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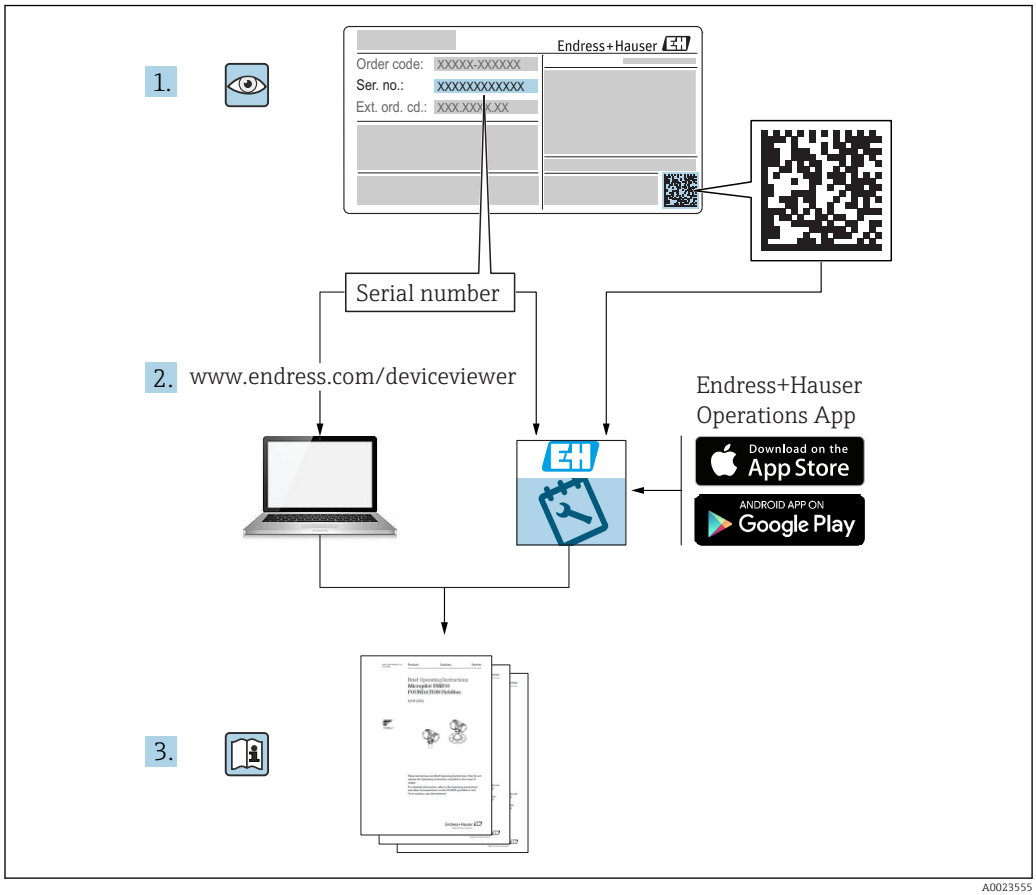
2019-10-31

Special Documentation
Remote display

Standalone display and configuration for reliable process control with Solitrend moisture sensors

Endress+Hauser
People for Process Automation


1.
Endress+Hauser
Order code: XXXXX-XXXXXX
Ser. no.: XXXXXXXXXXX
Ext. ord. cd.: XXX XXX XX XX
Serial number
2. www.endress.com/deviceviewer
Endress+Hauser
Operations App
Download on the App Store
ANDROID APP ON Google Play
3.
A0023555

Introduction

The data of up to 16 Solitrend sensors can be captured online via a serial interface and the measured values displayed on the LCD. The following actions and parameter settings can be performed with the remote display:

- Selection of a calibration curve (saved in the sensor)
- Configuration of the sensor's analog outputs
- Configuration of the sensor's operating mode
- Configuration of the averaging times
- Zero point adjustment
- Analysis and optimization for new applications

Table of contents

1 About this document

1.1 Document function

These Operating Instructions provide all of the information that is required in various phases of the life cycle of the device including:
- Product identification
- Incoming acceptance
- Storage
- Installation
- Connection
- Operation
- Commissioning
- Troubleshooting
- Maintenance
- 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

✓✓
Preferred
Procedures, processes or actions that are preferred

✗
Forbidden
Procedures, processes or actions that are forbidden

ℹ
Tip
Indicates additional information

Reference to documentation

Reference to graphic

▶
Notice or individual step to be observed

1., 2., 3.
Series of steps

↳
Result of a step

1, 2, 3, ...
Item numbers

A, B, C, ...
Views

⚠ → 📖
Safety instructions
Observe the safety instructions contained in the associated Operating Instructions

1.3 Terms and abbreviations

BA
Document type "Operating Instructions"

TI
Document type "Technical Information"

SD
Document type "Special Documentation"

PLC
Programmable logic controller (PLC)

1.4 Documentation

The following documentation types are available in the Downloads section of the Endress +Hauser website (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): Enter the serial number from nameplate
- *Endress+Hauser Operations App*: Enter the serial number from the nameplate or scan the 2D matrix code (QR code) on the nameplate

2 Basic safety instructions

2.1 Requirements for the personnel

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

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

2.2 Designated use

Application and media
The remote display is designed for the visualization and configuration of up to 16 Solitrend sensors.

Observe limit values. See the "Technical data" section

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

2.3 Workplace safety

When working 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 in proper technical condition and fail-safe condition only.
- The operator is responsible for interference-free operation of the device.

Conversions to the device

Unauthorized modifications to the device are not permitted and can lead to unforeseeable dangers.
- If, despite this, modifications are 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 repair of an electrical device.
- Use original spare parts and accessories from the manufacturer only.

Hazardous area

To eliminate a danger for persons or for the facility when the device is used in the hazardous area (e.g. explosion protection, pressure vessel safety):
- Based on the nameplate, check whether the ordered device is permitted for the intended use in the hazardous area.
- Observe the specifications in the separate supplementary documentation that is an integral part of these Instructions.

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

3 Incoming acceptance and product identification

3.1 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.

3.2 Product identification

The following options are available for the identification of the measuring device:
- Nameplate specifications
- Extended order code with breakdown of the device features on the delivery note

- Enter the serial number from the nameplates into *W@M Device Viewer* (www.endress.com/deviceviewer)
  - All the information about the measuring device and the scope of the associated Technical Documentation are displayed.

- Enter the serial number from the nameplate into the *Endress+Hauser Operations App* or use the *Endress+Hauser Operations App* to scan the 2-D matrix code (QR Code) provided on the nameplate
  - All the information about the measuring device and the scope of the associated Technical Documentation are displayed.

3.3 Manufacturer's address

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

3.4 Storage, transport

3.4.1 Storage conditions

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

3.4.2 Transporting the product to the measuring point

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

4 Electrical connection

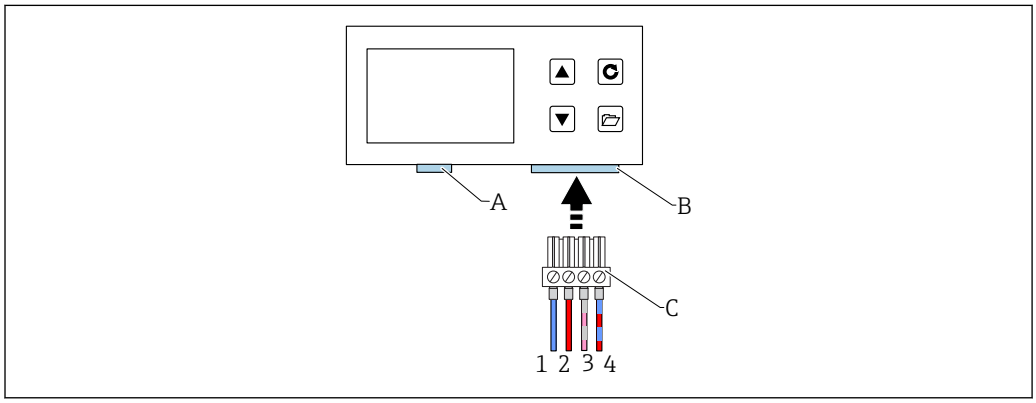
To operate the remote display, a supply voltage of 12 to 24 V DC is needed.

A common sensor ground line is not required. To connect the sensors, it suffices to connect the two bus lines "RT" and "COM".

The remote display is suitable for the visualization and configuration of up to 16 sensors. If more than 16 sensors are connected, an error message is displayed

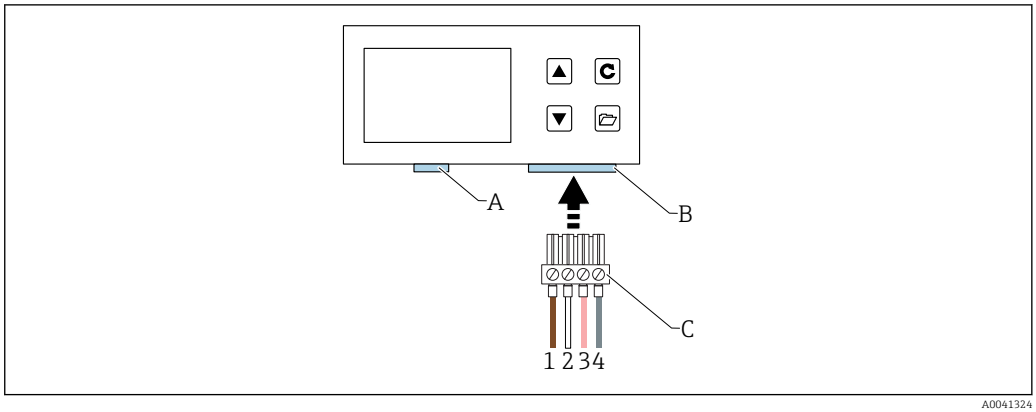
4.1 Connections

4.1.1 Round and rod sensors



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)

4.1.2 Rectangular sensors



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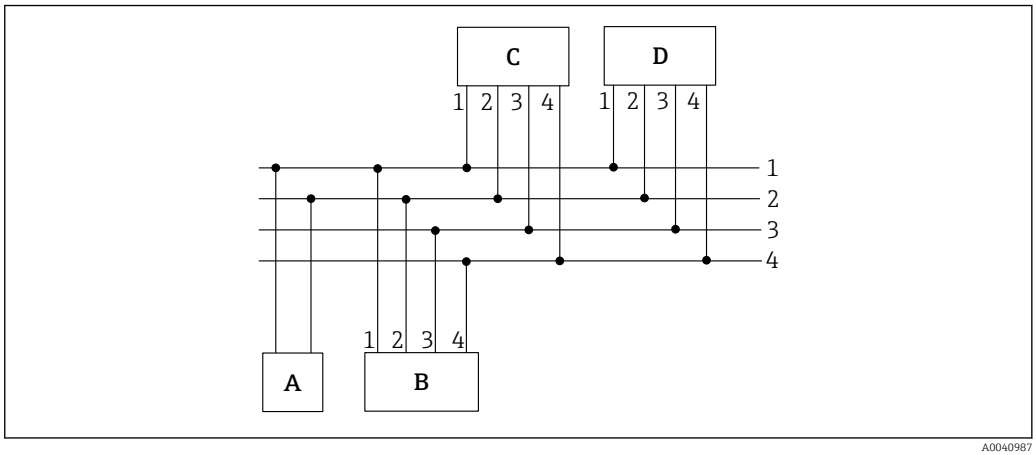
A USB (Mini B type), USB-IMP-Bridge, firmware update (only for service purposes)
B Socket for supply voltage and bus interface
C Connector for supply voltage and bus interface (included in the delivery for "remote display")
1 0 V_{DC} power supply
Wire color: brown (BN)
2 12 to 24 V_{DC} stabilized power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

