

Differential pressure transmitter DPT-20 Operating Instructions

4 ... 20 mA/HART SIL
With SIL qualification
Metallic measuring cell



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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

DPT-20 is an instrument for measurement of flow, level, differential pressure, density and interface.

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.

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 NAMUR recommendations

NAMUR is the automation technology user association in the process industry in Germany. The published NAMUR recommendations are accepted as the standard in field instrumentation.

The device fulfils the requirements of the following NAMUR recommendations:

- NE 21 – Electromagnetic compatibility of equipment
- NE 43 – Signal level for fault information from measuring transducers
- NE 53 – Compatibility of field devices and display/adjustment components
- NE 107 – Self-monitoring and diagnosis of field devices

For further information see www.namur.de.

2.8 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

A Class 2 power supply unit has to be used for the installation in the USA and Canada.

3 Product description

3.1 Configuration

Scope of delivery

The scope of delivery encompasses:

- Instrument DPT-20

The further scope of delivery encompasses:

- Documentation
 - Quick setup guide DPT-20
 - 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.

Scope of this operating instructions

This operating instructions manual applies to the following instrument versions:

- Hardware from 1.0.0
- Software version from 1.2.4



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*"

Type label

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

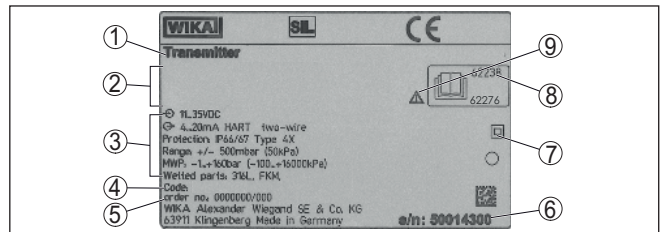


Fig. 1: Layout of the type label (example)

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

3.2 Principle of operation

Application area

DPT-20 is suitable universally for applications in virtually all industries. It is used for the measurement of the following pressure types:

- Differential pressure
- Static pressure

Measured products

Measured products are gases, vapours and liquids.

Measured variables

The differential pressure measurement enables the measurement of:

- Level
- Flow
- Differential pressure
- Density
- Interface

Level measurement

The instrument is suitable for level measurement in closed, superimposed pressure vessels. The static pressure is compensated by differential pressure measurement. It is available as a separate measured value for digital signal outputs.

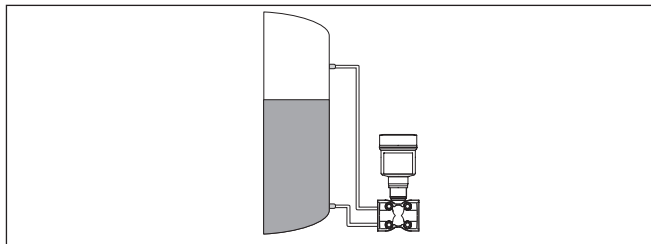


Fig. 2: Level measurement with DPT-20 in a pressurized vessel

Flow measurement

The flow measurement is carried out via an effective pressure transmitter, such as an orifice plate or pitot tube. The device records the resulting pressure difference and converts the measured value into the flow. With digital signal outputs, the static pressure is available as a separate measured value.

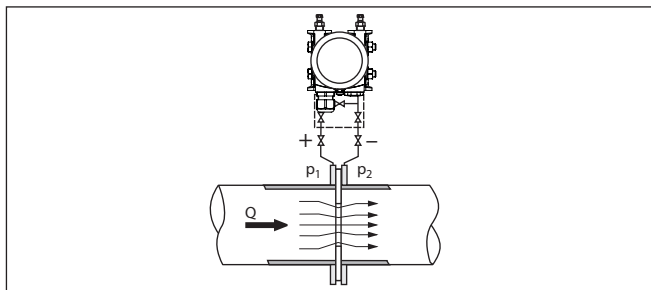


Fig. 3: Flow measurement with DPT-20 and orifice, Q = flow, differential pressure $\Delta p = p_1 - p_2$

Differential pressure measurement

The pressures in two different pipelines are acquired via effective pressure lines. The device determines the differential pressure.

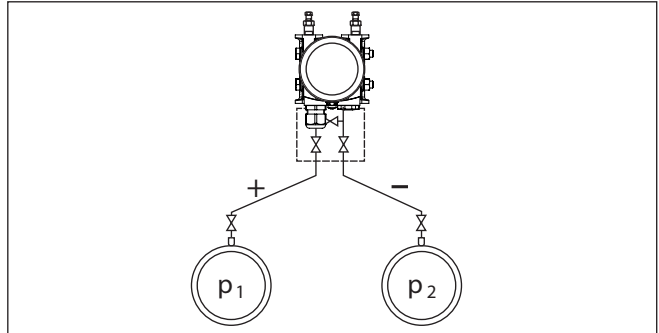


Fig. 4: Measurement of the differential pressure in pipelines with DPT-20, differential pressure $\Delta p = p_1 - p_2$

Density measurement

With the help of the instrument, density measurement in a vessel with changing level and homogeneous density distribution can be easily realized. The instrument is connected to the vessel via a chemical seal at two different measuring points.

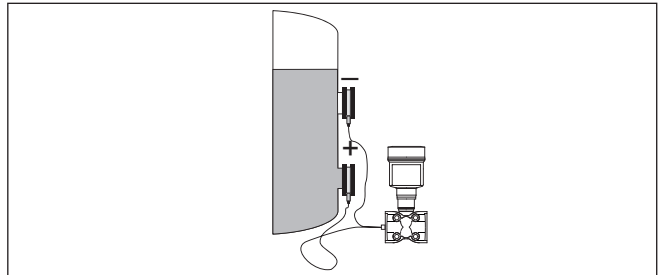


Fig. 5: Density measurement with DPT-20

Interface measurement

The instrument can also be used for interface measurement in a vessel with changing level. The instrument is connected to the vessel via a chemical seal at two different measuring points.

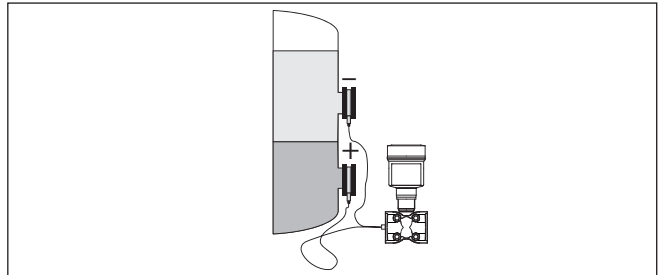


Fig. 6: Interface measurement with DPT-20

Functional principle

A metallic measuring cell is used as sensor element. The process pressures are transmitted via the separating diaphragms and filling oils to a piezoresistive sensor element (resistance measuring bridge using semiconductor technology).

The difference between the acting pressures changes the bridge voltage. This change is measured, further processed and converted into a corresponding output signal.

When measurement limits are exceeded, an overload system protects the sensor element against damage.

In addition, the measuring cell temperature and the static pressure are measured on the low pressure side. The measuring signals are further processed and are available as additional output signals.

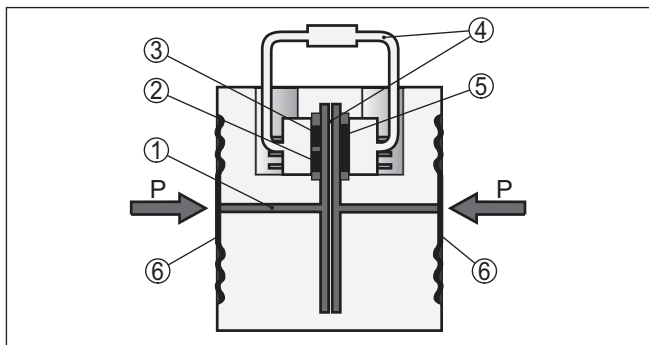


Fig. 7: Configuration metallic measuring cell

- 1 Filling fluid
- 2 Temperature sensor
- 3 Absolute pressure sensor, static pressure
- 4 Overload system
- 5 Differential pressure sensor
- 6 Separating diaphragm

Packaging

3.3 Packaging, transport and storage

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.



Caution:

Instruments for oxygen applications are sealed in PE foil and provided with a label "Oxygen! Use no Oil". Remove this foil just before mounting the instrument! See instruction under "Mounting".

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	<p>Up to the time of installation, the packages must be left closed and stored according to the orientation and storage markings on the outside.</p> <p>Unless otherwise indicated, the packages must be stored only under the following conditions:</p> <ul style="list-style-type: none">● 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	<ul style="list-style-type: none">● Storage and transport temperature see chapter " <i>Supplement - Technical data - Ambient conditions</i>"● 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.
3.4 Accessories	
Display and adjustment module	The display and adjustment module is used for measured value indication, adjustment and diagnosis.
External display and adjustment unit	DI-PT-E is an external display and adjustment unit for sensors with single chamber housing and Ex d double chamber housing.
Overvoltage protection	The overvoltage arrester is used instead of the terminals in the single or double chamber housing.
Mounting accessories	The suitable mounting accessories for DPT-20 include oval flange adapters, valve blocks as well as mounting brackets.

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

Permissible process pressure (MWP)

The permissible process pressure range is specified on the type label with "MWP" (Maximum Working Pressure), see chapter " *Configuration*". This specification refers to a reference temperature of +25 °C (+76 °F). The MWP may also be permanently applied on one side.

In order to prevent damage to the device, a test pressure acting on both sides 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 flange isolating diaphragms, can limit the permissible process pressure range according to the respective standard.

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 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.

Ventilation

The ventilation for the electronics housing is realised via a filter element in the vicinity of the cable glands.

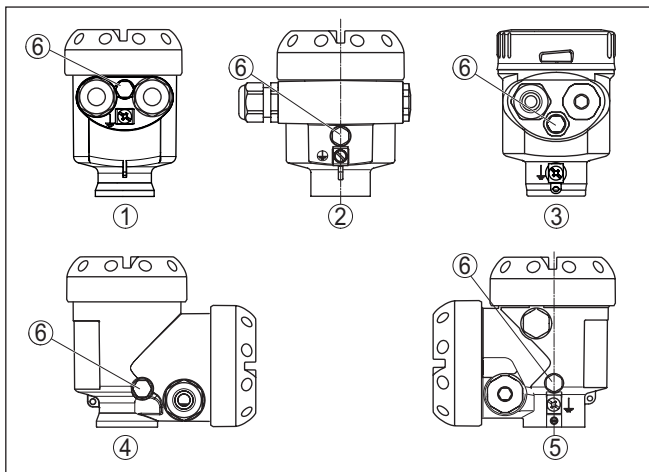


Fig. 8: Position of the filter element - non-Ex, Ex-ia and Ex-d-ia version

- 1 Plastic, stainless steel single chamber (precision casting)
- 2 Aluminium - single chamber
- 3 Stainless steel single chamber (electropolished)
- 4 Plastic double chamber
- 5 Aluminium, stainless steel double chamber housing (precision casting)
- 6 Filter element



Information:

Make sure that the filter element is always free of buildup during operation. A high-pressure cleaner may not be used for cleaning.

Turning the housing

For better readability of the display or access to the wiring, the electronics housing can be rotated by 330°. A stop prevents the housing from being turned too far.

Depending on the version and housing material, the locking screw on the neck of the housing must be slightly loosened. The housing can then be turned to the correct position. As soon as the requested position is reached, tighten the locking screw.

Mounting at the application site

It is recommended to protect the device at the application site against lateral forces, e.g. vibrations, by means of a suitable measuring instrument holder. This applies especially for device versions with a plastic process connection, e.g. with G½ thread.

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

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.

Oxygen applications**4.2 Instructions for oxygen applications**

Oxygen and other gases can be explosive when brought into contact with oils, grease and plastics, so the following measures must also be taken:

- All components of the system, e.g. measuring instruments, must be cleaned in accordance with the requirements of recognized regulations or standards
- Depending on the seal material, certain temperatures and pressures must not be exceeded in oxygen applications, see chapter " *Technical data*"

**Danger:**

Instruments for oxygen applications must be unpacked just before mounting. After removing the protective cover of the process fitting, the label "O₂" will be visible on the process fitting. Penetration of oil, grease and dirt should be avoided. Danger of explosion!

DP flow element**4.3 Connection to the process**

DP flow elements are installations in pipelines which generate a flow-dependent pressure drop. The flow rate is measured via this differential pressure. Typical DP flow elements are Venturi tubes, orifice plates or impact pressure probes.

Instructions for mounting the DP flow elements are stated in the appropriate standards as well as in the documentation from the respective manufacturer.

Effective pressure lines

Effective pressure lines are pipelines with a small diameter. They are used to connect the differential pressure transmitter to the pressure tapping point or the DP flow element.

Principles

Effective pressure lines for gases must always remain completely dry and no condensate must collect. Effective pressure lines for liquids must always be completely filled and must not contain any gas bubbles. Therefore, suitable venting systems must be provided for liquids and suitable drainage systems for gases.

Wiring

Effective pressure lines must always run with a sufficient, strictly monotonous slope/gradient of at least 2 %, but better up to 10 %.

Recommendations for wiring of effective pressure lines are stated in the corresponding national and international standards.

Connection

Effective pressure lines are connected to the device via standard cutting ring screw connections with suitable thread.

**Note:**

Follow the mounting instructions of the respective manufacturer and seal the thread, e.g. with PTFE tape.

Valve blocks

Valve blocks are used for initial shut-off when connecting the differential pressure transmitter to the process. They are also used for pressure compensation of the measuring chambers during adjustment.

3-fold and 5-fold valve blocks are available (see chapter "Mounting and connection instructions").

Ventilation valves, closing screws

Free openings on the process assembly must be closed by ventilation valves or closing screws. Required torque see chapter "Technical data".

**Note:**

Use the supplied parts and seal the thread with four layers of PTFE tape.

4.4 Mounting and connection instructions

Connection high/low pressure side

When connecting DPT-20 to the measuring point, take note of the high/low pressure side of the process component. ¹⁾

The "H" identifies the high pressure side, the low pressure side due to an "L" on the process component next to the oval flanges.

**Note:**

The static pressure is measured on the low pressure side "L".

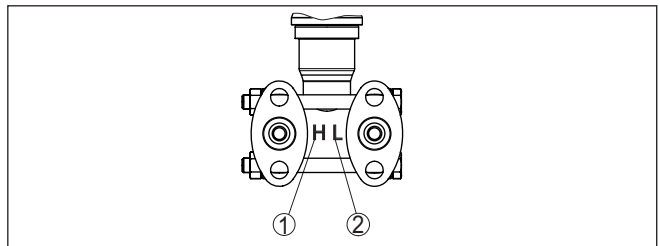


Fig. 9: Marking for high/low pressure side on the process component

- 1 H = High pressure side
- 2 L = Low pressure side

¹⁾ The pressure effective on "H" is considered as positive, the pressure effective on "L" as negative in the calculation of the pressure difference.

3-fold valve block

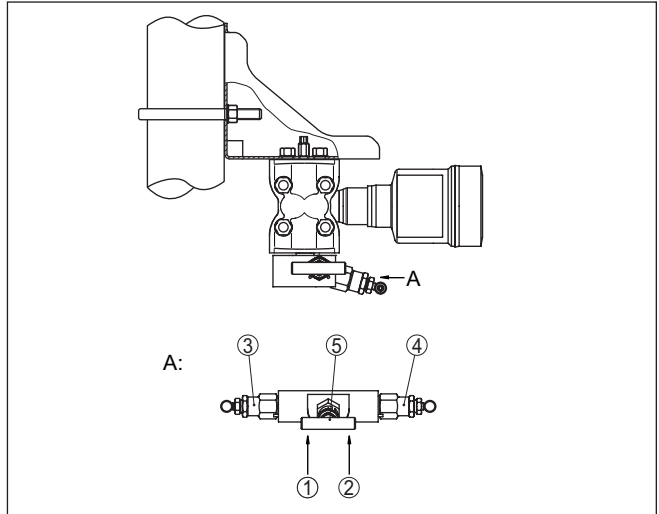


Fig. 10: Connection of a 3-fold valve block

- 1 Process fitting
- 2 Process fitting
- 3 Inlet valve
- 4 Inlet valve
- 5 Breather valve

3-fold valve block, flanging on both sides

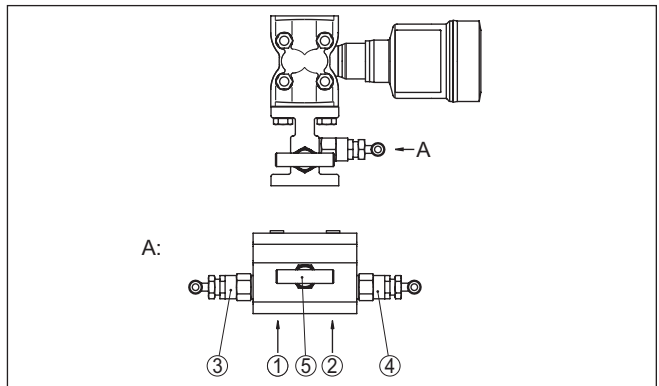


Fig. 11: Connection of a 3-fold valve block, flanging on both sides

- 1 Process fitting
- 2 Process fitting
- 3 Inlet valve
- 4 Inlet valve
- 5 Breather valve

**Note:**

No mounting bracket is required for valve blocks that can be flange-mounted on both sides. The process side of the valve block is mounted directly to a DP flow element, e.g. an orifice plate.

