Baumer
Passion for Sensors

How to specify a product

Process sensors

Keep the overview.

Here is some guideline information on how to specify our products. Intended as supplementary help to specification sheets and part numbers, the present pocket guide will prompt you to ask the right questions in order to find the ideal, application-specific product.

Content

Pressure sensors

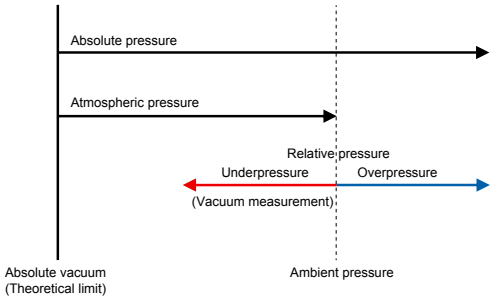
They enable customized solutions for almost any task in pressure transmitters – absolutely precise and reliable. We have to consider installation conditions (flush, non-flush), application requirements (hygienic, industrial) and media properties.

What we need to know:

- Process media
- Process temperature
- Process connection
- Pressure range, type & units of measurement
- Accuracy
- Signal output
- Electrical connection
- Integrated / detached / without display
- Certifications (e.g. 3-A, EHEDG)
- Hazardous area classification
- IP protection requirements

Types of pressure

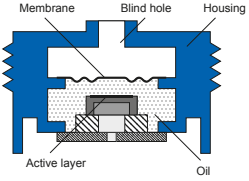
- **Absolute:**
  - Measurement of pressure with respect to vacuum
  - Leak-proof sensor without relative compensation
  - Monitoring or controlling of physical processes with respect to absolute pressure, for example steam pressure
- **Relative:**
  - Measurement of pressure with respect to atmospheric pressure
  - Sensor with relative compensation
  - "Open" sensor, therefore influenced by its surroundings
  - Monitoring or controlling of physical processes with respect to ambient conditions
  - Ex. underpressure: holding force through vacuum process for workpiece handling
  - Ex. overpressure: hydrostatic level measurement in ventilated tanks
- **Compound:** Measurement of gauge or differential pressure from negative to positive values
- **Differential:** Measurement of the difference between two pressures



