

Technical Information

Density Calculator QML51

Vibronic



Density calculator for liquids

Application

The density measuring line can be used in liquid media.
It is used for the following purposes:

- Density measurement
- Intelligent medium detection
- Calculation of reference density and concentration
- To convert values to different units such as °Brix, °Baumé, °API etc.

Advantages

- The Liquiphant Density is used directly in tanks or pipes without the need for additional pipework
- Density Calculator QML51 can be used for up to two measuring points
- Integration of a temperature measuring instrument for temperature-compensated density measurement
- Integration of a pressure measuring instrument for pressure-compensated density measurement

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About this document

Safety symbols



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



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



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



This symbol alerts you to a potentially harmful situation. Failure to avoid this situation can result in damage to the product or something in its vicinity.

Symbols on the device

Safety instructions:  → 

Observe the safety instructions contained in the associated Operating Instructions. Observe the information on the degree of protection and shock resistance.

Communication-specific symbols



LED is off



LED is on



LED flashing

Symbols for certain types of information



Permitted

Procedures, processes or actions that are permitted



Forbidden

Procedures, processes or actions that are forbidden



Tip

Indicates additional information



Reference to documentation



Reference to page



Reference to graphic

Symbols in graphics

1, 2, 3, ...

Item numbers



Result of a step



Notice or individual step to be observed

A, B, C, ...

Views



Hazardous area

Indicates the hazardous area



Safe area (non-hazardous area)

Indicates the non-hazardous area

Function and system design

Measuring principle

The measuring system consists of the following main components:

- Liquiphant Density
- Density calculator

In conjunction with the density calculator, the Liquiphant Density measures the density of a Newtonian, purely viscous, liquid in pipes and tanks.

A piezoelectric drive causes the vibrating fork of the Liquiphant Density to vibrate at its resonance frequency. Changes in liquid density cause a change in the resonance frequency of the vibrating fork. As a result, the density of the medium has a direct impact on the resonance frequency of the vibrating fork. This effect is used for density measurement.

In the density calculator, the density of the liquid is calculated from the resonance frequency of the vibrating fork transmitted by the sensor and from stored sensor-specific parameters. To compensate for temperature and pressure influences, additional corresponding sensors can be connected to the density calculator.

Function	In addition to calculating the density of a liquid medium, the Density Computer QML51 can also determine the reference density of the medium and the concentration of a solution, as well as detect up to four different media or an empty pipeline. In doing so, the density computer evaluates up to two measuring points and directly supplies connected two-wire transmitters with auxiliary power. This allows the connection of up to two Liquiphant Density sensors and temperature sensors for compensation of temperature effects in order to calculate reference densities. For concentration determination, stored standards such as ICUMSA for sugar concentrations, OIML ITS-90 for ethanol, and various preconfigured electrolyte solutions (according to the Laliberté-Cooper model) can be used. Specific reference density or concentration tables can be entered manually in the form of linearization tables or imported into the density computer in standard data formats (e.g. .csv, .xlsx) and used for calculations. Density and concentration values can be output in various units, for example, SI units, °Baume, °Brix or °API. Configuration of the QML51 is performed via an integrated web server, which can be accessed via a secure TLS connection using a standard web browser. For output to a PLC or a SCADA system, the QML51 supports the Ethernet protocols Modbus TCP and OPC UA. If a current signal is required for connection to a PLC, this can be generated via a converter. A converter that generates up to 4 channels with an analog 4 to 20 mA signal from the Modbus TCP protocol is available as an accessory.
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Specific density applications	The density computer's software calculates the density from the frequency, temperature and pressure input variables.
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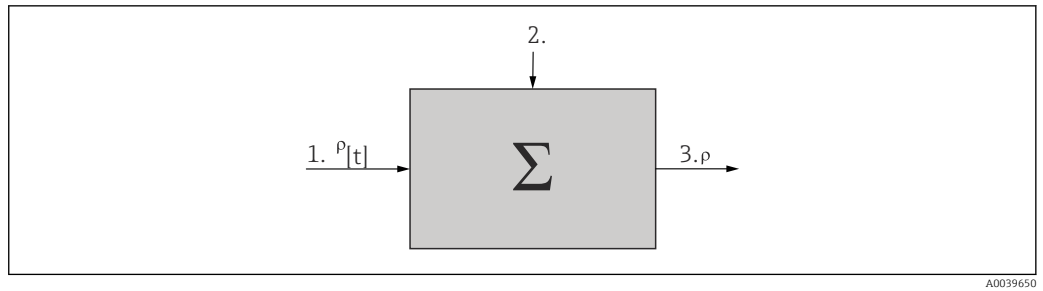
Operating principle

The oscillation frequency of the vibrating fork is reduced when the fork is completely covered with liquid. Since the density of the medium has a direct influence on the oscillation frequency, the density of the medium can be determined from the oscillation frequency based on this relationship. Using additional information, such as temperature and pressure, the current density of the medium can be compensated to a reference density or standard density. If the correlation between density and concentration is known, the concentration of the medium can be determined using a stored function. This value can be determined empirically or using existing tables or curves, for example. Standardized conversion tables from density to concentration are already stored in the density computer. Additional conversion tables can be provided by the customer and imported into the density computer.

Furthermore, up to four different media can be detected based on their density ranges. It is also possible to detect an empty pipe based on whether a certain density or frequency value is exceeded or not reached.

Reference density

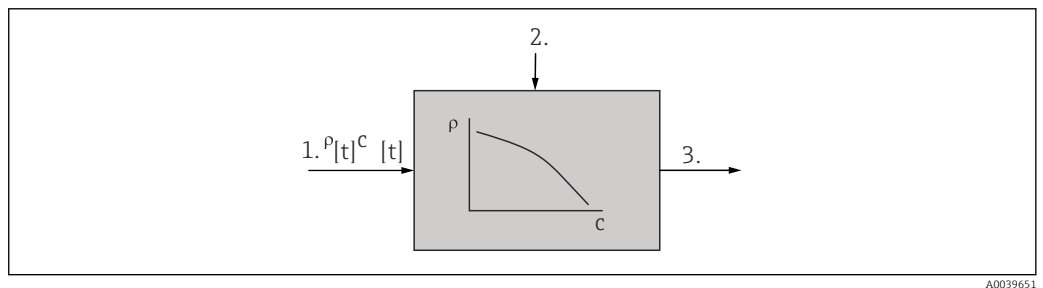
In this application, the system uses a reference temperature such as 15.56 °C (59 °F) or 20 °C (68 °F). The variation of the medium's density at other temperatures must be known.



