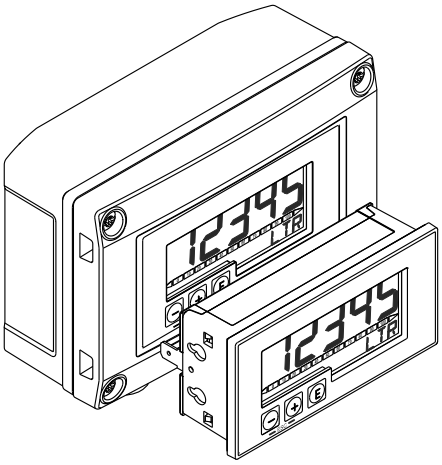
BA01203O/09/EN/05.23-00
71624922
2023-04-23

Valid as of firmware version:
ISU00XA (Standard): 01.06.xx

Operating Instructions
Loop-powered indicator

with HART® communication
ORIA15



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1 About this document

1.1 Document conventions

1.1.1 Safety symbols

⚠ DANGER
This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury.

⚠ WARNING
This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in serious or fatal injury.

⚠ CAUTION
This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or medium injury.

NOTICE
This symbol contains information on procedures and other facts which do not result in personal injury.

1.1.2 Electrical symbols

Symbol	Meaning
⎓	Direct current
~	Alternating current
⎓ ~	Direct current and alternating current
⏚	**Ground connection** A grounded terminal which, as far as the operator is concerned, is grounded via a grounding system.
⏚	**Potential equalization connection (PE: protective earth)** Ground terminals that must be connected to ground prior to establishing any other connections. The ground terminals are located on the interior and exterior of the device: ▪ Interior ground terminal: potential equalization is connected to the supply network. ▪ Exterior ground terminal: device is connected to the plant grounding system.

1.1.3 Symbols for certain types of information

Symbol	Meaning
✓	**Permitted** Procedures, processes or actions that are permitted.
✓✓	**Preferred** Procedures, processes or actions that are preferred.
✗	**Forbidden** Procedures, processes or actions that are forbidden.
ℹ	**Tip** Indicates additional information.
📖	Reference to documentation
📄	Reference to page

Symbol	Meaning
	Reference to graphic
	Notice or individual step to be observed
1., 2., 3...	Series of steps
	Result of a step
	Help in the event of a problem
	Visual inspection

1.1.4 Symbols in graphics

Symbol	Meaning	Symbol	Meaning
1, 2, 3,...	Item numbers	1., 2., 3...	Series of steps
A, B, C, ...	Views	A-A, B-B, C-C, ...	Sections
EX	Hazardous area	EX	Safe area (non-hazardous area)

1.1.5 Tool symbols

Symbol	Meaning
 A0011220	Flat-blade screwdriver
 A0011221	Allen key
 A0011222	Open-ended wrench
 A0013442	Torx screwdriver

1.2 Documentation

1.2.1 Document function

The following documentation may be available depending on the device version ordered:

Document type	Purpose and content of the document
Technical Information (TI)	**Planning aid for your device** The document contains all the technical data on the device and provides an overview of the accessories and other products that can be ordered for the device.
Brief Operating Instructions (KA)	**Guide that takes you quickly to the 1st measured value** The Brief Operating Instructions contain all the essential information from incoming acceptance to initial commissioning.

Document type	Purpose and content of the document
Operating Instructions (BA)	**Your reference document** The Operating Instructions contain all the information that is required in various phases of the life cycle of the device: from product identification, incoming acceptance and storage, to mounting, connection, operation and commissioning through to troubleshooting, maintenance and disposal.
Description of Device Parameters (GP)	**Reference for your parameters** The document provides a detailed explanation of each individual parameter. The description is aimed at those who work with the device over the entire life cycle and perform specific configurations.
Safety Instructions (XA)	Depending on the approval, safety instructions for electrical equipment in hazardous areas are also supplied with the device. The Safety Instructions are an integral part of the Operating Instructions. The nameplate indicates which Safety Instructions (XA) apply to the device in question.
Supplementary device-dependent documentation (SD/FY)	Always comply strictly with the instructions in the relevant supplementary documentation. The supplementary documentation is an integral part of the device documentation.

1.3 Registered trademarks

HART®
Registered trademark of the HART® Communication Foundation

2 Safety Instructions

2.1 Requirements for the personnel

The personnel for installation, commissioning, diagnostics and maintenance must fulfill the following requirements:
- Trained, qualified specialists must have a relevant qualification for this specific function and task.
- Are authorized by the plant owner/operator.
- Are familiar with federal/national regulations.
- Before starting work, read and understand the instructions in the manual and supplementary documentation as well as the certificates (depending on the application).
- Follow instructions and comply with basic conditions.

The operating personnel must fulfill the following requirements:
- Are instructed and authorized according to the requirements of the task by the facility's owner-operator.
- Follow the instructions in this manual.

2.2 Intended use

The process indicator displays analog process variables or HART ® process variables (option) on its screen.

The device is powered via the 4 to 20 mA current loop and does not require an additional power supply.

- The manufacturer accepts no liability for damages resulting from improper or non-intended use. The device must not be converted or modified in any way.
- Panel-mounted device:
  The device is designed for installation in a panel and must only be operated in an installed state.
- Field device:
  The device is designed for mounting in the field.
- The device may be operated only under the permitted ambient conditions→ 37.

2.3 Workplace safety

When working on and with the device:
- ▶ Wear the required personal protective equipment as per national regulations.

2.4 Operational safety

Damage to the device!
- ▶ Operate the device in proper technical condition and fail-safe condition only.
- ▶ The operator is responsible for the interference-free operation of the device.

Modifications to the device

Unauthorized modifications to the device are not permitted and can lead to unforeseeable dangers!
- ▶ If modifications are nevertheless required, consult with the manufacturer.

Repair

To ensure continued operational safety and reliability:
- ▶ Carry out repairs on the device only if they are expressly permitted.
- ▶ Observe federal/national regulations pertaining to the repair of an electrical device.
- ▶ Use only original spare parts and accessories.

2.5 Product safety

This measuring device is designed in accordance with good engineering practice to meet state-of-the-art safety requirements, has been tested, and left the factory in a condition in which it is safe to operate.

It meets general safety standards and legal requirements. It also complies with the EU directives listed in the device-specific EU Declaration of Conformity. The manufacturer confirms this by affixing the CE mark to the device.

2.6 IT security

Our warranty is valid only if the product is installed and used as described in the Operating Instructions. The product is equipped with security mechanisms to protect it against any inadvertent changes to the settings.

IT security measures, which provide additional protection for the product and associated data transfer, must be implemented by the operators themselves in line with their security standards.

3 Product description

3.1 Function

The process indicator is integrated into the 4 to 20 mA/HART® loop and displays the measuring signal in digital form. The process indicator does not require an external power supply. It is powered directly from the current loop.

The device meets the requirements of the HART® Communication Protocol Specifications and can be used with devices with HART® Revision ≥ 5.0 and higher.

3.2 Operating modes

3.2.1 Display functions

The indicator supports two different display modes:

4 to 20 mA mode:

In this operating mode, the process indicator is incorporated into the 4 to 20 mA current loop and measures the transmitted current. The variable calculated based on the current value and range limits is displayed in digital form on the 5-digit LCD. In addition, the associated unit and a bar graph can be displayed.

HART mode:

The device functions as an indicator even when operating with a HART® sensor/actuator. In this case, the indicator is also powered from the current loop.

The process indicator can optionally function either as a primary master or secondary master (default) in the HART® loop. When it functions as a master, the device can read process values from the measuring device and display them. HART® communication operates on the principle of master/slave. As a general rule, the sensor/actuator is a slave and only transmits information if a request has been made by the master.

A HART® loop can have a maximum of two HART® masters at any one time. For these HART® masters, a distinction is made between the primary (e.g. the control system) and the secondary master (e.g. a handheld device for onsite operation of the measuring devices). The two masters in the loop/in the network cannot be masters of the same type, e.g. they cannot be two "secondary masters".

If a third HART® master is added to the network, one of the other masters must be disabled; otherwise a collision occurs in the network.

If the process indicator is operating as "secondary master" and another "secondary master", e.g. a handheld device, is added to the network, the device interrupts HART® communication as soon as it detects that another "secondary master" is present. The display alternates between error message C970 "Multi master collision" and "- - -". A measured value is not displayed in this case. The device leaves the HART® loop for 30 seconds and tries to re-establish HART® communication once again. Once the additional "secondary master" is removed from the network, the device continues communication and displays the measured values of the sensor/actuator once more.

Please note that if two process indicators are to be used in a Multidrop connection, one device must be configured as the "primary master" and the other as the "secondary master" to prevent a master collision.

In HART® mode, the process indicator can display up to four device variables of a multivariable measuring device. These variables are referred to as the Primary Variable (PV), Secondary Variable (SV), Tertiary Variable (TV) and Quaternary Variable (QV). These

variables are placeholders for measured values that can be called up using HART® communication.

The HART® section at the end of these Operating Instructions provides examples of these four device variables for multivariable measuring devices → 46.

Refer to the Operating Instructions for each device for details on the variables that are set as default on the sensor/actuator and how they can be changed.

The process indicator can show each of these values. The individual values must be activated in the **SETUP** – **HART1** to **HART4** menu for this purpose. The individual parameters are assigned to fixed process variables in the device in this case:

HART1 = PV

HART2 = SV

HART3 = TV

HART4 = QV

For example, if the PV and TV are to be displayed on the process indicator, **HART1** and **HART3** must be activated.

The values can either be shown alternately on the process indicator or one value is displayed continuously and the other values are only shown by pressing '+' or '–'. The switching time can be configured in the **EXPRT – SYSTM – TOGTM** menu.

3.3 Input channels

The process indicator has one analog 4 to 20 mA input. In "HART" operating mode, this channel can be used to retrieve and display HART® values of a connected sensor/actuator. Here, a HART® device can be directly connected to the process indicator in a point-to-point connection, or the process indicator can be incorporated into a HART® Multidrop network.

4 Incoming acceptance and product identification

4.1 Incoming acceptance

Proceed as follows on receipt of the device:

1. Check whether the packaging is intact.
2. If damage is discovered:
   Report all damage immediately to the manufacturer.
3. Do not install damaged components, as the manufacturer cannot otherwise guarantee the material resistance or compliance with the original safety requirements, and can also not be held responsible for the consequences that may result.
4. Compare the scope of delivery against the contents of your order.
5. Remove all the packaging material used for transportation.
6. Do the data on the nameplate match the ordering information on the delivery note?
7. Are the technical documentation and all other necessary documents provided, e.g. certificates?

If one of the conditions is not satisfied, contact your Sales Center.

4.2 Product identification

The following options are available for identification of the device:
Nameplate specifications

4.2.1 Nameplate

The right device?

The nameplate provides you with the following information on the device:
- Manufacturer identification, device designation
- Order code
- Extended order code
- Serial number
- Tag name (TAG)
- Technical values: supply voltage, current consumption, ambient temperature, communication-specific data (optional)
- Degree of protection
- Approvals with symbols

▶ Compare the information on the nameplate with the order.

4.2.2 Name and address of manufacturer

Name of manufacturer:	Endress+Hauser Wetzer GmbH + Co. KG
Address of manufacturer:	Obere Wank 1, D-87484 Nesselwang or www.endress.com

4.3 Certificates and approvals

For certificates and approvals valid for the device: see the data on the nameplate

4.4 HART® protocol certification

The process indicator is registered by the HART® Communication Foundation. The device fulfills the requirements of HCF Specification, Revision 7.1. This version is downwards compatible with all sensors/actuators with HART® versions ≥ 5.0.

4.5 Storage and transport

Note the following:
The permitted storage temperature is –40 to 85 °C (–40 to 185 °F); it is possible to store the device at borderline temperatures for a limited period (48 hours maximum).

Pack the device for storage and transportation in such a way that it is reliably protected against impact and external influences. The original packaging offers the best protection.

Avoid the following environmental influences during storage and transport:
- Direct sunlight
- Vibration
- Aggressive media

5 Mounting

5.1 Installation conditions

Permitted ambient temperature: –40 to 60 °C (–40 to 140 °F)

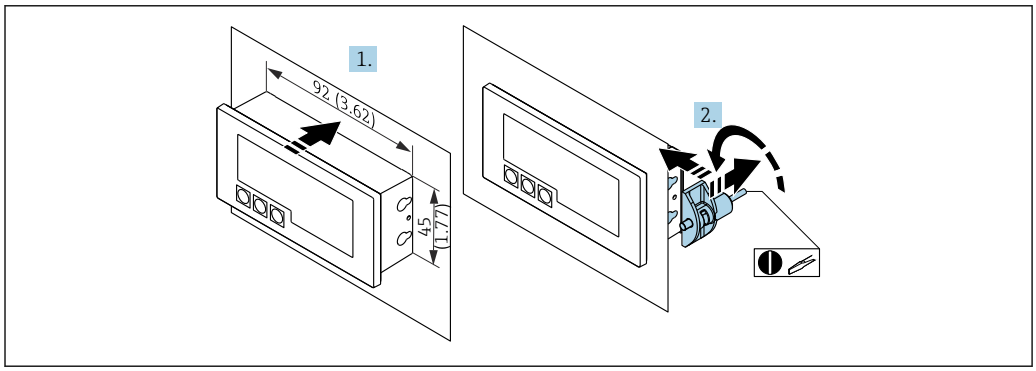
At temperatures below –25 °C (–13 °F) the readability of the display can no longer be guaranteed.

