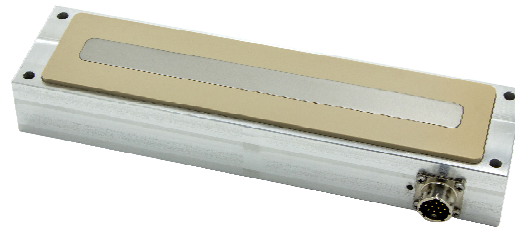


# Operating Instructions

## **Solitrend MMP60**

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 used

### 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

#### **Permitted**

Procedures, processes or actions that are permitted

#### **Forbidden**

Procedures, processes or actions that are forbidden

#### **Tip**

Indicates additional information



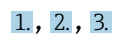
Reference to documentation



Reference to graphic



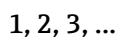
Notice or individual step to be observed



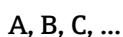
Series of steps



Result of a step



Item numbers



Views

## 1.3 Terms and abbreviations

### **BA**

Document type "Operating Instructions"

### **KA**

Document type "Brief Operating Instructions"

### **TI**

Document type "Technical Information"

### **XA**

Document type "Safety Instructions"

### **PLC**

Programmable logic controller (PLC)

## 1.4 Documentation

The following types of documentation are available in the Download Area of the Endress+Hauser website ([www.endress.com/downloads](http://www.endress.com/downloads)):



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

- *W@M Device Viewer* ([www.endress.com/deviceviewer](http://www.endress.com/deviceviewer)): Enter the serial number from the nameplate
- *Endress+Hauser Operations App*: Enter the serial number from the nameplate or scan the matrix code on the 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

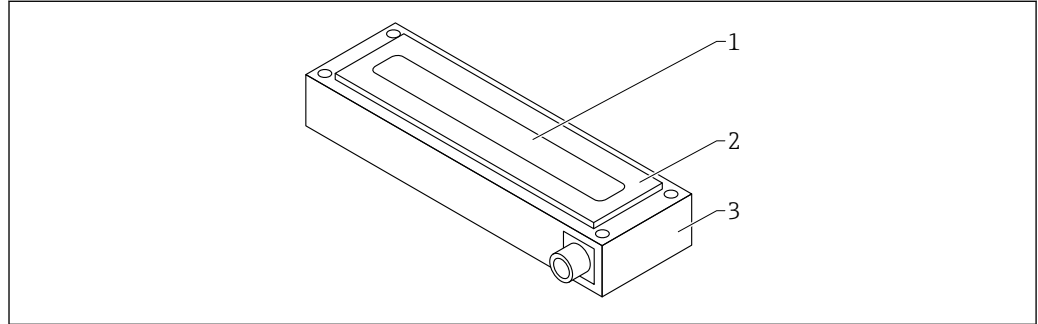
This device is designed in accordance with good engineering practice to meet state-of-the-art safety requirements, has been tested, and left the factory in a condition in which it is safe to operate.

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

Device for measuring low-density bulk solids with conductivity values up to 1 mS/cm.

#### 3.1 Product design



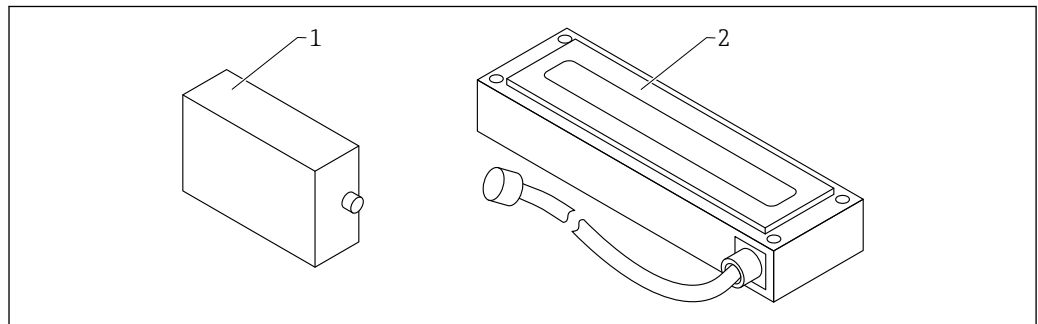
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##### 1 Product design

- 1 Wave guide
- 2 Measuring cell; TECAPEEK
- 3 Housing

#### 3.1.1 Remote electronics (accessories)

In the case of the order option **Accessories mounted: remote electronics 120 °C (248 °F)**, the electronics module is located in a separate housing and is connected using the HF cable that is permanently connected to the sensor.