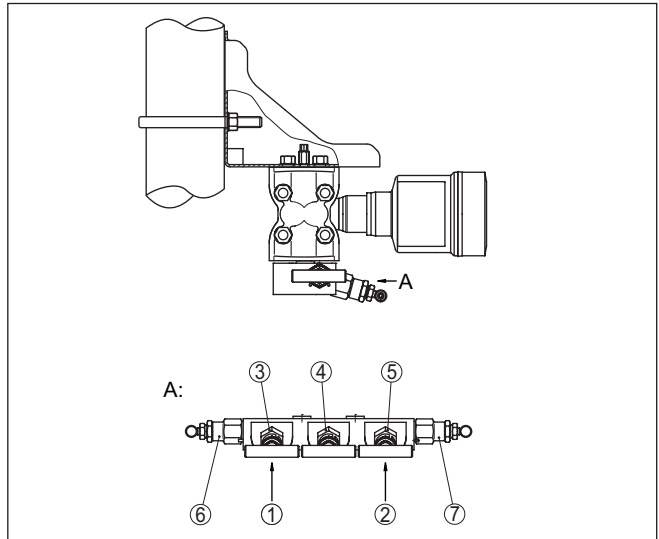
5-fold valve block

Fig. 12: Connection of a 5-fold valve block

- 1 Process fitting
- 2 Process fitting
- 3 Inlet valve
- 4 Breather valve
- 5 Inlet valve
- 6 Valve for checking/ventilating
- 7 Valve for checking/ventilating

4.5 Measurement setups

4.5.1 Overview

The following sections show common measurement setups:

- Level
- Flow
- Differential pressure
- Interface
- Density

Depending on the application, there may also be different arrangements.

**Note:**

For simplification, the effective pressure lines are partly shown with a horizontal course and sharp angles. For wiring, please observe the instructions in chapter "Mounting, Connection to the process" as well

as the hook ups in the supplementary instructions " *Mounting accessory pressure technology*".

4.5.2 Level

In closed vessels with effective pressure lines

- Mount device below the lower measurement connection so that the effective pressure lines are always filled with liquid
- Always connect the low pressure side above the max. level in the vessel
- For measurement in products with solid content, such as e.g. dirty liquids, the installation of separators and drain valves is recommended. Debris and sediment can thus be collected and removed.

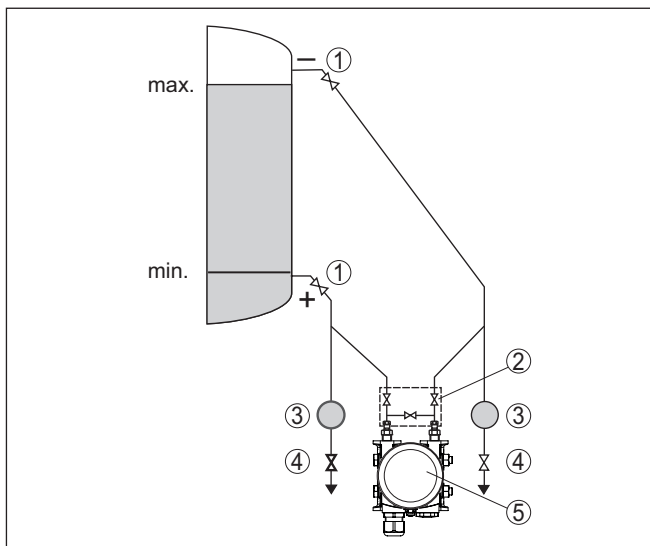


Fig. 13: Measurement setup, level measurement in closed vessel

- 1 Blocking valves
- 2 3-fold valve block
- 3 Precipitator
- 4 Drain valves
- 5 DPT-20

In closed vessels with single chemical seal

- Mount device directly to the vessel
- Always connect the low pressure side above the max. level in the vessel
- For measurement in products with solid content, such as e.g. dirty liquids, the installation of separators and drain valves is recommended. Debris and sediment can thus be collected and removed.

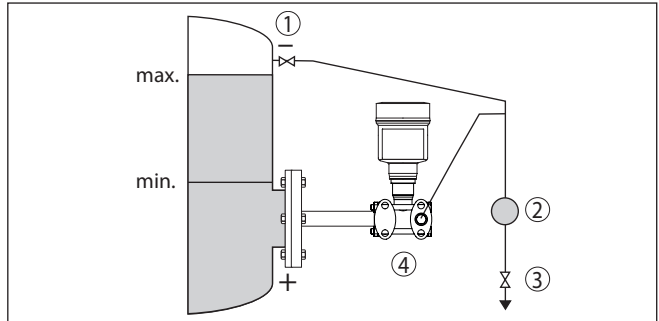


Fig. 14: Measurement setup, level measurement in closed vessel

- 1 Blocking valve
- 2 Precipitator
- 3 Drain valve
- 4 DPT-20

In closed vessels with double chemical seal

- Mount device below the lower chemical seal
- The ambient temperature should be the same for both capillaries



Information:

Level measurement is only carried out between the upper edge of the lower and the lower edge of the upper chemical seal.

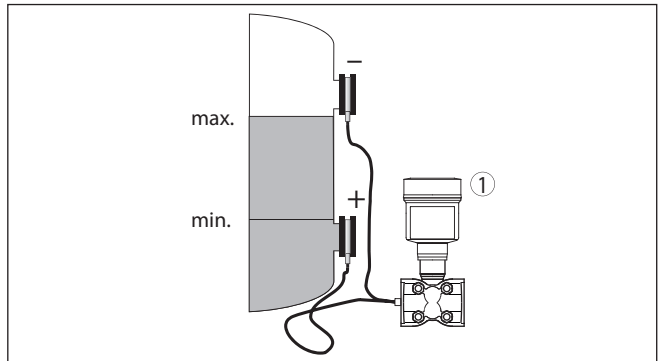


Fig. 15: Measurement setup, level measurement in closed vessel

- 1 DPT-20

In closed vessels with steam layering with effective pressure line

- Mount device below the lower measurement connection so that the effective pressure lines are always filled with liquid
- Always connect the low pressure side above the max. level in the vessel
- The condensate vessel ensures a constant pressure on the low pressure side
- For measurement in products with solid content, such as e.g. dirty liquids, the installation of separators and drain valves is recommended. Debris and sediment can thus be collected and removed.

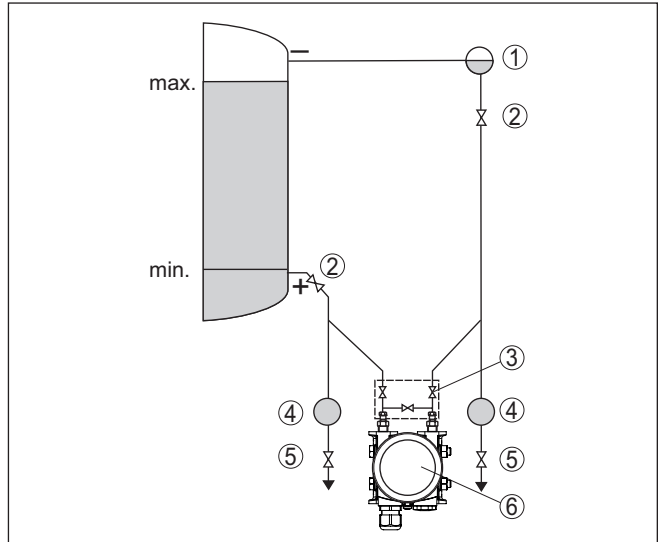


Fig. 16: Measurement setup in closed vessel with superimposed steam

- 1 Condensate vessel
- 2 Blocking valves
- 3 3-fold valve block
- 4 Precipitator
- 5 Drain valves
- 6 DPT-20

4.5.3 Flow

In gases

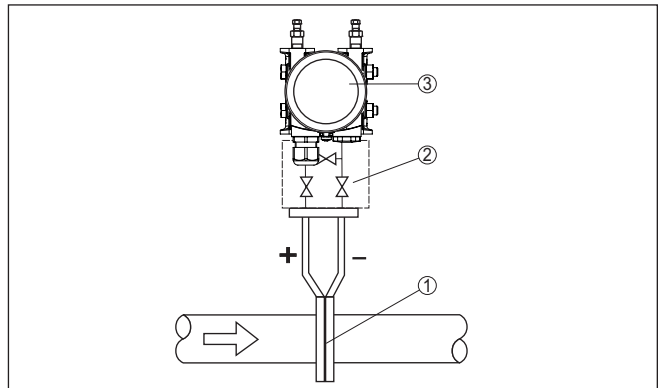


Fig. 17: Measurement setup with flow measurement of gases, connection via 3-fold valve block, flanging on both sides

- 1 Orifice or impact pressure probe
- 2 3-fold valve block, flanging on both sides
- 3 DPT-20

In vapours

- Mount the instrument below the measuring point
- Mount condensate vessels at the same height with the discharge socket and at the same distance to the device
- Fill the effective pressure lines to the height of the condensate vessels before setup

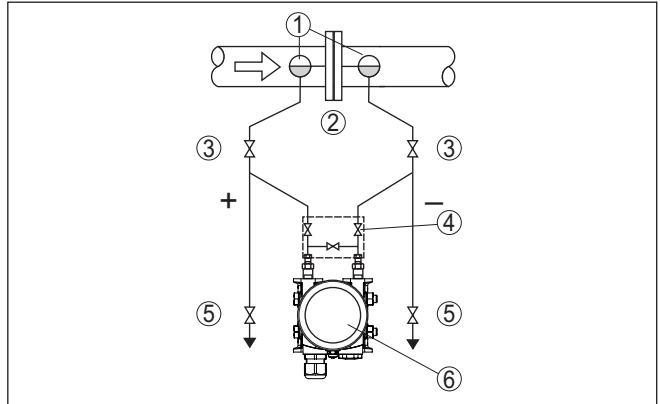


Fig. 18: Measurement setup, flow measurement in vapours

- 1 Condensate vessels
- 2 Orifice or impact pressure probe
- 3 Blocking valves
- 4 3-fold valve block
- 5 Drain or blow-off valves
- 6 DPT-20

In liquids

- Mount device below the measurement loop so that the effective pressure lines are always filled with liquid and gas bubbles can bubble up to the process line
- For measurements in products with solid content such as e.g. dirty liquids, the installation of separators and drain valves is recommended to enable collection and removal of debris and sediment.
- Fill the effective pressure lines to the height of the condensate vessels before setup

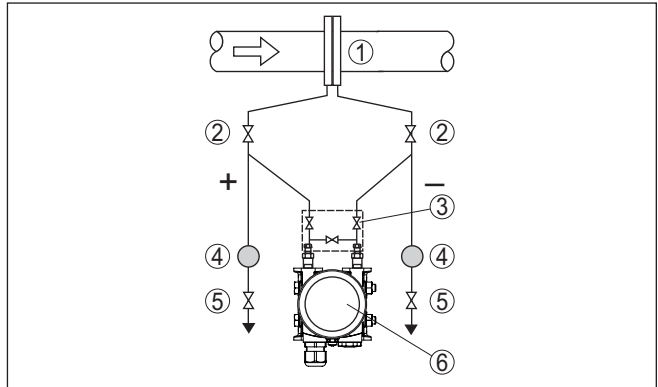


Fig. 19: Measurement setup, flow measurement in liquids

- 1 Orifice or impact pressure probe
- 2 Blocking valves
- 3 3-fold valve block
- 4 Precipitator
- 5 Drain valves
- 6 DPT-20

4.5.4 Differential pressure

In gases and vapours

- Mount device above the measurement loop so that condensate can drain off in the process cable.

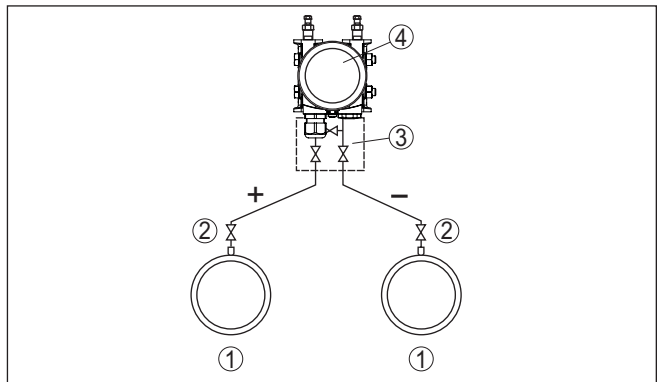


Fig. 20: Measurement setup with differential pressure measurement between two pipelines in gases and vapours

- 1 Pipelines
- 2 Blocking valves
- 3 3-fold valve block
- 4 DPT-20

In vapour and condensate plants

- Mount device below the measurement loop so that some condensate can collect in the effective pressure lines.

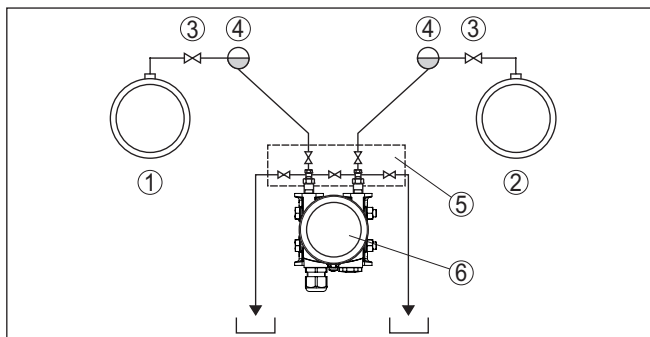


Fig. 21: Measurement setup with differential pressure measurement between a vapour and a condensate cable

- 1 Vapour cable
- 2 Condensate cable
- 3 Blocking valves
- 4 Condensate vessels
- 5 5-fold valve block
- 6 DPT-20

In liquids

- Mount device below the measurement loop so that the effective pressure lines are always filled with liquid and gas bubbles can bubble up to the process line
- For measurement in products with solid content, such as e.g. dirty liquids, the installation of separators and drain valves is recommended. Debris and sediment can thus be collected and removed.

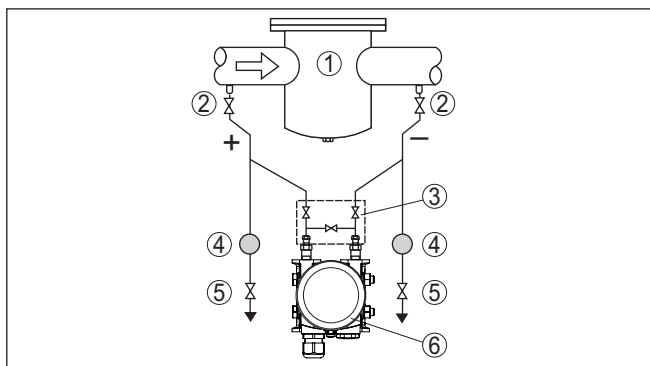


Fig. 22: Measurement setup with differential pressure measurement in liquids

- 1 e.g. filter
- 2 Blocking valves
- 3 3-fold valve block
- 4 Precipitator
- 5 Drain valves
- 6 DPT-20

When chemical seal systems are used in all products

- Mount chemical seal with capillaries on top or laterally on the pipeline

- In vacuum applications: Mount DPT-20 below the measurement loop
- The ambient temperature should be the same for both capillaries

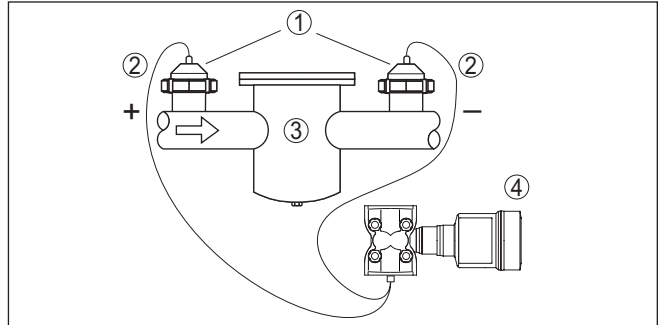


Fig. 23: Measurement setup, differential pressure measurement in gases, vapours and liquids

- 1 Chemical seal with slotted nut
- 2 Capillaries
- 3 E.g. filter
- 4 DPT-20

4.5.5 Density

Density measurement

- Mount device below the lower chemical seal
- The distance between the two measurement points must be as large as possible to ensure a high measurement accuracy
- The ambient temperature should be the same for both capillaries

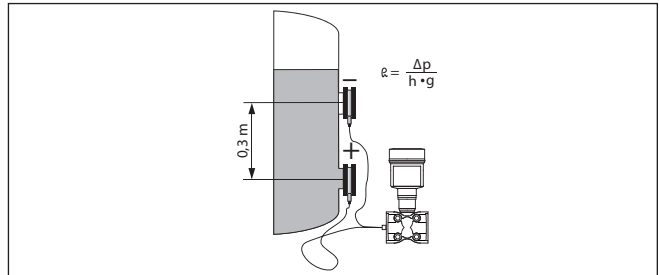


Fig. 24: Measurement setup for density measurement

Density measurement is only possible when the level remains above the upper measuring point. If the level falls below the upper measuring point, the measuring system continues to work with the last density value.

This density measurement functions with open as well as closed vessels. Make sure that small density changes cause only small changes to the measured differential pressure.

Example

Distance between the two measurement points 0.3 m, min. density 1000 kg/m³, max. density 1200 kg/m³

Carry out min. adjustment for the differential pressure measured with density 1.0:

$$\begin{aligned}\Delta p &= \rho \cdot g \cdot h \\ &= 1000 \text{ kg/m}^3 \cdot 9.81 \text{ m/s}^2 \cdot 0,3 \text{ m} \\ &= 2943 \text{ Pa} = 29.43 \text{ mbar}\end{aligned}$$

Carry out max. adjustment for the differential pressure measured with density 1.2:

$$\begin{aligned}\Delta p &= \rho \cdot g \cdot h \\ &= 1200 \text{ kg/m}^3 \cdot 9.81 \text{ m/s}^2 \cdot 0.3 \text{ m} \\ &= 3531 \text{ Pa} = 35.31 \text{ mbar}\end{aligned}$$

4.5.6 Interface

Interface measurement

- Mount device below the lower chemical seal
- The ambient temperature should be the same for both capillaries

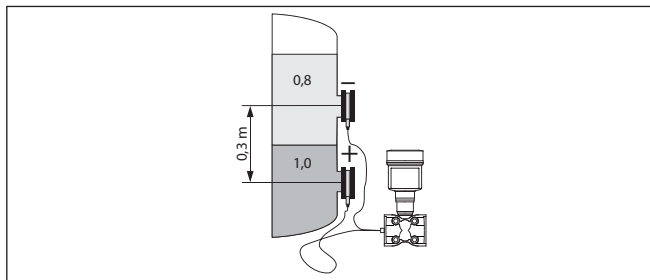


Fig. 25: Measurement setup with interface measurement

An interface measurement is only possible if the densities of the two media remain the same and the interface is between the two measurement points. The total level must be above the upper measurement point.

