delta-mobrey

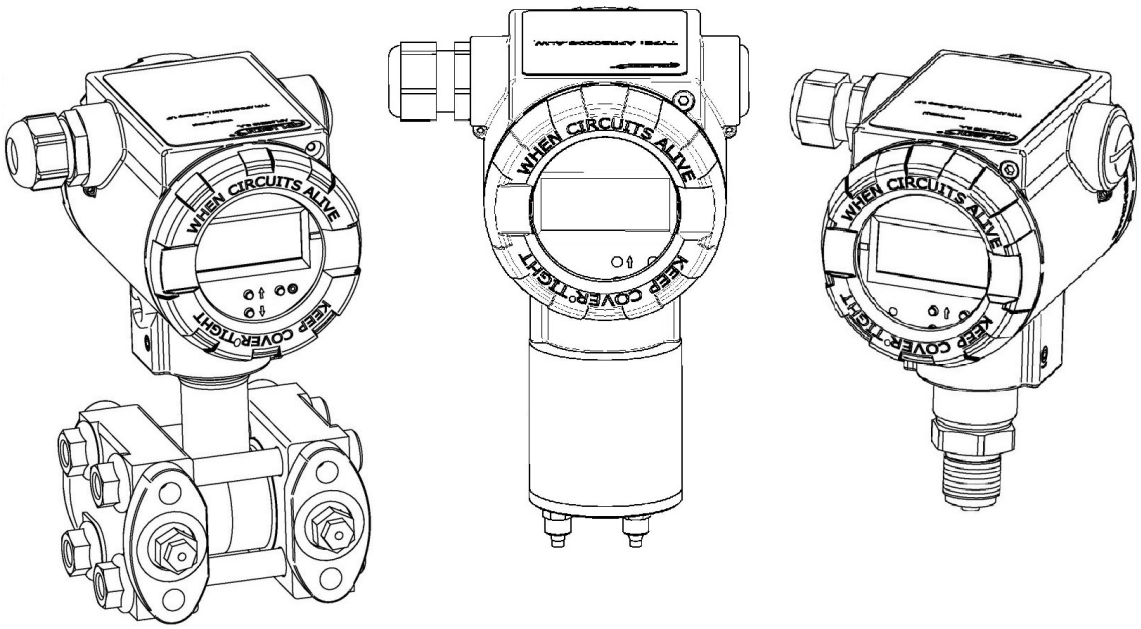
IOM-D21-D31-EX IS-A: NOV 2019

Delta Mobrey

USER'S MANUAL

PRESSURE AND DIFFERENTIAL PRESSURE TRANSMITTERS

D21, D31, D35, D34, D45



Delta Mobrey Ltd
Hudson House, Albany Park Camberley Surrey, GU16 7PL, UK.
+44(0) 1252 729 140, fax +44(0)1252 729 168
www.delta-mobrey.com, e-mail: sales@delta-mobrey.com

Symbol	Description
	Warning to proceed strictly in accordance with the information contained in the documentation in order to ensure the safety and full functionality of the device.
	Information particularly useful during installation and operation of the device.
	Information particularly useful during installation and operation of an Ex type device.
	Information on disposal of used equipment.

BASIC REQUIREMENTS AND SAFE USE

The manufacturer will not be liable for damage resulting from incorrect installation, failure to maintain suitable technical condition of the device, or use of the device other than for its intended purpose.

Installation should be carried out by qualified staff having the required authorizations to install electrical and I&C equipment. The installer is responsible for performing the installation in accordance with this manual and with the electromagnetic compatibility and safety regulations and standards applicable to the type of installation.

In systems with I&C equipment, in case of leakage, there is a danger to staff due to the medium under pressure. All safety and protection requirements must be observed during installation, operation and inspections.

If a device is not functioning correctly, disconnect it and send it for repair to the manufacturer.

In order to minimize the risk of malfunction and associated risks to staff, do not install or use the device particularly unfavourable conditions, where the following dangers occur:

- possibility of mechanical impacts, excessive shocks and vibration;
- excessive temperature fluctuation;
- condensation of steam, dust, ice.

Changes made to the production may be introduced before the paper version of the user's manual is updated. The up-to-date user's manual is available on the manufacturer's website: www.delta-mobrey.com.

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1. INTRODUCTION

1.1. Purpose of the document

The scope of this manual is smart pressure transmitters **D21** and smart differential pressure transmitters **D31, D34, D35** (hereinafter referred jointly to as transmitters) in flameproof version Exd and in intrinsically safe version and in flameproof version, marked with Exi and Exd. This manual contains data, tips and recommendations for safe installation and operation of transmitters, as well as proceeding in case of possible failure.

Please refer to the Technical Information IOM-D21-D31EX IS-A:NOV 2019 containing detailed technical data, parameters and recommendations for operation, installation and maintenance of the transmitters.

In case of Ex types of the device, it is mandatory to read Explosion-proof Device Manual IOM-D21-D31-EX D-A:2019, containing detailed data concerning the Ex transmitters.

1.2. Symbols used

The information which is particularly relevant and useful from the point of view of the user is additionally marked with special symbols. Descriptions of the individual symbols are available on the page of this User's Manual – see (➔ Symbols used).

1.3. Trademarks

HART® is a registered trademark of FieldComm Group.
Windows® – is a registered trademark of Microsoft Corporation.

1.4. Definitions and abbreviations

Table 1. Definitions and abbreviations.

Item no.	Abbreviation	Meaning
1	**LRV**	"Lower Range Value" – the value of the set range expressed in physical units corresponding to the current of 4.000mA, i.e. 0% of the output setpoint. The set range cannot exceed the set range limits. The minimum width of the set range **|(URV-LRV)|** is limited to 10% of the base range **(URL-LRL)**.
2	**URV**	"Upper Range Value" — the value of the set range expressed in physical units corresponding to the current of 20.000mA, i.e. 100% of the output setpoint. The set range cannot exceed the set range limits. The minimum width of the set range **|(URV-LRV)|** is limited to 10% of the base range **(URL-LRL)**.
3	**LRL** **LSL**	"Lower Range Limit" or "Lower Sensor Limit" – lower limit of set range expressed in physical units. Value **(URL-LRL)** or **(USL-LSL)** is referred to as the base transmitter range.
4	**URL** **USL**	"Upper Range Limit" or "Upper Sensor Limit" – upper limit of set range expressed in physical units. Value **(URL-LRL)** or **(USL-LSL)** is referred to as the base transmitter range.
5	**LPL**	"Lower Processing Limit" – lower limit of digital processing of measured value. The transmitter processes a digital measurement up to 50% of the base range width below the lower limit of set range **LRL (LSL).** After reaching the **LPL** and when below this value up to **LSAL**, the transmitter freezes the refreshing of digital value of the measurement. In this situation, message "UndEr" will be displayed on the display and diagnostic alarm mode will be activated depending on the settings I_AL < 3.650 mA or I_AL > 21.500 mA. Additionally, collective status PV_OUT_OF LIMITS and status PV_LOW_LIMITED in the Transducer Block will be set, which can be read out in the diagnostic tab via HART communication.
6	**UPL**	"Upper Processing Limit" – upper limit of digital processing of measured value. The transmitter processes a digital measurement up to 50% of the base range width above the upper limit of set range **URL (USL).** After reaching the **UPL** and when above this value up to **USAL**, the transmitter freezes the refreshing of digital value of the measurement. In this situation, message "OvEr" will be displayed on the display and diagnostic alarm mode will be activated depending on the settings I_AL< 3.650 mA or I_AL > 21.500 mA. Additionally, collective status PV_OUT_OF LIMITS and status PV_HIGH_LIMITED in the Transducer Block will be set, which can be read out in the diagnostic tab via HART communication.
7	**LSAL**	"Lower Saturation Limit" – lower limit of the A/D transmitter processing range. The lower limit of the A/D transmitter saturation is on the pressure/differential pressure scale below the **LPL** point and is associated with the minimum pressure, at which the analogue-digital pressure measurement transmitter reaches the lower limit of the processing capacity. The exact determination of this pressure is not possible, however usually the pressure does not exceed the pressure corresponding to 200% of the base range width **(URL-LRL)** below the lower limit of the digital processing of measured **LPL** value. After reaching **LSAL** and when below this value, error number E0256 will be displayed and the diagnostic alarm mode will be activated depending on the settings I_AL < 3.650 mA or I_AL > 21.500 mA. Additionally, collective status SENSOR_FAULT, PV_OUT_OF LIMITS, status NOREF+ERR@AIN1_AD7794 in the Sensor Block and PV_LOW_LIMITED in the Transducer Block will be set, which can be read out in the diagnostic tab via HART communication.
8	**USAL**	"Upper Saturation Limit" – upper limit of the A/D transmitter processing range. The upper limit saturation point of A/D transmitter is on the pressure/differential pressure scale above the **UPL** point and is associated with the maximum pressure at which the analogue-digital pressure measurement transmitter reaches the upper limit of the processing capacity. The exact determination of this pressure is not possible, however usually the pressure does not exceed the pressure corresponding to 200% of the base range width **(URL-LRL)** above the upper limit of the digital processing of measured **UPL** value. After reaching **USAL** and when above this value, error number E0256 will be displayed and the diagnostic alarm mode will be activated depending on the settings I_AL < 3.650 mA or I_AL > 21.500 mA. Additionally, collective status SENSOR_FAULT, PV_OUT_OF LIMITS, status NOREF+ERR@AIN1_AD7794 in the Sensor Block and PV_HIGH_LIMITED in the Transducer Block will be set, which can be read out in the diagnostic tab via HART communication.
9	**AL_L**	Low current alarm (I < 3.650 mA).

10	**AL_H**	High current alarm (I > 21.500 mA).
11	**I_AL**	The alarm current set by the transmitter controller in the current loop.

1.5. Transmitter set range

The figure below shows the transmitter set range and limits related to allowable set range, digital processing range and saturation limits of A/D pressure measurement transducer. As standard, values of 4 mA/20 mA currents are assigned to LRV/URV points. In order to obtain reverse characteristics, it is possible to reverse the assignment so that the LRV/URV points are assigned to 20 mA/4 mA currents. Therefore, the description in the figure below takes into account this situation by identifying a point corresponding to 4 mA as LRV/URV. For a point of 20 mA, the designation is URV/LRV.

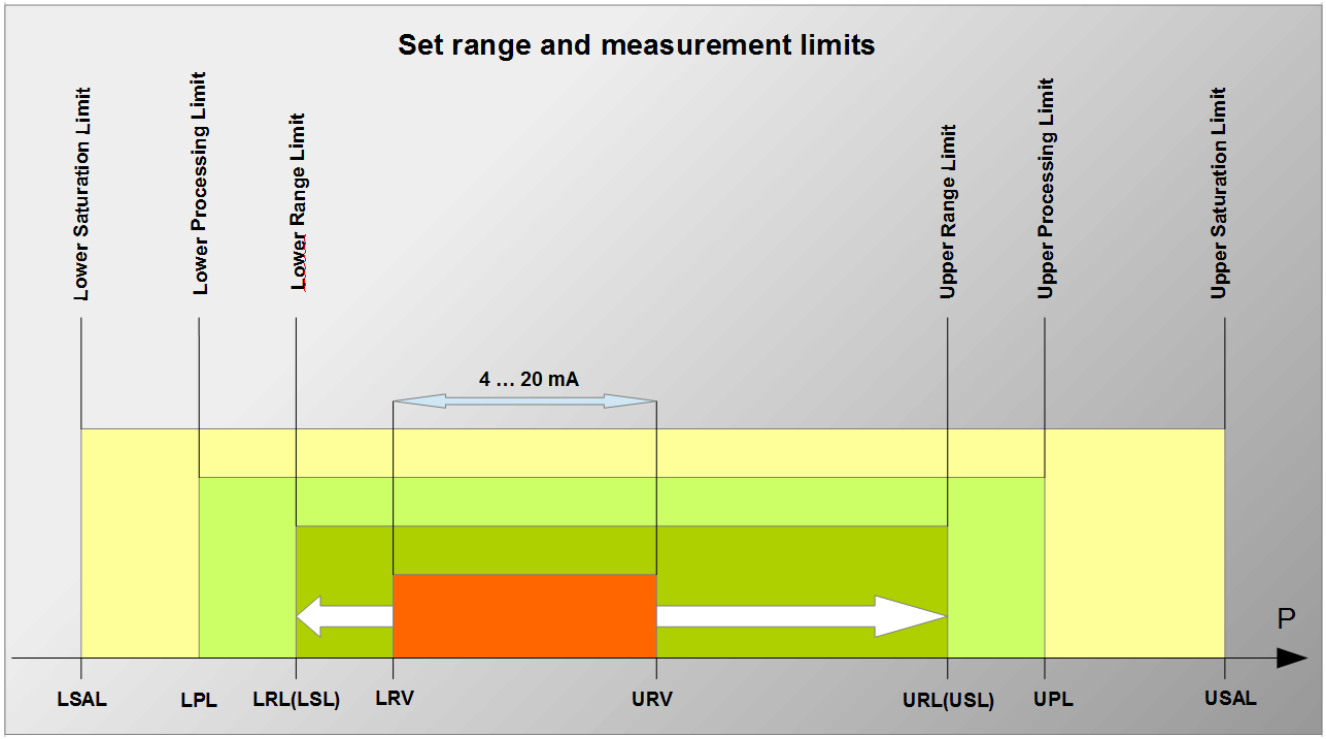
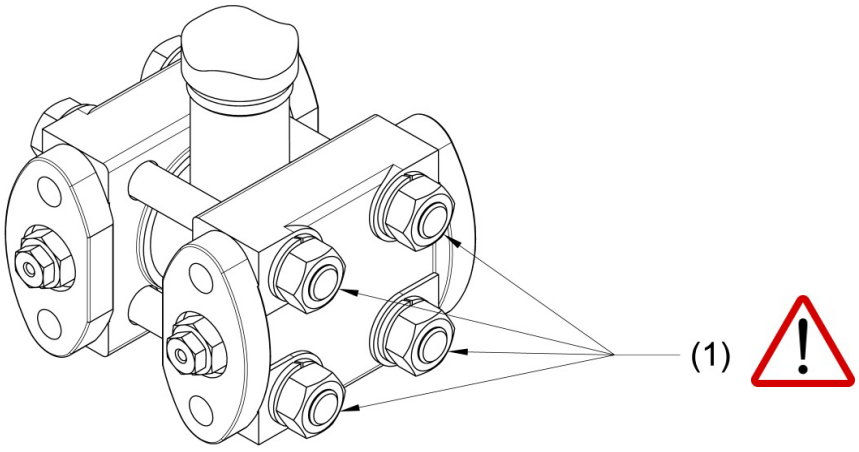


Figure 1. Set range and measurement limits.

2. SAFETY

- The installation and start-up of the device and any operations related to operation shall be carried out after thorough examination of the contents of this Manual and the instructions related thereto;
- installation and maintenance should be carried out by qualified staff having the required authorizations to install electrical and measuring devices;
- the device shall be used according to its intended purpose (➔ Intended use and features) in line with the permissible parameters specified on the nameplate (➔ Transmitter identification);
- the protecting elements used by the manufacturer may be less effective if the device is operated in a manner not consistent with its intended purpose;
- before installing or disassembling the device, it is absolutely necessary to disconnect it from the power source;
- no repairs or alterations to the transmitter electronic system are permitted. Assessment of damages and possible repair may only be performed by the manufacturer;
- do not use instruments if damaged. In case of failure, the device must be put out of operation;
- in case of transducers equipped with factory-mounted process connector of C and CR type, it is unacceptable to loosen the fixing screws of the connector cover (item 1). Any tampering will result in a loss of warranty.



3. LIST TO CHECK COMPLETENESS OF DELIVERY

With the transmitter the user receives the following:

a) Certificate of the Product, which also constitutes a guarantee card.
b) User's Manual IOM-D21-D31-EX IS-A: NOV 2019
c) Copies of certificates (on request).
d) Declaration of conformity (on request).
e) Copies of certificates (on request).

Additionally, in the case of Ex type transmitters:

f) Manual of Explosion-proof Variant IOM-D21-D31-EX D-A:2019

Items b)–d) are available at www.delta-mobrey.com
On the manufacturer's website you can also find:

g) Technical Information IOM-D21-D31-EX IS-A: NOV 2019

4. TRANSPORT AND STORAGE

4.1. Delivery check

After receiving the delivery of the equipment, it is necessary to:

- make sure that the packaging and its contents were not damaged during transport;
- check the completeness and correctness of the received order, and make sure no parts are missing.

4.2. Transport

Transport of transmitters shall be carried out with the use of covered means of transport, in original packages or process connectors (with diaphragm provided with protection during transport). The packaging shall be protected against movement and direct impact of atmospheric factors.

- The housing, diaphragm and capillaries may be subject to damage; in such a case, there is a risk of injury from damaged components.
- It is not allowed to use capillaries as additional support for diaphragm separators.

4.3. Storage

Transmitters shall be stored in a factory packaging, in a roofed room, without vapours and aggressive substances. They shall be also protected against mechanical impact.

Allowable range of storage temperature:
-40 ... 85 °C (-40 ... 185 °F).

5. GUARANTEE

The manufacturer shall provide the guarantee under the terms and conditions specified in the Certificate of Product, which also constitutes a guarantee card.

The guarantee shall be repealed if the device is used in against its intended use, failure to comply with this User's Manual, operation of the device by unqualified personnel or interference with the structure of the device.

6. IDENTIFICATION

6.1. Manufacturer's address

Delta Mobrey Limited
Hudson House
Albany Park
Camberley
Surrey GU16 7PL
www.delta-mobrey.com

6.2. Transmitter identification

Each transmitter is equipped with a nameplate showing the following data:

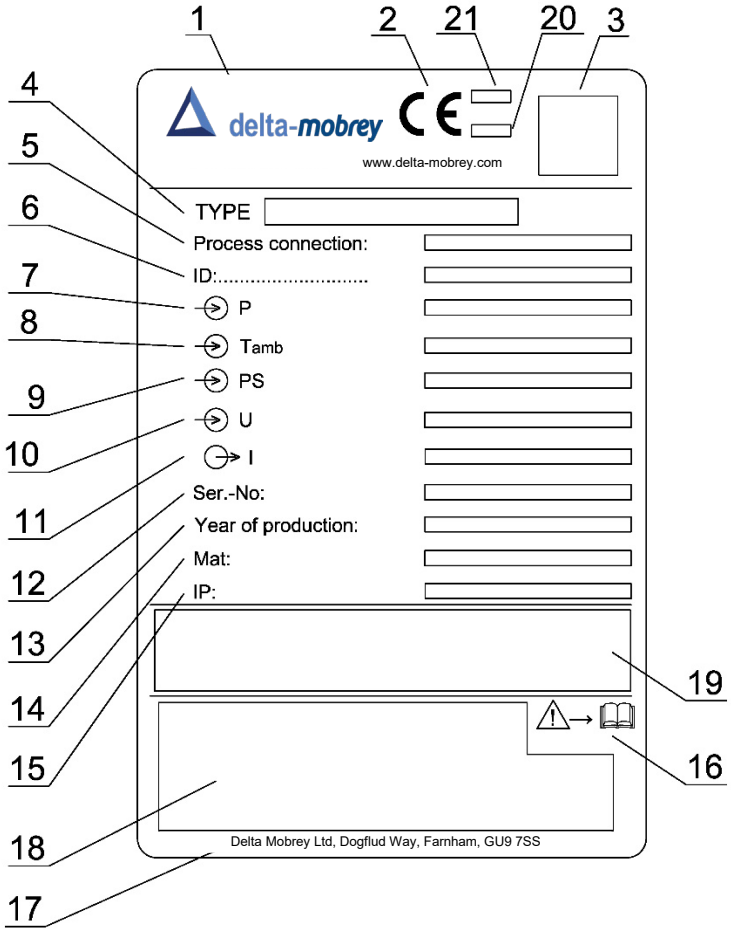


Figure 2. Nameplate – graphic version.

1. Logo and name of manufacturer.
2. CE mark.
3. Product code.
4. Transmitter type.
5. Type of process connector.
6. Transmitter ID model.
7. Base range.

8. Permissible range of ambient temperature.
9. Maximum static pressure.
10. Value of supply voltage.
11. Output signal.
12. Transmitter serial number.
13. Year of manufacture.
14. Material of wetted parts.
15. IP protection rating.
16. Note about the obligation to read the manual.
17. Manufacturer's address.

    Additionally the specific types of transmitters have the following data:

18. Designation of the explosion-proof type, designation of a certificate – for transducers with ATEX and/or IECEx certificate.
19. Data provided in case of types compliant with other directives and certificates.
20. Number of the notified body for transmitters with ATEX certificate.
21. Number of the notified body for transmitters with different certificates.

6.3. Identification of sensor/measuring head type

The head of each transmitter is marked on the housing with a number providing its clear and unambiguous identification.

6.4. CE mark, declaration of conformity

The device has been designed to meet the highest safety requirements. It has been tested and was shipped from the factory in a condition that is safe for operation. The device complies with the applicable standards and regulations listed in the EU Declaration of Conformity, and therefore complies with the statutory requirements of EU directives. Delta-Mobrey Limited. confirms the compliance of test results of the device with the requirements by placing the CE mark on it.

7. Construction

The basic components of the transmitter include two-chamber housing with microprocessor processing unit and an anti-interference filter in separate chambers and a measuring head.

7.1. Intended use and features

Pressure transmitters D21 and differential pressure transmitters D31, D34, D35 are designed for measurements in industrial automation systems, where the processed values of pressures (over- and under pressure) or absolute and differential pressures for: gases, steam and liquids are used.

Transmitters are equipped with a variety of different types of process connectors. Depending on the application and the medium measured, they can be installed with direct or distance separators, manifold valve or shut-off valve. This allows for measurement of various media such as: viscous, aggressive media and media at high and low temperatures.

The D35 transmitters are equipped with a number of different types of separators. Depending on the application and the medium being measured, the transmitters are installed with direct or distance separators. This makes it possible to measure various media, such as dense, aggressive media, as well as high and low temperature media.

The D34 transmitters are designed for measuring pressure, under and differential pressure of non-aggressive gases. Typical applications are measurements of blast pressure, chimney drafts, pressure or under pressure in combustion chambers.

Transmitters provide output signal 4...20 mA (20…4 mA in an inverted system), in a two-wire power supply system (current loop). Communication with the transmitter is ensured by using modulation FSK BELL202 with HART 5.1 or HART 7 protocol.

The configuration of the transmitters is performed by using:

- local keypad;
- DKAP03 or other type communicator using DDL libraries;
- computer with D-Soft and HART/RS232 or HART/USB converter;
- computer with software using DDL or DTM libraries;

7.2. Transmitter housing

The two chamber housing of transmitters made of high pressure aluminium alloy cast or acid-resistant steel, are closed with bolted-on covers, one of which has a small glass pane.
The housings have an internal and external earth clamp. When the cover of the main plate compartment is unscrewed, it is possible to change the position of the display module by the angle of every 15°. In the other chamber with threaded outlets (1/2NPT or M20x1.5) enabling to mount glands for connection cables, there is an anti-interference filter board with a terminal block.

7.3. Processing unit

The measuring head outputs an electric signal proportional to the pressure and temperature value, which is converted into a digital form and in this form, via an optoelectronic barrier, is transmitted to the main processor, which computes the exact pressure and temperature values. Process variables are displayed on LCD and the pressure value is transformed to 4...20 mA analogue signal. The BELL202 modem and the implemented HART stack Rev. 5.1 or HART stack Rev. 7 allows the transmitter to communicate using HART protocol. The electrical connector of the transmitter is protected by an anti-interference and surge protection filter. Transmitters monitor the operation of their blocks and if malfunctions occur they inform about errors, displaying messages on LCD, simultaneously setting low alarm current in the current loop.

7.4. Measuring head

A measuring element of the head is a piezoresistive silicon sensor separated from the measured medium by a separating diaphragm and dedicated gauge fluid. Pressure transmitter heads are equipped with process connectors. Data on the process connectors are provided in Technical Information IOM-D21-D31-EX IS-A NOV 2019.

7.5. Separators

Separators are used for the measurement of chemically aggressive, dense, food media or media with temperatures exceeding the temperature of the sensor and transmitter. The data of separators are included in the data sheets and in Technical Information IOM-D21-D31-EX IS-A NOV 2019.

8. INSTALLATION

8.1. General recommendations

It is recommended that the impulse tubes are installed at a gradient (not vertically, not horizontally unless the impulse tube is looped). Mount the impulse tubes as short as possible with a sufficiently large diameter, without sharp bends to avoid the possibility of clogging. The configuration of impulse tubes and valve connection system shall be selected taking into account the measurement conditions.

8.1.1. Transmitter installation site

Pressure and differential pressure transmitters can be installed both indoors and outdoors. If the transmitter is to operate in open air, it is recommended that it be placed in a box or under a roof. The location of the transmitter in the facility shall provide access for operators and protection against mechanical exposure.

8.1.2. Low temperature of measuring media

For measurements of pressure of liquids having a solidification temperature above the ambient temperature, it is necessary to provide protection of the measurement system against freezing. This applies especially to the installation of transducers in open air.

Impulse tubes filled, for example, with a mixture of ethylene glycol and water or other liquid with the solidification temperature lower than the ambient temperature, are used as protection. It is also possible to use the available thermal insulation methods. However, it is important to note that the thermal insulation of transmitter and impulse tubes can only protect them against short-term operation at low temperatures. When low temperatures continue for long time, the transmitter and impulse tubes must be heated.

8.1.3. High temperature of measuring media

For transmitters the temperature of pressure sensor in the measuring head must not exceed +85 °C. Sufficiently long impulse tubes shall be used additionally as a protection of the measuring head against temperature higher than +85 °C, or if not possible, separators with radiator to dissipate heat and reduce the temperature of the transmitter measuring head are to be used. More information in Technical Information IOM-D21-D31-EX IS-A NOV 2019.

8.1.4. Mechanical vibrations, surge

Transmitters are resistant to vibrations of the installation site. Where excessive vibrations may occur, the transmitters shall be insulated using flexible impulse tubes or other place of installation should be selected and distance separators should be used. More information in Technical Information.

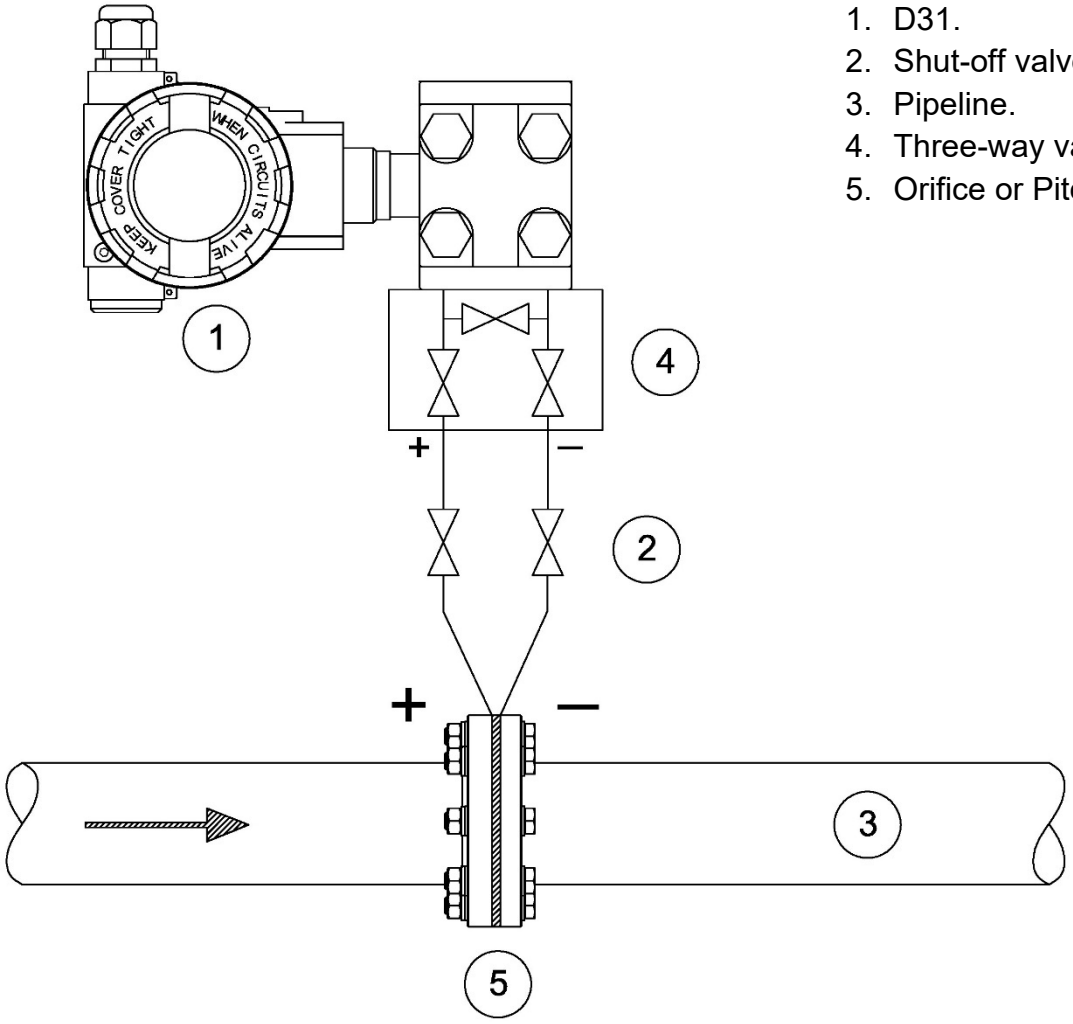
If there is a risk of exposure to impacts with heavy objects, which in extreme cases may lead to the breakage of a part of the system with the transmitter and the leakage of the medium, for safety reasons and to prevent sparking as well as damage to the transmitter it shall be necessary to use appropriate shields or other protection measures, or avoid installation of transmitters in such places.

8.2. Mounting and connection of mechanical transmitters

8.2.1. Gas and steam flow rate measurement system

Measurement of gas flow rate

Transmitter D31 must be installed above the measuring point so that the condensate can flow out of the process capillaries.