4.2 Connection examples

4.2.1 Example 1

Connection with two Solitrend sensors and a common power supply



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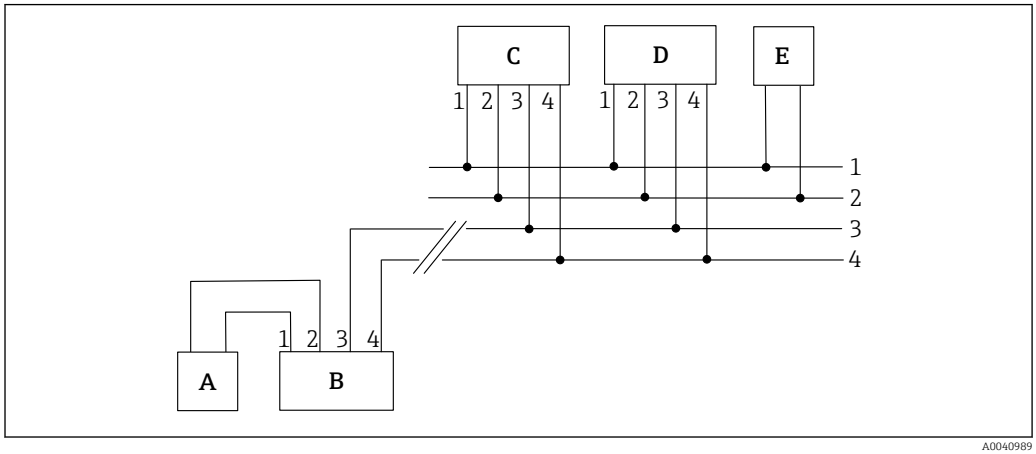
A Power supply
B Remote display
C Solitrend sensor 1
D Solitrend sensor 2
1 0 V_{DC} power supply
Wire color: blue (BU)
2 12 to 24 V_{DC} stabilized power supply
Wire color: red (RD)
3 IMP-Bus R/T
Wire color: gray (GY) / pink (PK)
4 IMP-Bus COM
Wire color: blue (BU) / red (RD)

4.2.2 Example 2

Connection with two Solitrend sensors via the IMP-Bus. The remote display and the sensors each have their own power supply. This can be useful if the distance between the measuring system and the display is large.



A Power supply for remote display
B Remote display
C Solitrend sensor 1
D Solitrend sensor 2
E Power supply for Solitrend sensors
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 R/T
Wire color: gray (GY) / pink (PK)
4 IMP-Bus COM
Wire color: blue (BU) / red (RD)

5 Commissioning

5.1 Safety instructions

NOTICE

- Before you commission the device, make sure to read the instructions in Section 1 and Section 2. Improper use can damage the device.

5.2 Checking the packaging contents

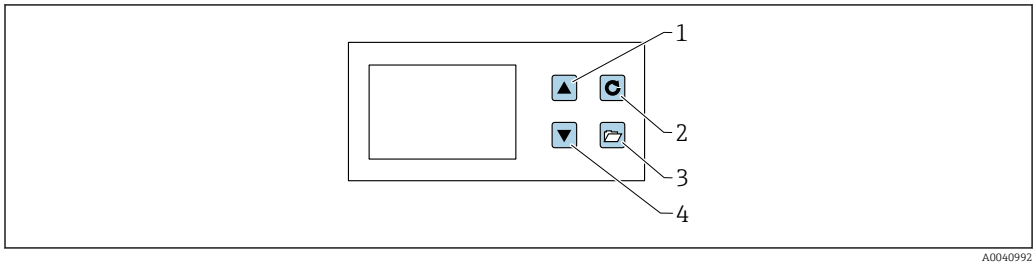
- Remote display
- Terminal block
- USB cable (Type A -> Mini B)

5.3 Connection

Connect the remote display as described in Section 4 "Electrical connection".

6 Operation

6.1 Operating elements



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1 *Navigation key*
2 *Enter key*
3 *Folder key*
4 *Navigation key*

6.2 Initial/new installation

You must set up the remote display the first time you connect it to the sensor network (new installation).

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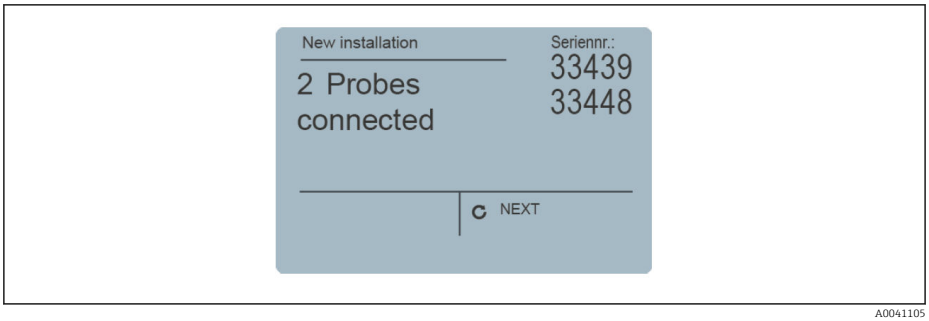
1. Press the confirmation key to start the setup
   ↳ The device searches the IMP-Bus for connected sensors
   After a few moments, the serial numbers of all the connected sensors are displayed on the screen



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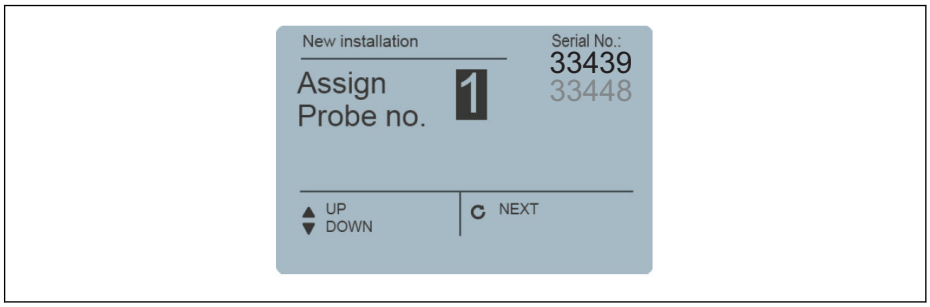
2. The remote display uses sensor numbers (1-16) to make it easier to manage the sensors.

3. In the next step, these sensor numbers must be assigned to the serial numbers found



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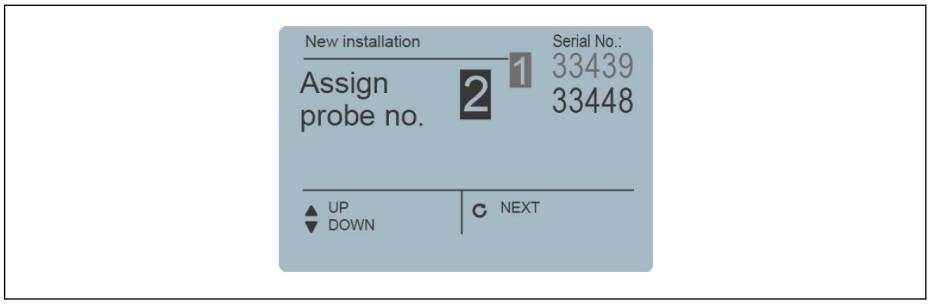
4. Using the navigation keys, select a serial number for each sensor number and press the Enter key to confirm



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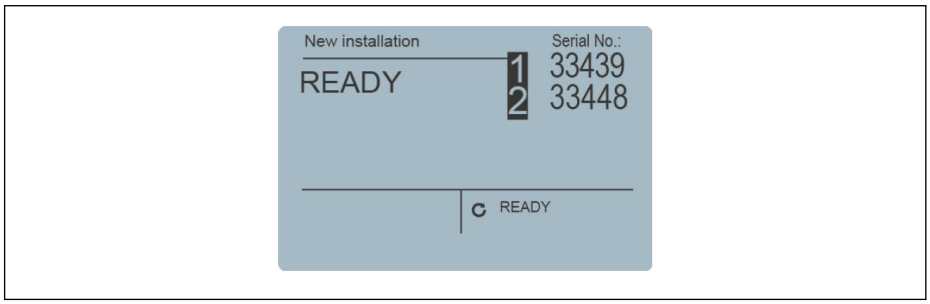
5. Repeat this procedure until all the serial numbers have been assigned to a sensor number
6. At the end, all the sensor numbers are displayed again in ascending order with the assigned serial numbers



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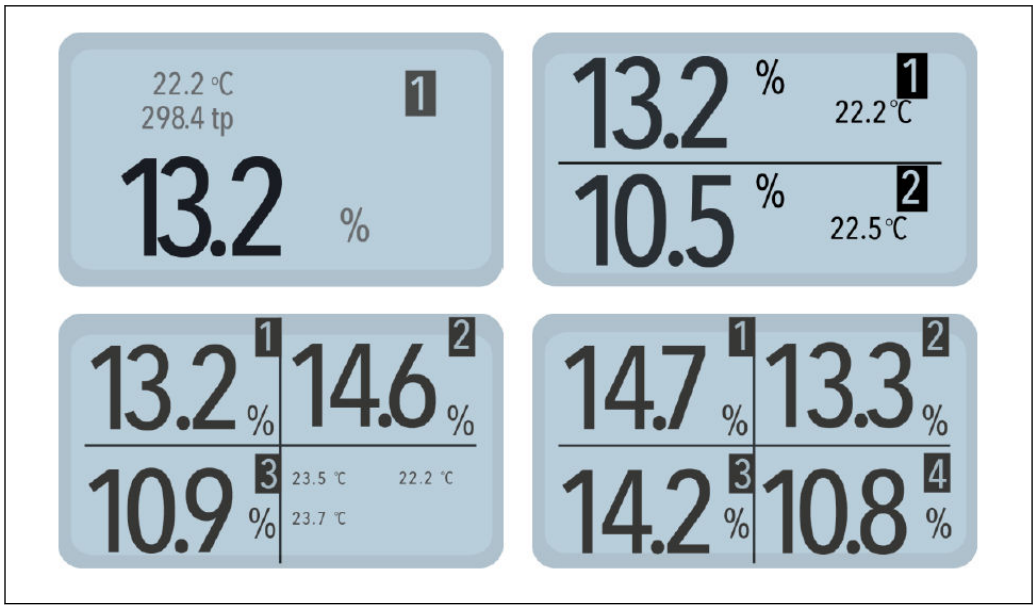
Press Enter to finish

At the end of the setup routine, the device reboots, checks the connected sensors and starts retrieving the measured data immediately.

6.3 Measured value display

The remote display starts retrieving and displaying the measured values of the sensors immediately after startup. It does so every 500 ms. Depending on the number of sensors that are connected, one of the following screens appears.



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The percentage moisture value and the number of the corresponding sensor are always displayed. If two or three sensors are connected, the temperature measured by the sensor is also displayed. If only one sensor is connected, the calibrated radar transit time is also displayed.

If more than one sensor is connected to the remote display, it is possible to switch between screens with the navigation keys. With each press of the navigation key, all the connected sensors are displayed in succession as individual sensors.

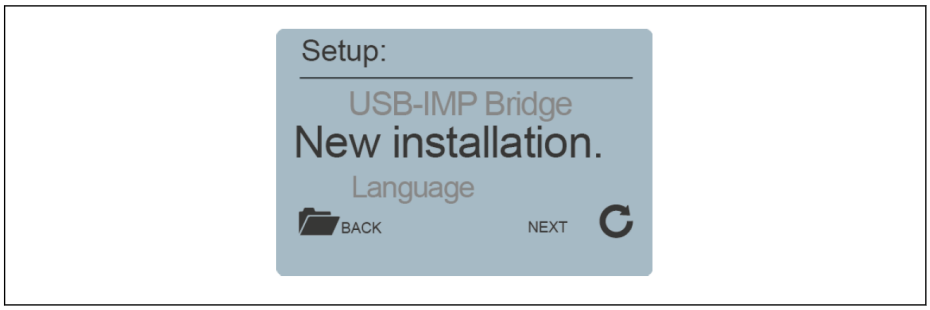
The sensor number is always displayed in the top right of the screen to clearly indicate which sensor the values refer to. If the user remains on a particular screen for longer, this screen is defined as the "default" screen. Following a restart, the device will then start with this defined default measuring screen.