- 1 Input data: Table ρ [t]
- 2 Measured liquid medium: Temperature and density
- 3 Output: Calculated density ρ [standard]

Concentration

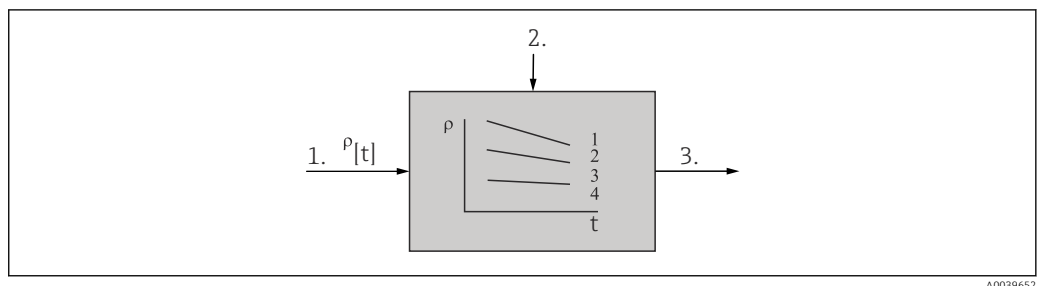
Using density and concentration tables or curves already available or determined empirically, it is possible to determine the concentration when substances are continuously dissolved in a medium.



- 1 Input data: Table ρ, c [t]
- 2 Measured liquid medium: Temperature and density
- 3 Output: Calculated concentration

Medium detection

To be able to distinguish between two to four media, the density function can be stored for several media, depending on the temperature. This allows the system to differentiate between two to four media.



- 1 Input data: Tables ρ [t] for two liquid media
- 2 Measured liquid medium: Temperature and density
- 3 Output: Modbus TCP

Network connection

The device can be connected into the computer network using 2 LAN ports that support the following connection speeds:

- 1 Gbit/s
- 100 Mbit/s
- 10 Mbit/s

 The LAN ports support the "Auto MDI-X" feature. The ports automatically detect the type of connected cable (crossover or straight).

No special cables are required to connect the components.

Dependability**Ease of maintenance**

Firmware updates can be installed from the web server.



The configuration of the device or saved log files are not changed if the firmware is updated.

Ease of maintenance

Firmware updates can be installed in a variety of ways:

- Ethernet connection
- SD card
- USB stick



The configuration of the device or saved log files are not changed if the firmware is updated.

IT security

The manufacturer 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.

Input and output

Density Calculator QML51 has inputs and outputs. The Ethernet-based interfaces Modbus TCP and OPC UA are available as outputs.

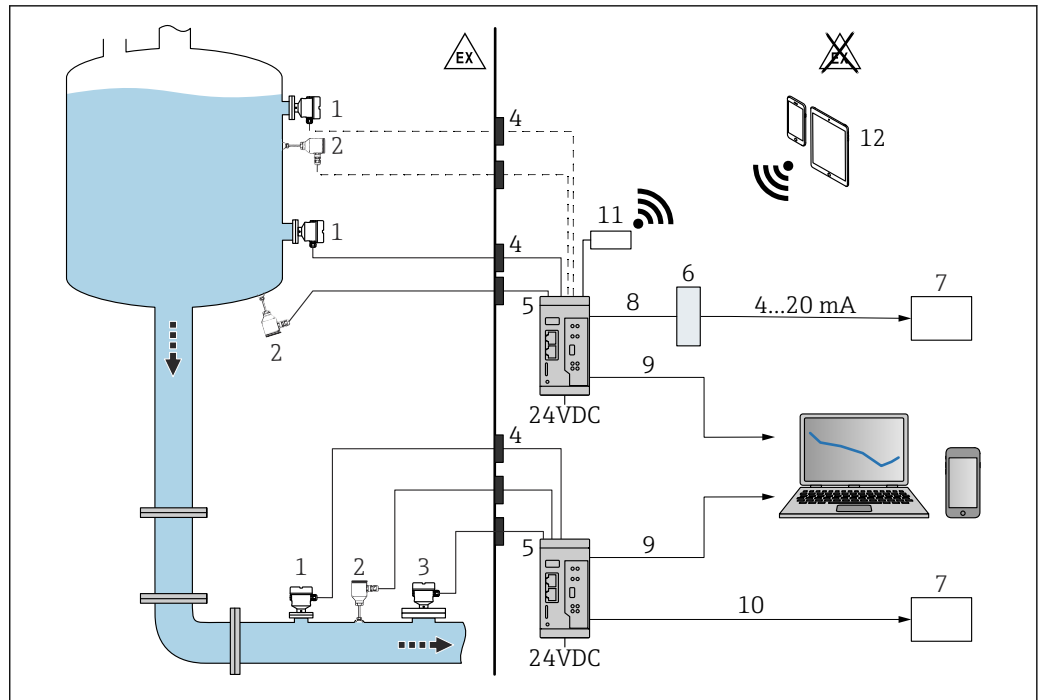
Density Calculator QML51 allows connection of up to four measuring instruments.

The typical parameters are preconfigured in Density Calculator QML51. Parameters must be checked and activated for the specific application.



