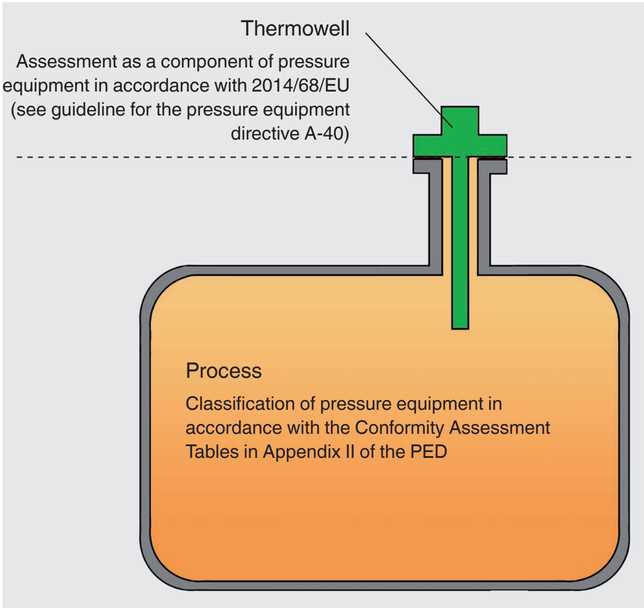
Pressure equipment directive 2014/68/EU (PED) in reference to thermowells

The following, among others, is defined in the 2014/68/EU Pressure equipment directive (PED) of the European Parliament and Council of 15 May 2014 on the harmonisation of the laws of the member states relating to the making available on the market of pressure equipment:
From 30th May 2002 onwards, all pressure measuring instruments placed onto the market in the EU with a maximum permissible pressure (PS) greater than 0.5 bar must comply with the PED. The applicability of the 2014/68/EU Pressure equipment directive in reference to thermowells is explained below.

In thermowells there is neither a fluid under pressure, nor is there any fluid transported within. Thermowells therefore are not "pressure-containing equipment" within the meaning of the Pressure equipment directive (see guideline for the pressure equipment directive A-40). The exception is for thermowells suitable for inline mounting in pipes, such as models TW61, TR25.

Thermowells are components within pressure equipment in accordance with the PED (guideline A-40). As such a component, it does not comply with the definition for pressure equipment in article 2 (1) of the PED and does not have to be marked with CE (see guideline A-22).



WIKA thermowells are designed and manufactured in compliance with "good engineering practice".

This is achieved, for example, by:

- Basic layout of the thermowell design from standard thermowells in accordance with national or international standards, such as DIN 43772
- Approval to AD2000 HP0 und DIN EN ISO 3834-2
- TÜV approved welding procedure tests to AD2000 HP2/1 (EN 288-3 / ISO 15614/1) or ASME sec. IX
- Certified welders
- Mill certificates to EN 10204
- Hydrostatic pressure testing with 1.5 x PN or to customer specification.
- Non-destructive testing by authorised personnel, such as dye penetrant testing, ultrasonic testing of the bore concentricity or wall thickness, PMI (positive material identification), X-ray tests, helium leak testing
- Thermowell strength calculations in accordance with ASME PTC 19.3 TW-2016 or Dittrich/Klotter
- Development and manufacturing certified in accordance with ISO 9001 QM system

Some of the above tests/certifications are conducted optionally on customer request.

09/2016 EN

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Temperature sensors, connection designs and thermowells for mechanical and mechatronic expansion thermometers

WIKA data sheet IN 00.20

Applications

- Determining the temperature sensor design
- Determining the required minimum length
- For all expansion thermometers

Versions

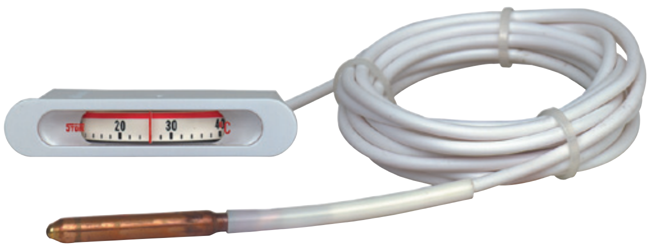
- Plain design
- Designs with screw connections
- Designs with thermowells

Description

Temperature sensors
The various temperature sensors can be combined with all expansion thermometers. They differ from each other with their various connection designs and wetted parts.
In addition to the standard designs, there are also special solutions for the widest variety of measuring point constructions.
The respective minimum required stem length, ET, for the various designs and display ranges are presented in a table.

Thermowells
The fast-response designs, in order to optimise the response characteristics, have both a reduced wall thickness and a minimised air gap between the thermowell inner wall and the fitted temperature sensor.

SB15 safety temperature limiter with an SF91/SV20 temperature sensor



Expansion thermometer model TF59 with a plain SF94 temperature sensor

Part of your business

Connection design

Connection rotatable with sealing cone, SF91/SV20

Available for models IFC, SB-, SC-, SW15 and TF58/59 expansion thermometers

Model SF91 temperature sensor

Process connection
G = G ¼ B; G ⅜ B; G ½ B; M14 x 1.5

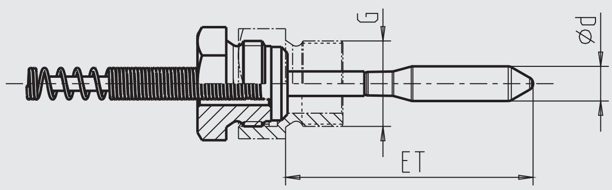
Stem diameter
D = 5; 6; 8; 8.5; 10 mm

Stem material
Brass (2.0401); Copper (Cu)
1.4571 stainless steel

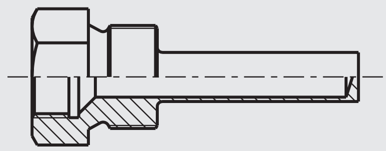
Fitting
Brass (2.0401)

Length is automatically determined from the required control volume for the respective measuring range
For minimum sensor length, ET, see tables on page 3

