OPTIBAR DP 7060 C Handbook

Differential pressure transmitter for measuring flow, level, differential pressure, density and interface

ER 1.01.00
SW: 1.2.2
HW: 1.0.1

KROHNE

IMPRINT

1.1 Software history

The "Electronic Revision" (ER) is consulted to document the revision status of electronic equipment according to NE 53 for all GDC devices. It is easy to see from the ER whether troubleshooting or larger changes in the electronic equipment have taken place and how that has affected the compatibility.

Changes and effect on compatibility

1	Downwards compatible changes and fault repair with no effect on operation (e.g. spelling mistakes on display)	
2-_	Downwards compatible hardware and/or software change of interfaces:	
	H	HART®
	P	PROFIBUS
	F	Foundation Fieldbus
	M	Modbus
	X	all interfaces
3-_	Downwards compatible hardware and/or software change of inputs and outputs:	
	I	Current output
	F, P	Frequency / pulse output
	S	Status output
	C	Control input
	CI	Current input
	X	all inputs and outputs
4	Downwards compatible changes with new functions	
5	Incompatible changes, i.e. electronic equipment must be changed.	

INFORMATION!
In the table below, "x" is a placeholder for possible multi-digit alphanumeric combinations, depending on the available version.

Release date	Revisions	Changes and compatibility	Documentation
2014-04-01	ER: 1.01.00 SW: 1.0.0 HW: 1.0.0	-	MA OPTIBAR DP 7060 R01
2014-11-01	ER: 1.01.00 SW: 1.1.2 HW: 1.0.0	1; 3-I; 4:	MA OPTIBAR DP 7060 R01
2014-11-01	ER: 1.01.00 SW: 1.1.2 HW: 1.0.1	1;	MA OPTIBAR DP 7060 R02
2015-11-09	ER: 1.01.00 SW: 1.2.2 HW: 1.0.1	1, 2-H, 4	MA OPTIBAR DP 7060 R03

1.2 Intended use

DANGER!
For devices used in hazardous areas, additional safety instructions apply.

CAUTION!
Responsibility for the use of the measuring devices with regard to suitability, intended use and corrosion resistance of the used materials against the measured fluid lies solely with the operator.

INFORMATION!
This device is a Group 1, Class A device as specified within CISPR11:2009. It is intended for use in industrial environment. There may be potential difficulties in ensuring electromagnetic compatibility in other environments, due to conducted as well as radiated disturbances.

INFORMATION!
The manufacturer is not liable for any damage resulting from improper use or use for other than the intended purpose.

The OPTIBAR DP 7060 C is a differential pressure transmitter suitable for measuring flow, level, differential pressure, density and interface of gases, vapours and liquids. The available measurement ranges and the respective permissible overloads are indicated on the nameplate. To observe the intended use, adhere to the following points:

- Observe the instructions in this document.
- Comply with the technical specifications (for further information refer to *Technical data* on page 63).
- Only suitably qualified personnel may install and operate the device.
- Observe the generally accepted standards of good practice.

CAUTION!
- *Any modification to the device, including drilling, sawing, trimming, welding and soldering of parts, or partially painting over or coating, is prohibited.*
- *Neither is it permitted to use the device as a climbing aid e.g. for installation purposes, as a holder for cables, pipes or other loads.*
- *The mounting or installation of parts is only permitted as described in this document, or insofar as it has been authorised by the manufacturer or a certified service partner.*

1.3 Technical limits

The device was constructed solely for use within the technical limits indicated on the nameplate and in the technical data. Applications outside of these limits are not permitted and could lead to significant risk of accident. For this reason, observe the following limits:

- Do not exceed the maximum working pressure (MWP).
- Do not exceed the indicated permissible operating temperature range.
- The permissible ambient temperatures given may not be exceeded or undershot.
- Observe the ingress protection of the housing during use.

1.4 Measured products

The device is designed to measure the pressure of vaporous, gaseous and liquid media. Prior to using any corrosive or abrasive products, the operator must check the resistance of all materials which are in contact with the product.

1.5 Certification

CE marking

The device fulfils the statutory requirements of the following EC directives:

- EMC Directive 2004/108/EC (valid until 2016/04/19) or
  EMC Directive 2014/30/EU (valid from 2016/04/20)

The manufacturer certifies successful testing of the product by applying the CE marking.

Pressure equipment directive 97/23/EC

Devices with a permissible pressure PS ≤ 200 bar (20 MPa) / 2900 psi comply with Article 3 Section (3) and are not subject to a conformity assessment. These devices were designed and manufactured in accordance with sound engineering practice (SEP).

The CE marking on the device does not apply to the Pressure Equipment Directive.

1.6 Safety instructions from the manufacturer

1.6.1 Copyright and data protection

The contents of this document have been created with great care. Nevertheless, we provide no guarantee that the contents are correct, complete or up-to-date.

The contents and works in this document are subject to copyright. Contributions from third parties are identified as such. Reproduction, processing, dissemination and any type of use beyond what is permitted under copyright requires written authorisation from the respective author and/or the manufacturer.

The manufacturer tries always to observe the copyrights of others, and to draw on works created in-house or works in the public domain.

The collection of personal data (such as names, street addresses or e-mail addresses) in the manufacturer's documents is always on a voluntary basis whenever possible. Whenever feasible, it is always possible to make use of the offerings and services without providing any personal data.

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We hereby expressly prohibit the use of the contact data published as part of our duty to publish an imprint for the purpose of sending us any advertising or informational materials that we have not expressly requested.

1.6.2 Disclaimer

The manufacturer will not be liable for any damage of any kind by using its product, including, but not limited to direct, indirect or incidental and consequential damages.

This disclaimer does not apply in case the manufacturer has acted on purpose or with gross negligence. In the event any applicable law does not allow such limitations on implied warranties or the exclusion of limitation of certain damages, you may, if such law applies to you, not be subject to some or all of the above disclaimer, exclusions or limitations.

Any product purchased from the manufacturer is warranted in accordance with the relevant product documentation and our Terms and Conditions of Sale.

The manufacturer reserves the right to alter the content of its documents, including this disclaimer in any way, at any time, for any reason, without prior notification, and will not be liable in any way for possible consequences of such changes.

1.6.3 Product liability and warranty

The operator shall bear responsibility for the suitability of the device for the specific purpose. The manufacturer accepts no liability for the consequences of misuse by the operator. Improper installation or operation of the devices (systems) will cause the warranty to be void. The respective "Standard Terms and Conditions" which form the basis for the sales contract shall also apply.

1.6.4 Information concerning the documentation

To prevent any injury to the user or damage to the device it is essential that you read the information in this document and observe applicable national standards, safety requirements and accident prevention regulations.

If this document is not in your native language and if you have any problems understanding the text, we advise you to contact your local office for assistance. The manufacturer can not accept responsibility for any damage or injury caused by misunderstanding of the information in this document.

This document is provided to help you establish operating conditions, which will permit safe and efficient use of this device. Special considerations and precautions are also described in the document, which appear in the form of icons as shown below.

1.6.5 Warnings and symbols used

Safety warnings are indicated by the following symbols.

DANGER!
This warning refers to the immediate danger when working with electricity.

DANGER!
This warning refers to the immediate danger of burns caused by heat or hot surfaces.

DANGER!
This warning refers to the immediate danger when using this device in a hazardous atmosphere.

DANGER!
These warnings must be observed without fail. Even partial disregard of this warning can lead to serious health problems and even death. There is also the risk of seriously damaging the device or parts of the operator's plant.

WARNING!
Disregarding this safety warning, even if only in part, poses the risk of serious health problems. There is also the risk of damaging the device or parts of the operator's plant.

CAUTION!
Disregarding these instructions can result in damage to the device or to parts of the operator's plant.

INFORMATION!
These instructions contain important information for the handling of the device.

LEGAL NOTICE!
This note contains information on statutory directives and standards.

- HANDLING
  This symbol designates all instructions for actions to be carried out by the operator in the specified sequence.

➲ RESULT
This symbol refers to all important consequences of the previous actions.

1.7 Safety instructions for the operator

WARNING!
In general, devices from the manufacturer may only be installed, commissioned, operated and maintained by properly trained and authorized personnel.
This document is provided to help you establish operating conditions, which will permit safe and efficient use of this device.

2.1 Scope of delivery

INFORMATION!
Inspect the packaging carefully for damages or signs of rough handling. Report damage to the carrier and to the local office of the manufacturer.

INFORMATION!
Do a check of the packing list to make sure that you have all the elements given in the order.

INFORMATION!
Look at the device nameplate to ensure that the device is delivered according to your order. Check for the correct supply voltage printed on the nameplate.

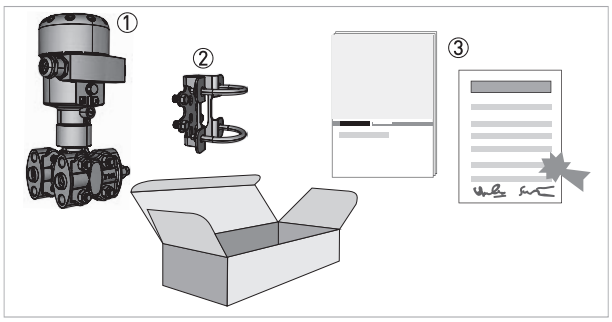


Figure 2-1: Scope of delivery

① Device in the version as ordered
② Mounting bracket
③ Documentation (test reports, factory and material certification (if ordered) and product documentation)

Optional accessories

- Oval flange adapter 1/2-14 NPT (female)
- Manifolds
- Gaskets

INFORMATION!
Assembly materials and tools are not part of the delivery. Use the assembly materials and tools in compliance with the applicable occupational health and safety directives.

2.2 Device description

The setup of the device is carried out via the display and adjustment module. For further information refer to *Keypad functions* on page 42.

A piezoresistive sensor element is used in the measuring cell.

The measuring device is supplied ready for operation. The factory settings for the process data correspond to your order specifications.

2.2.1 Device design

The following drawings show the basic components of the differential pressure transmitter.

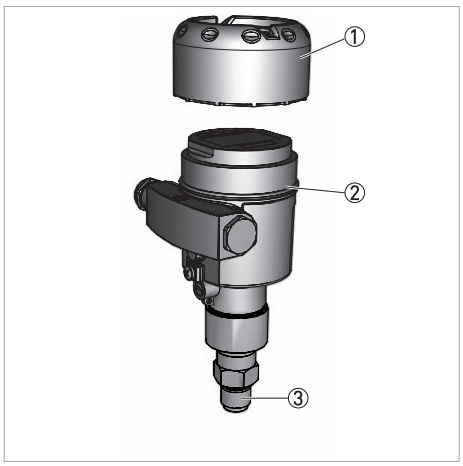


Figure 2-2: Basic components of single chamber pressure transmitter

① Housing cover, optional with display and adjustment module below
② Housing with electronics
③ Process assembly with measuring cell

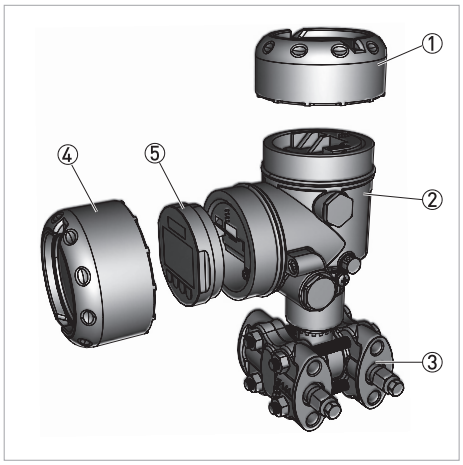


Figure 2-3: Basic components of double chamber differential pressure transmitter

① Housing cover
② Housing with electronics
③ Process assembly with measuring cell
④ Housing cover, optional with display and adjustment module below
⑤ Display and adjustment module

2.2.2 Connection variants

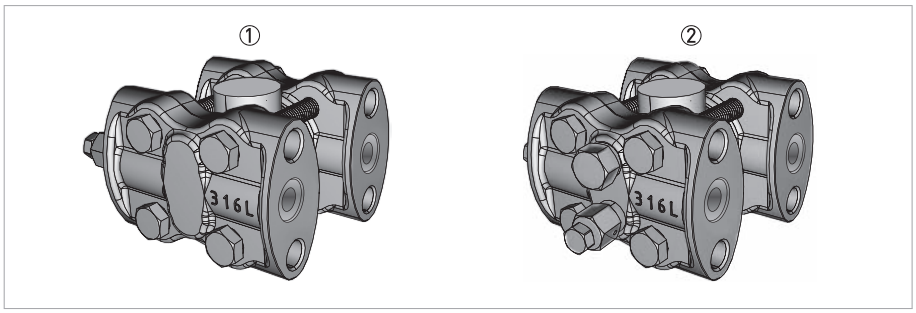


Figure 2-4: Process assembly

① Rear venting on process axis
② Side venting

Following connection variants are available:

- Process connection: 1/4-18 NPT acc. to IEC 61518 (female)
- Optional: oval flange adapter 1/2-14 NPT (female)

The optional venting and drain valves on the device must be chosen according to the installation situation.

2.3 Nameplates

DANGER!
For devices used in hazardous areas, additional safety notes apply; please refer to the Ex documentation.

INFORMATION!
Look at the device nameplate to ensure that the device is delivered according to your order. Check for the correct supply voltage printed on the nameplate.

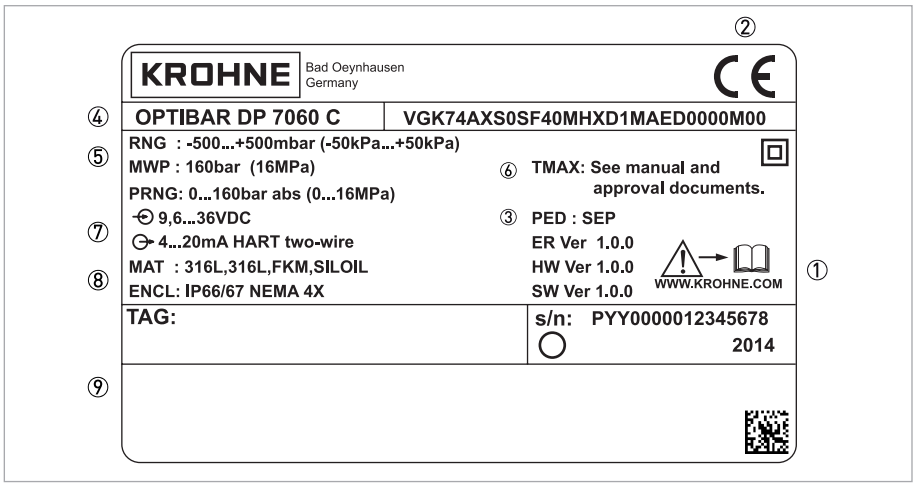


Figure 2-5: Example for a nameplate

① Observe the installation and operating instructions
② CE marking and marking of notified body
③ Hardware and Software version
④ Product name and type code
⑤ Nominal range
Permissible process pressure
Nominal range of absolute pressure measurement
⑥ Permissible temperature range
⑦ Electronics power supply and signal output
⑧ Ingress protection and material of wetted parts
(Diaphragm, process connections, gasket and fill fluid)
⑨ Approvals and approval guidelines

2.4 Terms and abbreviations

The following terms and abbreviations are used in this document.