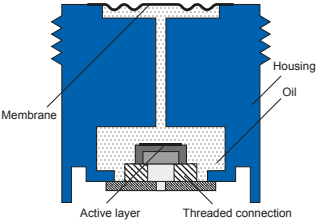
Pressure sensor technology

Piezoresistive sensor

Industrial

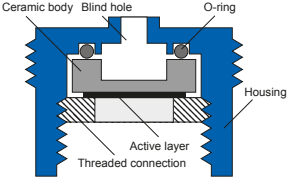


Flush membrane

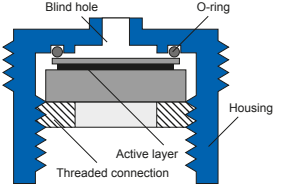


Ceramic sensor

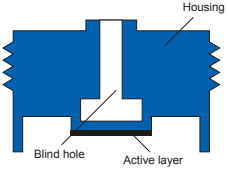
Monolithic



Hybrid



Metal thin-film



You can find further descriptions
of the technologies
at www.baumer.com

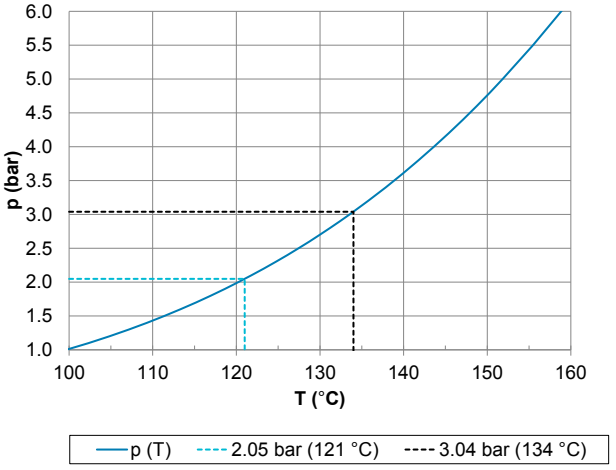
Suitability for gas applications

			Product line												
			CTX, CTL	PBSN	PBM4	PBMN low pressure	PBMN high pressure	EF6	PBMR	PBMN flush	PFMN	PBMH hygienic	PP20x	PFMH	PBMH autoclavable
Gas group	**Properties**	**Examples**													
Noble gases, Inert gases	High diffusion rate	Helium, argon			■	■	■		■	■	■	■	■	■	■
Non-flammable gases	Low diffusion rate, without danger of explosion	Air, carbon dioxide, nitrogen	■	■	■	■	■	■	■	■	■	■	■	■	■
	Reaction accelerator for the combustion of organic substances	Oxygen	■	■											
	Excellent electrical insulator	Sulfur hexafluoride		■		■			■	■	■	■	■	■	■
Flammable gases	Low diffusion rate, with danger of explosion	Propane, butane				■	■			■	■	■	■	■	
	High diffusion rate, with danger of explosion	Hydrogen					■								

Pressure in sterilization processes

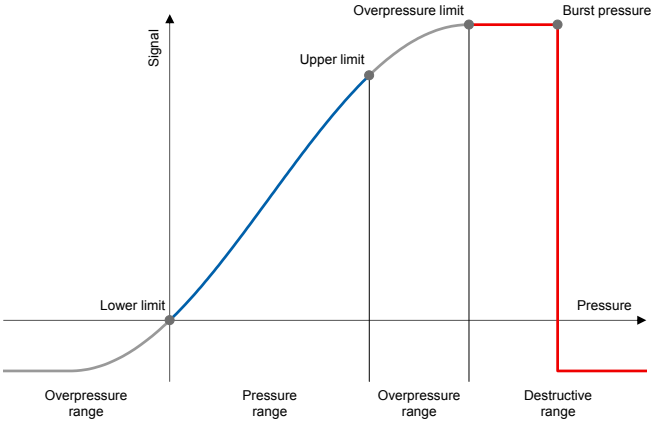
Hot steam is used to sterilize devices and equipment. Small elements, such as sensors (PBMH autoclavable), can be sterilized in a suitable chamber (autoclave). In larger installations, hot steam is fed through the system, which is described as "Sterilization in place" (SIP). Accordingly, a sensor must be designed to be robust, although the signal is generally not transmitted during the sterilization process. It must survive the prevailing temperature and pressure for the relevant time span (e.g., 134 °C at more than 3 bar for 30 min). In physical terms, pressure and temperature are coupled directly with each other, which is shown in the saturated steam curve.

Pressure of saturated steam with respect to temperature



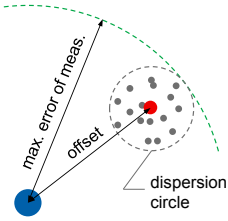
Baumer PBMx and PFMx pressure sensors are ideal for controlling the sterilization process. They provide accurate values even in the event of fast changes in temperature, and thus control the process reliably by monitoring pressure, which leads to the corresponding temperature.

Definition of the pressure ranges



Explanation of terminology and relationships

- **Precision:** This describes the possible deviation of a single measurement from the average of many measurements and can be interpreted as a dispersion circle. High precision: small dispersion circle, low precision: large dispersion circle.
- **Accuracy:** This describes the distance (offset) of the average value of many measurements from the true value. High accuracy: small offset, low accuracy: large offset.



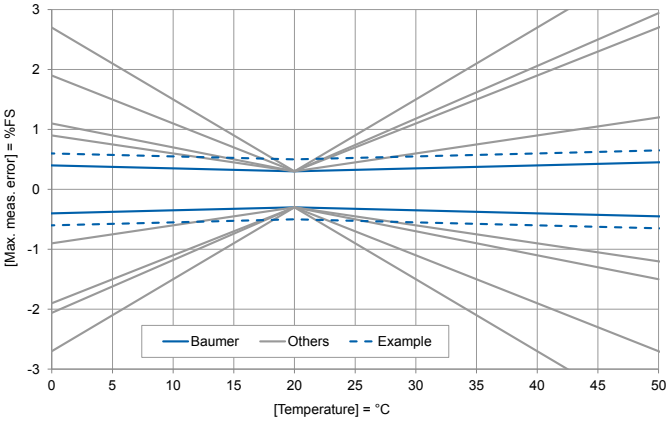
- **Standard error of measurement**: This information is obtained through the best fit straight line, BFSL, and describes precision (dispersion circle).
- **Maximum error of measurement:** This contains the standard error of measurement and the offset of a sensor.