Model SF91 temperature sensor



Model SH16 thermowell



Model SH16 thermowell

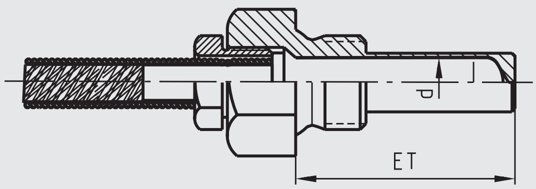
Process connection
G = G ⅜ B; G ½ B (for others see page 9)

Material
Brass (2.0401)
1.4571 stainless steel

Standard lengths
40, 50, 75, 80, 100, 150 mm

Immersion depth, ET = variable up to ET 80 mm one-piece, from 100 mm two-piece, soldered or welded
Immersion depth, ET = variable

Model SF91 temperature sensor with model SH16 thermowell



Connection rotatable with sealing cone, SF91/SV19

Available for models IFC, SB-, SC-, SW15 and TF58/59 expansion thermometers

Model SF91 temperature sensor

Process connection
G = G ¼ B; G ⅜ B; G ½ B; G ¾ B; G 1 B;
M14 x 1.5; M16 x 1.5; M18 x 1.5;

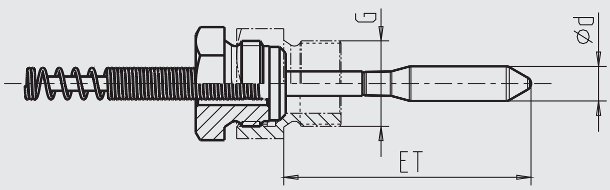
SV19 fitting
Brass (2.0401)
Stainless steel

Stem diameter
D = 5; 6; 8; 8.5; 10 mm

Stem material
Brass (2.0401)
Copper (Cu)
1.4571 stainless steel

Immersion depth, ET = variable
Length is automatically determined from the required control volume for the respective measuring range

Model SF91 temperature sensor



Model	Material	Sensor diameter in mm	Applicable for model	Minimum sensor length = ET min. X mm								
			Scale range in °C	-40 ... +40 0 ... 80	0 ... 40	0 ... 120	50 ... 150 50 ... 200	0 ... 200	0 ... 250	0 ... 300	0 ... 350	50 ... 250
SF91 SV20	Copper (Cu) BR (2.0401)	5	IFC SB15 SC15 SW15	250	-	200	150	100	100	100	50	100
		6		150	300	100	100	70	100	100	50	100
		8		100	150	50	50	50	50	50	50	50
		8.5		100	100	50	40	35	35	30	25	35
		10		70	100	50	50	50	40	50	50	40
	Stainless steel	6		250	-	200	150	100	100	100	50	100
		8		150	300	100	100	70	50	50	50	50
		10		50	150	50	50	50	50	50	50	50

Plain stem (without thread), SF94

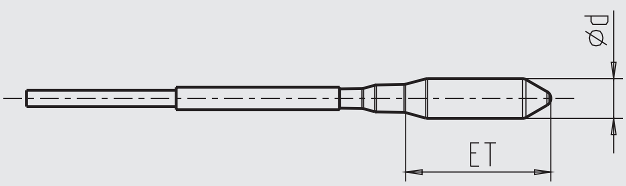
Available for models IFC, MFT, SB-, SC-, SW15 and TF58/59 expansion thermometers

Model SF94 temperature sensor

Stem diameter
D = 6; 8; 8.5; 10 mm

Immersion depth, ET = variable
Length is automatically determined from the required control volume for the respective measuring range
For minimum sensor length, ET, see table

Model SF94 plain temperature sensor



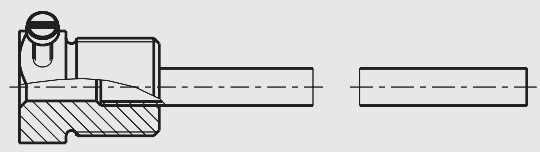
Model SH22 thermowell

Process connection
G = G ¼ B, G ⅜ B; G ½ B

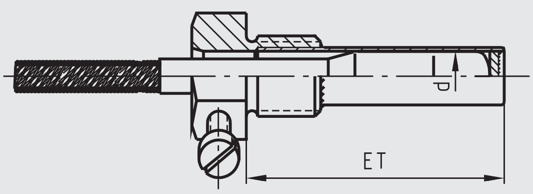
Standard lengths
50, 70, 100, 150 mm (for others see page 9)

Immersion depth ET = variable up to ET 80 mm one-piece, from 100 mm two-piece, soldered or welded

Model SH22 thermowell



Model SF94 temperature sensor with model SH22 thermowell



Model	Material	Sensor diameter in mm	Applicable for model	Minimum sensor length = ET min. X mm								
			Scale range in °C	-40 ... +40 0 ... 80	0 ... 40	0 ... 120	50 ... 150 50 ... 200	0 ... 200	0 ... 250	0 ... 300	0 ... 350	50 ... 250
SF94	Copper (Cu) BR (2.0401)	6	TF 58 TF 59 MFT	150	250	100	100	50	100	50	50	100
		8.5		80	-	65	60	60	60	60	55	70
		6	IFC SB15 SC15 SW15	150	300	100	100	70	100	100	50	100
		8		100	150	50	50	50	50	50	50	50
		8.5		100	100	50	40	35	35	30	25	35
		10		70	100	50	50	50	40	50	50	40
	Stainless steel	6		250	-	200	150	100	100	100	50	100
		8		150	300	100	100	70	50	50	50	50
		10		50	150	50	50	50	50	50	50	50

Connection rotatable with compression spring and fitting, SF95

Available for models IFC, SC15 and TF58/59 expansion thermometers

Model SF95 temperature sensor

Process connection
M10 x 1

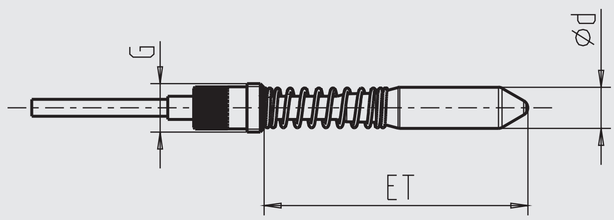
Fitting
Brass (2.0401)