URL Upper Range Limit	Upper measuring range limit. Also called nominal range. The highest value that can be measured by a particular device.
LRL Lower Range Limit	Lower measuring range limit. The lowest value that can be measured by a particular device.
URV Upper Range Value	The calibrated measuring range or the highest adjusted measured value. This value corresponds to 20 mA signal.
LRV Lower Range Value	The calibrated measuring range or the lowest adjusted measured value. This value corresponds to 4 mA signal.
SPAN Span	Measuring span or measuring range. SPAN = URL – LRL
CAL SPAN Calibrated Span	Calibrated or adjusted measuring span. CAL SPAN = URV – LRV. Also called "cSPAN". This is the span set to the 4…20 mA output.
TD Turn Down	The ratio from the measuring span to the adjusted measuring span. TD= SPAN/(CAL SPAN) = (+URL)/(CAL SPAN) The following applies: URV ≤ URL, CAL SPAN ≤ SPAN, TD ≥ 1

Example for **TD** Turn Down	
LRL= 0 bar **URL**= 3 bar / 43.5 psi	**SPAN**= 3 bar / 43.5 psi
URV= 2 bar / 29 psi **LRV**= 0.5 bar / 7.25 psi	**CAL SPAN**= 1.5 bar / 21.75 psi **TD**= 2:1

3.1 General notes on installation

INFORMATION!
Inspect the packaging carefully for damages or signs of rough handling. Report damage to the carrier and to the local office of the manufacturer.

INFORMATION!
Do a check of the packing list to make sure that you have all the elements given in the order.

INFORMATION!
Look at the device nameplate to ensure that the device is delivered according to your order. Check for the correct supply voltage printed on the nameplate.

3.2 Protection category of the housing

The housing of the pressure transmitter fulfills the requirements for ingress protection in accordance with IEC 60529. Housing for protection category IP69K in accordance with ISO 20653 is also available. For further information refer to *Technical data* on page 63.

CAUTION!
The first digit stands for the protection of the inner electronic components against the ingress of foreign bodies including dust. The first digit "6" means that the housing is dust-proof. The second digit designates the protection of the inner electronic components against the ingress of water. The second digit "6" means that the housing is waterproof and also resistant against a strong jet of water. The number "7" means that the housing is waterproof even submersed under water for a given pressure and time. The number "8" means that the housing is permanently waterproof even under water.

3.3 Packaging

CAUTION!
Devices for oxygen applications are sealed in PE foil and provided with a label "Oxygen! Use no Oil". Remove this foil just before mounting the device! After removing the protection for the process connection the label O_2 will be visible on the process connection. Penetration of oil, grease and dirt should be avoided. Danger of explosion!

Your device was protected by packaging during transport. Its capacity to handle normal loads during transport is assured by a test following ISO 22248. The packaging of standard devices consists of environmentally friendly, recyclable cardboard and PE foil. For special versions, PE foam or PE foil is also used. Dispose of the packaging material via specialised recycling companies.

3.4 Storage

CAUTION!
Observe the storage information found on the packaging. Labels on the original packaging must always remain legible and may not be damaged.

- Store the device in a dry and dust-free location.
- Avoid lasting direct exposure to the sun.
- Store the device in the original packaging supplied.
- Do not expose to aggressive media.
- Avoid mechanical shocks.
- Storage temperature of -40 to +80°C / -40 to +176°F.
- Relative air humidity of 20 to 85%.

3.5 Transport

- Use original packaging for transport and ensure that the packaging does not get crushed or damaged by sharp objects or other boxes.
- Do not throw or drop the device.
- Avoid temperatures below -40°C / -40°F and above +80°C / +176°F.
- When transporting by ship, use seaworthy outer packing.

3.6 Installation specifications

INFORMATION!
Observe the relevant directives, ordinances, standards and accident prevention regulations (e.g. VDE/VDI 3512, DIN 19210, VBG, Elex V, etc.).

The accuracy of the measurement is only guaranteed if the transmitter and accompanying impulse line(s), if any, have been correctly installed. In addition, extreme ambient conditions including large fluctuations in temperature, vibrations and shocks should be kept as far away as possible from the measuring equipment.

3.7 Installation

CAUTION!
- *Prior to installing the transmitter, it is essential to verify whether the version of the device on hand completely fulfils the technical and safety requirements of the measuring point. This applies in particular to the measuring range, overpressure resistance, temperature, explosion protection and operating voltage.*
- *Check the materials used for the wetted parts (e.g. gasket, process connection, separating diaphragm etc.) for suitability as regards process compatibility.*

3.7.1 Housing rotation

The transmitter housing can be rotated 350° for better readability of the display or access to the wiring. A stop prevents the housing from being rotated too far.

- Loose the locking screw on all 2 chamber housings at the neck of the housing.

➲ The housing can be rotated to the desired position.

- Tightened the locking screw if the desired position is reached.

3.7.2 Mounting the display and adjustment module

The optional display and adjustment module can be set in any one of four different positions at 90° intervals. The installation of the adjustment module is carried out as per the illustrations below. To do so, unscrew the housing cover and insert the adjustment module clockwise. The display can be installed rotated at 90°. It is not necessary to interrupt the power supply.

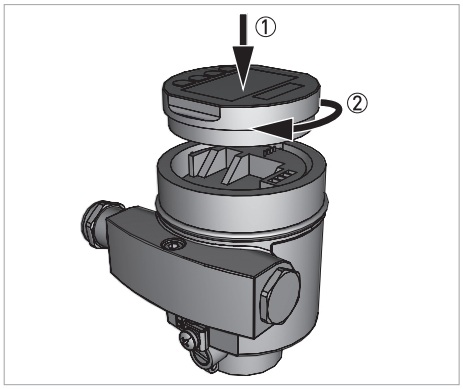


Figure 3-1: Installation in single chamber housing

① Insert the display and adjustment module into the housing
② Turn the display and adjustment module clockwise

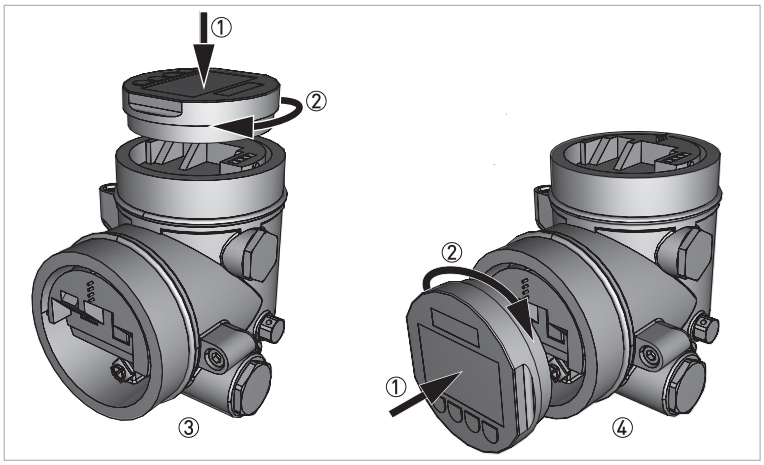


Figure 3-2: Installation in double chamber housing

① Insert the display and adjustment module into the housing
② Turn the display and adjustment module clockwise
③ Mounting on top
④ Mounting at side

3.7.3 Process connections

Before mounting of the device, please check the correct position of the high (H) and low (L) pressure side. You can see the designations (H / L) in the figure below.

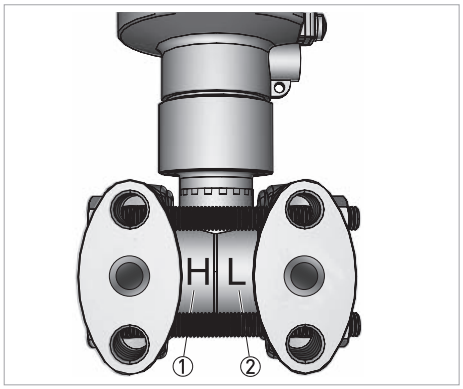


Figure 3-3: Process connection of the differential pressure transmitter

① High-pressure side
② Low-pressure side

The process connections of the differential pressure transmitter are usually 1/4-18 NPT (female) at a distance of 54 mm / 2.13". Through optional oval flange adapters the connections 1/2-14 NPT (female) are also selectable.

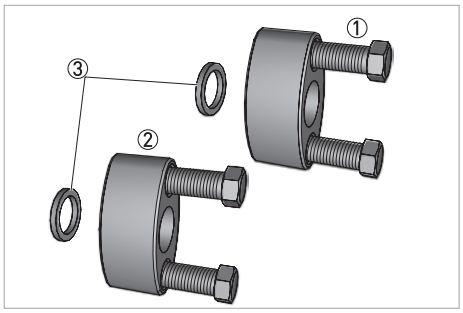


Figure 3-4: Oval flange adapter

① 7/16 UNF bolts
② Oval flange adapter
③ Sealing ring

If the adapter is not supplied pre-assembled, proceed as follows:

- Position the adapter with inserted O-ring.
- Use the screws supplied to screw the adapter to the transmitter.
- Tighten the screws to a torque of 25 Nm (stainless steel screws) or 12.5 Nm (stainless steel acc. to NACE).

3.7.4 Mounting bracket

A mounting bracket for easy pipe or wall mounting is included with each differential pressure transmitter.

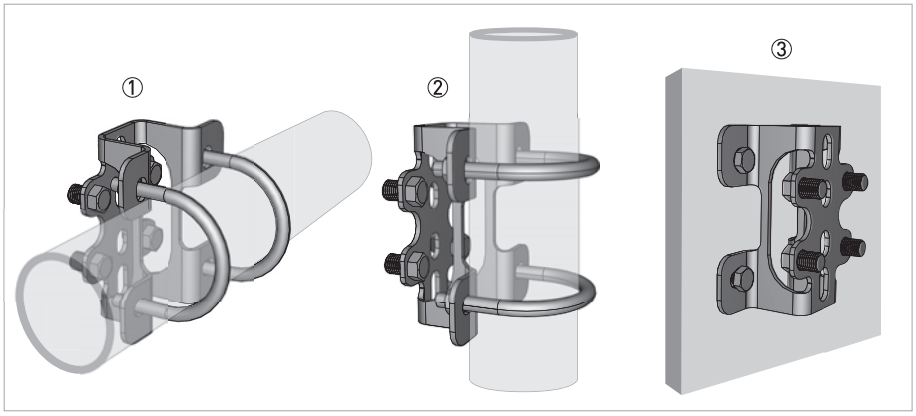


Figure 3-5: Mounting bracket

① Horizontal 2" pipe mounting
② Vertical 2" pipe mounting
③ Wall mounting

3.7.5 Manifolds

Manifolds allow for easy installation and commissioning of the transmitter. They separate the device from the process side and ensure simple control of the measuring point. They are available as 3-way and 5-way versions. The integrated equalize valve allows pressure equalization between the high (H) and low (L) pressure side during commissioning. With the manifold, it is possible to disassemble the differential pressure transmitter without interrupting the process. This means higher system availability and even simpler commissioning or maintenance purposes. The 3-way manifold with double-sided flange adapters allows a mechanically robust connection between the differential pressure transmitter and, for example, the impulse lines or the flange adapters of a averaging pitot tube. With a 5-way manifold, two additional valves allow to blow out of the impulse lines and the calibration of the differential pressure transmitter in place.

3.7.6 Primary element

Primary elements, such as averaging pitot tubes, orifice plates or venturis are designed for certain line sizes and flow conditions. Therefore, prior to installation, the line size and pressure rating has to be checked and the measuring point number compared. For detailed instructions on installing a primary element refer to DIN EN ISO 5167.

3.7.7 Pressure connection with impulse line

Please review the following information for pressure connection with impulse line:

- Select the shortest impulse line possible and install without sharp bends.
- Avoid material deposits and blockages in the impulse line. Accordingly, install the impulse lines so that such occurrences are impossible. Do not exceed a slope of approx. 8% in the piping.
- Ensure that the impulse line flows freely before installation and rinse with compressed air or, even better, with the product itself.
- When measuring liquid, the impulse line must be completely purged of air.
- Run the impulse line so that trapped air (when measuring liquids) or condensate (when measuring gas) can flow back into the process.
- Hot steam must not enter the process connection (the over temperature will destroy the device). To avoid this situation, a suitable water trap (such as a syphon filled with water prior to installation) can be installed upstream from the measuring device.
- All connections must be tight and fixed properly.
- The process lines must be installed so that the medium cannot be blown out of the measuring chambers.

3.7.8 Vibrations

In case of strong vibrations at the measuring point, the device should be mounted via impulse lines in a calm place.

3.7.9 Temperature limits

Higher process temperatures often mean also higher ambient temperatures for electronics and connection cables. Make sure that the upper temperature limits for the environment of the electronics housing and connection cable are not exceeded. For further information refer to *Technical data* on page 63.

3.8 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 plant, such as e.g. measuring devices must be cleaned according to the requirements of BAM (DIN 19247).
- Depending on the seal material, certain temperatures and pressures must not be exceeded in oxygen applications, refer to *Technical data* on page 63.

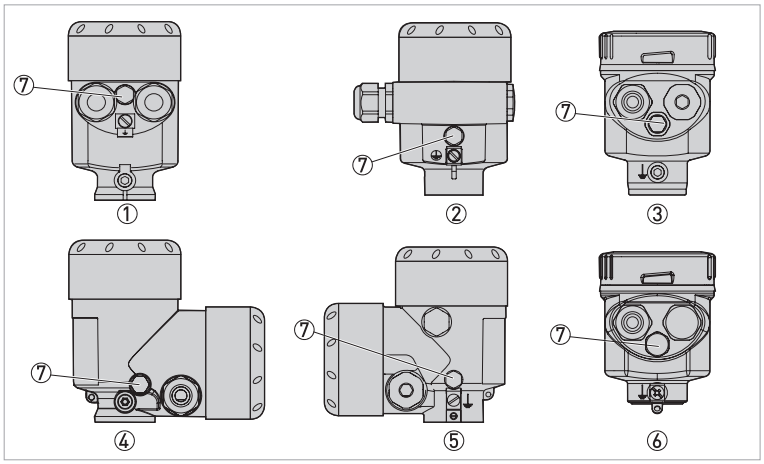
CAUTION!
Devices for oxygen applications are sealed in PE foil and provided with a label "Oxygen! Use no Oil". Remove this foil just before mounting the device! After removing the protection for the process connection the label O_2 will be visible on the process connection. Penetration of oil, grease and dirt should be avoided. Danger of explosion!

3.9 Venting

The ventilation for the electronics housing is assured via a filter element in the vicinity of the cable glands, which is permeable to air but water-absorbent.

CAUTION!
In order to ensure effective ventilation, the filter element must be always free of deposits.

CAUTION!
Do not use a high-pressure cleaner to clean the housing. The filter element may become damaged and as a result moisture can penetrate into the housing. The exception to this is the IP69K single chamber housing.



① Single chamber housing, plastic, stainless steel precision casting
② Single chamber housing, aluminium
③ Single chamber housing, stainless steel electro-polished
④ Double chamber housing, plastic
⑤ Double chamber housing, aluminium
⑥ Single chamber housing IP69k
⑦ Filter element

3.10 Measurement setup for flow measurement

3.10.1 In gases and liquids with solids content

- Include the pressure tapping points above or to the side on the process line.
- The device must be mounted above the chosen tapping point.

