

Operating Instructions

Process pressure transmitter IPT-2x

GB

Slave for electronic differential pressure
With SIL qualification
Metallic sensor



Process pressure transmitter IPT-2x



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Safety instructions for Ex areas



Take note of the Ex specific safety instructions for Ex applications. These instructions are attached as documents to each instrument with Ex approval and are part of the operating instructions.

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1 About this document

1.1 Function

This instruction provides all the information you need for mounting, connection and setup as well as important instructions for maintenance, fault rectification, the exchange of parts and the safety of the user. Please read this information before putting the instrument into operation and keep this manual accessible in the immediate vicinity of the device.

1.2 Target group

This operating instructions manual is directed to trained personnel. The contents of this manual must be made available to the qualified personnel and implemented.

1.3 Symbols used



Information, note, tip: This symbol indicates helpful additional information and tips for successful work.



Note: This symbol indicates notes to prevent failures, malfunctions, damage to devices or plants.



Caution: Non-observance of the information marked with this symbol may result in personal injury.



Warning: Non-observance of the information marked with this symbol may result in serious or fatal personal injury.



Danger: Non-observance of the information marked with this symbol results in serious or fatal personal injury.



Ex applications

This symbol indicates special instructions for Ex applications.



List

The dot set in front indicates a list with no implied sequence.



Sequence of actions

Numbers set in front indicate successive steps in a procedure.



Battery disposal

This symbol indicates special information about the disposal of batteries and accumulators.

2 For your safety

2.1 Authorised personnel

All operations described in this documentation must be carried out only by trained, qualified personnel authorised by the plant operator. During work on and with the device, the required personal protective equipment must always be worn.

2.2 Appropriate use

IPT-2x is a slave sensor for electronic differential pressure measurement.

You can find detailed information about the area of application in chapter "*Product description*".

Operational reliability is ensured only if the instrument is properly used according to the specifications in the operating instructions manual as well as possible supplementary instructions.

2.3 Warning about incorrect use

Inappropriate or incorrect use of this product can give rise to application-specific hazards, e.g. vessel overfill through incorrect mounting or adjustment. Damage to property and persons or environmental contamination can result. Also, the protective characteristics of the instrument can be impaired.

2.4 General safety instructions

This is a state-of-the-art instrument complying with all prevailing regulations and directives. The instrument must only be operated in a technically flawless and reliable condition. The operator is responsible for the trouble-free operation of the instrument. When measuring aggressive or corrosive media that can cause a dangerous situation if the instrument malfunctions, the operator has to implement suitable measures to make sure the instrument is functioning properly.

The safety instructions in this operating instructions manual, the national installation standards as well as the valid safety regulations and accident prevention rules must be observed by the user.

For safety and warranty reasons, any invasive work on the device beyond that described in the operating instructions manual may be carried out only by personnel authorised by the manufacturer. Arbitrary conversions or modifications are explicitly forbidden. For safety reasons, only the accessory specified by the manufacturer must be used.

To avoid any danger, the safety approval markings and safety tips on the device must also be observed.

2.5 EU conformity

The device fulfils the legal requirements of the applicable EU directives. By affixing the CE marking, we confirm the conformity of the instrument with these directives.

The EU conformity declaration can be found on our homepage.

Due to the design of its process fittings, the device does not subject of EU pressure device directive if it is operated at process pressures ≤ 200 bar.¹⁾

2.6 SIL qualification according to IEC 61508

The Safety Integrity Level (SIL) of an electronic system is used to assess the reliability of integrated safety functions.

For detailed specification of the safety requirements, multiple SIL levels are specified according to safety standard IEC 61508. You can find detailed information in chapter "*Functional safety (SIL)*" of the operating instructions.

The instrument meets the specifications of IEC 61508: 2010 (Edition 2). It is qualified for single-channel operation up to SIL2. The instrument can be used homogeneously redundant up to SIL3 in multi-channel architecture with HFT 1.

2.7 Installation and operation in the USA and Canada

This information is only valid for USA and Canada. Hence the following text is only available in the English language.

Installations in the US shall comply with the relevant requirements of the National Electrical Code (ANSI/NFPA 70).

Installations in Canada shall comply with the relevant requirements of the Canadian Electrical Code.

¹⁾ Exception: Versions with measuring ranges from 250 bar. These are subject of the EU Pressure Device Directive.

3 Product description

3.1 Configuration

Type label

The type label contains the most important data for identification and use of the instrument:

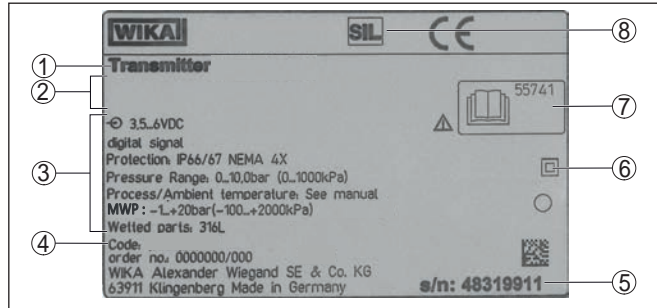


Fig. 1: Layout of the type label (example)

- 1 Instrument type
- 2 Field for approvals
- 3 Technical data
- 4 Product code
- 5 Serial number of the instrument
- 6 Symbol of the device protection class
- 7 ID numbers, instrument documentation
- 8 SIL identification

Scope of this operating instructions

This operating instructions manual applies to the following instrument versions:

- Hardware from 1.0.0
- Software version from 1.0.0



Note:

You can find the hardware and software version of the instrument as follows:

- On the type plate of the electronics module
- In the adjustment menu under "Info"

Scope of delivery

The scope of delivery encompasses:

- Instrument IPT-2x - Slave sensor
- Ready-made connection cable, unassembled cable gland
- Documentation
 - Quick setup guide IPT-2x
 - Safety Manual (SIL)
 - Documentation instrument parameters (default values)
 - Documentation order-relating instrument parameters (deviation from default values)
 - Test certificate for pressure transmitters
 - Instructions for optional instrument features
 - Ex-specific "Safety instructions" (with Ex versions)

- If necessary, further certificates

**Information:**

Optional instrument features are also described in this operating instructions manual. The respective scope of delivery results from the order specification.

3.2 Principle of operation

Application area

IPT-2x is suitable for applications in virtually all industries. It is used for the measurement of the following pressure types.

- Gauge pressure
- Absolute pressure
- Vacuum

Measured products

Measured products are gases, vapours and liquids.

The device is especially suitable for applications with higher temperatures and high pressures.

Measured variables

The electronic differential pressure measurement is suitable for the measurement of the following process variables:

- Level
- Flow
- Differential pressure
- Density
- Interface
- Level, density-compensated

Electronic differential pressure

The IPT-2x slave sensor is combined with a sensor from the instrument series for electronic differential pressure measurement.

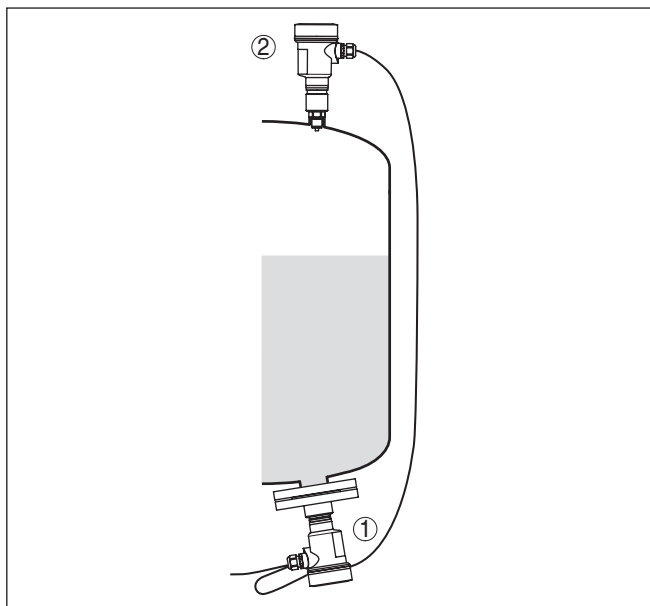


Fig. 2: Example, electronic differential pressure for level measurement in pressurized vessel

- 1 IPT-2x
- 2 IPT-2x, slave sensor

The sensors are connected via a screened four-wire cable. The measured value from the slave sensor is read in and factored into the calculations. Power supply and parameter adjustment are carried out through the master sensor.



Information:

The sensor versions "Relative pressure climate-compensated" as well as "Double chamber housing" are not suitable for connection of a slave sensor.

You can find further information in chapter "Combination Master - Slave" of this operating instructions.



To reach the Safety Integrity Level (SIL) for the electronic differential pressure, both instruments must be SIL-qualified.

Measuring system

The process pressure acts on the sensor element via the process diaphragm. The process pressure causes a resistance change which is converted into a corresponding output signal and output as measured value.

Piezoresistive sensor element

Measuring ranges up to 40 bar: piezoresistive sensor element with internal transmission liquid is used.

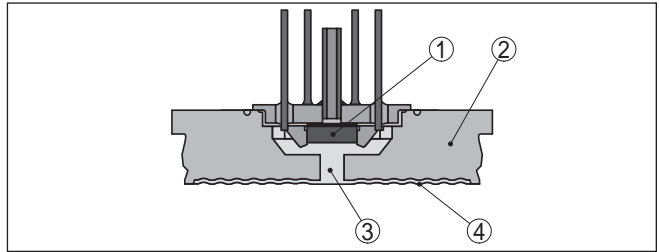


Fig. 3: Configuration of the measuring system with piezoresistive sensor element

- 1 Sensor element
- 2 Base element
- 3 Transmission liquid
- 4 Process diaphragm

Strain gauge (DMS) sensor element

For measuring ranges above 100 bar, a strain gauge (DMS) sensor element (dry system) is used.

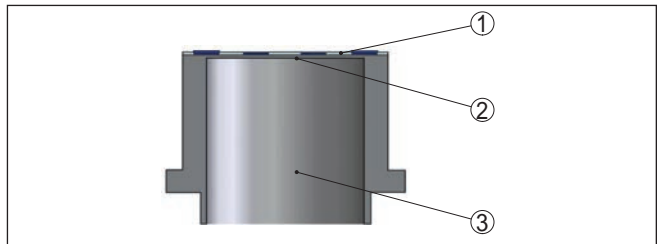


Fig. 4: Configuration of the measuring system with strain gauge (DMS) sensor element

- 1 Sensor element
- 2 Process diaphragm
- 3 Pressure cylinder

Ceramic/metallic measuring cell

With small measuring ranges ≤ 400 mbar or higher temperature ranges, the ceramic/metallic measuring cell is the measuring unit. It consists of the ceramic-capacitive measuring cell and a special, temperature-compensated chemical seal system.

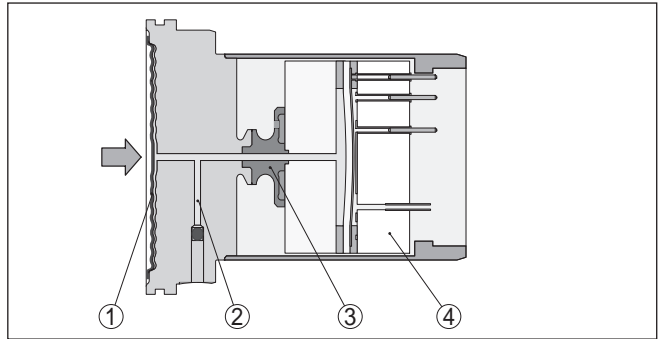


Fig. 5: Configuration of the ceramic/metallic measuring cell

- 1 Process diaphragm
- 2 Isolating liquid
- 3 FeNi adapter
- 4 Ceramic-capacitive measuring cell

Pressure types

Relative pressure: the measuring cell is open to the atmosphere. The ambient pressure is detected in the measuring cell and compensated. It thus has no influence on the measured value.

Absolute pressure: the measuring cell contains vacuum and is encapsulated. The ambient pressure is not compensated and does hence influence the measured value.

Seal concept

The measuring system is completely welded and thus sealed against the process.

The process fitting is sealed against the process by a suitable seal. It must be provided by the customer, depending on the process fitting also included in the scope of delivery, see chapter "Technical data", "Materials and weights".

3.3 Supplementary cleaning procedures

The IPT-2x is also available in the version "Oil, grease and silicone-free". These instruments have passed through a special cleaning procedure to remove oil, grease and paint-wetting impairment substances (PWIS).

The cleaning is carried out on all wetted parts as well as on surfaces accessible from outside. To keep the purity level, the instruments are immediately packed in plastic foil after the cleaning process. The purity level remains as long as the instrument is kept in the closed original packaging.



Caution:

The IPT-2x in this version may not be used in oxygen applications. For this purpose, instruments are available in the special version "Oil, grease and silicone-free for oxygen applications".

3.4 Packaging, transport and storage

Packaging

Your instrument was protected by packaging during transport. Its capacity to handle normal loads during transport is assured by a test based on ISO 4180.

The packaging consists of environment-friendly, recyclable cardboard. For special versions, PE foam or PE foil is also used. Dispose of the packaging material via specialised recycling companies.

Transport

Transport must be carried out in due consideration of the notes on the transport packaging. Nonobservance of these instructions can cause damage to the device.

Transport inspection

The delivery must be checked for completeness and possible transit damage immediately at receipt. Ascertained transit damage or concealed defects must be appropriately dealt with.

Storage

Up to the time of installation, the packages must be left closed and stored according to the orientation and storage markings on the outside.

Unless otherwise indicated, the packages must be stored only under the following conditions:

- Not in the open
- Dry and dust free
- Not exposed to corrosive media
- Protected against solar radiation
- Avoiding mechanical shock and vibration

Storage and transport temperature

- Storage and transport temperature see chapter "*Supplement - Technical data - Ambient conditions*"
- Relative humidity 20 ... 85 %

Lifting and carrying

With instrument weights of more than 18 kg (39.68 lbs) suitable and approved equipment must be used for lifting and carrying.

4 Mounting

4.1 General instructions

Process conditions



Note:

For safety reasons, the instrument must only be operated within the permissible process conditions. You can find detailed information on the process conditions in chapter "*Technical data*" of the operating instructions or on the type label.

Hence make sure before mounting that all parts of the instrument exposed to the process are suitable for the existing process conditions.

These are mainly:

- Active measuring component
- Process fitting
- Process seal

Process conditions in particular are:

- Process pressure
- Process temperature
- Chemical properties of the medium
- Abrasion and mechanical influences

Protection against moisture

Protect your instrument against moisture ingress through the following measures:

- Use a suitable connection cable (see chapter "*Connecting to power supply*")
- Tighten the cable gland or plug connector
- Lead the connection cable downward in front of the cable entry or plug connector

This applies mainly to outdoor installations, in areas where high humidity is expected (e.g. through cleaning processes) and on cooled or heated vessels.



Note:

Make sure that the degree of contamination specified in chapter "*Technical data*" meets the existing ambient conditions.



Note:

Make sure that during installation or maintenance no moisture or dirt can get inside the instrument.

To maintain the housing protection, make sure that the housing lid is closed during operation and locked, if necessary.

Screwing in

Devices with threaded fitting are screwed into the process fitting with a suitable wrench via the hexagon.

See chapter "*Dimensions*" for wrench size.

**Warning:**

The housing or the electrical connection may not be used for screwing in! Depending on the device version, tightening can cause damage, e. g. to the rotation mechanism of the housing.

Vibrations

If there is strong vibration at the mounting location, the instrument version with external housing should be used. See chapter "*External housing*".

Permissible process pressure (MWP) - Device

The permissible process pressure range is specified by "MWP" (Maximum Working Pressure) on the type label, see chapter "*Structure*". The MWP takes the element of the measuring cell and processing fitting combination with the weakest pressure into consideration and may applied permanently. The specification refers to a reference temperature of +20 °C (+68 °F). It also applies when a measuring cell with a higher measuring range than the permissible pressure range of the process fitting is installed order-related.

In order to prevent damage to the device, a test pressure may only exceed the specified MWP briefly by 1.5 times at reference temperature. The pressure stage of the process fitting as well as the overload resistance of the measuring cell are taken into consideration here (see chapter "*Technical Data*").

In addition, a temperature derating of the process fitting, e. g. with flanges, can limit the permissible process pressure range according to the respective standard.

Permissible process pressure (MWP) - Mounting accessory

The permissible process pressure range is stated on the type label. The instrument should only be operated with these pressures if the mounting accessory used also fulfils these values. This should be ensured by suitable flanges, welded sockets, tension rings with Clamp connections, sealings, etc.

Temperature limits

Higher process temperatures often mean also higher ambient temperatures. Make sure that the upper temperature limits stated in chapter "*Technical data*" for the environment of the electronics housing and connection cable are not exceeded.

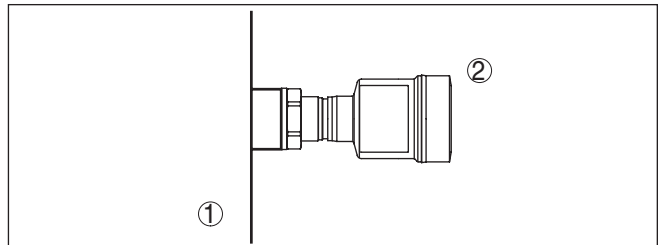


Fig. 6: Temperature ranges

- 1 Process temperature
- 2 Ambient temperature

4.2 Ventilation and pressure compensation

Filter element - Function

The filter element in the electronics housing has the following functions:

- Ventilation of the electronics housing
- Atmospheric pressure compensation (with relative pressure measuring ranges)



Caution:

The filter element causes a time-delayed pressure compensation. When quickly opening/closing the housing cover, the measured value can change for approx. 5 s by up to 15 mbar.

For an effective ventilation, the filter element must be always free from buildup. In case of horizontal mounting, turn the housing so that the filter element points downward after the instrument is installed. This provides better protection against buildup.



Caution:

Do not use a high-pressure cleaner. The filter element could be damaged, which would allow moisture into the housing.

The following paragraphs describe how the filter element is arranged in the different instrument versions.

Filter element - Position

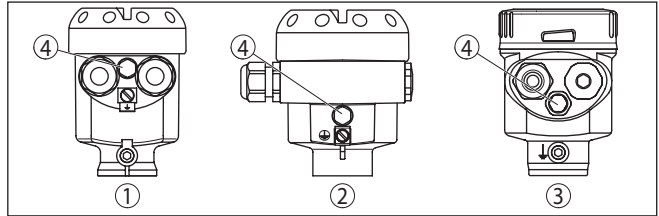


Fig. 7: Position of the filter element - non-Ex, Ex-ia version

- 1 Plastic, stainless steel housing (precision casting)
- 2 Aluminium housing
- 3 Stainless steel housing (electropolished)
- 4 Filter element

With the following instruments a blind plug is installed instead of the filter element:

- Instruments in protection IP66/IP68 (1 bar) - ventilation via capillaries in non-detachable cable
- Instruments with absolute pressure

Filter element - Position Ex-d version

→ Turn the metal ring in such a way that the filter element points downward after installation of the instrument. This provides better protection against buildup.

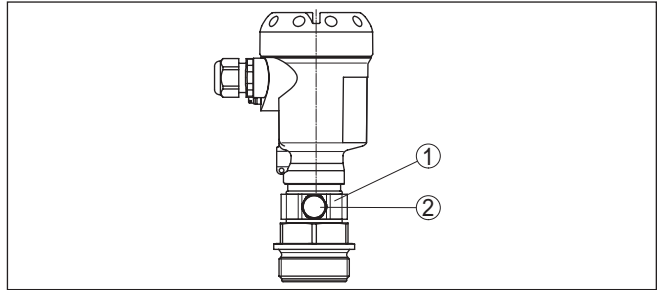


Fig. 8: Position of the filter element - Ex-d version

- 1 Rotatable metal ring
- 2 Filter element

Instruments with absolute pressure have a blind plug mounted instead of the filter element.