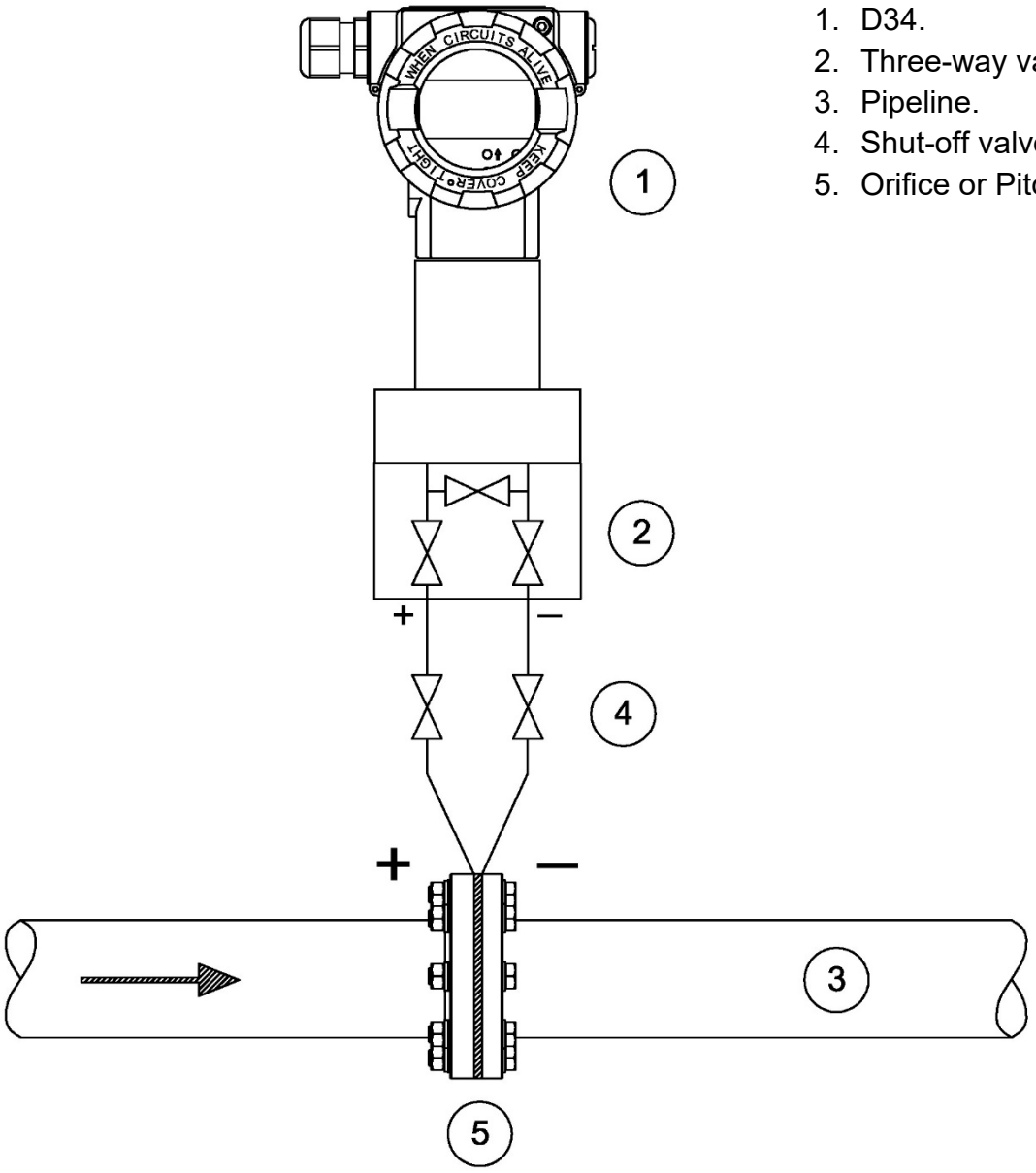


1. D31.
2. Shut-off valves.
3. Pipeline.
4. Three-way valve.
5. Orifice or Pitot tube.

Figure 3. Gas flow rate measurement system using D31.

Measurement of gas flow rate of low pressure

Transmitter D34 must be installed above the measuring point so that the condensate can flow out of the process capillaries.

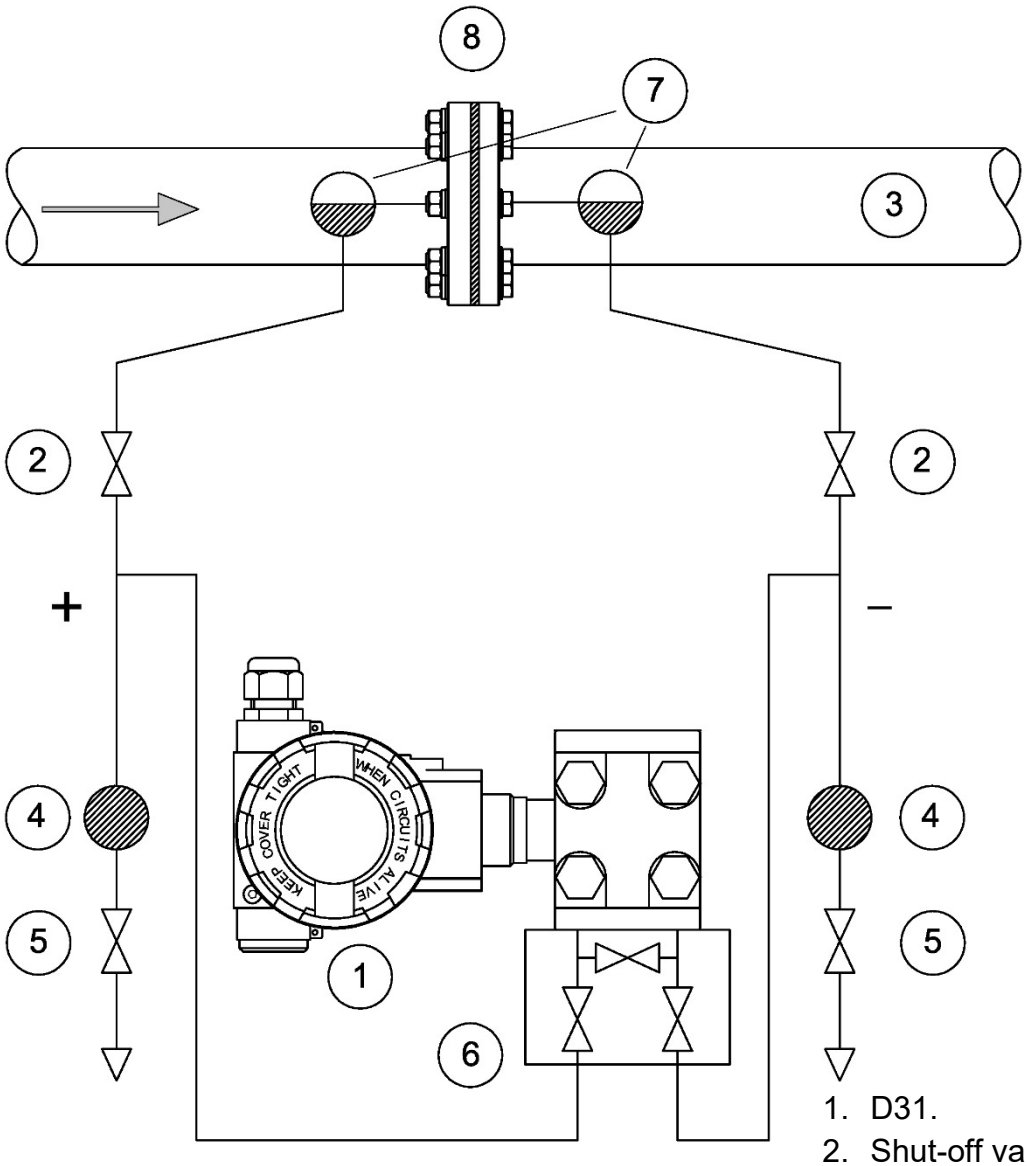


1. D34.
2. Three-way valve.
3. Pipeline.
4. Shut-off valve.
5. Orifice or Pitot tube.

Figure 4. Measurement system of **gas flow** rate of low pressure using D34.

Measurement of steam flow rate

Transmitter D31 must be installed below the measuring point.
Traps (siphons) should be located at the same level as the sampling points and at the same distance from the transmitter.
Before turning the device on fill the impulse tubes up to the height of condensate traps.

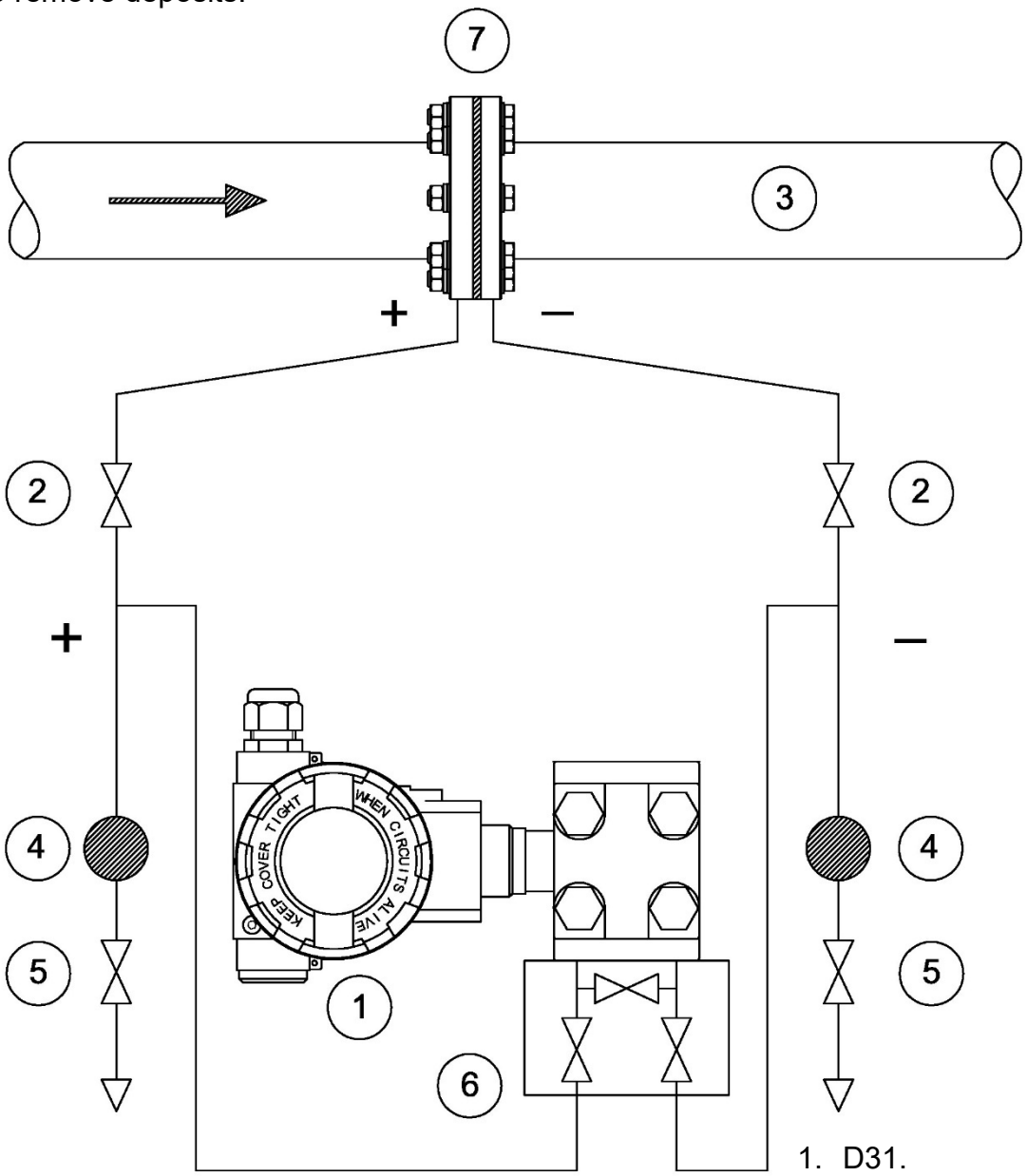


1. D31.
2. Shut-off valves.
3. Pipeline.
4. Separators.
5. Drain valves.
6. Three-way valve.
7. Traps (condensate traps).
8. Orifice or Pitot tube.

Figure 5. Steam flow rate measurement system using D31

8.2.2. Liquid flow rate measurement system

Transmitter D31 must be mounted below the measuring point so that the impulse tubes are always filled with liquid and the gas bubbles can freely escape to the process pipe.
If the measured medium contains particles, it is useful to install separators and drain valves to remove deposits.

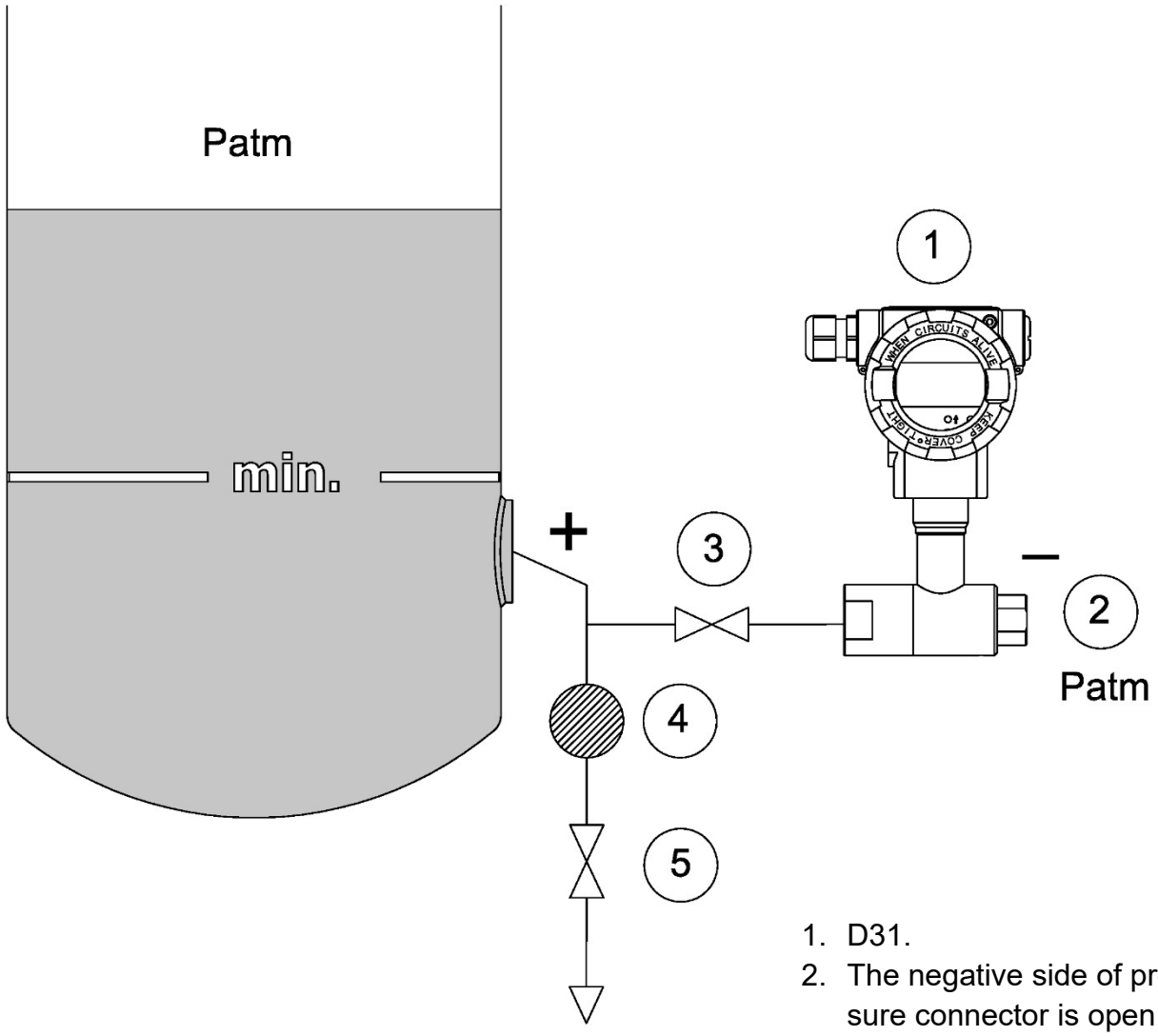


1. D31.
2. Shut-off valves.
3. Pipeline.
4. Separators.
5. Drain valves.
6. Three-way valve.
7. Orifice or Pitot tube.

Figure 6. Liquid flow rate measurement system using D31.

8.2.3. Liquid level measurement system in open tanks

Transmitter D31 must be mounted below the measuring point so that the impulse tubes are always filled with liquid.
The negative side of pressure connector is open to the atmosphere.
If the measured medium contains particles, it is useful to install separators and drain valves to remove deposits.

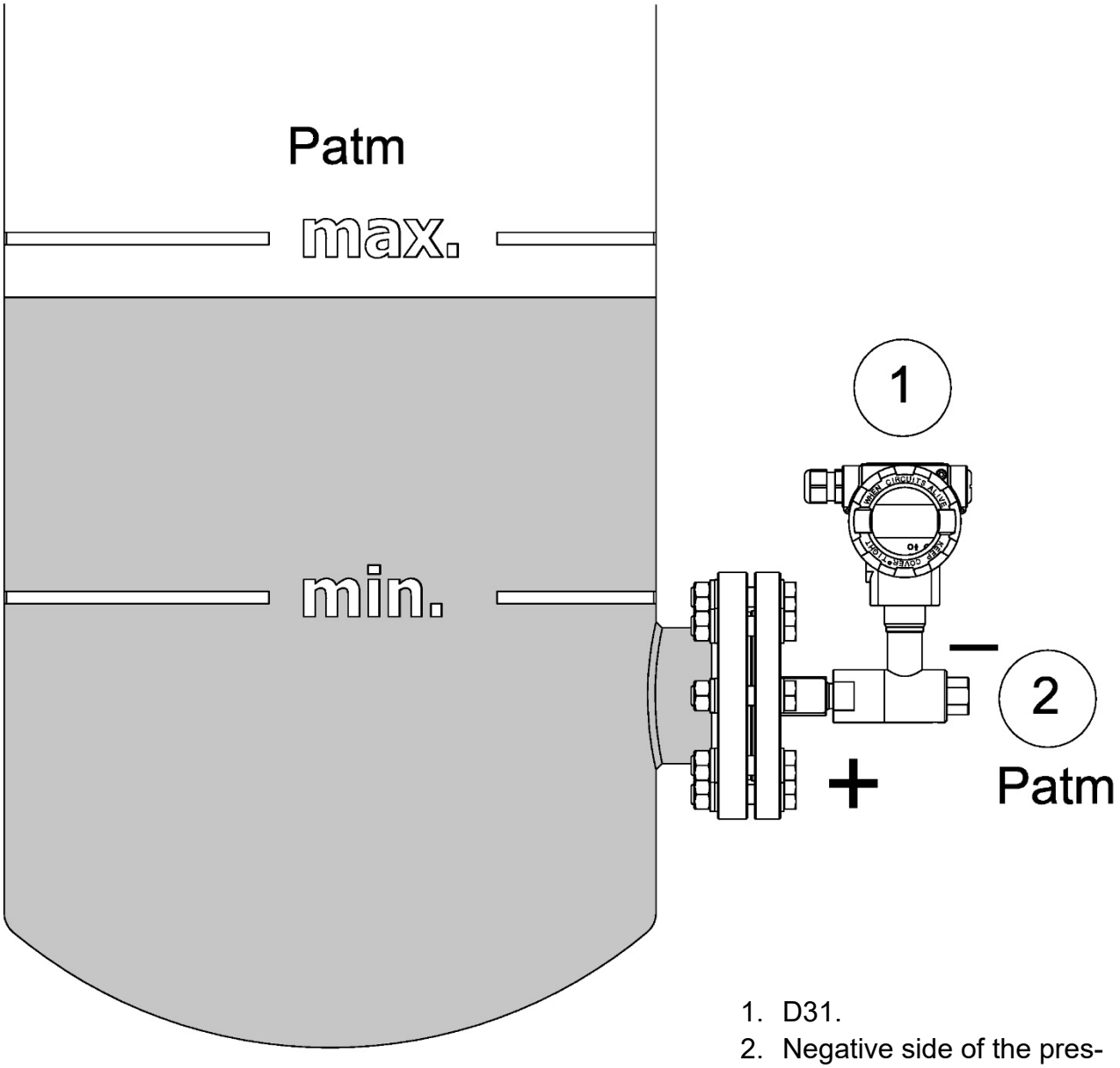


1. D31.
2. The negative side of pressure connector is open to atmosphere.
3. Shut-off valve.
4. Separators.
5. Drain valves.

Figure 7. System of **liquid level** measurement in open tanks using D31.

Liquid level measurement system in open tanks with the use of direct separator

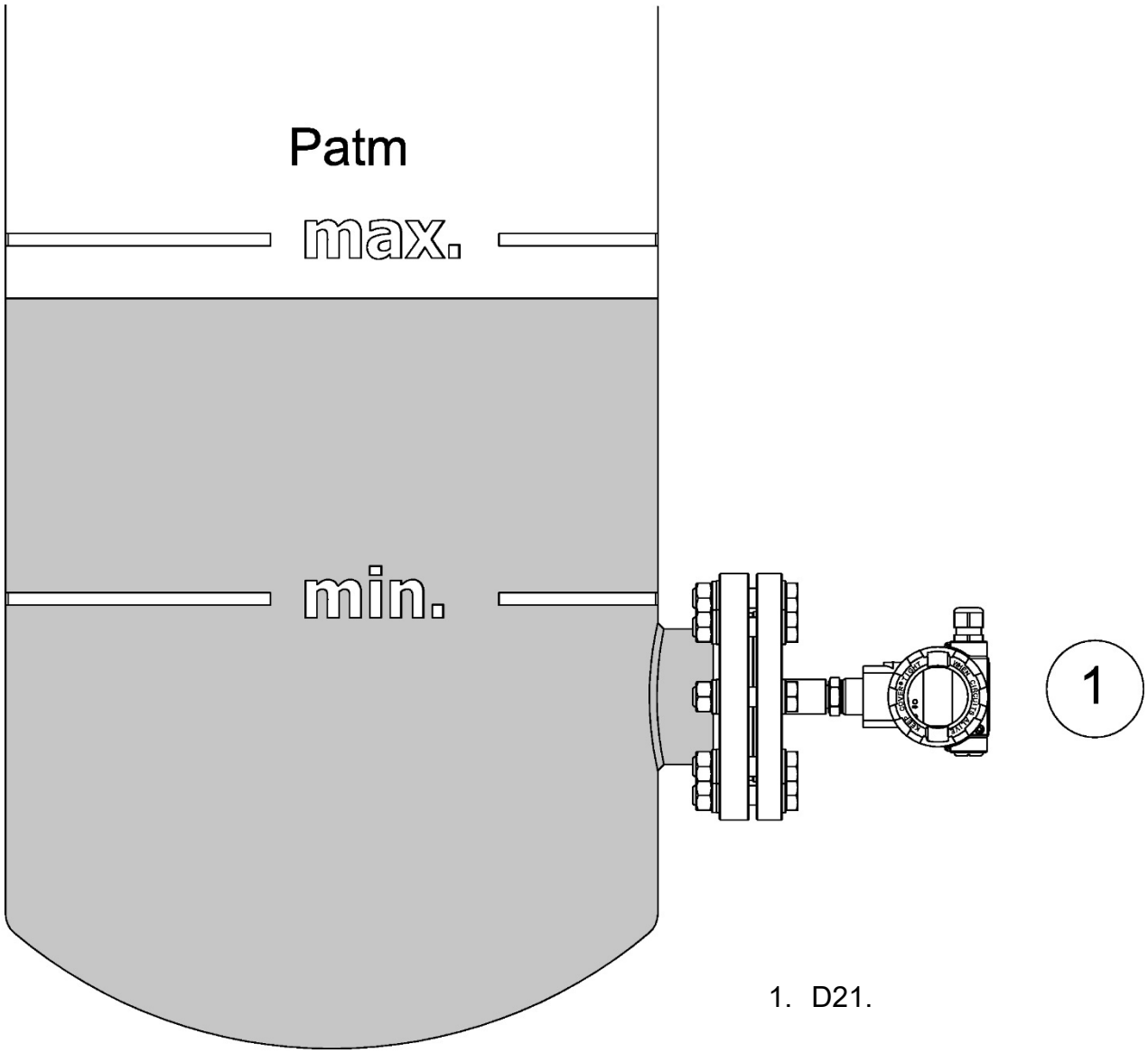
Transmitter D31 shall be mounted directly into the tank using an integrated separator always below the minimum liquid level.



1. D31.
2. Negative side of the pressure connector is open to the atmosphere.

Figure 8. Liquid level measurement system in open tanks using D31 with direct separator.

Transmitter D21 shall be mounted directly into the tank using an integrated separator always below the minimum liquid level.



1. D21.

Figure 9. Liquid level measurement system in open tanks using D21 with direct separator.

8.2.4. Liquid level measurement system in closed tanks

Transmitter D31 must be mounted below the measuring point so that the impulse tubes are always filled with liquid.
The negative side of pressure connector must be connected through a capillary tube always above the maximum liquid level.
If the measured medium contains particles, it is useful to install separators and drain valves to remove deposits.

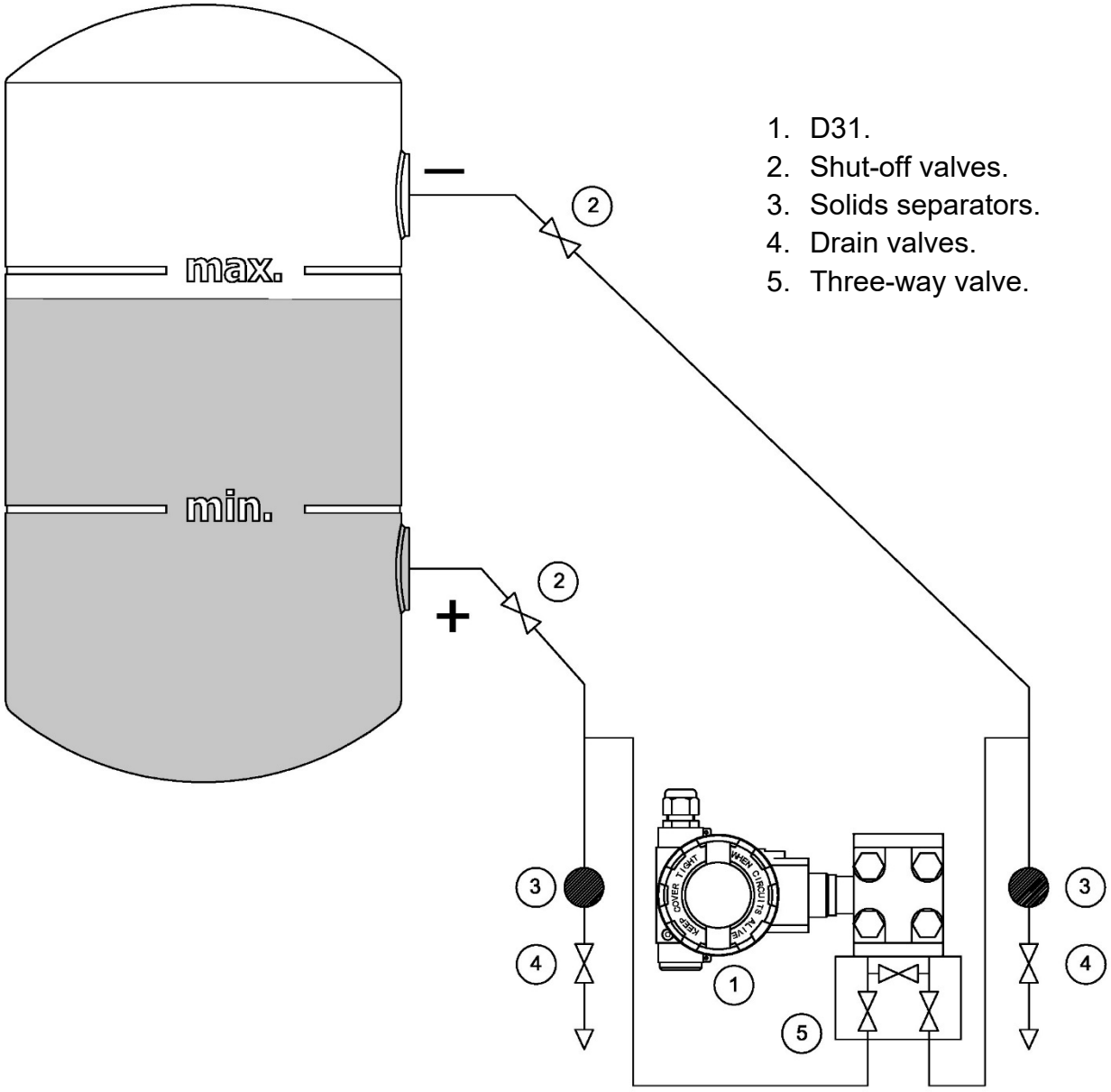


Figure 10. System of **liquid level** measurement in closed tanks using D31.

Liquid level measurement system in closed tanks with the use of direct separator

Transmitter D31 must be mounted directly into the tank using an integrated separator.
The negative side of pressure connector must be connected through a capillary tube always above the maximum liquid level.
If the measured medium contains particles, it is useful to install separators and drain valves to remove deposits.