6.4 Setup

Structure of the "Setup" menu:
- **New installation**: allows users to run a new scan for connected sensors
- **Language**: sets the language
- **Display contrast**: sets the contrast
- **About "remote display"**: serial number and other information about the "remote display"
- **Info**: support information
- **USB-IMP-Bridge**: service mode for Endress+Hauser engineers

Setup menu

1. Press the folder key when the measurement screen is displayed



The various settings and information about the remote display can now be accessed

2. Select the desired setting using the navigation keys
3. Press the Enter key to go to the selected setting
4. Press the Folder key again to exit the Setup menu

6.4.1 New installation

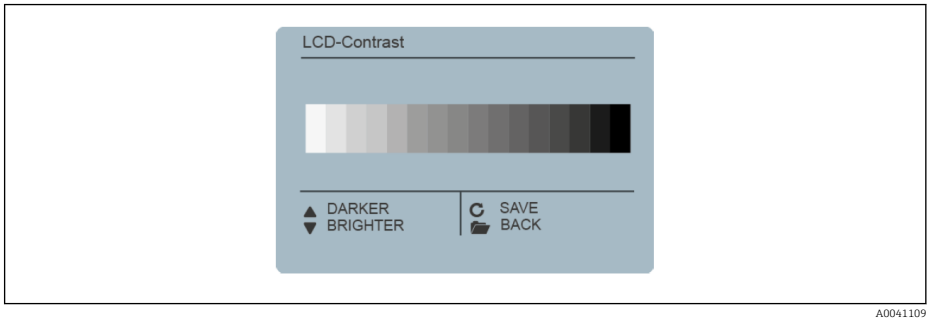
See the **"Initial/new installation"** section

6.4.2 Language

1. Select the desired language using the navigation keys
2. Press the Enter key to save the selected language as the default language
3. Press the Folder key to exit the "Language" menu item

6.4.3 Display contrast

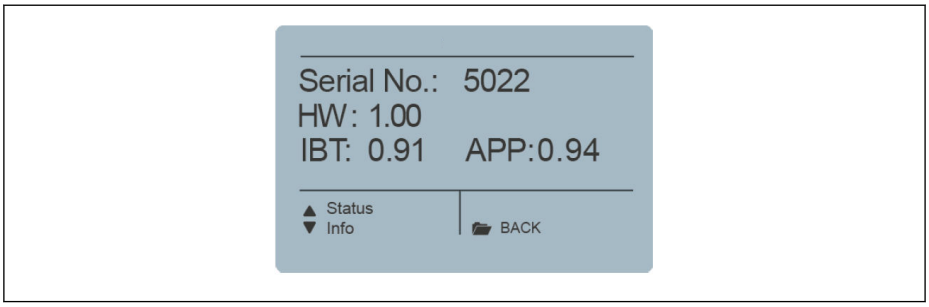
1. A bar with a gray scale appears on the display



2. Use the navigation keys to set the contrast so that all the gradations are visible
3. Press the Enter key to save the configured value
4. Press the Folder key to exit the "Display contrast" menu item

6.4.4 Information about the "remote display"

1. The serial number, HW version, IBT version and firmware version are displayed



2. Press the navigation key (1) to call up additional status information, e.g. connected sensors and system voltages
3. Press the Folder key to exit the "Remote display" menu item

6.4.5 Info

Links to the manufacturer's home page and the e-mail address for support questions.

6.4.6 USB-IMP Bridge

Service menu

► This menu item is reserved for service technicians

6.5 Sensor configuration

Structure of the "Sensor configuration" menu:
- **Sensor info** : displays information about the connected sensor
- **Material cal.** : choice of a material-specific calibration, 1-point calibration and 2-point calibration
- **Offset balancing**: offsets the measured value
- **Average mode** : sets the averaging mode
- **Average parameters**: sets the parameters for the configured averaging mode
- **Basic calibration**: "Zero value" calibration of the sensor in air
- **Analog parameter**: set the analog parameter

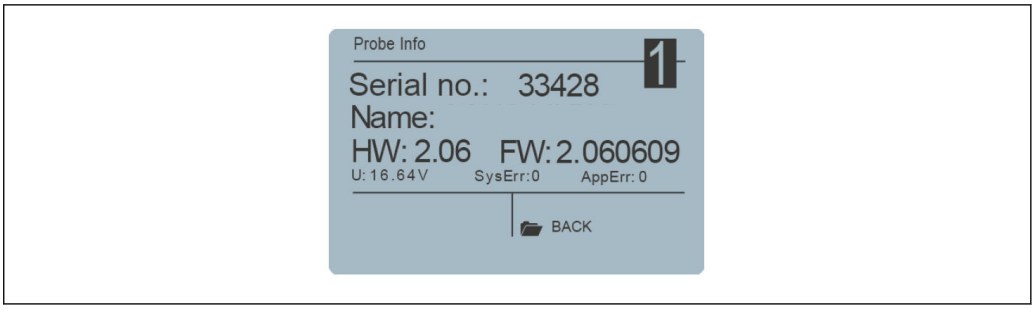
With the remote display it is possible to fully configure the connected sensors without a PC

1. Navigate to the sensor configuration with the navigation keys
2. Select the individual sensor screen of the sensor to be configured
3. Press the Enter key to call up the sensor settings for the current sensor

Only one sensor can be configured at any one time. If the settings for more than one sensor need to be modified, the process must be repeated for the other sensors.

Caution:
- The remote display enables access to the measurement parameters of the sensor.
- Make sure that the correct sensor is set before you change the parameters.
- Before changing a parameter, please refer to the Sensor Manual to ensure you know exactly how the parameter works and the function of the parameter.
- Changing a parameter can affect the reading, the accuracy and the measuring rate.

6.5.1 Sensor info



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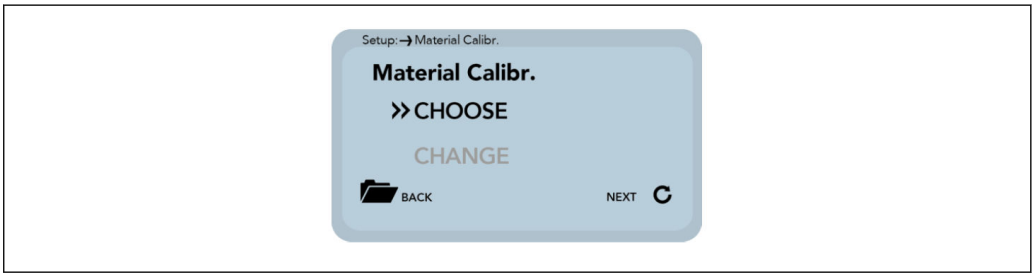
- If the "Sensor info" menu is called up, a range of information about the sensor is retrieved and displayed
- Press the Enter key to exit the "Sensor info" menu item

6.5.2 Material calibration

Options in the "Material calibration" menu
- Set the material-specific calibration saved in the sensor
- Calibrations in order to measure special materials

Function of the folder key:
- Press the Folder key briefly to go to the previous menu item
- Press the Folder key for longer to go back to the "Sensor configuration" menu (regardless of which "Material calibration" subitem is currently active)



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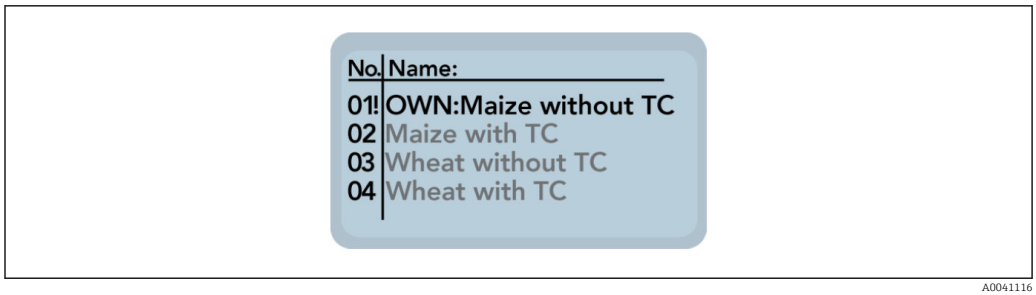
1. Select the "Material calibration" menu item
   ↳ "Choose" subitem: set one of the 15 saved material-specific calibrations with the navigation keys
   "Change" subitem: write a new calibration to one of the 15 calibration memories with the navigation keys.
2. Press the Enter key to select the subitem
3. Press the Folder key to exit the "Material calibration" menu item

Choose

In the "Choose" subitem, users can choose from up to 15 material-specific calibrations.



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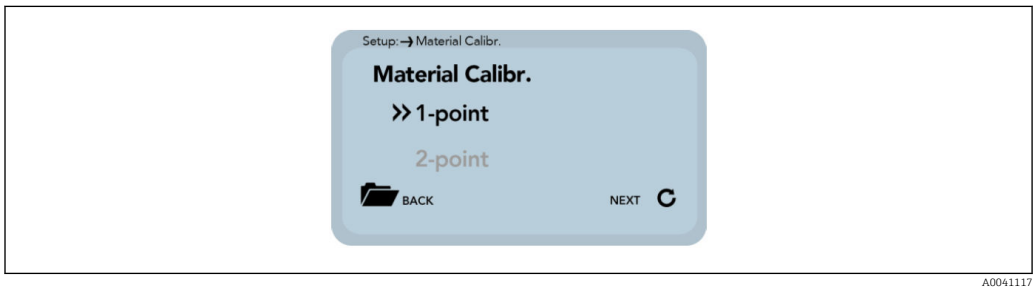
1. Use the navigation keys to select the material-specific calibrations
   ↳ "!" in front of a calibration indicates the current default calibration
2. Save the selected calibration as the default calibration by pressing the Enter key
   ↳ The configured calibration then remains saved in the sensor
3. Press the Folder key to exit the "Choose" subitem

Change

In the "Change" subitem, users can perform a 1-point calibration or a 2-point calibration.



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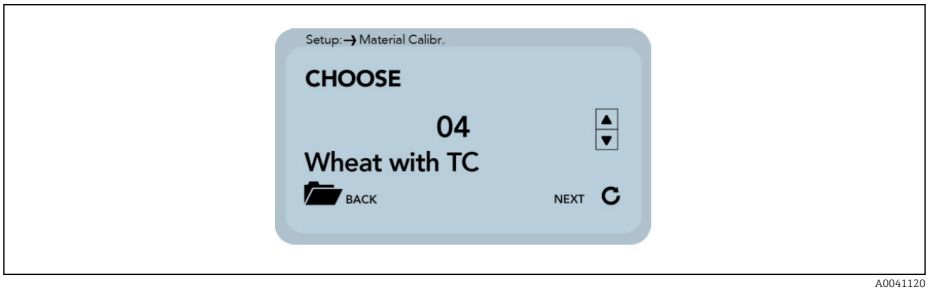
1. Use the navigation keys to switch between 1-point calibration and 2-point calibration
2. Press the Enter key to execute the selected subitem
3. Press the Folder key to exit the "Change" subitem

1-point calibration

With this material calibration option, a linear equation (f(x)=mx+b) is calculated using the dry density, a reference moisture and the tp value (radar signal transit time) which can be measured or set at the point of the reference moisture. While a higher-value polynomial is useful to achieve better accuracy, the linear equation often suffices to obtain very good results.