Instruments with Second Line of Defense

The process assembly of instruments with Second Line of Defense (gastight leadthrough) is completely encapsulated. An absolute pressure measuring cell is used so that no ventilation is required.

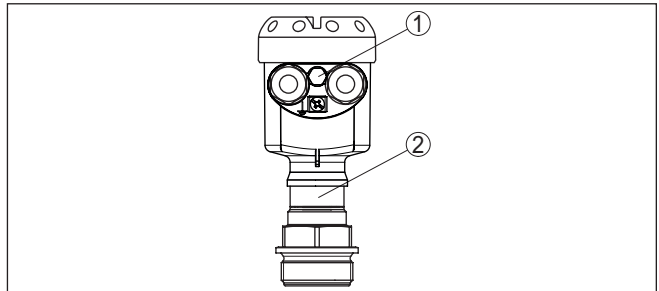


Fig. 9: Position of the filter element - gastight leadthrough

- 1 Filter element

Filter element - Position IP69K version

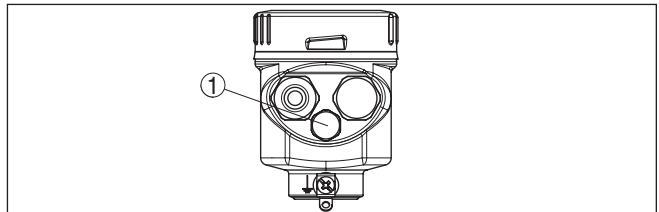


Fig. 10: Position of the filter element - IP69K version

- 1 Filter element

Instruments with absolute pressure have a blind plug mounted instead of the filter element.

4.3 Combination Master - Slave

In principle, any sensor combination within the instrument series is allowed. The following requirements must be fulfilled:

- Configuration, Master sensor suitable for electronic differential pressure
- Pressure type is identical for both sensors, i.e. relative pressure/relative pressure or absolute pressure/absolute pressure
- Master sensor measures the higher pressure
- Measurement setup as shown in the following chapters

The measuring range of each sensor is selected such that it fits the measuring loop. For this, the max. recommended turn down must be noted. See chapter "*Technical data*". It is absolutely necessary the measuring ranges of Master and Slave correspond.

Measurement result = Measured value of Master (total pressure) - measured value of Slave (static pressure)

Depending on the application, individual combinations can result, see following examples:

Example - large vessel

Data

Application: Level measurement

Medium: Water

Vessel height: 12 m, hydrostatic pressure = $12 \text{ m} \times 1000 \text{ kg/m}^3 \times 9.81 \text{ m/s}^2 = 117.7 \text{ kPa} = 1.18 \text{ bar}$

Superimposed pressure: 1 bar

Total pressure: $1.18 \text{ bar} + 1 \text{ bar} = 2.18 \text{ bar}$

Instrument selection

Nominal measuring range Master: 2.5 bar

Nominal measuring range Slave: 1 bar

Turn Down: $2.5 \text{ bar} / 1.18 \text{ bar} = 2.1 : 1$

Example - small vessel

Data

Application: Level measurement

Medium: Water

Vessel height: 500 mm, hydrostatic pressure = $0.50 \text{ m} \times 1000 \text{ kg/m}^3 \times 9.81 \text{ m/s}^2 = 4.9 \text{ kPa} = 0.049 \text{ bar}$

Superimposed pressure: 350 mbar = 0.35 bar

Total pressure: $0.049 \text{ bar} + 0.35 \text{ bar} = 0.399 \text{ bar}$

Instrument selection

Nominal measuring range Master: 0.4 bar

Nominal measuring range Slave: 0.4 bar

Turn Down: $0.4 \text{ bar} / 0.049 \text{ bar} = 8.2 : 1$

Example - orifice in pipeline

Data

Application: Differential pressure measurement

Medium: Gas

Static pressure: 0.8 bar

Differential pressure on orifice: 50 mbar = 0.050 bar

Total pressure: 0.8 bar + 0.05 bar = 0.85 bar

Instrument selection

Nominal measuring range Master: 1 bar

Nominal measuring range Slave: 1 bar

Turn Down: 1 bar/0.050 bar = 20 : 1

Output measured values

The measuring result (level, pressure difference) as well as measured value Slave (static or superimposed pressure) are output by the sensor. Depending on the instrument version, output as 4 ... 20 mA signal or digitally via HART, Profibus PA or Foundation Fieldbus.

SIL

To reach the Safety Integrity Level (SIL) for the electronic differential pressure, both instruments must be SIL-qualified.

Measurement setup

4.4 Level measurement

The master/slave combination is suitable for level measurement in a pressurized vessel

Keep the following in mind when setting up the measuring system:

- Mount the master sensor below the min. level
- Do not mount the master sensor close to the filling stream or emptying area
- Mount the master sensor so that it is protected against pressure shocks from the stirrer
- Mount the slave sensor above the max. level

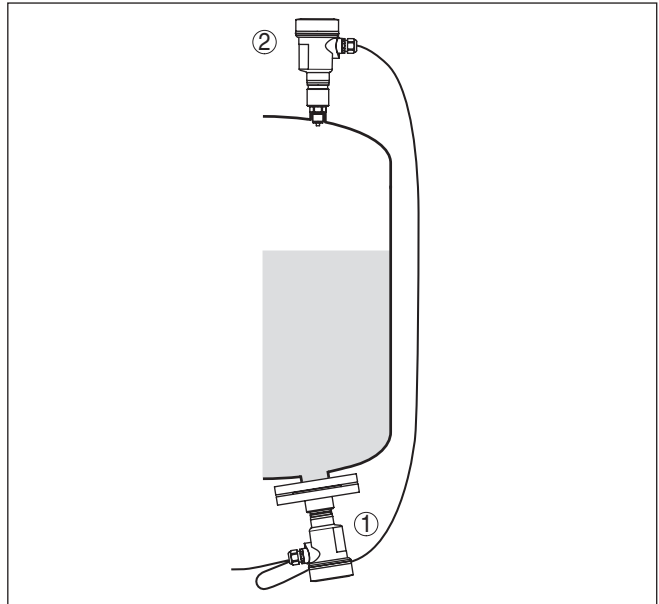


Fig. 11: Measurement setup, level measurement in pressurized vessel

1 IPT-2x

2 IPT-2x, slave sensor

Measurement setup

4.5 Differential pressure measurement

The master/slave combination is suitable for differential pressure measurement

Take note of the following instructions for the measurement setup, for example in gases:

- Mount the instruments above the measuring point

Possible condensation can then drain off into the process line.

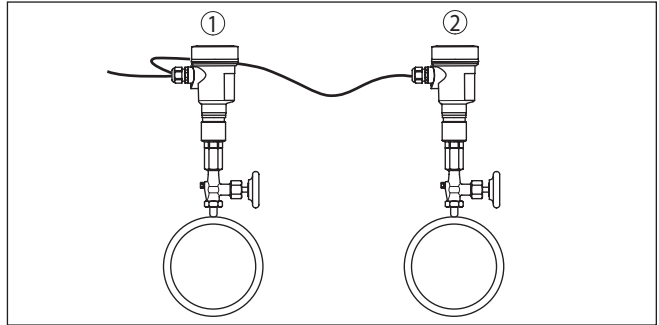


Fig. 12: Measurement setup for differential pressure measurement of gases in pipelines

1 IPT-2x

2 IPT-2x, slave sensor

Measurement setup

4.6 Interface measurement

The master/slave combination is suitable for interface measurement

Requirements for a functioning measurement are:

- Vessel with changing level
- Products with steady density
- Interface always between the measurement points
- Total level always above the upper measurement point

The mounting distance h of the two sensors should be at least 10 %, better 20 %, of the final value of the sensor measuring range. A bigger distance increases the accuracy of the interface measurement.

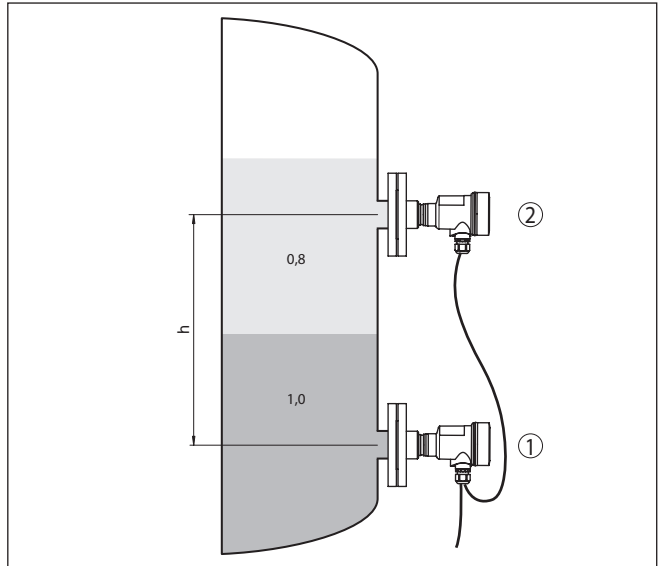


Fig. 13: Measurement setup with interface measurement, h = distance between the two measuring points

1 IPT-2x

2 IPT-2x, slave sensor

The interface measurement is possible in open as well as in closed vessels.

4.7 Density measurement

Measurement setup

The master/slave combination is suitable for density measurement. Requirements for a functioning measurement are:

- Vessel with changing level
- Distance between the measurement points as large as possible
- Level always above the upper measuring point

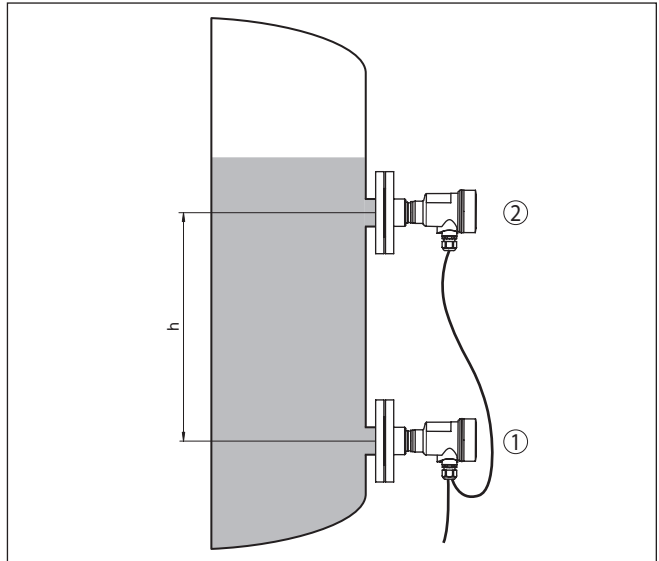


Fig. 14: Measurement setup for density measurement, h = distance between the two measuring points

1 IPT-2x

2 IPT-2x, slave sensor

The mounting distance h of the two sensors should be at least 10 %, better 20 %, of the final value of the sensor measuring range. A bigger distance increases the accuracy of the density measurement.

Slight density changes cause only slight changes of the measured differential pressure. The measuring range must hence be selected accordingly.

The density measurement is possible in open as well as in closed vessels.

4.8 Density-compensated level measurement

The master/slave combination is suitable for density-compensated level measurement

Keep the following in mind when setting up the measuring system:

- Mount the master sensor below the min. level
- Mount the slave sensor above the master sensor
- Mount both sensors away from the filling stream and emptying and protected against pressure shocks from the stirrer

Measurement setup

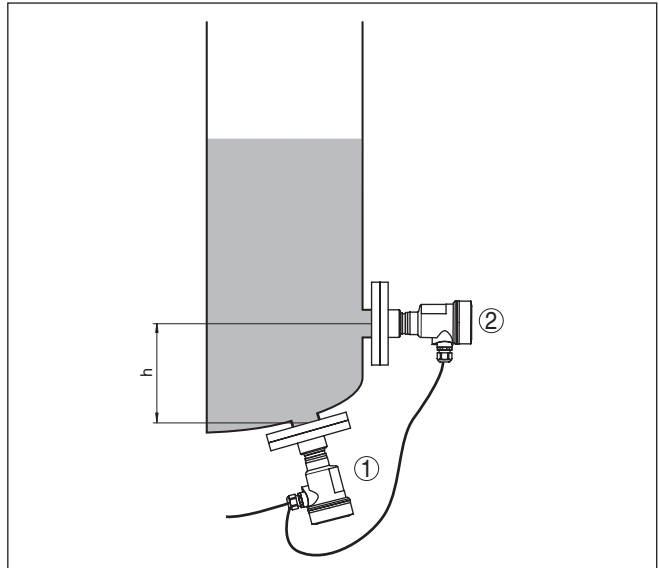


Fig. 15: Measurement setup for density-compensated level measurement, h = distance between the two measuring points

- 1 IPT-2x
- 2 IPT-2x, slave sensor

The mounting distance h of the two sensors should be at least 10 %, better 20 %, of the final value of the sensor measuring range. A bigger distance increases the accuracy of the density compensation.

The density-compensated level measurement starts with the stored density 1 kg/dm^3 . As soon as both sensors are covered, this value will be replaced by the calculated density. Density compensation means that the level value in height units and the adjustment values do not change in case of a fluctuating density.

The density-compensated level measurement is only possible in open, i.e. unpressurized vessels.

4.9 External housing

Configuration

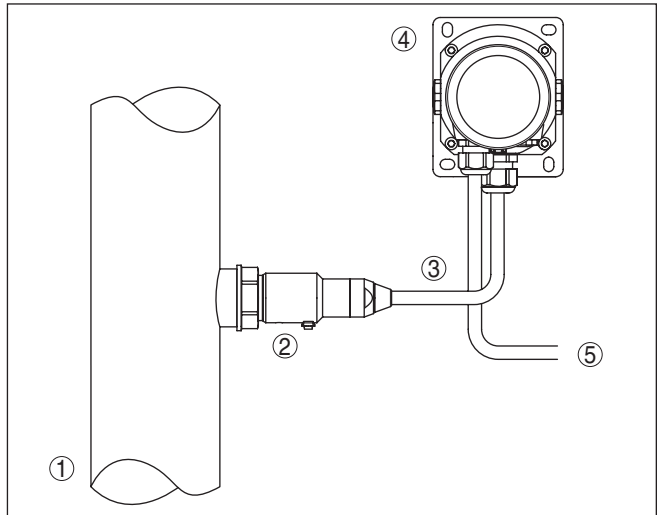


Fig. 16: Configuration, process module, external housing

- 1 Pipeline
- 2 Process module
- 3 Connection cable process assembly - External housing
- 4 External housing
- 5 Signal cable

5 Connecting to power supply

5.1 Preparing the connection

Safety instructions

Always keep in mind the following safety instructions:

- Carry out electrical connection by trained, qualified personnel authorised by the plant operator
- If overvoltage surges are expected, overvoltage arresters should be installed



Warning:

Only connect or disconnect in de-energized state.

Voltage supply

The voltage supply and the signal transmission are carried out via the four-wire, screened connection cable from the master sensor.

You can find the data for this signal circuit in chapter "*Technical data*".

Cable screening and grounding

The shielding of the cable between master and slave sensor must be connected on both ends to ground potential. In the sensor, the shielding is connected directly to the internal ground terminal. The ground terminal on the outside of the housing must be connected to the ground potential (low impedance).

Cable glands

Metric threads

In the case of instrument housings with metric thread, the cable glands are screwed in at the factory. They are sealed with plastic plugs as transport protection.



Note:

You have to remove these plugs before electrical connection.

NPT thread

In the case of instrument housings with self-sealing NPT threads, it is not possible to have the cable entries screwed in at the factory. The free openings for the cable glands are therefore covered with red dust protection caps as transport protection.



Note:

Prior to setup you have to replace these protective caps with approved cable glands or close the openings with suitable blind plugs.

On plastic housings, the NPT cable gland or the Conduit steel tube must be screwed into the threaded insert without grease.

Max. torque for all housings, see chapter "*Technical data*".

5.2 Connecting

Connection technology

The connection to the Master sensor is carried out through spring-loaded terminals in the respective housing. For this, use the supplied, confectioned cable. Solid cores as well as flexible cores with cable end sleeves are inserted directly into the terminal openings.

In case of flexible cores without end sleeves, press the terminal from above with a small screwdriver, the terminal opening is then free. When the screwdriver is released, the terminal closes again.



Information:

The terminal block is pluggable and can be removed from the electronics. To do this, lift the terminal block with a small screwdriver and pull it out. When reinserting the terminal block, you should hear it snap in.

You can find further information on the max. wire cross-section under "*Technical data - Electromechanical data*".

Connection procedure

Proceed as follows:

1. Unscrew the housing lid
2. Loosen compression nut of the cable gland and remove blind plug
3. Remove approx. 10 cm (4 in) of the cable mantle, strip approx. 1 cm (0.4 in) insulation from the individual wires or use supplied connection cable
4. Insert the cable into the sensor through the cable entry



Fig. 17: Connection steps 5 and 6

5. Insert the wire ends into the terminals according to the wiring plan
6. Check the hold of the wires in the terminals by lightly pulling on them
7. Connect the shielding to the internal ground terminal, connect the external ground terminal to potential equalisation
8. Tighten the compression nut of the cable entry gland. The seal ring must completely encircle the cable
9. Unscrew the blind plug on the Master, screw in the supplied cable gland
10. Connection cable to Master, see steps 3 to 8
11. Screw the housing lid back on

The electrical connection is finished.

5.3 Single chamber housing



The following illustration applies to the non-Ex, Ex-ia and Ex-d-ia version.

Electronics and connection compartment

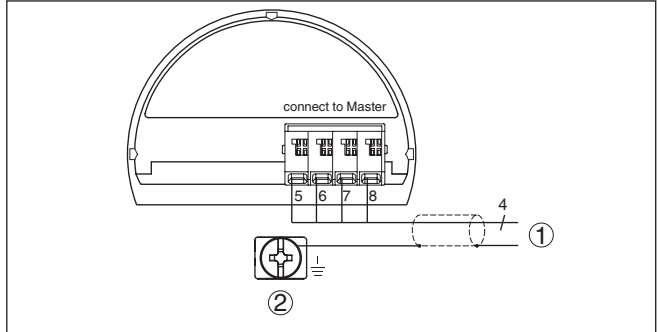


Fig. 18: Wiring plan IPT-2x Slave sensor

- 1 To the Master sensor
- 2 Ground terminal for connection of the cable screening²⁾

5.4 External housing with version IP68 (25 bar)

Overview

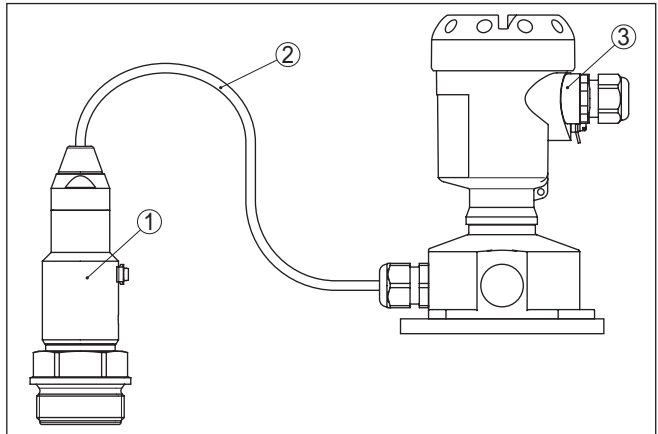


Fig. 19: IPT-2x in IP68 version 25 bar with axial cable outlet, external housing

- 1 Transmitter
- 2 Connection cable
- 3 External housing

²⁾ Connect shielding here. Connect ground terminal on the outside of the housing to ground as prescribed. The two terminals are galvanically connected.