This density measurement functions with open but also with closed vessel.

Example

Distance between the two measurement points 0.3 m, min. density 800 kg/m³, max. density 1000 kg/m³

Carry out min. adjustment for the differential pressure which is measured at the height of the interface on the lower measurement point:

$$\begin{aligned}\Delta p &= \rho \cdot g \cdot h \\ &= 800 \text{ kg/m}^3 \cdot 9.81 \text{ m/s} \cdot 0.3 \text{ m} \\ &= 2354 \text{ Pa} = 23.54 \text{ mbar}\end{aligned}$$

Carry out max. adjustment for the differential pressure which is measured at the height of the interface on the upper measurement point:

$$\begin{aligned}\Delta p &= \rho \cdot g \cdot h \\ &= 1000 \text{ kg/m}^3 \cdot 9.81 \text{ m/s} \cdot 0.3 \text{ m} \\ &= 2943 \text{ Pa} = 29.43 \text{ mbar}\end{aligned}$$

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

Power supply and current signal are carried on the same two-wire cable. The operating voltage can differ depending on the instrument version.

The data for power supply are specified in chapter " *Technical data*".

Provide a reliable separation between the supply circuit and the mains circuits according to DIN EN 61140 VDE 0140-1.

Power the instrument via an energy-limited circuit acc. to IEC 61010-1, e.g. via Class 2 power supply unit.

Keep in mind the following additional factors that influence the operating voltage:

- Lower output voltage of the power supply unit under nominal load (e.g. with a sensor current of 20.5 mA or 22 mA in case of fault)
- Influence of additional instruments in the circuit (see load values in chapter " *Technical data*")

Connection cable

The instrument is connected with standard two-wire cable without shielding. If electromagnetic interference is expected which is above the test values of EN 61326-1 for industrial areas, shielded cable should be used.

Use cable with round cross section for instruments with housing and cable gland. Use a cable gland suitable for the cable diameter to ensure the seal effect of the cable gland (IP protection rating).

We generally recommend the use of shielded cable for HART multidrop mode.

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*".

Cable screening and grounding

If shielded cable is required, we recommend connecting the cable screening on both ends to ground potential. In the sensor, the cable screening must be 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).



In Ex systems, the grounding is carried out according to the installation regulations.

In electroplating plants as well as plants for cathodic corrosion protection it must be taken into account that significant potential differences exist. This can lead to unacceptably high currents in the cable screen if it is grounded at both ends.

**Note:**

The metallic parts of the instrument (process fitting, sensor, concentric tube, etc.) are connected with the internal and external ground terminal on the housing. This connection exists either directly via the conductive metallic parts or, in case of instruments with external electronics, via the screen of the special connection cable.

You can find specifications on the potential connections inside the instrument in chapter " *Technical data*".

5.2 Connecting**Connection technology**

The voltage supply and signal output are connected via the spring-loaded terminals in the housing.

Connection to the display and adjustment module or to the interface adapter is carried out via contact pins in the housing.

**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.

Connection procedure

Proceed as follows:

1. Unscrew the housing lid
2. If a display and adjustment module is installed, remove it by turning it slightly to the left
3. Loosen compression nut of the cable gland and remove blind plug
4. Remove approx. 10 cm (4 in) of the cable mantle, strip approx. 1 cm (0.4 in) of insulation from the ends of the individual wires
5. Insert the cable into the sensor through the cable entry

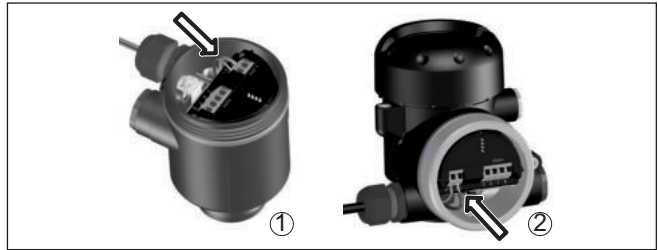


Fig. 26: Connection steps 5 and 6

- 1 Single chamber housing
- 2 Double chamber housing

6. Insert the wire ends into the terminals according to the wiring plan



Note:

Solid cores as well as flexible cores with wire 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.

- 7. Check the hold of the wires in the terminals by lightly pulling on them
 - 8. Connect the shielding to the internal ground terminal, connect the external ground terminal to potential equalisation
 - 9. Tighten the compression nut of the cable entry gland. The seal ring must completely encircle the cable
 - 10. Reinsert the display and adjustment module, if one was installed
 - 11. Screw the housing lid back on
- The electrical connection is finished.

5.3 Single chamber housing

5.3.1 Single chamber housing



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

Electronics and connection compartment

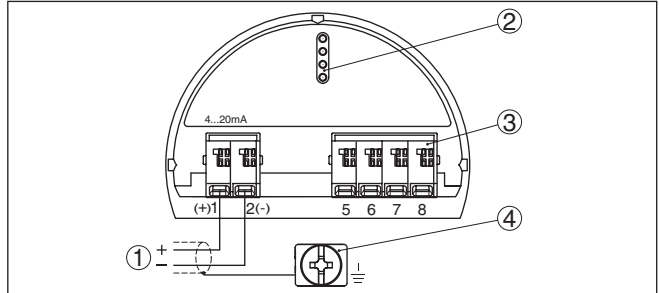


Fig. 27: Electronics and connection compartment - single chamber housing

- 1 Voltage supply, signal output
- 2 For display and adjustment module or interface adapter
- 3 For external display and adjustment unit or Secondary sensor
- 4 Ground terminal for connection of the cable screening

5.3.2 Double chamber housing



The following illustrations apply to the non-Ex as well as to the Ex-ia version.

Electronics compartment

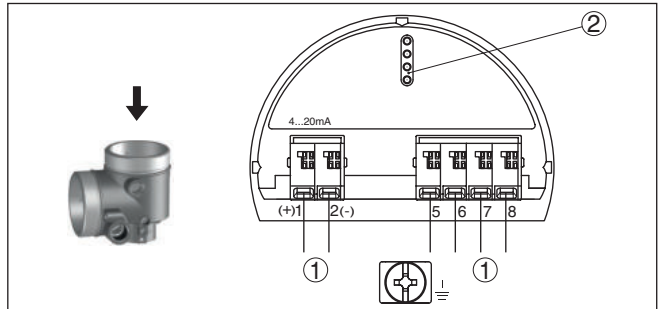


Fig. 28: Electronics compartment - double chamber housing

- 1 Internal connection to the connection compartment
- 2 For display and adjustment module or interface adapter

Connection compartment

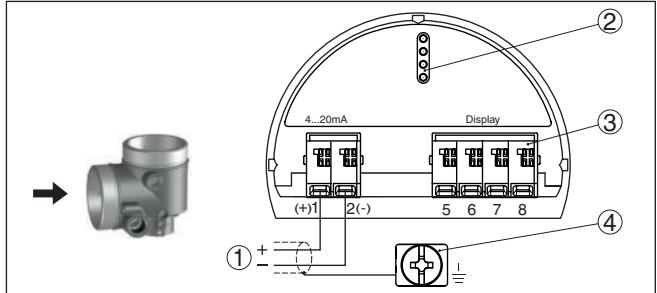


Fig. 29: Connection compartment - double chamber housing

- 1 Voltage supply, signal output
- 2 For display and adjustment module or interface adapter
- 3 For external display and adjustment unit
- 4 Ground terminal for connection of the cable screening

Supplementary electronics - Additional current output

To make a second measured value available for use, you can use the supplementary electronics "Additional current output".

Both current outputs are passive and need a power supply.

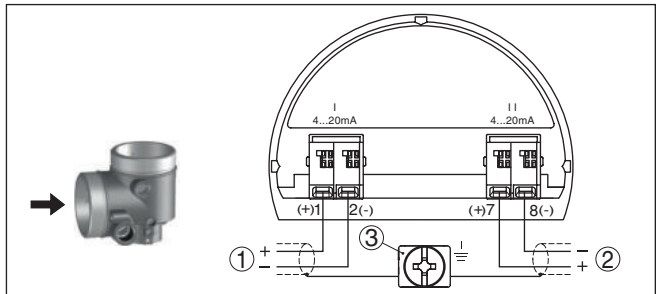


Fig. 30: Terminal compartment, double chamber housing, supplementary electronics "Additional current output"

- 1 First current output (I) - Voltage supply and signal output, sensor (HART)
- 2 Additional current output (II) - Voltage supply and signal output (without HART)
- 3 Ground terminal for connection of the cable screening

5.3.3 Double chamber housing Ex d

Electronics compartment

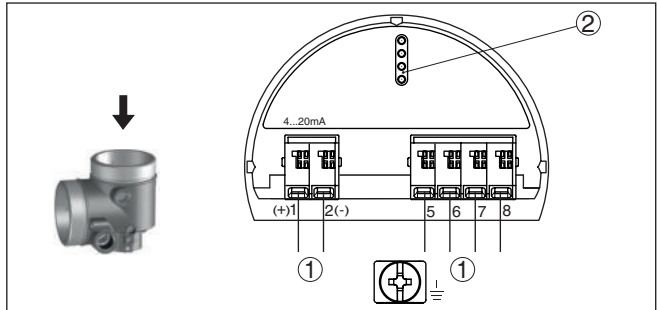


Fig. 31: Electronics compartment - Ex-d double chamber housing

- 1 Internal connection to the connection compartment
- 2 For display and adjustment module or interface adapter

Connection compartment

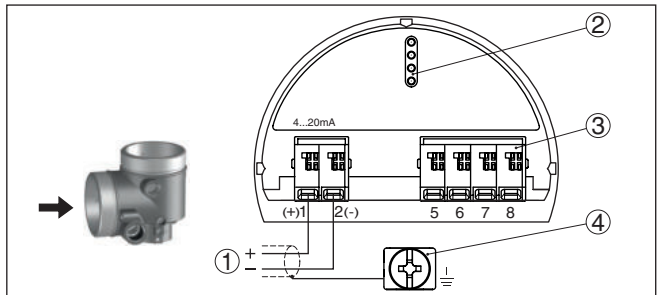


Fig. 32: Connection compartment - double chamber housing

- 1 Voltage supply, signal output
- 2 For display and adjustment module or interface adapter
- 3 For external display and adjustment unit
- 4 Ground terminal for connection of the cable screening

5.3.4 Housing IP66/IP68 (1 bar)

Wire assignment, connection cable

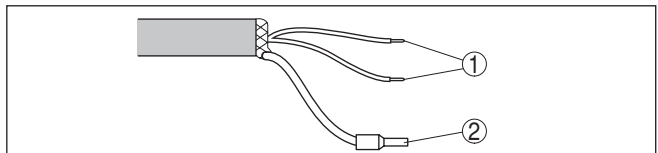


Fig. 33: Wire assignment in permanently connected connection cable

- 1 Brown (+) and blue (-) to power supply or to the processing system
- 2 Shielding

5.3.5 External housing with version IP68 (25 bar)

Electronics and connection compartment for power supply

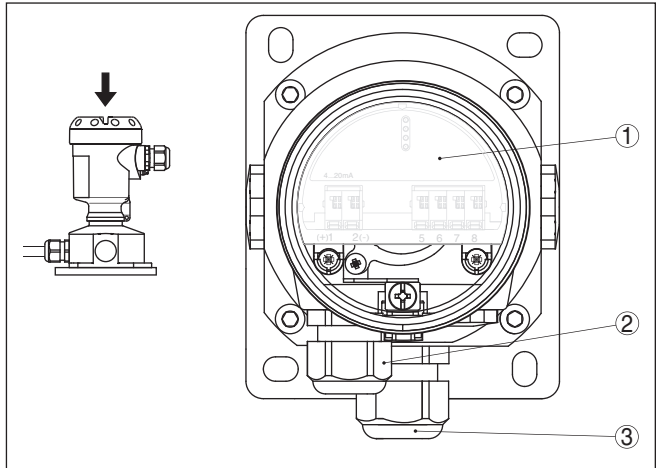


Fig. 34: Electronics and connection compartment

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

Terminal compartment, housing socket

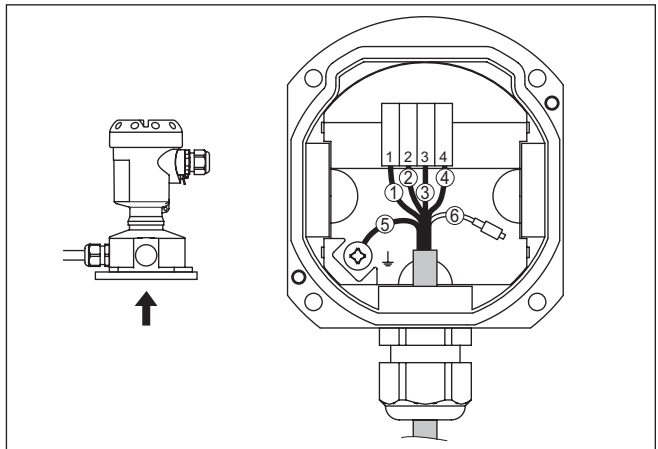


Fig. 35: Connection of the process component in the housing base

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

Electronics and connection compartment

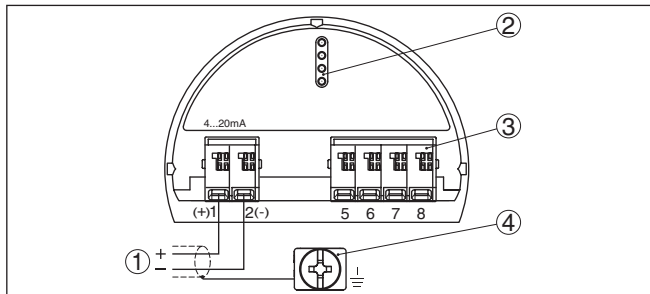


Fig. 36: Electronics and connection compartment - single chamber housing

- 1 Voltage supply, signal output
- 2 For display and adjustment module or interface adapter
- 3 For external display and adjustment unit or Secondary sensor
- 4 Ground terminal for connection of the cable screening

5.4 Connection example

Connection example, additional current output

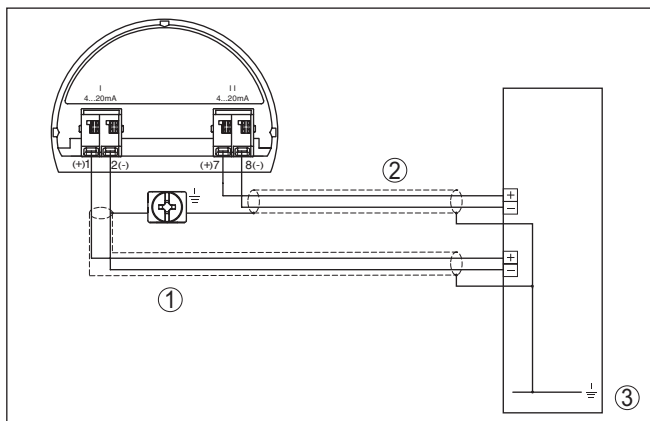


Fig. 37: Connection example DPT-20 additional current output

- 1 Supply and signal circuit, sensor
- 2 Signal circuit, additional current output
- 3 Input card PLC

Sensor	Circuit	Input card PLC
Terminal 1 (+) pas-sive	Supply and signal circuit, sensor	Input 1 terminal (+) active
Terminal 2 (-) pas-sive	Supply and signal circuit, sensor	Input 1 terminal (-) active
Terminal 7 (+) pas-sive	Signal circuit, additional current output	Input 2 terminal (+) active
Terminal 8 (-) pas-sive	Signal circuit, additional current output	Input 2 terminal (-) active

5.5 Switch-on phase

After connecting the instrument to power supply or after a voltage recurrence, the instrument carries out a self-check:

- Internal check of the electronics
- Indication of a status message on the display or PC
- The output signal jumps to the set fault current

Then the actual measured value is output to the signal cable. The value takes into account settings that have already been carried out, e.g. default setting.

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

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

Tool for operation and parameterization



Note:

For operation of the DPT-20 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 the sensor with the display and adjustment module

7.1 Insert display and adjustment module

The display and adjustment module can be inserted into the sensor and removed again at any time. You can choose any one of four different positions - each displaced by 90°. It is not necessary to interrupt the power supply.

Proceed as follows:

1. Unscrew the housing lid
2. Place the display and adjustment module on the electronics in the desired position and turn it to the right until it snaps in.
3. Screw housing lid with inspection window tightly back on

Disassembly is carried out in reverse order.

The display and adjustment module is powered by the sensor, an additional connection is not necessary.