A sample of the material being measured and its dry density are required to perform a 1-point calibration. The moisture value must be determined with another method (e.g. moisture analyzer) before the calibration.

1. At the start of the calibration, select the calibration memory (01-15) to be overwritten with the navigation keys
   ↳



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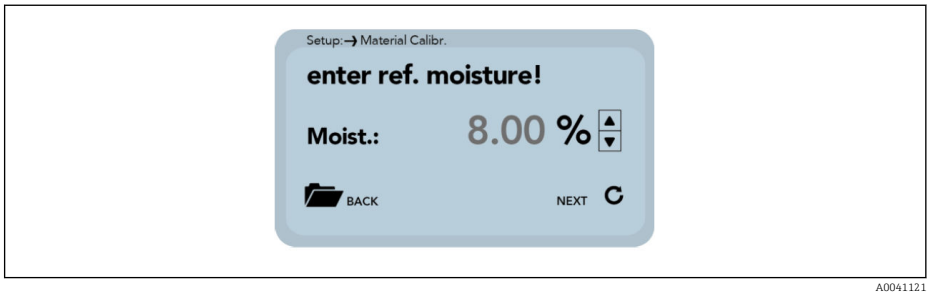
2. Press the Enter key to accept the setting
3. Press the Folder key to go back to the previous item
4. Set the percentage reference moisture of the material being measured with the navigation keys



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5. Press the Enter key to accept the setting
6. Press the Folder key to go back to the previous item
7. Set the dry density of the material being measured with the navigation keys

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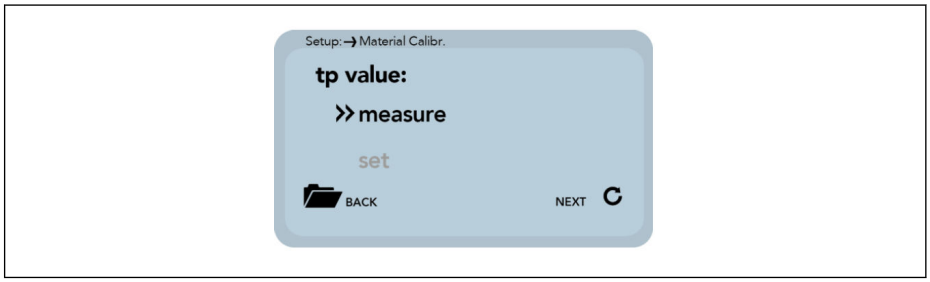
8. Press the Enter key to accept the setting
9. Press the Folder key to go back to the previous item
10. Use the navigation keys to switch between "Measure" and "Set"



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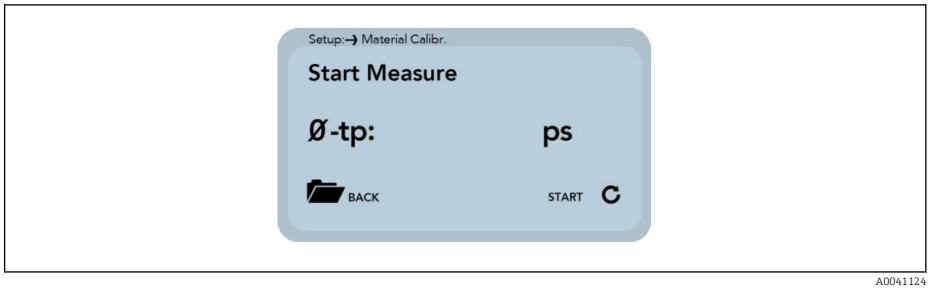
11. Press the Enter key to accept the setting
12. Press the Folder key to go back to the previous item

In the next step, the tp value (transit time of the radar signal) is determined by taking a measurement (with the connected sensor) or by setting the value manually.

Measure:

1. Press the Enter key to start the measurement



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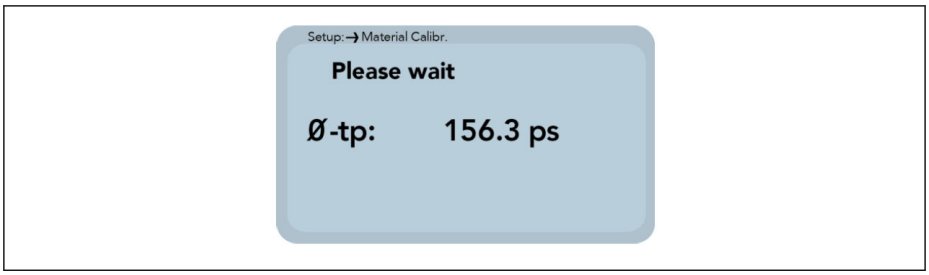
2. Press the Folder key to go back to the previous item
3. Press the Enter key to get an average of 10 measured values
   ↳


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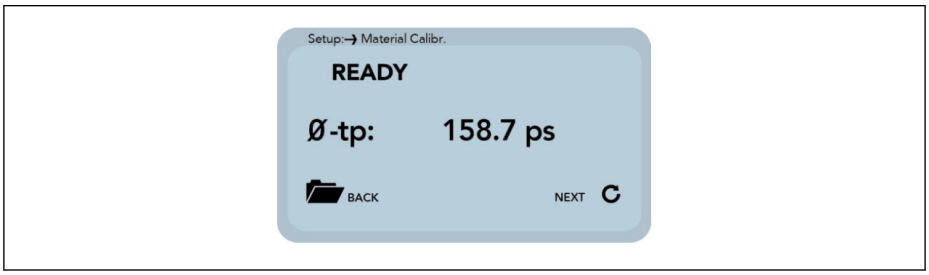
4. Wait
   ↳ The remote display does not respond to any entries made during this time
5. **The tp average value is displayed when the device is finished measuring**
   Press the Enter key to accept the measured value
   ↳


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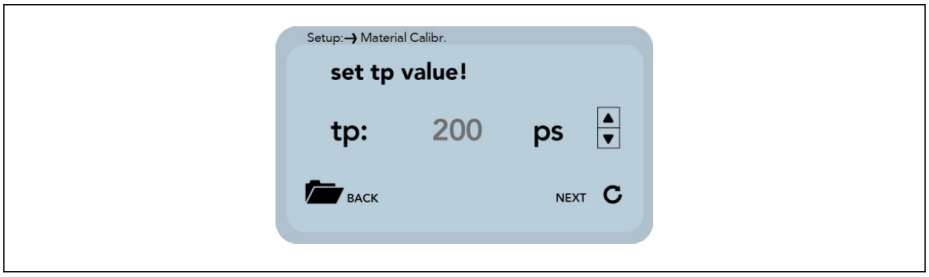
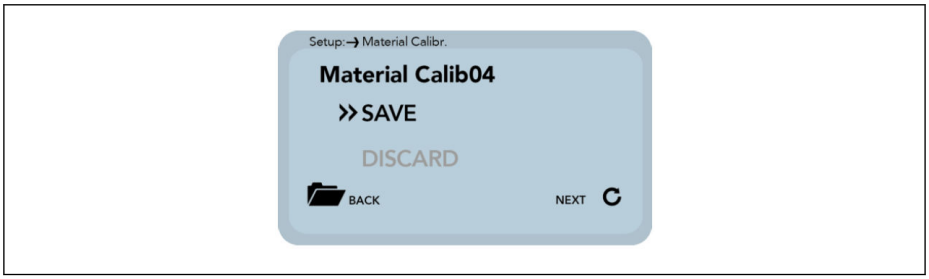
6. Press the Folder key to go back to the previous item
7. Use the navigation keys to manually set the tp value
   ↳


A0041127

8. Press the Enter key to accept the setting
9. Press the Folder key to go back to the previous item
10. Use the navigation keys to switch between "Save" and "Discard"
    ↳


A0041128

11. Press the Enter key to accept the setting
12. Press the Folder key to go back to the previous item

In the last step, the calibration settings you have made can be saved to the calibration memory previously selected by selecting "Save", or the settings can be canceled by selecting "Discard".

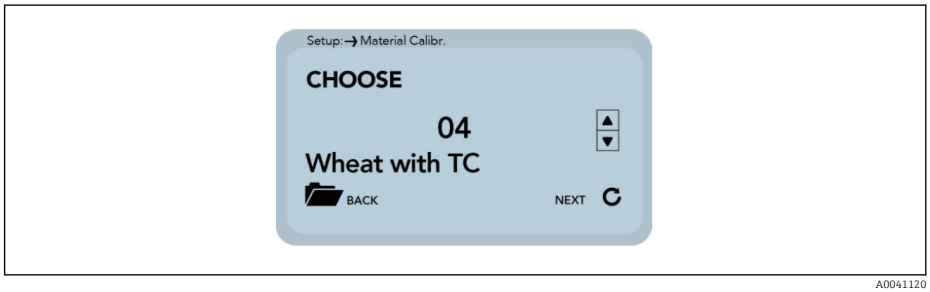
Once "Save" has been selected, the word "OWN:" is displayed in front of the original material calibration. This indicates that this is a user-defined material calibration.

2-point calibration

In the case of a 2-point calibration, a linear equation (f(x)=mx+b) is calculated using two moisture values of a material and the associated tp values (transit times of the radar signal) which can be measured or set at the particular material moisture. While a higher-value polynomial is useful to achieve better accuracy, the linear equation often suffices to obtain very good results.

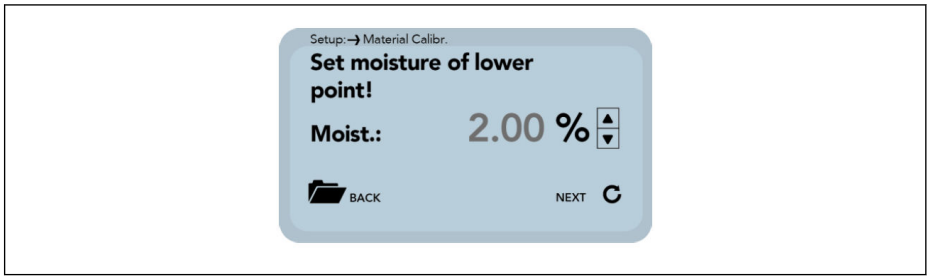
Two material samples with different moisture values are required to perform a 2-point material calibration. The moisture values must be determined with another method (e.g. moisture analyzer) before the calibration. It is important to adhere to the following sequence: first "lower moisture value" (drier material) and then "upper moisture value" (wetter material).

1. At the start of the calibration, select the calibration memory (01-15) to be overwritten with the navigation keys



A0041120

2. Press the Enter key to accept the setting
3. Press the Folder key to go back to the previous item
4. Set the percentage reference moisture at the lower point of the material being measured with the navigation keys

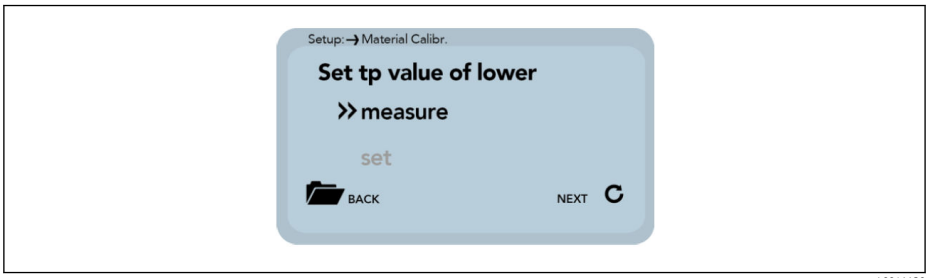


A0041129

5. Press the Enter key to accept the setting
6. Press the Folder key to go back to the previous item

In the next step, the tp value (transit time of the radar signal) is determined at the lower moisture value by taking a measurement (with the connected sensor) or by setting the value manually.