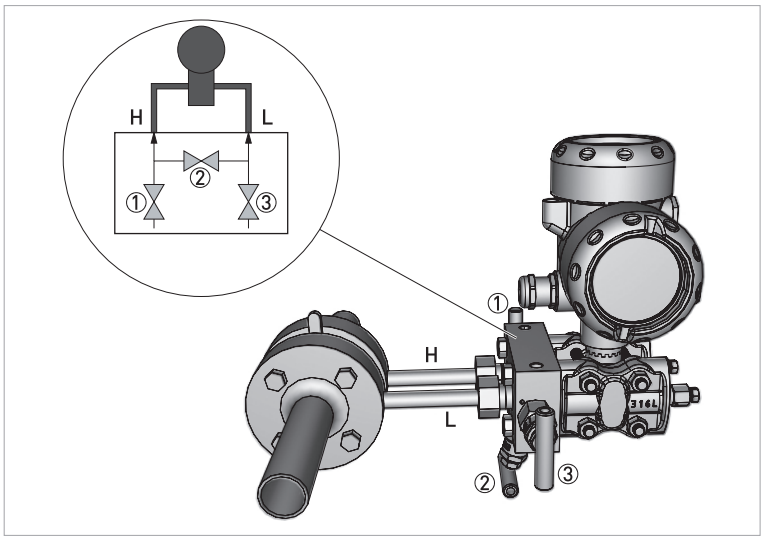


Figure 3-6: Application example

① Shut-off valve
② Equalize valve
③ Shut-off valve

3.10.2 In vapours and pure liquids

- Include the pressure tapping points to the side on the process line.
- The device must be mounted at the same height or underneath the tapping points.
- In steam applications, fill the impulse lines and/or condensate vessels with an appropriate liquid.

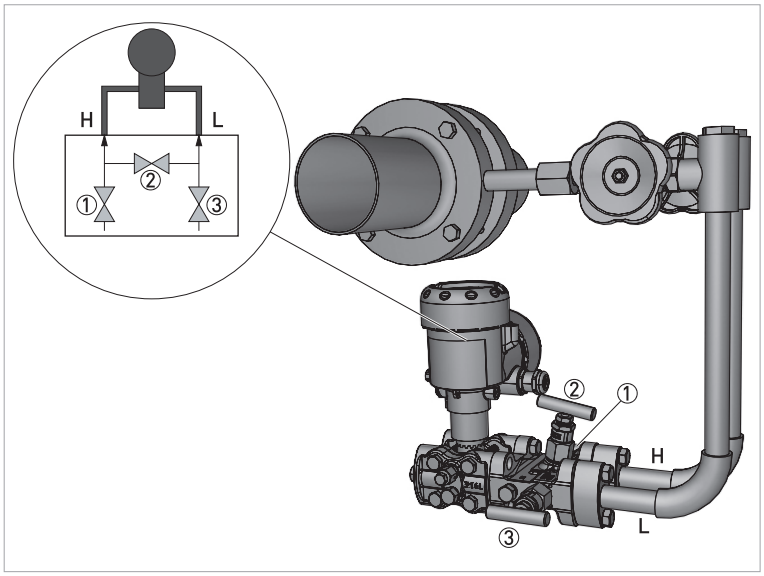


Figure 3-7: Application example

① Shut-off valve
② Equalize valve
③ Shut-off valve

3.11 Measurement setup for level measurement

3.11.1 In open vessels with impulse line

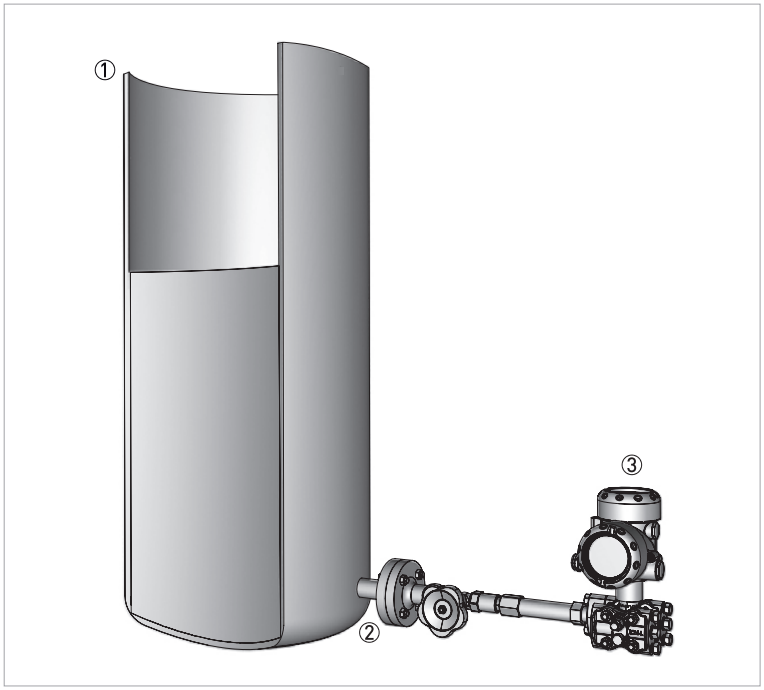


Figure 3-8: Application example

① Tank
② Impulse line
③ Differential pressure transmitter

The following points should be observed in this application:

- Mount the differential pressure transmitter below the lower process connection so that the impulse lines are always filled with liquid.
- The low pressure side (L) is open to atmospheric pressure.
- For measurements in products with solid content, the installation of separators and drain valves is recommended to enable collection and removal of debris and sediment.

3.11.2 In closed vessels with gas-filled impulse lines

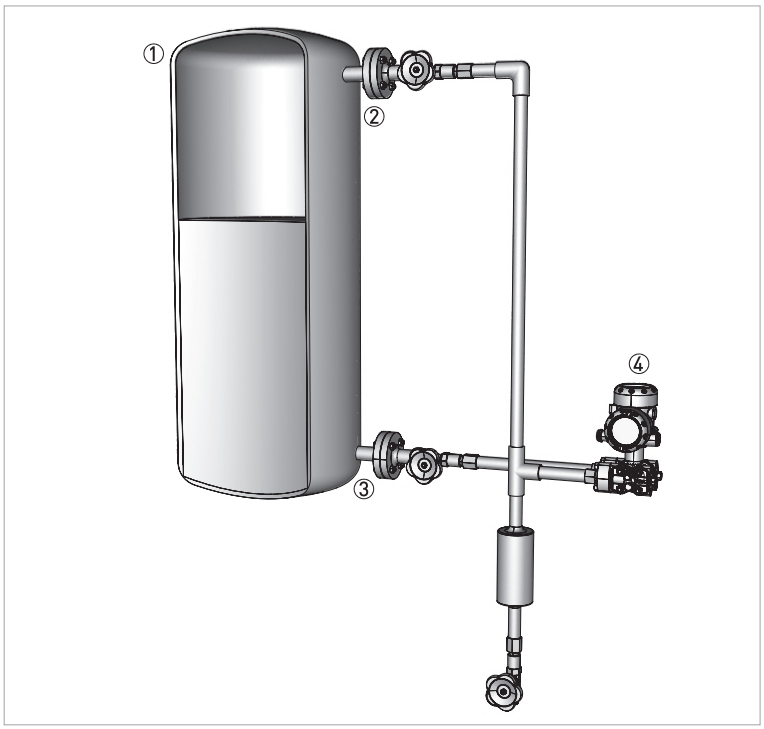


Figure 3-9: Application example

① Tank
② Low-pressure line (L)
③ High-pressure line (H)
④ Differential pressure transmitter

The following points should be observed in this application:

- Mount the differential pressure transmitter below the lower process connection so that the impulse line is always filled with liquid.
- The low pressure side (L) must always be connected above the maximum level.
- For measurements of fluids with solid content, the installation of separators and drain valves is recommended to enable collection and removal of debris and sediment.

3.11.3 In closed vessels with liquid / condensate filled impulse lines

Figure 3-10: Application example

① Tank
② Low-pressure line (L)
③ High-pressure line (H)
④ Differential pressure transmitter

The following points should be observed in this application:

- Mount the differential pressure transmitter below the lower process connection so that the impulse lines are always filled with liquid.
- The low pressure side (L) must always be connected above the maximum level.
- For measurements of fluids with solid content, the installation of separators and drain valves is recommended to enable collection and removal of debris and sediment.

4.1 Safety instructions

DANGER!
All work on the electrical connections may only be carried out with the power disconnected. Take note of the voltage data on the nameplate!

DANGER!
Observe the national regulations for electrical installations!

WARNING!
Observe without fail the local occupational health and safety regulations. Any work done on the electrical components of the measuring device may only be carried out by properly trained specialists.

INFORMATION!
Look at the device nameplate to ensure that the device is delivered according to your order. Check for the correct supply voltage printed on the nameplate.

4.2 Notes for electrical cables

DANGER!
The device must be grounded to a spot in accordance with regulations in order to protect personnel against electric shocks.

DANGER!
Cables may only be connected when the power is switched off! Since the transmitter has no switch-off elements, overcurrent protection devices, lightning protection and/or energy isolating devices must be provided by the customer.

4.2.1 Requirements for signal cables supplied by the customer

If the signal cable was not ordered, it is to be provided by the customer. The following requirements regarding the electrical specifications of the signal cable must be observed:

Specifications for standard signal cables

- Test voltage: ≥ 500 VAC RMS (750 VDC)
- Temperature range: -40...+105°C / -40...+221°F
- Capacity: ≤ 200 pF/m / 61 pF/ft
- Inductance: ≤ 0.7 µH/m / 0.2 µH/ft
- Use cable with round cross section.
- A cable outer diameter of 5…9 mm / 0.2…0.35" ensures the seal effect of the cable gland. If you are using cable with a different diameter or cross-section, exchange the seal or use a suitable cable gland.
- We generally recommend the use of a shielded cable for HART® multidrop mode.

4.2.2 Correct routing of electrical cables

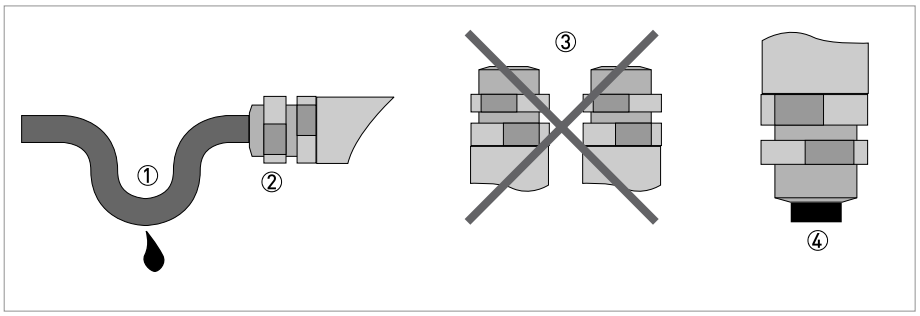


Figure 4-1: Protect housing from dust and water

① Lay the cable in a loop just before the housing.
② Tighten the screw connection of the cable entry securely.
③ Never mount the housing with the cable entries facing upwards.
④ Seal cable entries that are not needed with a plug.

4.2.3 Cable preparation

The device 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, a shielded cable should be used.

Check which outer diameter is suitable for the cable gland in order to ensure the sealing effect according to the specified IP protection class.

- 5...9 mm / 0.20...0.35" (standard)
- 6...12 mm / 0.24...0.47" (optional)
- 10...14 mm / 0.40...0.55" (optional)

The terminals in the terminal compartment are designed for wire cross-sections of up to 1.5 mm². To ensure a proper connection, you should strip the cable 40…50 mm / 1.6...2".

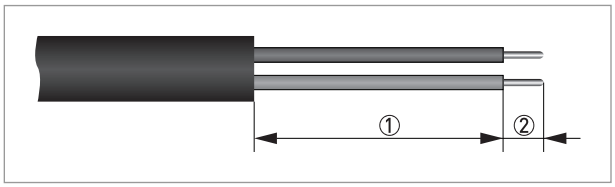


Figure 4-2: Stripping the cable

① 40...50 mm / 1.6...2"
② 5 mm / 0.2"

4.2.4 Cable entry 1/2-14 NPT (female)

With plastic housings, the NPT cable gland or the conduit steel tube must be screwed without grease into the thread.

4.2.5 Connector pin assignment

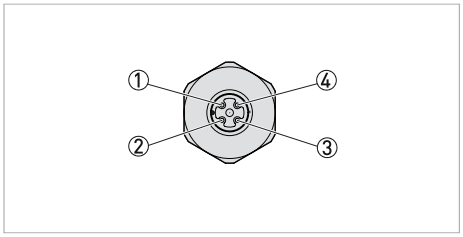


Figure 4-3: Connector M12 x 1, 4-pin, A-coding

① VS+
② Not connected
③ Not connected
④ VS-

Contact pin	Colour of cable	Electronic insert for terminal
Pin ①	Brown	1
Pin ④	Blue	2

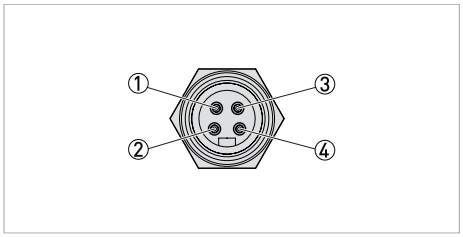


Figure 4-4: 7/8 connector, Foundation Fieldbus (FF)

① VS-
② VS+
③ Not connected
④ Cable shield

Contact pin	Colour of cable	Electronic insert for terminal
Pin ①	Blue	1
Pin ②	Brown	2
Pin ④	Green / yellow	Grounding

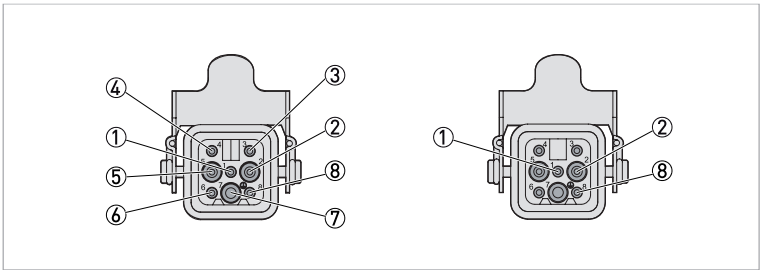


Figure 4-5: Connector, Harting HAN 8D (left) and Harting HAN 7D (right)

① VS-
② VS+

Contact pin	Colour of cable	Electronic insert for terminal
Pin ①	Black	1
Pin ②	Blue	2
Pin ⑧	Green / yellow	Grounding

4.2.6 Connection to the power supply

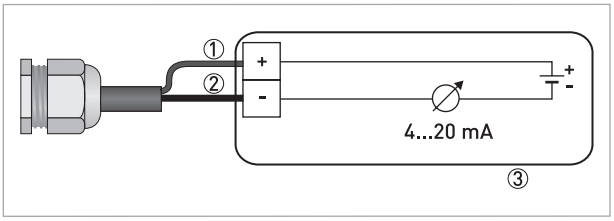


Figure 4-6: Connection to the power supply

① Red
② Black
③ Power supply with load

4.2.7 Cable shield and grounding

If a shielded cable is necessary, connect the cable shield on both ends to the grounding potential.

In the device, the cable shield must be connected directly to the internal ground terminal.

The ground terminal outside on the housing must be connected to the grounding potential with low impedance.

DANGER!
In hazardous areas, the grounding is carried out according to the installation instructions.

CAUTION!
Significant potential differences exist inside galvanization plants as well as on vessels with cathodic corrosion protection. A two-sided shield grounding can cause unacceptably high shield currents as a result.

CAUTION!
The metallic and wetted parts (process connection, cap flange, measuring cell and separating diaphragm etc.) are conductive connected with the inner and outer ground terminal on the housing.

4.3 Electrical connection

The connection of the power supply and the signal output is carried out via spring-loaded terminals in the housing. The display and adjustment module is connected via contact pins with the interface adapter.