Fig. 38: Installing the display and adjustment module in the electronics compartment of the single chamber housing

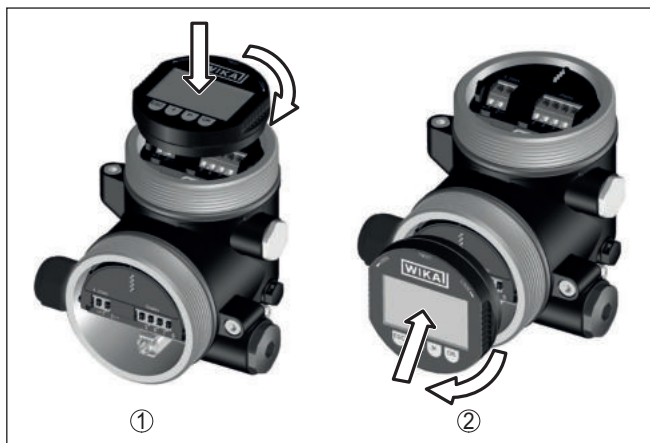


Fig. 39: Installing the display and adjustment module in the double chamber housing

- 1 In the electronics compartment
- 2 In the connection compartment



Note:

If you intend to retrofit the instrument with a display and adjustment module for continuous measured value indication, a higher lid with an inspection glass is required.

7.2 Adjustment system

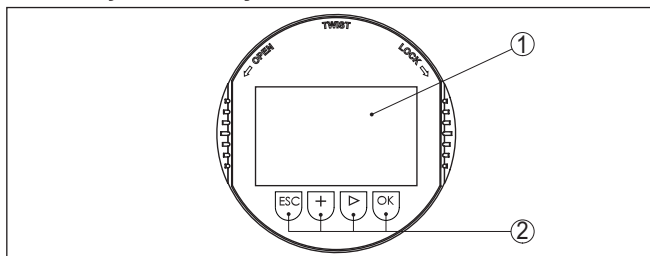


Fig. 40: Display and adjustment elements

- 1 LC display
- 2 Adjustment keys

Key functions

- **[OK]** key:
 - Move to the menu overview
 - Confirm selected menu
 - Edit parameter
 - Save value
- **[->]** key:
 - Change measured value presentation
 - Select list entry
 - Select menu items

- Select editing position
- **[+]** key:
 - Change value of the parameter
- **[ESC]** key:
 - Interrupt input
 - Jump to next higher menu

Adjustment system

The instrument is operated via the four keys of the display and adjustment module. The individual menu items are shown on the LC display. You can find the function of the individual keys in the previous illustration.

Time functions

When the **[+]** and **[->]** keys are pressed quickly, the edited value, or the cursor, changes one value or position at a time. If the key is pressed longer than 1 s, the value or position changes continuously.

When the **[OK]** and **[ESC]** keys are pressed simultaneously for more than 5 s, the display returns to the main menu. The menu language is then switched over to "English".

Approx. 60 minutes after the last pressing of a key, an automatic reset to measured value indication is triggered. Any values not confirmed with **[OK]** will not be saved.

7.3 Measured value indication

Measured value indication

With the **[->]** key you can move between three different indication modes.

In the first view, the selected measured value is displayed in large digits.

In the second view, the selected measured value and a respective bargraph presentation are displayed.

In the third view, the selected measured value as well as a second selectable value, e.g. the temperature, are displayed.



With the "**OK**" key you move (during the initial setup of the instrument) to the selection menu "Language".

Selection language

In this menu item, you can select the national language for further parameterization.



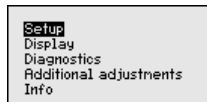
With the "**[->]**" button, you can select the requested language, with "**OK**" you confirm the selection and move to the main menu.

You can change your selection afterwards with the menu item " *Setup - Display, Menu language*".

7.4 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, disable/enable operation

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

Diagnosis: Information, for example, of device status, peak value, simulation

Additional adjustments: date/time, reset, copy function

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



Note:

For optimum setting of the measuring point, the individual submenu items in the main menu item " *Setup*" should be selected one after the other and provided with the correct parameters. If possible, go through the items in the given sequence.

The submenu points are described below.

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

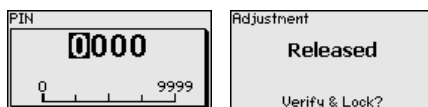
This ensures that all modified parameters have been deliberately changed.

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*".

7.4.1 Setup

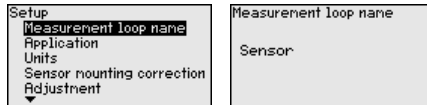
Measurement loop name

In the menu item " *Sensor TAG*" you edit a twelve-digit measurement loop designation.

You can enter an unambiguous designation for the sensor, e.g. the measurement loop name or the tank or product designation. In digital systems and in the documentation of larger plants, a singular designation must be entered for exact identification of individual measuring points.

The available digits include:

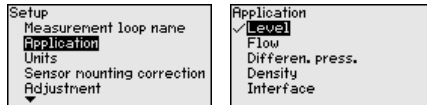
- Letters from A ... Z
- Numbers from 0 ... 9
- Special characters +, -, /, -



Application

The DPT-20 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.

Depending on the selected application, different subchapters in the following adjustment steps are important. There you can find the individual adjustment steps.

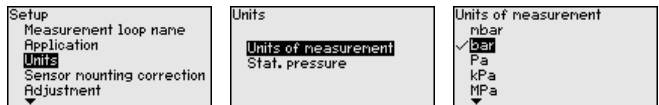


Enter the requested parameters via the appropriate keys, save your settings with [OK] and jump to the next menu item with the [ESC] and the [->] key.

Units

Unit of measurement:

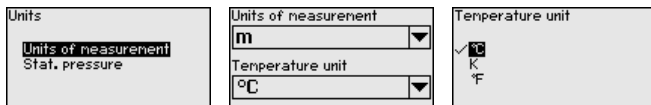
In this menu item, the adjustment units of the instrument are determined. The selection determines the unit displayed in the menu items " *Min. adjustment (Zero)*" and " *Max. adjustment (Span)*".



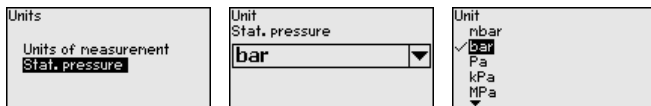
If the level should be adjusted in a height unit, the density of the medium must also be entered later during the adjustment.

Temperature unit:

In addition, the temperature unit of the instrument is specified. The selection determines the unit displayed in menu items " *Peak value, temperature*" and "in the variables of the digital output signal".

**Unit, static pressure:**

The unit "Static pressure" is also set here.



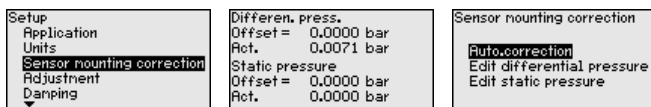
Enter the requested parameters via the appropriate keys, save your settings with **[OK]** and jump to the next menu item with the **[ESC]** and the **[->]** key.

Position correction

The installation position of the instrument can shift the measured value (offset). The position correction function compensates this offset. In the process the current measured value can be accepted automatically.

DPT-20 has two separate sensor systems: one sensor for differential pressure and one sensor for static pressure. The following possibilities thus result for position correction:

- Automatic correction for both sensors
- Manual correction for differential pressure
- Manual correction for static pressure



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.

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

DPT-20 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).

When using the application "Level", the hydrostatic pressure, e.g. with full and empty vessel, is entered as adjustment value. A superimposed pressure is detected by the low pressure side and automatically compensated. See the following example:

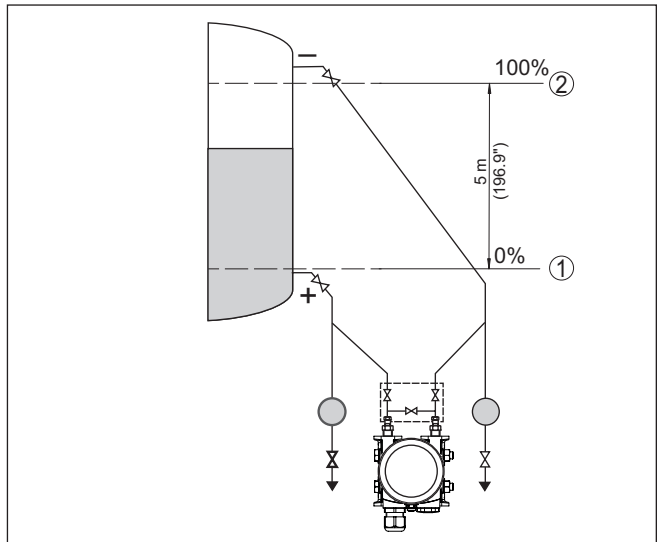


Fig. 41: Parameter adjustment example "Min./max. adjustment, level measurement"

- 1 Min. level = 0 % corresponds to 0.0 mbar
- 2 Max. level = 100 % corresponds to 490.5 mbar

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:

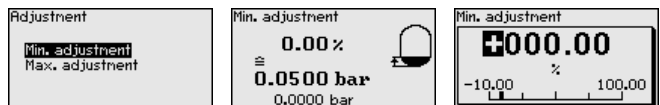
If the adjustment ranges are exceeded, the entered value will not be accepted. Editing can be interrupted with **[ESC]** or corrected to a value within the adjustment ranges.

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.

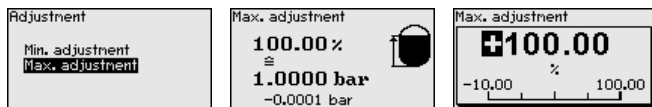
The min. adjustment is finished.

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]**

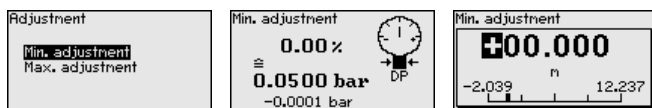
The max. adjustment is finished.

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]**.

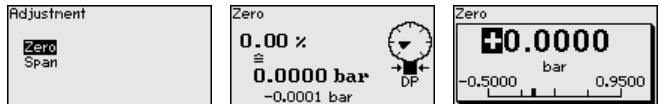
The max. adjustment is finished.

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:

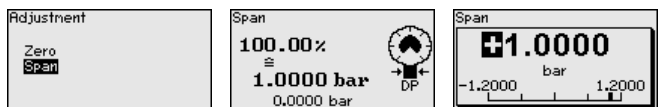
The Zero adjustment shifts the value of the span adjustment. The span, i.e. the difference between these values, however, remains unchanged.

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 **[>]**.

- Set the requested mbar value with **[+]** and store with **[OK]**.

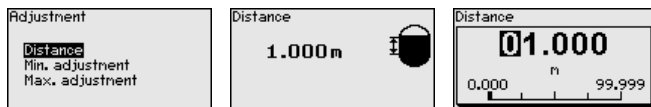
The span adjustment is finished.

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]**.



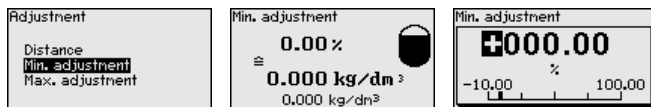
- Edit the sensor distance with **[OK]** and set the cursor to the requested position with **[>]**.
- Set the distance with **[+]** and save with **[OK]**.

The adjustment of the distance is hence finished.

Min. adjustment density

Proceed as follows:

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



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

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



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

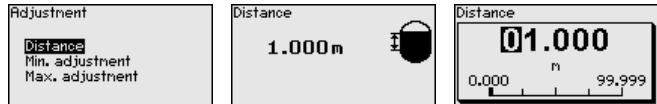
- Enter the max. density value corresponding to the percentage value.

The max. adjustment for density is finished.

Distance interface

Proceed as follows:

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



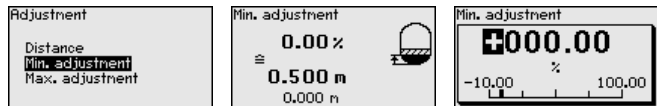
- Edit the sensor distance with [OK] and set the cursor to the requested position with [->].
- Set the distance with [+] and save with [OK].

The adjustment of the distance is hence finished.

Min. adjustment interface

Proceed as follows:

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



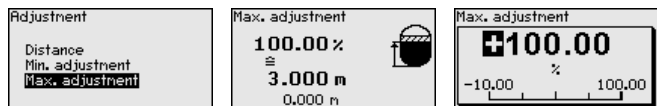
- Edit the percentage value with [OK] and set the cursor to the requested position with [->].
- Set the requested percentage value with [+] and save with [OK]. The cursor jumps now to the height value.
- Enter the min. height of the interface corresponding to the percentage value.
- Save settings with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

The min. adjustment for interface is thus finished.

Max. adjustment interface

Proceed as follows:

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



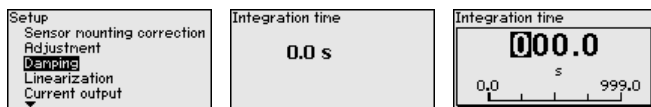
- Edit the percentage value with [OK] and set the cursor to the requested position with [->].
- Set the requested percentage value with [+] and save with [OK]. The cursor jumps now to the height value.

- Enter the max. height of the interface corresponding to the percentage value.

The max. adjustment for interface is finished.

Damping

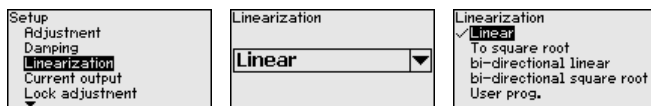
To damp process-dependent measured value fluctuations, set an integration time of 0 ... 999 s in this menu item. The increment is 0.1 s.



The setting in the delivery status depends on the sensor type.

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**".²⁾

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.

Current output

In the menu items "*Current output*" you determine the properties of the current output.

On instruments with integrated additional current output, the properties for each current output are adjusted individually. The following descriptions apply to both current outputs.

²⁾ 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.

Current output (mode)

In the menu item " *Current output mode*" you determine the output characteristics and reaction of the current output in case of fault.

Current output Current output mode Current output min./max.	Current output mode Output characteristic 4 ... 20 mA Failure mode <= 3.6 mA
--	--

The default setting is output characteristics 4 ... 20 mA, fault mode < 3.6 mA.

Current output (min./max.)

In the menu item " *Current output Min./Max.*", you determine the reaction of the current output during operation.

Current output Current output mode Current output min./max.	Current output min./max. Min. current 3.8 mA Max. current 20.5 mA
--	---

The default setting is min. current 3.8 mA and max. current 20.5 mA.

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

Setup Damping Current output Lock adjustment ----- Measurement loop name	Adjustment Released Verify & Lock?	PIN 0000 0 9999
--	---	-----------------------

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.

Zeichenfolgenvergleich Gerät: 1.23+4.56-789.0 Vorgabe: 1.23+4.56-789.0 Zeichenfolge identisch?

3. Serial number acknowledgement



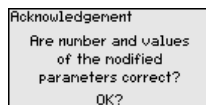
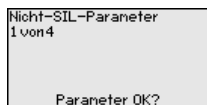
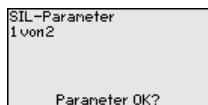
Afterwards you confirm that the serial number of your instrument was carried over correctly. This is used to check device communication.

4. Verify parameters

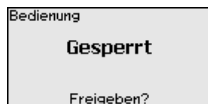
All safety-relevant parameters must be verified after a change:

- SIL parameter 1: Zero adjustment
- SIL parameter 2: Secondary 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.



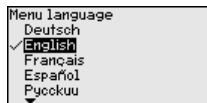
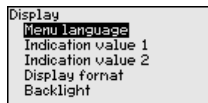
Information:

As long as the DPT-20 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.

7.4.2 Display

Language

This menu item enables the setting of the requested national language.



The following languages are available:

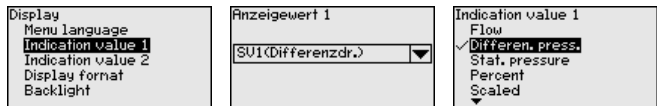
- German
- English
- French
- Spanish
- Russian

- Italian
- Dutch
- Portuguese
- Japanese
- Chinese
- Polish
- Czech
- Turkish

In delivery status, the DPT-20 is set to English.

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

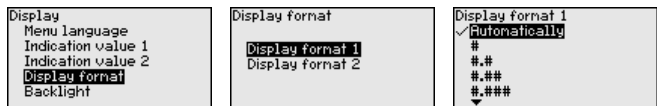
In this menu item, you define which measured value is displayed.



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

Display format 1 and 2

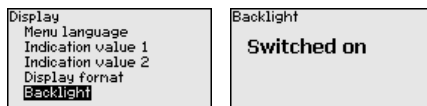
In this menu item you define the number of decimal positions with which the measured value is displayed.



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

Backlight

The display and adjustment module has a backlight for the display. In this menu item you can switch on the lighting. You can find the required operating voltage in chapter " *Technical data*".

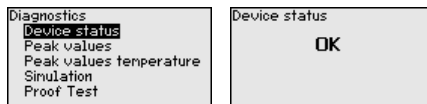


In delivery status, the lighting is switched on.

7.4.3 Diagnostics

Device status

In this menu item, the device status is displayed.

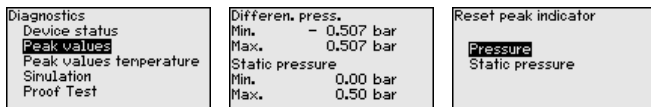


In case of error, e.g. the error code F017, e.g. the error description " *Adjustment span too small*" and a four digit figure are displayed for service purposes. You can find the error codes with description, reason as well as rectification in chapter " *Asset Management*".

Peak value, pressure

The respective min. and max. measured values for the differential pressure and static pressure are stored in the sensor. In menu item " *Peak value, pressure*", both values are displayed.

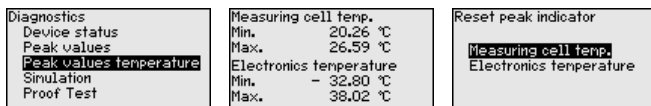
In another window you can carry out a reset of the peak values separately.



