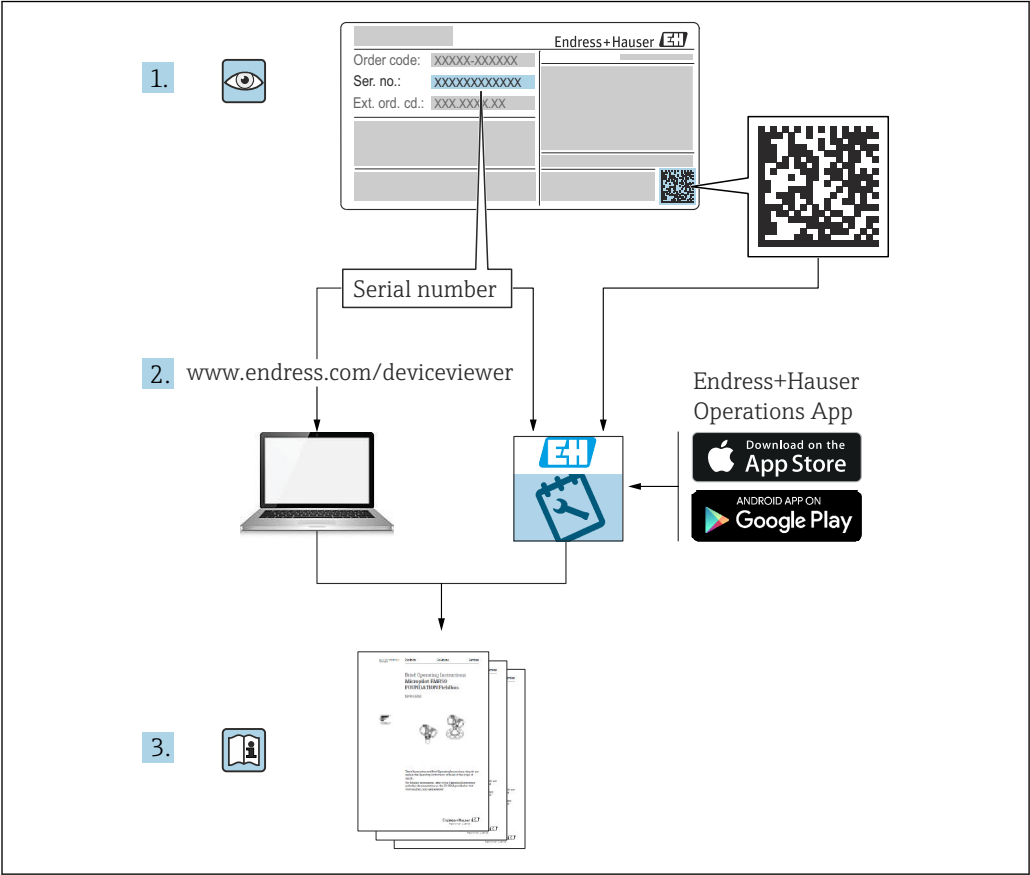


Operating Instructions

Solitrend MMP41

Material moisture measurement





A0023555

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1 About this document

1.1 Purpose of this document

These Operating Instructions contain all the information that is required in the 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.

1.2 Symbols

1.2.1 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.

1.2.2 Symbols for certain types of information and graphics

Tip

Indicates additional information



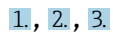
Reference to documentation



Reference to graphic



Notice or individual step to be observed



Series of steps



Result of a step

1, 2, 3, ...

Item numbers

A, B, C, ...

Views

1.3 Terms and abbreviations

PLC

Programmable logic controller (PLC)

1.4 Documentation

The following document types are available in the Downloads area of the Endress+Hauser website (www.endress.com/downloads):



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.

2 Basic safety instructions

2.1 Requirements for 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.
- ▶ Personnel must be authorized by the plant owner/operator.
- ▶ Be familiar with federal/national regulations.
- ▶ Before starting work: personnel must read and understand the instructions in the manual and supplementary documentation as well as the certificates (depending on the application).
- ▶ Personnel must follow instructions and comply with general policies.

The operating personnel must fulfill the following requirements:

- ▶ Personnel are instructed and authorized according to the requirements of the task by the facility's owner-operator.
- ▶ Personnel follow the instructions in this manual.

2.2 Intended use

Application and media

The device described in this manual is intended for the continuous moisture measurement of a wide variety of materials. Because of its operating frequency of approx. 1 GHz the device can also be used outside of closed metal vessels.

If operated outside of closed vessels, the device must be mounted in accordance with the instructions in the **Mounting** section. The operation of the devices does not present any health risk. If the limit values specified in the **Technical data** and the conditions listed in the instructions and additional documentation are observed, the measuring device may be used for the following measurements only:

- Measured process variables: material moisture, material conductivity and material temperature

To ensure that the device remains in proper condition throughout the operating period:

- ▶ Use the device only for media to which the process-wetted materials are sufficiently resistant.
- ▶ Observe the limit values in the "Technical data".

Incorrect use

The manufacturer is not liable for damage caused by improper or non-intended use.

Clarification of borderline cases:

- ▶ With regard to special fluids and media used for cleaning, the manufacturer is glad to assist in clarifying the corrosion resistance of materials in contact with the fluid, but does not accept any warranty or liability.

Residual risks

Due to the transfer of heat from the process and power dissipation within the electronics, the temperature of the electronics housing and the assemblies contained therein may increase to up to 70 °C (158 °F) during operation. The device may reach a temperature close to the medium temperature during operation.

Danger of burns from contact with surfaces!

- ▶ In the event of high medium temperatures, ensure protection against contact to prevent burns.

2.3 Workplace safety

For work on and with the device:

- ▶ Wear the required personal protective equipment according to federal/national regulations.

2.4 Operational safety

Risk of injury!

- ▶ Operate the device only if it is in proper technical condition, free from errors and faults.
- ▶ 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 from the manufacturer.

Hazardous area

To eliminate danger to persons or the installation when the device is used in the hazardous area (e.g. explosion protection, pressure vessel safety):

- ▶ Check the nameplate to verify whether the ordered device can be put to its intended use in the hazardous area.
- ▶ Observe the specifications in the separate supplementary documentation, which is an integral part of this manual.

2.5 Product safety

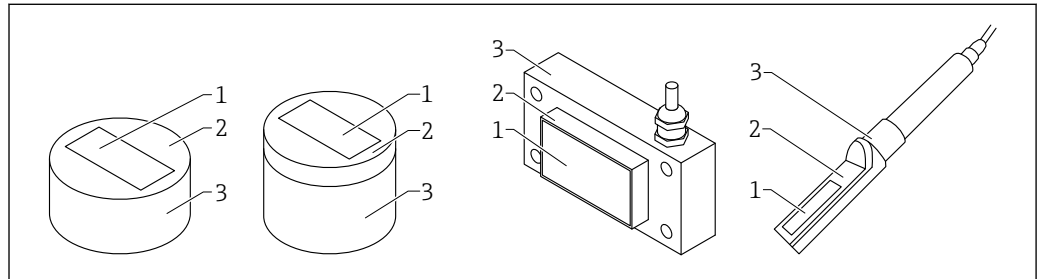
This device is designed in accordance with good engineering practice to meet state-of-the-art safety requirements, has been tested, and left the factory in a condition in which it is safe to operate.

It meets the 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.

3 Product description

TDR material moisture sensors for measuring bulk solids and media with higher material densities and conductivity values up to 5 mS/cm.

3.1 Product design

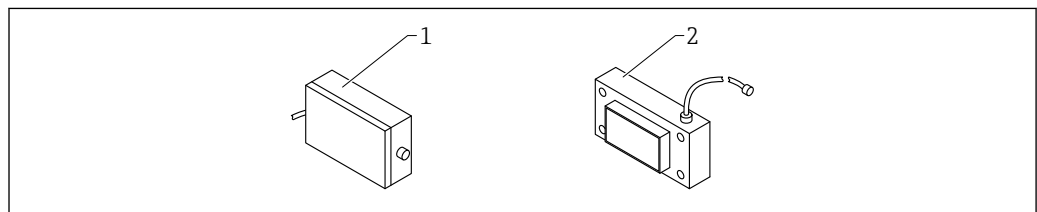


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 1 Product design

- 1 Measuring cell; ceramic (silicon nitride or aluminum oxide)
- 2 Sensor plate
- 3 Housing

3.1.1 ATEX version



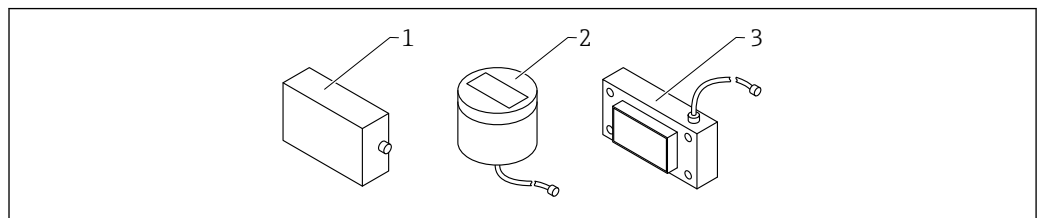
A0053310

 2 Rectangular sensor, ATEX version

- 1 ATEX electronics housing
- 2 Rectangular sensor

3.1.2 Sensor temperature range up to 120 °C (248 °F)

In the case of the order option "Sensor temperature range up to 120 °C (248 °F)", the electronics module is always located in a separate housing and is connected using the HF cable that is permanently connected to the sensor (round sensor, middle version or rectangular sensor).