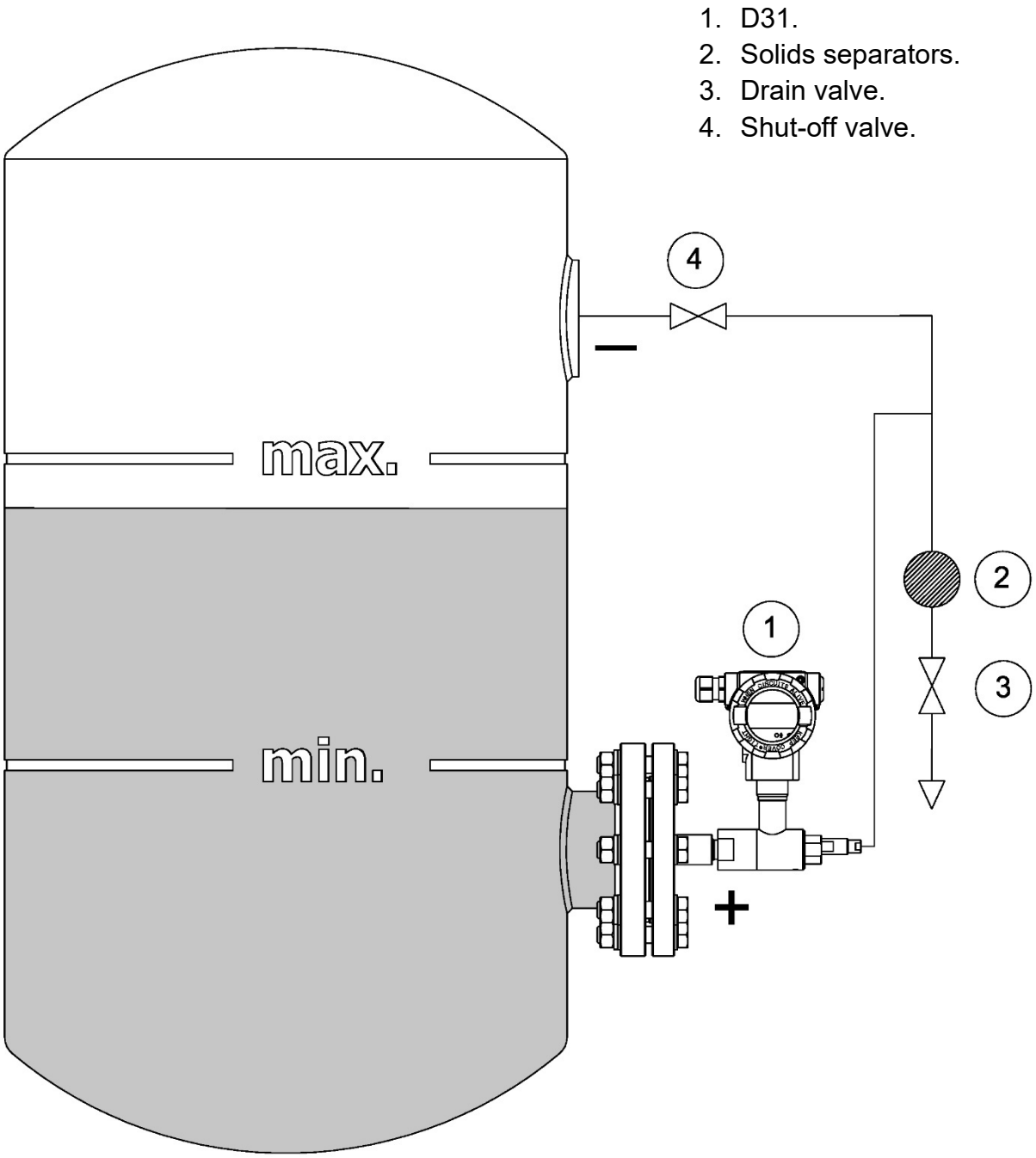


Figure 11. System of **liquid level** measurement in closed tanks using D31 and direct separator.

Liquid level measurement system in closed tanks with the use of distance separators

Transmitter D35 must be installed below the mounting points of distance separators.
Approximate ambient temperature in both capillaries connecting the transmitter with separators must be ensured.
The correct measurement is ensured only between the upper edge of the lower separator and the lower edge of the upper separator.

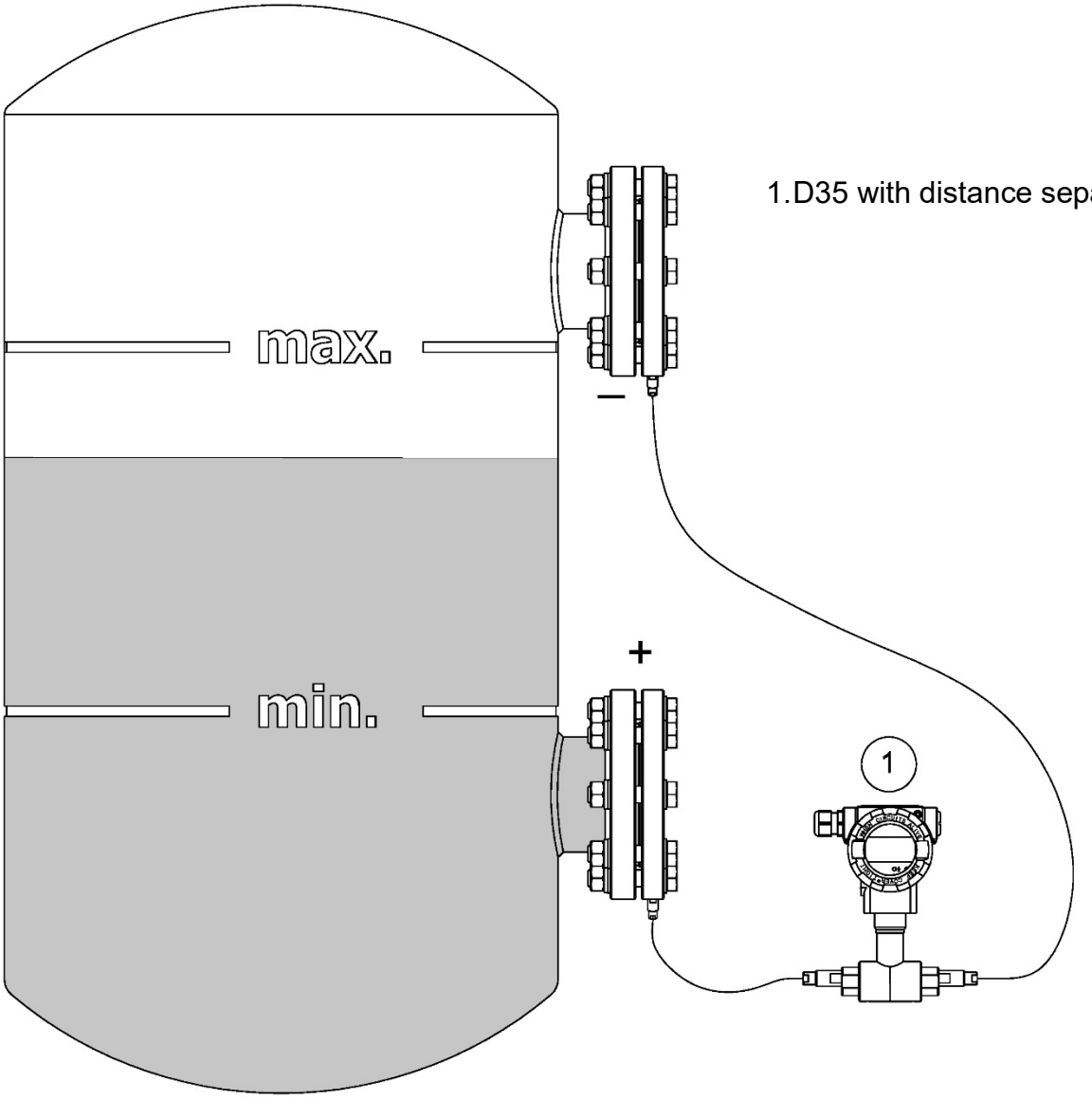


Figure 12. System of **liquid level** measurement in closed tanks using D35 and distance separators.

Liquid level measurement system in closed tanks with the use of direct and distance separator

Transmitter D35 must be mounted directly into the tank using an integrated separator.
The negative side of pressure connector must be connected through a distance separator always above the maximum liquid level.

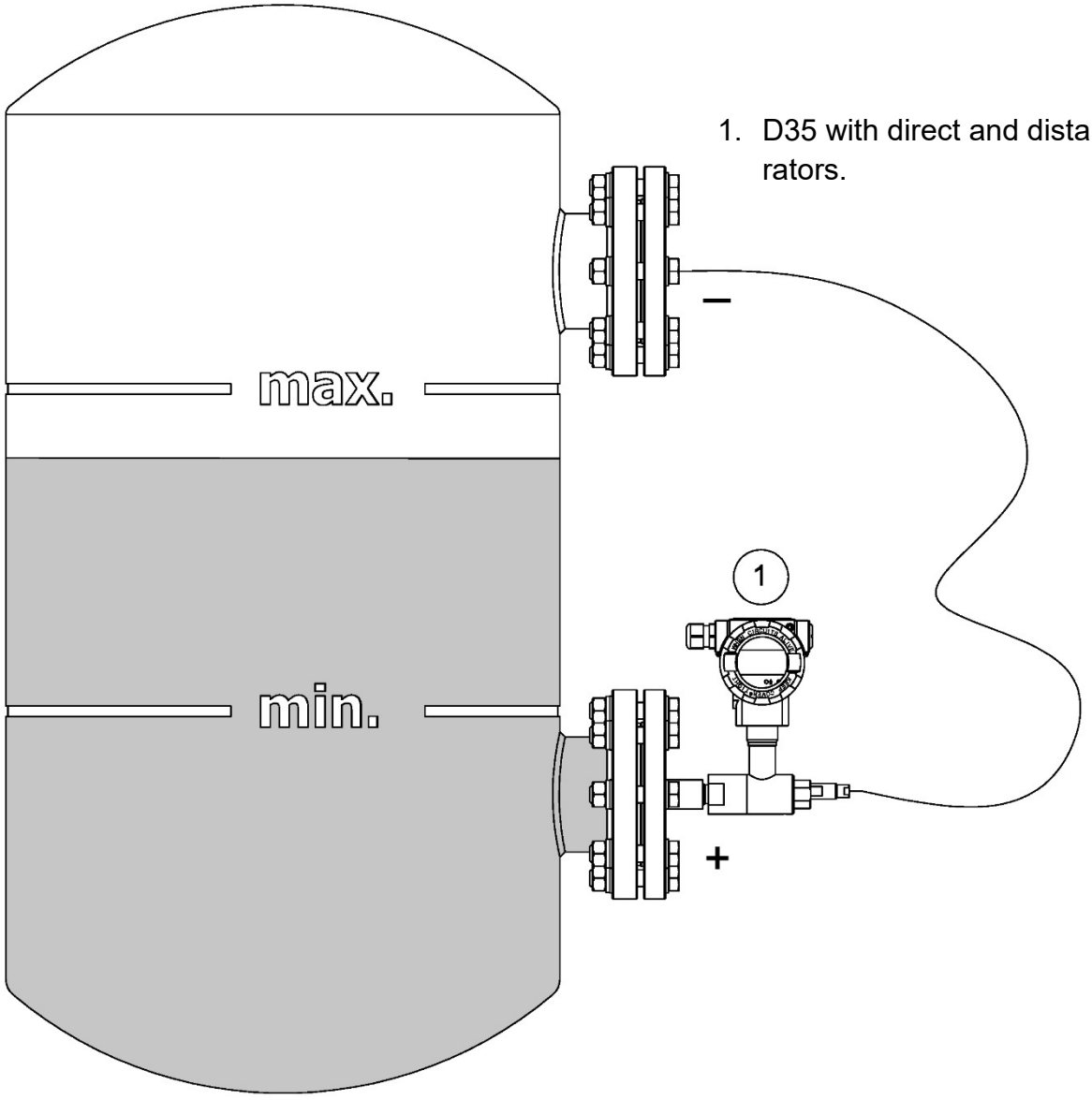


Figure 13. System of **liquid level** measurement in closed tanks using D35 with direct and distance separator.

Liquid level measurement system in closed tanks with steam cushion

Transmitter D31 must be mounted below the measuring point so that the impulse tubes are always filled with liquid.
The negative side of pressure connector must be connected through a capillary tube always above the maximum liquid level.
If the measured medium contains particles, it is useful to install separators and drain valves to remove deposits.

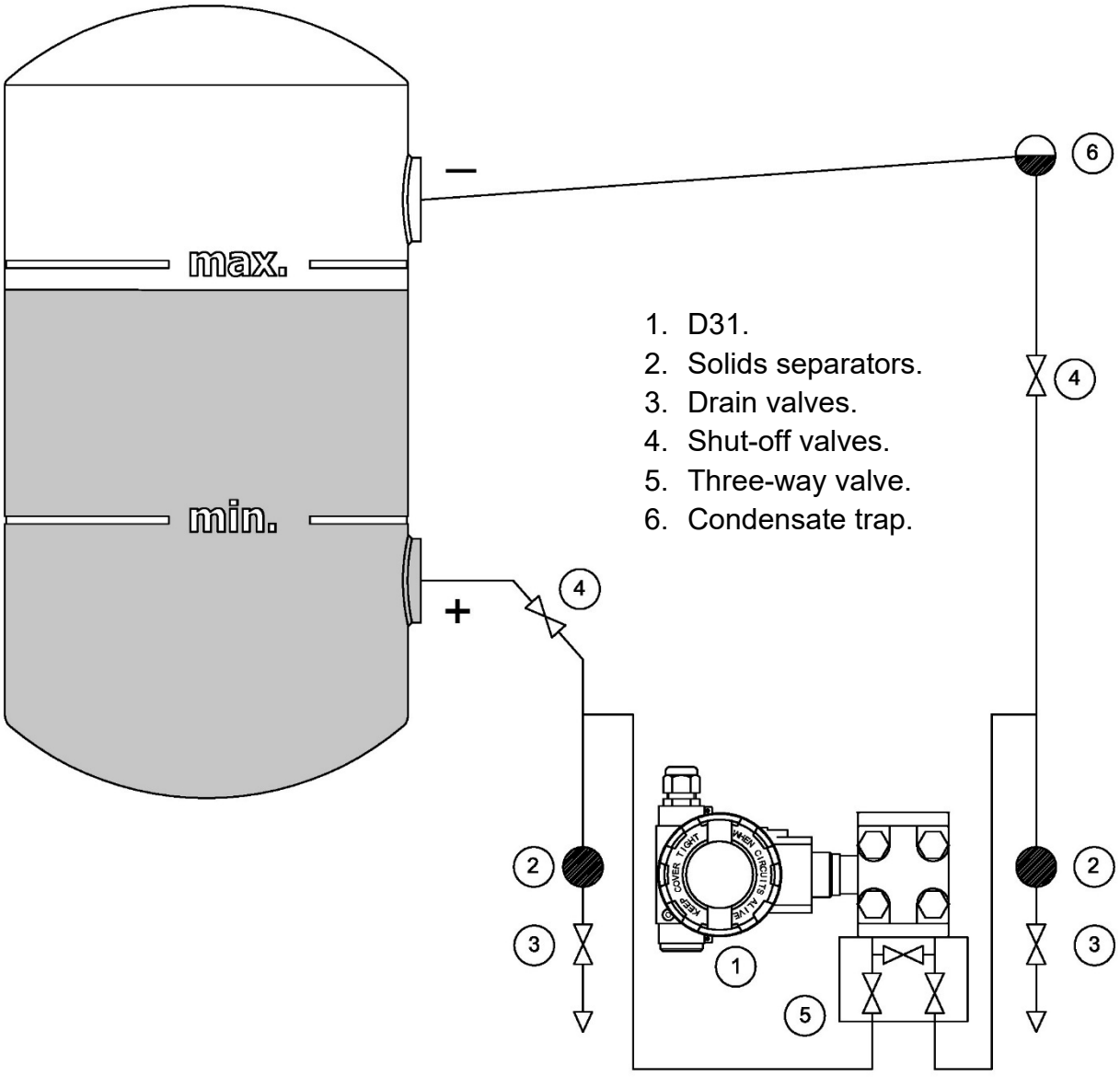


Figure 14. Liquid level measurement system in closed tanks with steam cushion using D31.

Liquid level measurement system in closed tanks with steam cushion with the use of direct separator

Transmitter D31 must be mounted directly into the tank using a direct separator.
The negative side of pressure connector must be connected through a capillary tube always above the maximum liquid level.
Condensate trap ensures constant pressure from the negative process pressure side.
When measuring medium contains solid particles, it is useful to install a separator and drain valve to remove deposits.

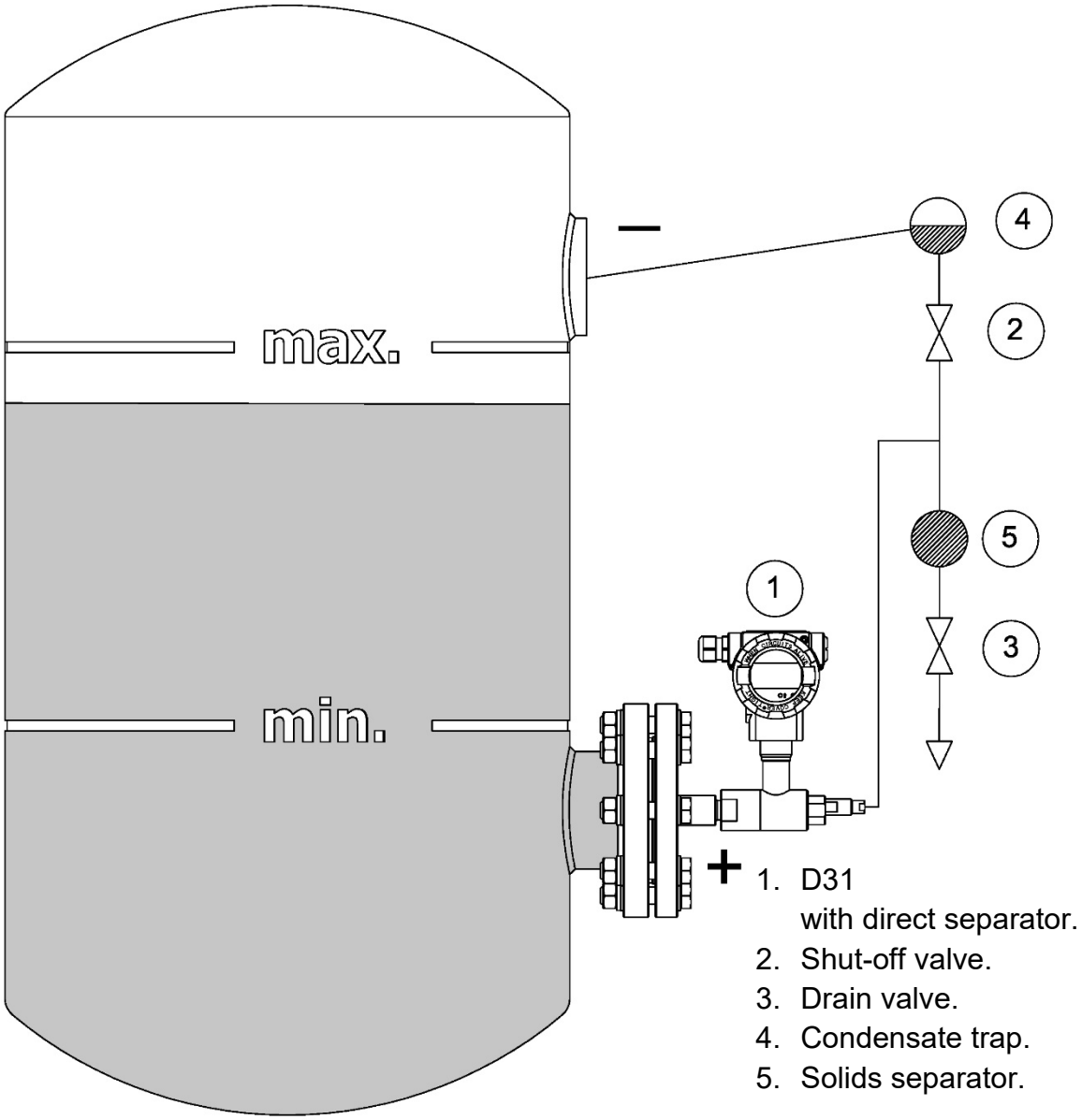


Figure 15. Liquid level measurement system in closed tanks with steam cushion using D31 with direct separator.

Liquid level measurement system in closed tanks with D45 level probe

The measurement is carried out using a D35 Differential Pressure transmitter with special chemical seal, enabling compensation for the static pressure in the tank. The value processed is the hydrostatic pressure of the medium measured at the level of the diaphragm of the lower level.

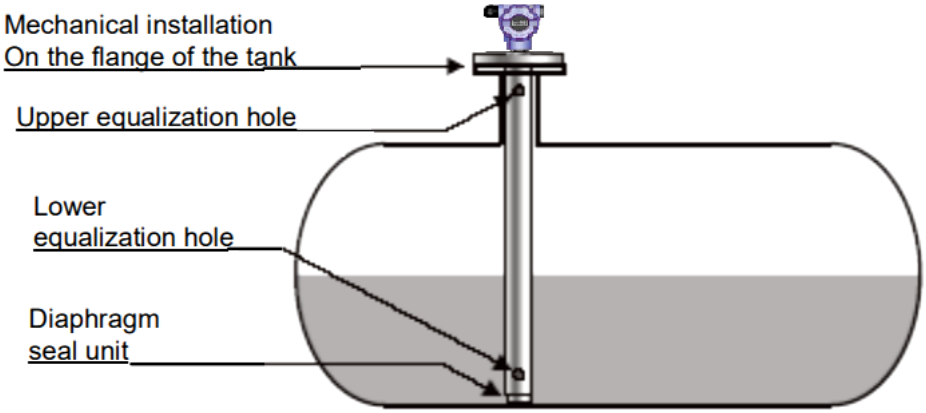
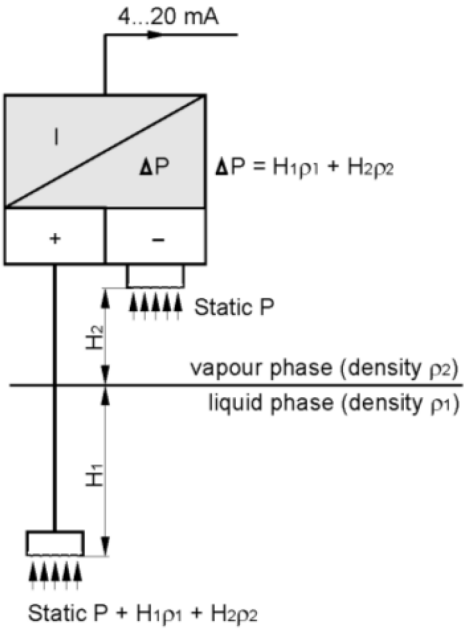


Figure16. Liquid level measurement system in closed tanks with steam cushion using D31 with direct separator

This is the sum of the hydrostatic pressure and the vapour phase of the medium In the most practical measurement situation, the density of the vapour phase is negligibly small and therefore, the measured hydrostatic pressure corrrespond only to the height of the liquid phase column and can be taken as the value of the level of the surface of the liquid phase. For media where the density of the vapour phase is significant (e.g. propane) the level found using this method described can be treated as the theoretical level of the liquid level obtained by adding the actual phase to the condensed vapour phase.



To convert a rise in the level of liquid with **density 0.87** from **0 to 3200 mm** heigh to a current change from 4 to 20 mA. 1.

A) Install the transmitter in working position, place the seal at the appropriate height (tank empty).

B) Calculate the width of the measurement range in mmH_2O (4°C): **3200 mm × 0.87 g/cm = 2784 mmH_2O.**

C) Using the communicator, set the transmitter to use the units mmH_2O at 4°C.

D) To determine the start of the measurement range, read off via the communicator the hydrostatic pressure produced by the manometric fluid in the capillary (e.g. **-4250 mmH_2O**).

E) To determine the end-point of the measurement range, add the value **(-4250 mmH_2O)** and the width of the measurement range **(-4250 mmH_2O + 2784 mmH_2O= -1466 mmH_2O)** .

F) Using the communicator enter the calculated start **(-4250 mm**H_2O) and end-point (**-1466 mmH_2O**) of the measurement range and send as a block to the transmitter. After receiving these parameters the transmitter will perform measurements as required.

8.2.5. Pressure measurement system

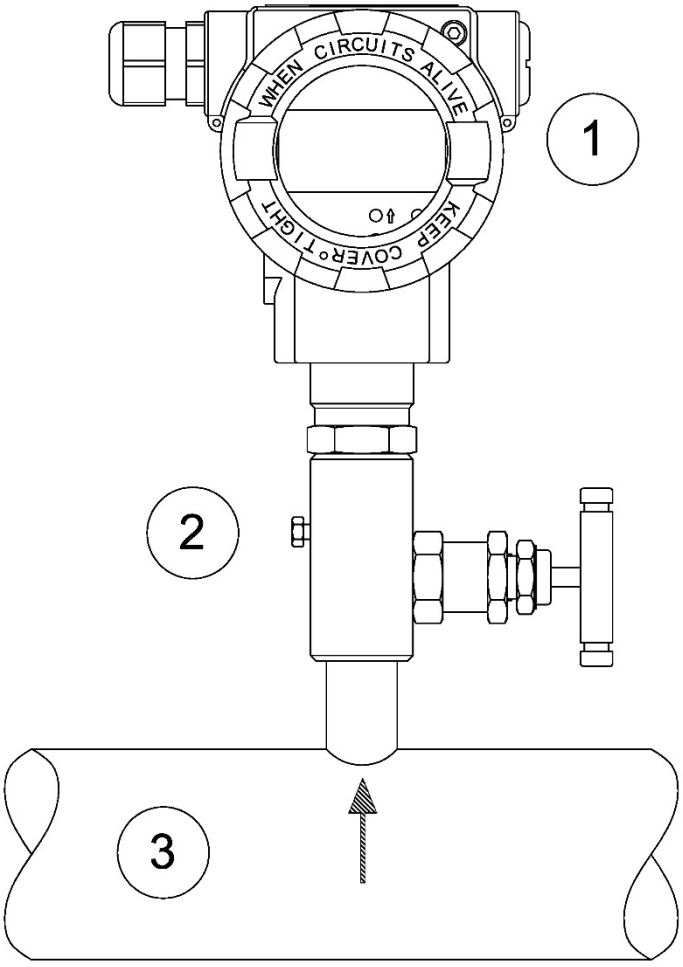
Transmitters with metric and inch stub pipes: use a flat gasket on the sealing surface of the process connector. Sealing hemp and similar materials shall not be used as seals.

Transmitters with NPT thread stubs: to seal the connection wrap the thread with Teflon tape.

The transmitter must be tightened only with the use of a hexagon nut of the process connector. Never use the housing as a lever to tighten the nut.

Gas pressure measurement system

Transmitter D21 must be installed above the measuring point so that the condensate can flow into the piping.

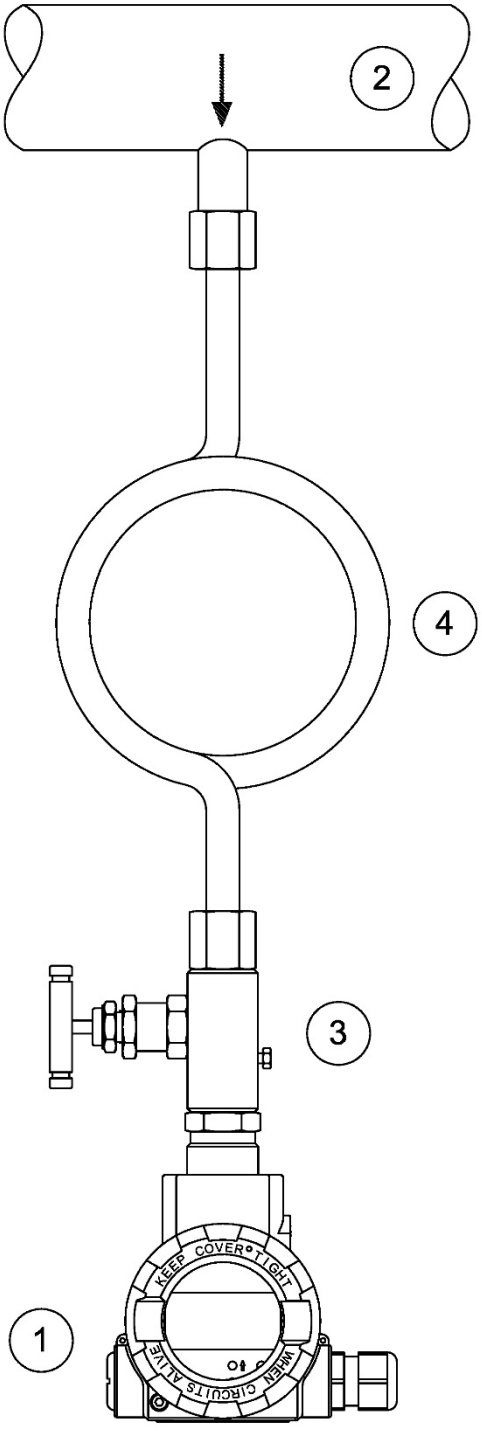


1. D21.
2. Shut-off valve.
3. Pipeline.

Figure 167. Gas pressure measurement system using D21.

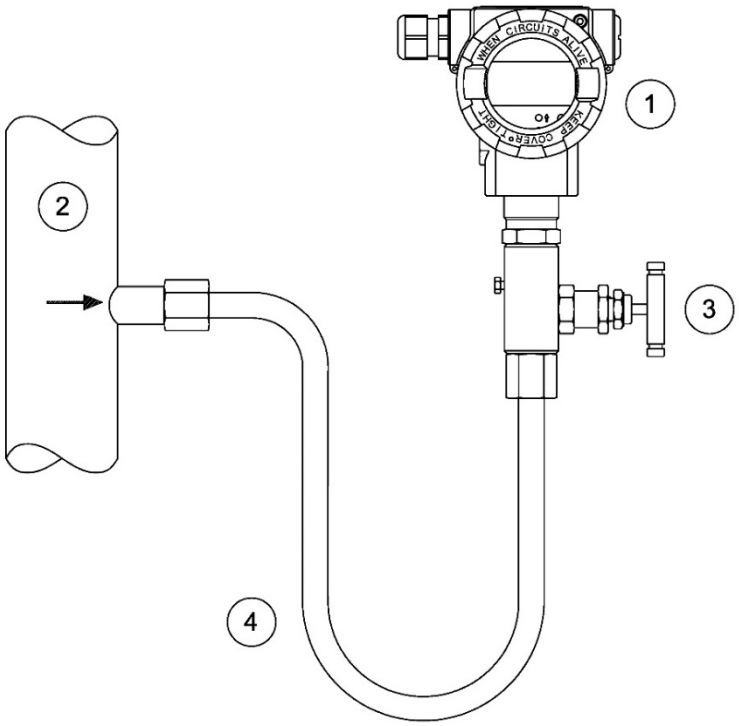
Steam pressure measurement system

Steam temperature reducing water-seal tubes should be used to measure the steam pressure.
Preferably transmitter D21 should be installed below the measuring point.
Before starting the water-seal tubes must be filled with liquid.