Temperature dependence

The application may deviate from the reference temperature (e.g. 20 °C), so that the standard or the maximum error of measurement must be regarded in a differentiated manner.

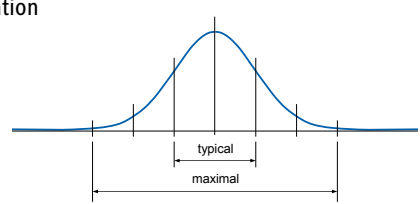
- The **"Temperature Coefficient zero point" (TC zero point)** describes the temperature dependence of the zero point and thus the influence on accuracy.
- The **"Temperature Coefficient span" (TC span)** describes the temperature dependence of the measuring range and thus the influence on precision, that is, the standard error of measurement.
- TC zero point and TC span together describe the temperature dependence on the maximum error of measurement.

Temperature dependence of the maximum error of measurement



In many cases, a temperature-stable sensor with lower initial accuracy is to be preferred to a more unstable sensor with higher initial accuracy if the operating temperature deviates from the reference temperature (e.g. 20 °C).

Error indication



Baumer specifies the “maximum error indication”, i. e. statistically, 99.7% of the sensors comply with the specification. Some competitors enter the “typical error indication”, in which 32% of the products do not comply with the specification.

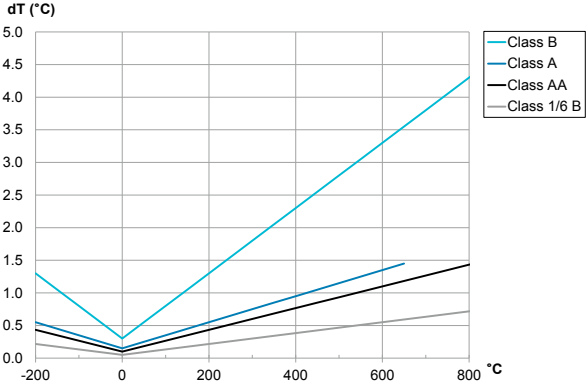
Temperature sensors

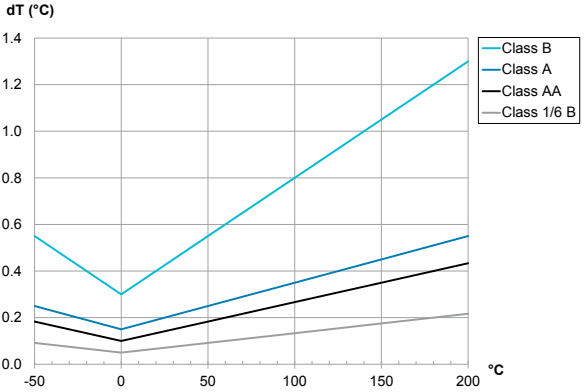
The temperature sensors in the broad Baumer portfolio meet all industry requirements and are compatible with process connections of international standards. Thanks to their building block architecture you will always find the right product for your application. Easily and with the highest level of flexibility.

What we need to know:

- Sensor element type (single / duplex, accuracy)
- Sensor insert (2-wire / 4-wire)
- Transmitter requirements
  - Required output signal
  - Accuracy
  - Galvanic insulation requirements
- Ambient temperature
- Process temperature
- Temperature range
- Process connection (industrial / hygienic environment)
- Sensor immersion depth
- Sensor sleeve diameter
- Response time
- Case type (IP-class, integrated display)
- Built-in display requirements
- Electrical connection
- Approvals and certifications (e.g. 3-A, EHEDG, FDA, EN 50155, ...)
- Hazardous area classification
- Thermowell

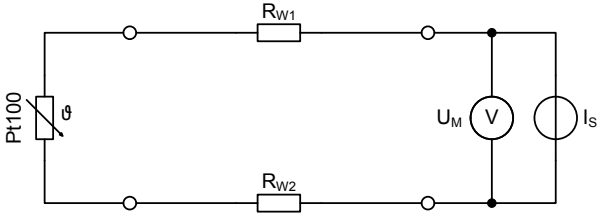
Accuracy Pt100 classes (according to DIN/EN/IEC 60751)