A0044424

- 1 Electronics housing
- 2 Round sensor, middle with HF cable 2.5 m (8.2 ft)
- 3 Rectangular sensor with HF cable 2.5 m (8.2 ft)

4 Incoming acceptance and product identification

4.1 Incoming acceptance

Check the following during incoming acceptance:

- ☐ Are the order codes on the delivery note and the product sticker identical?
- ☐ Are the goods undamaged?
- ☐ Do the nameplate data match the ordering information on the delivery note?
- ☐ If required (see nameplate): Are the safety instructions (XA) provided?

 If one of these conditions is not met, please contact the manufacturer's sales office.

4.2 Product identification

The following options are available for identification of the device:

- Nameplate specifications
- Extended order code with breakdown of the device features on the delivery note
- ▶ Enter serial number from nameplates in *W@M Device Viewer* (www.endress.com/deviceviewer)
 - ↳ All of the information on the measuring device and on the scope of the technical documentation pertaining to the device is displayed.
- ▶ Enter the serial number from the nameplate into the *Endress+Hauser Operations App* or scan the 2-D matrix code on the nameplate.
 - ↳ All of the information on the measuring device and on the scope of the technical documentation pertaining to the device is displayed.

4.3 Manufacturer's address

Endress+Hauser SE+Co. KG
Hauptstraße 1
79689 Maulburg, Germany

4.4 Storage, transport

4.4.1 Storage conditions

- Permitted storage temperature: -40 to +70 °C (-40 to +158 °F)
- Use original packaging.

4.4.2 Transporting the product to the measuring point

Transport the device to the measuring point in the original packaging.

5 Mounting

5.1 Mounting requirements

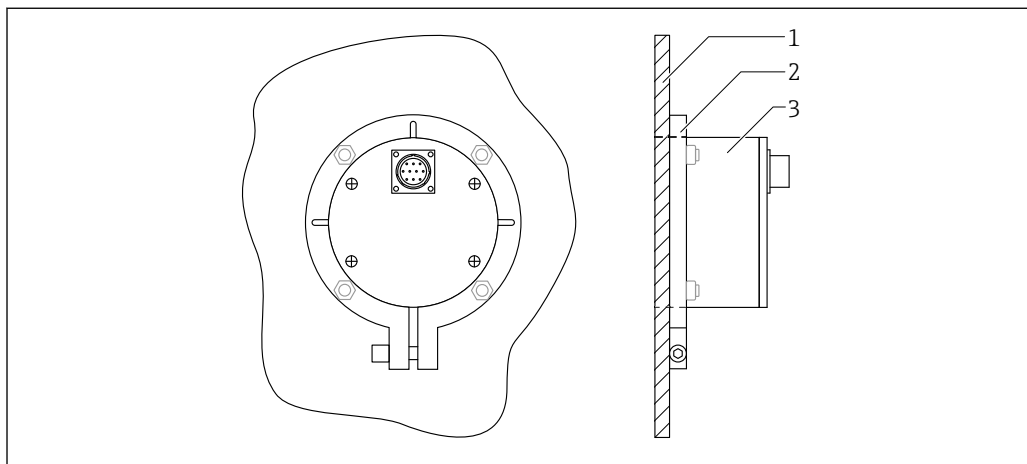
- The device must be installed at a point in the process in such a way that ensures a constant bulk density, as the bulk density directly affects the calculation of the water content. Where necessary, a bypass should be created or structural measures may be needed at the place of installation to ensure that the material flow, and therefore the bulk density, over the measurement surface is constant.
- The measuring field of the device must be completely covered by material and the material height must exceed the minimum layer of material covering on the measurement surface (depends on the device type and moisture).
- The flow of material over the measurement surface must be continuous. With the software, it is possible to automatically detect and bridge gaps in material flow in intervals of seconds.
- No material deposits or buildup may form on the measuring cell surface, as this would falsify the readings.

 Longer averaging times increase the stability of the measured value.

5.2 Installation instructions

5.3 Round sensor, short/middle

The round sensor, short / middle version, can be mounted with a mounting flange.

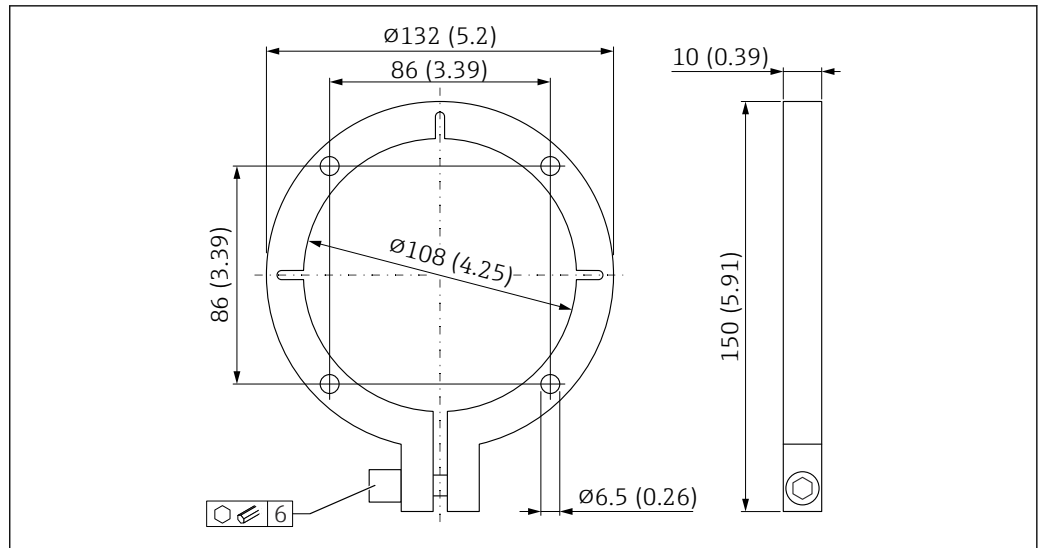


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 3 Round sensor mounted, rear view

- 1 Vessel wall
- 2 Mounting flange
- 3 Round sensor, short / middle

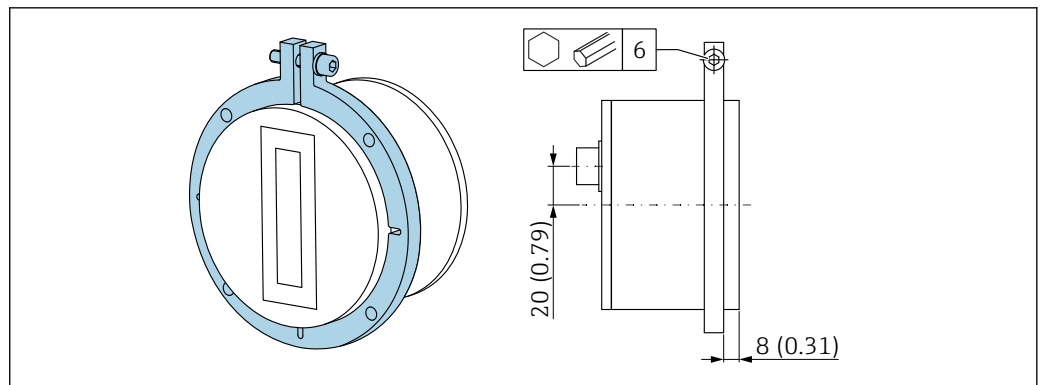
The mounting flange for the round sensor, short version or for the round sensor, middle version can be mounted on the floor or on the side wall of the vessel.



4 Mounting flange for round sensor, short version or round sensor, middle version. Unit of measurement mm (in)

The mounting flange serves as a template for the mounting bore holes and the cut-out for the sensor at the mounting location:

1. Check the fit between the sensor and mounting flange
2. Make the cut-out for the sensor at the mounting location
3. Mount the sensor and align it
 - ↳ The surface of the measuring cell is flush-fitted on the material side

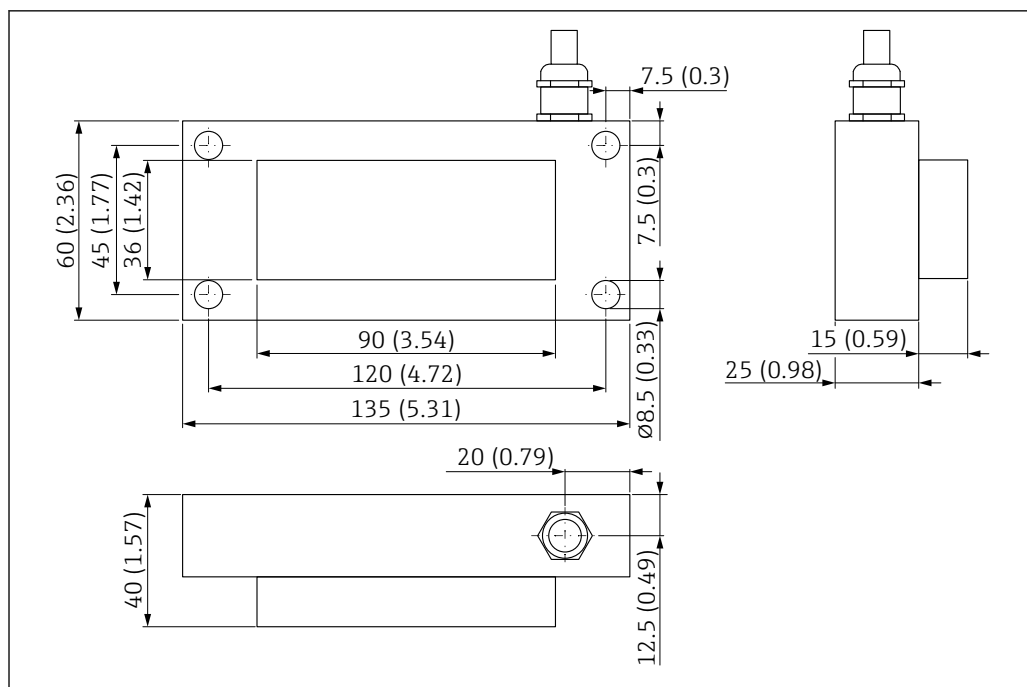


5 Mounting position, mounting flange and round sensor. Unit of measurement mm (in)

5.4 Rectangular sensor

The rectangular sensor can be installed with four screws (M8).