5.2 Installation Instructions

For device dimensions, see "Technical data".

5.2.1 Panel housing

- Degree of protection: IP65 front, IP20 rear (not evaluated by UL)
- Mounting position: horizontal



1 *Installation instructions for the panel housing*

Installation in a panel with a panel cutout 92x45 mm (3.62x1.77 in), max. panel thickness 13 mm (0.51 in)

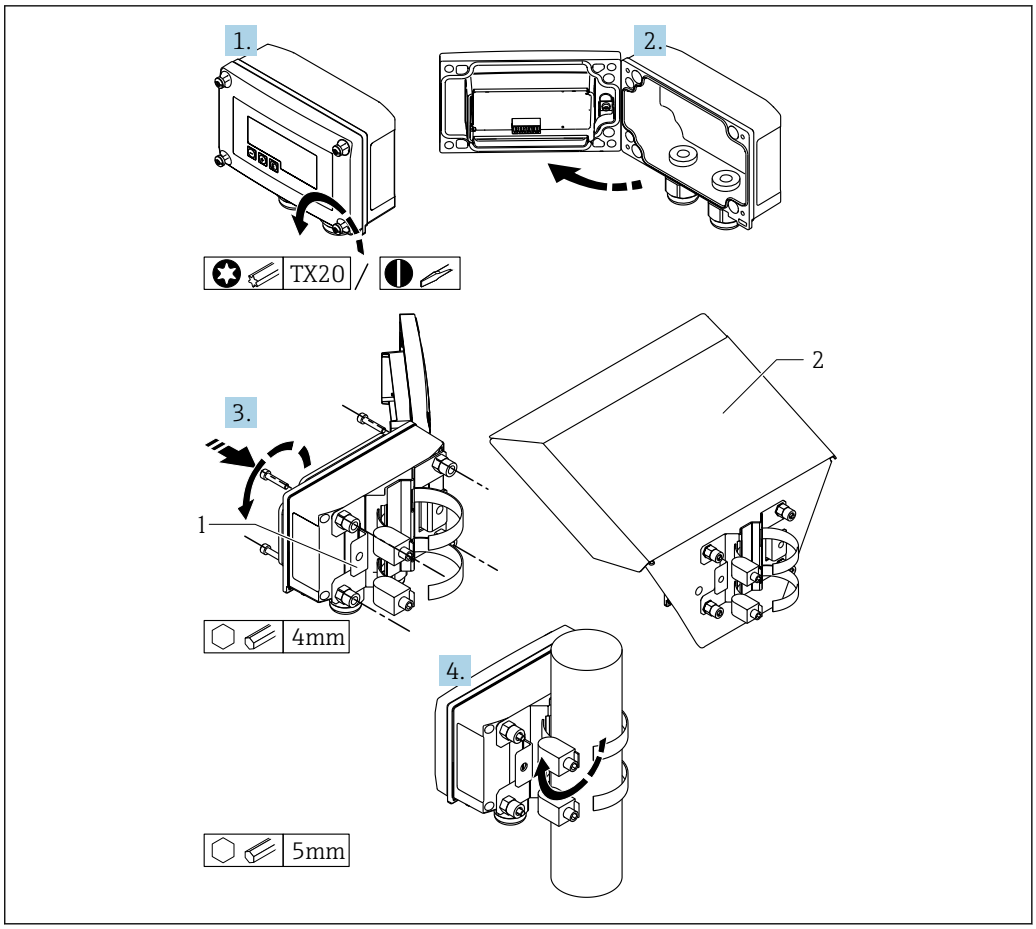
1. Slot the device into the panel cutout from the front.
2. Fit the mounting clips on the side of the housing and tighten the threaded rods (tightening torque: 0.4 to 0.6 Nm).

5.2.2 Field housing

- Degree of protection for aluminum housing: IP66/67, NEMA 4X (not evaluated by UL)
- Degree of protection for plastic housing: IP66/67 (not evaluated by UL)

Pipe mounting (with optional mounting kit)

The device can be mounted on a pipe with a diameter of up to 50.8 mm (2 in) with the mounting kit (optionally available).



2 *Mounting the process indicator on a pipe*

1 Mounting plate for pipe/wall mounting
2 Weather protection cover (optional)

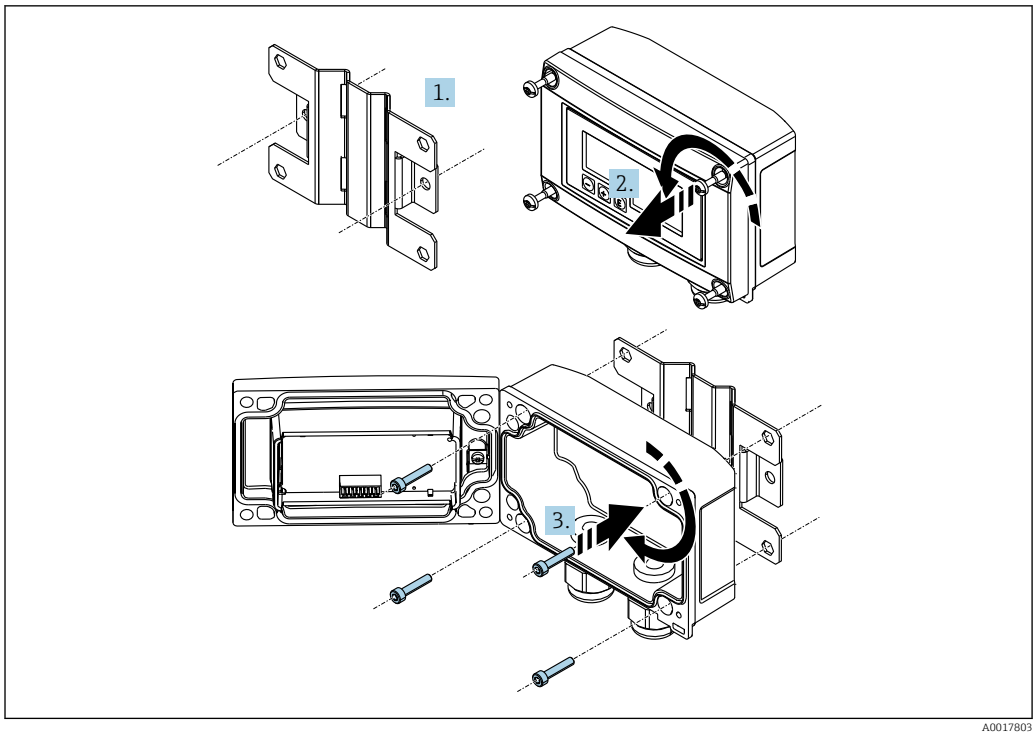
1. Release the 4 housing screws.
2. Open the housing.
3. Secure the mounting plate to the rear of the device with 4 screws supplied. The optional weather protection cover can be secured between the device and the mounting plate.
4. Guide the two gripper clamps through the mounting plate, fit them around the pipe and tighten.

Wall mounting

Wall mounting without a mounting kit

1. Open the housing.
2. Use the device as a stencil for 4 6 mm (0.24 in) bore holes, 99 mm (3.9 in) apart on the horizontal plane, 66 mm (2.6 in) apart on the vertical plane.
3. Secure the indicator on the wall with 4 screws.
4. Close the cover and tighten the housing screws.

Wall mounting with mounting kit (optionally available)

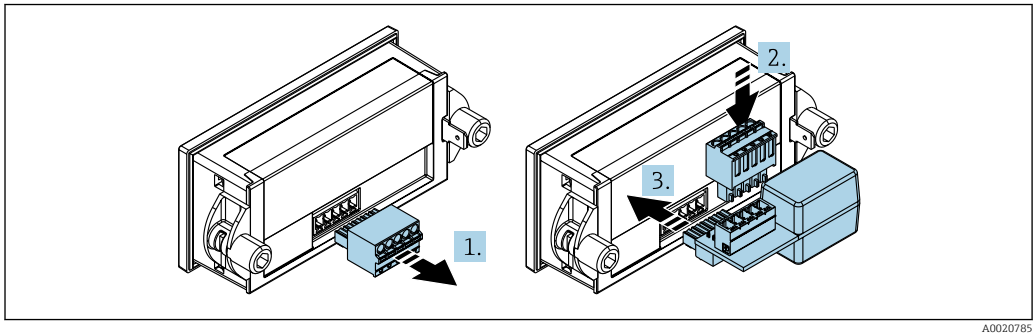


3 *Mounting the process indicator on a wall*

1. Use the mounting plate as a stencil for 2 6 mm (0.24 in) bore holes, 82 mm (3.23 in) apart, and secure the plate on the wall with 2 screws (not supplied).
2. Open the housing.
3. Secure the indicator on the mounting plate with the 4 screws supplied.
4. Close the cover and tighten the screws.

5.2.3 Installing the optional HART® communication resistance module

The HART® communication resistance module is available as an accessory; see the "Accessories" section.



4 *Installing the optional HART® communication resistance module*

1. Disconnect plug-in terminal block.
2. Insert the terminal block into the slot provided on the HART® communication resistance module.
3. Insert the HART® communication resistance module into the slot in the housing.

5.3 Post-installation check

5.3.1 Display unit in the panel-mount housing

- Is the seal undamaged?
- Are the mounting clips securely fastened on the housing of the device?
- Are the threaded rods properly tightened?
- Is the device located in the center of the panel cutout?

5.3.2 Display unit in the field housing

- Is the seal undamaged?
- Is the housing firmly screwed to the mounting plate?
- Is the mounting bracket firmly secured on the wall/pipe?
- Are the housing screws firmly tightened?

6 Wiring

⚠ WARNING

Danger! Electric voltage

▶ The entire connection of the device must take place while the device is de-energized.

Only certified devices (optionally available) may be connected in the hazardous area

▶ Observe the corresponding notes and wiring diagrams in the Ex-specific supplement to these Operating Instructions.

NOTICE

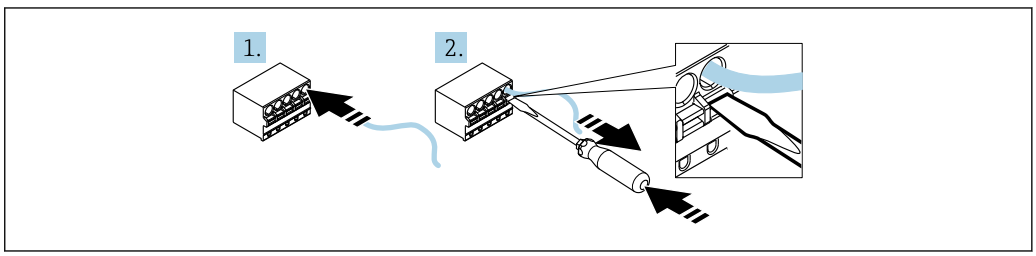
Device destroyed if current too high

▶ The device must be powered only by a power unit with an energy-limited circuit in accordance with UL/EN/IEC 61010-1, Section 9.4 and the requirements in Table 18.

▶ Do not operate the device at a voltage source without a current limiter. Instead, operate the device only in the current loop with a transmitter.

- **Panel housing:**
  The terminals are located on the rear of the housing.
- **Field housing:**
  The terminals are located inside the housing. The device has two M16 cable entries. The housing must be opened for wiring purposes.

Operation of the spring terminals



5 *Operation of the spring terminals*

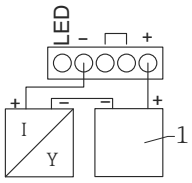
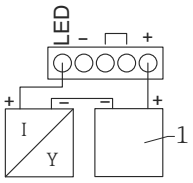
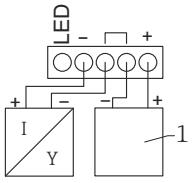
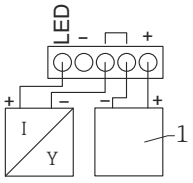
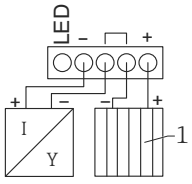
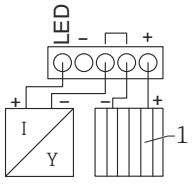
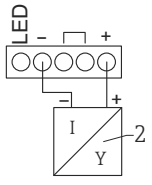
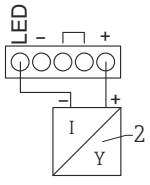
1. If using rigid cables or flexible cables with a ferrule, insert only the cable into the terminal to connect. No tools required. If using flexible cables without ferrules, the spring mechanism must be activated as shown in step 2.
2. In order to loosen the cable, push the spring mechanism in completely using a screwdriver or other suitable tool and pull out the cable.