1. D21.
2. Pipeline.
3. Shut-off valve.
4. Loop water-seal tube.

Figure 178. Steam pressure measurement system on horizontal pipeline using D21.

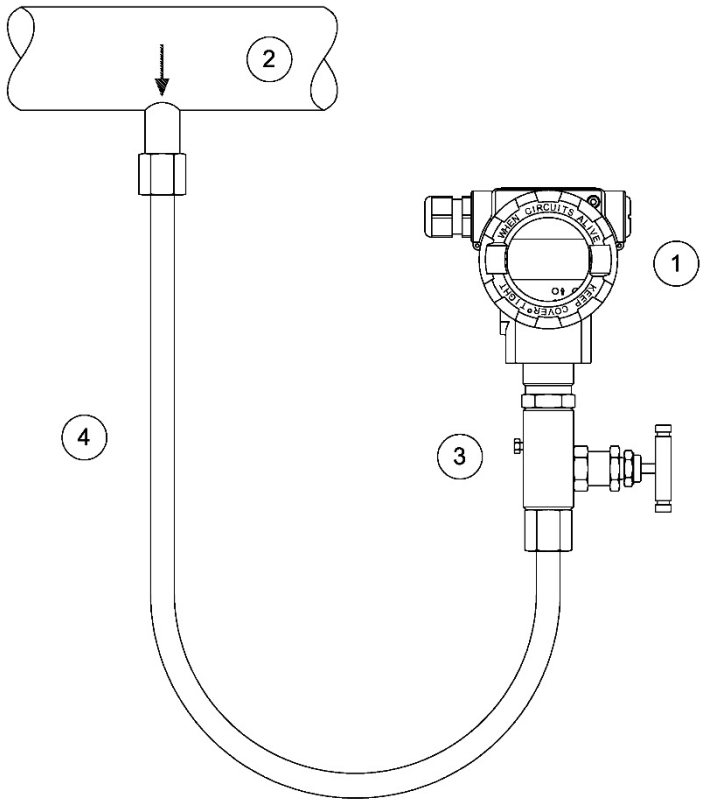


1. D21.
2. Pipeline.
3. Shut-off valve.
4. Water-seal tube.

Figure 18. Steam pressure measurement system on vertical pipeline using D21.

Liquid pressure measurement system

Transmitter D21 must be mounted below the measuring point or at the same level as the measuring point.



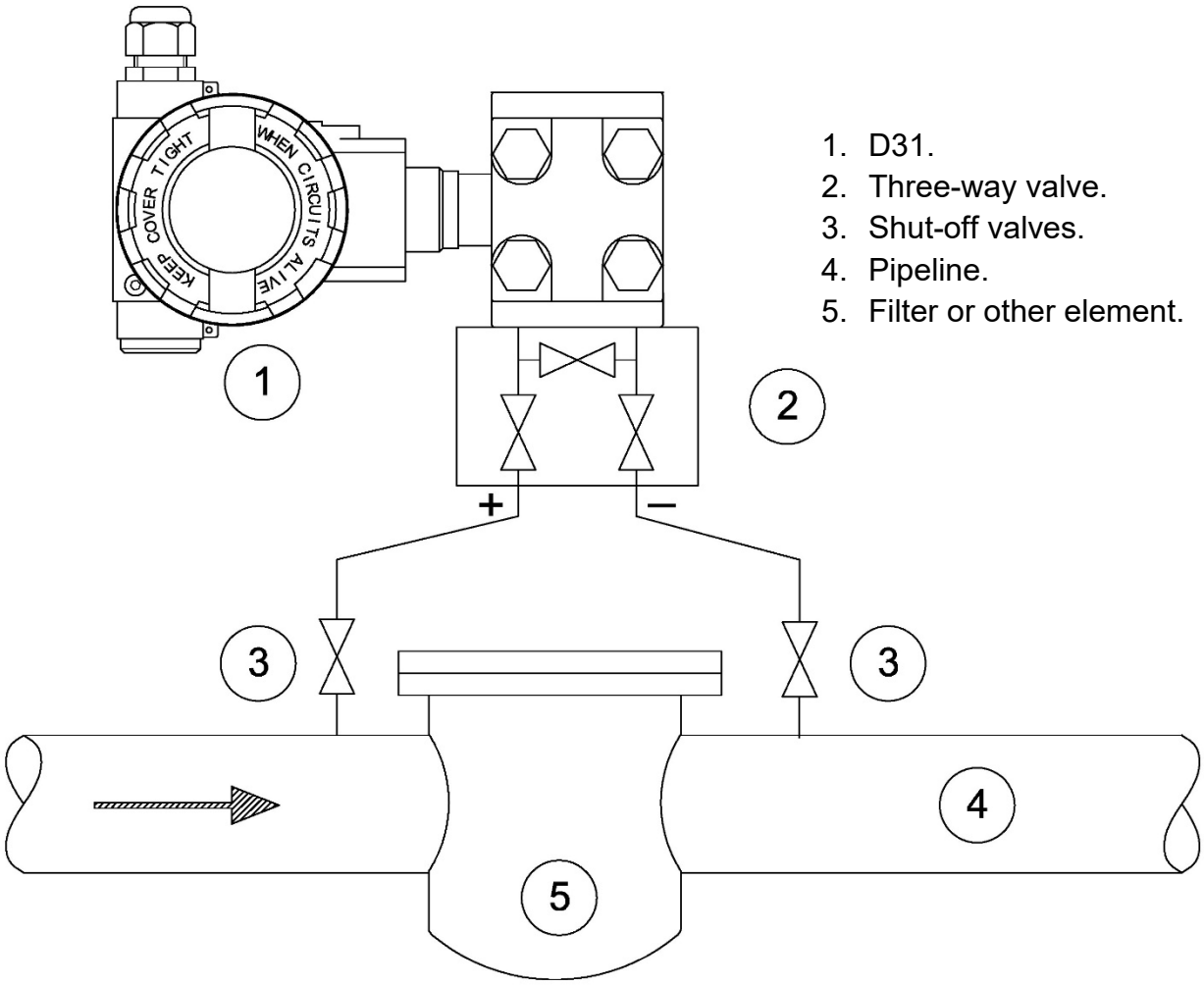
1. D21.
2. Pipeline.
3. Shut-off valve.
4. Water-seal tube.

Figure 19. Liquid pressure measurement system using D21.

8.2.6. Differential pressure measurement system

Gas and steam differential pressure measurement system

Transmitter D31 must be installed above the measuring point so that the condensate can flow through impulse tubes into the process pipes.

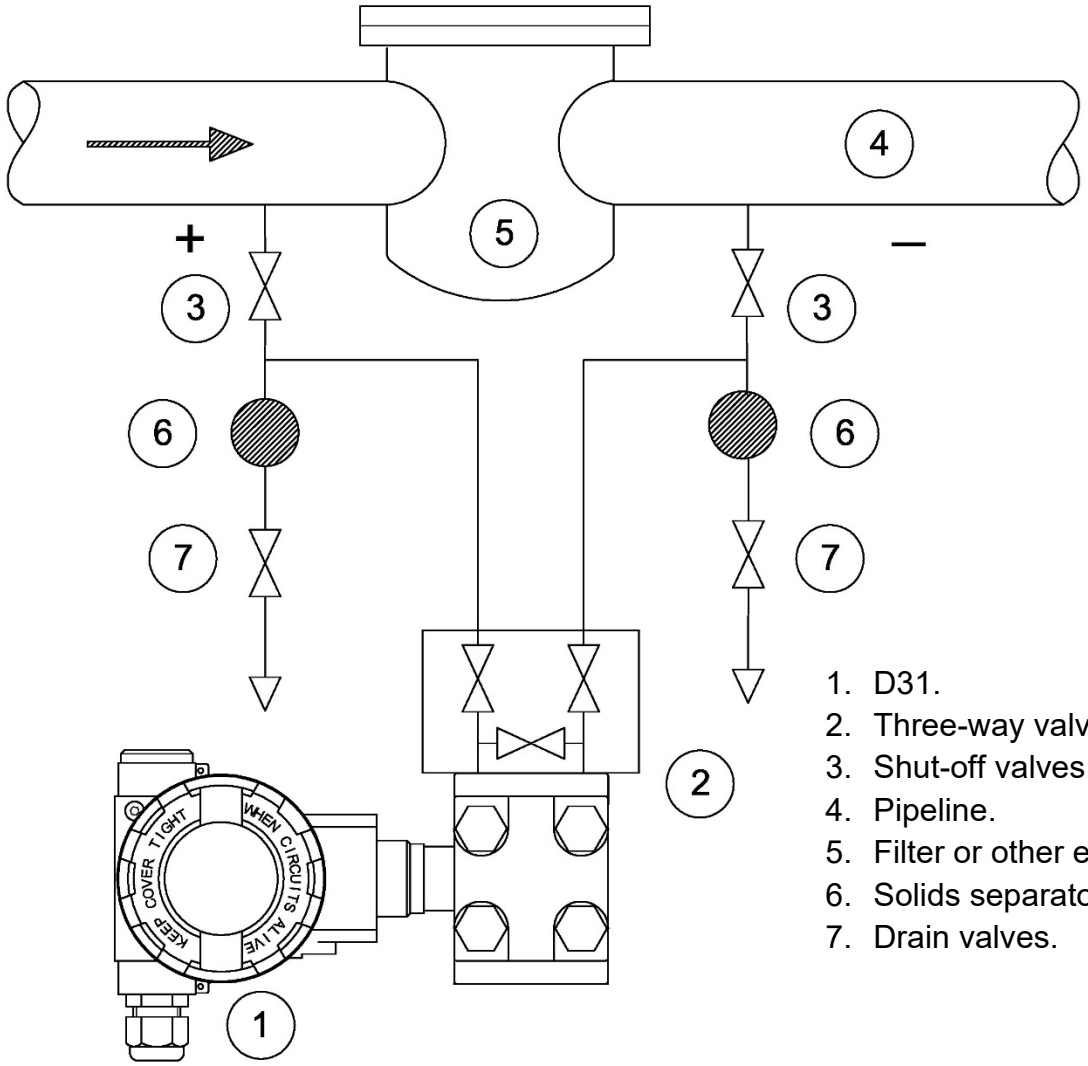


1. D31.
2. Three-way valve.
3. Shut-off valves.
4. Pipeline.
5. Filter or other element.

Figure 20. Gas and steam differential pressure measurement system using D31.

Liquid differential pressure measurement system

Transmitter D31must be mounted below the measuring point so that the impulse tubes are always filled with liquid and the gas bubbles can freely escape to the process pipe.
If the measured medium contains particles, it is useful to install separators and drain valves to remove deposits.

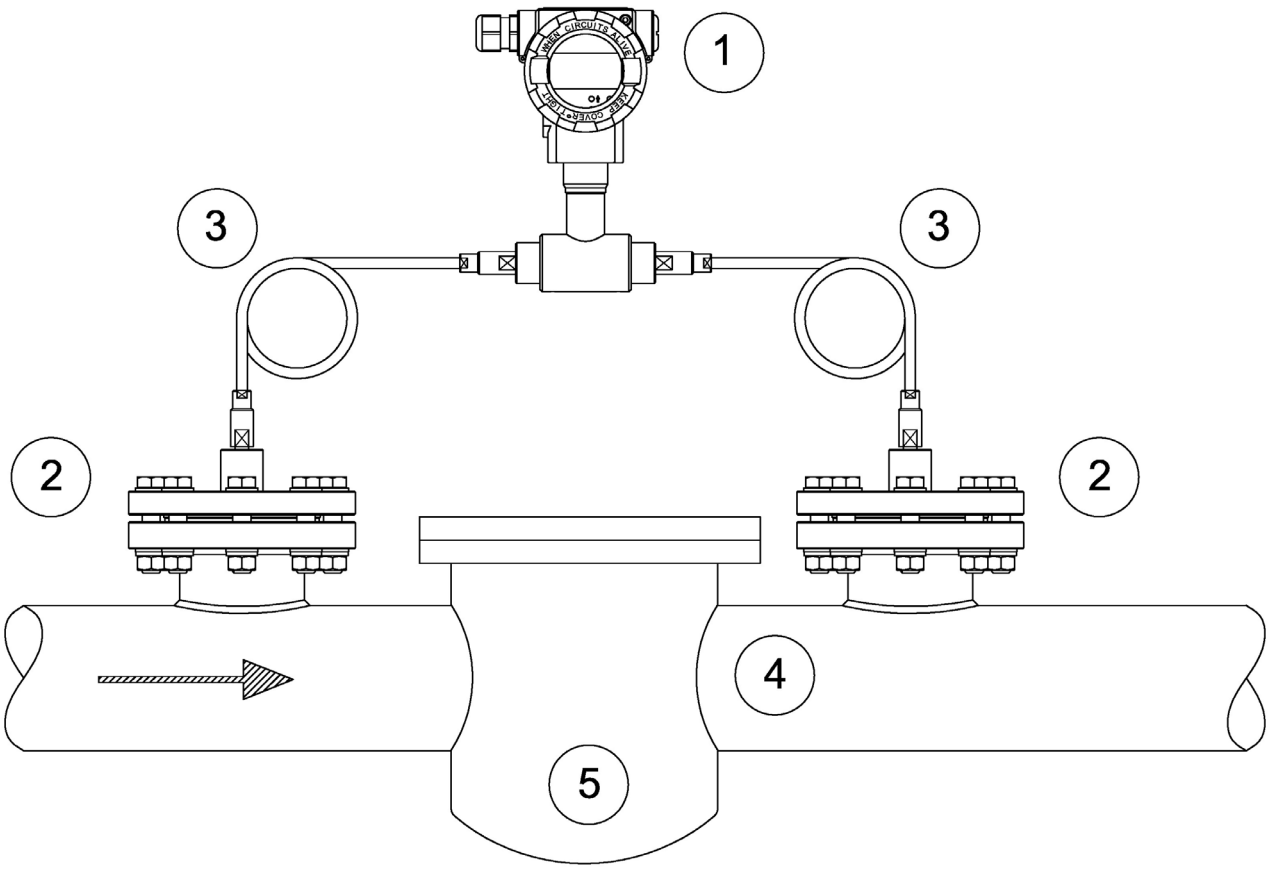


1. D31.
2. Three-way valve.
3. Shut-off valves.
4. Pipeline.
5. Filter or other element.
6. Solids separators.
7. Drain valves.

Figure 21. Liquid differential pressure measurement system using D31.

Gas, steam and liquid differential pressure measurement system with the use of distance separators

The separators must be mounted on the top or side of the pipeline.
For vacuum measurements, transmitter D35 must be installed below the measuring point.
Approximate ambient temperature in both capillaries connecting the transmitter with separators must be ensured.



1. D35.
2. Separators.
3. Capillary tubes.
4. Pipeline.
5. Filter or other element.

Figure 22. Gas, steam and liquid differential pressure measurement system using D35 with distance separators.

8.2.7. Installation instructions for transducers with distance separators

The protection of the separator diaphragm can only be removed immediately before installation.
The hydrostatic pressure of the gauge fluid column in the capillary may result in the zero pressure point drift in the transmitter. After installation, the transmitter must be pressure-reset.
Do not clean or touch the separator diaphragms using hard or pointy objects.

The separators with pressure transmitter form a closed calibrated system filled with gauge fluid. The opening for filling the device with gauge fluid is sealed and must not be opened.

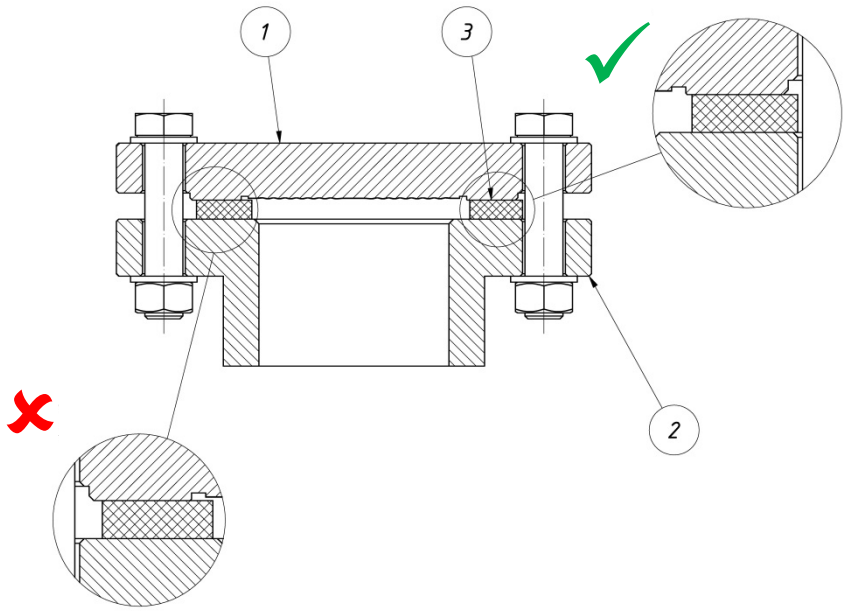
When using a mounting bracket, it is necessary to ensure sufficient stress relief of the capillaries tension in order to avoid excessive bending.

8.2.8. Flange gasket installation instructions

The correct position of the sealing in the connector is ensured by fixing screws, therefore the outer diameter of the gasket should be equal to the layout diameter of the fixing openings in the flange, reduced by one diameter of the opening.
The inner diameter of the gasket may not be smaller than the inner diameter of the sealing surface.

Incorrect installation of the sealing may result in incorrect measurement indications.

Special attention must be paid when selecting correct dimensions of the sealing.

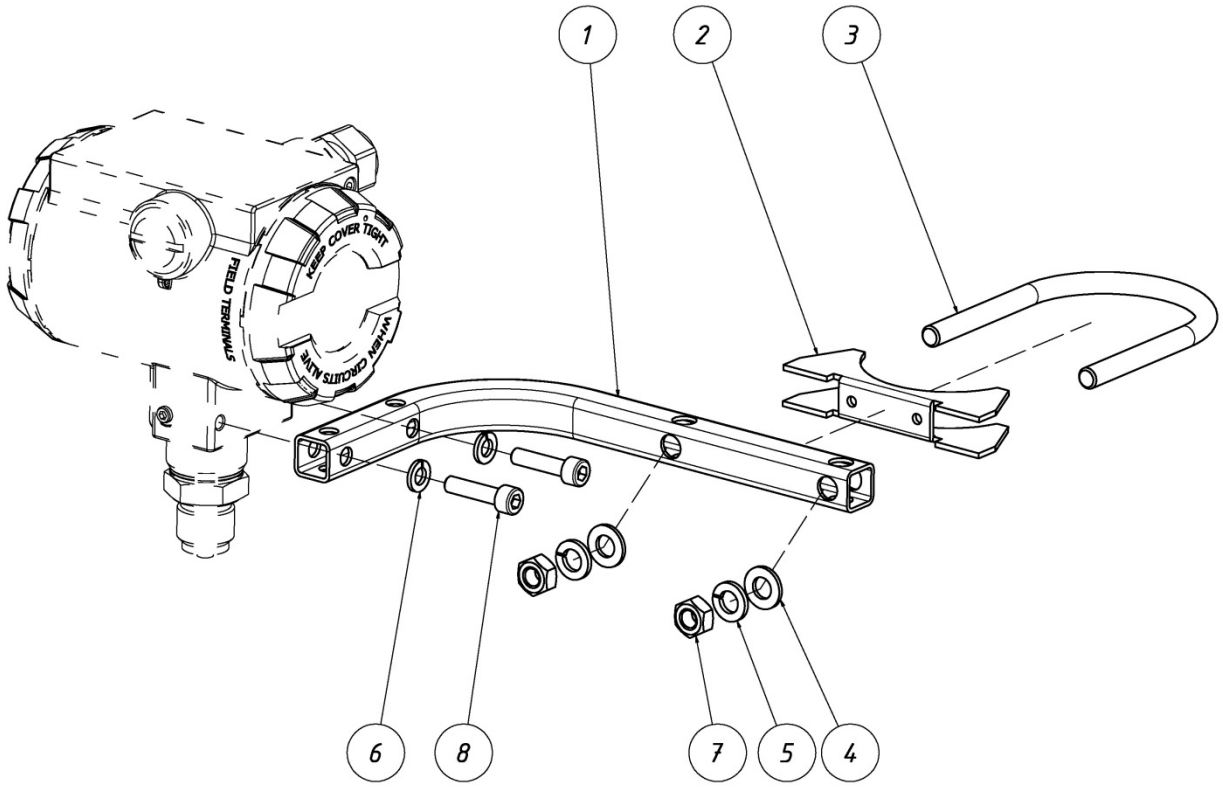


1. Separator.
2. Counter flange.
3. Gasket.

Figure 23. Installation of the flange gasket.

8.2.9. Instruction of installing the clamp to pipe and wall

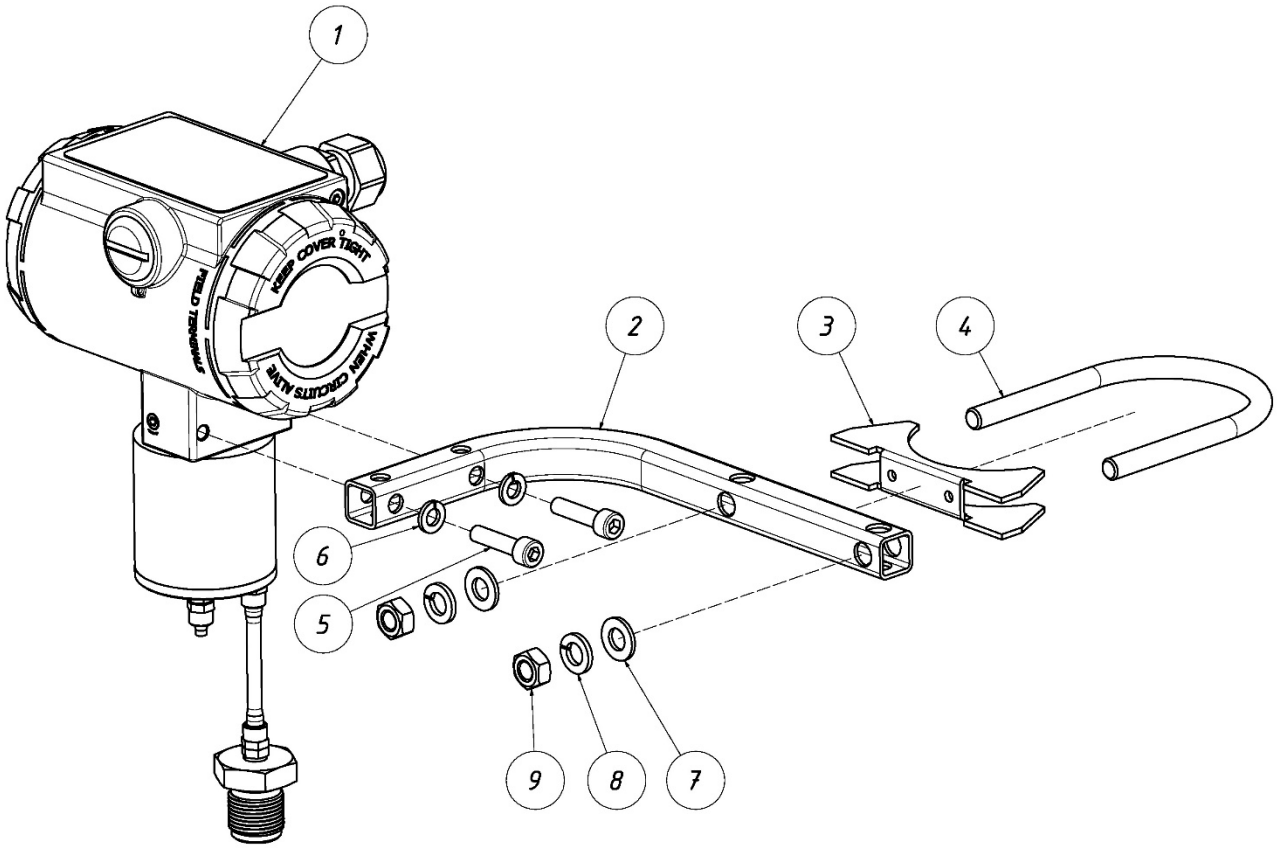
Transmitter D21/D31/D34/D35 can be mounted on the wall by means of an AL mounting arm (item 1) or to the pipe using the components as shown below:



1. AL mounting arm.
2. C2 clamp V-block.
3. Pipe mounting lug.
4. Flat washer Ø 8.4 acc. to DIN 125 (2 pcs).
5. Spring washer Ø 8.1 acc. to DIN 127 (2 pcs).
6. Spring washer Ø 6.1 acc. to DIN 127 (2 pcs).
7. M8 nut acc. to DIN 934 (2 pcs).
8. Hex socket head cap screw M6x25 acc. to DIN 912 (2 pcs).

Figure 24. Transmitter D21. Wall and pipe mounting.

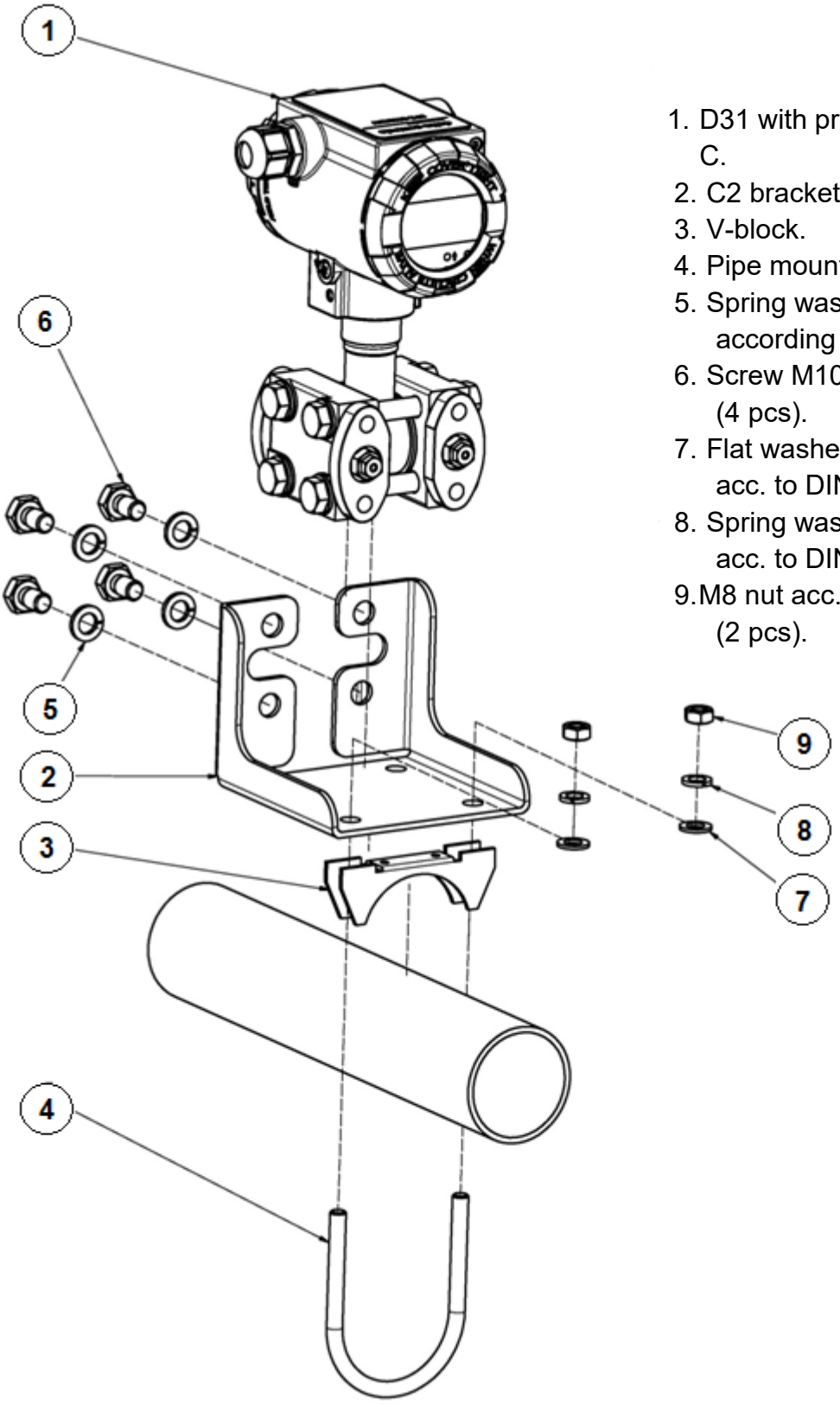
Transmitter D34 can be mounted on the wall by means of an AL mounting arm (item 2) or to the pipe using the components as shown below:



1. Transmitter D34.
2. AL mounting arm.
3. C2 clamp V-block.
4. Pipe mounting lug.
5. Hex socket head cap screw M6x25 acc. to DIN 912 (2 pcs).
6. Spring washer Ø 6.1 acc. to DIN 127 (2 pcs).
7. Flat washer Ø 8.4 acc. to DIN 125 (2 pcs).
8. Spring washer Ø 8.1 acc. to DIN 127 (2 pcs).
9. M8 nut acc. to DIN 934 (2 pcs).

Figure 25. Transmitter D34. Wall and pipe mounting.