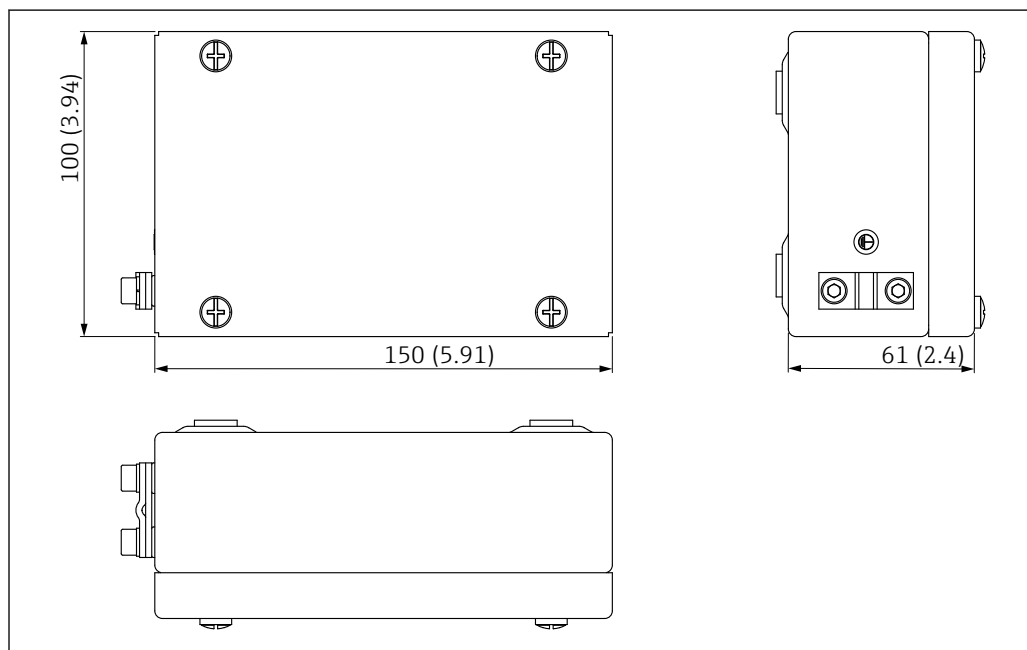
An appropriate cut-out must be created at the place of installation for the measuring cell and bores to secure it.



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6 Dimensions. Unit of measurement mm (in)

5.5 ATEX electronics housing

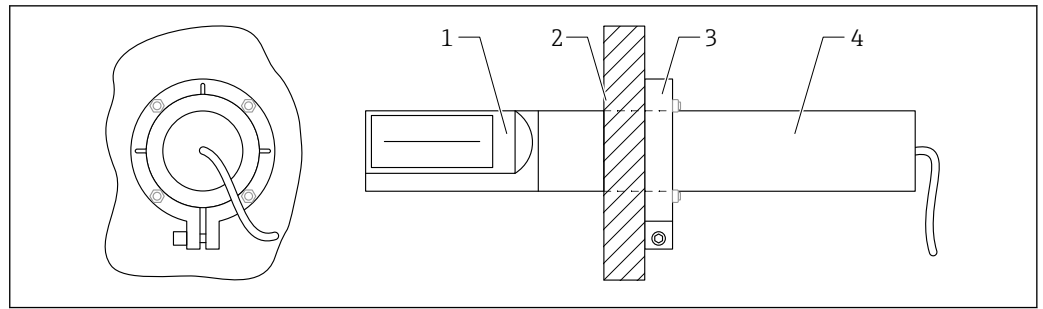


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7 Dimension of ATEX electronics housing. Unit of measurement mm (in)

5.6 Rod sensor

The rod sensor can be installed using a mounting flange and a 200 mm (7.87 in) long installation pipe (additional mounting accessories are optionally available).



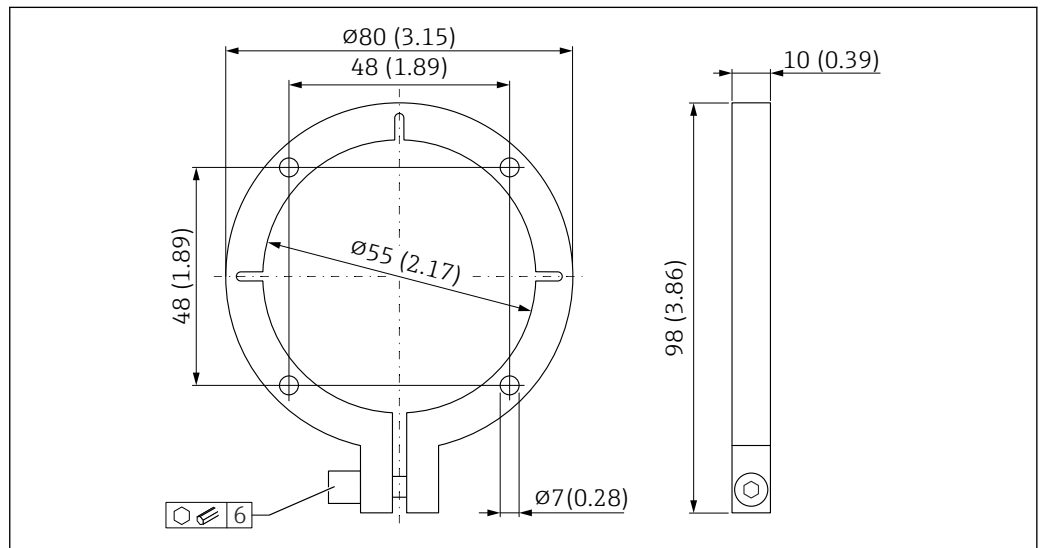
A0038248

8 Rod sensor mounted, rear view

- 1 Rod sensor
- 2 Vessel wall
- 3 Mounting flange
- 4 Installation pipe / extension / adapter (accessories)

5.6.1 Mounting flange Ø55 mm (2.17 in)

The mounting flange for the rod sensor can be mounted on the vessel wall.



A0038247

9 Mounting flange for the rod sensor. Unit of measurement mm (in)

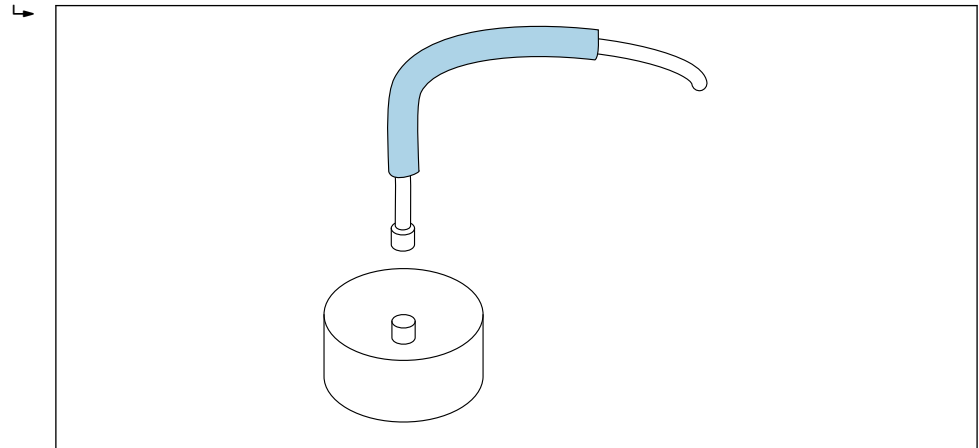
The mounting flange serves as a template for the mounting bore holes and the cut-out for the sensor in the vessel:

1. Check the fit between the sensor and mounting flange
2. An installation pipe must first be mounted on the sensor before the mounting flange can be fixed. It is available in two different lengths and can be ordered together with the device via the "Accessory mounted" or "Accessory enclosed" section of the product order structure.
3. Make the cut-out in the vessel
4. Mount the sensor and align it

5.7 Protection of sensor connector against abrasion

If sand and gravel can come into contact with the sensor connector when they flow over the baffle plate, it is recommended to mount an additional protective guard on the sensor connector.

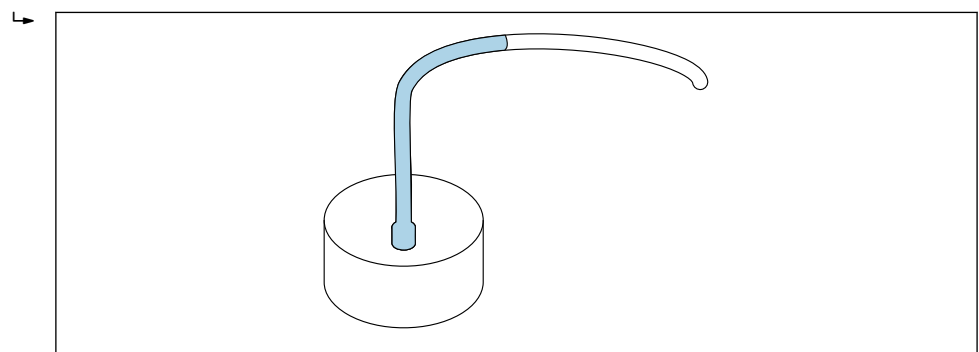
1. The heat-shrink tube supplied with the cable can be used to provide this protection.