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- 1 Electronics housing
- 2 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 device can be identified in the following ways:

- 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](http://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 in the *Endress+Hauser Operations app* or scan the 2-D matrix code on the nameplate with the camera
  - ↳ 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

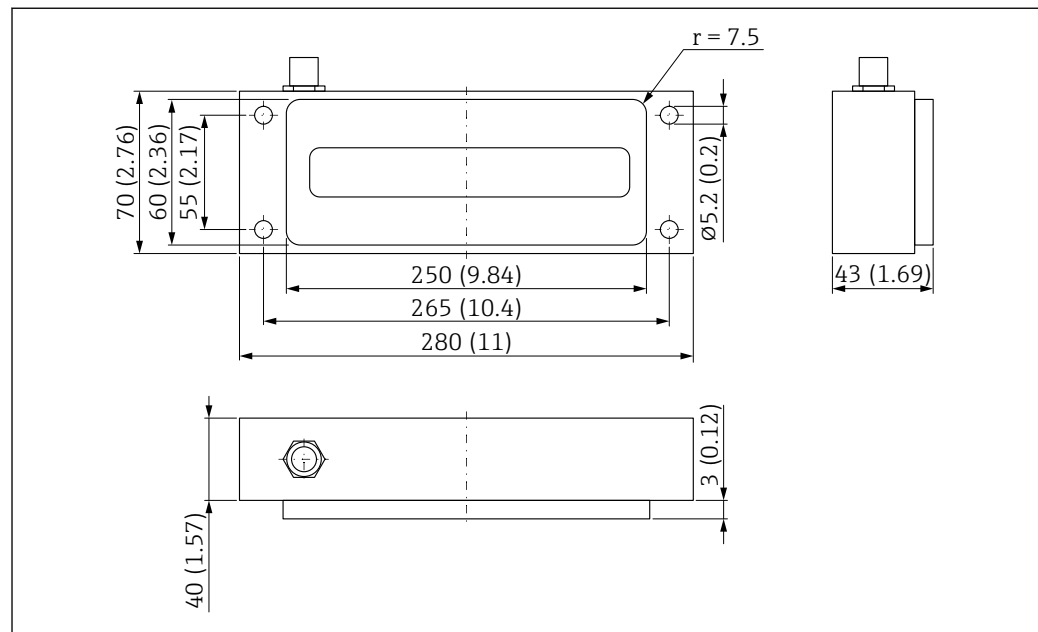
- The device must be installed at a point in the process in such a way that ensures a constant bulk density, as the bulk density directly affects the calculation of the water content. Where necessary, a bypass should be created or structural measures may be needed at the place of installation to ensure 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 Mounting the device

The device can be installed with four screws (M5).

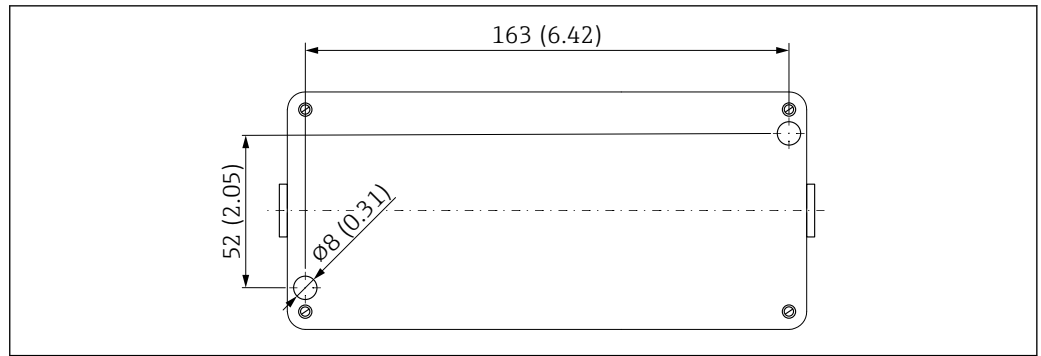
An appropriate cutout must be created at the place of installation for the measuring cell and bores to secure it.