Stem diameter
D = 8.5 mm

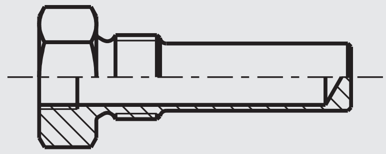
Stem material
Brass (2.0401)
Copper (Cu)
1.4571 stainless steel >300 °C

Immersion depth, ET = variable
Length is automatically determined from the required control volume for the respective measuring range

Model SF95 temperature sensor



Model SB18 thermowell



Model SB18 thermowell

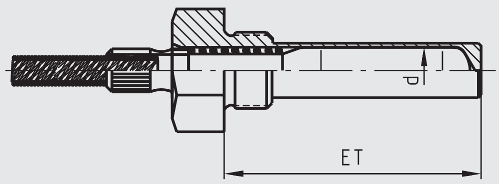
Process connection
G = G ¼ B, G ⅜ B, G ½ B

Material
Brass (2.0401)
1.4571 stainless steel

Standard lengths
29, 32, 45, 75, 100, 150 mm (for others see page 9)

Immersion depth, ET = variable up to ET 80 mm one-piece, from 100 mm two-piece, soldered or welded

Model SF95 temperature sensor with model SB18 thermowell



Model	Material	Sensor diameter in mm	Appli-cable for model	Minimum sensor length = ET min. X mm								
			Scale range in °C	-40 ... +40 0 ... 80	0 ... 40	0 ... 120	50 ... 150 50 ... 200	0 ... 200	0 ... 250	0 ... 300	0 ... 350	50 ... 250
SF95	Brass	8.5		65	120	50	50	35	35	30	30	35

Connection rotatable with straight sealing ring, SF96/SV20

(identical to BF2)

Available for models IFC, SC15, SB15 and SW15 expansion thermometers

Model SF96 temperature sensor

Process connection
G = G ¼ B; G ⅜ B; G ½ B; G ¾ B; M14 x 1

SV20 fitting
Brass (2.0401)
Stainless steel

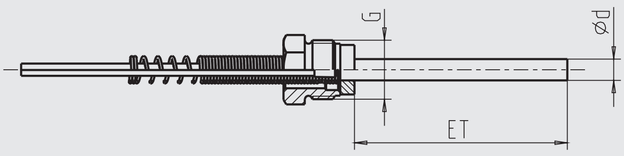
Stem diameter
D = 5; 6; 8; 10 mm

Stem material
Brass (2.0401)
Copper (Cu)
1.4571 stainless steel

Standard lengths l1 (ET)
80, 140, 180, 230 mm, consistent with thermowells in accordance with DIN 16179 Form BD, BE, BS

Immersion depth, ET = variable
Length is automatically determined from the required control volume for the respective measuring range

Model SF96 temperature sensor



Model	Material	Sensor diameter in mm	Applicable for model	Minimum sensor length = ET min. X mm								
			Scale range in °C	-40 ... +40 0 ... 80	0 ... 40	0 ... 120	50 ... 150 50 ... 200	0 ... 200	0 ... 250	0 ... 300	0 ... 350	50 ... 250
SF96	Brass Copper (Cu)	6	IFC SB15 SC15 SW15	150	300	100	100	70	100	100	50	100
		8		100	150	50	50	50	50	50	50	50
		10		70	100	50	50	50	40	50	50	40
	Stainless steel	6		250	-	200	150	100	100	100	50	100
		8		150	300	100	100	70	50	50	50	50
		10		50	150	50	50	50	50	50	50	50

Connection with union nut, SF97/SV21

(similar to Form 3, union nut)

Available for models IFC, SB-, SC-, SW15 expansion thermometers

Model SF97 temperature sensor

Process connection

G = G ¼ B; G ⅜ B; G ½ B; G ¾ B; G 1 B;
M12 x 1; M14 x 1.5; M18 x 1.5

SV21 fitting

Brass (2.0401)
Stainless steel

Stem diameter

D = 6, 8, 10 mm

Stem material

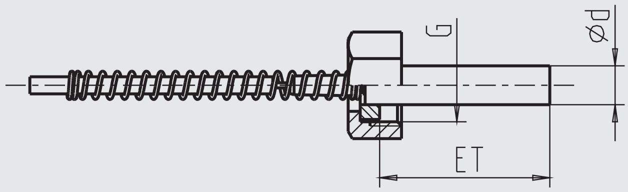
Brass (2.0401)
Copper (Cu)
1.4571 stainless steel

Standard lengths l1 (ET)

89, 126, 186, 226, 276 mm consistent with thermowells in accordance with DIN 16179 Form CD, CE, CS

Immersion depth ET = variable from minimum length (active part to the end of the stem extension)

Model SF97 temperature sensor



Model	Material	Sensor diameter in mm	Applicable for model	Minimum sensor length = ET min. X mm								
			Scale range in °C	-40 ... +40 0 ... 80	0 ... 40	0 ... 120	50 ... 150 50 ... 200	0 ... 200	0 ... 250	0 ... 300	0 ... 350	50 ... 250
SF97	Brass Copper (Cu)	6		150	300	100	100	70	100	100	50	100
		8		100	150	50	50	50	50	50	50	50
		10		70	100	50	50	50	40	50	50	40
	Stainless steel	6		250	-	200	150	100	100	100	50	100
		8		150	300	100	100	70	50	50	50	50
		10		50	150	50	50	50	50	50	50	50

Compression fitting sliding along the stem, SF98

(similar to BF4)

Available for models IFC, SB-, SC- and SW15 expansion thermometers

Model SF98 temperature sensor

Process connection

G = G ¼ B; G ⅜ B; G ½ B; G ¾ B; G 1 B;
M12 x 1; M14 x 1.5; M18 x 1.5

SV19 fitting

Brass (2.0401)
Stainless steel

Stem diameter

D = 8.5 mm (extension D = 6 mm)