A0037427

 10 Example of round sensor

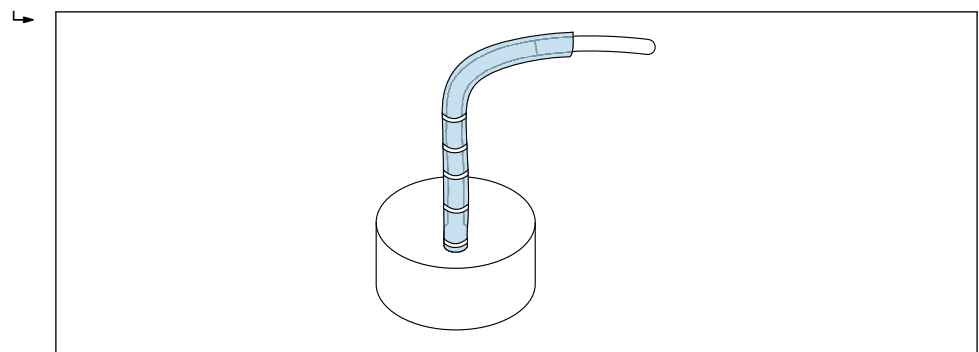
2. Once the sensor has been installed and the sensor cable connected, the heat-shrink tube can be shrunk onto the connector and cable with a hot air blower



A0037428

 11 Example of round sensor

3. In addition, the sensor and ground cable can be protected with a silicone tube (not included in the delivery)



A0037429

 12 Example of round sensor

5.8 Post-mounting check

Perform the following checks after mounting the device:

- ☐ Is the device undamaged (visual inspection)?

- ☐ If provided: are the measuring point number and labeling correct?
- ☐ Are the connections established correctly and protected against mechanical influences?
- ☐ If used: is the device securely positioned in the mounting flange / mounting frame (visual inspection)?
- ☐ Is the device securely mounted and is the measuring cell surface flush on the material side (visual inspection)?
- ☐ Is sufficient material coverage / material flow over the measurement surface ensured?

6 Electrical connection

6.1 Connecting requirements

6.1.1 Cable specification

Connecting cables are available in different versions and lengths (depending on design).

Device with 10-pin connector

Connecting cables with a pre-assembled 10-pin socket on the device side are available in different standard lengths:

- 4 m (13 ft)
- 10 m (32 ft)
- 25 m (82 ft)

UNITRONIC PUR CP shielded cable, twisted pairs $6 \times 2 \times 0.25 \text{ mm}^2$, PUR sheath resistant to oils and chemicals.

Rectangular sensors

Standard lengths (fixed cable):

- 5 m (16 ft)
- Cable lengths of 1 to 100 m (3 to 328 ft) are possible upon request

UNITRONIC PUR CP shielded cable, $10 \times 0.25 \text{ mm}^2$, PUR sheath resistant to oils and chemicals.

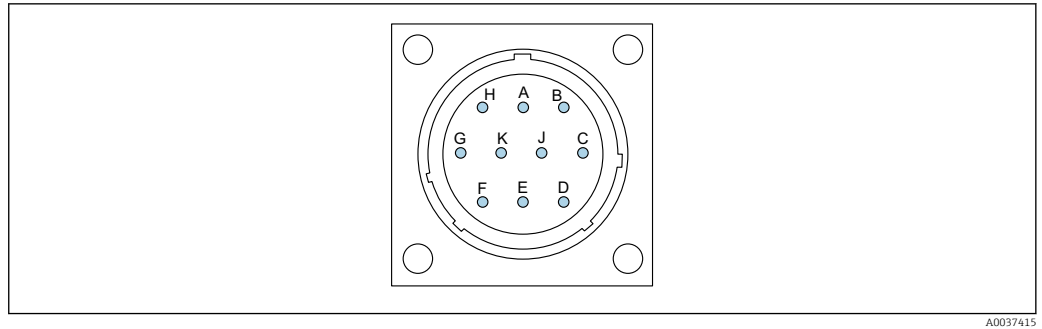
6.2 Connecting the measuring instrument

6.2.1 Terminal assignment

Round sensors

Round sensors are supplied with a 10-pin MIL plug as standard.

 In the high-temperature version 0 to 120 °C (32 to 248 °F), the sensor is separated from the electronics unit via a HF cable. The electronics housing is fitted with 10-pin MIL plugs on both sides.



A0037415

13 Assignment of the 10-pin plug

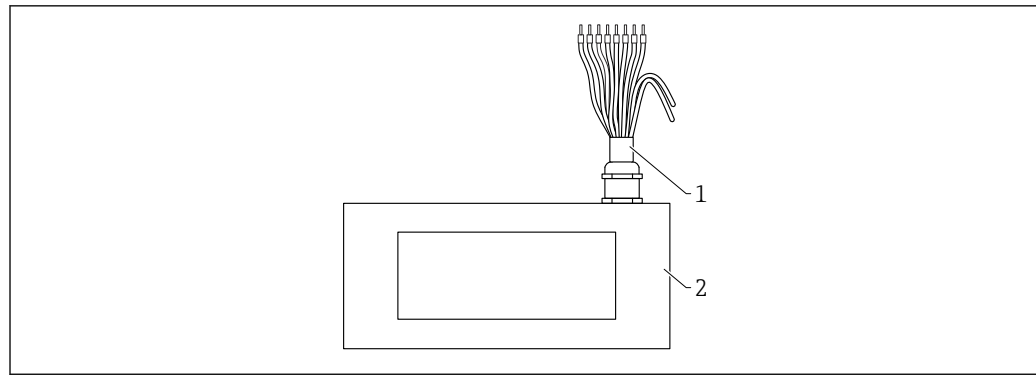
- A 12 to 24 V_{DC} stabilized power supply
Wire color: red (RD)
- B 0 V_{DC} power supply
Wire color: blue (BU)
- D 1st analog positive (+), material moisture
Wire color: green (GN)
- E 1st analog return line (-), material moisture
Wire color: yellow (YE)
- F RS485 A (must be enabled)
Wire color: white (WH)
- G RS485 B (must be enabled)
Wire color: brown (BN)
- C IMP-Bus RT
Wire color: gray (GY)/pink (PK)
- J IMP-Bus COM
Wire color: blue (BU)/red (RD)
- K 2nd analog positive (+)
Wire color: pink (PK)
- E 2nd analog return line (-)
Wire color: gray (GY)
- H Shield (is grounded at the sensor. The installation must be grounded correctly!)
Wire color: transparent

Rectangular sensors

Standard version of rectangular sensor:

- Cable length: 5 m (16 ft) (10-pin)
- The cable is firmly connected to the sensor
- The other end of the cable is fitted with ferrules

i In the high-temperature version 0 to 120 °C (32 to 248 °F), the sensor is separated from the electronics unit via a HF cable. The electronics housing is fitted with 10-pin MIL plugs on both sides.



A0044667

14 Rectangular sensor (standard version) with 10-pin cable assignment

- 1 10-pin cable with ferrules
 - 12 to 24 V_{DC} stabilized power supply
Wire color: white (WH)
 - 0 V_{DC} power supply
Wire color: brown (BN)
 - 1st analog positive (+), material moisture
Wire color: green (GN)
 - 1st analog return line (-), material moisture
Wire color: yellow (YE)
 - IMP-Bus RT
Wire color: pink (PK)
 - IMP-Bus COM
Wire color: gray (GY)
 - 2nd analog positive (+)
Wire color: blue (BU)
 - 2nd analog return line (-)
Wire color: violet (VT)
- 2 Rectangular sensor

ATEX rectangular sensors

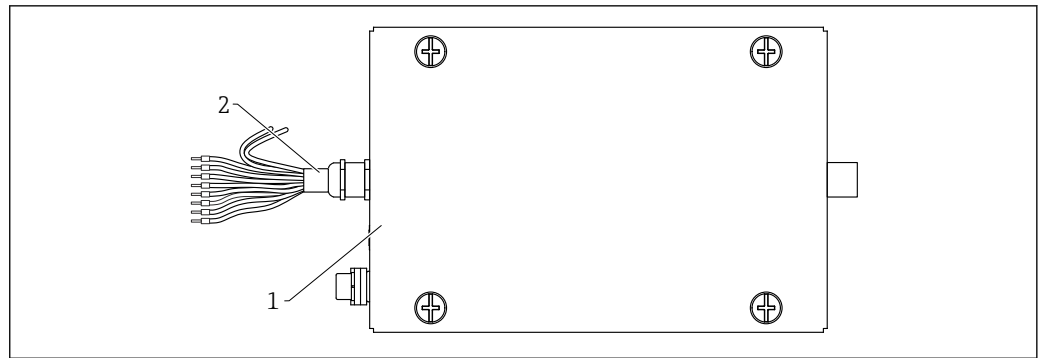
ATEX version

Rectangular sensor

- Cable length between sensor and ATEX electronics housing 5 m (16 ft)
- Cable firmly connected to the sensor with plug to the ATEX electronics housing

ATEX electronics housing

- Cable length: 5 m (16 ft) (10-pin)
- The cable is firmly connected to the electronics housing
- The other end of the cable is fitted with ferrules