1. Use the navigation keys to switch between "Measure" and "Set"

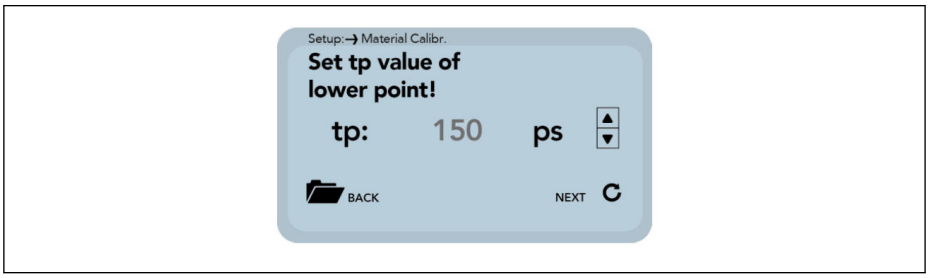


A0041130

2. Press the Enter key to accept the setting
3. Press the Folder key to go back to the previous item

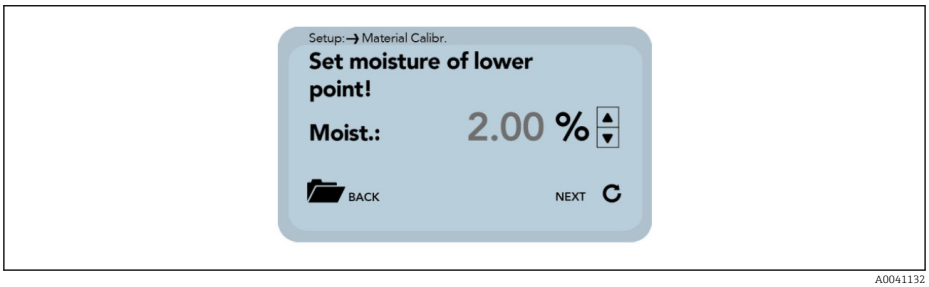
Measure: see Point "8.4.5 1-point calibration (Measure)".

1. Use the navigation keys to manually set the tp value at the lower moisture point



A0041131

2. Press the Enter key to accept the setting
3. Press the Folder key to go back to the previous item
4. Set the percentage reference moisture at the upper point of the material being measured with the navigation keys

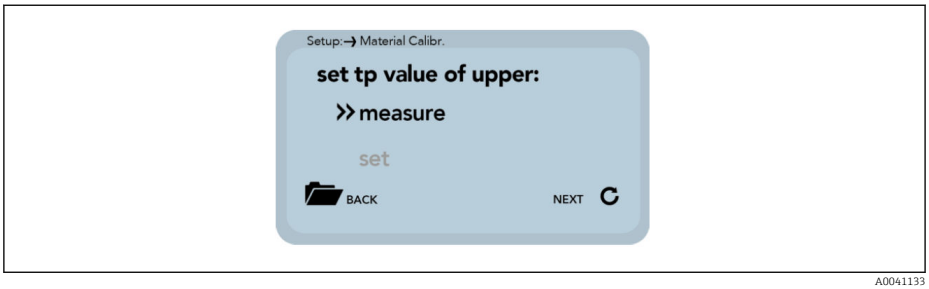


A0041132

5. Press the Enter key to accept the setting
6. Press the Folder key to go back to the previous item

In the next step, the tp value (transit time of the radar signal) is determined at the upper moisture value by taking a measurement (with the connected sensor) or by setting the value manually.

1. Use the navigation keys to switch between "Measure" and "Set"



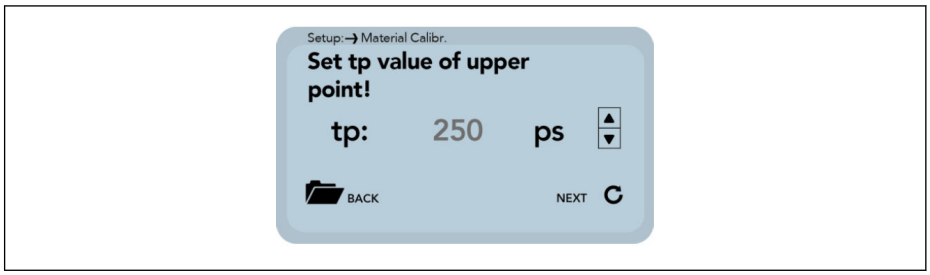
A0041133

2. Press the Enter key to accept the setting

3. Press the Folder key to go back to the previous item

Measure: see Point "8.4.5 1-point calibration (Measure)".

1. Use the navigation keys to manually set the tp value at the upper moisture point



A0041134

2. Press the Enter key to accept the setting
3. Press the Folder key to go back to the previous item

In the last step, the calibration settings you have made can now be saved to the calibration memory previously selected by selecting "Save", or the settings can be canceled by selecting "Discard".

Once "Save" has been selected, the word "OWN:" is displayed in front of the original material calibration. This indicates that this is a user-defined material calibration.

1. Use the navigation keys to switch between "Save" and "Discard"

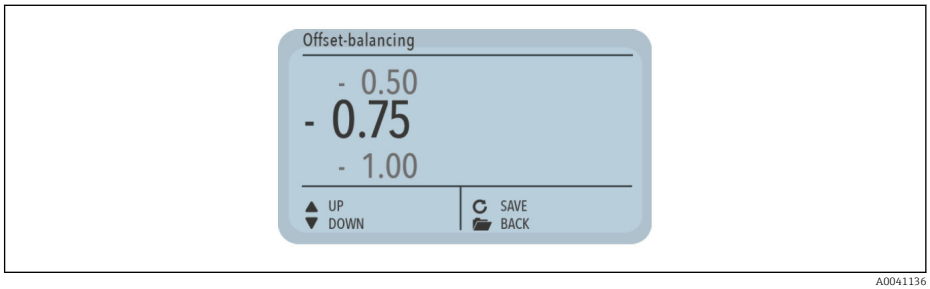
A0041135

2. Press the Enter key to accept the setting
3. Press the Folder key to go back to the previous item

6.5.3 Offset balancing

It is possible to linearly offset the measured value to compensate for measured errors caused by density variations in the material or by installation conditions, for example. This menu item is used for this purpose. You can offset the measured value between -10 and +10 percentage points. The configured offset is saved in the sensor and will subsequently also affect the analog output. The setting is saved and traceable.

1. Set the offset to the desired value using the navigation keys



A0041136

2. Press the Enter key to execute the selected subitem
3. Press the Folder key to exit the "Offset balancing" menu item

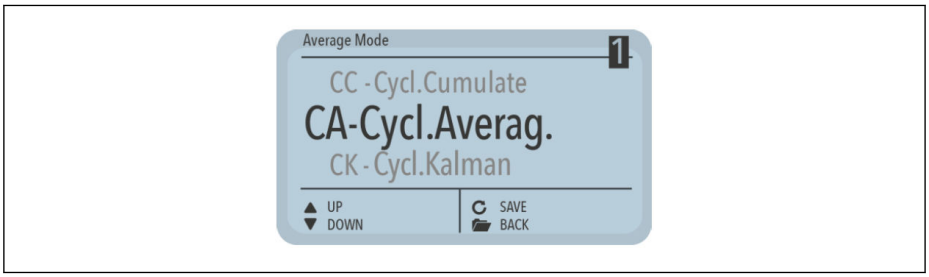
6.5.4 Average mode

With this menu item it is possible to activate or change value averaging in the sensor. The moisture sensors offer users the following options here:

- **Mode CS:**(Cyclic-Successive) For very short measurement cycles in the seconds range (5 to 20 s) without averaging, and with up to 100 measurements per second internally and a cycle time of 250 msat the analog output. The CS operating mode is also used to record raw values without averaging and filtering.
- **CA mode:** (Cyclic Average Filter) Standard averaging for relatively fast but continuous measurement processes, with filtering and an accuracy of up to 0.1%.
- **CF mode:** (Cyclic Floating Average with Filter) Floating average for very slow and continuous measurement processes, with filtering and an accuracy of up to 0.1%.
- **CK mode:** (Cyclic with Kalman Filter) For complex applications.
- **CC mode:** (Cyclic Cumulated) With automatic totalization of moisture quantity measurements in one batch process.
- **CH mode:** (Cyclic Hold) Similar to the CC mode but without totalization

See also additional information in the Operating Instructions for the sensors

1. Select the desired "Average Mode" with the navigation keys



2. Press the Enter key to save the configured mode as the standard mode
3. Press the Folder key to exit the "Offset balancing" menu item

6.5.5 Average parameters

Different average parameters are available to control the device, depending on the "Average mode" selected

CA – Cyclic Average
Available parameters:

- Average Time
- Filter Upper Limit Offset
- Filter Lower Limit Offset
- Upper Limit Keep Time
- Lower Limit Keep Time

CK – Cyclic Kalman
Available parameters:

- Kalman with Boost
- Average Time
- Filter Upper Limit Offset
- Filter Lower Limit Offset
- Upper Limit Keep Time
- Lower Limit Keep Time
- Q-Parameter
- R-Parameter
- K-Parameter
- Moisture Threshold
- Boost
- Offset

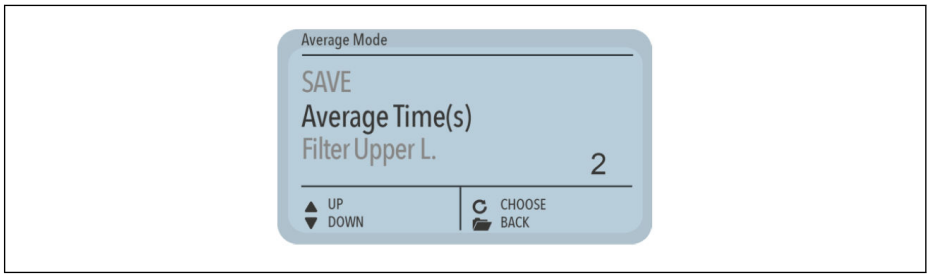
CF - Cyclic Floating
Available parameters:
- Average Time
- Filter Upper Limit Offset
- Filter Lower Limit Offset
- Upper Limit Keep Time
- Lower Limit Keep Time

CC - Cyclic Cumulate
Available parameters:
- Moisture Threshold
- No Material Delay

Changing a parameter can affect the reading, the accuracy and the measuring rate.

The parameters are enabled dynamically with the set "Average parameter".