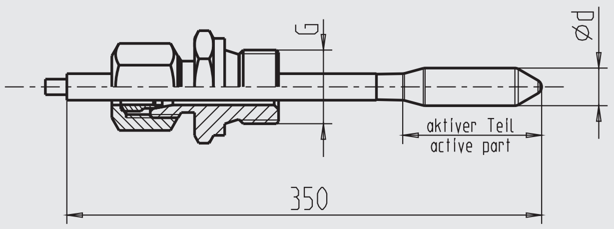
Stem material

Copper (Cu)
1.4571 stainless steel

Stem extension tube

Brass (2.0401)
1.4571 stainless steel

Model SF98 temperature sensor



Immersion depth ET = variable from minimum length (active part to the end of the stem extension)

Model	Material	Sensor diameter in mm	Appli-cable for model	Minimum sensor length = ET min. X mm								
			Scale range in °C	-40 ... +40 0 ... 80	0 ... 40	0 ... 120	50 ... 150 50 ... 200	0 ... 200	0 ... 250	0 ... 300	0 ... 350	50 ... 250
SF98	Brass Copper (Cu)	8.5		50	-	35	26	20	25	20	20	30

Thermowells

In order to eliminate corruption of the display, the temperature sensors which are fitted into the thermowells, are matched. The play between the thermowell drilling and the temperature sensor diameter must not be more than 0.2 mm.
The SF94 and SF95 temperature sensors must touch the bottom of the thermowell. The SF91 temperature sensor must fill the entire thermowell. The spiral at the end of the sensors protects the capillary against buckling. To prevent buckling of the capillary on insertion of sensors with longer immersion depths, ET, the temperature sensor is supplied with an extension tube. In order to prevent corruption of the display, all temperature sensors must be immersed with their complete active part into the medium. The active part extends, for the minimum length, over the entire sensor length.

Lock nuts and washers can be delivered for thermowells mounted in through-holes. For applications for thermowells at pressures over 10 bar with immersion depths over 50 mm, please consult with us.

Ordering example
SH22 thermowell in BR for temperature sensor with 8.5 mm diameter and an immersion depth of 100 mm and G ⅜ B mounting threads for temperatures under 120 °C.

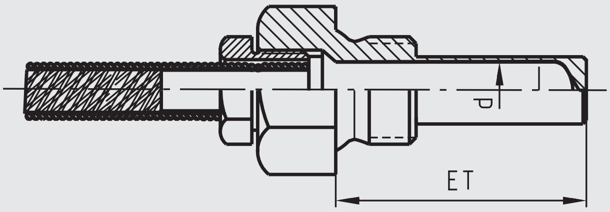
SH22-8.50-ET 100 G ⅜ B-MS-under 120 °C

Thermowells for temperatures under 120 °C are soft soldered.

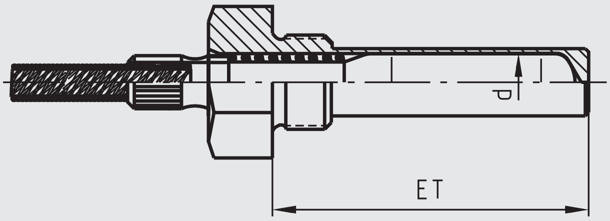
For special purposes V4A, chrome-plated BR and nickel-plated BR thermowells can be supplied.

Model	Mounting threads / process connection							Immersion depth in mm	Probe diameter			
	G ¼ B	G ⅜ B	G ½ B	G ¾ B	M14 x 1.5	M16 x 1.5	M18 x 1.5		6 mm	8 mm	8.5 mm	10 mm
SB18	X	X	X		X	X	X	29			X	
	X	X	X		X		X	32			X	
	X	X	X		X		X	45			X	
		X	X					60			X	
		X	X					75			X	
		X	X					90			X	
			X					100			X	
			X					150			X	
SH16	X	X						40		X	X	
	X	X	X					50	X	X	X	
	X	X						75	X		X	
	X	X	X					80			X	
	X	X	X	X	X	X		100	X	X	X	
	X	X						150	X	X	X	
	X	X						200	X	X	X	
	X	X	X					250		X	X	
SH22	X	X						45	X	X		
	X	X						50	X		X	
	X	X						60	X	X		
		X						75			X	X
	X	X						100	X	X	X	X
	X	X						150	X	X	X	
	X	X	X					200	X	X	X	
	X	X						250	X		X	
	X	X	X					300	X	X	X	

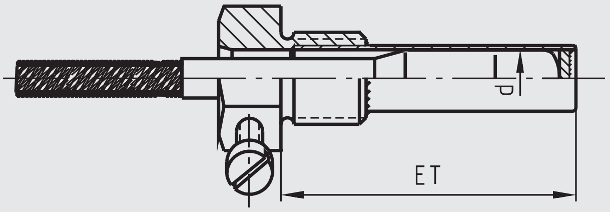
Model SF91 temperature sensor with model SH16 thermowell



Model SF95 temperature sensor with model SB18 thermowell



Model SF94 temperature sensor with model SH22 thermowell



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Mechanical temperature measuring instruments

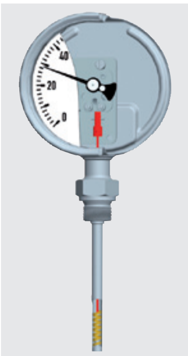
WIKA data sheet IN 00.07

Temperature is an indicator of the thermal condition of a homogenous material or body. It expresses the energy of motion that is contained in the molecules of the material. Transmission of temperature from one body to another, e.g. process medium and thermometric sensor, requires close physical contact between both bodies to achieve thermal equilibrium. Conventional temperature measurement is based on the property of certain materials to alter their physical shape or volume proportional to the temperature applied. The most commonly used principles in the WIKA production are highlighted below.