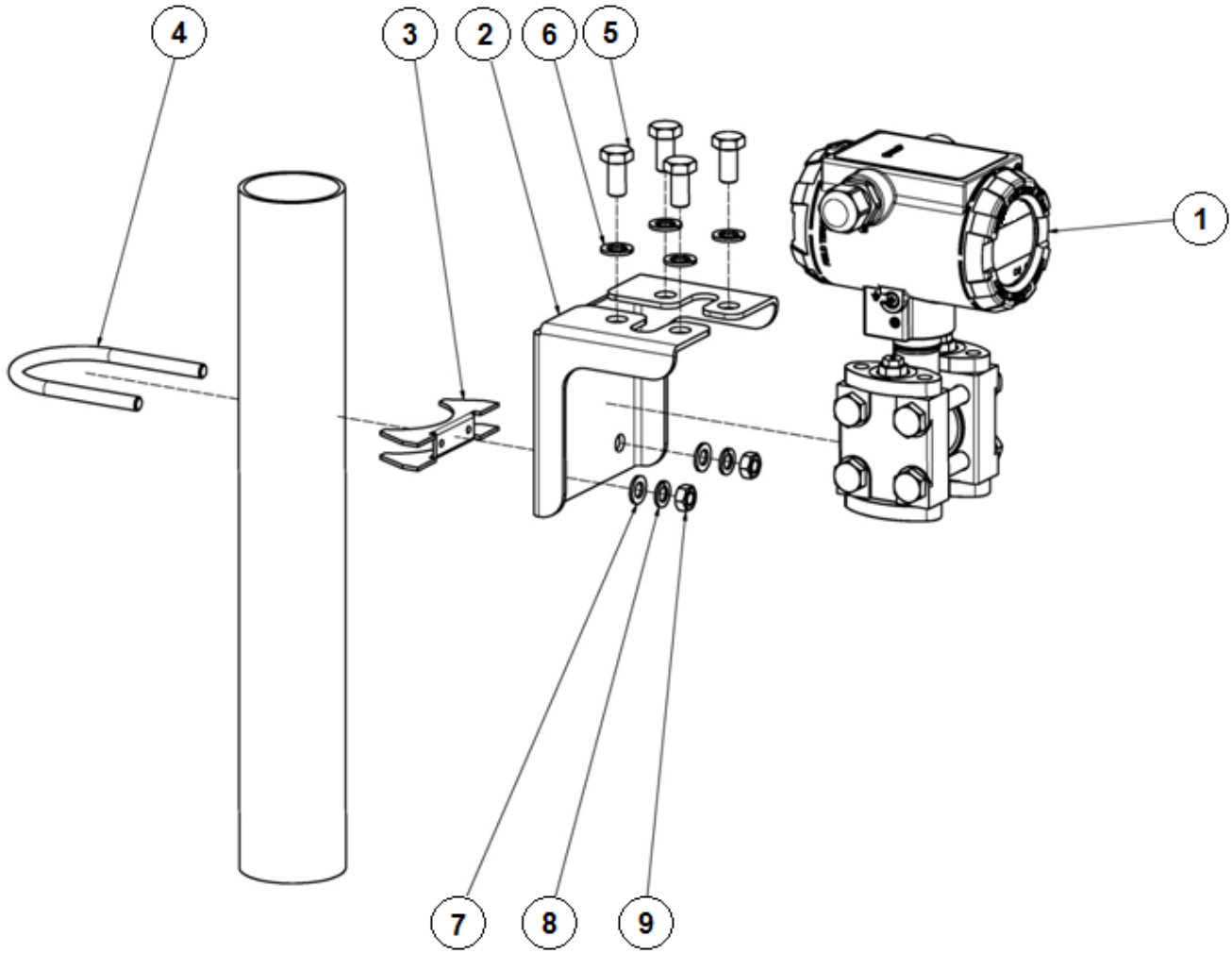
Differential pressure transmitters D31 with process connection of C type can be mounted to the pipe using the mounting bracket C2 in the following way:



1. D31 with process connector C.
2. C2 bracket.
3. V-block.
4. Pipe mounting lug.
5. Spring washer Ø 10.2 according to DIN 127A (4 pcs).
6. Screw M10x16 acc. to DIN 933 (4 pcs).
7. Flat washer Ø 8.4 acc. to DIN 125 (2 pcs).
8. Spring washer Ø 8.1 acc. to DIN 127 (2 pcs).
9. M8 nut acc. to DIN 934 (2 pcs).

Figure 26. Transmitter D31 with C type connector. Mounting on pipe.

Differential pressure transmitters D31 with process connection of CR type can be mounted to the pipe using the mounting bracket C2 in the following way:



1. D31 with process connector CR.
2. C2 bracket.
3. V-block.
4. Pipe mounting lug.
5. Screw M10x16 acc. to DIN 933.
6. Spring washer Ø10.2 acc. to DIN 127A (4 pcs).
7. Flat washer Ø 8.4 acc. to DIN 125 (2 pcs).
8. Spring washer Ø 8.1 acc. to DIN 127 (2 pcs).
9. M8 nut acc. to DIN 934 (2 pcs).

Figure 27. Transmitter D31 with CR connector. Mounting on pipe.

8.2.10. Assembly and mounting of the variant with distance separator

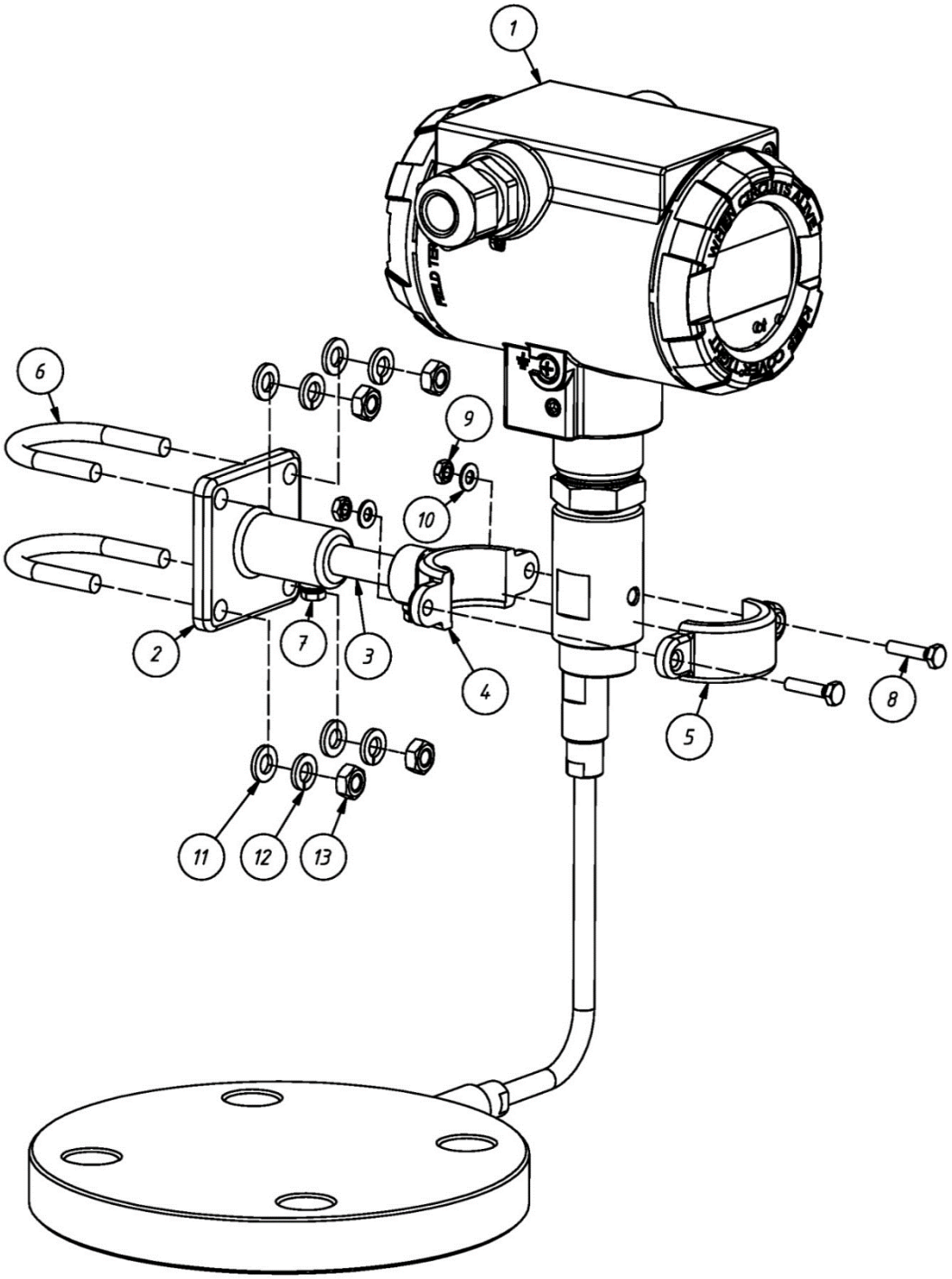


Figure 28. Assembly and mounting of the variant with distance separator.

List of parts for the PCR variant of the holder (pipe mounting):

1. D21 with distance separator.
2. Holder body.
3. Holder pin.
4. Holder clamp (bottom).
5. Holder clamp (top).
6. Lifting eye (2 pcs.).
7. Hex head screw M5×10 acc. to DIN 933 (2 pcs.).
8. Hex head screw M5×18 acc. to DIN 933 (2 pcs.).
9. M5 nut acc. to DIN 934 (2 pcs.).
10. Flat washer Ø5.3 acc. to DIN 433 (2 pcs.).
11. Flat washer Ø6.4 acc. to DIN 125 (4 pcs.).
12. Spring washer Ø6.1 acc. to DIN 127 (4 pcs.).
13. M6 nut acc. to DIN 934 (4 pcs.).

List of parts for the PC variant of the holder (wall mounting):

1. D21 with distance separator.
2. Holder body.
3. Holder pin.
4. Holder clamp (bottom).
5. Holder clamp (top).
7. Hex head screw M5×10 acc. to DIN 933 (2 pcs.).
8. Hex head screw M5×18 acc. to DIN 933 (2 pcs.).
9. M5 nut acc. to DIN 934 (2 pcs.).
10. Flat washer Ø5.3 acc. to DIN 433 (2 pcs.).

8.2.11. Rotation of the housing

The housing of transmitter can be rotated by 330°.
In order to do so:

- loosen the screw (item 1) to allow the housing to be rotated;
- position the transmitter housing as required (item 2);
- tighten the screw (item 1).

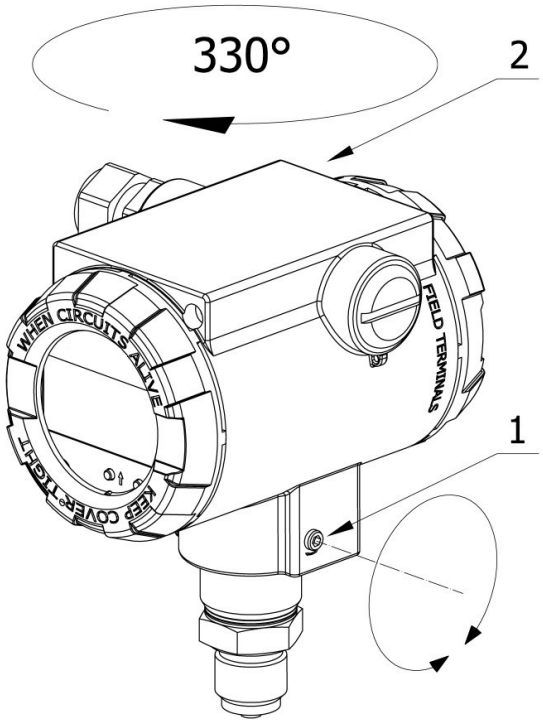


Figure 29. Rotation of the housing.

8.2.12. Closing of housing covers, sealing

The front and rear cover threads have a factory coating, therefore no additional coating is required.

Before tightening the covers, make sure that the thread surfaces are free of contamination, e.g. sand etc. It should be possible to screw the covers smoothly. If resistance is felt when tightening, on the thread there is probably dirt which must be removed before tightening.

The transmitter housing does not provide tightness if the housing or covers thread is damaged.

Some transmitter applications require an interlock and sealing of covers to prevent unauthorized access to settings and adjustments. The method of sealing transmitters is shown in the following figure:

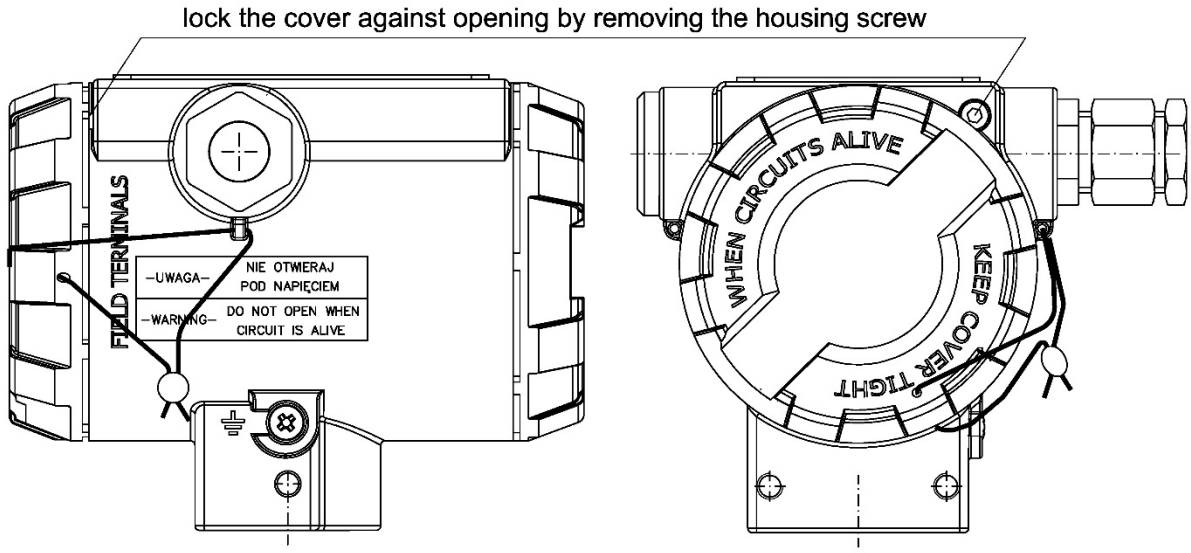


Figure 30. Housing covers and sealing principle.

8.3. Post-installation control operations

After installation, make sure that all the transmitter fixing screws, separators and holders are properly tightened.

9. ELECTRICAL CONNECTION

9.1. Cable connection to transmitter internal terminals

All connection and installation operations shall be performed with disconnected supply voltage and other external voltages, if used.

Risk of electric shock!

If the transmitter supply voltage exceeds 30 V DC, there is a risk of electric shock from electrical contacts after opening the rear cover of the housing body in damp environment.

Failure to provide proper connection of the transmitter may result in danger! Risk of electric shock and/or ignition in potentially explosive atmospheres!

In damp environment do not open the cover when the transmitter is energized.
When using the transmitter in explosion-risk atmospheres, the system must comply with the applicable national standards, regulations and safety instructions or drawings of the control system.
Devices with integrated lightning protection **(SA)** must be grounded.
The transmitter's internal circuits are protected against reversed polarization, impact of overvoltage and high-frequency electric fields.
The supply voltage must match the value given on the transmitter nameplate (➔ Transmitter identification).

9.1.1. Cable connection

In order to perform correct connection of the cables, the following steps shall be performed:

- disconnect power supply of the supply cable line before connecting the transmitter cabling;
- unscrew the rear cover of the transmitter body to access the power connector;
- pull the cable through the gland. For this purpose it is recommended to use two-wire screened twisted pair cable;
- connect the transmitter according to the figure below, paying attention to the correct tightening of the bolts fixing the conductor core to the terminal;
- depending on the assumed earthing model of the system, attach the cable screen to the bolted terminal of the body ground or cut the excess of the screen and secure with the insulation without connecting to the body ground;
- check the correct fixing of the HART local communication jumper;
- tighten the rear cover of the transmitter body until you feel resistance;
- leaving a small clearance of the cable inside the body, tighten the gland nut so that the gland seal is clamped on the power cable.

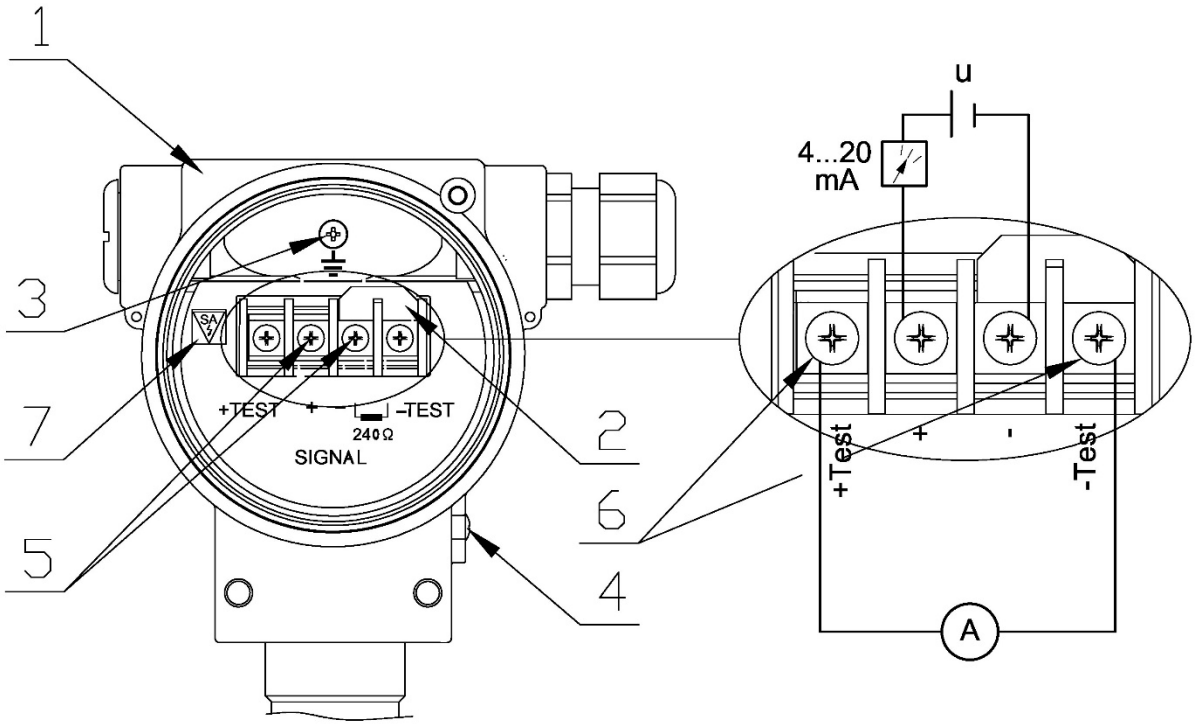


Figure 31. Electrical connection 4…20 mA of HART to transmitter.

1. Housing.
2. Jumper for local HART communication.
3. Internal ground terminal.
4. External ground terminal.
5. Transmitter power terminals, 4…20 mA current loop.
6. Ammeter connection terminals for uninterruptible current measurement (optional).
7. Designation of a device variant (SA) with integrated lightning protection.

9.1.2. Connection of transmitter with the option of using local HART communication

The transmitter allows to use the local HART communication. To do this you can use a HART communicator unit or modem interoperating with a computer or a smartphone.
In order to establish the local communication, it is necessary to:

- remove HART communication jumper (item 2);
- connect the communicator or modem to electrical terminals (item 8).

Opening of the HART jumper results in applying resistance of 240 Ω in series in line 4...20 mA. This resistance reduces voltage on transmitter supply terminals by approximately 5 V DC for maximum current that can be set by the transmitter. Therefore, when the jumper is removed, the minimum power supply voltage increases by 5 V DC. When using power supplies with supply voltages below 17 V DC, **to avoid the supply voltage deficit on the transmitter terminals, the HART jumper must be dismantled only for the time of performing the HART local communication.**

Connection diagram of the communicator or modem to energized transmitter is shown in the following figure:

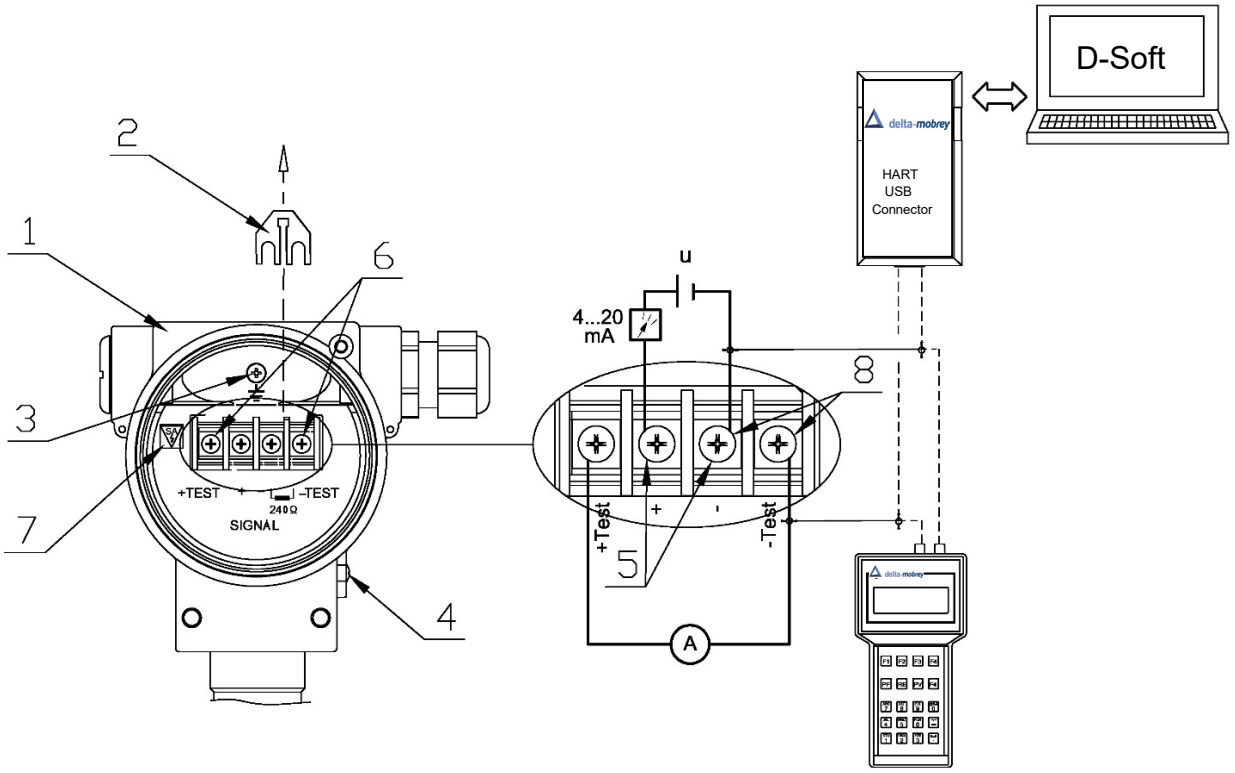


Figure 32. Electrical connection 4…20 mA of HART to transmitter with local HART communication.

1. Housing.
2. Removed local HART communication jumper.
3. Internal ground terminal.
4. External ground terminal.
5. Transmitter power terminals, 4 … 20 mA current loop.
6. Ammeter connection terminals for uninterruptible current measurement (optional).
7. Designation of a device variant (SA) with integrated lightning protection.
8. Terminals – point of connection of the communicator or HART modem.

9.2. Transmitter power supply

9.2.1. Transmitter supply voltage

Power cables may be live!
There is a risk of electric shock and/or explosion!

When using the transmitter in explosion-risk atmospheres, the system must comply with local national standards and regulations, with intrinsic safety instructions and installation drawings.

All explosion protection data is given in Manual IOM-D21-D31-EX IS-A: NOV 2019 which is available on request. Ex documentation is typically supplied with all equipment approved for use in potentially explosive environments.

Table 2. Permissible supply voltages depending on the version of electronics.

Electronics version	Minimum supply voltage	Maximum supply voltage
4...20 mA HART, N variant (to be used in non-explosive environments)	**10,0 V DC**	**55 V DC**
4...20 mA HART, Exi variant*	**10,5 V DC**	**30 V DC**
* For details on intrinsically safe variant see manual IOM-D21-D31-EX IS-A: NOV 2019 .		

9.2.2. Uninterruptible current measurement in 4…20mA current loop

The transmitter is capable of uninterruptible current measurement in the current loop using an ammeter. In order to maintain the current measurement error below 0.05%, the internal resistance of the ammeter shall be less than 10 Ω.
Ammeter connection diagram – see: (➔Figure 31. Electrical connection 4…20 mA of HART to transmitter.).

9.2.3. Specifications of electrical switching terminals

Internal electrical switching terminals are suitable for conductors with the cross-section from 0.5 to 2.5 mm^2. The internal and external electrical ground terminal of the body is suitable for conductors with cross-section from 0.5 to 5 mm^2.

9.2.4. Cabling specification

Delta Mobrey Limited recommends using two-wire screened twisted pair cable. The outer diameter of the cable shell from 5 to 9 mm is recommended.

9.2.5. Resistance load in power supply line

The power line resistance, power source resistance and other additional serial resistances increase the voltage drops between the power source and the transmitter terminals. The maximum transmitter current under normal operation conditions is 20.500 mA but during high alarm the value of current I_max is 22.000 mA.
The maximum resistance value in the power circuit (along with the power cables resistance) is defined by the formula:

R_{L_MAX} [Ω] ≤= $\dfrac{(U-10)[V]}{0{,}022[A]}$ for normal variant (N)

R_{L_MAX} [Ω] ≤= $\dfrac{(U-10{,}5)[V]}{0{,}022[A]}$ for intrinsically safe variant (Exia)

where:
U – voltage of 4…20 mA current loop power supply unit in [V];
R_{L_MAX} – maximum power supply line resistance in [Ω].

The above formula may be used to describe the indicative dependency of the maximum load resistance on the power supply voltage:

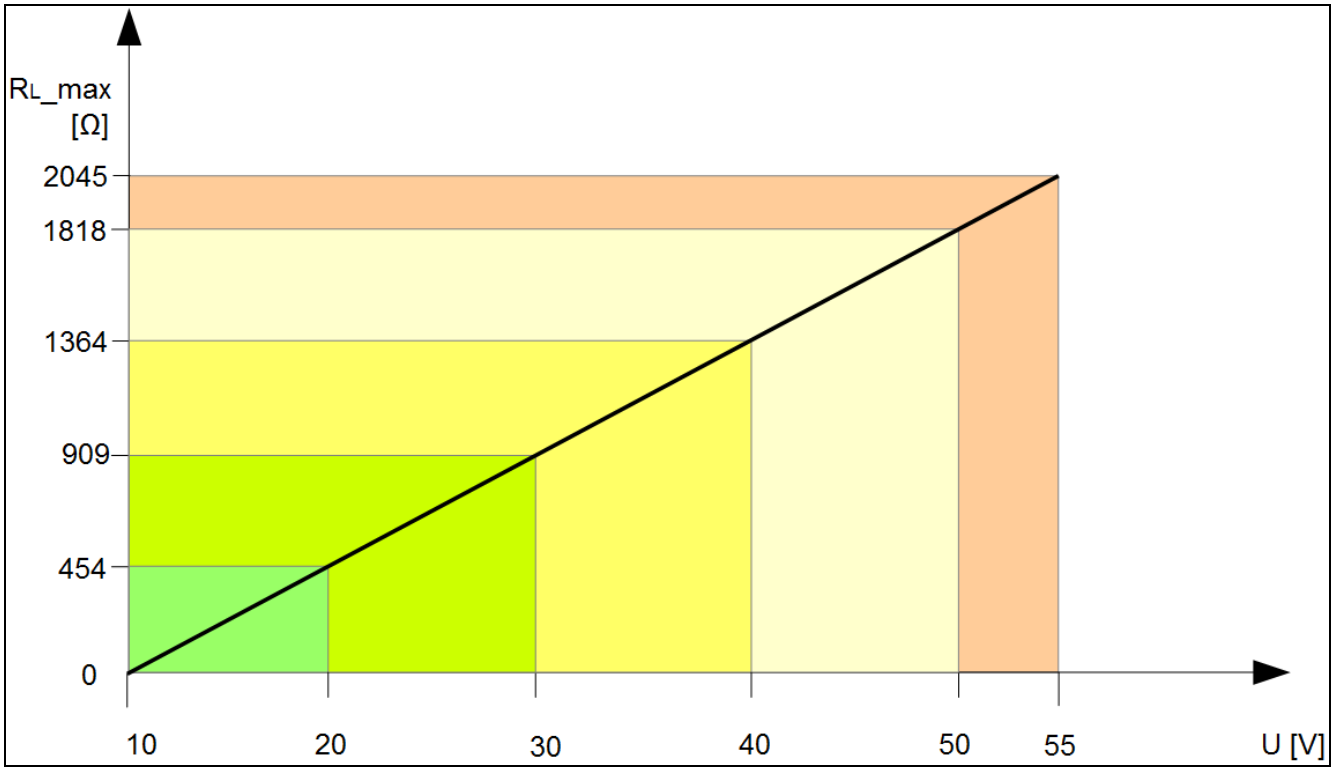


Figure 33. The maximum load resistance R_{L_MAX} [Ω] in the supply line of transmitter D21/D31 (N variant) depending on the power supply voltage U [V].