Peak value, temperature

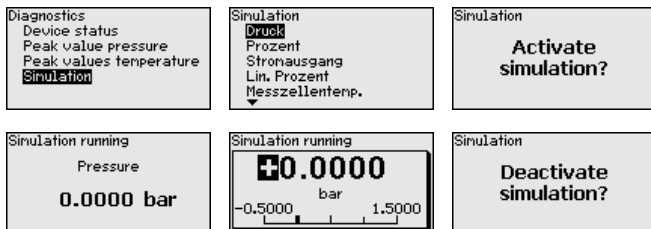
The respective min. and max. measured values of the measuring cell and the electronics temperature are stored in the sensor. In menu item "Peak value, temperature", both values are displayed.

In another window you can carry out a reset of the two peak values separately.



Simulation

In this menu item you can simulate measured values via the current output. 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 digital HART signal.



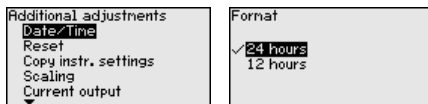
Information:

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

7.4.4 Additional adjustments

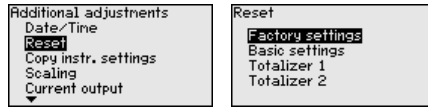
Date/Time

In this menu item, you adjust the internal clock of the sensor. There is no adjustment for summer/winter (daylight saving) time.



Reset

After a reset, certain parameter adjustments made by the user are reset.



The following reset functions are available:

Delivery status: Restores the parameter settings at the time of shipment from the factory, incl. the order-specific settings. Any user-defined linearisation curve as well as the measured value memory are deleted.

Basic settings: Resets the parameter settings, incl. special parameters, to the default values of the respective instrument. Any programmed linearisation curve as well as the measured value memory are deleted.

The following table shows the default values of the instrument. Depending on the instrument version or application, all menu items may not be available or some may be differently assigned:

Setup

Menu item	Parameter	Default value
Measurement loop name		Sensor
Application (SIL)	Application	Level
Units	Unit of measurement	mbar (with nominal measuring range ≤ 500 mbar) bar (with nominal measuring ranges ≥ 3 bar)
	Temperature unit	°C
Position correction (SIL)		0.00 bar
Adjustment (SIL)	Zero/Min. adjustment	0.00 bar 0.00 %
	Span/Max. adjustment	Nominal measuring range in bar 100.00 %
Damping (SIL)	Integration time	0.0 s
Linearisation		linear
Current output (SIL)	Current output - Mode	Output characteristics 4 ... 20 mA Reaction when malfunctions occur ≤ 3.6 mA
	Current output - Min./Max.	3.8 mA 20.5 mA
Lock adjustment (SIL)		Released

Display

Menu item	Default value
Menu language	Order-specific
Displayed value 1	Current output in %
Displayed value 2	Measuring cell temperature in °C Electronics temperature in °C
Display format 1 and 2	Number of positions after the decimal point, automatically
Backlight	Switched on

Diagnostics

Menu item	Parameter	Default value
Device status		-
Peak value indicator	Pressure	Actual measured value
	Temperature	Actual temperature values from measuring cell, electronics
Simulation		Process pressure

Additional adjustments

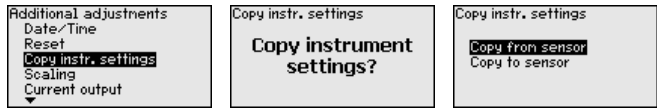
Menu item	Parameter	Default value
PIN		0000
Date/Time		Actual date/Actual time
Copy instrument settings		
Special parameters		No reset
Scaling	Scaling size	Volume in l
	Scaling format	0 % corresponds to 0 l 100 % corresponds to 100 l
Current output 1	Current output - Meas. variable	Lin. percent - Level
	Current output - Adjustment	0 ... 100 % correspond to 4 ... 20 mA
Current output 2	Current output - Meas. variable	Measuring cell temperature
	Current output - Adjustment	0 ... 100 °C correspond to 4 ... 20 mA
HART mode		Address 0

Copy instrument settings The instrument settings are copied with this function. The following functions are available:

- **Read from sensor:** Read data from sensor and store into the display and adjustment module
- **Write into sensor:** Store data from the display and adjustment module back into the sensor

The following data or settings for adjustment of the display and adjustment module are saved:

- All data of the menu " *Setup*" and " *Display*"
- In the menu " *Additional adjustments*" the items " *Reset*, *Date/Time*"
- The user-programmable linearization curve



The copied data are permanently saved in an EEPROM memory in the display and adjustment module and remain there even in case of power failure. From there, they can be written into one or more sensors or kept as backup for a possible electronics exchange.

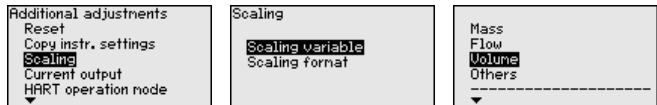


Note:

Before the data are saved in the sensor, a safety check is carried out to determine if the data match the sensor. In the process the sensor type of the source data as well as the target sensor are displayed. If the data do not match, a fault message is outputted or the function is blocked. The data are saved only after release.

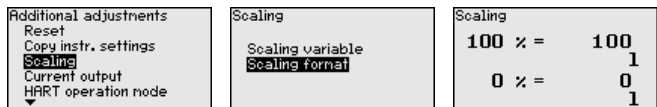
Scaling (1)

In menu item " *Scaling*" you define the scaling variable and the scaling unit for the level value on the display, e.g. volume in l.



Scaling (2)

In menu item " *Scaling (2)*" you define the scaling format on the display and the scaling of the measured level value for 0 % and 100 %.



Current output

In the menu items " *Current output*" you determine the properties of the current output.

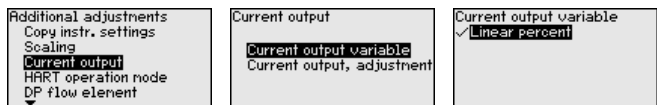
On instruments with integrated additional current output, the properties for each current output are adjusted individually. The following descriptions apply to both current outputs.



The additional current output cannot be used as an output in the sense of a safety-instrumented application (SIL).

Current output 1 and 2 (size)

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

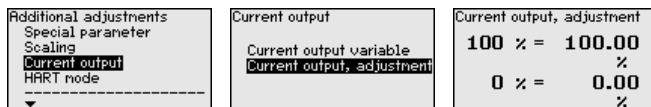


The following selection is possible depending on the selected application:

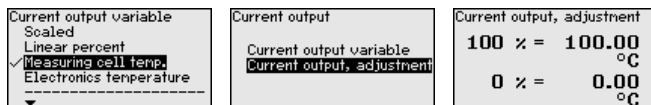
- Flow
- Height - Interface
- Density
- Differential pressure
- Static pressure
- Percent
- Scaled
- Percent linearized
- Measuring cell temperature (ceramic measuring cell)
- Electronics temperature

Current output (adjustment)

Depending on the selected measured variable, you assign in the menu item "Current output, adjustment" the measured values that 4 mA (0 %) and 20 mA (100 %) of the current output refer to.



If the measuring cell temperature is selected as measured variable, then e.g. 0 °C refers to 4 mA and 100 °C to 20 mA.

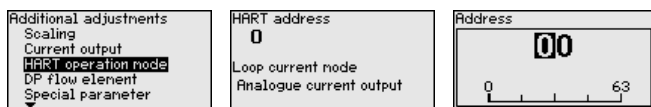


HART mode

The sensor is preset to the HART mode "Analogue current output".



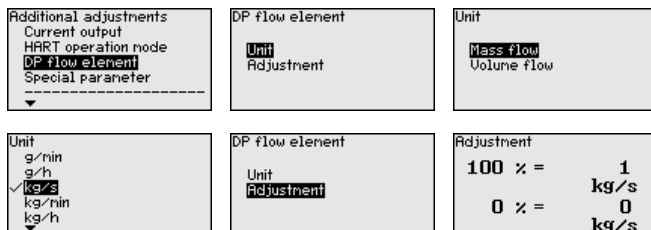
For instruments with SIL qualification, this parameter cannot be modified.



The default setting is "Analogue current output" and the address 00.

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.



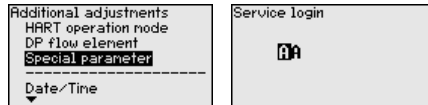
Furthermore the adjustment for the volume or mass flow at 0 % or 100 % is carried out.

The device automatically adds the flow in the selected unit. With appropriate adjustment and bidirectional linearization, the flow rate is counted both positively and negatively.

Special parameters

In this menu item you gain access to the protected area where you can enter special parameters. In exceptional cases, individual parameters can be modified in order to adapt the sensor to special requirements.

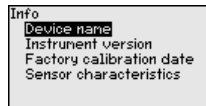
Change the settings of the special parameters only after having contacted our service staff.



7.4.5 Info

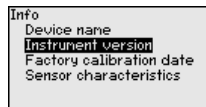
Device name

In this menu item, you can read out the instrument name and the instrument serial number:



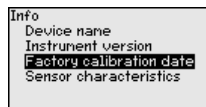
Instrument version

In this menu item, the hardware and software version of the sensor is displayed.



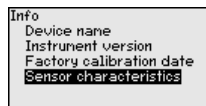
Factory calibration date

In this menu item, the date of factory calibration of the sensor as well as the date of the last change of sensor parameters are displayed via the display and adjustment module or via the PC.



Sensor characteristics

In this menu item, the features of the sensor such as approval, process fitting, seal, measuring range, electronics, housing and others are displayed.



7.5 Saving the parameterisation data

On paper

We recommended writing down the adjustment data, e.g. in this operating instructions manual, and archiving them afterwards. They are thus available for multiple use or service purposes.

In the display and adjustment module

If the instrument is equipped with a display and adjustment module, the parameter adjustment data can be saved therein. The procedure is described in menu item "*Copy device settings*".

8 Setup with PACTware

8.1 Connect the PC

Connection via HART

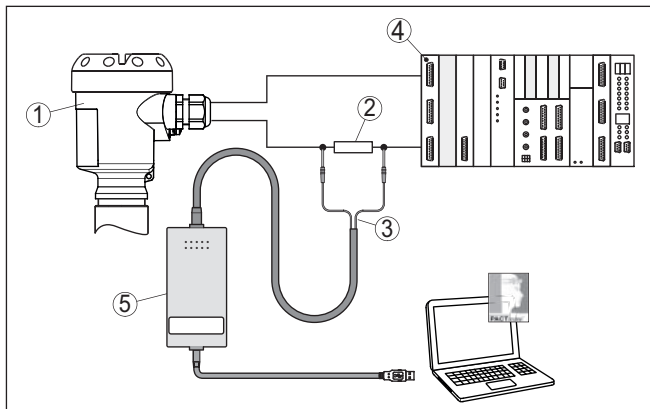


Fig. 42: Connecting the PC via HART to the signal cable

- 1 Sensor
- 2 HART resistance 250 Ω (optional depending on evaluation)
- 3 Adapter cable for HART modem
- 4 Processing system/PLC/Voltage supply
- 5 HART modem



Note:

For power supply units with integrated HART resistance (inner resistance approx. 250 Ω), there is no additional external resistance necessary. Standard Ex separators are often provided with a sufficiently high current limitation resistance. In such cases, the modem can be connected in parallel to the 4 ... 20 mA cable.

8.2 Parameter adjustment

The further setup steps with detailed descriptions can be found in the online help of PACTware and the DTMs.



Note:

Keep in mind that for the setup of device, the current version of the DTM Collection must be used.

The latest DTM Collection and PACTware version can be downloaded free of charge via the Internet.

8.3 Saving the parameterisation data

We recommend documenting or saving the parameterisation data via PACTware. That way the data are available for multiple use or service purposes.

9 Set up measuring system

9.1 Level measurement

Closed vessel

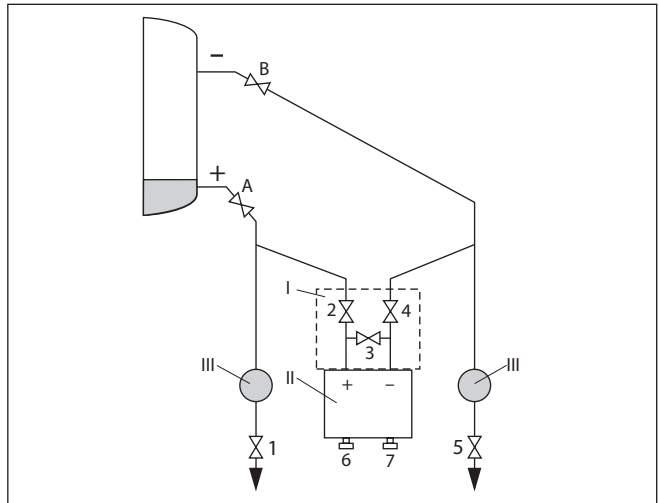


Fig. 43: Preferred measurement setup for closed vessels

- I DPT-20
- II 3-fold valve block
- III Precipitator
- 1, 5 Drain valves
- 2, 4 Inlet valves
- 3 Breather valve
- 6, 7 Vent valves on DPT-20
- A, B Blocking valves

Proceed as follows:

1. Fill the vessel to just above the lower tap
 2. Fill measuring system with medium
Close valve 3: Separate high/low pressure side
Open valve A and B: Open block valves
 3. Vent high pressure side (probably empty low pressure side)
Open valve 2 and 4: Discharge medium on the high pressure side
Briefly open valve 6 and 7, then close again: Fill the high pressure side completely with the medium and remove air.
 4. Set measurement loop to operation
- Now:
- Valve 3, 6 and 7 are closed
 - Valves 2, 4, A and B are open

Closed vessel with steam layer

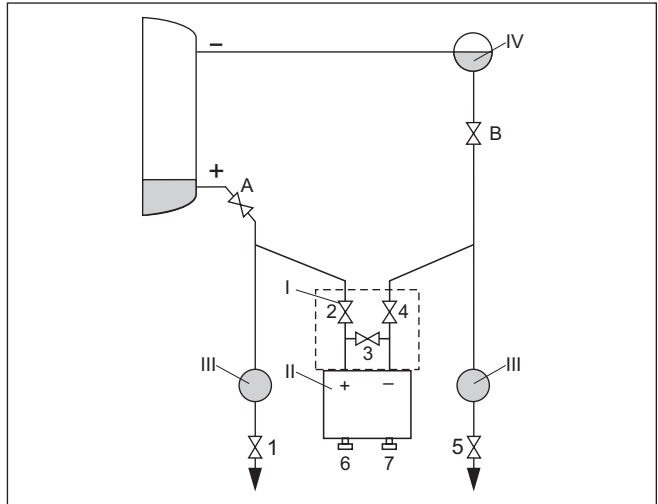


Fig. 44: Preferred measurement setup for closed vessels with steam overlay

- I DPT-20
- II 3-fold valve block
- III Precipitator
- IV Condensate vessel
- 1, 5 Drain valves
- 2, 4 Inlet valves
- 3 Breather valve
- 6, 7 Vent valves on DPT-20
- A, B Blocking valves

Proceed as follows:

1. Fill the vessel to just above the lower tap
2. Fill measuring system with medium
Open valve A and B: Open block valves
Fill the low pressure effective pressure line on the height of the condensation pot
3. Remove air from instrument:
Open valve 2 and 4: Discharge medium
Open valve 3: Equalisation high and low pressure side
Briefly open valve 6 and 7, then close again: Fill the measuring instrument completely with the medium and remove air
4. Put measurement loop into operation:
Close valve 3: Separate high and low pressure side
Open valve 4: Connect low pressure side
Now:
Valve 3, 6 and 7 are closed
Valves 2, 4, A and B are open.

9.2 Flow measurement

Gases

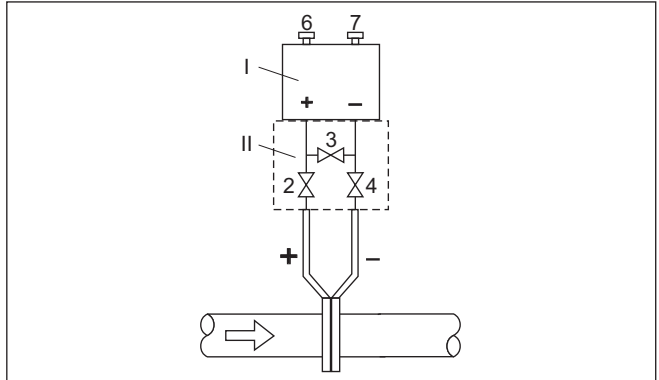


Fig. 45: Preferred measurement setup for gases, connection via 3-fold valve block, flanging on both sides

- I DPT-20
- II 3-fold valve block
- 2, 4 Inlet valves
- 3 Breather valve
- 6, 7 Vent valves on DPT-20

Liquids

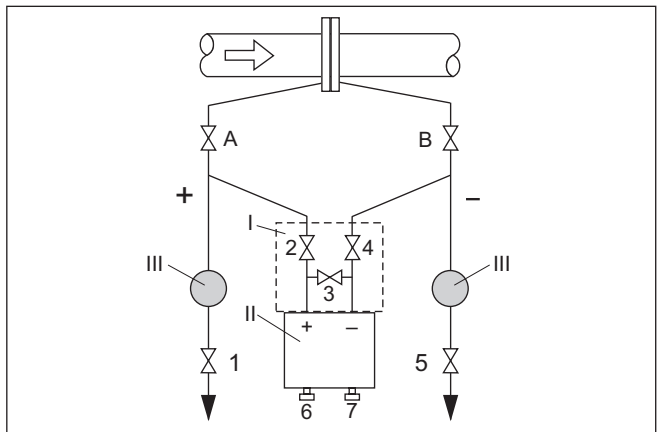


Fig. 46: Preferred measurement setup for liquids

- I DPT-20
- II 3-fold valve block
- III Precipitator
- 1, 5 Drain valves
- 2, 4 Inlet valves
- 3 Breather valve
- 6, 7 Vent valves on DPT-20
- A, B Blocking valves

Proceed as follows:

1. Close valve 3
2. Fill measuring system with medium.
For this purpose, open valves A, B (if available) as well as 2, 4:
Medium flows in
If necessary, clean the differential pressure lines: - with gases by blowing out with compressed air - with liquids by rinsing.³⁾
For this purpose close valve 2 and 4, i.e. block the instrument.
Then open valve 1 and 5 so that the effective pressure lines blow out/rinse.
Close valves 1 and 5 (if available) after cleaning
3. Remove air from instrument:
Open valves 2 and 4: Medium flows in
Close valve 4: Low pressure side is closed
Open valve 3: Equalisation high and low pressure side
Briefly open valve 6 and 7, then close again: Fill the measuring instrument completely with the medium and remove air
4. Carry out a position correction if the following conditions apply. If the conditions are not fulfilled, then carry out the position correction after step 6.
Conditions:
The process cannot be sealed off.
The pressure extraction points (A and B) are at the same geodesic height.
5. Put measurement loop into operation:
Close valve 3: Separate high and low pressure side
Open valve 4: Connect low pressure side
Now:
Valves 1, 3, 5, 6 and 7 are closed⁴⁾
Valves 2 and 4 are open
Valves A and B open
6. Carry out position correction, if flow can be blocked. In this case, step 5 is not required.