 2 Dimensions. Unit of measurement mm (in)

#### 5.2.1 Mounting the housing with the remote electronics module

The housing with the remote electronics module can be mounted with two screws (M5).



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3 Mounting stencil for housing with remote electronics module

### 5.3 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 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)

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

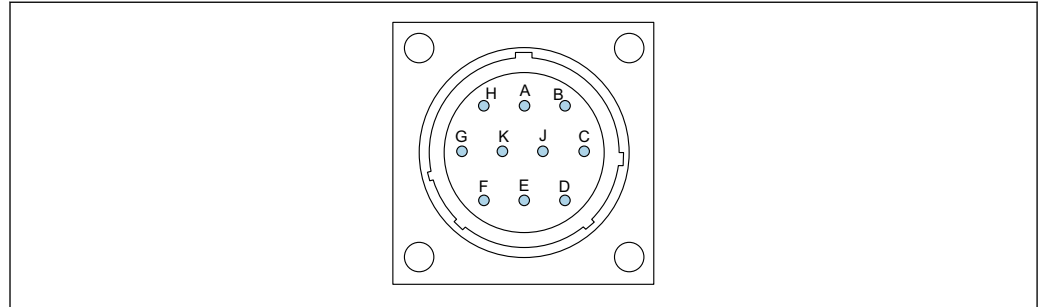
On request: Shielded cable **UNITRONIC ROBUST CP**  $10 \times 0.25 \text{ mm}^2$ , PUR sheath resistant to oils and chemicals.

### 6.2 Connecting the device

#### 6.2.1 Terminal assignment

The device is supplied as standard with a 10-pin plug, series 26482, with IP67 protection.

**i** In the case of the electronics module located remotely by means of the HF cable, the electronics housing is fitted on both sides with plugs with IP67 protection.

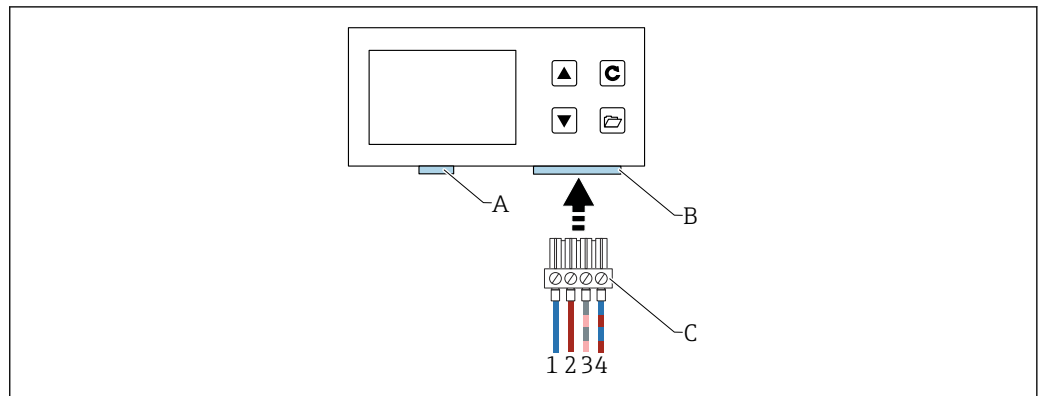


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**4** Assignment of the 10-pin plug

- A 12 to 24 V<sub>DC</sub> stabilized power supply  
Wire color: red (RD)
- B 0 V<sub>DC</sub> 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), see figure below
- J IMP-Bus COM  
Wire color: blue (BU) / red (RD), see figure below
- K 2nd analog positive (+)  
Wire color: pink (PK)
- E 2nd analog return line (-)  
Wire color: gray (GY)
- H Shield (is grounded at the device. The installation must be grounded correctly!)  
Wire color: transparent