6.1 Quick wiring guide

Terminal	Description
+	Positive connection, current measurement
-	Negative connection, current measurement (without backlighting)
LED	Negative connection, current measurement (with backlighting)
⊓	Auxiliary terminals (electrically connected internally)
⏚	Functional grounding: ▪ Panel-mounted device: Terminal on the rear of the housing ▪ Field device: Terminal in the housing

6.2 Connection in 4 to 20 mA mode

The following diagrams show in a simplified way how the process indicator is connected in the 4 to 20 mA mode.

	Connection without backlighting	Connection with backlighting
Connection with transmitter power supply and transmitter	 A0017704 *1 Transmitter power supply*	 A0017705 *1 Transmitter power supply*
Connection with transmitter power supply and transmitter using the auxiliary terminal	 A0017706 *1 Transmitter power supply*	 A0017707 *1 Transmitter power supply*
Connection with PLC and transmitter	 A0019720 *1 PLC*	 A0019721 *1 PLC*
Connection without transmitter power supply directly in the 4 to 20 mA circuit	 A0017708 *2 4 to 20 mA power source*	 A0017709 *2 4 to 20 mA power source*

6.3 Connection in HART mode

The following diagrams show in a simplified way how the process indicator is connected in the HART mode.

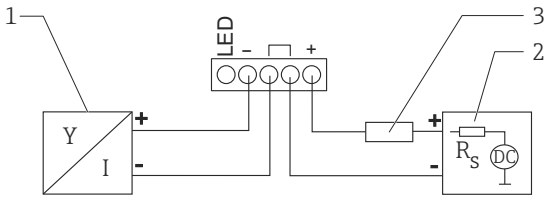
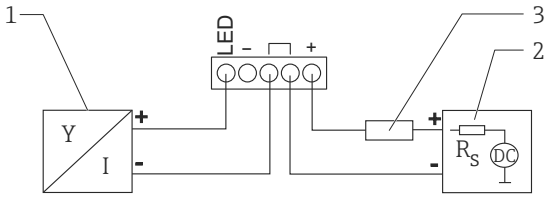
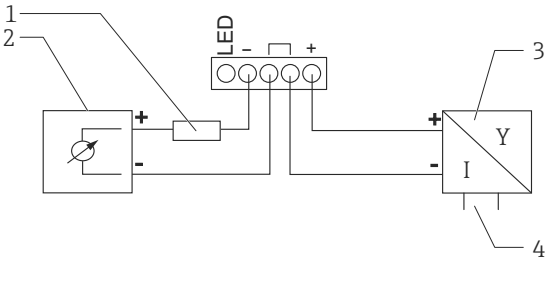
6.3.1 HART® connection

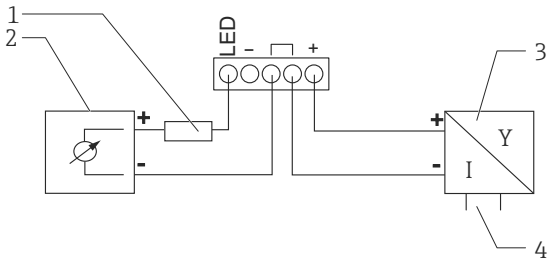
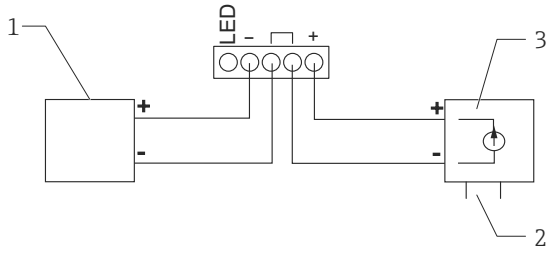
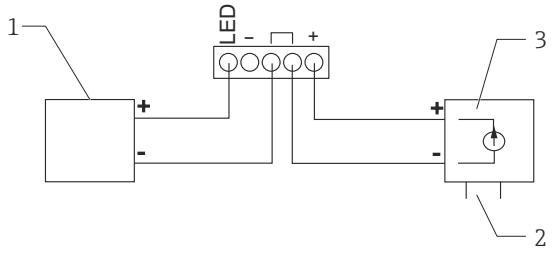
NOTICE

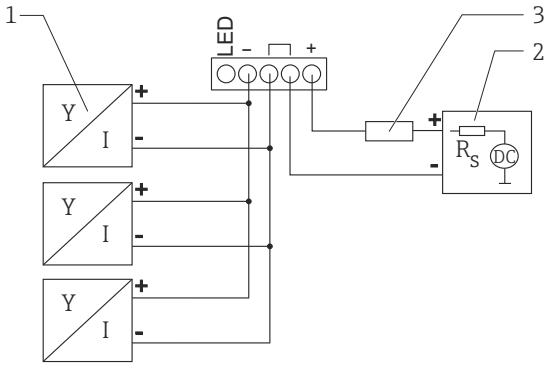
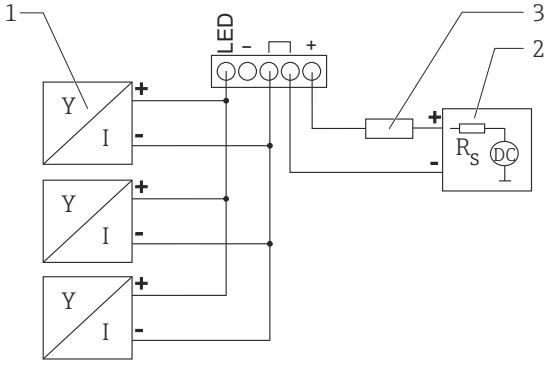
Undefined behavior due to incorrect wiring of an actuator

- When installing the process indicator together with an actuator, the operating instructions for the actuator must always be followed.

The 230 Ω HART® communication resistor in the signal line is always necessary in the case of a low-impedance power supply. It must be installed between the power supply and the indicator.

	Circuit diagram / Description
2-wire sensor with process indicator and transmitter power supply, without backlighting	 *1 Sensor* *2 Power supply* *3 HART® resistor*
2-wire sensor with process indicator and transmitter power supply, with backlighting	 *1 Sensor* *2 Power supply* *3 HART® resistor*
4-wire sensor with process indicator and transmitter power supply, without backlighting	 *1 HART® resistor* *2 Current measuring device (optional)* *3 Sensor* *4 Power supply 4-wire device*

	Circuit diagram / Description
4-wire sensor with process indicator and transmitter power supply, with backlighting	 A0019571 *1 HART® resistor* *2 Current measuring device (optional)* *3 Sensor* *4 Power supply 4-wire device*
Current output with process indicator and actuator (e.g. actuator valve), without backlighting	 A0019573 *1 Actuator* *2 Power supply 4-wire device* *3 Current output*
Current output with process indicator and actuator (e.g. actuator valve), with backlighting	 A0019574 *1 Actuator* *2 Power supply 4-wire device* *3 Current output*

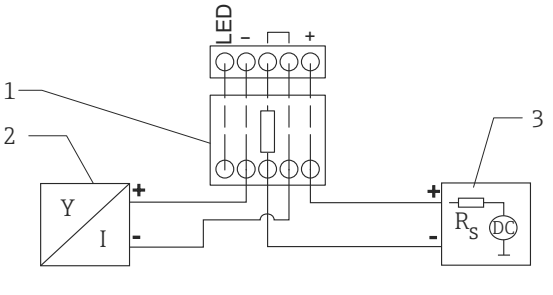
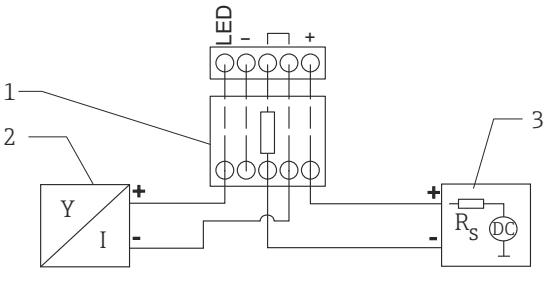
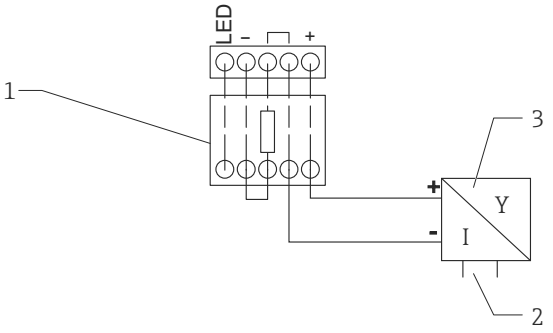
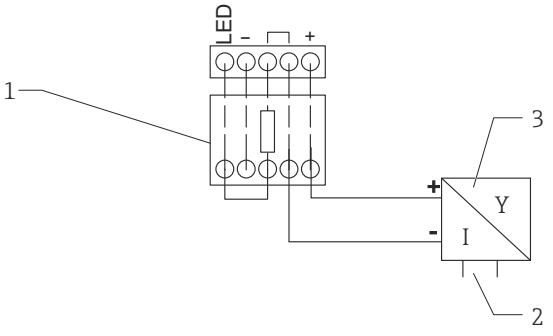
	Circuit diagram / Description
Multidrop 2-wire sensors with process indicator and transmitter power supply	 *1 Sensors* *2 Power supply* *3 HART® resistor*
Multidrop 2-wire sensors with process indicator and transmitter power supply, with backlighting	 *1 Sensors* *2 Power supply* *3 HART® resistor*

Optional HART® communication resistance module

A HART® communication resistance module is available as an accessory; see the "Accessories" section → 34.

To install the HART® communication resistance module, see the Installation section → 12

Wiring

	Circuit diagram / Description
2-wire sensor with process indicator and transmitter power supply, without backlighting	 A0020839 *1 HART® communication resistance module* *2 Sensor* *3 Power supply*
2-wire sensor with process indicator and transmitter power supply, with backlighting	 A0020840 *1 HART® communication resistance module* *2 Sensor* *3 Power supply*
4-wire sensor with process indicator and transmitter power supply, without backlighting	 A0020837 *1 HART® communication resistance module* *2 Power supply 4-wire device* *3 Sensor*
4-wire sensor with process indicator and transmitter power supply, with backlighting	 A0020838 *1 HART® communication resistance module* *2 Power supply 4-wire device* *3 Sensor*

Configuration of HART® devices

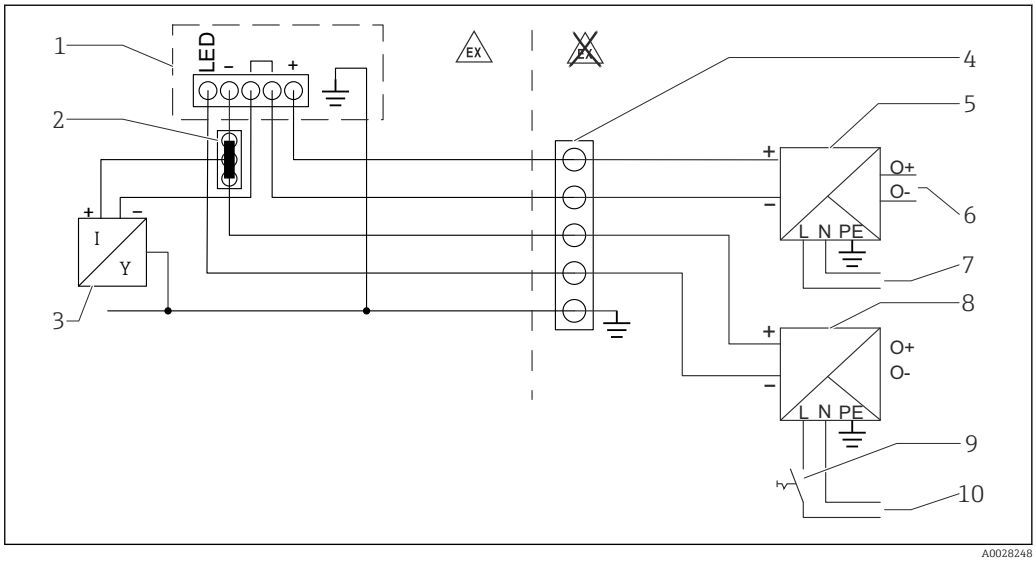
The process indicator cannot be used to configure connected HART® devices. Configuration is done using a special device configurator, for example.

6.4 Wiring with switchable backlighting

An additional current-limited power source (e.g. active barrier from the Endress+Hauser RN product family) is required to implement switchable backlighting. This power source is used to supply the LED backlighting of up to seven process indicators without generating an additional voltage drop in the measuring loop. The backlighting can be switched on and off using an external switch.