1. Navigate through the individual parameters with the navigation keys



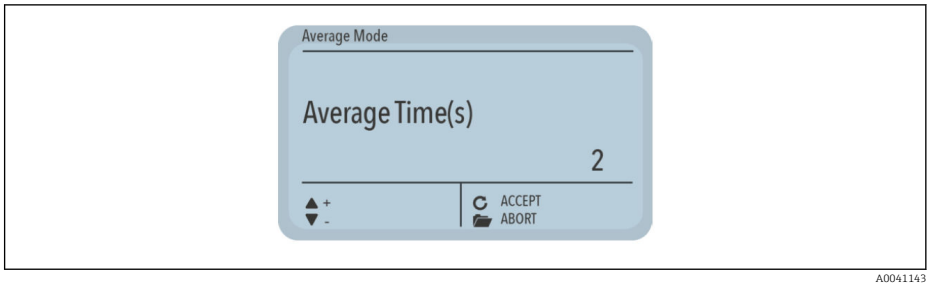
A0041142

The current value of the selected parameter is displayed on the bottom right

2. The value can be changed after the Enter key has been pressed

The value now appears enlarged on the display

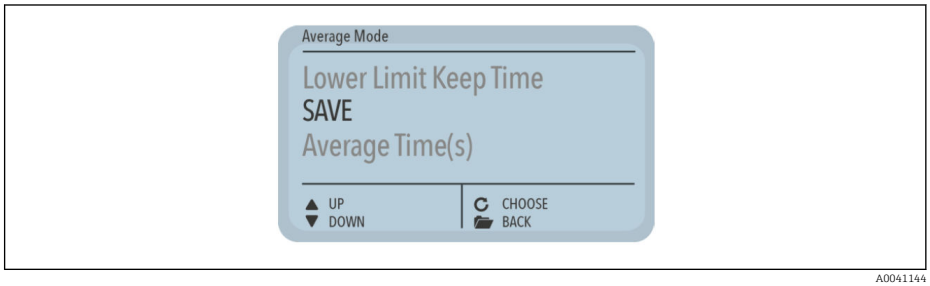
1. Change the value using the navigation keys



A0041143

2. Press the Enter key to accept the configured value
3. Press the Folder key to exit the entry mode without changing the value
4. Repeat this process for all the parameters to be modified

1. Change all the parameters as required



A0041144

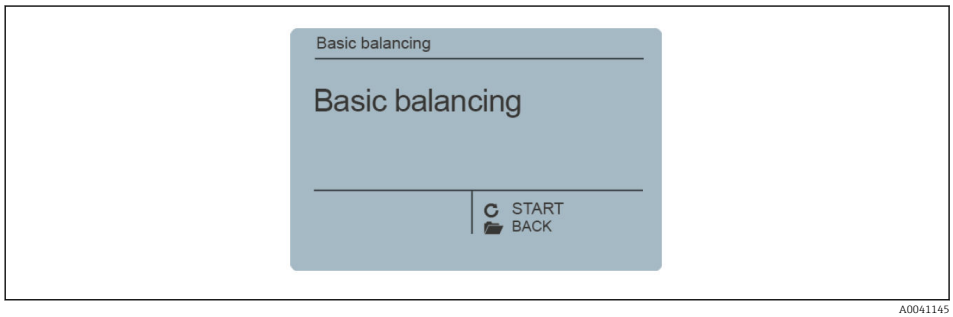
2. Select the "Save" item

3. Press the Enter key
   ↳ The parameters are written to the sensor and apply immediately
4. Press the Folder key to exit the "Average Parameters" menu item without saving the changes
   ↳ Caution: all changes made are then lost!

6.5.6 Basic balancing

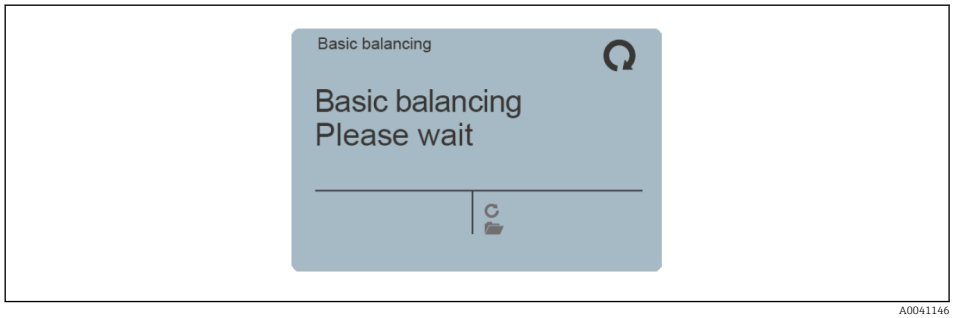
If a sensor head or a sensor with a fixed cable is replaced, it may be necessary to perform a basic adjustment (basic balancing) in air due to the different cable lengths (in versions with remote electronics). Here, the sensor's moisture measured value is re-adjusted to the correct "zero value". The 2-point adjustment (e.g. air/water for MMP40/MMP41 sensors or air/dry glass beads for MMP42/MMP44/MMP60 sensors) can only be performed by Endress+Hauser Service.

▶ Press the Folder key
↳



Basic balancing is started
The adjustment is then performed.

▶ The message "Please wait" appears on the screen
↳



The process takes approximately 30 s

To ensure an air calibration is performed correctly, the sensor must be dry and free from any material during the basic adjustment.

6.5.7 Analog parameter

1. Press the Enter key
   ↳ The **"Sensor calibration"** menu with its various submenus appears on the display **"Sensor calibration" submenu:** "Analog parameter", "Analog simulation", "Sensor info", "Material cal." , etc.
2. Using the navigation keys, select the **"Analog parameter" menu** and press the Enter key to confirm
   ↳ **"Analog parameter" submenu**: "Analog signal", "Analog version", "Moisture min", "Moisture max", "Temp. min", "Temp. max", "RbC min"," RbC max", "SAVE"
3. Using the navigation keys, select a parameter set and press the Enter key to confirm

4. Set the desired value using the navigation keys
5. Press the Enter key to confirm the selected value
6. Select the "SAVE" menu item using the navigation keys
7. Press the Enter key
   ↳ The changes are now stored permanently

7 Measured value pre-processing in Solitrend sensors

7.1 Data logging, physical preliminary check, averaging and filtering

Solitrend sensors measure internally at cycle rates in the 10 kHz range, but output the measured value at the analog output with a cycle time of 280 ms. During these 280 ms, the moisture value undergoes a preliminary check in the sensor, i.e. only plausible individual measured values that are already physically checked and averaged individual values are processed further. This considerably increases the reliability of measured value logging at a downstream controller.

In the **CS measurement mode** (Cyclic-Successive), values are not averaged further and the cycle time here is 200 ms. In the **CA, CF, CH, CC and CK measurement mode,** the individual values currently measured are not output directly. Instead an average of a configurable number of measurements is calculated, making it possible to filter out temporary variations. These variations can be caused by non-homogeneous moisture distribution in the material at the measuring cell. Solitrend sensors are delivered from the factory with suitable parameters for the averaging time and a powerful filter function for common applications. The averaging time and various filter functions can be adjusted for special applications.

7.1.1 Behavior of sensors in event of wear

The sensor design of the SOLITREND series with the TDR-based radar measurement method ensures longer operating times. Recalibration is not necessary if the dielectric coating changes on account of abrasion. The material to be measured is always in direct contact with the measuring cell even if the sensor head shows signs of minor or more pronounced wear. This also means continuous reliability and longer maintenance cycles.

7.1.2 Determining the mineral concentration

With the TDR 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 measurement method delivers a radar-based conductivity value (RbC – Radar-based-Conductivity) in mS/cm as the characteristic value. This value is determined depending on the mineral concentration and is output as an unscaled value. The conductivity measuring range of Solitrend sensors is 0 to 20 mS/cm.

7.1.3 Material temperature measurement

The Solitrend sensors contain 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. As the sensor electronics use approx. 1.5 mW of power, the sensor housing heats up slightly. Therefore the precise measurement of the material temperature is only possible to a certain extent. With the device installed and with good heat distribution conditions throughout the system, the material temperature can, however, be determined following an external calibration and compensation of the sensor's internal heating. The temperature offset value resulting from the internal heating can be adjusted by the Service technician.

8 Operating modes of the Solitrend sensors

8.1 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 A - OnRequest (only in network mode for calling up measured values via the serial interface for calibration purposes).
- 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 seconds) without averaging and without filter functions, and with up to 100 measurements per second internally and a cycle time of 250 milliseconds 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 subsequently be able to analyze the measured data and identify the best 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.

8.2 Measurement mode CA, CF, CH, CC and CK

Solitrend sensors are delivered from the factory with suitable parameters for the averaging time and with a universal filter function for common applications. The configuration options and special functions described in this chapter are only needed on rare occasions.

If the settings are modified or special functions are executed, this can result in the incorrect operation of the sensor.

The settings described below in this context can be modified with the Service program.

For applications with non-continuous material flow, it is possible to optimize the readings using the configurable filter values **Filter-Lower-Limit-Offset, Filter-Upper-Limit-Offset** . Averaging can be configured with the **Average-Time** parameter.

The standard settings described below for the filter function in the **CH measurement mode** have proven effective and reliable in many situations and should only be changed for special applications.

8.2.1 Average-Time

Parameter in measurement modes CA, CC, CF, CH and CK
- Standard setting: 2 s
- Range of adjustment: 1 to 20 s
- Unit: seconds

Function
- **CA/CF:** The time for averaging the values can be set with this parameter.
- **CC/CH/CK:** The time can be set for the calculation of the trend value/expected value for the weighting function **(Boost & Offset)**.

8.2.2 Filter-Upper-Limit Offset

Parameter in measurement modes CA, CC, CF, CH and CK
- Standard setting: 25 %
- Range of adjustment: 1 to 100 %
- Unit: % absolute

Function
CA/CC/CF/CH/CK: Filters out excessively high measured values caused by metal scrapers or blades around the sensor head, for example. The offset value in % is added to the dynamic current average value.

8.2.3 Filter-Lower-Limit Offset

Parameter in measurement modes CA, CC, CF, CH and CK
- Standard setting: 25 %
- Range of adjustment: 1 to 100 %
- Unit: % absolute

Function
CA/CC/CF/CH/CK: Filters out excessively low measured values caused by insufficient material or material flow at the sensor head. The offset value in % is subtracted from the dynamic current average value.

8.2.4 Upper-Limit-Keep-Time

Parameter in measurement modes CA, CC, CF, CH and CK
- Standard setting: 10 s
- Range of adjustment: 1 to 100 s
- Unit: seconds

Function
CA/CC/CF/CH/CK: The duration of the filter function for upper limit interference (e.g. caused by metal scrapers) can be time-limited with this parameter to avoid the risk of undefined states.

8.2.5 Lower-Limit-Keep-Time

Parameter in measurement modes CA, CC, CF, CH and CK
- Standard setting: 10 s
- Range of adjustment: 1 to 100 s
- Unit: seconds

Function
CA/CC/CF/CH/CK: The duration of the filter function for lower limit interference (e.g. caused by insufficient material flow during longer "gaps in material") can be time-limited with this parameter to avoid the risk of undefined states, or to define the hold time at the end of a batch.

8.2.6 Moisture Threshold (starting threshold) in % moisture

Parameter in measurement modes CA, CC, CF, CH and CK
- Standard setting: 0.1 %
- Range of adjustment: 0 to 100 %
- Unit: % absolute

Function
- **CA/CF/CK:** Inactive
- **CC/CH:** The sensor starts the measurement process if the set threshold is exceeded. If the sensor value drops below this threshold again, the **measured value is held** and the **No-Material-Delay** time starts. This is used to eliminate interruptions in the material flow as a disturbance variable.

8.2.7 No-Material-Delay (expiration time)

Parameter in measurement modes CA, CC, CF, CH and CK
- Standard setting: 10 s
- Range of adjustment: 1 to 100 s
- Unit: seconds

Function
- **CA/CF/CK:** Inactive
- **CC/CH:** Using the measured value defined as the Moisture Threshold, the sensor detects when no more material (i.e. air) is present at the sensor. The last average value measured is then "held" and output at the analog output for the duration of the No-Material-Delay. If no valid moisture value is recorded at the end of the No-Material-Delay, the algorithm starts to re-converge. This ensures that the measured value memory is cleared for a new batch and the measured value is therefore not based on a mix of consecutive batches. It also ensures that measuring is not restarted with every brief delay in a batch!

8.2.8 Boost

Parameter in measurement modes CA, CC, CF, CH and CK
- Standard setting: 35nn
- Range of adjustment: 0 to 100nn
- Unit: none

Function
- **CA/CF:** Inactive
- **CC/CH/CK:** Defines how single values are weighted depending on the deviation from the current expected value. For example, if the current single value deviates by 1% from the expected value and Boost=35, this value is only factored into the new average with a weighting of 65% (100% - (1% *35) = 65%).