4.3.1 Connection in the terminal compartment

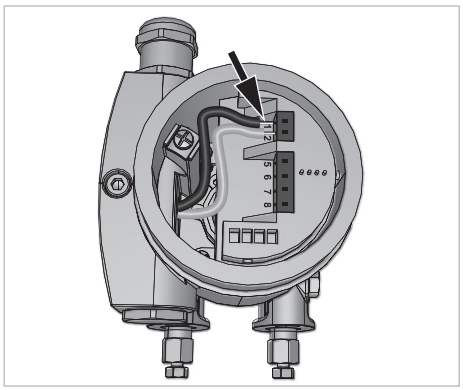


Figure 4-7: Terminal compartment from above

Procedure

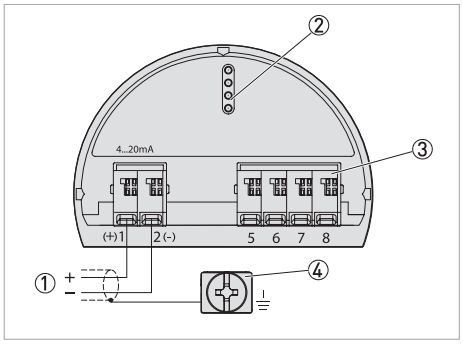
- Unscrew the housing cover.
- If present, remove the display and adjustment module by turning it to the left.
- Loosen union nut of the cable gland.
- For preparation of connection cable refer to *Cable preparation* on page 32.
- Push the cable through the cable gland into the terminal compartment.
- Insert the wire ends into the open terminal connection according to the wiring plan. Flexible cores with cable end sleeves as well as solid cores can be inserted directly into the terminal openings. In case of flexible cores, press the spring terminal with a small screwdriver to open the terminal opening.
- Check the proper hold of the wires in the terminals by lightly pulling on them.
- Connect the cable shield to the internal ground terminal, connect the outer ground terminal to the customer/plant equipotential bonding.
- Tighten the union nut of the cable gland. The sealing ring must completely enclose the cable.
- Screw the housing cover back on.

4.3.2 Single chamber housing

DANGER!
For devices used in hazardous areas, additional safety notes apply; please refer to the Ex documentation.

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

Electronics compartment



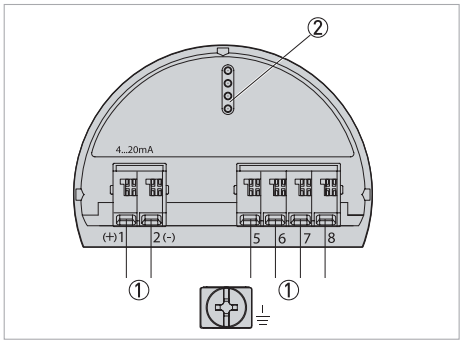
① Power supply / signal output
② Interface adapter for the display and adjustment module
③ Digital interface
④ Ground terminal for connection of the cable shield

4.3.3 Double chamber housing

DANGER!
For devices used in hazardous areas, additional safety notes apply; please refer to the Ex documentation.

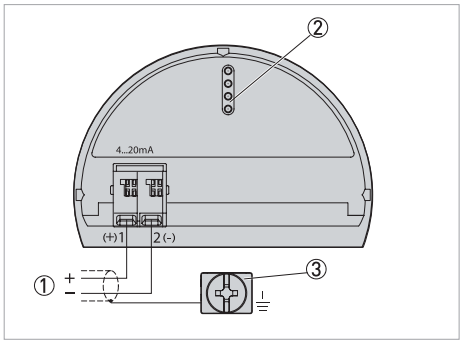
The following illustration applies to both the non-Ex as well as the Ex ia, and the Ex d version.

Electronics compartment



① Internal connection to terminal compartment
② Interface adapter for the display and adjustment module

Terminal compartment

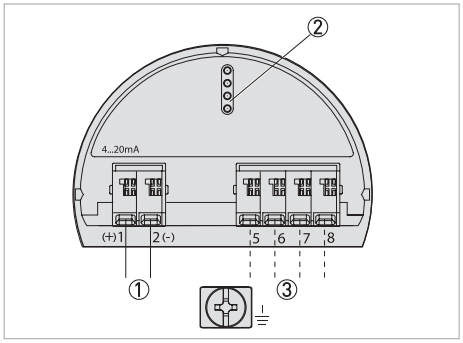


① Power supply / signal output
② Interface adapter for the display and adjustment module
③ Ground terminal for connection of the cable shield

4.3.4 Double chamber housing Ex d ia

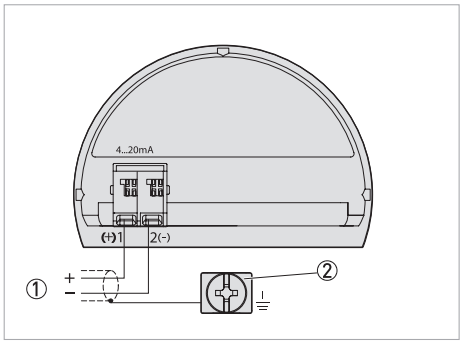
DANGER!
For devices used in hazardous areas, additional safety notes apply; please refer to the Ex documentation.

Electronics compartment



① Power supply / signal output
② Interface adapter for the display and adjustment module
③ Digital interface

Terminal compartment



① Power supply / signal output
② Ground terminal for connection of the cable shield

4.4 Grounding the measuring device

WARNING!
Within galvanic plants as well as vessels with cathodic corrosion protection there are considerable potential differences. Considerably equipotential bonding currents can be caused via the cable shield when the shield is grounded on both ends. To avoid this, the cable shield must only be connected to the grounding potential on one side of the control cabinet in such applications. The cable shield must not be connected to the internal ground terminal in the device and the outer ground terminal on the housing not to the equipotential bonding!

CAUTION!
The metallic and wetted parts (process connection, cap flange, measuring cell and separating diaphragm etc.) are conductive connected with the inner and outer ground terminal on the housing.

If a shielded cable is necessary, connect the cable shield on both ends to the grounding potential. In the signal converter, the cable shield must be connected directly to the internal ground terminal. The ground terminal outside on the housing must be connected to the equipotential bonding with low impedance. If equipotential bonding currents are expected, the evaluation side must be connected with a ceramic capacitor (e.g. 1 nF, 1500 V). The low frequency equipotential bonding currents are thus suppressed, but the protective effect against high frequency interference signals remains.

4.5 Description of the current output

The current output is a 2-wire 4...20 mA output with a low alarm of 3.6 mA and high alarm of 21 mA set by default. A high frequency HART® signal superimposes this signal. For further information on the current output, refer to *Technical data* on page 63.

5.1 Start-up

The signal converter may only be started up after it has been completely installed and checked by appropriately qualified personnel. Switch on the operating voltage for start-up.

Prior to applying the operating voltage check that

1. the pressure transmitter is completely installed
2. the process connection fits properly
3. the signal and, if necessary, supply lines are properly connected
4. the impulse lines are completely filled with the process medium

After connecting the signal converter to the power supply or after voltage recovery, the device performs a self test for approximately 10 seconds.

Self testing routine

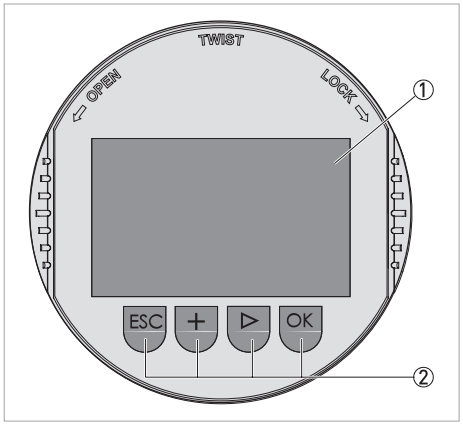
1. Internal check of the electronics.
2. Indication of the device type, hardware and software version as well as the measurement loop name on the display or PC.
3. Indication of a status message on the display or PC.
4. Output signal jumps to the set alarm current.
5. The current measuring value is output to the signal cable.

Then proceed with start-up. For further information refer to *Start-up* on page 46.

5.2 Keypad functions

INFORMATION!
The device can be configured either via the relevant fieldbus or the adjustment module.

The display and adjustment module is used for indication of measuring values, adjustment and diagnosis.



① LCD display
② Function buttons

The device is operated via the four keys of the display and adjustment module ②. The LC display ① indicates the individual menu items. Approx. 60 minutes after the last pressing of a key, an automatic reset in the indication of measuring values is triggered. Any values not confirmed with [OK] will not be saved.

[OK]

- Move back to the menu overview
- Confirm selected menu
- Editing the parameters
- Store value

[▷]

- Change measured value
- Select list entry
- Select editing position

[+]

- Change value of the parameter

[ESC]

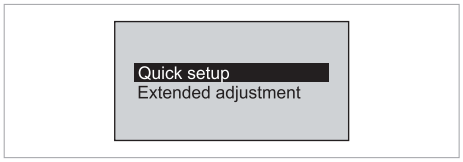
- Cancel entry
- Jump to next higher menu

5.3 Quick setup

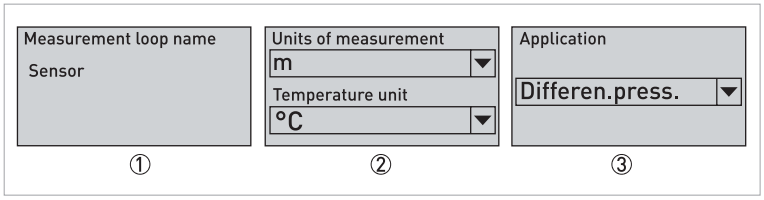
To adapt the device quickly and easily to the application, select the menu item "Quick setup".

This parameter adjustment essentially involves the selection of the:

- Application
- Position correction
- Adjustment of the span



In this chapter, not all settings are displayed graphically but all settings are described.



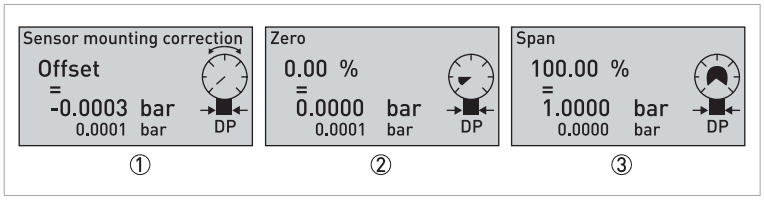
① **Measurement loop name**
Assign a suitable measurement loop name

② **Adjustment units**
Determine the adjustment and temperature units of the device.
and
Unit of static pressure
Determine the unit of static pressure.

③ **Application**
The selection includes differential pressure, level, flow, interface and density measurement.

5.3.1 Adjustment differential pressure

Adjustment differential pressure



① **Sensor mounting correction**
In this menu item you compensate the influence of the installation position of the device (offset) on the measured value.

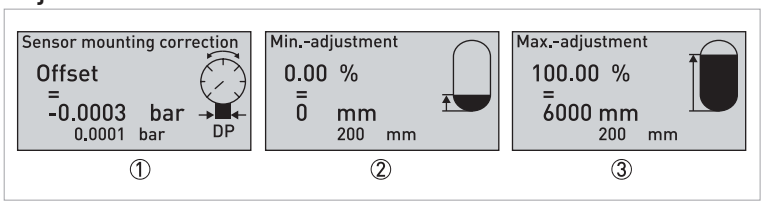
② **Zero**
In this menu item you determine the zero point of your measurement (LRV)
This value corresponds to the output signal of 4 mA.

③ **Span**
This value corresponds 100%, or rather an output signal of 20 mA (URV)
If the zero point is actually 0, this value corresponds to the measuring span.

In bidirectional measurements the zero point has to be set in the negative measurement range.
e.g.
Zero 0%: -250 mbar
Span 100%: 250 mbar
Total span: 500 mbar

5.3.2 Adjustment level

Adjustment level



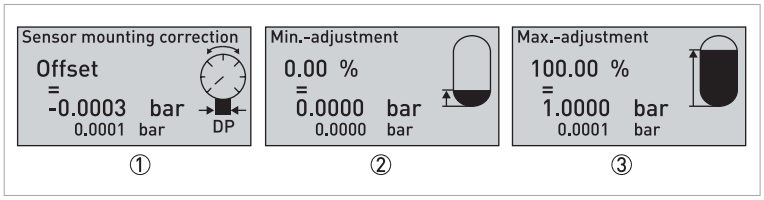
① **Sensor mounting correction**
In this menu item you compensate the influence of the installation position of the device (offset) on the measured value.

② **Min.-adjustment**
Enter the (pressure) value for the min. level.
At 0% this corresponds to the output signal of 4 mA.

③ **Max.-adjustment**
Enter the (pressure) value for the max. level.
At 100% this corresponds to the output signal of 20 mA.

5.3.3 Adjustment flow

Adjustment flow



① **Sensor mounting correction**
In this menu item you compensate the influence of the installation position of the device (offset) on the measured value.

② **Min.-adjustment**
Enter the (pressure) value for the min. flow.
At 0% this corresponds to the output signal of 4 mA.

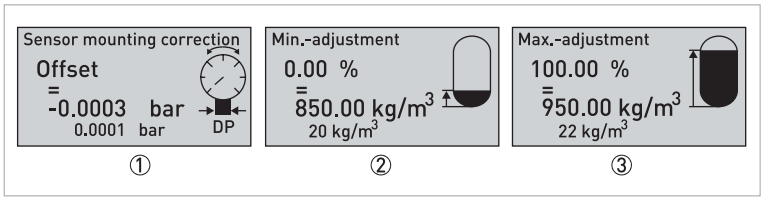
③ **Max.-adjustment**
Enter the (pressure) value for the max. flow.
At 100% this corresponds to the output signal of 20 mA.

④ **Linearization**
The following output characteristics are available for selection:
Linear (Standard)
To square root
Bi-directional linear
Bi-directional square root
User programmable

The adjustment "flow" is equal to the adjustment "differential pressure", with the additional setting for square root characteristics and low flow cut-off.

5.3.4 Adjustment density

Adjustment density



① **Sensor mounting correction**
In this menu item you compensate the influence of the installation position of the device (offset) on the measured value.
Distance max./min.
Enter the distance between both measuring points.

② **Min.-adjustment**
Enter the (pressure) value for the min. density.
This corresponds to the output signal of 4 mA.

③ **Max.-adjustment**
Enter the (pressure) value for the max. density.
At 100% this corresponds to the output signal of 20 mA.