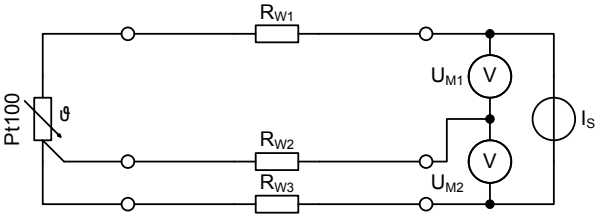
Pt100 signal transmission

2-wire technology



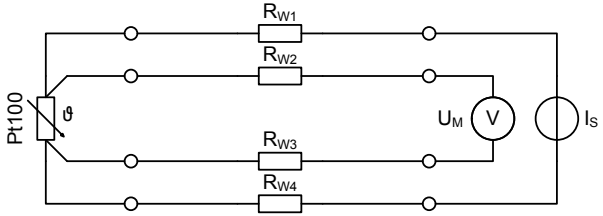
+ Very little wiring required
– Offset error due to R_W cable resistors, e.g. +0.25 °C per meter at A = 0.34 mm²
o Offset error can be corrected

3-wire technology



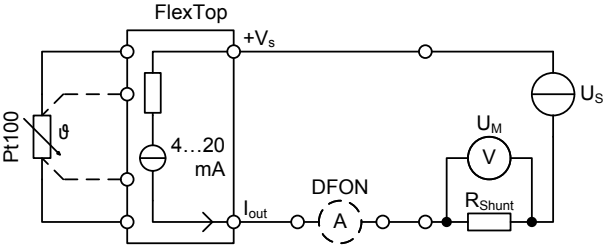
+ Virtually error-free transmission through measurement of the error on one line
– Line and contact resistors R_{W1} and R_{W3} must be the same
o Medium amount of wiring required

4-wire technology



+ Error-free transmission through currentless voltage measuring path
+ No influence in the event of changes in line and contact resistors, e.g. clips
– Increased amount of wiring required

Integrated transmitter with 4 … 20 mA output



+ Error-free and reliable transmission through current loop signal
+ Control with ammeter or measured value display (e.g. DFON) possible at any point in the line
+ Very little wiring required
+ Compact transmitter available for TE2 and TER8
– Higher costs due to transmitter

Temperature transmitter FlexTop

Baumer offers a wide range of temperature transmitters that convert either an RTD or T / C signal into analog or digital communication (HART). The portfolio comprises transmitters for in-head and rail mounting.

What we need to know:

- Rail or head mounting
- Type of sensor input
- Wiring configuration
- Output signal – mA / HART
- Hazardous area classification
- Programming of measuring range
- Failure mode settings

Configurable sensing elements from the FlexTop family

RTD: Abbreviation for "Resistance Temperature Detector", a temperature-variable resistor. In addition to the standard platinum-based Pt100 and Pt1000 types, others based on copper or nickel can be configured with FlexTop.

Pt100: RTD from a thin platinum layer with 100 Ohm at 0 °C (32 °F). The calibration curve and accuracy classes are defined in DIN/EN/IEC 60751, with the change in resistance being largely linear at 0.38%/K. With FlexTop, these and other calibration curves can be configured (by the a-value).

Pt1000: RTD analog as with the Pt100 , but with 1000 Ohm at 0 °C (32 °F) and thus ten times the absolute change in resistance. Compared to the Pt100 and while having applied the 2-wire technology the same offset results after 10 times the wire length. On the other hand, increased attention must be paid to insulation faults, for example due to moisture infiltration. The Pt100 may be more robust in this respect.

Thermocouples (T/C): Two wires made of different metallic materials are connected to each other. At the open ends, the "thermoelectric voltage" is measured (Seebeck effect); depending on the material combination and temperature, this is in the millivolt range. The purely metallic sensing elements allow the measurement of very high temperatures up to more than 1800 °C (3300 °F). If the thermocouple is extended, a "compensating line" made of the same material is required. Otherwise the cold junction compensation is distorted. Generally speaking, the thermocouple (small voltage signal and cold junction temperature measurement) involves more work than in the case of resistor elements.