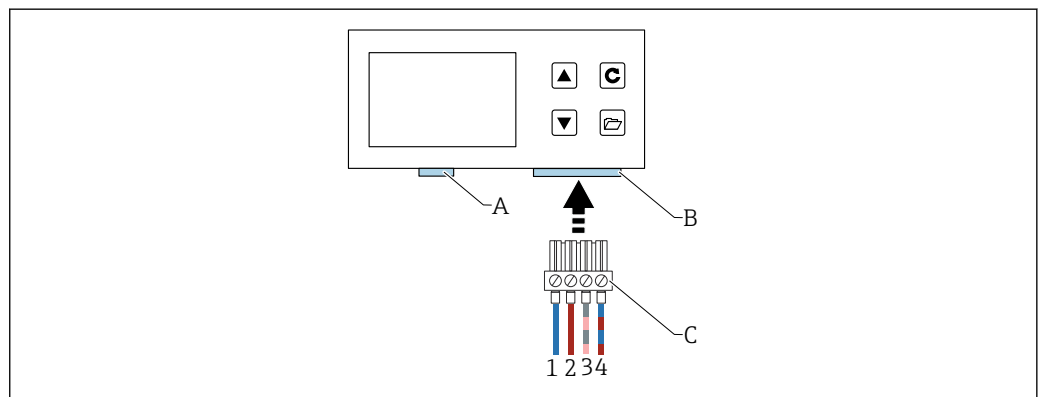


A0053676

15 ATEX electronics housing with assignment of the 10-pin cable

- 1 10-pin cable with ferrules
 - 12 to 24 V_{DC} stabilized power supply
Wire color: red (RD)
 - 0 V_{DC} power supply
Wire color: blue (BU)
 - 1st analog positive (+), material moisture
Wire color: green (GN)
 - 1st analog return line (-), material moisture
Wire color: yellow (YE)
 - IMP-Bus RT
Wire color: gray/pink (GY/PK)
 - IMP-Bus COM
Wire color: blue/red (BU/RD)
 - 2nd analog positive (+)
Wire color: pink (PK)
 - 2nd analog return line (-)
Wire color: gray (GY)
- 2 Rectangular sensor

Connection to a remote display (optional)

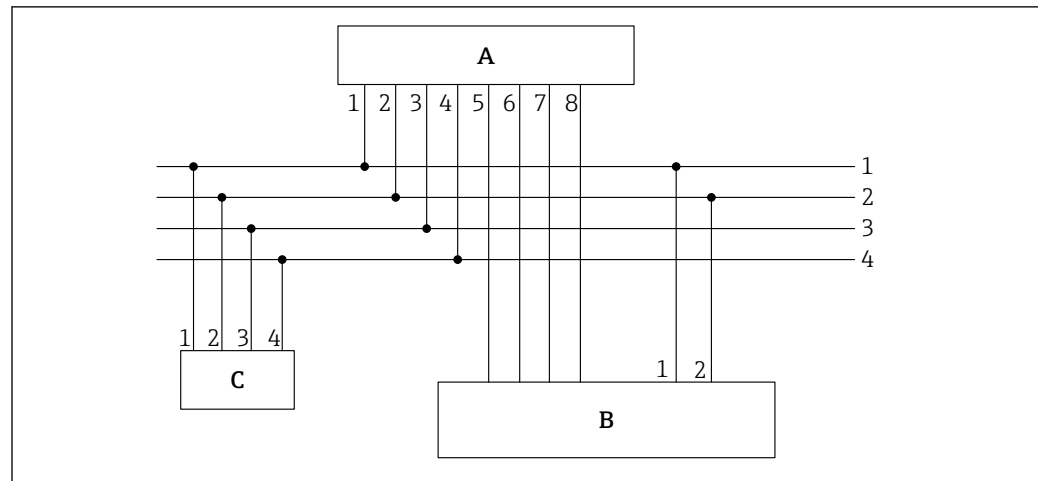


A0040962

16 Connection to a remote display

- A USB (Mini B type), USB-IMP-Bridge, firmware update (only for service purposes)
- B Socket for supply voltage and bus interface
- C Connector for supply voltage and bus interface (included in the delivery for "remote display")
- 1 0 V_{DC} power supply
Wire color: blue (BU)
- 2 12 to 24 V_{DC} stabilized power supply
Wire color: red (RD)
- 3 IMP-Bus (RT)
Wire color: gray (GY) / pink (PK)
- 4 IMP-Bus (COM)
Wire color: blue (BU) / red (RD)

6.2.2 Connection example of 10-pin socket



A0037418

17 Connection example, cable with 10-pin socket (on device side) and wire end ferrules at the cable end

- A Transmitter
- B PLC/distribution box
- C Remote display (optional)
- 1 0 V_{DC} power supply
Wire color: blue (BU)
- 2 12 to 24 V_{DC} stabilized power supply
Wire color: red (RD)
- 3 IMP-Bus RT
Wire color: gray (GY)/pink (PK)
- 4 IMP-Bus COM
Wire color: blue (BU)/red (RD)
- 5 1st current output (+), analog
Wire color: green (GN)
- 6 1st current output (-), analog
Wire color: yellow (YE)
- 7 2nd current output (+), analog
Wire color: pink (PK)
- 8 2nd current output (-), analog
Wire color: gray (GY)

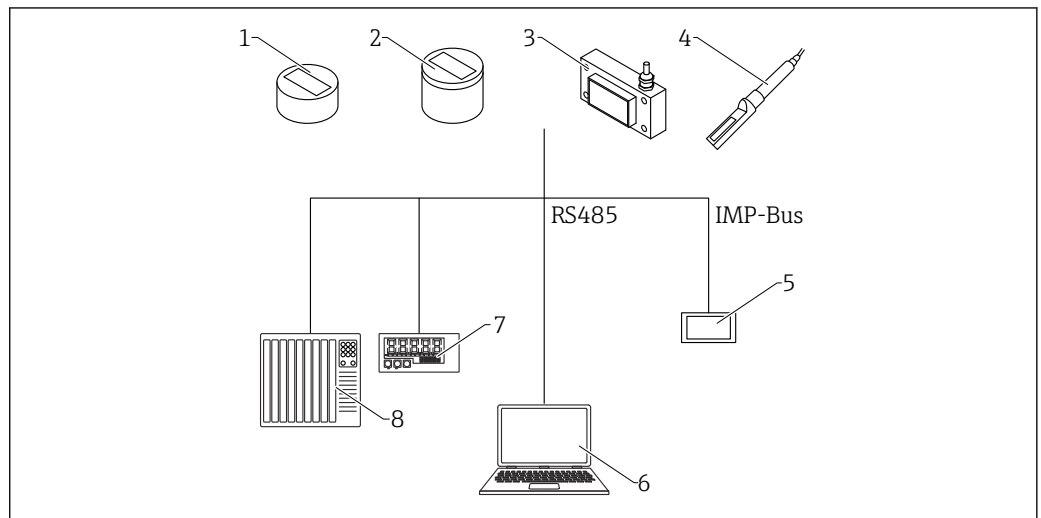
i The moisture content determined and the conductivity/temperature can either be fed directly into a PLC via analog outputs 0 to 20 mA/4 to 20 mA or queried via the serial interface (IMP-Bus) using the display (optional).

6.3 Post-connection check

- ☐ Is the device or cable undamaged (visual inspection)?
- ☐ Does the supply voltage match the specifications on the nameplate?
- ☐ Are the connections established correctly and protected against mechanical influences?

7 Operation options

7.1 Overview of operation options



A0040210

18 Operation options

- 1 Round sensor, short
- 2 Round sensor, middle
- 3 Rectangular sensor
- 4 Rod sensor
- 5 Remote display
- 6 Computer
- 7 LED display
- 8 PLC or water dosing computer

8 Commissioning

8.1 Analog outputs for measured value output

The measured values are output as a current signal via the analog output. The device can be set to 0 to 20 mA or 4 to 20 mA.

 The current output can also be set inversely to 20 to 0 mA or 20 to 4 mA for special controllers and applications.

The analog outputs can be set differently to the following possible options:

Moisture, temperature

- Output 1: moisture in % (variable setting)
- Output 2: material temperature 0 to 100 °C (32 to 212 °F), this also applies for the high-temperature version.

Moisture, conductivity

- Output 1: moisture in % (variable setting)
- Output 2: conductivity 0 to 20 mS/cm(factory setting)

Moisture, temperature/conductivity

- Output 1: moisture in % (variable setting)
- Output 2: material temperature 0 to 100 °C (32 to 212 °F) and conductivity 0 to 20 mS/cm with automatic window switching.

It is also possible to divide output 2 into two ranges to output both the conductivity and the temperature, namely the 4 to 11 mA range for the temperature and the 12 to 20 mA range for the conductivity. Output 2 automatically switches between these two windows every 5 s.

 Output 1 can be scaled at the factory or subsequently scaled as required (variably) using the remote display (optionally available), e.g. 0 to 10 %, 0 to 20 % or 0 to 30 %

8.1.1 Possible settings

There are several possible settings for the analog outputs:

Analog outputs

Options:

- 0 to 20 mA
- 4 to 20 mA

 The current output can also be set inversely for special controllers and applications.

- 20 to 0 mA
- 20 to 4 mA

Channels of the analog outputs

 The analog outputs can be set differently to the following possible options:

Moisture, temperature

Output 1 for moisture, output 2 for material temperature.

Moisture, conductivity

Output 1 for moisture, output 2 for conductivity in the range from 0 to 20 mS/cm (factory setting)

Moisture, temperature/conductivity

Output 1 for moisture, output 2 for material temperature and conductivity with automatic window switching.