## 6.2.2 Connection to a remote display (optional)

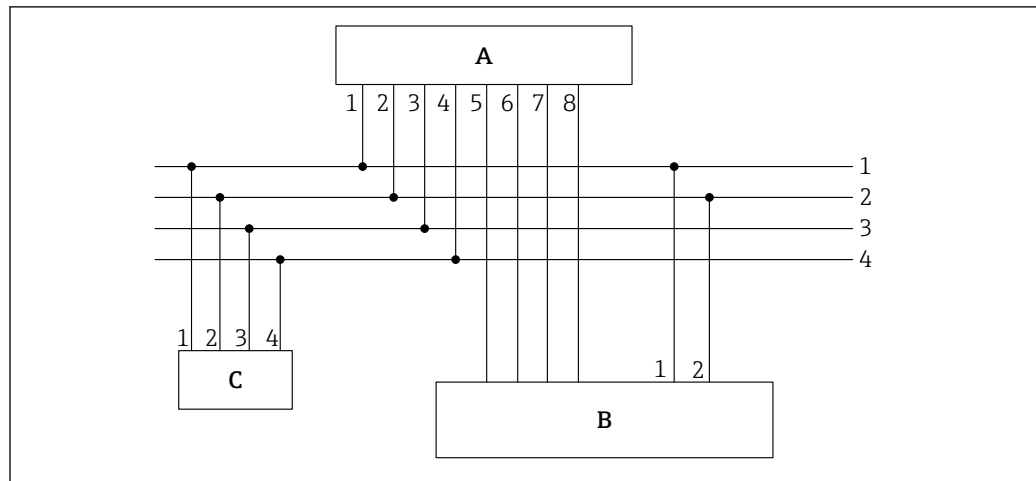


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### 5 Connection to a remote display

- 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<sub>DC</sub> power supply  
Wire color: blue (BU)
- 2 12 to 24 V<sub>DC</sub> 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)

### 6.2.3 Connection example of 10-pin socket



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

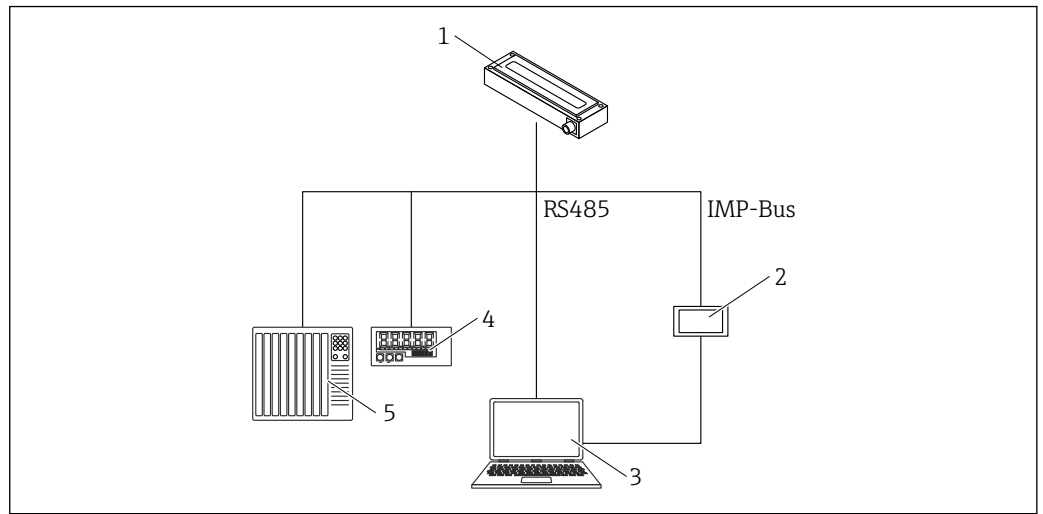
- A Transmitter  
 B PLC / distribution box  
 C Remote display (optional)
- 1  $0 V_{DC}$  power supply  
 Wire color: blue (BU)
- 2 12 to 24  $V_{DC}$  stabilized power supply  
 Wire color: red (RD)
- 3 IMP-Bus RT  
 Wire color: gray (GY) / pink (PK)
- 4 IMP-Bus COM  
 Wire color: blue (BU) / red (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).