Electronics and connection compartment for power supply

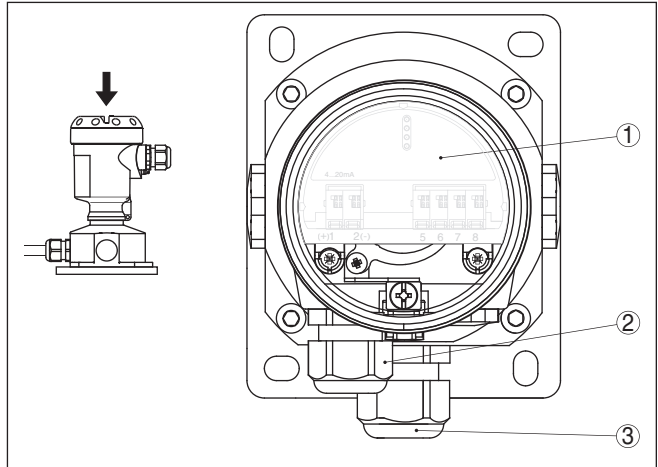


Fig. 20: Electronics and connection compartment

- 1 Electronics module
- 2 Cable gland for voltage supply
- 3 Cable gland for connection cable, transmitter

Terminal compartment, housing socket

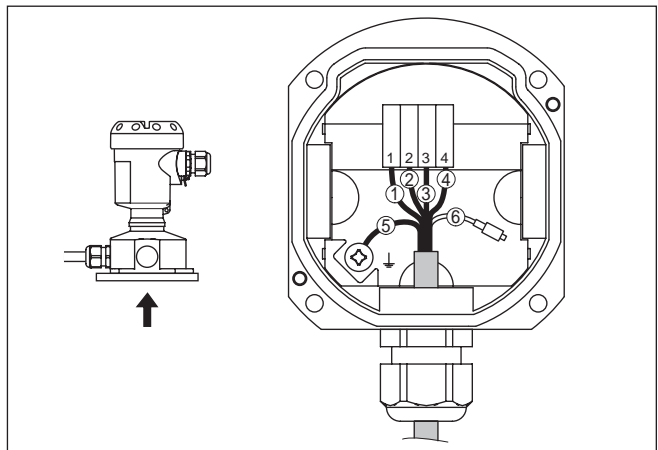


Fig. 21: Connection of the process component in the housing base

- 1 Yellow
- 2 White
- 3 Red
- 4 Black
- 5 Shielding
- 6 Breather capillaries

Electronics and connection compartment

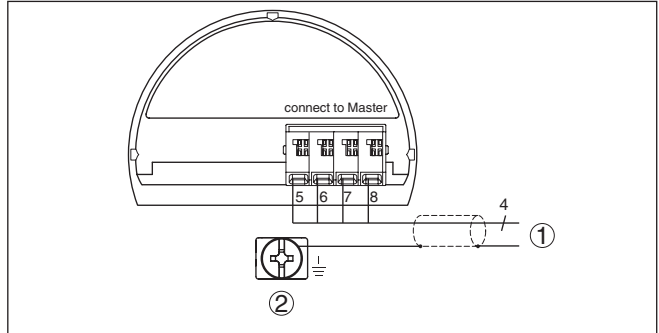


Fig. 22: Wiring plan IPT-2x Slave sensor

- 1 To the Master sensor
- 2 Ground terminal for connection of the cable screening³⁾

Connection example, electronic differential pressure

5.5 Connection example

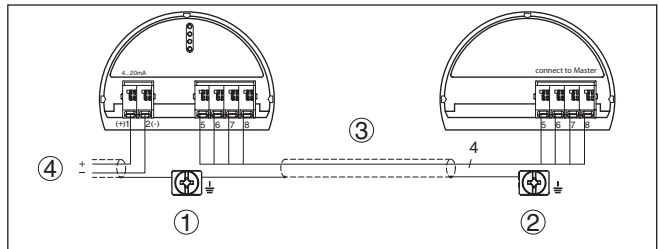


Fig. 23: Connection example, electronic differential pressure

- 1 Master sensor
- 2 Slave sensor
- 3 Connection cable
- 4 Supply and signal circuit, Master sensor

Connection between master and sensor is carried out according to the table:

Master sensor	Slave sensor
Terminal 5	Terminal 5
Terminal 6	Terminal 6
Terminal 7	Terminal 7
Terminal 8	Terminal 8

³⁾ Connect shielding here. Connect ground terminal on the outside of the housing to ground as prescribed. The two terminals are galvanically connected.

6 Functional safety (SIL)

6.1 Objective

Background

In case of dangerous failures, processing facilities and machines can cause risks for persons, environment and property. The risk of such failures must be judged by the plant operator. Dependent thereon are measures for risk reduction through error prevention, error detection and fault control.

Plant safety by risk reduction

The part of plant safety depending on the correct functioning of safety-related components for risk reduction is called functional safety. Components used in such safety-instrumented systems (SIS) must therefore execute their intended function (safety function) with a defined high probability.

Standards and safety levels

The safety requirements for such components are described in the international standards IEC 61508 and 61511, which set the standard for uniform and comparable judgement of instrument and plant (or machine) safety and hence contribute to worldwide legal certainty. We distinguish between four safety levels, from SIL1 for low risk to SIL4 for very high risk (SIL = Safety Integrity Level), depending on the required degree of risk reduction.

6.2 SIL qualification

Properties and requirements

When developing instruments that can be used in safety-instrumented systems, the focus is on avoiding systematic errors as well as determining and controlling random errors.

Here are the most important characteristics and requirements from the perspective of functional safety according to IEC 61508 (Edition 2):

- Internal monitoring of safety-relevant circuit parts
- Extended standardization of the software development
- In case of failure, switching of the safety-relevant outputs to a defined safe state
- Determination of the failure probability of the defined safety function
- Reliable parameterization with non-safe user environment
- Proof test

Safety Manual

The SIL qualification of components is specified in a manual on functional safety (Safety Manual). Here, you can find all safety-relevant characteristics and information the user and the planner need for planning and operating the safety-instrumented system. This document is attached to each instrument with SIL rating and can be also found on our homepage via the search.

6.3 Application area

The instrument can be used, for example, for process pressure and hydrostatic level measurement of liquids in safety-instrumented sys-

tems (SIS) acc. to IEC 61508 and IEC 61511. Note the specifications in the Safety Manual.

The following inputs/outputs are permitted:

- 4 ... 20 mA current output

6.4 Safety concept of the parameterization

Tool for operation and parameterization

The following tools are permitted for parameterization of the safety function:

- The integrated display and adjustment unit for on-site adjustment
- The DTM suitable for the controller in conjunction with an adjustment software according to the FDT/DTM standard, e. g. PACTware



Note:

For operation of the IPT-2x an actual DTM Collection is required. The modification of safety-relevant parameters is only possible with active connection to the instrument (online mode).

Safe parameterization

To avoid possible errors during parameterisation in a non-safe operating environment, a verification procedure is used that enables reliable detection of parameter adjustment errors. The safety-relevant parameters have to be verified after they are saved in the instrument. In normal operating condition, the instrument is also protected (locked) against inadvertent or unauthorized parameter changes. This concept applies to adjustment directly on the instrument as well as adjustment with PACTware and DTM.

Safety-relevant parameters

To prevent unintentional or unauthorized adjustment, the set parameters must be protected from unauthorized access. For this reason the instrument is shipped in locked condition. The PIN in delivery status is "0000".

When shipped with a specific parameter adjustment, the instruments are accompanied by a list with the values deviating from the basic setting.

All safety-relevant parameters must be verified after a change.

The parameter settings of the measurement loop must be documented. You can find a list of all safety-relevant parameters in the delivery status in chapter "*Setup with the display and adjustment module*" under "*Additional adjustments - Reset*". In addition, a list of the safety-relevant parameters can be stored and printed via PACTware/DTM.

Unlock adjustment

For each parameter change, the instrument must be unlocked via a PIN (see chapter "*Parameter adjustment, setup steps - Lock adjustment*"). The device status is indicated in the DTM by the symbol of an unlocked or locked padlock.

In delivery status, the PIN is **0000**.

Unsafe device status



Warning:

If adjustment is enabled, the safety function must be considered as unreliable. This applies until the parameterisation is terminated

correctly. If necessary, other measures must be taken to maintain the safety function.

Change parameters

All parameters changed by the operator are automatically stored temporarily so that they can be verified in the next step.

Verify parameters/Lock adjustment

After setup, the modified parameters must be verified (confirm the correctness of the parameters). To do this, you first have to enter the PIN. Here the adjustment is locked automatically. Then you carry out a comparison of two character strings. You must confirm that the character strings are identical. This is used to check the character presentation.

Then you confirm that the serial number of your instrument has been carried over correctly. This is used to check device communication.

Then, all modified parameters that have to be confirmed are listed. After this process is terminated, the safety function is again ensured.

Incomplete process



Warning:

If the described process was not carried out completely or correctly (e.g. due to interruption or voltage loss), the instrument remains in an unlocked, and thus unsafe, status.

Instrument reset



Warning:

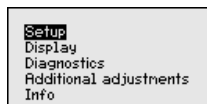
In case of a reset to basic settings, all safety-relevant parameters will also be reset to default. Therefore all safety-relevant parameters must be checked or readjusted.

7 Set up with the display and adjustment module

7.1 Parameter adjustment

Main menu

The main menu is divided into five sections with the following functions:



Setup: Settings, e.g., for measurement loop name, application, units, position correction, adjustment, signal output

Display: Settings, e.g., for language, measured value display, lighting

Diagnosis: Information, e.g. on instrument status, pointer, measurement reliability, simulation

Additional adjustments: PIN, date/time, reset, copy function

Info: Instrument name, hardware and software version, date of manufacture, sensor features

In the main menu item "*Setup*", the individual submenu items should be selected one after the other and provided with the correct parameter values.

The following submenu points are available:



In the following section, the menu items from the menu "*Setup*" for electronic differential pressure measurement are described in detail. Depending on the selected application, different sections are relevant.



Information:

Further menu items of the menu "*Setup*" as well as the complete menus "*Display*", "*Diagnosis*", "*Additional adjustments*" and "*Info*" are described in the operating instructions of the respective master sensor.

Operating sequence

A parameter change with SIL qualified instruments must always be carried out as follows:

- Unlock adjustment
- Change parameters
- Lock adjustment and verify modified parameters

This ensures that all modified parameters have been deliberately changed.

Unlock adjustment

The instrument is shipped in locked condition.

To prevent unintentional or unauthorized adjustment, the instrument is protected (locked) against all parameter changes while in normal operating condition.

For each parameter change you have to enter the PIN of the instrument. In delivery status, the PIN is "0000".



Change parameters

You can find a description below the respective parameter.

Lock adjustment and verify modified parameters

You can find a description below the parameter "Setup - Lock adjustment".

7.1.1 Setup

Application

In this menu item you activate/deactivate the slave sensor for electronic differential pressure and select the application.

The IPT-2x in conjunction with a slave sensor can be used for flow, differential pressure, density and interface measurement. The default setting is differential pressure measurement. Switchover is carried out in the adjustment menu.

If you have connected a slave sensor, you confirm this with "Activate".



Note:

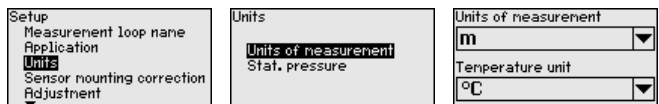
It is absolutely necessary to activate the slave sensor to have the applications displayed in the electronic differential pressure measurement menus.



Enter the requested parameters via the appropriate keys, save your settings with **[OK]** and jump to the next menu item with the **[ESC]** and the **[->]** key.

Units

In this menu item, you determine the units for the "Min. adjustment/Zero" and "Max. adjustment/Span" as well as the static pressure.



If the level should be adjusted in a height unit, the density of the medium must also be entered later during the adjustment.

In addition, the unit is determined in the menu item "*Peak value temperature*".

Enter the requested parameters via the appropriate keys, save your settings with **[OK]** and jump to the next menu item with the **[ESC]** and the **[->]** key.

Position correction

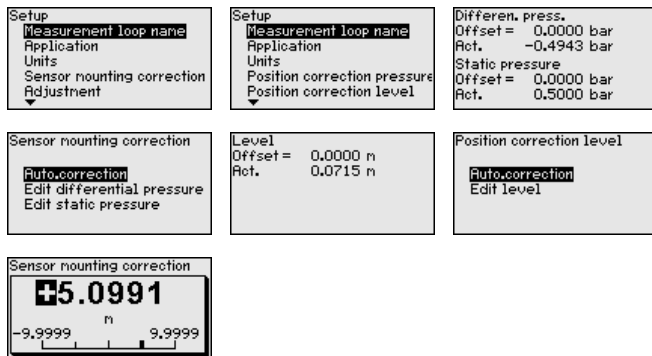
Especially with chemical seal systems, the installation position of the instrument can shift (offset) the measured value. Position correction compensates this offset. In the process, the actual measured value is taken over automatically. With relative pressure measuring cells a manual offset can also be carried out.

There are the following possibilities for a position correction with a master/slave combination

- Automatic correction for both sensors
- Manual correction for the Master (differential pressure)
- Manual correction for the Slave (static pressure)

With a master/slave combination in the application "*Density-compensated level measurement*" there are the following additional options for the position correction

- Automatic correction, master (level)
- Manual correction for the Master (level)



During an automatic position correction, the current measured value is accepted as the correction value. This value must not be influenced/corrupted by product coverage or static pressure.

In case of a manual position correction, the offset value is determined by the user. Select for this purpose the function "*Edit*" and enter the requested value.

Save your settings with **[OK]** and move with **[ESC]** and **[->]** to the next menu item.

After the position correction is carried out, the actual measured value is corrected to 0. The corrective value appears with an inverse sign as offset value in the display.

The position correction can be repeated any number of times.

Adjustment

IPT-2x always measures pressure independently of the process variable selected in the menu item "Application". To output the selected process variable correctly, an allocation of the output signal to 0 % and 100 % must be carried out (adjustment).

With the application "Level", the hydrostatic pressure, e.g. with full and empty vessel, is entered for adjustment. A superimposed pressure is detected by the slave sensor and automatically compensated. See the following example:

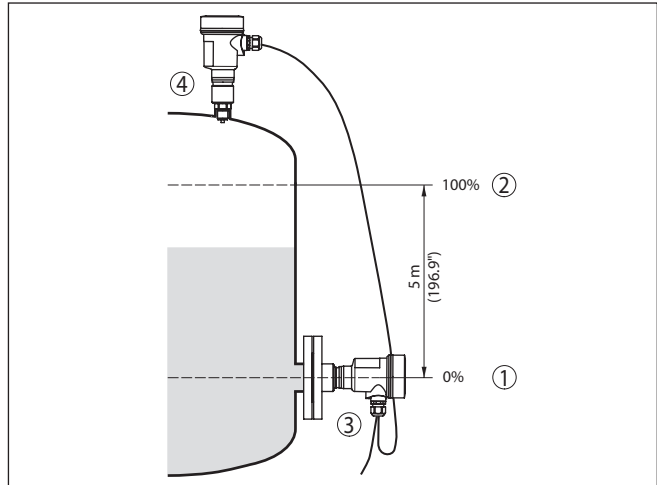


Fig. 24: Parameter adjustment example "Min./max. adjustment, level measurement"

- 1 Min. level = 0 % corresponds to 0.0 mbar
- 2 Max. level = 100 % corresponds to 490.5 mbar
- 3 IPT-2x
- 4 IPT-2x, slave sensor

If these values are not known, an adjustment with filling levels of e.g. 10 % and 90 % is also possible. By means of these settings, the real filling height is then calculated.

The actual product level during this adjustment is not important, because the min./max. adjustment is always carried out without changing the product level. These settings can be made ahead of time without the instrument having to be installed.



Note:

If the adjustment ranges are exceeded, the entered value will not be accepted. Editing can be interrupted with **[ESC]** or corrected to a value within the adjustment ranges.

For the other process variables such as e.g. process pressure, differential pressure or flow, the adjustment is performed in like manner.

Min. adjustment level

Proceed as follows:

1. Select the menu item "Setup" with [->] and confirm with [OK].
Now select with [->] the menu item "Adjustment", then "Min. adjustment" and confirm with [OK].



2. Edit the percentage value with [OK] and set the cursor to the requested position with [->].
3. Set the requested percentage value (e.g. 10 %) with [+] and save with [OK]. The cursor jumps now to the pressure value.
4. Enter the pressure value corresponding to the min. level (e.g. 0 mbar).
5. Save settings with [OK] and move with [ESC] and [->] to the max. adjustment.

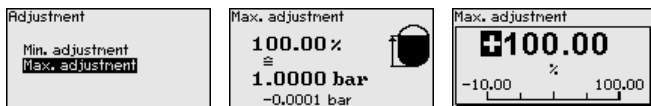
The min. adjustment is finished.

For an adjustment with filling, simply enter the actual measured value indicated at the bottom of the display.

Max. adjustment level

Proceed as follows:

1. Select with [->] the menu item Max. adjustment and confirm with [OK].



2. Edit the percentage value with [OK] and set the cursor to the requested position with [->].
3. Set the requested percentage value (e.g. 90 %) with [+] and save with [OK]. The cursor jumps now to the pressure value.
4. Enter the pressure value for the full vessel (e.g. 900 mbar) corresponding to the percentage value.
5. Save settings with [OK]

The max. adjustment is finished.

For an adjustment with filling, simply enter the actual measured value indicated at the bottom of the display.

Min. adjustment flow

Proceed as follows:

1. Select the menu item "Setup" with [->] and confirm with [OK].
Now select with [->] the menu item "Min. adjustment" and confirm with [OK].



2. Edit the mbar value with [OK] and set the cursor to the requested position with [->].

3. Set the requested mbar value with **[+]** and store with **[OK]**.
4. Change with **[ESC]** and **[>-]** to the span adjustment

With flow in two directions (bidirectional) a negative differential pressure is also possible. The maximum negative pressure must then be entered for the min. adjustment. For linearization, select "*bidirectional*" or "*bidirectional-extracted by root*" accordingly, see menu item "*Linearization*".

The min. adjustment is finished.

For an adjustment with pressure, simply enter the actual measured value indicated at the bottom of the display.

Max. adjustment flow

Proceed as follows:

1. Select with **[>-]** the menu item Max. adjustment and confirm with **[OK]**.



2. Edit the mbar value with **[OK]** and set the cursor to the requested position with **[>-]**.
3. Set the requested mbar value with **[+]** and store with **[OK]**.

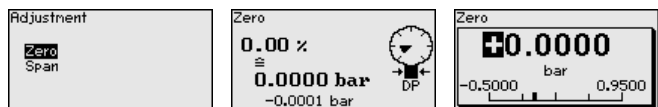
The max. adjustment is finished.

For an adjustment with pressure, simply enter the actual measured value indicated at the bottom of the display.

Zero adjustment differential pressure

Proceed as follows:

1. Select the menu item "*Setup*" with **[>-]** and confirm with **[OK]**.
Now select with **[>-]** the menu item "*Zero adjustment*" and confirm with **[OK]**.



2. Edit the mbar value with **[OK]** and set the cursor to the requested position with **[>-]**.
3. Set the requested mbar value with **[+]** and store with **[OK]**.
4. Change with **[ESC]** and **[>-]** to the span adjustment

The zero adjustment is finished.



Information:

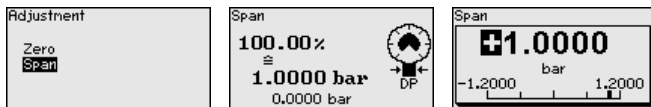
The Zero adjustment shifts the value of the span adjustment. The span, i.e. the difference between these values, however, remains unchanged.

For an adjustment with pressure, simply enter the actual measured value indicated at the bottom of the display.