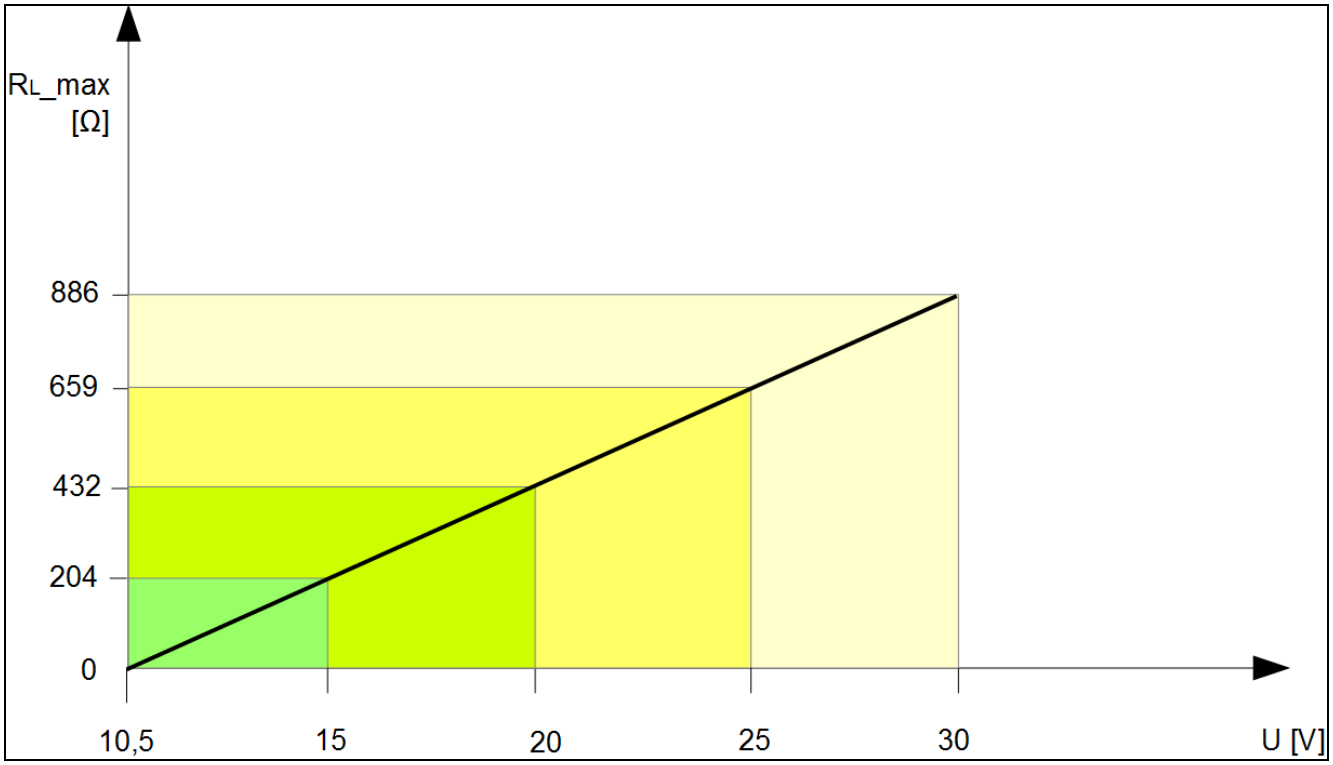


Figure 34. The maximum load resistance RL_MAX [Ω] in the supply line of transmitter D21/D31(Ex i variant) depending on the power supply voltage U [V].

9.2.6. Shielding, equipotential bonding

- Optimal protection against interference is provided by the earthing of the screen on both sides (in the cabinet and equipment). In case of potential difference between earthing points of devices which may result in the flow of equipotential currents, the screen shall be earthed on one side – preferably at the transmitter.
- When used in potentially explosive environments, the applicable regulations must be observed. As a standard, all Ex transmitters are accompanied with separate documentation IOM-D21-D31-EX IS-A:NOV 2019, containing additional technical data concerning explosion-proof devices.

9.2.7. Connection of HART communicator unit

- For entering parameters into the transmitter, it is possible to use communicator **DKAP-03** manufactured by **Delta Mobrey Limited.** or a communicator by another company which accepts DDL libraries;
- when the communicator is used in potentially explosive environments, the applicable regulations must be observed.

The method of connecting the communicator or modem to the transmitter for local HART communication is shown in (➔Figure 32. Electrical connection 4…20 mA of HART to transmitter with local HART communication.).

9.2.8. Connection of HART modem

For entering parameters into the transmitter a HART modem can be used, e.g. **HART/USB converter** by **Delta Mobrey Limited.** The converter may interoperate with **D-Soft** by **Delta Mobrey Limited** under the control of Windows 7/10 operating systems or the software by a different company accepting DDL or DTM libraries.

The method of connecting the communicator or modem to the transmitter for local HART communication is shown in (➔Figure 32. Electrical connection 4…20 mA of HART to transmitter with local HART communication.).

9.3. Equipotential bonding

When using a communicator in explosion-risk atmospheres, it may be required to use equipotential bonding of the equipment by means of equipotential bonding conductors. In this regard, it is necessary to comply with locally applicable regulations.

9.4. Lightning protection

Transmitters D21/D31 with EMC standards for safety-related products used in general industrial environment. Transmitters D21/D31 in normal variant are fitted with lightning protection. In order to increase the resistance of transmitters in Exia variant to excessive surge, it is possible to use the lightning protection version **(SA).** Transmitters with integrated lightning protection **(SA)** must be grounded. Presence of protection in the transmitter is confirmed by the mark **(SA)** on the plastic cover of the power supply connector terminals.

Parameters of lightning protection equipment:

- discharge threshold voltage: 230 V DC;
- discharge threshold impulse voltage: 450 V (pulse 100 V/µs);
- discharge threshold impulse voltage: 600 V (pulse 1000 V/µs);
- discharge current for 1 surge: 20 kA, 8/20 µs;
- discharge current for 10 surges: 10 kA, 8/20 µs;
- discharge current for 300 surges: 200 A, 10/1000 µs.

9.5. Final inspection of cabling

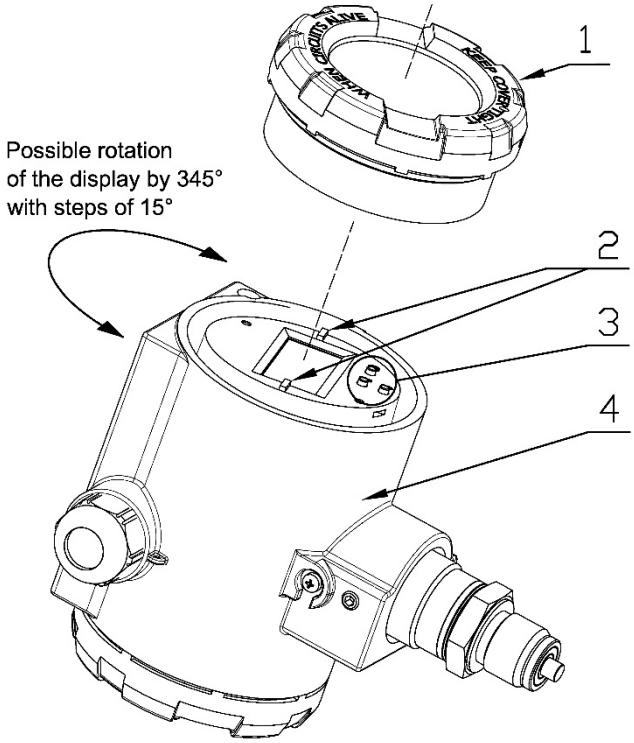
After completing the electrical installation of the transmitter it is necessary to check the following:

- does the supply voltage measured at the transmitter terminals at maximum set current match the range of supply voltage specified on the transmitter nameplate?
- Is the transmitter connected according to the information given in section (➔ Cable connection to transmitter internal terminals)?
- Are all the screws properly tightened?
- Are the transmitter covers properly screwed?
- Are the cable gland and the gland plug correctly tightened?

10. OPERATION

10.1. Local LCD display

The transmitter gives the possibility of adjusting the display position to the mounting position of the body. Access to the holders (item 2) used to rotate the display is provided after opening the front cover (item 1). The display may be rotated by an angle of 345° with a step of 15°:



1. Front cover.
2. Handles for rotation.
3. Local keypad buttons.
4. Housing.

Figure 36 Change of display position and access to buttons.

The LCD has three primary information fields identified in the figure below as LCD1, LCD2, LCD3.

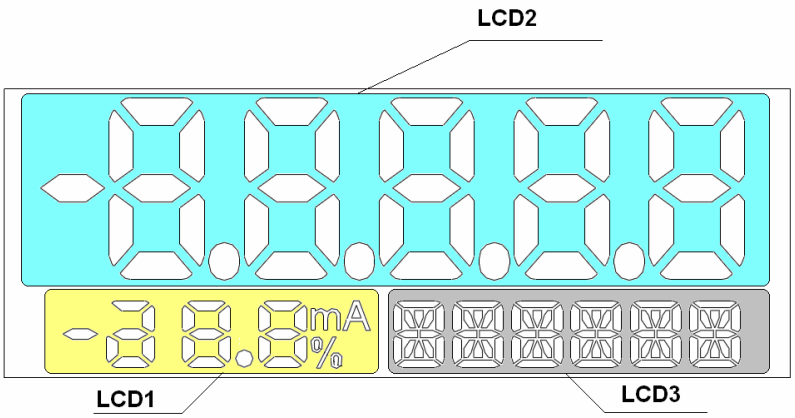


Figure 35. Display information fields.

Depending on the configuration **LCD1** field is used to display:

- values of process variable for current in [**mA**] with 0.1 mA resolution;
- values of the set range of current output in percent [%] with 1% resolution.

Depending on the configuration **LCD2** field is used to display:

- values of pressure/differential pressure in physical units;
- values of pressure/differential pressure in the user's units and scaling;
- value of temperature of the pressure sensor body;
- value of CPU temperature;
- values of the set range when changing the range by entering a number;
- information on error or failure number;
- information on exceeding the range of displayed values;
- information about exceeding the set range limits (only in MID mode).

Depending on the configuration **LCD3** field is used to display:

- physical unit of pressure displayed on LCD2;
- user's unit when displaying values of pressure/differential pressure on LCD2 in user's units and scaling done by the user;
- option of selecting a setpoint using the local setpoint change MENU;
- numbers of errors related to the execution of commands of the local setpoint change MENU.

Display configuration is possible with the use of the local keypad/local MENU or via HART communication.

The local LCD has a limited number of character fields. For this reason, the majority of the messages are given in an abbreviated form.
Below you will find a list of abbreviations used for each character field:

LCD1 field:
[mA] – value (milliamperes) of process current in line 4...20 mA, proportional to the measured pressure.

[%] – value (percentage) of the setpoint $U(t)$ of current controller in current loop 4...20 mA. This value is the ratio of the process current $Ip(t)$ to the current range width according to the following formula:

$$\%U(t) = \frac{Ip(t)-4}{16}\frac{[mA]}{[mA]} * 100[\%]$$

LCD2 field:
The LCD2 field is used mainly to display floating point decimal values in a unit displayed on LCD3. In some cases, other messages may be displayed:

- **ERROR** in case of some operating errors or failure diagnosed in the transmitter, error/failure number **Exxxx** will appear on LCD2, the **ERROR** message will be displayed on LCD3. The image will blink to attract the operator's attention. The transmitter will set the current output to alarm status depending on the configuration I_AL < 3.650 mA or I_AL > 21.500 mA.
  In order to identify the cause, please refer to section (➔TROUBLESHOOTING);
- **undEr** the message will appear when 50% of the base range below the lower limit range of the set LRL (LSL) is exceeded. After reaching the LPL and when below this value up to LSAL, the transmitter freezes the refreshing of digital value of the measurement. In this situation, message "UndEr" will be displayed. The image will blink to attract the operator's attention. The diagnostic alarm mode will be enabled depending on the settings I_AL < 3.650 mA or I_AL > 21.500 mA. Additionally, common status PV_OUT_OF LIMITS and status PV_LOW_LIMITED in the Sensor Block will be set, which can be read out in the diagnostic tab via HART communication. If the limit below LRV of the set range (only in MID mode) is exceeded by the process, **undEr** (under) message will appear on LCD1. The image will blink to attract the operator's attention. The transmitter will set the current output to alarm status depending on the configuration I_AL < 3.650 mA or I_AL > 21.500 mA;
- **ouEr** the message will appear when 50% of the base range below the lower limit range of the set URL (USL) is exceeded. After reaching the UPL and when above this value up to USAL, the transmitter freezes the refreshing of digital value of the measurement. In this situation, the message "ovEr" will be displayed. The image will blink to attract the operator's attention. The diagnostic alarm mode will be enabled depending on the settings I_AL < 3.650 mA or I_AL > 21.500 mA. Additionally, common status PV_OUT_OF LIMITS and status PV_HIGH_LIMITED in the Sensor Block will be set, which can be read out via HART communication. If the limit above URV of the set range (only in MID mode) is exceeded by the process, **ouEr** (over) message will appear on LCD1. The image will blink to draw the operator's attention. The transmitter will set the current output to alarm status depending on the configuration
  I_AL < 3.650 mA or I_AL > 21.500 mA;
- ● ● ● ● when the set position of comma (point) on LCD2 does not allow for the correct display of the process variable, four dots ● ● ● ● will appear on LCD.
  The image will blink to attract the operator's attention. In this situation, change the decimal point position in the local setpoint change MENU or via HART communications.

LCD3 field:

Abbreviations of physical units of pressures and levels and their description:

INH2O	inches of water column with temperature of 0°C.
INHG	inches of mercury column with temperature of 0°C.
FTH2O	feet of water column with temperature of 20°C (68°F).
MMH2O	millimeters of water column with temperature of 20°C (68°F).
MMHG	millimeters of mercury column with temperature of 0°C.
PSI	pounds per square inch.
BAR	bars.
MBAR	millibars.
GSQCM	grams per square centimeter.
KGSQCM	kilograms per square centimeter.
PA	pascals.
KPA	kilopascals.
TORR	torrs.
ATM	atmosphere.
MH2O4	metres of water column with temperature of 4°C.
MPA	megapascals.
INH2O4	inches of water column with temperature of 4°C.
MMH2O4	millimeters of water column with temperature of 4°C.
NOUNIT	the shortcut displayed when a unit not implemented in the transmitter is configured via HART communication.

Abbreviations of temperature measurement point name:

SENS °C	temperature of pressure/differential pressure sensor measurement structure in degrees Celsius.
CPU °C	temperature of the main CPU structure in degrees Celsius.

Abbreviations displayed during configuration via local MENU and their descriptions:

<-BACK	return to one level above in local MENU.
EXIT	going out of the local MENU.
UNIT	pressure and level unit selection menu.
SENS_T	option of measuring the temperature of pressure/differential pressure sensor measurement structure.
CPU_T	option of measuring the main CPU structure temperature.
DAMPIN	menu of selecting damping time constant of process variable.
TRANSF	menu of selecting the current output linearization function.
%SQRT	menu of selecting the deadband percentage of the root characteristics of the current output linearization.
PVZERO	pressure transmitter resetting menu and option.
SETURV	URV setting menu (upper pressure of the set range).
SETLRV	LRV setting menu (lower pressure of the set range).
BYPRES	option of setting the range according to pressure.
BYVALU	option of setting the set range by entering a value.
RESET	transmitter hot restart software menu.
LCD1VR	menu for selection of the type of measurement displayed on LCD1.
LCD2VR	menu for selection of the type of measurement displayed on LCD2.

LCD2DP	menu for selecting position of comma / decimal point.
FACTOR	return to factory values menu.
RECALL	option of return to factory settings. Factory pressure/differential pressure calibrations, zero setpoints of pressure and current will be restored.
LINEAR	option of linear function of current output setpoint linearization.
SQRT	option of root function of current output setpoint linearization.
SPECIA	option of the user's special characteristics of current output setpoint linearization.
SQUARE	option of square function of current output setpoint linearization.
CURREN	option of selecting the display of set current on LCD1.
PERCEN	option of selecting the display of set percentage on LCD1.
PRESS	option of selecting the display of pressure/differential pressure on LCD1.
USER	option of selecting user's units and scaling to be displayed on LCD1.
MID_WP	MID mode setting menu. In this mode, the option of changing the setpoints related to the transmitter metrology is disabled. Additionally, the exceeding of LRV and URV limits results in displaying the undEr or ouEr message, blinking of the display and setting of the process output to the current alarm mode depending on the configuration I_AL < 3.650 mA or I_AL > 21.500 mA.
ON	MID mode activation option.
OFF	MID mode deactivation option.
X.XXXX	option of selecting position of comma / decimal point.
XX.XXX	option of selecting position of comma / decimal point.
XXX.XX	option of selecting position of comma / decimal point.
XXXX.X	option of selecting position of comma / decimal point.
XXXXX.	option of selecting position of comma / decimal point.
0 [S]	option of selecting damping time constant.
2 [S]	option of selecting damping time constant.
5 [S]	option of selecting damping time constant.
10 [S]	option of selecting damping time constant.
30 [S]	option of selecting damping time constant.
60 [S]	option of selecting damping time constant. The 60-second damping constant is only available from the local keypad; the configuration via HART in Revision 5 does not allow a damping value greater than 30 seconds. Other damping values are possible to be set via HART communication.
0.0%	option of selecting root characteristics deadband point.
0.2%	option of selecting root characteristics deadband point.
0.4%	option of selecting root characteristics deadband point.
0.6%	option of selecting root characteristics deadband point.
0.8%	option of selecting root characteristics deadband point.
1.0%	option of selecting root characteristics deadband point.
	Other deadband values are possible to be set via HART communication.
DONE	message about the acceptance and implementation of the set-point change.

Abbreviations of local configuration errors and description of abbreviations:

ER_L07	message displayed on LCD3. It is displayed if a user tries to change the setpoint in the transmitter protected against entry (change of setpoints) or in active MID mode.
ER_L09	message displayed on LCD3. It is displayed if: – a user tries to change the set range by set pressure which is not within the allowable upper URL pressure. – A user tries to reset pressure when the pressure exceeds the allowable upper limit.
ER_L10	message displayed on LCD3. It is displayed if: – a user tries to change the set range by set pressure which is not within the allowable lower LRL pressure. – A user tries to reset pressure when the pressure exceeds the allowable lower limit.
ER_L14	message displayed on LCD3. It is displayed if: – the adopted URV value through the set pressure or entry of a value cannot be accepted because it causes a reduction of the set pressure range set below the allowable limit.
ER_L16	message displayed on LCD3. It is displayed if: – a user tried to perform an operation that is disabled or unavailable. It may be caused by: • attempting to access the local setpoint change MENU when the access to the local MENU is disabled; • attempting to reset pressure in the absolute pressure measurement transducer.
WG_L14	the message will appear if the assumed LRV value through the set pressure or entry of a value causes a decrease of the current set range. Entry of LRV automatically results in the transmitter's attempt to set URV in such a way that the current width of the set range is maintained. If this is not possible due to exceeded URL, the transmitter automatically adopts the URV = URL and a new LRV. Since the set range width and URV deviate from previous values, a message is displayed.

ASCII characters displayed on LCD3 in user's unit:

– using HART communication, the user can configure its own 6-character unit displayed on LCD3. It is possible to display ASCII characters from the range (32 ... 96 dec) or (20 … 60 hex), i.e.:

!"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`

10.2. Local keypad

The local keypad is used to enable the configuration mode of some transmitter parameters and to navigate through MENU and accept MENU options. The MENU can be accessed by pressing and holding any of the keys for at least 4 seconds. After this time, the LCD3 field of the local display will show an **EXIT** message. This signals entering into the MENU navigation mode.

10.3. Local configuration of setpoints

Transmitter enables local configuration of some of the most common setpoints via local key-pad and local LCD display.

10.4. Navigation in local setpoints MENU

The MENU can be accessed by pressing and holding any of the keys for at least 4 seconds. After this time, the LCD3 field of the local display will show an **EXIT** message. This signals entering into the local configuration MENU. Pressing the buttons with arrows [↑] [↓] for at least 1 second you can move up or down MENU.

10.5. Acceptance of local setpoints

The key marked with symbol [●] is used to accept the selection. The acceptance of setpoint change is confirmed by a **DONE** message displayed on LCD3. After changing the setpoint, the transmitter leaves the local configuration change MENU. If in MENU mode, we will not make any choice, after 2 minutes the transmitter automatically returns to display of standard messages. The MENU can also be left by selecting and accepting the **EXIT** option.

10.6. List of local setpoints MENU messages

EXIT→	[↓][scroll down]	[↑][scroll up]	→	◙ [set]
PVZERO→	[↓][scroll down] ←BACK PVZERO	[↑][scroll up] ←BACK PVZERO	→	◙ [set]
SETLRV→	[↓][scroll down] ←BACK SETLRV	[↑][scroll up] ←BACK SETLRV	→	◙ [set]
SETURV→	[↓][scroll down] ←BACK SETURV	[↑][scroll up] ←BACK SETURV	→	◙ [set]
UNIT→	[↓][scroll down] ←BACK INH2O INHG FTH2O MMH2O MMHG PSI BAR MBAR GSQCM KGSQCM PA KPA TORR ATM MH2O4 MPA INH2O4 MMH2O4	[↑][scroll up] ←BACK MMH2O4 INH2O4 MPA MH2O4 ATM TORR KPA PA KGSQCM GSQCM MBAR BAR PSI MMHG MMH2O FTH2O INHG INH2O	→	◙ [set]

DAMPIN→	[↓][scroll down] ←BACK 60 [S] 30 [S] 10 [S] 5 [S] 2 [S] 0 [S]	[↑][scroll up] ←BACK 0 [S] 2 [S] 5 [S] 10 [S] 30 [S] 60 [S]	→	◙ [set]
TRANSF→	[↓][scroll down] ←BACK LINEAR SQRT SPECIA SQUARE	[↑][scroll up] ←BACK SQUARE SPECIA SQRT LINEAR	→	◙ [set]
%SQRT→	[↓][scroll down] ←BACK 1.0 % 0.8 % 0.6 % 0.4 % 0.2 % 0.0 %	[↑][scroll up] ←BACK 0.0 % 0.2 % 0.4 % 0.6 % 0.8 % 1.0 %	→	◙ [set]
LCD1VR→	[↓][scroll down] ←BACK CURREN PERCEN	[↑][scroll up] ←BACK PERCEN CURREN	→	◙ [set]
LCD2VR→	[↓][scroll down] ←BACK PRESS USER SENS_T CPU_T	[↑][scroll up] ←BACK CPU_T SENS_T USER PRESS	→	◙ [set]
LCD2DP→	[↓][scroll down] ←BACK XXXXX● XXXX●X XXX●XX XX●XXX X●XXXX	[↑][scroll up] ←BACK X●XXXX XX●XXX XXX●XX XXXX●X XXXXX●	→	◙ [set]
FACTOR→	[↓][scroll down] ←BACK RECALL	[↑][scroll up] ←BACK RECALL	→	◙ [set]
RESET→	[↓][scroll down] ←BACK RESET	[↑][scroll up] ←BACK RESET	→	◙ [set]
MID_WP→	[↓][scroll down] ←BACK ON OFF	[↑][scroll up] ←BACK OFF ON	→	◙ [set]

10.7. Structure of local setpoints MENU

(Press and hold any of 3 buttons for 4 s.)

If you navigate through the active local MENU area, you should hold the button for at least 1s to trigger the action. The pushing and holding of button ↑ or ↓ results in scrolling of the MENU items approximately every 1 s. If you leave the local MENU inactive for more than 2 minutes, the transmitter will automatically leave the local MENU and begins displaying the process variable.

```
||
EXIT                        (The first message you will see when Local Menu is
|                           enabled. If you accept this option, you will leave the Local Menu
|                           and return to the process variable display.)
|
PVZERO_____
|           \
|           ←BACK           (Return to Local Menu. If you approve this option,
|           |               you will return to the main tree of the Local Menu.)
|           |
|           PVZERO          (Pressure resetting. If you approve this option,
|                           the transmitter will confirm that it received the command using
|                           "DONE" message or will display a relevant error number.)
|
SETLRV_____                 (Setting of the beginning of set LRV range.)
|           \
|           ←BACK           (Return to Local Menu. If you approve this option,
|           |               you will return to the main tree of the Local Menu.)
|           |
|           BYPRESsure      (Setting of LRV through set pressure. After parameter acceptance
|           |               the transmitter will confirm that it received the command using
|           |               "DONE" message or will display a relevant error number.)
|           |
|           BYVALUe         (Setting of LRV by entering a digit.)
|                 \
|           (When approved, the current LRV value will be displayed before
|           going to the edit mode.)
|                 ↓
|                 ↓
|                 +/-       (Select and confirm the character of the parameter you entered.)
|                 ↓
|                 00000     (Enter a 5-digit number, digit by digit,
|                           with or without a decimal point. After accepting the last 5th digit of the
|                           parameter the transmitter will confirm that it received the command by
|                           displaying the following message "DONE" or will display a relevant error
|                           number.
|                           The parameter is entered in "UNITs".)
|
SETURV_____                 (Setting of the end of set URV range.)
|           \
|           ←BACK           (Return to Local Menu. If you approve this option,
|           |               you will return to the main tree of the Local Menu.)
|           |
```

| **BYPRESsure** (Setting of URV through set pressure. After parameter acceptance
| | the transmitter will confirm that it received the command using
| | "DONE" message or will display a relevant error number.)
| |
| **BYVALUe** (Setting of URV by entering a digit)
| \
| *(After accepting, the current URV value will be displayed before*
| *going to the edit mode.)*
| **↓**
| **↓**
| **+/-** (Select and confirm the character of the parameter you entered.)
| **↓**
| **00000** (Enter a 5-digit number, digit by digit,
| with or without a decimal point. After accepting the last 5th digit of the
| parameter the transmitter will confirm that it received the command by
| displaying the following message "DONE" or will display a relevant error
| number.
| The parameter is entered in "UNITs".)
|
UNIT_____
| \
| **←BACK** (Return to Local Menu. If you approve this option,
| | you will return to the main tree of the Local Menu.)
| |
| | (Accept one of the following units by
| | pressing ● button. After accepting the parameter,
| | the transmitter will confirm that it received the command by displaying the
| | following message "DONE".)
| **INH2O**
| **INHG**
| **FTH2O**
| **MMH2O**
| **MMHG**
| **PSI**
| **BAR**
| **MBAR**
| **GSQCM**
| **KGSQCM**
| **PA**
| **KPA**
| **TORR**
| **ATM**
| **MH2O4**
| **MPA**
| **INH2O4**
| **MMH2O4**

|DAMPINg___ (Setting of damping time constant of process variable.)
| \
| **←BACK** (Return to Local Menu. If you approve this option,
| | you will return to the main tree of the Local Menu.)
| |
| | (Accept one of the following values of time constant by

| | | pressing and holding ● button. After accepting the parameter,
| | | the transmitter will confirm that it received the command by displaying the
| | | following message “DONE”.)
| **0 [s]**
| **2 [s]**
| **5 [s]**
| **10 [s]**
| **30 [s]**
| **60 [s]**
|
|
TRANSFer____ (Setting of transfer type for current output characteristics.)
| \
| **←BACK** (Return to Local Menu. If you approve this option,
| | you will return to the main tree of the Local Menu.)
| |
| | (Accept one of the following values of time by pressing and holding
| | pressing ● button. After accepting the parameter,
| | the transmitter will confirm that it received the command by displaying the
| | following message “DONE”.)
| **LINEAr** (Linear)
| **SQRT** (Square root.)
| **SPECIAl** (Special user specified.)
| **SQUARE** (Square.)
|
|
% SQRT_____ (Setting of root characteristic cut-off point.)
| \
| **←BACK** (Return to Local Menu. If you approve this option,
| | you will return to the main tree of the Local Menu.)
| |
| | (Accept one of the following values by pressing and holding
| | pressing ● button. After accepting the parameter,
| | the transmitter will confirm that it received the command by displaying the
| | following message “DONE”.)
| **0.0%**
| **0.2%**
| **0.4%**
| **0.6%**
| **0.8%**
| **1.0%**
|
|
LCD1VaRiable_ (Type of process variable displayed on LCD1.)
| \
| **←BACK** (Return to Local Menu. If you approve this option,
| | you will return to the main tree of the Local Menu.)
| |
| | (Accept one of the following options by
| | pressing ● button. After accepting the parameter,
| | the transmitter will confirm that it received the command by displaying the
| | following message “DONE”.)

| **CURRENt** (LCD1 display will display a value of current
| | in the current loop.)
| |
| **PERCENt** (LCD1 display will display a percentage value
| of output setpoint.)
|
|
LCD2VaRiable_ (Type of variable displayed on LCD2.)
| \
| **←BACK** (Return to Local Menu. If you approve this option,
| | you will return to the main tree of the Local Menu.)
| |
| | (Accept one of the following options by
| | pressing ● button. After accepting the parameter,
| | the transmitter will confirm that it received the command by displaying the
| | following message “DONE”.)
| |
| **PRESSure** (LCD2 will display pressure.)
| |
| **USER** (LCD2 display will display the value
| | scaled in user units.)
| |
| **SENS_T** (LCD2 display will display the current
| | temperature of pressure sensor – head in °C.)
| |
| **CPU_T** (LCD2 display will display the current
| temperature of transducer CPU – electronic elements in °C.)
|
LCD2DP_____ (Position of decimal point of the variable displayed on LCD2.)
| \
| **←BACK** (Return to Local Menu. If you approve this option,
| | you will return to Local Menu main tree.)
| |
| | (Accept one of the following options by
| | pressing ● button. After accepting the parameter,
| | the transmitter will confirm that it received the command by displaying the
| | following message “DONE”.)
| |
| **XXXXX●**
| |
| **XXXX●X**
| |
| **XXX●XX**
| |
| **XX●XXX**
|
| **X●XXXX**
|
FACTORy____ (Removal of pressure and current sub-calibration. Return to
| \ factory settings.)
| \
| **←BACK** (Return to Local Menu. If you approve this option,
| | you will return to the main tree of the Local Menu.)

		(Accept the following command by pressing and holding
		● button. After accepting the parameter, the transmitter
		will confirm that it has received the command with “DONE” message.)
	RECALL	
RESET_____		(Software forcing of transmitter reset.)
	\	
	←BACK	(Return to Local Menu. If you approve this option,
		you will return to the main tree of the Local Menu.)
		(Accept the following command by pressing and holding
		● button. After accepting the parameter, the transmitter
		will perform hot restart.)
	RESET	
MID_WP_____		(Locked modification of parameters related to MID metrology.)
	\	
	←BACK	(Return to Local Menu. If you approve this option,
		you will return to the main tree of the Local Menu.)
		(Accept one of the following options by
		pressing ● button. After accepting the parameter,
		the transmitter will confirm that it received the command by displaying the following message “DONE”.)
	ON	(Activation of the interlock of parameters affecting metrology.)
	OFF	(Deactivation of the interlock of parameters affecting metrology.)

10.8. Remote configuration of setpoints (HART)

The transmitter allows to read out and configure the parameters via HART communication using 4...20 mA loop as a physical layer for modulation FSK BELL 202.