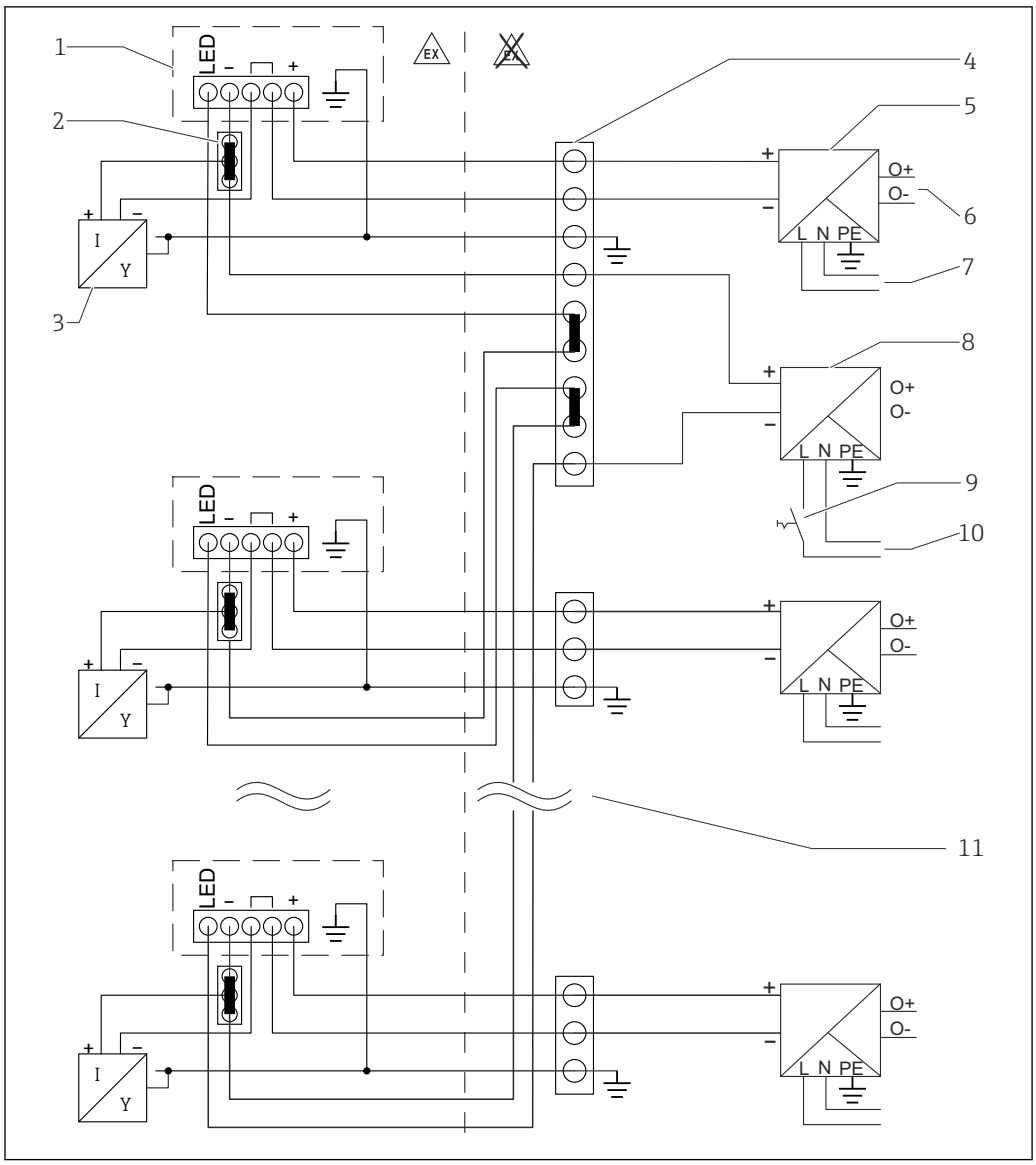
The following shows connection examples for the hazardous area. Wiring is similar for the non-hazardous area; however, it is not necessary to use Ex-certified devices.

6.4.1 Connection diagram for a process indicator



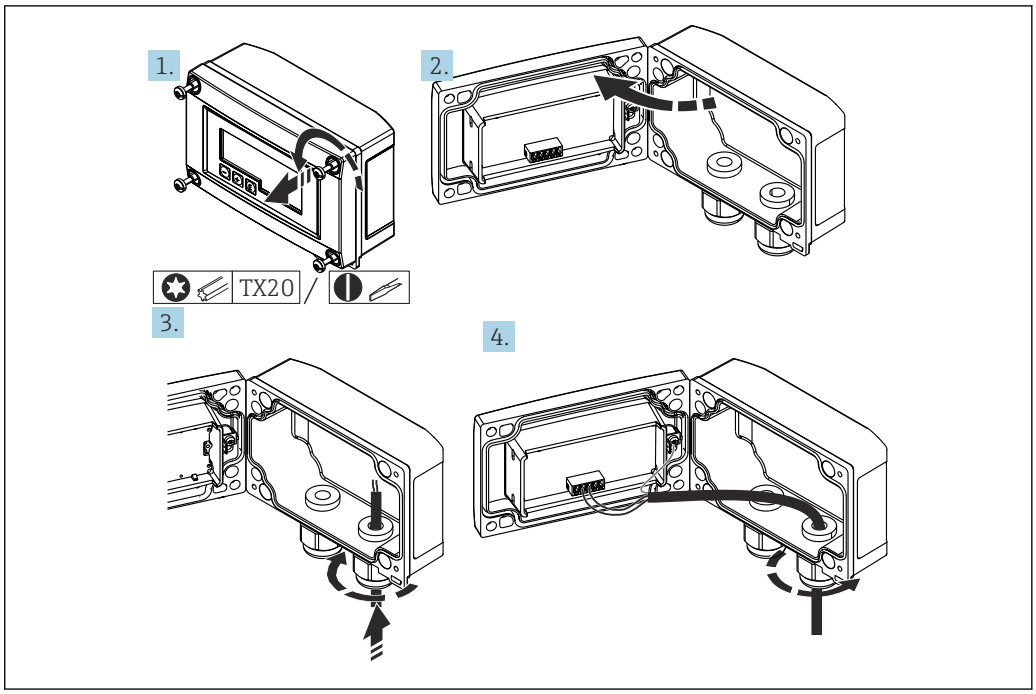
1 *Process indicator*
2 *3-wire connector, e.g. WAGO 221 series*
3 *2-wire sensor*
4 *Terminal block on DIN rail*
5 *Active barrier (e.g. RN product family from Endress+Hauser)*
6 *4 to 20 mA output to the control unit*
7 *Power supply*
8 *Power source (e.g. RN product family from Endress+Hauser)*
9 *Switch to activate backlighting*
10 *Power supply*

6.4.2 Connection diagram for multiple process indicators



1 Process indicator
2 3-wire connector, e.g. WAGO 221 series
3 2-wire sensor
4 Terminal block on DIN rail
5 Active barrier (e.g. RN product family from Endress+Hauser)
6 4 to 20 mA output to the control unit
7 Power supply
8 Power source (e.g. RN product family from Endress+Hauser)
9 Switch to activate backlighting
10 Power supply
11 Can be extended to 7 devices

6.5 Inserting the cable, field housing



6 *Inserting the cable, field housing*

Inserting the cable, field housing, connection without transmitter power supply (example)

1. Release the housing screws.
2. Open the housing.
3. Open the cable gland (M16) and insert the cable.
4. Connect the cable including the functional grounding and close the cable gland.

6.6 Shielding and grounding

Optimum electromagnetic compatibility (EMC) can only be guaranteed if the system components and, in particular, the lines are shielded and the shield forms as complete a cover as possible. A shield coverage of 90% is ideal.

- To ensure an optimum EMC protective effect when communicating with HART®, connect the shield as often as possible to the reference ground.
- For reasons of explosion protection, you should refrain from grounding however.

To comply with both requirements, three different types of shielding are possible when communicating with HART®:
- Shielding at both ends
- Shielding at one end on the feed side with capacitance termination at the field device
- Shielding at one end on the feed side

Experience shows that the best results with regard to EMC are achieved in most cases in installations with one-sided shielding on the feed side (without capacitance termination at the field device). Appropriate measures with regard to input wiring must be taken to allow unrestricted operation when EMC interference is present. These measures have been taken into account for this device. Operation in the event of disturbance variables as per NAMUR NE21 is thus guaranteed. Where applicable, national installation regulations and guidelines must be observed during the installation! Where there are large differences in potential between the individual grounding points, only one point of the shielding is connected directly with the reference ground. In systems without potential equalization,

therefore, cable shielding of fieldbus systems should only be grounded on one side, for example at the supply unit or at safety barriers.

NOTICE

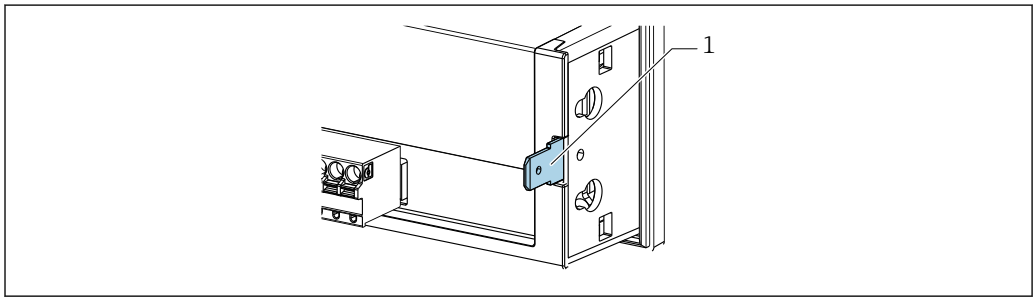
If the shielding of the cable is grounded at more than one point in systems without potential matching, power supply frequency equalizing currents can occur that damage the signal cable or have a serious effect on signal transmission.

- In such cases the shielding of the signal cable should be grounded on one side only, i.e. it must not be connected to the ground terminal of the housing. The shield that is not connected should be insulated!

6.7 Connecting to functional grounding

6.7.1 Panel-mounted device

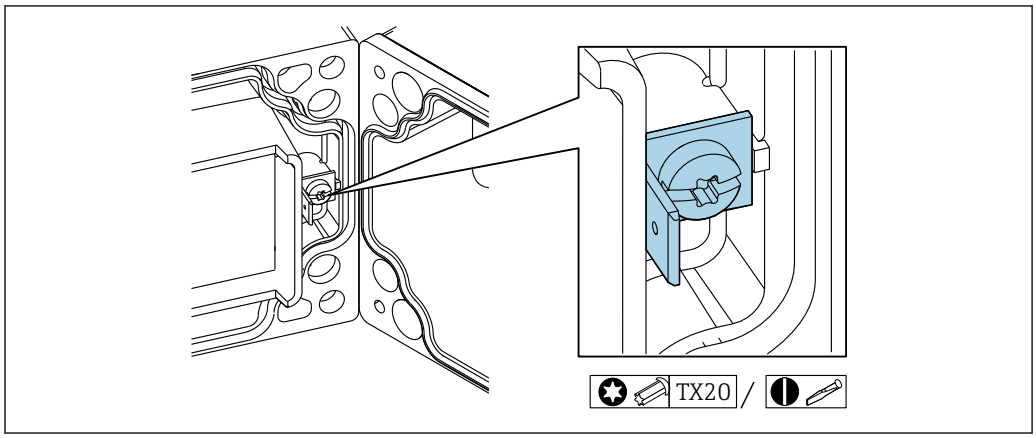
For EMC reasons, the functional grounding should always be connected. When the device is used in the hazardous area (with optional Ex approval) the connection is obligatory.



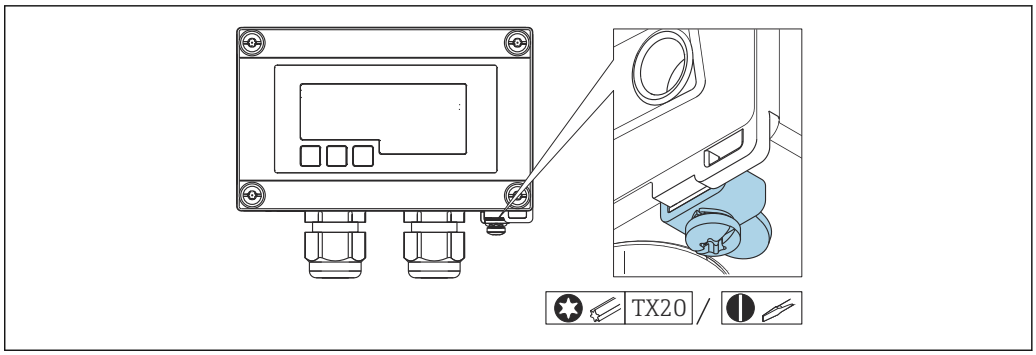
7 *Functional grounding terminal on panel-mounted device*

6.7.2 Field device

For EMC reasons, the functional grounding should always be connected. When used in the hazardous area (with optional Ex approval), the connection is obligatory and the field housing must be grounded via a grounding screw fitted on the outside of the housing.