Span adjustment differential pressure

Proceed as follows:

1. Select with **[->]** the menu item Span adjustment and confirm with **[OK]**.



2. Edit the mbar value with **[OK]** and set the cursor to the requested position with **[->]**.
3. Set the requested mbar value with **[+]** and store with **[OK]**.

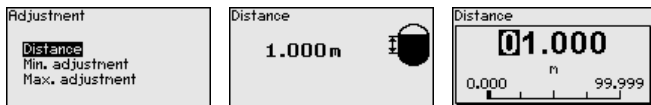
The span adjustment is finished.

For an adjustment with pressure, simply enter the actual measured value indicated at the bottom of the display.

Distance density

Proceed as follows:

- Select in the menu item "Setup" with **[->]** "Adjustment" and confirm with **[OK]**. Now confirm the menu item "Distance" with **[OK]**.



- Edit the sensor distance with **[OK]** and set the cursor to the requested position with **[->]**.
- Set the distance with **[+]** and save with **[OK]**.

The adjustment of the distance is hence finished.

Min. adjustment density

Proceed as follows:

1. Select the menu item "Setup" with **[->]** and confirm with **[OK]**. Now select with **[->]** the menu item "Min. adjustment" and confirm with **[OK]**.



2. Edit the percentage value with **[OK]** and set the cursor to the requested position with **[->]**.
3. Set the requested percentage value with **[+]** and save with **[OK]**. The cursor jumps now to the density value.
4. Enter the min. density corresponding to the percentage value.
5. Save settings with **[OK]** and move with **[ESC]** and **[->]** to the max. adjustment.

The min. adjustment for density is finished.

Max. adjustment density

Proceed as follows:

1. Select the menu item "Setup" with **[->]** and confirm with **[OK]**. Now select with **[->]** the menu item "Max. adjustment" and confirm with **[OK]**.



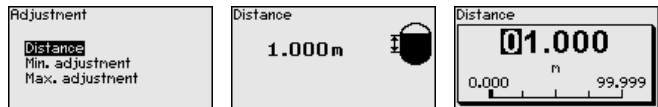
2. Edit the percentage value with **[OK]** and set the cursor to the requested position with **[->]**.
3. Set the requested percentage value with **[+]** and save with **[OK]**. The cursor jumps now to the density value.
4. Enter the max. density value corresponding to the percentage value.

The max. adjustment for density is finished.

Distance interface

Proceed as follows:

1. Select in the menu item "Setup" with **[->]** "Adjustment" and confirm with **[OK]**. Now confirm the menu item "Distance" with **[OK]**.



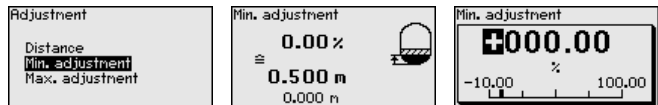
2. Edit the sensor distance with **[OK]** and set the cursor to the requested position with **[->]**.
3. Set the distance with **[+]** and save with **[OK]**.

The adjustment of the distance is hence finished.

Min. adjustment interface

Proceed as follows:

1. Select the menu item "Setup" with **[->]** and confirm with **[OK]**. Now select with **[->]** the menu item "Min. adjustment" and confirm with **[OK]**.



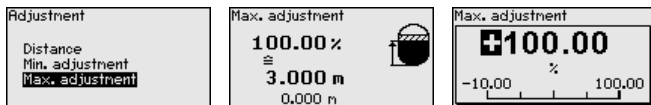
2. Edit the percentage value with **[OK]** and set the cursor to the requested position with **[->]**.
3. Set the requested percentage value with **[+]** and save with **[OK]**. The cursor jumps now to the height value.
4. Enter the min. height of the interface corresponding to the percentage value.
5. Save settings with **[OK]** and move with **[ESC]** and **[->]** to the max. adjustment.

The min. adjustment for interface is thus finished.

Max. adjustment interface

Proceed as follows:

1. Select the menu item "Setup" with **[->]** and confirm with **[OK]**. Now select with **[->]** the menu item "Max. adjustment" and confirm with **[OK]**.



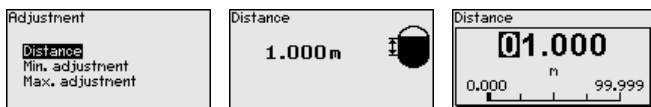
2. Edit the percentage value with **[OK]** and set the cursor to the requested position with **[->]**.
3. Set the requested percentage value with **[+]** and save with **[OK]**. The cursor jumps now to the height value.
4. Enter the max. height of the interface corresponding to the percentage value.

The max. adjustment for interface is finished.

Distance level density-compensated

Proceed as follows:

- Select in the menu item "Setup" with **[->]** "Adjustment" and confirm with **[OK]**. Now confirm the menu item "Distance" with **[OK]**.



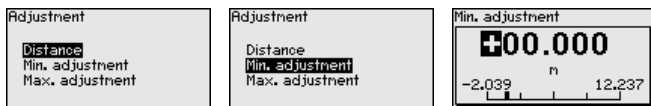
- Edit the sensor distance with **[OK]** and set the cursor to the requested position with **[->]**.
- Set the distance with **[+]** and save with **[OK]**.

The adjustment of the distance is hence finished.

Min. adjustment level density-compensated

Proceed as follows:

1. Select the menu item "Setup" with **[->]** and confirm with **[OK]**. Now select with **[->]** the menu item "Adjustment", then "Min. adjustment" and confirm with **[OK]**.



2. Edit the percentage value with **[OK]** and set the cursor to the requested position with **[->]**.
3. Set the requested percentage value (e.g. 0 %) with **[+]** and save with **[OK]**. The cursor jumps now to the pressure value.
4. Enter the value corresponding to the min. level (e.g. 0 m).
5. Save settings with **[OK]** and move with **[ESC]** and **[->]** to the max. adjustment.

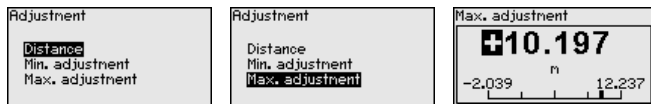
The min. adjustment is finished.

For an adjustment with filling, simply enter the actual measured value indicated at the bottom of the display.

Max. adjustment level density-compensated

Proceed as follows:

1. Select with **[->]** the menu item Max. adjustment and confirm with **[OK]**.



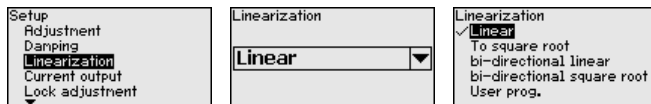
2. Edit the percentage value with **[OK]** and set the cursor to the requested position with **[->]**.
3. Set the requested percentage value (e.g. 100 %) with **[+]** and save with **[OK]**. The cursor jumps now to the pressure value.
4. Enter the value for the full vessel (e.g. 10 m) corresponding to the percentage value.
5. Save settings with **[OK]**

The max. adjustment is finished.

For an adjustment with filling, simply enter the actual measured value indicated at the bottom of the display.

Linearisation

A linearization is necessary for all applications in which the measured process variable does not increase linearly with the measured value. This applies for example to the flow measured via the differential pressure or the vessel volume measured via the level. Corresponding linearization curves are preprogrammed for such cases. They represent the correlation between the measured value percentage and process variable. The linearization applies to the measured value indication and the current output.



With flow measurement and selection "Linear" display and output (percentage/current) are linear to "Differential pressure". This can be used, for example, to feed a flow computer.

With flow measurement and selection "Extraction by root" display and output (percentage/current) are linear to "Flow".⁴⁾

With flow in two directions (bidirectional) a negative differential pressure is also possible. This must already be taken into account in menu item "Min. adjustment flow".



Caution:

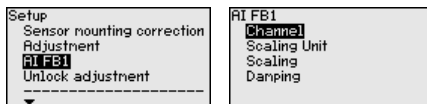
Note the following, if the respective sensor is used as part of an over-fill protection system according to WHG:

If a linearisation curve is selected, the measuring signal is no longer necessarily linear to the filling height. This must be considered by the user especially when setting the switching point on the limit signal transmitter.

AI FB1

Since the parameter adjustment of the Function Block 1 (FB1) is very comprehensive, it was divided into various submenu items.

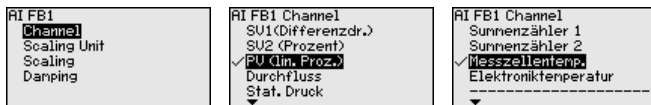
⁴⁾ The device assumes an approximately constant temperature and static pressure and calculates the flow rate from the measured differential pressure using the characteristic curve extracted by root.



AI FB1 - Channel

In menu item "Channel" you determine the input signal for further processing in AI FB 1.

As input signals, the output values of Transducer Block (TB) can be selected.



Lock adjustment

With this menu item you safeguard the sensor parameters against unauthorized or unintentional modifications.



To avoid possible errors during parameter adjustment in a non-safe environment, a verification procedure is used that enables reliable detection of parameter adjustment errors. In this procedure, safety-relevant parameters are verified before saving them in the instrument.

In addition, as a protection against unintentional or unauthorized adjustment, the instrument is locked against all parameter changes in normal operating condition.

1. Enter PIN

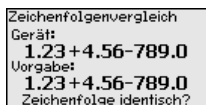


The instrument is shipped in locked condition. The PIN in the delivery status is "0000".

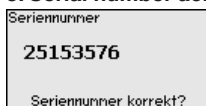
2. Character string comparison

You then have to carry out the character string comparison. This is used to check the character presentation.

Confirm if the two character strings are identical. The verification texts are provided in German and in the case of all other menu languages, in English.



3. Serial number acknowledgement



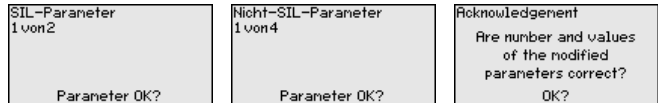
Afterwards you confirm that the serial number of your instrument was carried over correctly. This is used to check device communication.

4. Verify parameters

All safety-relevant parameters must be verified after a change:

- SIL parameter 1: Zero adjustment
- SIL parameter 2: Slave on/off
- Non-SIL parameter 1: Measured value presentation
- Non-SIL parameter 2: Display value 1, unit of the application
- Non-SIL parameter 3: Menu language
- Non-SIL parameter 4: Lighting

Confirm the modified values one after the other.



If the described process of parameter adjustment was run through completely and correctly, the instrument will be locked and hence ready for operation.



Otherwise the instrument remains in the released and hence unsafe condition.



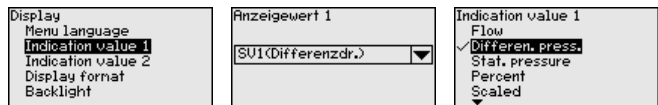
Information:

As long as the IPT-2x is powered, the display and adjustment module remains in the actually set adjustment menu. An automatic, time-controlled reset to the measured value indication is not carried out.

7.1.2 Display

Display value 1 and 2 - 4 ... 20 mA

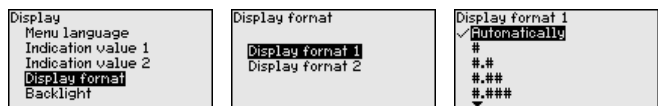
In this menu item, you define which measured value is displayed.



The default setting for the displayed value is "Differential pressure".

Display format 1 and 2

In this menu item you define the number of decimal positions with which the measured value is displayed.

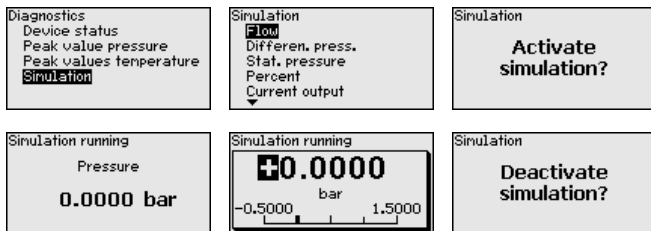


The default setting for the display format is "Automatic".

7.1.3 Diagnostics

Simulation 4 ... 20 mA/HART

In this menu item you can simulate measured values. This allows the signal path to be tested, e.g. through downstream indicating instruments or the input card of the control system.



Select the requested simulation variable and set the requested value.

To deactivate the simulation, you have to push the **[ESC]** key and confirm the message "Deactivate simulation" with the **[OK]** key.



Caution:

During simulation, the simulated value is output as 4 ... 20 mA current value and as digital HART signal. The status message within the context of the asset management function is "Maintenance".



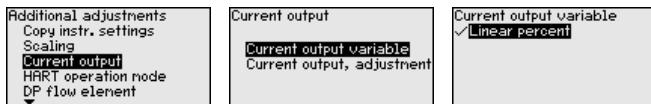
Note:

Without manual deactivation, the sensor terminates the simulation automatically after 60 minutes.

7.1.4 Additional adjustments

Current output 1 and 2 (size)

In menu item "Current output, variable" you specify which measured variable is output via the current output.

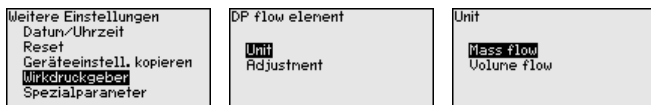


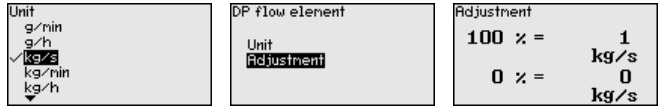
The following selection is possible depending on the selected application:

- Flow
- Height - Interface
- Density
- Differential pressure
- Static pressure
- Percent
- Scaled
- Percent linearized
- Measuring cell temperature (ceramic measuring cell)
- Electronics temperature

Characteristics values DP flow element

In this menu item, the units for the DP flow element are determined and the selection of mass or volume flow is carried out.





Furthermore the adjustment for the volume or mass flow rate at 0 % or 100 % is carried out.

8 Diagnosis, asset management and service

8.1 Maintenance

Maintenance

If the device is used properly, no special maintenance is required in normal operation.

In some applications, product buildup on the diaphragm can influence the measuring result. Depending on the sensor and application, take precautions to ensure that heavy buildup, and especially a hardening thereof, is avoided.

Proof test

To identify possible undetected, dangerous failures, the safety function of the instrument must be checked in adequate intervals by a proof test.



During the function test, the safety function must be treated as unsafe. Keep in mind that the function test influences downstream connected devices.

If one of the tests proves negative, the entire measuring system must be switched out of service and the process held in a safe state by means of other measures.

You can find detailed information on the proof test in the Safety Manual (SIL).

8.2 Rectify faults

Reaction when malfunction occurs

The operator of the system is responsible for taking suitable measures to rectify faults.

Fault rectification

The first measures are:

- Evaluation of fault messages
- Checking the output signal
- Treatment of measurement errors

Further comprehensive diagnostics options are available with a PC/notebook with PACTware and the suitable DTM. In many cases, the reasons can be determined in this way and faults rectified.

Reaction after fault rectification

Depending on the reason for the fault and the measures taken, the steps described in chapter "Setup" must be carried out again or must be checked for plausibility and completeness.

8.3 Exchange process module on version IP68 (25 bar)

On version IP68 (25 bar), the user can exchange the process module on site. Connection cable and external housing can be kept.

Required tools:

- Hexagon key wrench, size 2



Caution:

The exchange may only be carried out in the complete absence of line voltage.



In Ex applications, only a replacement part with appropriate Ex approval may be used.



Caution:

During exchange, protect the inner side of the parts against contamination and moisture.

Proceed as follows when carrying out the exchange:

1. Loosen the fixing screw with the hexagon key wrench
2. Carefully detach the cable assembly from the process module

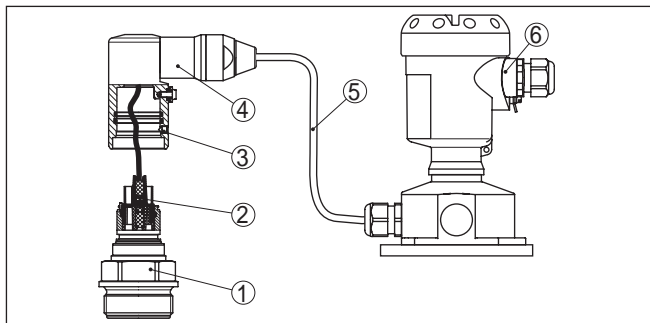


Fig. 25: IPT-2x in IP68 version, 25 bar and lateral cable outlet, external housing

- 1 Process module
- 2 Plug connector
- 3 Fixing screw
- 4 Cable assembly
- 5 Connection cable
- 6 External housing

3. Loosen the plug connector
 4. Mount the new process module on the measuring point
 5. Plug the connector back in
 6. Mount the cable assembly on the process module and turn it to the desired position
 7. Tighten the fixing screw with the hexagon key wrench
- The exchange is finished.

8.4 Instrument repair

You can find information for a return shipment under "Service" on our local website.

If a repair is necessary, please proceed as follows:

- Complete one form for each instrument
- If necessary, state a contamination
- Clean the instrument and pack it damage-proof
- Attach the completed form and possibly also a safety data sheet to the instrument

9 Dismount

9.1 Dismounting steps

**Warning:**

Before dismantling, be aware of dangerous process conditions such as e.g. pressure in the vessel or pipeline, high temperatures, corrosive or toxic media etc.

Take note of chapters "*Mounting*" and "*Connecting to voltage supply*" and carry out the listed steps in reverse order.

9.2 Disposal

The instrument consists of materials which can be recycled by specialised recycling companies. We use recyclable materials and have designed the electronics to be easily separable.

WEEE directive

The instrument does not fall in the scope of the EU WEEE directive. Article 2 of this Directive exempts electrical and electronic equipment from this requirement if it is part of another instrument that does not fall in the scope of the Directive. These include stationary industrial plants.

Pass the instrument directly on to a specialised recycling company and do not use the municipal collecting points.

If you have no way to dispose of the old instrument properly, please contact us concerning return and disposal.

10 Supplement

10.1 Technical data

Note for approved instruments

The technical data in the respective safety instructions which are included in delivery are valid for approved instruments (e.g. with Ex approval). These data can differ from the data listed herein, for example regarding the process conditions or the voltage supply.

All approval documents can be downloaded from our homepage.

Materials and weights

Materials, wetted (piezoresistive/strain gauge measuring cell)

Process fitting	316L
Diaphragm standard	316L
Diaphragm from measuring range 25 bar, Elgiloy (2.4711) with not flush version	
Seal ring, O-ring	FKM (VP2/A), EPDM (A+P 70.10-02), FFKM (Perlast G75S), FEPM (Fluoraz SD890)
Seal for process fitting (in the scope of delivery)	
– Thread G½ (EN 837)	Klingersil C-4400

Materials, wetted (ceramic/metallic measuring cell)

Process fitting	316L
Diaphragm	Alloy C276 (2.4819), gold-coated 20 µ, gold/rhodium-coated 5 µ/1 µ ⁵⁾
Seal for process fitting (in the scope of delivery)	
– Thread G1½ (DIN 3852-A)	Klingersil C-4400
– Thread M44 x 1.25 (DIN 13)	FKM, FFKM, EPDM

Materials for applications in foodstuffs

Surface quality, hygienic process fittings, $R_a < 0.8 \mu\text{m}$ typ.

Seal below wall mounting plate with 3A approval EPDM

Materials, non-wetted parts

Type label support on connection cable	PE hard
Isolating liquid ceramic/metallic measuring cell	KN 92 medical white oil (FDA conform)
Internal transmission liquid piezoresistive measuring cell	Synthetic oil, Halocarbon oil ⁶⁾⁷⁾
Housing	
– Plastic housing	Plastic PBT (Polyester)

⁵⁾ Not on instruments with SIL qualification.