### 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



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### 7 Overview

- 1 Device
- 2 Remote display
- 3 Computer
- 4 LED display
- 5 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 also 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.

 The moisture range may not exceed 100 %.

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

### Measure mode and parameters:

The following device settings can be changed

- Measure mode C - Cyclic (default setting for devices 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

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

### 8.2.1 Operating mode

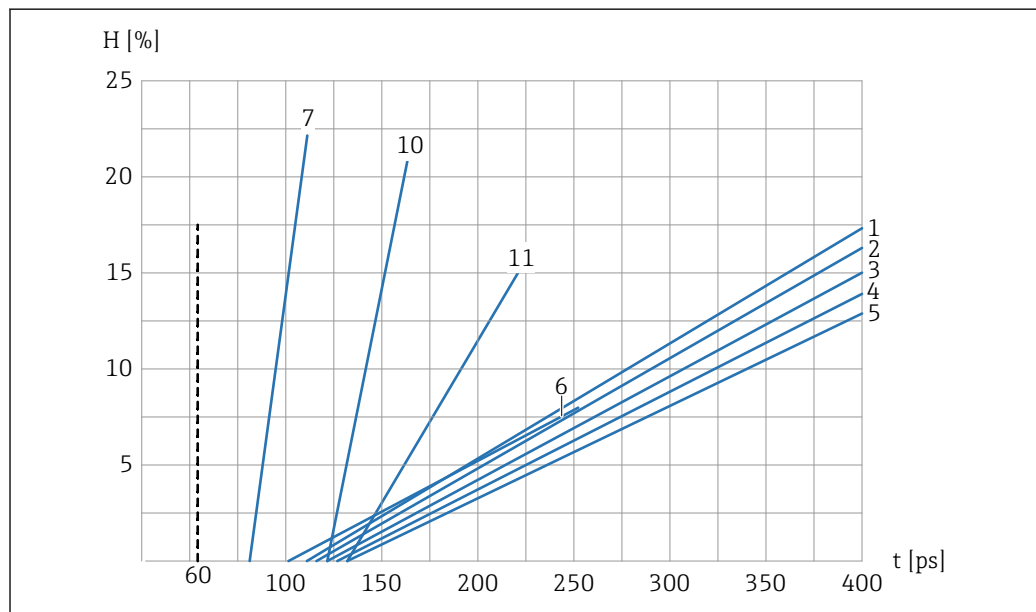
The device is supplied from the factory with the **CH** mode for applications in the construction industry, and with the **CA** mode for general process applications. 6 different operating modes are available in the **C** measuring mode, depending on the application.

- **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 s 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.

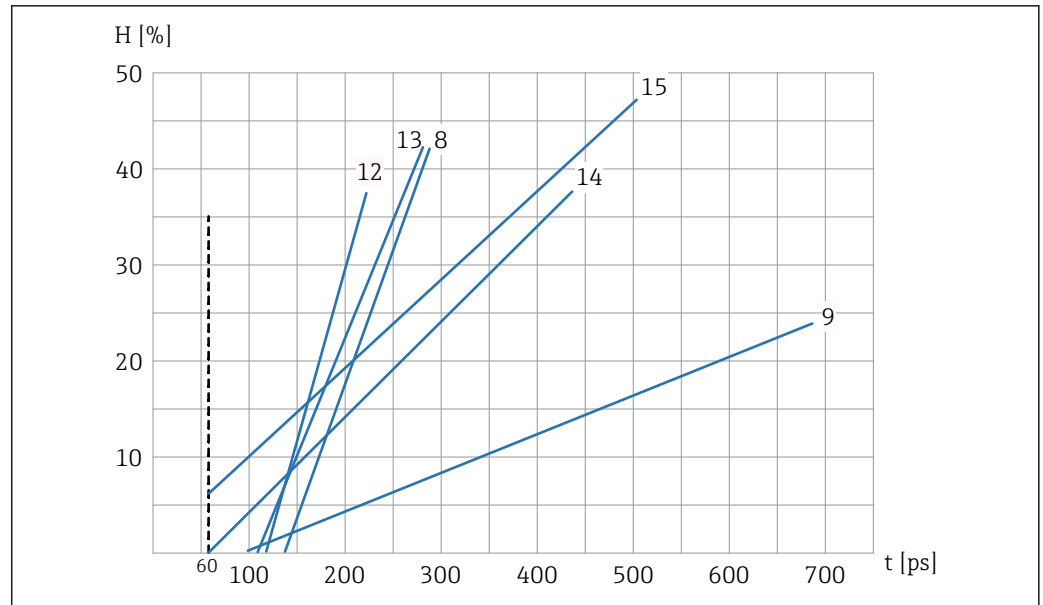
### 8.3 Calibration curve set A for general bulk solids applications