Bimetal thermometers

Operating principle
The temperature is measured by means of a bimetal system inside the temperature sensor. The bimetal is made from two metal strips, permanently joined together, each metal having a different thermal expansion coefficient. This causes the strip to deflect in proportion to the temperature variation. The actual bimetal system consists of a bimetal strip that is either

- helically or
- spirally



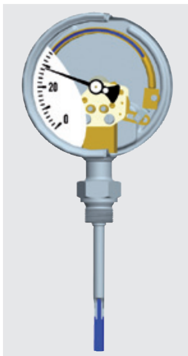
wound, depending on the size of the sensor and the temperature range to be measured. Any temperature variation causes the bimetal to rotate an attached spindle.
This rotation is indicated by a pointer on a dial scale.
WIKA bimetal thermometers are available for temperature ranges from -70 to +600 °C with accuracies complying with Class 1 and 2 of EN 13190.

Expansion thermometers

Operating principle
The temperature is measured by a liquid-filled measuring system consisting of a temperature probe, a capillary and a bourdon tube. These three components form a sealed system. Any temperature variation causes a change in the internal pressure of this system. As a result of this pressure change the shaft and pointer connected to the tube rotate and the temperature value is indicated on the scale. With capillary lengths available between 500 and 10,000 mm, it is also possible to measure temperatures at remote measuring points.
WIKA expansion thermometers are available for temperature ranges from -40 to +400 °C with accuracies complying with Class 1 and 2 of EN 13190.

Gas actuated thermometer with or without capillary

Operating principle
Gas actuated thermometers consist of a stem, a capillary and a case containing the bourdon tube element. These components are connected to form a single system. The complete measuring system is filled with an inert gas under pressure. Any temperature variation causes a change in the internal pressure of the stem, leading to a deflection of the bourdon tube. A mechanical linkage (movement) transmits this deflection to the pointer.



Variations in the ambient temperature acting on the case are compensated for by a bimetal element mounted between the movement and the bourdon tube.
WIKA gas actuated thermometers are available for temperature ranges from -200 to +700 °C with an accuracy complying with Class 1 of EN 13190.

Conversion reference

How to calculate	From K	°C	°F	°R	°Ré
K	x	K= °C + 273.15	K= 5/9 (°F + 459.67)	K= 5/9 °R	K= 5/4 °Ré + 273.15
°C	°C= K - 273.15	x	°C= 5/9 (°F - 32)	°C= 5/9 °R - 273.15	°C= 5/4 °Ré
°F	°F= 9/5 K - 459.67	°F= 9/5 °C + 32	x	°F= °R - 459.67	°F= 9/4 °Ré + 32
°R	°R= 9/5 K	°R= 9/5 °C + 491.68	°R= °F + 459.67	x	°R= 9/4 °Ré + 491.68
°Ré	°Ré= 4/5 K - 218.52	°Ré= 4/5 °C	°Ré= 4/9 (°F - 32)	°Ré= 4/9 °R - 218.52	x

Limit of error in °C

per DIN EN 13190

Applicable for expansion and bimetal dial thermometers

Scale range in °C	Measuring range in °C	Limit of error in ± °C Class 1	Class 2
-20 ... +40	-10 ... +30	1	2
-20 ... +60	-10 ... +50	1	2
-20 ... +120	-10 ... +110	2	4
-30 ... +30	-20 ... +20	1	2
-30 ... +50	-20 ... +40	1	2
-30 ... +70	-20 ... +60	1	2
-40 ... +40	-30 ... +30	1	2
-40 ... +60	-30 ... +50	1	2
-100 ... +60	-80 ... +40	2	4
0 ... 60	10 ... 50	1	2
0 ... 80	10 ... 70	1	2
0 ... 100	10 ... 90	1	2
0 ... 120	10 ... 110	2	4
0 ... 160	20 ... 140	2	4
0 ... 200	20 ... 180	2	4
0 ... 250	30 ... 220	2.5	5
0 ... 300	30 ... 270	5	10
0 ... 400	50 ... 350	5	10
0 ... 500	50 ... 450	5	10
0 ... 600	100 ... 500	10	15
0 ... 700	100 ... 600	10	15
50 ... 650	150 ... 550	10	15
100 ... 700	200 ... 600	10	15

Basic points of thermo-dynamic temperature scales

Unit	Symbol	Reference value absolute zero	triple point of water
Kelvin	K	0	273.16
Grad Celcius	°C	-273.15	0.01
Grad Fahrenheit	°F	-459.67	32.01
Grad Rankine	°R	0	491.68
Grad Réaumur	°Ré	-218.52	0

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Notes on equipment protection per IEC/EN 60529 and NEMA For Bourdon tube or diaphragm pressure gauges

WIKA data sheet IN 00.18

General information

This technical information describes the measures to prevent both the formation of condensation within a hermetically sealed case, and also the intrusion of water into cases vented to the atmosphere. These measures apply both to Bourdon tube pressure gauges and to diaphragm pressure gauges.

1. Introduction and explanation of physical conditions

The formation of condensation in the cases of hermetically sealed, unfilled instruments cannot generally be avoided. This is based on the physical fact that the humidity found in air, under particular conditions, settles on cold surfaces as condensation. The warmer the air, the more humidity it can hold. If the air cools (e.g. at the window of a measuring instrument), then the air can only hold a small amount of humidity. The excess humidity settles as condensation on the window.

In addition, water in the form of splash, jet and rain water from outside can intrude into the case, so long as the instrument is vented to atmosphere.

2. Explanation of the degrees of protection per IEC/EN 60529

Degrees of protection against solid foreign bodies, defined by the first index number

First index number	Degree of protection	
	Code designation	Definition
0	Not protected	–
1	Protected against solid foreign bodies of 50 mm diameter and larger	The object probe, a round body of 50 mm diameter, must not fully intrude 1)
2	Protected against solid foreign bodies of 12.5 mm diameter and larger	The object probe, a round body of 12.5 mm diameter, must not fully intrude 1)
3	Protected against solid foreign bodies of 2.5 mm diameter and larger	The object probe, 2.5 mm in diameter, must not intrude at all 1)
4	Protected against solid foreign bodies of 1.0 mm diameter and larger	The object probe, 1.0 mm in diameter, must not intrude at all 1)
5	Dust protected	Ingress of dust is not completely prevented, but dust may not intrude in a such a quantity that the satisfactory operation of the instrument or safety is impaired
6	Dust-proof	No ingress of dust

1) The full diameter of the object probe must not pass through any opening in the case.