5.4 Extended adjustment

The main menu is divided into five sections:

- Start-up
- Display
- Diagnosis
- Additional adjustments
- Info

5.4.1 Start-up

Measurement loop name	Assign a unique device ID. This is useful or even necessary in digital systems and for monitoring large systems.	
Application	In this menu item you select the application: differential pressure, level, flow, density and interface are available. The default setting is differential pressure.	
Units	In this menu item the adjustment units, as well as the temperature unit are determined. The selection of the adjustment unit determines the unit displayed in the "Min-adjustment" and "Max-adjustment" items. In "Level" mode, it is possible to carry out the adjustment in a height unit (e.g. meters), the density of the medium must also be specified.	
	Adjustment units	**Differential pressure and flow** mbar, bar, Pa, kPa, MPa, psi, mmH2O, mmHg, inH2O, inHg and user-defined
		Level Density input required: mm, cm, m, in and ft
		Density measurement kg/dm^3 and lb/ft^3
		Interface mm, cm, m, in and ft with density input/unit of medium
	Temperature unit	°C, °F and K
	Static pressure	mbar, bar, Pa, kPa, MPa, psi, mmH2O, mmHg, inH2O and inHg

Sensor mounting correction	The mounting position of the device has a great impact on the measured value (offset), especially with small measuring ranges and isolating systems. The sensor mounting correction compensates this offset. The sensor mounting correction can automatically take on the current measured value as correction value (auto correct). Alternatively, this correction value can also be manually entered using the "Edit" function. Once the sensor mounting correction has taken place, the measured value is corrected to 0. The sensor mounting correction can compensate a maximum of 20% of the nominal range.	
	Offset	Input in adjustment unit, automatic transfer of the current measured value
Adjustment	Adjustment refers to setting the zero point (zero) and maximum measured value (span). These values correspond to the values of 4 and 20 mA. If the adjustment ranges are exceeded, the message "Outside parameter limits" is displayed.	
	Distance	**Density** Distance in m (for kg/cm^3) and ft (for lb/ft^3) **Interface** Distance in mm, cm, m, in and ft
	Min.-adjustment / Zero	**Process pressure, differential pressure** Zero in %, pressure **Level and flow (standard 0%)** Min. in X %, pressure or filling height **Density** Min. in X %, density **Interface** Min. in X %, interface
	Max.-adjustment / Span	**Process pressure, differential pressure** Span in %, pressure **Level and flow (standard 100%)** Min. in X %, pressure or filling height **Density** Min. in X %, density **Interface** Min. in X %, interface
Damping	For the damping of process-dependent measured value fluctuations, you can choose a suitable integration time. The values which can be entered are from 0 ... 999 seconds with an increment of 0.1 seconds.	
	Integration time	In 0.1 second increments
Linearization	A linearization is necessary for all vessels in which the volume does not increase linearly with the level height, e.g. in a horizontal cylindrical or spherical tank, and the indication or output of the volume is required. Corresponding linearization curves are preprogrammed for these vessels. They represent the correlation between the level percentage and vessel volume. By activating the appropriate curve, the volume percentage of the vessel is displayed correctly. Enter the desired parameters using the function buttons and save the entries. If a linearization curve is selected, the measuring signal is no longer linearly proportional to the level. This must be taken into consideration by the user, particularly when setting the switching point on the limit signal indicator.	
	Type of linearization	**Level** Linear, Horiz.cylinder, Sphere and User programmable
	The square of the flow is proportional to the pressure differential at the orifice plate or averaging pitot tube: $q^2 \sim dp$ To establish a linear relationship between flow rate and output variable, a square root extraction is required: $q \sim \sqrt{dp}$ The differential pressure transmitter has this square root function. It is selected in menu item "linearization curve". Enter the desired parameter using the appropriate keys and save your entries. When selecting the "bi-directional square root" flow, the minimum adjustment must be entered with a negative sign.	
	Type of linearization	**Flow** Linear, To square root, Bi-directional linear, Bi-directional square root and User programmable

Current output	In the current output menu, the saturation region for above or below a threshold is set. Under "Current output min./max." these limit values can be set. The factory setting is 3.8 mA and 20.5 mA. This corresponds to the NAMUR recommendation NE 43.		
	Mode	Output characteristic	0...100% = 4...20 mA or 0...100% = 20...4 mA Additional bi-directional flow: 20...4...20 mA or 4...20...4 mA
		Failure mode	≤ 3.6 mA, ≥ 21 mA, last valid measured value
	Min. and Max.	Min. current	3.8 mA, 4 mA
		Max. current	20.5 mA, 20 mA
Lock adjustment / Unlock adjustment	In this menu item, a 4-digit PIN can be activated, which protects against undesirable or unintended changes of the settings. With a PIN active, remote access via software or other systems is also no longer possible.		
	Run now		

5.4.2 Display

Menu language	In this menu item you can set the desired language. Factory settings: English	
	German, English, French, Spanish, Portuguese, Italian, Dutch, Russian, Turkish, Polish and Czech	
Displayed value 1 and 2	In this menu item you can define how the measured value should be presented on the display. The factory setting is "Linear percent".	
	"Level"	Filling height or Pressure (Adjustment units), Static pressure, Percent, Scaled, Current output, Linear percent, Meas. cell temp. and Electronics temperature
	"Differential pressure"	Differential pressure, Static pressure, Percent, Scaled, Current output, Linear percent, Meas. cell temp. and Electronics temperature
	"Flow"	Flow, Differential pressure, Static pressure, Pressure/percent, Scaled, Current output, Linear percent, Totalizer 1, Totalizer 2, Meas. cell temp. and Electronics temperature
	"Interface"	Interface height, Differential pressure, Percent, Scaled, Current output, Linear percent, Meas. cell temp. and Electronics temperature
	"Density"	Density, Differential pressure, Percent, Scaled, Current output, Linear percent, Meas. cell temp. and Electronics temperature
Backlight	A backlight on the display is available, which can be turned on or off in this menu. By default, this function is disabled.	
	Off, On	

5.4.3 Diagnosis

Device status	Status signals	Check function, Out of Specification, Maintenance required, Failure
Peak value	The respective minimum and maximum pressure values are stored in the device. Under "Peak values", these values can be viewed or reset. In addition to the pressure, the minimum and maximum values of the sensor cell and the electronics temperature is stored. These can be viewed or reset here.	
	Peak value "Pressure"	Reset peak value
	Peak value "Differential pressure"	Reset peak value
	Peak value "Static pressure"	Reset peak value
	Peak value "Meas. cell temp."	Reset peak value
	Peak value "Electronics temperature"	Reset peak value
Simulation	In menu item "Simulation", measured values can be simulated via the current output. These are issued as both analogue and digital (via HART ®). The simulation is automatically cancelled 60 minutes after the last key stroke.	
	For applications "Differential pressure"	Differential pressure, Static pressure, Percent, Current output, Linear percent, Meas. cell temp. and Electronics temperature
	For applications "Flow"	Flow, Differential pressure, Static pressure, Pressure, Scaled, Current output, Linear percent, Meas. cell temp. and Electronics temperature
	For applications "Level"	Filling height or Pressure (Adjustment units), Static pressure, Percent, Current output, Linear percent, Meas. cell temp. and Electronics temperature
	For applications "Interface"	Interface height, Differential pressure, Percent, Current output, Linear percent, Meas. cell temp. and Electronics temperature
	For applications "Density"	Density, Differential pressure, Percent, Current output, Linear percent, Meas. cell temp. and Electronics temperature

5.4.4 Additional adjustments

PIN	In this menu item the PIN can be changed. This option is only available if it has been enabled under "Setup - Lock adjustment". The PIN is "0000" by default factory conditions.	
	0000	Change PIN
Date / Time	Internal clock setting	
	Write date, time, data in device	
Reset	For further information refer to *Reset* on page 51.	
	Factory settings, Basic settings, Totalizer 1 and Totalizer 2	
Copy instrument settings	For further information refer to *Saving the device settings* on page 52.	
	Copy instrument settings	
Special parameters	Changing these settings is possible only after consultation with a service employee.	
Scaling	In menu item "Scaling variable" you define the scaling variables and the scaling unit for the level mode. In menu item "Scaling format" you define the scaling format on the display and the scaling of the level measurement for 0% and 100%.	
	Scaling variable	Scaling variable
		Scaling unit
	Scaling format	Scaling format
		100% corresponds - user-defined value
		0% corresponds - user-defined value
Current output	In this menu item it is determined which measured variable relates to which current output. Under "Current output - Adjustment", the current output can be assigned a corresponding measured value.	
	Current output variable	For applications "Level" Filling height or Pressure (Adjustment units), Static pressure, Percent, Scaled, Linear percent, Meas. cell temp. and Electronics temperature
		For applications "Differential pressure" Differential pressure, Static pressure, Percent, Linear percent, Meas. cell temp. and Electronics temperature
		For applications "Flow" Flow, Differential pressure, Static pressure, Pressure, Percent, Scaled, Linear percent, Meas. cell temp. and Electronics temperature
		For applications "Interface" Interface height, Differential pressure, Percent, Scaled, Linear percent, Meas. cell temp. and Electronics temperature
		For applications "Density" Density, Differential pressure, Percent, Scaled, Linear percent, Meas. cell temp. and Electronics temperature
	Current output, adjustment	0% = 0% or 100% = 100%
HART®-Mode	The differential pressure transmitter offers the HART® modes "Analogue current output" and "Fix current (4 mA)". Under "Fix current (4 mA)", up to 64 sensors can be operated on a two-wire multidrop mode. Each device must be assigned a HART® address between 0 and 63. The analogue signal is fixed at 4 mA. Under "Analogue current output", however, a 4…20 mA signal can also be issued for the assigned HART® address in multidrop mode.	
	HART® address	0...63
	Output mode	Analogue current output with HART® or Fix current (4 mA) with HART®

Primary element parameters	In this menu item more information can be given on the primary elements used in the "flow" application. This can be displayed as either flow or mass flow. The respective display and adjustment units can then be selected accordingly.	
	Unit	Volume flow, Mass flow and User-defined
	Adjustment	0 % = xxxx m^3/h, 100 % = xxxx m^3/h

5.4.5 Info

Device name	Device name
	Serial number
Instrument version	Software version
	Hardware version
Factory calibration	Factory calibration date
	Date of last change
Sensor characteristics	Order-related device characteristics

5.5 Reset

The reset function resets specific user entries. There are two reset functions available.

5.5.1 Delivery status

Restore the default values at the time of delivery, including the order-specific settings. A false signal suppression, user programmable linearization curve as well as the measured value memory will be deleted.

5.5.2 Basic settings

Reset the set data, including special parameters to the default values of the manufacturer. A false signal suppression, user programmable linearization curve as well as the measured value memory will be deleted.

The following menu items are affected during a reset

Menu item	Parameter	Default
Measurement loop name		Sensor
Application		No reset
Unit	Adjustment units	mbar (cell ≤ 500 mbar) bar (cell ≥ 1 bar)
	Temperature unit	°C
Sensor mounting correction		0.00 bar
Adjustment	Zero / Min. adjustment	0.00 bar - 0.00%
	Span / Max. adjustment	+URL in bar - 100%
Damping	Integration time	0.0 seconds
Current output	Current output mode	Output characteristic 4...20 mA Failure mode ≤ 3.6 mA
	Current output variable	Linear percent - Level
	Current output, adjustment	0...100% = 4...20 mA
	Current output min./max.	Min. 3.8 mA Max. 20.5 mA

Menu item	Parameter	Default
Lock adjustment		Unlock
Language		English
Displayed value 1		Current output in %
Displayed value 2		Meas. cell temp. in °C
Backlight		Off
Simulation		Differential pressure
PIN		0000
Scaling	Scaling variable	Volume in L
	Scaling format	0% = 0 L / 100% = 0 L
HART® mode		Address 0

5.6 Saving the device settings

We recommended noting the parameters and archiving them afterwards. They are thus available for multiple use or service purposes. If the signal converter is equipped with a display and adjustment module, the most important data can be read out of the sensor into the display and adjustment module. The data remain there permanently even if the sensor power supply fails. If it is necessary to exchange the signal converter, the display and adjustment module is inserted into the replacement device and the data are written into the signal converter under the menu item "Copy device data".

The following data and settings are saved in the adjustment module:

- All data from the "Set-up" and "Display" menus
- Sensor-specific units
- Temperature unit
- Linearisation
- User programmable linearisation curve

5.6.1 Copy device settings

This function allows you to upload the selected data to the display and adjustment module or download selected data to the signal converter. This function serves as a backup of the data, since it is retained even if the power fails.

The following settings are saved:

- all settings from the "Setup" and "Display" menus
- the menu items "Reset" and "Date/Time"
- Special parameters

5.7 Diagnosis memory

The device has several internal memories which are available for diagnosis purposes. The data remain even with voltage interruption.

Measured value memory
Up to 60,000 measured values can be stored in a ring memory. Each entry contains a time stamp as well as the respective measured value. Storable values are for example:

- Differential pressure
- Static pressure
- Level
- Flow rate
- Density
- Interface
- Percent value
- Linear percent
- Scaled values
- Meas. cell temp.
- Electronic temperature

With the default factory settings, the measured value memory is active and stores differential pressure, measurement reliability and electronics temperature every minute. The requested values and recording conditions are set via a PC with PACTware^{TM}/DTM or the control system with EDD.

Event memory
Up to 500 events are automatically stored with a time stamp in the event memory (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 message acc. to NE 107
- Error message acc. to NE 107

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

5.8 Failures and diagnostics

The operator of the system is responsible for taking suitable measures to remove interferences. The differential pressure transmitter offers maximum reliability. Nevertheless, faults can occur during operation. The first measures are to evaluate the error messages, check the output signals as well as the verification of measurement errors.

Asset Management and diagnostics acc. to NE 107
The device 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 display and adjustment module, PACTware™/DTM and EDD.

Status messages
The status messages are divided into the following categories in accordance with NE 107:

- **Failure**
  Due to a malfunction in the device, a failure message is output. This status message is always active. It cannot be deactivated by the user.
- **Check function**
  The device is in operation, the measured value is temporarily invalid. This status message is inactive by default. It can be activated by the user via PACTware/DTM or EDD.
- **Out of specification**
  The measured value is unstable because the device specification is exceeded. This status message is inactive by default. It can be activated by the user via PACTware™/DTM or EDD.
- **Maintenance required**
  Due to external influences, the device function is limited. The measurement is affected, but the measured value is still valid. Plan in maintenance for the device because a failure is expected in the near future. This status message is inactive by default. It can be activated by the user via PACTware™/DTM or EDD.

5.8.1 Error codes

Failure

Code Text message	Cause	Action or description
F013 No measurement value available	No valid measured value available	Check the measuring cell or the overpressure and underpressure conditions
F017 Adjustment span too small	Adjustment not within specification	Change adjustment according to the limit values
F025 Error in the linearisation table	Index markers are not continuously rising, for example illogical value pairs	Check linearization table, Delete table/Create new
F36 No operable sensor software	Failed or interrupted software update	Repeat software update Check electronics version Exchange the electronics or send device for repair
F40 Error in the electronics	Hardware defect	Exchange the electronics or send device for repair
F041 Error in the electronics	No connection to sensor electronics	Check connection to sensor electronics (with remote version)
F080	General software error	Disconnect operating voltage briefly
F113 Communication error with the display and adjustment module, operating software PACTware TM disturbed	EMC interference	Remove EMC influences
F125 Impermissible electronics temperature	Temperature of the electronics in the non-specified section	Check ambient temperature Isolate electronics Use device with higher temperature range
F260 Error in the calibration	Error in the calibration carried out in the factory Error in EEPROM	Exchange the electronics Send device for repair
F261 Error in the configuration	Error during setup Error when carrying out a reset	Repeat setup, Repeat reset
F265 Measurement function disturbed	Sensor no longer carries out a measurement	Carry out a reset Disconnect operating voltage briefly
F266 Impermissible operating voltage	Operating voltage is below the specified range	Check electrical connection - if necessary, increase operating voltage

Check function

Code Text message	Cause	Action or description
C700 Simulation active	A simulation is active	Finish simulation Automatic end after 60 minutes

Out of specification

Code Text message	Cause	Action or description
S600 Impermissible electronics temperature	Temperature of the electronics in the non-specified section	Check ambient temperature Isolate electronics Use device with higher temperature range
S603 Impermissible operating voltage	Operating voltage below specified range	Check electrical connection - if necessary, increase operating voltage

Only for signal converter with SIL-qualification
When "Out of specification" is activated, the measured values and electronics temperature are monitored. If the values are outside of the specified range, the following messages are displayed:

- Status message "Failure"
- Fault signal via the current output

Maintenance required

Code Text message	Cause	Action or description
M500 Error with the reset delivery status	Saved reset delivery status is incorrect	Send device for repair
M501 Error in the non-active linearization table	Index markers are not continuously rising, for example illogical value pairs	Check linearization table, Delete table/Create new
M502 Error in the event memory	Hardware error in EEPROM	Exchange the electronics Send device for repair
M504 Error on a device interface	Hardware defect	Check connections Exchange the electronics Send device for repair
M507 Error in the device settings	Error during setup Error when carrying out a reset	Repeat setup, Repeat reset

5.8.2 Check 4...20 mA signal

Connect a multimeter in the suitable measuring range according to the wiring plan.