8.2.9 Offset

Parameter in measurement modes CA, CC, CF, CH and CK
- Standard setting: 0.5 %
- Range of adjustment: 0 to 5 %
- Unit: % absolute

Function
- **CA/CF:** Inactive
- **CC/CH/CK:** Process non-linearities (e.g. density variations) can be compensated for by adjusting the expected value (i.e. the value calculated over the Average-Time). By increasing this value, more weighting can be given to high values. For example, when measuring sand moisture under the silo, lower values are less likely because they are caused by density differences, arising from uneven material flow.

8.2.10 Weight

Parameter in measurement modes CA, CC, CF, CH and CK
- Standard setting: 5 values
- Range of adjustment: 0 to 50
- Unit: measured values with sensor sampling cycles of approx. 3 measured values per second; each individual value is already averaged.

Function
- **CA/CC/CF:** Inactive
- **CH:** Average value calculation for analog measured value output. This parameter influences the response time of the sensor; in the CH mode the response time can be taken to be in real time (e.g. 15 values would be 15/3=5 seconds).
- **CK:** Here it can roughly be assumed that the number of values = response time in seconds, as the average value is calculated statistically. However, please note that the more homogeneous the material being measured the faster the algorithm response time!

8.2.11 Invalid Measure Count

Parameter in measurement modes CA, CC, CF, CH and CK
- Standard setting: 2 values
- Range of adjustment: 0 to 10
- Unit: measured values (with approx. 3 individual values per second)

Function
- **CA/CF/CK:** Inactive
- **CC/CH:** Number of the first measured values rejected following a batch restart if "No-Material-Delay" has been triggered. The first invalid measured values, e.g. due to slow material flow at the start or free water, are rejected completely.

8.2.12 Moisture Std. Deviation Count

Parameter in measurement modes CA, CC, CF, CH and CK
- Standard setting: 5 values
- Range of adjustment: 0 to 20
- Unit: measured values (with approx. 3 individual values per second)

Function
CA/CC/CF/CH/CK: If the temperature and RbC or EC-TRIME parameters are not needed, the sensor can be switched to the Moist/Moist Std. Deviation analog mode. The calculated standard deviation of all the moisture individual values is then output on the 2nd analog channel. Caution: The setting for this parameter cannot be longer than the Average-Time! This parameter can then be used to check the homogeneity of the individual values in order to validate the moisture values or to monitor a control process.

8.2.13 Quick and Quick-Precision

Parameter in measurement modes CA, CC, CF, CH and CK
- With Meas Time (no. values)
- Unit: none

Function
CA/CC/CF/CH/CK/CS: The standard recommended setting here is Quick Precision and Meas Time = 2 with a more precise detection of the TDR pulse. To achieve somewhat better accuracies, the Meas Time can be increased. However a single measurement with internal averaging then no longer takes approx. 280 ms, but instead increases by 60 ms per step.

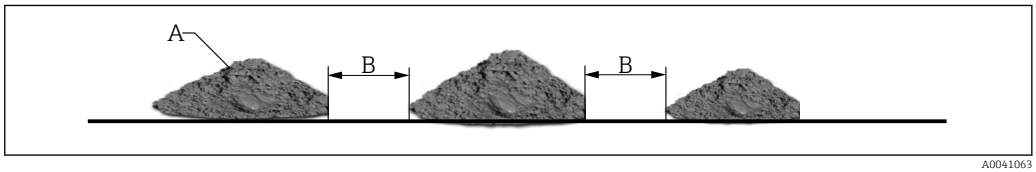
8.3 Averaging in the CA and CF measurement mode

Every 200 ms, the Solitrend sensor calculates a new measured value from several single measured values that are used to calculate an average value, and displays the average value at the analog output at this cycle rate. The averaging time is therefore like the "memory" of the sensor. The longer the averaging time selected, the slower the response if material of a different moisture content flows by the sensor. A longer averaging time delivers a more stable measured value. This must be taken into consideration particularly if the sensor is operated in different installations, in order to balance out variations in the measured value caused by material with varying moisture content.

The **Average-Time** is set to 5 s in the default factory setting. This value has proven to be effective in many installations. A lower value can be set for applications that require a faster response time. A higher value should be selected if the display is too "unstable". Please note that the **Average-Time** and the **R-Parameter** have a similar effect on the measurement behavior.

8.4 Filtering in the event of material gaps in the CA and CF measurement mode

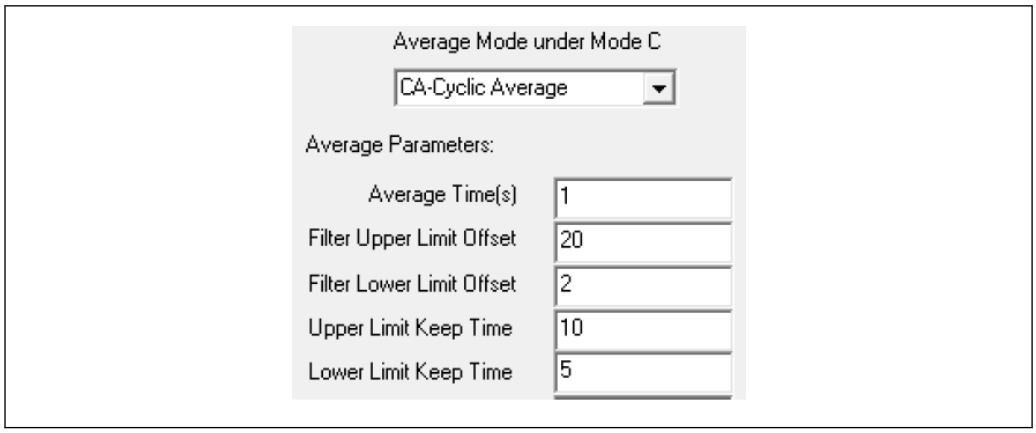
Solitrend sensors can use an algorithm to filter out incorrect individual measured values. The system recognizes when there is little or no material around the sensor head. Particular attention must be given to times when the sensor's measurement volume is only partly filled with product for longer periods, i.e. if the material (e.g. sand) no longer fully covers the sensor head. During such times, the sensor reading would be too low. On the other hand, if metal blades or scrapers strike the sensor head, the measured value that the sensor calculates can be too high and must be filtered out. To bridge these gaps in material flow, we recommend using the CA operating mode with the Upper- and Lower-Limit setting, wherein the Lower-Limit can be set to 2% with a Lower-Limit-Keep-Time of 5 s for example. If, during a gap in material flow, the sensor now detects a moisture value that is 2% below the average value of, for example, 8% (< 6%), then the average value is "frozen" for 5 s, making it possible to bridge the gap in material. This powerful function in the sensor works like a high-pass filter here: the higher moisture values are used to calculate the average value, while lower or incorrect measured values are filtered out. This function is illustrated with parameters below.



A0041063

A Sufficient material for correct measurement
B 3-second gap in material which should be bridged for correct measurement. Possible with a Lower Limit Keep Time of 5s

The following parameter setting in the CA or CF operating mode is suitable for this filter function to be able to bridge gaps in material flow.



A0041065

Here, the Filter Upper Limit is deactivated with a value of 20, while the Filter Lower Limit is set at 2%. If a Lower Limit Keep Time of 5 seconds is set, the average is frozen for 5 s if the value is 2% below the average. After these 5 s, the average value is deleted and a new averaging cycle starts. The filter function is reset if measured values are within the limit.

8.5 CC operating mode

Automatic totalization of moisture quantity measurements in an extended batch process.

Simpler controllers are often unable to automatically record the moisture values of an entire extended batch process, calculate an average and save the value. In addition, there are also applications without a controller where the totalized moisture of an entire extended batch process is to be presented to the operating staff on a display unit over an extended period.

In the CC mode, Solitrend sensors automatically only totalize the times where material really is present at the sensor. This increases the reliability of moisture calculation in a batch process. Due to precise moisture measurement even in the lower moisture range, the sensors can record and totalize the moisture values of an entire batch process without a trigger signal and keep outputting the values as an analog signal until a new batch process starts. The controller then has enough time to retrieve the totalized and "frozen" moisture value of the entire batch. This way, a display unit can keep showing the totalized moisture value on the display until a new batch process begins. The start threshold that specifies where totalization is to begin can be configured with the **Moisture Threshold** parameter. As the sensors do not need to be recalibrated, it is possible to maintain the zero point precisely. The start threshold should be determined depending on the system. A setting of 0.5% to 1%, for example, is recommended. With the **No-Material-Delay** parameter, it is possible to specify a time range as of which the sensor is ready to start a new batch process.

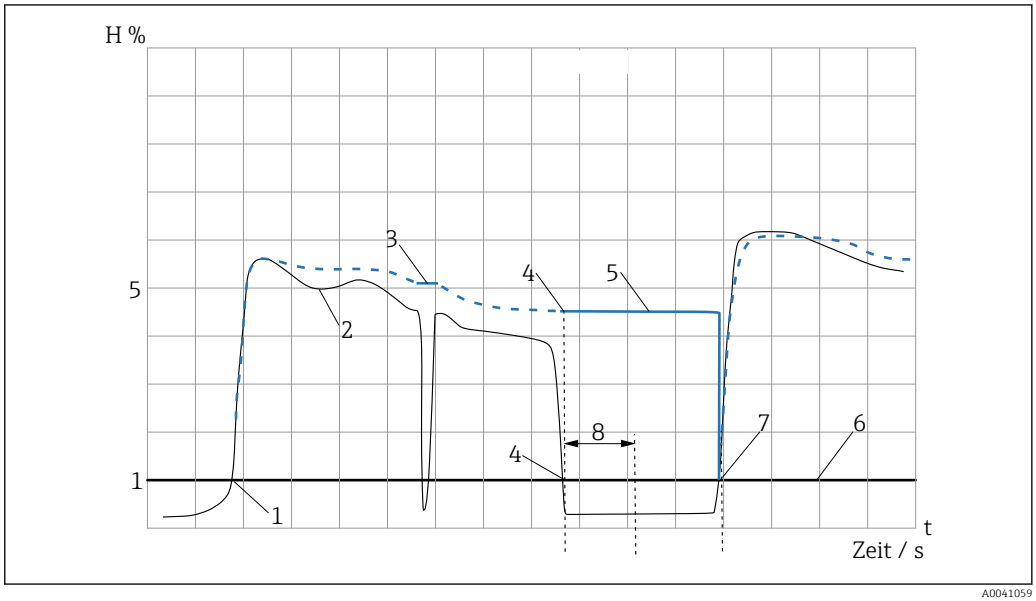
If brief material gaps occur during a batch process that are shorter than the "No-Material-Delay" - i.e. the moisture value drops below the start threshold and there is no material at the sensor - then the sensor only briefly pauses the totalization. If the pause is longer than the "No-Material-Delay" then the sensor is ready to start a new batch process.

How can the CC mode be used if material cannot be drained above the sensor, i.e. if material is always present at the sensor or for a longer time before material is transported:

In this case, the sensor cannot independently detect the start of material transportation. Here, the sensor can be reset by briefly interrupting the operating voltage of the sensor (e.g. 0.5 seconds using a relay contact of the PLC). As soon as the operating voltage is reapplied, the sensor starts totalizing and averaging immediately.

Please note:

It is important to ensure that no material sticks to the sensor, as this would push up the moisture zero point between the batches and the sensor would no longer be able to detect when the moisture threshold is undershot. If the PLC is already totalizing automatically, the CC operating mode would result in errors. In such scenarios, the CH mode should be set in the sensor.



1 *Time chart for the CC mode*

Legend:

1: Start of the 1st batch process. The sensor detects that the configurable starting threshold of 1%, for example, has been exceeded and automatically starts totalizing the measured values (blue curve)

2: Moisture curve in sand

3: Brief interruptions are bridged

4: Analog output: end of the 1st batch process. The sensor detects that the threshold of 1% has been undershot and automatically stops totalizing the measured values (blue curve)

5: The last totalized average remains at the analog output until a new batch process begins after the configurable "No-Material-Delay" time of 5 seconds, for example, has elapsed.