Additional information:

SD (in preparation)



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1 Density measurement with Density Calculator QML51

- 1 Liquiphant Density with electronic insert FEL60D → pulse output
- 2 Temperature sensor, e.g. 4 to 20 mA output
- 3 Pressure transmitter 4 to 20 mA output; required for pressures above 6 bar (87 psi) or for pressure fluctuations.
- 4 Ex barrier (Liquiphant Density, temperature and/or pressure measuring cell installed in the hazardous area)
- 5 Density Calculator QML51
- 6 Modbus TCP to 4 to 20 mA converter
- 7 Programmable logic controller (PLC)
- 8 Modbus TCP
- 9 Ethernet
- 10 Modbus TCP or OPC UA
- 11 Mobile devices, wireless connection possible via TELTONIKA Router RUT241 (accessory)



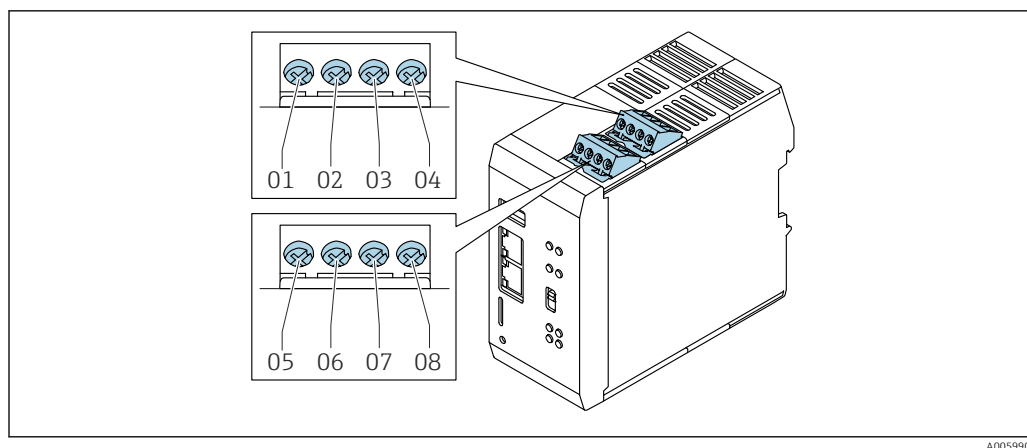
For use in hazardous areas: Ex barrier via RN22 active barrier. The single-channel or two-channel RN22 active barrier powers analog device circuits and safety equipment up to SIL 2 (SC 3). The intrinsically safe, HART® transparent interface provides a reliable connection between the field devices and Density Calculator QML51. It is connected to 2-wire/4-wire devices in hazardous areas and provides a second galvanically isolated signal output in accordance with NAMUR NE 175.

Galvanic isolation

The interfaces are galvanically isolated from each other.

Pulse and analog input

- The terminals of Density Calculator QML51 serve as an input for sensor signals.
- The terminal blocks are galvanically isolated from each other.
- The terminal blocks are plug-in.



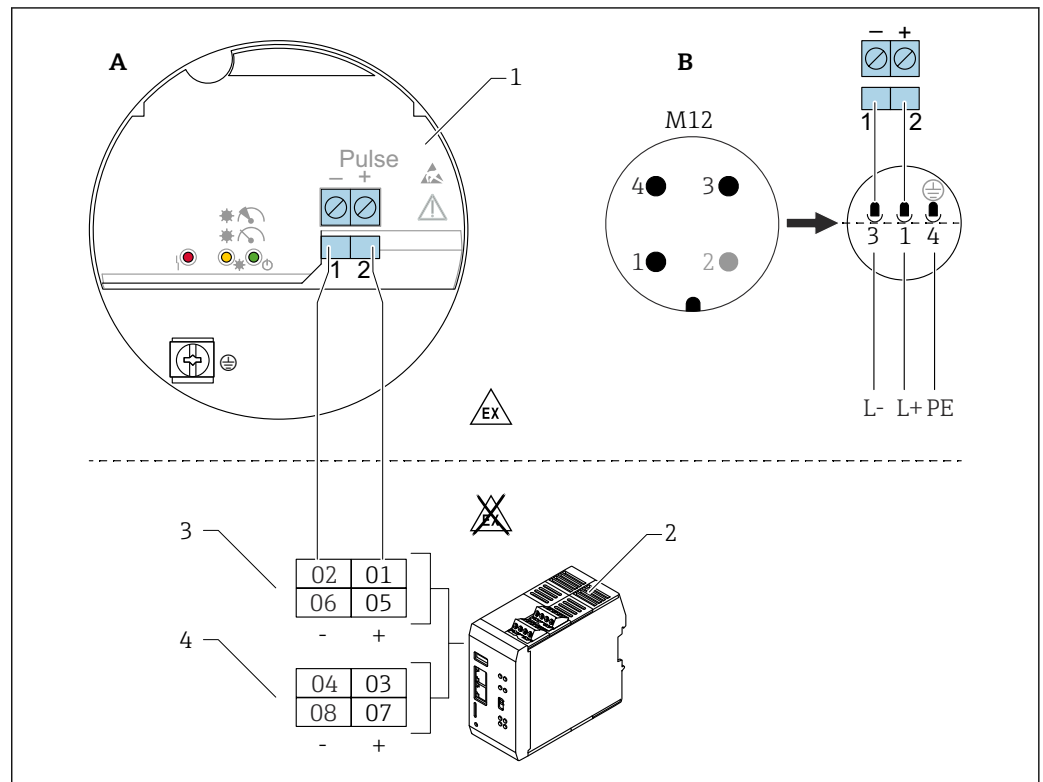
2 Terminal assignment

- 01 Channel 3 (+), default setting: PFM
- 02 Channel 3 (-), default setting: PFM
- 03 Channel 4 (+), default setting: 4 to 20 mA(HART)
- 04 Channel 4 (-), default setting: 4 to 20 mA(HART)
- 05 Channel 1 (+), default setting: PFM
- 06 Channel 1 (-), default setting: PFM
- 07 Channel 2 (+), default setting: 4 to 20 mA(HART)
- 08 Channel 2 (-), default setting: 4 to 20 mA(HART)



For more information, see the Operating Instructions.

Terminal assignment



3 Connection diagram: connection of electronic insert FEL60D to the Density Calculator QML51

A Connection wiring with terminals

B Connection wiring with M12 plug in housing as per EN61131-2 standard

1 Electronic insert FEL60D

2 Density Calculator QML51

3 PFM channels (default setting)

4 4 to 20 mA (HART) channels (default setting), e.g. for temperature measuring devices

i The channels are preset. The configuration can be changed.

i It is not possible to connect a device with a pulse output (PFM) and a device with a 4 to 20 mA HART or HART-only transmission to the same terminal block if the measured values are to be transmitted via HART communication.

i It is not possible to connect two devices with a pulse output (PFM) to the same terminal block.