Illustration 1
Source: IEC/EN 60529

Degrees of protection against water, defined by the second index number

Second index number	Degree of protection	
	Code designation	**Definition**
0	Not protected	–
1	Protected against dripping water	Perpendicularly falling drops must have no damaging effects.
2	Protected against dripping water when the case is inclined to 15°.	Perpendicularly falling drops must have no damaging effects, when the case is inclined to an angle of up to 15°, either side of perpendicular.
3	Protected against sprayed water	Water that is sprayed at an angle of up to 60°, either side of perpendicular, must have no damaging effects.
4	Protected against splash water	Water that splashes against the case from any direction must have no damaging effects.
5	Protected against water jets	Water that splashes against the case, as a jet, from any direction, must have no damaging effects.
6	Protected against strong water jets	Water that splashes against the case, as a strong jet, from any direction, must have no damaging effects.
7	Protected against the effects of temporary immersion in water	Water must not enter in any quantity which could cause damage, when the case, under standardised pressure and temperature conditions, is temporarily immersed in water.
8	Protected against the effects of permanent immersion in water	Water must not enter in any quantity which could cause damage, when the case is permanently immersed in water, under conditions which must be agreed between the manufacturer and user. The conditions must, however, be more demanding than those for the index number 7.

Illustration 2

Source: IEC/EN 60529

Example: Ingress protection IP65

- First index number 6: Dust-proof, no ingress of dust
- Second index number 5: Protected against water jets: Water that splashes against the case as a jet from any direction must have no damaging effects.

3. Comparison of NEMA (National Electrical Manufacturers Association) and IEC/EN 60529

NEMA ingress protection Model number	IEC/EN 60529 ingress protection Classification
1	IP10
2	IP11
3	IP54
3 R	IP14
3 S	IP54
4 and 4 X	IP66
5	IP52
6 and 6 P	IP67
12 and 12 K	IP52
13	IP54

Illustration 3

4. Measures against the formation of condensation

Different fill fluids depending on the ambient temperature and the electrical conductivity

In order to avoid the formation of condensation in the case, WIKA recommends filling the instruments with glycerine. For contact gauges, the filling can be made with silicone oil, since silicone oil, unlike glycerine, is not hygroscopic and therefore prevents a short-circuit within the instrument.

If the ambient temperature drops below -20 °C, then we recommend that the instrument absolutely must be filled with silicone oil. Even at temperatures down to -50 °C, silicone oil can still be used due to its low viscosity.
For flammable and/or explosive media, e.g. oxygen, inert fill fluids must be used.

5. Hermetically sealed instruments and effects associated with them

In order to prevent the intrusion of water into the case, it is recommended that an ingress protection method is chosen that reliably inhibits this (see illustrations 1 and 2). The ingress protection demands that the instrument is hermetically sealed.

With vented instruments, the vent valve has to be closed in order to achieve the specified ingress protection. This, however, produces a temperature error, which can affect the measuring result (see illustrations 4, 5 and 6). Therefore the vent valve has to be opened for a short time before reading the measured value.

5.1 Temperature errors in unfilled and filled Bourdon tube pressure gauges

A standard 232.50/30 instrument with a pressure range greater than 25 bar can be made hermetically sealed without any problems, and manufactured with an ingress protection of IP66. The temperature error that occurs with these instruments is negligible, since it is so small in relation to the pressure range, that the instrument still will operate within its specified class accuracy.

Instruments with a scale range of less than 25 bar can likewise be made hermetically sealed, though a temperature error will then be present (see illustration 4). The temperature errors present are shown in the following graphs.