6: Configurable starting threshold (Moisture Threshold)

7: Start of the 2nd batch process. Once the "No-Material-Delay" time has elapsed (e.g. 5 seconds), the sensor detects that the threshold of 1% has been exceeded again. The measured value saved beforehand is deleted and the sensor starts automatically totalizing the measured values again (blue curve)

8: Configurable "No-Material-Delay" of 5 seconds, for example

8.6 CH operating mode

Automatic moisture measurement in one batch.

The **CH mode** is the **standard operating mode for sensors installed under a silo discharge hatch** and is ideal for relatively short batch times down to 5 s if the sensor has been installed under the silo discharge hatch. In the CH mode, the sensor performs filtering automatically. This allows drip water that forms in the silo to be filtered out of the measured value, for example. In the CH mode, the **Invalid Measure Count** function can be used to filter out initial "invalid measured values" once the silo discharge hatch is opened. The procedure followed in the CH operating mode is identical to the procedure in the CC

mode. With **Moisture Threshold**, measuring is started automatically but totalization does not take place

Overview of possible parameter settings in different operating modes and applications

8.6.1 Under the silo discharge hatch, sand/gravel

- **Operating mode:** CH
- **Average-Time:** 2
- **Filter-Upper-Limit Offset:** inactive / 100
- **Filter-Lower-Limit Offset:** inactive / 100
- **Upper-Limit- Keep-Time:** inactive / 10
- **Lower-Limit-Keep-Time:** inactive / 10
- **Moisture Threshold:** 0.1
- **No-Material- Delay:** 10
- **Boost:** 35
- **Offset:** 0.5
- **Weight:** 5
- **Invalid Measure Count:** 2

8.6.2 On the conveyor belt

- **Operating mode:** CH
- **Average-Time:** 2
- **Filter-Upper-Limit Offset:** inactive / 100
- **Filter-Lower-Limit Offset:** inactive / 100
- **Upper-Limit- Keep-Time:** inactive / 10
- **Lower-Limit-Keep-Time:** inactive / 10
- **Moisture Threshold:** 0.1
- **No-Material- Delay:** 10
- **Boost:** 35
- **Offset:** 0.5
- **Weight:** 5
- **Invalid Measure Count:** 2

8.6.3 In concrete mixer

- **Operating mode:** CH
- **Average-Time:** 5
- **Filter-Upper-Limit Offset:** inactive / 100
- **Filter-Lower-Limit Offset:** inactive / 100
- **Upper-Limit- Keep-Time:** inactive / 10
- **Lower-Limit-Keep-Time:** inactive / 10
- **Moisture Threshold:** 0.1
- **No-Material- Delay:** 10
- **Boost:** 20
- **Offset:** 1
- **Weight:** 25
- **Invalid Measure Count:** inactive

8.6.4 General basic applications

- **Operating mode:** CA
- **Average-Time:** 10
- **Filter-Upper-Limit Offset:** e.g. 20
- **Filter-Lower-Limit Offset:** e.g. 10
- **Upper-Limit- Keep-Time:** e.g. 10
- **Lower-Limit-Keep-Time:** e.g. 10

- **Moisture Threshold:** -
- **No-Material- Delay:** -
- **Boost:** -
- **Offset:** -
- **Weight:** -
- **Invalid Measure Count:** -

8.6.5 In a screw conveyor with disturbance from spiral

- **Operating mode:** CK
- **Average-Time:** 10
- **Filter-Upper-Limit Offset:** inactive / 100
- **Filter-Lower-Limit Offset:** inactive / 100
- **Upper-Limit- Keep-Time:** inactive / 10
- **Lower-Limit-Keep-Time:** inactive / 10
- **Moisture Threshold:** 0.1
- **No-Material- Delay:** inactive
- **Boost:** 20
- **Offset:** 1
- **Weight:** 50
- **Invalid Measure Count:** inactive

8.6.6 In a screw conveyor without disturbance from spiral

- **Operating mode:** CF
- **Average-Time:** 10
- **Filter-Upper-Limit Offset:** e.g. 20
- **Filter-Lower-Limit Offset:** e.g. 5
- **Upper-Limit- Keep-Time:** e.g. 10
- **Lower-Limit-Keep-Time:** e.g. 10
- **Moisture Threshold:** -
- **No-Material- Delay:** -
- **Boost:** -
- **Offset:** -
- **Weight:** -
- **Invalid Measure Count:** -

For very difficult applications where it is not clear which operating mode is best suited for the application, we recommend selecting the CA mode and setting an averaging time = 1 second.

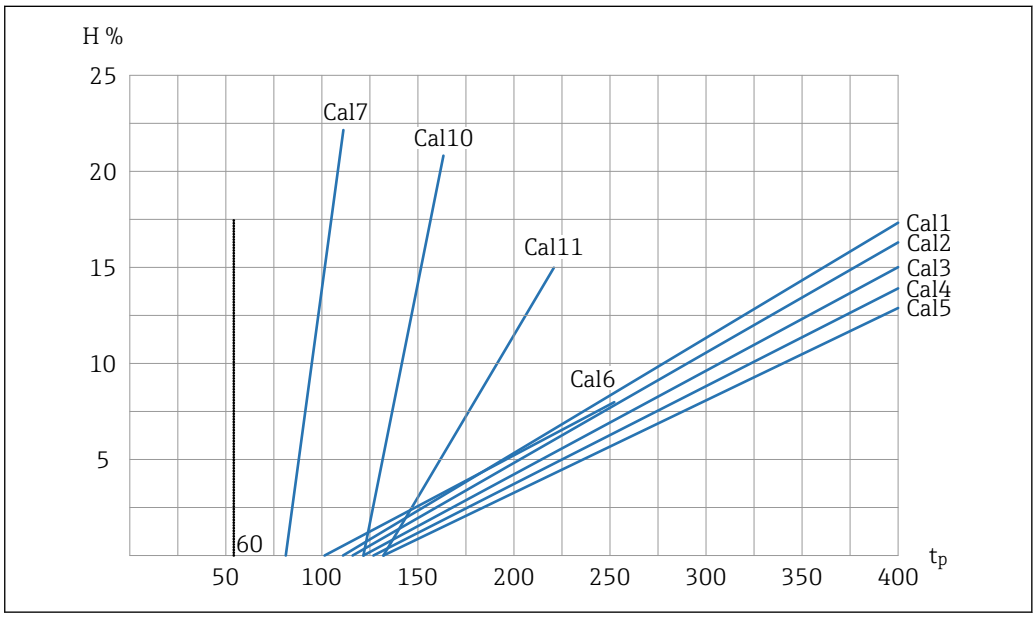
9 Creating a linear calibration curve for a special material

Calibration curves Cal1 to Cal15 can be easily created or customized for special materials using the remote display. Two reference measuring points must be determined for this purpose, namely **point P1 for dry material** and **point P2 for moist material**. There should be a sufficient distance between points P1 and P2 to obtain the best possible calibration curve. The moisture values of the material at points P1 and P2 can be determined using a laboratory measurement procedure (moisture analyzer, drying oven etc.). However, it is important to ensure that sufficient material is measured so that a representative value is obtained.

In the **"Material cal."** menu item, the calibration curves saved in the sensor - Cal1 to Cal15 - are loaded from the sensor (see the "Material calibration" section).

10 Calibration curves Cal1 to Cal15

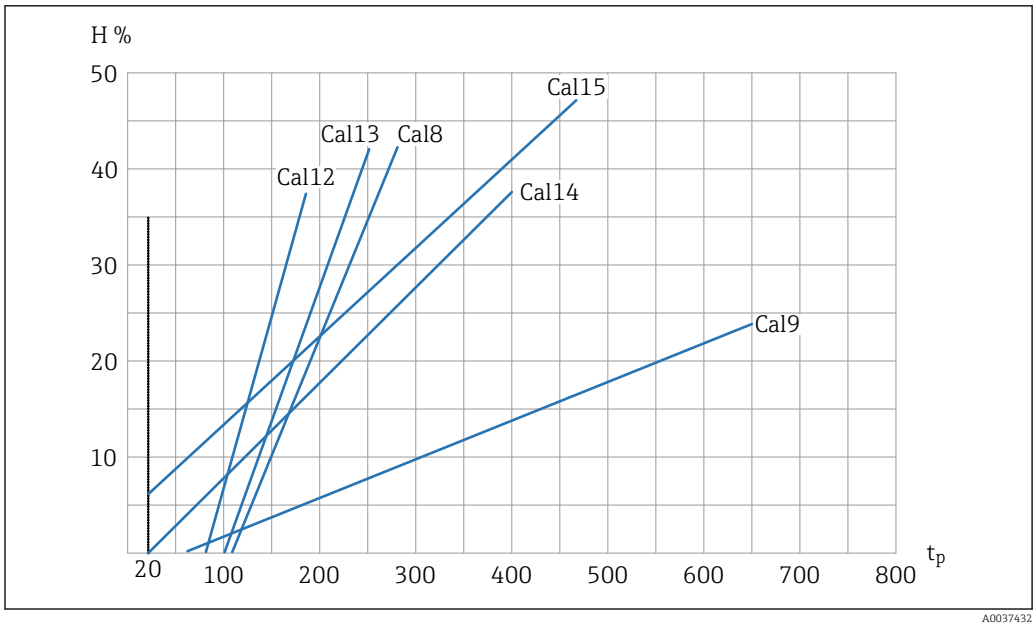
The sensors are supplied with a suitable calibration. A maximum of 15 different calibrations (Cal1 to Cal15) can be saved in the sensor and can be activated via the remote display. To pre-test the compatibility of a calibration curve, the user can select individual calibration curves (Cal1 to Cal15) in the "Material cal." menu item, test the curves with the material to be measured and activate them. The desired calibration curve (which may have been modified) is active when the sensor operating voltage is switched on. Non-linear calibrations are possible with polynomials up to degree 5 (coefficients m0-m5).



2 *Linear calibration curves (Cal1, Cal2, Cal3, Cal4, Cal5, Cal6, Cal7, Cal10, Cal11)*

H Gravimetric moisture; %
tp Radar transit time; picoseconds

Assignment of the calibration curve to the material to be measured
- **Cal1**: Universal; sand/gravel/grit
- **Cal2**: Sand 1.6
- **Cal3**: Sand 1.7
- **Cal4**: Sand 1.8
- **Cal5**: Sand 1.9
- **Cal6**: Gravel/grit
- **Cal7**: Wood chips
- **Cal10**: Grains of wheat
- **Cal11**: Light sand



3 Linear calibration curves (Cal8, Cal9, Cal12, Cal13, Cal14, Cal15)

H Gravimetric moisture; %
tp Radar transit time; picoseconds

Assignment of the calibration curve to the material to be measured
- **Cal8**: Lignite
- **Cal9**: Basic calibration
- **Cal12**: Sewage sludge
- **Cal13**: Cereals (linear)
- **Cal14**: Air/water 0 to 100 %
- **Cal15**: Raw data calibration (1/10 of Ø radar transit time)

The graphics show the linear calibration curves (Cal1 to Cal15) for various materials. These curves are saved in the sensor and can be selected by the user. The gravimetric moisture (H) is indicated on the y-axis, and the associated radar transit time (tp) in picoseconds is displayed on the x-axis. This depends on the specific calibration curve. The radar transit time is displayed simultaneously with the moisture value during moisture measurement. In air, the sensors measure approx. 60 picoseconds radar transit time, and 1000 picoseconds in water.

11 Technical data

11.1

Power supply	12 to 24 V DC / 0.7 W stabilized
Operating temperature	0 to 50 °C
Dimensions	145 mm x 75 mm x 34 mm
Weight	153 g
Installation	DIN rail (optional)
Interfaces	IMP-Bus (rt/com)
Protection class	IP20

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