⁶⁾ Synthetic oil for measuring ranges up to 40 bar, FDA listed for the food processing industry. For measuring ranges up to 100 bar dry measuring cell.

⁷⁾ Halocarbon oil: Generally in oxygen applications, not with vacuum measuring ranges, not with absolute measuring ranges < 1 bar_{abs}.

– Aluminium die-cast housing	Aluminium die-casting AlSi10Mg, powder-coated (Basis: Polyester)
– Stainless steel housing	316L
– Cable gland	PA, stainless steel, brass
– Sealing, cable gland	NBR
– Blind plug, cable gland	PA
– Seal between housing and housing lid	Silicone SI 850 R, NBR silicone-free
– Inspection window housing cover	Polycarbonate (UL-746-C listed), glass ⁸⁾
– Ground terminal	316L
External housing	
– Housing	Plastic PBT (Polyester), 316L
– Socket, wall mounting plate	Plastic PBT (Polyester), 316L
– Seal between base and wall mounting plate	EPDM (fixed connected)
Inspection window in housing cover	Polycarbonate, UL746-C listed (with Ex-d version: glass)
Seal, housing lid	Silicone SI 850 R, NBR silicone-free
Ground terminal	316Ti/316L
Connection cable to the master sensor	PE, PUR
Weights	
Total weight IPT-2x	approx. 0.8 ... 8 kg (1.764 ... 17.64 lbs), depending on process fitting and housing

Torques

Max. torque, metric process fittings

– G¼, G½	50 Nm (36.88 lbf ft)
– G½ front-flush, G1 front-flush	40 Nm (29.50 lbf ft)
– G1½ front-flush (piezoresistive measuring cell)	40 Nm (29.50 lbf ft)
– G1½ front-flush (ceramic/metallic measuring cell)	200 Nm (147.5 lbf ft)

Max. torque, non-metric process fittings

– ½ NPT inside, ¼ NPT, ≤ 40 bar/500 psig	50 Nm (36.88 lbf ft)
– ½ NPT inside, ¼ NPT, > 40 bar/500 psig	200 Nm (147.5 lbf ft)
– 7/16 NPT for tube ¼"	40 Nm (29.50 lbf ft)
– 9/16 NPT for tube 3/8"	50 Nm (36.88 lbf ft)

Max. torque for NPT cable glands and Conduit tubes

– Plastic housing	10 Nm (7.376 lbf ft)
– Aluminium/Stainless steel housing	50 Nm (36.88 lbf ft)

⁸⁾ Glass with Aluminium and stainless steel precision casting housing

Input variable - Piezoresistive/Strain gauge measuring cell

The specifications are only an overview and refer to the measuring cell. Limitations due to the material and version of the process fitting as well as the selected pressure type are possible. The specifications on the nameplate apply.⁹⁾

Nominal measuring ranges and overload capability in bar/kPa

Nominal range	Overload capability	
	Maximum pressure	Minimum pressure
Gauge pressure		
0 ... +0.4 bar/0 ... +40 kPa	+1.2 bar/+120 kPa	-1 bar/-100 kPa
0 ... +1 bar/0 ... +100 kPa	+3 bar/+300 kPa	-1 bar/-100 kPa
0 ... +2.5 bar/0 ... +250 kPa	+7.5 bar/+750 kPa	-1 bar/-100 kPa
0 ... +5 bar/0 ... +250 kPa	+15 bar/+1500 kPa	-1 bar/-100 kPa
0 ... +10 bar/0 ... +1000 kPa	+30 bar/+3000 kPa	-1 bar/-100 kPa
0 ... +16 bar/0 ... +1600 kPa	+48 bar/+5000 kPa	-1 bar/-100 kPa
0 ... +25 bar/0 ... +2500 kPa	+75 bar/+7500 kPa	-1 bar/-100 kPa
0 ... +40 bar/0 ... +4000 kPa	+120 bar/+12 MPa	-1 bar/-100 kPa
0 ... +60 bar/0 ... +6000 kPa	+180 bar/+18 MPa	-1 bar/-100 kPa
0 ... +100 bar/0 ... +10 MPa	+200 bar/+20 MPa	-1 bar/-100 kPa
0 ... +160 bar/0 ... +10 MPa	+320 bar/+20 MPa	-1 bar/-100 kPa
0 ... +250 bar/0 ... +25 MPa	+500 bar/+20 MPa	-1 bar/-100 kPa
0 ... +400 bar/0 ... +40 MPa	+800 bar/+80 MPa	-1 bar/-100 kPa
0 ... +600 bar/0 ... +60 MPa	+1200 bar/+120 MPa	-1 bar/-100 kPa
0 ... +1000 bar/0 ... +100 MPa	+1500 bar/+150 MPa	-1 bar/-100 kPa
-1 ... 0 bar/-100 ... 0 kPa	+3 bar/+300 kPa	-1 bar/-100 kPa
-1 ... +1.5 bar/-100 ... +150 kPa	+7.5 bar/+750 kPa	-1 bar/-100 kPa
-1 ... +5 bar/-100 ... +500 kPa	+15 bar/+1500 kPa	-1 bar/-100 kPa
-1 ... +10 bar/-100 ... +1000 kPa	+30 bar/+3000 kPa	-1 bar/-100 kPa
-1 ... +25 bar/-100 ... +2500 kPa	+75 bar/+7500 kPa	-1 bar/-100 kPa
-1 ... +40 bar/-100 ... +4000 kPa	+120 bar/+12 MPa	-1 bar/-100 kPa
-0.2 ... +0.2 bar/-20 ... +20 kPa	+1.2 bar/+120 kPa	-1 bar/-100 kPa
-0.5 ... +0.5 bar/-50 ... +50 kPa	+3 bar/+300 kPa	-1 bar/-100 kPa
Absolute pressure		
0 ... 1 bar/0 ... 100 kPa	3 bar/300 kPa	0 bar abs.
0 ... 2.5 bar/0 ... 250 kPa	7.5 bar/750 kPa	0 bar abs.
0 ... 5 bar/0 ... 500 kPa	15 bar/1500 kPa	0 bar abs.
0 ... 10 bar/0 ... 1000 kPa	30 bar/3000 kPa	0 bar abs.
0 ... 16 bar/0 ... 1600 kPa	50 bar/5000 kPa	0 bar abs.

⁹⁾ Data on overload capability apply for reference temperature.

Nominal range	Overload capability	
	Maximum pressure	Minimum pressure
0 ... 25 bar/0 ... 2500 kPa	75 bar/+7500 kPa	0 bar abs.
0 ... 40 bar/0 ... 4000 kPa	120 bar/+12 MPa	0 bar abs.

Input variable - Ceramic/metallic measuring cell

The specifications are only an overview and refer to the measuring cell. Limitations due to the material and version of the process fitting are possible. The specifications on the nameplate apply.¹⁰⁾

Nominal measuring ranges and overload capability in bar/kPa

Nominal range	Overload capability	
	Maximum pressure	Minimum pressure
Gauge pressure		
0 ... +0.1 bar/0 ... +10 kPa	+15 bar/+1500 kPa	-1 bar/-100 kPa
0 ... +0.4 bar/0 ... +40 kPa	+30 bar/+3000 kPa	-1 bar/-100 kPa
0 ... +1 bar/0 ... +100 kPa	+35 bar/+3500 kPa	-1 bar/-100 kPa
0 ... +2.5 bar/0 ... +250 kPa	+50 bar/+5000 kPa	-1 bar/-100 kPa
0 ... +10 bar/0 ... +1000 kPa	+50 bar/+5000 kPa	-1 bar/-100 kPa
0 ... +25 bar/0 ... +2500 kPa	+50 bar/+5000 kPa	-1 bar/-100 kPa
-1 ... 0 bar/-100 ... 0 kPa	+35 bar/+3500 kPa	-1 bar/-100 kPa
-1 ... +1.5 bar/-100 ... +150 kPa	+50 bar/+5000 kPa	-1 bar/-100 kPa
-1 ... +10 bar/-100 ... +1000 kPa	+50 bar/+5000 kPa	-1 bar/-100 kPa
-1 ... +25 bar/-100 ... +2500 kPa	+50 bar/+5000 kPa	-1 bar/-100 kPa
-0.2 ... +0.2 bar/-20 ... +20 kPa	+20 bar/+3000 kPa	-1 bar/-100 kPa
-0.5 ... +0.5 bar/-50 ... +50 kPa	+35 bar/+3500 kPa	-1 bar/-100 kPa
Absolute pressure		
0 ... 1 bar/0 ... 100 kPa	35 bar/3500 kPa	0 bar abs.
0 ... 2.5 bar/0 ... 250 kPa	50 bar/5000 kPa	0 bar abs.
0 ... 10 bar/0 ... 1000 kPa	50 bar/5000 kPa	0 bar abs.
0 ... 25 bar/0 ... 2500 kPa	50 bar/5000 kPa	0 bar abs.

Nominal measuring ranges and overload capacity in psi

Nominal range	Overload capability	
	Maximum pressure	Minimum pressure
Gauge pressure		
0 ... +1.5 psig	+220 psig	-14.5 psig
0 ... +5 psig	+435 psig	-14.5 psig

¹⁰⁾ Data on overload capability apply for reference temperature.

Nominal range	Overload capability	
	Maximum pressure	Minimum pressure
0 ... +15 psig	+510 psig	-14.5 psig
0 ... +30 psig	+725 psig	-14.5 psig
0 ... +150 psig	+725 psig	-14.5 psig
0 ... +300 psig	+725 psig	-14.5 psig
-14.5 ... 0 psig	+510 psig	-14.5 psig
-14.5 ... +20 psig	+725 psig	-14.5 psig
-14.5 ... +150 psig	+725 psig	-14.5 psig
-14.5 ... +300 psig	+725 psig	-14.5 psig
-3 ... +3 psig	+290 psi	-14.5 psig
-7 ... +7 psig	+525 psig	-14.5 psig
Absolute pressure		
0 ... 15 psi	525 psi	0 psi
0 ... 30 psi	725 psi	0 psi
0 ... 150 psi	725 psig	0 psi
0 ... 300 psi	725 psig	0 psi

Adjustment ranges

Specifications refer to the nominal measuring range, pressure values lower than -1 bar cannot be set

Level (min./max. adjustment)

- Percentage value -10 ... 110 %
- Pressure value -120 ... 120 %

Flow (min./max. adjustment)

- Percentage value 0 or 100 % fix
- Pressure value -120 ... 120 %

Differential pressure (zero/span adjustment)

- Zero -95 ... +95 %
- Span -120 ... +120 %

Density (min./max. adjustment)

- Percentage value -10 ... 100 %
- Density value according to the measuring ranges in kg/dm³

Interface (min./max. adjustment)

- Percentage value -10 ... 100 %
- Level value according to the measuring ranges in m

Max. permissible Turn Down

Unlimited (recommended 20 : 1)

Max. permissible turn down with SIL applications

10 : 1

Dynamic behaviour output

Dynamic characteristics depending on medium and temperature

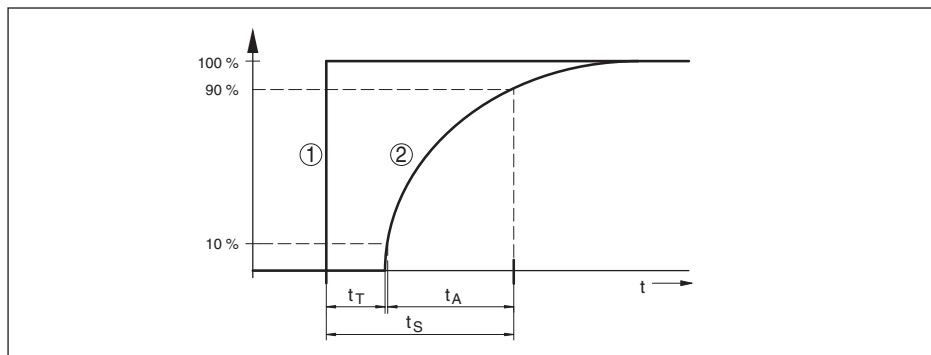


Fig. 26: Behaviour in case of sudden change of the process variable. t_T : dead time; t_A : rise time; t_S : jump response time

1 Process variable

2 Output signal

	IPT-2x	IPT-2x - IP68 (25 bar)
Dead time	≤ 25 ms	≤ 50 ms
Rise time (10 ... 90 %)	≤ 55 ms	≤ 150 ms
Step response time (ti: 0 s, 10 ... 90 %)	≤ 80 ms	≤ 200 ms

Damping (63 % of the input variable) 0 ... 999 s, adjustable via menu item "Damping"

Reference conditions and influencing variables (according to DIN EN 60770-1)

Reference conditions according to DIN EN 61298-1

– Temperature	+18 ... +30 °C (+64 ... +86 °F)
– Relative humidity	45 ... 75 %
– Air pressure	860 ... 1060 mbar/86 ... 106 kPa (12.5 ... 15.4 psi)
Determination of characteristics	Limit point adjustment according to IEC 61298-2
Characteristic curve	Linear
Reference installation position	upright, diaphragm points downward
Influence of the installation position	
– Piezoresistive/strain gauge measuring cell	depending on the process fitting and the chemical seal
– Ceramic/metallic measuring cell	< 5 mbar/0.5 kPa (0.07 psig)
Deviation in the current output due to strong, high-frequency electromagnetic fields acc. to EN 61326-1	< ±150 µA

Deviation (according to IEC 60770-1)

Specifications refer to the set span. Turn down (TD) is the ratio: nominal measuring range/set span.

Accuracy class	Non-linearity, hysteresis and repeatability with TD 1 : 1 up to 5 : 1	Non-linearity, hysteresis and repeatability with 5 : 1
0.075 %	< 0.075 %	< 0.015 % x TD
0.1 %	< 0.1 %	< 0.02 % x TD
0.2 %	< 0.2 %	< 0.04 % x TD

Influence of the product temperature

Thermal change zero signal and output span

Turn down (TD) is the relation nominal measuring range/adjusted span.

The thermal change of the zero signal and output span corresponds to the value F_T in chapter "Calculation of the total deviation (according to DIN 16086)".

Piezoresistive/strain gauge measuring cell

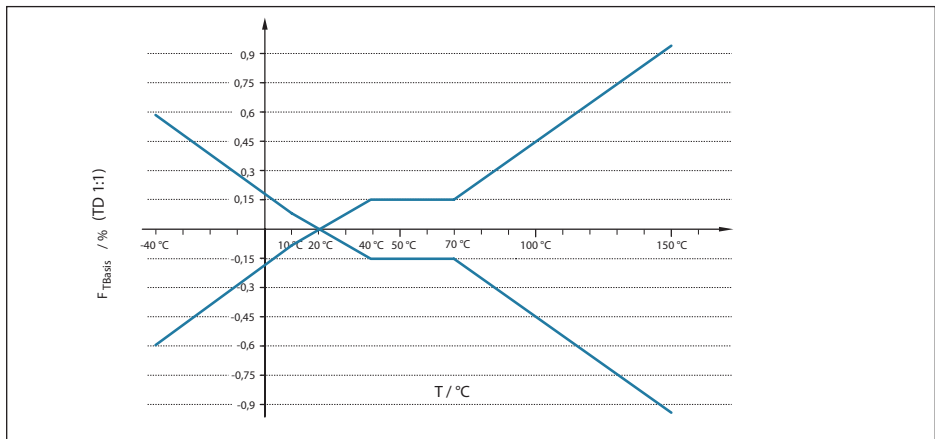


Fig. 27: Basic temperature error F_{TBasis} at TD 1 : 1

The basic temperature error in % from the above graphic can increase due to the additional factors such as accuracy class (factor FMZ) and Turn Down (factor FTD). The additional factors are listed in the following tables.

Additional factor through accuracy class

Accuracy class	0.075 %, 0.1 %	0.2 %
Factor FMZ	1	3

Additional factor through Turn Down

The additional factor FTD through Turn down is calculated according to the following formula:

$$F_{TD} = 0.5 \times TD + 0.5$$

In the table, example values for typical Turn downs are listed.

Turn down	TD 1 : 1	TD 2.5 : 1	TD : 1	TD 10 : 1	TD 20 : 1
Factor FTD	1	1.75	3	5.5	10.5

Ceramic/Metal measuring cell - Standard

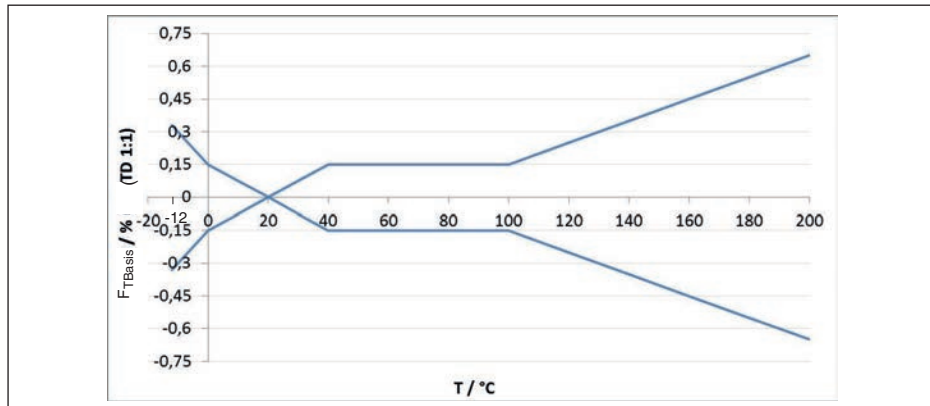


Fig. 28: Basic temperature error F_{TBasis} at TD 1 : 1

The basic temperature error in % from the above graphic can increase due to the additional factors, depending on the measuring cell version (factor FMZ) and the Turn Down (factor FTD). The additional factors are listed in the following tables.

Additional factor through measuring cell version

Measuring cell version	Measuring cell - Standard	
	0.075 %, 0.1 %	0.2 %
Factor FMZ	1	3

Additional factor through Turn Down

The additional factor FTD through Turn down is calculated according to the following formula:

$$F_{TD} = 0.5 \times TD + 0.5$$

In the table, example values for typical Turn downs are listed.

Turn down	TD 1 : 1	TD 2.5 : 1	TD 5 : 1	TD 10 : 1	TD 20 : 1
Factor FTD	1	1.75	3	5.5	10.5

Long-term stability (according to DIN 16086)

Applies to the respective **digital** signal output (e.g. HART, Profibus PA) as well as to **analogue** current output 4 ... 20 mA under reference conditions. Specifications refer to the set span. Turn down (TD) is the ratio nominal measuring range/set span.¹¹⁾

Long-term stability - Ceramic/metallic measuring cell

Time period	
One year	< 0.05 % x TD
Five years	< 0.1 % x TD

¹¹⁾ With ceramic/metallic measuring cell with gold-coated diaphragm, the values must be multiplied with factor 3.