8 *Functional grounding terminal in field housing*



9 *Ground terminal on field housing*

6.8 Ensuring the degree of protection

6.8.1 Field housing

The devices meet all the requirements of IP67. It is absolutely essential to comply with the following points to ensure this protection is guaranteed after mounting or servicing the device:

- The housing seal must be clean and undamaged when inserted into the groove. The seal must be cleaned, dried or replaced if necessary.
- The cables used for connection must be of the specified outside diameter (e.g. M16 x 1.5, cable diameter 5 to 10 mm (0.2 to 0.39 in)).
- Mount the measuring device in such a way that the cable entries point downwards.
- Replace unused cable entries with dummy plugs.
- The housing cover and the cable entries must be firmly tightened.

6.8.2 Panel housing

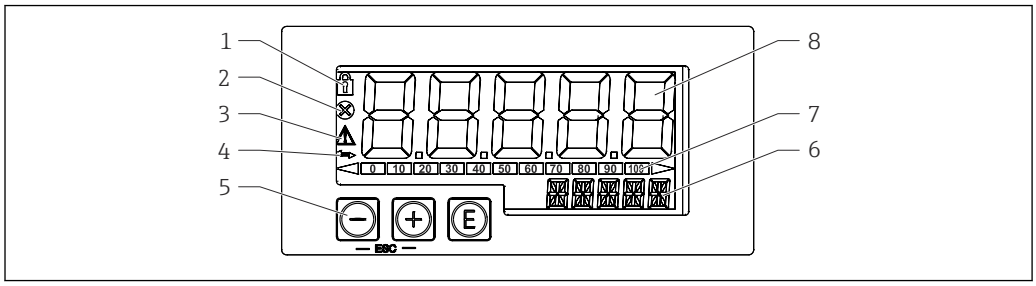
The front of the device meets the requirements of IP65. It is absolutely essential to comply with the following points to ensure this protection is guaranteed after mounting or servicing the device:

- The seal between the front of the housing and the panel must be clean and undamaged. The seal must be cleaned, dried or replaced if necessary.
- The threaded rods of the panel mounting clips must be firmly tightened (tightening torque: 0.4 to 0.6 Nm).

6.9 Post-connection check

Device condition and specifications	**Notes**
Are cables or the device damaged?	Visual inspection
Electrical connection	**Notes**
Does the supply current match the specifications on the nameplate?	-
Are the cables, incl. functional grounding, connected correctly and strain-relieved?	-
Field housing: Are the cable glands securely closed?	-

7 Operation



10 *Display and operating elements of the process indicator*

1 *Symbol: operating menu disabled*
2 *Symbol: error*
3 *Symbol: warning*
4 *Symbol: HART® communication active (option)*
5 *Operating keys "-", "+", "E"*
6 *14-segment display for unit/TAG*
7 *Bar graph with indicators for under range and over range*
8 *5-digit 7-segment display for measured value, digit height 17 mm (0.67 in)*

The device is operated using three operating keys on the front of the housing. The device setup can be disabled with a 4-digit user code. If the setup is disabled, a padlock symbol appears on the display when an operating parameter is selected.

 A0017716	Enter key; for calling up the operating menu, confirming the selection/configuration of parameters in the operating menu
 A0017714	Selecting and setting/changing values in the operating menu; pressing the '-' and '+' keys simultaneously takes the user back up a menu level. The configured value is not saved
 A0017715	

7.1 Operating functions

The operating functions of the process indicator are divided into the following menus. The individual parameters and settings are described in the "Commissioning" section.

If the operating menu is disabled by means of a user code, the individual menus and parameters can be displayed but not changed. To change a parameter, the user code must be entered. As the display unit can only display digits in the 7-segment display and not alphanumeric characters, the procedure for number parameters is different to that for text parameters.

If the operating position contains only numbers as parameters, the operating position is displayed in the 14-segment display and the configured parameter is displayed in the 7-segment display. To edit, press the 'E'-button followed by the user code.

If the operating position contains text parameters, only the operating position is initially displayed in the 14-segment display. If the 'E' button is pressed again, the configured parameter is displayed in the 14-segment display. To edit, press the '+' button followed by the user code.

Setup (SETUP)	Basic device settings → 🖹 25
Diagnostics (DIAG)	Device information, display of error messages → 🖹 27
Expert (EXPRT)	Expert settings for the device setup → 🖹 25 The Expert menu is protected from editing by an access code (default 0000).

8 Commissioning

8.1 Post-installation check and switching on the device

Perform the final checks before commissioning the device:
- Checklist for "post-installation check" → 🖹 13.
- Checklist for "post-connection check" → 🖹 23.

The device starts after being connected to the 4 to 20 mA/HART® circuit. The firmware version appears on the display during the start-up phase.

When the device is being commissioned for the first time, program the setup in accordance with the descriptions in the Operating Instructions.

If you are commissioning a device that is already configured or preset, the device immediately starts measuring the current or making a HART® request as defined in the settings. The values of the currently activated process variables appear in the display.

Remove the protective film from the display as this would otherwise affect the readability of the display.

8.2 Operating matrix

Setup menu (SETUP)			
Parameter	**Values (default in bold)**	**Displayed when**	**Description**
MODE	**4-20** HART		Select the operating mode for the indicator. 4-20: The 4 to 20 mA signal of the circuit is displayed. HART: Up to four HART® variables (PV, SV, TV, QV) of a sensor/actuator in the loop can be displayed.
DECIM	0 DEC **1 DEC** 2 DEC 3 DEC 4 DEC	MODE = 4-20	Number of decimal places for the 4 to 20 mA display mode.
SC__4	Numerical value –19 999 to 99 999 Default: **0.0**	MODE = 4-20	5-digit value (number of decimal places as configured under DECIM) for scaling the measured value at 4 mA Example: SC__4 = 0.0 → 0.0 displayed at measuring current 4 mA The unit selected under UNIT is used to display the value.
SC_20	Numerical value –19 999 to 99 999 Default: **100.0**	MODE = 4-20	5-digit value (number of decimal places as configured under DECIM) for scaling the measured value at 20 mA Example: SC_20 = 100.0 → 100.0 displayed at measuring current 20 mA The unit selected under UNIT is used to display the value.
UNIT	% °C °F K USER	MODE = 4-20	Use this function to select the unit for displaying the value. If "USER" is selected, a user-defined unit can be entered in the TEXT parameter.
TEXT	Customized text, 5-digit	MODE = 4-20	User-defined unit, only visible if the "USER" option has been selected under UNIT.

Setup menu (SETUP)			
Parameter	**Values (default in bold)**	**Displayed when**	**Description**
SCAN	**NO** YES	MODE = HART	Select "YES" to start scanning. All addresses are then automatically scanned once in a HART® application until a sensor/actor is found. Scanning runs from 0 to 63. Only addresses up to 15 are permitted for HART 5. Once the address of the sensor/actor whose values are to be displayed is found, the address must be confirmed by pressing the 'E' key. This address is adopted and is used even after a device restart. By pressing the '+' or '–' key, it is possible to search for other addresses. Pressing '+'- and '-' simultaneously will cancel scanning. If "NO" is selected, scanning is not active. The address of the sensor/actor whose values are to be displayed on the process indicator must be configured manually using the operating keys.
ADDR	Numerical value 0 to 63 Default: **0**	MODE = HART	Use this function to enter manually the address of the HART® sensor/actor whose values are to be displayed. If the address of the HART® slave is changed, it must also be changed on the process indicator. To do this, either enter the address manually or search using SCAN mode.
MTYPE	PRIM **SEC**	MODE = HART	Use this function to select the HART® master type: PRIM = Primary master SEC = Secondary master
HART1-HART4		MODE = HART	Use this function to select which HART® value of a sensor/actor (PV, SV, TV, QV) should be activated and configured: HART1 = PV HART2 = SV HART3 = TV HART4 = QV Press the E key to open the configuration submenu.
DISP1–DISP4	OFF MAN AUTO Default: DISP1: **AUTO** DISP2: **MAN** DISP3: **MAN** DISP4: **MAN**	MODE = HART	Use this function to select how or whether the value should be displayed. OFF: Value is not displayed MAN: You can manually scroll through activated HART® values by pressing '+' or '–'. Otherwise the values are not displayed. If all four HART® values (HART1 to HART4) are set to "MAN", HART1 (PV) is displayed if you do not scroll manually through the values. AUTO: Activated HART® values are displayed alternately (switching time can be configured in the EXPRT menu under "TOGTM"). If one value is set to AUTO, this value is displayed continuously on the device.
DEC1 – DEC4	0 DEC **1 DEC** 2 DEC 3 DEC 4 DEC	MODE = HART	Number of decimal places for the values HART1 - HART4.
BGLO1-BGLO4	Numerical value –19 999 to 99 999 Default: **0.0**	MODE = HART	5-digit value (number of decimal places as configured under DEC1-DEC4) for scaling the lower range of the bar graph for HART1 - HART4. The bar graph is disabled if BGLOx and BGHIx are set to "0.0".
BGHI1-BGHI4	Numerical value –19 999 to 99 999 Default: **0.0**	MODE = HART	5-digit value (number of decimal places as configured under DEC1-DEC4) for scaling the upper range of the bar graph for HART1 - HART4. The bar graph is disabled if BGLOx and BGHIx are set to "0.0".
UNIT1-UNIT4	**HART** % °C °F K USER	MODE = HART	Use this function to select the unit for displaying the HART® value. If "HART" is selected, the unit configured on the sensor/actor is automatically adopted for the relevant HART® value. Only units with a maximum of 5 characters can be shown. Longer units are displayed as unit code "UCxxx". The table in the HART® communication section at the end of these Operating Instructions provides an overview of the units that can be displayed. If "USER" is selected, a user-defined unit can be entered in the TEXT1-TEXT4 parameter.
TEXT1-TEXT4	Customized text, 5-digit	MODE = HART	User-defined unit. Only visible if the "USER" option has been selected under UNIT

Diagnostics menu (DIAG)		
Parameter	**Values**	**Description**
AERR	Read only	The current diagnostic message appears on the display. If several messages occur simultaneously, the message with the highest priority is shown on the display.
LERR	Read only	The last diagnostic message with the highest priority appears on the display.
FWVER	Read only	The firmware version appears on the display.

Expert menu (EXPRT); a code must be entered				
In addition to all the parameters in the Setup menu, the Expert menu also contains the parameters described in this table. If you call up the Expert menu, you will be asked to enter the user code (UCODE, default: 0000).				
Parameter		**Values (default in bold)**	**Displayed when**	**Description**
SYSTM				
	UCODE	Numerical value 0000 to 9999 Default: **0000**		4-digit user code With the user code it is possible to protect the device setup from unauthorized modifications. If the setup is disabled, a padlock symbol appears on the display when an operating parameter is selected. The user code is not active with the default setting "0000". This means that setup parameters can be changed without entering the code. The code must always be entered for the Expert menu, even for the default setting.
	FRSET	**NO** YES		Resets the device setup. The values are reset to the preset values for preconfigured devices, and to the default values for all other devices. Select "YES" and press "E" by way of confirmation to reset the device.
	TOGTM	**5** 10 15 20	MODE = HART	Select the switching time in seconds between the HART® values if "AUTO" was selected in the DISP1-DISP4 menu.
INPUT				The following parameters are available in addition to the parameters from the Setup menu.
	CURV	**LINAR** SQRT		**Use this to select the calculation function for the process value (for MODE = 4-20)** **LINAR** (scaling with SC__4 and SC_20): Process value = (mA value - 4)/16 * (SC_20 - SC__4) + SC__4 + OFFST **SQRT** (square root extraction and scaling): Process value = Square root((mA value - 4)/16) * (SC_20 - SC__4) + SC__4 + OFFST Negative values when calculating the square root are set to 0. **Use this to select the calculation function for the HART1 value (PV) (for MODE = HART)** **LINAR**: HART1 value (PV) = "exported PV value" * FACT1 + OFFS1 **SQRT** (square root extraction and scaling with BGLO1 and BGHI1): HART1 value (PV) = (square root("exported percentage PV value" / 100) * (BGHI1 - BGLO1) + BGLO1) * FACT1 + OFFS1 Negative values when calculating the square root are set to 0. **Example for SQRT:** ▪ exported percentage PV value = 50 ▪ BGLO1 = 100.0 ▪ BGHI1 = 200.0 ▪ FACT1 = 1 ▪ OFFS1 = 0.0 HART1 value (PV) = (square root(50/100) * (200 - 100) + 100) * 1 + 0 = 170.7
	NAMUR	NO **YES**	MODE = 4-20	Used for determining the maximum permissible errors in accordance with standard NAMUR NE 43 → 🖹 29
	RNGLO	Numerical value	NAMUR = NO	Lower range limit. An error message is displayed if the measured current falls below this limit.
	RNGHI	Numerical value	NAMUR = NO	Upper range limit. An error message is displayed if the measured current exceeds this limit.