Sensing elements

FlexTop	Input	Standard	Measuring range	Min. measuring span	Reso-lution	Max. measuring error
2211, 2221	Pt25 ... Pt1000	DIN/EN/IEC 60751	–200 ... 850 °C *	10 °C	0.1 °C	0.1 °C
	Pt25 ... Pt1000	a=0,003902	–200 ... 850 °C *	10 °C	0.1 °C	0.1 °C
	Pt25 ... Pt1000	a=0,003916	–200 ... 850 °C *	10 °C	0.1 °C	0.1 °C
	Ni25 ... Ni1000	DIN 43760	–50 ... 250 °C *	10 °C	0.1 °C	0.1 °C
	Cu25 ... Cu1000	0,428 Ohm / °C	–50 ... 200 °C	10 °C	0.1 °C	0.1 °C
	B (PtRh30-Pt)	IEC 584	100 ... 1820 °C	50 °C	0.1 °C	2 °C
	E (NiCr-CuNi)	IEC 584	–270 ... 900 °C	50 °C	0.1 °C	1 °C
	J (Fe-CuNi)	IEC 584	–210 ... 1200 °C	50 °C	0.1 °C	1 °C
	K (NiCr-Ni)	IEC 584	–250 ... 1370 °C	50 °C	0.1 °C	1 °C
	L (Fe-CuNi)	DIN 43710	–200 ... 900 °C	50 °C	0.1 °C	1 °C
	N (NiCrSi-NiSi)	IEC 584	–200 ... 1300 °C	50 °C	0.1 °C	1 °C
	R (PtRh13-Pt)	IEC 584	–50 ... 1750 °C	100 °C	0.1 °C	2 °C
	S (PtRh10-Pt)	IEC 584	–50 ... 1750 °C	100 °C	0.1 °C	2 °C
	T (Cu-CuNi)	IEC 584	–250 ... 400 °C	40 °C	0.1 °C	1 °C
	U (Cu-CuNi)	DIN 43710	–200 ... 600 °C	50 °C	0.1 °C	1 °C

	W5-Re (Type C)	ASTM 988	0 ... 2 300 °C	100 °C	0.1 °C	2 °C
	W3-Re (Type D)	ASTM 988	0 ... 2300 °C	100 °C	0.1 °C	2 °C
	U	Volt	–10 ... 70 mV	2 mV	0.1 mV	0.04 mV
	U	Volt	–0.1 ... 1,1 V	20 mV	1 mV	0.4 mV
	R	Ohm	0 ... 390 Ohm	5 Ohm	0.01 mV	0.05 mV
	R	Ohm	0 ... 2200 Ohm	25 Ohm	0.1 mV	0.25 mV
2202	Pt100	DIN/EN/IEC 60751	–200 ... 850 °C *	25 °C	12 bit	0.25 °C
	R	Ohm	0 ... 500 Ohm	5 Ohm	12 bit	1 Ohm
2203	B (PtRh30-Pt)	IEC 584	100 ... 1820 °C	50 °C	12 bit	5 °C (> 500 °C)
	J (Fe-CuNi)	IEC 584	–210 ... 1200 °C	50 °C	12 bit	3 °C
	K (NiCr-Ni)	IEC 584	–250 ... 1370 °C	50 °C	12 bit	3 °C
	N (NiCrSi-NiSi)	IEC 584	–200 ... 1300 °C	50 °C	12 bit	4 °C
	S (PtRh10-Pt)	IEC 584	–50 ... 1750 °C	100 °C	12 bit	5 °C (> 50 °C)
	U	Volt	–10 ... 100 mV	5 mV	12 bit	0.2 mV
2204	Pt500	DIN/EN/IEC 60751	–100 ... 160 °C *	25 °C	12 bit	0.25 °C
	R	Ohm	0 ... 1000 Ohm	5 Ohm	12 bit	1 Ohm

*The max. temperature is limited for RTD-elements in the range 500 ... 1000 Ohm, e.g. Pt1000 max. 350 °C.