Time period	
Ten years	< 0.2 % x TD

Long-term stability - Piezoresistive/Strain gauge measuring cell

Version	
Measuring ranges > 1 bar	< 0.1 % x TD/year
Measuring ranges > 1 bar, isolating liquid, synthetic oil, diaphragm Elgiloy (2.4711)	< 0.15 % x TD/year
Measuring range 1 bar	< 0.15 % x TD/year
Measuring range 0.4 bar	< 0.35 % x TD/year

Process conditions - Piezoresistive/Strain gauge measuring cell

Process temperature

Seal	Sensor version				
	Standard	Extended temperature range	Hygienic fittings		Version for oxygen applications
	$p_{abs} \geq 1 \text{ mbar}$		$p_{abs} \geq 1 \text{ mbar}$	$p_{abs} \geq 10 \text{ mbar}$	$p_{abs} \geq 10 \text{ mbar}$
Without consideration of the seal ¹²⁾	-20/-40 ... +105 °C (-4/-40 ... +221 °F)	-	-	-	-20 ... +60 °C (-4 ... +140 °F)
FKM (VP2/A)	-20 ... +105 °C (-4 ... +221 °F)	-20 ... +150 °C (-4 ... +302 °F)	-20 ... +85 °C (-4 ... +185 °F)	-20 ... +150 °C (-4 ... +302 °F)	
EPDM (A+P 70.10-02)					
FFKM (Perlast G75S)	-15 ... +105 °C (+5 ... +221 °F)	-15 ... +150 °C (+5 ... +302 °F)	-15 ... +85 °C (+5 ... +185 °F)	-15 ... +150 °C (+5 ... +302 °F)	-15 ... +60 °C (+5 ... +140 °F)
FEPM (Fluoraz SD890)	-5 ... +105 °C (+23 ... +221 °F)	-	-	-	-5 ... +60 °C (+23 ... +140 °F)

Temperature derating

¹²⁾ Process fittings acc. to DIN 3852-A, EN 837

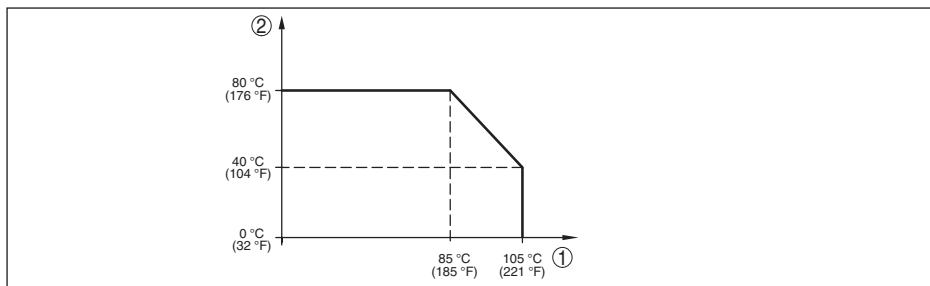


Fig. 29: Temperature derating IPT-2x, version up to +105 °C (+221 °F)

- 1 Process temperature
- 2 Ambient temperature

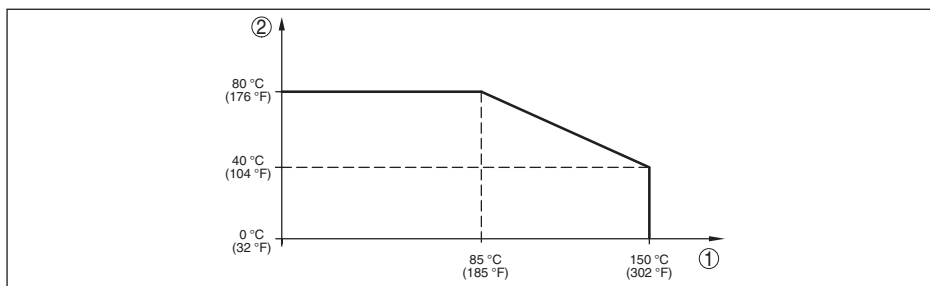


Fig. 30: Temperature derating IPT-2x, version up to +150 °C (+302 °F)

- 1 Process temperature
- 2 Ambient temperature

SIP process temperature (SIP = Sterilization in place)

Vapour stratification for 2 h¹³⁾ +150 °C (+302 °F)

Process pressure

Permissible process pressure see specification "Process pressure" on the type label

Mechanical stress

Version	Without cooling zone		With cooling zone	
	All housing versions	Double chamber stainless steel housing	All housing versions	Double chamber stainless steel housing
Vibration resistance 1 to 4 g at 5 ... 200 Hz according to EN 60068-2-6 (vibration with resonance)	4 g (GL characteristics 2)	0.7 g (GL characteristics 1)	4 g (GL characteristics 2)	0.7 g (GL characteristics 1)
Shock resistance 2.3 ms according to EN 60068-2-27 (mechanical shock)	50 g		50 g	20 g

¹³⁾ Instrument configuration suitable for vapour

Process conditions - Ceramic/metallic measuring cell

Process temperature

Version	Temperature range		
	$p_{abs} \geq 50 \text{ mbar}$	$p_{abs} \geq 10 \text{ mbar}$	$p_{abs} \geq 1 \text{ mbar}$
Standard	-12 ... +150 °C (+10 ... +284 °F)		
Extended temperature range	-12 ... +180 °C (+10 ... +356 °F)	-12 ... +160 °C (+10 ... +320 °F)	-12 ... +120 °C (+10 ... +248 °F)
	-12 ... +200 °C (+10 ... +392 °F)		

Temperature derating

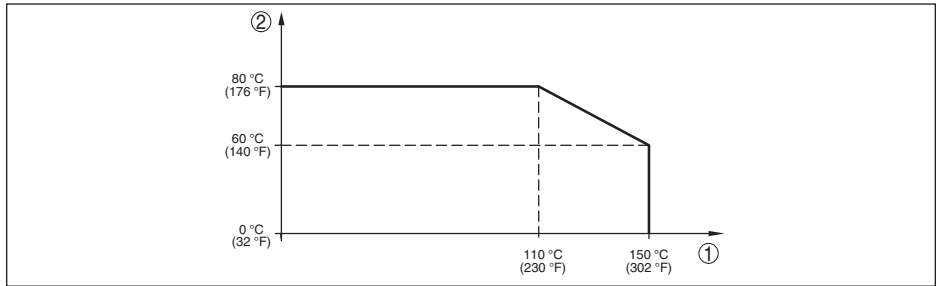


Fig. 31: Temperature derating IPT-2x, version up to +150 °C (+302 °F)

- 1 Process temperature
- 2 Ambient temperature

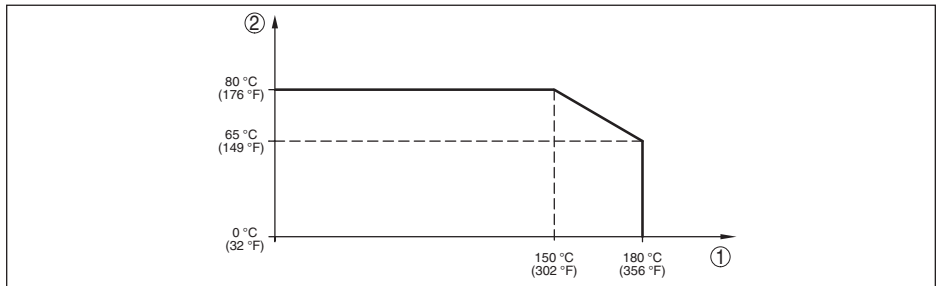


Fig. 32: Temperature derating IPT-2x, version up to +180 °C (+356 °F)

- 1 Process temperature
- 2 Ambient temperature

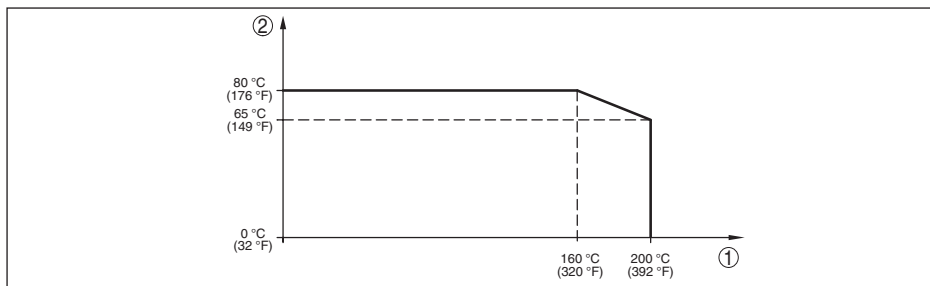


Fig. 33: Temperature derating IPT-2x, version up to +200 °C (+392 °F)

1 Process temperature

2 Ambient temperature

Process pressure

Permissible process pressure

see specification "Process pressure" on the type label

Mechanical stress¹⁴⁾

Vibration resistance 1 to 4 g at

4 g

5 ... 200 Hz according to EN 60068-2-6

(vibration with resonance)

Shock resistance

50 g, 2.3 ms according to EN 60068-2-27 (mechanical shock)¹⁵⁾

Ambient conditions

Version	Ambient temperature	Storage and transport temperature
Standard version	-40 ... +80 °C (-40 ... +176 °F)	-60 ... +80 °C (-76 ... +176 °F)
Version IP66/IP68 (1 bar)	-20 ... +80 °C (-4 ... +176 °F)	-20 ... +80 °C (-4 ... +176 °F)
Version IP68 (25 bar), with connection cable PUR	-20 ... +80 °C (-4 ... +176 °F)	-20 ... +80 °C (-4 ... +176 °F)
Version IP68 (25 bar), connection cable PE	-20 ... +60 °C (-4 ... +140 °F)	-20 ... +60 °C (-4 ... +140 °F)

Electromechanical data - version IP66/IP67 and IP66/IP68 (0.2 bar)¹⁶⁾

Options of the cable entry

- Cable entry M20 x 1.5; ½ NPT
- Cable gland M20 x 1.5; ½ NPT (cable diameter see below table)
- Blind plug M20 x 1.5; ½ NPT
- Closing cap ½ NPT

Material cable gland/Seal insert	Cable diameter		
	5 ... 9 mm	6 ... 12 mm	7 ... 12 mm
PA/NBR	●	●	-

¹⁴⁾ Depending on the instrument version.

¹⁵⁾ 2 g with housing version stainless steel double chamber

¹⁶⁾ IP66/IP68 (0.2 bar), only with absolute pressure.

Material cable gland/Seal insert	Cable diameter		
	5 ... 9 mm	6 ... 12 mm	7 ... 12 mm
Brass nickel-plated/NBR	●	●	–
Stainless steel/NBR	–	–	●

Wire cross-section (spring-loaded terminals)

- Massive wire, stranded wire 0.2 ... 2.5 mm² (AWG 24 ... 14)
- Stranded wire with end sleeve 0.2 ... 1.5 mm² (AWG 24 ... 16)

Electromechanical data - version IP68 (25 bar)

Connection cable transmitter - external housing, mechanical data

- Configuration Wires, strain relief, breather capillaries, screen braiding, metal foil, mantle¹⁷⁾
- Standard length 5 m (16.40 ft)
- Max. length 180 m (590.5 ft)
- Min. bending radius at 25 °C/77 °F 25 mm (0.985 in)
- Diameter approx. 8 mm (0.315 in)
- Material PE, PUR
- Colour Black, blue

Connection cable transmitter - external housing, electrical data

- Wire cross-section 0.5 mm² (AWG 20)
- Wire resistance 0.037 Ω/m (0.012 Ω/ft)

Interface to the Master sensor

Data transmission Digital (I²C-Bus)

Connection cable Slave - Master, mechanical data

- Configuration Cores, strain relief, braided, metal foil, jacket
- Standard length 5 m (16.40 ft)
- Max. length 25 m (82.02 ft)
- Min. bending radius (at 25 °C/77 °F) 25 mm (0.985 in)
- Diameter approx. 8 mm (0.315 in), approx. 6 mm (0.236 in)
- Material PE, PUR
- Colour Black

Connection cable Slave - Master, electrical data

- Wire cross-section 0.34 mm² (AWG 22)
- Wire resistance < 0.05 Ω/m (0.015 Ω/ft)

Voltage supply for the complete system through Master

Operating voltage

- U_{B min} 12 V DC
- U_{B min} with lighting switched on 16 V DC

¹⁷⁾ Breather capillaries not with Ex-d version.

– $U_{B \max}$ Depending on signal output and version of the master sensor

Potential connections and electrical separating measures in the instrument

Electronics	Not non-floating
Reference voltage ¹⁸⁾	500 V AC
Conductive connection	Between ground terminal and metallic process fitting

Electrical protective measures

Housing material	Version	Protection acc. to IEC 60529	Protection acc. to NEMA
Plastic	Single chamber	IP66/IP67	Type 4x
Aluminium		IP66/IP67	Type 4x
		IP66/IP68 (0.2 bar)	Type 6P
Stainless steel (electro-polished)		IP66/IP67	Type 4x
		IP69K	-
Stainless steel (precision casting)		IP66/IP67	Type 4x
	IP66/IP68 (0.2 bar)	Type 6P	
Stainless steel	Transmitter for external housing	IP68 (25 bar)	-

Altitude above sea level

- by default up to 2000 m (6562 ft)
- with connected overvoltage protection on the master sensor up to 5000 m (16404 ft)

Pollution degree¹⁹⁾ 4

Protection rating (IEC 61010-1) II

10.2 Calculation of the total deviation

The total deviation of a pressure transmitter indicates the maximum measurement error to be expected in practice. It is also called maximum practical deviation or operational error.

According to DIN 16086, the total deviation F_{total} is the sum of the basic deviation F_{perf} and the long-term stability F_{stab} :

$$F_{\text{total}} = F_{\text{perf}} + F_{\text{stab}}$$

The basic deviation F_{perf} consists of the thermal change of the zero signal and the output span F_T as well as the deviation F_{KI} :

$$F_{\text{perf}} = \sqrt{(F_T)^2 + (F_{KI})^2}$$

The thermal change of zero signal and output span F_T is specified in chapter "Technical data". The basic temperature error F_T is shown in a graphic. Depending on the measuring cell version and Turn down, this value must be multiplied with the additional factors FMZ and FTD:

$$F_T \times \text{FMZ} \times \text{FTD}$$

Also these values are specified in chapter "Technical data".

¹⁸⁾ Galvanic separation between electronics and metal housing parts

¹⁹⁾ When used with fulfilled housing protection.

This applies for a digital signal output through HART, Profibus PA or Foundation Fieldbus.
With a 4 ... 20 mA output, the thermal change of the current output F_a must be added:

$$F_{\text{perf}} = \sqrt{((F_T)^2 + (F_{Kl})^2 + (F_a)^2)}$$

To provide a better overview, the formula symbols are listed together below:

- F_{total} : Total deviation
- F_{perf} : Basic deviation
- F_{stab} : Long-term stability
- F_T : Thermal change of zero signal and output span (temperature error)
- F_{Kl} : Deviation
- F_a : Thermal change of the current output
- FMZ: Additional factor measuring cell version
- FTD: Additional factor Turn down

10.3 Practical example

Data

Level measurement in a small vessel, 500 mm height corresponds to **0.049 bar** (4.9 KPa), superimposed pressure 0.35 bar (35 KPa), medium temperature 40 °C

IPT-2x Master and slave sensor each with nominal measuring range **0.4 bar** (40 KPa), deviation < 0.1 %, process fitting G1 (piezoresistive measuring cell)

The required values for the temperature error F_T , deviation F_{Kl} and long-term stability F_{stab} are available in the technical data.

1. Calculation of the Turn down

$TD = 0.4 \text{ bar} / 0.049 \text{ bar}$, $TD = \mathbf{8.2 : 1}$

2. Determination temperature error F_T

The temperature error F_T consists of the basic temperature error F_{TBasis} , the additional factor measuring cell F_{MZ} and the additional factor Turn Down F_{TD} .

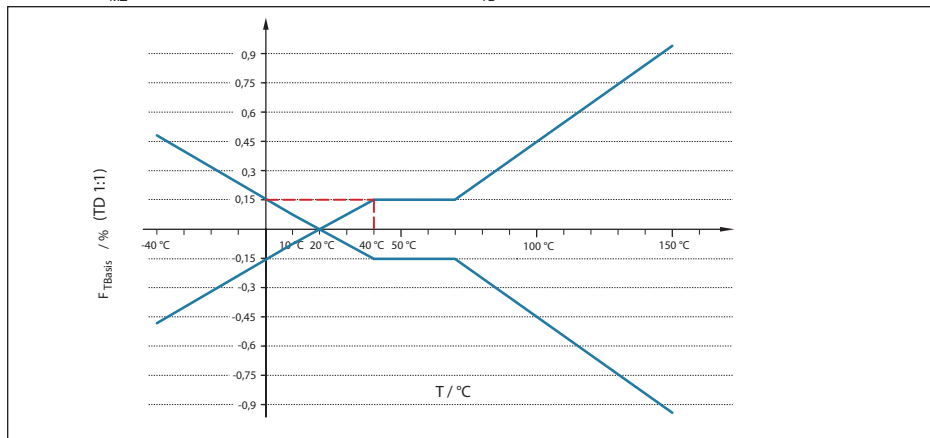


Fig. 34: Determination of the basic temperature error for the above example: $F_{\text{TBasis}} = \mathbf{0.15 \%}$

Accuracy class	In the compensated temperature range of 10 ... +70 °C	
	0.075 %, 0.1 %	0.2 %
Factor FMZ	1	3

Tab. 19: Determination of the additional factor measuring cell for above example: $F_{MZ} = 1$

The additional factor FTD through Turn down is calculated according to the following formula:

$F_{TD} = 0.5 \times TD + 0.5$, with TD = 8.2:1 of above calculation

$F_{TD} = 0.5 \times 8.2 + 0.5 = 4.6$

Determination of the temperature error master sensor for above example:

$F_T = F_{TBasis} \times F_{MZ} \times F_{TD}$

$F_T = 0.15 \% \times 1 \times 4.6$

$F_T = 0.69 \%$

The temperature error of each sensor is hence 0.69 %

3. Determination of deviation and long-term stability

The required values for deviation F_{KI} and long-term stability F_{stab} are available in the technical data:

Accuracy class	Non-linearity, hysteresis and non-repeatability	
	TD ≤ 5 : 1	TD > 5 : 1
0.075 %	< 0.075 %	< 0.015 % x TD
0.1 %	< 0.1 %	< 0.02 % x TD
0.2 %	< 0.2 %	< 0.04 % x TD

Tab. 20: Determination of the deviation from the table: $F_{KI} = 0.02 \% \times TD = 0.02 \% \times 8.2 = 0.16 \%$

Version	
Measuring ranges > 1 bar	< 0.1 % x TD/year
Measuring ranges > 1 bar, isolating liquid, synthetic oil, diaphragm Elgiloy (2.4711)	< 0.15 % x TD/year
Measuring range 1 bar	< 0.15 % x TD/year
Measuring range 0.4 bar	< 0.35 % x TD/year

Determination of the long-term stability from the table, consideration for one year: $F_{stab} = 0.1 \% \times 8.2 = 0.82 \%$

4. Calculation of the total deviation

- 1. step: Basic accuracy F_{perf}

$F_{perf} = \sqrt{(F_T)^2 + (F_{KI})^2}$

$F_T = 0.69 \%$

$F_{KI} = 0.16 \%$ (calculation of above table)

$F_{perf} = \sqrt{(0.69 \%)^2 + (0.16 \%)^2}$

$F_{perf} = 0.71 \%$

- 2. step: Total deviation F_{total}

$F_{total} = F_{perf} + F_{stab}$

$$F_{\text{perf}} = 0.71 \% \text{ (result of step 1)}$$

$$F_{\text{stab}} = 0.82 \% \text{ (from top)}$$

$$F_{\text{total}} = 0.71 \% + 0.82 \% = 1.53 \%$$

The total deviation of each sensor is hence 1.53 %.

5. Calculation of the total deviation of the measuring system

Both sensors are included in the calculation of the total deviation of the measuring system. With 4 ... 20 mA master sensors the thermal error of the analogue output is also added:

$$F_{\text{total}} = \sqrt{(F_{\text{total-Master}})^2 + (F_{\text{total-Slave}})^2 + (F_a)^2}$$

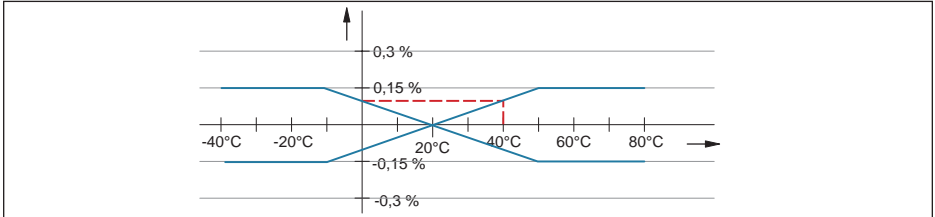


Fig. 35: F_a through thermal change current output, in this example = 0.1 %

$$F_{\text{total}} = \sqrt{(1.53 \%)^2 + (1.53 \%)^2 + (0.1 \%)^2} = 2.17 \%$$

The total deviation of the measuring system is hence 2.17 %.