Expert menu (EXPRT); a code must be entered				
In addition to all the parameters in the Setup menu, the Expert menu also contains the parameters described in this table. If you call up the Expert menu, you will be asked to enter the user code (UCODE, default: 0000).				
Parameter		**Values (default in bold)**	**Displayed when**	**Description**
	OFFST	Numerical value −19 999 to 99 999	MODE = 4-20	Use this function to enter an offset value to display the measured value.
	FACT1-FACT4	1E-6 1E-5 1E-4 1E-3 1E-2 1E-1 **1** 1E1 1E2 1E3 1E4 1E5 1E6	MODE = HART	As the display is limited to 5 characters, the measured value must be multiplied by a factor if necessary. For example: conductivity 0.00003 S multiplied by factor 1E6 →30.000 µS. If a factor is used, it is recommended to set the unit under UNIT1-4 to "UNIT" and to enter user-defined text because the unit automatically delivered via HART® no longer matches the displayed value.
	OFFS1-OFFS4	Numerical value −19 999 to 99 999	MODE = HART	Use this function to enter an offset value to display the HART1-HART4 measured value. If a factor is used, the offset is added to the multiplied value (displayed value = measured value*factor + offset)
	EXP1-EXP4	**YES** NO	MODE = HART	Measured value display for measured values greater than 99999. ▪ YES: If the display overruns, the measured value is displayed in exponential notation. ▪ NO: Values with more than 5 digits are not displayed if the display overruns. Value is displayed with leading zeros. **Example:** Measured value: 130002.4 YES => 1.30E5 NO => 0002.4
DIAG				
	CNTHI	Read only	MODE = HART	Counter for the number of values transmitted via HART® , 5 top positions. The counter goes back to 0 after a device restart or scan.
	CNTLO	Read only	MODE = HART	Counter for the number of values transmitted via HART® , 5 bottom positions. The counter goes back to 0 after a device restart or scan.
	RETRY	Read only	MODE = HART	Counter for the number of retries to establish HART® communication. The counter goes back to 0 after a device restart or scan.
	FAIL	Read only	MODE = HART	Counter for the number of failed attempts to establish HART® communication. The counter goes back to 0 after a device restart or scan.
	HLEVL			
	Tx mV	Read only	MODE = HART	Value of the peak-to-peak level of the transmission signal in mV
	Rx mV	Read only	MODE = HART	Value of the peak-to-peak level of the received signal in mV
	NOISE	Read only	MODE = HART	Displays the level of the interference signal LO = low interference signal MED = medium interference signal HI = high interference signal
	Rc Ω	Read only	MODE = HART	Value of the total resistance in the HART® loop in Ohm

9 Troubleshooting

9.1 Error limits as per NAMUR NE 43

In Mode=4-20, the device can be set to error limits as per NAMUR NE 43→ 27.

The device displays an error message if a value is outside these limits.

Current value	Error	Diagnostic code
≤ 3.6 mA	Under range	F100
3.6 mA < x ≤ 3.8 mA	Unpermitted measured value	S901
20.5 mA ≤ x < 21.0 mA	Unpermitted measured value	S902
> 21.0 mA	Over range	F100

9.2 Diagnostic messages

If several errors are pending simultaneously, the device always displays the error with the highest priority.

1 = Highest priority

Diagnostic number	Short text	Remedial action	Status signal	Diagnostic behavior	Priority
Diagnostics for the sensor					
F100	Sensor error	▪ Check electrical wiring ▪ Check the sensor ▪ Check sensor settings	F	Alarm	6
S901	Input signal too small	▪ Check transmitter output for defect and conformity error ▪ Check transmitter for incorrect configuration	S	Warning	4
S902	Input signal too large		S	Warning	5
Diagnostics for the electronics					
F261	Electronics module	Replace electronics	F	Alarm	1
F283	Memory content	▪ Restart device ▪ Reset device ▪ Replace electronics	F	Alarm	2
F431	Factory calibration	Replace electronics	F	Alarm	3
Diagnostics for the configuration					
M561	Display overshoot	Check scaling	M	Warning	7

9.2.1 HART® diagnostic messages

If several errors are pending simultaneously, the device always displays the error with the highest priority.

1 = Highest priority

Diagnostic number	Short text	Remedial action	Status signal	Diagnostic behavior	Priority
F960	HART® communication (slave not responding)	▪ Verify HART slave address ▪ Check electrical wiring (HART®) ▪ Check HART® function sensor/actor	F	Alarm	8
C970	Multi-master collision	▪ Check additional master in HART® network (e.g. handheld) ▪ Check master setting (secondary/primary)	C	Check	9
F911	HART® slave device error (HART® Field Device Status)	Check sensor/actor configuration or check for defects	F	Alarm	10
S913	HART® slave current output saturated (HART® Field Device Status)	▪ Commissioning: Check sensor/actor for incorrect configuration, check sensor/actor configuration ▪ Operation: Process parameter outside valid range	S	Warning	11
S915	HART® slave variable outside limits of range (HART® Field Device Status)		S	Warning	12

9.2.2 Other diagnostics in the HART® mode

The process indicator has an integrated HART® diagnostics function. This function can be used to estimate the HART® signal level, the applicable communication resistance, and the noise of the network.

The indicator can measure and display the following values:

Parameter	Description	Indication	
Tx mV	Process indicator signal level	mV	Peak-to-peak level of the transmission signal
Rx mV	Slave signal level	mV	Peak-to-peak level of the received signal
NOISE	Weighting of the interference signal	LO / MED / HI	Categorization of the interference into low, medium or high
Rc Ω	Effective communication resistance	Ω	Resistance in Ohm

The values can be called up in the EXPRT – DIAG – HLEVL menu.

Measuring the transmission signal level "Tx":

The Tx measurement can be used to assess the signal level of the transmission signal.

Ideally this should vary between 200 mV and 800 mV . The following values are displayed:

Tx	< 120 mV	120 to 200 mV	200 to 800 mV	800 to 850 mV	> 850 mV
Indication	LO	Level in mV			HI
Bargraph	<	<	0 to 100 %	>	>

Measuring the received signal level "Rx":

The Rx measurement can be used to assess the signal level of the received signal. Ideally this should vary between 200 mV and 800 mV .

The Rx signal value that is displayed is a filtered signal level as assessed by the process indicator. In this way, the value measured externally and the displayed value can differ from one another, for example in the case of a trapezoidal received signal.

The following values are displayed:

Rx	< 120 mV	120 to 200 mV	200 to 800 mV	800 to 850 mV	> 850 mV
Indication	LO	Level in mV			HI
Bargraph	<	<	0 to 100 %	>	>

Measuring the "NOISE" interference signal:

When the interference signal level is measured, the interference signal determined is divided into three categories:

LO = low

MED = medium

HIGH = high

The noise measurement is also a filtered signal level as assessed by the process indicator. The value measured externally and the displayed value can therefore differ from one another, depending on the frequency and the form of the signal.

With low wanted signal levels (Rx, Tx), transmission errors can occur even if the interference signal level is low ("LO" displayed).

Measuring the communication resistance "Rc":

The "Rc" measurement can be used to determine the network resistance of the HART® network. Ideally this should vary between 230 Ω and 600 Ω .

The network resistance is the sum of the HART® communication resistance, the device's input resistance, the transmission line resistance and line capacitance.

The following values are displayed:

Rc	< 100 Ω	100 to 230 Ω	230 to 600 Ω	600 to 1 000 Ω	> 1 000 Ω
Indication	LO	Resistance in Ω			HI
Bargraph	<	< .-	0 to 100 %	>	>

9.2.3 Error messages during basic configuration of connected transmitters

While configuring connected transmitters, it may happen that the transmitter responds with a response code not equal to 0. In this case, the response code is displayed briefly on the process indicator ("RC XX"). The current setting on the transmitter is then retrieved again and displayed on the process indicator.

The response codes are dependent on the connected transmitter. For further information, see the Operating Instructions of the relevant transmitter.

9.3 Firmware history

Release

The firmware version on the nameplate and in the Operating Instructions indicates the device release: XX.YY.ZZ (example 1.02.01).

XX	Change to main version No longer compatible The device and Operating Instructions change.
YY	Change to functions and operation Compatible The Operating Instructions change.
ZZ	Fixes and internal changes No changes to the Operating Instructions

Date	Firmware version	Software changes	Documentation
04/2013	ISU00XA: 1.01.00	HART® option, only relevant for HART® version	BA01203O/09/EN/01.13
08/2013	ISU00XA: 1.02.00	HART® level measurement, only relevant for HART® version	BA01203O/09/EN/02.13
12/2014	ISU00XA: 1.03.00	New EXP1-EXP4 parameter for HART® option	BA01203O/09/EN/03.14
05/2016	ISU00XA: 1.04.00	Changes not relevant for the operation of this version	BA01203O/09/EN/04.16
07/2019	ISU00XA: 1.06.xx	Display of the mA value in 4-20 mA mode via + or - key held down	BA01203O/09/EN/05.23

10 Maintenance

No special maintenance work is required for the device.

10.1 Cleaning

A clean, dry cloth can be used to clean the device.

11 Repair

11.1 General information

The device has a modular design and repairs can be carried out by the customer's electrotechnical personnel. For more information on service and spare parts, contact the supplier.

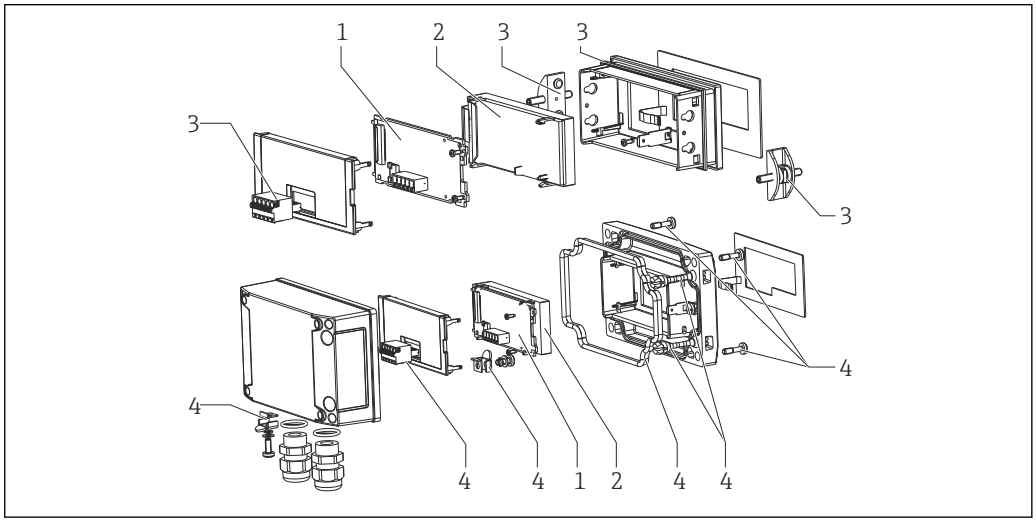
11.1.1 Repair of Ex-certified devices

- Only specialist personnel or the manufacturer may undertake repairs on Ex-certified devices.
- The prevailing standards, national hazardous area regulations, safety instructions and certificates must be observed.
- Only use original spare parts from the manufacturer.
- When ordering spare parts, check the device designation on the nameplate. Parts may only be replaced by identical parts.

- Carry out repairs according to the instructions. On completion of the repair, carry out the routine test specified for the device.
- A certified device may only be converted to another certified device version by the manufacturer only.
- Document all repairs and modifications.

11.2 Spare parts

Contact supplier if necessary. Always quote the serial number of the device when ordering spare parts!



11 *Spare parts of the process indicator*

Item no.	Name	Order number
1	Mainboard HART®	Contact supplier if necessary.
2	LCD module	Contact supplier if necessary.
3	Small parts set for panel-mount housing (5-pin plug-in terminal, seal on front frame, 2x fastening clip)	Contact supplier if necessary.
4	Small parts set for field housing (5-pin plug-in terminal, seal on cover, 2x cover hinge, grounding connection on bottom, cover screws, grounding lug)	Contact supplier if necessary.
4	Cable gland with integrated pressure compensation membrane	Contact supplier if necessary.
	Plastic field housing W18 RAL5012, conductive	Contact supplier if necessary.

11.3 Return

The requirements for safe device return can vary depending on the device type and national legislation.

1. Ask your supplier for information on returning the device.
2. Return the device if repairs or a factory calibration are required, or if the wrong device was ordered or delivered.