Error code	Cause	Action or description
4...20 mA signal is missing	Faulty connection to power supply	Check connection and if necessary correct according to wiring plan
	No power supply	Check cable for breaks; repair if necessary
	Operating voltage too low or load-resistance too high	Check, adapt if necessary
Signal is >22 mA or <3.6 mA	Electronic module or sensor defective	Exchange the device or send device for repair

DANGER!
In hazardous area applications, the regulations for the wiring of intrinsically safe circuits must be observed.

5.8.3 Error messages via the display and operating module

Error code	Cause	Action or description
E013	No measurement value available or pressure greater than nominal range	Exchange the device or send device for repair
E017	Adjustment span too small	Repeat with modified values
E036	No executable signal converter software	Carry out software update or send device for repair
E041	Hardware error	Exchange the device or send device for repair

Depending on the reason for the fault and the measures taken, the steps described previously may need to be carried out again.

5.8.4 Change electronic insert

WARNING!
Installation, assembly, start-up and maintenance may only be performed by personnel trained in ***explosion protection****. Additional regional standards, safety directives and laws must be observed at all times.*

In case of a defect, the electronic insert can be exchanged by the user against an identical type. If no electronic insert is available on site, it can be ordered from the local sales office. To order a replacement, the serial number is required. This is located on the nameplate of the device or on the delivery note.

5.8.5 Software update

The following components are required for an update of the device software:

- Sensor
- Power supply
- USB interface adapter
- PC with PACTware™
- Software update as file

The latest version of the device software can be found on the manufacturer website. Further information is provided in the software update file.

Certain approvals can be subject to a specific software version. Therefore, when carrying out an update, ensure the approval is retained.

Only for signal converter with SIL-qualification
Ensure that you are using the correct software with SIL-qualification. Devices with SIL-qualification can only be updated with the appropriate software. It is impossible to accidentally update it with the wrong software version.

6.1 Replacement

DANGER!
Observe the national regulations for electrical installations!

DANGER!
All work on the electrical connections may only be carried out with the power disconnected. Take note of the voltage data on the nameplate!

DANGER!
Check whether the ambient air around the signal converter is explosive. Opening the signal converter in an explosive atmosphere may result in ignition and explosion.

WARNING!
Installation, assembly, start-up and maintenance may only be performed by personnel trained in ***explosion protection****. Additional regional standards, safety directives and laws must be observed at all times.*

WARNING!
Observe without fail the local occupational health and safety regulations. Any work done on the electrical components of the measuring device may only be carried out by properly trained specialists.

CAUTION!
The product may cause the signal converter to become extremely hot. Possible risk of burning. For this reason, promptly shut off the process or isolate the signal converter sufficiently from the product prior to starting work and check that the converter has cooled down to room temperature.

Change electronic insert
In case of a defect, the electronic insert can be exchanged by the user against an identical type. If no electronic insert is available on site, it can be ordered from the respective local sales representative. To order a replacement, the serial number of the signal converter is required. This is located on the nameplate of the device or on the delivery note.

6.2 Maintenance

When used correctly, no maintenance is required in normal operation. In some applications, the measurement can be distorted by adhesive media. In this case, suitable measures should be taken to avoid adhesions and especially hardening on the diaphragm surface and in the pressure connection.

6.3 Spare parts availability

The manufacturer adheres to the basic principle that functionally adequate spare parts for each device or each important accessory part will be kept available for a period of 3 years after delivery of the last production run for the device.

This regulation only applies to spare parts which are subject to wear and tear under normal operating conditions.

6.4 Availability of services

The manufacturer offers a range of services to support the customer after expiration of the warranty. These include repair, maintenance, technical support and training.

INFORMATION!
For more precise information, please contact your local sales office.

6.5 Repairs

Repairs may be carried out exclusively by the manufacturer or the manufacturer authorised specialist companies.

6.6 Returning the device to the manufacturer

6.6.1 General information

This device has been carefully manufactured and tested. If installed and operated in accordance with these operating instructions, it will rarely present any problems.

CAUTION!
Should you nevertheless need to return a device for inspection or repair, please pay strict attention to the following points:

- *Due to statutory regulations on environmental protection and safeguarding the health and safety of the personnel, the manufacturer may only handle, test and repair returned devices that have been in contact with products without risk to personnel and environment.*
- *This means that the manufacturer can only service this device if it is accompanied by the following certificate (see next section) confirming that the device is safe to handle.*

CAUTION!
If the device has been operated with toxic, caustic, flammable or water-endangering products, you are kindly requested:

- *to check and ensure, if necessary by rinsing or neutralising, that all cavities are free from such dangerous substances,*
- *to enclose a certificate with the device confirming that is safe to handle and stating the product used.*

6.6.2 Form (for copying) to accompany a returned device

CAUTION!
To avoid any risk for our service personel, this form has to be accessible from outside of the packaging with the returned device.

Company:		Address:
Department:		Name:
Tel. no.:		Fax no. and/or Email address:
Manufacturer's order no. or serial no.:		
The device has been operated with the following medium:		
This medium is:		radioactive
		water-hazardous
		toxic
		caustic
		flammable
		We checked that all cavities in the device are free from such substances.
		We have flushed out and neutralized all cavities in the device.
We hereby confirm that there is no risk to persons or the environment through any residual media contained in the device when it is returned.		
Date:		Signature:
Stamp:		

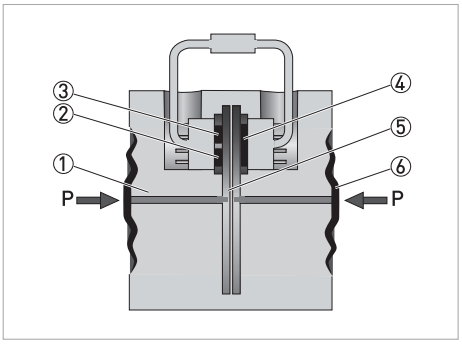
6.7 Disposal

CAUTION!
Disposal must be carried out in accordance with legislation applicable in your country.

Separate collection of WEEE (Waste Electrical and Electronic Equipment) in the European Union:

According to the directive 2012/19/EU, the monitoring and control instruments marked with the WEEE symbol and reaching their end-of-life **must not be disposed of with other waste**.
The user must dispose of the WEEE to a designated collection point for the recycling of WEEE or send them back to our local organisation or authorised representative.

7.1 Measuring principle



① Fill fluid
② Temperature sensor
③ Absolute pressure sensor
④ Differential pressure sensor
⑤ Overload system
⑥ Separating diaphragm

The process pressure is transferred via the separating metallic diaphragms ⑥ of the high and low pressure side and the fill fluid ① to the piezoresistive silicon sensor. Through the prevailing pressure differential, the silicon diaphragm of the differential pressure sensor ④ is deflected and changes the resistance value of the four piezoresistive elements in the bridge circuit. The change in resistance of the bridge circuit is proportional to the differential pressure. Additionally, the measured cell temperature ② and the prevailing static pressure ③ on the low pressure side is measured and then made available to the signal converter for further processing. If the measurement limit is exceeded, the overload system ⑤ restricts the prevailing process pressure at the differential pressure sensor and protects it from damage.

7.2 Technical data

INFORMATION!

- *The following data is provided for general applications. If you require data that is more relevant to your specific application, please contact us or your local sales office.*
- *Additional information (certificates, special tools, software,...) and complete product documentation can be downloaded free of charge from the website (Downloadcenter).*

Measuring system

Measuring principle	Piezoresistive differential pressure cell
Application range	• Flow measurement (volume or mass flow) with corresponding differential pressure transmitter in gases, vapours and liquids • Differential pressure measurement • Interface and density measurement • Level, volume and mass measurement of liquids
Measuring range	10 mbar...16 bar / 0.14...232 psi
Display and User interface	
Display on signal converter	• Dot-matrix display 45x27 mm / 1.77x1.06", illuminated • Display turnable in 90° steps • Digit size 13x7 mm / 0.51x0.27" • Ambient temperatures below -20°C / -4°F may affect the readability of the display
Display function	• Display of measured value or derived measured value such as filling height, density, interface position, volume or mass flow and total counter • Warning and diagnostic information • All parameters are accessible via the operating menu
Operating and display languages	German, English, French, Spanish, Portuguese, Italian, Dutch, Russian, Turkish, Polish and Czech
Operation	Local operation via 4 push buttons on the display and adjustment module
Remote control	• PACTware™, incl. Device Type Manager (DTM) • HART® Hand Held Communicator from Emerson Process • AMS® from Emerson Process • PDM® from Siemens
Integrated clock	
Date format	Day / Month / Year
Time format	12 hours / 24 hours
Time zone	CET (Factory setting)
Rate deviation	Maximum 10.5 minutes / year

Measuring accuracy

<table>
<tr><td colspan="6">Differential pressure</td></tr>
<tr><td>Reference conditions acc. to IEC 60770-1</td><td colspan="5">• Ambient temperature (constant): +18...+30°C / +64...+86°F
• Relative humidity (constant): 45...75%
• Ambient pressure (constant): 860...1060 mbar / 12.5...15.4 psi
• Mounting position: vertical
• Rising characteristics
• Measurement start at 0.00 bar / psi
• Process diaphragm: 316L / 1.4404
• Fill fluid: silicone oil
• Material of process flanges: 316L / 1.4404
• Power supply: 24 VDC ±3 VDC
• Load for HART®: 250 Ω</td></tr>
<tr><td rowspan="8">Reference accuracy acc. to DIN EN 61298</td><td colspan="5">Includes linearity, hysteresis and non-repeatability under reference conditions. Applies to the digital interfaces (HART®, Profibus PA, Foundation Fieldbus) as well as for the analogue 4…20 mA current output.
[% of the set span]</td></tr>
<tr><td></td><td>TD < 5:1</td><td>TD > 5:1</td><td>TD < 10:1</td><td>TD > 10:1</td></tr>
<tr><td>10 mbar / 0.145 psi</td><td rowspan="2">< ±0.10 %</td><td rowspan="2"><± 0.02% x TD</td><td rowspan="2">-</td><td rowspan="2">-</td></tr>
<tr><td>30 mbar / 0.44 psi</td></tr>
<tr><td>100 mbar / 1.5 psi</td><td rowspan="4">-</td><td rowspan="4">-</td><td rowspan="4"><± 0.065%</td><td><± -0.035% + 0.01% x TD</td></tr>
<tr><td>500 mbar / 7.3 psi</td><td rowspan="3"><± 0.015% + 0.005% x TD</td></tr>
<tr><td>3 bar / 43.51 psi</td></tr>
<tr><td>16 bar / 232.1 psi</td><td><± -0.035% + 0.01% x TD</td></tr>
<tr><td rowspan="8">Effect of ambient temperature</td><td colspan="5">Ambient temperature effect on zero and span in relation to the set measuring span. Applies to the digital interfaces (HART®, Profibus PA, Foundation Fieldbus) as well as for the analogue 4…20 mA current output.
[% of the set span]</td></tr>
<tr><td></td><td>up to TD</td><td>-10...+60°C / +14...+140°F</td><td colspan="2">-40...+85°C / -40...+185°F</td></tr>
<tr><td>10 mbar / 0.145 psi</td><td>20:1</td><td><± 0.15% + 0.20% x TD</td><td colspan="2"><± 0.4% + 0.3% x TD</td></tr>
<tr><td>30 mbar / 0.44 psi</td><td>30:1</td><td><± 0.10% + 0.10% x TD</td><td colspan="2"><± 0.15% + 0.15% x TD</td></tr>
<tr><td>100 mbar / 1.5 psi</td><td rowspan="4">100:1</td><td><± 0.15% + 0.15% x TD</td><td colspan="2"><± 0.15% + 0.20% x TD</td></tr>
<tr><td>500 mbar / 7.3 psi</td><td rowspan="3"><± 0.08% + 0.05% x TD</td><td colspan="2" rowspan="3"><± 0.12% + 0.06% x TD</td></tr>
<tr><td>3 bar / 43.51 psi</td></tr>
<tr><td>16 bar / 232.1 psi</td><td><± 0.15% + 0.015% x TD</td></tr>
<tr><td rowspan="8">Effect of system pressure</td><td colspan="5">Ambient temperature effect on zero and span in relation to the set measuring span. Zero point errors can be calibrated out under operating pressure. Applies to the digital interfaces (HART®, Profibus PA, Foundation Fieldbus) as well as for the analogue 4…20 mA current output.
[% of the set span]</td></tr>
<tr><td></td><td>up to nominal pressure</td><td>on zero</td><td colspan="2">on span</td></tr>
<tr><td>10 mbar / 0.145 psi</td><td rowspan="2">40 bar / 580 psi</td><td rowspan="6"><± 0.10% x TD</td><td colspan="2" rowspan="6"><± 0.10%</td></tr>
<tr><td>30 mbar / 0.44 psi</td></tr>
<tr><td>100 mbar / 1.5 psi</td><td rowspan="4">160 bar / 2320 psi</td></tr>
<tr><td>500 mbar / 7.3 psi</td></tr>
<tr><td>3 bar / 43.51 psi</td></tr>
<tr><td>16 bar / 232.1 psi</td></tr>
<tr><td rowspan="2">Effect of mounting position</td><td colspan="5">A position-dependent zero offset can be corrected.</td></tr>
<tr><td colspan="5">≤0.1 mbar per 10° inclination</td></tr>
</table>

<table>
<tr><td>Long-term stability acc. to DIN 16086 and IEC 60770-1</td><td colspan="4">Applies to the digital interfaces (HART®, Profibus PA, Foundation Fieldbus) as well as for the analogue 4…20 mA current output.
[% of the set span]</td></tr>
<tr><td></td><td colspan="4"><0.1% x TD (Turn Down) over a period of 5 years</td></tr>
<tr><td rowspan="10">Total performance in accordance with DIN 16086</td><td colspan="4">At a temperature change of -10...+60°C / +14...+140°F, up to the indicated nominal pressure.
[% of the set span]</td></tr>
<tr><td></td><td>up to TD</td><td>Nominal pressure</td><td>-10...+60°C / +14...+140°F</td></tr>
<tr><td>10 mbar / 0.145 psi</td><td rowspan="6">1:1</td><td rowspan="2">40 bar / 580 psi</td><td><± 0.42%</td></tr>
<tr><td>30 mbar / 0.44 psi</td><td><± 0.29%</td></tr>
<tr><td>100 mbar / 1.5 psi</td><td rowspan="4">160 bar / 2320 psi</td><td><± 0.32%</td></tr>
<tr><td>500 mbar / 7.3 psi</td><td rowspan="3"><± 0.18%</td></tr>
<tr><td>3 bar / 43.51 psi</td></tr>
<tr><td>16 bar / 232.1 psi</td><td><± 0.32%</td></tr>
<tr><td colspan="4">The details of total performance comprise the reference accuracy, the effect of the ambient temperature on the zero signal and the measuring span as well as the effect of the static pressure on the measuring span.</td></tr>
<tr><td colspan="4">$E_{perf}=\sqrt{([E_{\Delta TZ}+E_{\Delta TS}]^2+E_{\Delta PS}^2+E_{lin}^2)}$
$E_{\Delta TZ}$= Effect of ambient temperature on the zero signal
$E_{\Delta TS}$= Effect of ambient temperature on the measuring span
$E_{\Delta PS}$= Effect of the static pressure on the measuring span
E_{lin} = Reference accuracy</td></tr>
<tr><td>Dynamic output behaviour</td><td colspan="4">These parameters depend on the fill fluid, temperature and, if applicable, the diaphragm seal. For more information refer to Dynamic output behaviour on page 71</td></tr>
<tr><td>Damping</td><td colspan="4">63% of the input variable 0…999 seconds, adjustable in 0.1 second steps.</td></tr>
<tr><td colspan="5">Temperature</td></tr>
<tr><td colspan="5">The evaluation is made using the HART® output signal.</td></tr>
<tr><td>Resolution</td><td colspan="4">1°C / 1.8°F</td></tr>
<tr><td>Accuracy</td><td colspan="4">± 1°K</td></tr>
<tr><td colspan="5">System pressure</td></tr>
<tr><td>Reference conditions acc. to IEC 60770-1</td><td colspan="4">• Ambient temperature (constant): +18...+30°C / +64...+86°F
• Relative humidity (constant): 45...75%
• Ambient pressure (constant): 860...1060 mbar / 12.5...15.4 psi
• Mounting position: vertical</td></tr>
<tr><td rowspan="8">Reference accuracy acc. to DIN EN 61298</td><td colspan="4">Includes the non-linearity, hysteresis and repeatability under reference conditions. Applies to the digital interfaces (HART®, Profibus PA, Foundation Fieldbus) as well as for the analogue 4…20 mA current output. [% of URL]</td></tr>
<tr><td></td><td colspan="2">up to nominal pressure acc. to URL absolute pressure</td><td>TD 1:1</td></tr>
<tr><td>10 mbar / 0.145 psi</td><td colspan="2" rowspan="2">40 bar / 580 psi</td><td rowspan="6"><± 0.10%</td></tr>
<tr><td>30 mbar / 0.44 psi</td></tr>
<tr><td>100 mbar / 1.5 psi</td><td colspan="2" rowspan="4">160 bar / 2320 psi</td></tr>
<tr><td>500 mbar / 7.3 psi</td></tr>
<tr><td>3 bar / 43.51 psi</td></tr>
<tr><td>16 bar / 232.1 psi</td></tr>
</table>