Deviation in mm: 2.17 % of 500 mm = 11 mm

The example shows that the measurement error in practice can be considerably higher than the basic accuracy. Reasons are temperature influence and Turn down.

The thermal change of the current output in this example is negligible.

10.4 Dimensions

Housing

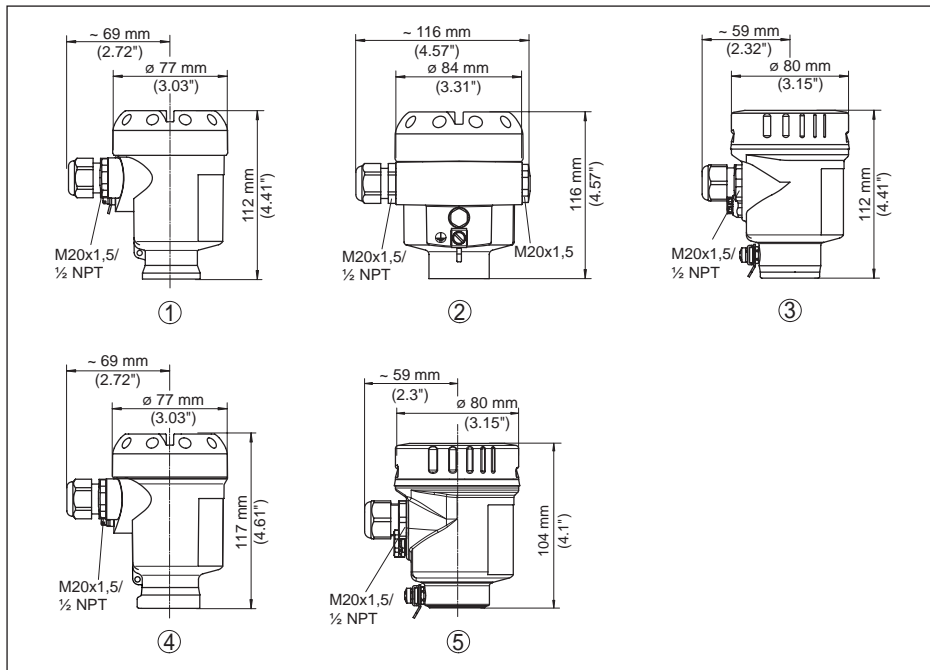


Fig. 36: Housing versions in protection IP66/IP67 and IP66/IP68 (0.2 bar)

- 1 Plastic single chamber (IP66/IP67)
- 2 Aluminium - single chamber
- 3 Stainless steel single chamber (electropolished)
- 4 Stainless steel single chamber (precision casting)
- 5 Stainless steel single chamber (electropolished) IP69K

External housing with IP68 (25 bar) version

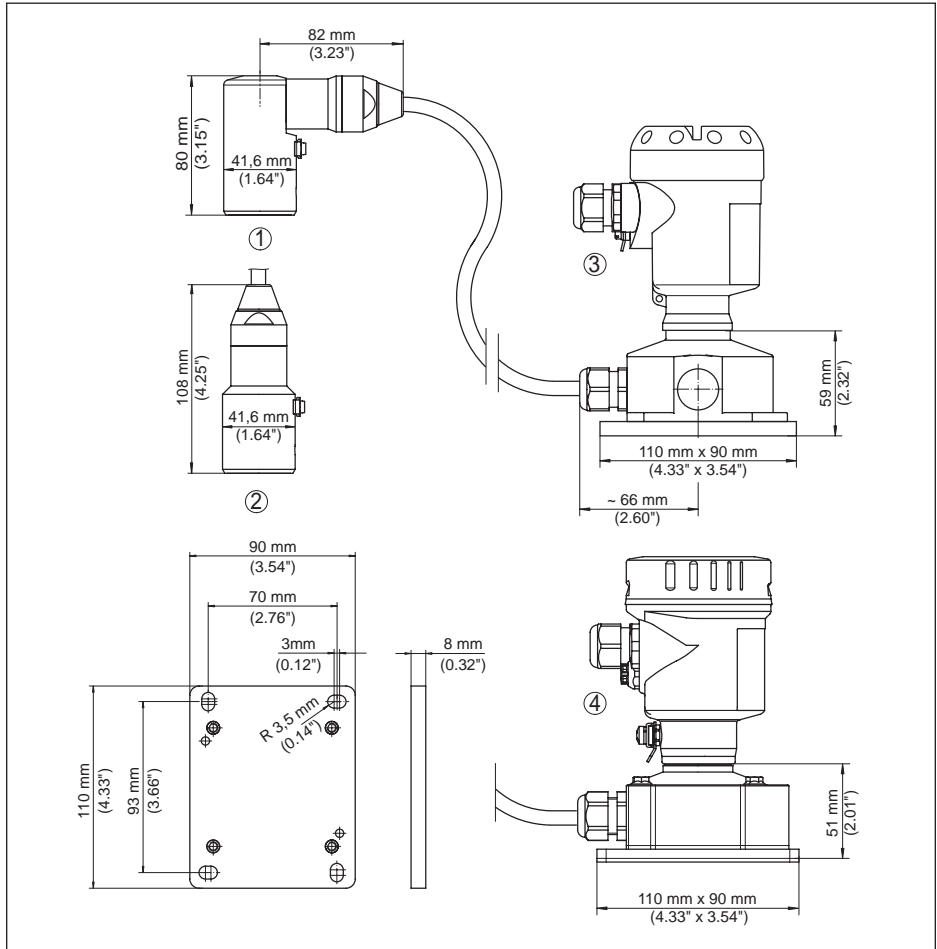


Fig. 37: IP68 version with external housing

- 1 Lateral cable outlet
- 2 Cable outlet axial
- 3 Plastic housing
- 4 Stainless steel housing, electropolished

IPT-2x, threaded fitting not front-flush

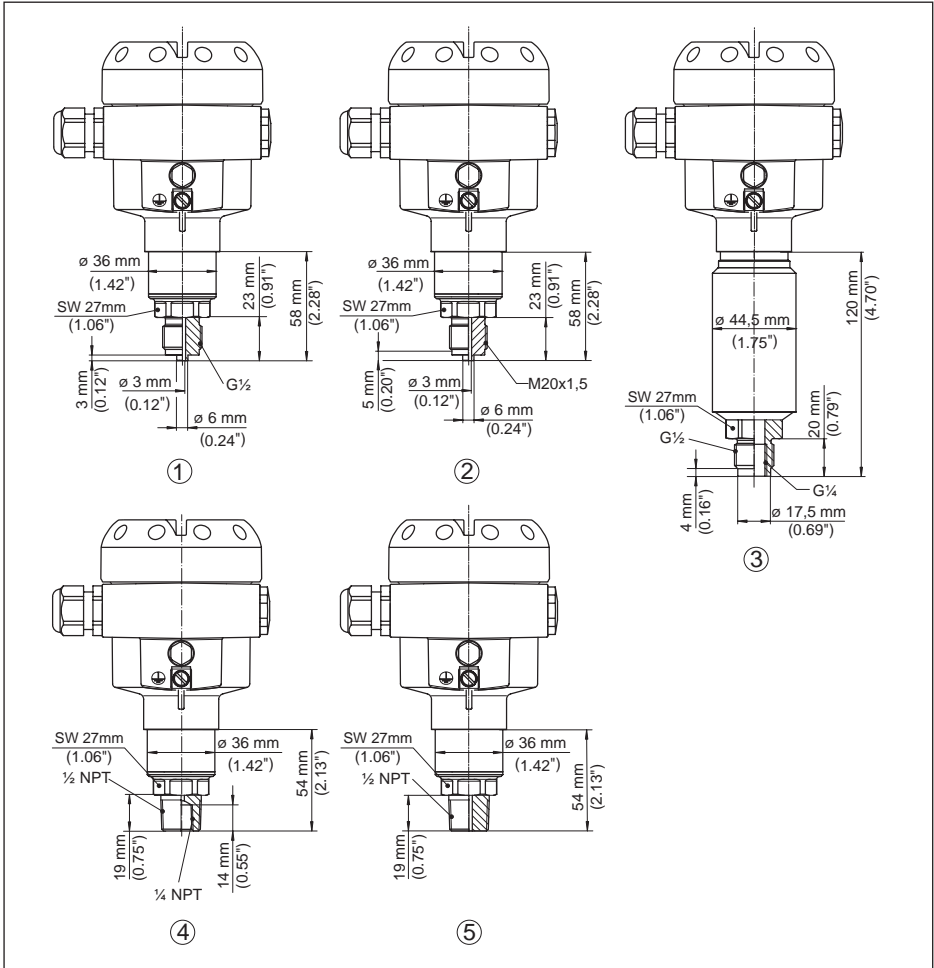


Fig. 38: IPT-2x, threaded fitting not front-flush

- 1 G $\frac{1}{2}$ manometer connection (EN 837)
- 2 M20 x 1.5 manometer connection (EN 837)
- 3 G $\frac{1}{2}$ A inside G $\frac{1}{4}$ (ISO 228-1)
- 4 $\frac{1}{2}$ NPT, inside $\frac{1}{4}$ NPT (ASME B1.20.1)
- 5 $\frac{1}{2}$ NPT PN 1000

For the version with "Second Line of Defense", the measure of length increases by 17 mm (0.67 in).

IPT-2x, threaded fitting front-flush

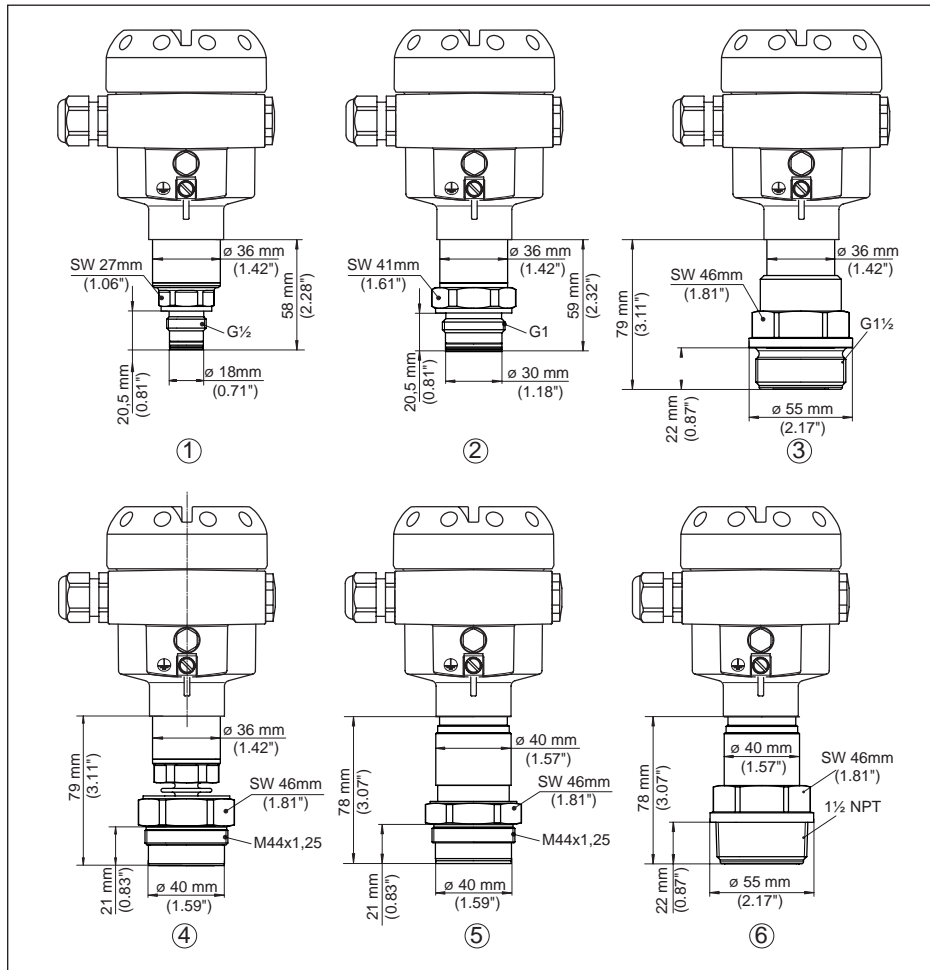


Fig. 39: IPT-2x, threaded fitting front-flush

- 1 G $\frac{1}{2}$ (ISO 228-1) with O-ring
- 2 G1 (ISO 228-1) with O-ring
- 3 G $\frac{1}{2}$ (DIN3852-A)
- 4 M44 x 1.25
- 5 3 and 4 with temperature adapter and screen sheet for 180 °C/200 °C
- 6 1 $\frac{1}{2}$ NPT (ASME B1.20.1)

For the version with "Second Line of Defense", the measure of length increases by 17 mm (0.67 in).

IPT-2x, hygienic fitting 150 °C (piezoresistive/strain gauge measuring cell)

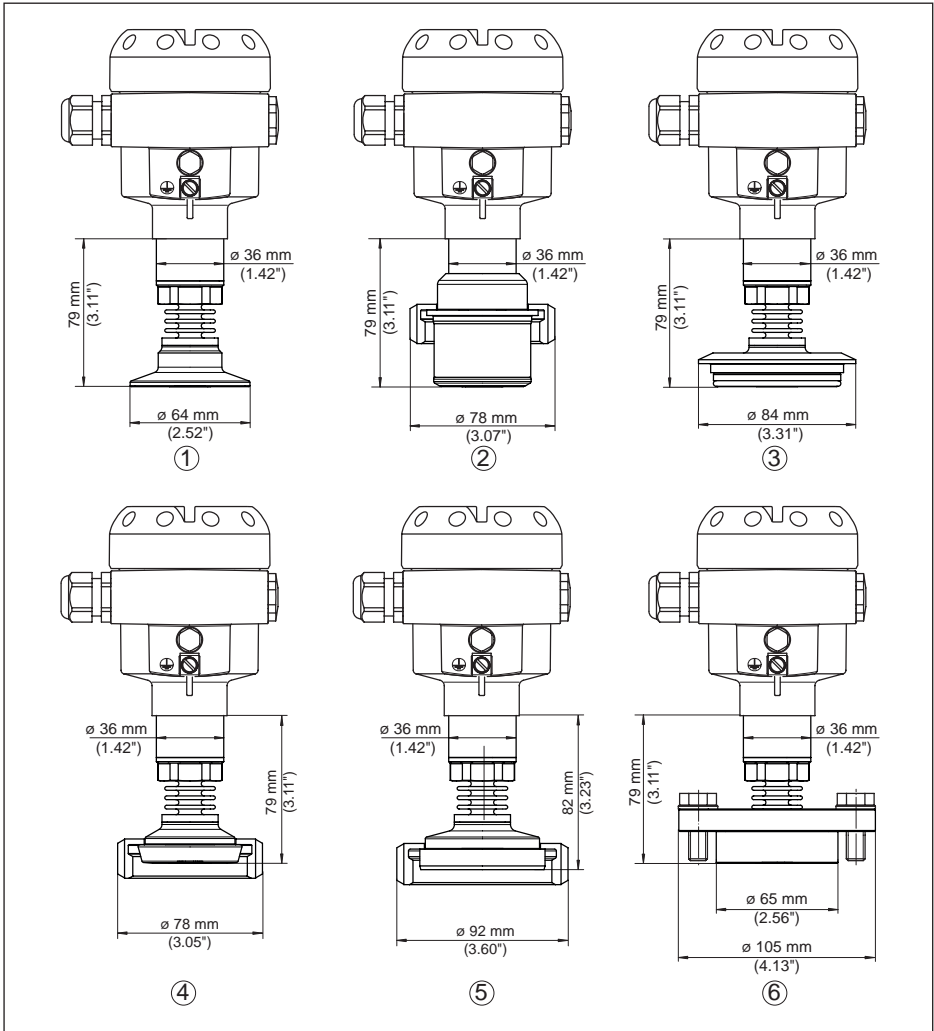


Fig. 40: IPT-2x, hygienic fitting 150 °C (piezoresistive/strain gauge measuring cell)

- 1 Clamp 2" PN16 (ø64mm) DIN 32676, ISO 2852
- 2 Hygienic fitting with compression nut F 40 PN 25
- 3 Varivent N 50-40 PN 25
- 4 Collar socket DN 40 PN 40, DIN 11851
- 5 Collar socket DN 50 PN 25 Form A, DIN 11864
- 6 DRD PN 40

For the version with "Second Line of Defense", the measure of length increases by 17 mm (0.67 in).

IPT-2x, hygienic fitting 150 °C (metallic/ceramic measuring cell)

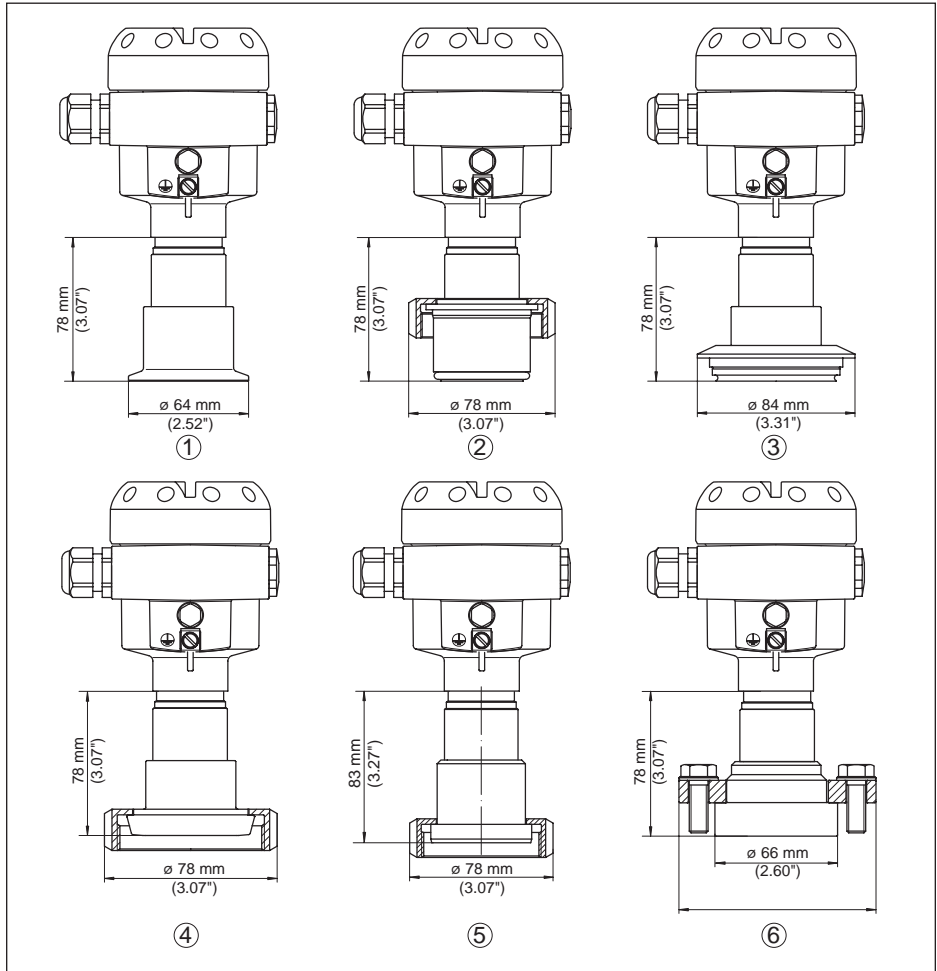


Fig. 41: IPT-2x, hygienic fitting 150 °C (metallic/ceramic measuring cell)

- 1 Clamp 2" PN16 ($\varnothing 64$ mm) DIN 32676, ISO 2852
- 2 Hygienic fitting with compression nut F 40 PN 25
- 3 Varivent N 50-40 PN 25
- 4 Collar socket DN 40 PN 40, DIN 11851
- 5 Collar socket DN 50 PN 25 Form A, DIN 11864
- 6 DRD PN 40

For the version with "Second Line of Defense", the measure of length increases by 17 mm (0.67 in).