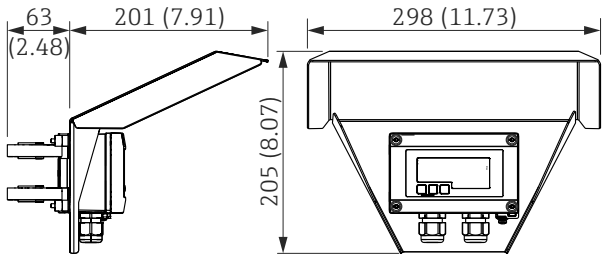
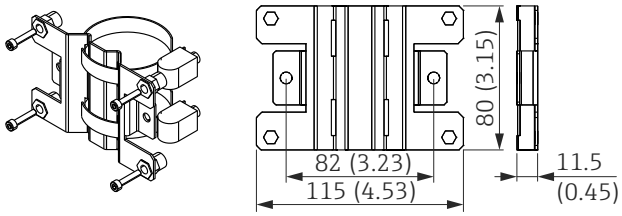
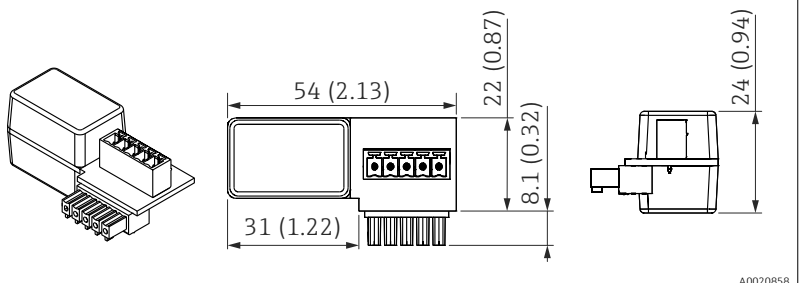
11.4 Disposal

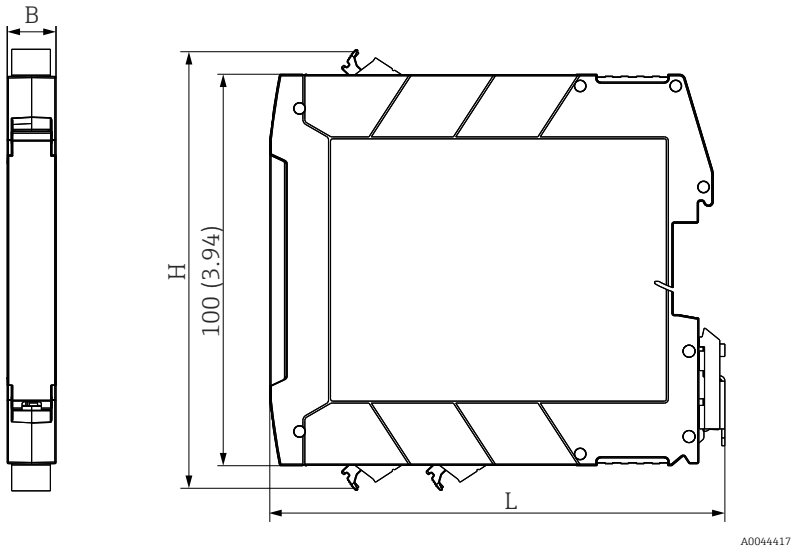
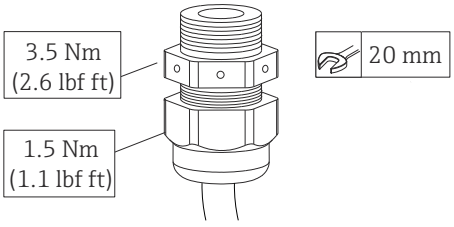
If required by the Directive 2012/19/EU on waste electrical and electronic equipment (WEEE), the product is marked with the depicted symbol in order to minimize the disposal of WEEE as unsorted municipal waste. Do not dispose of products bearing this marking as unsorted municipal waste. Instead, return them to the manufacturer for disposal under the applicable conditions.

12 Accessories

Various accessories are available for the device, and can be ordered with the device or at a later stage. Contact the supplier if necessary.

12.1 Device-specific accessories

Weather protection cover	 12 Dimensions of protective cover, engineering unit mm (in)
Mounting kit for wall/ pipe mounting	 13 Dimensions of mounting bracket, engineering unit mm (in)
HART® communication resistance module	 14 Dimensions of communication resistance module, engineering unit mm (in)

Active barrier from the Endress+Hauser RN product family	
	15 *Dimensions of active barrier for DIN rail mounting, unit mm (in)*
M16 cable gland with integrated pressure compensation membrane	

13 Technical data

13.1 Input

Voltage drop	
Standard device with 4 to 20 mA communication	≤ 1.0 V
Device with HART® communication	≤ 1.9 V
Display lighting	Additional 2.9 V

HART® input impedance
Rx = 40 kΩ
Cx = 2.3 nF

Measured variable

The input variable is either the 4 to 20 mA current signal or the HART® signal.
HART® signals are not affected.

Measuring range

4 to 20 mA (scalable, reverse polarity protection)
Max. input current 200 mA

13.2 Power supply

Supply voltage

NOTICE

SELV/Class 2 device

- The device may be powered only by a power unit with an energy-limited circuit in accordance with UL/EN/IEC 61010-1 Paragraph 9.4 or Class 2 as per UL 1310: 'SELV or Class 2 circuit'.

The process indicator is loop-powered and does not require any external power supply. The voltage drop is ≤1 V in the standard version with 4 to 20 mA communication, ≤1.9 V with HART® communication and an additional 2.9 V if display lighting is used.

13.3 Performance characteristics

Reference operating conditions

Reference temperature 25 °C ±5 °C (77 °F ±9 °F)

Humidity 20 to 60 % relative humidity

Maximum measured error

Input	Range	Measured error of measuring range
Current	4 to 20 mA Over range up to 22 mA	±0.1 %

Resolution

Signal resolution > 13 bit

Influence of ambient temperature

< 0.02 %/K (0.01 %/°F) of measuring range

Warm-up period

10 minutes

13.4 Installation

Mounting location

Panel housing

The device is designed for use in a panel.

Required panel cutout 45x92 mm (1.77x3.62 in)

Field housing

The field housing version is designed for use in the field. The unit is mounted directly on a wall, or on a pipe with a diameter of up to 2 " with the aid of an optional mounting bracket. An optional weather protection cover protects the device from the effects of weather conditions.

Orientation

Panel housing

The orientation is horizontal.

Field housing

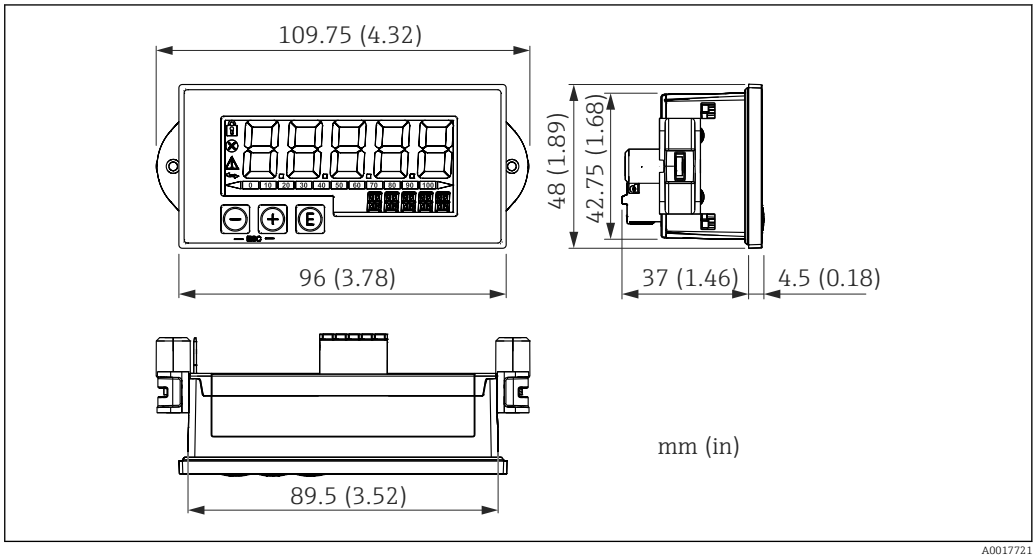
The device must be mounted in such a way that the cable entries point downwards.

13.5 Environment

Ambient temperature range	−40 to 60 °C (−40 to 140 °F) At temperatures below −25 °C (−13 °F) the readability of the display can no longer be guaranteed.
Storage temperature	−40 to 85 °C (−40 to 185 °F)
Climate class	IEC 60654-1, Class B2
Operating altitude	Up to 5 000 m (16 400 ft) above MSL in accordance with IEC61010-1
Degree of protection	**Panel housing** IP65 at front, IP20 at rear **Field housing** Aluminum housing: degree of protection IP66/67, NEMA 4x Plastic housing: degree of protection IP66/67
Electromagnetic compatibility	▪ Interference immunity: As per IEC61326 (Industrial Environments) / NAMUR NE 21 Maximum measured error < 1 % o. MR ▪ Interference emission: As per IEC61326, Class B
Electrical safety	Class III, overvoltage protection category II, pollution degree 2

13.6 Mechanical construction

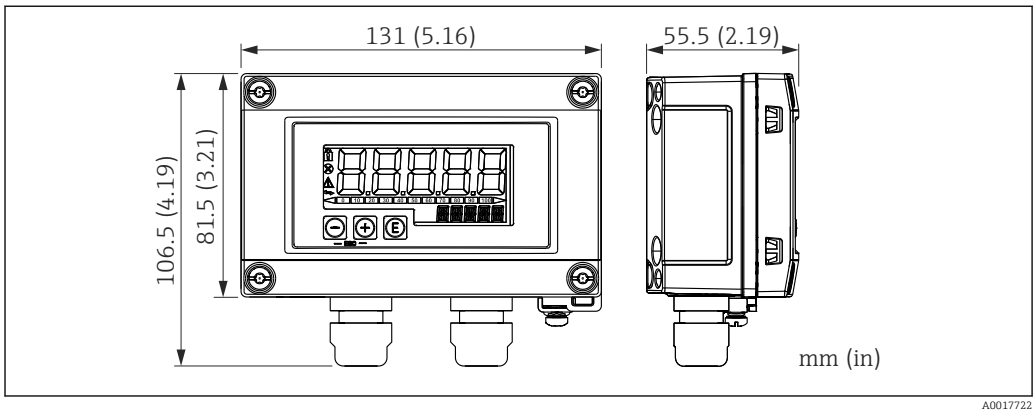
Design, dimensions	**Panel-mount housing**



16 *Dimensions of the panel housing*

Required panel cutout 45x92 mm (1.77x3.62 in), max. panel thickness 13 mm (0.51 in).

Field housing



17 *Dimensions of the field housing incl. cable entries (M16)*

Weight

Panel-mount housing

115 g (0.25 lb.)

Field housing

520 g (1.15 lb)

Materials

Panel-mount housing

Front: aluminum

Rear panel: polycarbonate PC

Field housing

Aluminum

13.7 Operability

Local operation

The device is operated with the 3 operating keys on the front of the housing. The device setup can be disabled with a 4-digit user code. If the setup is disabled, a padlock symbol appears on the display when an operating parameter is selected.

 A0017716	Enter key; calling up the operating menu, confirming the option/setting parameters in the operating menu
 A0017714	Selecting and setting values in the operating menu; pressing the - and + keys simultaneously takes the user back up a menu level. The configured value is not saved (ESC)
 A0017715	

13.8 Certificates and approvals

Ex-approval	Information about currently available Ex versions (ATEX, FM, CSA, etc.) can be supplied by your supplier. All explosion protection data are given in a separate documentation which is available upon request.
Functional safety	A SIL version of the device is optionally available. It can be used in safety equipment in accordance with IEC 61508 up to SIL 2. Refer to Safety Manual FY01098K for the use of the device in safety instrumented systems according to IEC 61508.
Marine approval	Marine approval (optional)
UL approval	More information under UL Product iq™, search for keyword "E225237")
HART® communication	The indicator is registered by the HART® Communication Foundation. The device meets the requirements of the HART® Communication Protocol Specifications, May 2008, Revision 7.1. This version is downwards compatible with all sensors/actuators with HART® versions ≥ 5.0.
Other standards and guidelines	The manufacturer confirms compliance with all the relevant external standards and guidelines.

14 HART® communication

HART® (Highway Addressable Remote Transducer) is an established global industry standard, which has been tried and tested in the field and has an installed base of over 14 million devices.

HART® is a "smart" technology which enables 4 to 20 mA analog transmission and digital communication to occur simultaneously along the same wire pair. With HART®, transmission is based on the Bell 202 Frequency Shift Keying standard (FSK). A high-frequency wave (±0.5 mA) is superimposed on the low-frequency analog signal (4 to 20 mA). Maximum transmission distances depend on the network structure and ambient conditions.