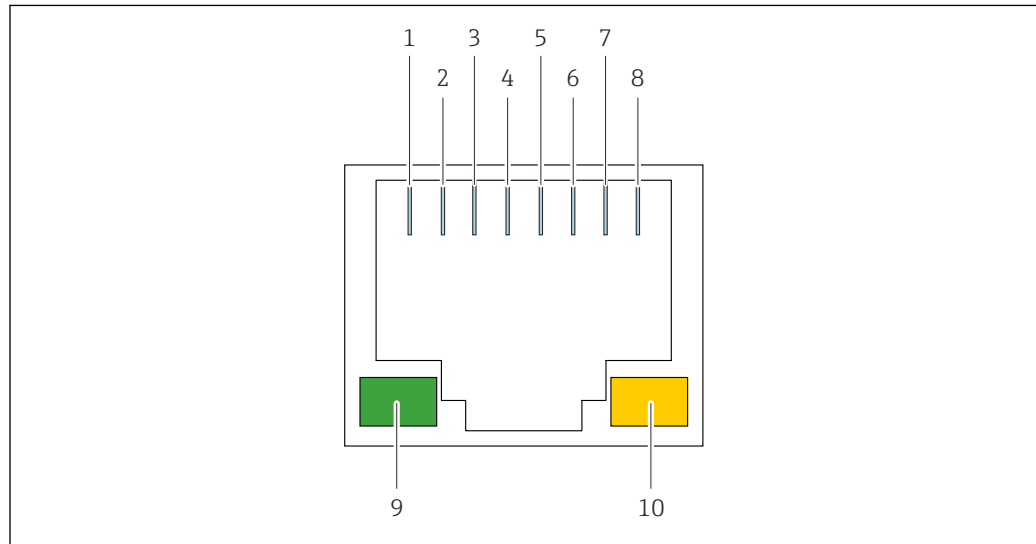
The following devices can be connected to one terminal block:

- One device with a pulse output and one additional device with an analog output (4 to 20 mA).
- One device with a pulse output and one additional device with a 4 to 20 mA HART output, provided that HART communication is not used.
- Only one device with a pulse output. An additional device with a pulse output cannot be connected to the same terminal block.
- One or 2 devices with 4 to 20 mA or 4 to 20 mA HART. In this case, HART communication can be used by both devices.

i The previous Liquiphant Density version with FEL50D is compatible with Density Calculator QML51.

LAN interface

- 2 shielded RJ45 sockets are available.
- The LAN interface is compatible with the IEEE 802.3 standard.
- The assignment corresponds to a standard-compliant MDI interface (AT&T258).
- The device can be connected to other devices via the LAN interface using a hub or switch.
- Half-duplex and full-duplex data transmission are supported.
- A shielded 1:1 cable with a maximum length of 100 m (328 ft) can be used.
- The LAN interface is designed for a bandwidth of 1 Gbit/s, 100 Mbit/s and 10 Mbit/s.
- Observe the safety distances specified in the EN 60950 office equipment standard.



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 4 Pin assignment of the RJ45 sockets and LED description

- | | |
|----|---------------------------------------|
| 1 | Tx+ |
| 2 | Tx- |
| 3 | Rx+ |
| 4 | Not connected |
| 5 | Not connected |
| 6 | Rx- |
| 7 | Not connected |
| 8 | Not connected |
| 9 | Green LED: link indicator |
| 10 | Yellow LED: active transfer indicator |

Power supply

Supply voltage

The supply voltage is 24 V_{DC} (±20 %).

⚠ WARNING

Risk of electric shock! The output terminal can be hazardous if the power supply insulation is damaged!

Death, cardiac arrest and skin burns may result.

- ▶ Disconnect the power supply unit from the mains voltage source before removing cables from the connections.
- ▶ Only use power supply units that ensure safe electrical insulation according to IEC 61558-2-6 (SELV/PELV or NEC Class 2) and that are designed as limited-energy circuits.
- ▶ Provide a suitable circuit breaker for the device in accordance with IEC/EN 61010.
- ▶ Do not use a power supply unit that is not insulated.

Power consumption

< 9 W

Potential equalization**Standard**

When planning the shielding and grounding for a fieldbus system, observe the following points:

- Safety of the personnel
- Explosion protection
- Electromagnetic compatibility (EMC)

The following conditions must be met to ensure optimum electromagnetic compatibility of systems:

- The system components must be shielded.
- All cables connecting the components together must also be shielded.
- The cable shields must be connected to the metal housings of the connected field devices.
- Keep the stripped and twisted lengths of cable shield to the terminals as short as possible.

Since the metal housings of the connected field devices are generally connected to the functional earth (FE), the shield of the bus cable is grounded many times. This approach offers the best electromagnetic compatibility and a high level of safety for the staff.

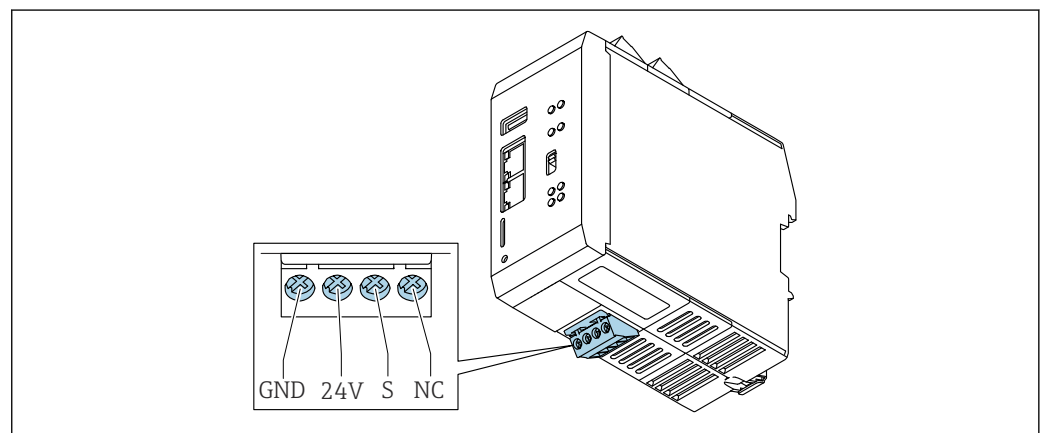
In systems with good potential equalization, the device can be used without restrictions.

 In systems without electrical potential equalization, there is a risk that an equalizing current will flow between the two grounding points. This equalizing current can cause damage and interference.