Temperature errors in hermetically sealed, unfilled Bourdon tube pressure gauges

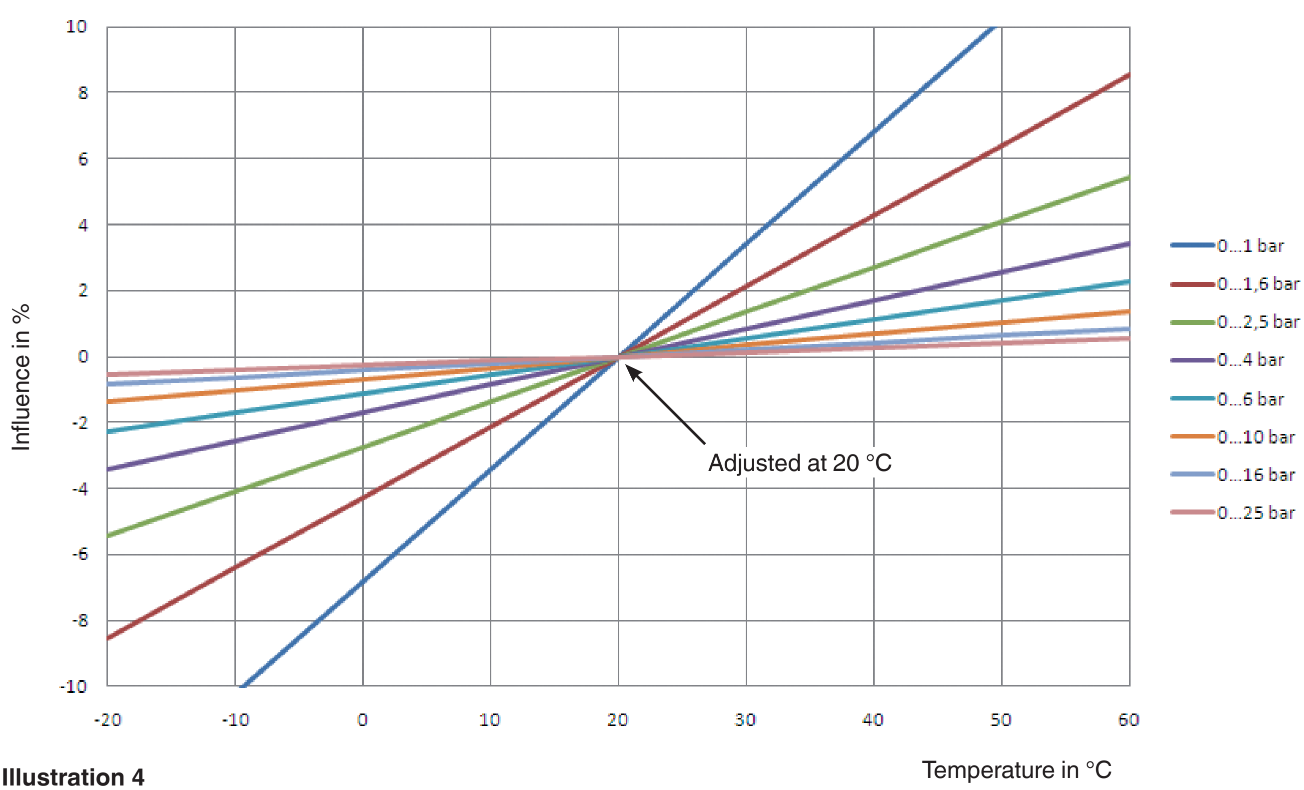

Illustration 4

Temperature errors in hermetically sealed, filled Bourdon tube pressure gauges

Filled to 90 % with glycerine

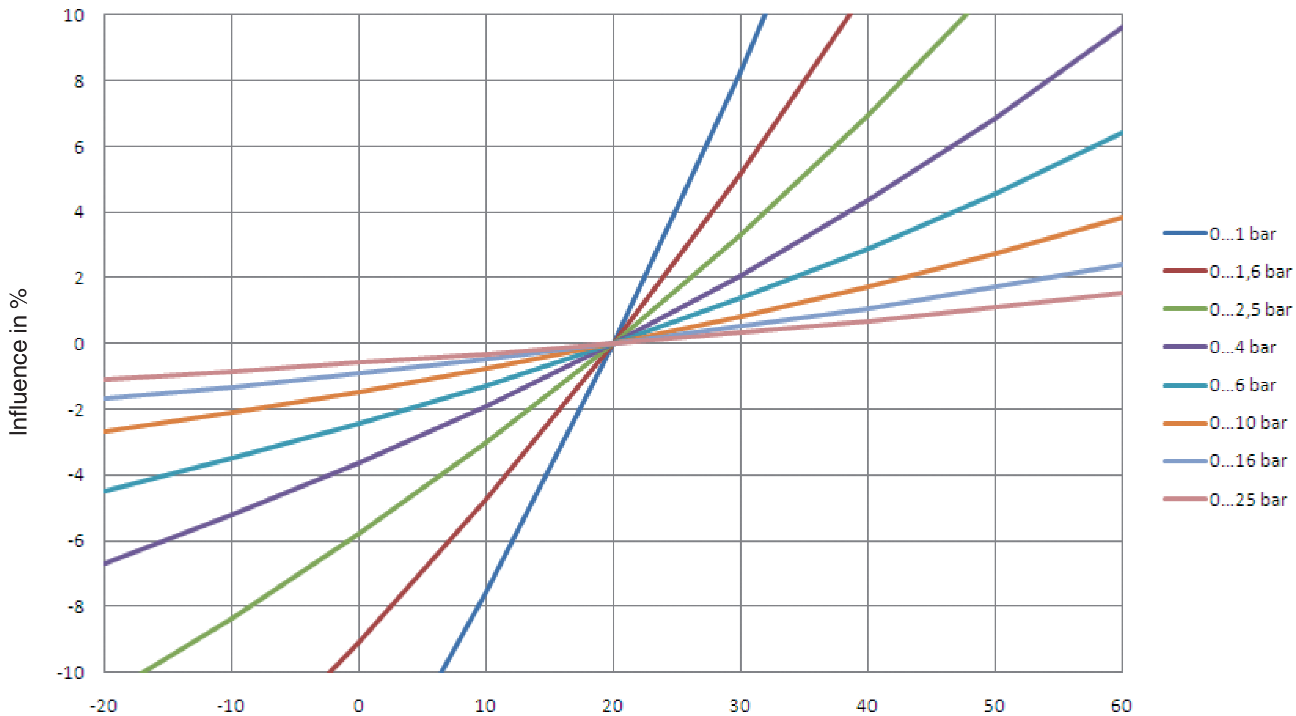

Illustration 5

Temperature in °C

Filled to 90 % with silicone oil

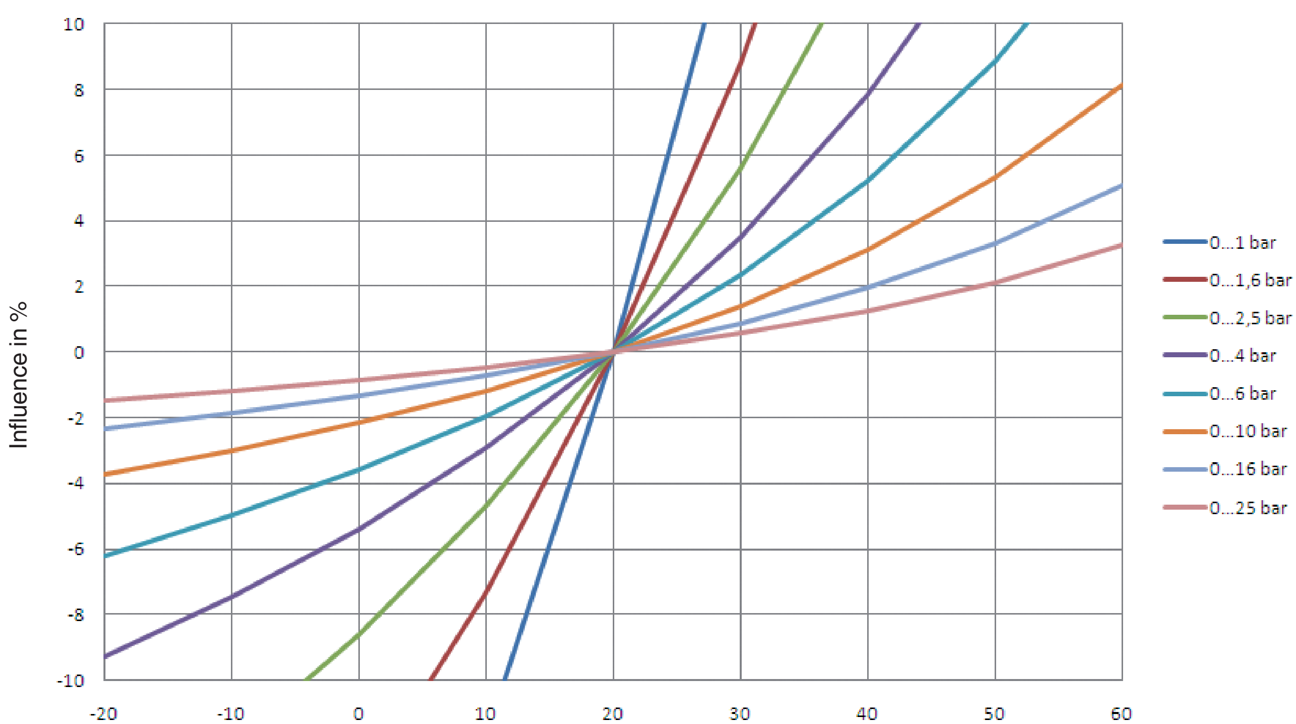

Illustration 6

Temperature in °C

5.1 Temperature errors in unfilled and filled diaphragm pressure gauges

With model 4, 5 and 7 hermetically sealed diaphragm pressure gauges, the temperature error for scale ranges ≥ 100 mbar is negligible. For scale ranges < 100 mbar we recommend only using instruments with a pressure compensating diaphragm.

For instrument models 7xx.14, DPG40, DPGS40, DPGS40TA, DPGT40, DPS40, 700.01/02 and 7x2.15, due to their mechanical design, there are no additional temperature errors.

5.3 Model overview

Pressure gauges for which the formation of condensation and the ingress of water from the outside can be prevented:

Influence	Bourdon tube pressure gauges					Diaphragm pressure gauges					
	Model 2 unfilled		Model 2 filled		Model 233.30 filled, with pressure compensating diaphragm	Model 4 and 7 unfilled		Model 4 and 7 filled		Model 4 and 7 unfilled, with pressure compensating diaphragm	Model 4 and 7 filled, with pressure compensating diaphragm