In many applications, the HART® signal is used only for configuration purposes. However, with the appropriate tools, HART® can be used for device monitoring, device diagnosis and for recording multivariable process information.

The HART® protocol is based on the master/slave principle. This means that during normal operation, all communication is initiated by the master. Unlike other master-slave communication types, HART® permits two masters in one loop/network: a primary master, e.g. the distributed control system, and a secondary master, e.g. a handheld terminal. However, two masters of the same type are not permitted simultaneously. Secondary master devices can be used without affecting communication to and from the primary master. The field devices are generally the HART® slaves and respond to HART® commands from the master that are addressed directly to them or to all devices.

The HART® specification stipulates that the masters transmit a voltage signal, while the sensors/actuators (slaves) convey their messages using load-independent currents. The current signals are converted to voltage signals at the internal resistor of the receiver (load).

To ensure reliable signal reception, the HART® protocol specifies that the total load of the current loop - including cable resistance - must be between a minimum of 230 Ω and a

maximum of 600 Ω. If the resistance is less than 230 Ω, the digital signal is greatly attenuated or short-circuited. Therefore, a HART® communication resistor is always required in the 4 to 20 mAcable in the case of a low-impedance power supply.

14.1 HART® protocol command classes

Each command is assigned to one of the following three classes:
- Universal commands
  are supported by all devices using the HART® protocol (e.g. device tag, firmware no. etc.).)
- Common practice commands
  offer functions that are supported by many but not by all HART® instruments (e.g. read out value, set parameter etc.)
- Device-specific commands
  provide access to device data that are not HART® standard but are unique to a particular device model (e.g. linearization, advanced diagnostic functions)

Since the HART® protocol is an open communication protocol between the control device and the field device, it can be implemented by any manufacturer and freely applied by the user. The necessary technical support is provided by the HART® Communication Foundation (HCF).

14.2 HART® commands used

The process indicator uses the following HART® universal commands:

Universal command number	Response data used
0 Unique device identifier	The device identifier provides information on the device and manufacturer; it cannot be changed. The response comprises a 12-byte device ID. The following bytes are used by the process indicator: ▪ Byte 0: fixed value 254 ▪ Byte 2: device type ID, for slave addressing with long address format ▪ Byte 3: number of preambles ▪ Byte 9-11: device identification, for slave addressing with long address format
2 Read the primary process variable as current in mA and the percentage value based on the current range	The response comprises 8 bytes: ▪ Byte 0-3: current in mA ▪ Byte 4-7: percentage value
3 Read the primary process variable as current in mA and four dynamic process variables	The response comprises 24 bytes: The following bytes are used by the process indicator: ▪ Byte 4: HART® unit code of the primary process variable ▪ Byte 5-8: primary process variable ▪ Byte 9: HART® unit code of the secondary process variable ▪ Byte 10-13: secondary process variable ▪ Byte 14: HART® unit code of the third process variable ▪ Byte 15-18: third process variable ▪ Byte 19: HART® unit code of the fourth process variable ▪ Byte 20-23: fourth process variable

The universal commands used by the process indicator must be supported by the slaves to guarantee proper communication.

14.3 Field device status

The field device status is contained in the second data byte of a slave/actuator response.

The following bits are analyzed by the process indicator and displayed as a diagnostic message:

Bit mask	Definition	Used in the process indicator
0x80	Device error function – The device has detected a serious error or an error function which affects the operation of the device.	Diagnostic F911
0x40	Configuration changed – A function was executed which has changed the device configuration.	No
0x20	Cold start – The supply voltage has failed or a device reset has occurred.	No
0x10	Additional status available – Additional status information is available via command #48.	No
0x08	Loop current fixed – The loop current is maintained at a fixed value and does not react to changes in the process.	No
0x04	Loop current saturated – The loop current has reached its upper (or lower) limit point and cannot increase (decrease) further.	Diagnostic S913
0x02	Non-primary variable out of limits.	Diagnostic S915
0x01	Primary variable out of limits.	Diagnostic S915

14.4 Supported units

If "HART" is configured in the UNIT1-4 parameter, the units are automatically read out and displayed by the transmitter.

However, if the transmitted unit cannot be clearly displayed, the HART-UnitCode "UCxxx" is displayed instead, with xxx standing for the unit code number.

In this case, a self-defined text can be specified for the unit via the TEXT1-4 parameter.

Unit code	Description	Display text
1	Inches of water at 68 °F	inH2O
2	Inches of mercury at 0 °C	inHG
3	Feet of water at 68 °F	FTH2O
4	Millimeters of water at 68 °F	mmH2O
5	Millimeters of mercury at 0 °C	mmHG
6	Pounds per square inch	PSI
7	Bar	BAR
8	Millibars	mBAR
9	Grams per square centimeter	g/cm2
10	Kilograms per square centimeter	UC010
11	Pascals	Pa
12	Kilopascals	kPa
13	Torr	TORR
14	Atmospheres	ATM
15	Cubic feet per minute	UC015
16	Gallons per minute	UC016
17	Liters per minute	l/min
18	Imperial gallons per minute	UC018
19	Cubic meters per hour	m3/h

Unit code	Description	Display text
20	Feet per second	FT/S
21	Meters per second	m/S
22	Gallons per second	gal/S
23	Million gallons per day	MGD
24	Liters per second	l/S
25	Million liters per day	MLD
26	Cubic feet per second	FT3/S
27	Cubic feet per day	FT3/d
28	Cubic meters per second	m3/S
29	Cubic meters per day	m3/d
30	Imperial gallons per hour	UC030
31	Imperial gallons per day	UC031
32	Degrees Celsius	°C
33	Degrees Fahrenheit	°F
34	Degrees Rankine	°R
35	Kelvin	K
36	Millivolts	mV
37	Ohms	Ohms
38	Hertz	HZ
39	Milliamperes	mA
40	Gallons	gal
41	Liter	LITERS
42	Imperial gallons	Igal
43	Cubic meters	m3
44	Feet	FEET
45	Meters	METER
46	Barrels	bbl
47	Inches	inch
48	Centimeters	cm
49	Millimeters	mm
50	minutes	min
51	Seconds	SEC
52	Hours	HOUR
53	Days	DAY
54	Centistokes	cST
55	Centipoises	cP
56	Microsiemens	uS
57	Percent	%
58	Volts	VOLT
59	pH	PH
60	Grams	g
61	Kilograms	Kg
62	Metric tons	T

Unit code	Description	Display text
63	Pounds	lb
64	American tons	TN SH
65	British tons	TN L
66	Millisiemens per centimeter	mS/cm
67	Microsiemens per centimeter	uS/cm
68	Newton	N
69	Newton meters	Nm
70	Grams per second	g/S
71	Grams per minute	g/min
72	Grams per hour	g/h
73	Kilograms per second	Kg/S
74	Kilograms per minute	Kg/mi
75	Kilograms per hour	Kg/h
76	Kilograms per day	Kg/d
77	Metric tons per minute	T/min
78	Metric tons per hour	T/h
79	Metric tons per day	T/d
80	Pounds per second	lb/S
81	Pounds per minute	lb/mi
82	Pounds per hour	lb/h
83	Pounds per day	lb/d
84	American tons per minute	TnS/m
85	American tons per hour	TnS/h
86	American tons per day	TnS/d
87	British tons per hour	Tnl/h
88	British tons per day	Tnl/d
89	Deka therm	dTh
90	Specific gravity units	UC090
91	Grams per cubic centimeter	g/cm3
92	Kilograms per cubic meter	Kg/m3
93	Pounds per gallon	lb/ga
94	Pounds per cubic feet	lb/F3
95	Grams per milliliter	g/ml
96	Kilograms per liter	Kg/l
97	Grams per liter	g/l
98	Pounds per cubic inch	lb/ci
99	American tons per cubic yard	UC099
100	Degrees Twaddell	°Tw
101	Degrees Brix	°BX
102	Degrees Baumé heavy	UC102
103	Degrees Baumé light	UC103
104	Degrees API	°API
105	Percent solids per weight	%wT

Unit code	Description	Display text
106	Volume percent	%VOL
107	Degrees Balling	°bal
108	Proof per volume	P/VOL
109	Proof per mass	P/maS
110	Bushels	bSh
111	Cubic yards	YARD3
112	Cubic feet	FEET3
113	Cubic inches	inch3
114	Inches per second	in/S
115	Inches per minute	in/mi
116	Feet per minute	F/min
117	Degrees per second	DEG/S
118	Revolutions per second	RPS
119	Revolutions per minute	RPM
120	Meters per hour	m/h
121	Normal cubic meters per hour	Nm3/h
122	Normal liters per hour	Nl/h
123	Normal cubic feet per minute	F3/mi
124	Fluid barrel (1 barrel = 31.5 U.S. gallons)	UC124
125	Ounces	ouncE
126	Foot Pound Force	FTLBF
127	Kilowatts	kW
128	Kilowatt hours	kWh
129	Horse power	HP
130	Cubic feet per hour	FT3/h
131	Cubic meters per minute	m3/mi
132	Barrels per second	bbl/S
133	Barrels per minute	bbl/m
134	Barrels per hour	bbl/h
135	Barrels per day	bbl/d
136	Gallons per hour	gal/h
137	Imperial gallons per second	UC137
138	Liters per hour	l/h
139	Parts per million	PPm
140	Mega calories per hour	UC140
141	Mega joules per hour	mJ/h
142	British Thermal Units per hour	BTU/h
143	Degrees	DEG
144	Radian	rad
145	Millimeters of water at 60 °F	inH2O
146	Micrograms per liter	ug/l
147	Micrograms per cubic meter	ug/m3
148	Percent consistency	%con

Unit code	Description	Display text
149	Volume percent	VOL%
150	Percent steam quality	%SQ
151	Feet inch sixteenths	UC151
152	Cubic feet per pound	F3/lb
153	Picofarads	PF
154	Milliliters per liter	ml/l
155	Microliters per liter	ul/l
156-159	Unit Code Expansion Tables	UC156 - UC159
160	Percent Plato	%P
161	Percent lower explosion level	%LEL
162	Mega calories	Mcal
163	Kilo ohms	KOHM
164	Mega joules	MJ
165	British Thermal Unit	BTU
166	Standard cubic meters	Nm3
167	Normal liters	Nl
168	Normal cubic feet	SCF
169	Parts per billion	PPb
170 - 219	Unit Code Expansion Tables See Operating Instructions of connected transmitter / sensor. For CM82: see chapter "Troubleshooting"	UC170 - UC219
220 - 234	not defined	UC220 - UC234
235	Gallons per day	gal/d
236	Hectoliters	hl
237	Megapascals	MPa
238	Inches of water at 4 °C	inH2O
239	Millimeters of water at 4 °C	mmH2O
240 - 249	Manufacturer-specific	UC240 - UC249
250	Not used	-----
251	None	
252	Unknown	UC252
253	Special	UC253

14.5 HART® protocol connection types

The HART protocol can be used for point-to-point and Multidrop connections:

Point to point (TYPICAL)

In a point-to-point connection, the HART® master communicates with precisely one HART® slave.

A point-to-point connection should always be the preferred option where possible.

Multidrop (measurement not by current, slower)

In Multidrop mode, several HART® devices are incorporated in a single current loop. Analog signal transmission is disabled in this case and the data and measured values are exchanged exclusively via the HART® protocol. The current output of each connected device is set to a fixed value of 4 mA and is used only to supply power to the two-wire devices.

Using Multidrop, several sensors/actuators can be connected in parallel to one wire pair. The master then differentiates between devices based on the configured addresses. Each device must have a different address. When more than seven sensors/actuators are connected in parallel, an increased voltage drop occurs.

The loop must not include a mixture of devices with an active current output (e.g. four-wire devices) and devices with a passive current output (e.g. two-wire devices).

The HART® protocol is a form of communication that is not susceptible to interference. This means that, during operation, communication devices can be connected or removed without putting components of the other devices at risk or interrupting their communication.

14.6 Device variables for multivariable measuring devices

Multivariable measuring devices can transmit up to four device variables via HART®: the primary variable (PV), the secondary variable (SV), the tertiary variable (TV) and the quarternary variable (QV).

Below you will find some examples of what default values can be set for these variables for various sensors/actuators:

e.g. flowmeter:

- Primary process variable (PV) → Mass flow
- Secondary process variable (SV) → Totalizer 1
- Third process variable (TV) → Density
- Fourth process variable (QV) → Temperature

e.g. temperature transmitter:

- Primary process variable (PV) → Sensor 1
- Secondary process variable (SV) → Device temperature
- Third process variable (TV) → Sensor 1
- Fourth process variable (QV) → Sensor 1

HART® actuator, e.g. positioner:

- Primary process variable (PV) → Actuating value
- Secondary process variable (SV) → Valve set point
- Third process variable (TV) → Target position
- Fourth process variable (QV) → Valve position

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