Terminals**Screw terminals**

- Plug-in screw terminals
- Coded supply terminal (mechanical coding prevents incorrect insertion of the terminal)
- Clamping range: 0.5 to 2.5 mm² (20 to 13 AWG)

 Use flexible stranded conductors only with ferrules.

Power supply

 5 Overview of the power supply terminals

GND : functional grounding and negative potential of the power supply

24V : positive potential of the power supply

S : shield

NC : Not connected

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Cable specification**Power supply line**

Conductor cross-section: 0.5 to 2.5 mm² (20 to 13 AWG)

Shielded cable not required.

Fieldbus connection

Conductor cross-section: 0.5 to 2.5 mm² (20 to 13 AWG)

 Use shielded cables.

HART communication line

- For applications with HART protocol transmission, use a shielded cable.
 - For applications with pure analog signal transmission, an unshielded cable may be used.
-  Observe the grounding concept of the plant. Connect the shielding according to the application.

Overvoltage protection

Overvoltage Category II.

NOTICE

Risk of overvoltage and device damage!

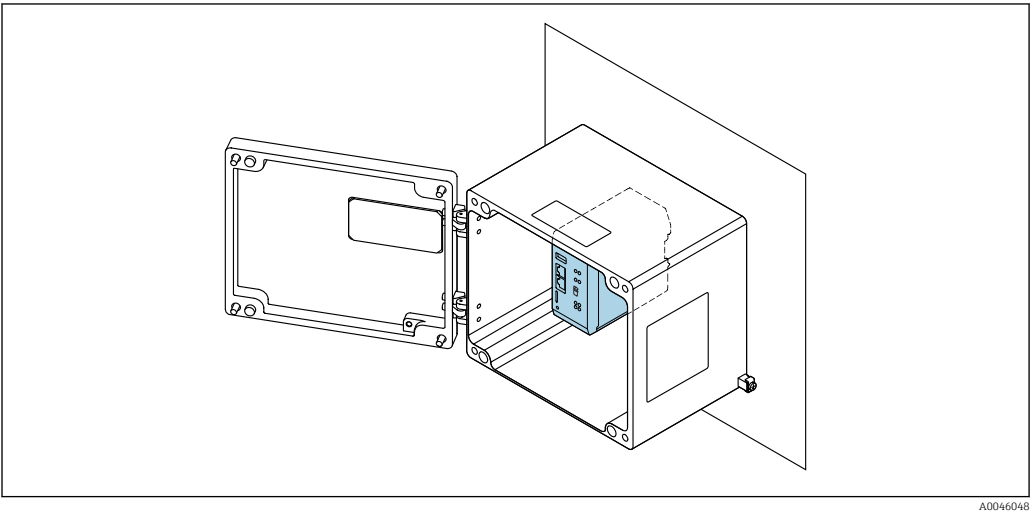
- The device can be protected by a suitable overvoltage protection system, installed in addition to the overvoltage protection integrated in the device.

Installation

Mounting location

Installation requirements:

- Install the device outside the hazardous area.
- Use a control cabinet. The control cabinet must be securely and firmly mounted.
- For installation in a humid environment or outdoors:
The degree of protection of the control cabinet must be at least IP67 in accordance with IEC 60529



 6 Example illustration: installation in a control cabinet

-  Check the environmental requirements before installing the device in an outdoor location.

-  Detailed information on the environmental requirements can be found in the "Technical data" section in the Operating Instructions for the device.

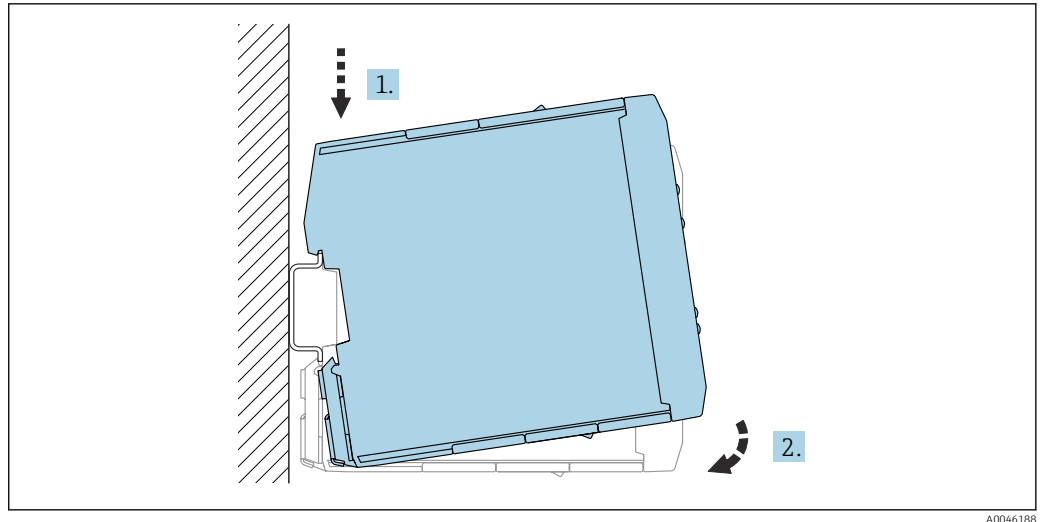
Orientation

Vertical or horizontal installation on DIN rail (TH35 in accordance with EN 60715).