Level sensors

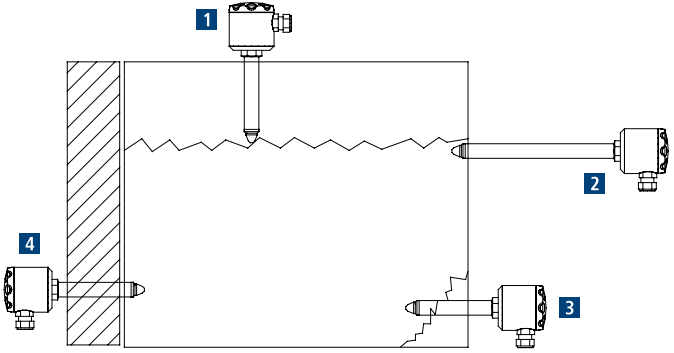
The Baumer level switch is designed for point level measurement in any task and industry. Universal in use, *CleverLevel* is capable of detecting all media – whether solid, liquid or adhering. *CleverLevel* is the smart alternative to vibrating forks.

What we need to know:

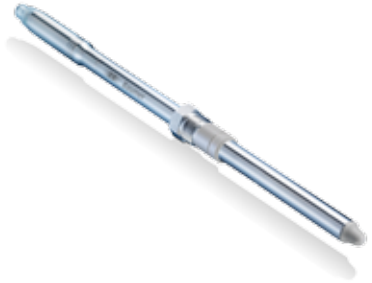
- Ambient temperature
- Process connection (industrial / hygienic)
- Electrical connection
- Hazardous area classification
- Signal output
- Approvals
- Media temperature
- Configured in the factory

Installation examples

- Applications for the level switch with sliding connection (see illustration).



1 Mounted at the top of a tank to adjust a maximum level (250 mm).
2 Serving as a cooling neck in high media temperature applications.
3 Flexible adjustment of the sensor tip to ensure true level detection, e.g. for powder media.
4 To penetrate insulation material of vessels.



Conductivity sensors

The Baumer conductivity transmitters are designed for media separation and analysis in applications in the food and beverage industry and water treatment. They provide outstanding benefits in terms of accuracy and display options.

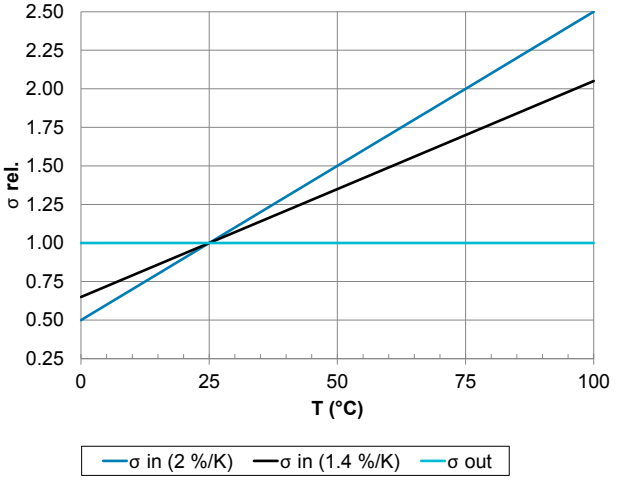
What we need to know:

- Electrical connection
- Cable length, if using a detached display (split version)
- Media temperature
- Ambient temperature
- Integrated / detached / without display
- Immersion length
- Approvals
- Configured in the factory

Temperature compensation

The conductivity of a liquid generally depends on the temperature. For many aqueous solutions, it increases at +2%/K. To be able to compare measurements, measuring devices refer the directly determined conductivity back to a reference temperature. This is usually defined as 25 °C. In addition to this definition, the AFI also allows the input of a temperature coefficient in %/K. This must be set to 0%/K if temperature compensation is to be dispensed with. Non-linear temperature coefficients can be specified with an additional quadratic element.

Temperature dependence of the conductivity of fluids

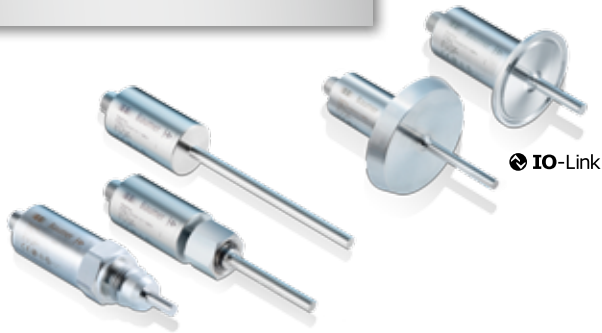


Flow sensors

The *FlexFlow* flow sensor measures the flow velocity of aqueous media such as CIP cleaning agents and beverages. It operates according to the calorimetric measuring principle. In addition to monitoring the flow velocity, this also makes it possible to determine the media temperature.