Effect of ambient temperature	Ambient temperature effect on zero and span. [% of URL]			
		up to nominal pressure acc. to URL absolute pressure	-10...+60°C / +14...140°F	-40...+80°C / -40...+176°F
	10 mbar / 0.145 psi	40 bar / 580 psi	<± 0.10%	<± 0.15%
	30 mbar / 0.44 psi			
	100 mbar / 1.5 psi	160 bar / 2320 psi		
	500 mbar / 7.3 psi			
	3 bar / 43.51 psi			
	16 bar / 232.1 psi			
Long-term stability acc. to DIN EN 61298-1	<± 0.1% of URL over a period of 5 years			

Operating conditions

Temperature	
Operating temperature / nominal temperature range	-40...+80°C / -40...+176°F
Ambient temperature	-40...+80°C / -40...+176°F
Storage temperature	-40...+80°C / -40...+176°F
Climate category	4K 4H (air temperature: -20...+55°C, humidity: 4...100% according to DIN EN 60721-3-4)

Further operating conditions

Ingress protection acc. to IEC 529 / EN 60529			
Plastic (PBT)	Single chamber	IP66 / IP67	NEMA 6P
	Double chamber	IP66 / IP67	NEMA 6P
Aluminium	Single chamber	IP66 / IP67	NEMA 6P
		IP68 (1 bar / 14.5 psi)	-
	Double chamber	IP66 / IP67	NEMA 6P
Stainless steel (electro-polished)	Single chamber	IP69K	-
	Single chamber	IP66 / IP67	NEMA 6P
Stainless steel (precision casting)	Single chamber	IP66 / IP67	NEMA 6P
		IP68 (1 bar / 14.5 psi)	-
	Double chamber	IP66 / IP67	NEMA 6P
Stainless steel	Sensor for external housing	IP68 (25 bar / 362.6 psi)	-

Vibration	
Reference conditions	• Without mounting bracket • Process flanges 316 L / 1.4404 PN 160 • Single chamber housing, aluminium
Vibration resistance acc. to EN 60770-1	10...58 Hz, 0.35 mm 58...1000 Hz, 20 m/s^2 1 octave per minute, 10 cycles per axis
Shock resistant according to EN 60770-1	500 m/s^2, 6 ms 100 shocks per axis
Noise according to IEC 60770-1	10...200 Hz, 1 $(m/s^2)^2/Hz$ 200...500 Hz, 0.3 $(m/s^2)^2/Hz$ 4 hours per axis

Materials

Gaskets	
EPDM	-40...+85°C / -40...+185°F
FKM	-20...+85°C / -4...+185°F
Filling oil	
Silicone oil	-40...+85°C / -40...+185°F
Wetted parts	
Process connection, screwed flange	316L / 1.4404, Hastelloy® C-276 NACE MR0175
Separating diaphragm	316L / 1.4404, Hastelloy® C-276 NACE MR0175
Vent and lock screws	316L / 1.4404, Hastelloy® C-276 NACE MR0175
Internal transmission fluid	Silicone oil
Non-wetted parts	
Electronics housing	Plastic PBT (Polyester), powder coated die-cast aluminium, 316L / 1.4404
Housing cover sealing ring	Silicone (aluminium or plastic housing), NBR (stainless steel housing)
Inspection window in housing cover (display, adjustment module)	Polycarbonate (UL746-C listed)
Screws and bolts for the side flanges	PN 160: hexagon screw DIN 931 M8 x 90 A4 70, hexagon nut DIN 934 M8 A4 70
Grounding flange	316Ti, 316L / 1.4404

Process connection

Standard	1/4-18 NPT (female), IEC 61518 A

Electrical connections

Mechanical		
Cable gland	M20 x 1.5 mm	
cable diameter	5...9 mm / 0.20...0.35" 6...12 mm / 0.24...0.47" 10...14 mm / 0.39...0.55"	
Cable entry 1/2 NPT	Blind plug: M20x 1.5 mm, 1/2-14 NPT	
	Closing cap: M20 x 1.5 mm, 1/2-14 NPT	
	Connector option: M12 x 1, Harting HAN 7D,8D, 7/8 FF	
Wire cross-section	Solid wire with cords: 0.2 mm...2.5 mm^2 / AWG 24...14	
	Cord with wire end sleeve: 0.2 mm...1.5 mm^2 / AWG 24...16	
Electrical		
Supply voltage	Non-Ex device: 11...35 VDC	
	Ex ia device: 11...30 VDC	
	Ex d device: 11...35 VDC	
	Ex ia d device: 15...35 VDC	
Reverse polarity protection	Integrated	
Permissible residual ripple	Non-Ex devices,	for U_n 12 VDC (11 < UB < 14 VDC) ≤ 0.7 V_{eff} (16...400 Hz)
	Ex ia devices, Ex ia d devices	for U_n 24 VDC (18 < UB < 35 VDC) ≤ 1.0 V_{eff} (16...400 Hz)
Load	$R_{L,max}$=(UB-11) / 22 mA	
Potential connection in device	Electronics: not electrically isolated	
	Ground terminal: galvanically connected with process connection	
Overvoltage category	III	
Protection class	II	

Inputs and outputs

Output signal	
Output signal	4...20 mA / HART® version 7.3 3.8...20.5 mA (factory setting acc. to NAMUR recommendation)
Signal resolution	0.3 µA
Error signal of current output (adjustable)	High alarm ≥ 21 mA Low alarm ≤ 3.6 mA, last valid measurement
Max. output current	21.5 mA
Boot-up current	≤ 10 mA for 5 ms after switching on, then ≤ 3.6 mA
Damping	0...999 seconds, adjustable

Approvals and certificates

CE	The device fulfils the statutory requirements of the EC directives. The manufacturer certifies that these requirements have been met by applying the CE marking.
Electromagnetic compatibility (EMC)	EN 61326-1:2013 EN 61326-2-3:2013
NAMUR	NE 21 - Electromagnetic compatibility of equipment NE 43 - Signal level for the failure information of digital transmitters NE 53 - Compatibility of field devices and display/adjustment components
Classification according to Pressure Equipment Directive (PED 97/23/EC)	PN160 (MWP 2320 psi) - For gases of fluid group 1 and liquids of fluid group 1, the requirements are fulfilled according to article 3, paragraph 3 (sound engineering practice).

7.3 Pressure ranges

Nominal range	10 mbar	30 mbar	100 mbar	500 mbar	3 bar	16 bar
Limit URL (upper)	10 mbar	30 mbar	100 mbar	500 mbar	3 bar	16 bar
Limit LRL (lower)	-10 mbar	-30 mbar	-100 mbar	-500 mbar	-3 bar	-16 bar
Smallest adjustable measuring span	0.5 mbar	1 mbar	1 mbar	5 mbar	30 mbar	160 mbar
Turn down	20:1	30:1	100:1	100:1	100:1	100:1
MWP (maximum system pressure) ①	40 bar	40 bar	160 bar	160 bar	160 bar	160 bar
Minimum system pressure	5 mbar abs (under reference conditions)					

① MWP corresponds to the PS designation in the PED (maximum system pressure)

Nominal range	0.15	0.44 psi	1.50 psi	7.30 psi	43.51 psi	232.1 psi
Limit URL (upper)	0.15	0.44 psi	1.50 psi	7.30 psi	43.51 psi	232.1 psi
Limit LRL (lower)	-0.15	-0.44 psi	-1.45 psi	-7.25 psi	-43.51 psi	-232.1 psi
Smallest adjustable measuring span	0.007	0.015 psi	0.015 psi	0.073 psi	0.44 psi	2.32 psi
Turn down	20:1	30:1	100:1	100:1	100:1	100:1
MWP (maximum system pressure) ①	580 psi	580 psi	2321 psi	2321 psi	2321 psi	2321 psi
Minimum system pressure		0.073 psi abs (under reference conditions)				

① MWP corresponds to the PS designation in the PED (maximum system pressure)

7.4 Ambient temperature effect on current output

< 0.05% / 10 K, max. < 0.15%, each case at -40...+80°C / -40...+176°F

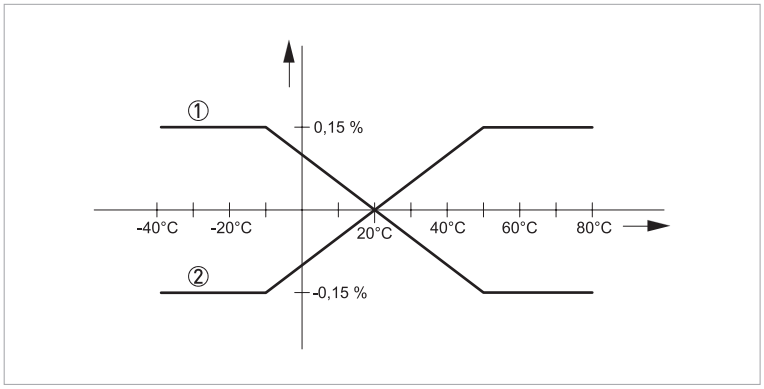


Figure 7-1: Ambient temperature effect on current output

① Falling characteristics
② Rising characteristics

7.5 Dynamic output behaviour

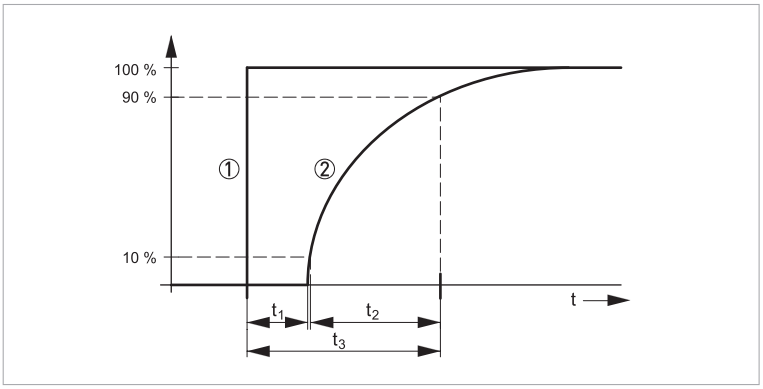


Figure 7-2: Behaviour at an abrupt change in the process variable.
t_1 - dead time; t_2 - rise time; t_3 - step response time

① Process variable
② Output signal

These parameters depend on the filling medium, temperature and, if applicable, the chemical seal.

	Dead time (t1) [ms]	T90% (t2) [ms]	Step response time (t3) [ms] ①
10 mbar / 0.15 psi	90	115	205
30 mbar / 0.44 psi	90	115	205
100 mbar / 1.50 psi	60	95	155
500 mbar / 7.3 psi		75	135
3 bar / 43.51 psi		60	120
16 bar / 232.1 psi			

① Step response time is the sum of dead time and T90%

7.6 Dimensions and weights

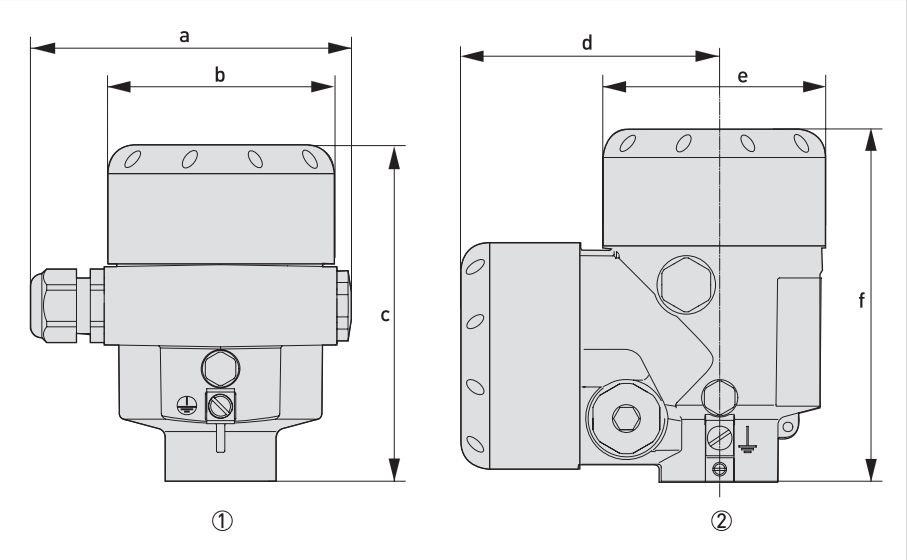


Figure 7-3: Aluminium housing

① Single chamber
② Double chamber

	Dimension [mm]	Dimension [inch]
a	116	4.57
b	86	3.39
c	116	4.57
d	87	3.43
e	86	3.39
f	120	4.72

INFORMATION!
With integrated display and adjustment module the height of the housing increases by 9 mm / 0.35 inch.