10.8.1. Compatible devices

The following devices may be used to communicate with the transmitter:

- Delta Mobrey Limited DKAP-03 communicator;
- communicators from other companies, including those using DDL and DTM libraries;
- PC computers equipped with HART modem (e.g. HART/USB converter by Delta Mobrey Limited.) with Windows7 or Windows10 operating system with installed D-Soft;
- PC computers equipped with HART modem using software from other companies, accepting DDL and DTM libraries;

10.8.2. Compatible configuration software

- D-Soft Delta Mobrey under control of Windows 7 or Windows 10;
- every software from other companies accepting DDL and DTM libraries.

10.8.3. Local HART communication jumper

The transmitter allows to use the local HART communication. To do this you can use a HART communicator unit or modem interoperating with a computer or a smartphone. In order to establish communication, it is necessary to:

- remove the HART communication jumper (➔Figure 32, item 2);
- connect the communicator or modem to terminals (➔ Connection of transmitter with the option of using local HART communication).

10.8.4. Method of connecting communication devices

The method of connecting the communication devices locally to the transmitter is described in section (➔ Connection of transmitter with the option of using local HART communication). In case of remote communication, HART modem should be incorporated in parallel to line 4...20 mA. It is required that resistance between the power supply and the modem connection point be greater than 240 Ω. One shall also observe the guidelines of the minimum load resistance R_{L_MAX} described in section (➔ Resistance load in power supply line). When using measuring cards with built-in HART master, it shall be necessary to observe the regulations of the card manufacturer.

10.8.5. Structure of remote configuration menu

Transmitter provides a number of parameters, data and methods via remote HART communication. The structure of the menu in this configuration and access to other data depends on the software used to communicate with the transmitter or libraries used in the applications. Therefore, it is not possible to describe this structure in this manual.
The transmitter meets the requirements of the HART standard, Revision 5.1 and Revision 7. The available commands and the associated parameters and methods are shown in Table 3 and Table 4.

Table 3. HART Rev. 5.1 communication. Commands, parameters, methods.

APC(R)-2000ALW. Specific data related to the HART Rev. 5.1 protocol application layer		
HART Command No	Type	Function
Universal commands		
0	READ	Read unique identifier
1	READ	Read primary variable
2	READ	Read current and percent of range
3	READ	Read current and four dynamics variables
6	WRITE	Write pooling address
11	READ	Read unique identifier associated with TAG
12	READ	Read message
13	READ	Read TAG, DESCRIPTOR, DATE
14	READ	Read PV sensor information
15	READ	Read output information
16	READ	Read final Assembly Number
17	WRITE	Write message
18	WRITE	Write tag, descriptor, date
19	WRITE	Write final assembly number
General-purpose commands		
34	WRITE	Write PV damping value
35	WRITE	Write PV unit code and upper and lower range values
36	WRITE	Set PV upper range value URV by PV value
37	WRITE	Set PV lower range value LRV by PV value
38	WRITE	Reset “configuration changed” flag
40	WRITE	Enter/exit PV current mode
42	WRITE	Perform master reset
43	WRITE	Set PV zero
44	WRITE	Write PV unit
45	WRITE	Trim PV current DAC zero
46	WRITE	Trim PV current DAC gain
47	WRITE	Write PV transfer function
48	READ	Read additional transmitter status
59	WRITE	Set numbers of response preambles
Manufacturer’s specific commands		
128	READ	Read static data materials
129	READ	Read device variable trim points
130	WRITE	Trim upper sensor calibration
131	WRITE	Trim lower sensor calibration
132	WRITE	LCD1 variable, LCD2 variable, decimal points, LCD operation, keyboards operation – set local control modes
133	READ	Read local control modes
135	WRITE	Write user's characteristic coefficients
136	READ	Read user's characteristic coefficients
138	WRITE	Return to factory settings
141	WRITE	Write Analog Input function block configurations
142	READ	Read Analog Input function block configurations
230	READ	Read CPU, Master, Slave, HART firmware revision
231	READ	Read product codes
233	READ	Read separator codes
235	READ	Read manifold codes

237	READ	Read operational limits
240	WRITE	Write long TAG
241	READ	Read long TAG
242	WRITE	Write sqrt start point coefficient
243	READ	Read sqrt start point coefficient
244	WRITE	Write User's unit name and rearrange coefficients
245	READ	Read User's unit name and rearrange coefficients
246	WRITE	Write customer’s security code
247	WRITE	Set write protect code

Table 4. HART Rev. 7 communication. Commands, parameters, methods.

APC(R)-2000ALW. Specific data related to the HART Rev. 7 protocol application layer		
HART Command No	Type	Function
Universal commands		
0	READ	Read unique identifier
1	READ	Read primary variable
2	READ	Read current and percent of range
3	READ	Read current and four dynamics variables
6	WRITE	Write pooling address
7	WRITE	Read Loop Configuration
8	READ	Read Dynamic Variable Classifications
9	READ	Read Device Variables with Status
11	READ	Read unique identifier associated with TAG
12	READ	Read message
13	READ	Read TAG, DESCRIPTOR, DATE
14	READ	Read PV sensor information
15	READ	Read output information
16	READ	Read final Assembly Number
17	WRITE	Write message
18	WRITE	Write tag, descriptor, date
19	WRITE	Write final assembly number
20	READ	Read Long Tag
21	READ	Read Unique Identifier Associated With Long Tag
22	WRITE	Write Long Tag
38	WRITE	Reset Configuration Changed Flag
48	READ	Read Additional Device Status
General-purpose commands		
31	READ/WRITE	Extended Command Numbers
34	WRITE	Write Primary Variable Damping Value
35	WRITE	Write Primary Variable Range Values
36	WRITE	Set Primary Variable Upper Range Value
37	WRITE	Set Primary Variable Lower Range Value
38	WRITE	Reset Configuration Changed Flag
40	WRITE	Enter/Exit Fixed Current Mode
42	WRITE	Perform Device Reset
43	WRITE	Set Primary Variable Zero
44	WRITE	Write Primary Variable Units
45	WRITE	Trim Loop Current Zero

46	WRITE	Trim Loop Current Gain
47	WRITE	Write Primary Variable Transfer Function
50	READ	Read Dynamic Variable Assignments
54	READ	Read Device Variable Information
59	WRITE	Write Number Of Response Preambles
80	READ	Read Device Variable Trim Points
81	READ	Read Device Variable Trim Guidelines
82	WRITE	Write Device Variable Trim Point
83	WRITE	Reset Device Variable Trim
1280	READ	Read Pressure Status
1281	READ	Read Capabilities
1282	READ	Read Supported Status Mask
1283	READ	Read Pressure Sensor Information
1284	READ	Read Process Connection
1285	READ	Read Associated Device Variables
Manufacturer’s specific commands		
128	READ	Read static data materials
129	READ	Read device variable trim points
130	WRITE	Trim upper sensor calibration
131	WRITE	Trim lower sensor calibration
132	WRITE	LCD1 variable, LCD2 variable, decimal points, LCD operation, keyboards operation - set local control modes
133	READ	Read local control modes
134	WRITE	Write HART5/HART7 mode
135	WRITE	Write user's characteristic coefficients
136	READ	Read user's characteristic coefficients
138	WRITE	Return to factory settings
141	WRITE	Write Analog Input function block configurations
142	READ	Read Analog Input function block configurations
230	READ	Read CPU, Master, Slave, HART firmware revision
231	READ	Read product codes
233	READ	Read separator codes
235	READ	Read manifold codes
237	READ	Read operational limits
240	WRITE	Write long TAG
241	READ	Read long TAG
242	WRITE	Write sqrt start point coefficient
243	READ	Read sqrt start point coefficient
244	WRITE	Write User's unit name and rearrange coefficients
245	READ	Read User's unit name and rearrange coefficients
246	WRITE	Write customer’s security code
247	WRITE	Set write protect code

Configurable, non-configurable parameters, methods and diagnostic statuses are described in detail in Technical Information.

11. START-UP

The transmitter is typically set to the set range equal to the base range. The base range and the basic unit of the transmitter can be read out from its nameplate (➔ Transmitter identification).

Danger of injury due to component breakage after exceeding the maximum permitted operating pressure!

Always use the transmitter within the allowable pressure limits!

11.1. Alarm configuration

Transmitter D21/D31 has extensive internal diagnostics. The transmitter's internal diagnostics monitors the operation of its electronic circuits, process parameters and environmental parameters, thus it ensures increased level of process safety. Diagnosis of hazardous statuses or malfunctioning of the internal transmitter systems results in setting alarm current depending on the configuration I_AL < 3.650 mA or I_AL > 21.500 mA. Using HART communication, user can enable / disable diagnostics or change the alarm current. The figure below shows the normal operational ranges of the transmitter process output and the ranges of saturation and alarm currents.

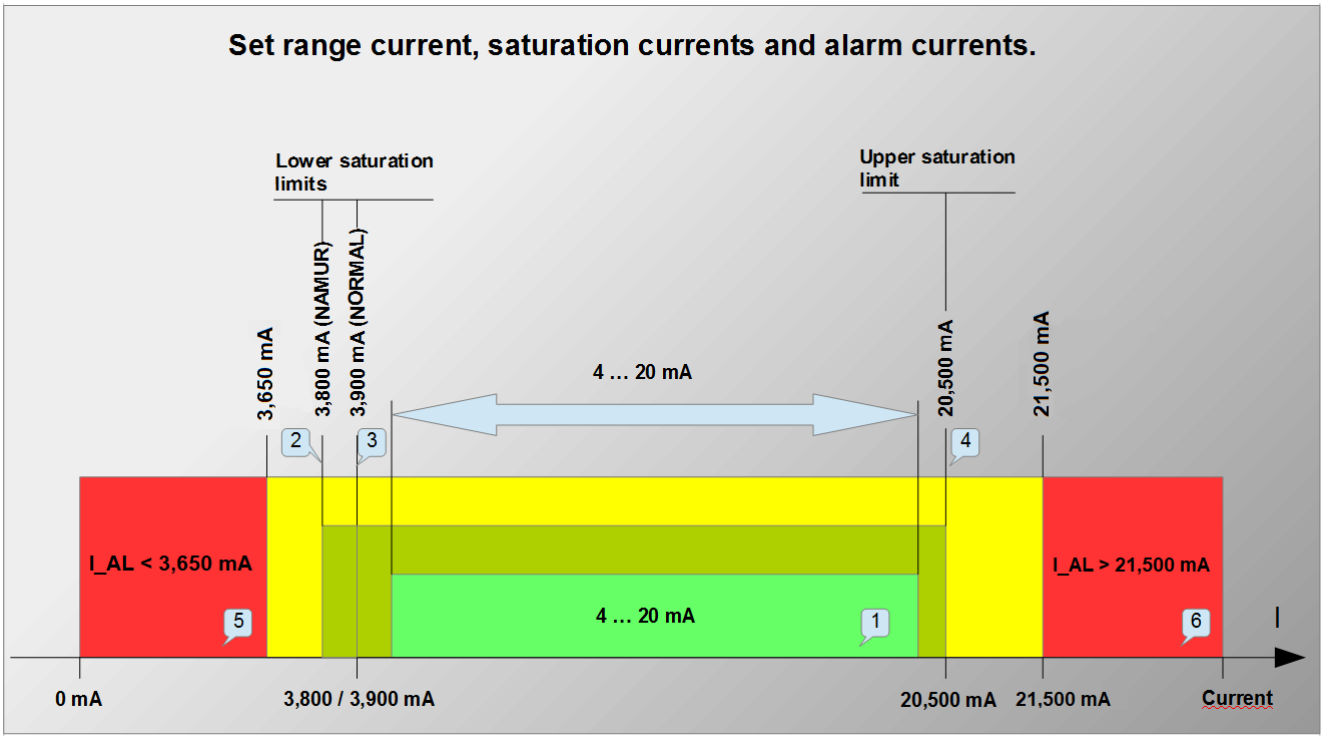


Figure 36. Set range current, saturation currents, alarm currents.

1 – Set 4...20 mA current area is corresponding to setpoint 0…100% of the process output.
2 – Lower saturation current of 3.800 mA for NAMUR mode.
3 – Lower saturation current of 3.900 mA for NORMAL mode.
4 – Upper saturation current of 20.500 mA for NAMUR and NORMAL mode.
5 – Alarm current area AL_L < 3,650 mA for internal diagnostic alarm
6 – Alarm current area AL_H > 21,500 mA for alarms related to safe failures with external diagnostics.

The transmitter diagnostics continually tests the environmental parameters:

- temperature of the pressure measurement structure sensor;
- temperature of the ADC transducer converting the electric signal from the pressure sensor to the digital value of measurement;
- temperature of the CPU structure (transmitter's main microcontroller). In the case of alarms from 2, 3 and 4 process variable (temperatures) enabled, if the transmitter operating temperature limits are exceeded, the diagnostics will trigger an alarm depending on the configuration AL_L < 3.650 mA or AL_H > 21.500 mA. Temperature return to permissible range of the transmitter operation will result in deactivation of the diagnostic alarm mode and return to normal operation.

The transmitter diagnostics continually tests the pressure process parameters:

- if the pressure/differential pressure value increases to the upper limit of ADC measurement transducer converting, reaching the USAL point, the diagnostics will trigger an alarm depending on the configuration AL_L < 3.650 mA or AL_H > 21.500 mA. The return of the pressure/differential pressure below the USAL point will result in deactivating the alarm and returning the transmitter to its normal operation;
- if the pressure/differential pressure value decreases to the lower limit of ADC measurement transducer converting, reaching the LSAL point, the diagnostics will trigger an alarm depending on the configuration AL_L < 3.650 mA or AL_H > 21.500 mA. The return of the pressure/differential pressure above the LSAL point will result in deactivating the alarm and returning the transmitter to its normal operation.

The transmitter diagnostics continually tests electric parameters and software resources of transmitter:

- if the inner diagnostics detects the malfunctioning or failure of the transmitter which are not critical with regard of integrity of hardware and software, the transmitter software will activate alarm depending on the configuration AL_L < 3.650 mA or AL_L > 21.500 mA. The diagnostic alarm condition will continue until the failure or damage is resolved. Error/failure number **Exxxx** will appear on LCD2; the **ERROR** message will be displayed on LCD3. The image will blink to attract the operator's attention. The transmitter will set the current output to alarm status I_AL< 3.600 mA. In order to identify the cause, please refer to section (➔ TROUBLESHOOTING);
- if the internal diagnostics detects malfunctioning or failure of the transmitter which are critical from the point of view of integrity of hardware and software, such as the hardware error of RAM, FLASH, SVS, CPU logs, mathematical computation error, or if there is a difference exceeding 1% between the set process current and the current measured in the line, the transmitter will immediately stop operation and activate the critical diagnostic alarm mode. The transmitter display will be switched off. HART

communication with the transmitter will not be possible. In the critical diagnostic alarm mode, the additional protection of the transmitter will lower the current in the loop 4...20 mA. In such a case, alarm current I_AL is much lower than 3.650 mA, amounting about 0.150 mA. The transmitter will remain in the critical alarm status for approx. 10 seconds, then it will attempt to restart. When the internal diagnostics detects no hardware errors after restart, the transmitter will return to normal operation.

11.2. Configuration of operating mode

Before starting the work, the transmitter must be configured. The configuration should cover the following basic parameters:

- basic unit of transmitter;
- processing characteristics;
- the beginning of the set LRV range;
- the end of the set URV range;
- damping time constant;
- NORMAL/NAMUR analogue output operation mode;
- analog output operation mode in alarm status (AL_L / AL_H);
- alarm mode for indicating environmental events and defects;
- transmitter tag (TAG / LONG_TAG);
- LCD display configuration parameters;
- setting of the settings change lock password.

11.3. Correction of impact of mounting position

Once the transmitter is mounted in a target location, it must be reset. This operation will eliminate the possible influence of the mounting position on the indication of pressure/differential pressure. In order to do so:

- in the case of atmospheric pressure transmitter without pressure supplied (vented), perform the pressure resetting operation using the local MENU or HART communication;
- in the case of a differential pressure transmitter, at compensated pressures on the L and H supply, perform the pressure reset operation by means of local MENU or HART communication;
- in case of absolute pressure transmitter the resetting is not possible. The attempt to reset the transmitter will result in error message being displayed.

Once the transmitter parameters have been entered and it has been reset at the workstation, it is required to:

- **secure the device against the possibility of making changes in the local setpoint change MENU;**
- **set your own password different from default password of “00000000”. The new password may consist of any combination of 8 hexadecimal characters 0...9, A…F. Store the password in a safe place. If the password is lost, its restoration or resetting to factory settings may only be performed by the manufacturer;**
- **activate the setpoint change lock to secure the transmitter against accidental, unintentional change of parameters.**

Pressure resetting can be done via local setpoint change MENU or HART communication. The remaining operations described in this section may only be performed using HART communication.

11.4. Flow measurements

Differential pressure transmitter D31 can be used for flow measurement. The method of connecting the transmitter to the pressure system is described in sections (➔ Gas and steam flow rate measurement system) and (➔ Liquid flow rate measurement system).
Flow measurements often require setting of pressure-processing characteristics for output current setpoints other than linear. In D31 the following characteristics are available for the user:

- linear characteristics;
- second-stage root characteristics with relay characteristics and 0.2% hysteresis in the deadband;
- manufacturer's dual linear characteristics No 1 + second-stage root characteristics for constant deadband = 0.6% of setpoints;
- manufacturer's single linear characteristics No 2 + second-stage root characteristics and 0.2% hysteresis in the deadband;
- square characteristics;
- special characteristics based on user-modified table.

For more flow measurement issues refer to Technical Information IOM-D21-D31-EX IS-A NOV 2019.

11.5. Level measurements

Transmitters D21, D31, D34, D35can be used for liquid level measurement in open or closed tanks.
The method of connecting the transmitter to the level measurement system is described in the following sections: ➔ Liquid level measurement system in open tanks and ➔ Liquid level measurement system in closed tanks.
The transmitter can be configured in physical units of liquid column such as water and mercury at several temperatures of the liquid. It is also possible to enter the user's unit and perform scaling of the setpoint indication. In case of tanks with irregular shapes, it is possible to use the user's characteristics to compensate the effect of the shape on the converted volume of liquid in the tank.
For more level measurement issues refer to Technical Information IOM-D21-D31-EX IS-A NOV 2019.

11.6. Pressure measurements

Transmitter D21, D31can be used for pressure measurement. The method of connecting the transmitter to the measurement system is similar to the method of connecting the differential pressure measurement system. If differential pressure transmitter D31 is used, one pressure side of the transmitter is connected to the process, the other one remains open to the atmosphere. For more pressure measurement issues refer to Technical Information IOM-D21-D31-EX IS-A NOV 2019.

11.7. Differential pressure measurements

The method of connecting transmitter D31 to the differential pressure measurement system is described in the section (➔ Differential pressure measurement system).
The transmitter can be configured in one of many physical units of pressure. It is also possible to enter the user's unit and perform scaling of the setpoint indication.
For more differential pressure measurement issues refer to Technical Information IOM-D21-D31-EX IS-A NOV 2019.

12. MAINTENANCE

12.1. Periodic inspections

Periodic inspections shall be carried out in accordance with applicable standards.
During the inspection, the condition of the pressure (absence of loosened elements and leaks) and electrical (check of connections reliability and condition of gaskets and glands) connectors, condition of separating diaphragms (tarnish, corrosion) and stability of fixing of the housing and holder (if used) shall be checked. Check the processing characteristics by performing the operations specific for the CALIBRATION and possibly CONFIGURATION procedure.

12.2. Non-periodic inspections

If the transmitter at the installation site has been exposed to mechanical damage, pressure overload, hydraulic pulses, overvoltage, deposits, medium crystallization, undercutting of the diaphragm, or incorrect operation of the transmitter is detected, proceed as necessary. Check the condition of the diaphragm, clean it, check the electrical functionality of the transmitter and the processing characteristics.

If there is no signal in the transmission line or its value is improper, check the supply line, connection status on terminal blocks, connectors, etc. Check the correct supply voltage value and load resistance.

12.3. Cleaning / washing

To remove impurities from the external surfaces of the transmitter, it must be wiped out/dry washed or, if necessary, wiped with the wetted cloth.

12.3.1. Diaphragm cleaning

The only possible method of cleaning the transmitter diaphragms is to dissolve the sludge produced.

Do not remove deposits and dirt from the transmitter diaphragms, which are formed during operation, mechanically using tools, since the diaphragms and the transmitter can be damaged.

The causes of transmitter malfunctioning also include damages to the sensors diaphragm resulting from overloads caused, for example, by:
- application of too high pressure;
- freezing or solidification of medium;
- pushing or scraping the diaphragm with a hard object, e.g. with a screwdriver.
The symptoms of damage are generally such that the transmitter does not respond to pressure changes or responds incorrectly.

12.4. Spare parts

Parts of the transducer that may be worn or damaged and thus replaced:
- cover seal.

Other parts in the case of ATEX type of the transmitter may be replaced only by the manufacturer!

12.5. Repair

Faulty or non-operational transmitter shall be provided to the manufacturer.

12.6. Returns

In the following cases the transmitter shall be returned directly to the manufacturer:
- the need for repair has been identified;
- it is necessary to perform factory calibration;
- a wrongly selected transmitter has been ordered;
- an incorrect transmitter has been delivered.

13. SCRAPPING, DISPOSAL

Worn or damaged devices shall be scrapped in accordance with WEEE Directive (2012/19/EU) on waste electrical and electronic equipment or returned to the manufacturer.

14. TROUBLESHOOTING

14.1. Malfunction messages on LCD display

In the case of diagnosed failures, Transmitter will notify the user by setting the alarm current (depending on the settings AL_L < 3.650 mA or AL_H > 21.500 mA) and displaying a blinking collective error number on LCD2. The error number is displayed in the
E character format and 4-digit decimal numbers. To identify the cause of malfunction, it is necessary to:

- read out statuses of Analog Input, Physical Block, Sensor Block and Transducer Block through HART communication, The statuses marked in these blocks will indicate a relatively accurate cause of a failure. This is a recommended method of obtaining information about a kind of malfunction.

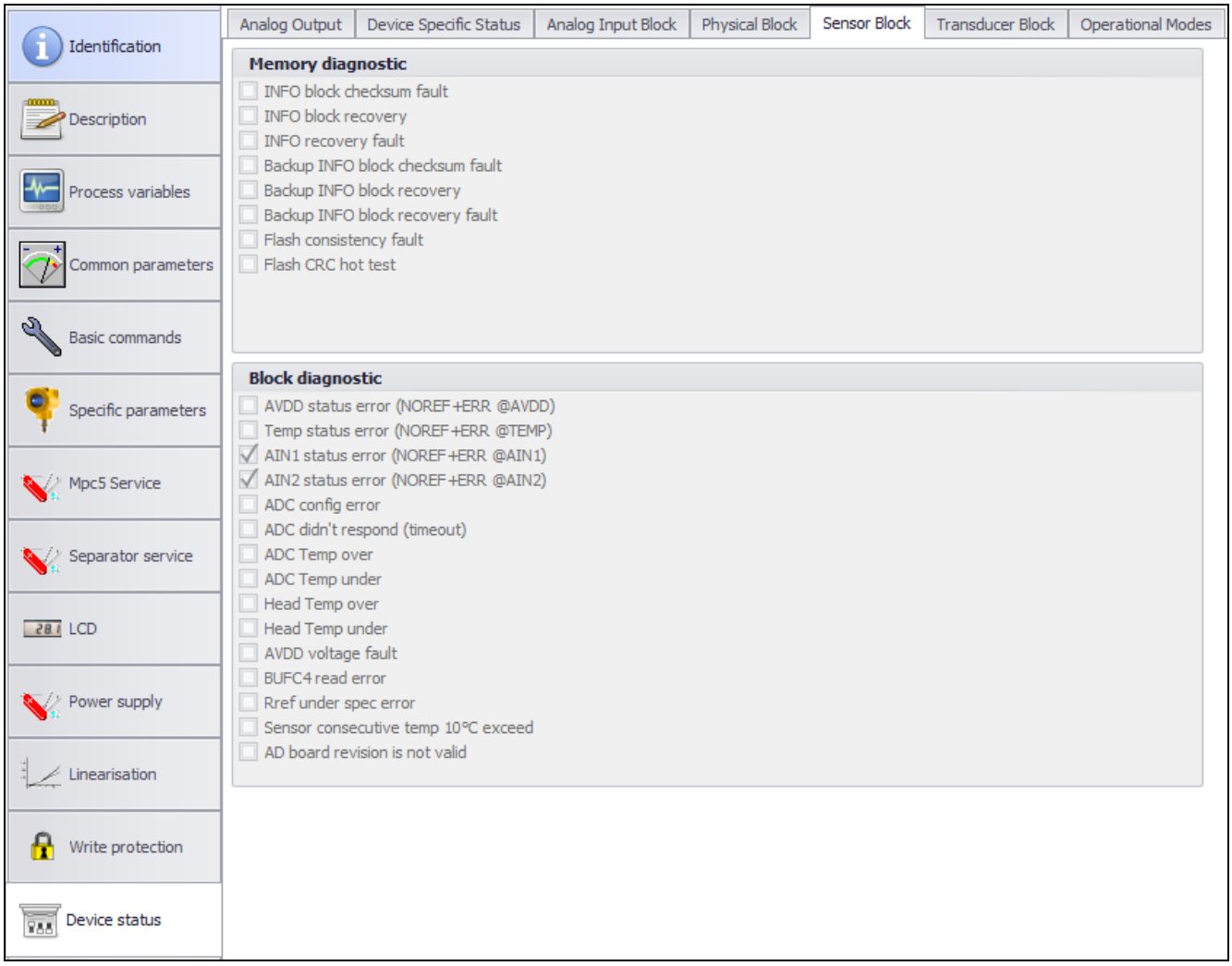


Figure 37. Example of the Sensor Block statuses read out from the transmitter via D-Soft.

- If the readout via HART communication is difficult or impossible for some reasons, it is possible to use the error status number displayed on the transmitter's LCD2 screen. This is a summary status which is a synthesis of failures and errors of all the blocks. For this reason, it is less precise.

To decode it, proceed as follows:

- replace a 4-digit decimal number displayed after E to a binary value, e.g. by means of a Windows calculator with a programmer's view option;
- read out statuses from the table below, one in the binary value item means that the status is active, zero means the status is not active.

Table 5. Numbers of error statuses displayed on the display.

Binary value bit	Status name	Description
BIT0 (1 dec)	RAM_TEST_ERROR	RAM memory failure was detected. This is a major hardware failure. The message on the display may appear only momentarily because due to the critical failure, the control will be taken over by the internal redundant alarm module WDT_SIL which will disconnect the transmitter's internal power supply. The display will be off. Current in the current loop will be I_AL << 3.650 mA. This status will last approximately 10 s, then the transmitter will attempt to restart. If the failure occurs once again, the transmitter must be sent back to the service center.
BIT1 (2 dec)	FLASH_CRC_ERROR	FLASH program memory failure was diagnosed. This is a major hardware failure. The message on the display may appear only momentarily because due to the critical failure, the control will be taken over by the internal redundant alarm module WDT_SIL which will disconnect the transmitter's internal power supply. The display will be off. Current in the current loop will be I_AL << 3.650 mA. This status will last approximately 10 s, then the transmitter will attempt to restart. If the failure occurs once again, the transmitter must be sent back to the service center.
BIT2 (4 dec)	BAD-CRC_IN_SEGMENT_INFO	FLASH data memory failure was diagnosed. This is a major hardware failure. The message on the display may appear only momentarily because due to the critical failure, the control will be taken over by the internal redundant alarm module WDT_SIL which will disconnect the transmitter's internal power supply. The display will be off. Current in the current loop will be I_AL << 3.650 mA. This status will last approximately 10 s, then the transmitter will attempt to restart. If the failure occurs once again, the transmitter must be sent back to the service center.
BIT3 (8 dec)	OSCILLATOR_FAULT	The local quartz generator failure has been diagnosed. The transmitter will switch to the operation mode with the DCO standby generator and will set alarm current depending on the settings I_AL < 3,650 mA or I_AL > 21,500 mA. This condition will continue until the transmitter is reset or disconnected and then re-energized. If the failure is repeated once again, the transmitter must be sent back to the service center.
BIT4 (16 dec)	CURRENT_LOOP_FAULT	Difference greater than 1% (160 μA) between the current measured by the transmitter in the current loop 4...20 mA and set current calculated by the transmitter was detected. The transmitter will set the alarm current depending on the settings I_AL < 3.650 mA or I_AL > 21.500 mA. If in an alarm condition the difference between the measured current and the set current calculated by the transmitter is less than 1%,

		the transmitter will remain in such an alarm condition for a few seconds and then will attempt to set the correct process current. If the error occurs again, transmitter will return to the alarm state. This condition will continue until the cause of the damage ceases to exist. However, if the alarm current will also deviate by more than 1% from the value of set current calculated by the transmitter, the control will be taken over by redundant alarm module WDT_SIL which disconnects the transmitter's internal power supply. The display will be off. Current will flow in the current loop I_AL << 3.600 mA. This status will last approximately 10 s, then the transmitter will attempt to restart. As the error may appear as a result of very strong over-normative radio interference, the quality of the voltages supplying the transmitter with regard to EMC must be checked. If the power supply is correct and the failure is repeated once again, the transmitter must be sent back to the service center.
BIT5 (32 dec)	EEP_LOOPBACK_ FAULT	The digital communication failure with the measuring head's EEPROM memory through an optical galvanic isolation has been detected. The transmitter will set the alarm current depending on the settings I_AL < 3.650 mA or I_AL > 21.500 mA. This status will continue until the cause of the damage ceases to exist. The transmitter must be sent back to the service center.
BIT6 (64 dec)	ADC_LOOPBACK_ FAULT	Malfunction or lack of digital communication with transmitter ADC in the pressure / differential pressure measuring head has been detected. The transmitter will set the alarm current depending on the settings I_AL < 3.650 mA or I_AL > 21.500 mA. This status will continue until the cause of the damage ceases to exist. The transmitter must be sent back to the service center.
BIT7 (128 dec)	ADC_NOT_ RESPONDED	Exceeding of transmitter ADC response time has been detected after sending the measurement configuration. The transmitter will set the alarm current depending on the settings I_AL < 3.650 mA or I_AL > 21.500 mA. This status will continue until the cause of the damage ceases to exist. The transmitter must be sent back to the service center.
BIT8 (256 dec)	SENSOR_FAILURE	Saturation of A/D transducer (USAL, LSAL), equipment problem related to damage of pressure measuring structure in the head or component damage were diagnosed in the pressure sensor block or pressure sensor power supply. The transmitter will set alarm current depending on the settings I_AL < 3,650 mA or I_AL > 21,500 mA. This condition will continue until the cause of the damage ceases to exist. To determine whether the cause may be pressure overload, the pressure transmitter should be vented or pressure should be compensated between L and H levels (for differential pressure transmitter). If after this operation, the transmitter returns to the measurement indication without error, this means that the cause of the error was exceeded pressure (USAL or LSAL). Otherwise, if the error is still displayed, it is likely that a failure occurred and the transmitter must be sent back to service center.
BIT9 (512 dec)	SENSOR_NOT_ CONNECTED	Damage of the pressure measurement sensor or its associated components has been detected. The transmitter will set

		the alarm current depending on the settings I_AL < 3.650 mA or I_AL > 21.500 mA. This status will continue until the cause of the damage ceases to exist. The transmitter must be sent back to the service center.
BITA (1024 dec)	PRIMARY_VARIABLE_ NOT_VALID	Failure of the microcontroller has been diagnosed during mathematical operations. This is a critical failure. Current in the current loop will be I_AL << 3.650 mA. This status will last approximately 10 s, then the transmitter will attempt to restart. If the failure occurs once again, the transmitter must be sent back to the service center.
BITB (2048dec)	PRIMARY_VARIABLE_ OUT_OF_LIMITS	The LPL or UPL point was exceeded on pressure/differential pressure scale. The digital measurement of the transmitter outside these points is not possible. The transmitter will set the alarm current depending on the settings I_AL < 3.650 mA or I_AL > 21.500 mA. This condition will continue until the cause of the overload ceases to exist. If the transmitter is within the correct pressure range according to the information on the nameplate and the error message is still displayed, this may indicate a failure of the transmitter component. In this situation, the transmitter must be sent back to the service center.
BITC (2048dec)	SECONDARY_ VARIABLE_ OUT_OF_LIMITS	The limits of the permissible temperature range of the transmitter operation were exceeded. The temperature measurement is done at 3 points: pressure sensor, A/D transducer and main CPU controller. The transmitter will set the alarm current depending on the settings I_AL < 3.650 mA or I_AL > 21.500 mA. This condition will continue until the operating temperature returns to its correct range. If the transmitter is within the correct temperature range according to the information on the nameplate and the error message is still displayed, this may indicate a failure of the transmitter component. In this situation, the transmitter must be sent back to the service center.