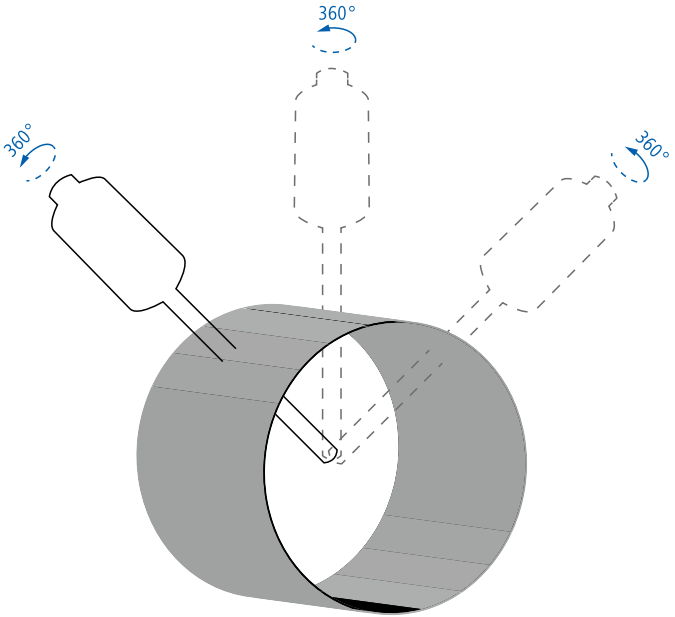
What we need to know:

- Process media
- Hygienic requirements
- Process pressure
- Process temperature
- Tube diameter
- Penetration depth
- Process connection
- Signal output
- Interface



Flexible installation situation

The symmetrical and centered sensor design allows for optimal installation in the process in any position for best aligment. This ensures precise measurements and process safety.



Guidelines and certifications

European Hygienic Engineering & Design Group
European, non-profit consortium of users, suppliers and health care bodies. Assessment of the cleanability of hygienic components on the basis of a laboratory test in which the test object is compared to a reference tube. If the test is passed, EHEDG issues a certificate. The consortium also issues guidelines. The cleanability of the outside of devices (cases etc.) is referred to as “washdown”, which is used particularly in location sensors (e.g. light barriers). This can also be used for cable connections and connectors.

3-A Sanitary Standard, Inc.
Independent, non-profit company in the US. Representation of the interests of public and state health bodies, machine and food manufacturers. Establishes standards for materials and design for use in the beverage, food and pharmaceutical industries. The assessment of the compliance of a test object is carried out by an inspector on the basis of the design drawing and a visual inspection. If this is positive, 3-A issues a certificate. In addition to the parts coming into contact with the process, the exterior design (case etc.) must comply with certain guidelines, for example, no liquid may remain on flat surfaces.

U.S. Food & Drug Administration
Supervisory authority in the United States for the protection of humans and animals. In process technology, responsible for the selection of materials. Certain materials such as high-alloy stainless steel and various synthetic materials (e.g. PEEK) are listed for safe medium contact. These are given a specific “CFR” number. Baumer declares compliance with FDA requirements on its own responsibility with the “Food Regulatory

Declaration of Harmlessness".

European Regulation 1935/2004/EC
Materials and articles intended to come into contact with food. 10/2011/EU: Plastic materials and articles intended to come into contact with food. 2023/2006/EC: Good manufacturing practice. With the "Safety for contact with food" certificate, Baumer declares its compliance with these regulations. For bought-in parts we require appropriate evidence from our suppliers.

Conformité Européenne
Compliance with European directives. By attaching the CE mark, Baumer declares the relevant product-specific compliance: 2014/30/EU: Electromagnetic compatibility (EMC) (replaces 2004/108/EC). 2011/65/EU: Restriction of the use of certain Hazardous Substances in electrical and electronic equipment (RoHS) (replaces 2002/95/EC). 2014/68/EU: Making available on the market of pressure equipment (Pressure Equipment Directive) (replaces 97/23/EC). This is used from certain volumes and pressures. The directives and any standards applied are to be specified in a "Declaration of Conformity" with the type designation of the device and the manufacturer's address. With this document, which is to be presented on request, the manufacturer declares compliance on his own responsibility.