Moisture range

The moisture range and the temperature range at outputs 1 and 2 can be individually configured.

- **Moisture range in %**
 - Maximum: e.g. 20 %
 - Minimum: 0 %
- **Temperature range in °C**
 - Maximum: 100 °C, this also applies for the high-temperature version.
 - Minimum: 0 °C
- **Conductivity in mS/cm**
 - Maximum 20 mS/cm
 - Minimum 0 mS/cm



The devices can measure the conductivity depending on the device type and the moisture. The output is set to 0 to 20 mS/cm at the factory.

8.2 Operating mode

The sensor configuration is preset at the factory before the sensor is delivered. This device setting can then be optimized to suit the process.

Measure mode and parameters:

The following sensor settings can be changed

- Measure mode C - Cyclic (default setting for sensors with cyclic measurement).
- Average time, reaction speed of the measured values
- Calibration (when different materials are used)
- Filter function
- Precision of a single value measurement

Operating mode

The sensors are supplied from the factory with the CH mode for applications in the construction industry, and with the CA mode for general process applications. Six different operating modes are available in the C mode, depending on the application

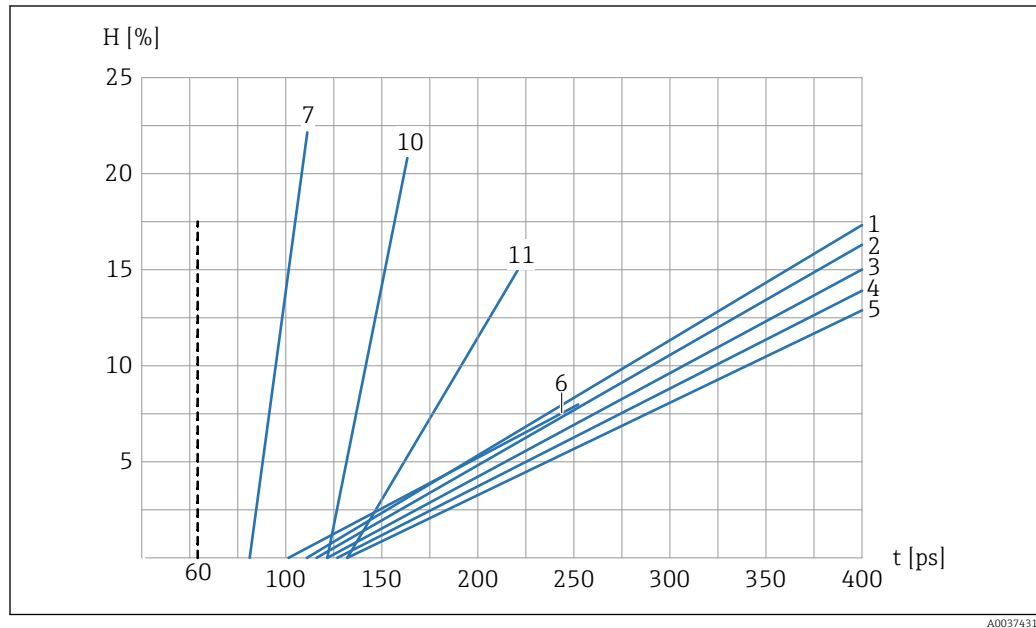
- **CS mode** (Cyclic-Successive)
For very short measurement cycles in the seconds range (e.g. 1 to 10 s) without averaging and without filter functions, and with up to 100 measurements per second internally and a cycle time of 250 ms at the analog output.
- **CA mode** (Cyclic Average Filter)
Standard averaging for relatively fast but continuous measurement processes, with simple filtering and an accuracy of up to 0.1%. The CA operating mode is also used to record raw values, without averaging and filtering, to be able to subsequently analyze the measured data and determine the optimum operating mode.
- **CF mode** (Cyclic Floating Average with Filter)
Floating average for very slow and continuous measurement processes, with simple filtering and an accuracy of up to 0.1 %. Suitable for applications on a conveyor belt etc.
- **CK mode** (Cyclic with Boost Filter)
For complex applications in mixers and dryers
- **CC mode** (Cyclic Cumulated)
With automatic totalization of moisture quantity measurements in one batch process if no PLC controller is used
- **CH mode** (Cyclic Hold)
Standard operating mode for applications in the construction industry. Similar to the CC mode, but with filtering and without totalization. The CH mode is ideal for very short batch times down to 2 seconds if the sensor has been installed under the silo discharge hatch. The CH mode performs filtering automatically. This allows drip water that forms in the silo to be filtered out of the measured value, for example.



Each of these settings is retained even after the sensor is switched off, i.e. the setting is saved to the non-volatile memory of the sensor.

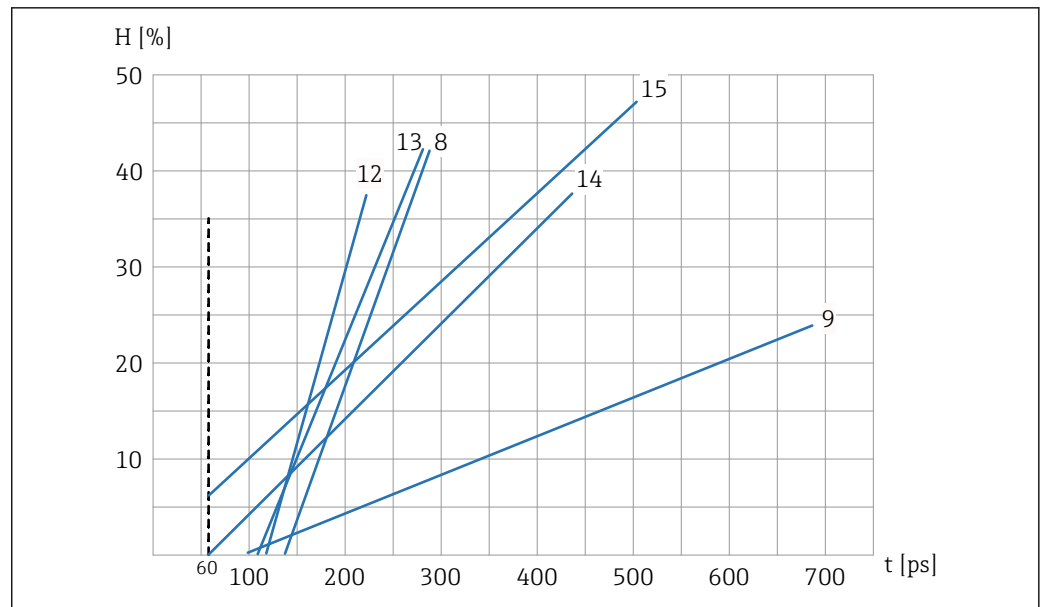
8.3 Calibration curve set A for general bulk solids applications

The devices are supplied with a suitable calibration. A maximum of 15 different calibrations can be saved in the device and can be activated and adjusted via the remote display. To pre-test the compatibility of a calibration curve, the user can select individual calibration curves (Cal.1 to Cal.15) in the **Material cal.** menu item, test the curve with the material to be measured and activate it. The desired calibration curve - which may have been modified - is active once the operating voltage is switched on.



19 Calibration curve set A (Cal.1, Cal.2, Cal.3, Cal.4, Cal.5, Cal.6, Cal.7, Cal.10, Cal.11)

- H Gravimetric moisture; %
 t Radar transit time; picoseconds
 1 Cal.1, Universal; sand/gravel/grit
 2 Cal.2, Sand 1.6
 3 Cal.3, Sand 1.7
 4 Cal.4, Sand 1.8
 5 Cal.5, Sand 1.9
 6 Cal.6, Gravel/grit
 7 Cal.7, Wood chips
 10 Cal.10, Grains of wheat
 11 Cal.11, Light sand



A0037432

20 Calibration curve set A (Cal.8, Cal.9, Cal.12, Cal.13, Cal.14, Cal.15)

- H* Gravimetric moisture; %
t Radar transit time; picoseconds
 8 Cal.8, Lignite
 9 Cal.9, Basic calibration
 12 Cal.12, Sewage sludge
 13 Cal.13, Cereals (linear)
 14 Cal.14, Air/water 0 to 100 %
 15 Cal.15, Raw data calibration ($1/10$ of average radar transit time)

The graphics show the linear calibration curves (Cal.1 to Cal.15) for various materials that are saved and can be selected in the device. The gravimetric moisture (H) is indicated as a percentage on the y-axis, and the associated radar transit time (t) in picoseconds is indicated on the x-axis. The radar transit time is displayed simultaneously with the moisture value during moisture measurement. In air, the devices measure approx. 60 ps radar transit time, and 1 000 ps in water.

8.4 Special functions

8.4.1 Determining the mineral concentration

With the radar-based measurement method, it is possible to draw conclusions about the conductivity or mineral concentration. Here, the device determines the attenuation of the radar pulse in the measured volume of a material. This method delivers a characteristic value depending on the mineral concentration. The conductivity measuring range of the sensors here is up to 5 mS/cm, depending on the moisture content.

8.4.2 Material temperature measurement

The sensor contains an integrated temperature sensor, which determines the housing temperature 3 mm below the surface of the sensor head. The temperature can optionally be output at analog output 2. Due to the internal heating of the sensor electronics, the precise measurement of the material temperature is only possible to a limited extent.