Installation instructions

Installing the device

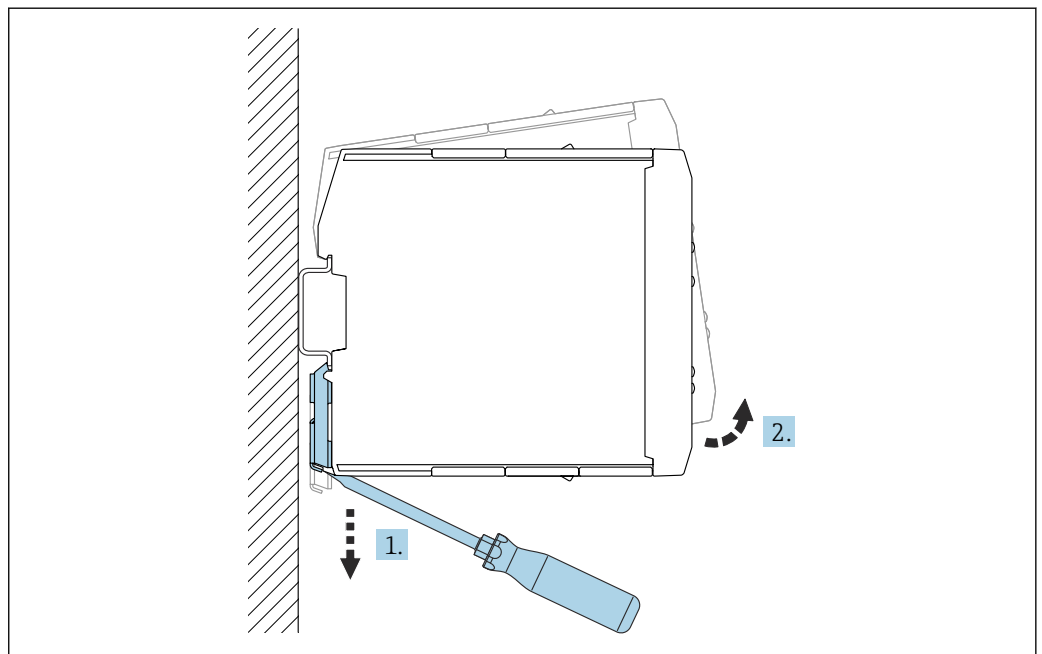
- Install the device on a DIN rail.



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1. Hook the housing onto the DIN rail.
2. Press the housing downward until it snaps into place on the DIN rail.

Removing device from top-hat rail



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1. Unlock the latch.
2. Pull up the housing.

Environment

Ambient temperature range -20 to 60 °C (-4 to 140 °F)

Transport and storage temperature -25 to 85 °C (-13 to 185 °F)

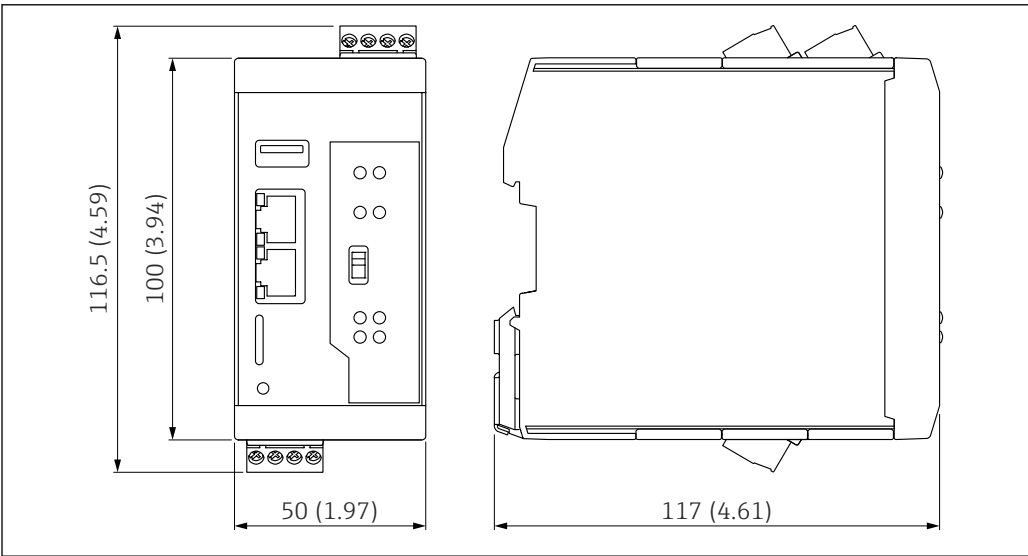
Humidity EN 60068-2-30; Db; 0.5 K/min: 5 to 85 %; non-condensing

Condensation	Not permitted
Operating height	Up to 2 000 m (6 562 ft) above sea level
Climate class	IEC 60654-1, Class B2
Ambient class	Pollution degree: 2
Degree of protection	IP20 (as per IEC/EN 60529, NEMA 1) IK06 (as per IEC/EN 61010-1)
Vibration resistance	EN 60068-2-64 / IEC60068-2-64: 20 to 2 000 Hz, 0.01 g ² /Hz
Shock resistance	IEC60068-2-27:2008, ±15 g; 11 ms
Impact resistance	1 J
Electromagnetic compatibility (EMC)	■ Interference immunity: as per IEC 61326, industrial environment ■ Interference emissions: as per IEC 61326, Class B  Information on connecting shielded cables is provided in Technical Information TI00241F, "EMC test procedures".

Mechanical construction

 The following dimensions are rounded values. As a result, there may be deviations from the specifications in the Product Configurator at www.endress.com.

Design, dimensions

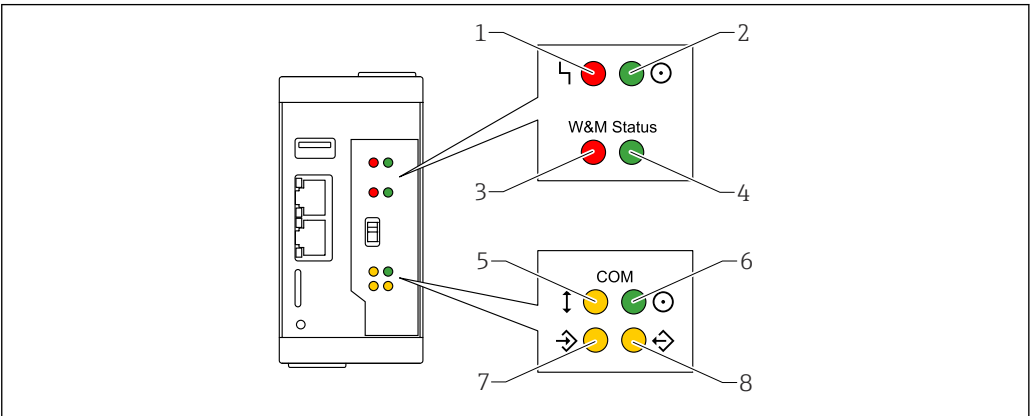


 7 Dimensions. Unit of measurement mm (in)

Weight	260 g (0.57 lb)
Materials	Housing: Polyamide

Operability

Local display



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8 Description of LED statuses

