used for temperature measurement, as the negative measuring range is sufficient. Liquid hydrogen is the exception here.

Oxygen: -182.9 °C [-297.3 °F]
Argon: -185.8 °C [-302.4 °F]
Nitrogen: -195.8 °C [-320.4 °F]
Hydrogen: -252.9 °C [-423.2 °F]

Sensor

Measuring element		
Connection method		
Single element	■ Pt1000, 1 x 4-wire ■ Thermocouple type E	
Validity limits of the class accuracy in accordance with EN 60751		
Pt1000	±3 K [1]	-253 ... -200 °C [-423 ... -328 °F]
	Class B	-200 ... +50 °C [-432 ... +122 °F] [2]
Validity limits of the class accuracy in accordance with IEC 60584-1		
Type E	±3 K [1]	-253 ... -200 °C [-423 ... -328 °F]
	Class 2	-200 ... -40 °C [-328 ... -40 °F]
	Class 1	-40 ... +250 °C [-40 ... +482 °F]

1) Only in combination with a suitable temperature transmitter (model T32 or T38).
2) Measuring range to 250 °C [482 °F] on request

Measuring insert

Thin-film measuring resistor Pt1000 [1]

Diameter ⌀ d in mm [in]	Index per DIN 43735	Tolerance in mm	Sheath material	
			Standard design	Recessed soldering lugs
3 [0.12]	-	$3\ ^{0}_{-0,5}$	Stainless steel 1.4571	Stainless steel 1.4571
6 [0.24]	60	$6\ ^{0}_{-0,1}$	■ Stainless steel 1.4571 ■ Stainless steel 316 L	Stainless steel 1.4571
6 [0.24 in] (with sleeve)	-	$6\ ^{0}_{-0,1}$	Stainless steel 1.4571	Stainless steel 1.4571
8 [0.31]	-	$8\ ^{0}_{-0,1}$	Stainless steel 1.4571	Stainless steel 1.4571

1) Bendable from 50 mm [1.97 in] of measuring insert length

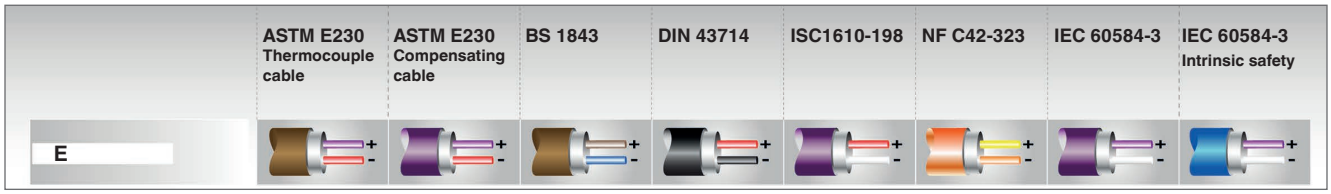
Sheathed thermocouple type E

Measuring insert diameter ⌀ d in mm [in]	Index per DIN 43735	Tolerance in mm	Sheath material
1.5 [0.06]	-	1.5 ±1%	Stainless steel: 1.4571
3 [0.12]	30	$3\ ^{0}_{-0.5}$	Ni alloy: Alloy 600
6 [0.24]	60	$6\ ^{0}_{-0.1}$	
6 [0.24] (with sleeve)	-	$8\ ^{0}_{-0.1}$	Ni alloy: Alloy 600
8 [0.31]	80	$8\ ^{0}_{-0.1}$	Ni alloy: Alloy 600

Thermocouple cable

To bridge the distance between thermocouple and evaluation instrumentation, special connection cables must be used with thermocouples. The internal leads of the thermocouple cable are manufactured from the original material of the type E thermocouple and are used for thermometers in cryo design with accuracy class 1. It should be noted that the potential errors of thermocouple and connection lead add to each other.

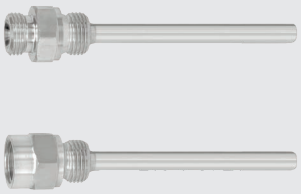
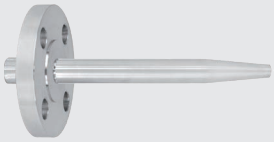
Colour code of thermocouple cable and compensating cable



Transmitter

For applications down to -258 °C [-432 °F], the T32 or T38 digital temperature transmitter with HART® protocol can be used in head-mounted and rail-mounted versions. The upper end of the measuring range of 50 °C [122 °F] when using the Pt1000 was defined to enable the best possible measurement accuracy, due to the available number of characteristic curve programmable points. On customer request, the transmitter measuring range can be extended up to 250 °C [482 °F].

Thermowell selection

Thermowell selection		
Model	**Data sheet**	**Illustration**
TW10	TW 95.10	
TW15	TW 95.15	
TW20	TW 95.20	
TW25	TW 95.25	
TW30	TW 95.30	
TW45	TW 95.45	
TW50	TW 95.50	
TW55	TW 95.55	

→ Special thermowells on request

Thermowell materials

For cryogenic applications, we recommend using austenitic stainless steels such as 1.4571, 316/316L and nickel-based materials. Welding procedure tests for standard ranges of use are available. In cryogenic areas, explicit proof of capability is unusual.

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