	≥ 25 bar	< 25 bar	≥ 25 bar	< 25 bar	all pressure ranges	> 100 mbar	< 100 mbar	> 100 mbar	< 100 mbar	all pressure ranges	all pressure ranges
Formation of condensation	unavoidable		✓	✓	✓	unavoidable		✓	✓	unavoidable	✓
Hermetically sealed 1)	Influence negligible	For influence see illustration 4	Influence negligible	For influence see illustration 5 or 6	✓	Influence negligible	Technically not solvable	Influence negligible	Technically not solvable	✓	✓

1) Hermetically sealed = air-tight case

Illustration 7

6. Pressure compensating diaphragm

As can be seen in illustration 7, formation of condensation in filled pressure gauges can be prevented by the use of pressure compensation diaphragms, without any temperature error. Pressure compensation diaphragms can be used for all safety pressure gauges per EN 837-1 S3.

Illustration 8: Rear wall of case with pressure compensating diaphragm, nominal size 63

Illustration 9: Rear wall of case with pressure compensating diaphragm, nominal size 100

Illustration 10: Rear wall of case with pressure compensating diaphragm for contact gauges, nominal size 160

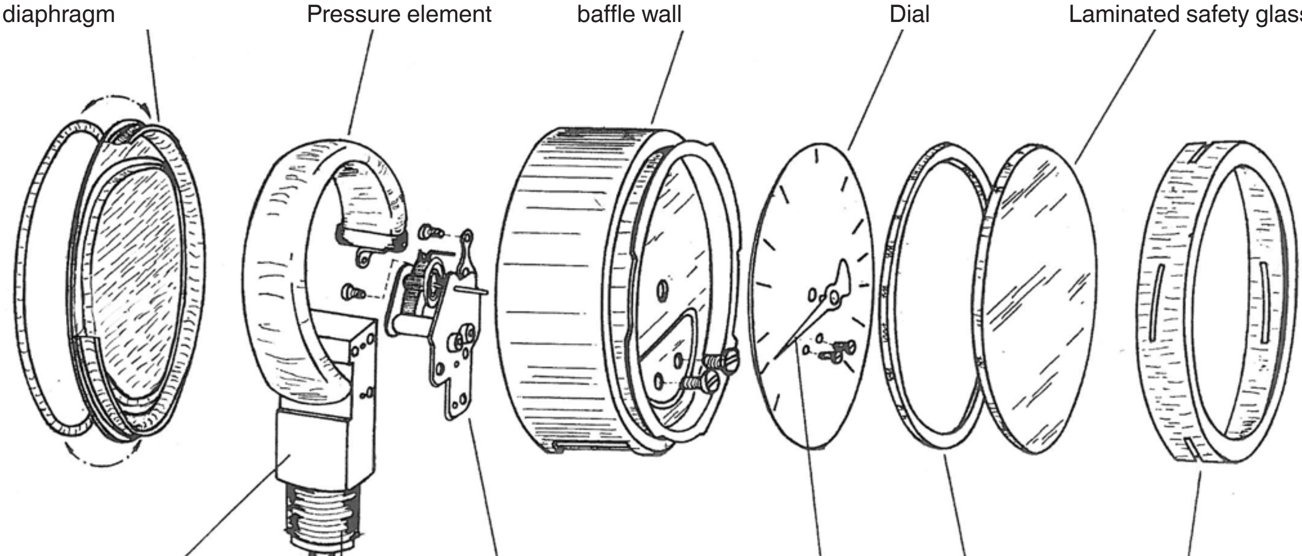

Illustration 11: Exploded view drawing

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