IPT-2x, flange connection 150 °C (piezoresistive/strain gauge measuring cell)

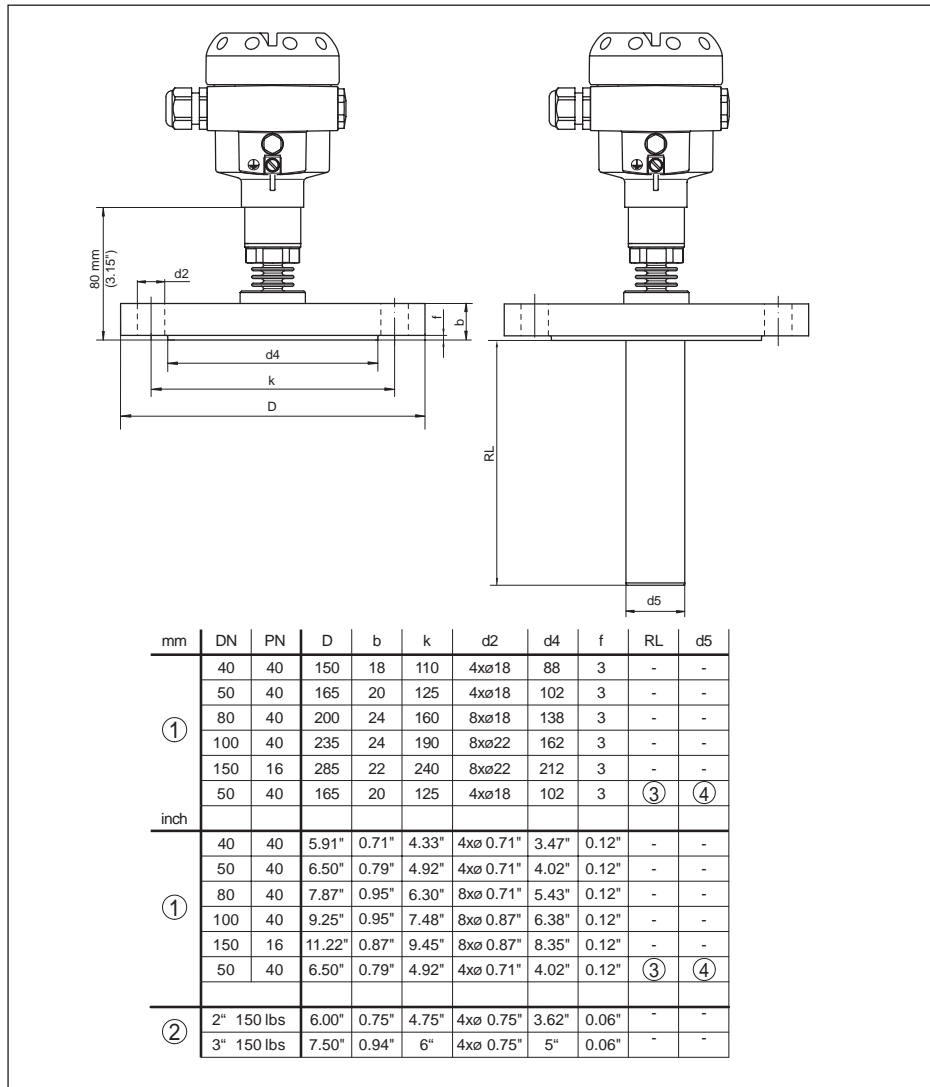


Fig. 42: IPT-2x, flange connection 150 °C (piezoresistive/strain gauge measuring cell)

- 1 Flange connection according to DIN 2501
- 2 Flange connection according to ASME B16.5
- 3 Order-specific
- 4 Order-specific

For the version with "Second Line of Defense", the measure of length increases by 17 mm (0.67 in).

IPT-2x, flange connection 180 °C/200 °C (ceramic/metallic measuring cell)

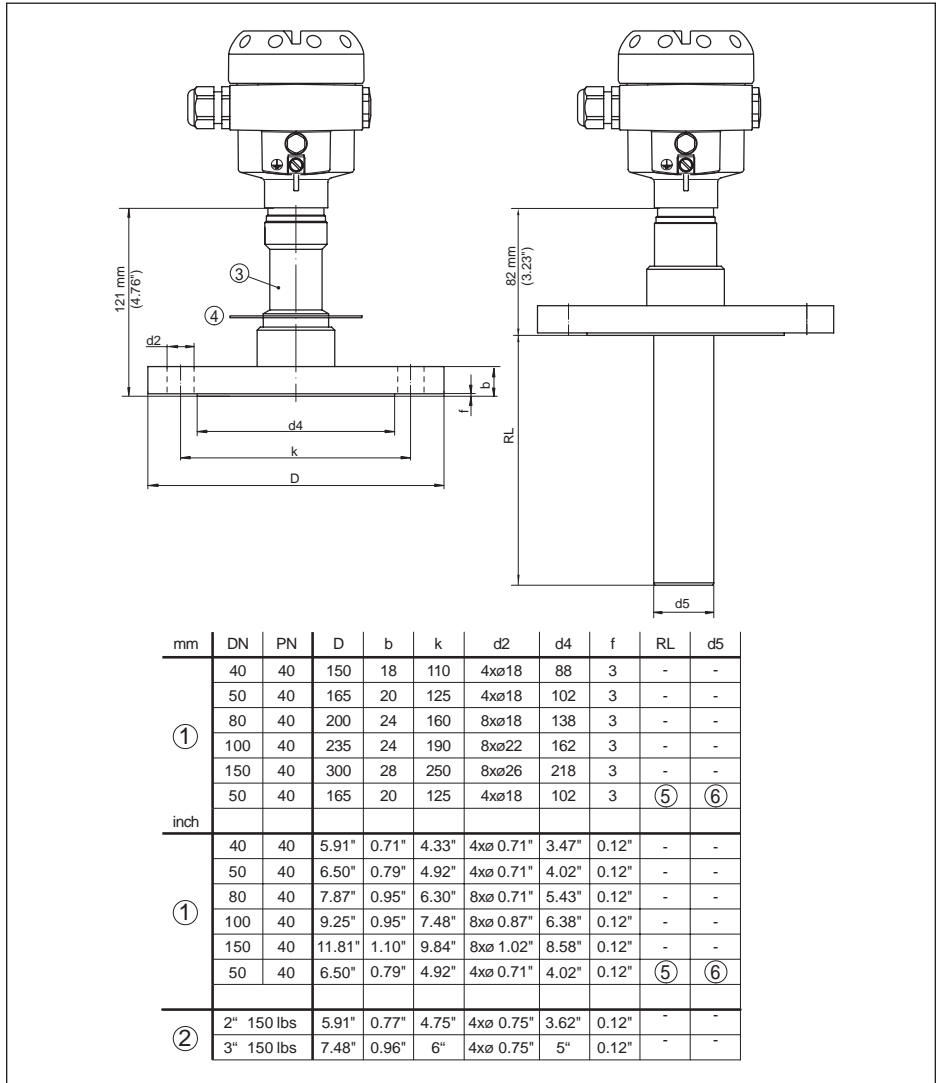


Fig. 43: IPT-2x, flange connection 180 °C/200 °C (ceramic/metallic measuring cell)

- 1 Flange connection according to DIN 2501
- 2 Flange connection according to ASME B16.5
- 3 Temperature adapter up to 180 °C
- 4 Temperature screen sheet up to 200 °C
- 5 Order-specific
- 6 Order-specific

For the version with "Second Line of Defense", the measure of length increases by 17 mm (0.67 in).

10.5 Trademark

All the brands as well as trade and company names used are property of their lawful proprietor/originator.

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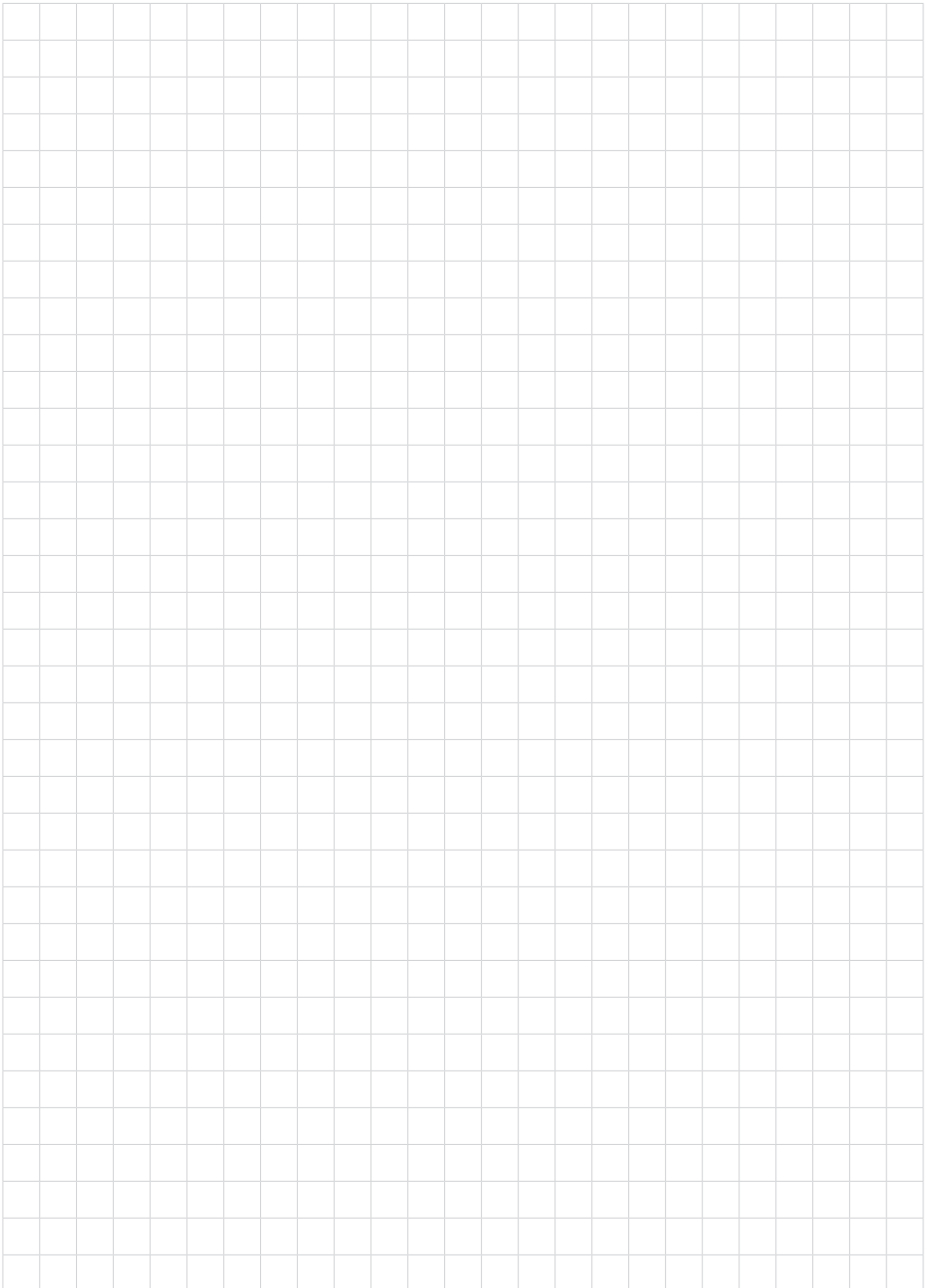
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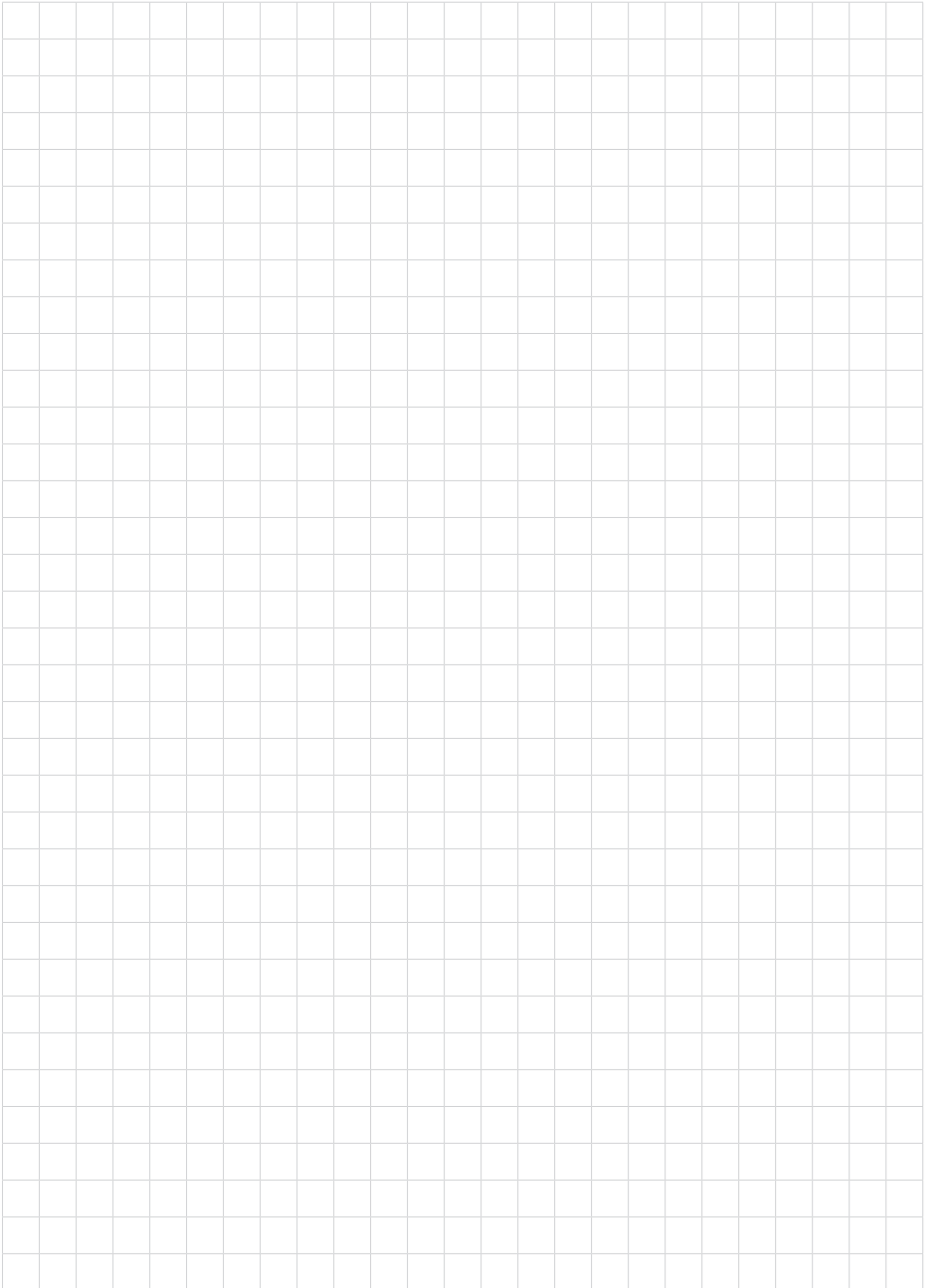
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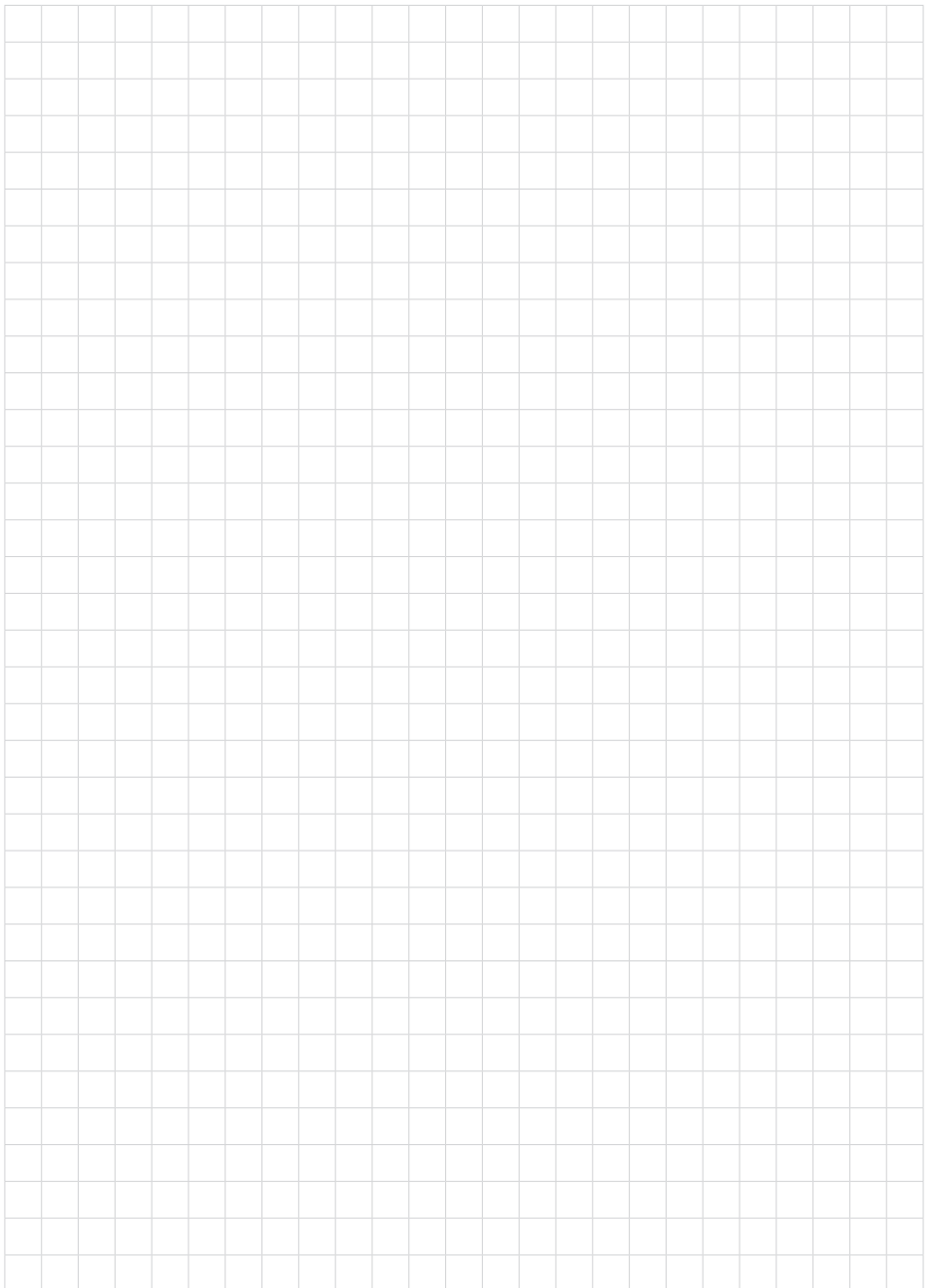
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S

Safety Integrity Level (SIL)







Printing date:

All statements concerning scope of delivery, application, practical use and operating conditions of the sensors and processing systems correspond to the information available at the time of printing.



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