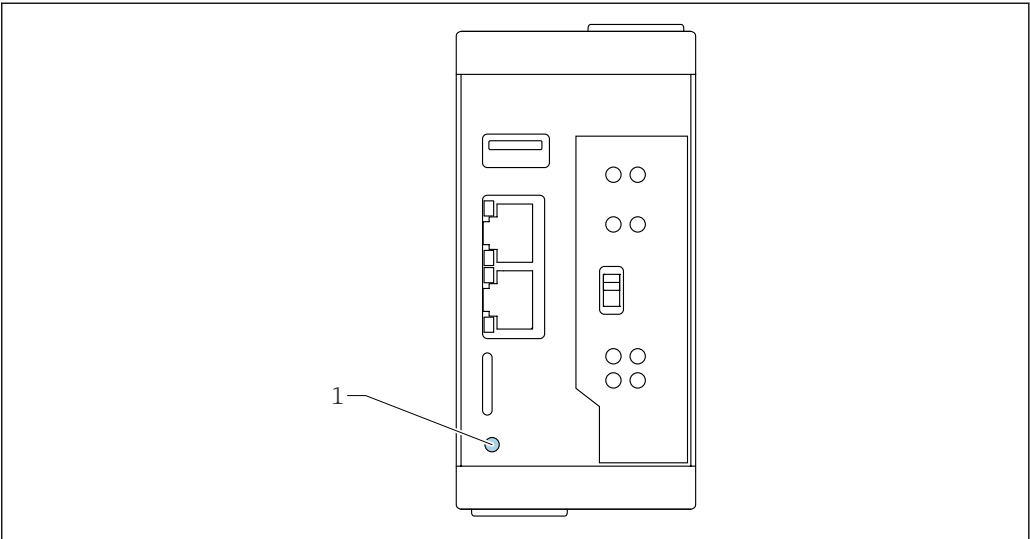
- 1 Red LED: Fault
- 2 Green LED: Power supply status
- 3 Red LED: verification switch in the locked position (no function assigned for Density Calculator QML51)
- 4 Green LED: verification switch in the unlocked position (no function assigned for Density Calculator QML51)
- 5 Yellow LED: Field communication status
- 6 Green LED: Power supply status of the communication interface
- 7 Yellow LED: Incoming data packets
- 8 Yellow LED: Outgoing data packets

Controls

Reset button

The device is reset to the factory settings.

Use a pen tip to press the reset button.

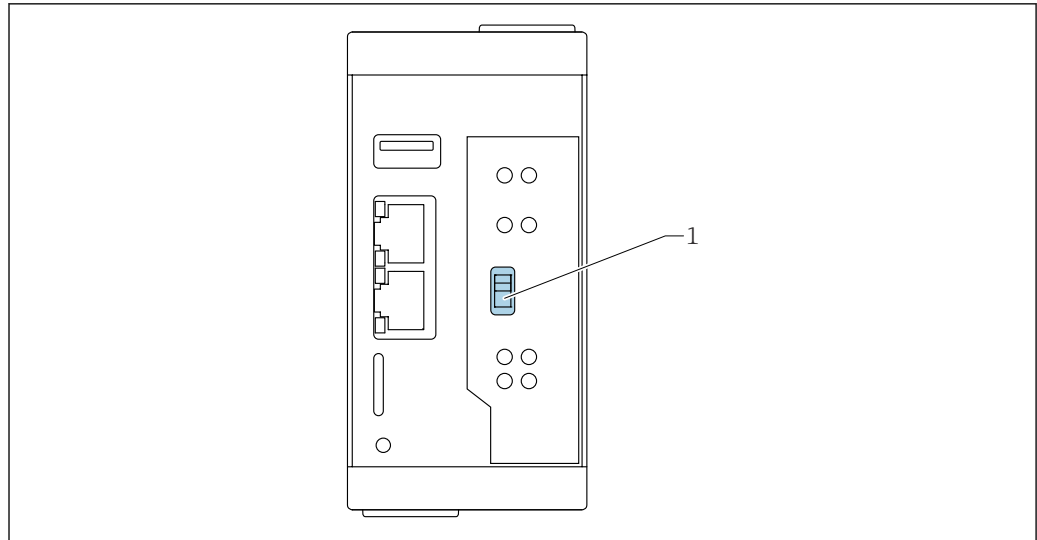


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9 Reset button position

- 1 Reset button

Hardware switch (no function)



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1 Hardware switch (no function)



This switch has no function on the Density Calculator QML51.

Interfaces for data transmission

The device configuration (user data, log files, certificates, or diagnostic codes) can be saved.

Prerequisites:

- To save a backup to a USB stick or an SD card, an appropriate permitted storage medium must be available and have been detected by the device.
- If the backup is to be saved on an FTP server, an FTP server must first be set up and connection must be possible.

A backup can be protected with a password by the system. The password can be freely selected without restriction. A password-protected backup can only be imported to another system with the associated password.

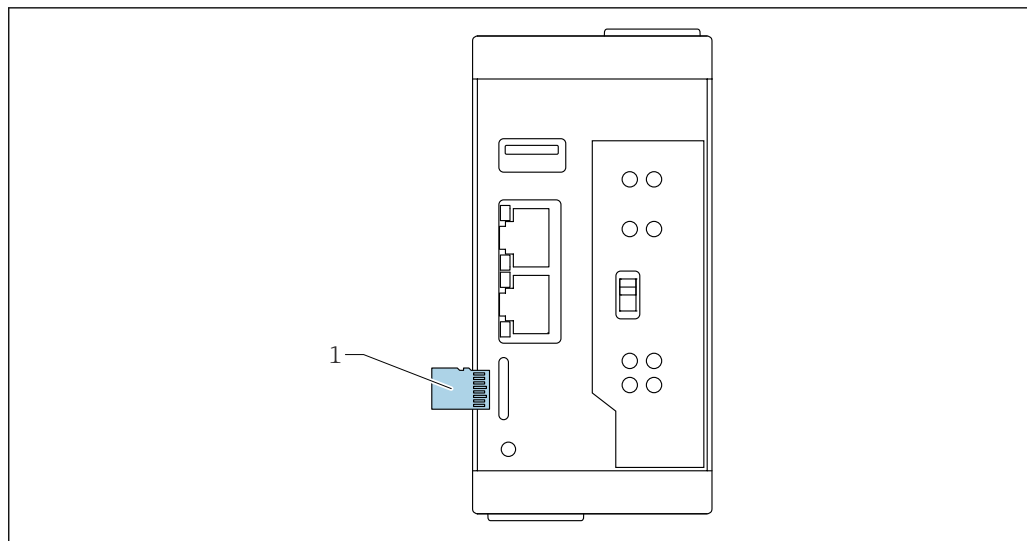
Card slot



The microSD card is not included in the delivery.