8.4.3 Material temperature compensation

When used in higher temperature ranges, the dielectric constant (ϵ_r) of water and certain materials being measured show a temperature dependency. Moisture is determined using

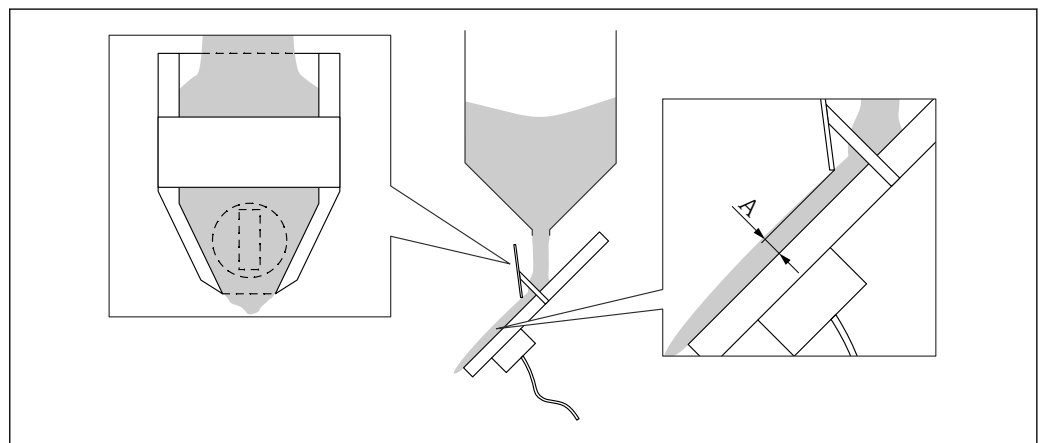
the dielectric constant, i.e. the dielectric constant is the actual parameter measured during moisture measurement. If materials being measured, such as maize, display a very special temperature dependency of the dielectric constant, such as a temperature dependency only in very specific moisture ranges, it may be necessary to perform complex material temperature compensation. This involves a considerable amount of work in the laboratory, however. In addition to the measurement of the moisture, this also requires the temperature of the material to be measured with the temperature sensor integrated in a sensor. Parameters t0 to t5 can be set in each of the 15 calibration stages Cal1 to Cal15 (see the "Selecting the individual calibrations" section). If necessary, contact the manufacturer's Service Department if you require assistance with this very complex material-specific temperature compensation process.

9 Diagnostics and troubleshooting

9.1 Optimizing the material flow

For accurate measurement results, certain limits must be respected with regard to the installation and environmental conditions, and the associated bulk density of the material being measured. Furthermore, there must be a sufficiently thick layer of material covering the sensor.

If the material flow is too fast, the level of material above the surface of the sensor can be too low. A hopper chute with guide plates can concentrate and increase the level of material above the sensor head. Ideally - particularly in the case of wet sand - the guide plates have a PTFE coating so that no material can stick to them. The sensor requires a layer of material of at least 45 mm. There are installations where the amount of material is too low or too spread out to ensure sufficient material flow over the sensor. In such cases it may be necessary to "concentrate" the material flow so that material accumulates above the sensor as it flows. The diagram below shows an example of a possible unit where the material is concentrated at the side of the sensor and above the sensor.



21 Example: "Concentration of material"

In addition, in the case of non-homogeneous material flow it is possible to use the filter functions, with upper and lower limits, that are implemented in the sensor to filter out "wrong" measured values.

9.2 Difference between measured moisture value and laboratory value too large during initial commissioning

The sensor is usually precalibrated with Cal14 (air/water 0 to 100 %) upon delivery. In the case of sand and gravel applications, the sensor is precalibrated upon delivery (if the application is known and specified beforehand) with the Cal1 calibration curve (universal calibration curve for sand/gravel).

During initial commissioning, the measured moisture value should match the laboratory value, which is determined using another method, with an accuracy of at least ± 1 %.

If this is the case, the sensor can then be fine-tuned to achieve an accuracy of ± 0.1 % in relation to the laboratory value in a variety of ways.

- Depending on the PLC, it is possible to perform a parallel shift/offset in the PLC. The parameter has different names depending on the PLC (e.g. initial load, zero point, offset, measuring range, etc.).

Please contact the PLC manufacturer for more information.

- With the remote display, a fine adjustment or parallel shift in the sensor can be performed using the "Offset" parameter.

If the moisture value of the sensor deviates by more than ± 1 % from the laboratory value during initial commissioning, this may be due to the following:

- The sensor is not correctly installed under the silo discharge hatch. The surface of the sensor must be completely covered with sand/gravel when the hatch opens. A good, stable flow of material **must** be guaranteed. A video of the batch process can be helpful for analysis purposes.
- The wrong calibration curve is configured in the sensor. The sensor is supplied with the universal calibration curve Cal1 for sand and gravel.
- Incorrect moisture scaling is configured in the PLC. In the sensor, 0 to 20 % moisture corresponds to the current output of 0 to 20 mA or 4 to 20 mA. The 0 to 20 % moisture scaling must also be entered in the PLC.

Please contact the PLC manufacturer for more information.

- A 2-point calibration in the PLC or the sensor may be required for special sands (e.g. fine sand).
- In the case of gravel and grit, limits must be set in the PLC, as running water in the gravel or grit results in an excessively high moisture value in the sensor.
Please contact the PLC manufacturer for more information.
- Due to inaccurate data processing, it may be necessary to check the moisture value displayed in the PLC. For this purpose, connect the sensor to the remote display and check/compare the moisture value shown in the PLC with the moisture value shown on the display.

Caution:

The "CH" operating mode in the sensor must then be set to the "CC" mode for a test run, and then switched back to "CH" afterwards.

- Check the start/stop conditions in the PLC
 - Start condition: time in seconds or kg in the scales
 - Stop condition: usually % of target weight
 - Please contact the PLC manufacturer for more information



If the solutions outlined here do not rectify the problem → contact the manufacturer's Service Department.

10 Maintenance

No special maintenance work is required.

10.1 Exterior cleaning

When cleaning the exterior, make sure that the cleaning agent used does not corrode the surface of the measuring cells and housing.

11 Repair

11.1 General information

11.1.1 Repair concept

Under the Endress+Hauser repair concept for the device, the device can be repaired by the Endress+Hauser Service Department.

For more information, please contact the Service Department at Endress+Hauser.

11.2 Return

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

For information on device return, please see:

<http://www.endress.com/support/return-material>

11.3 Disposal



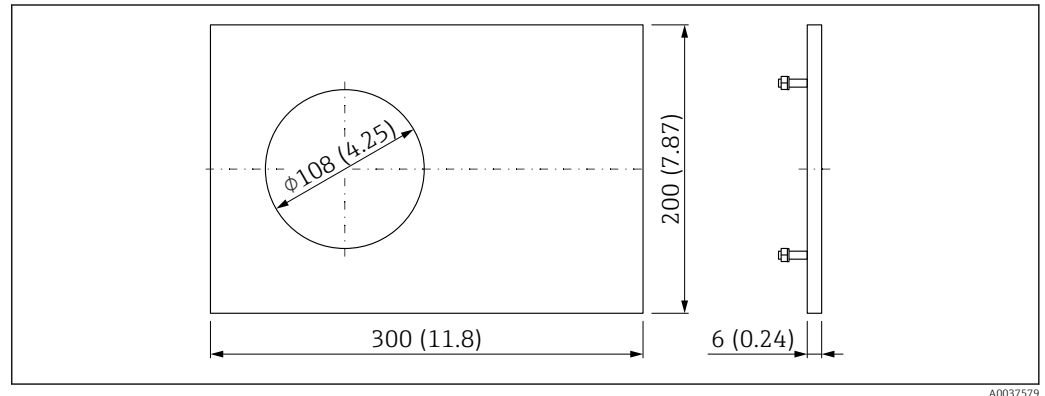
If required by the Directive 2012/19/EU on waste electrical and electronic equipment (WEEE), the product is marked with the depicted symbol in order to minimize the disposal of WEEE as unsorted municipal waste. Do not dispose of products bearing this marking as unsorted municipal waste. Instead, return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

12 Accessories

12.1 Device-specific accessories

12.1.1 Baffle plate for round sensor

The baffle plate, 1.4301 for the round sensor, can be ordered together with the device via the "Accessory enclosed" section of the product order structure.

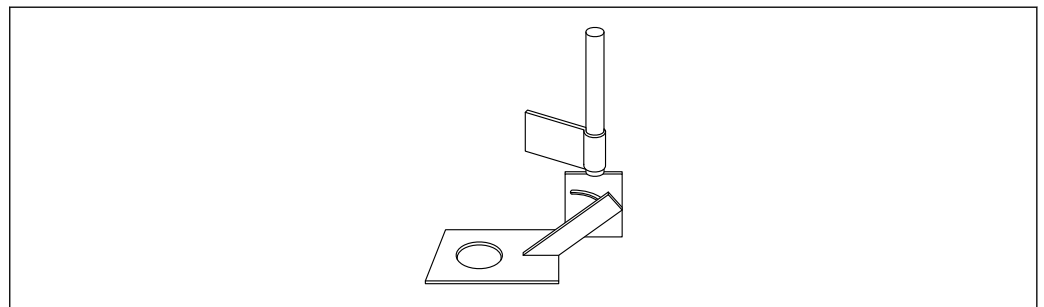


22 Baffle plate, 1.4301, sensor cut-out $\varnothing 108$ mm (4.25 in). Unit of measurement mm (in)

12.1.2 Universal holder with tilt mechanism for round sensor

The universal holder, 1.4301 for the round sensor, can be ordered together with the device via the "Accessory enclosed" section of the product order structure.