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.




8 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



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 9 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 Settings

### 8.4.1 Material calibration

In the **Material calibration** menu item, the necessary calibration can be selected via the optional remote display, depending on the application. In this way, one device can cover a range of different applications.

It is also possible to perform your own calibrations and overwrite an existing calibration curve.

 SD02333M **Remote display** - Description of operation and material calibration.

## 8.5 Special functions

### 8.5.1 Determining the mineral concentration

With the radar-based measurement method, it is not only possible to measure moisture but also 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. Depending on the moisture content, the conductivity measuring range of the devices here is up to 1 mS/cm.

### **8.5.2 Material temperature measurement**

The device contains an integrated temperature sensor, which measures the housing temperature. The temperature is measured 3 mm below the measuring cell 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.

### **8.5.3 Material temperature compensation**

When used in higher temperature ranges, the dielectric constant of water and certain materials being measured shows a temperature dependency ( $\epsilon_r$ ). Moisture is determined using the dielectric constant, i.e. the dielectric constant is the actual parameter measured during moisture measurement. If materials being measured display a temperature dependency, a material-specific temperature compensation must be performed. Contact the manufacturer's Service Department for this material-specific temperature compensation.

## 9 Diagnostics and troubleshooting

The device is normally precalibrated with calibration set B and Cal.14 (air/water 0 to 100 %) upon delivery.

Fine-tuning to achieve an accuracy of  $\pm 0.1$  % in relation to the laboratory value can be performed via a PLC or the remote display (optional).

### Fine-tuning with the PLC

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.).

- ▶ Perform a parallel shift / offset in the PLC
  - ↳ Contact the PLC manufacturer

### Fine-tuning with the remote display

- ▶ Perform fine-tuning / parallel shift in the device via the **Offset** parameter

## 9.1 Different moisture value

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

### Incorrect installation in the material flow

The measurement surface must be sufficiently covered. A good, stable flow of material **must** be guaranteed.

- ▶ Correct the installation or material flow
  - ↳ A video of the material flow during the batch process can be helpful for analysis purposes.

### The wrong calibration curve is set

The device is delivered with calibration curve Cal.14 (air / water 0 to 100 %).

- ▶ Select a suitable calibration curve.


### Moisture scaling set incorrectly in the PLC

In the device, 0 to 20 % moisture corresponds to the current output of 0 to 20 mA or 4 to 20 mA.

- ▶ Enter the 0 to 20 % moisture scaling in the PLC.
  - ↳ Contact the PLC manufacturer

### The calibration curves that are saved do not match the material

In the case of materials where the slope does not roughly correspond to a calibration curve saved in the device, a 2-point calibration (dry and wet material sample) may be necessary in the PLC or sensor.

- ▶  SD02333M **Remote display** - Description of operation and material calibration

### Moisture value too high

In the case of coarse-grained or hydrophobic materials, water can escape directly onto the measurement surface and therefore cause a high moisture value.

- ▶ Enter limit values in the PLC.
  - ↳ Contact the PLC manufacturer

**Incorrect data processing**

In the event of inaccurate data processing, check the moisture value displayed in the PLC.

1. Connect the device to the remote display
2. Compare the moisture value shown in the PLC with the moisture value shown on the display
3. For a test run, set the **CS** operating mode in the device
4. After the test run, set the operating mode back to **CA**

**Start/stop conditions are not correct**

- Start condition: time in seconds or kg in the scales
- Stop condition: usually % of target weight
- ▶ Check the start/stop conditions in the PLC
  - ↳ Contact the PLC manufacturer

 If the solutions described 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 Endress+Hauser for disposal under the applicable conditions.