Atmosphère Explosible

European directive 2014/34/EU: Equipment and protective systems intended for use in potentially explosive atmospheres (replaces 94/9/EC). Compliance is to be examined by a certified body and confirmed with a type examination certificate (e.g. TÜV). Baumer declares the compliance of appropriate sensors with the directive in the CE Declaration of Conformity.

Underwriters Laboratories (UL)

Independent organization in the US. Issues standards and tests products for compliance with special requirements, for example safety. Canadian Standards Association (CSA) is the counterpart in Canada. The “cULus” pictogram indicates the recognition of the relevant test for both countries. After successful testing, the laboratory issues a certificate (UL listed). The test is largely required by European OEMs that supply machines to the US. Their testing costs are reduced if individual components are already listed. Listing is not mandatory for the simple sale of sensors in the United States and Canada, since our devices do not use voltages or currents that pose the risk of electrical shock or fire.

DNV-GL

Amalgamation of the classification companies “Det Norske Veritas” (Norway) and “Germanischer Lloyd” (Germany). DNV-GL certifies equipment for the maritime sector, mainly for use on ships. Before a certificate can be issued, increased vibration resistance in particular must be demonstrated in laboratory tests.

Lloyd's Register
Classification company with headquarters in London (UK). It issues certificates on the basis of laboratory tests complying with the Lloyd's Register Quality Assurance system. In addition to the shipping sector, the company is also active in the railway sector.

WHG (German Water Act)
The German law essentially regulates water legislation. Type examinations can be used for level switches; these examinations ensure the suitability of these switches for leak detection or overfill protection. In the use of certain water-endangering media, appropriate safety measures must be installed, including, among other things, level switches tested in accordance with the German Water Act. Testing in accordance with the German Water Act can be carried out by TÜV or the "Deutsches Institut für Bautechnik" (German Institute for Building Technology).

Certificates

Certificate according SN/EN 10204:2004	Declaration of compliance 2.1	Test report 2.2	Inspection certificate 3.1
What does it mean?	Confirmation of compliance with the order	Confirmation of compliance with the order in reference to chosen quality characteristics Surface roughness Free of oil and grease Ferrite content Material	Confirmation of compliance with the order in reference to chosen quality characteristics Material analysis Calibration
How it is tested?	No real test, just documentation of delivered products	No specific measurement, quality characteristics are confirmed by means of our production standard	Specific measurement of quality characteristics
Along with which product can it be ordered?	All products	All products, but certain paramters are only available if applicable to the reference product	Not all products, compare Productfinder

Productfinder

For easy access to the required certificate use the Productfinder at **www.baumer.com**

Unit Conversions

Pressure	Pa	mbar	H2O	psi	Torr
1 Pa =	1	0.01	0.102 mm	0.000145	0.0075
1 hPa =	100	1	10.2 mm	0.0145	0.75
1 bar =	100 000	1 000	10.2 m	14.5	750.2
1 m H_2O =	9 810	98.10	1 000 mm	1.422	73.56
1 psi =	6 895	68.95	0.703 m	1	51.72
1 Torr =	133.3	1.333	13.6 mm	0.01933	1

Temperature

°C	−40	−30	−20	−10	0	10	20	30	40	50	60	70	80	90
°F	−40	−22	−4	14	32	50	68	86	104	122	140	158	176	194

°F	−20	0	−10	20	40	60	80	100	120	130	140	160	180
°C	−29	−18	−23	−7	4	16	27	38	49	54	60	71	82

°C	90	100	110	120	130	140	150	160	170	180	190	200	210	220
°F	194	212	230	248	266	284	302	320	338	356	374	392	410	428

°F	200	220	240	260	280	300	320	330	340	360	380	400	420
°C	93	104	116	127	138	149	160	166	171	182	193	204	216

Dimension	mm	cm	m	ft	inch
1 mm =	1	0.1	0.001	0.003281	0.03937
1 cm =	10	1	0.01	0.03281	0.3937
1 m =	1 000	100	1	3.281	39.37
1 ft =	304.8	30.48	0.3048	1	12
1 inch =	25.4	2.54	0.0254	0.8333	1

Values partly rounded

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