³⁾ Arrangement with 5 valves.

⁴⁾ Valves 1, 3, 5: Configuration with 5 valves.

10 Diagnosis, asset management and service

10.1 Maintenance

Maintenance

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

Precaution measures against buildup

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.

Cleaning

The cleaning helps that the type label and markings on the instrument are visible.

Take note of the following:

- Use only cleaning agents which do not corrode the housings, type label and seals
- Use only cleaning methods corresponding to the housing protection rating

10.2 Diagnosis memory

The instrument has several memories available for diagnostic purposes. The data remain there even in case of voltage interruption.

Measured value memory

Up to 100,000 measured values can be stored in the sensor in a ring memory. Each entry contains date/time as well as the respective measured value.

Depending on the instrument version, values that can be stored are for example:

- Level
- Process pressure
- Differential pressure
- Static pressure
- Percentage value
- Scaled values
- Current output
- Lin. percent
- Measuring cell temperature
- Electronics temperature

When the instrument is shipped, the measured value memory is active and stores pressure value and measuring cell temperature every 10 s, with electronic differential pressure also the static pressure.

The requested values and recording conditions are set via a PC with PACTware/DTM or the control system with EDD. Data are thus read out and also reset.

Event memory

Up to 500 events are automatically stored with a time stamp in the sensor (non-deletable). Each entry contains date/time, event type, event description and value. Event types are for example:

- Modification of a parameter

- Switch-on and switch-off times
- Status messages (according to NE 107)
- Error messages (according to NE 107)

The data are read out via a PC with PACTware/DTM or the control system with EDD.

10.3 Asset Management function

The instrument features self-monitoring and diagnostics according to NE 107 and VDI/VDE 2650. In addition to the status messages in the following tables there are more detailed error messages available under the menu item "Diagnostics" via the respective adjustment module.

Status messages

The status messages are divided into the following categories:

- Failure
- Function check
- Out of specification
- Maintenance required

and explained by pictographs:

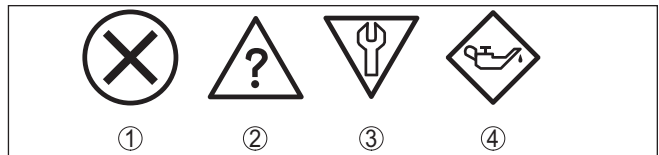


Fig. 47: Pictographs of the status messages

- 1 Failure - red
- 2 Out of specification - yellow
- 3 Function check - orange
- 4 Maintenance required - blue

Failure: Due to a malfunction in the instrument, a fault message is output.

This status message is always active. It cannot be deactivated by the user.

Function check: The instrument is being worked on, the measured value is temporarily invalid (for example during simulation).

This status message is inactive by default.

Out of specification: The measured value is unreliable because an instrument specification was exceeded (e.g. electronics temperature).

This status message is inactive by default.

Maintenance required: Due to external influences, the instrument function is limited. The measurement is affected, but the measured value is still valid. Plan in maintenance for the instrument because a failure is expected in the near future (e.g. due to buildup).

This status message is inactive by default.

Failure

Code Text message	Cause	Rectification	DevSpec State in CMD 48
F013 No valid measured value available	Gauge pressure or low pressure Measuring cell defective	Exchange measuring cell Send instrument for repair	Byte 5, Bit 0 of Byte 0 ... 5
F017 Adjustment span too small	Adjustment not within specification	Change the adjustment according to the limit values	Byte 5, Bit 1 of Byte 0 ... 5
F025 Error in the linearization table	Index markers are not continuously rising, for example illogical value pairs	Check linearization table Delete table/Create new	Byte 5, Bit 2 of Byte 0 ... 5
F036 no operable sensor software	Failed or interrupted software update	Repeat software update Check electronics version Exchanging the electronics Send instrument for repair	Byte 5, Bit 3 of Byte 0 ... 5
F040 Error in the electronics	Hardware defect	Exchanging the electronics Send instrument for repair	Byte 5, Bit 4 of Byte 0 ... 5
F041 Communication error	No connection to the sensor electronics	Check connection between sensor and main electronics (with separate version)	-
F080 General software error	General software error	Disconnect operating voltage briefly	Byte 5, Bit 5 of Byte 0 ... 5
F105 Measured value is determined	The instrument is still in the switch-on phase, the measured value could not yet be determined	Wait for the end of the switch-on phase	Byte 5, Bit 6 of Byte 0 ... 5
F125 Impermissible electronics temperature	Electronics temperature in the non-specified range	Check ambient temperature Insulate electronics Use instrument with higher temperature range	Byte 5, Bit 7 of Byte 0 ... 5
F260 Error in the calibration	Error in the calibration carried out in the factory Error in the EEPROM	Exchanging the electronics Send instrument for repair	Byte 4, Bit 0 of Byte 0 ... 5
F261 Error in the instrument settings	Error during setup Error when carrying out a reset	Repeat setup Repeat reset	Byte 4, Bit 1 of Byte 0 ... 5
F264 Installation/Setup error	Inconsistent settings (e.g.: distance, adjustment units with application process pressure) for selected application Invalid sensor configuration (e.g.: application electronic differential pressure with connected differential pressure measuring cell)	Modify settings Modify connected sensor configuration or application	Byte 4, Bit 2 of Byte 0 ... 5

Code Text message	Cause	Rectification	DevSpec State in CMD 48
F265 Measurement function disturbed	Sensor no longer carries out a measurement	Carry out a reset Disconnect operating voltage briefly	Byte 4, Bit 3 of Byte 0 ... 5
F266 Impermissible voltage supply	Operating voltage below specified range	Check electrical connection If necessary, increase operating voltage	Byte 4, Bit 6 of Byte 0 ... 5

Function check

Code Text message	Cause	Rectification	DevSpec State in CMD 48
C700 Simulation active	A simulation is active	Finish simulation Wait for the automatic end after 60 mins.	"Simulation Active" in "Standardized Status 0"
C701 Parameter verification	Parameter verification was interrupted	Finish parameter verification	Bit 13 of Byte 14 ... 24

Out of specification

Code Text message	Cause	Rectification	DevSpec State in CMD 48
S600 Impermissible electronics temperature	Temperature of the electronics in the non-specified range	Check ambient temperature Insulate electronics	Byte 23, Bit 0 of Byte 14 ... 24
S603 Impermissible operating voltage	Operating voltage below specified range	Check electrical connection If necessary, increase operating voltage	-
S605 Impermissible pressure value	Measured process pressure below or above the adjustment range	Check nominal measuring range of the instrument If necessary, use an instrument with a higher measuring range	-

Maintenance

Code Text message	Cause	Rectification	DevSpec State in CMD 48
M500 Error in the delivery status	The data could not be restored during the reset to delivery status	Repeat reset Load XML file with sensor data into the sensor	Bit 0 of Byte 14 ... 24
M501 Error in the non-active linearisation table	Index markers are not continuously rising, for example illogical value pairs	Check linearization table Delete table/Create new	Bit 1 of Byte 14 ... 24
M502 Error in the event memory	Hardware error EEPROM	Exchanging the electronics Send instrument for repair	Bit 2 of Byte 14 ... 24

Code Text message	Cause	Rectification	DevSpec State in CMD 48
M504 Error at a device interface	Hardware defect	Exchanging the electronics Send instrument for repair	Bit 3 of Byte 14 ... 24
M507 Error in the instrument settings	Error during setup Error when carrying out a reset	Carry out reset and repeat setup	Bit 4 of Byte 14 ... 24

10.4 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.

4 ... 20 mA signal

Connect a multimeter in the suitable measuring range according to the wiring plan. The following table describes possible errors in the current signal and helps to eliminate them:

Error	Cause	Rectification
4 ... 20 mA signal not stable	Fluctuating measured value	Set damping
4 ... 20 mA signal missing	Electrical connection faulty	Check connection, correct, if necessary
	Voltage supply missing	Check cables for breaks; repair if necessary
	Operating voltage too low, load resistance too high	Check, adapt if necessary
Current signal greater than 22 mA, less than 3.6 mA	Sensor electronics defective	Replace device or send in for repair depending on device version

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.

10.5 Replace process flanges

If required, the process flanges can be replaced by an identical type by the user.

Preparations

Required spare parts, depending on order specification:

- Process flanges
- Seals
- Screws, nuts

Required tools:

- Wrench SW 13

It is recommended that the work be carried out on a clean, level surface, e.g. a workbench.



Caution:

There is a risk of injury due to residues of process media in the process flanges. Take suitable protective measures against this.

Dismounting

Proceed as follows:

1. Loosen hexagon head screws crosswise with wrench
2. Carefully remove the process flanges without damaging the differential pressure measuring cell
3. Lift O-ring seals out of the grooves of the process flanges using a pointed tool
4. Clean O-ring grooves and separating diaphragms with a suitable cleaner and soft cloth



Note:

Note additional cleaning for oil and grease-free version

Mounting

Proceed as follows:

1. Insert new, undamaged O-ring seals into the grooves, check for correct position
2. Mount process flanges carefully on the differential pressure measuring cell, the seal must remain in the groove
3. Insert undamaged screws and nuts, screw together crosswise
4. First tighten with 8 Nm, then with 12 Nm
5. Finally tighten with 16 Nm at 160 bar, 18 Nm at 400 bar, 22 Nm for copper gaskets.

The process flanges are exchanged.



Note:

After installing the device in the measuring point, carry out a position correction again.

10.6 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

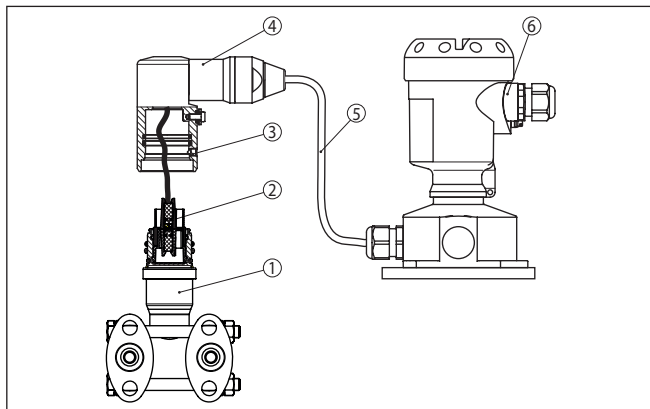


Fig. 48: DPT-20 in IP68 version, 25 bar and lateral cable outlet, external housing

- 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.

The necessary serial number can be found on the type label of the instrument or on the delivery note.

10.7 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

11 Dismount

11.1 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.

11.2 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.

12 Supplement

12.1 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

Material 316L corresponds to stainless steel 1.4404 or 1.4435

Materials, wetted parts

- | | |
|--|---|
| - Process fitting with lateral flanges | 316L, Alloy C276 (2.4819), Superduplex (1.4410) |
| - Separating diaphragm | 316L, Alloy C276 (2.4819), 316L/1.4404 6 µm gold coated |
| - Seal | FKM (ERIKS 514531), EPDM (ERIKS 55914) |
| - Seal for chemical seal assembly | Copper sealing ring |
| - Screw plugs | 316L |
| - Ventilation valves | 316L |

Internal transmission liquid

- | | |
|-------------------------|------------------------------|
| - Standard applications | Silicone oil |
| - Oxygen applications | Halocarbon oil ⁵⁾ |

Materials, non-wetted parts

- | | |
|--|--|
| - Electronics housing | Plastic PBT (polyester), Alu die-casting, powder-coated, 316L |
| - Cable gland | PA, stainless steel, brass |
| - Sealing, cable gland | NBR |
| - Blind plug, cable gland | PA |
| - External housing | Plastic PBT (Polyester), 316L |
| - Socket, wall mounting plate external electronics housing | Plastic PBT (Polyester), 316L |
| - Seal between housing socket and wall mounting plate | TPE (fixed connected) |
| - Seal, housing lid | Silicone SI 850 R, NBR silicone-free |
| - Inspection window housing cover | Polycarbonate (UL-746-C listed), glass ⁶⁾ |
| - Screws and nuts for lateral flange | PN 160 and PN 400: Hexagon screw DIN 931 M8 x 85 A2-70, hexagon nut DIN 934 M8 A2-70 |
| - Ground terminal | 316Ti/316L |
| - Connection between IP68 transmitter and external electronics housing | PE, PUR |

⁵⁾ Note deviating process temperature limits

⁶⁾ Glass with Aluminium and stainless steel precision casting housing

– Type label support with IP68 version on cable PE hard

Weight approx. 4.2 ... 4.5 kg (9.26 ... 9.92 lbs), depending on process fitting

Max. torques

Fixing nuts bracket for mounting angle	30 Nm (22.13 lbf ft)
Mounting screws for oval flange adapter, valve block and mounting bracket on the process assembly	25 Nm (18.44 lbf ft)
Ventilation valves, closing screws ⁷⁾	18 Nm (13.28 lbf ft)
Mounting screws for process assembly	
– 160 bar	16 Nm (11.80 lbf ft)
– 400 bar	18 Nm (13.28 lbf ft)
Socket screws, external housing	5 Nm (3.688 lbf ft)
NPT cable glands and Conduit tubes	
– Plastic housing	10 Nm (7.376 lbf ft)
– Aluminium/Stainless steel housing	50 Nm (36.88 lbf ft)

Input variable

Pressure ranges in bar/Pa

Nominal range	Lower measurement limit	Upper measuring limit
10 mbar (1 kPa)	-10 mbar (-3 kPa)	+10 mbar (+3 kPa)
30 mbar (3 kPa)	-30 mbar (-3 kPa)	+30 mbar (+3 kPa)
100 mbar (10 kPa)	-100 mbar (-10 kPa)	+100 mbar (+10 kPa)
500 mbar (50 kPa)	-500 mbar (-50 kPa)	+500 mbar (+50 kPa)
3 bar (300 kPa)	-3 bar (-300 kPa)	+3 bar (+300 kPa)
16 bar (1600 kPa)	-16 bar (-1600 kPa)	+16 bar (+1600 kPa)

Pressure ranges in psi

Nominal range	Lower measurement limit	Upper measuring limit
0.15 psig	-0.15 psig	+0.15 psig
0.45 psig	-0.45 psig	+0.45 psig
1.5 psig	-1.5 psig	+1.5 psig
7.5 psig	-7.5 psig	+7.5 psig
45 psig	-45 psig	-45 psig
240 psig	-240 psig	+240 psig

⁷⁾ 4 layers PTFE

Adjustment ranges ⁸⁾

Maximum permissible Turn Down	Unlimited (recommended up to 20 : 1)
-------------------------------	--------------------------------------

Adjustment differential pressure

Zero/Span adjustment:

- | | |
|-----------------------|--------------------------|
| - Pressure value zero | -120 ... +120 % |
| - Pressure value span | Zero + (-240 ... +240 %) |

Adjustment level

Min./Max. adjustment:

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

Adjustment flow

Zero/Span adjustment:

- | | |
|-----------------------|-----------------|
| - Pressure value zero | -120 ... +120 % |
| - Pressure value span | -120 ... +120 % |

Switch-on phaseStart-up time with operating voltage U_B

- | | |
|------------------------------------|---------------|
| - ≥ 12 V DC | ≤ 9 s |
| - < 12 V DC | ≤ 22 s |
| Starting current (for run-up time) | ≤ 3.6 mA |

Output variable

Output signal	4 ... 20 mA/HART
Range of the output signal	3.8 ... 20.5 mA/HART (default setting)
Fulfilled HART specification	7.3
Signal resolution	0.3 μ A
Fault signal, current output (adjustable)	≤ 3.6 mA, ≥ 21 mA, last measured value ⁹⁾
Max. output current	21.5 mA
Load	See load resistance under Power supply
Starting current	≤ 10 mA for 5 ms after switching on, ≤ 3.6 mA
Damping (63 % of the input variable), adjustable	0 ... 999 s
HART output values according to HART 7 (default setting) ¹⁰⁾	
- First HART value (PV)	Linear percentage value
- Second HART value (SV)	Static pressure
- Third HART value (TV)	Differential pressure
- Fourth HART value (QV)	Electronics temperature

⁸⁾ The specifications refer to the nominal measuring range.

⁹⁾ Last measured value not possible with SIL.

¹⁰⁾ The output values can be assigned individually.