## 12 Technical data

### 12.1 Input

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Measured variable	<ul style="list-style-type: none"> <li>■ <b>Channel 1</b> Material moisture in % (variable setting)</li> <li>■ <b>Channel 2</b> Conductivity 0 to 1 mS/cm or temperature 0 to 100 °C (32 to 212 °F), this also applies for the high-temperature version.</li> </ul>
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Measuring range	<ul style="list-style-type: none"> <li>■ <b>Material moisture</b> The material moisture can be determined with a water content ranging from 0 to 100 %, in relation to the total mass</li> <li>■ <b>Temperature sensor</b> 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.</li> <li>■ <b>Material conductivity</b> Material conductivity can be determined up to a maximum value of 1 mS/cm</li> </ul>
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### 12.2 Output

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Analog	<ul style="list-style-type: none"> <li>■ Channel 1 (material moisture): 0 to 20 mA / 4 to 20 mA</li> <li>■ Channel 2 (material conductivity or material temperature): 0 to 20 mA / 4 to 20 mA</li> </ul> <p> The analog outputs can be set differently to the following possible options:</p> <ul style="list-style-type: none"> <li><b>Moisture, temperature</b> Analog output 1 for moisture, output 2 for material temperature.</li> <li><b>Moisture, conductivity</b> Analog output 1 for moisture, output 2 for conductivity from 0 to 20 mS/cm.</li> <li><b>Moisture, temperature/conductivity</b> Analog output 1 for moisture, output 2 for material temperature and conductivity with automatic window switching.</li> </ul>
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#### Starting time

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

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Digital	<ul style="list-style-type: none"> <li>■ Serial interface, RS485 standard</li> <li>■ IMP-Bus <ul style="list-style-type: none"> <li>■ Signal cable and operating voltage are galvanically isolated</li> <li>■ Data transmission rate 9 600 Bit/s</li> </ul> </li> </ul>
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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.
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## 12.3 Performance characteristics

Reference operating conditions

**The following reference conditions apply to the performance characteristics:**

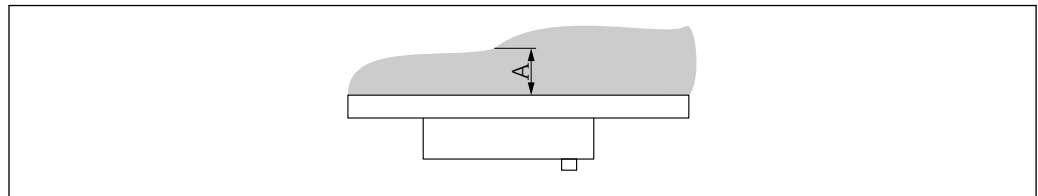
- Ambient temperature: 24 °C (75 °F) ±5 °C (±9 °F)
- Ideal installation conditions:
  - Constant bulk density
  - Sufficient volume flow through the measuring field
  - No buildup

Measured value resolution

**Measurement surface coverage / material height**

A sufficient level (height) of material is needed over the measurement surface to ensure a precise measurement.

Minimum measurement surface coverage: 85 mm (3.35 in) (moisture-dependent)



10 Material height over the measurement surface

A Minimum measurement surface coverage

**Measuring field propagation**

≥ 85 mm (3.15 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

**Material temperature**

Measuring range: 0 to 100 °C (32 to 212 °F)

The temperature is measured 3 mm below the measuring cell 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.

**Maximum measured error**

Accuracy up to ±0.1 % under ideal, constant installation and material conditions.

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.

## 12.4 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)

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Operating altitude            Up to 2 000 m (6 600 ft) above sea level

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Degree of protection        IP67


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## 12.5 Process

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Process temperature range

- Standard, 0 to 70 °C (32 to 158 °F)
- High-temperature version (electronics module located remotely in separate housing), 0 to 120 °C (32 to 248 °F)

 Moisture measurement below 0 °C (32 °F) is not possible.  
Frozen water (ice) cannot be detected.



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