Endress+Hauser recommends using microSD cards with the following parameters:

- Storage capacity: 8 to 64 GB
- Temperature range: -40 to 85 °C (-40 to 185 °F)



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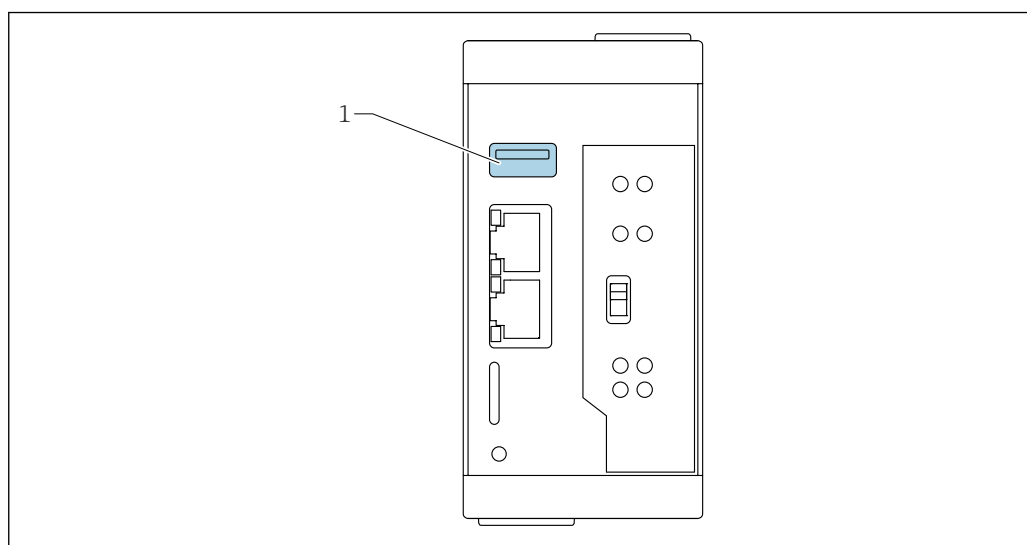
10 Position of the card slot

1 microSD card

USB port

USB (type A) port data:

- USB 2.0 Host
- Up to 480 Mbit/s
- 5 V_{DC} up to 1.5 A



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11 USB port position

1 USB port

Certificates and approvals

Current certificates and approvals for the product are available at www.endress.com on the relevant product page:

1. Select the product using the filters and search field.
2. Open the product page.
3. Select **Downloads**.

CE mark

The measuring system meets the legal requirements of the applicable EU Directives. These are listed in the corresponding EU Declaration of Conformity along with the standards applied.

Endress+Hauser confirms that the device has been successfully tested by applying the CE mark.

Ordering information

Detailed ordering information is available from the following sources:

- In the *Product Configurator* on the Endress+Hauser website: www.endress.com -> click *Corporate* -> Select your country -> Click *Products* -> Select the product using the filter and search mask -> Open product page -> The *Configuration* button to the right of the product image opens the Product Configurator.
- From your Endress+Hauser sales organization: www.addresses.endress.com.



Product Configurator - the tool for individual product configuration

- Current configuration data
- Depending on the device: direct input of information specific to the measuring point, such as the measuring range or operating language
- Automatic verification of exclusion criteria
- Automatic creation of the order code and its breakdown in PDF or Excel output format
- Ability to order directly in the Endress+Hauser Online Shop

Accessories

The accessories currently available for the product can be selected at www.endress.com:

1. Select the product using the filters and search field.
2. Open the product page.
3. Select **Spare parts & Accessories**.



The accessories can be partially ordered via the "Accessory enclosed" product structure.

Device Viewer

All the spare parts for the device, along with the order code, are listed in the *Device Viewer* (www.endress.com/deviceviewer).

Accessories enclosed**RN22 active barrier**

- Active barrier, 2-channel for 4 to 20 mA, HART® transparent with 24 V DC and active/passive input and output
- Material number: 71440875
- Order number: 71748585, RN22 active barrier, ATEX
- Order number: 71748586, RN22 active barrier, CSA C/US
- Order number: 71748588, RN22 active barrier, NEPSI

Signal converter Modbus TCP/4 to 20 mA

- Converts Modbus TCP signals to 4 isolated channels into analog 4–20 mA signals. Active and passive outputs. Supply voltage: 18 to 30 V DC
- Material number: 71765893

Additional products**RNB22 system power supply unit**

- System power supply for parallel operation with 100 to 250 V AC input and 24 V DC 2.5 A output as well as static/dynamic boost
- Material number: 71455664

Global Router RUT241 cellular radio and WLAN

- For 4G LTE (Cat4), 3G, 2G. Worldwide, Verizon excluded
- Material number: 71677203

Field housing, R4 182x180x165, 5x M20, PC

- Minitec protective housing. Plastic housing with sight glass cover
- IP66 degree of protection
- Material number: 52010132

Documentation



For an overview of the scope of the associated Technical Documentation, refer to the following:

- *Device Viewer* (www.endress.com/deviceviewer): Enter the serial number from the nameplate
- *Endress+Hauser Operations app*: Enter serial number from nameplate or scan matrix code on nameplate.

Standard documentation

Document type: Operating Instructions (BA)

Installation and initial commissioning – contains all the functions in the operating menu that are needed for a normal measuring task. Functions beyond this scope are not included.

Document type: Brief Operating Instructions (KA)

Quick guide to the first measured value – includes all essential information from incoming acceptance to electrical connection.

Document type: Safety Instructions, certificates

Depending on the approval, Safety Instructions are also supplied with the device, e.g. XA. This documentation is an integral part of the Operating Instructions.

The nameplate indicates the Safety Instructions (XA) that are relevant to the device.

Registered trademarks

Modbus®

Registered trademark of SCHNEIDER AUTOMATION, INC.

OPC UA

Registered trademark of the OPC Foundation, Scottsdale, Arizona, USA

HART®

Registered trademark of the FieldComm Group, Austin, Texas, USA



www.addresses.endress.com