Output variable - Additional current output

For details on the operating voltage see chapter "Voltage supply"

Output signal	4 ... 20 mA (passive)
Range of the output signal	3.8 ... 20.5 mA (default setting)
Signal resolution	0.3 μ A
Fault signal, current output (adjustable)	Last valid measured value, ≥ 21 mA, ≤ 3.6 mA
Max. output current	21.5 mA
Starting current	≤ 10 mA for 5 ms after switching on, ≤ 3.6 mA
Load	Load resistor, see chapter "Voltage supply"
Damping (63 % of the input variable), adjustable	0 ... 999 s

Dynamic behaviour output

Dynamic characteristics depending on medium and temperature

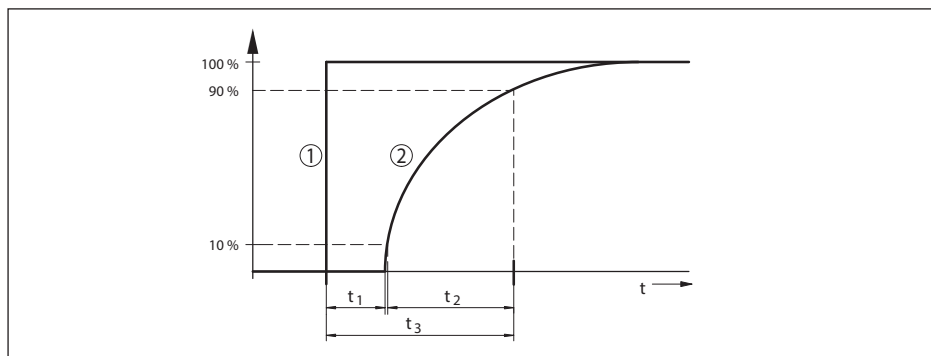


Fig. 49: Behaviour in case of sudden change of the process variable. t_1 : dead time; t_2 : rise time; t_3 : jump response time

- 1 Process variable
- 2 Output signal

Version, nominal measuring range	Dead time t_1	Rise time t_2	Step response time t_3
Basic version 10 bar and 30 bar	160 ms	115 ms	275 ms
Basic version 100 mbar	130 ms	95 ms	225 ms
Basic version 500 mbar		75 ms	205 ms
Basic version, 3 bar		60 ms	190 ms
Basic version, 16 bar			
Chemical seal version, all nominal measuring ranges	Dependent on the chemical seal	Dependent on the chemical seal	Dependent on the chemical seal
Version IP68 (25 bar)	additionally 50 ms	additionally 150 ms	additionally 200 ms

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

Additional output parameter - Measuring cell temperature

Range	-40 ... +85 °C (-40 ... +185 °F)
Measuring cell temperature	
– Resolution	1 K
– Deviation	±1 K
Output of the temperature values	
– Indication	Via the display and adjustment module
– Analogue	Via the current output, the additional current output
– Digital	Via the digital output signal (depending on the electronics version)

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 psig)
Determination of characteristics	Limit point adjustment according to IEC 61298-2
Characteristic curve	Linear
Calibration position of the measuring cell	Vertical, i.e. upright process component
Influence of the installation position	<0.35 mbar/20 Pa (0.003 psig) 10° inclination each around the transverse axis
Material, lateral flanges	316L
Deviation at the current output due to strong, high-frequency electromagnetic fields	
– In accordance with EN 61326-1	< ±80 µA
– In accordance with IACS E10 (ship-building)/IEC 60945	<= ±160 µA

Deviation determined according to the limit point method according to IEC 60770 or IEC 61298

The measurement deviation includes the non-linearity, hysteresis and non-reproducibility.

The values apply to the **digital** signal output (HART, Profibus PA, Foundation Fieldbus) as well as to the **analogue** current output 4 ... 20 mA. For differential pressure they refer to the set span, for static pressure to the measuring range final value. Turn down (TD) is the ratio of the nominal measuring range to the set span.

Differential pressure

Measuring range	TD ≤ 5 : 1	TD > 5 : 1	TD > 10 : 1
10 mbar (1 kPa)/0.145 psi	< ±0.1 %		< ±0.02 % x TD
30 mbar (3 kPa)/0.44 psi			
100 mbar (10 kPa)/1.5 psi	< ±0.065 %		< ±0.035 % + 0.01 % x TD
500 mbar (50 kPa)/7.3 psi			< ±0.015 % + 0.005 % x TD
3 bar (300 kPa)/43.51 psi			< ±0.035 % + 0.01 % x TD
16 bar (1600 kPa)/232.1 psi			< ±0.035 % + 0.01 % x TD

Static pressure

Measuring range	Up to nominal pressure ¹¹⁾	TD 1:1
10 mbar (1 kPa)/0.145 psi	40 bar (4000 kPa)	< ±0.1 %
30 mbar (3 kPa)/0.44 psi		
100 mbar (10 kPa)/1.5 psi	160 bar (16000 kPa) resp. 400 bar (40000 kPa)	
500 mbar (50 kPa)/7.3 psi		
3 bar (300 kPa)/43.51 psi		
16 bar (1600 kPa)/232.1 psi		

Flow > 50 %¹²⁾

Measuring range	TD ≤ 5 : 1	TD > 5 : 1	TD > 10 : 1
10 mbar (1 kPa)/0.145 psi	< ±0.1 %		< ±0.02 % x TD
30 mbar (3 kPa)/0.44 psi			
100 mbar (10 kPa)/1.5 psi	< ±0.065 %		< ±0.035 % + 0.01 % x TD
500 mbar (50 kPa)/7.3 psi			< ±0.015 % + 0.005 % x TD
3 bar (300 kPa)/43.51 psi			
16 bar (1600 kPa)/232.1 psi			< ±0.035 % + 0.01 % x TD

25 % < Flow ≤ 50 %¹³⁾

Measuring range	TD ≤ 5 : 1	TD > 5 : 1	TD > 10 : 1
10 mbar (1 kPa)/0.145 psi	< ±0.2 %		< ±0.04 % x TD
30 mbar (3 kPa)/0.44 psi			
100 mbar (10 kPa)/1.5 psi	< ±0.13 %		< ±0.07 % + 0.02 % x TD
500 mbar (50 kPa)/7.3 psi			< ±0.03 % + 0.01 % x TD
3 bar (300 kPa)/43.51 psi			
16 bar (1600 kPa)/232.1 psi			< ±0.07 % + 0.02 % x TD

Influence of the medium or ambient temperature

The values apply to the **digital** signal output as well as to the **analogue** current output 4 ... 20 mA. Turn down (TD) is the ratio "nominal measuring range/set span".

Thermal change zero signal and output span, differential pressure¹⁴⁾

Measuring range	-10 ... +60 °C / +14 ... +140 °F	-40 ... -10 °C / -40 ... +14 °F und +60 ... +85 °C / +140 ... +185 °F
10 mbar (1 kPa)/0.145 psi	< ±0.15 % + 0.20 % x TD	< ±0.4 % + 0.3 % x TD
30 mbar (3 kPa)/0.44 psi	< ±0.15 % + 0.10 % x TD	< ±0.2 % + 0.15 % x TD
100 mbar (10 kPa)/1.5 psi	< ±0.15 % + 0.15 % x TD	< ±0.15 % + 0.20 % x TD

¹¹⁾ Measuring range end, absolute pressure

¹²⁾ Root characteristic

¹³⁾ Root characteristic

¹⁴⁾ Relating to the adjusted span.

Measuring range	-10 ... +60 °C / +14 ... +140 °F	-40 ... -10 °C / -40 ... +14 °F und +60 ... +85 °C / +140 ... +185 °F
500 mbar (50 kPa)/7.3 psi	< ±0.15 % + 0.05 % x TD	< ±0.2 % + 0.06 % x TD
3 bar (300 kPa)/43.51 psi		
16 bar (1600 kPa)/232.1 psi	< ±0.15 % + 0.15 % x TD	< ±0.15 % + 0.20 % x TD

Thermal change zero signal and output span, static pressure¹⁵⁾

Measuring range	Up to nominal pressure¹⁶⁾	-40 ... +80 °C / -40 ... +176 °F
10 mbar (1 kPa)/0.145 psi	40 bar (4000 kPa)	< ±0.5 %
30 mbar (3 kPa)/0.44 psi		
100 mbar (10 kPa)/1.5 psi	160 bar (16000 kPa) resp. 400 bar (40000 kPa)	
500 mbar (50 kPa)/7.3 psi		
3 bar (300 kPa)/43.51 psi		
16 bar (1600 kPa)/232.1 psi		

Thermal change current output through ambient temperature

Applies also to the **analogue** 4 ... 20 mA current output and refers to the set span.

Thermal change, current output < 0.05 %/10 K, max. < 0.15 %, each with -40 ... +80 °C (-40 ... +176 °F)

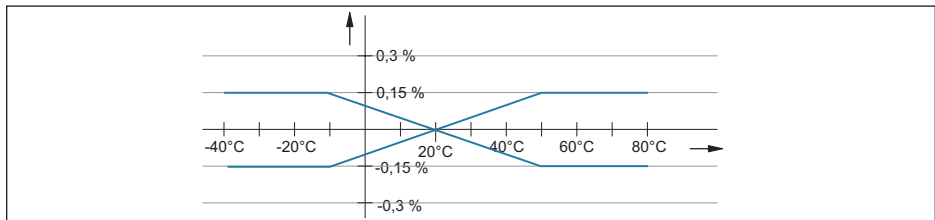


Fig. 50: Thermal change, current output

Influence of the static pressure

The values apply to the **digital** signal output (HART, Profibus PA, Foundation Fieldbus) as well as to the **analogue** current output 4 ... 20 mA and refer to the set span. Turn down (TD) is the ratio "nominal measuring range/set span".

Change zero signal and output span

Nominal range	Up to nominal pressure¹⁷⁾	Influence on the zero point	Influence on the span
10 mbar (1 kPa), (0.145 psi)	40 bar (4000 kPa), (600 psi)	< ±0.10 % x TD	< ±0.10 %
30 mbar (3 kPa), (0.44 psi)			

¹⁵⁾ Relating to the measuring range end value.

¹⁶⁾ Measuring range end, absolute pressure.

¹⁷⁾ Measuring range end, absolute pressure.

Nominal range	Up to nominal pressure ¹⁷⁾	Influence on the zero point	Influence on the span		
100 mbar (10 kPa), (1.5 psi)	160 bar (16000 kPa), (2400 psi)	160 bar (16000 kPa), (2400 psi): < ±0.10 % x TD	160 bar(16000 kPa), (2400 psi): < ±0.10 %		
500 mbar (50 kPa), (7.3 psi)					
3 bar (300 kPa), (43.51 psi)				400 bar (4000 kPa), (5800 psi)	400 bar(4000 kPa), (5800 psi): ≤ 0.25 %
16 bar (1600 kPa), (232.1 psi)				≤ 0.25 % x TD	

Long-term stability (according to DIN 16086)

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

The long-term stability of the zero signal and output span corresponds to the value F_{Stab} in chapter "Calculation of the total deviation (according to DIN 16086)".

Long-term stability zero signal and output span

Measured variable	Time range		
	1 year	5 years	10 years
Differential pressure ¹⁾	< 0.065 % x TD	< 0.1 % x TD	< 0.15 % x TD
Static pressure ¹⁾	< ±0.065 %	< ±0.1 %	< ±0.15 %

Process conditions

Process temperature

Material seal	Filling oil	Temperature limits
FKM (ERIKS 514531)	Silicone oil	-20 ... +85 °C (-4 ... +185 °F)
	Halocarbon oil for oxygen applications	-10 ... +60 °C (-4 ... +140 °F)
EPDM (ERIKS 55914)	Silicone oil	-40 ... +85 °C (-40 ... +185 °F)
	Halocarbon oil for oxygen applications	-10 ... +60 °C (-4 ... +140 °F)
Copper	Silicone oil	-40 ... +85 °C (-40 ... +185 °F)
	Halocarbon oil for oxygen applications	-20 ... +60 °C (-4 ... +140 °F)

Process pressure ¹⁾

Nominal range	Max. permissible process pressure (MWP)	Overload unilateral (OPL)	Overload bilateral (OPL)	Min. permissible static pressure
10 mbar (1 kPa)	40 bar (4000 kPa)	40 bar (4000 kPa)	60 bar (6000 kPa)	1 mbar _{abs} (100 Pa _{abs})
30 mbar (3 kPa)				
100 mbar (10 kPa)	160 bar (16000 kPa)	160 bar (16000 kPa)	240 bar (24000 kPa)	
500 mbar (50 kPa)	160 bar (16000 kPa)	160 bar (16000 kPa)	240 bar (24000 kPa)	
3 bar (300 kPa)	400 bar (40000 kPa)	400 bar (40000 kPa)	630 bar (63000 kPa)	
16 bar (1600 kPa)				

Nominal range	Max. permissible process pressure (MWP)	Overload unilateral (OPL)	Overload bilateral (OPL)	Min. permissible static pressure
0.15 psig	580.1 psig	580.1 psig	870.2 psig	0.015 psi
0.45 psig				
1.5 psig	2320 psig	2320 psig	3481 psig	
7.5 psig	2320 psig	2320 psig	3481 psig	
45 psig	5802 psig	5802 psig	9137 psig	
240 psig				

Mechanical stress

Vibration resistance

4 g at 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) ¹⁾**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) ¹⁾

Options of the cable entry

- Cable entry M20 x 1.5; ½ NPT
- Cable gland M20 x 1.5, ½ NPT (cable ø 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	10 ... 14 mm
PA/NBR	●	●	–	●
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 IP66/IP68 (1 bar)

Connection cable, mechanical data

- Configuration Wires, strain relief, breather capillaries, screen braiding, metal foil, mantle
- Standard length 5 m (16.4 ft)
- Min. bending radius (at 25 °C/77 °F) 25 mm (0.984 in)
- Diameter approx. 8 mm (0.315 in)
- Colour - version PE Black
- Colour - version PUR Blue

Connection cable, electrical data

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

Electromechanical data - version IP68 (25 bar)

Connection cable, mechanical data

- Configuration Wires, strain relief, breather capillaries, screen braiding, metal foil, mantle
- 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)
- Colour PE Black
- Colour PUR Blue

Connection cable, electrical data

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

Display and adjustment module

Display element Display with backlight

Measured value indication

- Number of digits 5

Adjustment elements

– 4 keys *[OK], [->], [+], [ESC]*

Protection rating

– unassembled IP20
 – Mounted in the housing without lid IP40

Materials

– Housing ABS
 – Inspection window Polyester foil

Functional safety

SIL non-reactive

Interface to the external display and adjustment unit

Data transmission Digital (I²C-Bus)

Connection cable Four-wire

Sensor version	Configuration, connection cable	
	Max. cable length	Shielded
4 ... 20 mA/HART 4 ... 20 mA/HART SIL	50 m	●
Profibus PA, Foundation Fieldbus	25 m	●

Integrated clock

Date format Day.Month.Year

Time format 12 h/24 h

Time zone, factory setting CET

Max. rate deviation 10.5 min/year

Additional output parameter - Electronics temperature

Range -40 ... +85 °C (-40 ... +185 °F)

Resolution < 0.1 K

Deviation ±3 K

Output of the temperature values

– Indication Via the display and adjustment module
 – Output Via the respective output signal

Voltage supply

Operating voltage U_B 11 ... 35 V DC

Operating voltage U_B with lighting switched on 16 ... 35 V DC

Reverse voltage protection Integrated

Permissible residual ripple

– for U_N 12 V DC ($11 \text{ V} < U_B < 14 \text{ V}$) $\leq 0.7 V_{\text{eff}}$ (16 ... 400 Hz)
 – for U_N 24 V DC ($18 \text{ V} < U_B < 35 \text{ V}$) $\leq 1.0 V_{\text{eff}}$ (16 ... 400 Hz)

Load resistor

- Calculation $(U_B - U_{min})/0.022 \text{ A}$
- Example - $U_B = 24 \text{ V DC}$ $(24 \text{ V} - 11 \text{ V})/0.022 \text{ A} = 591 \Omega$

Potential connections and electrical separating measures in the instrument

Electronics	Not non-floating
Reference voltage ¹⁾	500 V AC
Conductive connection	Between ground terminal and metallic process fitting

Electrical protective measures ¹⁾

Housing material	Version	Protection acc. to IEC 60529	Protection acc. to NEMA
Plastic	Single chamber	IP66/IP67	Type 4X
	Double chamber		
Aluminium	Single chamber	IP66/IP67 IP66/IP68 (0.2 bar) IP68 (1 bar)	Type 4X Type 6P -
	Double chamber	IP66/IP67 IP66/IP68 (0.2 bar)	Type 4X Type 6P
Stainless steel (electro-polished)	Single chamber	IP66/IP67 IP69K	Type 4X
Stainless steel (precision casting)	Single chamber	IP66/IP67 IP66/IP68 (0.2 bar) IP68 (1 bar)	Type 4X Type 6P -
	Double chamber	IP66/IP67 IP66/IP68 (0.2 bar)	Type 4X Type 6P
Stainless steel	Transmitter, version with external housing	IP68 (25 bar)	-

Connection of the feeding power supply unit Networks of overvoltage category III

Altitude above sea level

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

Pollution degree ¹⁾ 2

Protection rating (IEC/EN 61010-1) II

12.2 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} :

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

The basic deviation F_{perf} in turn consists of the thermal change of the zero signal and the output span F_T (temperature error) as well as the deviation F_{KI} :

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

The thermal change of the zero signal and output span F_T is specified in chapter " *Technical data*".

This applies initially to the digital signal output through HART, Profibus PA, Foundation Fieldbus or Modbus.