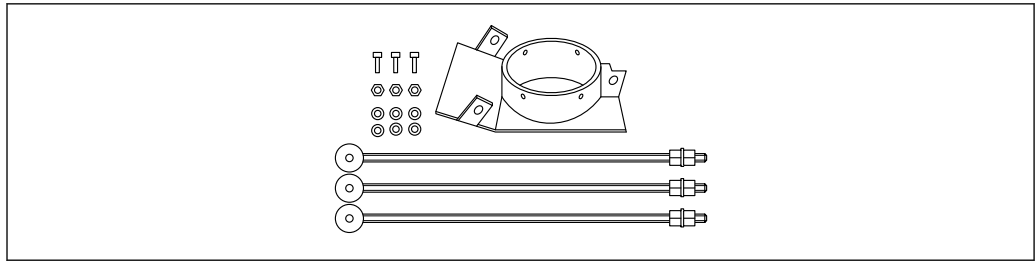
i Tilt mechanism with retaining head. For installing the device beneath a silo hatch or above a conveyor belt.



23 Universal holder, 1.4301, with tilt mechanism and retaining head, sensor cut-out $\varnothing 108$ mm (4.25 in)

12.1.3 Sliding carriage, for round sensor

The sliding carriage for the round sensor can be ordered together with the device via the "Accessory enclosed" section of the product order structure.



A0037578

24 Sliding carriage

Material

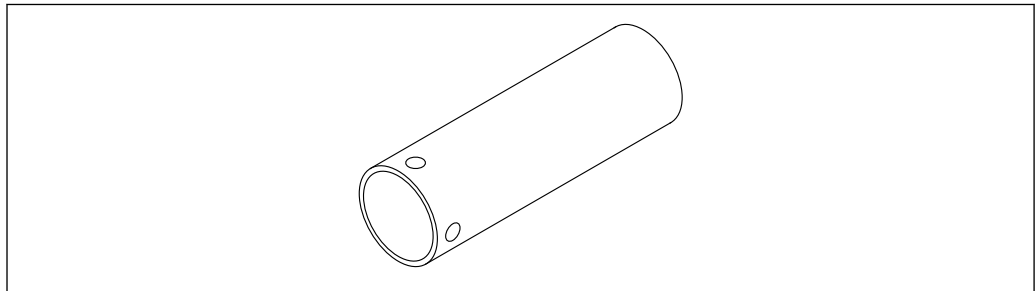
- Fastening:
1.4301
- Sliding carriage:
1.0037 or 1.4301
- Sliding surface:
Coated hard metal (for sliding carriage made of 1.0037) or uncoated hard metal (for sliding carriage made of 1.4301)
- 3× threaded bolts for fastening



For installation on conveyor belts.

12.1.4 Installation pipe 0.7 m (2.3 ft) for rod sensor

The installation pipe for the rod sensor can be ordered together with the device via the "Accessory enclosed" section of the product order structure.



A0037581

25 Installation pipe 0.7 m (2.3 ft) for rod sensor

Material

1.4301

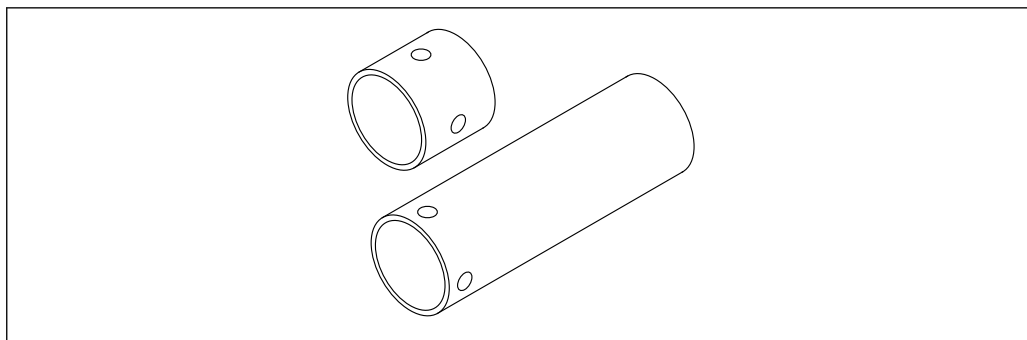
Dimensions

- Ø55 mm (2.17 in)
- L = 0.7 m (2.3 ft)

12.1.5 Adapter set for rod sensor

The adapter set for the rod sensor can be ordered together with the device via the "Accessory enclosed" section of the product order structure.

Adapter from 55 mm (2.17 in) to 76.2 mm (3.00 in) outer diameter.



A0037580

26 Adapter set for rod sensor

Material

- 1.4301
- 1× adapter to Ø76.2 mm (3.00 in) L = 80 mm (3.15 in)
- 1× installation pipe/extension Ø55 mm (2.17 in) L = 200 mm (7.87 in)

13 Technical data

13.1 Input

Measured variable	■ Channel 1 Material moisture in % (variably adjustable) ■ Channel 2 Conductivity 0 to 5 mS/cm or temperature 0 to 100 °C (32 to 212 °F), this also applies for the high-temperature version.
Measuring range	■ Material moisture The material moisture can be determined with a water content ranging from 0 to 100 % ■ Temperature sensor The temperature can be determined in the range from 0 to 100 °C (32 to 212 °F), this also applies for the high-temperature version. ■ Material conductivity Material conductivity can be determined up to a maximum value of 5 mS/cm

13.2 Output

Analog	■ Channel 1 (material moisture): 0 to 20 mA / 4 to 20 mA ■ Channel 2 (material conductivity or material temperature): 0 to 20 mA / 4 to 20 mA  The analog outputs can be set differently to the following possible options: Moisture, temperature Output 1 for moisture, output 2 for material temperature. Moisture, conductivity Output 1 for moisture, output 2 for conductivity in the range from 0 to 20 mS/cm (factory setting). Moisture, temperature/conductivity Output 1 for moisture, output 2 for material temperature and conductivity with automatic window changeover.
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Starting time

The first stable measured value is present at the analog output after approx. 1 s.

Digital	■ Serial interface, RS485 standard ■ IMP-Bus ■ Signal cable and operating voltage are galvanically isolated ■ Data transmission rate 9 600 Bit/s
Linearization	15 different calibration curves can be selected and saved via the remote display (optional). Customer-specific calibrations can also be created and saved via the display.

13.3 Performance characteristics

Reference operating conditions

The following reference conditions apply to the performance characteristics:

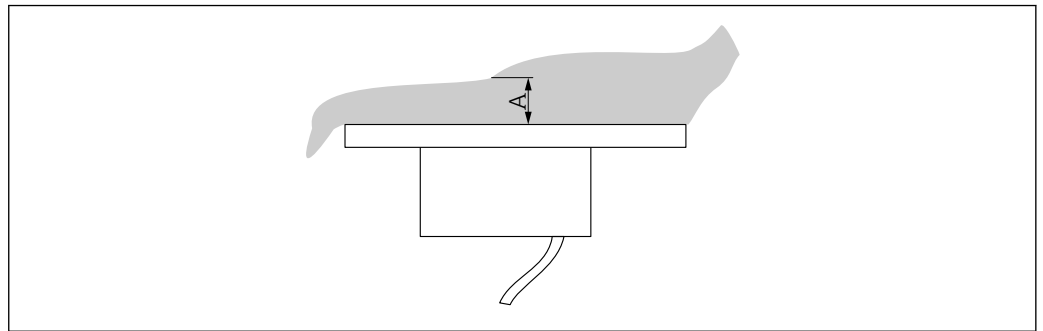
- Ambient temperature: 24 °C (75 °F) ± 5 °C (± 9 °F)
- Ideal installation conditions:
 - Constant bulk density
 - Sufficient material volume flow through the measuring field
 - No buildup

Measured value resolution

Sensor coverage / material height

For accurate measurement, the material on top of the sensor must be of a sufficient height.

Minimum sensor coverage (A): 45 mm (1.77 in) (moisture-dependent)



A0043610

27 Height of material on top of sensor

A Minimum sensor coverage

Measuring field propagation

≥ 45 mm (1.77 in) depending on material and moisture

Material moisture

Measuring range up to 100 % vol.

Conductivity

- The device delivers a characteristic value depending on the mineral concentration
- The conductivity range is reduced in material moisture measurement ranges > 50 %
- The conductivity value determined is uncalibrated and is primarily used to characterize the material being measured

Temperature

Measuring range: 0 to 100 °C (32 to 212 °F), this also applies for the high-temperature version.

The temperature is measured 3 mm below the sensor surface in the housing and can be output at analog output 2. Due to the internal heating of the electronics, the precise measurement of the material temperature is only possible to a limited extent. The material temperature can be determined following an external calibration and compensation of the sensor's internal heating.

Maximum measured error

The measured error depends on the operating mode and on the flow of material over the measurement surface. The longer the averaging time and the more stable the material density over the measurement surface, the lower the measured error.

Measured errors of up to ± 0.1 % are possible.

Heterogeneous materials such as bulk solids with varying grain size require a continuous flow of material over the surface of the sensor.

13.4 Environment

Ambient temperature range	At the housing: -40 to +70 °C (-40 to +158 °F)
Storage temperature	-40 to +70 °C (-40 to +158 °F)
Operating altitude	Up to 2 000 m (6 600 ft) above sea level
Degree of protection	IP67

13.5 Process

Process temperature range	■ Standard, 0 to 70 °C (32 to 158 °F) ■ High-temperature version, 0 to 120 °C (32 to 248 °F) (not available for the round sensor, short version, or the rod sensor)  Moisture measurement below 0 °C (32 °F) is not possible. Frozen water (ice) cannot be detected.
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