Housing version	Weight [kg]	Weight [lb]
Single chamber, aluminium	0.83	1.84
Double chamber, aluminium	1.24	2.73

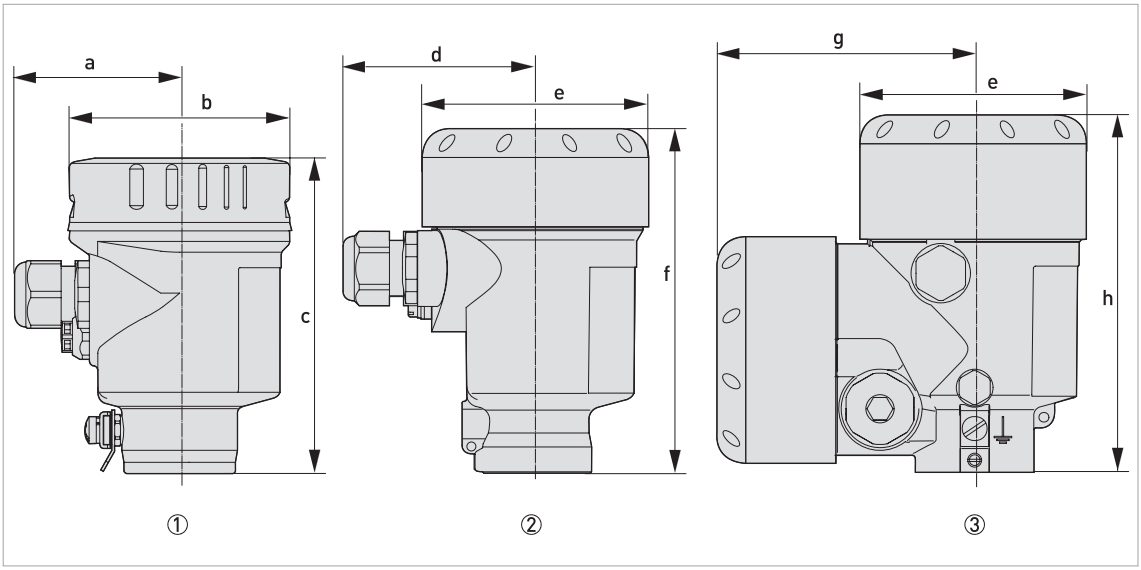


Figure 7-4: Stainless steel housing

① Single chamber, stainless steel (electro-polished)
② Single chamber, precision casting
③ Double chamber, precision casting

	Dimension [mm]	Dimension [inch]
a	59	2.32
b	80	3.15
c	112	4.41
d	69	2.72
e	79	3.11
f	117	4.61
g	87	3.42
h	79	3.11
i	120	4.72

INFORMATION!
With integrated display and adjustment module the height of the housing increases by 9 mm / 0.35 inch.

Housing version	Weight [kg]	Weight [lb]
Single chamber, stainless steel (electro-polished)	0.73	1.61
Single chamber, precision casting	1.31	2.89
Double chamber, precision casting	2.86	6.31

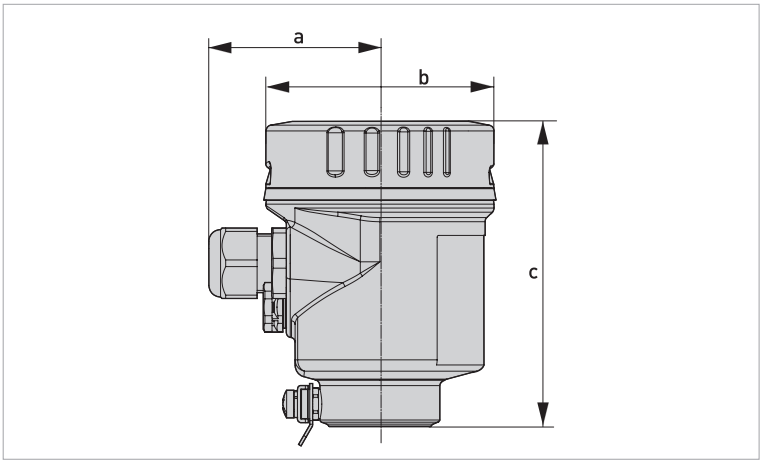


Figure 7-5: Stainless steel (electro-polished) in IP69K version

	Dimension [mm]	Dimension [inch]
a	59	2.32
b	80	3.15
c	104	4.10

INFORMATION!
With integrated display and adjustment module the height of the housing increases by 9 mm / 0.35 inch.

Housing version	Weight [kg]	Weight [lb]
Single chamber, stainless steel (electro-polished)	0.73	1.61

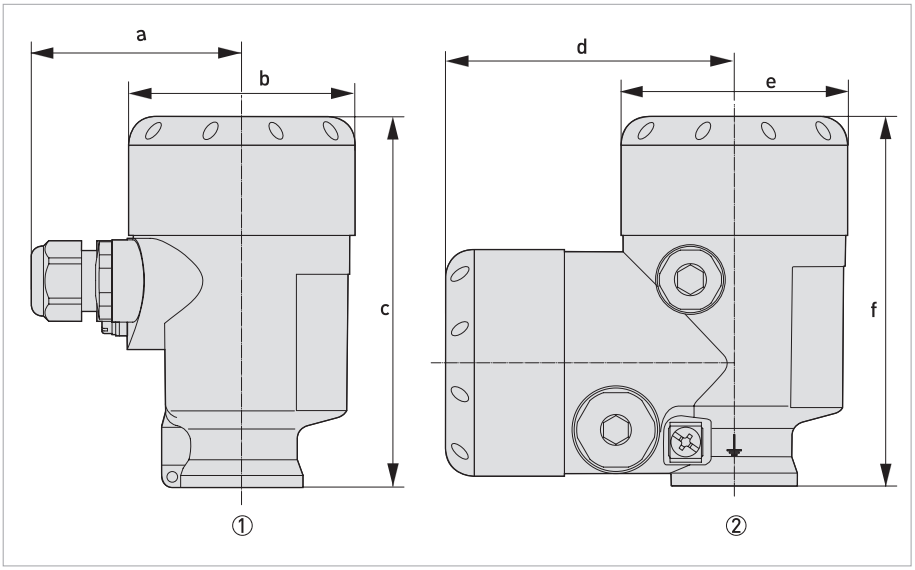


Figure 7-6: Plastic housing

① Single chamber
② Double chamber

	Dimension [mm]	Dimension [inch]
a	69	2.72
b	79	3.11
c	112	4.41
d	84	3.31
e	79	3.11
f	112	4.41

INFORMATION!
With integrated display and adjustment module the height of the housing increases by 9 mm / 0.35 inch.

Housing version	Weight [kg]	Weight [lb]
Single chamber, plastic	0.40	0.88
Double chamber, plastic	0.51	1.13

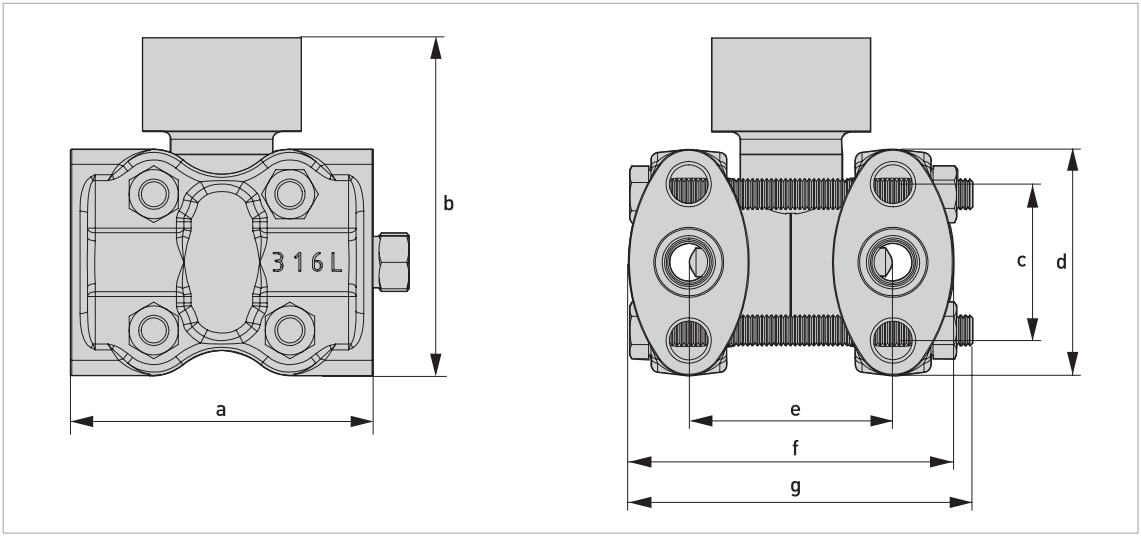


Figure 7-7: 1/4-18 NPT process connection

	Dimension [mm]	Dimension [inch]
a	80	3.15
b	88	3.46
c	41.3	1.63
d	60	2.36
e	54	2
f	86	3.39
g	91	3.58

	Weight [kg]	Weight [lb]
Process connection	2.0	4.41

INFORMATION!
Overall height of the differential pressure transmitter = b (process connection) + overall height of the respective housing

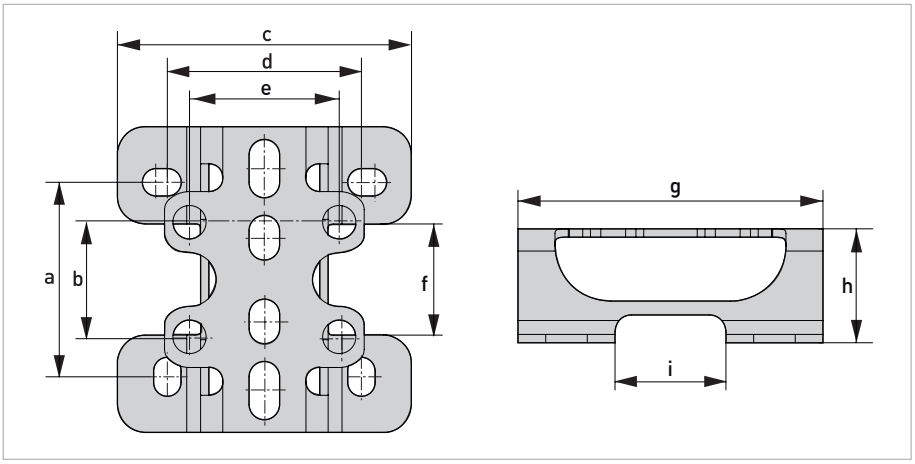


Figure 7-8: Mounting bracket

	Dimension [mm]	Dimension [inch]
a	70	2.76
b	41.3	1.63
c	106	4.17
d	70	2.76
e	54	2.13
f	40	1.57
g	110	4.33
h	41	1.61
i	40	1.57

	Weight [kg]	Weight [lb]
Mounting bracket	0.33	0.73

8.1 General description

The open HART® protocol, which can be used for free, is integrated into the signal converter for communication.

Devices which support the HART® protocol are classified as either operating devices or field devices. When it comes to operating devices (Master), both manual control units (Secondary Master) and PC-supported workstations (Primary Master) are used in, for example, a control centre.

HART® field devices include measuring sensors, signal converters and actuators. The field devices range from 2-wire to intrinsically safe versions for use in hazardous areas.

The HART® data are superimposed over the analogue 4...20 mA signal via FSK modem. This way, all of the connected devices can communicate digitally with one another via the HART® protocol while simultaneously transmitting the analogue signals.

When it comes to the field devices and secondary masters, the FSK or HART® modem is integrated. If a PC is used, an external modem must be connected to the serial interface (USB interface). There are, however, other connection variants which can be seen in the following connection figures.

8.2 Software history

INFORMATION!
In the table below, "x" is a placeholder for possible multi-digit alphanumeric combinations, depending on the available version.

Release date	SW version	HW version	HART®	
			Device Revision	DD Revision
2013-04-01	1.0.x	1.0.x	1	1

HART® identification codes and revision numbers

Manufacturer ID:	69 (0x45)
Device:	195 (0xC5)
Device Revision:	1
DD Revision:	1
HART® Universal Revision:	7
FC 475 system SW.Rev.:	≥ 3.7
PDM version:	≥ 8.0
FDT version:	≥ 1.2

8.3 Connection variants

The signal converter is a 2-wire device with a passive 4...20 mA current output and a HART® interface.

- **Point-to-Point is supported**
  In conventional point-to-point operation, the signal converter communicates as a slave with the master.
- **Multidrop mode is supported**
  In a multidrop communication system, more than 2 devices are connected to a common transmission cable.
- **Burst mode is not supported**
  In the burst operation a slave device transfers cyclic pre-defined response telegrams, to get a higher rate of data transfer.

There are two ways of using the HART® communication:

- as Point-to-Point connection and
- as multidrop connection, with 2-wire connection.

8.3.1 Point-to-Point connection - analogue / digital mode

Point-to-Point connection between the signal converter and the HART® Master.

The current output of the device is passive.

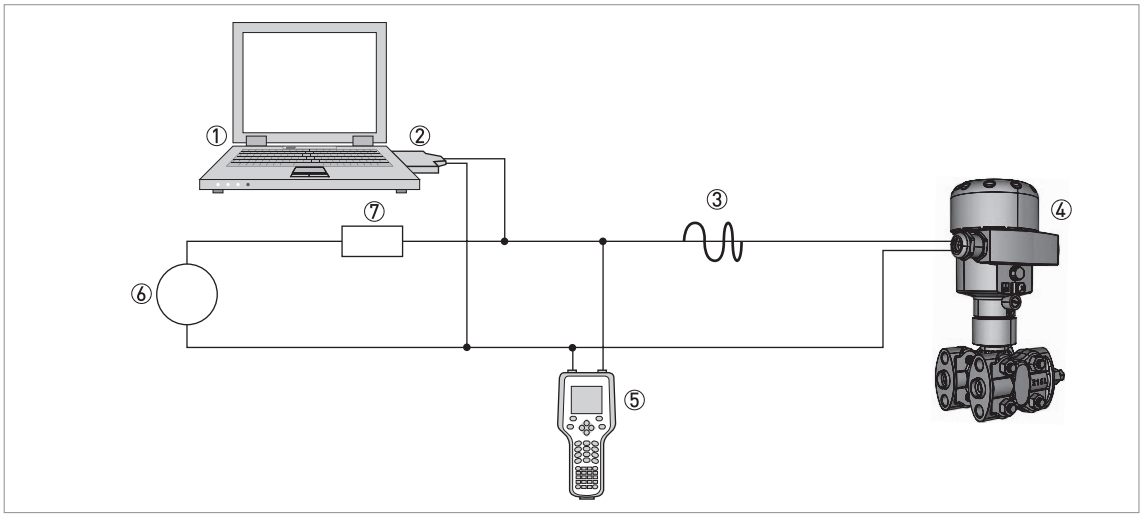


Figure 8-1: Point-to-Point connection

① Primary master with e.g. PACTware™ FDT/DTM
② FSK modem
③ HART® signal
④ OPTIBAR DP 7060 C
⑤ Secondary master with HART® DD
⑥ Power supply for devices (slaves) with passive current output
⑦ Load ≥ 250 Ω (Ohm)

8.4 Inputs/outputs and HART® dynamic variables and device variables

PV = Primary Variable; SV = Secondary Variable; TV = Third Variable; QV = Quarternary Variable

HART® dynamic variable			
PV	SV	TV	QV
Linear percent value	Physical unit	Meas. cell temp.	Electronic temperature

Table 8-1: HART® output values acc. to HART® 7 (factory setting)

8.5 Field Communicator 475 (FC 475)

The Field Communicator is a hand terminal from Emerson Process Management that is designed to configure HART® and Foundation Fieldbus devices. Device Descriptions (DDs) are used to integrate different devices into the Field Communicator.

8.5.1 Installation

The HART® Device Description for the signal converter must be installed on the Field Communicator. Otherwise only the functions of a generic DD are available to the user and the entire device control is not possible. A "Field Communicator Easy Upgrade Programming Utility" is required to install the DDs on the Field Communicator.

The Field Communicator must be equipped with a system card with "Easy Upgrade Option". For details consult the Field Communicator User's Manual.

8.5.2 Operation

Operating the signal converter via the Field Communicator is very similar to manual device control using the keyboard.

8.6 Field Device Tool / Device Type Manager (FDT / DTM)

A Field Device Tool Container (FDT Container) is basically a PC program used to configure a field device via HART®. To adapt to different devices, the FDT container uses a so-called Device Type Manager (DTM).

8.6.1 Installation

If the DTM for the signal converter has not yet been installed on the FDT Container, setup is required and is available for download from the website or on CD-ROM. See the supplied documentation for information on how to install and set up the DTM.

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