With 4 ... 20 mA output, the thermal change of the current output F_a must be added:

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

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_{KI} : Deviation
- F_a : Thermal change of the current output
- FMZ: Additional factor measuring cell version
- FTD: Additional factor Turn down

12.3 Calculation of the total deviation - Practical example

Data

Differential pressure **250 mbar** (25 kPa), medium temperature on the measuring cell 60 °C

DPT-20 with measuring range **500 mbar**

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

1. Calculation of the Turn down

$$\text{TD} = 500 \text{ mbar} / 250 \text{ mbar}$$

$$\text{TD} = \mathbf{2:1}$$

2. Determination temperature error F_T

Measuring range	-10 ... +60 °C / +14 ... +140 °F	-40 ... -10 °C / -40 ... +14 °F und +60 ... +85 °C / +140 ... +185 °F
10 mbar (1 kPa)/0.145 psi	< ±0.15 % + 0.20 % x TD	< ±0.4 % + 0.3 % x TD
30 mbar (3 kPa)/0.44 psi	< ±0.15 % + 0.10 % x TD	< ±0.2 % + 0.15 % x TD
100 mbar (10 kPa)/1.5 psi	< ±0.15 % + 0.15 % x TD	< ±0.15 % + 0.20 % x TD
500 mbar (50 kPa)/7.3 psi	< ±0.15 % + 0.05 % x TD	< ±0.2 % + 0.06 % x TD
3 bar (300 kPa)/43.51 psi		
16 bar (1600 kPa)/232.1 psi	< ±0.15 % + 0.15 % x TD	< ±0.15 % + 0.20 % x TD

$$F_T = 0.15 \% + 0.05 \% \times \text{TD}$$

$$F_T = 0.15 \% + 0.1 \%$$

$$F_T = \mathbf{0.25 \%}$$

3. Determination of deviation and long-term stability

Deviation

Measuring range	TD 1 : 1 up to 5 : 1	TD > 5 : 1	TD > 10 : 1
10 mbar (1 kPa)/0.145 psi	< ±0.1 %		< ±0.02 % x TD
30 mbar (3 kPa)/0.44 psi			
100 mbar (10 kPa)/1.5 psi	< ±0.065 %		< ±(0.035 % + 0.01 %) x TD
500 mbar (50 kPa)/7.3 psi			
3 bar (300 kPa)/43.51 psi			< ±(0.015 % + 0.005 %) x TD
16 bar (1600 kPa)/232.1 psi			< ±(0.035 % + 0.01 %) x TD

Long-term stability

Measured variable	Time range		
	1 year	5 years	10 years
Differential pressure ¹⁾	< 0.065 % x TD	< 0.1 % x TD	< 0.15 % x TD
Static pressure ¹⁾	< ±0.065 %	< ±0.1 %	< ±0.15 %

4. Calculation of the total deviation - digital output signal

- 1. step: Basic deviation F_{perf}

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

$$F_{\text{T}} = 0.25 \%$$

$$F_{\text{Kl}} = 0.065 \%$$

$$F_{\text{perf}} = \sqrt{(0.25 \%)^2 + (0.065 \%)^2}$$

$$F_{\text{perf}} = 0.26 \%$$

- 2. step: Total deviation F_{total}

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

$$F_{\text{perf}} = 0.26 \%$$
 (result of step 1)

$$F_{\text{stab}} = 0.065 \% \times \text{TD}$$

$$F_{\text{stab}} = 0.065 \% \times 2$$

$$F_{\text{stab}} = 0.13 \%$$

$$F_{\text{total}} = 0.26 \% + 0.13 \% = 0.39 \%$$

5. Calculation of the total deviation - 4 ... 20 mA signal

- 1. step: Basic deviation F_{perf}

$$F_{\text{perf}} = \sqrt{((F_{\text{T}})^2 + (F_{\text{Kl}})^2 + (F_{\text{a}})^2)}$$

$$F_{\text{T}} = 0.25 \%$$

$$F_{\text{Kl}} = 0.065 \%$$

$$F_{\text{a}} = 0.15 \%$$

$$F_{\text{perf}} = \sqrt{(0.25 \%)^2 + (0.065 \%)^2 + (0.15 \%)^2}$$

$$F_{\text{perf}} = 0.3 \%$$

- 2. step: Total deviation F_{total}

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

$$F_{\text{stab}} = 0.065 \% \times \text{TD}$$

$$F_{\text{stab}} = 0.065 \% \times 2$$

$$F_{\text{stab}} = 0.13 \%$$

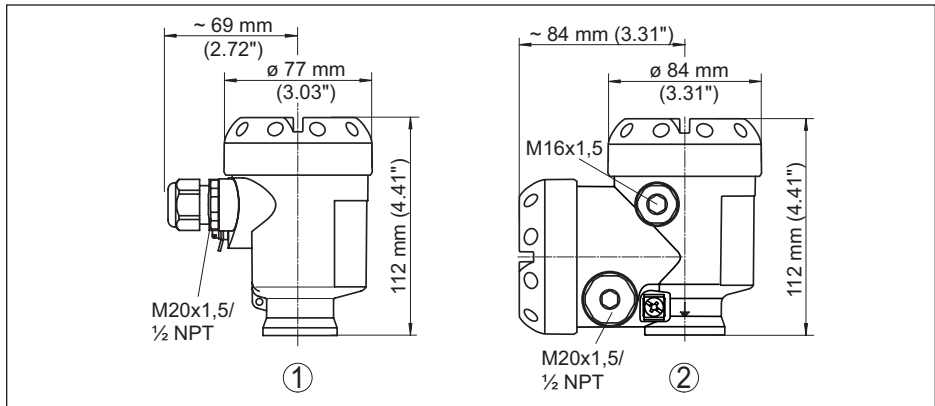
$$F_{\text{total}} = 0.3 \% + 0.13 \% = 0.43 \%$$

The total percentage deviation of the measurement is thus 0.43 %. The absolute total deviation is 0.43 % of 250 mbar = 1.1 mbar

The example shows that in practice the error of use can be significantly higher than the actual measurement error. The causes are temperature influence and turn down.

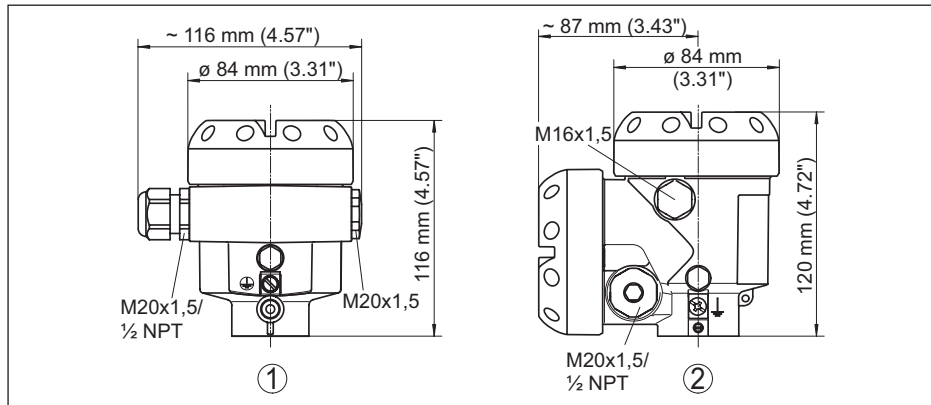
12.4 Dimensions, versions process component

Plastic housing



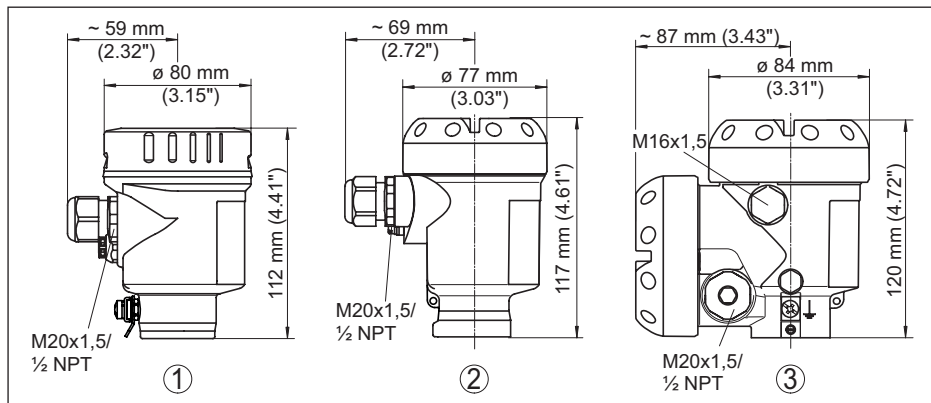
- 1 Plastic single chamber
- 2 Plastic double chamber

Aluminium housing



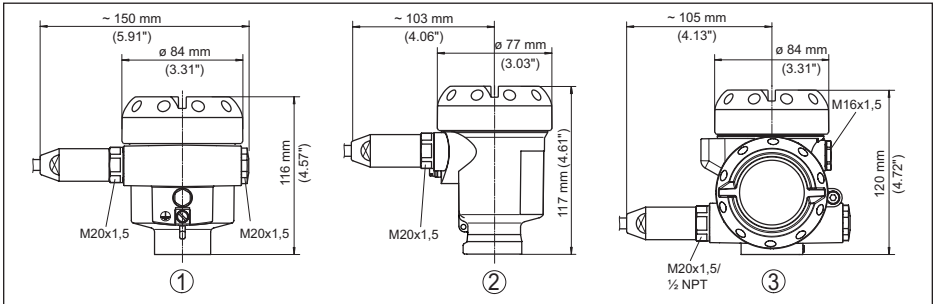
- 1 Aluminium - single chamber
- 2 Aluminium - double chamber

Stainless steel housing



- 1 Stainless steel single chamber (electropolished)
- 2 Stainless steel single chamber (precision casting)
- 3 Stainless steel double chamber housing (precision casting)

Aluminium and stainless steel housing in protection IP66/IP68 (1 bar)



- 1 Aluminium - single chamber
- 2 Stainless steel single chamber (precision casting)
- 3 Aluminium double chamber housing, stainless steel double chamber housing (precision casting)

External housing with IP68 (25 bar) version

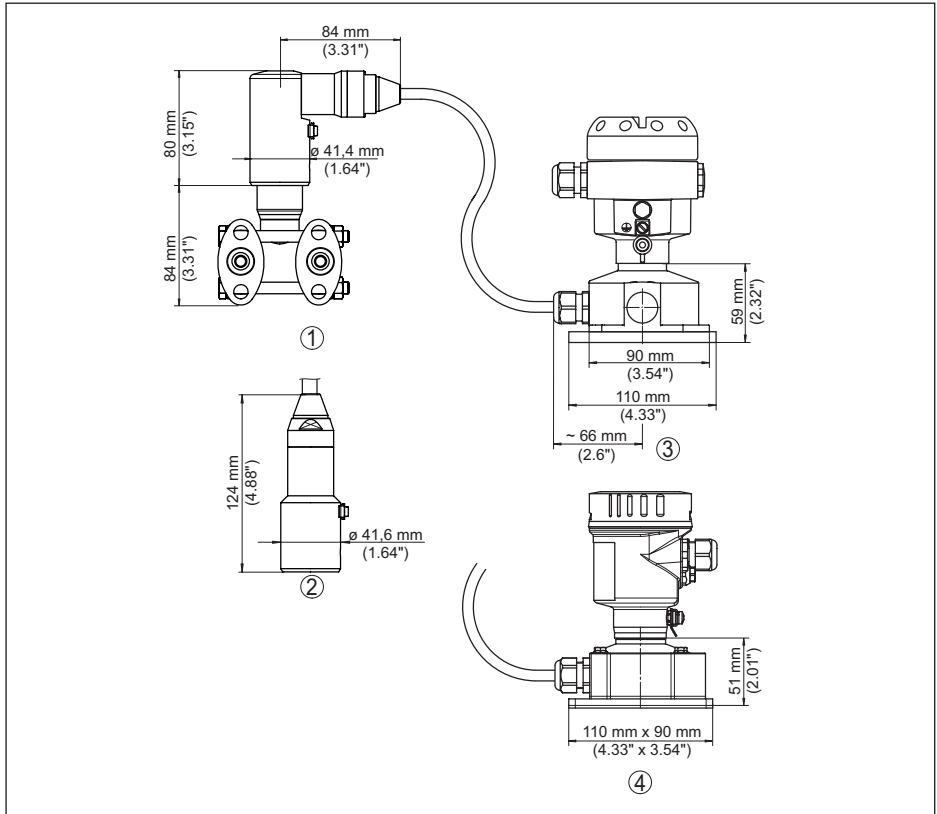


Fig. 51: External housing

- 1 Lateral cable outlet
- 2 Cable outlet axial
- 3 Plastic single chamber
- 4 Stainless steel single chamber

Ventilation on process axis

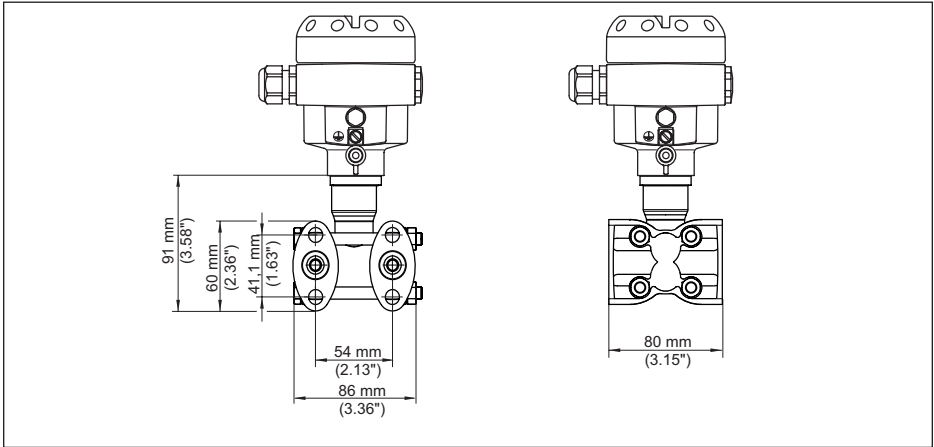


Fig. 52: DPT-20, ventilation on process axis

Connection	Fastening	Material	Scope of delivery
¼-18 NPT, IEC 61518	7/16-20 UNF	316L	incl. 2 vent valves 316L
¼-18 NPT, IEC 61518	7/16-20 UNF	Alloy C276 (2.4819)	
¼-18 NPT, IEC 61518	7/16-20 UNF	Super Duplex (2.4410)	

Lateral ventilation

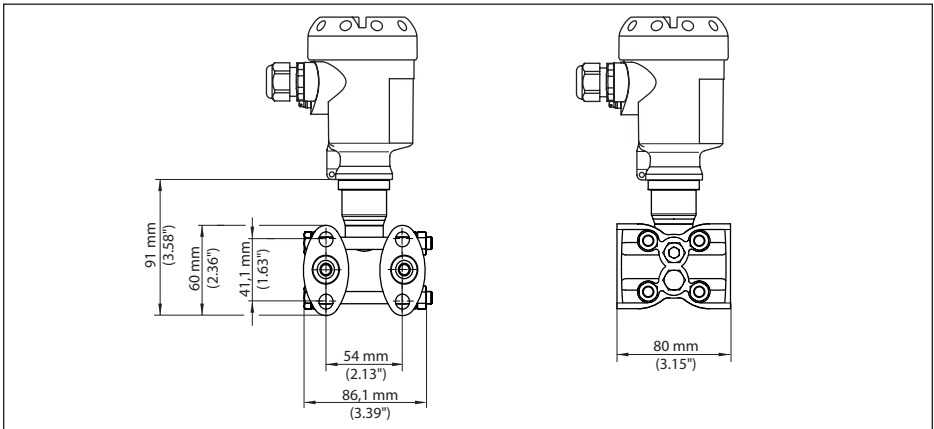


Fig. 53: DPT-20, lateral ventiation

Connection	Fastening	Material	Scope of delivery
¼-18 NPT, IEC 61518	7/16-20 UNF	316L	incl. 4 closing screws and 2 ventilation valves 316L
¼-18 NPT, IEC 61518	7/16-20 UNF	Alloy C276 (2.4819)	

Oval flange, prepared for chemical seal connection

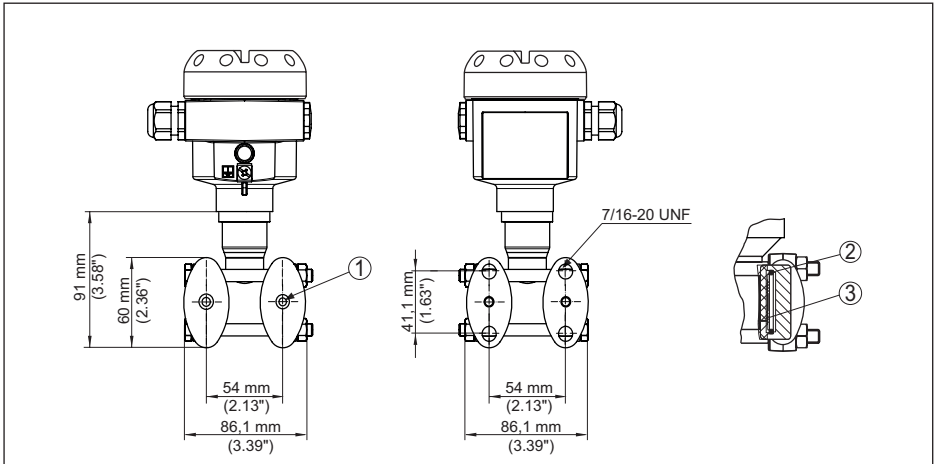


Fig. 54: left: Process fitting DPT-20 prepared for chemical seal assembly. right: Position of the copper ring seal

- 1 Chemical seal connection
- 2 Copper ring seal
- 3 Separating diaphragm

12.5 Trademark

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