14.2. Failure statuses read using HART

The transmitter allows to reading out statuses using HART communication. The range of information available in this way is broader than the information that is diagnosed based on the error number shown on the transmitter display. Diagnostics allows to read out the operation parameters of the transmitter blocks. Exemplary screen shots from D-Soft show the range of available diagnostic information. If the transmitter reports an error and the cause is not known, the manufacturer recommends using HART diagnostics to determine the type of failure during contact with the service center. The statuses indicated in the figures below are of indicative nature and show the way of displaying the failures.

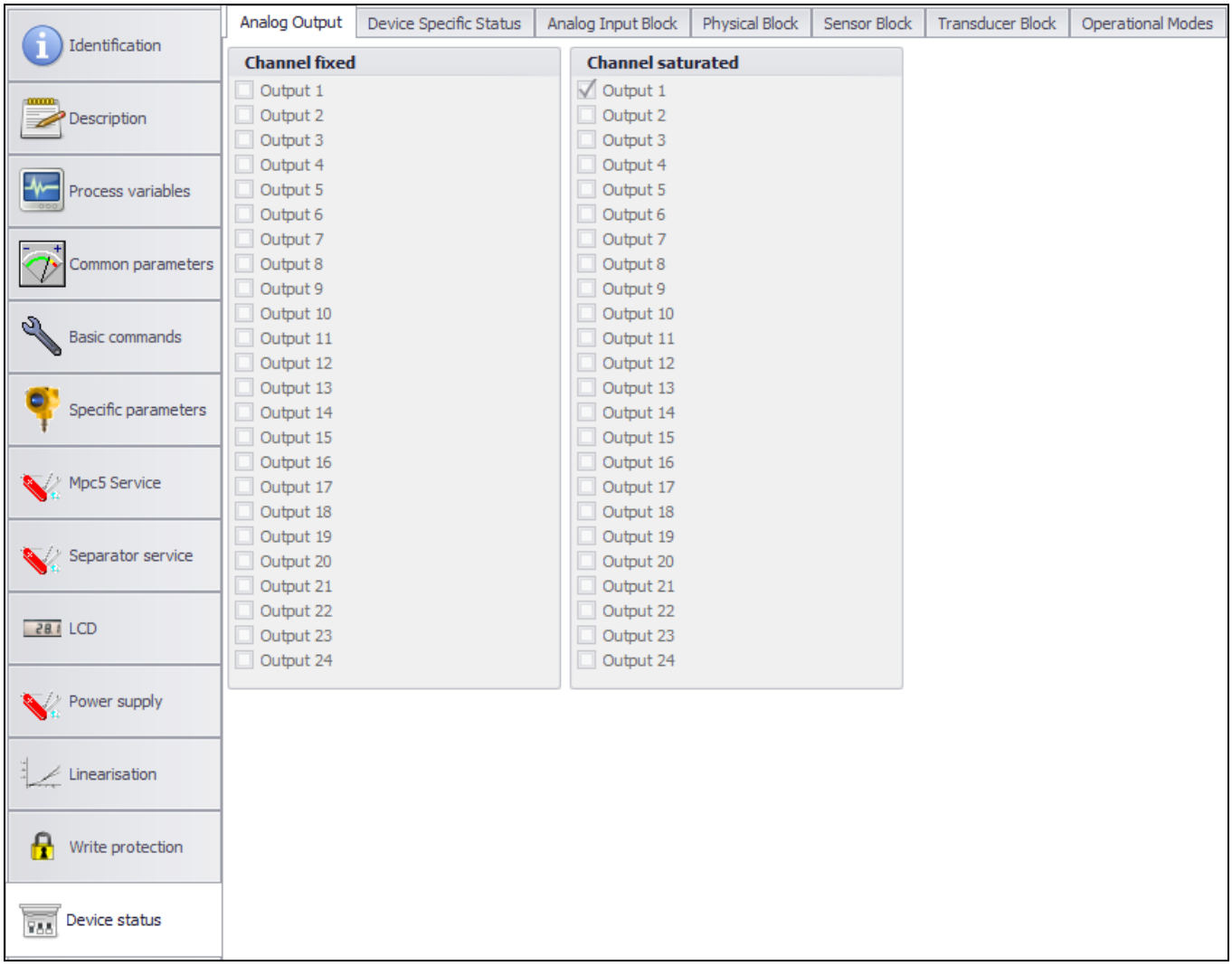


Figure 40. Statuses of the analogue output block.

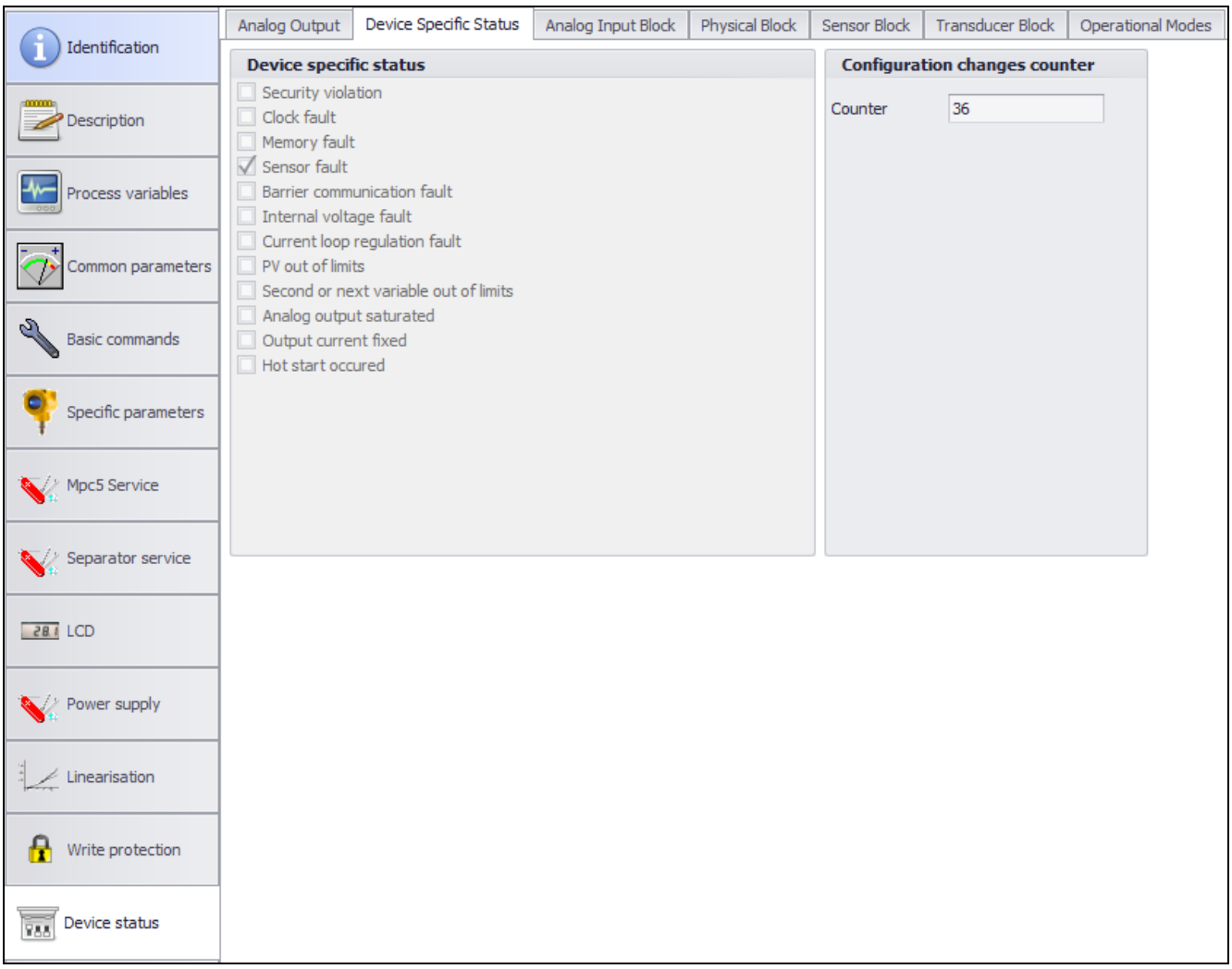


Figure 38. Device specific (summary) statuses.

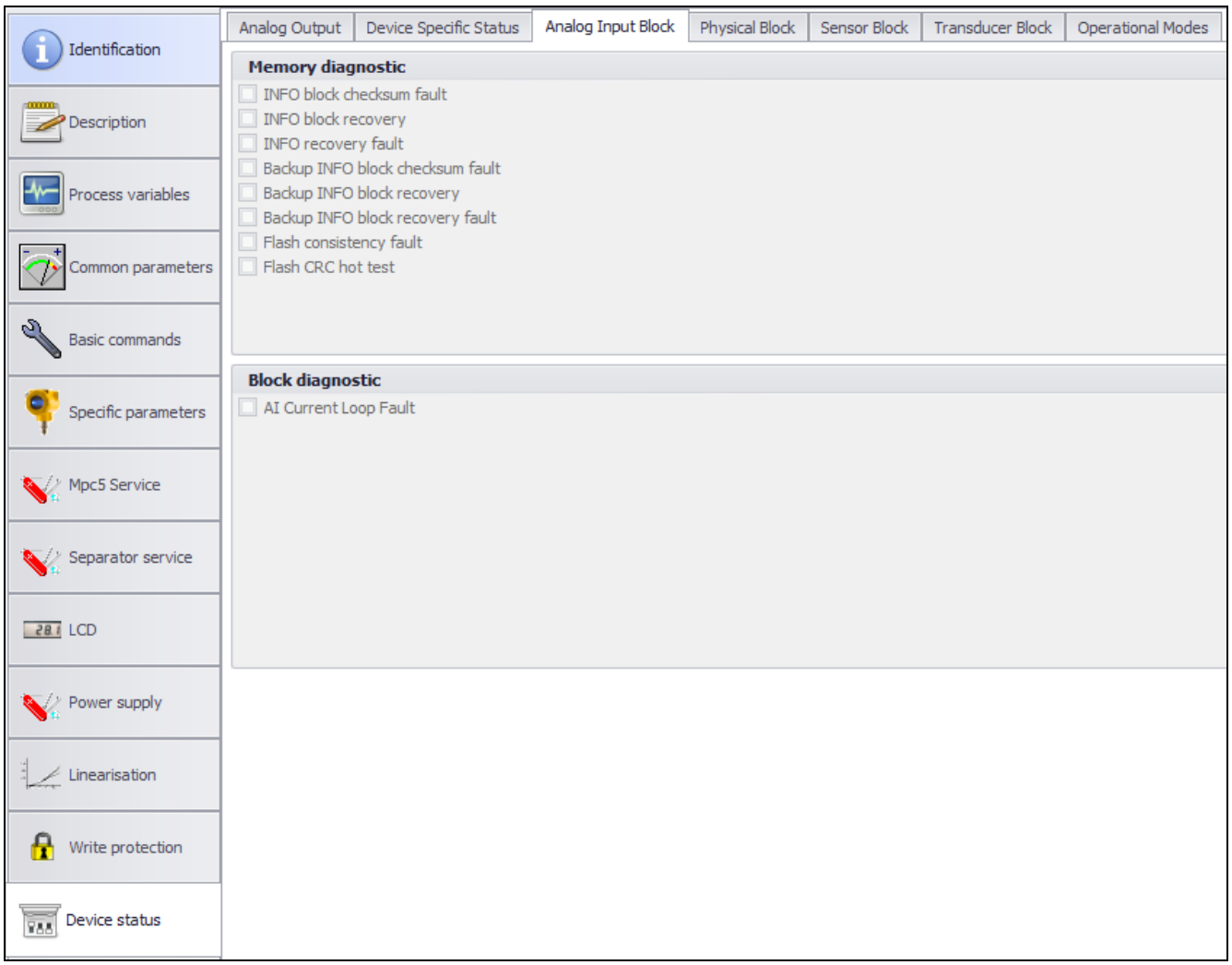


Figure 39. Analog input block statuses.

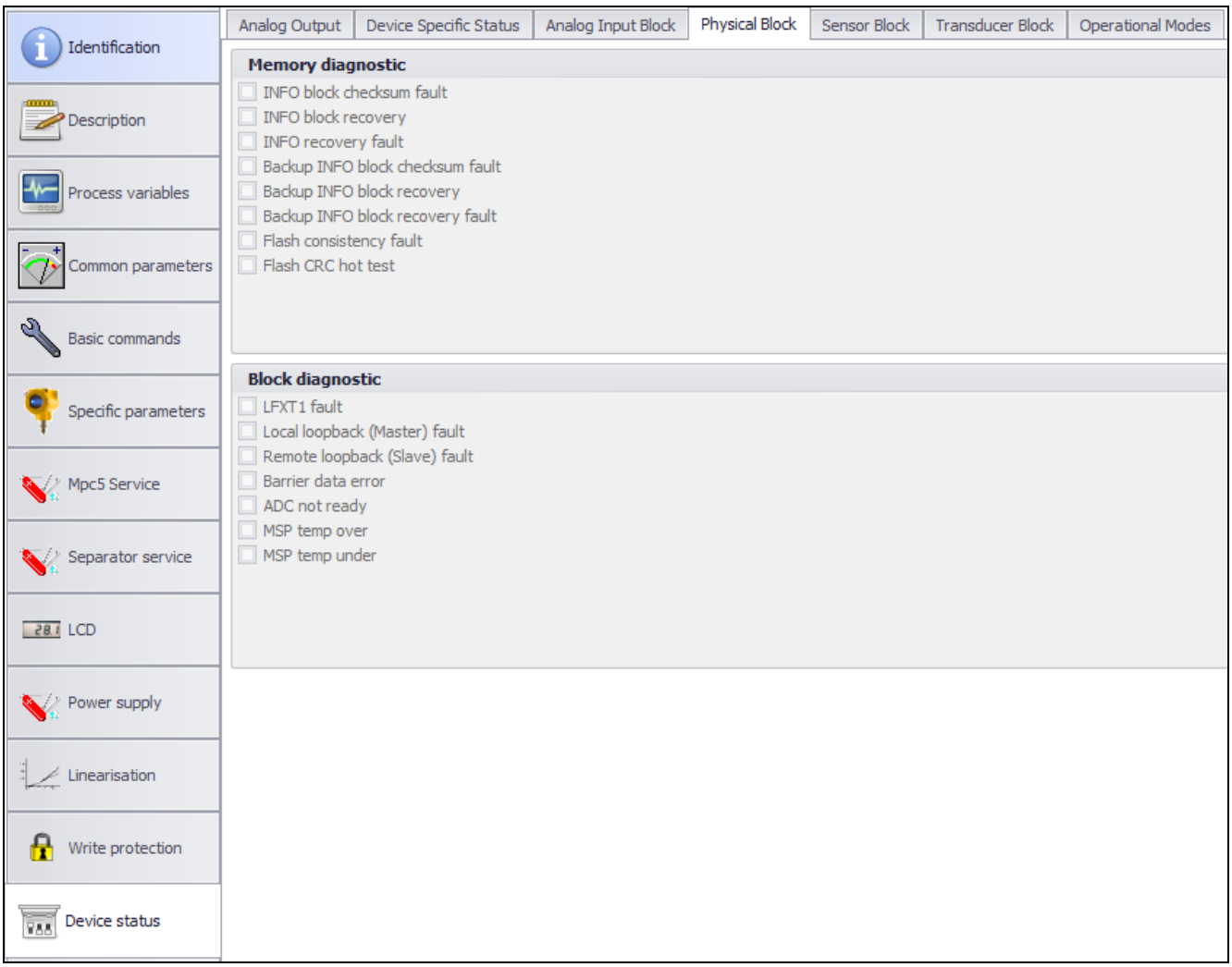


Figure 40. Physical block statuses.

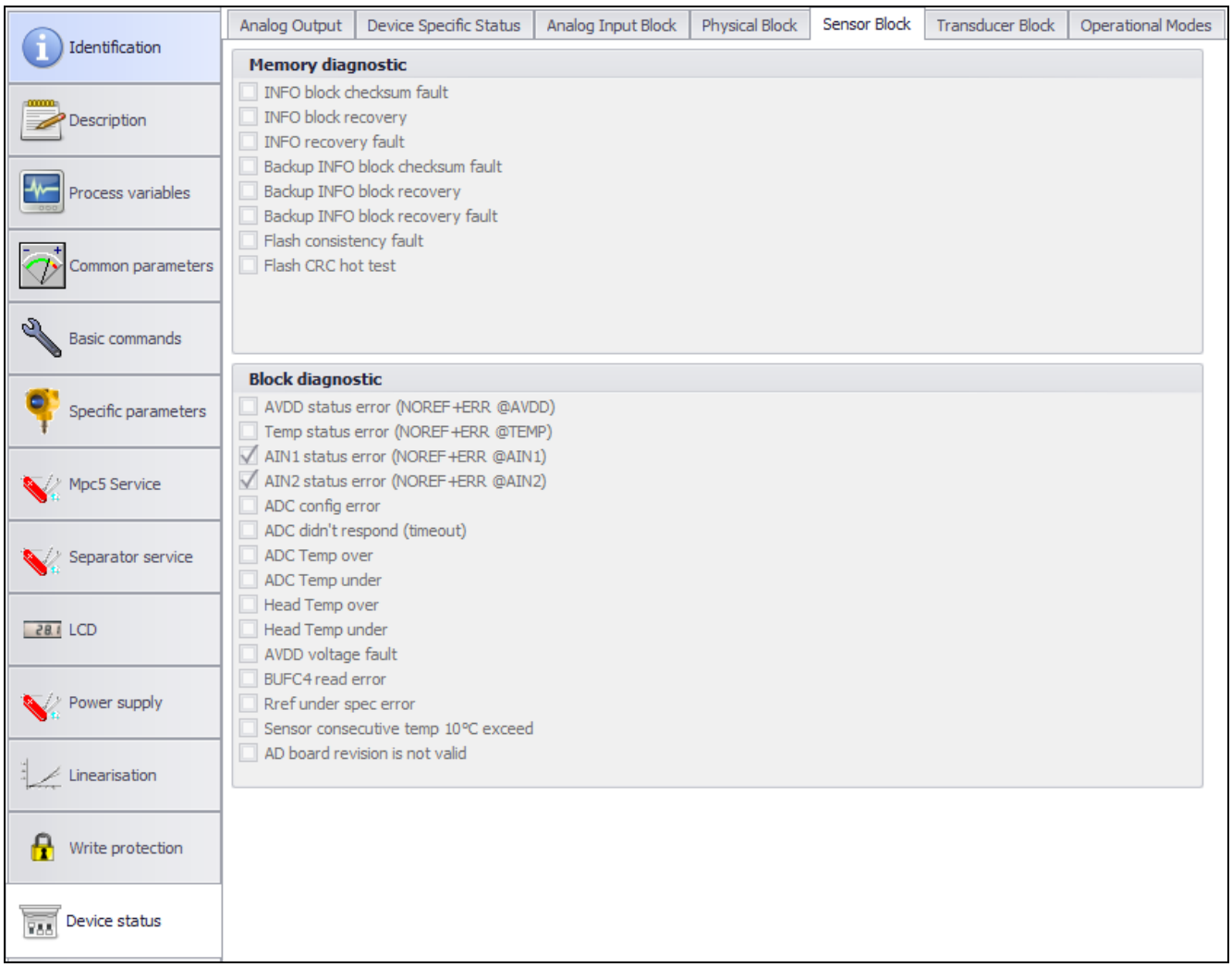


Figure 44 Pressure sensor block statuses.

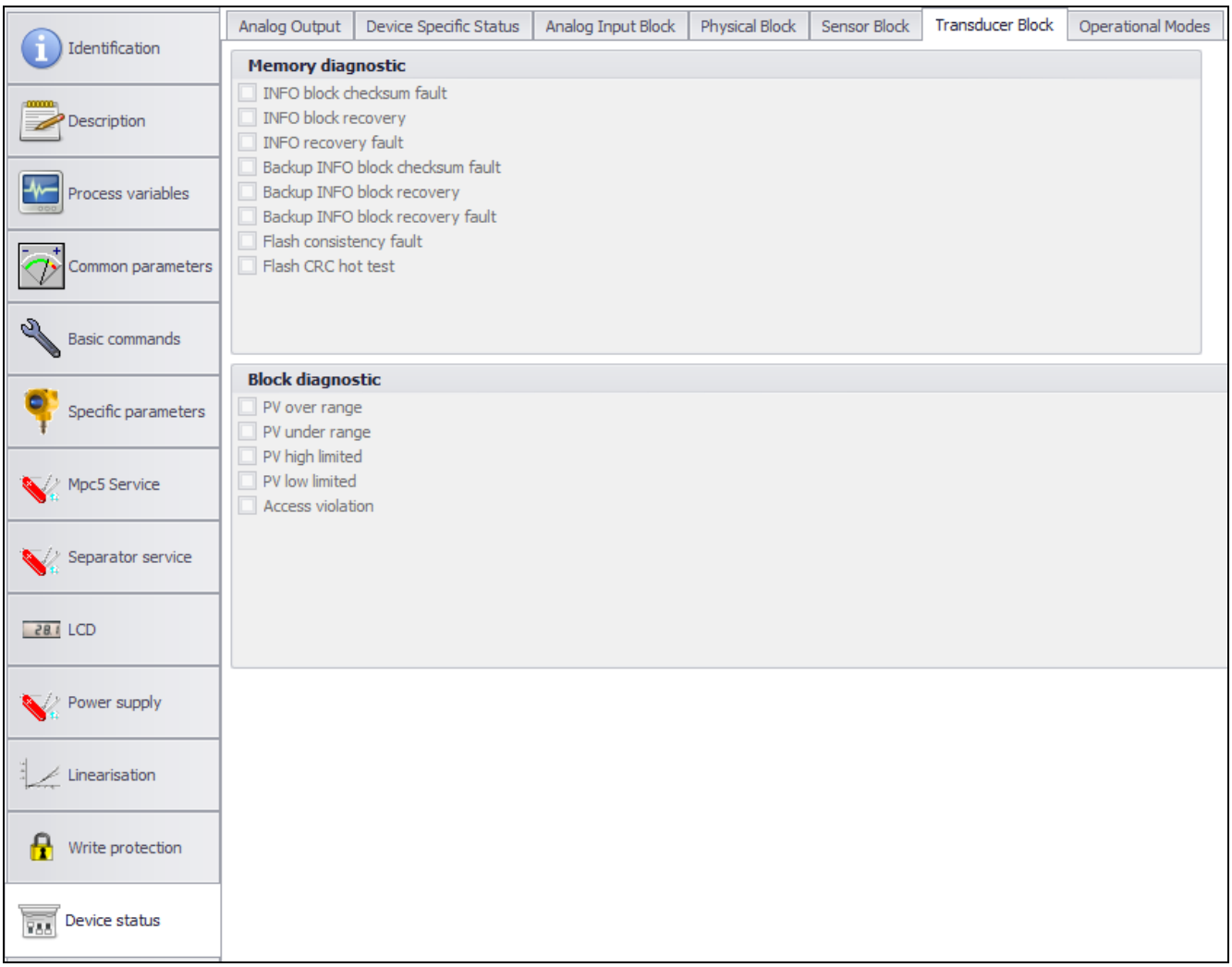


Figure 45. Transducer block statuses.

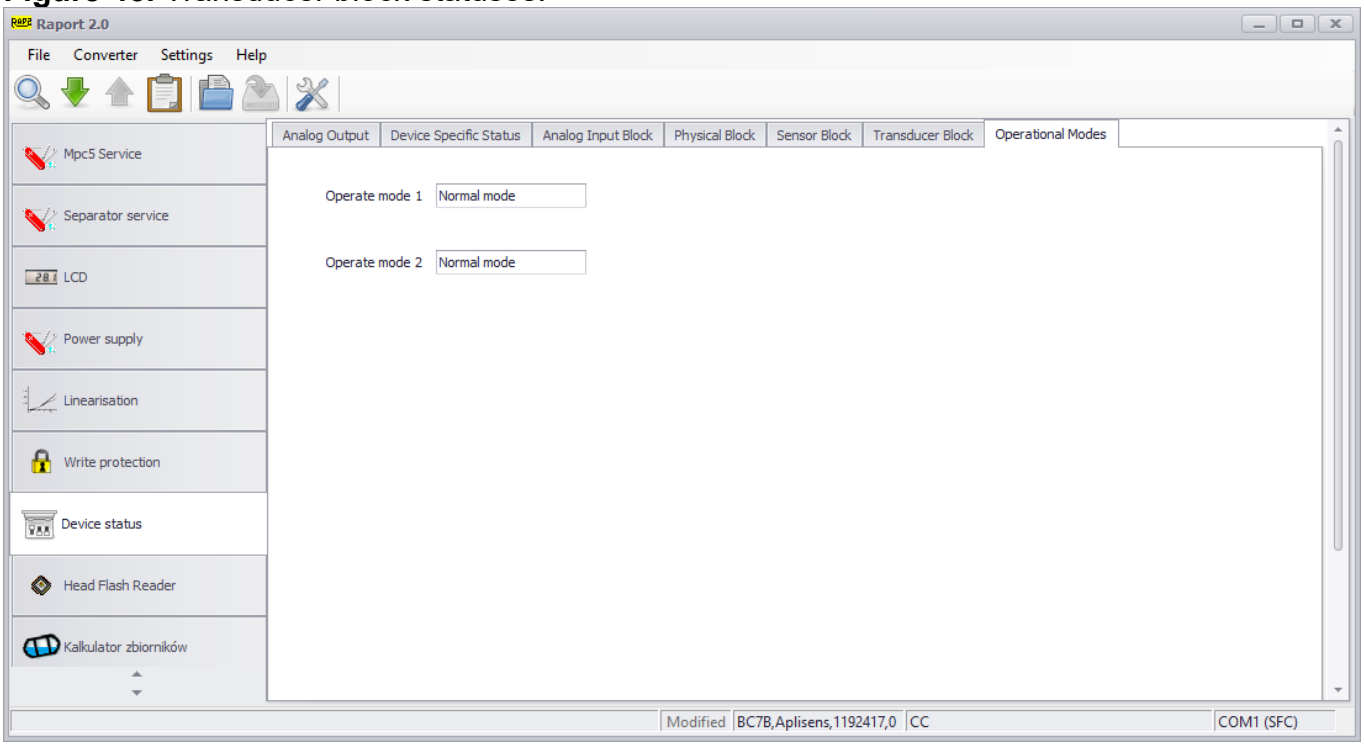


Figure 41. Operational modes statuses.

14.3. Influence of malfunction and failure on transmitter operation and output current

Any diagnosed malfunctioning and failures trigger alarm current I_AL < 3.650 mA (approx. 3.600 mA), I_AL > 21.500 mA (approx. 22.000 mA) or I_AL << 3.650 mA (approx. 0.150 mA). These three types of alarms differ from one another in the method of their handling.
When the cause of failure ceases to exist, alarm current I_AL < 3.650 mA (approx. 3.600 mA) or I_AL > 21,500 mA (approx. 22.000 mA) usually automatically returns to the process current of the measurement.
Alarm current I_AL << 3.650 mA (approx. 0.150 mA) is activated by a separate alarm module triggered in critical situations from the point of view of the transmitter diagnostics. The transmitter operates in this status for about 10 s, then it attempts to restart. The recurring alarm status indicates a permanent failure of the transmitter hardware.

15. TECHNICAL DATA

Technical parameters of the device are included in Technical Information available on the manufacturer's website.

16. ADDITIONAL INFORMATION

16.1. Additional information

The manufacturer reserves the right to introduce structural and technological changes to the device, which does not deteriorate its performance.

16.2. History of revisions

Revision No	Document revision	Description of changes
-	A:NOV 2019	Initial document version. Prepared by AH.